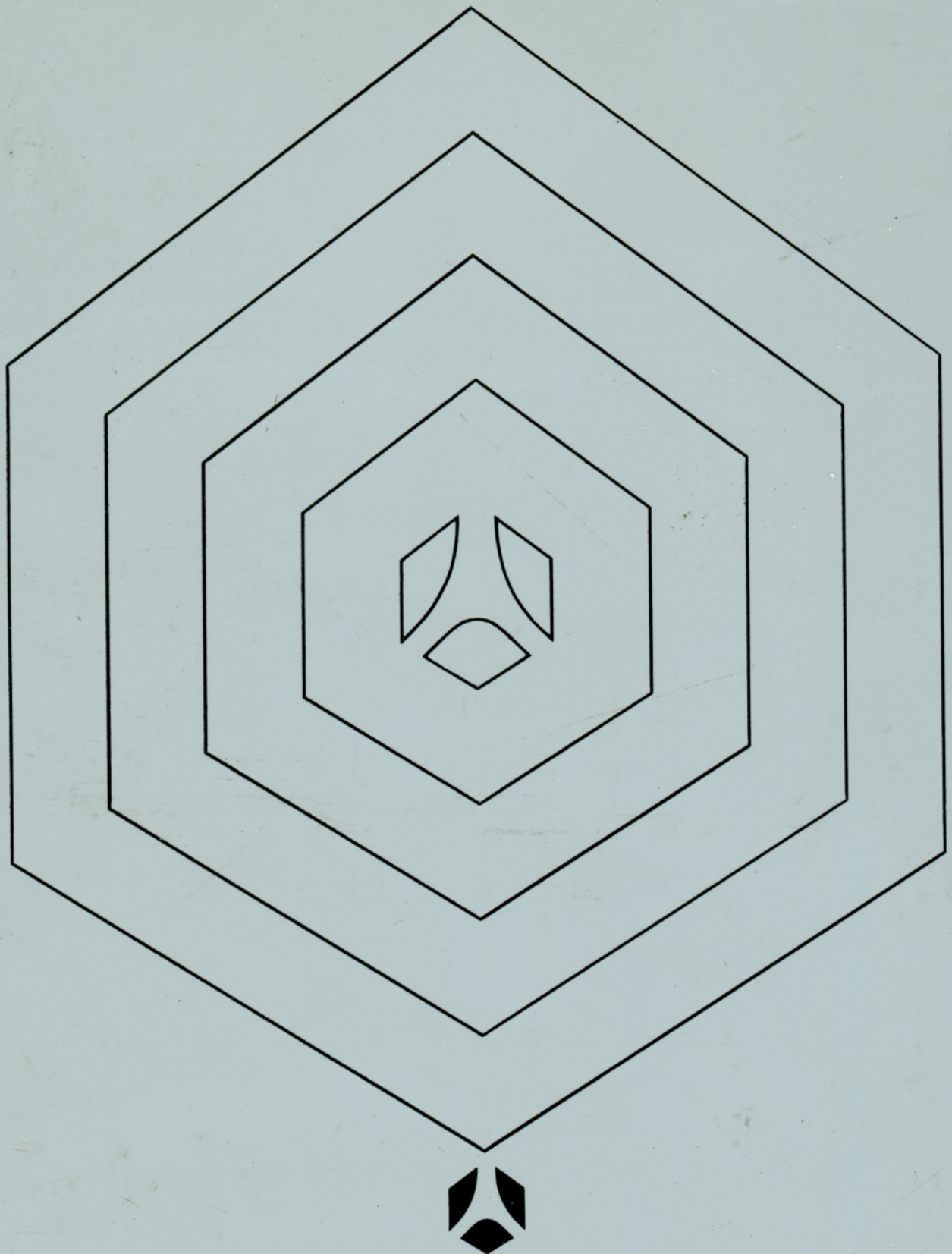


THOMSON-CSF

GROUPEMENT TUBES ELECTRONIQUES

TUBES ET DISPOSITIFS A IMAGE

INDEXED
FEBRUARY
1976

THOMSON-CSF

TUBES ET DISPOSITIFS
A IMAGE
TOME 1

Exemplaire N° 0237

SON-CSF
TUBES ELECTRONIQUES

31 Décembre 1972

DATE 15 MAR 1973
NO.
FILE
CI
CS
REPLIED

Vous trouverez ci-joint la mise à jour de votre catalogue :

TUBES ET DISPOSITIFS A IMAGE

N'omettez pas de vérifier, d'après le répertoire joint, si votre catalogue est bien complet ; s'il vous manque une ou plusieurs notices, n'hésitez pas à nous le signaler, elles vous seront envoyées dans les délais les plus brefs.

Si l'adresse à laquelle cette mise à jour vous est adressée est inexacte ou incomplète, veuillez remplir le formulaire ci-dessous et le renvoyer à :

THOMSON-CSF - Groupement Tubes Electroniques
Service Relations Publiques - Publicité
8, rue Chasseloup-Laubat - 75737 Paris CEDEX 15

CHANGEMENT D'ADRESSE

NOUVELLE ADRESSE :

NOM .....
TITRE OU FONCTION .....
RAISON SOCIALE DE LA SOCIETE .....
SERVICE OU DEPARTEMENT .....
ADRESSE .....

ANCIENNE ADRESSE .....
.....
.....
.....

N° DU CATALOGUE .....

THOMSON-CSF

GROUPEMENT TUBES ELECTRONIQUES

Decer

You will find here enclosed the updating of your Data Book :

IMAGE AND DISPLAY TUBES

Do not forget to check carefully, with the enclosed repertory, if your data book is complete : if not, do not hesitate to ask for the missing data sheets, we shall send them promptly. If this shipment is not correctly addressed, please fill the attached form and return it to :

THOMSON-CSF - Groupement Tubes Electroniques
Service Relations Publiques - Publicité
8, rue Chasseloup-Laubat - 75737 Paris CEDEX 15 - FRANCE

CHANGE OF ADDRESS FORM

NEW ADDRESS :

NAME .....

TITLE OR FUNCTION .....

SOCIETY .....

DEPARTMENT .....

ADDRESS .....

FORMER ADDRESS .....

.....

.....

.....

CATALOG N° .....

TUBES ET DISPOSITIFS A IMAGE
Image and Display Tubes

PRODUITS *PRODUCTS*	Notice N° *Data sheet number*	Date d'édition *Date of issue*	Notice N° *Data sheet number*	Date d'édition *Date of issue*	Note *Note*
1. 1 TUBES DE PRISE DE VUE VIDICONS					
TH 9801			* TEV 3090	7. 71	
TH 9806 PA			* TEV 3094	7. 71	
TH 9807 PA			* TEV 3097	9. 71	
TH 9808 PA			* TEV 3107	2. 72	
TH 9810			* TEV 3091	7. 71	
TH 9812 PA			* TEV 3100	10. 71	
TH 9813			* TEV 3113	2. 72	
TH 9814 PA	TEV 3121	8. 72	(* TEV 3066)	1. 71	
TH 9815 PA			* TEV 3098	9. 71	
TH 9817 PA			* TEV 3101	10. 71	
TH 9820	TEV 3163	1. 74	(* TEV 3171)	2. 74	
TH 9824			* TEV 3123	9. 72	
TH 9828	TEV 3232	9. 76	(* TEV 3229)	9. 76	←
TH 9830			* TEV 3060	2. 71	
TH 9834	TEV 3161	1. 74	(* TEV 3170)	2. 74	
TH 9835			* TEV 3235	11. 76	←
TH 9840	TEV 3213	10. 75	(* TEV 3233)	9. 76	
TH 9844			* TEV 3236	11. 76	←
TH 9890			* TEV 3076	2. 71	
TH 9892	TEV 3058	10. 70	(* TEV 3112)	2. 72	
TH 9893	TEV 3086	5. 71			
TH 9894			* TEV 3065	12. 70	
TH 9895	TEV 3087	5. 71			
TH 9896			* TEV 3067	1. 71	
1. 2 TUBES DE PRISE DE VUE A BAS NIVEAU DE LUMIERE					
TH 9610	TEV 3030	5. 70			
TH 9650			* TEV 3133	11. 72	
TH 9651			* TEV 3135A	11. 72	
TH 9652	TEV 3134	11. 72			
TH 9654	TEV 3122	8. 72			
TH 9655	TEV 3150	6. 73	(* TEV 3155)	10. 73	
TH 9659	TEV 3230	9. 76	(* TEV 3231)	9. 70	←

* Notices en anglais - *Data sheets in english*
→ Mise à jour n° 12 - *Supplement No 12*

PRODUITS *PRODUCTS*	Notice N° *Data sheet number*	Date d'édition *Date of issue*	Notice N° *Data sheet number*	Date d'édition *Date of issue*	Note *Note*
1.3 TUBES INTENSIFICATEURS ET CONVERTISSEURS D'IMAGE					
6914 (D16)			* TEV 3096	September 1971	
TH 9301	TEV 3144	Février 1973			
TH 9302	TEV 3136	Décembre 1972			
TH 9303			* TEV 3234	November 1976	←
TH 9304 V1	TEV 3196	Mai 1975			
TH 9463			* TEV 3072	February 1971	
TH 9473	TEV 3092	Juillet 1971			
TH 9475			* TEV 3062	December 1970	
TH 9476	TEV 3126	Septembre 1972			
TH 9477	TEV 3028	Mai 1970			
TH 9478	TEV 3093	Juillet 1971	(* TEV 3116)	June 1972	
TH 9479	TEV 3162	Janvier 1974			
1.4 TUBES INTENSIFICATEURS D'IMAGE DE RAYONS X					
TH 9412 B	TEV 3200	Juin 1975	(* TEV 3222)	December 1975	
TH 9415			* TEV 3057	November 1970	
TH 9417	TEV 3146	Mars 1973			
TH 9421 S	TEV 3147	Mars 1973			
TH 9423 B	TEV 3198	Mai 1975			
TH 9426			* TEV 3032	May 1970	
TH 9427			* TEV 3033	June 1970	
TH 9428	TEV 3153	Août 1973			
TH 9428 A	TEV 3190	Janvier 1975			
TH 9429 A	TEV 3188	Janvier 1975			
TH 9432			* TEV 3178	May 1974	
TH 9448	TEV 3197	Septembre 1974	(* TEV 3214)	October 1975	

PRODUITS *PRODUCTS*	Notice N° *Data sheet number*	Date d'édition *Date of issue*	Notice N° *Data sheet number*	Date d'édition *Date of issue*	Note *Note*
1.5 TUBES A MEMOIRE					
TMA 406			* TEV 3018	February 1970	
TMA 408			* TEV 3019	February 1970	
TMA 410			* TEV 3084	May 1971	
TMA 426			* TEV 3111	February 1972	
TEI 1114			* TEV 3056	October 1970	
TEI 1187			* TEV 3053	October 1970	
TME 1238			* TEV 3016A	September 1970	
TME 1238 A			* TEV 3202	August 1975	
TME 1239			* TEV 3017A	September 1970	
TME 1239 A			* TEV 3203	August 1975	
TEI 1323			* TEV 3069	January 1971	
TEI 1347			* TEV 3024	April 1970	
TME 1348			* TEV 3104	December 1971	
TME 1496			* TEV 3156	November 1973	
TH 1507 S			* TEV 3208	September 1975	
F 8029			* TEV 3022	March 1970	
F 8036			* TEV 3021	March 1970	
F 8055			* TEV 3023	March 1970	
F 8086			* TEV 3071	February 1971	
TH 8802	TEV 3114	Avril 1972			
TH 8803			* TEV 3183	July 1974	
TH 8804 (TMA 506)			* TEV 3179	May 1974	
TH 8806			* TEV 3206	September 1975	
TH 8902			* TEV 3209	October 1975	
1.6 DIVERS					
TH 9510	TEV 3177	Juin 1974			

Vous trouverez
dans ce catalogue ...

1-1 TUBES de PRISE de VUE
VIDICONS

1-2 TUBES de PRISE de VUE
à BAS NIVEAU de LUMIERE

1-3 TUBES INTENSIFICATEURS et
CONVERTISSEURS d'IMAGE

1-4 TUBES INTENSIFICATEURS d'IMAGE
de RAYONS X

1-5 TUBES à MEMOIRE
- tubes à mémoire analyseurs (TMA)
- tubes à mémoire enregistreurs (TME)
- tubes à entretien d'image (TEI)

1-6 DIVERS

1-1 TUBES de PRISE de VUE
VIDICONS

1-2 TUBES de PRISE de VUE
à BAS NIVEAU de LUMIERE

1-3 TUBES INTENSIFICATEURS et
CONVERTISSEURS d'IMAGE

1-4 TUBES INTENSIFICATEURS d'IMAGE
de RAYONS X

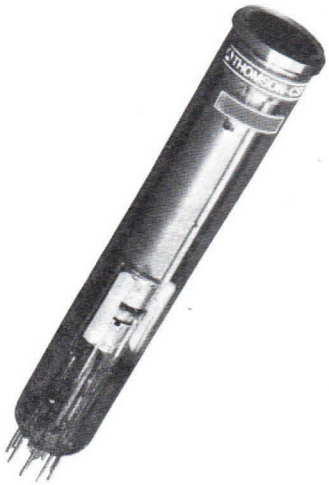
1-5 TUBES à MEMOIRE
- tubes à mémoire analyseurs (TMA)
- tubes à mémoire enregistreurs (TME)
- tubes à entretien d'image (TEI)

1-6 DIVERS

TH 9801
1" VIDICON

- MAGNETIC FOCUS AND DEFLECTION
- HIGH RESOLUTION (850 T.V. LINES)
- LOW LAG
- ECONOMY C. C. T. V.

TH 9801 is a 1" Vidicon used for inexpensive TV cameras. This tube incorporates in its structure the latest isolated post-acceleration electrode with separate external connection.



TH 9801 is intended for normal light level conditions: the quality of image is satisfactory for 100 lux (10 fc) scene illumination.

Satisfactory quality picture with good resolution and acceptable signal to noise ratio can be obtained at illuminations of 1 lux (100 mfc) to 2 lux (200 mfc) on the faceplate (10 to 20 lux on the subject with an unity numerical aperture lens) giving rise to a signal current of 100 nA at 50 nA dark current. For such illuminations, higher signal currents are obtained by increasing the dark current up to 100 nA, value beyond which a signal saturation will occur.

Due to a new low lag photoconductive layer an excellent picture quality can be obtained within a large range of illuminations with good signal uniformity and appropriate "gamma" characteristics.

The tube sensitivity can be controlled by the target voltage which also causes some variation of the dark current.

TH 9801 can be operated over a wide range of electrode voltage selection although the recommended adjustment requires a g4 voltage to g3 voltage ratio of 1.4 - 1.5. Under these conditions TH 9801 can provide an optimum resolution and a uniform signal output over the entire scanned area with a low geometrical distortion.

The limiting resolution of the TH 9801 is about 950 T.V. lines at center of picture and 550 T.V. lines at corner. This high resolution is obtained with 900V on electrode g4 and 600V on g3. When the TH 9801 is operated at a lower g4 voltage of 500V and g3 voltage of 300V, its limiting resolution will be 850 T.V. lines at center and 450 T.V. lines at corner. Operating g4 voltage at 1.5 times g3 voltage requires 20% deflection current increase over the current necessary for "g3 - g4 connected" mode. Focusing field is not noticeably changed with such an operation.

Full advantage of resolution and signal uniformity is achieved when the deflecting and focusing components are properly designed and when the tube is correctly located inside. The thickness of the photoconductive layer is made very uniform and allows for a constant output signal and a constant dark current. When the landing error due to an imperfect scanning system is present, the voltage gradient across the photoconductive layer is not uniform and a signal variation (shading) is introduced which can be compensated by proper adjustment of the cathode, g1 and g2 voltages.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Due to good design, high reliability is obtained throughout the tube life. The necessary alignment field is reduced to a minimum by precise electron gun mounting. An extremely flat faceplate avoids all optical distortions and permits the use of any good quality lens. Particle barriers adjacent to the field mesh allow these tubes to operate in any position.

One watt power heater makes these Vidicons particularly suitable for transistorized equipment. The reduced heat dissipation improves the quality of the picture by lowering faceplate temperature.

GENERAL CHARACTERISTICS

Electrical

Heater	for unipotential cathode indirectly heated	
Heater :		
- Voltage	6.3 ± 10%	V
- Current at 6.3V	0.15	A
Minimum preheating time	60	s
Output capacitances :		
- Target to all other electrodes	4.5	pF
Spectral response	see curve	
Focusing method	magnetic	
Deflection method	magnetic	

Mechanical

Base (Ditetrar, 8 pins)	UTE 9C15 (JEDEC N° E8 - 11)	
Socket (note 1)	METOX N° 30.250	
Deflecting yoke (note 2)	GERHARD BV 200 - 1k1	
Dimensions	see drawing	
Photoconductive layer :		
- Normal dimensions of image on target	12.7 x 9.5	mm
- Maximum useful diagonal diameter (4 x 3 aspect ratio)	17	mm
Orientation of quality rectangle : Horizontal scan parallel to the plane passing through the tube axis and short index pin (note 3)		
Maximum temperature of faceplate	70	°C
Mounting position	any	
Net weight, approximate	60	g

OPERATING CONDITIONS

Scanned area 12.7 x 9.5 mm

Maximum ratings

E lectrode g4 voltage (post-acceleration electrode)	1000	V
Electrode g3 voltage (wall electrode)	1000	V
Electrode g2 voltage (accelerator)	350	V
Electrode g1 voltage (electrode for picture cut-off)		
- Negative bias value	300	V
- Positive bias value	0	V
Target voltage	125	V
Dark current	0.20	µA
Peak target current (note 4)	0.60	µA
Faceplate :		
- Illumination	10000 or 1000	lux fc
- Temperature	70	°C

Typical operation

Scanned area 12.7 x 9.5 mm
Faceplate temperature 25 °C (note 5)

Electrode voltage modes :	Low	Intermediate	High	
Electrode g4 voltage	300.	500	900	V
Electrode g3 voltage	180	300 to 350	600	V
Electrode g2 voltage	300	300	300	V
Electrode g1 (note 6)	-45 to -110	-45 to -110	-45 to -110	V
Average "gamma" for a target illumination between 1 and 100 lux (note 7)	0.65	0.65	0.65	
Minimum blanking peak to peak voltage :				
- Applied to electrode g1	−75	−75	−75	V
- Applied to cathode	+20	+20	+20	V
Limiting resolution at center of picture (note 8)	750	850	950	TV lines
Limiting resolution at corner of picture.	350	450	550	TV lines
M.T.F. response at 400 T.V. lines at center of picture (5 MHz - 625 CCIR standard) (note 9)	25	35	45	%
Field at center of focusing coil	30 ± 2	40 ± 2	50 ± 2	Gauss
Peak deflecting coil current :				
- Horizontal	130	170	200	mA
- Vertical	15	20	24	mA
Field of alignment coil	0 to 4	0 to 4	0 to 4	Gauss

1 - HIGH LIGHT LEVEL OPERATION

(faceplate illumination 100 lux or 10 fc)

Dark current io	5	nA
Target voltage for io = 5 nA (note 10)	10 to 25	V
Faceplate illumination (2854 °K) (note 11)	100	lux
	or 10	fc
Signal current	250	nA
Lag : (note 12)		
- Maximum	15	%
- Average	10	%

2 - AVERAGE SENSITIVITY OPERATION

(faceplate illumination 10 lux or 1 fc)

Dark current io	20	nA
Target voltage for io = 20 nA (note 10)	15 to 50	V
Faceplate illumination (2854 °K) (note 11)	10	lux
	or 1	fc
Signal current	150	nA
Corresponding sensitivity	125	µA/lm
Target illumination for 100 nA signal current	5	lux
	or 500	mfc
Lag : (note 12)		
- Maximum	20	%
- Average	12	%

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

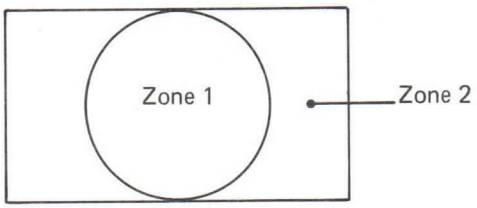
3 - HIGH SENSITIVITY OPERATION

(faceplate illumination 5 lux or 500 mfc)

Dark current io	50	nA
Target voltage for io = 50 nA (note 10)	20 to 60	V
Faceplate illumination (2854 °K) (note 11)	5 lux or 500	mfc
Signal current	180	nA
Corresponding sensitivity	300	µA/lm
Target illumination for 100 nA signal current	2	lux
	or 200	mfc
Lag : (note 12)		
- Maximum	20	%
- Average	15	%

4 - SPURIOUS SIGNAL TEST

The test is performed using a uniformly diffused white test pattern that is separated into two zones as shown in drawing



The tube is operated under the "Typical Operation" conditions with a dark current of 20 nanoamperes and the lens adjusted to provide a signal current of 200 nanoamperes.

Spurious signals are classified by their size, which is measured in percent of raster height.

Will actually be considered as defects, blemishes of contrast greater than 50% (note 13).

Allowable spot size for each zone is shown in table :

Ratio D/H * (Percent raster height)	Number Allowed			
	Zone 1	Zone 1 + Zone 2		
		a	a + b	a + b + c
a : 0.8 % < D/H ⩽ 1 %	2	3	7	12
b : 0.6 % < D/H ⩽ 0.8 %	3			
c : 0.2 % < D/H ⩽ 0.6 %	4			

0.2 % and under : do not count spots of this size unless concentration causes a smudge appearance.

* D : average diameter of spot
H : raster height

Smudges, streaks, mottled or grainy background having a contrast ratio greater than 15 % constitute a reject.

NOTES

1 - METOX - 86, rue de Villiers de l'isle Adam - PARIS 20ème
Téléphone : 636 31 10

2 - GERHARD KG - REICHELSHEIM / ODW Germany

3 - It is necessary to assure correct positioning of the tube inside the coils. An immediate test consists in observing the fine mesh grid, the wires of which should be inclined 45° with respect to scanning. Then again the front end of the deflecting yoke should be positioned at 20 mm from the tube faceplate.

4 - Target current is defined as total current in load resistance connected to target electrode: signal current plus dark current, dark current being the current left when illumination is subtracted.
Video amplifiers must be designed properly to handle peak target current of 0.7 μA to avoid amplifier overload and picture distortion.

5 - All these characteristics are provided for a temperature of faceplate of 25 °C, the temperature range recommended is within 20 to 30 °C. The rise of faceplate temperature is a function of ambient temperature, thermic dissipation of ambient devices and of the tube itself. Consequently, 10 °C of faceplate temperature rise implies a dark current multiplied by a factor of 2.

6 - Without blanking pulses applied on electrode g1.

7 - Average "gamma" should be defined as the slope of the rectilinear part of transfer characteristics in log coordinates.

8 - Pratically, limiting resolution corresponds to the resolution measured with twin bar test card with a modulation ratio of about 7 %.

9 - For 625 lines C.C.I.R. standard, line duration being 52 μs (line suppression period not included), 400 TV lines correspond to 5 MHz.

10 - Indicated range of each type of service serves only to illustrate the operating target voltage range normally encountered. The target voltage for each Vidicon must be adjusted to that value which gives the designed operating dark current.

11 - All the above mentioned illumination assume 2854 °K incandescent tungsten source.

12 - Lag is defined as the ratio of residual signal current measured 60 milliseconds after light excitation being removed to the initial signal current : this value assumes 50 field/second scanning rate.

13 - Contrast is defined as : $100 \times \frac{\text{increment in video current due to the blemish}}{\text{normal signal current}}$

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Figure 1

TYPICAL SPECTRAL SENSITIVITY CHARACTERISTICS

For equal values of signal current at all wavelengths
(0.02 μA signal current and 0.02 μA dark current
for scanned area of 12.7 x 9.5 mm)

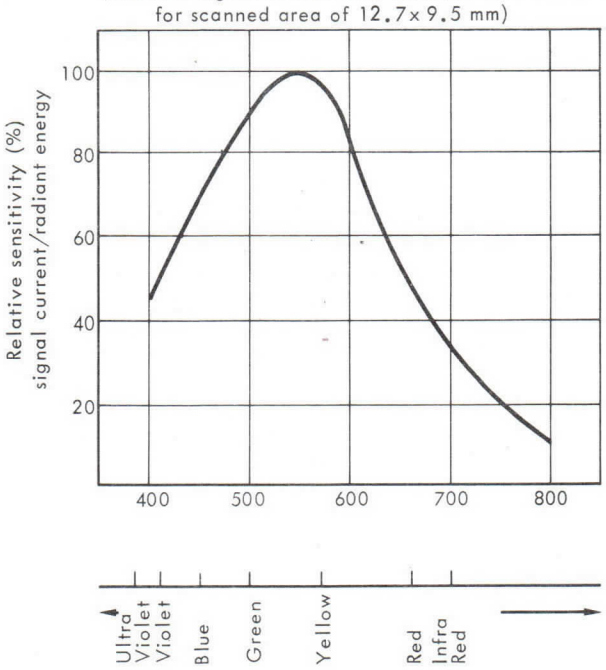


Figure 2

LIGHT TRANSFER CHARACTERISTICS

Illumination uniform over photoconductive layer scanned
area 12.7 x 9.5 mm-face plate temperature 25°C

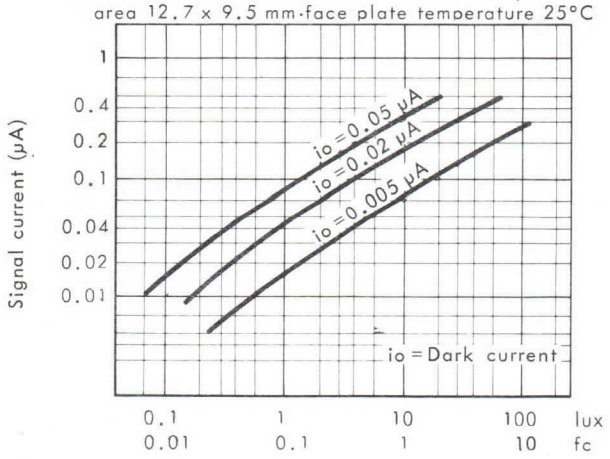


Figure 3

RANGE OF DARK CURRENT

Scanned area of photoconductive layer 12.7 x 9.5 mm

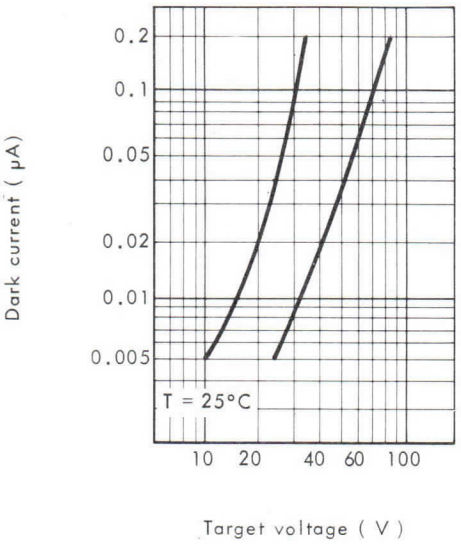


Figure 4

TYPICAL PERSISTENCE CHARACTERISTICS

Initial highlight signal current of 0.2 µA scanned area of photoconductive layer 12.7 x 9.5 mm

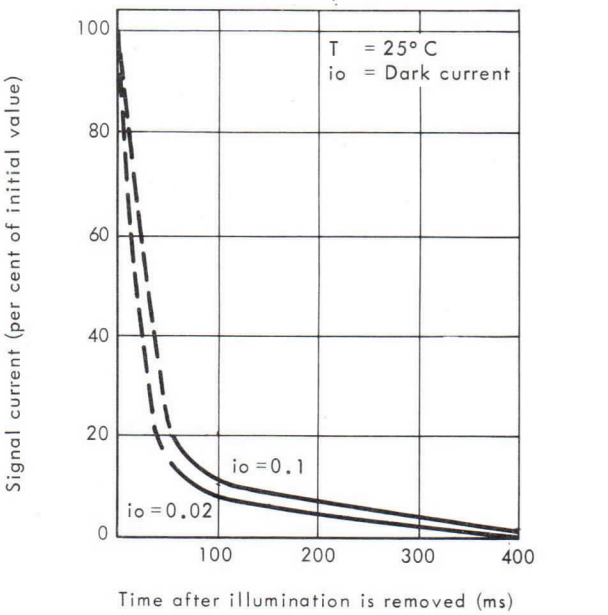
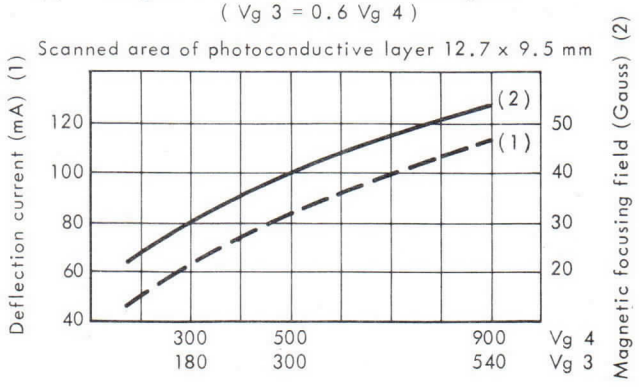


Figure 5

(1) Deflection current as a function of electrode g3 and g4 voltages (Vg 3 = 0.6 Vg 4)

(2) Magnetic field at center of focusing coil (Vg 3 = 0.6 Vg 4)

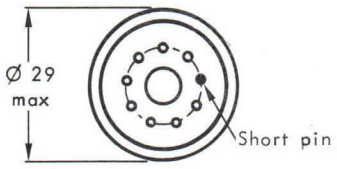
Scanned area of photoconductive layer 12.7 x 9.5 mm



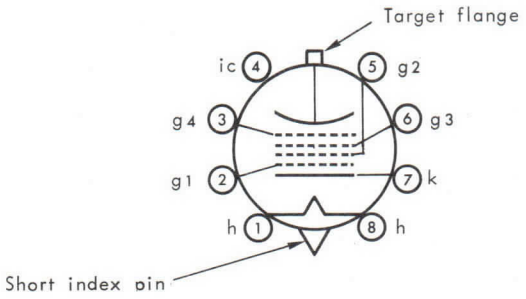
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING

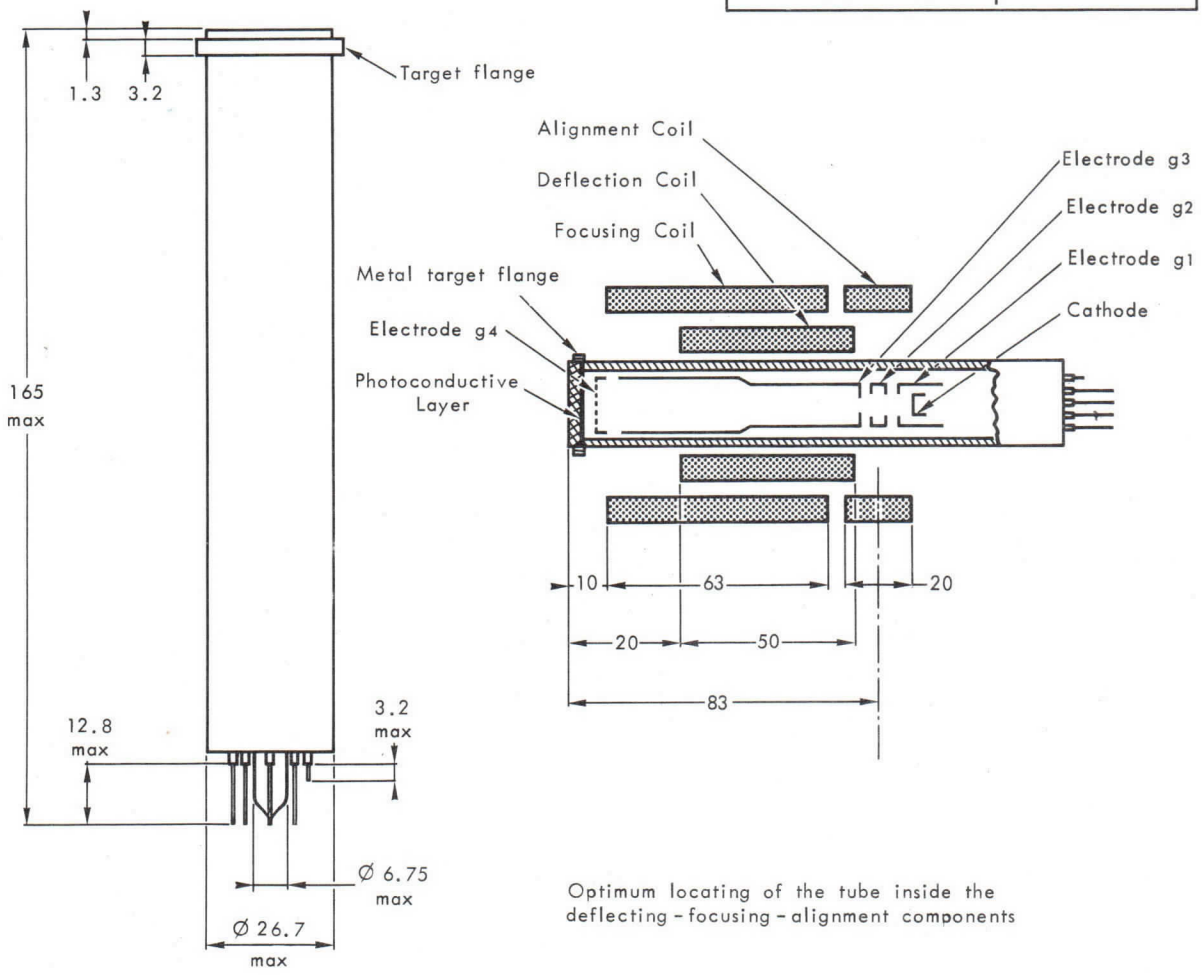
UTE 9C15 base
(JEDEC E8-11)



BASING DIAGRAM



1 - Heater	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode
4 - Internal connection	8 - Heater



Optimum locating of the tube inside the deflecting - focusing - alignment components

Dimensions in mm.

TH 9806 PA
1" VIDICON

- MAGNETIC FOCUS AND DEFLECTION
- HIGH RESOLUTION (900 TV LINES)
- NORMAL SENSITIVITY
- LOW LAG
- PROFESSIONAL TV

TH 9806 PA is a 1" Vidicon designed especially for pick-up in high quality TV cameras (black and white or color TV cameras) with normal light level conditions. This tube incorporates in its structure the latest isolated post-acceleration electrode with separate external connection. Due to this feature TH 9806 PA provides higher resolution, higher output signal capability and better resolution and signal uniformity than previous Vidicon tubes.

TH 9806 PA is intended for all professional and educational applications : compact light weight camera and all closed circuit TV where high quality of image is essential.

The sensitivity of TH 9806 PA can be equivalent to photographic film having an ASA exposure index of 1200 (32/10 DIN, 39 Sch). Satisfactory quality picture with good resolution and acceptable signal to noise ratio can be obtained at illuminations of 0.5 lux (50 mf.c) to 1 lux (100 mf.c) on the faceplate (5 to 10 lux on the subject with an unity numerical aperture lens) giving rise to a signal current of 50 nA at 50 nA dark current. For such illuminations, higher signal current is obtained by increasing dark current up to 100 nA, value beyond which a signal saturation will occur.

Due to a new low lag photoconductive layer, excellent picture quality can be obtained within a large illumination range with good signal uniformity and appropriate "gamma" characteristics.

TH 9806 PA performances are substantially identical under high or low level illumination conditions. The tube sensitivity can be controlled by target voltage which also causes some variation of dark current.

TH 9806 PA can be operated over a wide range of electrode voltage selection although recommended adjustment requires a g4 voltage to g3 voltage ratio of 1.4 – 1.5. Under these conditions TH 9806 PA can provide an optimum resolution and an uniform signal output over the entire scanned area with a beam landing considerably improved minimizing "porthole" effect and geometrical distortion.

The limiting resolution of TH 9806 PA is about 1000 T.V. lines at center of picture and 600 T.V. lines at corner. This high resolution is obtained with 900 V on electrode g4 and 600 V on g3. When the TH 9806 PA is operated at a lower g4 voltage of 500 V and g3 voltage of 300 V, its limiting resolution will be 900 T.V. lines at center and 500 T.V. lines at corner. Operating g4 voltage at 1.5 times g3 voltage requires 20 % deflection current increase over the current necessary for "g3 - g4 connected" mode. Focusing field is not noticeably changed with such an operation.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Full advantage of resolution and signal uniformity is achieved when the deflecting and focusing components are properly designed and when the tube is correctly located inside. The thicknessof the photoconductive layer is made very uniform and allows for constant output signal and constant dark current. When the landing error due to an imperfect scanning system is present, the voltage gradient across the photoconductive layer is not uniform and a signal variation (shading) is introduced which can be compensated by proper adjustment of the cathode, g1 and g2 voltages.

Due to good design, high reliability is obtained throughout the tube life. The necessary aligment field is reduced to a minimum by precise electron gun mounting. An extremely flat faceplate avoids all optical distortions and permits the use of any good quality lens. Particle barriers adjacent to the field mesh allow these tubes to operate in any position.

One watt power heater makes these Vidicons particularly suitable for transistorized equipment. The reduced heat dissipation improves the quality of the picture by lowering faceplate temperature.

GENERAL CHARACTERISTICS

Electrical

Heater	for unipotential cathode indirectly heated
Heater :	
voltage	6.3 ± 10 % V
current at 6.3 V	0.15 A
Minimum preheating time	60 s
Output capacitances :	
target to all other electrodes	4.5 pF
Spectral response	see curve
Focusing method	magnetic
Deflection method	magnetic

Mechanical

Base (Ditetrar, 8 pins)	UTE 9 C 15 (JEDEC N° E8 - 11)
Socket (note 1)	METOX N° 30.250
Deflecting yoke - focusing coil assembly (note 2)	GERHARD type BV 200 1K 1
Alignment coil (note 2)	GERHARD type BV 80/3
Dimensions	see drawing
Photoconductive layer :	
normal dimensions of image on target	12.7 mm x 9.5 mm
maximum useful diagonal diameter (4 x 3 aspect ratio)	17 mm
orientation of quality rectangle :	
horizontal scan parallel to the plane passing through the tube axis and short index pin (note 3)	
Maximum temperature of faceplate	70 °C
Mounting position	any
Net weight, approximate	60 g

OPERATING CONDITIONS

SCANNED AREA 12. 7 mm x 9. 5 mm

Maximum ratings (Absolute values)

Electrode g4 voltage (post acceleration electrode)	1000	V
Electrode g3 voltage (wall electrode)	1000	V
Electrode g2 voltage (accelerator)	350	V
Electrode g1 voltage (electrode for picture cut-off) :		
negative bias value	150	V
positive bias value	0	V
Peak heater cathode voltage :		
heater negative with respect to cathode	125	V
heater positive with respect to cathode	10	V
Target voltage	125	V
Dark current	0. 20	µA
Peak target current (note 4)	0. 60	µA
Faceplate :		
illumination	10000 or 1000	lux fc
temperature	70	°C

Typical operation

SCANNED AREA 12. 7 x 9. 5 mm
FACEPLATE TEMPERATURE 25 °C (note 5)

Electrode voltage modes :	Low	Intermediate	High	
Electrode g4 voltage	300	500	900	V
Electrode g3 voltage	180	300 to 350	600	V
Electrode g2 voltage	300	300	300	V
Electrode g1 (note 6)	-45 to - 110	-45 to - 110	-45 to - 110	V
Average "gamma" for a target illumination between 1 and 100 lux (note 7)	0. 65	0. 65	0. 65	
Minimum blanking peak to peak voltage :				
applied to electrode g1	-75	-75	-75	V
applied to cathode	+20	+20	+20	V
Limiting resolution at center of picture — (note 8)	800	900	1000	TV lines
Limiting resolution at corner of picture	400	500	600	TV lines
M.T.F. response at 400 T.V. lines at center of picture (5 MHz - 625 CCIR standard) (note 9)	30	40	50	%
Field strength at center of focusing coil	30 ± 2	40 ± 2	50 ± 2	Gauss
Peak deflecting coil current :				
horizontal	130	170	200	mA
vertical	15	20	24	mA
Field strength of alignment coil	0 to 4	0 to 4	0 to 4	Gauss

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

1 - HIGH LIGHT LEVEL OPERATION

(FACEPLATE ILLUMINATION 100 lux OR 10 fc)

Dark current i_o	5	nA
Target voltage for i_o = 5 nA (note 10)	10 to 25	V
Faceplate illumination (2854 °K) (note 11)	100	lux
	or 10	fc
Signal current	300	nA
Lag : (note 12)		
maximum	15	%
average	10	%

2 - AVERAGE SENSITIVITY OPERATION

(FACEPLATE ILLUMINATION 10 lux OR 1 fc)

Dark current i_o	20	nA
Target voltage for i_o = 20 nA (note 10)	20 to 50	V
Faceplate illumination (2854 °K) (note 11)	10	lux
	or 1	fc
Signal current	200	nA
Corresponding sensitivity	170	µA/lm
Target illumination for 100 nA signal current	3	lux
	or 300	mfc
Lag : (note 12)		
maximum	20	%
average	12	%

3 - HIGH SENSITIVITY OPERATION

(FACEPLATE ILLUMINATION 5 lux OR 500 mfc)

Dark current i_o	50	nA
Target voltage for i_o = 50 nA (note 10)	25 to 60	V
Faceplate illumination (2854 °K) (note 11)	5 lux or 500	mfc
Signal current	200	nA
Corresponding sensitivity	350	µA/lm
Target illumination for 100 nA signal current	1. 5	lux
	or 150	mfc
Lag : (note 12)		
maximum	20	%
average	15	%

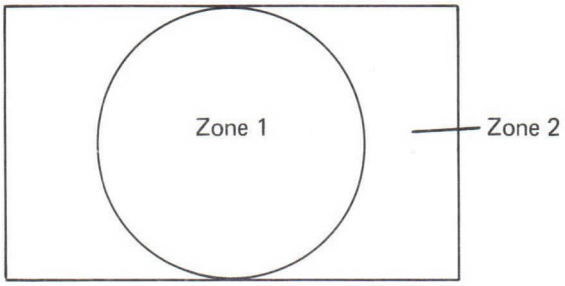
4 - VERY HIGH SENSITIVITY OPERATION

(FACEPLATE ILLUMINATION 1 lux OR 100 mfc)

Dark current i_o	100	nA
Target voltage for i_o = 100 nA (note 10)	30 to 70	V
Faceplate illumination (2854 °K) (note 11)	1 lux or 100	mfc
Signal current	100	nA
Corresponding sensitivity	800	µA/lm
Target illumination for 50 nA signal current	0. 3	lux
	or 30	mfc
Lag : (note 12)		
maximum	20	%
average	17	%

5 - SPURIOUS SIGNAL TEST

The test is performed using a uniformly diffused white test pattern that is separated into two zones as shown in drawning :



The tube is operated under "Typical Operation" with a dark current of 20 nanoampères and the lens adjusted to provide a signal current of 200 nanoampères.

Spurious signals are classified by their size which is measured in percent of raster height.

Will actually be considered as defects, blemishes of contrast greater than 25 % (note 13).

Allowable spot size for each zone is shown in table :

*Ratio D / H (Percent raster height)	Number Allowed			
	Zone 1	Zone 1 + Zone 2		
		a	a + b	a + b + c
a : 0.8 % < D/H ⩽ 1 %	0	0	1	3
b : 0.6 % < D/H ⩽ 0.8 %	0			
c : 0.2 % < D/H ⩽ 0.6 %	1			

0. 2 % and under : do not count spots of this size unless concentration causes a smudge appearance

* D : average diameter of spot

H : raster height

Smudges, streaks, mottled or grainy background having a contrast ratio greater than 10 % constitute a reject.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

NOTES

1 — METOX - 86, rue de Villiers de l'isle Adam - PARIS 20 ème
Téléphone : 636 - 31 - 10

2 — GERHARD KG - REICHELSHEIM / ODW Germany

3 — It is necessary to assure correct positioning of the tube inside the coils. An immediate test consists in observing the fine mesh grid, the wires of which should be inclined 45 ° with respect to scanning. Then again the front end of the deflecting yoke should be positioned at 20 mm from the tube faceplate.

4 — Target current is defined as total current in load resistance connected to target electrode : signal current plus dark current, dark current being the current left when illumination is subtracted.
Video amplifiers must be designed properly to handle peak target current of 0.7 μA to avoid amplifier overload and picture distortion.

5 — All these characteristics are provided for a temperature of faceplate of 25 °C, the temperature range recommended is within 20 to 30 °C. The rise of faceplate temperature is a function of ambient temperature, thermic dissipation of ambient devices and of the tube itself. Consequently, 10 °C of faceplate temperature rise implies a dark current multiplied by a factor of 2.

6 — Without blanking pulses applied on electrode g1.

7 — Average "gamma" should be defined as the slope of the rectilinear part of transfer characteristics in log coordinates.

8 — Practically, limiting resolution corresponds to the resolution measured with twin bar test card with a modulation ratio of about 7 %.

9 — For 625 lines C.C.I.R. standard, line duration being 52 μs (line suppression period not included), 400 TV lines correspond to 5 MHz.

10 — Indicated range of each type of service serves only to illustrate the operating target voltage range normally encountered. The target voltage for each Vidicon must be adjusted to that value which gives the designed operating dark current.

11 — All the above mentioned illumination assume 2854 °K incandescent tungsten source.

12 — Lag is defined as the ratio of residual signal current measured 60 milliseconds after light excitation being removed to the initial signal current ; this value assumes 50 field/second scanning rate.

13 — Contrast is defined as :

$$100 \times \frac{\text{increment in video current due to the blemish}}{\text{normal signal current}}$$

Figure 1

TYPICAL SPECTRAL SENSITIVITY CHARACTERISTICS

For equal values of signal current at all wavelengths
(0.02 µA signal current and 0.02 µA dark current
for scanned area of 12.7 mm x 9.5 mm)

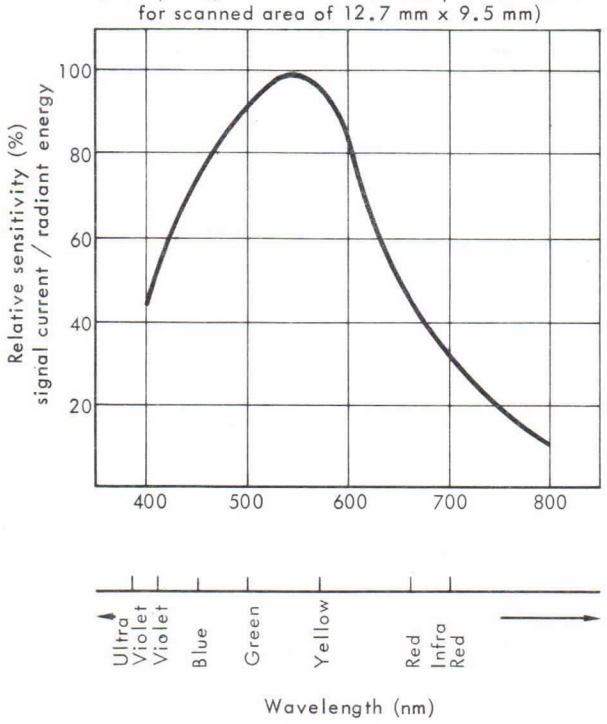


Figure 2

LIGHT TRANSFER CHARACTERISTICS

Illumination uniform over photoconductive layer scanned
area 12.7 mm x 9.5 mm face plate temperature 25°C

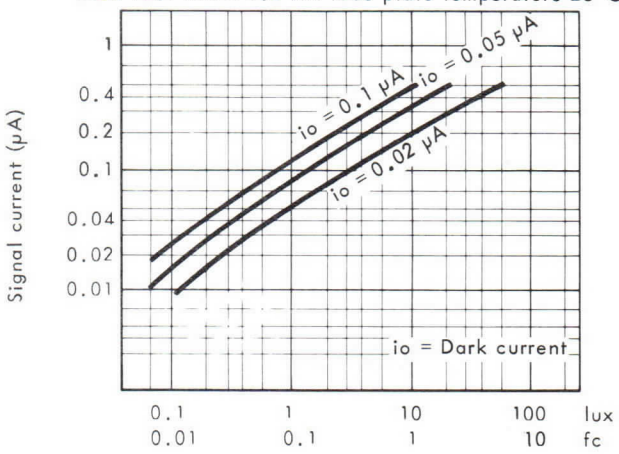
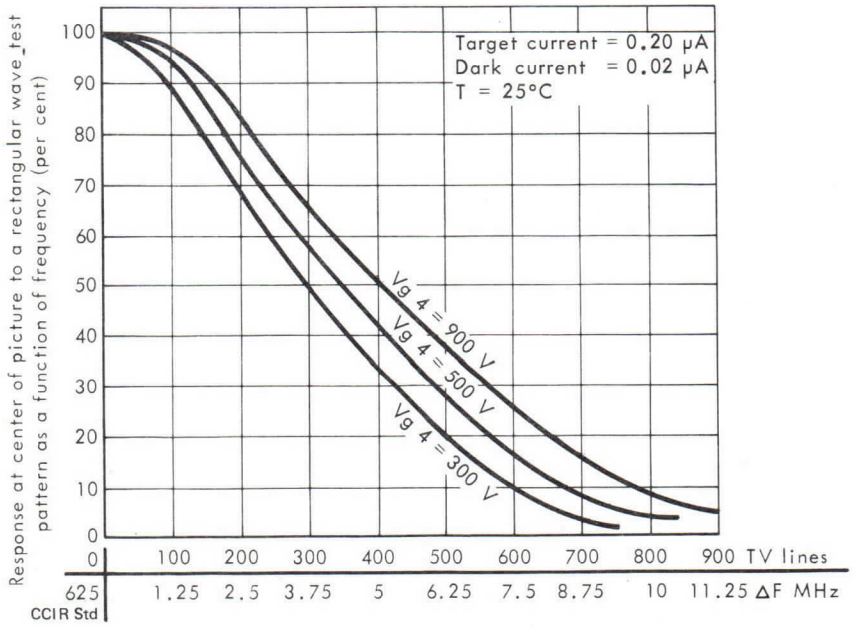


Figure 3

MODULATION TRANSFER FUNCTION



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Figure 4

RANGE OF DARK CURRENT

Scanned area of photoconductive layer 12.7 mm x 9.5 mm

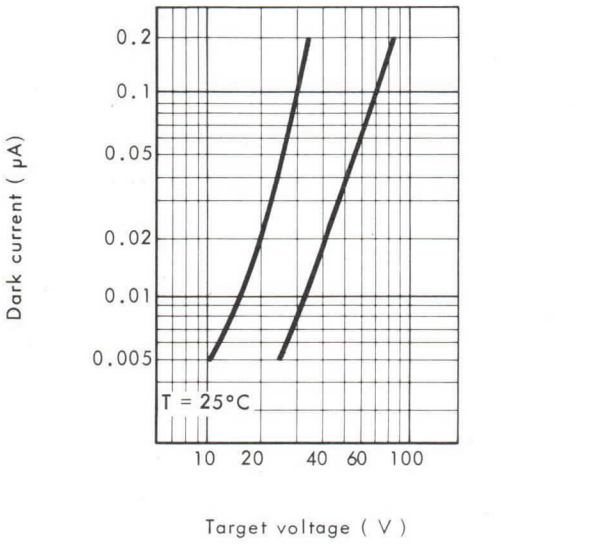


Figure 5

TYPICAL PERSISTENCE CHARACTERISTICS

Initial highlight signal current of 0.2 µA scanned area of photoconductive layer 12.7 mm x 9.5 mm

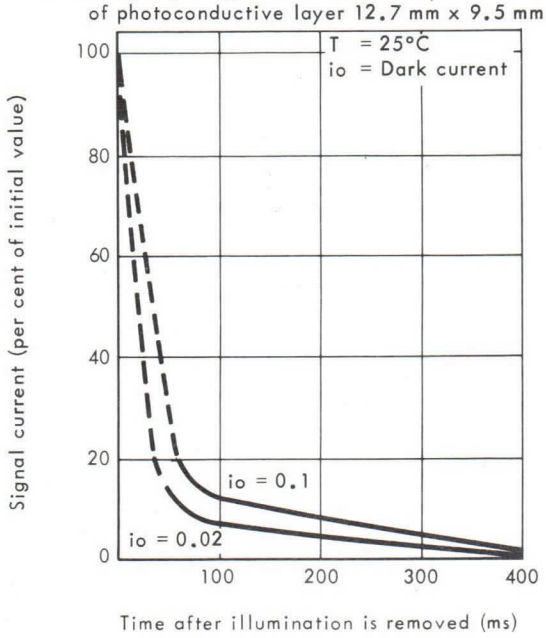
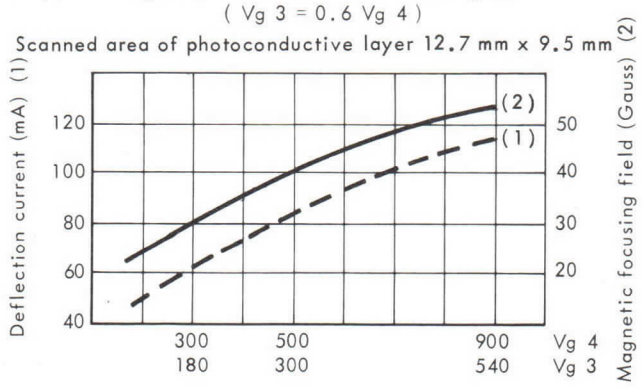


Figure 6

(1) Deflection current as a function of electrode g3 and g4 voltages (Vg 3 = 0.6 Vg 4)

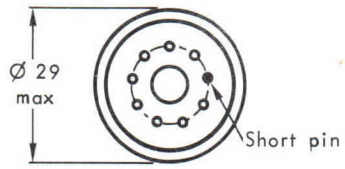
(2) Magnetic field at center of focusing coil (Vg 3 = 0.6 Vg 4)

Scanned area of photoconductive layer 12.7 mm x 9.5 mm

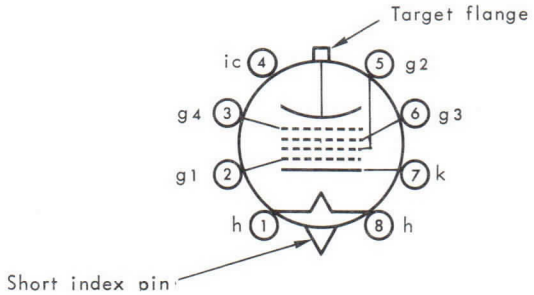


OUTLINE DRAWING

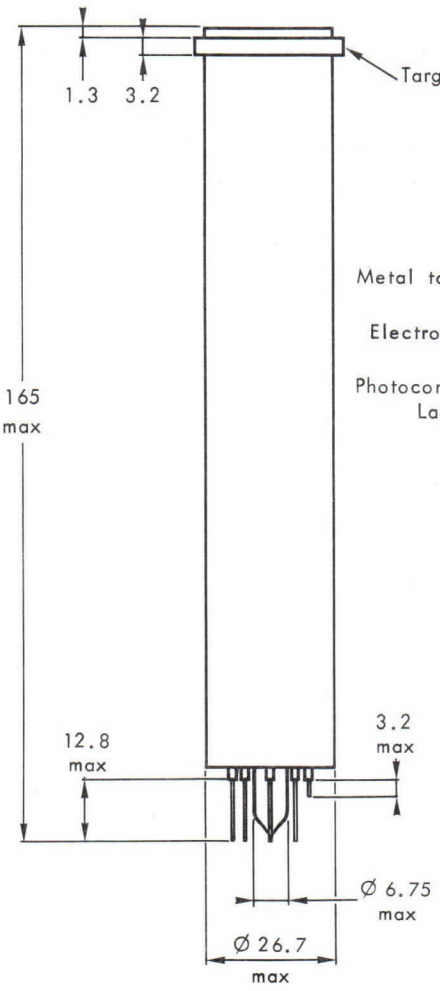
UTE 9C15 base
(JEDEC E8-11)

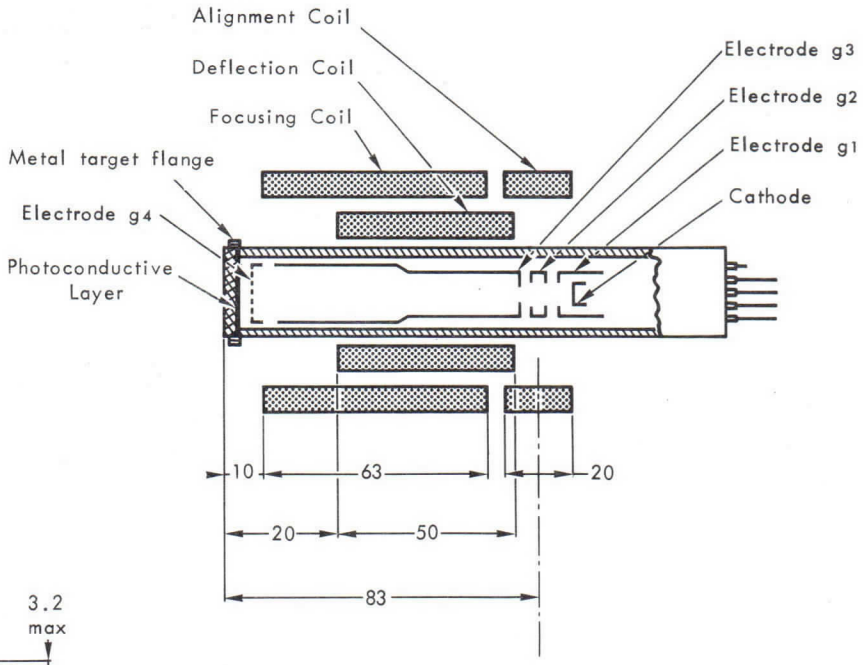


BASING DIAGRAM



1 - Heater	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4 ,	7 - Cathode
4 - Internal connection	8 - Heater





Optimum locating of the tube inside the deflecting - focusing - alignment components

Dimensions in mm.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

THOMSON-CSF

TH 9807 PA
1" VIDICON

- MAGNETIC FOCUS AND DEFLECTION
- HIGH RESOLUTION (1000 TV lines)
- NORMAL SENSITIVITY
- EXCELLENT IMAGE UNIFORMITY
- LOW LAG
- TELECINE AND BROADCAST TV

TH 9807PA is a 1" Vidicon designed especially for pick-up in high quality TV cameras (black and white or color TV cameras). This tube incorporates in its structure the latest isolated post-acceleration electrode with separate mesh connection. Due to this feature TH 9807PA provides higher resolution, higher output signal capability and better resolution and signal uniformity than previous Vidicon tubes.

TH 9807PA Vidicon is intended for Telecine and slides T.V. cameras. This tube can operate at high output signal and low target voltage without impairing the quality of image.

The maximum sensitivity of TH 9807PA can be equivalent to photographic film having an ASA exposure index of 200 to 1000 (adjustable by target voltage). In Telecine applications, for a normally encountered faceplate illumination of 10 to 100 lux (1 to 10 fc) TH 9807PA provides an output signal of 150 to 400 nA at 10 nA dark current approximately. In these conditions, excellent quality of image is obtained (resolution, signal to noise ratio, signal uniformity). For lower level illuminations the same output current can be maintained with a slightly higher dark current value.

Due to a new low lag photoconductive layer excellent quality of picture can be obtained within a large illumination range with good signal uniformity and appropriate "gamma" characteristics.

TH 9807PA performances are substantially identical under high or low level illumination conditions. Tubes sensitivity can be controlled by target voltage which also causes some variation of dark current within a narrow range.

TH 9807PA can be operated over a wide range of electrode voltage selection although recommended adjustment requires a g4 voltage to g3 voltage ratio of 1.4 – 1.5. Under these conditions TH 9807PA can provide an optimum resolution and an uniform signal output over the entire scanned area with a beam landing considerably improved minimizing "porthole" effect and geometrical distortion.

The limiting resolution of TH 9807PA is about 1000 T.V. lines at center of picture and 600 T.V. lines at corner. This high resolution is obtained with 900 V on electrode g4 and 600 V on g3. When the TH 9807PA is operated at a lower g4 voltage of 500 V and g3 voltage of 330 V, its limiting resolution will be 900 T.V. lines at center and 500 T.V. lines at corner. Operating g4 voltage at 1.5 times g3 voltage requires 20 % deflection current increase over current necessary for g3 – g4 connected mode. Focusing field is not noticeably changed with such an operation.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Full advantage of resolution and signal uniformity is achieved when deflecting and focusing components are properly designed and when the tube is correctly located inside. The thickness of the photoconductive layer is made very uniform and allows for constant output signal and constant dark current. When landing error due to imperfect scanning system is present, the voltage gradient across the photoconductive layer is not uniform and a signal variation (shading) is introduced which can be compensated by proper adjustment of the cathode, g1 and g2 voltages.

Due to good design, high reliability is obtained all along tube life. Requirement alignment field is reduced to a minimum by precise electron gun mounting. An extremely flat faceplate avoids all optical distortions and allows for the use of any good quality lens. Particle barriers adjacent to the field mesh allows these tubes to operate in any position.

One watt power heater makes these Vidicons particularly suitable for transistorized equipment. The reduced heat dissipation improves the quality of the picture by lowering faceplate temperature.

GENERAL CHARACTERISTICS

Electrical

Heater	for unipotential cathode indirectly heated	
Heater :		
— Voltage	6.3 ± 10 %	V
— Current at 6.3 V	0.15	A
Minimum preheating time	60	s
Output capacitances :		
— Target to all other electrodes	4.5	pF
Spectral response	see curve	
Focusing method	magnetic	
Deflection method	magnetic	

Mechanical

Base (Ditetrar, 8 pins)	UTE 9 C 15 (JEDEC N° E8 - 11)	
Socket — note 1	METOX N° 30.250	
Deflecting yoke - Focusing coil Assembly — note 2	GERHARD type BV 200-1K1	
Alignment coil — note 2	GERHARD type BV 80/3	
Dimensions	see drawing	
Photoconductive layer :		
— normal dimensions of image on target	12.7 mm x 9.5 mm	
— maximum useful diagonal diameter (4 x 3 aspect ratio)	17	mm
— orientation of quality rectangle : horizontal scan parallel to the plane passing through the tube axis and short index pin — note 3		
Maximum temperature of faceplate	70	°C
Mounting position	any	
Net weight, approximate	60	g

OPERATING CONDITIONS

Scanned area 12.7 mm x 9.5 mm

Maximum ratings

Electrode g4 voltage (post-acceleration electrode)	1000	V
Electrode g3 voltage (wall electrode)	1000	V
Electrode g2 voltage (accelerator)	350	V
Electrode g1 voltage (electrode for picture cut-off)		
– negative bias value	150	V
– positive bias value	0	V
Peak heater-cathode voltage :		
– heater negative with respect to cathode	125	V
– heater positive with respect to cathode	10	V
Target voltage	125	V
Dark current	0. 20	µA
Peak target current (note 4)	0. 60	µA
Faceplate :		
– Illumination	10000	lux
	or 1000	fc
– Temperature	70	°C

Typical operation

Scanned area 12.7 mm x 9.5 mm
Faceplate temperature 25 °C (note 5)

Electrode voltage modes :	**Intermediate**	**High**	
Electrode g4 voltage	500	900	V
Electrode g3 voltage	330	600	V
Electrode g2 voltage	300	300	V
Electrode g1 (note 6)	–45 to –110	–45 to –110	V
Average "gamma" for a target illumination between 1 and 100 lux (note 7)	0. 65	0. 65	
Minimum blanking peak to peak voltage :			
– applied to electrode g1	–75	–75	V
– applied to cathode	+20	+20	V
Limiting resolution at center of picture (note 8)	900	1000	TV lines
Limiting resolution at corner of picture	500	600	TV lines
M.T.F. response at 400 TV lines at center of picture (5 MHz - 625 CCIR standard) (note 9)	40	50	%
Field strength at center of focusing coil	40 ± 2	50 ± 2	Gauss
Peak deflecting coil current :			
– horizontal	170	200	mA
– vertical	20	24	mA
Field strength of alignment coil	0 to 4	0 to 4	Gauss

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

1 - HIGH LIGHT LEVEL OPERATION

(faceplate illumination 100 lux or 10 fc)

Dark current i_o	5	nA
Target voltage for $i_o = 5$ nA (note 10)	10 to 25	V
Faceplate illumination (2854 °K) (note 11)	100	lux
	or 10	fc
Signal current	300	nA
Lag : (note 12)		
– maximum	15	%
– average	10	%

2 - AVERAGE SENSITIVITY OPERATION

(faceplate illumination 10 lux or 1 fc)

Dark current i_o	20	nA
Target voltage for $i_o = 20$ nA (note 10)	20 to 50	V
Faceplate illumination (2854 °K) (note 11)	10	lux
	or 1	fc
Signal current	180	nA
Corresponding sensitivity	150	µA/lm
Target illumination for 100 nA signal current	3	lux
	or 300	mfc
Lag : (note 12)		
– maximum	20	%
– average	12	%

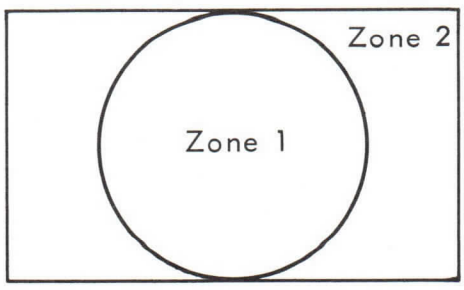
3 - HIGH SENSITIVITY OPERATION

(faceplate illumination 5 lux or 500 mfc)

Dark current i_o	50	nA
Target voltage for $i_o = 50$ nA (note 10)	25 to 60	V
Faceplate illumination (2854 °K) (note 11)	500	mfc
Signal current	200	nA
Corresponding sensitivity	350	µA/lm
Target illumination for 100 nA signal current	1.5	lux
	or 150	mfc
Lag : (note 12)		
– maximum	20	%
– average	15	%

4 - SPURIOUS SIGNAL TEST

The test is performed using a uniformly diffused white test pattern that is separated into two zones as shown in drawing :



The tube is operated under the "Typical Operation" conditions with a dark current of 20 nanoamperes and the lens adjusted to provide a signal current of 400 nanoamperes.

Spurious signals are classified by their size which is measured by percent of raster height.

Will actually be considered as a defect, a spot blemish (black or white spot) having a contrast ratio greater than 25 %. (note 13)

Allowable spot size for each zone is shown in table :

Ratio D/H* (percent raster height)	Number allowed	
	Zone 1	Zone 2
D/H $\geqslant$ 0,4 %	0	0
D/H $<$ 0,4 %	0	4

* D : average diameter of spot
H : raster height

The picture must be of a very imperceptible mottled or grainy appearance with no streaks of large area.

NOTES

1 - METOX - 86, rue de Villiers de l'isle Adam - PARIS 20ème.
Telephone : 636 - 31 -10

2 - GERHARD KG - REICHELSHEIM / ODW Germany

3 - It is necessary to assure correct positioning of the tube inside the coils. An immediate test consists in observing the fine mesh grid, the wires of which should be inclined 45° with respect to scanning. Then again the front end of the deflecting yoke should be positioned at 20 mm from the tube faceplate.

4 - Target current is defined as total current in load resistance connected to target electrode : signal current plus dark current, dark current being the current left when illumination is subtracted.
Video amplifiers must be designed properly to handle peak target current of 0.6 μA to avoid amplifier overload and picture distortion.

5 - All these characteristics are provided for a temperature of faceplate of 25 °C, the temperature range recommended is within 20 to 30 °C. The rise of faceplate temperature is a function of ambient temperature, thermic dissipation of ambient devices and of the tube itself. Consequently, 10 °C of faceplate temperature rise implies a dark current multiplied by a factor of 2.

6 - Without blanking pulses applied on electrode g1.

7 - Average "gamma" should be defined as the slope of the rectilinear part of transfer characteristics in log coordinates.

8 - Practically, limiting resolution corresponds to the resolution measured with twin bar test card with a modulation ratio of about 7 %.

9 - For 625 lines C.C.I.R. standard, line duration being 52 μs (line suppression period not included), 400 TV lines correspond to 5 MHz.

10 - Indicated range of each type of service serves only to illustrate the operating target voltage range normally encountered. the target voltage for each Vidicon must be adjusted to that value which gives the designed operating dark current.

11 - All the above mentionned illumination assume 2854°K incandescent tungsten source.

12 - Lag is defined as the ratio of residual signal current measured 60 milliseconds after light excitation being removed to the initial signal current ; this value assumes 50 field/second scanning rate.

13 - Contrast is defined as : $100 \times \dfrac{\text{increment in video current due to the blemish}}{\text{normal signal current}}$

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Figure 1

TYPICAL SPECTRAL SENSITIVITY CHARACTERISTICS

For equal values of signal current at all wavelengths
(0.02 µA signal current and 0.02 µA dark current
for scanned area of 12.7 x 9.5 mm)

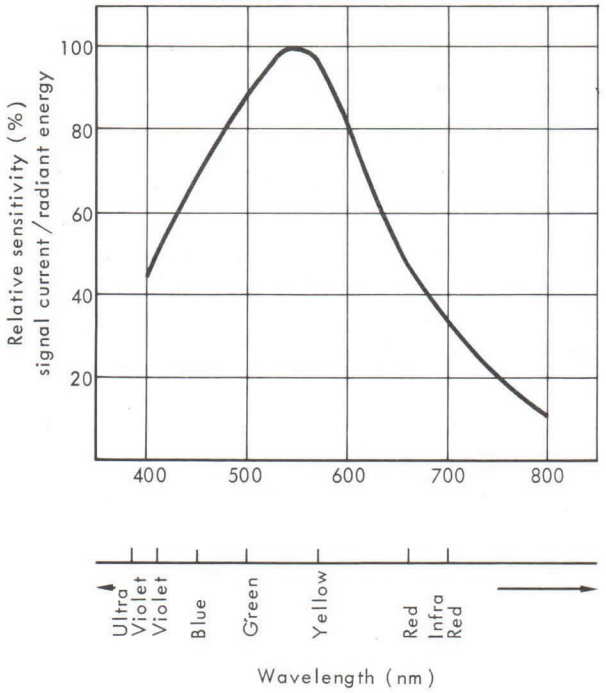
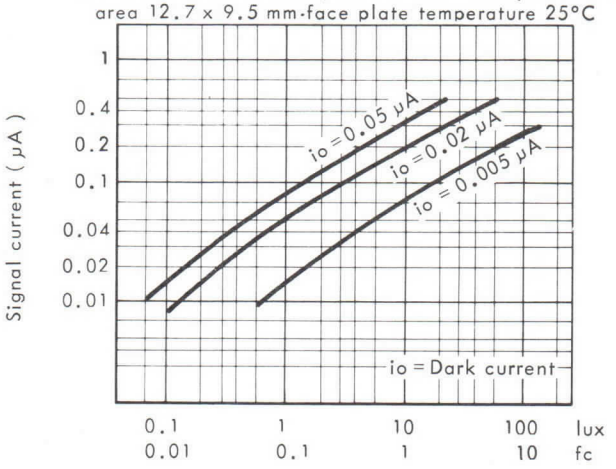


Figure 2

LIGHT TRANSFER CHARACTERISTICS

Illumination uniform over photoconductive layer scanned
area 12.7 x 9.5 mm-face plate temperature 25°C



Illumination in lux and foot candles

Figure 3

MODULATION TRANSFER FUNCTION

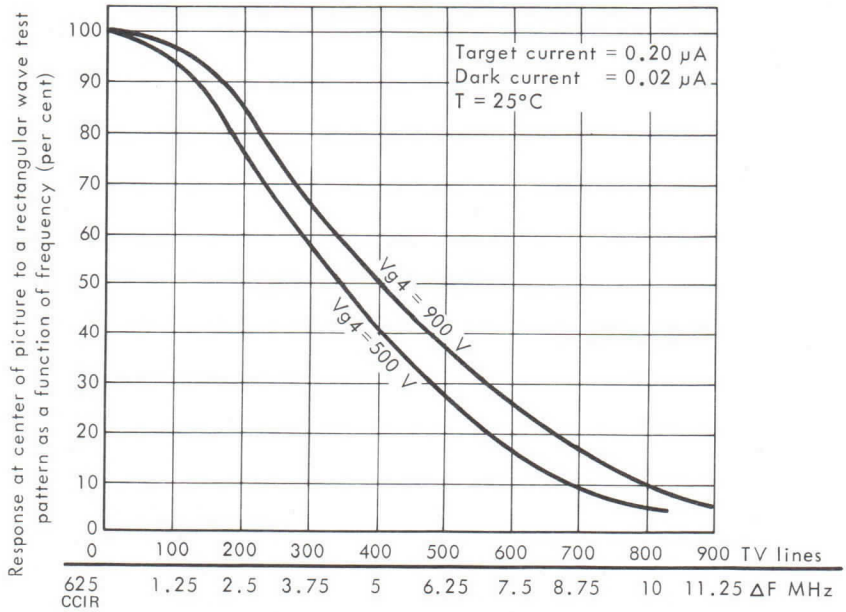


Figure 4

RANGE OF DARK CURRENT
Scanned area of photoconductive layer 12.7 mm x 9.5 mm

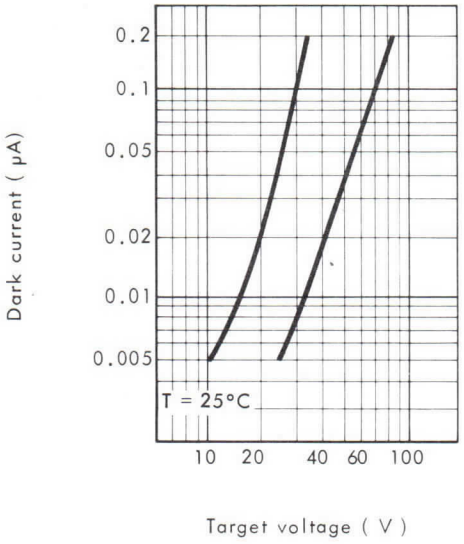


Figure 5

TYPICAL PERSISTENCE CHARACTERISTICS
Initial highlight signal current of 0.2 µA scanned area of photoconductive layer 12.7x9.5 mm

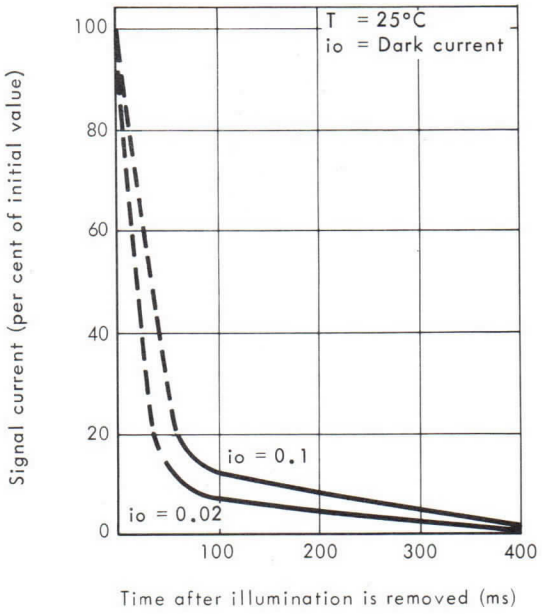
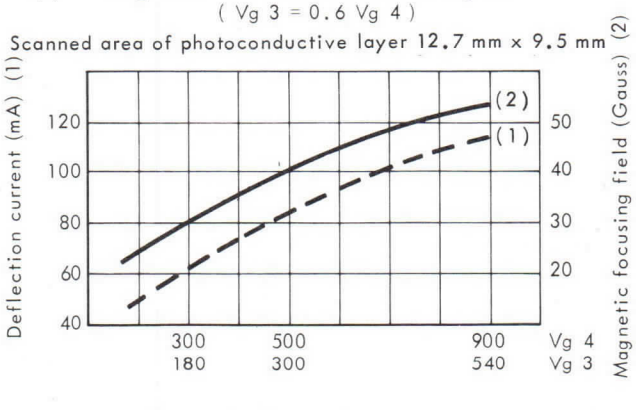


Figure 6

(1) Deflection current as a function of electrode g3 and g4 voltages (Vg 3 = 0.6 Vg 4)

(2) Magnetic field at center of focusing coil (Vg 3 = 0.6 Vg 4)

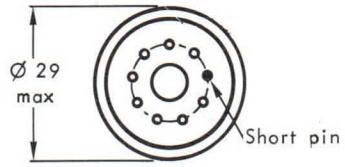
Scanned area of photoconductive layer 12.7 mm x 9.5 mm



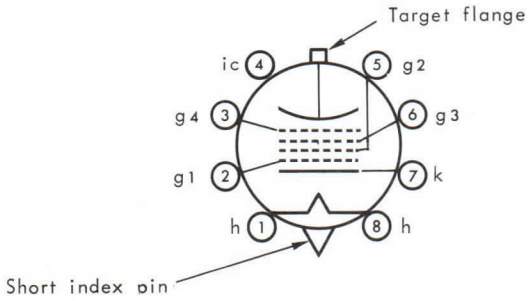
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING

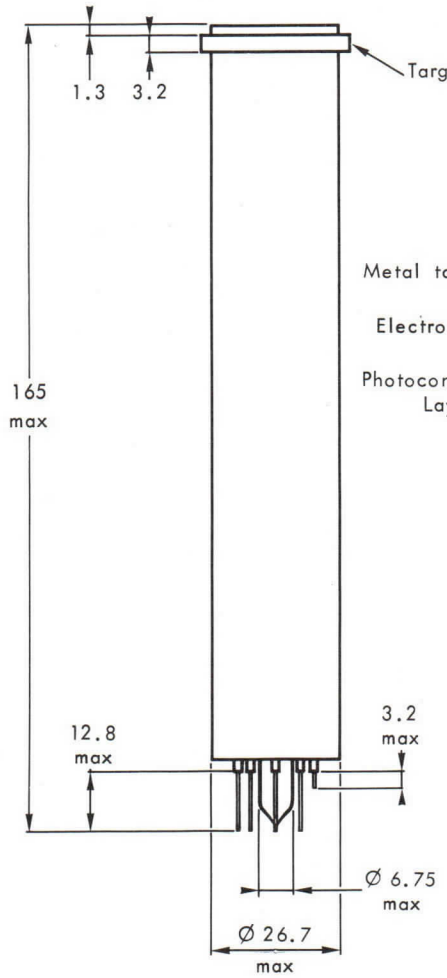
UTE 9C15 base
(JEDEC E8-11)

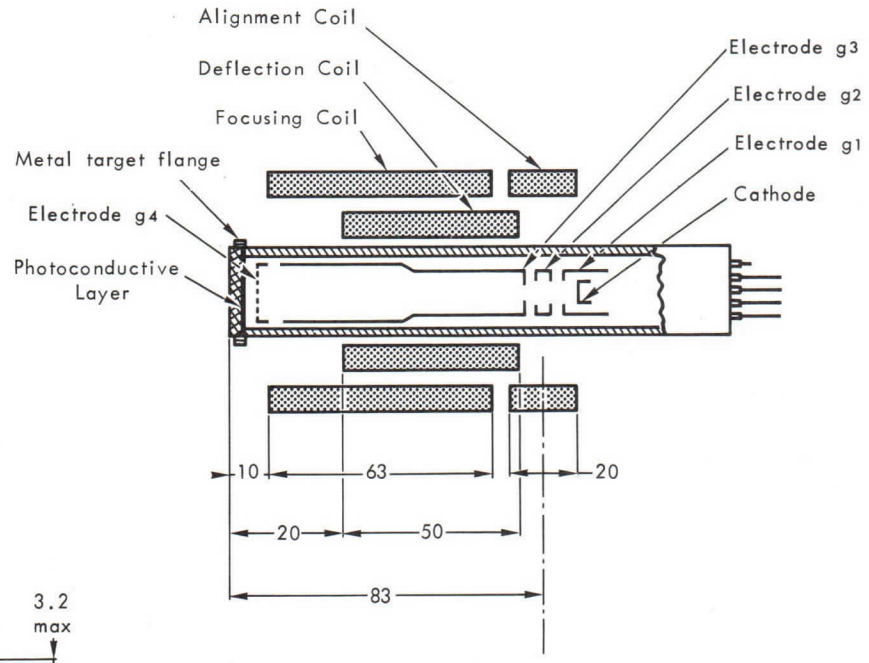


BASING DIAGRAM



1 - Heater	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode
4 - Internal connection	8 - Heater





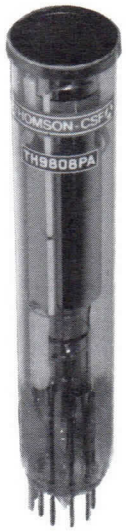
Optimum locating of the tube inside the deflecting - focusing - alignment components

Dimensions in mm.

TH 9808PA
1" VIDICON

- MAGNETIC FOCUS AND DEFLECTION
- HIGH RESOLUTION (1000 T.V. LINES)
- NORMAL SENSITIVITY
- LOW LAG
- HIGH QUALITY INDUSTRIAL C.C.T.V.

TH 9808PA is a 1" Vidicon designed especially for pick-up in high quality TV camaras (black and white or color TV camaras). This tube incorporates in its structure the latest isolated post-acceleration electrode with separate mesh connection. Due to this feature TH 9808PA provides higher resolution, higher output signal capability and better resolution and signal uniformity than previous Vidicons tubes.



TH 9808PA is intended for all industrial T.V. applications and specially for normal light level condition : the quality of image is satisfactory for 10 lux (1fc) scene illumination.

The sensitivity of TH 9808PA can be equivalent to photographic film having an ASA exposure index of 1200 (32/ 10 DIN, 39 Sch). Satisfactory quality picture with good resolution and acceptable signal to noise ratio can be obtained at illumination of 0. 5 lux (50 mf.c) to 1 lux (100 mf.c) on the faceplate (5 to 10 lux on the subject with an unity numerical aperture lens) giving rise to a signal current of 50 nA at 50 nA dark current. For such illuminations higher signal current is obtained by increasing dark current up to 100 nA, value beyond which a signal saturation will occur.

Due to a new low lag photoconductive layer excellent quality of picture can be obtained within a large illumination range with good signal uniformity and appropriate "gamma" characteristics.

TH 9808PA performances are substantially identical under high or low level illumination conditions. Tube sensitivity can be controlled by target voltage which also causes some variation of dark current.

TH 9808PA can be operated over a wide range of electrode voltage selection although recommended adjustment requires a g4 voltage to g3 voltage ratio of 1.4 – 1.5. Under these conditions TH 9808PA can provide an optimum resolution and an uniform signal output over the entire scanned area with a beam landing considerably improved minimizing "porthole" effect and geometrical distortion.

The limiting resolution of TH 9808PA is about 1000 T.V. lines at center of picture and 600 T.V. lines at corner. This high resolution is obtained with 900 V on electrode g4 and 600 V on g3. When the TH 9808PA is operated at a lower g4 voltage of 500 V and g3 voltage of 300 V, its limiting resolution will be 900 T.V. lines at center and 500 T.V. lines at corner. Operating g4 voltage at 1.5 times g3 voltage requires 20% deflection current increase over current necessary for g3 – g4 connected mode. Focusing field is not noticeably changed with such an operation.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Full advantage of resolution and signal uniformity is achieved when deflecting and focusing components are properly designed and when the tube is correctly located inside. The thickness of the photoconductive layer is made very uniform and allows for constant output signal and constant dark current. When landing error due to imperfect scanning system is present, the voltage gradient across the photoconductive layer is not uniform and a signal variation (shading) is introduced which can be compensated by proper adjustment of the cathode, g1 and g2 voltages.

Due to good design, high reliability is obtained throughout the tube life. Requirement for alignment field is reduced to a minimum by precise electron gun mounting. An extremely flat faceplate avoids all optical distortions and allows for the use of any good quality lens. Particle barriers adjacent to the field mesh allows these tubes to operate in any position.

One watt power heater makes these Vidicons particularly suitable for transistorized equipment. The reduced heat dissipation improves the quality of the picture by lowering faceplate temperature.

GENERAL CHARACTERISTICS

Electrical

Cathode	unipotential indirectly heated oxide coated	
Heater :		
- voltage	6. 3	V
- current at 6. 3 V	0. 135 to 0. 165	A
Minimum preheating time	60	s
Output capacitances :		
- target to all other electrodes	4. 5	pF
Spectral response	see curve	
Focusing method	magnetic	
Deflection method	magnetic	

Mechanical

Overall length	max.	164 mm	(6. 46")
Overall diameter	max.	29 mm	(1. 14")
Bulb diameter	max.	26. 7 mm	(1. 03")
Base diameter		UTE 9 C 15 (JEDEC N° E8 - 11)	
Socket (note 1)		METOX N° 30. 250	
Deflecting yoke - Focusing coil assembly (note 2)		GERHARD type BV 200 - 1k1	
Alignment coil (note 2)		GERHARD type BV 80/3	
or Deflecting yoke - Focusing coil - Alignment coil assembly (note 2)		CLEVELAND type VYFA - 355.2	
Photoconductive layer :			
- normal dimensions of image on target		12. 7 mm x 9. 5 mm	
- maximum useful diagonal diameter (4 x 3 aspect ratio)		17 mm	
- orientation of quality rectangle: horizontal scan parallel to the plane passing through the tube axis and short index pin (note 3)			
Mounting position		any	
Net weight, approximate		60 g	

OPERATING CONDITIONS

(All potentials are referred to cathode)

Maximum ratings : *(absolute values)*

Electrode g4 voltage (post-acceleration electrode)		1 000	V
Electrode g3 voltage (wall electrode)		1 000	V
Electrode g2 voltage (accelerator)		350	V
Electrode g1 voltage (electrode for picture cut-off) :			
- negative bias value		150	V
- positive bias value		0	V
Heater voltage	max.	6. 9	V
	min.	5. 7	V
Peak heater cathode voltage :			
- heater negative with respect to cathode		125	V
- heater positive with respect to cathode		10	V
Target voltage		125	V
Dark current		0. 20	µA
Peak target current (note 4)		0. 60	µA
Faceplate :			
- illumination		10 000	lux
		or 1 000	fc
- temperature		70	°C

Operational conditions

Scanned area 12. 7 mm x 9. 5 mm
Faceplate temperature 25 °C (note 5)

Electrode voltage modes :	Low	Intermediate	High	
Electrode g4 voltage	300	500	900	V
Electrode g3 voltage	180	300 to 350	600	V
Electrode g2 voltage	300	300	300	V
Electrode g1 (note 6)	−45 to −110	−45 to −110	−45 to −110	V
Average ' gamma" for a target illumination : between 1 and 100 lux (note 7)	0. 65	0. 65	0. 65	
Minimum blanking peak to peak voltage :				
- applied to electrode g1	− 75	− 75	− 75	V
- applied to cathode	+ 20	+ 20	+ 20	V
Limiting resolution at center of picture (note 8)	800	900	1 000	TV lines
Limiting resolution at corner of picture	400	500	600	TV lines
M.T.F. response at 400 T.V. lines at center of picture (5 MHz–625 CCIR standard) (note 9)	30	40	50	%
Field strength at center of focusing coil	30 ± 2	40 ± 2	50 ± 2	Gauss
Peak deflecting coil current :				
- horizontal	130	170	200	mA
- vertical	15	20	24	mA
Field strength of alignment coil	0 to 4	0 to 4	0 to 4	Gauss

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Typical performance

1 - HIGH LIGHT LEVEL OPERATION
(Faceplate illumination 100 lux or 10 fc)

Dark current i_o	5	nA
Target voltage for i_o = 5 nA (note 10)	10 to 25	V
Faceplate illumintation (2854 °K) (note 11)	100	lux
	or 10	fc
Signal current	300	nA
Lag : (note 12)		
- maximum	15	%
- average	10	%

2 - AVERAGE SENSITIVITY OPERATION
(Faceplate illumination 10 lux or 1 fc)

Dark current i_o	20	nA
Target voltage for i_o = 20 nA (note 10)	20 to 50	V
Faceplate illumination (2854 °K) (note 11)	10	lux
	or 1	fc
Signal current	180	nA
Corresponding sensitivity	150	µA/lm
Target illumination for 100 nA signal current	3	lux
	or 300	mfc
Lag : (note 12)		
- maximum	20	%
- average	12	%

3 - HIGH SENSITIVITY OPERATION
(Faceplate illumination 5 lux or 500 fc)

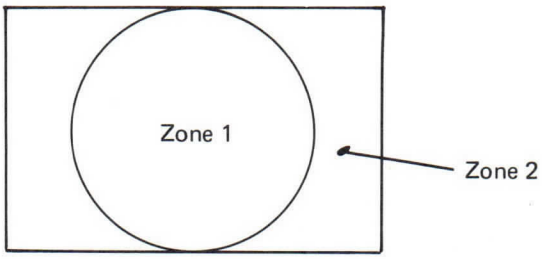
Dark current i_o	50	nA
Target voltage for i_o = 50 nA (note 10)	25 to 60	V
Faceplate illumination (2854 °K) (note 11)	500	mfc
Signal current	200	nA
Corresponding sensitivity	350	µA/lm
Target illumination for 100 nA signal current	1. 5	lux
	or 150	mfc
Lag : (note 12)		
- maximum	20	%
- average	15	%

4 - VERY HIGH SENSITIVITY OPERATION
(Faceplate illumination 1 lux or 100 mfc)

Dark current i_o	100	nA
Target voltage for i_o = 100 nA (note 10)	30 to 70	V
Faceplate illumination (2854 °K) (note 11)	100	mfc
Signal current	100	nA
Corresponding sensitivity	800	µA/lm
Target illumination for 50 nA signal current	0. 3	lux
	or 30	mfc
Lag : (note 12)		
- maximum	20	%
- average	17	%

SPURIOUS SIGNAL TEST

The test is performed using a uniformly diffused white test pattern that is separated into two zones as shown in drawing.



The tube is operated under "Typical Operation" with a dark current of 20 nanoamperes and the lens adjusted to provide a signal current of 200 nanoamperes.

Spurious signals are classified by their size which is measured in percent of raster height.

Will actually be considered as defects, blemishes of contrast greater than 50% (note 12).

Allowable spot size for each zone is shown in table :

*Ratio D / H (Percent raster height)	Number Allowed			
	Zone 1	Zone 1 + Zone 2		
		a	a + b	a + b + c
a : 0.8% < D/H ⩽ 1%	0	1	3	6
b : 0.6% < D/H ⩽ 0.8%	1			
c : 0.2% < D/H ⩽ 0.6%	3			

0.2 % and under : do not count spots of this size unless concentration causes a smudge appearance

* D : average diameter of spot

H : raster height

Smudges, streaks, mottled or grainy background having a contrast ratio greater than 15% constitute a reject.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

NOTES

1 - METOX - 86, rue de Villiers de l'isle Adam - PARIS 20ème - Téléphone : 636. 31-10.

2 - GERHARD KG - REICHELSHEIM/ODW Germany.
CLEVELAND ELECTRONICS Inc. - 2000 Highland Road - TWINSBURG - OHIO 44 - 087.

3 - It is necessary to assure correct positioning of the tube inside the coils. An immediate test consists in observing the fine mesh grid, the wires of which should be inclined 45° with respect to scanning. Then again the front end of the deflecting yoke should be positioned at 20 mm from the tube faceplate.

4 - Target current is defined as total current in load resistance connected to target electrode : signal current plus dark current, dark current being the current left when illumination is subtracted.
Video amplifiers must be designed properly to handle peak target current of 0.6 μA to avoid amplifier overload and picture distortion.

5 - All these characteristics are provided for a temperature of faceplate of 25 °C, the temperature range recommended is within 20 to 30 °C. The rise of faceplate temperature is a function of ambient temperature, thermic dissipation of ambient devices and of the tube itself. Consequently, 10 °C of faceplate temperature rise implies a dark current multiplied by a factor of 2.

6 - Without blanking pulses applied on electrode g1.

7 - Average "gamma' should be defined as the slope of the rectilinear part of transfer characteristics in log coordinates.

8 - Practically, limiting resolution corresponds to the resolution measured with twin bar test card with a modulation ratio of about 7%.

9 - For 625 lines C.C.I.R. standard, line duration being 52 μs (line suppression period not included), 400 TV lines correspond to 5 MHz.

10 - Indicated range of each type of service serves only to illustrate the operating target voltage range normally encountered. The target voltage for each Vidicon must be adjusted to that value which gives the designed operating dark current.

11 - All the above mentioned illumination assume 2854 °K incandescent tungsten source.

12 - Lag is defined as the ratio of residual signal current measured 60 milliseconds after light excitation being removed to the initial signal current ; this value assumes 50 field/second scanning rate.

13 - Contrast is defined as : $100 \times \frac{\text{increment in video current due to blemish}}{\text{normal signal current}}$

Figure 1

TYPICAL SPECTRAL SENSITIVITY CHARACTERISTICS

For equal values of signal current at all wavelengths
(0.02 µA signal current and 0.02 µA dark current
for scanned area of 12.7 x 9.5 mm)

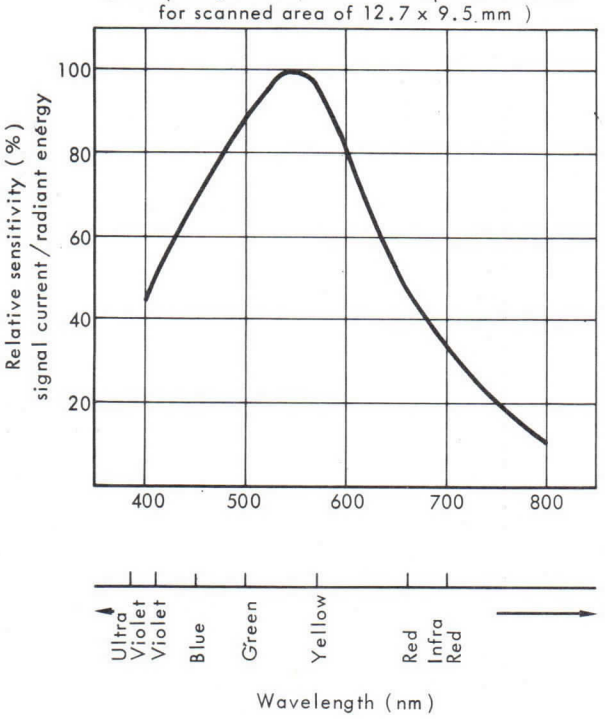


Figure 2

LIGHT TRANSFER CHARACTERISTICS

Illumination uniform over photoconductive layer scanned
area 12.7 x 9.5 mm-face plate temperature 25°C

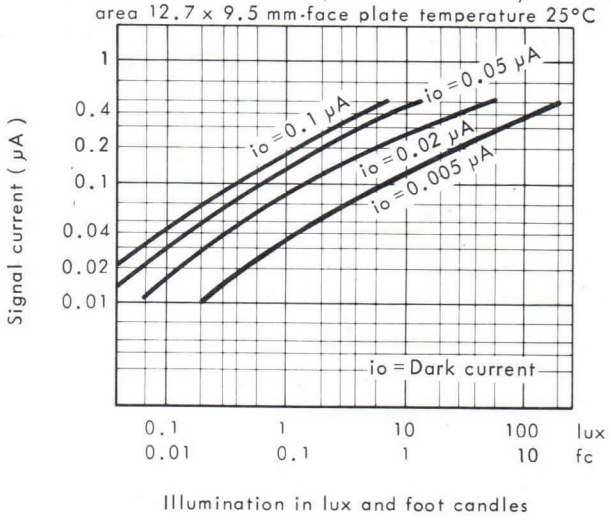
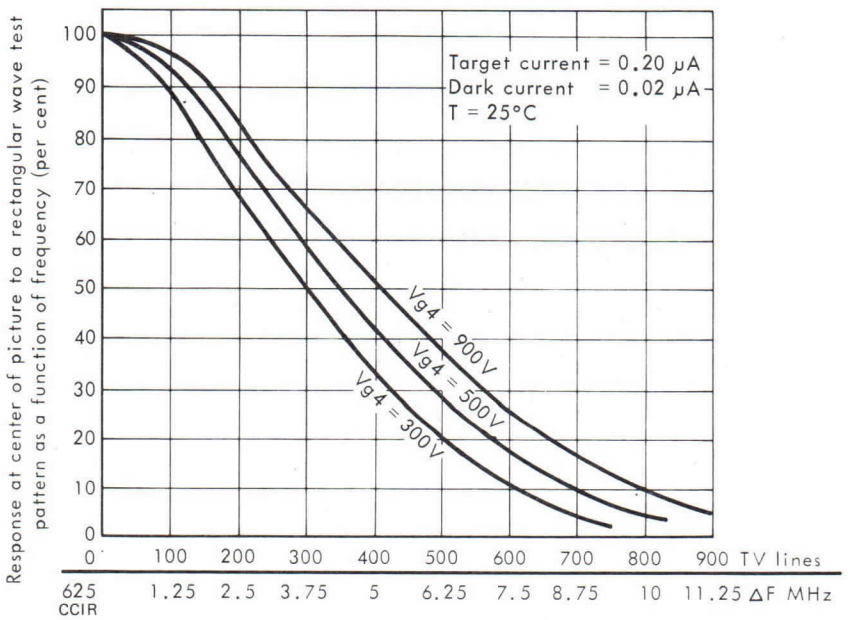


Figure 3

MODULATION TRANSFER FUNCTION



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Figure 4

RANGE OF DARK CURRENT

Scanned area of photoconductive layer 12.7 mm x 9.5 mm

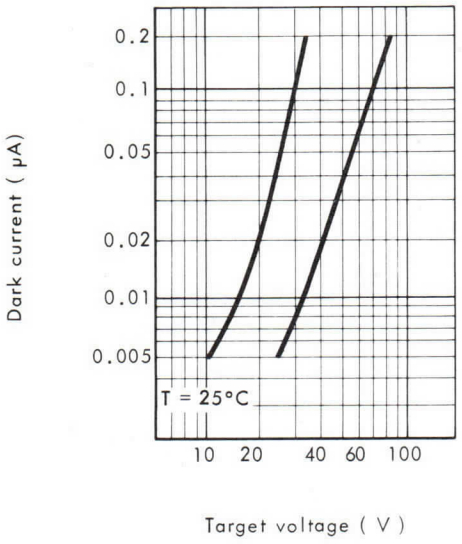


Figure 5

TYPICAL PERSISTENCE CHARACTERISTICS

Initial highlight signal current of 0.2 µA scanned area of photoconductive layer 12.7 mm x 9.5 mm

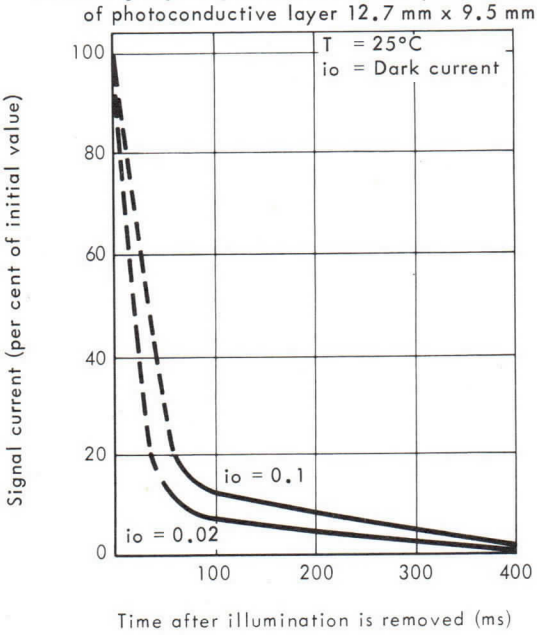
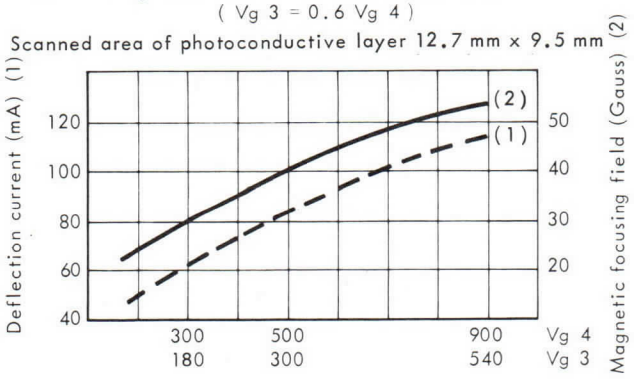


Figure 6

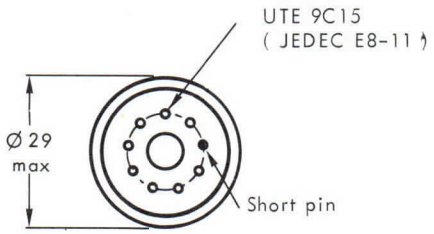
(1) Deflection current as a function of electrode g3 and g4 voltages (Vg 3 = 0.6 Vg 4)

(2) Magnetic field at center of focusing coil (Vg 3 = 0.6 Vg 4)

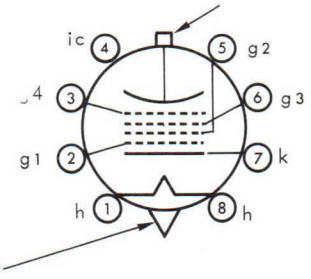
Scanned area of photoconductive layer 12.7 mm x 9.5 mm



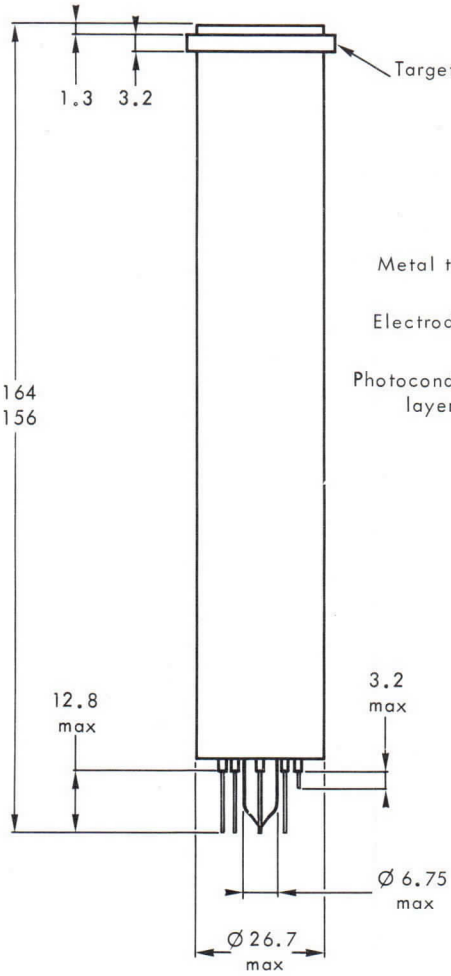
OUTLINE DRAWING

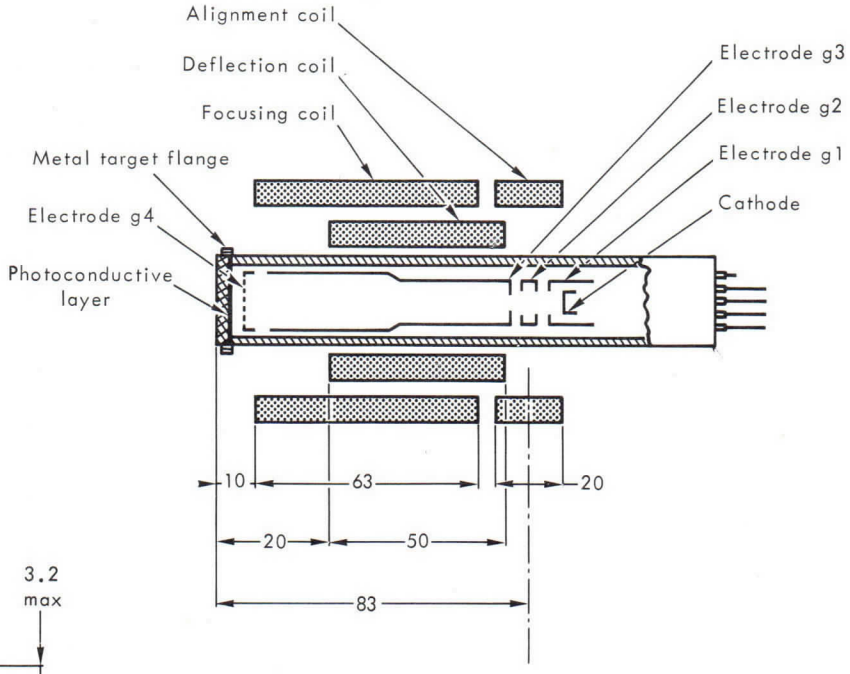


BASING DIAGRAM



1 - Heater	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode
4 - Internal connection	8 - Heater





Optimum locating of the tube inside the deflecting-focusing-alignment components

Dimensions in mm.

TH 9808PA

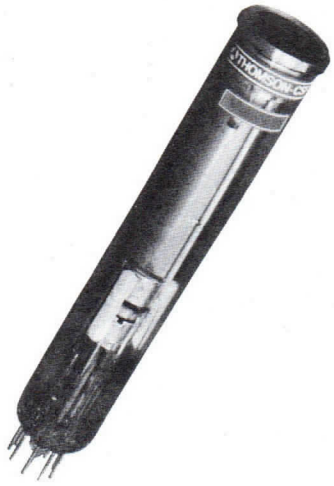
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

THOMSON-CSF

TH 9810
1" VIDICON

- MAGNETIC FOCUS AND DEFLECTION
- HIGH RESOLUTION (850 T.V. LINES)
- LOW LAG
- GENERAL PURPOSE C. C. T. V.

TH 9810 is a 1" Vidicon used for general purpose C.C.T.V. This tube incorporates in its structure the latest isolated post-acceleration electrode with separate external connection.



TH 9810 is intended for normal light level conditions: the quality of image is satisfactory for 100 lux (10 fc) scene illumination.

Satisfactory quality picture with good resolution and acceptable signal to noise ratio can be obtained at illuminations of 1 lux (100 mfc) to 2 lux (200 mfc) on the faceplate (10 to 20 lux on the subject with an unity numerical aperture lens) giving rise to a signal current of 100 nA at 50 nA dark current. For such illuminations, higher signal currents are obtained by increasing the dark current up to 100 nA, value beyond which a signal saturation will occur.

Due to a new low lag photoconductive layer an excellent picture quality can be obtained within a large range of illuminations with good signal uniformity and appropriate "gamma" characteristics.

The tube sensitivity can be controlled by the target voltage which also causes some variation of the dark current.

TH 9810 can be operated over a wide range of electrode voltage selection although the recommended adjustment requires a g4 voltage to g3 voltage ratio of 1.4 - 1.5. Under these conditions TH 9810 can provide an optimum resolution and a uniform signal output over the entire scanned area with a low geometrical distortion.

The limiting resolution of the TH 9810 is about 950 T.V. lines at center of picture and 550 T.V. lines at corner. This high resolution is obtained with 900V on electrode g4 and 600V on g3. When the TH 9810 is operated at a lower g4 voltage of 500V and g3 voltage of 300V, its limiting resolution will be 850 T.V. lines at center and 450 T.V. lines at corner. Operating g4 voltage at 1.5 times g3 voltage requires 20% deflection current increase over the current necessary for "g3 - g4 connected" mode. Focusing field is not noticeably changed with such an operation.

Full advantage of resolution and signal uniformity is achieved when the deflecting and focusing components are properly designed and when the tube is correctly located inside. The thickness of the photoconductive layer is made very uniform and allows for a constant output signal and a constant dark current. When the landing error due to an imperfect scanning system is present, the voltage gradient across the photoconductive layer is not uniform and a signal variation (shading) is introduced which can be compensated by proper adjustment of the cathode, g1 and g2 voltages.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Due to good design, high reliability is obtained throughout the tube life. The necessary alignment field is reduced to a minimum by precise electron gun mounting. An extremely flat faceplate avoids all optical distortions and permits the use of any good quality lens. Particle barriers adjacent to the field mesh allow these tubes to operate in any position.

One watt power heater makes these Vidicons particularly suitable for transistorized equipment. The reduced heat dissipation improves the quality of the picture by lowering faceplate temperature.

GENERAL CHARACTERISTICS

Electrical

Heater	for unipotential cathode indirectly heated	
Heater :		
- Voltage	6.3 ± 10%	V
- Current at 6.3V	0.15	A
Minimum preheating time	60	s
Output capacitances :		
- Target to all other electrodes	4.5	pF
Spectral response	see curve	
Focusing method	magnetic	
Deflection method	magnetic	

Mechanical

Base (Ditetrar, 8 pins)	UTE 9C15 (JEDEC N° E8 - 11)	
Socket (note 1)	METOX N° 30.250	
Deflecting yoke (note 2)	GERHARD BV 200 - 1k1	
Dimensions	see drawing	
Photoconductive layer :		
- Normal dimensions of image on target	12.7 x 9.5	mm
- Maximum useful diagonal diameter (4 x 3 aspect ratio)	17	mm
Orientation of quality rectangle : Horizontal scan parallel to the plane passing through the tube axis and short index pin (note 3)		
Maximum temperature of faceplate	70	°C
Mounting position	any	
Net weight, approximate	60	g

OPERATING CONDITIONS

Scanned area 12.7 x 9.5 mm

Maximum ratings

E lectrode g4 voltage (post-acceleration electrode)	1000	V
Electrode g3 voltage (wall electrode)	1000	V
Electrode g2 voltage (accelerator)	350	V
Electrode g1 voltage (electrode for picture cut-off)		
- Negative bias value	300	V
- Positive bias value	0	V
Target voltage	125	V
Dark current	0.20	µA
Peak target current (note 4)	0.60	µA
Faceplate :		
- Illumination	10000 or 1000	lux fc
- Temperature	70	°C

Typical operation

Scanned area 12.7 x 9.5 mm
Faceplate temperature 25 °C (note 5)

Electrode voltage modes :	Low	Intermediate	High	
Electrode g4 voltage	300.	500	900	V
Electrode g3 voltage	180	300 to 350	600	V
Electrode g2 voltage	300	300	300	V
Electrode g1 (note 6)	-45 to -110	-45 to -110	-45 to -110	V
Average "gamma" for a target illumination between 1 and 100 lux (note 7)	0.65	0.65	0.65	
Minimum blanking peak to peak voltage :				
- Applied to electrode g1	−75	−75	−75	V
- Applied to cathode	+20	+20	+20	V
Limiting resolution at center of picture (note 8)	750	850	950	TV lines
Limiting resolution at corner of picture.	350	450	550	TV lines
M.T.F. response at 400 T.V. lines at center of picture (5 MHz - 625 CCIR standard)(note 9)	25	35	45	%
Field at center of focusing coil	30 ± 2	40 ± 2	50 ± 2	Gauss
Peak deflecting coil current :				
- Horizontal	130	170	200	mA
- Vertical	15	20	24	mA
Field of alignment coil	0 to 4	0 to 4	0 to 4	Gauss

1 - HIGH LIGHT LEVEL OPERATION

(faceplate illumination 100 lux or 10 fc)

Dark current io	5	nA
Target voltage for io = 5 nA (note 10)	10 to 25	V
Faceplate illumination (2854 °K) (note 11)	100	lux
	or 10	fc
Signal current	250	nA
Lag : (note 12)		
- Maximum	15	%
- Average	10	%

2 - AVERAGE SENSITIVITY OPERATION

(faceplate illumination 10 lux or 1 fc)

Dark current io	20	nA
Target voltage for io = 20 nA (note 10)	15 to 50	V
Faceplate illumination (2854 °K) (note 11)	10	lux
	or 1	fc
Signal current	150	nA
Corresponding sensitivity	125	µA/lm
Target illumination for 100 nA signal current	5	lux
	or 500	mfc
Lag : (note 12)		
- Maximum	20	%
- Average	12	%

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

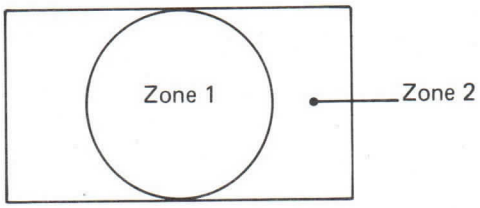
3 - HIGH SENSITIVITY OPERATION

(faceplate illumination 5 lux or 500 mfc)

Dark current io	50	nA
Target voltage for io = 50 nA (note 10)	20 to 60	V
Faceplate illumination (2854 °K) (note 11)	5 lux or 500	mfc
Signal current	180	nA
Corresponding sensitivity	300	µA/lm
Target illumination for 100 nA signal current	2	lux
	or 200	mfc
Lag : (note 12)		
- Maximum	20	%
- Average	15	%

4 - SPURIOUS SIGNAL TEST

The test is performed using a uniformly diffused white test pattern that is separated into two zones as shown in drawing



The tube is operated under the "Typical Operation" conditions with a dark current of 20 nanoamperes and the lens adjusted to provide a signal current of 200 nanoamperes.

Spurious signals are classified by their size, which is measured in percent of raster height.

Will actually be considered as defects, blemishes of contrast greater than 50% (note 13).

Allowable spot size for each zone is shown in table :

Ratio D/H * (Percent raster height)	Number Allowed			
	Zone 1	Zone 1 + Zone 2		
		a	a + b	a + b + c
a : 0.8 % < D/H ⩽ 1 %	1	2	5	8
b : 0.6 % < D/H ⩽ 0.8 %	3			
c : 0.2 % < D/H ⩽ 0.6 %	4			

0.2 % and under : do not count spots of this size unless concentration causes a smudge appearance.

* D : average diameter of spot
H : raster height

Smudges, streaks, mottled or grainy background having a contrast ratio greater than 15 % constitute a reject.

NOTES

1 - METOX - 86, rue de Villiers de l'isle Adam - PARIS 20ème
Téléphone : 636 31 10

2 - GERHARD KG - REICHELSHEIM / ODW Germany

3 - It is necessary to assure correct positioning of the tube inside the coils. An immediate test consists in observing the fine mesh grid, the wires of which should be inclined 45° with respect to scanning. Then again the front end of the deflecting yoke should be positioned at 20 mm from the tube faceplate.

4 - Target current is defined as total current in load resistance connected to target electrode: signal current plus dark current, dark current being the current left when illumination is subtracted.
Video amplifiers must be designed properly to handle peak target current of 0.7 μA to avoid amplifier overload and picture distortion.

5 - All these characteristics are provided for a temperature of faceplate of 25 °C, the temperature range recommended is within 20 to 30 °C. The rise of faceplate temperature is a function of ambient temperature, thermic dissipation of ambient devices and of the tube itself. Consequently, 10 °C of faceplate temperature rise implies a dark current multiplied by a factor of 2.

6 - Without blanking pulses applied on electrode g1.

7 - Average "gamma" should be defined as the slope of the rectilinear part of transfer characteristics in log coordinates.

8 - Pratically, limiting resolution corresponds to the resolution measured with twin bar test card with a modulation ratio of about 7 %.

9 - For 625 lines C.C.I.R. standard, line duration being 52 μs (line suppression period not included), 400 TV lines correspond to 5 MHz.

10 - Indicated range of each type of service serves only to illustrate the operating target voltage range normally encountered. The target voltage for each Vidicon must be adjusted to that value which gives the designed operating dark current.

11 - All the above mentioned illumination assume 2854 °K incandescent tungsten source.

12 - Lag is defined as the ratio of residual signal current measured 60 milliseconds after light excitation being removed to the initial signal current : this value assumes 50 field/second scanning rate.

13 - Contrast is defined as : $100 \times \frac{\text{increment in video current due to the blemish}}{\text{normal signal current}}$

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Figure 1

TYPICAL SPECTRAL SENSITIVITY CHARACTERISTICS

For equal values of signal current at all wavelengths
(0.02 μA signal current and 0.02 μA dark current
for scanned area of 12.7 x 9.5 mm)

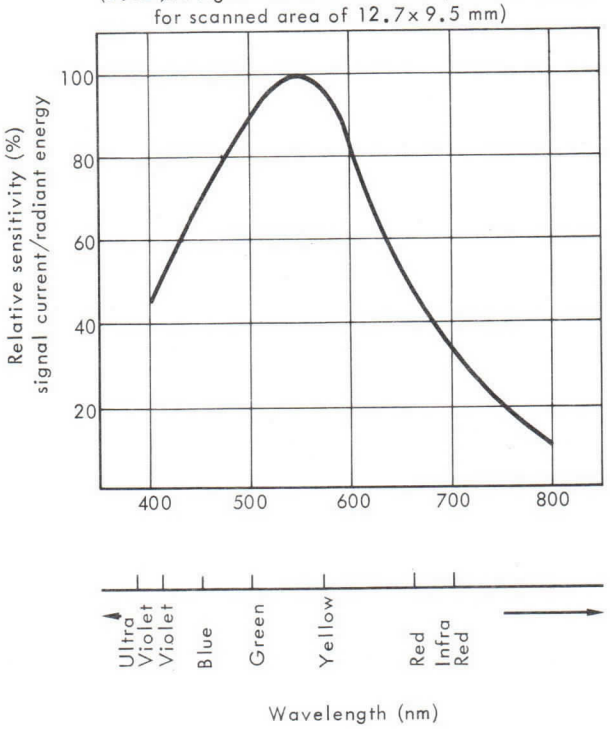


Figure 2

LIGHT TRANSFER CHARACTERISTICS

Illumination uniform over photoconductive layer scanned
area 12.7 x 9.5 mm-face plate temperature 25°C

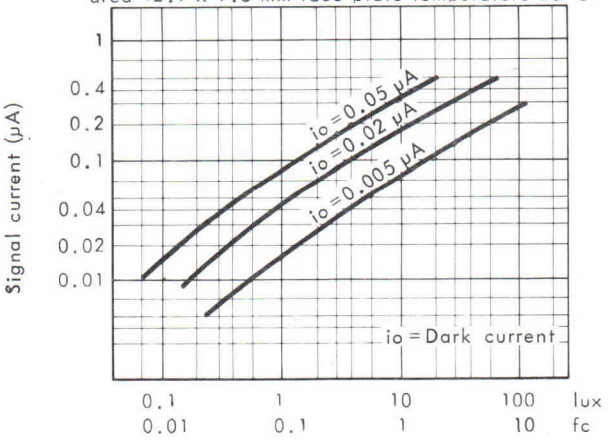


Figure 3

RANGE OF DARK CURRENT
Scanned area of photoconductive layer 12.7 x 9.5 mm

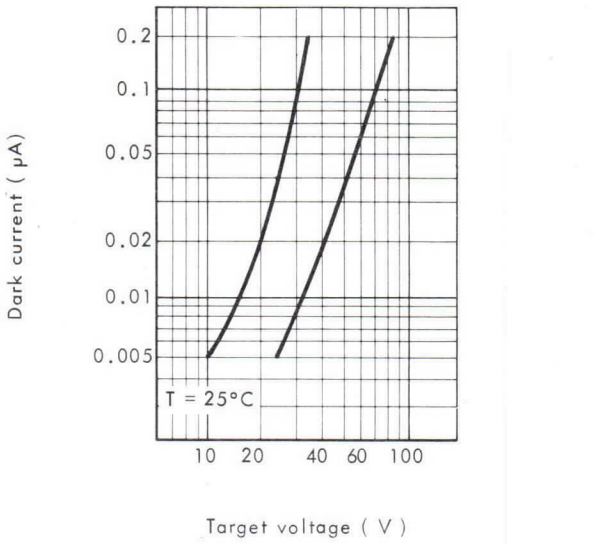


Figure 4

TYPICAL PERSISTENCE CHARACTERISTICS
Initial highlight signal current of 0.2 µA scanned area of photoconductive layer 12.7x9.5 mm

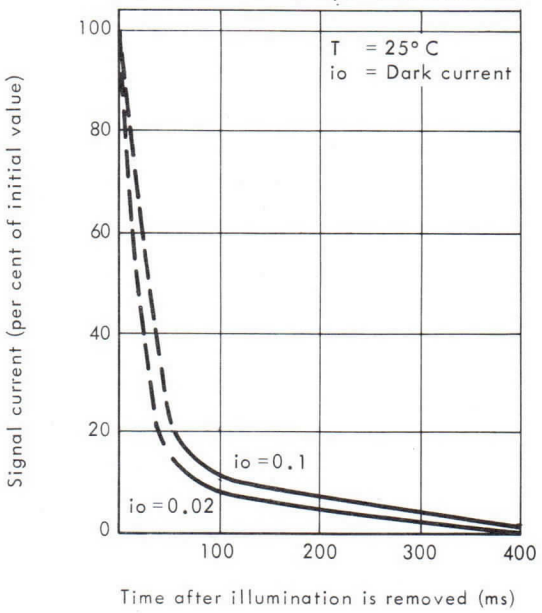
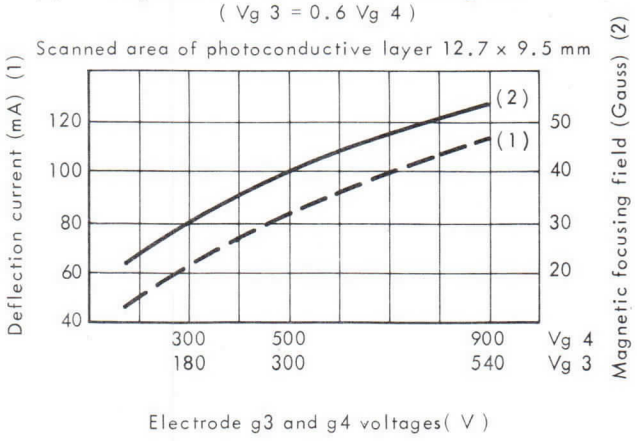


Figure 5

(1) Deflection current as a function of electrode g3 and g4 voltages (Vg 3 = 0.6 Vg 4)

(2) Magnetic field at center of focusing coil (Vg 3 = 0.6 Vg 4)

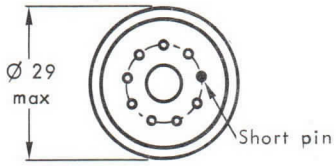
Scanned area of photoconductive layer 12.7 x 9.5 mm



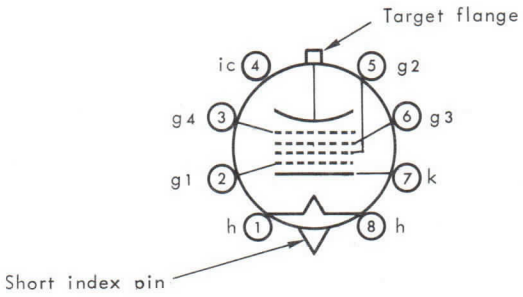
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING

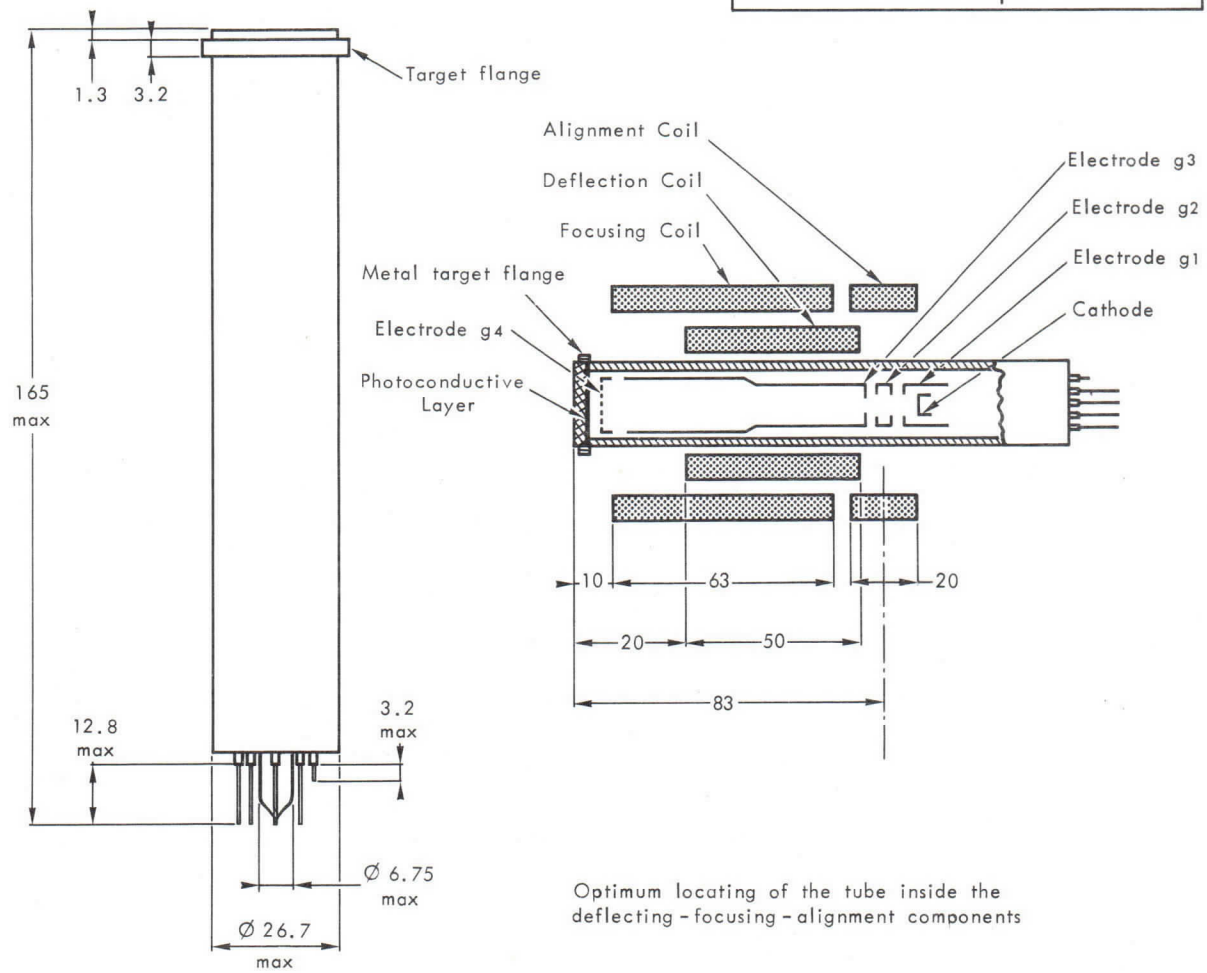
UTE 9C15 base
(JEDEC E8-11)



BASING DIAGRAM



1 - Heater	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode
4 - Internal connection	8 - Heater

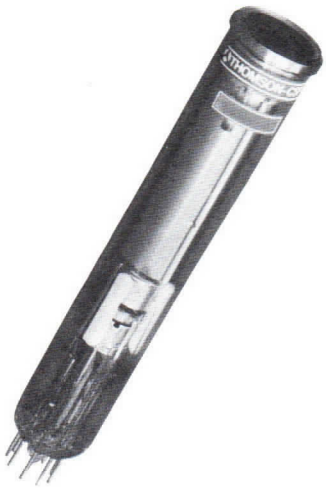


Optimum locating of the tube inside the deflecting - focusing - alignment components

Dimensions in mm.

TH 9812 PA
1" VIDICON

- MAGNETIC FOCUS AND DEFLECTION
- HIGH RESOLUTION(900 TV LINES)
- HIGH SENSITIVITY (900 μA/lm WITH 1 lux ON FACEPLATE)
- LOW LAG
- INDUSTRIAL TV



TH 9812PA is a 1" Vidicon especially designed for pick-up high quality TV cameras (black and white or color cameras). This tube incorporates in its structure the latest isolated post-acceleration electrode with separate mesh connection. Due to this feature TH 9812PA provides higher resolution, higher output signal capability and better resolution and signal uniformity than previous Vidicon tubes.

TH 9812PA is intended for industrial TV applications, specially for low light level condition : the quality of image is satisfactory for scene illumination of 5 lux (0.5 fc) and even less.

The sensitivity of TH 9812PA can be equivalent to photographic film having an ASA exposure index of 2000 (34/10 DIN, 41 Sch). Satisfactory quality picture with good resolution and acceptable signal to noise ratio can be obtained at illumination of 0.3 lux (30 mfc) on the faceplate (3 to 6 lux on the subject with an unity numerical aperture lens) giving rise to a signal current of 50 nA at 50 nA dark current. For such illuminations, higher signal current is obtained by increasing dark current up to 100 nA value beyond which a signal saturation will occur.

Due to a new low lag photoconductive layer excellent quality of picture can be obtained within a large illumination range with good signal uniformity and appropriate "gamma" characteristics.

TH 9812PA performances are substantially identical under high or low level illumination conditions. Tube sensitivity can be controlled by target voltage which also causes some variation of dark current.

TH 9812PA can be operated over a wide range of electrode voltage selection although recommended adjustment requires a g4 voltage to g3 voltage ratio of 1.4 - 1.5. Under these conditions TH 9812PA can provide an optimum resolution and a uniform signal output over the entire scanned area with a beam landing considerably improved minimizing "porthole" effect and geometrical distortion.

The limiting resolution of TH 9812PA at the center of the picture is about 1000 T.V. lines and about 600 T.V. lines at the corner. This high resolution is obtained with electrode g4 voltage of 900 V and electrode g3 voltage of 600 V. When TH 9812PA is operated at a lower g4 voltage of 500 V and a g3 voltage of 300 to 350 V, its resolution will be about 900 T.V. lines at the center and 500 T.V. lines at the corner. Operating g4 voltage at 1.5 times g3 voltage requires a 20 % deflection current increase over current necessary for g3 - g4 connected electrodes mode. Focusing field is not noticeably changed with such an operation.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Full advantage of resolution and signal uniformity is achieved when deflecting and focusing components are properly designed and when the tube is correctly located inside. The thickness of the photoconductive layer is made very uniform and allows for constant output signal and constant dark current. When landing error due to imperfect scanning system is present, the voltage gradient across the photoconductive layer is not uniform and a signal variation (shading) is introduced which can be compensated by proper adjustment of the cathode, g1 and g2 voltages.

Due to good design, high reliability is obtained thoughout the tube life. Requirement for alignment field is reduced to a minimum by precise electron gun mounting. An extremely flat faceplate avoids all optical distortions and allows for the use of any good quality lens. Particle barriers adjacent to the field mesh allows these tubes to operate in any position.

One watt power heater makes these Vidicons particularly suitable for transistorized equipment. The reduced heat dissipation improves the quality of the picture by lowering faceplate temperature.

GENERAL CHARACTERISTICS

Electrical

Heater	for unipotential cathode indirectly heated
Heater :	
voltage	6.3 ± 10 % V
current at 6.3 V	0.15 A
Minimum preheating time	60 s
Output capacitances :	
target to all other electrodes	4.5 pF
Spectral response	see curve
Focusing method	magnetic
Deflection method	magnetic

Mechanical

Base (Ditetrar, 8 pins)	UTE 9 C 15 (JEDEC N° E8 - 11)
Socket (note 1)	METOX N° 30.250
Deflecting yoke - focusing coil assembly (note 2)	GERHARD type BV 200 1K 1 or equivalent
Alignment coil (note 2)	GERHARD type BV 80/3 or equivalent
Deflection - focus - alignment assembly (note 2)	CLEVELAND VYFA - 355 - 2 or equivalent
Dimensions	see drawing
Photoconductive layer :	
normal dimensions of image on target	12.7 mm x 9.5 mm
maximum useful diagonal diameter (4 x 3 aspect ratio)	17 mm
orientation of quality rectangle : horizontal scan parallel to the plane passing through the tube axis and short index pin (note 3)	
Maximum temperature of faceplate	70 °C
Mounting position	any
Net weight, approximate	60 g

OPERATING CONDITIONS

SCANNED AREA 12. 7 mm x 9. 5 mm

Maximum ratings (Absolute values)

Electrode g4 voltage (post acceleration electrode)	1000	V
Electrode g3 voltage (wall electrode)	1000	V
Electrode g2 voltage (accelerator)	350	V
Electrode g1 voltage (electrode for picture cut-off) :		
negative bias value	150	V
positive bias value	0	V
Peak heater cathode voltage :		
heater negative with respect to cathode	125	V
heater positive with respect to cathode	10	V
Target voltage	125	V
Dark current	0. 20	µA
Peak target current (note 4)	0. 60	µA
Faceplate :		
illumination	10000	lux
	or 1000	fc
temperature	70	°C

Typical operation

SCANNED AREA 12. 7 x 9. 5 mm
FACEPLATE TEMPERATURE 25 °C (note 5)

Electrode voltage modes :	Low	Intermediate	High	
Electrode g4 voltage	300	500	900	V
Electrode g3 voltage	180	300 to 350	600	V
Electrode g2 voltage	300	300	300	V
Electrode g1 (note 6)	-45 to - 110	-45 to - 110	-45 to - 110	V
Average "gamma" for a target illumination between 1 and 100 lux (note 7)	0. 65	0. 65	0. 65	
Minimum blanking peak to peak voltage :				
applied to electrode g1	-75	-75	-75	V
applied to cathode	+20	+20	+20	V
Limiting resolution at center of picture — (note 8)	800	900	1000	TV lines
Limiting resolution at corner of picture	400	500	600	TV lines
M.T.F. response at 400 T.V. lines at center of picture (5 MHz - 625 CCIR standard) (note 9)	30	40	50	%
Field strength at center of focusing coil	30 ± 2	40 ± 2	50 ± 2	Gauss
Peak deflecting coil current :				
horizontal	130	170	200	mA
vertical	15	20	24	mA
Field strength of alignment coil	0 to 4	0 to 4	0 to 4	Gauss

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

1 - HIGH LIGHT LEVEL OPERATION

(faceplate illumination 100 lux or 10 fc)

Dark current i_o	5	nA
Target voltage for i_o = 5 nA (note 10)	10 to 25	V
Faceplate illumination (2854 °K) (note 11)	100	lux
	or 10	fc
Signal current	350	nA
Lag : (note 12)		
– maximum	15	%
– average	10	%

2 - AVERAGE SENSITIVITY OPERATION

(faceplate illumination 10 lux or 1 fc)

Dark current i_o	20	nA
Target voltage for i_o = 20 nA (note 10)	20 to 50	V
Faceplate illumination (2854 °K (note 11)	10	lux
	or 1	fc
Signal current	250	nA
Corresponding sensitivity	200	µA/lm
Target illumination for 100 nA signal current	1.5	lux
	or 150	mfc
Lag : (note 12)		
– maximum	20	%
– average	12	%

3 - HIGH SENSITIVITY OPERATION

(faceplate illumination 1 lux or 100 mfc)

Dark current i_o	50	nA
Target voltage for i_o = 50 nA (note 10)	25 to 60	V
Faceplate illumination (2854 °K) (note 11)	1	lux
	or 100	mfc
Signal current	110	nA
Corresponding sensitivity	900	µA/lm
Target illumination for 100 nA signal current	0.8	lux
	or 80	mfc
Lag : (note 12)		
– maximum	20	%
– average	15	%

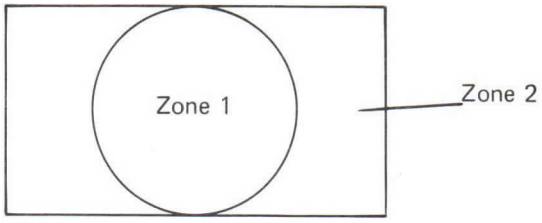
4 - VERY HIGH SENSITIVITY OPERATION

(faceplate illumination 0.5 lux or 50 mfc)

Dark current i_o	100	nA
Target voltage for i_o = 100 nA (note 10)	30 to 70	V
Faceplate illumination (2854 °K) (note 11)	0.5	lux
	or 50	mfc
Signal current	100	nA
Corresponding sensitivity	1500	µA/lm
Target illumination for 50 nA signal current	0.1	lux
	or 10	mfc
Lag : (note 12)		
– maximum	20	%
– average	17	%

5 - SPURIOUS SIGNAL TEST

The test is performed using a uniformly diffused white test pattern that is separated into two zones as shown in drawing.



The tube is operated under the "Typical operation" condition with a dark current of 20 nanoampères and the lens adjusted to provide a signal current of 200 nanoampères.

Spurious signals are classified by their size, which is measured in percent of raster height.

Will actually be considered as defects, spot blemishes (black or white spots) of 30 % minimal contrast (note 13).

Allowable spot size for each zone is shown in table :

Ratio D/H* (Percent raster height)	Number allowed	
	Zone 1	Zone 2
D/H $>$ 1 %	0	0
0.8 $<$ D/H $\leqslant$ 1 %	0	2
0.5 $\leqslant$ D/H $\leqslant$ 0.8 %	2	4
D/H $<$ 0.5 %	3	allowed
Total spots	6	

Spot blemishes with contrast less than 30 % :

- if D/H $\leqslant$ 1 % , are allowed
- if D/H $\leqslant$ 2 %, five defects are allowed.

* *D : average diameter of spot* *H : raster height*

Smudges, streaks, mottled or grainy background having a contrast ratio less than 15 % are allowed.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

NOTES

1 — METOX - 86, rue de Villiers de l'isle Adam - PARIS 20ème
Téléphone : 636 - 31 - 10

2 — GERHARD KG - REICHELSHEIM / ODW Germany
CLEVELAND ELECTRONICS INC. 2000 Highland Road - TWINSBURG - OHIO 44 087.

3 — It is necessary to assure correct positioning of the tube inside the coils. An immediate test consists in observing the fine mesh grid, the wires of which should be inclined 45 ° with respect to scanning. Then again the front end of the deflecting yoke should be positioned at 20 mm from the tube faceplate.

4 — Target current is defined as total current in load resistance connected to target electrode : signal current plus dark current, dark current being the current left when illumination is subtracted.
Video amplifiers must be designed properly to handle peak target current of 0.7 μA to avoid amplifier overload and picture distortion.

5 — All these characteristics are provided for a temperature of faceplate of 25 °C, the temperature range recommended is within 20 to 30 °C. The rise of faceplate temperature is a function of ambient temperature, thermic dissipation of ambient devices and of the tube itself. Consequently, 10 °C of faceplate temperature rise implies a dark current multiplied by a factor of 2.

6 — Without blanking pulses applied on electrode g1.

7 — Average "gamma" should be defined as the slope of the rectilinear part of transfer characteristics in log coordinates.

8 — Practically, limiting resolution corresponds to the resolution measured with twin bar test card with a modulation ratio of about 7 %.

9 — For 625 lines C.C.I.R. standard, line duration being 52 μs (line suppression period not included), 400 TV lines correspond to 5 MHz.

10 — Indicated range of each type of service serves only to illustrate the operating target voltage range normally encountered. The target voltage for each Vidicon must be adjusted to that value which gives the designed operating dark current.

11 — All the above mentioned illumination assume 2854 °K incandescent tungsten source.

12 — Lag is defined as the ratio of residual signal current measured 60 milliseconds after light excitation being removed to the initial signal current ; this value assumes 50 field/second scanning rate.

13 — Contrast is defined as :

$$100 \times \frac{\text{increment in video current due to the blemish}}{\text{normal signal current}}$$

Figure 1

TYPICAL SPECTRAL SENSITIVITY CHARACTERISTICS

For equal values of signal current at all wavelengths
(0.02 µA signal current and 0.02 µA dark current
for scanned area of 12.7 x 9.5 mm)

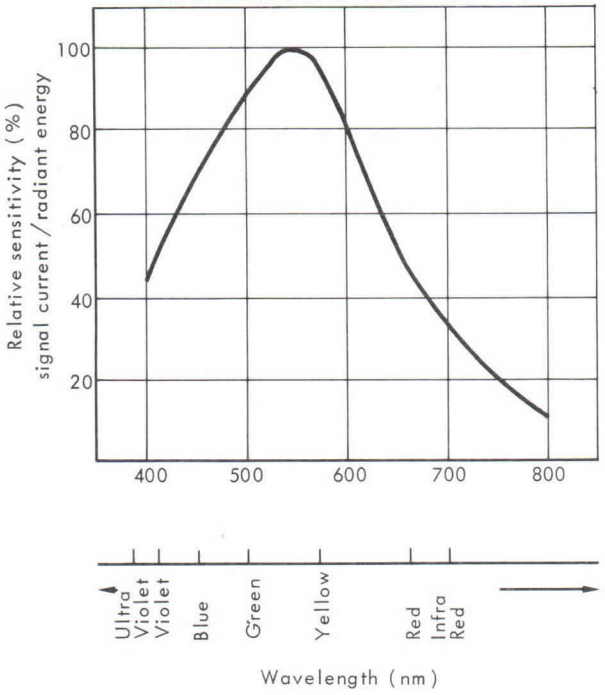


Figure 2

LIGHT TRANSFER CHARACTERISTICS

Illumination uniform over photoconductive layer scanned
area 12.7 x 9.5 mm-face plate temperature 25°C

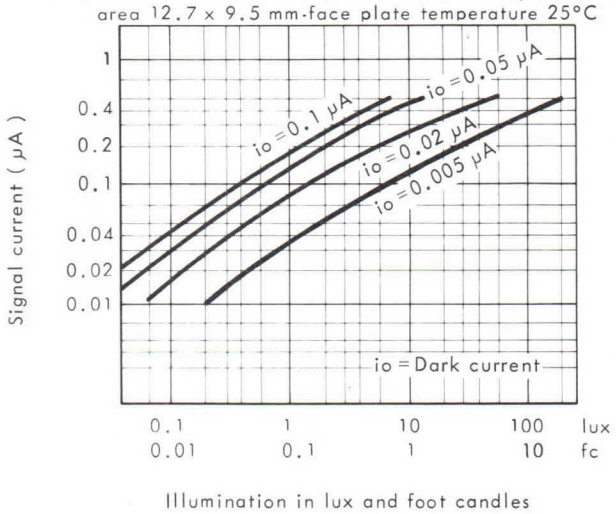
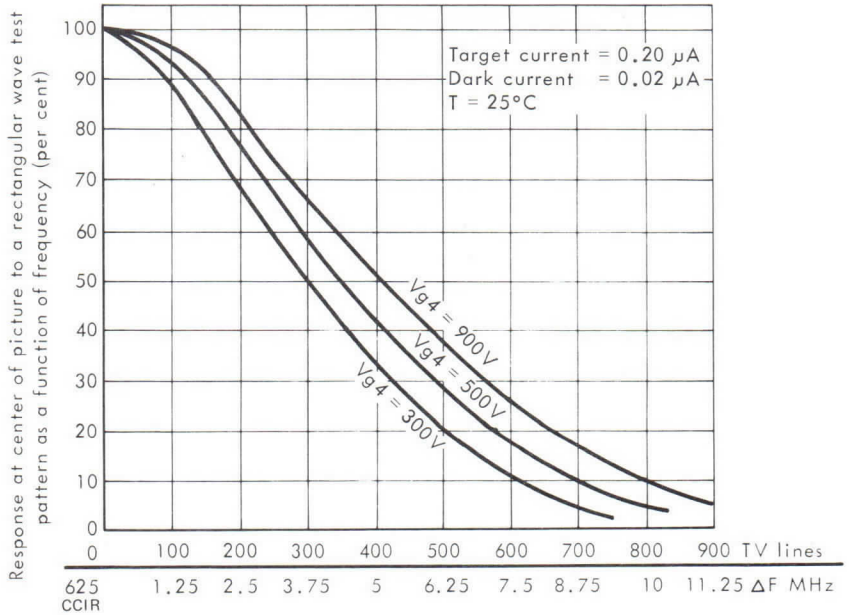


Figure 3

MODULATION TRANSFER FUNCTION



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Figure 4

RANGE OF DARK CURRENT

Scanned area of photoconductive layer 12.7 mm x 9.5 mm

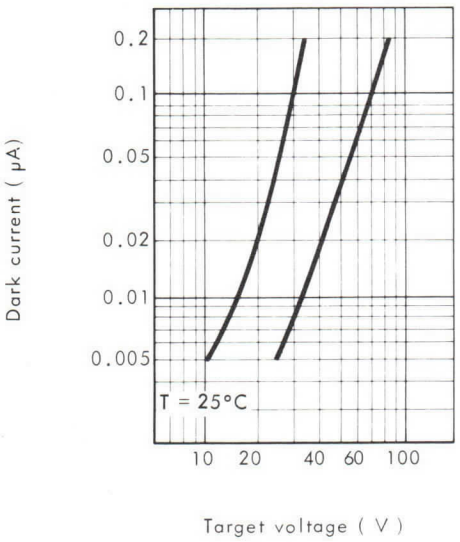


Figure 5

TYPICAL PERSISTENCE CHARACTERISTICS

Initial highlight signal current of 0.2 µA scanned area of photoconductive layer 12.7x 9.5 mm

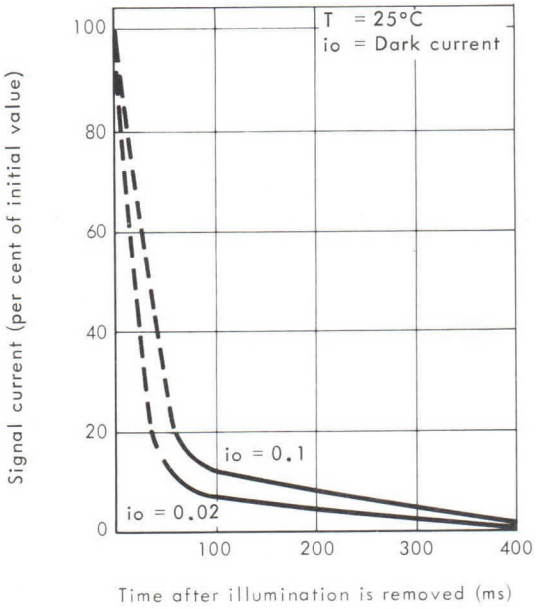
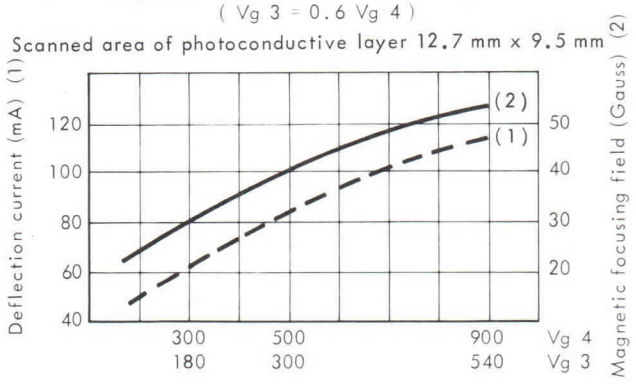


Figure 6

(1) Deflection current as a function of electrode g3 and g4 voltages (Vg 3 = 0.6 Vg 4)

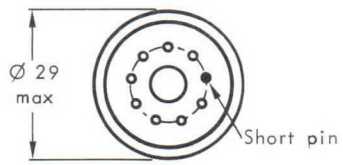
(2) Magnetic field at center of focusing coil (Vg 3 = 0.6 Vg 4)

Scanned area of photoconductive layer 12.7 mm x 9.5 mm

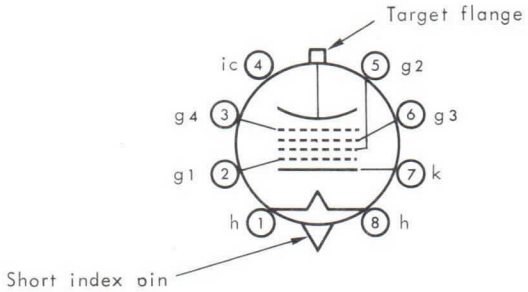


OUTLINE DRAWING

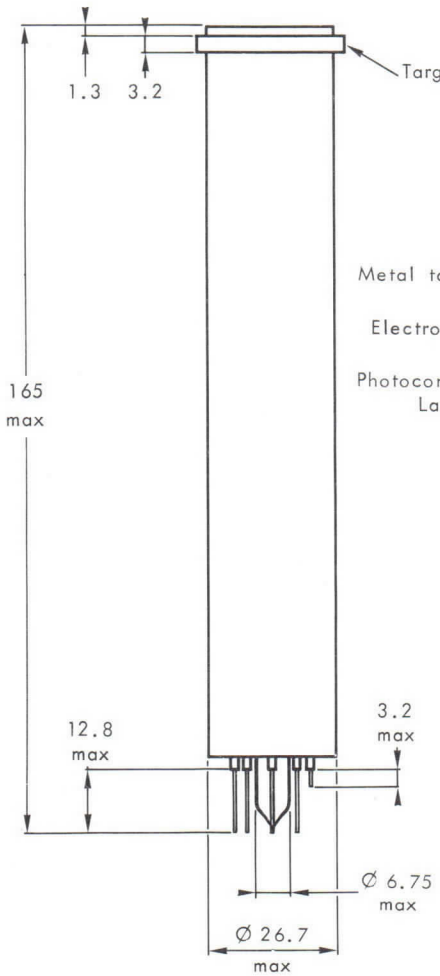
UTE 9C15 base
(JEDEC E8-11)

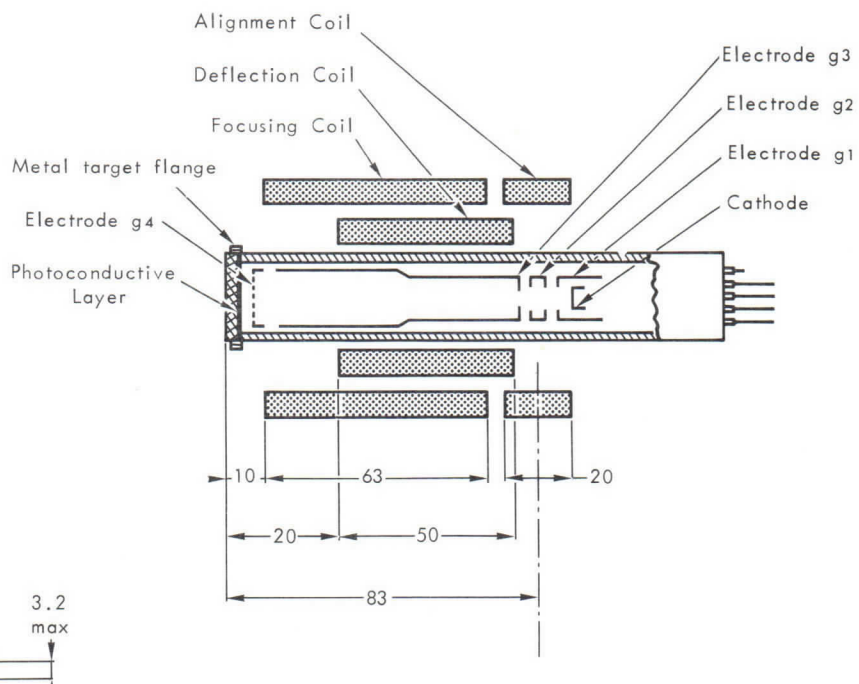


BASING DIAGRAM



1 - Heater	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode
4 - Internal connection	8 - Heater





Optimum locating of the tube inside the deflecting - focusing - alignment components

Dimensions in mm.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

THOMSON-CSF

TH 9813

1" VIDICON

- ELECTROSTATIC FOCUS - MAGNETIC DEFLECTION
- EXCELLENT RESOLUTION (750 TV Lines)
- HIGH SENSITIVITY
- GOOD RASTER LINEARITY
- LOW LAG
- INDUSTRIAL C.C.T.V.

TH 9813 is a 1" (26 mn) diameter, electrostatic focus and magnetic deflection Vidicon designed for compact lightweight camera and especially for transistorized and other closed-circuit TV applications.

The focusing of the scanning electron beam is achieved through a separate electrode adjusted at proper voltage. The focusing coil used with conventional magnetic focus and deflection Vidicon is supressed.

TH 9813 exhibits all high performances obtained with conventional Vidicon, but, in addition, advantages of this new Vidicon type are the following :

- Dimensions and weight of camera are reduced ; outer diameter of Vidicon and associated deflecting yoke does not exceed 40 mm.
- Important reduction of electrical power requirements. Scanning power is reduced by a factor higher than 4 in the case of standard deflecting yoke. Smaller size, low impedance yoke can be designed and allows for more reduction in scanning power. On the other hand, power required for focus electrode is negligible.
- Excellent resolution uniformity is achieved on the entire scanned area and is maintained with high output signal current. Limiting resolution can be improved by the use of a very weak alignment magnetic field.
- Output signal uniformity is improved by a field electrode g5 with separate connection ; g5 voltage is optimum at 1.4 to 1.6 times g4 voltage. In this way beam landing error is minimized and extremely good uniformity of signal and resolution over the entire scanned area is obtained.

A limiting resolution in excess of 750 TV lines with a good resolution uniformity is obtained when the tube is operated at g5 voltage of 750 V and g4 voltage of 450 V. When the tube is operated at lower g5 and g4 voltages (g5 = 500 V – g4 = 300 V) the limiting resolution is in excess of 650 T.V. lines.

Full advantage of resolution and signal uniformity is achieved when deflecting components are properly designed and when the tube is correctly located inside. The thickness of the photoconductive layer is made very uniform and allows for constant output signal and constant dark current. When landing error due to imperfect scanning system is present, the voltage gradient across the photoconductive layer is not uniform and a signal variation (shading) is introduced which can be compensated by proper adjustment of the cathode, g1 and g2 voltages.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

The sensitivity of the TH 9813 can be equivalent to photographic film having an ASA exposure index of 1600 (33/10 DIN, 40 Sch). Satisfactory quality picture with good resolution and acceptable signal to noise ratio can be obtained at illumination of 0.4 lux (0.04 fc) on the faceplate (4 to 8 lux on the subject with an unity numerical aperture lens) giving rise to a signal current of 0.05 μA at 0.05 μA dark current. For such illuminations higher signal current is obtained by increasing dark current up to 0.1 μA value beyond which a signal saturation will occur.

Due to good design, high reliability is obtained throughout the tube life. Requirement for alignment field is reduced to a minimum by precise electron gun mounting. An extremely flat faceplate avoids all optical distortions and allows for the use of any good quality lens. Particle barriers adjacent to the field mesh allows these tubes to operate in any position.

One Watt power heater makes these Vidicons particularly suitable for transistorized equipment. The reduced heat dissipation improves the quality of the picture by lowering faceplate temperature.

On request, a variant of this tube, the Vidicon TH 9813N may be provided which is built with a non-browing glass faceplate allowing the tube to be operated in severe nuclear environnements.

GENERAL CHARACTERISTICS

Electrical

Cathode	unipotential indirectly heated oxide coated	
Heater :		
- voltage	6.3	V
- current at 6.3 V	0.135 to 0.165	A
Minimum preheating time	60	s
Output capacitance :		
- target to all other electrodes	5.0	pF
Spectral response	see curve	
Focusing method	electrostatic	
Deflection method	magnetic	

Mechanical

Overall length	max.	165 mm	(6.49")
Overall diameter	max.	29 mm	(1.14")
Bulb diameter	max.	26.7 mm	(1.03")
Base (Ditetrar, 8 pins)		UTE 9 C 15 (JEDEC N° E8 - 11)	
Socket (note 1)		METOX N° 30.250	
Deflecting yoke and alignment coil assembly (note 2)		GERHARD BV 150/41 CLEVELAND VYA 300 or equivalent	
Photoconductive layer :			
- normal dimensions of image on target		12.7 mm x 9.5 mm	
- maximum useful diagonal diameter		17 mm	
- orientation of quality rectangle : horizontal scan parallel to the plane passing through the tube axis and short index pin (note 3)			
Mounting position		any	
Net weight, approximate		65 g	

OPERATING CONDITIONS

(All potentials are referred to cathode)

Maximum ratings : *(absolute values)*

Electrode g5 voltage (field electrode)		1 000	V
Electrode g4 voltage (wall electrode)		1 000	V
Electrode g3 voltage (focusing electrode)		300	V
Electrode g2 voltage (accelerator electrode)		350	V
Electrode g1 voltage (picture cut-off electrode) :			
- negative bias value		150	V
- positive bias value		0	V
Heater voltage	max.	6. 9	V
	min.	5. 7	V
Peak heater cathode voltage :			
- heater negative with respect to cathode		125	V
- heater positive with respect to cathode		10	V
Target voltage		125	V
Dark current		0. 20	µA
Peak target current (note 4)		0. 60	µA
Faceplate :			
- illumination		10 000	lux
		or 1 000	fc
- temperature		70	°C

Operational conditions

Scanned area 12. 7 mm x 9. 5 mm
Faceplate temperature 25 °C (note 5)

Electrode voltage modes :	Low	Intermediate	High	
Electrode g5 voltage	300	500	750	V
Electrode g4 voltage	180	300	450	V
Electrode g3 voltage	0 to 60	50 to 100	75 to 150	V
Electrode g2 voltage	300	300	300	V
Electrode g1 voltage (note 6)	−45 to −125	−45 to −125	−45 to −125	V
Electrode current :				
Electrode g5 current	1	1. 5	2	µA
Electrode g4 current	0. 06	0. 1	0. 15	µA
Electrode g3 current	0. 001	0. 0015	0. 002	µA
Electrode g2 current (note 7)	600	600	600	µA
Average "gamma" between 1 and 100 lux (0. 1 and 10 fc) (note 8)	0. 65	0. 65	0. 65	
Minimum blanking peak to peak voltage :				
- applied to electrode g1	−75	−75	−75	V
- applied to cathode	+20	+20	+20	V
Limiting resolution at center of picture (note 9)	550	650	750	TV lines
M.T.F. response for 400 T.V. lines at center of picture (5 MHz-625 CCIR standard (note 10)	20	25	35	%

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Typical performance

1 - INTERMEDIATE SENSITIVITY OPERATION

(Faceplate illumintation 10 lux or 1 fc)

Dark current i_o	20	nA
Target voltage for i_o = 20 nA (note 11)	20 to 50	V
Faceplate illumination (2854 °K) (note 12)	10	lux
	or 1	fc
Signal current	210	nA
Corresponding sensitivity	175	µA/lm
Lag : (note 13)		
- maximum value	20	%
- average value	12	%

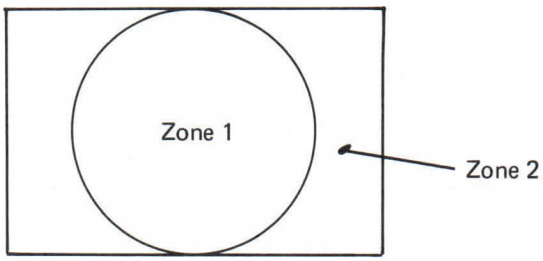
2 - HIGH SENSITIVITY OPERATION

(Faceplate illumination 1 lux or 100 mfc)

Dark current i_o	100	nA
Target voltage for i_o = 100 nA (note 11)	30 to 70	V
Faceplate illumination (2854 °K) (note 12)	1	lux
	or 100	mfc
Signal current	125	nA
Corresponding sensitivity	1 000	µA/lm
Lag : (note 13)		
- maximum value	20	%
- average value	17	%

SPURIOUS SIGNAL TEST

The test is performed using a uniformly diffused white test pattern that is separated into two zones as shown in drawing.



The tube is operated under "Typical Operation" with a dark current of 20 nanoamperes and the lens adjusted to provide a signal current of 200 nanoamperes.

Spurious signals are classified by their size which is measured in percent of raster height.

Will actually be considered as defects, blemishes of contrast greater than 50% (note 12).

Allowable spot size for each zone is shown in table :

*Ratio D / H (Percent raster height)	Number Allowed			
	Zone 1	Zone 1 + Zone 2		
		a	a + b	a + b + c
a : 0.8% < D/H ⩽ 1%	0	1	3	6
b : 0.6% < D/H ⩽ 0.8%	1			
c : 0.2% < D/H ⩽ 0.6%	3			

0.2 % and under : do not count spots of this size unless concentration causes a smudge appearance

* D : average diameter of spot

H : raster height

Smudges, streaks, mottled or grainy background having a contrast ratio greater than 15% constitute a reject.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

NOTES

1 - METOX - 86, rue de Villiers de l'isle Adam - PARIS 20ème - Téléphone : 636. 31 - 10.

2 - GERHARD KG - REICHSHEIM/ODW Germany.
CLEVELAND ELECTRONICS Inc. - 2000 Highland Road - TWINSBURG - OHIO 44 - 087.

3 - It is necessary to assure correct positioning of the tube inside the coils. An immediate test consists in observing the fine mesh grid, the wires of which should be inclined 45° with respect to scanning. Then the front end of the deflecting yoke should be positioned 20 mm from the tube faceplate.

4 - Target current is defined as total current in load resistance connected to target electrode : signal current plus dark current, dark current being the current left when illumination is subtracted.
Video amplifiers must be designed properly to handle peak target current of 0.6 μA to avoid amplifier overload and picture distortion.

5 - All these characteristics are provided for a temperature of faceplate of 25 °C, the temperature range recommended is within 20 to 30 °C. The rise of faceplate temperature is a function of ambient temperature, thermic dissipation of ambient devices and of the tube itself. Consequently, 10 °C of faceplate temperature rise implies a dark current multiplied by a factor of 2.

6 - Without blanking pulses applied on electrode g1.

7 - Power source of the equipment should be designed properly to handle this current.

8 - Average "gamma" should be defined as the slope of the rectilinear part of transfer characteristics in log coordinates.

9 - Practically, limiting resolution corresponds to the resolution measured with twin bar test card with a M.T.F. response of about 7%.

10 - For 625 C.C.I.R. standard, line duration being 52 μs (line suppression period not included) 400 TV lines correspond to 5 MHz.

11 - Indicated range of each type of service serves only to illustrate the operating target voltage range normally encountered. The target voltage for each Vidicon must be adjusted to that value which gives the designed operating dark current.

12 - All the above mentioned illuminations assume a 2854 °K incandescent tungsten source.

13 - Lag is defined as the ratio of residual signal current measured 60 milliseconds after light excitation being removed to the initial signal current ; this value assumes 50 fields/second scanning rate.

14 - Contrast is defined as : $100 \times \frac{\text{increment in video current due to blemish}}{\text{normal signal current}}$

Figure 1

TYPICAL SPECTRAL SENSITIVITY CHARACTERISTICS

For equal values of signal current at all wavelengths
(0.02 μA signal current and 0.02 μA dark current
for scanned area of 12.7mm x 9.5mm)

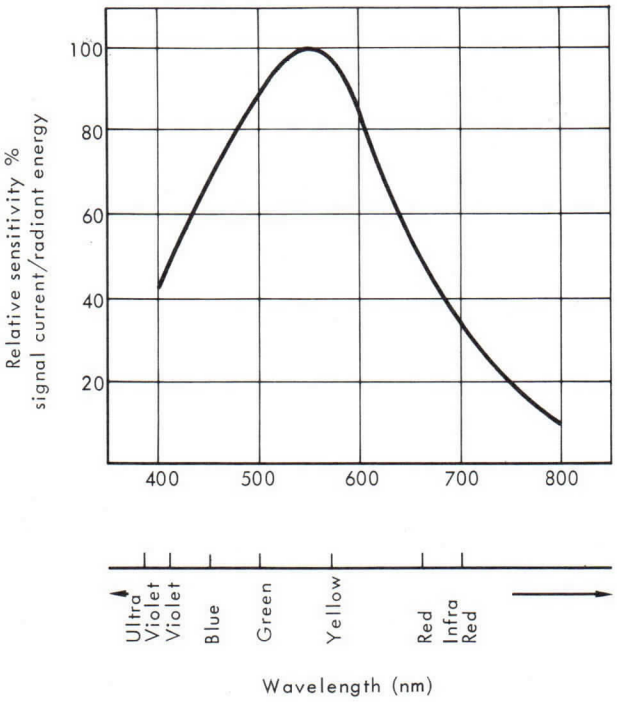
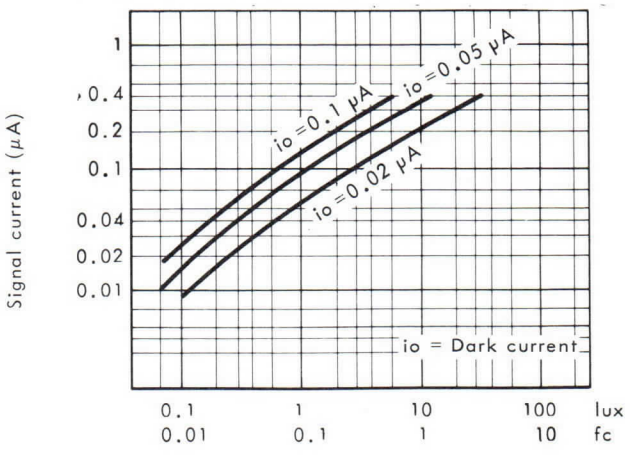


Figure 2

LIGHT TRANSFER CHARACTERISTICS

Illumination uniform over photoconductive layer scanned
area 12.7mm x 9.5mm face plate temperature 25°C



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Figure 3

MODULATION TRANSFER FUNCTION

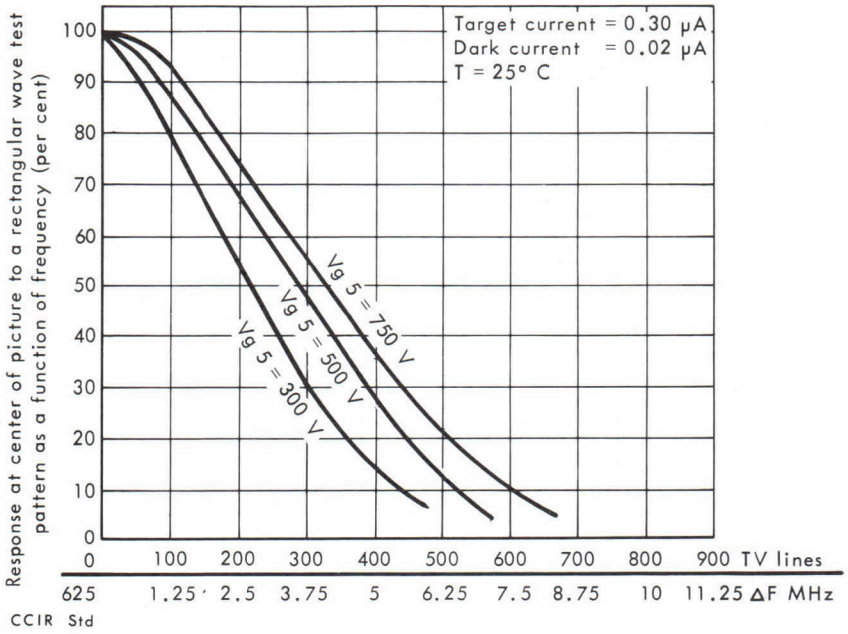


Figure 4

RANGE OF DARK CURRENT

Scanned area of photoconductive layer 12.7mm x 9.5mm

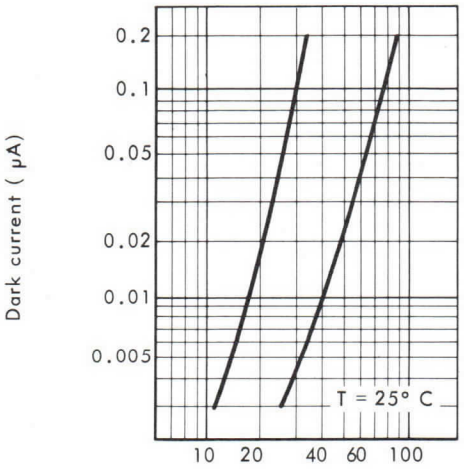


Figure 5

TYPICAL PERSISTENCE CHARACTERISTICS

Initial highlight signal current of 0.2 μA scanned area of photoconductive layer 12.7mm x 9.5mm

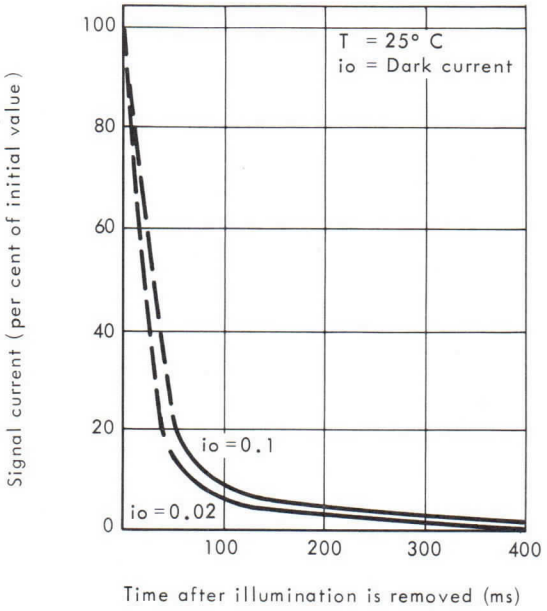
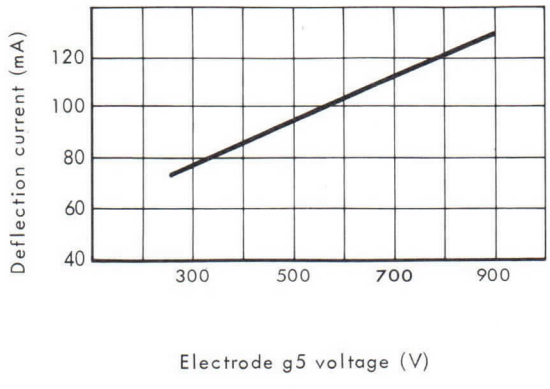


Figure 6

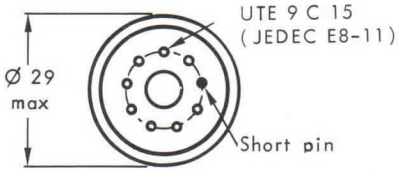
Deflection current as a function of electrode g4 and g5 voltage (Vg 5 = 1.5 Vg 4)

Scanned area of photoconductive layer 12.7mm x 9.5mm

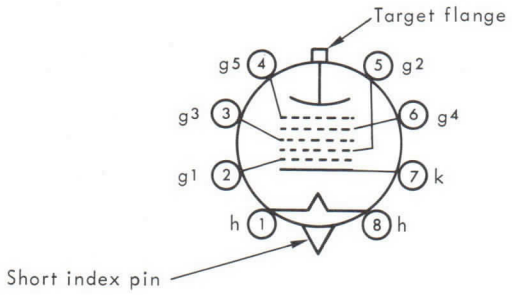


THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

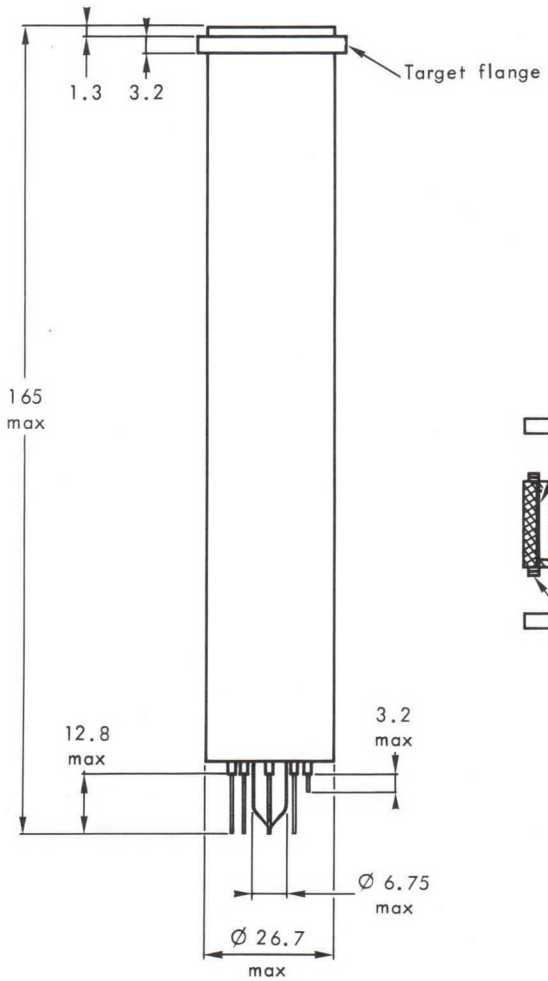
OUTLINE DRAWING

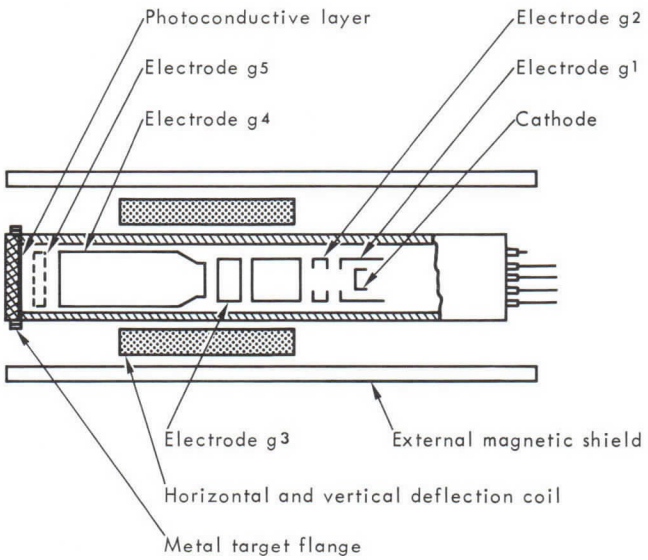


BASING DIAGRAM



1 - Heater	5 - Electrode g2
2 - Electrode g1	6 - Electrode g4
3 - Electrode g3	7 - Cathode
4 - Electrode g5	8 - Heater





Dimensions in mm.

TH 9814 PA
1" VIDICON

- RUGGEDIZED CONSTRUCTION
- SHORT LENGTH (130 mm)
- MAGNETIC FOCUS AND DEFLECTION
- HIGH RESOLUTION (900 TV LINES)
- LOW LAG
- MILITARY AND SPACE TV

TH 9814 PA is a 1" Vidicon designed especially for pick-up in high quality TV cameras (black and white or color TV cameras). This tube incorporates in its structure the latest isolated post-acceleration electrode with separate external connection. Due to this feature TH9814 PA provides higher resolution, higher output signal capability and better resolution and signal uniformity than previous Vidicon tubes.

TH 9814 PA is a small size (130 mm long) ruggedized Vidicon intended for compact equipment operating under severe mechanical conditions (vibrations, acceleration, shock ...). Specially designed for military and space applications, the TH 9814 PA enables to obtain high signal to noise ratio thus allowing the tube to be operated with low target voltage in the case of high light slides transmission. It also permits high sensitivity operation mode in the case of low light scene pick-up.

The sensitivity of TH 9814 PA can be equivalent to photographic film having an ASA exposure index of 1200 to 1800 ASA. Satisfactory quality picture with good resolution and acceptable signal to noise ratio can be obtained at illumination of 0.5 to 1 lux (50 mfc to 100 mfc) on the faceplate (5 to 10 lux or 0.5 to 1 fc on the subject with an unity numerical aperture lens) giving rise to a signal current of 50 nA at 50 nA dark current. For such illumination, higher signal current is obtained by increasing dark current up to 100 nA, value beyond which a signal saturation will occur.

Due to a new low lag photoconductive layer, excellent quality of picture can be obtained within a large illumination range with good signal uniformity and appropriate "gamma" characteristics.

TH 9814 PA performances are substantially identical under high or low level illumination conditions. Tube sensitivity can be controlled by target voltage which also determines variation of dark current within a narrow range.

TH 9814 PA can be operated over a wide range of electrode voltage selection although recommended adjustment requires a g4 voltage to g3 voltage ratio of 1.5 - 1.6. Under these conditions TH 9814 PA can provide an optimum resolution and an uniform signal output over the entire scanned area with a beam landing considerably improved minimizing "porthole" effect and geometrical distortion.

The limiting resolution of TH 9814 PA at the center of the picture is about 1000 TV lines and about 600 TV lines at the corner. This high resolution is obtained with an electrode g4 voltage of 900 V and an electrode g3 voltage of 600 V. When TH 9814 PA is operated at a lower g4 voltage of 500 V and a g3 voltage of 300 V, its resolution will be about 900 TV lines at the center and 500 TV lines at the corner. Operating g4 voltage at 1,5 times g3 voltage requires a 20 % deflection current increase over current necessary for a g3-g4 connected electrode mode. Focusing field is not noticeably changed with such an operation.

Full advantage of resolution and signal uniformity is achieved when deflecting and focusing components are properly designed and when the tube is correctly located inside. The thickness of the photoconductive layer is made very uniform and allows for constant output signal and constant dark current. When landing error due to imperfect scanning system is present, the voltage gradient across the photoconductive layer is not uniform and a signal variation is introduced (shading) which can be compensated by proper adjustment of the cathode, g1 and g2 voltages.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Due to good design, high reliability is obtained all along tube life. Requirement for alignment field is reduced to a minimum by precise electron gun mounting. An extremely flat faceplate avoids all optical distortions and allows for the use of any good quality lens. Particle barriers adjacent to the field mesh allows these tubes to operate in any position.

One watt power heater makes these Vidicons particularly suitable for transistorized equipment. The reduced heat dissipation improve the quality of the picture by lowering faceplate temperature.

TH 9814 PA is capable of withstanding shock pulses of 100 g's (6 ms) and 15 g peak sinusoidal vibration in any axis in the 5 to 2000 Hz frequency range. It will also withstand atmospheric pressure of 760 mm Hg to 1 mm Hg between 0 to 55 °C and up to 95% humidity. (See "Environmental Performances"). When this tube is operated in severe environment it should be used with special deflecting components and connectors.

ENVIRONMENTAL PERFORMANCES

The TH 9814 PA is designed to withstand the following operational and non operational environmental tests.

Rejection criteria

After completion of the environment tests the tube meets the characteristics specified under typical operation data. Some more spots could be observed after these tests.

Operational tests

The tube is operated as shown under the typical low voltage mode.

VIBRATIONS (MIL - STD - 810 B Method 514 Procedure I)

1 - The tube is subjected with a suitable mounting jig, to 10 g peak sinusoidal vibration from 5 to 500 Hz. There will be no loss of resolution, and amplitude of spurious signal is lower than 20% of the white peak signal.

2 - The tube is subjected, with a suitable mounting jig, to 10 g peak sinusoidal vibration from 5 to 2000 Hz. The minimum resolution is 450 TV lines and spurious signal amplitude lower than 75% of the maximum white peak signal.

Non operational tests

SHOCKS (MIL - STD - 810 B Method 516 Procedure IV)
The tube is subjected to 20 shocks of 100 g (6 ms) terminal peak sawtooth shock pulse.

VIBRATIONS (MIL- STD - 810 B Method 514 Procedure I)
The tube is subjected to 15 g peak sinusoidal vibration from 5 to 2000 Hz.

TEMPERATURE - ALTITUDE (MIL - STD - 810 B Method 504 Procedure I)
The tube and its components are subjected to the separate and combined effects of varying temperature from 0 to 55 °C and pressure from 760 mm Hg to 1 mm Hg.

HUMIDITY (MIL - STD - 810 B Method 507 Procedure I)
The tube is subjected to humidity up to 95% at temperatures from 0 to 55 °C.

GENERAL CHARACTERISTICS

Electrical

Heater	for unipotential cathode indirectly heated	
Heater :		
— voltage	6.3 ± 10 %	V
— current at 6.3 V	0.15	A
Minimum preheating time	60	s
Output capacitance :		
— target to all other electrodes	4.5	pF
Spectral response	see curve	
Focusing method	magnetic	
Deflection method	magnetic	

Mechanical

Base	DITETRAR, 8 pins (JEDEC N° E8 – 11)	
Socket (note 1)	METOX N° 30.250	
Deflecting yoke (note 2)	GERHARD	
Dimensions	see drawing	
Photoconductive layer :		
– normal dimensions of image on target	12. 7 x 9. 5	mm
– maximum useful diagonal diameter (4 x 3 aspect ratio)	17	mm
– orientation of quality rectangle : horizontal scan parallel to the plan passing through the tube axis and short index pin (note 3)		
Maximum temperature of faceplate	70	°C
Mounting position	any	
Net weight, approximate	60	g

OPERATING CONDITIONS

Maximum ratings (Absolute values)

Scanned area 12. 7 x 9. 5 mm

Electrode g4 voltage (post-acceleration electrode)	1000	V
Electrode g3 voltage (wall electrode)	1000	V
Electrode g2 voltage (accelerator)	700	V
Electrode g1 voltage (electrode for picture cut-off)		
– negative bias value	300	V
– positive bias values	0	V
Target voltage	125	V
Dark current	0. 20	µA
Peak output current (note 4)	0. 40	µA
Faceplate :		
– illumination	1000 or 100	lux fc
– temperature	70	°C

Typical operation

Scanned area 12. 7 x 9. 5 mm
Faceplate temperature 25 °C (note 5)

Electrode voltage modes :	Low	Intermediate	High	
Electrode g4 voltage	300	500	900	V
Electrode g3 voltage	180	300 to 350	600	V
Electrode g2 voltage	300	300	300	V
Electrode g1 voltage (note 6)	–45 to –110	–45 to –110	–45 to –110	V
Illumination between 1 to 100 lux (0. 1 to 10 fc) (note 7)	0. 65	0. 65	0. 65	
Minimum blanking peak to peak voltage :				
– applied to electrode g1	–75	–75	–75	V
– applied to cathode	+20	+20	+20	V
Limiting resolution at center of picture (note 8)	800	900	1000	TV lines
Limiting resolution at corner of picture (note 9)	400	500	600	TV lines
MTF response for 400 TV lines at the center of picture (5 Mz 625 CCIR standard) (note 9)	30	40	50	%
Field strength at center of focusing coil	30 ± 2	40 ± 2	50 ± 2	Gauss
Peak deflecting coil current *				
– horizontal	130	170	200	mA
– vertical	15	20	24	mA
Field strength of aligment coil	0 to 4	0 to 4	0 to 4	Gauss

* In the case of GERHARD 200 IJI type coils.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

1 - HIGH LIGHT LEVEL OPERATION

(faceplate illumination 100 lux or 10 f.c.)

Dark current i_o	5	nA
Target voltage for i_o = 5 nA (note 10)	10 to 25	V
Faceplate illumination (2854 °K) (note 11)	100	lux
	or 10	fc
Signal output current	300	nA
Lag : (note 12)		
– maximum	15	%
– average	10	%

2 - AVERAGE SENSITIVITY OPERATION

(faceplate illumination 10 lux or 1 f.c.)

Dark current i_o	20	nA
Target voltage for i_o = 20 nA (note 10)	20 to 50	V
Faceplate illumination (2854 °K) (note 11)	10	lux
	or 1	f.c.
Signal output current	180	nA
Corresponding sensitivity	150	µA/lm
Target illumination for 100 nA signal current	3	lux
	0.3	fc
Lag : (note 12)		
– maximum	20	%
– average	12	%

3 - HIGH SENSITIVITY OPERATION

(faceplate illumination 5 lux or o.5 f.c.)

Dark current i_o	50	nA
Target voltage for i_o = 50 nA (note 10)	25 to 60	V
Faceplate illumination (2854 °K) (note 11)	5	lux
	0.5	fc
Signal output current	200	nA
Corresponding sensitivity	350	µA/lm
Target illumination for 100 nA signal current	1.5	lux
	0.15	fc
Lag : (note 12)		
– maximum	20	%
– average	15	%

4 - VERY HIGH SENSITIVITY OPERATION

(faceplate illumination 1 lux or 0.1 f.c.)

Dark current i_o	100	nA
Target voltage for i_o = 100 nA (note 10)	30 to 70	V
Faceplate illumination (2854 °K) (note 11)	1	lux
	0.1	fc
Signal output current	100	nA
Corresponding sensitivity	800	µA/lm
Target illumination for 50 nA signal current	0.3	lux
	0.03	fc
Lag : (note 12)		
–maximum	20	%
–average	17	%

NOTES

1 - METOX - 86 rue de Villiers de l'isle Adam - PARIS 20 eme
tel : 636 - 31 - 10

2 - GERHARD KG - REICHELSHEIM/ODW - GERMANY -

3 - It is necessary to assure correct positioning of the tube inside the coils. An immediate test consists in observing the fine mesh grid, the wires of which should be inclined 45° with respect to scanning. Then the front end of the deflecting yoke should be positioned 20 mm from the tube faceplate.

4 - Output current is defined as total current in load resistance connected to target electrode : signal current + dark current, dark current being the current left when illumination is removed.
Video amplifiers must be designed properly to handle peak output current of 0. 5 μA to avoid amplifier overload and picture distortion.

5 - All these characteristics are provided for a temperature of faceplate of 25 °C, the temperature range recommended is within 20 to 30 °C. The rise of faceplate temperature is a function of ambient temperature, heat dissipation of ambient devices and of the tube itself. Consequently, 10 °C of faceplate temperature rise involves a dark current multiplied by a factor of 2.

6 - Without blanking pulses applied on electrode g1.

7 - Average "gamma" should be defined as the slope of the rectilinear part of transfer characteristics in log coordinates.

8 - Practically, limiting resolution corresponds to the resolution measured with twin bar test card with a modulation ratio of about 7 %.

9 - For 625 CCIR, standard, line duration being 52 μs (line suppression period not included), 400 TV lines correspond to 5 MHz.

10 - Indicated range of each type of service serves only to illustrate the operating target voltage range normally encountered. The target voltage for each Vidicon must be adjusted to that value which gives the designed operating dark current.

11 - All the above mentioned illuminations assume a 2854 °K incandescent tungsten source.

12 - Lag is defined as the ratio of residual output current measured 60 milli-seconds after light excitation being removed to the initial output current ; this value assumes 50 fields/second scanning rate.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Figure 1

TYPICAL SPECTRAL SENSITIVITY CHARACTERISTICS

For equal values of signal output current at all wavelengths
(0.02 µA signal output and 0.02 µA dark current
for scanned area of 12.7 x 9.5 mm)

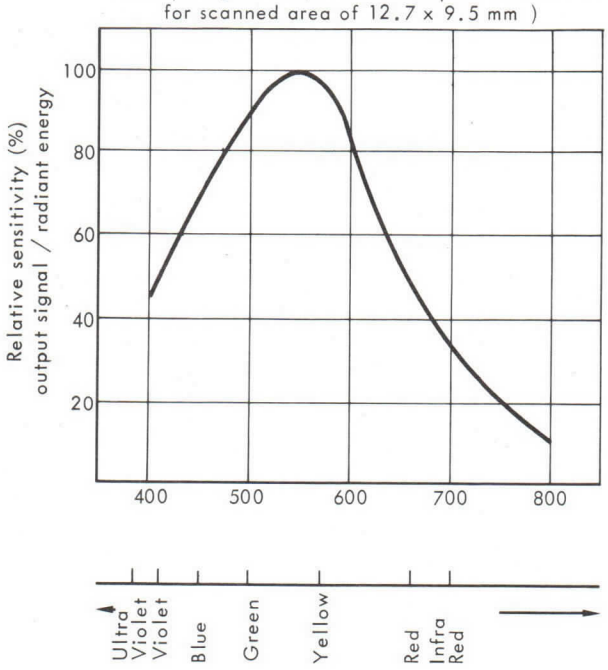
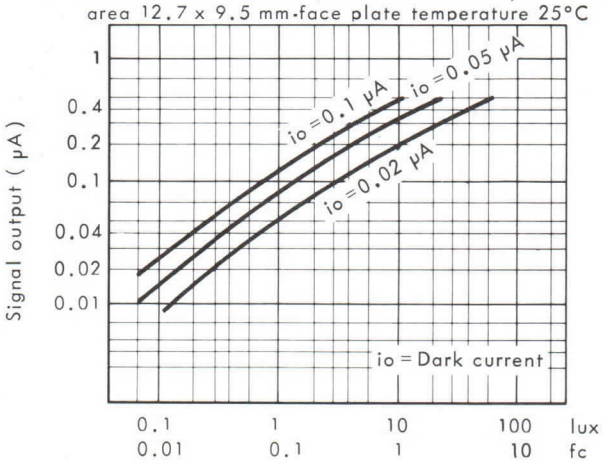


Figure 2

LIGHT TRANSFER CHARACTERISTICS

Illumination uniform over photoconductive layer scanned
area 12.7 x 9.5 mm-face plate temperature 25°C



Illumination in lux and foot candles

Figure 3

MODULATION TRANSFER FUNCTION

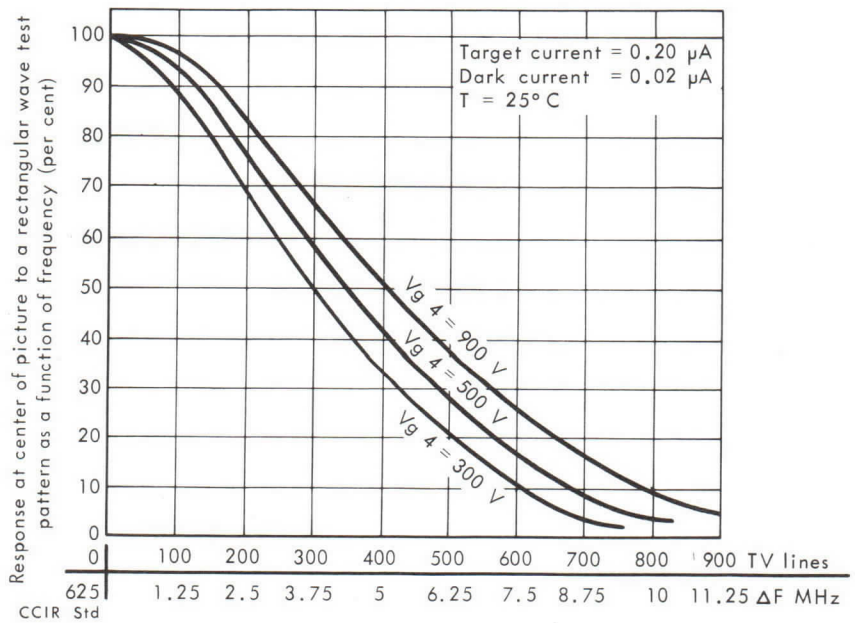


Figure 4

RANGE OF DARK CURRENT
Scanned area of photoconductive layer 12.7 x 9.5 mm

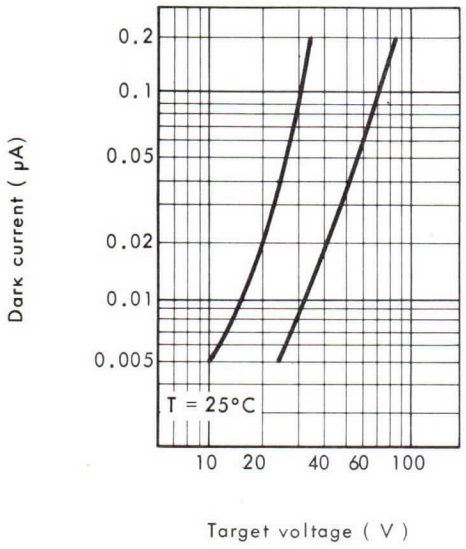


Figure 5

TYPICAL PERSISTENCE CHARACTERISTICS
Initial highlight signal output of 0.2 µA scanned area of photoconductive layer 12.7 x 9.5 mm

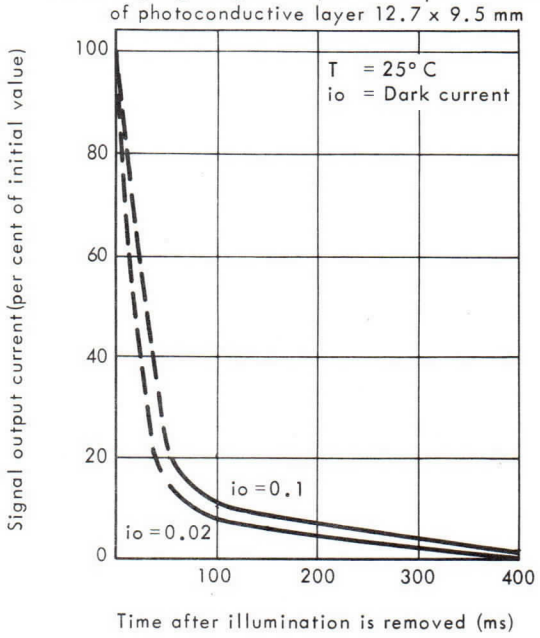
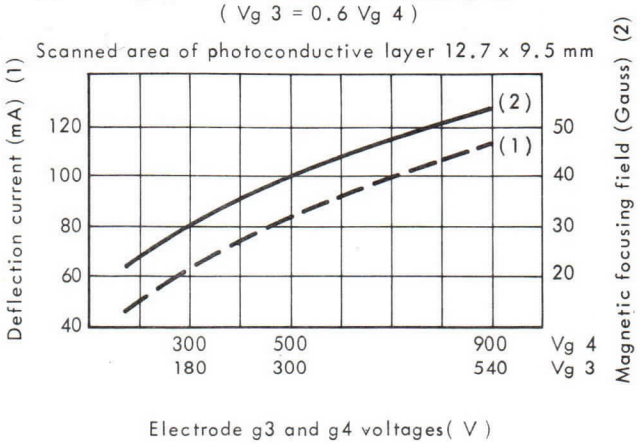


Figure 6

(1) Deflection current as a function of electrode g3 and g4 voltages (Vg 3 = 0.6 Vg 4)

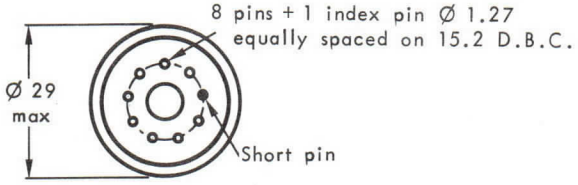
(2) Magnetic field at center of focusing coil (Vg 3 = 0.6 Vg 4)

Scanned area of photoconductive layer 12.7 x 9.5 mm

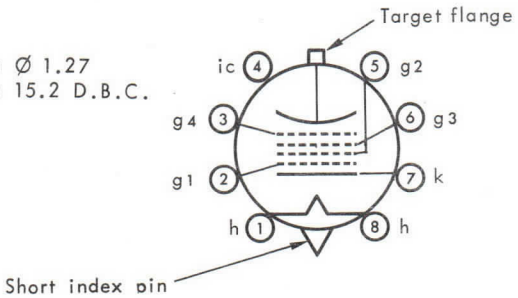


THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

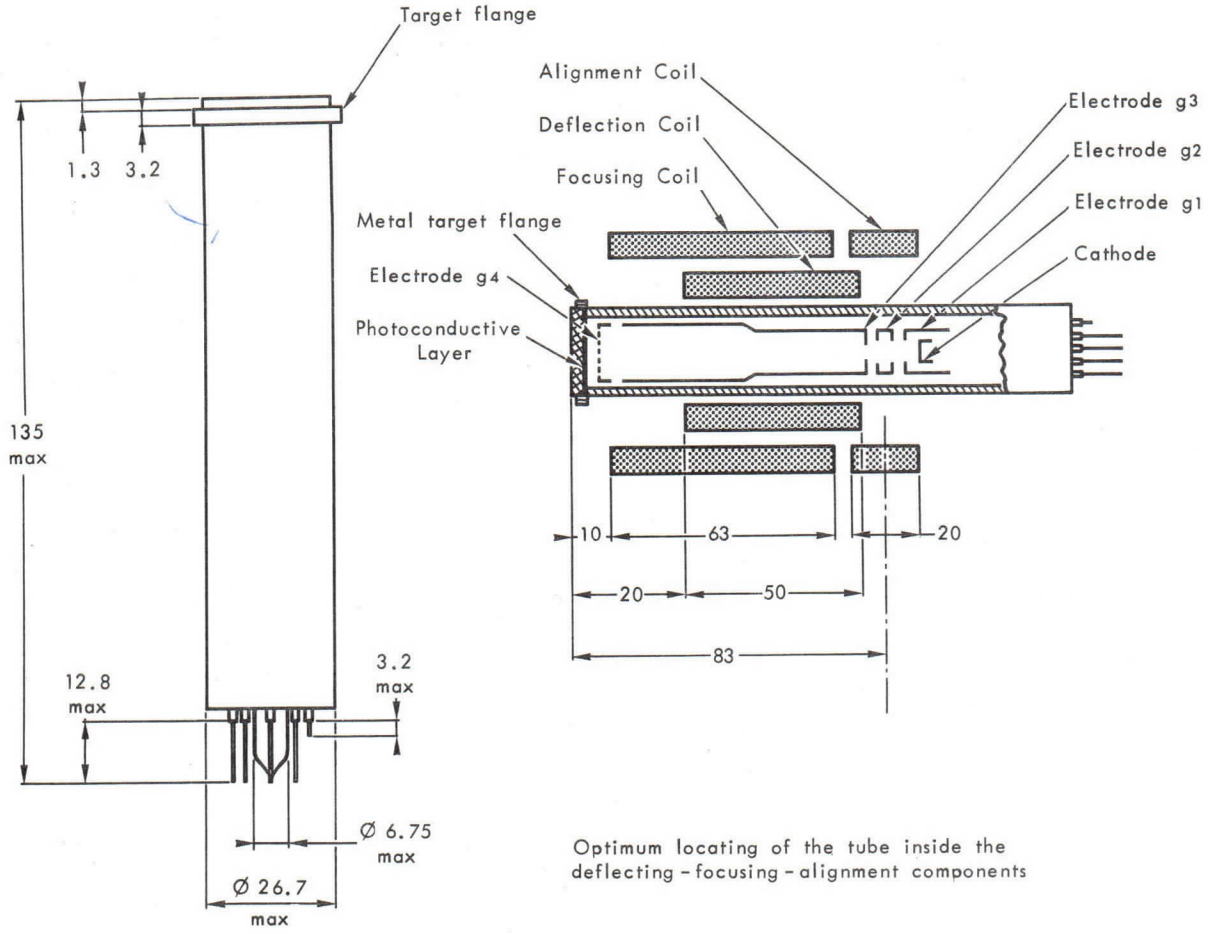
OUTLINE DRAWING



BASING DIAGRAM



1 - Heater	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode
4 - Internal connection	8 - Heater



Optimum locating of the tube inside the deflecting - focusing - alignment components

Dimensions in mm.

TH 9814 PA
VIDICON 1"

- TUBE ROBUSTE
- LONGUEUR REDUITE (130 mm)
- CONCENTRATION ET DEVIATION ELECTROMAGNETIQUES
- HAUTE RESOLUTION (900 lignes T.V.)
- FAIBLE REMANENCE
- TELEVISION MILITAIRE ET SPATIALE.

Le Vidicon TH 9814 PA est un tube de prise de vue spécialement conçu pour des caméras de télévision de haute qualité (noir et blanc ou couleur). Le tube comporte une grille séparée de post-accélération permettant d'obtenir une plus grande résolution, un signal de sortie plus élevé et une plus grande uniformité de résolution et de signal que les Vidicons normaux.

Le TH 9814 PA a une longueur réduite (130 mm) et une structure robuste permettant de le faire fonctionner dans des conditions d'environnement sévères (vibration, accélération, choc...). Spécialement conçu pour des applications militaires et spatiales, le Vidicon TH 9814 PA procure un rapport signal/bruit élevé permettant de le faire fonctionner avec une faible tension de cible pour des forts éclairements. Il permet aussi un fonctionnement à haute sensitivité dans le cas de prise de vue à faible niveau de lumière.

La sensibilité du TH 9814 PA est comparable à celle d'un film ayant un index de 1200 à 1800 A.S.A. Un éclairement de cible de 0,5 à 1 lux (5 à 10 lux sur l'objet avec un objectif d'ouverture F/1) produisant un courant de signal de 50 nA pour 50 nA de courant d'obscurité, fournit d'excellentes images ayant une bonne résolution et un bon rapport signal sur bruit. Pour de tels éclairements, on peut obtenir un courant de signal plus élevé en élevant la tension de l'électrode de signal. Le courant d'obscurité peut atteindre 100 nA, toutefois il n'est pas recommandé de dépasser cette valeur puisque la saturation du signal est pratiquement atteinte.

Le Vidicon TH 9814 PA permet d'obtenir d'excellentes images présentant une bonne uniformité de signal et un "gamma" approprié grâce à l'emploi d'une nouvelle couche photoconductrice à faible rémanence.

Les performances du TH 9814 PA sont pratiquement identiques à haut ou bas niveau d'éclairement sur la face avant. La tension de cible réglable permet de contrôler la sensibilité et en même temps de faire varier le courant d'obscurité dans de faibles limites.

Le Vidicon TH 9814 PA peut fonctionner avec des tensions d'électrodes variables dans de grandes limites ; toutefois il est recommandé de le faire fonctionner avec une tension de grille g4 1,5 à 1,6 fois supérieure à la tension de grille g3. Dans ces conditions le Vidicon TH 9814 PA peut fournir une résolution et une uniformité de signal optimales sur la totalité de la surface balayée sans distorsion géométrique de l'image ni perte de qualité pour un réglage même excédentaire du courant de faisceau.

La résolution limite du Vidicon TH 9814 PA est d'environ 1000 lignes T.V. au centre de l'image et 600 lignes T.V. dans les coins. Cette résolution élevée est obtenue avec une tension de grille g4 de 900 V et une tension de grille g3 de 600 V. Quand on opère avec une tension g4 de 500 V et une tension g3 de 300 V, la résolution est de 900 lignes T.V. au centre et 500 lignes T.V. dans les coins. Dans le fonctionnement avec la tension g4 égale à 1, 5 fois la tension g3 le courant de déviation est de 20 % supérieur à celui nécessaire au cas où g3 et g4 sont au même potentiel, par contre le champ de concentration ne subit pas de changement notable.

Les performances optimales de résolution et d'uniformité de signal ne sont atteintes que pour autant qu'on dispose de bobines de déviation et de concentration bien étudiées et que le tube soit correctement positionné par rapport à l'ensemble de ces composants. Les courants de signal et d'obscurité sont maintenus constants sur toute la surface de la cible grâce à l'emploi d'une couche photoconductrice d'épaisseur très uniforme. Au cas où une erreur de "landing" due à un système de balayage imparfait se produit, le gradient de potentiel sur la couche photoconductrice n'est pas uniforme et il en résulte une variation de signal, variation qui peut être compensée par l'application sur la cathode et les grilles g1, g2 du tube de tensions de correction aux fréquences de trame et de ligne de forme et d'amplitude appropriées.

Grâce aux soins apportés à sa résolution, le Vidicon TH 9814 PA permet un fonctionnement très sûr et une longue durée de vie. La précision dans le montage du canon à électrons réduit le champ d'alignement à une valeur minime. La face d'entrée, optiquement plane, évite toutes aberrations optiques et permet l'utilisation de n'importe quel objectif de bonne qualité. Une barrière de particule située à proximité de la grille de champ autorise le tube à fonctionner dans n'importe quelle position.

La puissance de chauffage extrêmement faible permet l'emploi de ce tube dans des équipements transistorisés. La réduction de la puissance dissipée améliore d'autre part la qualité de l'image en diminuant l'élévation de la température de la face avant du tube en fonctionnement.

Le Vidicon TH 9814 PA peut supporter des impulsions de choc de 100 g (6 ms) et des vibrations sinusoïdales de 15 g crête suivant chaque axe dans la gamme de fréquence de 5 à 2000 Hz. Il peut aussi supporter des pressions de 760 mm Hg à 1 mm Hg entre 0 et 55 °C et jusqu'à 95 % d'humidité (voir "Essais d'Environnement").

Quand le tube fonctionne dans des conditions d'environnement sévères, il doit être équipé de bobines et de connecteurs spéciaux.

ESSAIS D'ENVIRONNEMENT

Le TH 9814 PA est conçu pour supporter des essais d'environnement en fonctionnement et hors fonctionnement les essais suivants :

Critère de rejet

Après exécution de ces essais le tube doit satisfaire aux performances électronoptiques définies dans les conditions d'emploi. Quelques taches supplémentaires peuvent être observées après ces essais.

Essais en fonctionnement

Le tube fonctionne suivant le mode de tensions faibles comme indiqué dans l'exemple de fonctionnement.

– VIBRATIONS (MIL - STD - 810 B - Method 514 - Procedure I)

1 - Le tube avec un montage approprié est soumis à une vibration sinusoïdale de 10 g crête de 5 à 500 Hz. Il ne doit pas se produire de perte de résolution et l'amplitude du signal de défaut doit être inférieure à 20 % du signal crête correspondant au blanc.

2 - Le tube avec un montage approprié est soumis à une vibration sinusoïdale de 10 g crête de 5 à 2000 Hz. La résolution minimale est de 450 lignes T.V. et l'amplitude du signal de défaut inférieure à 75 % du signal crête correspondant au blanc.

Essais hors fonctionnement

– CHOCS (MIL - STD - 810 B - Method 516 - Procedure IV)

Le tube est soumis à 20 chocs de 100 g crête. L'impulsion de choc a une forme en dent de scie et une durée de 6 ms.

– VIBRATIONS (MIL - STD - 810 B - Method 514 - Procedure I)

Le tube est soumis à une vibration sinusoïdale de 15 g crête de 5 à 2000 Hz.

– TEMPERATURE - ALTITUDE (MIL - STD - 810 B - Method 504 - Procedure I)

Le tube et ses composants sont soumis aux effets séparés et combinés de la variation de température de 0 à 55 °C et de la variation de pression de 760 mm Hg à 1 mm Hg.

– HUMIDITE (MIL - STD - 810 B - Method 507 - Procedure I)

Le tube est soumis à une humidité de 95 % aux températures variant de 0 à 55 °C.

CARACTERISTIQUES GENERALES

Electriques

Mode de chauffage	cathode à oxydes - équipotentielle chauffage indirect	
Tension de chauffage	6, 3	V
Courant de chauffage à 6, 3 V	0, 135 à 0, 165	A
Temps minimal de préchauffage	60	s
Capacité de sortie du tube : électrode de signal par rapport à toutes les autres électrodes réunies	4, 5	pF
Réponse spectrale	voir courbe	
Mode de concentration	magnétique	
Mode de déviation	magnétique	

Mécaniques

Longueur hors-tout max.	135	mm
Diamètre hors-tout max.	28, 83	mm
Diamètre de l'ampoule max.	26, 6	mm
Embase (Ditetrar 8 broches)	UTE 9 C 15 (JEDEC N° E8 - 11)	
Support (note 1)	METOX N° 30 520	
Ensemble bobines de déviation et concentration (note 2).	GERHARD type BV 200 - 1 K 1	
Bobines d'alignement (note 2)	GERHARD type BV 80/3	
ou Ensemble bobines de déviation - concentration - alignement (note 2)	CLEVELAND type VYFA - 355 - 2	
Cible photoconductrice :		
- format normal d'image sur cible	12, 7 x 9, 5	mm
- diagonale maximale utile d'une image rectangulaire, format 4 x 3	17	mm
- orientation de l'image : tracé du balayage horizontal parallèle à un plan diamétral passant par la broche courte de l'embase (note 3)		
Température maximale de la face avant	70°	C
Position de fonctionnement	indifférente	
Poids net approximatif	60	g

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

CONDITIONS D'EMPLOI

Valeurs limites d'utilisation : (limites absolues)

aire balayée 12, 7 mm x 9, 5 mm

Tension de l'électrode g4 (de champ)		1 000	V
Tension de l'électrode g3 (de paroi)		1 000	V
Tension de l'électrode g2 (accélératrice)		700	V
Tension de l'électrode g1 (extinction du faisceau) :			
- tension de polarisation négative		300	V
- tension de polarisation positive		0	V
Tension de chauffage	max.	6, 9	V
	min.	5, 7	V
Tension crête entre filament et cathode :			
- filament négatif par rapport à la cathode		125	V
- filament positif par rapport à la cathode		10	V
Tension de l'électrode de signal		125	V
Courant d'obscurité		0, 20	µA
Courant de sortie crête (note 4)		0, 40	µA
Face d'entrée :			
- éclairement		10 000	lux
- température		70	°C

Exemples de fonctionnement

aire balayée 12, 7 mm x 9, 5 mm
température de la face avant 25 °C (note 5)

Tensions appliquées sur les électrodes :	Faibles	Intermédiaires	Elevées	
Tension de l'électrode g4	300	500	900	V
Tension de l'électrode g3	180	300 à 350	600	V
Tension de l'électrode g2	300	300	300	V
Tension de l'électrode g1 (note 6)	−45 à − 110	−45 à − 110	−45 à − 110	V
Gamma moyen pour des éclairements de cible compris entre 1 et 100 lux (note 7)	0, 65	0, 65	0, 65	
Tension crête minimale de blocage :				
- appliquée sur l'électrode g1	−75	−75	−75	V
- appliquée sur la cathode	+20	+20	+20	V
Résolution limite au centre de l'image (note 8)	800	900	1000	lignes T.V.
Résolution limite dans les coins	400	500	600	lignes T.V.
Taux de modulation à 400 lignes T.V. au centre de l'image (5 MHz - Standard CCIR 625 lignes) (note 9)	30	40	50	%
Champ magnétique de concentration	30 ± 2	40 ± 2	50 ± 2	Gauss
Courant crête de déviation :				
- horizontale	130	170	200	mA
- verticale	15	20	24	mA
Champ magnétique d'alignement	0 à 4	0 à 4	0 à 4	Gauss

Performances typiques

1 - ECLAIREMENT ELEVE
(100 lux sur la face avant)

Courant d'obscurité i_o	5	nA
Tension de l'électrode de signal pour $i_o = 5$ nA (note 10)	10 à 25	V
Eclairement de la cible (2854 °K) (note 11)	100	lux
Courant de signal	300	nA
Rémanence (note 12) :		
- maximum	15	%
- moyen	10	%

2 - SENSIBILITE MOYENNE
(10 lux sur la face avant)

Courant d'obscurité i_o	20	nA
Tension de l'électrode de signal pour $i_o = 20$ nA (note 10)	20 à 50	V
Eclairement de la cible (2854 °K) (note 11)	10	lux
Courant de signal	180	nA
Sensibilité correspondante	150	µA/lm
Eclairement de la cible pour obtenir un courant de signal de 100 nA	3	lux
Rémanence (note 12) :		
- maximum	20	%
- moyen	12	%

3 - SENSIBILITE ELEVEE
(5 lux sur la face avant)

Courant d'obscurité i_o	50	nA
Tension de l'électrode de signal pour $i_o = 50$ nA (note 10)	25 à 60	V
Eclairement de la cible (2854 °K) (note 11)	5	lux
Courant de signal	200	nA
Sensibilité correspondante	350	µA/lm
Eclairement de la cible pour obtenir un courant de signal de 100 nA	1, 5	lux
Rémanence (note 12) :		
- maximum	20	%
- moyen	15	%

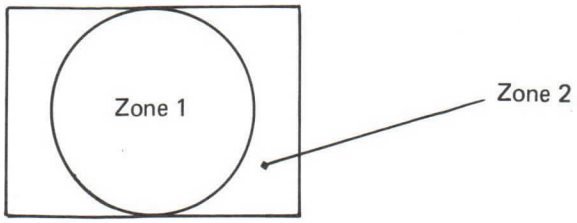
4 - SENSIBILITE TRES ELEVEE
(1 lux sur la face avant)

Courant d'obscurité i_o	100	nA
Tension de l'électrode de signal pour $i_o = 100$ nA (note 10)	30 à 70	V
Eclairement de la cible (2854 °K) (note 11)	1	lux
Courant de signal	100	nA
Sensibilité correspondante	800	µA/lm
Eclairement de la cible pour obtenir un courant de signal de 50 nA	0, 3	lux
Rémanence (note 12) :		
- maximum	20	%
- moyen	17	%

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

EXAMEN DE DEFAUTS D'IMAGES

Observation sur une mire blanche éclairée uniformément et divisant la surface de l'image en deux zones de qualité comme indiquées sur le dessin.



Le tube fonctionne comme indiqué dans les exemples de fonctionnement avec un courant d'obscurité de 20 nA et l'objectif réglé pour obtenir un courant de signal de 200 nA.

L'interprétation des défauts est faite en évaluant le rapport D/H en %, D étant le diamètre moyen du défaut et H la hauteur d'image.

Seuls sont pris en considération, les points dont le contraste avec le fond est supérieur à 50 % (note 13).

Rapport D/H (en %)	Nombre de défauts admis			
	Zone 1	Zone 1 + Zone 2		
		a	a + b	a + b + c
a : 0,8 < D/H ⩽ 1	0	1	3	6
b : 0,6 < D/H ⩽ 0,8	1			
c : 0,2 < D/H ⩽ 0,6	3			

Les défauts tels que D/H ⩽ 0, 2 % ne sont pas pris en considération si leur densité ne détériore pas localement la qualité de l'image.

Les défauts non ponctuels tels que granulation, marbrure, ligne, tache dont le contraste avec le fond est supérieur à 15 % ne sont pas admis.

NOTES

1 - METOX - 86, rue de Villiers de l'Isle Adam - 75020 PARIS - Téléphone : 636. 31-10.

2 - GERHARD KG - REICHELSHEIM/ODW - Allemagne.
CLEVELAND ELECTRONICS Inc. - 2000 Highland Road - TWINSBURG - OHIO 44 - 087.

3 - Il est indispensable de s'assurer de la position correcte du tube à l'intérieur des bobines. Une vérification immédiate consiste à observer la grille à mailles fines dont les traits doivent alors être à 45° approximativement des traces de balayage. D'autre part le plan extrême des bobines de balayage doit être situé à 20 mm environ de la face avant du tube.

4 - On définit le courant de sortie du tube comme étant le courant total circulant dans la résistance de charge connectée à l'électrode de signal : courant de signal + courant d'obscurité, le courant d'obscurité étant le facteur subsistant, dans le cas de la cible non éclairée.

Les amplificateurs vidéo doivent être calculés convenablement pour supporter des courants de sortie de 0, 5 μA afin d'éviter des surcharges d'alimentation ou des distorsions d'image.

5 - Toutes les caractéristiques sont données pour une température de la face avant de 25 °C, les limites de température recommandées pour un bon fonctionnement étant de 20 à 30 °C. L'élévation de la température de la face avant est conditionnée à la fois par les variations de la température ambiante, par la dissipation thermique des dispositifs environnants et du tube lui-même. Une élévation de la température de la face avant de 10 °C entraîne une variation du courant d'obscurité dans le rapport de 1 à 2.

6 - Sans impulsions de blocage appliquées sur l'électrode g1.

7 - Le "gamma" moyen peut être défini comme la pente de la partie rectiligne de la caractéristique de transfert en coordonnées logarithmiques.

8 Pratiquement la résolution limite correspond, sur des barres de définition noires et blanches, à un taux de modulation voisin de 7 %.

9 - Pour le standard C.C.I.R. 625 lignes, le temps d'une ligne est de 52 μs, temps de suppression exclu, 400 lignes T.V. correspondent à une fréquence de 5 MHz.

10 - Dans la plupart des cas la tension cible se situe dans ces limites qui ne présentent cependant qu'une valeur moyenne indicative. Il est bien entendu que le réglage de la tension de cible correspondant à un courant d'obscurité indiqué doit être fait pour chaque tube.

11 - Les éclairements mentionnés sont uniquement valables dans le cas d'une source lumineuse dont la température de couleur est d'environ 2854 °K.

12 - La rémanence s'exprime par le rapport du courant de sortie résiduel, mesuré 60 ms après l'extinction lumineuse, au courant de sortie initial. Les valeurs indiquées sont valables pour une cadence de balayage de 50 trames/seconde.

13 - Le contraste est défini par le rapport :

$$100 \times \frac{\text{incrément du signal vidéo dû au défaut}}{\text{courant de signal normal}}$$

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Figure 1

REPONSE SPECTRALE

Sensibilité en fonction de la longueur d'onde à courant de sortie constant (0.02 µA de courant de signal et 0.02 µA de courant d'obscurité pour une aire balayée de 12.7mm x 9.5mm.

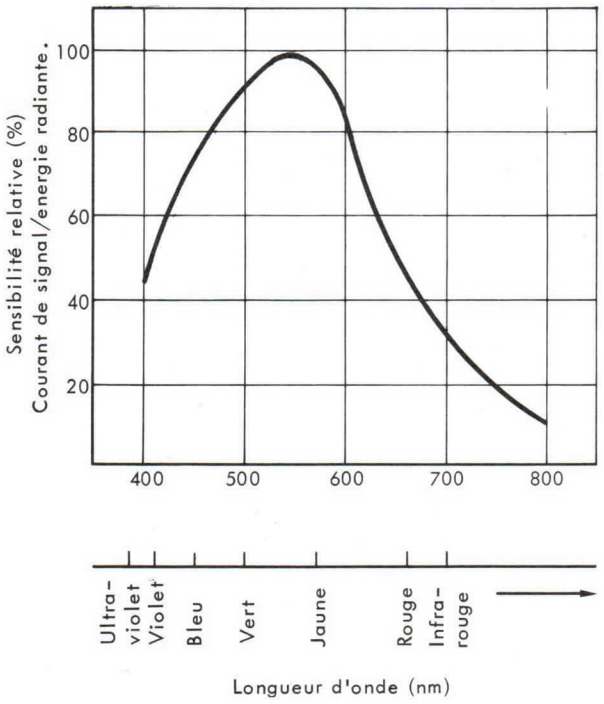
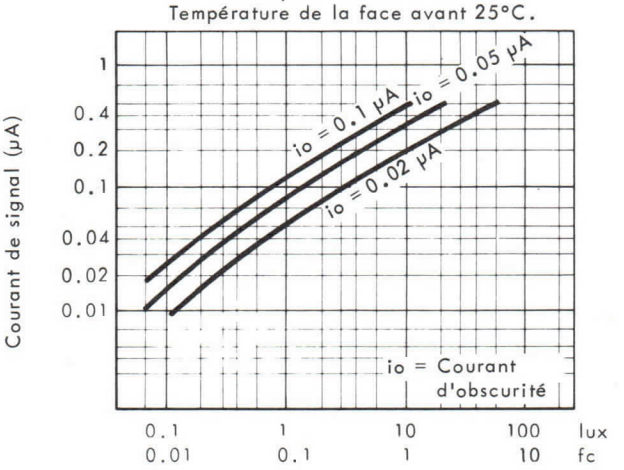


Figure 2

CARACTERISTIQUES DE TRANSFERT SIGNAL-ECLAIREMENT

Eclairement uniforme de la cible photoconductrice
Aire balayée 12.7mm x 9.5mm.
Température de la face avant 25°C.



Eclairement en lux et fc.

Figure 3

FONCTION DE TRANSFERT DE MODULATION

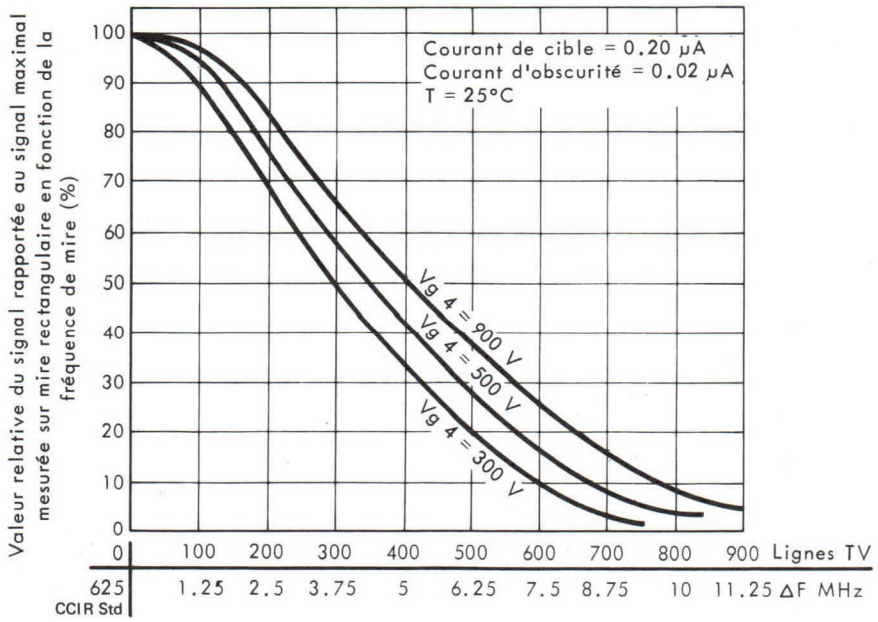


Figure 4

GAMME DE COURANT D'OBSCURITE
Aire balayée de la cible 12.7mm x 9.5mm

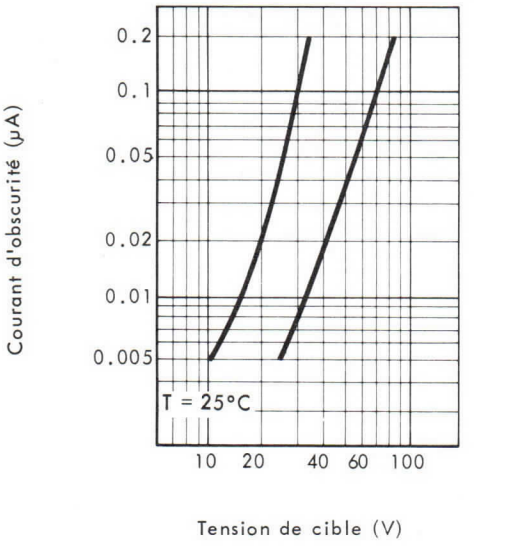


Figure 5

CARACTERISTIQUES DE REMANENCE
Cible eclairée pour un courant de signal initial de 0.2 µA. Aire balayée de la cible 12.7mm x 9.5mm.

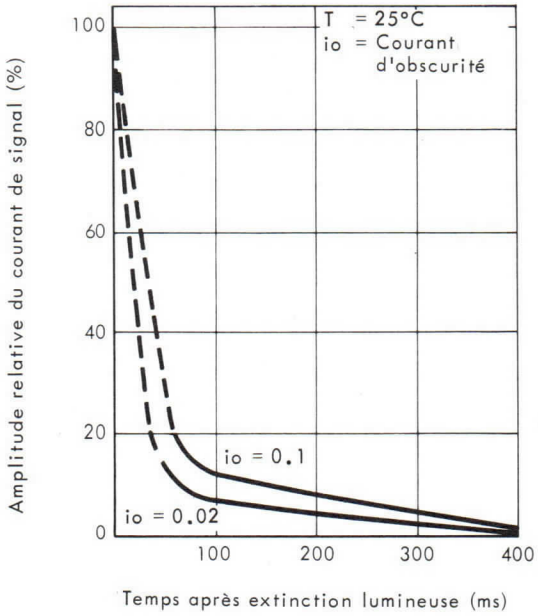
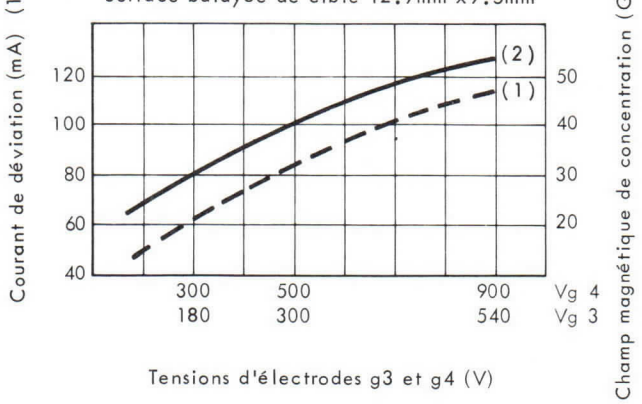


Figure 6

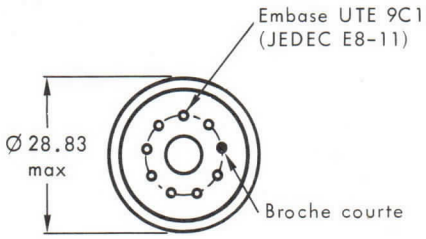
(1) Courant de déviation en fonction des tensions d'électrodes g3 et g4 (Vg3 = 0.6 Vg4)
(2) Champ magnétique au centre de la bobine de concentration

Surface balayée de cible 12.7mm x9.5mm

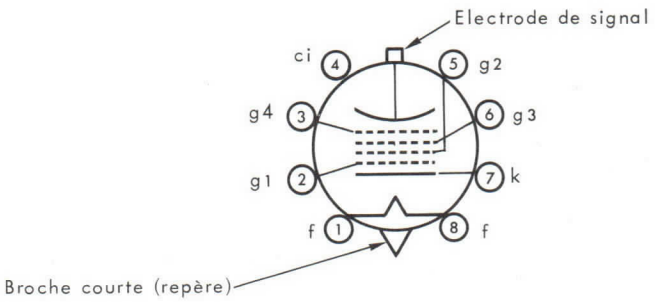


THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

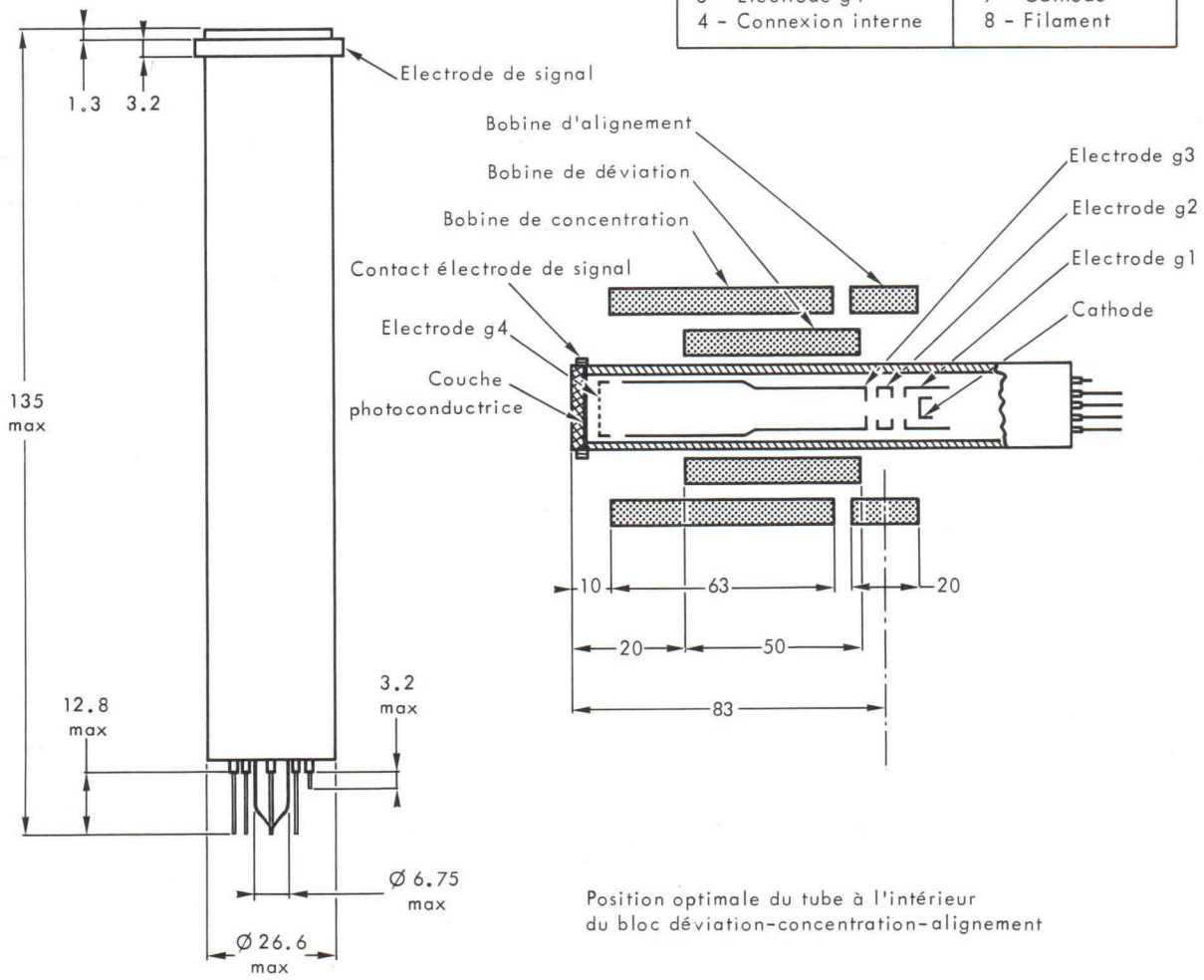
DESSIN D'ENCOMBREMENT



BROCHAGE



1 - Filament	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode
4 - Connexion interne	8 - Filament



Position optimale du tube à l'intérieur
du bloc déviation-concentration-alignement

Cotes en mm.

TH 9815 PA
1" VIDICON

- MAGNETIC FOCUS AND DEFLECTION
- HIGH RESOLUTION (1000 TV LINES)
- HIGH SENSITIVITY
- LOW LAG
- RADIOLOGICAL T.V.

TH 9815PA is a photoconductive pick-up tube specially intended for televising picture obtained from X-rays image intensifier tubes. This tube incorporates in its structure the latest isolated post-acceleration electrode with separate mesh connection. Due to this feature TH 9815PA tube provides higher resolution, higher output signal capability and better resolution and signal uniformity than previous Vidicon tubes.

The spectral response of the photoconductive layer allows for good matching with P20 (yellow-green) and P11 (blue) output screen of X-ray image intensifiers.

Selected photoconductive targets secure good uniformity of signal on the entire square scanned area suitable for circular pictures delivered by image intensifier tubes.

When used with a P20 output screen image intensifier, having a conversion factor of 100 $cd/m^2/mR/s$ (30 ft.L/mR/s), excellent quality picture of still and moving bodies can be obtained at dose rate lower than 150 micro-Roëntgen/second, with a coupled optical system at unity aperture. Sensitivity is equivalent to a photographic film having an ASA exposure index of 2400 (35/10 DIN 42 Sch).

Lag characteristics allow for reduction of quantum noise of X-ray photons when incident dose rate is reduced at image intensifier input without impairing details and low contrast perception in case of moving bodies.

Tube sensitivity can be controlled by target voltage which also causes some variation of dark current within a narrow range. Maximum sensitivity at output signal of 50 nA and optimum gamma characteristic is obtained by increasing dark current to a maximum value of 100 nA. Gamma characteristic is close to 0.9 for illumination lower than 0.2 lux (20 mfc) on the target and decreases to 0.6 for illumination reaching 20 lux (2 fc) on the target. This performance allows for over exposure of the target without impairing final quality of the picture by limiting the range of the output signal avoiding spurious signals.

TH 9815PA can be operated over a wide range of electrode voltage selection although recommended adjustment requires a g4 voltage to g3 voltage ratio of 1.4 - 1.5. Under these conditions TH 9815PA can provide an optimum resolution and an uniform signal output over the entire scanned area with a beam landing considerably improved minimizing "porthole" effect and geometrical distortion.

The limiting resolution of TH 9815PA is about 1000 T.V. lines at center of picture and 600 T.V. lines at corner. This high resolution is obtained with 900 V on electrode g4 and 600 V on g3. When the TH 9815PA is operated at a lower g4 voltage of 500 V and g3 voltage of 350 V, its limiting resolution will be 900 T.V. lines at center and 500 T.V. lines at corner. Operating g4 voltage at 1.5 times g3 voltage requires 20 % deflection current increase over current necessary for g3 - g4 connected mode. Focusing field is not noticeably changed with such an operation.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Full advantage of resolution and signal uniformity is achieved when deflecting and focusing components are properly designed and when the tube is correctly located inside. The thickness of the photoconductive layer is made very uniform and allows for constant output signal and constant dark current. When landing error due to imperfect scanning system is present, the voltage gradient across the photoconductive layer is not uniform and a signal variation (shading) is introduced which can be compensated by proper adjustment of the cathode, g1 and g2 voltages.

Due to good design, high reliability is obtained all along tube life. Requirement alignment field is reduced to a minimum by precise electron gun mounting. An extremely flat faceplate avoids all optical distortions and allows for the use of any good quality lens. Particle barriers adjacent to the field mesh allows these tubes to operate in any position.

One watt power heater makes these Vidicons particularly suitable for transistorized equipment. The reduced heat dissipation improves the quality of the picture by lowering faceplate temperature.

GENERAL CHARACTERISTICS

Electrical

Heater	for unipotential cathode indirectly heated	
Heater :		
— Voltage	6.3 ± 10 %	V
— Current at 6.3 V	0. 15	
Minimum preheating time	60	s
Output capacitances :		
— Target to all other electrodes	4. 5	pF
Spectral response	see curve	
Focusing method	magnetic	
Deflection method	magnetic	

Mechanical

Base (Ditetrar, 8 pins)	UTE 9 C 15 (JEDEC N° E8 - 11)	
Socket note 1	METOX N° 30.250	
Deflecting yoke - Focusing coil Assembly note 2	GERHARD type BV 200 - 1K1 or equivalent	
Alignment coil note 2	GERHARD type BV 80/3 or equivalent	
Dimensions	see drawing	
Photoconductive layer :		
— normal dimensions of image on target	12.7 mm x 9,5	mm
— maximum useful diagonal diameter (4 x 3 aspect ratio)	17	mm
— orientation of quality rectangle : horizontal scan parallel to the plane passing through the tube axis and short index pin note 3		
Maximum temperature of faceplate	70	°C
Mounting position	any	
Net weight, approximate	60	g

OPERATING CONDITIONS

Scanned area 12.7 mm x 9.5 mm

Maximum ratings

Electrode g4 voltage (post acceleration electrode)	1000	V
Electrode g3 voltage (wall electrode)	1000	V
Electrode g2 voltage (accelerator)	350	V
Electrode g1 voltage (electrode for picture cut-off)		
– negative bias value	150	V
– positive bias value	0	V
Peak heater - cathode voltage :		
– heater negative with respect to cathode	125	V
– heater positive with respect to cathode	10	V
Target voltage	125	V
Dark current	0. 20	µA
Peak target current (note 4)	0. 40	µA
Faceplate :		
– Illumination	10000 or 1000	lux fc
– Temperature	70	°C

Typical operation

Scanned area 12.7 mm x 9.5 mm
Faceplate temperature 25 °C (note 5)

Electrode voltage modes :	low	Intermediate	High	
Electrode g4 voltage	300	500	900	V
Electrode g3 voltage	200	350	600	V
Electrode g2 voltage	300	300	300	V
Electrode g1 (note 6)	–45 to –110	–45 to –110	–45 to –110	V
Average "gamma" for a target illumination between 1 and 100 lux (note 7)	0. 65	0. 65	0. 65	
Minimum blanking peak to peak voltage :				
– applied to electrode g1	–75	–75	–75	V
– applied to cathode	+20	+20	+20	V
Limiting resolution at center of picture (note 8)	800	900	1000	TV lines
Limiting resolution at corner of picture	400	500	600	TV lines
M.T.F. response at 400 T.V. lines at center of picture (5 MHz - 625 CCIR standard) (note 9)	30	40	50	%
Field strength at center of focusing coil	30 ± 2	40 ± 2	50 ± 2	Gauss
Peak deflecting coil current :				
– horizontal	130	170	200	mA
– vertical	15	20	24	mA
Field strength of alignment coil	0 to 4	0 to 4	0 to 4	Gauss

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

1 - AVERAGE SENSITIVITY OPERATION

(faceplate illumination 10 lux or 1 fc)

Dark current i_o	20	nA
Target voltage for i_o = 20 nA (note 10)	20 to 50	V
Faceplate illumination (2854 °K (note 11)	10	lux
	or 1	fc
Signal current	250	nA
Corresponding sensitivity	200	µA/lm
Target illumination for 100 nA signal current	1.5	lux
	or 150	mfc
Lag : (note 12)		
– maximum	20	%
– average	12	%

2 - HIGH SENSITIVITY OPERATION

(faceplate illumination 1 lux or 100 mfc)

Dark current i_o	50	nA
Target voltage for i_o = 50 nA (note 10)	20 to 60	V
Faceplate illumination (2854 °K) (note 11)	1	lux
	or 100	mfc
Signal current	110	nA
Corresponding sensitivity	900	µA/lm
Target illumination for 100 nA signal current	0.2 to 0.3	lux
	or 20 to 30	mfc
Lag : (note 12)		
– maximum	20	%
– average	15	%

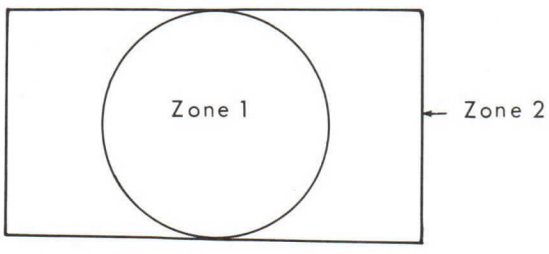
3 - VERY HIGH SENSITIVITY OPERATION

(faceplate illumination 0.5 lux or 50 mfc)

Dark current i_o	100	nA
Target voltage for i_o = 100 nA (note 10)	30 to 70	V
Faceplate illumination (2854 °K) (note 11)	0.5	lux
	or 50	mfc
Signal current	100	nA
Corresponding sensitivity	1500	µA/lm
Target illumination for 50 nA signal current	0.1	lux
	or 10	mfc
Lag : (note 12)		
– maximum	20	%
– average	17	%

4 - SPURIOUS SIGNAL TEST

The test is performed using a uniform grey test pattern that is separated into two zones as shown in drawing :



The tube is operated under the "Typical Operation" conditions with a dark current of 50 nanoamperes and the lens adjusted to provide a signal current of 50 nanoamperes.

Spurious signals are classified by their size which is measured by percent of raster height.

Will actually be considered as a defect, a spot blemish (black or white spot) having a contrast ratio greater than 25 %. (note 13)

Allowable spot size for each zone is shown in table :

Ratio D/H* (percent raster height)	Number allowed	
	Zone 1	Zone 2
D/H > 0.6 %	0	0
0.4 ⩽ D/H ⩽ 0.6 %	1	1
0.25 ⩽ D/H < 0.4 %	2	2
0.15 ⩽ D/H < 0.25 %	2	4
Total spots	6	

0.15 % and under : do not count spots of this size unless concentration causes a smudge appearance.

* *D : average diameter of spot*
H : raster height

Smudges, streaks, mottled or grainy background having a contrast ratio greater than 10 % constitute a reject.

NOTES

1 - METOX - 86, rue de Villiers de l'isle Adam - PARIS 20ème - Telephone : 636 - 31 - 10.

2 - GERHARD KG - REICHELSHEIM / ODW Germany

3 - It is necessary to assure correct positioning of the tube inside the coils. An immediate test consists in observing the fine mesh grid, the wires of which should be inclined 45° with respect to scanning. Then again the front end of the deflecting yoke should be positioned at 20 mm from the tube faceplate.

4 - Target current is defined as total current in load resistance connected to target electrode : signal current plus dark current, dark current being the current left when illumination is subtracted.
Video amplifiers must be designed properly to handle peak target current of 0.4 µA to avoid amplifier overload and picture distortion.

5 - All these characteristics are provided for a temperature of faceplate of 25 °C, the temperature range recommended is within 20 to 30 °C. The rise of faceplate temperature is a function of ambient temperature, thermic dissipation of ambient devices and of the tube itself. Consequently, 10 °C of faceplate temperature rise implies a dark current multiplied by a factor of 2.

6 - Without blanking pulses applied on electrode g1.

7 - Average "gamma" should be defined as the slope of the rectilinear part of transfer characteristics in log coordinates.

8 - Practically, limiting resolution corresponds to the resolution measured with twin bar test card with a modulation ratio of about 7 %.

9 - For 625 lines C.C.I.R. standard, line duration being 52 µs (line suppression period not included), 400TV lines correspond to 5 MHz.

10 - Indicated range of each type of service serves only to illustrate the operating target voltage range normally encountered. The target voltage for each Vidicon must be adjusted to that value which gives the designed operating dark current.

11 - All the above mentioned illumination assume 2854 °K incandescent tungsten source.

12 - Lag is defined as the ratio of residual signal current measured 60 milliseconds after light excitation being removed to the initial signal current ; this value assumés 50 field/second scanning rate.

13 - Contrast is defined as : $100 \times \frac{\text{increment in video current due to the blemish}}{\text{normal signal current}}$

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Figure 1

TYPICAL SPECTRAL SENSITIVITY CHARACTERISTICS

For equal values of signal current at all wavelengths
(0.02 µA signal current and 0.02 µA dark current
for scanned area of 12.7 x 9.5 mm)

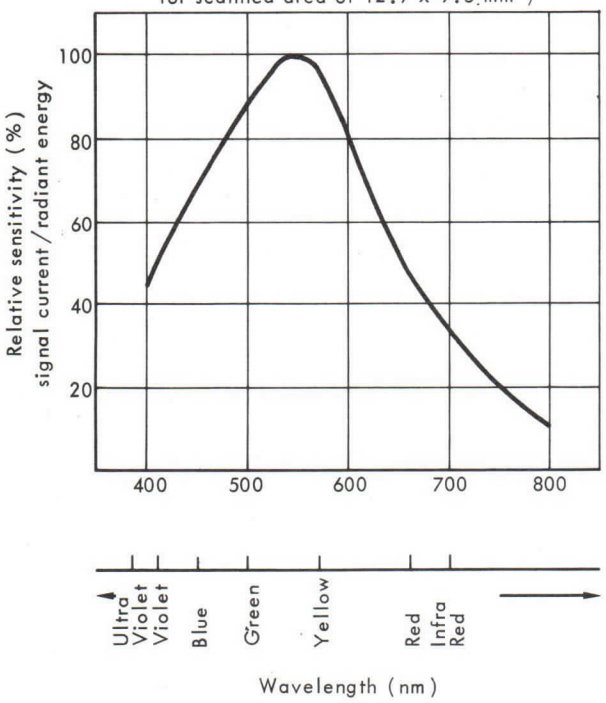


Figure 2

LIGHT TRANSFER CHARACTERISTICS

Illumination uniform over photoconductive layer scanned
area 12.7 x 9.5 mm-face plate temperature 25°C

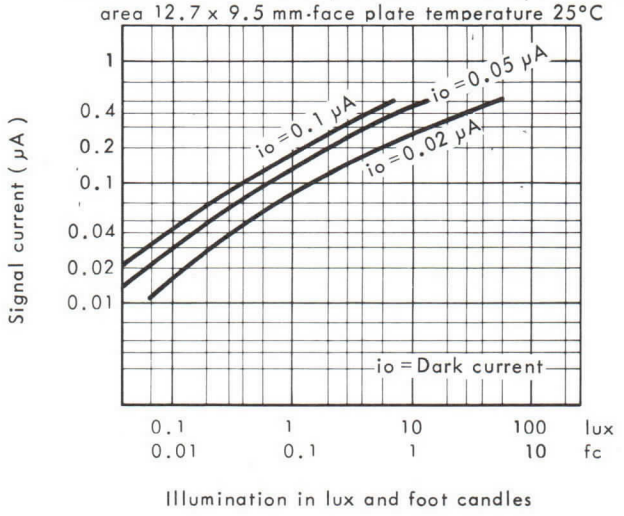


Figure 3

MODULATION TRANSFER FUNCTION

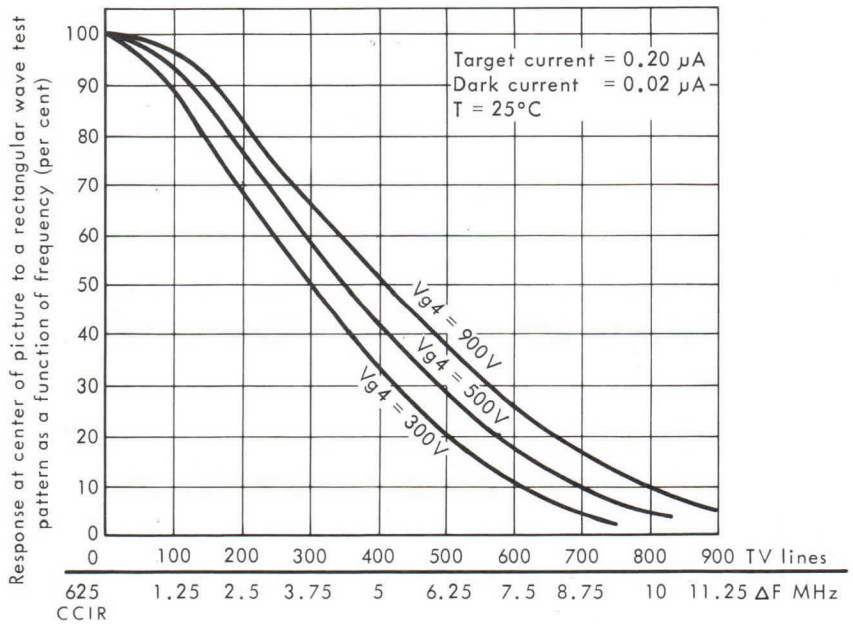


Figure 4

RANGE OF DARK CURRENT
Scanned area of photoconductive layer 12.7 mm x 9.5 mm

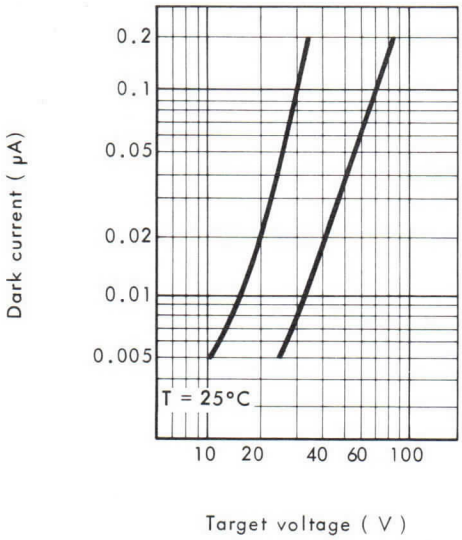


Figure 5

TYPICAL PERSISTENCE CHARACTERISTICS
Initial highlight signal current of 0.2 µA scanned area of photoconductive layer 12.7x 9.5 mm

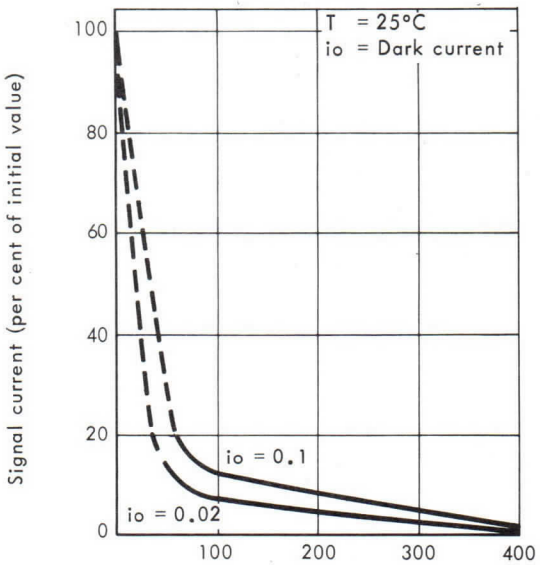
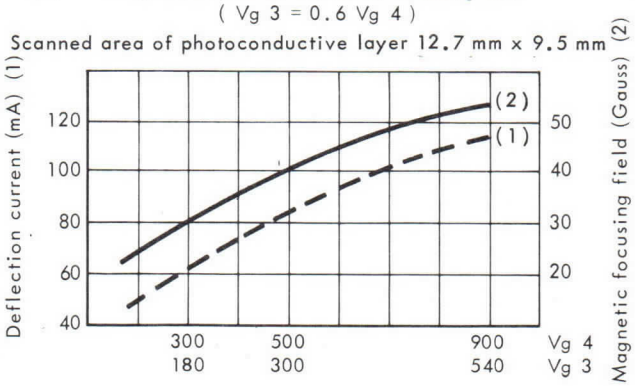


Figure 6

(1) Deflection current as a function of electrode g3 and g4 voltages (Vg 3 = 0.6 Vg 4)

(2) Magnetic field at center of focusing coil (Vg 3 = 0.6 Vg 4)

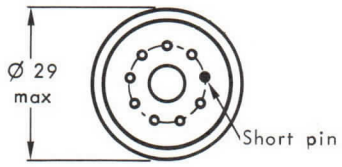
Scanned area of photoconductive layer 12.7 mm x 9.5 mm



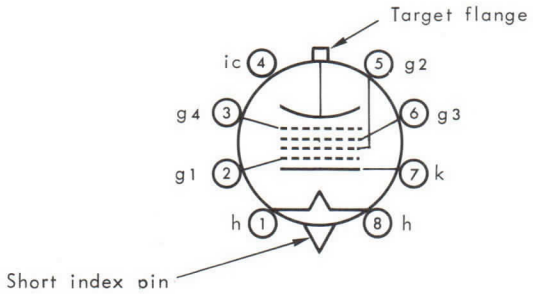
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING

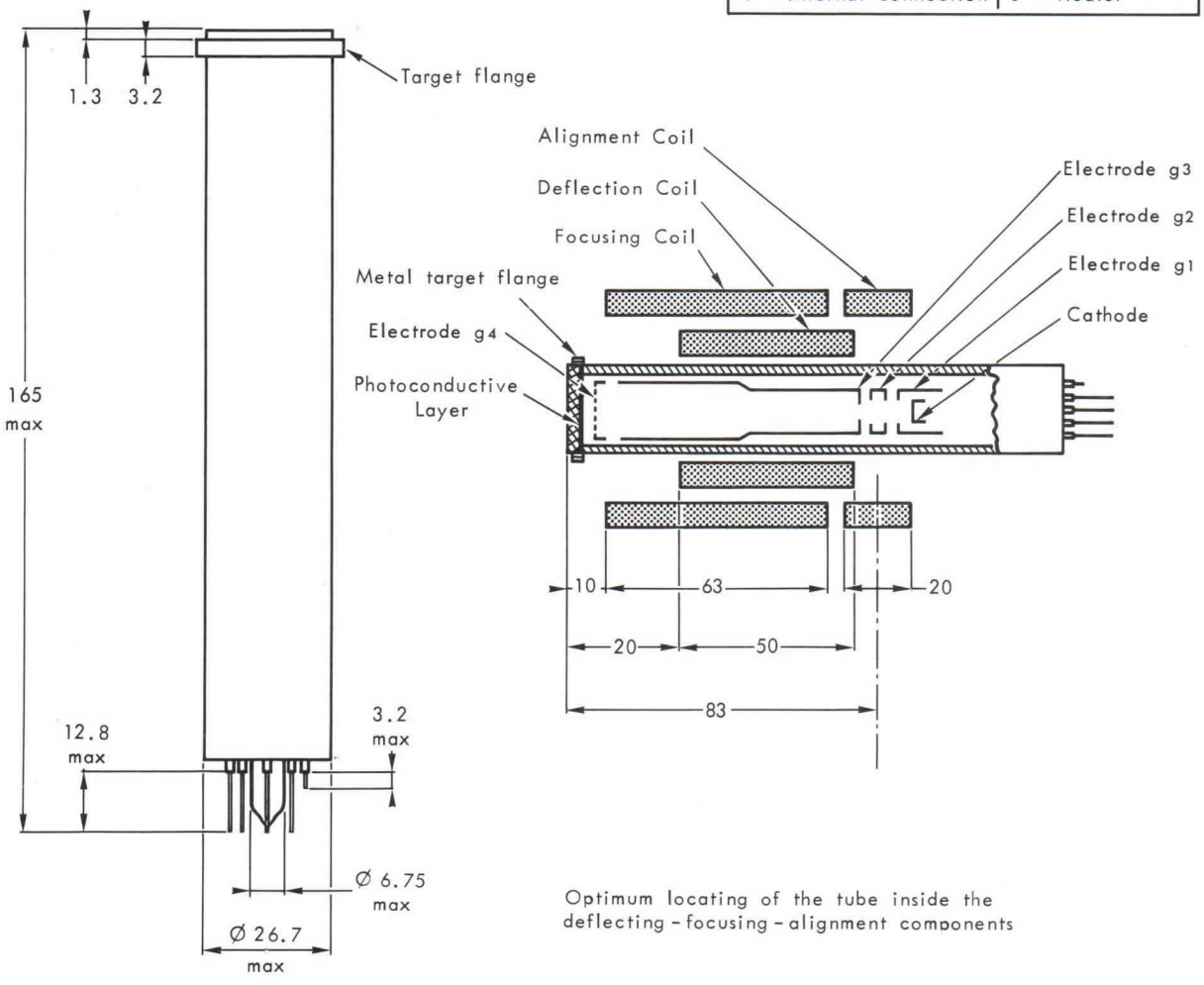
UTE 9C15 base
(JEDEC E8-11)



BASING DIAGRAM



1 - Heater	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode
4 - Internal connection	8 - Heater



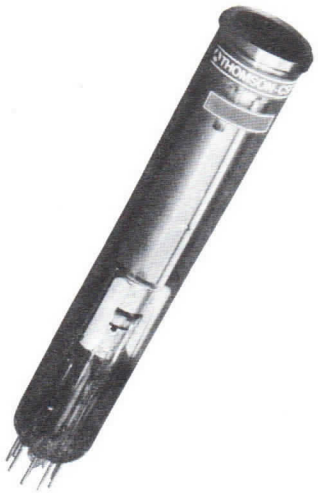
Optimum locating of the tube inside the deflecting - focusing - alignment components

Dimensions in mm.

TH9817 PA
1" VIDICON

- MAGNETIC FOCUS AND DEFLECTION
- VERY HIGH RESOLUTION (1100 TV LINES)
- HIGH SENSITIVITY (900 μA/lm WITH 1 lux ON FACEPLATE)
- EXCELLENT IMAGE UNIFORMITY
- LOW LAG
- LIVE SCENE PICK-UP BROADCAST TV

TH 9817PA is a 1" Vidicon specially designed for high quality pick-up cameras in black and white or color T.V. This Vidicon includes in its structure the latest insulated post-acceleration electrode with separate mesh connection. Due to this feature TH 9817PA Vidicon allows for higher resolution and output signal, better uniformity of resolution and signal than conventional Vidicons.



TH 9817PA is intended for live scene pick-up T.V. (black and white or color). It can operate within a very wide range and allows for excellent quality of image even in the case of low level illumination of about 5 lux (0.5 fc).

When operating with about 1 to 10 lux (0.1 to 1 fc) target illumination normally encountered, TH 9817PA delivers a signal current from 100 nA to 300 nA giving rise to excellent quality images of high resolution and high signal to noise ratio. The sensitivity of TH 9817PA can be equivalent to photographic film having an A.S.A. exposure index of 2000 (34/10DIN41 Sch). With a target illumination of 0.3 lux to 0.5 lux (3 to 10 lux on the object with a unity numerical lens aperture) giving rise to a signal of 50 nA at 50 nA dark current, satisfactory quality of image can be obtained. For such illuminations, higher signal current can be obtained by increasing target voltage. Nevertheless, it is not recommended to go beyond 100 nA dark current, saturation of signal being pratically reached.

Due to a new low lag photoconductive layer, excellent quality of picture can be obtained with good signal uniformity and appropriate gamma characteristics.

TH 9817PA performances are substantially identical under high or low level illumination conditions. The sensitivity of the tube can be controlled by target voltage which also causes some variation of dark current.

TH 9817PA Vidicon can operate within a wide range of electrode voltage selection although it is recommended to operate with a g4 electrode voltage 1.4 to 1.5 times g3 electrode voltage. In these conditions, TH 9817PA can provide optimum resolution and uniformity of signal on the entire scanned area without distortion and loss of quality even for overbeaming conditions.

The limiting resolution of TH 9817PA is about 1100 T.V. lines at center of image and 700 T.V. lines at corners. This high resolution is obtained with 750 to 800 V on g4 electrode and 450 to 600 V on g3 electrode. When it operates with 500 V on g4 and 300 V on g3, the resolution is 1000 T.V. lines at center of image and 600 T.V. lines at corners. In operation where g4 voltage is equal to 1.5 times g3 voltage, the deflection current is 20 % higher than the current necessary for g4 = g3 operation mode but the focus field is not noticeably changed.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Full advantage of resolution and signal uniformity is achieved when deflecting and focusing components are properly designed and when the tube is correctly located inside. The thickness of the photoconductive layer is made very uniform and allows for constant output signal and constant dark current. When landing error due to imperfect scanning system is present, the voltage gradient across the photoconductive layer is not uniform and a signal variation (shading) is introduced which can be compensated by proper adjustment of the cathode, g1 and g2 voltages.

Due to good design, high reliability is obtained thoughout the tube life. Requirement for alignment field is reduced to a minimum by precise electron gun mounting. An extremely flat faceplate avoids all optical distortions and allows for the use of any good quality lens. Particle barriers adjacent to the field mesh allows these tubes to operate in any position.

One watt power heater makes these Vidicons particularly suitable for transistorized equipment. The reduced heat dissipation improves the quality of the picture by lowering faceplate temperature.

GENERAL CHARACTERISTICS

Electrical

Heater	for unipotential cathode indirectly heated
Heater :	
voltage	6.3 ± 10 % V
current at 6.3 V	0.15 A
Minimum preheating time	60 s
Output capacitances :	
target to all other electrodes	4.5 pF
Spectral response	see curve
Focusing method	magnetic
Deflection method	magnetic

Mechanical

Base (Ditetrar, 8 pins)	UTE 9 C 15 (JEDEC N° E8 - 11)
Socket (note 1)	METOX N° 30.250
Deflecting yoke - focusing coil assembly (note 2)	GERHARD type BV 200 1K 1 or equivalent
Alignment coil (note 2)	GERHARD type BV 80/3 or equivalent
Deflection - focus - alignment assembly (note 2)	CLEVELAND VYFA - 355 - 2 or equivalent
Dimensions	see drawing
Photoconductive layer :	
normal dimensions of image on target	12.7 mm x 9.5 mm
maximum useful diagonal diameter (4 x 3 aspect ratio)	17 mm
orientation of quality rectangle :	
horizontal scan parallel to the plane passing through the tube axis and short index pin (note 3)	
Maximum temperature of faceplate	70 °C
Mounting position	any
Net weight, approximate	60 g

OPERATING CONDITIONS

Scanned area 12.7 mm x 9.5 mm

Maximum ratings (absolute values)

Electrode g4 voltage (post-acceleration electrode)	1000	V
Electrode g3 voltage (wall electrode)	1000	V
Electrode g2 voltage (accelerator)	350	V
Electrode g1 voltage (electrode for picture cut-off)		
– negative bias value	150	V
– positive bias value	0	V
Peak heater-cathode voltage :		
– heater negative with respect to cathode	125	V
– heater positive with respect to cathode	10	V
Target voltage	125	V
Dark current	0. 20	µA
Peak target current (note 4)	0. 60	µA
Faceplate :		
– illumination	10000 or 1000	lux fc
– temperature	70	°C

Typical operation

Scanned area 12,7 mm x 9.5 mm
Faceplate temperature 25 °C (note 5)

Electrode voltage modes :	Intermediate	High	
Electrode g4 voltage	500	750 to 800	V
Electrode g3 voltage	300 to 400	450 to 600	V
Electrode g2 voltage	300	300	V
Electrode g1 voltage (note 6)	–45 to –110	–45 to –110	V
Average "gamma" for target illumination between 1 and 100 lux (note 7)	0. 65	0. 65	
Minimum blanking peak to peak voltage :			
– applied to electrode g1	–75	–75	V
– applied to cathode	+20	+20	V
Limiting resolution at center of picture (note 8)	1000	1100	T.V. lines
Limiting resolution at corners of picture	600	700	T.V. lines
MTF response at 400 T.V. lines at center of picture (5 MHz - 625 CCIR Standard) (note 9)	40	50	%
Field strength at center of focusing coil	40 to 48	50 to 60	Gauss
Peak deflecting coil current :			
– horizontal	170	200	mA
– vertical	20	24	mA
Field strength of alignment coil	0 to 4	0 to 4	Gauss

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

1 - HIGH LIGHT LEVEL OPERATION

(faceplate illumination 100 lux or 10 fc)

Dark current i_o	5	nA
Target voltage for i_o = 5 nA (note 10)	10 to 25	V
Faceplate illumination (2854 °K) (note 11)	100	lux
	or 10	fc
Signal current	350	nA
Lag : (note 12)		
– maximum	15	%
– average	10	%

2 - AVERAGE SENSITIVITY OPERATION

(faceplate illumination 10 lux or 1 fc)

Dark current i_o	20	nA
Target voltage for i_o = 20 nA (note 10)	20 to 50	V
Faceplate illumination (2854 °K (note 11)	10	lux
	or 1	fc
Signal current	250	nA
Corresponding sensitivity	200	µA/lm
Target illumination for 100 nA signal current	1.5	lux
	or 150	mfc
Lag : (note 12)		
– maximum	20	%
– average	12	%

3 - HIGH SENSITIVITY OPERATION

(faceplate illumination 1 lux or 100 mfc)

Dark current i_o	50	nA
Target voltage for i_o = 50 nA (note 10)	25 to 60	V
Faceplate illumination (2854 °K) (note 11)	1	lux
	or 100	mfc
Signal current	110	nA
Corresponding sensitivity	900	µA/lm
Target illumination for 100 nA signal current	0.8	lux
	or 80	mfc
Lag : (note 12)		
– maximum	20	%
– average	15	%

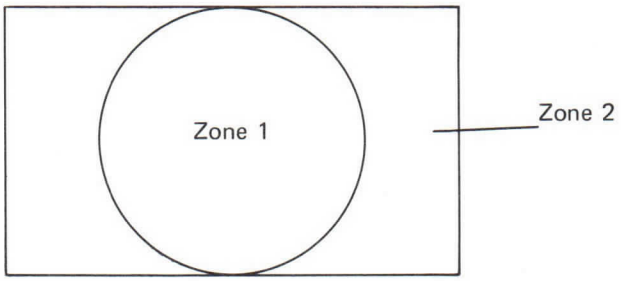
4 - VERY HIGH SENSITIVITY OPERATION

(faceplate illumination 0.5 lux or 50 mfc)

Dark current i_o	100	nA
Target voltage for i_o = 100 nA (note 10)	30 to 70	V
Faceplate illumination (2854 °K) (note 11)	0.5	lux
	or 50	mfc
Signal current	100	nA
Corresponding sensitivity	1500	µA/lm
Target illumination for 50 nA signal current	0.1	lux
	or 10	mfc
Lag : (note 12)		
– maximum	20	%
– average	17	%

5 - SPURIOUS SIGNAL TEST

The test is performed using a uniformly diffused white test pattern that is separated into two zones as shown in drawing :



The tube is operated under the "Typical Operation" conditions with a dark current of 20 nanoamperes and the lens adjusted to provide a signal current of 220 nanoamperes.

Spurious signals are classified by their size which is measured by percent of raster height.

Will actually be considered as a defect, a spot blemish (black or white spot) having a contrast ratio greater than 25 % . (note 13)

Allowable spot size for each zone is shown in table :

Ratio D/H* (percent raster height)	Number allowed	
	Zone 1	Zone 2
D/H $\geqslant$ 0,4 %	0	0
D/H $<$ 0,4 %	0	4

* *D : average diameter of spot*
H : raster height

The picture must be of a very imperceptible mottled or grainy appearance with no streaks of large area.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

NOTES

1 — METOX - 86, rue de Villiers de l'isle Adam - PARIS 20ème
Téléphone : 636 - 31 - 10

2 — GERHARD KG - REICHELSHEIM / ODW Germany
CLEVELAND ELECTRONICS INC. 2000 Highland Road - TWINSBURG - OHIO 44 087.

3 — It is necessary to assure correct positioning of the tube inside the coils. An immediate test consists in observing the fine mesh grid, the wires of which should be inclined 45 ° with respect to scanning. Then again the front end of the deflecting yoke should be positioned at 20 mm from the tube faceplate.

4 — Target current is defined as total current in load resistance connected to target electrode : signal current plus dark current, dark current being the current left when illumination is subtracted.
Video amplifiers must be designed properly to handle peak target current of 0.7 μA to avoid amplifier overload and picture distortion.

5 — All these characteristics are provided for a temperature of faceplate of 25 °C, the temperature range recommended is within 20 to 30 °C. The rise of faceplate temperature is a function of ambient temperature, thermic dissipation of ambient devices and of the tube itself. Consequently, 10 °C of faceplate temperature rise implies a dark current multiplied by a factor of 2.

6 — Without blanking pulses applied on electrode g1.

7 — Average "gamma" should be defined as the slope of the rectilinear part of transfer characteristics in log coordinates.

8 — Practically, limiting resolution corresponds to the resolution measured with twin bar test card with a modulation ratio of about 7 %.

9 — For 625 lines C.C.I.R. standard, line duration being 52 μs (line suppression period not included), 400 TV lines correspond to 5 MHz.

10 — Indicated range of each type of service serves only to illustrate the operating target voltage range normally encountered. The target voltage for each Vidicon must be adjusted to that value which gives the designed operating dark current.

11 — All the above mentioned illumination assume 2854 °K incandescent tungsten source.

12 — Lag is defined as the ratio of residual signal current measured 60 milliseconds after light excitation being removed to the initial signal current ; this value assumes 50 field/second scanning rate.

13 — Contrast is defined as :

$$100 \times \frac{\text{increment in video current due to the blemish}}{\text{normal signal current}}$$

Figure 1

TYPICAL SPECTRAL SENSITIVITY CHARACTERISTICS

For equal values of signal current at all wavelengths
(0.02 µA signal current and 0.02 µA dark current
for scanned area of 12.7 x 9.5 mm)

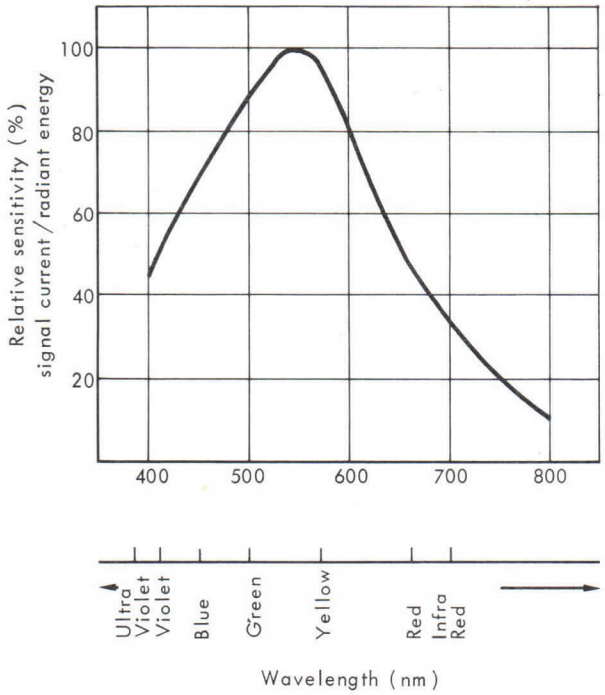


Figure 2

LIGHT TRANSFER CHARACTERISTICS

Illumination uniform over photoconductive layer scanned
area 12.7 x 9.5 mm-face plate temperature 25°C

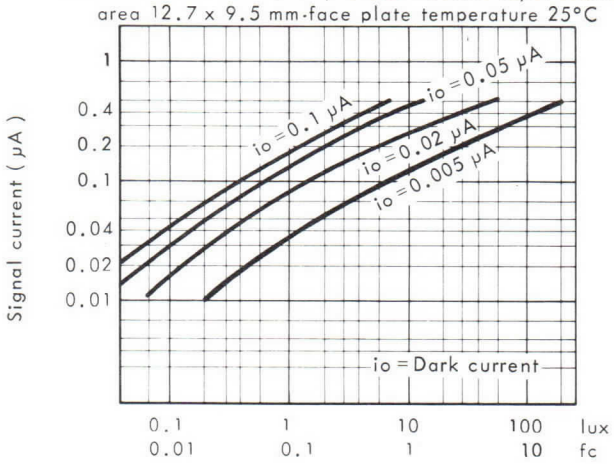
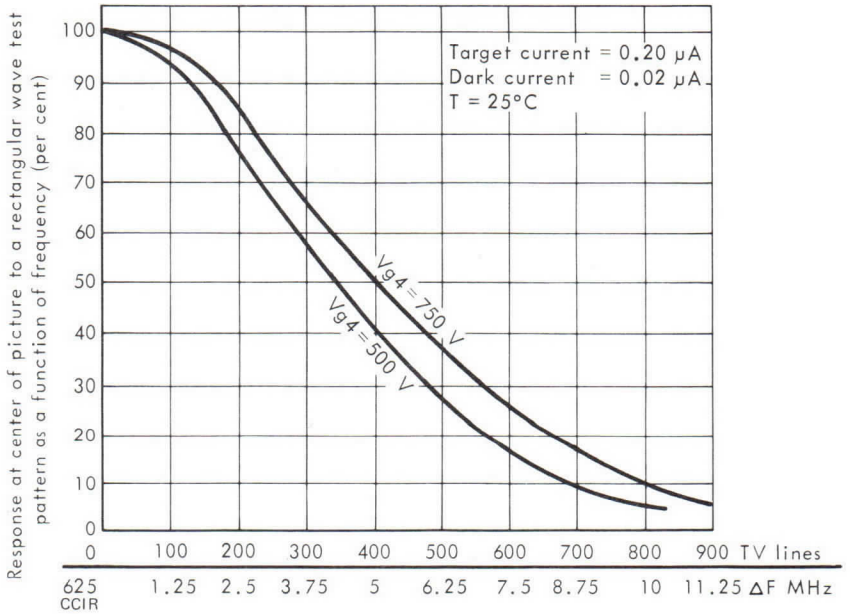


Figure 3

MODULATION TRANSFER FUNCTION



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Figure 4

RANGE OF DARK CURRENT

Scanned area of photoconductive layer 12.7 mm x 9.5 mm

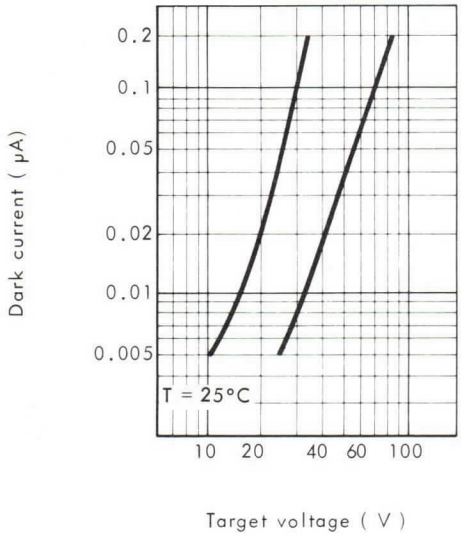


Figure 5

TYPICAL PERSISTENCE CHARACTERISTICS

Initial highlight signal current of 0.2 µA scanned area of photoconductive layer 12.7x9.5 mm

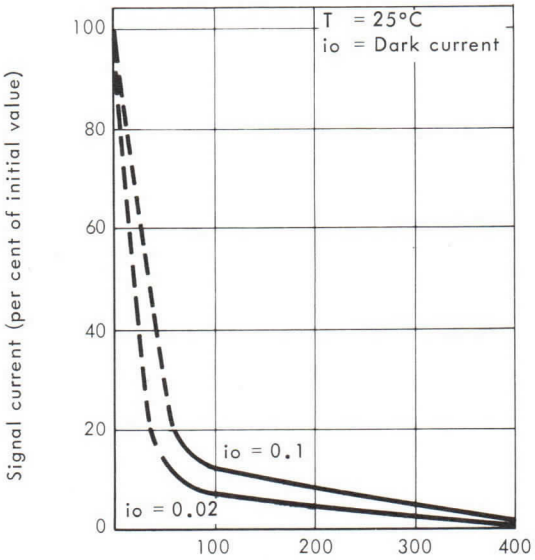
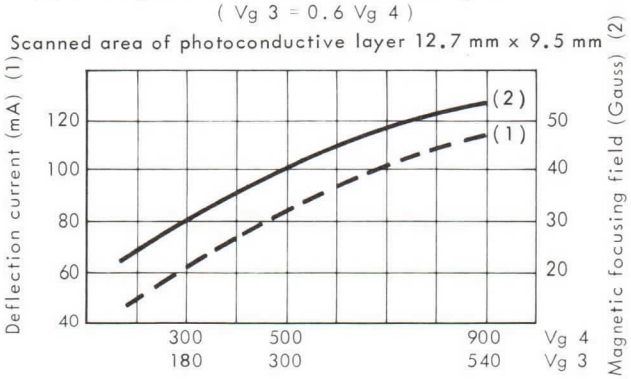


Figure 6

(1) Deflection current as a function of electrode g3 and g4 voltages(Vg 3 = 0.6 Vg 4)

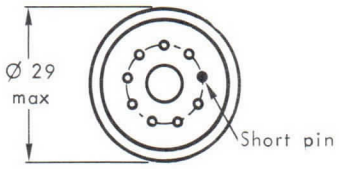
(2) Magnetic field at center of focusing coil (Vg 3 = 0.6 Vg 4)

Scanned area of photoconductive layer 12.7 mm x 9.5 mm

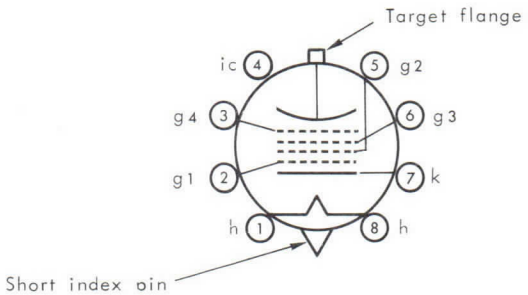


OUTLINE DRAWING

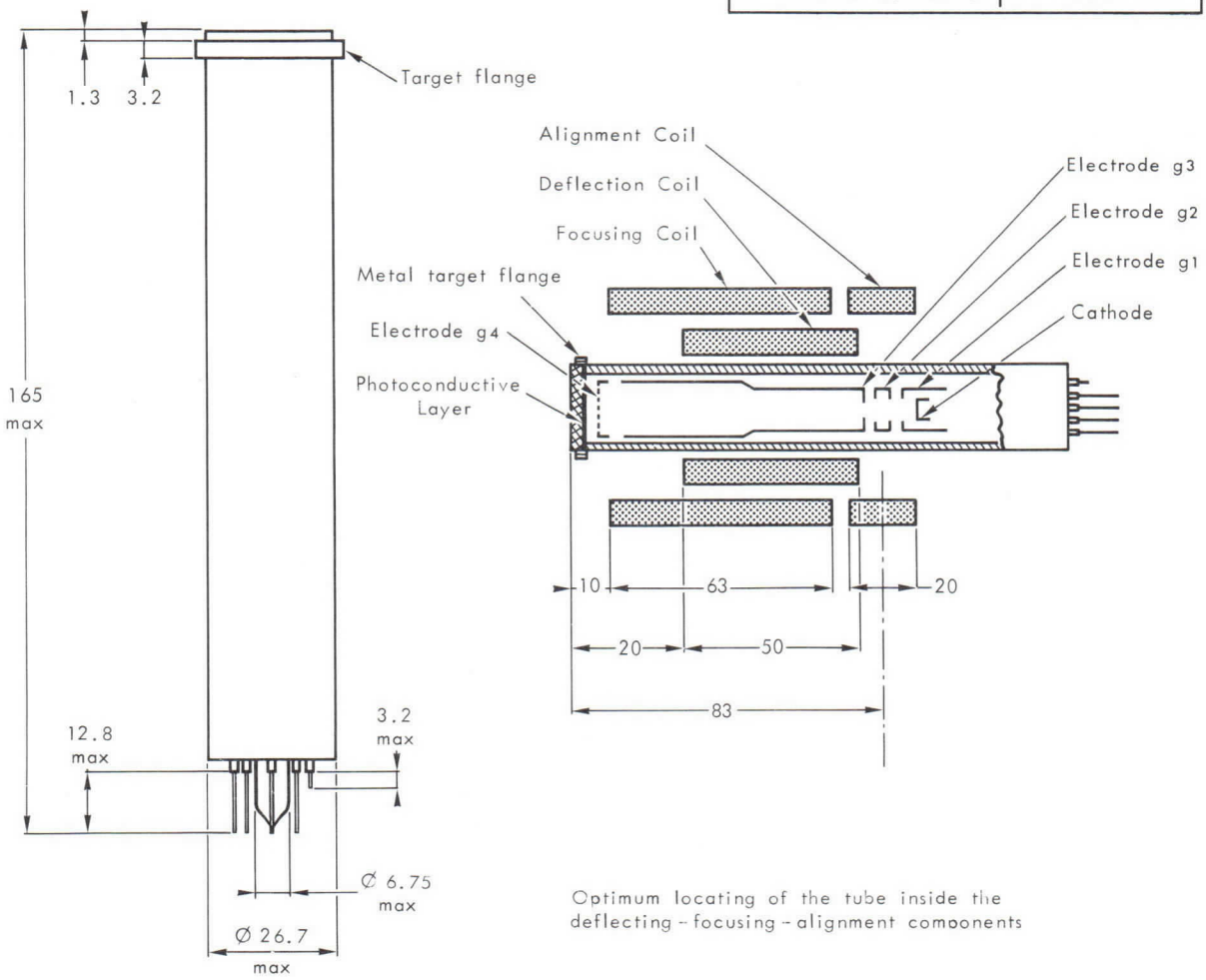
UTE 9C15 base
(JEDEC E8-11)



BASING DIAGRAM



1 - Heater	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode
4 - Internal connection	8 - Heater



Optimum locating of the tube inside the deflecting - focusing - alignment components

Dimensions in mm.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

THOMSON-CSF

TH 9820
VIDICON 26mm (1")
A CIBLE SILICIUM A MOSAIQUES DE DIODES

- Concentration et déviation électromagnétiques.
- Cible Silicium à grande sensibilité.
- Large réponse spectrale (400 à 1100 nm).
- Faible rémanence.
- Faible courant d'obscurité.
- Excellente résistance au marquage.

Le tube TH 9820 est un tube de prise de vue du type Vidicon à concentration et déviation électromagnétiques utilisant une cible en Silicium à mosaïque de diodes. La conception générale du tube est identique à celle des Vidicons classiques TH 9808, TH 9812 ... avec lesquels il est interchangeable.

La cible du TH 9820, en plus de sa grande sensibilité, présente l'avantage d'être très résistante au marquage d'image.

La sensibilité du tube ne dépend pas de la tension de cible ; celle-ci est faible comparée aux Vidicons à cible photoconductrice ; le courant d'obscurité qui en résulte est également faible.

Compte tenu de la très grande largeur de réponse spectrale (400 à 1100 nm), il peut être souhaitable, suivant les applications, d'utiliser des filtres appropriés permettant la sélection du spectre utile (visible ou infra-rouge).

Le gamma, égal à l'unité, permet d'obtenir des images contrastées surtout aux faibles niveaux de lumière. La possibilité d'obtenir un courant de signal élevé entraîne une très grande dynamique de fonctionnement.

Les tubes TH 9820 sont normalement livrables en 3 classes : classe NOR, classe IND et classe AMR. Suivant les classes, les tubes ne diffèrent que par les critères d'acceptation du fait des défauts d'image.

Principales applications

La sensibilité du tube dans le proche infra-rouge permet la réalisation de caméras de surveillance à bas niveaux de lumière utilisant des sources de lumières artificielles (lampe à incandescence à 2854 °K par exemple); un éclairement de la face avant de l'ordre de 0,1 lux est suffisant, ce qui représente un gain en lumière de l'ordre de 10 par rapport à un Vidicon normal. D'autre part, cette sensibilité permet de l'utiliser pour des applications dans lesquelles le spectre de la source comporte peu ou pas de radiations visibles, par exemple pour la surveillance des laboratoires de photographie. Enfin, grâce à sa grande largeur de réponse spectrale, ce tube est parfaitement adapté aux caméras utilisées en télé-microscopie.

CARACTERISTIQUES GENERALES

Electriques

Cathode	équipotentielle chauffage indirect à oxydes
Chauffage filament :	
- tension	6, 3 V
- courant à 6, 3 V	0, 15 ± 10 % A
Temps minimal de préchauffage	60 s
Capacité de sortie (entre électrode de signal et les autres électrodes)	5 pF
Concentration	électromagnétique
Déviation	électromagnétique
Alignement	électromagnétique

Optiques

Cible :	
- diamètre utile maximal (format 4 x 3)	17 mm
- format normal sur cible	12, 7 mm x 9, 5 mm
Orientation de l'image : Trace du balayage horizontal parallèle à un plan diamétral passant par la broche courte de l'embase.	
Réponse spectrale	Figure 1

Mécaniques (voir cotes d'encombrement Figure 11)

Longueur hors-tout, max.	165 mm
Diamètre hors-tout, max.	29 mm
Diamètre du ballon, max.	26, 7 mm
Embase (Ditétrar, 8 broches)	UTE 9 C 15 JEDEC E8 - 11
Support (Note 1)	METOX N° 30520
Bloc bobines de déviation et de concentration (Notes 2 et 3)	GERHARD N° BV 200 - 1 K 1
ou	équivalent
Bobine d'alignement (Notes 2 et 3)	GERHARD N° BV 80/3
ou	équivalent
Bloc bobines de déviation, concentration et alignement (Notes 2 et 3)	THOMSON-CSF N° TH 7200
ou	CLEVELAND ELECTRONICS N° VYLFA 959
ou	PENN - TRAN N° 1465
ou	équivalent
Masse approximative	60 g
Position de fonctionnement	indifférente

CONDITIONS DE FONCTIONNEMENT

Tous les potentiels sont référencés par rapport à la cathode.

Valeurs limites d'utilisation (limites absolues)

Tension de grille g4 (post-accélération)		350	V
Tension de grille g3 (paroi)		350	V
Tension de grille g2 (accélération)		350	V
Tension de grille g1 (extinction de faisceau) :			
- valeur continue négative		125	V
- valeur continue positive		0	V
Tension filament	max.	6, 6	V
	min.	6	V
Tension crête entre filament et cathode :			
- filament négatif par rapport à la cathode		125	V
- filament positif par rapport à la cathode		10	V
Tension de cible (Note 4)		300	V
Courant crête de cible (Note 5 - Figure 2)		750	nA
Face avant :			
- éclairement		6×10^8	lux
- température (fonctionnement et stockage)		90	°C

Exemple de fonctionnement

Température de fonctionnement 25 °C (Note 6)
Standard d'analyse : 25 images/seconde - 625 lignes entrelacées
Format de l'image sur cible : 12, 5 mm x 9, 7 mm

Tension de cible (voir note dans Consignes d'utilisation)		8	V
Tension de grille g4 (Note 7)		340	V
Tension de grille g3		290	V
Tension de grille g2		300	V
Tension de grille g1 (extinction de l'image) (Note 8)	max.	− 40	V
	min.	− 100	V
Tension crête minimale de blocage :			
- appliquée sur la grille g1		− 75	V
- appliquée sur la cathode		+ 20	V
Champ magnétique de concentration		40	Gauss
Courant crête de déviation (avec bloc Gerhard BV-200-1K1) :			
- horizontale		200	mA
- verticale		25	mA
Champ magnétique d'alignement		0 à 4	Gauss

Performances électro-optiques

Mêmes conditions de fonctionnement que celles données dans l'exemple de fonctionnement.

Sensibilité radiante à 730 nm (Figure 1)	380	mA/W
Courant d'obscurité (Figure 3)	7	nA

– SENSIBILITE A 2854 °K (Note 9 - Figure 4)

Eclairement de la face avant	1	lux
Sensibilité	5750	µA/lm
Courant de signal	700	nA

– SENSIBILITE DANS LE VISIBLE (Figure 4)

Eclairement incident à 2854 °K sur filtre SCHOTT - KG3 (Note 10)	1	lux
Sensibilité (suivant épaisseur du filtre) :		
- épaisseur 1 mm	2480	µA/lm
- épaisseur 2 mm	1640	µA/lm
- épaisseur 3 mm	1400	µA/lm
- épaisseur 4 mm	1060	µA/lm
- épaisseur 5, 5 mm	825	µA/lm
Courant de signal correspondant :		
- épaisseur 1 mm	300	nA
- épaisseur 2 mm	200	nA
- épaisseur 3 mm	170	nA
- épaisseur 4 mm	125	nA
- épaisseur 5, 5 mm	100	nA

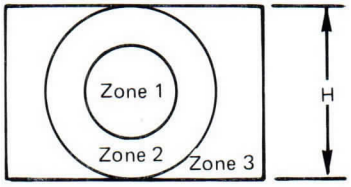
– SENSIBILITE DANS L'INFRA-ROUGE (Figure 5)

Eclairement incident à 2854 °K sur filtre SCHOTT - RG 715 épaisseur 3 mm (Note 11)	1	lux
Courant de signal correspondant	340	nA
Eclairement incident à 2854 °K sur filtre CORNING-C S 7-56 (Note 12)	1	lux
Courant de signal correspondant	65	nA
Gamma moyen pour un courant de signal compris entre 1 et 700 nA (Note 13)	1	
Caractéristiques typiques d'éblouissement à 2854 °K pour un éclairement égal à 100 fois l'éclairement initial (Note 14)	Figure 6	
Résolution limite au centre de l'image (Note 15 - Figure 7)	700	lignes T.V.
Taux de modulation à 400 lignes T.V. au centre de l'image (Note 16 - Figure 7)	40	%
Rémanence pour un courant de signal de 200 nA sur la 3ème trame balayée (Note 17 - Figure 8)	10	%

CARACTERISTIQUES D'ASPECT

Conditions de mesures

- Tension cible V_c = 8 V.
- Courant de signal I_s = 200 nA.
- Le gain de l'amplificateur vidéo et le récepteur de contrôle sont réglés pour obtenir une image optimale (Note 18).
- Les défauts d'aspect sont observés sur une mire blanche uniformément éclairée, sur laquelle figurent les cercles délimitant les zones de qualité.



Les zones de qualités sont définies de la façon suivante, H représentant la hauteur d'image :

- La zone 1 est limitée à l'intérieur du cercle de diamètre H/2.
- La zone 2 est comprise entre les cercles de diamètres H/2 et H.
- La zone 3 représente la surface extérieure au cercle de diamètre H.

Défauts ponctuels

Points noirs et blancs.
Seuls sont pris en considération les points dont le contraste est C ⩾ 15 % (Note 19) en lumière ou dans l'obscurité.

CLASSE "NOR"

Rapport D/H* en % * D diamètre moyen du défaut H hauteur du cadre de l'image	Zone 1		Zone 2		Zone 3	
	Blanc	Noir	Blanc	Noir	Blanc	Noir
D/H > 1, 2 %	0	0	0	0	0	0
1, 2 % ⩾ D/H > 0, 8 %	0	0	0	1	0	3
0, 8 % ⩾ D/H > 0, 2 %	0	2	2	7	2	9
0, 2 % ⩾ D/H	0	+	+	+	+	+

CLASSE "IND"

Rapport D/H* en % * D diamètre moyen du défaut H hauteur du cadre de l'image	Zone 1		Zone 2		Zone 3	
	Blanc	Noir	Blanc	Noir	Blanc	Noir
D/H > 1, 6 %	0	0	0	0	0	0
1, 6 % ⩾ D/H > 1, 2 %	0	0	0	2	0	2
1, 2 % ⩾ D/H > 0, 8 %	0	0	0	6	0	6
0, 8 % ⩾ D/H > 0, 2 %	1	5	2	16	3	21
0, 2 % ⩾ D/H	5	+	+	+	+	+

CLASSE "AMR"

Rapport D/H* en % * D diamètre moyen de défaut H hauteur du cadre de l'image	Zone 1		Zone 2		Zone 3	
	Blanc	Noir	Blanc	Noir	Blanc	Noir
D/H > 3, 2 %	0	0	0	0	0	0
3, 2 % ⩾ D/H > 2, 4 %	0	0	0	0	0	1
2, 4 % ⩾ D/H > 1, 6 %	0	0	0	2	0	2
1, 6 % ⩾ D/H > 1, 2 %	0	1	0	4	0	4
1, 2 % ⩾ D/H > 0, 8 %	0	3	0	8	0	8
0, 8 % ⩾ D/H > 0, 2 %	4	11	5	20	6	20
0, 2 % ⩾ D/H	+	+	+	+	+	+

+ Ces défauts ne sont pas pris en considération si leur nombre ou leur concentration ne détériore pas localement la qualité de l'image.
Il en est de même pour les défauts ponctuels de contraste C < 15 %.

Défauts non ponctuels

Les marbrures, granulations, taches et zones (blanches et noires) sont admises si leur contraste est C ⩽ 5 %.

NOTES

1 - METOX - 86, rue de Villiers de l'Isle Adam - 75020 PARIS - Téléphone 636 31 10.

2 - GERHARD KG - Reichelsheim / ODW - GERMANY.
THOMSON-CSF - GTE - 8, rue Chasseloup-Laubat - 75737 PARIS CEDEX 15 - Téléphone 566 70 04.
CLEVELAND ELECTRONICS Inc. - 2000 Highland Road - TWINSBURG - Ohio 44087.
PENN - TRAN Inc. - 1155 Zion Road - BELLEFONTE P A.

3 - Il est indispensable de s'assurer de la position correcte du tube à l'intérieur des bobines.

4 - En fonctionnement normal, la tension de cible ne dépassera pas 15 V. Voir les "Consignes d'utilisation".

5 - Le courant de cible est défini comme étant le courant total circulant dans la résistance de charge connectée à l'électrode de signal : courant de signal + courant d'obscurité, le courant d'obscurité étant le courant subsistant dans le cas de la cible non éclairée.
Les amplificateurs vidéo doivent être calculés convenablement pour supporter des courants de cible de 1 μA afin d'éviter des surcharges des amplificateurs ou distorsions d'image.

6 - Toutes les caractéristiques sont données pour une température de la face avant de 25 °C, les limites de température recommandées pour un bon fonctionnement étant de 20 °C à 30 °C.
L'élévation de la température de la face avant est conditionnée à la fois par les variations de la température ambiante, par la dissipation thermique des dispositifs environnants et du tube lui-même.
Une élévation de la température de la face avant du tube de 10 °C entraîne une variation du courant d'obscurité dans le rapport de 1 à 2.

7 - Dans tous les cas, la tension de la grille g4 doit être supérieure aux tensions des grilles g3 et g2.

8 - Sans impulsion de blocage appliquée sur la grille g1.

9 - La source lumineuse est une lampe à filament de tungstène fonctionnant à la température de couleur de 2854 °K.

10 - Les filtres utilisés, SCHOTT et GEN Réf. KG3 d'épaisseur 1 mm, 2 mm, 3 mm, 4 mm et 5,5 mm, sont placés entre la source lumineuse et la face avant du tube (voir Figure 9).
SCHOTT et GEN, 128 Boulevard Haussmann - 75008 PARIS.

11 - Le filtre utilisé, SCHOTT et GEN Réf. RG715 d'épaisseur 3 mm, est placé entre la source lumineuse et la face avant du tube (voir Figure 10).

12 - Le filtre utilisé, CORNING Réf. CS7-56, est placé entre la source lumineuse et la face avant du tube (voir Figure 10) .
CORNING GLASS WORKS, CORNING, N.Y. 14830.

13 - Le "gamma" moyen peut être défini comme la pente de la partie rectiligne de la caractéristique de transfert en coordonnées logarithmiques.

14 - L'image d'un point circulaire éclairée d'un diamètre compris entre 1 % et 10 % de la diagonale de l'image (1 % équivaut à 10 lignes T.V. environ), est analysée en ligne à ligne à l'aide d'un oscilloscope.
La mesure consiste à comparer la largeur du signal vidéo pour un éclairement initial E_1 et la largeur du signal correspondant à un éclairement $E_2 = 100\ E_1$.
L'éclairement E_1 sera ajusté pour obtenir un courant de signal I_{s1} de 500 nA et le courant de faisceau sera réglé pour cette valeur de I_c1.

15 - Pratiquement, la résolution limite correspond, sur une mire de définition à lignes noires et blanches ayant 100 % de contraste, à un taux de modulation voisin de 5 %.

16 - Dans le Standard C.C.I.R. de 625 lignes, la durée d'une ligne est de 52 μs (temps de suppression exclu), 400 lignes T.V. correspondent à une fréquence de 5 MHz.

17 - La rémanence s'exprime par le rapport en % du courant de signal résiduel mesuré à la fin de la n^e trame balayée après extinction de l'excitation lumineuse, au courant de signal initial.
La valeur indiquée est valable pour une cadence de balayage de 50 trames/seconde.

18 - Le réglage du récepteur est obtenu de la façon suivante :
- pour le niveau zéro (noir) la brillance de l'écran est réglé au point d'extinction de celui-ci.
- pour le niveau maximal (blanc), le gain du récepteur est ajusté pour obtenir une image optimale, fonction du contenu de l'image et de l'éclairage ambiant.

19 - Le contraste C est défini comme le rapport en % du courant de signal délivré par le défaut au courant de signal délivré par le tube.

CONSIGNES D'UTILISATION

1 - Les tensions de balayage doivent être appliquées avant les tensions d'électrodes.

Lorsque les prises de vue sont terminées, elles doivent être coupées après les tensions d'électrodes.

2 - Le tube ne doit pas être soumis à des niveaux lumineux supérieurs à celui donné dans les "Valeurs limites" afin d'éviter une élévation excessive de la température de cible.

3 - Note sur la tension de cible

Le courant d'obscurité et les défauts d'aspect de la cible augmentent avec la valeur de la tension de cible.

La sensibilité du tube est indépendante du potentiel de la cible.

La valeur optimale de la tension de cible est celle qui permet d'obtenir le courant de signal maximal et le courant d'obscurité minimal. Cette valeur est de l'ordre de 8 à 10 V avec les blocs de bobines mentionnés dans cette Notice.

Une utilisation avec une tension de cible supérieure à 15 V peut entraîner une destabilisation de la cible rendant impossible la recharge de celle-ci par le faisceau.

Il est possible de restabiliser la cible en opérant un cycle de restauration comme suit :

a - Boucher l'optique,
b - Balayer toute la cible,
c - Ajuster la tension de la grille g1 autour de − 5 Volts,
d - Porter la tension de cible V_c à 300 V pendant 1 à 2 secondes,
e - Polariser la grille g1 à la valeur du cut-off,
f - Ramener V_c à sa valeur normale soit 8 à 10 Volts,
g - Réajuster la tension de g1 pour obtenir un faisceau déchargeant normalement la cible.

Le tube est de nouveau prêt à fonctionner.

REMARQUE

La variation de la tension de cible ne peut être utilisée pour la commande automatique de sensibilité comme dans le cas d'un Vidicon conventional à photoconducteur $Sb_2 S_3$.

Pour la réalisation d'un dispositif de commande automatique de sensibilité, il sera fait appel à un objectif à iris automatique ou asservi au signal vidéo et, lors de grandes variations d'éclairement, à l'interposition de filtres.

Figure 1

CARACTERISTIQUE TYPIQUE DE
REPONSE SPECTRALE

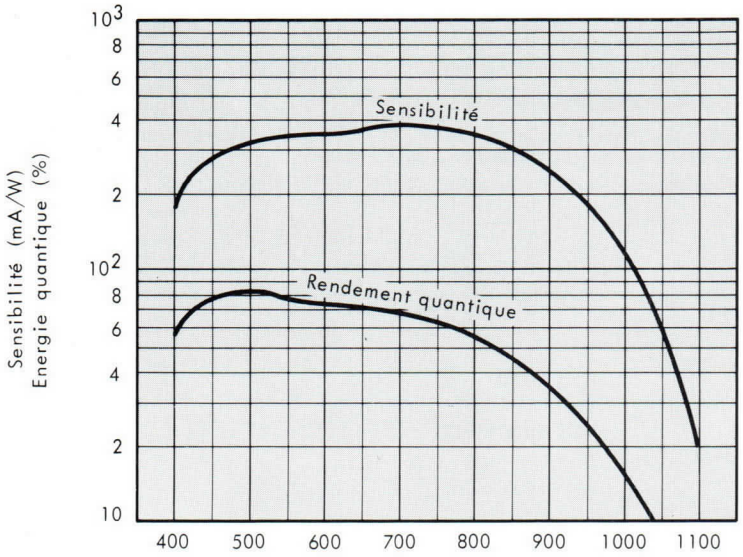


Figure 2

CARACTERISTIQUE DE COURANT DE
CIBLE DE SATURATION

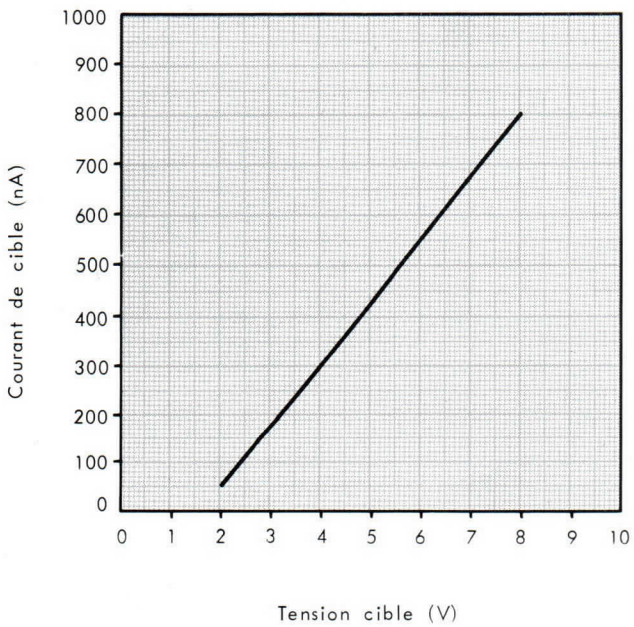


Figure 3

CARACTERISTIQUE DE COURANT
D'OBSCURITE

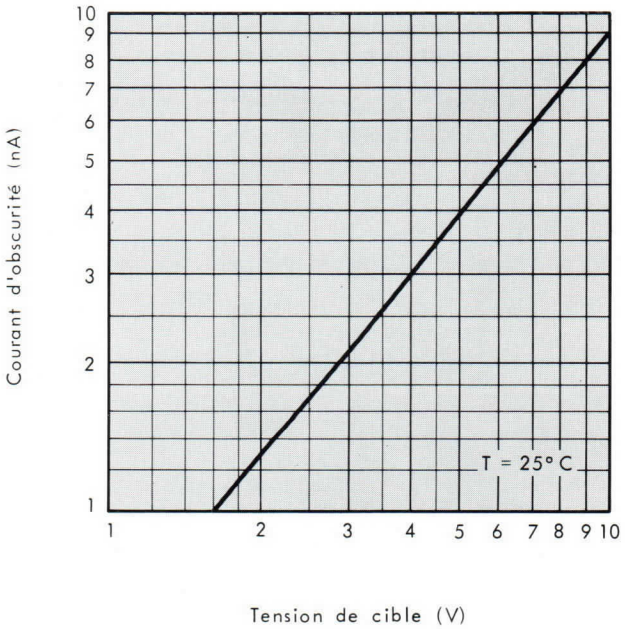


Figure 4

CARACTERISTIQUE DE TRANSFERT TYPIQUE
A 2854° K DANS LE VISIBLE

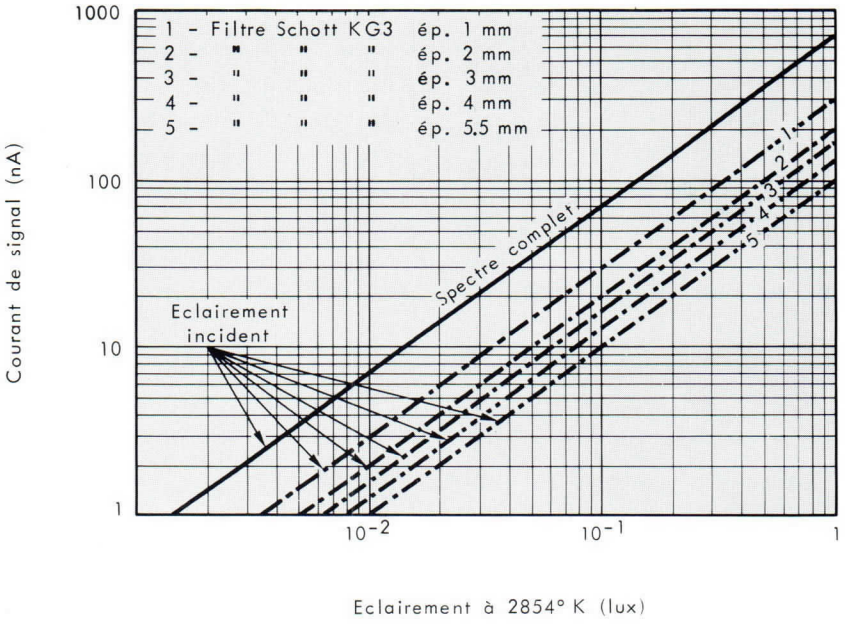


Figure 5

CARACTERISTIQUE DE TRANSFERT TYPIQUE DANS
LE PROCHE INFRA-ROUGE ET L'INFRA-ROUGE

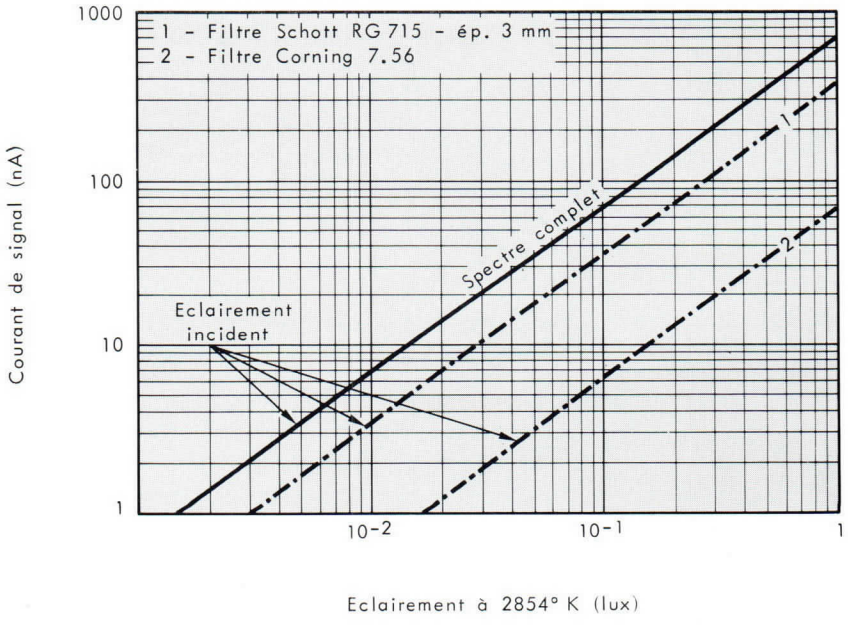


Figure 6

CARACTERISTIQUE TYPIQUE D'EBLOUISSEMENT

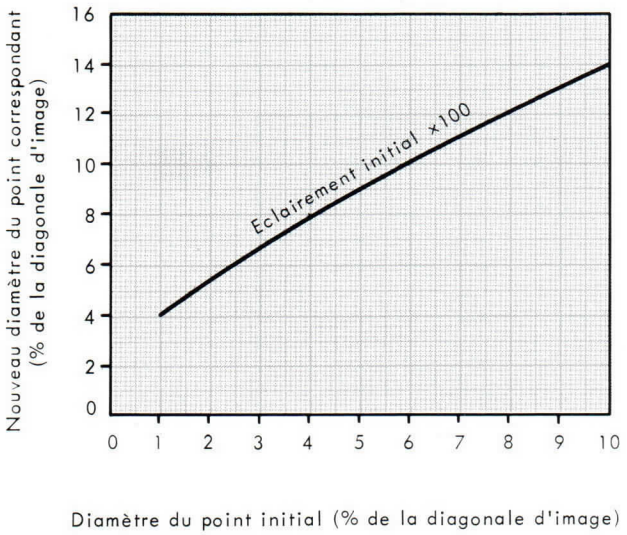


Figure 7

CARACTERISTIQUE TYPIQUE DE F.T.M. - MIRE P200

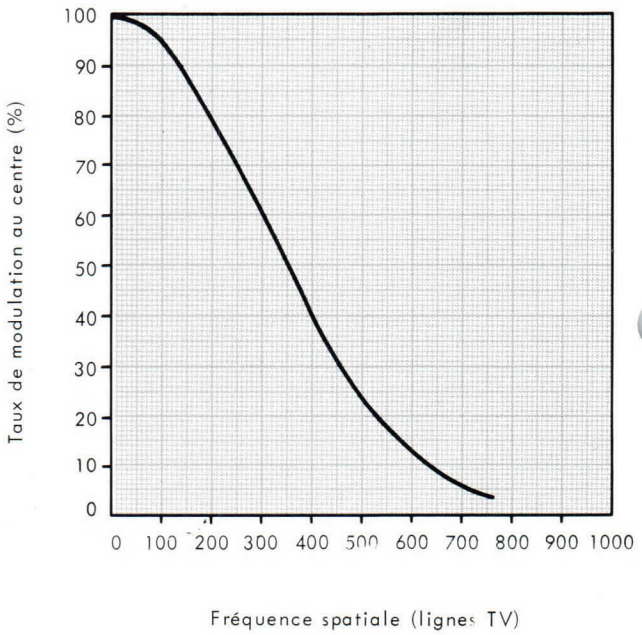


Figure 8

CARACTERISTIQUES TYPIQUES DE REMANENCE

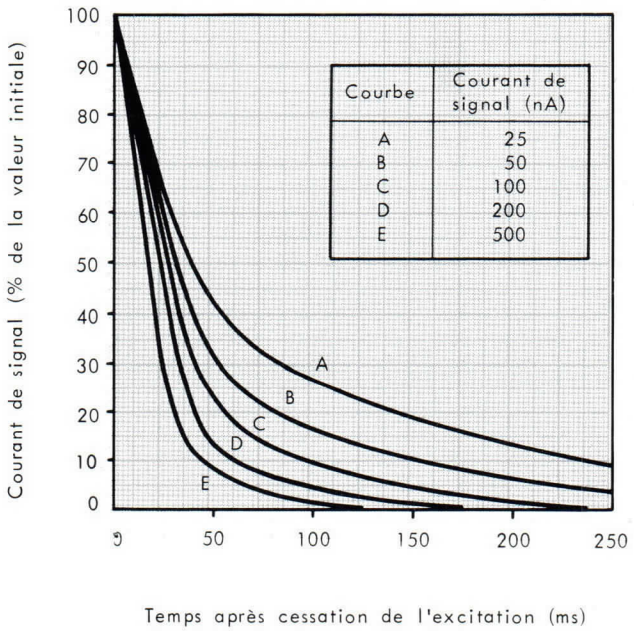


Figure 9

TRANSMISSION TYPIQUE DES FILTRES
SCHOTT KG3 (absorbant l'infra-rouge).

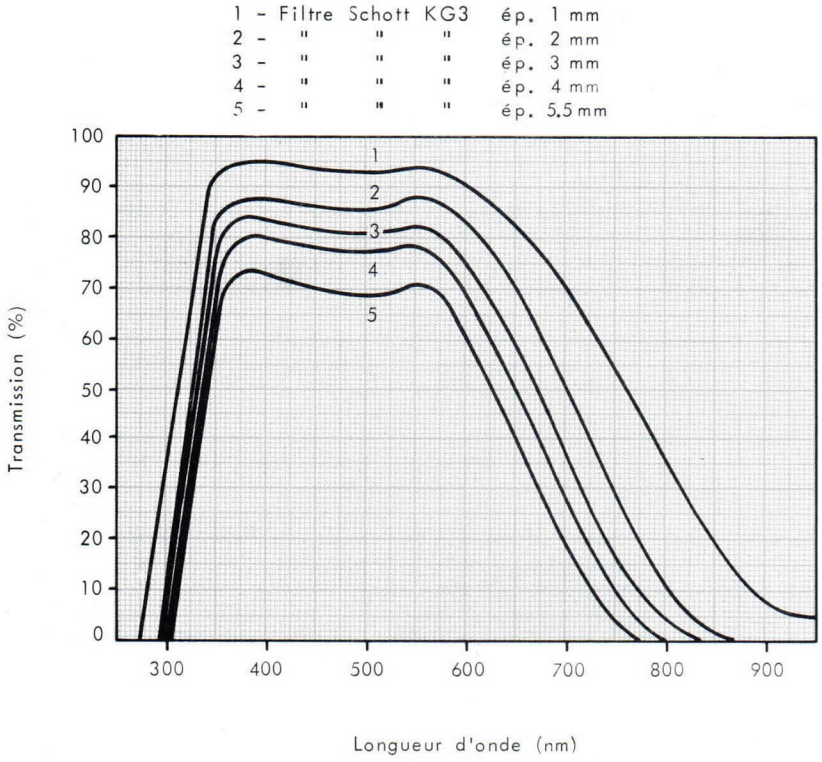
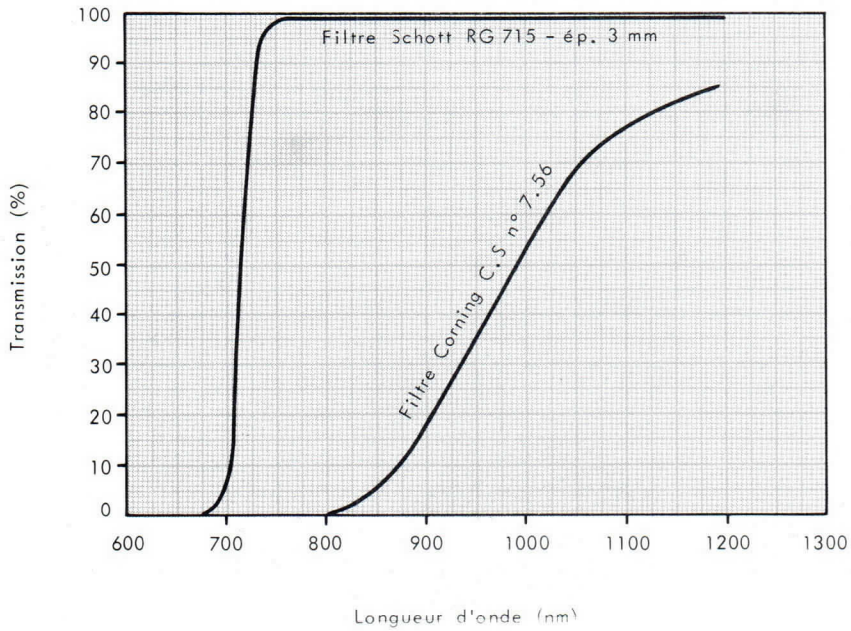


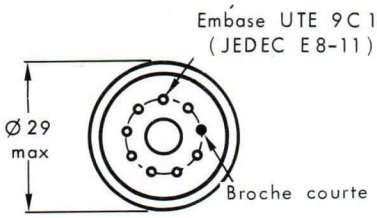
Figure 10

TRANSMISSION TYPIQUE DES FILTRES SCHOTT RG 715
ET CORNING CS7.56 (absorbant le visible)

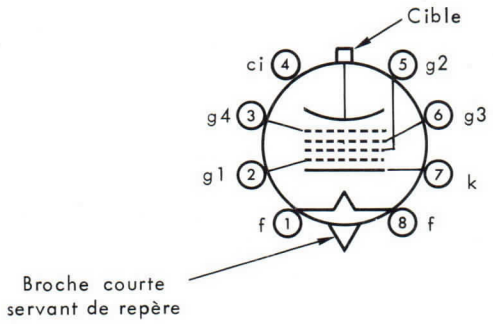


THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

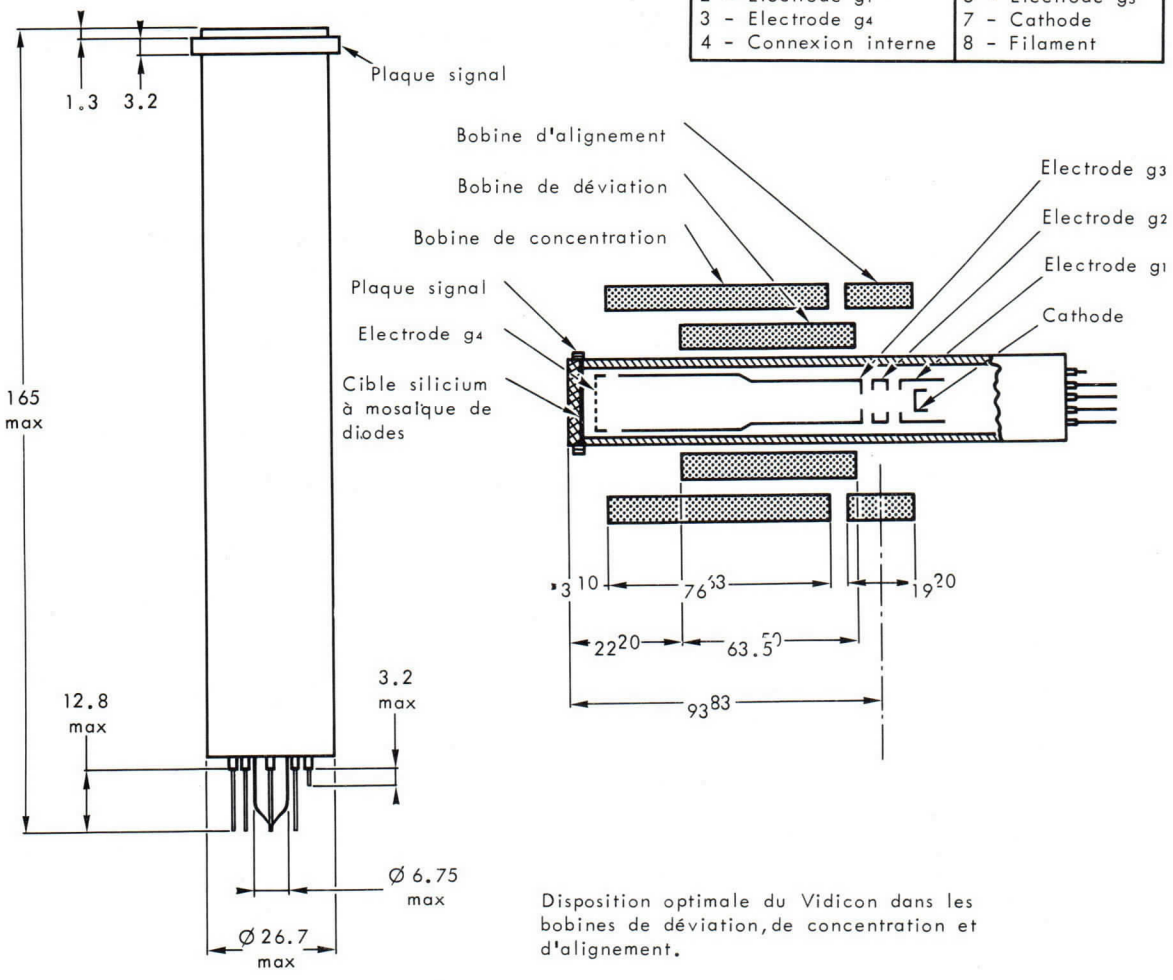
DESSIN D'ENCOMBREMENT



BROCHAGE



1 - Filament	5 - Electrode g_2
2 - Electrode g_1	6 - Electrode g_3
3 - Electrode g_4	7 - Cathode
4 - Connexion interne	8 - Filament



Disposition optimale du Vidicon dans les bobines de déviation, de concentration et d'alignement.

Figure 11

Cotes en mm.

Imprimé en France

TH 9824
1" VIDICON

- ELECTROSTATIC FOCUS AND DEFLECTION
- GOOD RESOLUTION
- EXCELLENT UNIFORMITY
- GOOD RASTER LINEARITY
- FOR LIGHTWEIGHT CAMERA
- MILIRARY AND SPACE TV

The TH 9824 is a fully electrostatic 1'' Vidicon particularly suitable for applications where power, weight and volume are all of prime consideration. TH 9824 is intended for compact, lightweight, transistorized cameras in space T.V. and other closed circuit equipments.

The scanning electron beam is focused by a separate electrode operating at an appropriate potential. The deflection is ensured by two crossed pairs of deflection plates to which are applied periodical scanning voltages. These characteristics allow for suppressing the focus and deflection coils used in previous Vidicons.

Additional features over conventional Vidicons are :

- Reduction of the size and weight of the camera (the outer diameter of the camera can be less than 38 mm).
- Substantial reduction of power requirements.
- Great simplicity in supplying the electrodes of the tube : focusing voltage is simply provided by a bridge and deflection voltages are easily provided by usual transistorized supply.
- Resolution and image dimensions are maintained even for large variations of electrode voltages if these electrodes are energized by the same power supply.
- Excellent uniformity of output signal due to the separate post-acceleration electrode g5 the voltage of which is 1.5 to 2 times the g4 voltage in optimum operating.
- Higher uniformity of resolution on the entire scanned area. The limiting resolution can be reached by the use of a weak alignment field.

Optimum resolution and uniformity of signal are reached when the tube is protected on its entire length by a double metallic shield made with suitable magnetic permeability material designed to prevent external magnetic and electric fields from impairing the resolving capability of TH 9824.

Due to a new low lag photoconductive layer excellent images are obtained for a wide range of faceplate illuminations.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Satisfactory quality picture with good resolution and acceptable signal to noise ratio can be obtained at illumination of 0.4 lx (40 mfc) on the faceplate (4 to 8 lx on the subject with an unity numerical aperture lens) giving rise to a signal current of 50 nA at 50 nA dark current. For such illuminations, higher signal current is obtained by increasing dark current up to 100 nA, value beyond which a signal saturation will occur.

Due to good design, high reliability is obtained throughout the tube life. Requirement for alignment field is reduced to a minimum by precise electron gun mounting. An extremely flat faceplate avoids all optical distortions and allows for the use of any good quality lens.

The heater power requirement is low and the reduced heat dissipation improves the quality of the picture by lowering the faceplate temperature.

GENERAL CHARACTERISTICS

Electrical

Cathode	unipotential indirectly heated oxide coated	
Heater :		
- voltage	6.3	V
- current	0.135 to 0.165	A
Minimum preheating time	60	s
Output capacitances :		
- target to all other electrodes	2.5	pF
- deflector to all other electrodes	6	pF
Spectral response	see curve	
Focusing method	electrostatic	
Deflection method	electrostatic	

Mechanical

Overall length	max.	165	mm	(6.49")
Overall diameter	max.	29	mm	(1.14")
Bulb diameter	max.	26.7	mm	(1.03")
Base (Ditetrar 13 pins)	JEDEC E 13 - 90			
Socket (note 1)	CINCH 203 - 62 - 13.031 or equivalent			
Photoconductive layer :				
- normal dimensions of image on target	12.7 x 9.5		mm	
- maximum useful diagonal diameter (4 x 3 aspect ratio)	17		mm	
- orientation of quality rectangle	horizontal scan parallel to the plane passing through the tube axis and short index pin			
Mounting position	any			
Net weight, approximate	60		g	

OPERATING CONDITIONS

(note 2)

Maximum ratings (absolute values)

Electrode g5 voltage (post acceleration electrode)		800	V
Electrode g4 voltage (wall electrode)		800	V
Horizontal deflection D.C. voltage		500	V
Vertical deflection D.C. voltage		500	V
Peak to peak horizontal deflection voltage		2 x 70	V
Peak to peak vertical deflection voltage		2 x 70	V
Electrode g3 voltage (beam focus)		800	V
Electrode g2 voltage (accelerator)		350	V
Electrode g1 voltage (electrode for picture cut-off)			
- negative bias value		300	V
- positive bias value		0	V
Heater voltage	max.	6.9	V
	min.	5.7	V
Peak heater-cathode voltage :			
- heater negative with respect to cathode		125	V
- heater positive with respect to cathode		10	V
Target voltage		100	V
Dark current		100	nA
Peak target current (note 3)		300	nA
Face plate :			
- illumination		10000 lx or 1000	fc
- temperature		70	°C

TYPICAL OPERATION

Operational conditions

Scanned area . . . . . *12.7 mm x 9.5 mm*
Faceplate temperature . . . . *25 ± 5°C*

Electrode g5 voltage	500 to 600	V
Electrode g4 voltage	300	V
Deflection D.C. voltage (note 4) :		
- horizontal deflection	270 to 330	V
- vertical deflection	270 to 330	V
Peak to peak deflection voltage (note 5) :		
- horizontal x 1 - x 2 or D1 - D2	2 x 40	V
- vertical y 1 - y 2 or D3 - D4	2 x 30	V
Electrode g3 voltage	0 to 120	V
Electrode g2 voltage	300	V
Electrode g1 voltage (note 6)	- 40 to - 130	V
Minimum blanking peak to peak voltage :		
- applied to electrode g1	- 75	V
- applied to cathode	+ 20	V

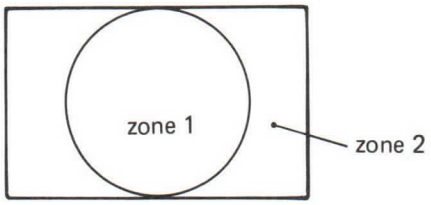
Typical performances (note 7)

Dark current	20	nA
Target voltage (note 8)	20 to 70	V
Faceplate illumination (note 9)	10 lux or 1	fc
Signal current	200	nA
Average gamma for target illumination between (0.1 and 1 fc) (note 10)	0.65	
Limiting resolution at center of picture (note 11)	450	T.V. lines
Lag (note 12) :		
- maximum	30	%
- average	25	%

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

SPURIOUS SIGNAL TEST

The test is performed using a uniformly diffused white test pattern that is separated into two zones as shown in drawing.



The tube is operated under "Typical Operation" with a dark current of 20 nanoamperes and the lens adjusted to provide a signal current of 100 nanoamperes.

Spurious signals are classified by their size which is measured in percent of raster height.

Will actually be considered as defects, blemishes of contrast greater than 50 % (note 13).

Allowable spot size for each zone is shown in table :

* Ratio D / H (Percent raster height)	Number Allowed			
	Zone 1	Zone 1 + Zone 2		
		a	a + b	a + b + c
a : 0. 8% < D/H ⩽ 1%	0	1	3	6
b : 0. 6% < D/H ⩽ 0. 8%	1			
c : 0. 2% < D/H ⩽ 0. 6%	3			

0. 2% and under : do not count spots of this size unless concentration causes a smudge appearance

* D : average diameter of spot

H : raster height

Smudges, streaks, mottled or grainy background having a contrast ratio greater than 15% constitute a reject.

NOTES

1 - CINCH Manufacturing Company, 1501 Morse Avenue, Elk Grove Village, IL, 60007.

2 - When putting the tube into service or during different adjustments, no particular precautions are to be observed (except for cut-off g1 voltage) for applying starting voltages on different electrodes.

Acceleration voltages being applied it is recommended that D.H. and D.V. voltages are put on before controlling the beam by electrode g1.

3 - Target current is defined as total current in load resistance connected to target electrode : signal current plus dark current.

Video amplifiers must be designed properly to handle peak target current of 0.3 μA to avoid amplifier overload and picture distortion.

4 - D.C. voltages are applied on the deflection plates. These adjustable voltages compensate the geometrical distortions due to electron beam or to imperfect mounting of the deflecting plates. The selection of the appropriate voltages allows for obtaining the best resolution for the chosen electrical mode. The optimum values to be applied on each pair of deflection plates which correspond to a minimum astigmatism of the beam can be different for D.H. and D.V. plates.

5 - The deflection voltages are symetrically applied on each plate of the deflecting system. Indicated values are, for each electrode, the peak to peak periodical voltages.

6 - Without blanking pulses applied on electrode g1.

7 - For 819 interlaced lines standard, 50 frames/second. Test patterns consist in uniformly illuminated slides whose radiance in white level is 100 fc. A substandard 16 mm camera lens at a maximum numerical aperture of f/2 - 35 mm is used

8 - Indicated range of service serves only to illustrate the operating target voltage range normally encountered. The target voltage must be adjusted to that value which gives the designed operating dark current.

9 - All the above mentioned illuminations assume a 2854 $^{\circ}$K incandescent tungsten source.

10 - Average "gamma" should be defined as the slope of the rectilinear part of transfer characteristics in log coordinates.

11 - Practically, limiting resolution corresponds to the resolution measured with twin bar test card with a M.T.F. response of about 7%.

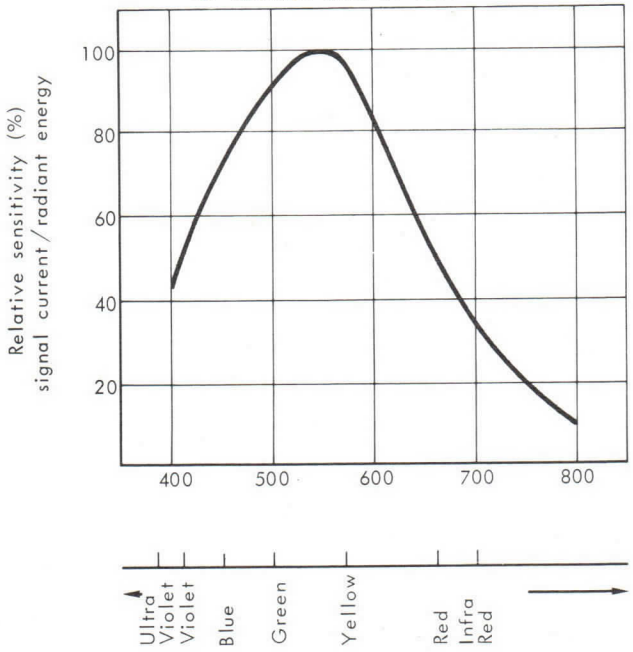
12 - Lag is defined as the ratio of residual signal current measured 60 milliseconds after light excitation being removed to the initial signal current ; this value assumes 50 fields/second scanning rate.

13 - Contrast is defined as : $100 \times \frac{\text{increment in video current due to blemish}}{\text{normal signal current}}$

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

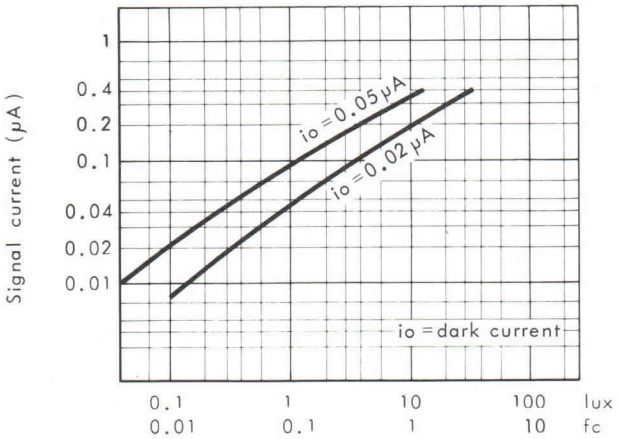
TYPICAL SPECTRAL SENSITIVITY CHARACTERISTICS

For equal values of signal current at all wavelengths
(0.02 µA signal current and 0.02 µA dark current
for scanned area of 12.7 mm x 9.5 mm)



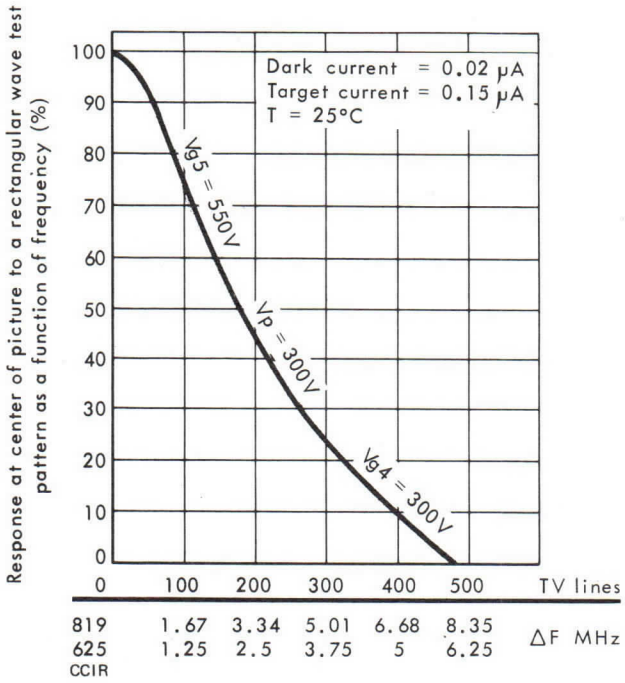
LIGHT TRANSFER CHARACTERISTICS

Illumination uniform over photoconductive layer scanned
area 12.7 mm x 9.5 mm - face plate temperature 25° C



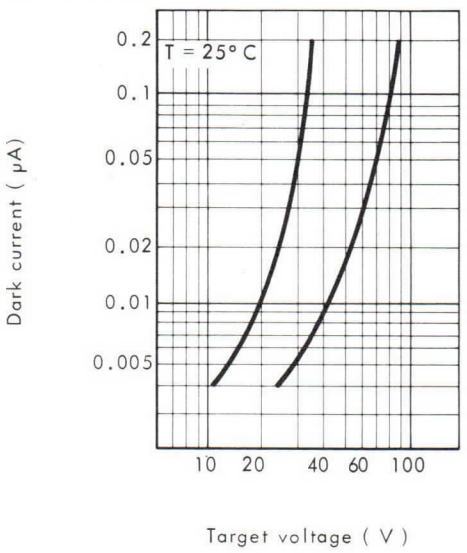
Illumination in lux and foot candles

MODULATION TRANSFER FUNCTION



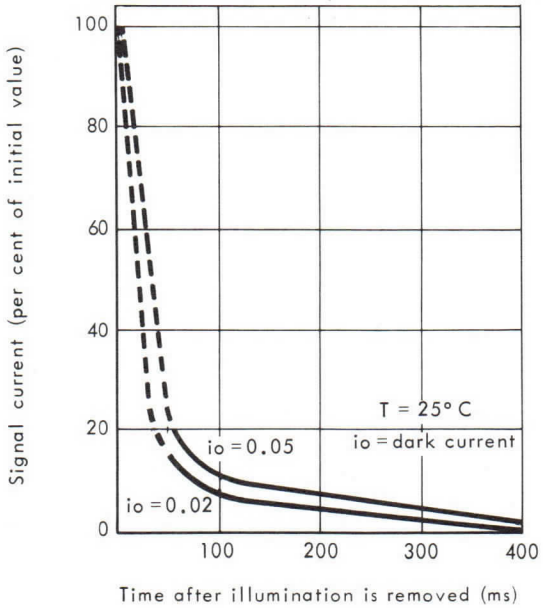
RANGE OF DARK CURRENT

Scanned area of photoconductive layer 12.7mm x 9.5mm



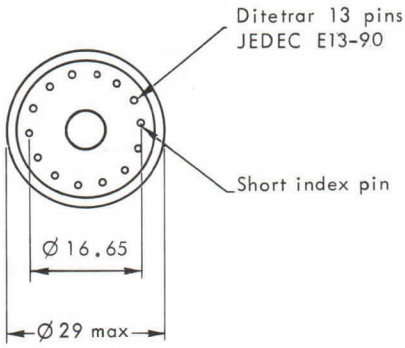
TYPICAL PERSISTENCE CHARACTERISTICS

Initial highlight signal current of 0.15µA scanned area of photoconductive layer 12.7mm x 9.5mm

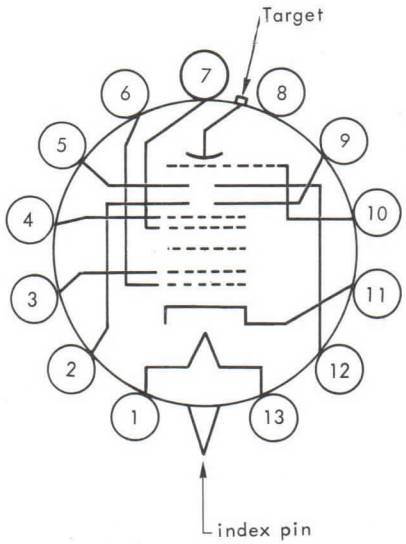


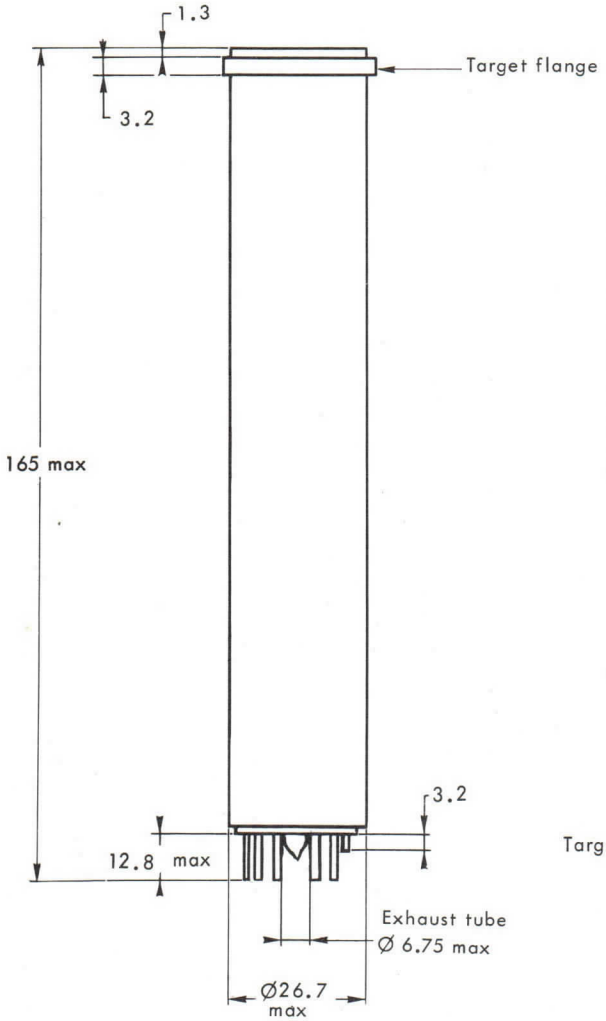
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING

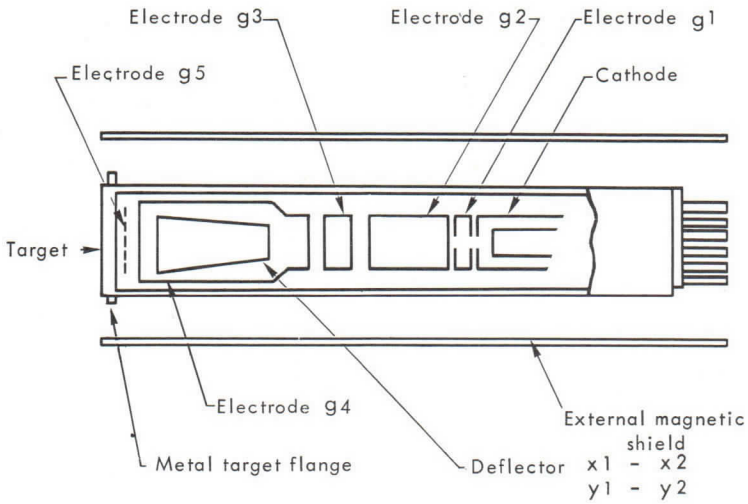


BASING DIAGRAM





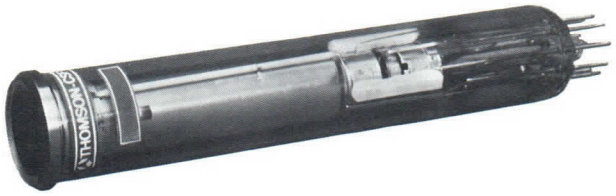
CONNECTIONS			
1	heater	8	internal connection
2	x1 - horizontal deflector	9	x2 - horizontal deflector
3	g2 electrode	10	g5 electrode
4	g4 electrode	11	cathode
5	y2 - vertical deflector	12	y1 - vertical deflector
6	g1 electrode	13	heater
7	g3 electrode	14	short index pin
flange : target			



Dimensions in mm.

TH 9828
VIDICON 26mm (1")
A CIBLE SILICIUM A MOSAIQUE DE DIODES

- **Concentration et déviation électromagnétiques.**
- **Cible silicium à grande sensibilité.**
- **Large réponse spectrale (400 à 1100 nm).**
- **Faible éblouissement.**
- **Faible rémanence.**
- **Faible courant d'obscurité.**
- **Excellente résistance au marquage.**



Le tube TH 9828 est un tube de prise de vue du type Vidicon à concentration et déviation électromagnétiques utilisant une cible en silicium à mosaïque de diodes. La conception générale du tube est identique à celle des Vidicons classiques TH 9808, TH 9812... avec lesquels il est interchangeable.

La cible du TH 9828, en plus de sa grande sensibilité, présente l'avantage d'être très résistante au marquage d'image. En outre, sa technologie minimise les phénomènes d'éblouissement.

La sensibilité du tube ne dépend pas de la tension de cible ; celle-ci est faible comparée aux Vidicons à cible photoconductrice ; le courant d'obscurité qui en résulte est également faible.

Compte tenu de la très grande largeur de réponse spectrale (400 à 1100 nm), il peut être souhaitable, suivant les applications, d'utiliser des filtres appropriés permettant la sélection du spectre utile (visible ou infra-rouge).

Le gamma, égal à l'unité, permet d'obtenir des images contrastées surtout aux faibles niveaux de lumière. La possibilité d'obtenir un courant de signal élevé entraîne une très grande dynamique de fonctionnement.

Les tubes TH 9828 sont normalement livrables en 3 classes : classe NOR, classe IND et classe AMR. Suivant les classes, les tubes ne diffèrent que par les critères d'acceptation du fait des défauts d'image.

Principales applications

La sensibilité du tube dans le proche infra-rouge permet la réalisation de caméras de surveillance à bas niveaux de lumière utilisant des sources de lumière artificielles (lampe à incandescence à 2854 °K par exemple) ; un éclairement de la face avant de l'ordre de 0, 1 lux est suffisant, ce qui représente un gain de lumière de l'ordre de 10 par rapport à un Vidicon normal. D'autre part, cette sensibilité permet de l'utiliser pour des applications dans lesquelles le spectre de la source comporte peu ou pas de radiations visibles, par exemple pour la surveillance des laboratoires de photographie. Enfin, grâce à sa grande largeur de réponse spectrale, ce tube est parfaitement adapté aux caméras utilisées en télé-microscopie.

CARACTERISTIQUES GENERALES

Electriques

Cathode . . . . . équipotentielle, chauffage indirect, à oxydes
Chauffage filament :
- tension . . . . . 6, 3 V
- courant à 6, 3 V . . . . . 0, 10 ± 10 % A

Temps minimal de préchauffage . . . . . 60 s
Capacité de sortie (entre électrode de signal et les autres électrodes) . . . . . 5 pF
Concentration . . . . . électromagnétique
Déviation . . . . . électromagnétique
Alignement . . . . . électromagnétique

Optiques

Cible :
- diamètre utile maximal (format 4 x 3) . . . . . 17 mm
- format normal sur cible . . . . . 12, 7 mm x 9, 5 mm

Orientation de l'image :
Trace du balayage horizontal parallèle à un plan diamétral passant par la broche courte de l'embase
Réponse spectrale . . . . . Figure 1

Mécaniques (voir cotes d'encombrement Figure 11)

Longueur hors-tout, max . . . . . 165 mm
Diamètre hors-tout, max . . . . . 29 mm
Diamètre du ballon, max . . . . . 26, 7 mm
Embase (Ditétrar, 8 broches) . . . . . UTE 9 C 15 - JEDEC E8 - 11
Support (Note 1) . . . . . METOX N° 30520
Bloc bobines de déviation et de concentration (Notes 2 et 3) . . . . . GERHARD N° BV 200-1K1
ou équivalent
Bobine d'alignement (Notes 2 et 3) . . . . . GERHARD N° BV 80/3
ou équivalent
Bloc bobines de déviation, concentration et alignement (Notes 2 et 3) . . . . . THOMSON-CSF N° TH 7200
ou CLEVELAND ELECTRONICS N° VYLFA 959
ou PENN - TRAN N° 1465
ou équivalent
Masse approximative . . . . . 60 g
Position de fonctionnement . . . . . indifférente

CONDITIONS DE FONCTIONNEMENT

Tous les potentiels sont référencés par rapport à la cathode

Valeurs limites d'utilisation (limites absolues)

Tension de grille g4 (post-accélération)		350	V
Tension de grille g3 (paroi)		350	V
Tension de grille g2 (accélération)		350	V
Tension de grille g1 (extinction de faisceau) :			
- valeur continue négative		150	V
- valeur continue positive		0	V
Tension filament	max.	6, 6	V
	min.	6	V
Tension crête entre filament et cathode :			
- filament négatif par rapport à la cathode		125	V
- filament positif par rapport à la cathode		10	V
Tension de cible (Note 4)		300	V
Courant crête de cible (Note 5 - Figure 2)		750	nA
Face avant :			
- éclairement		6×10^8	lux
- température (fonctionnement et stockage)		90	°C

Exemple de fonctionnement

Température de fonctionnement 25 °C (Note 6)
Standard d'analyse : 25 images/seconde - 625 lignes entrelacées
Format de l'image sur cible : 12, 7 mm x 9, 5 mm
Bloc bobines : GERHARD ou équivalent

Tension de cible (voir note dans Consignes d'Utilisation)		8	V
Tension de grille g4 (Note 7)		340	V
Tension de grille g3		290	V
Tension de grille g2		300	V
Tension de grille g1 (extinction de l'image) (Note 8)	max.	− 40	V
	min.	− 100	V
Tension crête minimale de blocage :			
- appliquée sur la grille g1		− 75	V
- appliquée sur la cathode		+20	V
Courant dans la bobine de concentration		67 ± 2	mA
Courant dans chaque paire de bobines d'alignement		0 à 36	mA
Courant crête dans les bobines de déviation :			
- horizontale		170	mA
- verticale		20	mA

Performances électro-optiques

Mêmes conditions de fonctionnement que celles données dans l'exemple de fonctionnement

Sensibilité radiante à 730 nm (Figure 1)	380	mA/W
Courant d'obscurité (Figure 3)	4	nA

– SENSIBILITE A 2854 °K (Note 9 - Figure 4)

Eclairement de la face avant	1	lux
Sensibilité	5750	µA/lm
Courant de signal	700	nA

– SENSIBILITE DANS LE VISIBLE (Figure 4)

Eclairement incident à 2854 °K sur filtre SCHOTT - KG3 (Note 10)	1	lux
Sensibilité (suivant épaisseur du filtre) :		
- épaisseur 1 mm	2480	µA/lm
- épaisseur 2 mm	1640	µA/lm
- épaisseur 3 mm	1400	µA/lm
- épaisseur 4 mm	1060	µA/lm
- épaisseur 5,5 mm	825	µA/lm
Courant de signal correspondant :		
- épaisseur 1 mm	300	nA
- épaisseur 2 mm	200	nA
- épaisseur 3 mm	170	nA
- épaisseur 4 mm	125	nA
- épaisseur 5,5 mm	100	nA

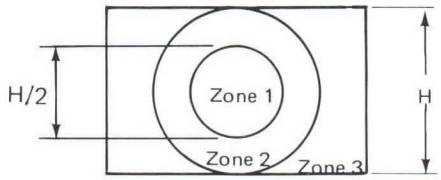
– SENSIBILITE DANS L'INFRA-ROUGE (Figure 5)

Eclairement incident à 2854 °K sur filtre SCHOTT-RG 715 épaisseur 3 mm (Note 11)	1	lux
Courant de signal correspondant	340	nA
Eclairement incident à 2854 °K sur filtre CORNING-C S 7-56 (Note 12)	1	lux
Courant de signal correspondant	65	nA
Gamma moyen pour un courant de signal compris entre 1 et 700 nA (Note 13)	1	
Caractéristiques typiques d'éblouissement à 2854 °K (Note 14)		Figure 6
Résolution limite au centre de l'image (Note 15 - Figure 7)	700	lignes TV
Taux de modulation à 400 lignes TV au centre de l'image (Note 16 - Figure 7)	40	%
Rémanence pour un courant de signal de 200 nA sur la 3ème trame balayée (Note 17 - Figure 8)	6	%

CARACTERISTIQUES D'ASPECT

Conditions de mesures

- Tension cible $V_C = 8$ V.
- Courant de signal $I_s = 200$ nA.
- Le gain de l'amplificateur vidéo et le récepteur de contrôle sont réglés pour obtenir une image optimale (Note 18).
- Les défauts d'aspect sont observés sur une mire blanche uniformément éclairée, sur laquelle figurent les cercles délimitant les zones de qualité.



Les zones de qualités sont définies de la façon suivante, H représentant la hauteur d'image :

- La zone 1 est limitée à l'intérieur du cercle de diamètre H/2.
- La zone 2 est comprise entre les cercles de diamètre H/2 et H.
- La zone 3 représente la surface extérieure au cercle de diamètre H.

Défauts ponctuels

Points noirs et blancs.
Seuls sont pris en considération les points dont le contraste avec le fond est C $\geqslant$ 15 % en lumière ou dans l'obscurité.

CLASSE "NOR" — Nombre de défauts permis

Rapport D/H* en %	Zone 1		Zones 1 + 2		Zones 1 + 2 + 3	
* D diamètre moyen du défaut H hauteur du cadre de l'image	Blanc	Total	Blanc	Total	Blanc	Total
D/H $>$ 1, 2	0	0	0	0	0	0
D/H $>$ 0, 8	0	0	0	0	0	1
D/H $>$ 0, 2	0	2	1	4	2	8
D/H $\leqslant$ 0, 2	0	+	+	+	+	+

CLASSE "IND" — Nombre de défauts permis

Rapport D/H* en %	Zone 1		Zones 1 + 2		Zones 1 + 2 + 3	
* D diamètre moyen du défaut H hauteur du cadre de l'image	Blanc	Total	Blanc	Total	Blanc	Total
D/H $>$ 1, 6	0	0	0	0	0	0
D/H $>$ 1, 2	0	0	0	2	0	4
D/H $>$ 0, 8	0	1	0	6	0	10
D/H $>$ 0, 2	1	6	3	22	6	30
D/H $\leqslant$ 0, 2	5	+	+	+	+	+

CLASSE "AMR"

Nombre de défauts permis

Rapport D/H* en % * D diamètre moyen du défaut H hauteur du cadre de l'image	Zone 1		Zones 1 + 2		Zones 1 + 2 + 3	
	Blanc	Total	Blanc	Total	Blanc	Total
D/H > 3, 2	0	0	0	0	0	0
D/H > 2, 4	0	0	0	0	0	1
D/H > 1, 6	0	0	0	2	0	4
D/H > 1, 2	0	1	0	5	0	9
D/H > 0, 8	0	3	0	11	0	19
D/H > 0, 2	4	11	9	31	15	51
D/H ⩽ 0, 2	+	+	+	+	+	+

+Ces défauts ne sont pas pris en considération si leur nombre ou leur concentration ne détériore pas localement la qualité de l'image.
Il en est de même pour les défauts ponctuels de contraste C < 15 %.

Défauts non ponctuels

Les marbrures, granulations, taches et zones (blanches et noires) sont admises si leur contraste est C ⩽ 5 %.

NOTES

1 - METOX - 86 rue Villiers de l'Isle Adam - 75020 PARIS - Téléphone 636 31 10.

2 - GERHARD KG - Reichelsheim / ODW -GERMANY.
THOMSON-CSF - DTE - 38, Rue Vauthier - 92100 BOULOGNE- BILLANCOURT - Téléphone 604 81 75.
CLEVELAND ELECTRONICS Inc. - 2000 Highland Road - TWINSBURG - Ohio 44087.
PENN - TRAN Inc. 1155 Zion Road - BELLEFONTE P A.

3 - Il est indispensable de s'assurer de la position correcte du tube à l'intérieur des bobines.

4 - En fonctionnement normal, la tension de cible ne dépassera pas 15 V. Voir les "Consignes d'Utilisation".

5 - Le courant de cible est défini comme étant le courant total circulant dans la résistance de charge connectée à l'électrode de signal : courant de signal + courant d'obscurité, le courant d'obscurité étant le courant subsistant dans le cas de la cible non éclairée. Les amplificateurs vidéo doivent être calculés convenablement pour supporter des courants de cible de 1 μA afin d'éviter des surcharges des amplificateurs ou distorsions d'image.

6 - Toutes les caractéristiques sont données pour une température de la face avant de 25 °C, les limites de température recommandées pour un bon fonctionnement étant de 20 °C à 30 °C.
L'élévation de la température de la face avant est conditionnée à la fois par les variations de la température ambiante, par la dissipation thermique des dispositifs environnants et du tube lui-même.
Une élévation de la température de la face avant du tube de 10 °C entraîne un doublement du courant d'obscurité.

7 - Dans tous les cas, la tension de grille g4 doit être supérieure aux tensions des grilles g3 et g2.

8 - Sans impulsion de blocage appliquée sur la grille g1,

9 - La source lumineuse est une lampe à filament de tungstène fonctionnant à la température de couleur de 2854 °K.

10 - Les filtres utilisés, SCHOTT et GEN Réf. KG3 d'épaisseur 1 mm, 2 mm, 3 mm, 4 mm et 5, 5 mm, sont placés entre la source lumineuse et la face avant du tube (voir Figure 9).
SCHOTT et GEN, 128 Boulevard Haussmann - 75008 PARIS.

11 - Le filtre utilisé, SCHOTT et GEN Réf. RG 715 d'épaisseur 3 mm, est placé entre la source lumineuse et la face avant du tube (voir Figure 10).

12 - Le filtre utilisé, CORNING Réf. CS7-56, est placé entre la source lumineuse et la face avant du tube (voir Figure 10).
CORNING GLASS WORKS, CORNING, N.Y. 14830.

13 - Le "gamma" moyen peut être défini comme la pente de la partie rectiligne de la caractéristique de transfert en coordonnées logarithmiques.

14 - La saturation est définie comme la valeur de l'éclairement incident sur la face avant pour lequel l'éblouissement commence à apparaitre ; la source de lumière est un filament de tungstène à la température de 2854 °K.

15 - Pratiquement, la résolution limite correspond, sur une mire de définition à lignes noires et blanches ayant 100 %de contraste, à un taux de modulation voisin de 5 %.

16 - Dans le Standard CCIR de 625 lignes, la durée d'une ligne est de 52 μs (temps de suppression exclu), 400 lignes TV correspondent à une fréquence de 5 MHz.

17 - La rémanence s'exprime par le rapport en %du courant de signal résiduel mesuré à la fin de la n^{e} trame balayée après extinction de l'excitation lumineuse, au courant de signal initial.
La valeur indiquée est valable pour une cadence de balayage de 50 trames/seconde.

18 - Le réglage du récepteur est obtenu de la façon suivante :
- pour le niveau zéro (noir) la brillance de l'écran est réglée au point d'extinction de celui-ci.
- pour le niveau maximal (blanc), le gain du récepteur est ajusté pour obtenir une image optimale, fonction du contenu de l'image et de l'éclairage ambiant.

CONSIGNES D'UTILISATION

1 - Les tensions de balayage doivent être appliquées avant les tensions d'électrodes.

Lorsque les prises de vue sont terminées, elles doivent être coupées après les tensions d'électrodes.

2 - Le tube ne doit pas être soumis à des niveaux lumineux supérieurs à celui donné dans les "Valeurs Limites" afin d'éviter une élévation excessive de la température de cible.

3 - Note sur la tension de cible:

Le courant d'obscurité et les défauts d'aspect de la cible augmentent avec la valeur de la tension de cible.

La sensibilité du tube est indépendante du potentiel de la cible.

La valeur optimale de la tension de cible est celle qui permet d'obtenir le courant de signal maximal et le courant d'obscurité minimal. Cette valeur est de l'ordre de 8 à 10 V avec les blocs de bobines mentionnés dans cette Notice.

Une utilisation avec une tension de cible supérieure à 15 V peut entraîner une déstabilisation de la cible rendant impossible la recharge de celle-ci par le faisceau.

Il est possible de restabiliser la cible en opérant un cycle de restauration comme suit :

a - Boucher l'optique.
b - Balayer toute la cible.
c - Ajuster la tension de la grille g1 autour de −5 V.
d - Porter la tension de cible V_c à 300 V pendant 1 à 2 secondes.
e - Polariser la grille g1 à la valeur du cut-off.
f - Ramener V_c à sa valeur normale soit 8 à 10 V.
g - Réajuster la tension de g1 pour obtenir un faisceau déchargeant la cible.

Le tube est de nouveau prêt à fonctionner.

REMARQUE

La variation de la tension de cible ne peut être utlisée pour la commande automatique de sensibilité comme dans le cas d'un Vidicon conventionnel à photoconducteur $Sb_2 S_3$.

Pour la réalisation d'un dispositif de commande automatique de sensibilité, il sera fait appel à un objectif à iris automatique ou asservi au signal vidéo et, lors de grandes variations d'éclairement, à l'interposition de filtres.

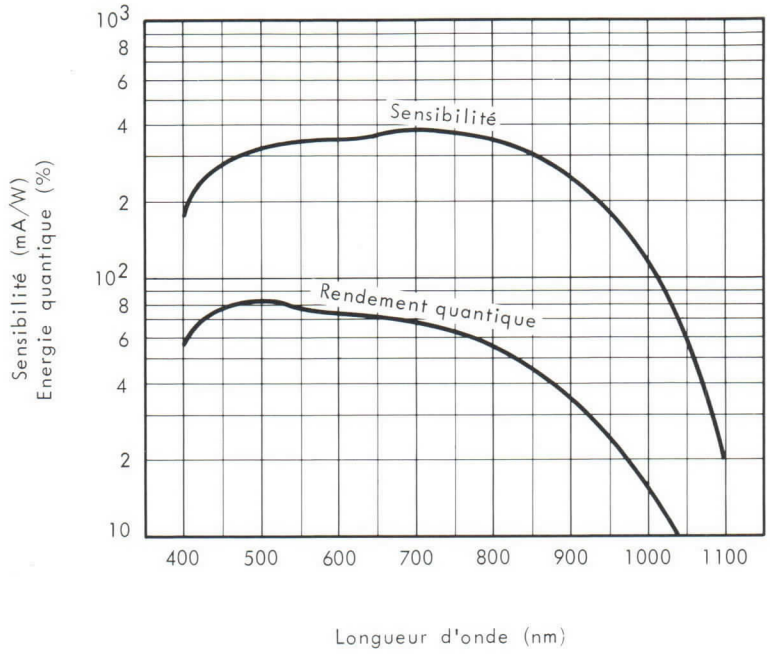


Figure 1 - Caractéristique typique de réponse spectrale.

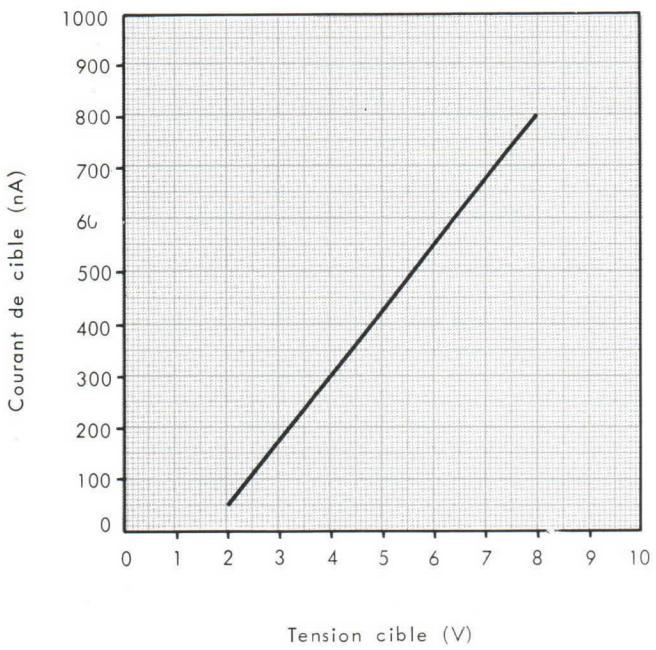


Figure 2 - Caractéristique de courant de cible de saturation.

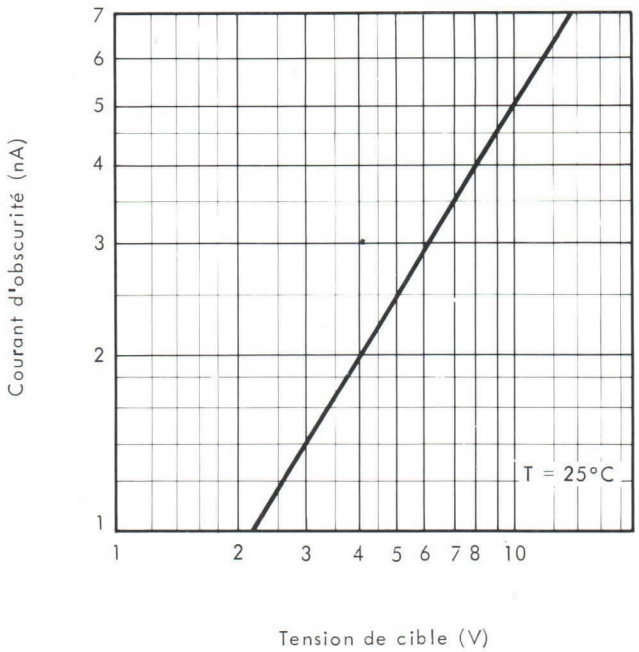


Figure 3 - Caractéristique de courant d'obscurité.

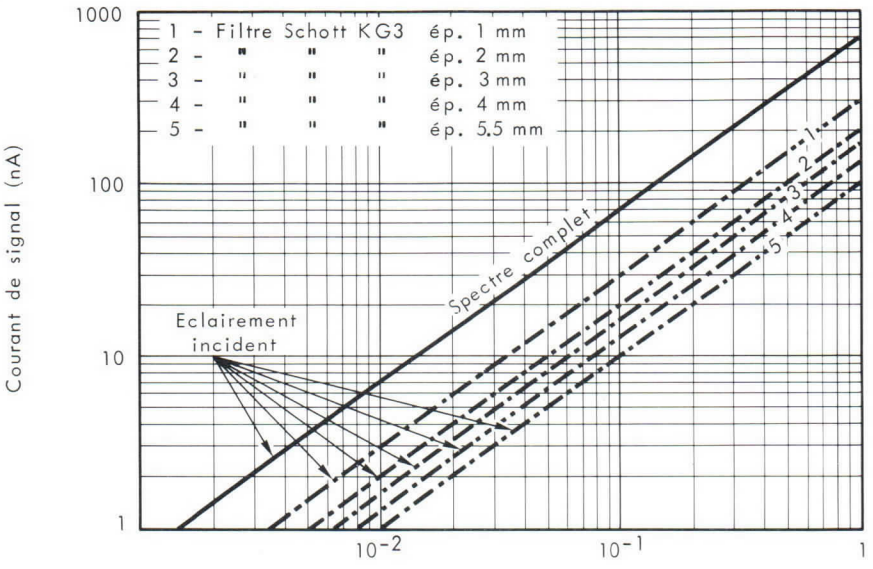


Figure 4 - Caractéristique de transfert typique à 2854°K dans le visible.

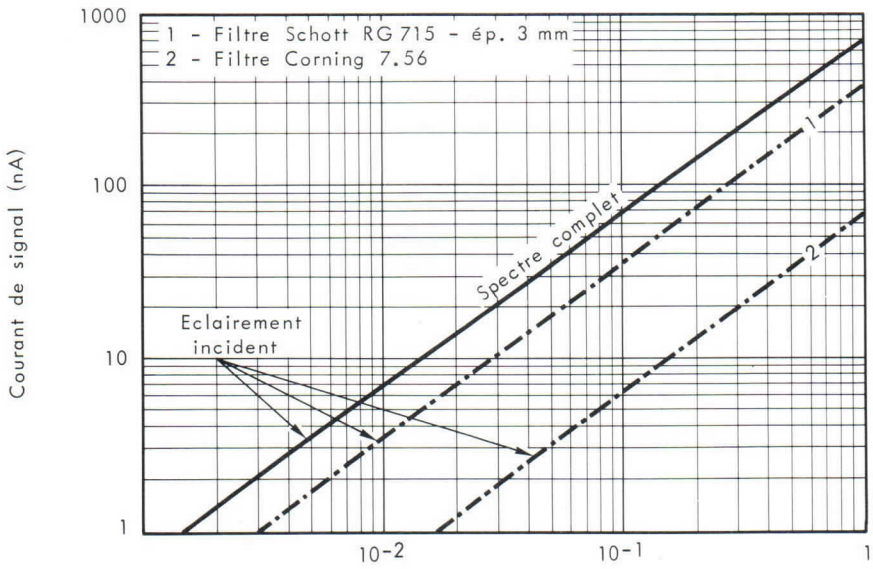


Figure 5 - Caractéristique de transfert typique dans le proche infra-rouge

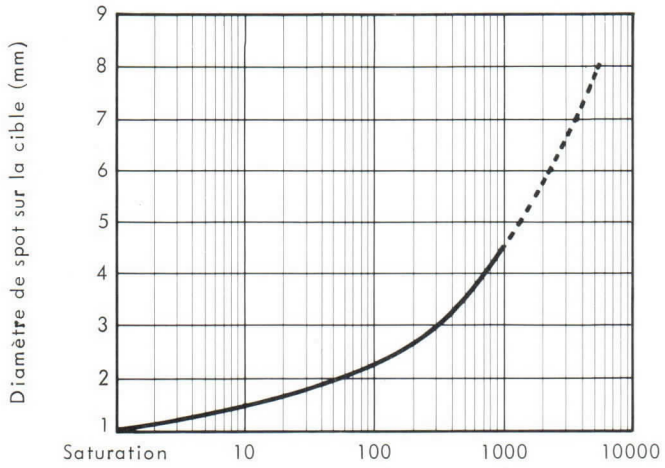


Figure 6 - Caractéristique typique d'éblouissement.

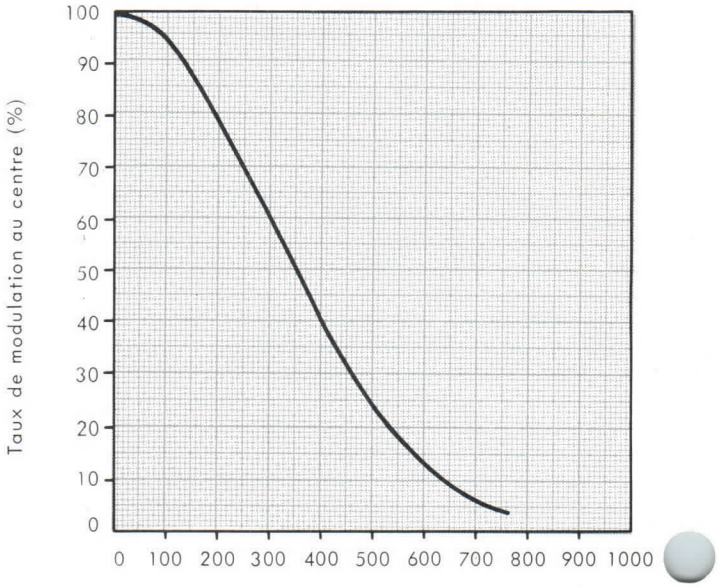


Figure 7 - Caractéristique typique de F.T.M. - Mire P200

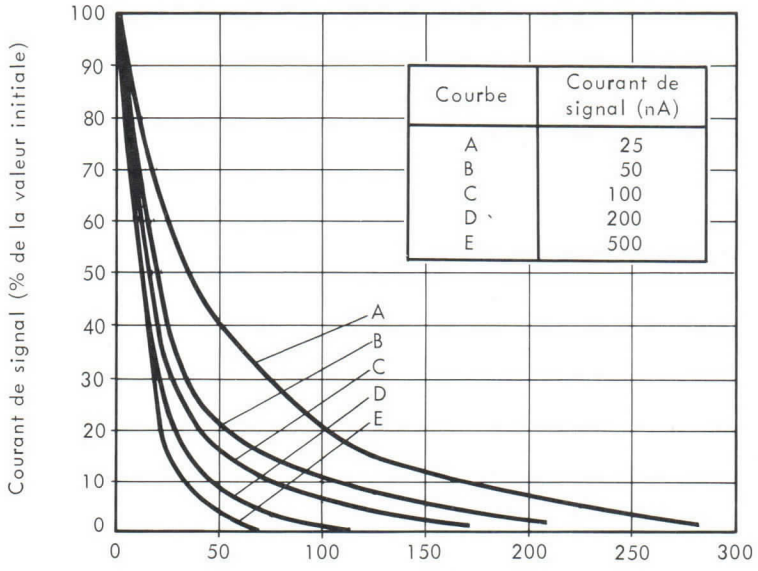


Figure 8 - Caractéristique typique de rémanence.

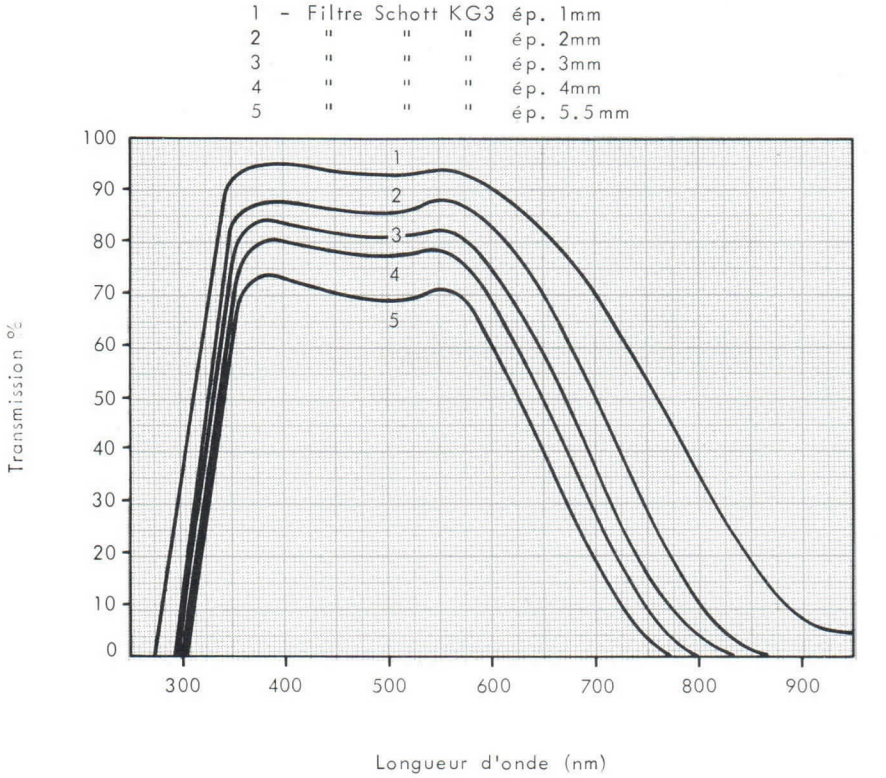


Figure 9 - Transmission typique des filtres SCHOTT KG3 absorbant l'infra-rouge.

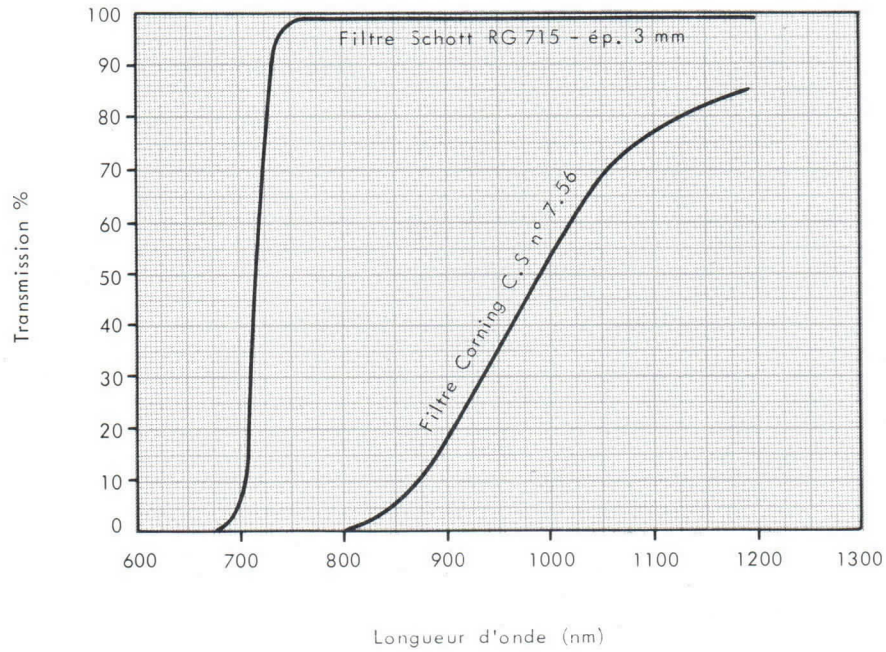
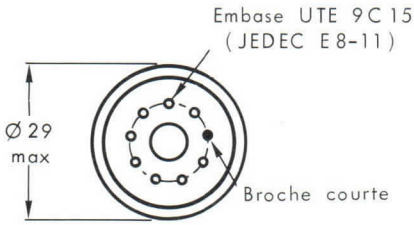
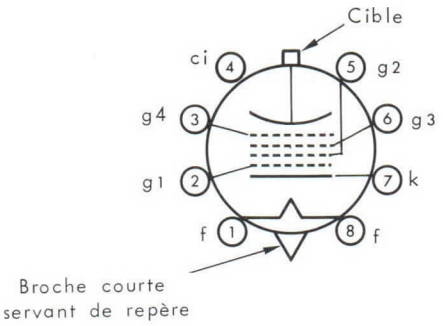


Figure 10 - Transmission typique des filtres SCHOTT RG 715 et CORNING CS 7.56 absorbant le visible.

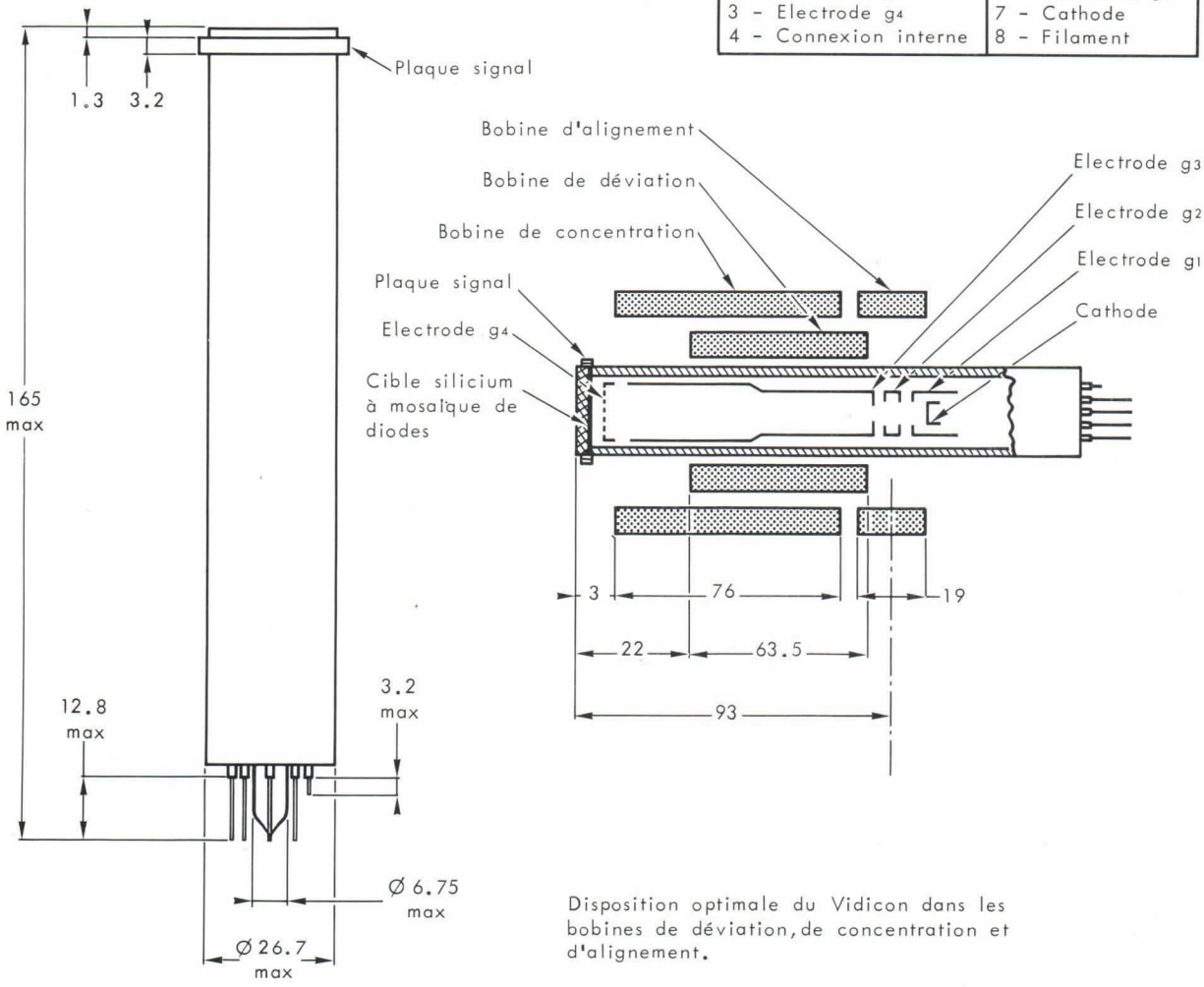
DESSIN D'ENCOMBREMENT



BROCHAGE



1 - Filament	5 - Electrode g_2
2 - Electrode g_1	6 - Electrode g_3
3 - Electrode g_4	7 - Cathode
4 - Connexion interne	8 - Filament



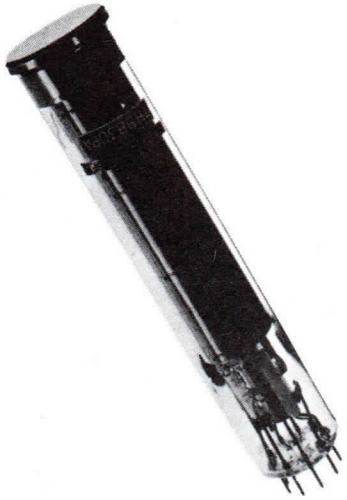
Disposition optimale du Vidicon dans les bobines de déviation, de concentration et d'alignement.

Cotes en mm.

TH 9830
1½" VIDICON

- MAGNETIC FOCUS AND DEFLECTION
- HIGH RESOLUTION (1200 TV. LINES)
- LOW LAG
- FOR HIGH PERFORMANCE TV.CAMERA
- BROADCAST TV, TELECINE, DATA TRANSMISSION

TH 9830 is a 1 1/2" (38 mm) diameter magnetic focus, magnetic deflection Vidicon specially designed for high performance. Special features allowing for high resolution, possibility of large output current associated with the use of a low lag, high sensitivity photoconductive layer, make the tube suitable for broadcast service equipment or data transmission applications.



A scanned area of the photoconductive layer larger than that commonly used with 1" Vidicon makes possible to obtain higher electron-optical performances. Due to a new low lag photoconductive layer excellent quality of picture can be obtained within a large illumination range with good signal uniformity and appropriate "gamma" characteristics.

A field mesh with separate external connection allows good uniformity of signal and resolution on the entire scanned area. High voltage operation for this mesh improves limiting resolution and capability of large output current. Appropriate ratio voltages between this electrode and the wall electrode secures good signal uniformity and raster linearity by improving electronoptics and minimizes scanning power.

The sensitivity of the TH 9830 can be equivalent to photographic film having an ASA exposure index of 2000 (34/10 DIN, 41 Sch). Satisfactory quality picture with good resolution and acceptable signal to noise ratio can be obtained at illumination of 0.3 lux (0.03 fc) on the faceplate, 3 to 6 lux (0.3 to 0.6 fc) on the subject with an unity numerical aperture lens giving rise to a signal current of 0.1 μA at 0.1 μA dark current. For such illumination, higher signal current is obtained by increasing dark current up to 0.2 μA beyond which a signal saturation will occur.

A limiting resolution in excess of 1200 TV lines with a good resolution uniformity is obtained when the tube is operated with the electrode g4 voltage at 1400 V and g3 voltage at 900 V.

When operated with sufficient illumination on the target, TH 9830 can deliver an output signal in excess of 0.4 μA without loss of resolution and geometrical landing distortions. This characteristic makes the tube suitable for motion picture film cameras.

Full advantage of resolution and signal uniformity is achieved when deflecting and focusing components are properly designed and when the tube is correctly located inside. The thickness of the photoconductive layer is made very uniform and allows for constant output signal and constant dark current. When landing error due to imperfect scanning system is present, the voltage gradient across the photoconductive layer is not uniform and a signal variation is introduced (shading) which can be compensated by proper adjustment of the cathode, g1, g2 voltages.

Due to good design, high reliability is obtained all along tube life. Requirement for alignment field is reduced to a minimum by precise electron gun mounting. An extremely flat faceplate avoids all optical distortions and allows for the use of any good quality lens. Particle barriers adjacent to the field mesh allow these tubes to operate in any position.

One Watt power heater makes these Vidicons particularly suitable for transistorized equipment. The reduced heat dissipation improves the quality of pictures by lowering the faceplate temperature.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

GENERAL CHARACTERISTICS

Electrical

Heater	for unipotential cathode indirectly heated
Heater :	
- voltage	6.3 ± 10 % V
- current under 6.3 V	0.15 A
Minimum preheating time	60 s
Output capacitances :	
target to all other electrodes	8 pF
Spectral response	see drawing
Focusing method	magnetic
Deflection method	magnetic

Mechanical

Base	Super DITETRAR, 8 Pins JEDEC N° E8-78
Socket (note 1)	ALDEN N° 208-SBS DC or equivalent
Deflection and focusing coils (note 2)	CLEVELAND ELECTRONICS n° 15 VFA 259 and n° 15 VY 258 or equivalent
Dimensions	see drawing
Photoconductive layer :	
- normal image on target	20.4 x 15.2 mm^2
- maximum useful diagonal diameter (4 x 3 aspect ratio)	25.4 mm
- orientation of quality rectangle (note 3)	horizontal scan parallel to a plane passing through the tube axis and short index pin
Maximum temperature of faceplate	70 °C
Mounting position	any
Net weight, approximate	100 g

OPERATING CONDITIONS

Maximum ratings

Scanned area ... 20.4 x 15.2 mm^2

Electrode g4 voltage (field electrode)	1500	V
Electrode g3 voltage (wall electrode)	1200	V
Electrode g2 voltage (accelerator)	700	V
Electrode g1 voltage (electrode for picture cut-off) :		
negative bias value	300	V
positive bias value	0	V
Peak heater cathode voltage :		
heater negative with respect to cathode	125	V
heater positive with respect to cathode	10	V
Target voltage	125	V
Dark current	0.20	µA
Peak target current (note 4)	0.60	µA
Faceplate illumination	10000	lux
	or 1000	f.c.

Typical operation

Scanned area	*20. 4 x 15. 2*	*mm^2*
Temperature of faceplate (note 5)	*25*	*°C*

Electrode g4 voltage	1400	V
Electrode g3 voltage	800 to 1000	V
Electrode g2 voltage	300	V
Electrode g1 voltage (note 6)	−45 to −125	V
Field strength at center of focusing coil	46	Gauss
Field strength at center of alignment coil	0 to 4	Gauss
Average "Gamma" for target illumination between 1 to 100 lux (0. 1 to 10 f.c.) (note 7)	0. 65	
Minimum blanking peak to peak voltage :		
applied to electrode g1	−75	V
applied to cathode (note 8)	+20	V
Limiting resolution at center of picture	1200	TV lines
Modulation transfer function		
- for 450 TV lines at the center of picture (5.76 MHz - 625 CCIR Standard) (note 9)	60	%
- for 750 TV lines (9.6 MHz - 625 CCIR Standard)	25	%

1 - HIGH SIGNAL OUTPUT CURRENT OPERATION
(for telecine operating)

Dark current i_o		0. 008	µA
Target voltage for i_o = 0.008 µA (note 10)		12 to 35	V
Faceplate illumination (2854° K) (note 11)		100	lux
		or 10	f.c.
Signal output current	min.	0. 40	µA
Lag : (note 12)			
maximum		18	%
average		15	%

2 - AVERAGE SENSITIVITY OPERATION
(for live-scene pick-up TV)

Dark current i_o		0. 02	µA
Target voltage for i_o = 0.02 µA (note 10)		20 to 50	V
Faceplate illumination (2854° K) (note 11)		10	lux
		or 1	f.c.
Signal output current	min.	0. 30	µA
Corresponding sensitivity		100	µA/lm
Lag : (note 12)			
maximum		20	%
average		17	%

3 - HIGH SENSITIVITY OPERATION

Dark current i_o		0. 10	µA
Target voltage for i_o = 0.10 µA (note 10)		30 to 65	V
Faceplate illumination (2854° K) (note 11)		1	lux
		or 0. 1	f.c.
Target illumination for 0.05 µA output current		0. 05 to 0. 1	lux
		or 0. 005 to 0. 01	f.c.
Signal output current	min.	0. 20	µA
Corresponding sensitivity		700	µA/lm
Lag : (note 12)			
maximum		25	%
average		20	%

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

NOTES

1 - ALDEN PRODUCTS COMPANY
9140 North Main Street - BROCKTON 64 (Massachusett)

2 - CLEVELAND ELECTRONIC INC.
1974 East 61st Street - CLEVELAND (Ohio)

3 - It is necessary to assure correct positioning of the tube inside the coils. An immediate test consists in observing the fine mesh grid the wires of which should be inclined 45° with respect to scanning. Then again the front end of the deflecting yoke should be positionned 20 mm from the tube faceplate.

4 - Output current is defined as total current in load resistance connected to target electrode : signal current + dark current, dark current being the current left when illumination is subtracted.

Video amplifiers must be designed properly to handle peak output current of 0.60 μA to avoid amplifier overload and picture distortion.

5 - All these characteristics are provided for a temperature of faceplate of 25° C, the temperature range recommended is within 25 to 35° C. The rise of faceplate temperature is a function of ambient temperature, heat dissipation of ambient devices and of the tube itself. Consequently, 10° C of faceplate temperature rise implies a dark current multiplied by a factor of 2.

6 - Without blanking pulses applied on electrode g1.

7 - Average "Gamma" should be defined as the slope of the rectilinear part of transfert characteristics in log coordinates.

8 - Practically, limiting resolution corresponds to the resolution measured with twin bar test card with a modulation ratio of about 7 %.

9 - In the case of 625 lines CCIR standard, line duration being 52 μs, 450 TV lines correspond to a frequency of 5.76 MHz and 750 TV lines correspond to 9.6 MHz. In the case of 819 lines French standard,line duration being 40 μs, 450 TV lines correspond to 7.5 MHz and 750 TV lines to 12.5 MHz.

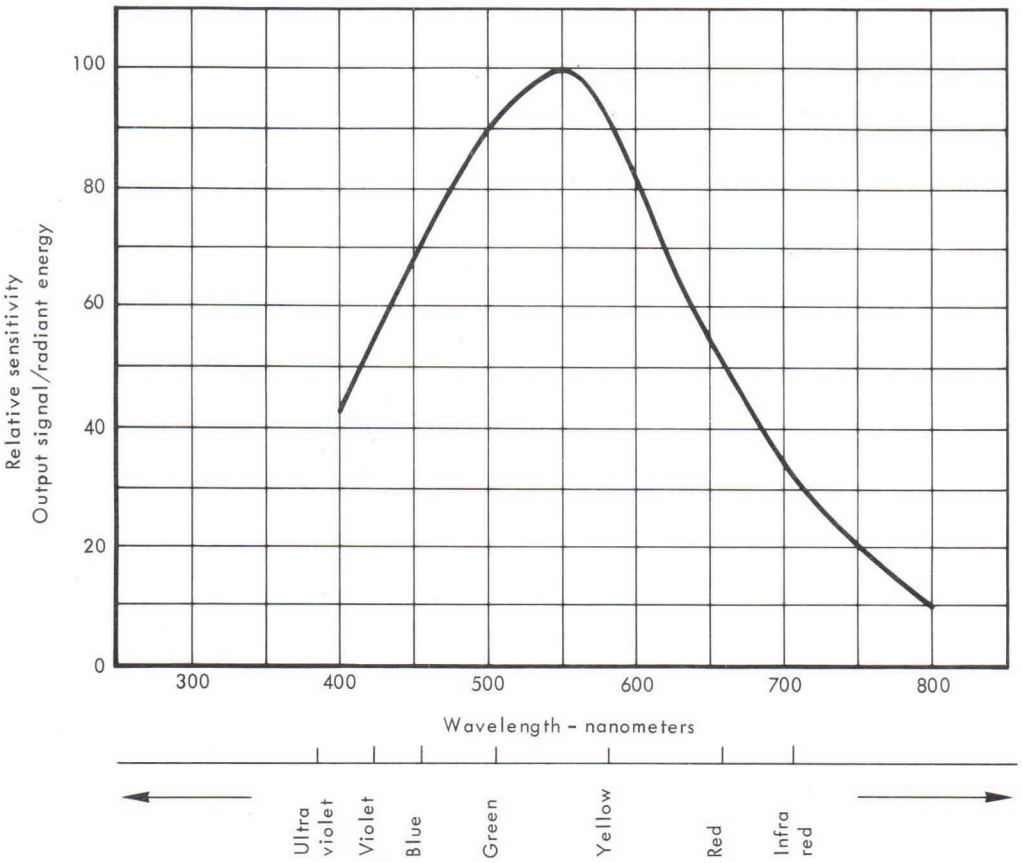
10 - Indicated range of each type of service serves only to illustrate the operating target voltage range normally encountered. The target voltage for each Vidicon must be adjusted to that value which gives the desired operating dark current.

11 - All the above mentioned illuminations assume a 2854° K incandescent tungsten source.

12 - Lag is defined as the ratio of residual output current measured 60 milliseconds after light excitation being subtracted to the initial output current ; this value assumes 50 fields/second scanning rate.

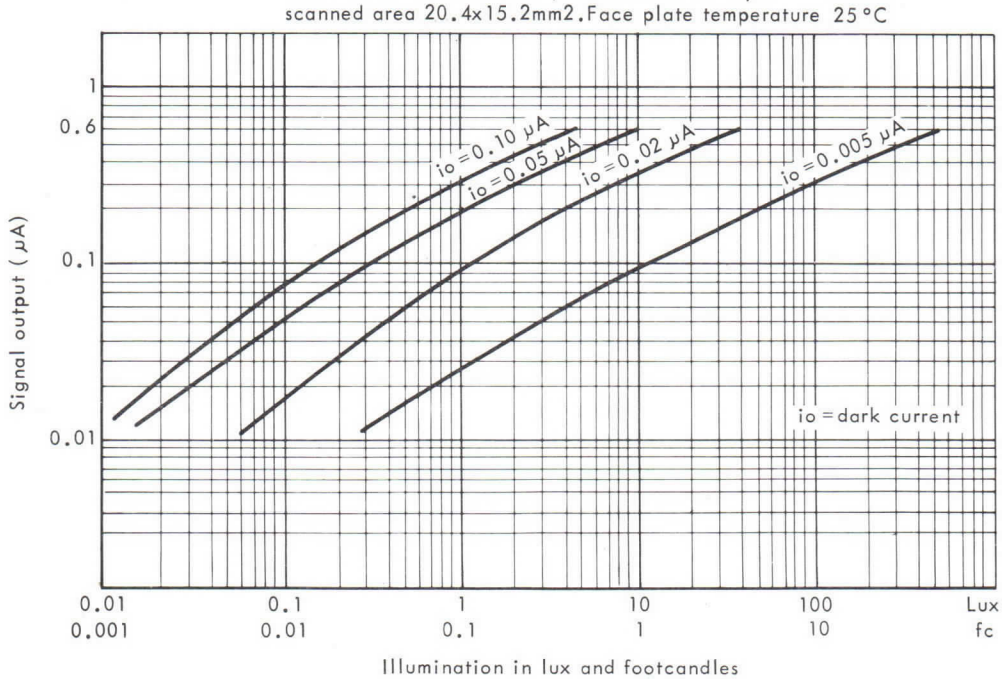
TYPICAL SPECTRAL SENSITIVITY CHARACTERISTICS

For equal values of signal output current at all wavelengths
(0.02 µA signal output and 0.02 µA dark current for scanned area of 20.4x 15.2 mm2)

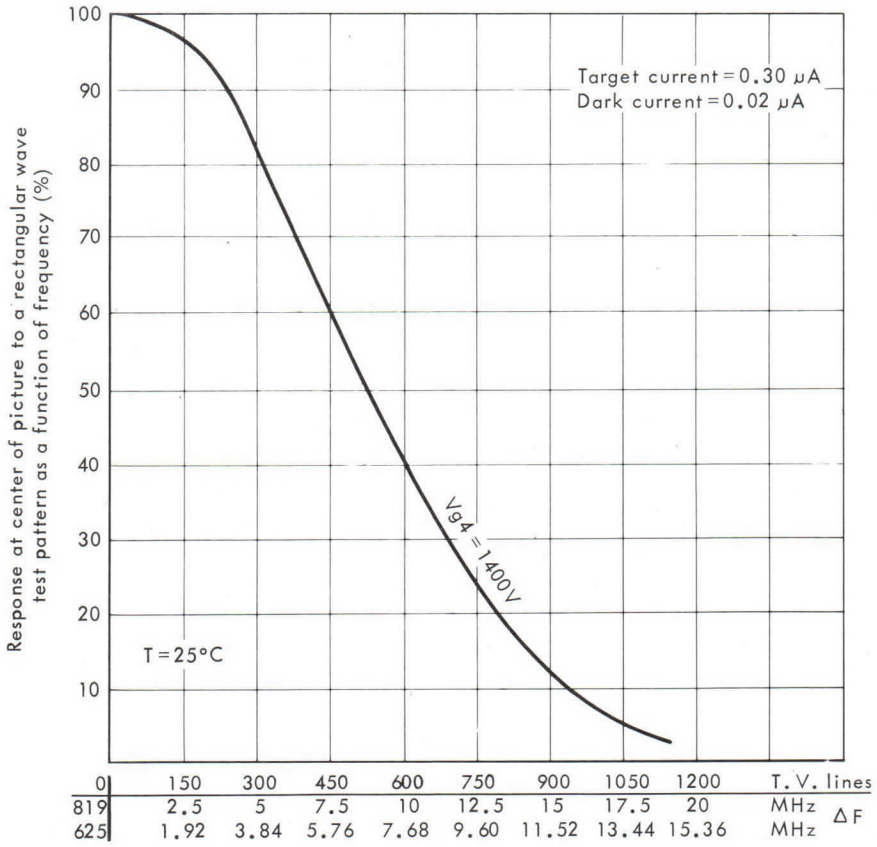


SIGNAL OUTPUT

Illumination uniform over photoconductive layer
scanned area 20.4x15.2mm2. Face plate temperature 25 °C

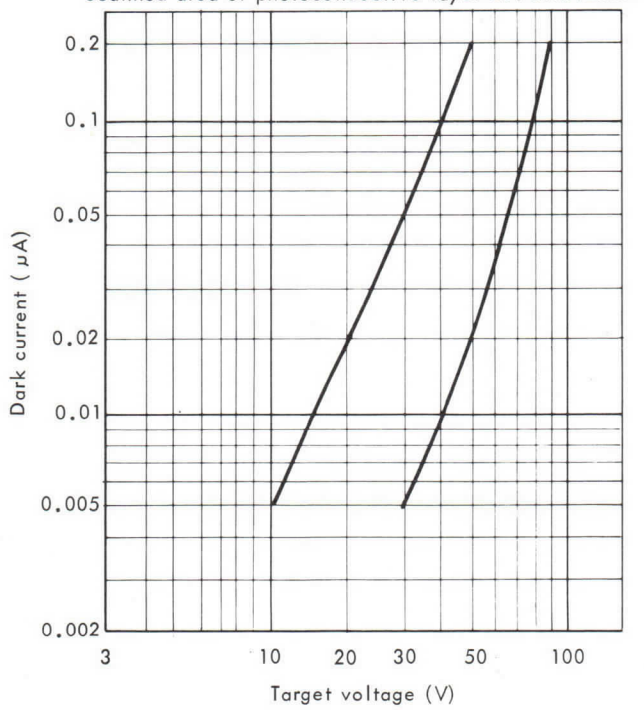


THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES



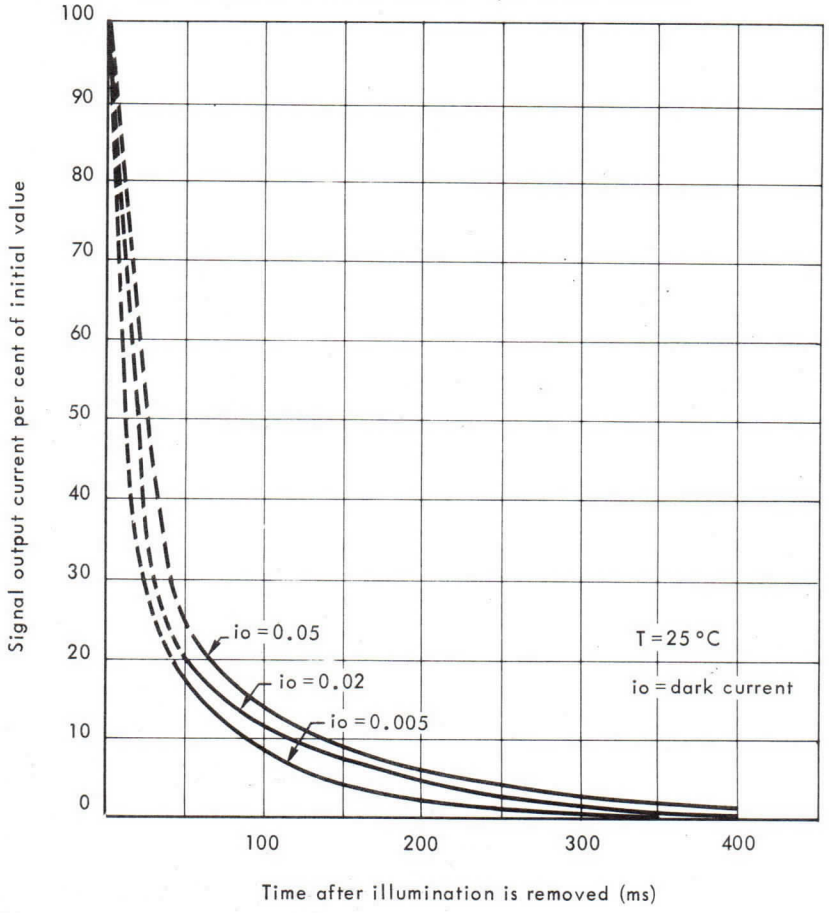
RANGE OF DARK CURRENT

Scanned area of photoconductive layer 20.4x15.2mm2



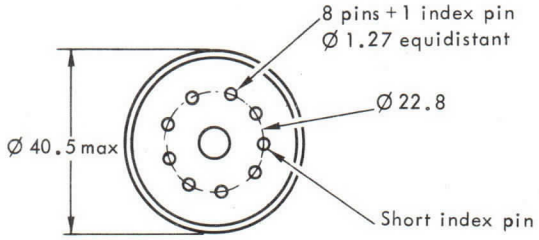
TYPICAL PERSISTENCE CHARACTERISTICS

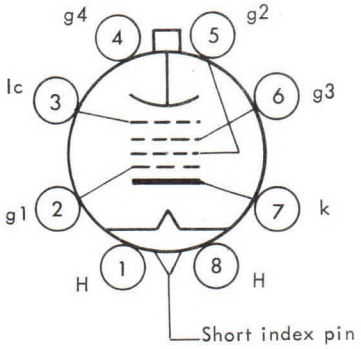
Initial highlight signal output of 0.30 μA
scanned area of photoconductive layer 20.4x15.2mm2

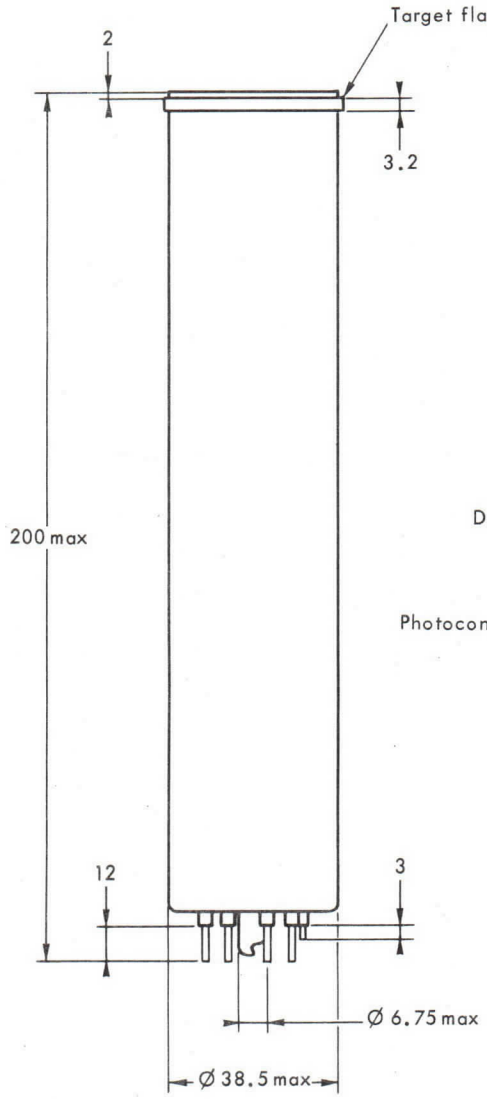


THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

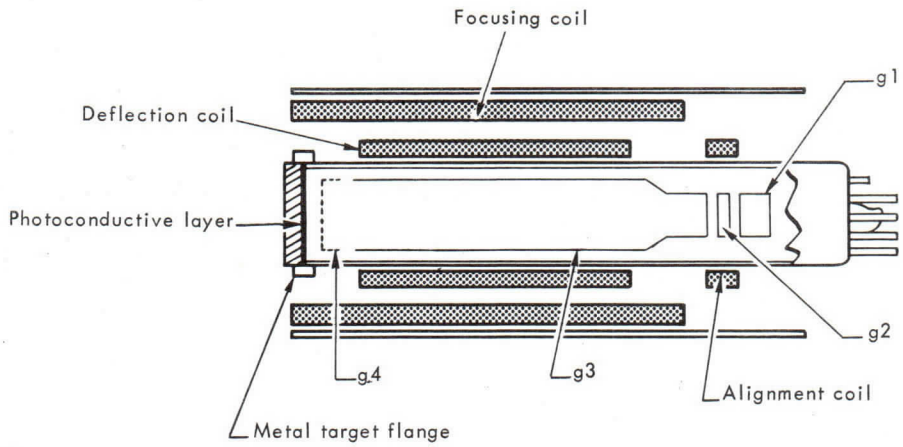
OUTLINE DRAWING







1 - Heater
2 - Electrode g1
3 - Internal connection
4 - Electrode g4
5 - Electrode g2
6 - Electrode g3
7 - Cathode
8 - Heater
Flange : Target



Dimensions in mm.

TH 9834
ENSEMBLE VIDICON 26 mm
ET BOBINES DE CONCENTRATION - DEVIATION

- Ensemble de faible encombrement et faible poids :
  Longueur : 100 mm
  Diamètre : 37 mm
  Poids : 190 g
- Construction robuste
- Bobines intégrées pour constituer un ensemble indissociable.
- Absence d'alignement du faisceau.
- Haute résolution.
- Faible rémanence.

L'ensemble TH 9834 est constitué d'un Vidicon 26 mm, très court (longueur 100 mm) et robuste, associé à un bloc de bobines de concentration et de déviation spécialement étudiées pour ce tube.

Cet ensemble permet de réaliser des caméras de télévision très compactes et robustes, à performances électro-optiques élevées, notamment sur le plan du pouvoir de résolution et de l'uniformité du signal de sortie vidéo, tout en offrant une grande simplicité d'exploitation.

Les performances de l'ensemble sont optimisées par le réglage en usine du tube et de ses accessoires fixées définitivement sur le tube.

L'emploi des bobines à basse impédance sur circuit imprimé permet par ailleurs d'obtenir une excellente linéarité de balayage et facilite l'utilisation de la télévision dans un certain nombre de domaines civils et militaires nécessitant une haute qualité d'image et une parfaite fiabilité.

CARACTERISTIQUES GENERALES

Electriques

– TUBE

Cathode	équipotentielle chauffage indirect à oxydes	
Chauffage filament :		
- tension	6, 3	V
- courant à 6, 3 V	0, 10 ± 10 %	A
Temps minimal de préchauffage	60	s
Capacité de sortie (entre l'électrode de signal et les autres électrodes)	9	pF
Concentration	électromagnétique	
Déviation	électromagnétique	

– BOBINES

Bobine de concentration		
- résistance	70 ± 7	Ω
Bobine de déviation horizontale		
- résistance	12 ± 4	Ω
- inductance	360 ± 30	μH
Bobine de déviation verticale		
- résistance	12 ± 4	Ω
- inductance	350 ± 30	μH

– OPTIQUES

Cible :	
- diamètre utile maximal (format 4 x 3)	17 mm
- format normal sur cible	12, 7 mm x 9, 5 mm
Réponse spectrale	voir figure 1

Mécaniques

Longueur hors-tout, max.	101, 6 mm
Diamètre hors-tout, max.	37 mm
Embase (Ditétrar - 8 broches)	UTE 9 C 15 (JEDEC N° E8-11)
Support (note 1)	THOMSON-CSF N° 8192138
Position de fonctionnement	indifférente
Masse approximative	190 g

CONDITIONS D'EMPLOI

Les potentiels sont définis par rapport à la cathode, celle-ci étant reliée à la masse.

Valeurs limites d'utilisation (limites absolues)

Température de fonctionnement et de stockage,	min.	– 55	°C
	max.	+ 70	°C

– TUBE

Tension de la cible		125	V
Tension de grille g4 (champ)		1000	V
Tension de grille g3 (paroi)		1000	V
Tension de grille g2 (accélération)		350	V
Tension de grille g1 (extinction du faisceau) :			
- valeur continue négative		150	V
- valeur continue positive		0	V
Tension de cathode k		0	V
Tension de filament	max.	6, 6	V
	min.	6	V

Tension crête entre filament et cathode :		
- filament négatif par rapport à la cathode	125	V
- filament positif par rapport à la cathode	10	V
Courant d'obscurité	0, 20	µA
Courant crête de cible (note 2)	0, 60	µA
Eclairement de la face avant	10 000	lux

– BOBINES

Tension entre enroulements	250	V
Tension entre enroulements et masse	250	V
Courant dans la bobine de concentration	300	mA
Courant continu dans chaque déviateur	0, 5	A
Courant crête dans chaque déviateur	1	A

Exemple de fonctionnement

– CONDITION DE FONCTIONNEMENT

Température de la face avant (note 3)	25	°C
Format de l'image sur la cible	12, 7 mm x 9, 5 mm	
Standard d'analyse	25 images/s 625 lignes entrelacées	

– TUBE

Tension de grille g4		400	V
Tension de grille g3		300	V
Tension de grille g2		300	V
Tension de grille g1 (extinction de l'image) (note 4)	min.	– 45	V
	max.	– 110	V
Tension crête minimale de blocage :			
- appliquée sur la grille g1		– 75	V
- appliquée sur la cathode		+ 20	V
Gamma moyen pour un éclairement de cible compris entre 1 et 100 lux (note 5)		0, 65	
Résolution limite au centre de l'image (note 6 et figure 3)		1000	lignes T.V.
Résolution limite au bord de l'image		600	lignes T.V.
F.T.M. à 400 lignes T.V. au centre de l'image (note 7 et figure 3)		60	%
Distorsion géométrique		1	%

– BOBINES

Courant dans la bobine de concentration	110 ± 10	mA
Courant crête à crête dans le déviateur horizontal	290 ± 30	mA
Courant crête à crête dans le déviateur vertical	220 ± 20	mA

Performances typiques

1 - GRAND ECLAIREMENT A L'ENTREE DU TUBE
(100 lux sur la face avant)

Courant d'obscurité i_o	5	nA
Tension de cible pour i_o = 5 nA (note 8 et figure 4)	10 à 25	V
Eclairement de cible (2854 °K) (note 9)	100	lux
Courant de signal	300	nA
Rémanence : (note 10 et figure 5)		
- maximale	15	%
- moyenne	10	%

2 - SENSIBILITE MOYENNE
(10 lux sur la face avant)

Courant d'obscurité i_o	20	nA
Tension de cible pour i_o = 20 nA (note 8 et figure 4)	20 à 50	V
Eclairement de cible (2854 °K) (note 9)	10	lux
Courant de signal	180	nA
Sensibilité correspondante	150	µA/lm
Eclairement de cible pour un courant de signal de 100 nA	3	lux
Rémanence : (note 10 et figure 5)		
- maximale	20	%
- moyenne	12	%

3 - SENSIBILITE ELEVEE
(5 lux sur la face avant)

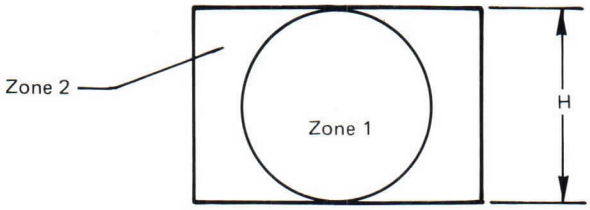
Courant d'obscurité i_o	50	nA
Tension de cible pour i_o = 50 nA (note 8 et figure 4)	25 à 60	V
Eclairement de cible (2854 °K) (note 9)	5	lux
Courant de signal	200	nA
Sensibilité correspondante	350	µA/lm
Eclairement de cible pour un courant de signal de 100 nA	1, 5	lux
Rémanence : (note 10 et figure 5)		
- maximale	20	%
- moyenne	15	%

4 - SENSIBILITE TRES ELEVEE
(1 lux sur la face avant)

Courant d'obscurité i_o	100	nA
Tension de cible pour i_o = 100 nA (note 8 et figure 4)	30 à 70	V
Eclairement de cible (2854 °K) (note 9)	1	lux
Courant de signal	100	nA
Sensibilité correspondante	800	µA/lm
Eclairement de cible pour un courant de signal de 50 nA	0, 3	lux
Rémanence : (note 10 et figure 5)		
- maximale	20	%
- moyenne	17	%

CARACTERISTIQUES D'ASPECT

Les défauts d'aspect sont observés sur une mire blanche éclairée uniformément sur laquelle figurent les courbes délimitant les zones de qualité.



Le tube fonctionne dans les conditions typiques données dans l'exemple de fonctionnement avec un courant d'obscurité de 20 nA et l'optique réglée pour un courant de signal de 200 nA.

Défauts ponctuels

Les défauts sont classés suivant leur dimension exprimée en % de la hauteur du cadre de l'image.

Seuls sont pris en considération les points dont le contraste est de $C > 50$ % (note 11).

Le nombre de défauts admis dans chaque zone est donné dans le tableau suivant :

Rapport D/H* en % * D diamètre moyen du défaut H hauteur du cadre de l'image	Nombre de défauts admis			
	Zone 1	Zone 1 + Zone 2		
		a	a + b	a + b + c
a : 0,8 < D/H ⩽ 1 %	0	1	3	6
b : 0,6 < D/H ⩽ 0,8 %	1			
c : 0,2 % < D/H ⩽ 0,6 %	3			

0, 2 % et au dessous : ces défauts ne sont pas pris en considération si leur nombre ou leur concentration ne détériore pas localement la qualité de l'image.

Il en est de même pour les défauts de contraste $C \leqslant 50$ %.

Défauts non ponctuels

Les marbrures, granulations, taches et zones (blanches ou noires) sont admises si leur contraste est de $C \leqslant 15$ %.

NOTES

1 - THOMSON-CSF - Groupement Tubes Electroniques - 8, rue Chasseloup-Laubat - 75737 PARIS CEDEX 15 Tél. PARIS (1) 566 70 04.

2 - Le courant de cible est défini comme étant le courant total circulant dans la résistance de charge connectée à l'électrode de signal : courant de signal + courant d'obscurité, le courant d'obscurité étant le courant subsistant dans le cas de la cible non éclairée.

3 - Les amplificateurs vidéo doivent être calculés convenablement pour supporter des courants de cible de 1 μA afin d'éviter des surcharges des amplificateurs ou des distorsions d'image.

3 - Toutes les caractéristiques sont données pour une température de la face avant de 25 °C, les limites de température recommandées pour un bon fonctionnement étant de 20 °C à 30 °C. L'élévation de la température de la face avant est conditionnée à la fois par les variations de température ambiante, par la dissipation thermique des dispositifs environnants et du tube lui-même.

4 - Sans impulsions de blocage appliquées sur l'électrode g1.

5 - Le "gamma" moyen peut être défini comme la pente de la partie rectiligne de la caractéristique de transfert en coordonnées logarithmiques.

6 - Pratiquement la résolution limite correspond, sur des barres de définition noires et blanches ayant 100 % de contraste à un taux de modulation voisin de 5 %.

7 - Pour le standard CCIR de 625 lignes, la durée d'une ligne est de 52 μs (temps de suppression exclu), 400 lignes T.V. correspond à une fréquence de 5 MHz.

8 - Dans la plupart dès cas, la tension cible se situe dans ces limites qui ne représentent cependant qu'une valeur moyenne indicative. Il est bien entendu que le réglage de la tension de cible correspondant au courant d'obscurité indiqué doit être fait pour chaque tube.

9 - Les éclairements mentionnés sont uniquement valables dans le cas d'une source lumineuse dont la température de couleur est d'environ 2854 °K.

10 - La rémanence s'exprime par le rapport du courant de signal résiduel, mesuré 60 ms après l'extinction de l'excitation lumineuse, au courant de signal initial. Les valeurs indiquées sont valables pour une cadence de balayage de 50 trames/seconde.

11 - Le contraste est défini comme le rapport en % du signal vidéo délivré par le défaut au courant de signal normal délivré par le tube.

Figure 1

CARACTERISTIQUE TYPIQUE DE REPONSE SPECTRALE

Sensibilité en fonction de la longueur d'onde, à courant de signal constant (0.2 µA de signal et 0.02 µA d'obscurité pour une aire balayée de 12.7mm x 9.5mm).

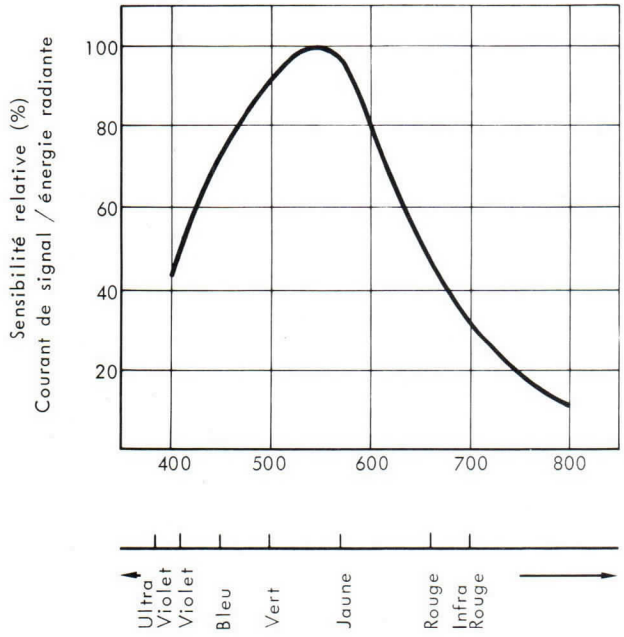


Figure 2

CARACTERISTIQUES DE TRANSFERT SIGNAL - ECLAIREMENT

Eclairement uniforme de la cible photoconductrice Aire balayée 12.7mm x 9.5mm. Température de la face avant : 25° C.

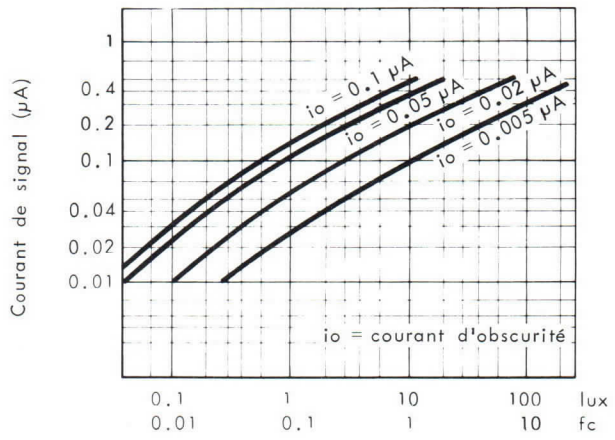


Figure 3

FONCTION DE TRANSFERT DE MODULATION

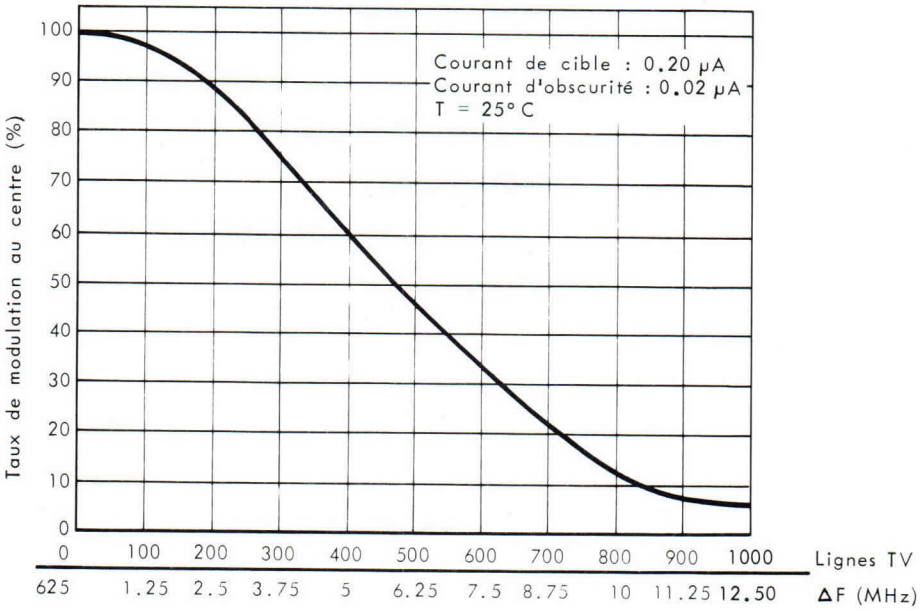


Figure 4

GAMME DE COURANT D'OBSCURITE

Aire balayée de la cible : 12.7mm x 9.5mm.

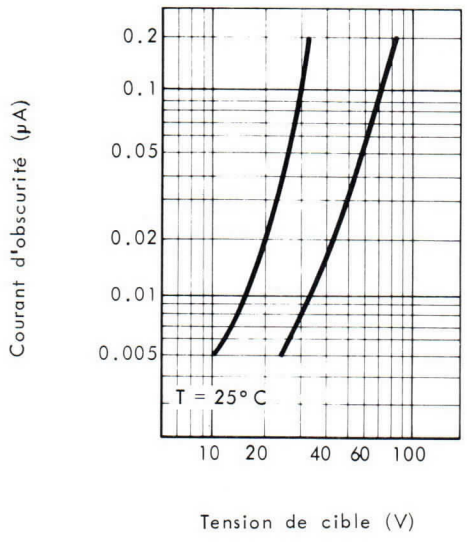
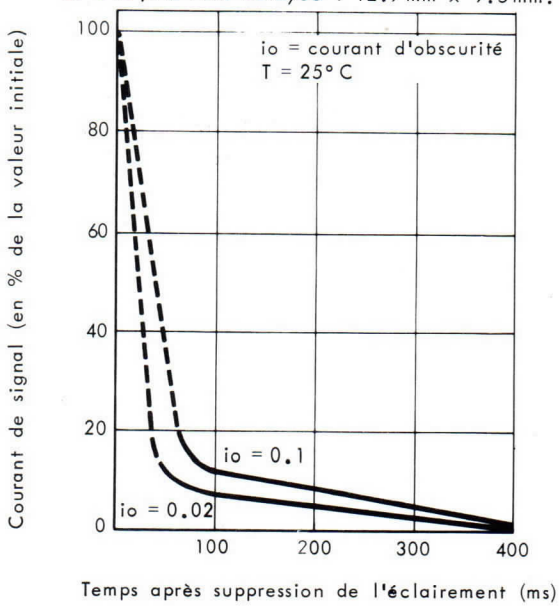


Figure 5

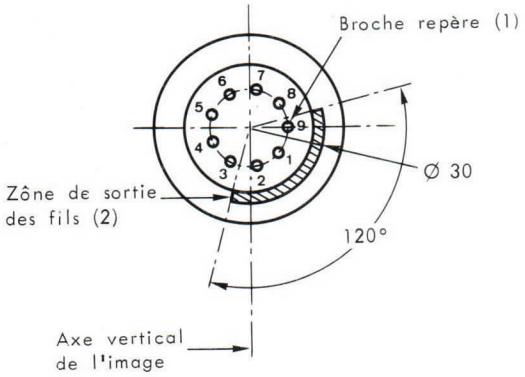
CARACTERISTIQUES TYPIQUES DE REMANENCE

Cible éclairée pour un courant de signal initial de 0.2 µA. Aire balayée : 12.7mm x 9.5mm.



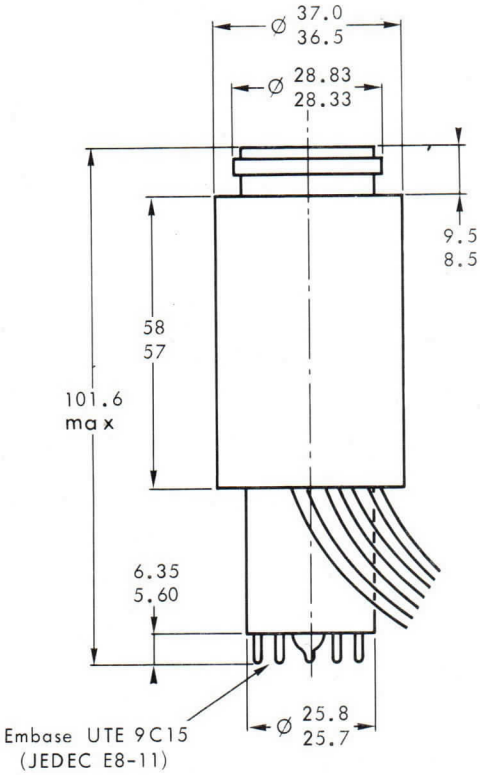
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

DESSIN D'ENCOMBREMENT

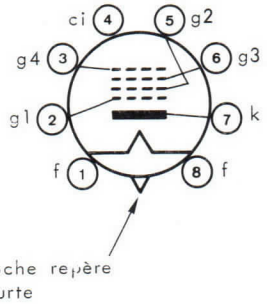


CONNEXIONS PAR FILS		
Masse	:	Gris
Focalisation	:	Orange (+) Marron (-)
Balayage ligne	:	Rouge (+) Noir (-)
Balayage trame	:	Vert (+) Blanc (-)

Longueur des fils : 250



CONNEXIONS EMBASE
(vue de dessous)



1 - Filament f	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode k
4 - Connexion interne	8 - Filament f

(1) - L'orientation de la broche repère par rapport aux axes de l'image peut être quelconque.

(2) - La position de cette zône par rapport aux axes de l'image peut être quelconque.

Cotes en mm.

Imprimé en France

TH 9835
SILICON-DIODE-ARRAY TARGET 1" VIDICON
with integral focusing coil and deflecting yokes

Compact and lightweight :

Length : 100 mm
Diameter : 37 mm
Weight : 190 g

No need for beam alignment.

Broad spectral range (400 to 1100 nm).

Low blooming.

Small dark current.

Low lag.

Highly burn-resistant.

Description

The TH 9835 is composed of a short (100 mm) sturdy 1" vidicon and an associated focusing-coil and deflecting-yokes assembly, specially matched to the camera tube.

The TH 9835 incorporates a broad spectral range, high-sensitivity silicon-diode-array (SDA) target. In addition to featuring high sensitivity, the SDA target is resistant to image burn-in and the THOMSON-CSF proprietary technologies used also reduce blooming effects. The sensitivity of the TH 9835 is not dependent on the target voltage, which is low as compared to photoconductive-target vidicons. This results in a very small dark current.

Since the tube has a broad spectral response (400 to 1100 nm), it is advisable to use the correct filters to select the useful spectral range (visible or infrared), depending on the applications considered. The TH 9835's unity gamma allows obtaining high image contrast, especially at low light levels. The high signal current leads to a wide operating dynamic range.

The TH 9835, easy to install and to operate, is designed for use in compact, ruggedized TV cameras having high sensitivity, high resolution and good uniformity of the video output signal.

Its performance is optimized by factory adjustment of the tube and the associated components, which are permanently attached to the tube.

The printed-circuit, low-impedance yokes yield good deflection linearity and make the TH 9835 suitable for use in professional or military cameras requiring high image quality and good reliability.

The TH 9835 can be optionally provided with a soldered target lead, potted base and connection leads, depending on the specific application.

Main Applications

The sensitivity of the TH 9835 in the near infrared makes it suitable for surveillance cameras operating at low light levels and using artificial light sources (an incandescent lamp at 2854 °K, for example). An input face illumination as low as 0.1 lux is sufficient, which represents a gain on the order of 10 as compared to a convential vidicon. Furthermore, this sensitivity allows the tube to be used in applications where the light-source spectrum includes little or no visible radiation.

GENERAL CHARACTERISTICS

Electrical

– VIDICON

Cathode	Unipotential, indirectly heated, oxide-coated	
Heater :		
- voltage	6.3	V
- current at 6.3 V	0.10 A ± 10 %	
Minimum preheating time	60	s
Output capacitance (target to all other electrodes)	6.5	pF
Focusing method	Electromagnetic	
Deflecting method	Electromagnetic	

– FOCUSING COIL - DEFLECTING YOKES

Focusing coil :		
- resistance	70 ± 7	Ω
Horizontal deflecting yoke :		
- resistance	12 ± 4	Ω
- self-inductance	360 ± 30	μH
Vertical deflecting yoke :		
- resistance	12 ± 4	Ω
- self-inductance	350 ± 30	μH

Optical

Target :		
- maximum useful diameter (format 4 x 3)	17	mm
- nominal image dimensions	12.7 x 9.5	mm
Spectral response	See Figure 1	

Mechanical

Maximum overall length	103.6	mm
Maximum outer diameter	37.0	mm
Base (Ditetrar - 8 pins) (see the Outline Drawing)	UTE 9 C 15 (JEDEC No. E8-11)	
Socket (Note 1)	THOMSON-CSF No. 8192138	
Operating position	Any	
Weight, approx.	190 g	

OPERATING CONDITIONS

(All potentials are referred to the cathode)

Maximum Ratings (absolute values)

– VIDICON

Electrode g4 voltage (post-acceleration)		350	V
Electrode g3 voltage (wall)		350	V
Electrode g2 voltage (acceleration)		350	V
Electrode g1 voltage (for picture cutoff) :			
- negative bias value		150	V
- positive bias value		0	V
Heater voltage	max.	6.6	V
	min.	6	V
Peak heater-to-cathode voltage :			
- heater negative with respect to cathode		125	V
- heater positive with respect to cathode		10	V
Target voltage (Note 2)		300	V
Peak target current (Note 3 - Figure 2)		750	nA

Faceplate :			
- illumination		6 x 10^8	lux
- temperature (operation and storage)	min.	−40	°C
	max.	+ 70	°C
– COIL AND YOKES			
Voltages between coils		250	V
Voltage between coils and ground		250	V
Current in the focusing coil		300	mA
Direct current in each deflecting yoke		0. 5	A
Peak current in each deflecting yoke		1	A

Operational Conditions

– VIDICON

Operating temperature : 25 °C (Note 4)
Scanning standard : 25 images/second - 625 interlaced lines
Image dimensions on target : 12. 7 mm x 9. 5 mm

Target voltage (see note in Operating Instructions)		8	V
Electrode g4 voltage (Note 5)		340	V
Electrode g3 voltage		220	V
Electrode g2 voltage		300	V
Electrode g1 voltage (picture cutoff) (Note 6)	max.	−40	V
	min.	−100	V
Minimum blanking pulse amplitude :			
- added to electrode g1 voltage		−75	V
- applied to cathode		+ 20	V

– COIL AND YOKES

Current in the focusing coil		110 ± 10	mA
Peak-to-peak current in deflecting yokes :			
- horizontal deflection		290 ± 30	mA
- vertical deflection		220 ± 20	mA

Electrooptical Performances

Tube operated under the same conditions as those given in "Operational Conditions"

Radiant sensitivity at 730 nm (Figure 1)		380	mA/W
Dark current (Figure 3)		4	nA

– SENSITIVITY TO LIGHT SOURCE AT 2854 °K (Note 7 - Figure 4)

Faceplate illumination		1	lux
Sensitivity		5750	µA/lm
Signal current		700	nA

– SENSITIVITY TO VISIBLE LIGHT (Figure 4)

Illumination from 2854 °K light source incident on SCHOTT-KG3 filter (Note 8)		1	lux
Sensitivity (depending on filter thickness) :			
- 1-mm thickness		2480	µA/lm
- 2-mm thickness		1640	µA/lm
- 3-mm thickness		1400	µA/lm
- 4-mm thickness		1060	µA/lm
- 5. 5-mm thickness		825	µA/lm
Corresponding signal current :			
- 1-mm thickness		300	nA
- 2-mm thickness		200	nA
- 3-mm thickness		170	nA
- 4-mm thickness		125	nA
- 5. 5-mm thickness		100	nA

– SENSITIVITY TO INFRARED LIGHT (Figure 5)

Illumination from 2854 °K light source incident on 3-mm thick SCHOTT-RG 715 filter (Note 9)	1	lux
Corresponding signal current	340	nA
Illumination from 2854 °K light source incident on CORNING-CS 7. 56 filter (Note 10)	1	lux
Corresponding signal current	65	nA
Average gamma for a signal current between 1 and 700 nA (Note 11)	1	
Typical blooming characteristics at 2854 °K (Note 12)	See Figure 6	
Limiting resolution at center of image (Note 13 - Figure 7)	700 TV lines	
MTF for 400 TV lines at center of image (Note 14 - Figure 7)	40	%
Lag : ratio of residual signal on the 3rd frame to initial signal current of 200 nA after illumination is removed (Note 15 - Figure 8)	6	%

SPURIOUS-SIGNAL TEST

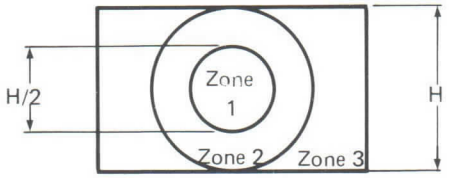
Measurement Conditions

Target voltage V_c = 8 V

Signal current i_s = 200 nA

The gain of the video amplifier and the monitor are adjusted so as to obtain the best image (Note 16).

The test is performed using a uniformly diffused white test pattern that shows 3 zones as indicated in the following drawing.



The different zones are defined as follows :

H = raster height
Zone 1 = diameter H/2
Zone 2 = diameter H
Zone 3 = peripheral area

Spots

Both black and white spots are counted, but actually considered as defects are only those spots having a contrast C ⩾ 15 %, in light or in darkness.

The contrast is defined as $C = 100 \times \frac{i_{sb}}{i_s}$ %,

where : i_{sb} = increment in video current due to the spot,
i_s = normal signal current.

TH 9835 "IND" — Allowed spots

D/H* ratio in %	Zone 1		Zones 1 + 2		Zones 1 + 2 + 3	
* D : average diameter of the spot H : raster height	White	Total	White	Total	White	Total
D/H > 1. 6	0	0	0	0	0	0
1. 6 ⩾ D/H > 1. 2	0	0	0	2	0	4
1. 2 ⩾ D/H > 0. 8	0	1	0	6	0	10
0. 8 ⩾ D/H > 0. 2	1	6	3	22	6	30
0. 2 ⩾ D/H	5	+	+	+	+	+

TH 9835 "AMR"

Allowed spots

D/H* ratio in % * D : average diameter of the spot H : raster height	Zone 1		Zone 1 + 2		Zones 1 + 2 + 3	
	White	Total	White	Total	White	Total
D/H > 3.2	0	0	0	0	0	0
3.2 ⩾ D/H > 2.4	0	0	0	0	0	1
2.4 ⩾ D/H > 1.6	0	0	0	2	0	4
1.6 ⩾ D/H > 1.2	0	1	0	5	0	9
1.2 ⩾ D/H > 0.8	0	3	0	11	0	19
0.8 ⩾ D/H > 0.2	4	11	9	31	15	51
0.2 ⩾ D/H	+	+	+	+	+	+

\+ Any number of spots of this size are allowed, unless concentration causes a smudged appearance.

Do not count spots of contrast C < 15 %.

Other Defects

Smudges, streaks, mottled or grainy background (black and white) are not considered as defects if their contrast is C ⩽ 5 %.

NOTES

1 - THOMSON-CSF - DTE 38, rue Vauthier - 92100 BOULOGNE-BILLANCOURT - Tel. 604 81 75.

2 - In normal operation, the target voltage will not exceed 15 V. See the note on target voltage in the "Operating Instructions".

3 - The target current is the total current drawn in the load resistance connected to the target : signal current + dark current ; the dark current is the component existing when the illumination is removed.
The video amplifiers must be designed to handle target currents of 1 μA in order to avoid amplifier overloads or image distortions.

4 - All characteristics are given for a faceplate temperature of 25 °C to 30 °C. The rise of the faceplate temperature is determined by the ambient temperature, by the thermal dissipation of surrounding components and of the tube itself.
A faceplate temperature rise of 10 °C will result in the dark current being multiplied by a factor of 2.

5 - In all cases, the grid g4 voltages should be higher than the g3 and g2 voltages.

6 - Without blanking pulses applied to grid g1.

7 - The light source is a tungsten lamp at 2854 °K color temperature.

8 - The SCHOTT-KG3 filters, of 1-mm, 2-mm, 3-mm, 4-mm and 5. 5-mm thickness, are placed between the light source and the tube faceplate (see Figure 9). SCHOTT and GEN-128 Bd. Haussmann - 75008 PARIS.

9 - The 3-mm thick SCHOTT-RG 715 filter is placed between the light source and the tube faceplate (see Figure 10).

10 - The CORNING CS-7. 56 filter is placed between the light source and the tube faceplate (see Figure 10).
CORNING GLASS WORKS, CORNING, N.Y. 14830.

11 - Average gamma is defined as the slope of the rectilinear part of the light transfer characteristics in logarithmic coordinates.

12 - Saturation is defined as that value of incident light on the tube faceplate at which blooming just becomes evident ; the light source is a tungsten filament at 2854 °K.

13 - Practically, the limiting resolution corresponds to the resolution measured with a twin-bar test card at 5 % amplitude response.

14 - In 625-lines CCIR Standard, line duration being 52 μs (line suppression period not included), 400 TV lines correspond to 5 MHz.

15 - The lag is defined as the percentage of the residual signal (measured on the n^{th} field after illumination is removed) to the initial signal. This value assumes 50 frames/second scanning rate.

16 - The monitor is adjusted as follows :

- for the pedestal level (black), the luminance of the screen is set at cutoff.
- for the maximum level (white), the gain of the monitor is adjusted to obtain an optimum image depending on image content and ambient light.

OPERATING INSTRUCTIONS

1 - The deflection voltages must be applied before any electrode voltages are applied.

For shutdown, the deflection voltages must be switched off only after all electrode voltages have been turned off.

2 - The tube must not be exposed to lighting conditions exceeding those given in the "Maximum Ratings", in order to avoid an excessive increase of target temperature.

3 - Note relative to target voltage :

The dark current and spurious signals increase with a target voltage increase.
The tube sensitivity is not dependent on target potential.
The optimum value of target voltage is the one that yields a maximum signal current and a minimum dark current. This value is approximately 8 to 10 V. When the target voltage is set a value higher than 15 V, target destabilization can eventually occur, with the result that is becomes impossible to recharge the target with the beam.

In such case, follow this recommended procedure :

a) Shut the optics.

b) Scan the whole target.

c) Set V_{g1} at about −5 V.

d) Raise target voltage V_c to 300 V for 1 or 2 seconds

e) Cut the beam off completely (V_{g1} at cutoff).

f) Reset target voltage to normal operating voltage : 8 to 10 V.

g) Increase beam current to normal target discharge by adjusting V_{g1}.

The tube can then be operated normally.

Remark

The variation of the target voltage can not be used for automatic control of the sensitivity, as in conventional vidicons having an $Sb_2 S_3$ photoconductor.

Automatic control of the sensitivity requires the use of an iris, either automatic or slaved to the video signal, and, for large variations of illumination, the use of proper filters.

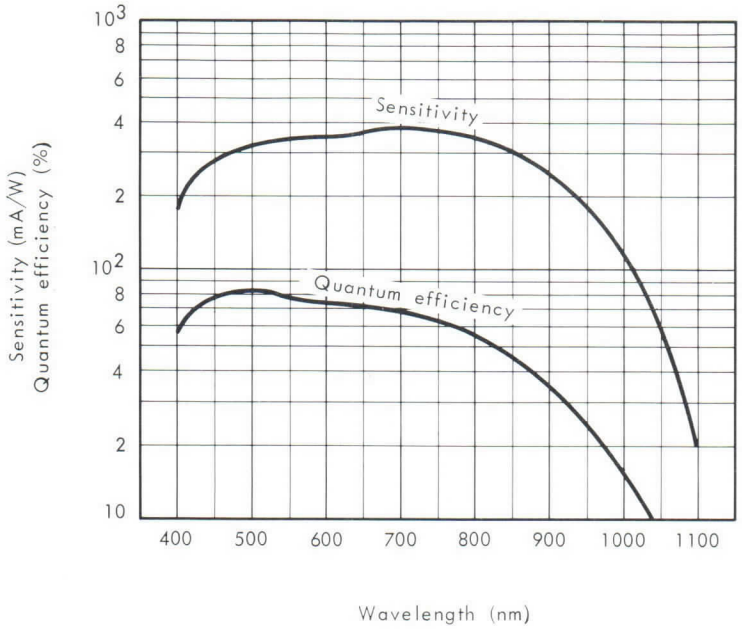


Figure 1 - Typical spectral-response characteristics.

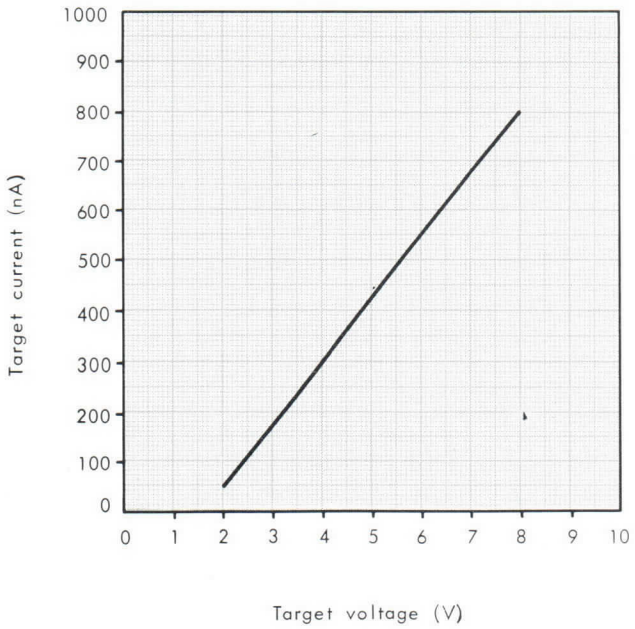


Figure 2 - Saturation target current characteristics.

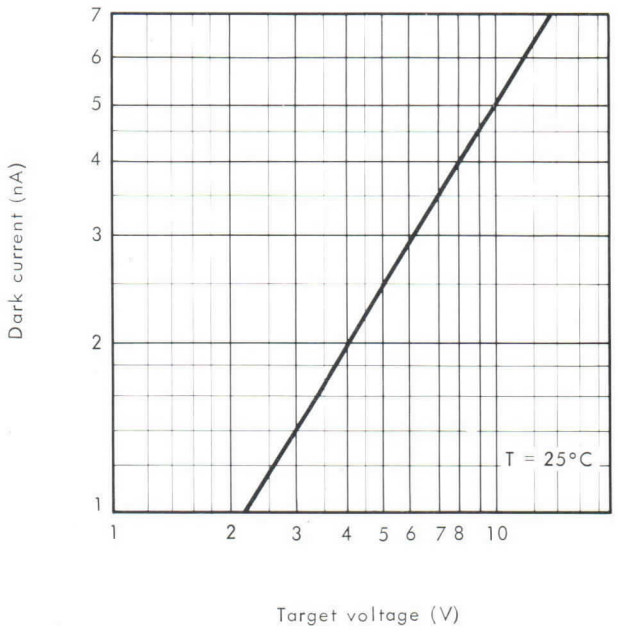


Figure 3 - Dark-current characteristics.

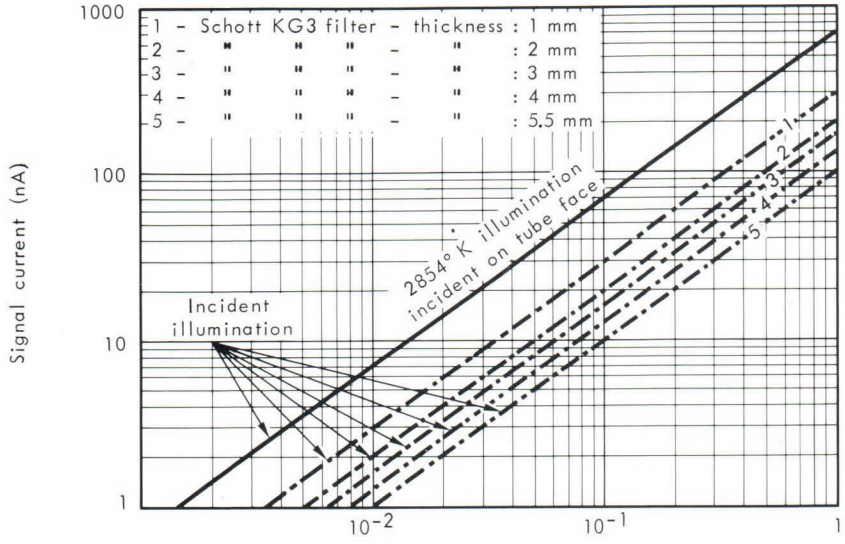


Figure 4 - Typical light-transfer characteristics at 2854°K in the visible range

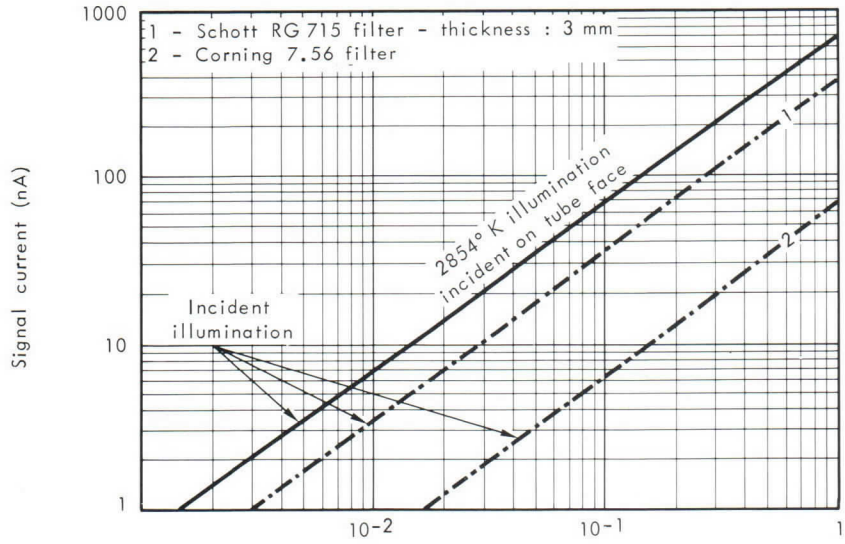


Figure 5 - Typical light-transfer characteristics in the near infrared and infrared

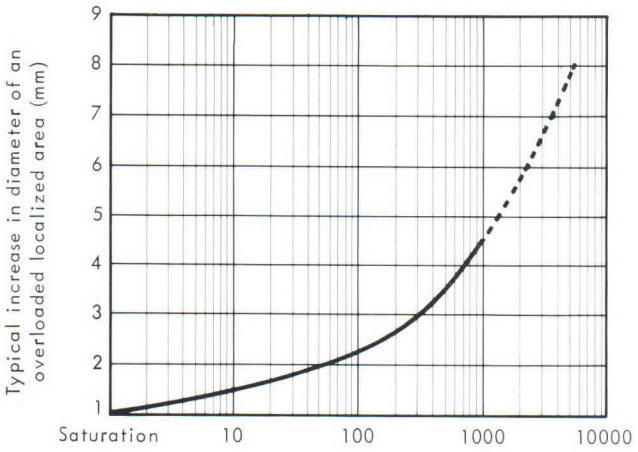


Figure 6 - Typical blooming characteristics.

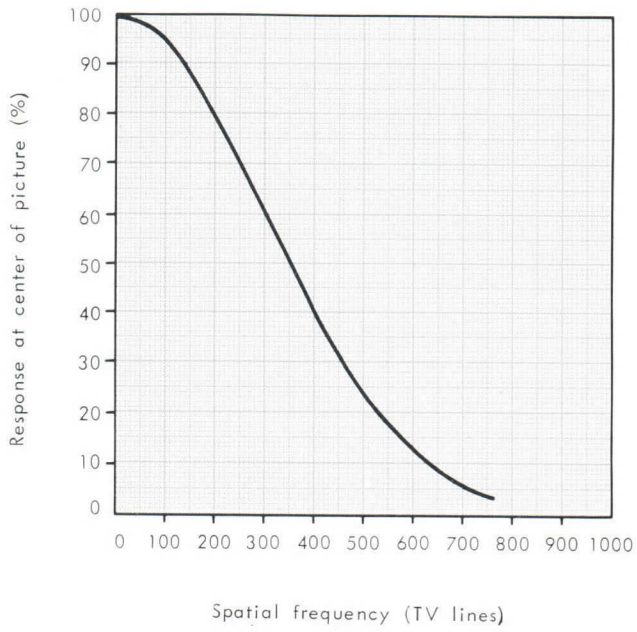


Figure 7 - Typical MTF characteristics with a 100 % contrast vertical bar test pattern.

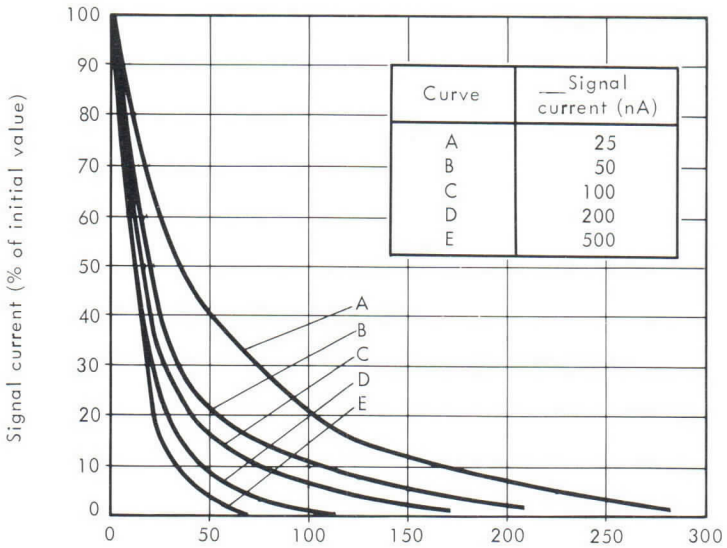


Figure 8 - Typical persistence characteristics.

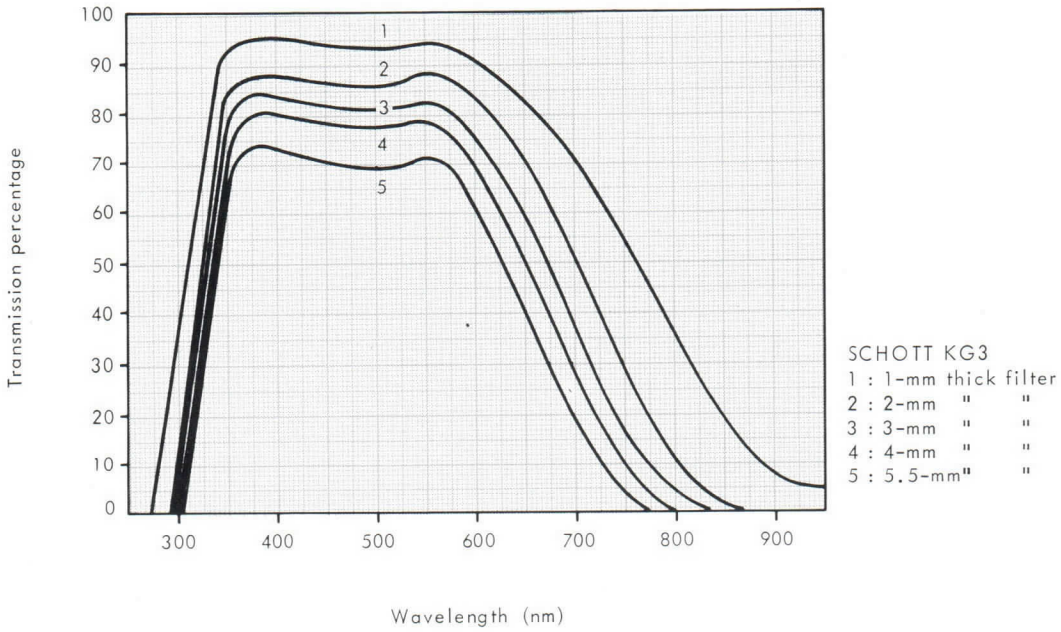


Figure 9 - Typical transmission of SCHOTT KG3 infrared absorbing filters.

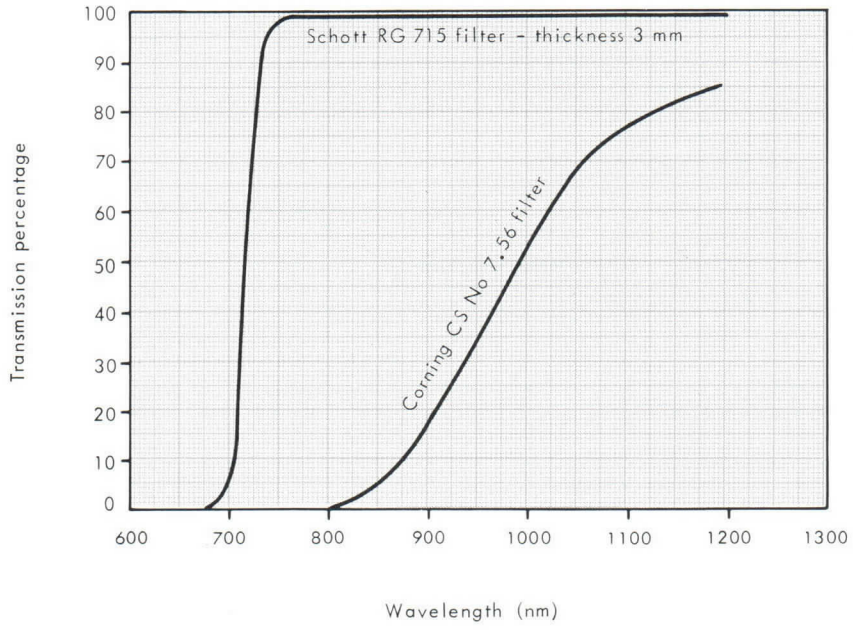
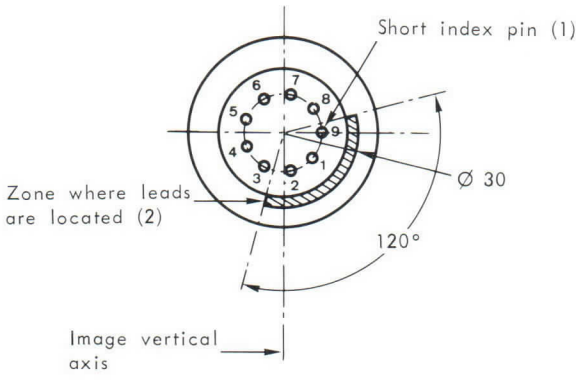
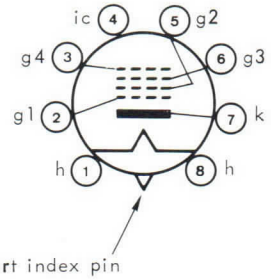


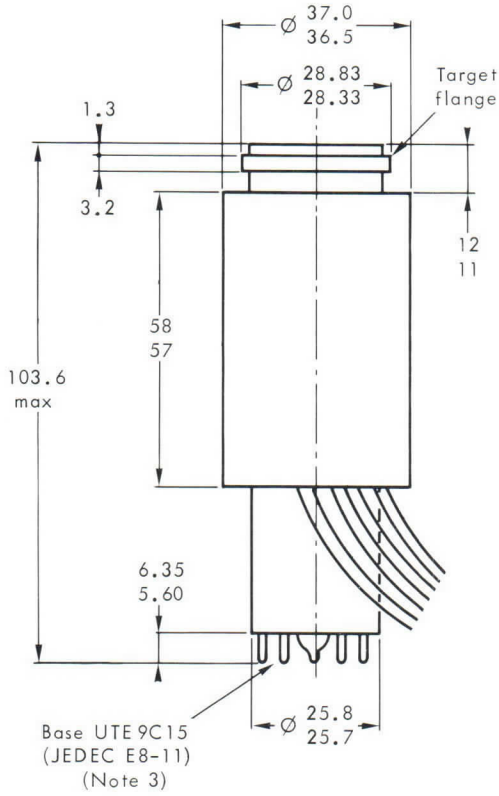
Figure 10 - Typical transmission of SCHOTT RG 715 and CORNING CS 7.56 visible-light absorbing filters.

OUTLINE DRAWING



BASING DIAGRAM
(bottom view)





1 - Heater h	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode k
4 - Internal connection	8 - Heater h

FLYING LEAD COLOR CODE		
Ground	:	Gray
Focus coil	:	Orange (+) Brown (-)
Horizontal deflection	:	Red (+) Black (-)
Vertical deflection	:	Green (+) White (-)

Length of leads : 250

(1) - The orientation of the index pin may be in any position with respect to the image axes.

(2) - The location of this zone may be in any position with respect to the image axes.

(3) - The base complies with JEDEC standard except for pin length.

Dimensions in mm, nominal
unless otherwise indicated

THOMSON-CSF

DIVISION TUBES ELECTRONIQUES

TH 9840

1" PYRICON

INFRA-RED PICK-UP TUBE FOR THERMAL TV

- OPERATING AT AMBIENT TEMPERATURE
- PYROELECTRIC TARGET SENSITIVE TO VERY LOW TEMPERATURE DIFFERENCE
- EXTENDED SPECTRAL SENSITIVITY
- GENERAL CONSTRUCTION SIMILAR TO 1" VIDICON
- ELECTROMAGNETIC FOCUS AND DEFLECTION

MAIN CHARACTERISTICS

- Infra-red sensitive pick-up tube utilizing the thermal radiant energy of bodies.
- Wide spectral sensitivity in the infra-red range ; the sensitivity is in practice limited by the input window transparency. For the TH 9840, it is optimized in the 8000 to 14000 nm band which corresponds to the maximum radiant energy of objects at ambient temperature.
- Minimum resolvable temperature lower than 0.5 °C in the case of a black body at 300 °K (27 °C).
- Electronic scan - Ease of operation.
- Motion retrieval.

TYPICAL APPLICATIONS

Thermal TV gives an additional "dimension" to the daylight or night TV operating in the visible range of the spectrum. It shows information that would not be provided by a conventional camera. Operating at European TV standard (625 lines/50 Hz) or American TV standard (525 lines/60 Hz) the thermal TV is suited to all existing CCTV equipment (or even broadcast TV equipment). It is easy to superimpose or to add thermal to visible information in the displayed image.

Thermal TV permits the observation of objects through light diffusing media such as flames, fog... ; the direct and passive viewing of variation or difference of temperature or emissivity.

In the **industrial field**, thermal TV permits technical inspection of materials, welds, engine components , electric lines, electronic circuits, heat exchangers.

In the **security field**, it permits the detection of fire, fluid leakage, the surveillance of technical installations, intruder detection, camouflage detection.

In the **environment protection field**, it can be used to detect effluents.

In the **medical field**, it is a diagnostic instrument for circulation troubles, burns, healing and diverse lesions.

DESCRIPTION

The TH 9840 Pyricon is an infra-red sensitive pick-up tube which includes a pyroelectric retina one side of which faces the scanning electron beam while the other side is backed by a metal electrode used as the signal electrode.

The general configuration of the tube is similar to a vidicon but it mainly differs by the input window, transparent to infra-red radiation and by the target made out of a thin wafer of pyroelectric material.

In the direction normal to its surface, the target presents a spontaneous polarization which varies as a function of its temperature (pyroelectric effect). When an image is projected through the input window, the incident energy is absorbed in the target and produces local variations of temperature which induce a surface distribution of charges. These charges are compensated by the scanning beam which gives rise to the video signal through capacitive coupling with the signal electrode.

At any point of the target, the reading beam permits the detection of temperature variation between two successive scans. Consequently, a still object at a constant temperature cannot be detected when the target has reached its thermal equilibrium. In this case, it is necessary to chop the infra-red flux by means of a chopper or to permanently displace the image on the target either by modifying the angle of view (panning) or by using an optical device (orbiter).

Temperature variations induce either positive or negative charges in the target depending on the direction of variation (increase or decrease of temperature). In the C.P.S. mode (Cathode Potential Stabilization), the electron beam stabilizes the target face at cathode potential ; so the negative charges cannot be compensated by the electron beam. To neutralize these charges, the retina face is raised to a positive potential between two scans by positive ions. These positive ions are provided by the electron beam which ionizes the molecules of a gas maintained at a certain pressure inside the tube by means of a reservoir. This polarization produces, in the absence of incident radiation, a dark current called pedestal current.

GENERAL CHARACTERISTICS

Electrical

Cathode	unipotential, indirectly heated, oxide coated	
Heater :		
- voltage	6.3	V
- current at 6.3 V	0.15 ± 10 %	A
Gas reservoir :		
- voltage	1 to 4	V
- current, max.	0.5	A
Minimum preheating time	5	mn
Output capacitance (signal electrode to all other electrodes)	< 6	pF
Focusing method	electromagnetic	
Deflection method	electromagnetic	

Optical

Target :		
- minimum useful target diameter	16	mm
- minimum scanning format	18 mm x 24	mm
Orientation of quality rectangle :		
Horizontal scan parallel to the plane passing through the tube axis and short index pin.		
Spectral response	Note 1 and Figure 1	

Mechanical

Input window thickness (germanium)	2.1 ± 0.1	mm
Distance from target to window inner face	1.2 to 1.5	mm
Overall length, max.	165	mm
Outer diameter, max.	29	mm
Bulk diameter, max.	26.7	mm
Base (Ditetrar 8 pins)	UTE 9 C 15 - JEDEC E 8 - 11	
Socket	METOX No. 30520	
Focus and deflection coils	GERHARD No. 200 - 1K1 or equivalent	
Alignment coil	GERHARD No. BV 80/3 or equivalent	
Focus - deflection - alignment coil assembly	THOMSON-CSF No. TH 7200 or equivalent	
Weight, approx.	60 g	
Operating position	any	

OPERATING CONDITIONS

All potentials referred to cathode

Maximum ratings

Heater voltage	max.	7	V
	min.	6. 3	V
Peak heater cathode voltage :			
- heater negative with respect to cathode		125	V
- heater positive with respect to cathode		10	V
Grid g1 voltage :			
- negative bias value		125	V
- positive bias value		0	V
Grid g2 voltage		200	V
Grid g3 voltage		400	V
Grid g4 voltage		500	V
Target voltage (signal electrode)	min.	0	V
	max.	− 10	V
Pedestal current (Note 2)		100	nA
Grid g4 current (Note 2)		15	μA
Gas reservoir voltage (Note 2)	max.	5	V
Maximum irradiance faceplate for continuous operating in the 8000 to 14 000 nm range (Note 3)		40	$W.m^{-2}$
Faceplate temperature (Note 4)	max.	40	°C

Typical operation

Faceplate temperature : 30 °C
Scanning standard : 625 lines interlaced - 25 images/second
Preamplifier bandwidth : 2. 5 MHz at 3 dB
Scanned image format : 18 mm x 24 mm ; scanned area A = 4. 3 cm^2 (Note 5)
Target poling (Note 6 and Fig. 2)

Target voltage		0 to − 5	V
Grid g4 voltage (Note 7)		225 to 275	V
Grid g3 voltage (Note 7)		160 to 200	V
Grid g2 voltage		160	V
Grid g1 voltage : to be adjusted for I_{g4} = 5 μA		− 10 to − 30	V
Picture cut-off	max.	− 20	V
	min.	− 60	V
Minimum blanking peak to peak voltage :			
- applied to g1		− 75	V
- applied to cathode		+ 20	V
Grid g4 current		5	μA
Pedestal current		50	nA

Electro-optical

Under conditions given in Typical Operation

• Average gamma		1	
• Average intrinsic responsivity in the 8000 - 14 000 nm range (Note 8)		⩾ 3. 5	$\mu A.W^{-1}$
• Responsivity uniformity referred to the retina center, measured on centered circles of :			
8 mm diameter (Note 9)		± 12. 5	%
13 mm diameter (Note 9)		± 17. 5	%
• Resolution (Note 10) :			
- limiting, in panning mode ($v \sim 0.4$ $cm.s^{-1}$)		6	lp/mm
- at 50 % modulation :			
in panning mode ($v \sim 0.4$ $cm.s^{-1}$) (Figure 3)		> 2	lp/mm
in transient mode at the first frame		> 2	lp/mm
• Minimum difference of temperature resolved		see Figure 4	

• Signal current :

A tube having an intrinsic responsivity of S = 4 $\mu A.W^{-1}$ submitted to a differential irradiance ΔE_e = 1 $W.m^{-2}$ in the 8000 to 14 000 nm range delivers a signal current of I_s = 1. 7 nA .

With a lens matching the 8000 - 14 000 nm range at F/1 aperture, the signal current is 1 nA for $\Delta\theta$ = 1 °C (in the case of a black body at temperature close to 300 °K).

NOTES

1 - The spectral response of the tube is determined by the transmittance of the input window. For the TH 9840, the transmittance τ is higher than 90 % in the 8000 to 14 000 nm range.

2 - The pedestal current is the difference between the currents in signal electrode when the electron beam scans the mask which borders the retina and the retina itself respectively.

Its value increases when the I_{g4} current and the reservoir voltage increase. It must be sufficient to permit the reading of negative charges which are generated when the target temperature decreases after irradiation is removed.

The value of the pedestal current can be calculated, assuming that the preamplifier characteristics are known, from the pre-amplifier output voltage by line measurement on an oscilloscope.

In normal operating conditions, I_{g4} is 5 μA and pedestal current 50 nA. The voltage to be applied to the reservoir is given in Test Report accompanying the tube.

In order to make the adjustment easier and to obtain better stability in operation, I_{g4} current can be regulated (by action on V_{g1}) and reservoir voltage slaved to the chosen pedestal current (THOMSON-CSF patent).

3 - An irradiance $\Delta E = 40\ W.m^{-2}$ corresponds, for a F/1 lens aperture and $\tau = 0.8$ transmittance, to an exitance of $470\ W.m^{-2}$ i.e. to source temperature of about 85 °C in the case of a black body ($\Delta\theta = 58$ °C).

The tube even out of use and without lens must be protected against intensive infra-red irradiance which could abruptly raise the retina temperature (sun for example).

With its lens, too hot point sources of radiation can also damage the target.

4 - The optimal operating temperature is from 20 °C to 30 °C. For temperatures lower than 20 °C, the tube sensitivity progressively decreases. For temperatures higher than 30 °C, the capacitance of the retina increases which results in excessive lag hence degradation of tube performance. At temperature near to the Curie point (49 °C) of retina material, the sensitivity to radiation (i.e. pyroelectric effect) disappears.

5 - In order to obtain stable operation, the target must be entirely scanned. The format 18 mm x 24 mm is recommended.

The signal current is proportional to scanned area, However increasing this area is not advantageous because lag and increase of video band are the limiting factors.

6 - Before a normal operation, the polarization of the target must be made uniform over its whole surface and oriented in such a way that a temperature increase gives rise to positive charges on the inner face of the retina. This is done by raising the potential of the retina surface to a value of about 150 V higher than that of the backplate during 20 to 30 seconds. The field between the two faces of the retina is then suppressed before returning to the normal operating conditions.

This sequence (poling) can be realized by negatively biasing the cathode-control grid assembly while maintaining the signal electrode at 0 V in order to raise the surface of the retina to a potential near to that of grid g4 through secondary emission ratio $\delta > 1$.

The polarization field must be maintained for 20 to 30 seconds and then suppressed by shifting V_{g4} down to 0 V. After 10 to 20 seconds, the beam current is switched-off and the cathode-control grid assembly potential returns to its normal value. The beam is then switched on and the tube is operative.

7 - The grids g3 and g4 voltages must be adjusted in order to obtain a good image uniformity ; V_{g4} must be higher than V_{g3} so as to avoid a brilliant zone at the center of image.

8 - The intrinsic responsivity is determined by measuring the signal current delivered by the tube 60 ms after irradiance setting ; the zone to be irradiated is limited to a circle of 2 mm diameter centered on the faceplate.

The infra-red flux is in the 8000 to 14 000 nm range and the irradiance $\Delta E = 7$ to $10\ W.m^{-2}$.

The intrinsic responsivity is defined by :

$$S = \frac{Is}{\Delta E.A}$$

with Is = signal current in amperes
ΔE = irradiance on input window in $W.m^{-2}$
A = scanned area in m^2
S = responsivity in $A.W^{-1}$

9 - The measurement of the responsivity uniformity is made at 8 points of 2 mm diameter located at the crossing points of the two circles of 8 mm and 13 mm diameter and two perpendicular axes, one of this axis being parallel to image scanning line.

10 - The resolution is measured as follows :

- in **panning mode** : the image of an infra-red test chart is displaced on the retina at a rate of 0.4 $cm.s^{-2}$; two resolutions are determined : the limiting resolution corresponding to the limit of discernibility and the resolution corresponding to 50 % modulation by using a storage oscilloscope at the preamplifier output.
- in **transient mode** : the still image of an infra-red test chart is projected on the retina through an electronic chopper synchronized to frame scan.
  The modulation of the resulting signal, after 20 ms irradiance, is measured at the preamplifier output by a storage oscilloscope.

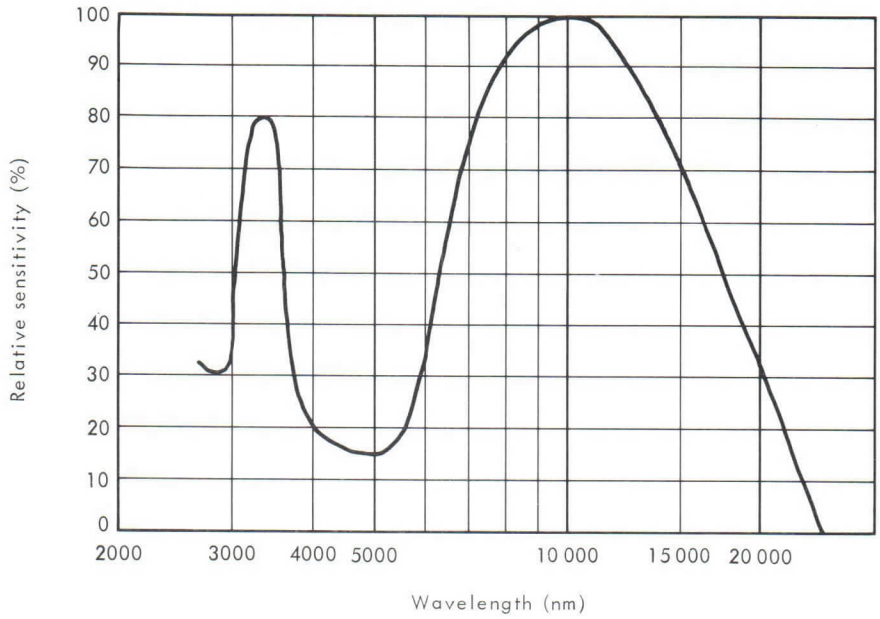


Figure 1 - Spectrale response.

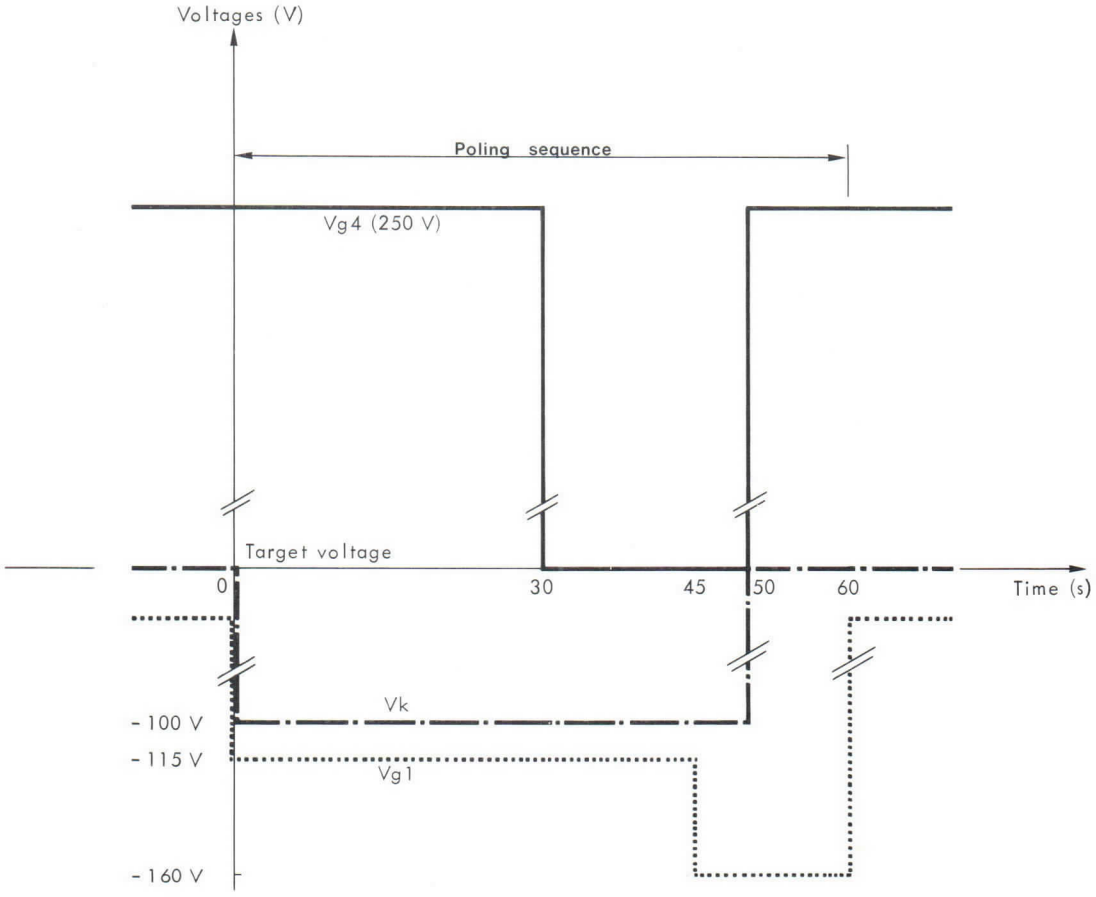


Figure 2 - Poling sequence of a Pyricon with grounded target by k, g1, g4 voltages switching. The grids g3 and g2 voltages are kept constant (Vg3 = 180 V; Vg2 = 160 V).

(Note : The value of Vg1 as compared to Vk is such that the Ig4 current is between 5 and 10 µA).

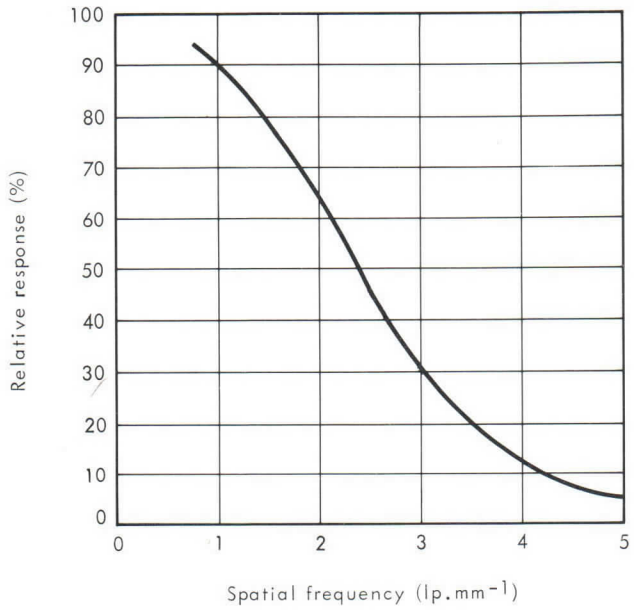


Figure 3 - M.T.F. measured in panning mode v = 0.4 cm.s^{-1}
Scanning standard : 625 lines/25 Hz
Bandwidth : 2.5 MHz

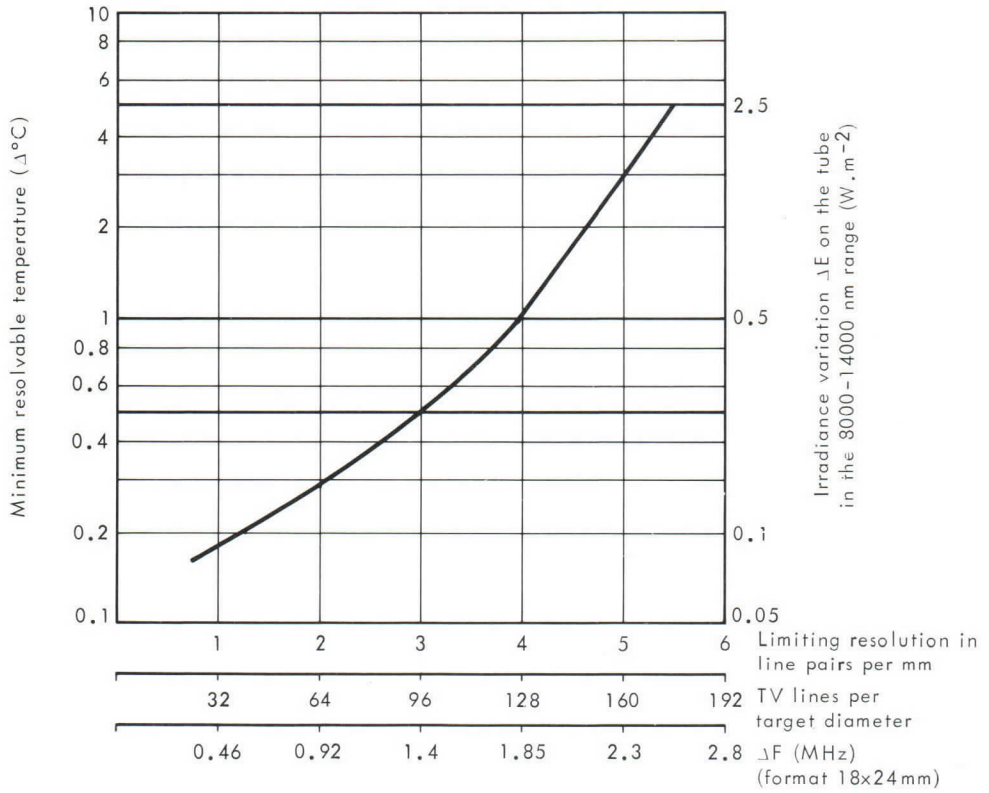
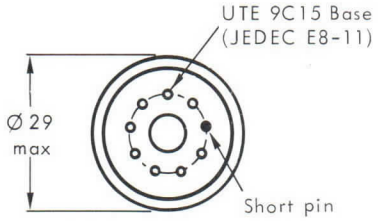
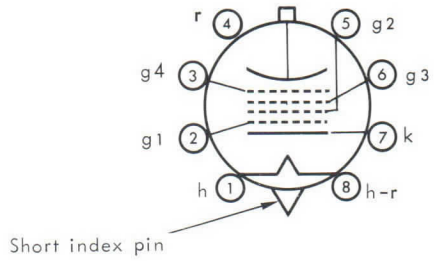


Figure 4 - Minimum resolvable temperature in panning mode (v = 0.4 cm.s^{-1})
Black body near to ambient temperature - F/1 aperture number.

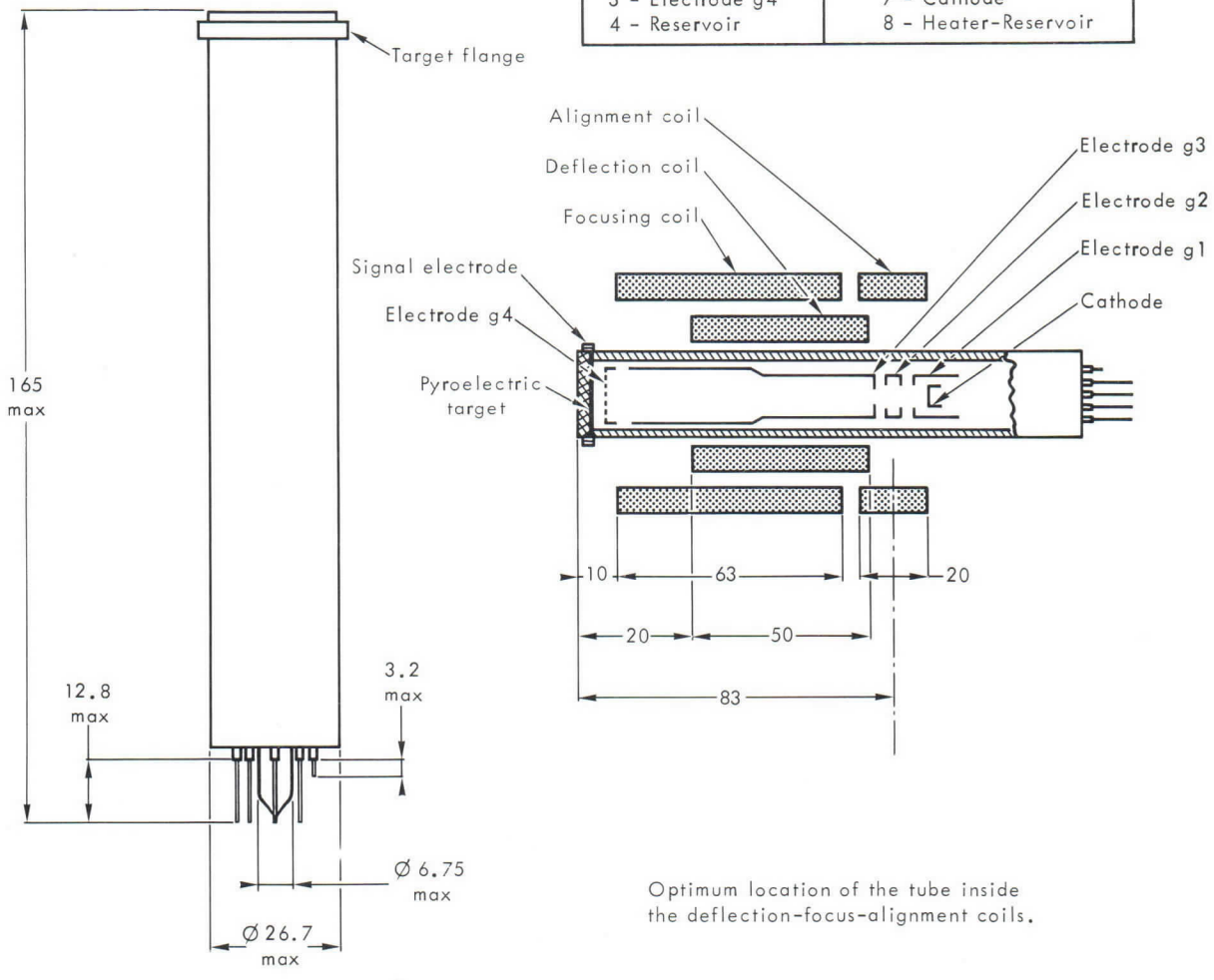
OUTLINE DRAWING



BASING

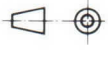


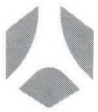
1 - Heater	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode
4 - Reservoir	8 - Heater-Reservoir



Optimum location of the tube inside the deflection-focus-alignment coils.

Dimensions in mm.





THOMSON-CSF

DIVISION TUBES ELECTRONIQUES

TH 9844
1" VIDICON
with integral focusing coil and deflecting yokes

Compact and lightweight :

Length : 100 mm
Diameter : 37 mm
Weight : 190 g

Rugged structure.

Focusing coil and deflecting yokes permanently assembled to the tube.

No need for beam alignment.

High resolution.

Low lag.

The TH 9844 is composed of a short (100 mm), sturdy 1" vidicon and an associated focusing-coil and deflecting-yokes assembly, matched to the camera tube.

The TH 9844, easy to install and to operate, is designed for compact, ruggedized TV cameras featuring high resolution and good uniformity of the video output signal.

Its performance is optimized by factory adjustment of the tube and the associated components, which are permanently attached to the tube.

The printed-circuit, low-impedance yokes also yield good deflection linearity and make the TH 9844 suitable for use in professional or miliraty TV cameras requiring high image quality and good reliability.

The TH 9844 can be optionally provided with a soldered target lead, potted base and connection leads, depending on the specific application.

GENERAL CHARACTERISTICS

Electrical

– TUBE

Cathode	Unipotential, indirectly heated, oxide coated
Heater :	
- voltage	6.3 V
- current at 6.3 V	0.10 A ± 10 %
Minimum preheating time	60 s
Output capacitance (target to all other electrodes)	6.5 pF
Focusing method	Electromagnetic
Deflecting method	Electromagnetic

– FOCUSING COIL - DEFLECTING YOKES

Focusing coil :		
- resistance	70 ± 7	Ω
Horizontal deflecting yoke :		
- resistance	12 ± 4	Ω
- self-inductance	360 ± 30	μH
Vertical deflecting yoke :		
- resistance	12 ± 4	Ω
- self-inductance	350 ± 30	μH

Optical

Target :		
- maximum useful diameter (format 4 x 3)	17	mm
- nominal image dimensions	12. 7 x 9. 5	mm
Spectral response	See Figure 1	

Mechanical

Maximum overall length	101. 6 mm
Maximum outer diameter	37.0 mm
Base (Ditetrar-8 pins) (see the Outline Drawing)	UTE 9 C 15 (JEDEC No. E8-11)
Socket (Note 1)	THOMSON-CSF No. 8192138
Operating position	Any
Weight, approx.	190 g

OPERATING CONDITIONS

(All potentials are referred to grounded cathode)

Maximum Ratings (absolute values)

Operating and storage temperature	max.	+ 70	°C
	min.	–40	°C

– VIDICON

Target voltage		125	V
Electrode g4 voltage (field)		750	V
Electrode g3 voltage (wall)		750	V
Electrode g2 voltage (acceleration)		350	V
Electrode g1 voltage (for picture cutoff) :			
- negative bias value		150	V
- positive bias value		0	V
Cathode k voltage		0	V
Heater voltage	max.	6. 6	V
	min.	6	V
Peak heater-to-cathode voltage :			
- heater negative with respect to cathode		125	V
- heater positive with respect to cathode		10	V
Dark current		0. 20	μA
Peak target current (Note 2)		0. 60	μA
Faceplate illumination		10 000	lux

– COIL AND YOKES

Voltages between coils	250	V
Voltage between coils and ground	250	V
Current in the focusing coil	300	mA
Direct current in each deflecting yoke	0. 5	A
Peak current in each deflecting yoke	1	A

Operational Conditions

– VIDICON

Faceplate temperature (Note 3)		25	°C
Image dimensions on target		12. 7 x 9. 5	mm
Scanning standard		25 images/second, 625 interlaced lines	
Electrode g4 voltage		420	V
Electrode g3 voltage		290	V
Electrode g2 voltage		300	V
Electrode g1 voltage (for picture cutoff) (Note 4)	max.	– 45	V
	min.	– 110	V
Minimum peak blanking voltage :			
- applied to g1		–75	V
- applied to cathode		+ 20	V
Average gamma for target illumination between 1 and 100 lux (Note 5)		0. 65	
Limiting resolution at center of image (Note 6 - Figure 3)		1000 TV lines	
Limiting resolution at corners of image (without dynamic focus)		600 TV lines	
MTF for 400 TV lines at center of image (Note 7 - Figure 3)		60	%
Image distortion		1	%

– COIL AND YOKES

Current in the focusing coil	110 ± 10	mA
Peak-to-peak current in deflecting yokes :		
- horizontal deflection	290 ± 30	mA
- vertical deflection	220 ± 20	mA

Typical Performance

1 - HIGH LIGHT LEVEL OPERATION

(Faceplate illumination = 100 lux)

Dark current i_o	5	nA
Target voltage for i_o = 5 nA (Note 8 - Figure 4)	10 to 25	V
Faceplate illumination (2854 °K) (Note 9)	100	lux
Signal current	300	nA
Lag : (Note 10 - Figure 5) :		
- maximum	15	%
- average	10	%

2 - AVERAGE SENSITIVITY OPERATION

(Faceplate illumination = 10 lux)

Dark current i_o	20	nA
Target voltage for i_o = 20 nA (Note 8 - Figure 4)	20 to 50	V
Faceplate illumination (2854 °K) (Note 9)	10	lux
Signal current	200	nA
Corresponding sensitivity	170	µA/lm
Target illumination for 100 nA signal current	3	lux
Lag : (Note 10 - Figure 5)		
- maximum	20	%
- average	12	%

3 - HIGH SENSITIVITY OPERATION

(Faceplate illumination = 5 lux)

Dark current i_o	50	nA
Target voltage for i_o = 50 nA (Note 8 - Figure 4)	25 to 60	V
Faceplate illumination (2854 °K) (Note 9)	5	lux
Signal current	200	nA
Corresponding sensitivity	300	µA/lm
Target illumination for 100 nA signal current	1. 5	lux
Lag : (Note 10 - Figure 5)		
- maximum	20	%
- average	15	%

4 - VERY HIGH SENSITIVITY OPERATION

(Faceplate illumination = 1 lux)

Dark current i_o	100	nA
Target voltage for i_o = 100 nA (Note 8 - Figure 4)	30 to 70	V
Faceplate illumination (2854 °K) (Note 9)	1	lux
Signal current	100	nA
Corresponding sensitivity	800	µA/lm
Target illumination for 50 nA signal current	0.3	lux
Lag : (Note 10 - Figure 5)		
- maximum	20	%
- average	17	%

SPURIOUS-SIGNAL TEST

Measurement Conditions

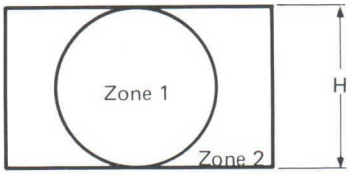
Dark current i_o = 20 nA

Signal current i_s = 200 nA

The tube is adjusted to provide maximum image resolution.

The gain of the video amplifier and the monitor are adjusted to obtain the best image (Note 11).

The test is performed using a uniformly diffused white test pattern that shows two zones, as indicated in the following drawing.



Zone 1 : area inside the circle inscribed in the raster height, H.
Zone 2 : peripheral area.

Spots

Both black and white spots are counted, but actually considered as defects are only those spots having a contrast $C \geqslant 50$ %, in light or in darkness.

The contrast is defined as $C = 100 \times \frac{i_{sb}}{i_s}$ %,

where : i_{sb} = increment in video current due to the spot,
i_s = normal signal current.

D/H* ratio (%) * D : average diameter spot H : raster height	Allowed spots			
	Zone 1	Zone 1 + Zone 2		
		a	a + b	a + b + c
a : 0.8 < D/H ⩽ 1	0	1	3	6
b : 0.6 < D/H ⩽ 0.8	1			
c : 0.2 < D/H ⩽ 0.6	3			

Any numbers of spots having D/H up to and including 0.2 % are allowed unless concentration causes a smudged appearance.

Do not count spots of contrast $C < 50$ %.

Other Defects

Smudges, streaks, mottled or grainy background (black and white) are not considered as defects if their contrast is $C \leqslant 15$ %.

NOTES

1 - THOMSON-CSF - DTE, 38, rue Vauthier - 92100 BOULOGNE-BILLANCOURT - Tel. 604 81 75.

2 - The target current is the total current drawn in the load resistance connected to the target : signal current + dark current ; the dark current is the component existing when the illumination is removed.
The video amplifiers must be designed to handle a peak target current of 1 μA in order to avoid amplifier overload or image distortions.

3 - All characteristics are given for a faceplate temperature of 25 °C, the recommended temperature range being 20 °C to 30 °C.
The rise of the faceplate temperature is determined by the ambient temperature and by the thermal dissipation of surrounding components and of the tube itself.

4 - Without blanking pulses applied to grid g1.

5 - Average gamma is defined as the slope of the rectilinear part of the light transfer characteristics in logarithmic coordinates.

6 - Practically, the limiting resolution corresponds to the resolution measured with a twin-bar test card at 5 % amplitude response.

7 - In 625-lines CCIR Standard, line duration being 52 μs (line suppression period not included), 400 TV lines correspond to 5 MHz.

8 - Indicated range of each type of service serves only to illustrate the operating target voltage range normally encountered. The target voltage for each vidicon must be adjusted to that value which gives the designed operating dark current.

9 - All the above-mentioned illuminations assume a 2854 °K incandescent tungsten source.

10 - The lag is defined as the percentage of the residual signal (measured 60 milliseconds after light excitation removal) to the initial current. This value assumes 50 frames/second scanning rate.

11 - The monitor is adjusted as follows :

- for the pedestal level (black), the luminance of the screen is set at cutoff.
- for the maximum level (white), the gain of the monitor is adjusted to obtain an optimum image depending on image content and ambient light.

Figure 1

TYPICAL SPECTRAL SENSITIVITY CHARACTERISTICS

For equal values of signal current at all wavelengths (0.2 μA signal current and 0.02 μA dark current for scanned area of 12.7mm x 9.5mm)

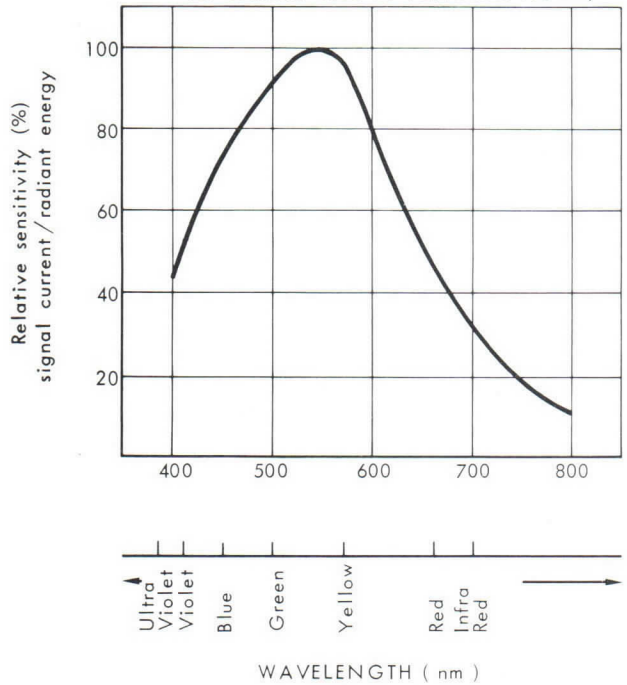
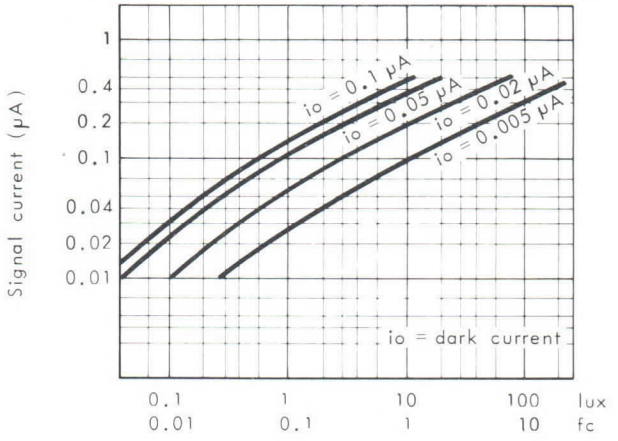


Figure 2

LIGHT TRANSFER CHARACTERISTICS

Illumination uniform over photoconductive layer-scanned area 12.7mm x 9.5mm - face plate temperature 25° C



Illumination in lux and foot candles

Figure 3

MODULATION TRANSFER FUNCTION

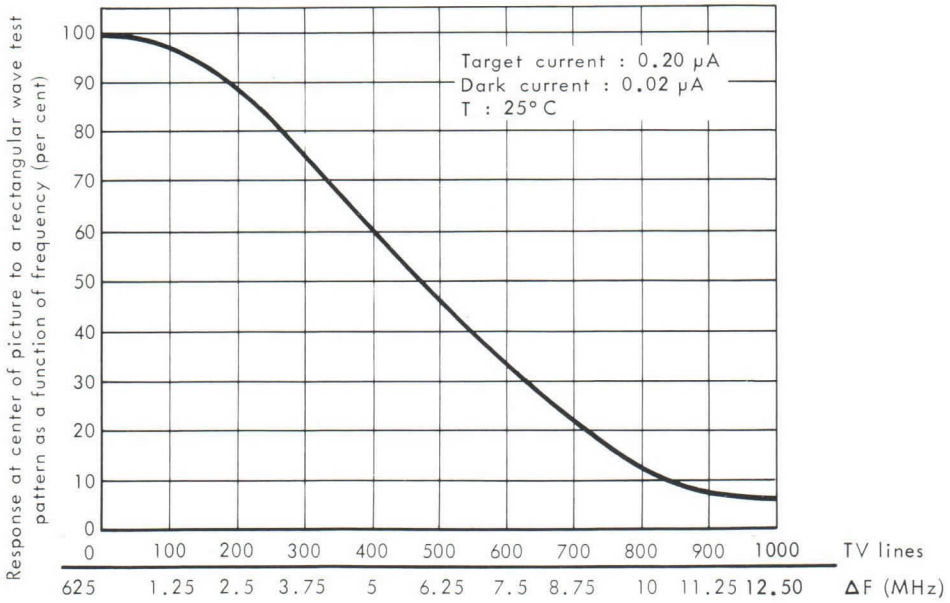


Figure 4

RANGE OF DARK CURRENT

Scanned area of photoconductive layer 12.7mm x 9.5mm

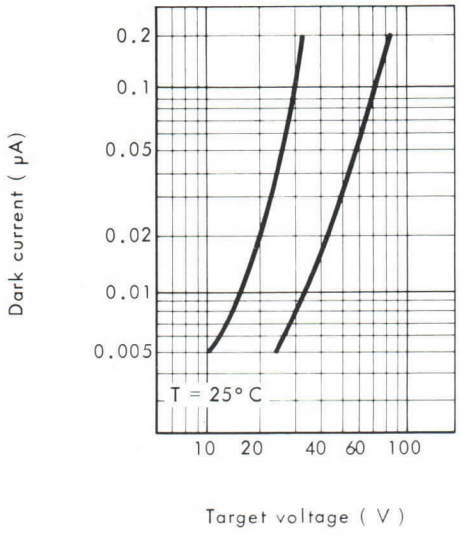
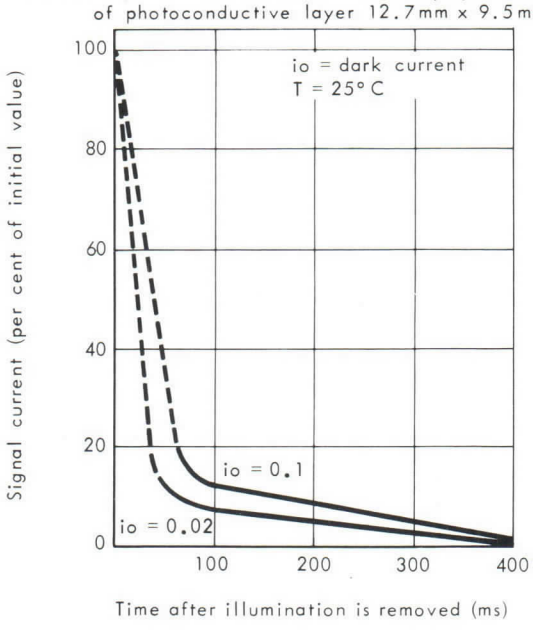


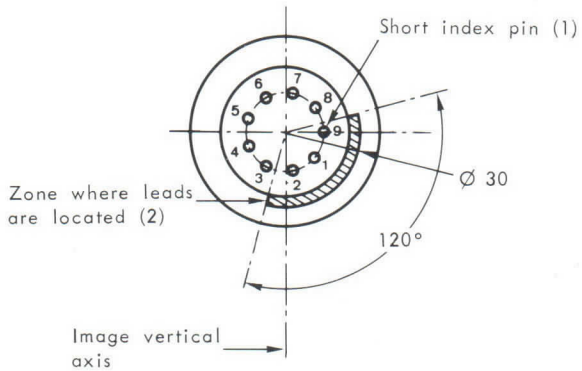
Figure 5

TYPICAL PERSISTENCE CHARACTERISTICS

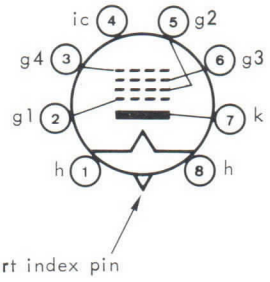
Initial highlight signal current of 0.2 µA, scanned area of photoconductive layer 12.7mm x 9.5mm

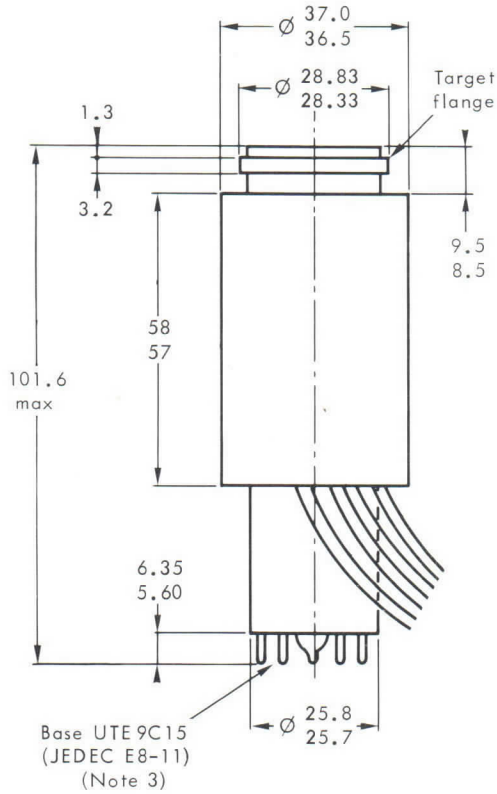


OUTLINE DRAWING



BASING DIAGRAM
(bottom view)





1 - Heater h	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode k
4 - Internal connection	8 - Heater h

FLYING LEAD COLOR CODE		
Ground	:	Gray
Focus coil	:	Orange (+) Brown (-)
Horizontal deflection	:	Red (+) Black (-)
Vertical deflection	:	Green (+) White (-)

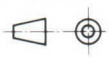
Length of leads : 250

(1) - The orientation of the index pin may be in any position with respect to the image axes.

(2) - The location of this zone may be in any position with respect to the image axes.

(3) - The base complies with JEDEC standard except for pin length.

Dimensions in mm, nominal
unless otherwise indicated



THOMSON-CSF

DIVISION TUBES ELECTRONIQUES

TH 9890
1" VIDICON

- HIGHLY SENSITIVE TO INFRA-RED RADIATION
- UP TO 2 MICRONS WAVELENGTHS
- MAGNETIC FOCUS AND DEFLECTION

TH 9890 is a television camera tube of Vidicon type, the threshold wavelength of which extends over 2 μm. It is suitable both for television operation in infra-red light and for observing hot bodies.

The sensitivity of Vidicon TH 9890 is sufficient to image objects at 200 °C by their own thermal radiation ; it can thus be used to measure temperature and to observe its distribution.

Other interesting applications of TH 9890 are : measurement of the emission coefficient of a radiator, observation of dislocation and homogeneity in silicon and germanium, viewing of laser patterns, observation of hydrogen flames in sunlight, infra-red night-vision instruments. TH 9890 can be used in any television camera which is suitable for the operation of conventional 1" Vidicon.

GENERAL CHARACTERISTICS

Electrical

Heating	unipotential cathode indirect
Heater voltage	6.3 ± 10 % V
Heater current	0, 15 A
Spectral response	see curves
Focusing method	magnetic
Deflection method	magnetic

Mechanical

Base	ditetrar 8 pins (JEDEC E8 - 11)
Socket	metox - 30.250
Dimensions	see drawing
Photoconductive layer :	
- normal dimensions of image on target	12, 7 x 9, 5 mm
- maximum useful diagonal diameter (4 x 3 aspect ratio).	17 ' mm
- orientation of quality rectangle : horizontal scan parallel to the plane passing through the tube axis and short index pin	

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OPERATING CONDITIONS

Maximum ratings

Scanned area : 12. 7 x 9. 5 mm.

Signal electrode voltage	125	V
Grid n° 4 and grid n° 3 voltage	350	V
Grid n° 2 voltage	350	V
Grid n° 1 voltage :		
- negative bias value	125	V
- positive bias value	0	V
Peak heater-cathode voltage :		
- heater negative with respect to cathode	125	V
- heater positive with respect to cathode	10	V
Dark current	0. 05	µA
Faceplate :		
illumination	500 lux - 1000 IR lux (1) or 50 f.c. - 100 IR f.c.	
temperature	60	°C

Typical operation

Grid n° 3 connected to grid n° 4
Scanned area : 12. 7 x 9. 5 mm
Faceplate temperature : 25 to 35 °C

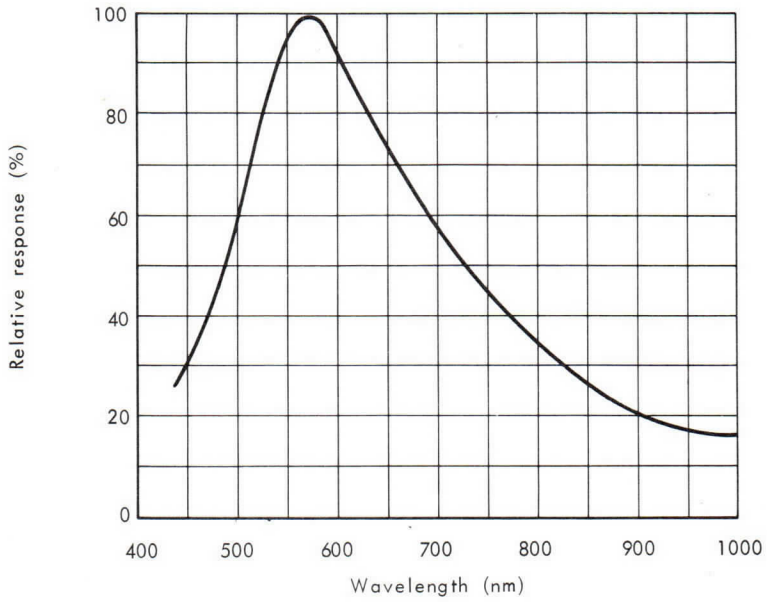
Signal electrode voltage	40 to 100	V
Grid n° 3 and grid n° 4 voltage	250 to 300	V
Grid n° 2 voltage	300	V
Grid n° 1 voltage	–45 to –100	V
Signal output current at 10 IR lux 1 IR f.c.	0. 07 to 0. 20	µA
Dark current	0. 001 to 0. 005	µA
Minimum blanking peak to peak voltage :		
- when applied to grid n° 1	40	V
- when applied to cathode	10	V
Field strength at centre of focusing coil	40	Gauss
Field strength of alignment coil	0 to 4	Gauss

NOTE

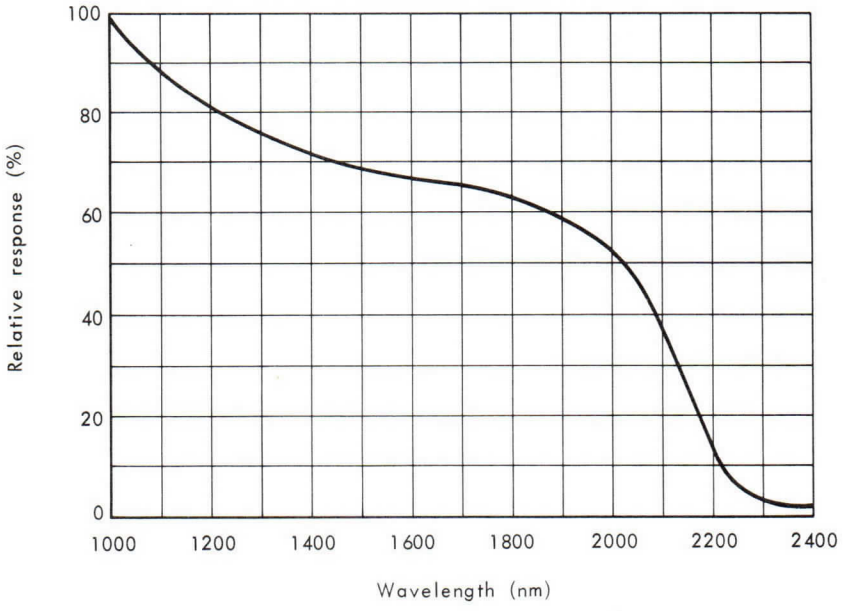
1 - *1 IR. lux is defined as the infra-red illumination intensity through an infra-red filter where illumination intensity from a tungsten lamp of colour temperature 2854 °K is 1 lux.*
Spectral transmittance of filter :

0 % at 800 nm
60 % at 1000 nm
85 % from 1300 nm to 2400 nm

SPECTRAL RESPONSE
(visible and near infra-red region)

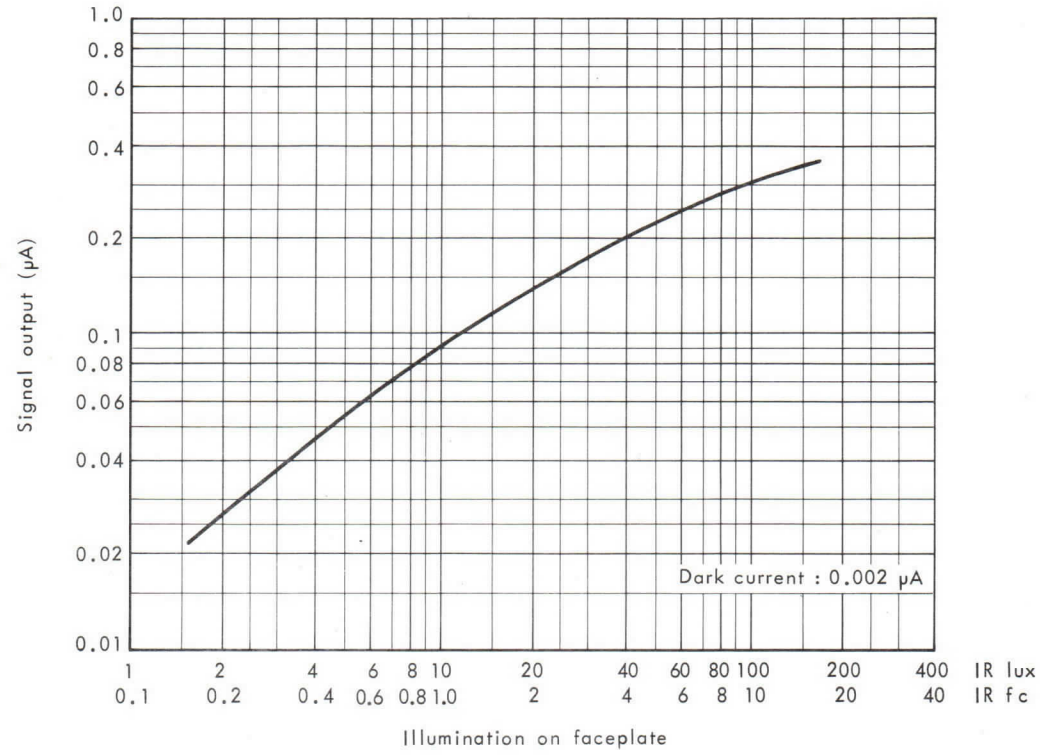


(infra-red region)

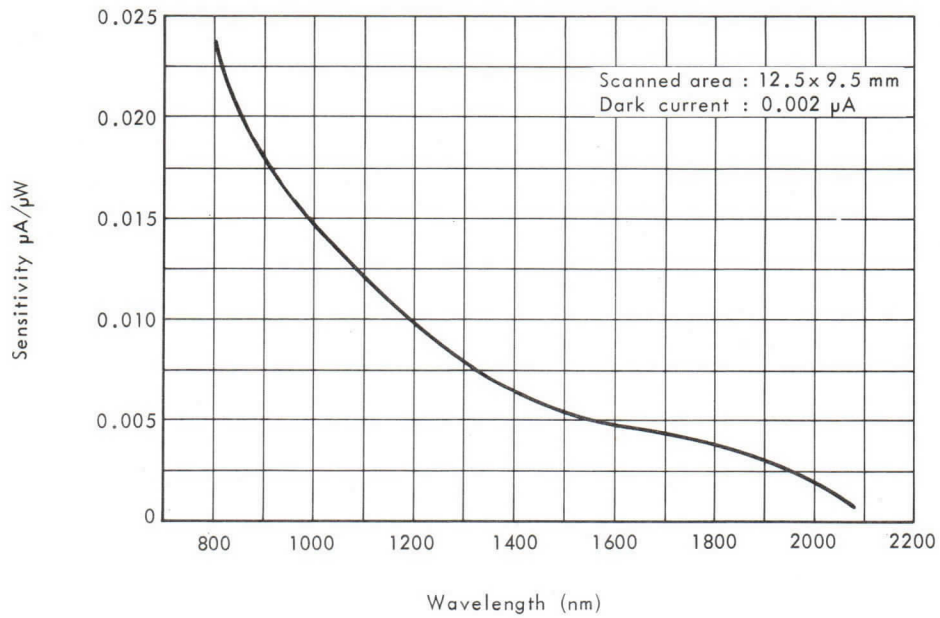


THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

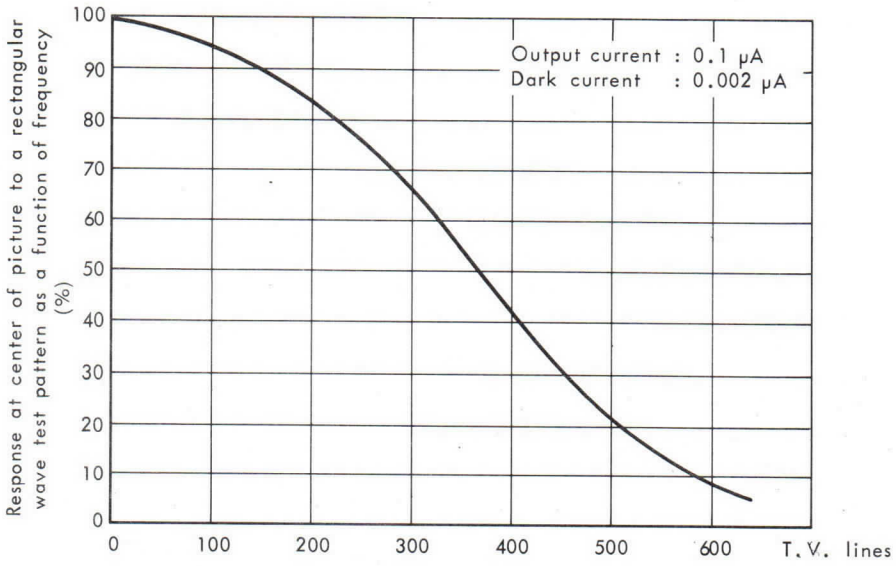
LIGHT TRANSFER CHARACTERISTICS



SPECTRAL SENSITIVITY

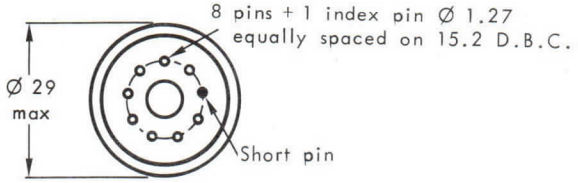


MODULATION TRANSFER FUNCTION

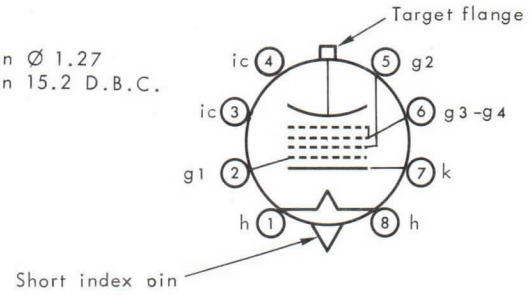


THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

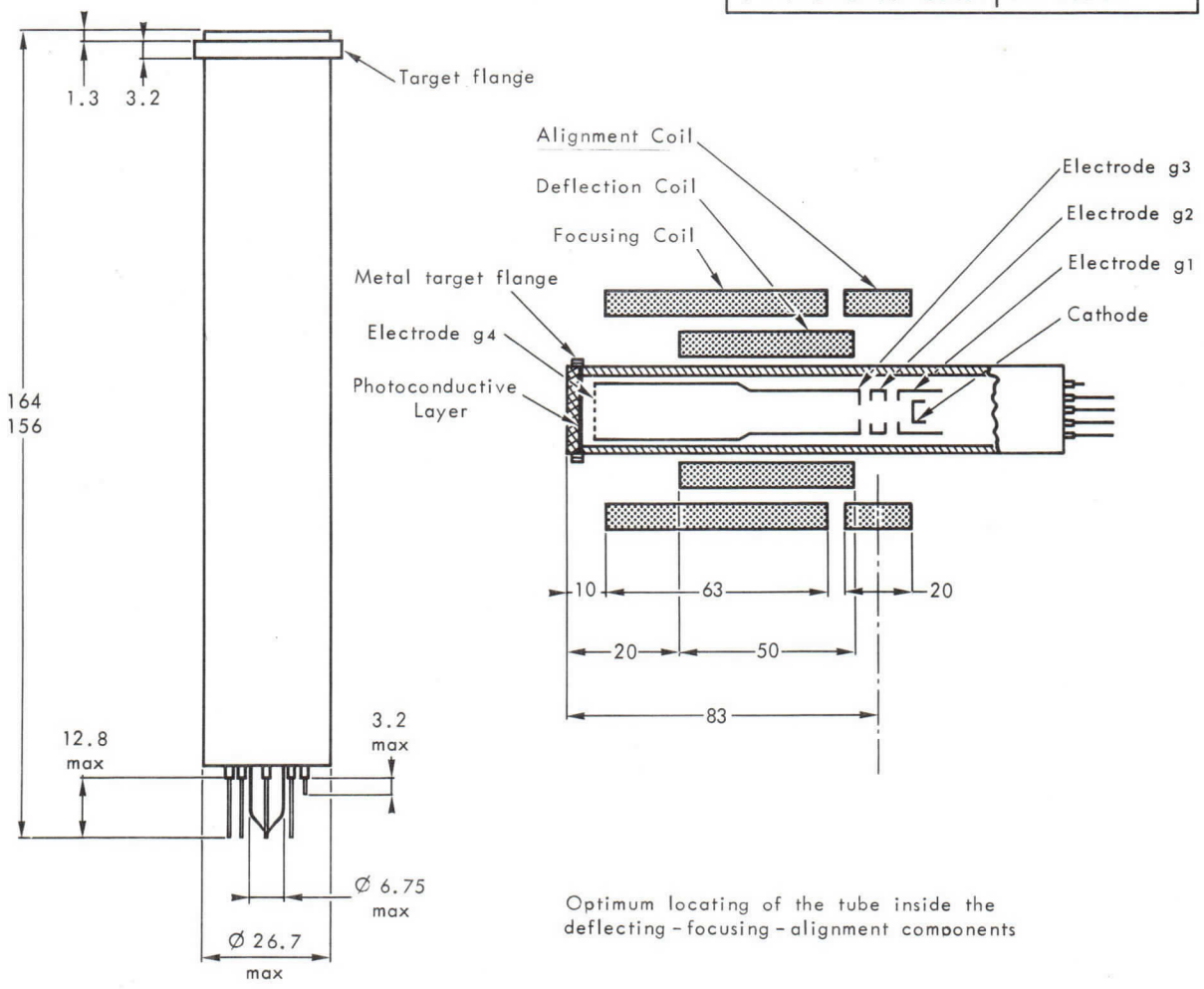
OUTLINE DRAWING



BASING DIAGRAM



1 - Heater	5 - Electrode g2
2 - Electrode g1	6 - Electrodes g3g4
3 - Internal connection	7 - Cathode
4 - Internal connection	8 - Heater



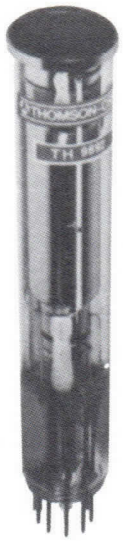
Optimum locating of the tube inside the deflecting - focusing - alignment components

Dimensions in mm.

TH 9892
1" VIDICON

- MAGNETIC FOCUS AND DEFLECTION
- HIGH RESOLUTION (1000 T.V. LINES)
- NORMAL SENSITIVITY
- EXCELLENT LIGHT INTEGRATION
- FOR SLOW SCAN OR DELAYED READOUT

The TH 9892 is a photoconductive camera tube of the Vidicon type designed for narrow bandpass transmission where the tube is scanned at low frame rate. It permits also integration and storage of input image information and delayed signal readout after a more or less long period of storage.



The TH 9892 includes a photoconductive target made with a high electrical resistivity material which allows for a relaxation time large enough to permit frame scan period of several seconds. When operated at 25 images per second, tube sensitivity is equivalent to that of Vidicon TH 9808 (250 μA/lumen). At slow scanning rate, its sensitivity is about the same and signal current is a linear function of exposure time ; so, a signal current of 20 nA can be obtained for an exposure of 1 lux.s. (0.1 fc.s.). A good quality image is obtained within a dynamic range of 10^{-2} to 10 lux.s. (10^{-3} to 1 fc.s.) for scanning rate of 1 to some tens seconds. The gamma near to 1 allows for a very good integration of charges and the tube output current is found to remain approximately constant, at a given readout rate, if the product of target illumination and exposure time is constant.

The very high resistivity of the photoconductive layer permits also to maintain useful resolution for long storage of gathered charges.

Due to these characteristics, TH 9892 is particularly well suited for slow scan operation including three sequences : a short exposure time, a storage period and a long period of signal generation allowing for a high signal to noise ratio corresponding to narrow band-pass. Readout can be made immediately after the exposure time or delayed. The three sequences (exposure, storage, readout) can be recurrent or intermittent. For recurrent operation, the response rate of the photoconductive layer is satisfactory and similar to that obtained for 25 images/second scanning. For intermittent operation, in which an apparent decrease of sensitivity is observed, an erasure preceding a new exposure can be necessary to diminish the residual signal.

Due to these characteristics, TH 9892 is well adapted for slow or very slow scan pick-ups requiring a high resolution, such as for space applications. TH 9892 is also suited for narrow band-pass transmission (data transmission in which high signal to noise ratio is imperative) or very narrow band-pass (transmission of video information over telephone lines).

The excellent light integration and storage characteristics make the Vidicon TH 9892 ideal for televising at low light levels. The light from poorly illuminated scenes is gathered over a period of time and thus serves to increase output signal while a good resolution capability is maintened.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

GENERAL CHARACTERISTICS

Electrical

Cathode	for unipotential cathode indirectly heated	
Heater :		
- voltage	6.3	V
- current at 6.3 V	0.135 to 0.165	A
Minimum preheating time	60	s
Output capacitance :		
- signal electrode to all other electrodes	4.5	pF
Spectral response	see curve	
Focus mode	electromagnetic	
Deflection mode	electromagnetic	

Mechanical

Overall length max.	164 mm (6.46")	
Overall diameter max.	29 mm (1.14")	
Bulb diameter max.	26.7 mm (1.03")	
Base (Ditetrar, 8 pins)	UTE 9 C 15 (JEDEC N° E8 - 11)	
Socket (note 1)	METOX N° 30.250	
Deflecting yoke - Focusing coil assembly (note 2)	GERHARD type BV 200 - 1k1	
Alignment coil (note 2)	GERHARD type BV 80/3	
or Deflecting yoke - Focusing coil - Alignment coil assembly (note 2).	CLEVELAND type VYFA - 355.2 or equivalent	
Photoconductive layer :		
- maximum useful image diameter (4 x 3 aspect ratio)	16	mm
- rectangular frame, max.	9.5 mm x 12.7 mm	
- square frame, max.	11 mm x 11	mm
- orientation of quality area : horizontal scan parallel to plane passing through the tube axis and short index pin (note 3)		
Operating mounting	any	
Net weight, approx.	60 g	

OPERATING CONDITIONS

(all potentials are referred to cathode)

Maximum ratings : *(absolute values)*

Electrode g4 (post-acceleration electrode)	1 000	V
Electrode g3 voltage (wall electrode)	1 000	V
Electrode g2 voltage (accelerator)	350	V
Electrode g1 voltage (electrode for picture cut-off) :		
- negative bias	150	V
- positive bias	0	V
Heater voltage max.	6.9	V
min.	5.7	V
Filament-cathode peak voltage :		
- filament negative with respect to cathode	125	V
- filament positive with respect to cathode	10	V
Target voltage	30	V
Dark current (image period : 40 ms)	5	nA
Peak target current (image period : 40 ms) (note 4)	300	nA
Faceplate :		
- exposure	250	lux.s
	or 25	fc. s
- temperature (storage and operating)	−10 to + 50 °C	

Operationnal conditions

Scanned area : 9. 5 mm x 12. 7 mm
Faceplate temperature : 25 °C (note 5)

Electrode voltage modes :	Low	Intermediate	High	
Electrode g4 voltage	300	450	750	V
Electrode g3 voltage	180	300	500	V
Electrode g2 voltage	300	300	300	V
Electrode g1 voltage (note 6)	−45 to −100	−45 to −100	−45 to −100	V
Average "gamma" for target illumination : 1 to 100 lux. (0.1 to 10 fc.) (note 7)	0. 95	0. 95	0.95	
Minimum blanking peak to peak voltage :				
- applied to g1 electrode	−75	−75	−75	V
- applied to cathode	+20	+20	+20	V
Limiting resolution at center of picture (note 8).	600	800	1 000	TV lines
Limiting resolution at corners	400	600	800	TV lines
M.T.F. response for 500 TV lines at center of picture (note 9)	20	40	50	%
Focus magnetic field	30 ± 2	40 ± 2	50 ± 2	Gauss
Deflecting coil peak current :				
- horizontal	130	170	200	mA
- vertical	15	20	24	mA
Alignment field	0 to 4	0 to 4	0 to 4	Gauss

Typical performance *

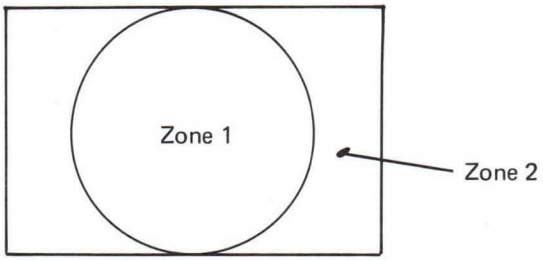
Faceplate temperature	25	°C
Readout time T_i (note 10)	1	s
Exposure time T_e	100	ms
Operating mode	recurrent	
Dark current	0. 4 to 0. 8	nA
Signal electrode voltage (note 11)	30	V
Exposure	1	lux.s.
	or 0. 1	fc.s
Signal current	20	nA
Average gamma between 0. 05 lux.s and 5 lux.s. (0. 005 fc.s and 0. 5 fc.s)	0. 9 to 1	

* IMPORTANT - *These values correspond to a given operating mode. For particular application, please consult THOMSON - CSF.*

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

SPURIOUS SIGNAL TEST

The test is performed using a uniformly diffused white test pattern that is separated into two zones as shown in drawing.



The tube is operated under "Typical Operation" with target voltage of 30 V and the lens adjusted to provide a signal current of 200 nanoamperes in standard TV (625 C.C.I.R.).

Spurious signals are classified by their size which is measured in percent of raster height.

Will actually be considered as defects, blemishes of contrast greater than 50% (note 12).

Allowable spot size for each zone is shown in table :

*Ratio D / H (Percent raster height)	Number Allowed			
	Zone 1	Zone 1 + Zone 2		
		a	a + b	a + b + c
a : 0.8% < D/H ⩽ 1%	0	1	3	6
b : 0.6% < D/H ⩽ 0.8%	1			
c : 0.2% < D/H ⩽ 0.6%	3			

0.2 % and under : do not count spots of this size unless concentration causes a smudge appearance

* D : average diameter of spot

H : raster height

Smudges, streaks, mottled or grainy background having a contrast ratio greater than 15% constitute a reject.

NOTES

1 - METOX - 86, rue de Villiers de l'isle Adam - PARIS 20ème - Téléphone : 636. 31-10.

2 - GERHARD KG - REICHELSHEIM/ODW Germany.
CLEVELAND ELECTRONICS Inc. - 2000 Highland Road - TWINSBURG - OHIO 44 - 087.

3 - It is necessary to assure correct positioning of the tube inside the coils. An immediate test consists in observing the fine mesh grid, the wires of which should be inclined 45° with respect to scanning. Then again the front end of the deflecting yoke should be positioned at 20 mm from the tube faceplate.

4 - Target current is defined as total current in load resistance connected to target electrode : signal current plus dark current, dark current being the current left when illumination is subtracted.
Video amplifiers must be designed properly to handle peak target current of 0.3 μA to avoid amplifier overload and picture distortion.

5 - All these characteristics are provided for a temperature of faceplate of 25 °C, the temperature range recommended is within 20 to 30 °C. The rise of faceplate temperature is a function of ambient temperature, thermic dissipation of ambient devices and of the tube itself. Consequently, 10 °C of faceplate temperature rise implies a dark current multiplied by a factor of 2.

6 - Without blanking pulses applied on electrode g1.

7 - Average "gamma" should be defined as the slope of the rectilinear part of transfer characteristics in log coordinates.

8 - Pratically, limiting resolution corresponds to the resolution measured with twin bar test card with a modulation ratio of about 7 %.

9 - For 625 lines C.C.I.R. standard, line duration being 52 μs (line suppression period not included), 500 TV lines correspond to 6. 25 MHz.

10 - For readout time between 1 and 100 s, dark current and signal current are approximately inversely proportional to this time.

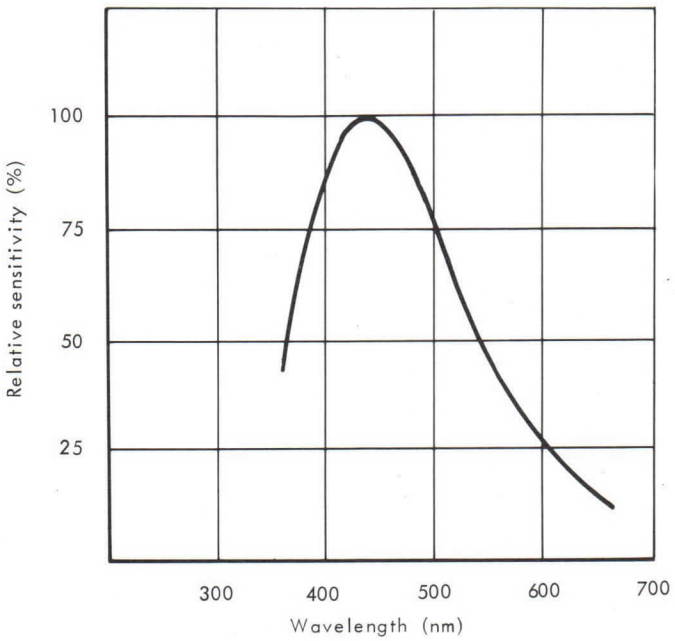
11 - The signal electrode voltage is adjusted for maximum sensitivity. The corresponding value Vsm is the voltage that generally gives rise to white spots visible in darkness. It is advisable to operate with a voltage of 5 V below Vsm.

12 - Contrast is defined as : $100 \times \frac{\text{increment in video current due to blemish}}{\text{normal signal current}}$

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

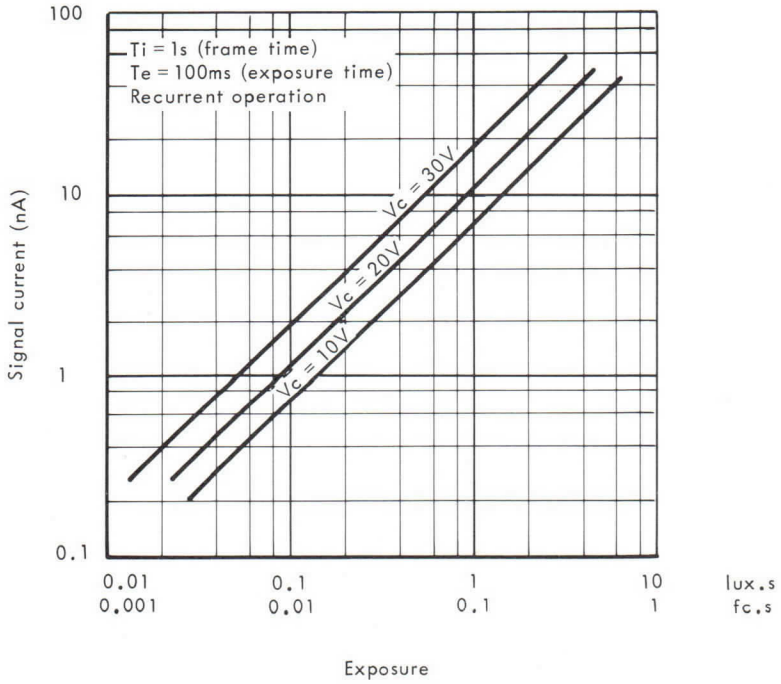
- Figure 1 -

SPECTRAL RESPONSE



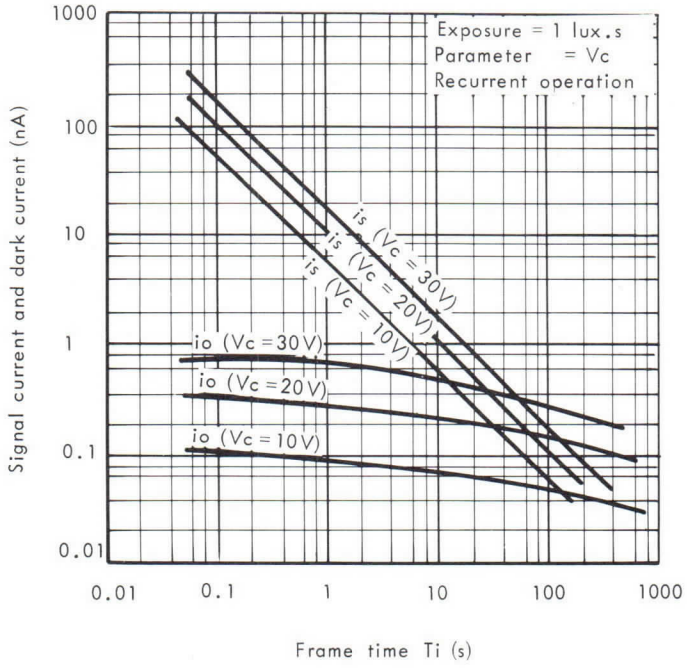
- Figure 2 -

LIGHT TRANSFER CHARACTERISTICS



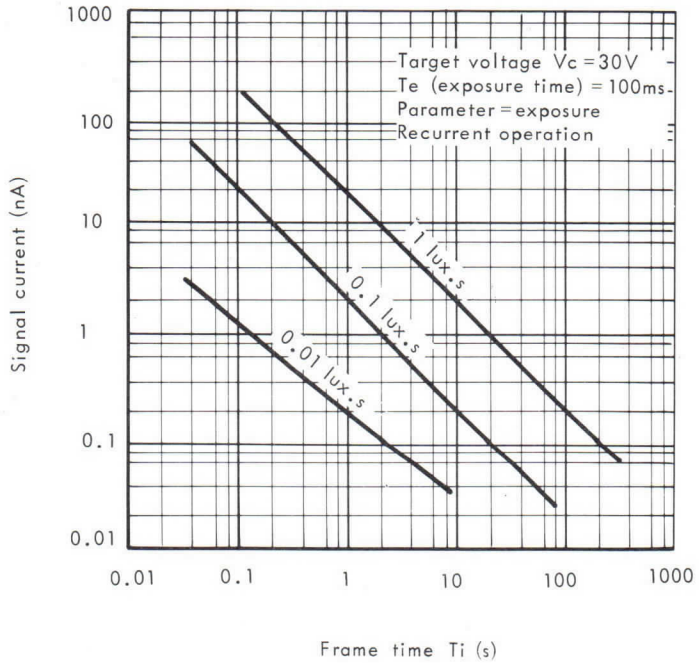
- Figure 3 -

CHARACTERISTICS OF SIGNAL CURRENT AND DARK CURRENT VERSUS FRAME TIME (Ti) FOR DIFFERENT VALUES OF SIGNAL ELECTRODE VOLTAGE (Vc)



- Figure 4 -

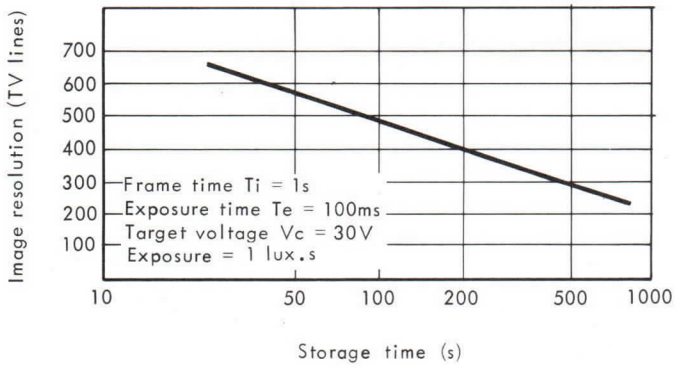
CHARACTERISTICS OF SIGNAL CURRENT VERSUS FRAME TIME (Ti) FOR DIFFERENT VALUES OF EXPOSURE



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

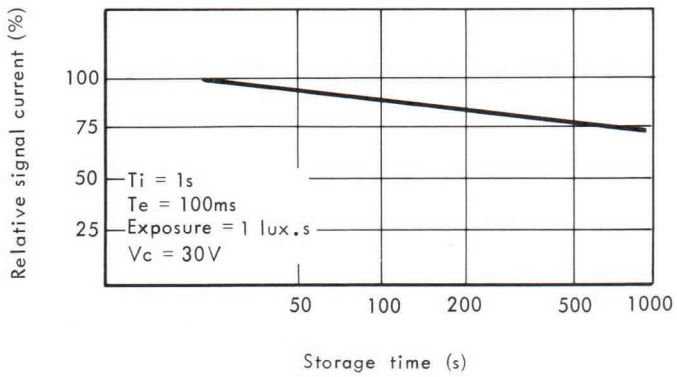
- Figure 5 -

RESOLUTION CHARACTERISTICS VERSUS STORAGE TIME



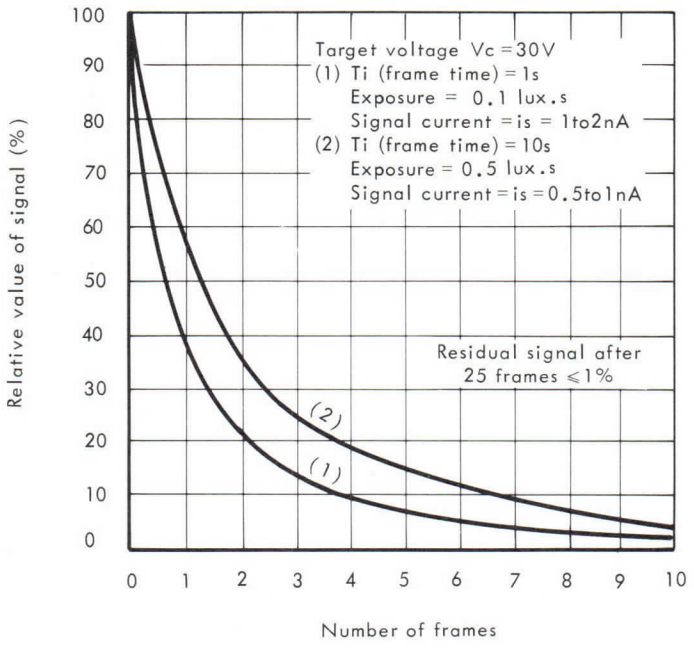
- Figure 6 -

TYPICAL RELATIVE SIGNAL CURRENT VERSUS STORAGE TIME



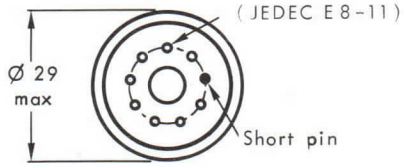
- Figure 7 -

RESIDUAL SIGNAL IN PER CENT OF INITIAL SIGNAL CURRENT
VERSUS NUMBER OF SCANNING FRAMES

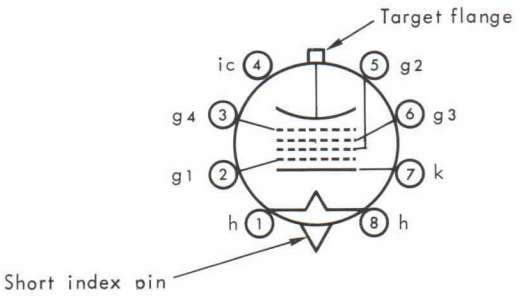


THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

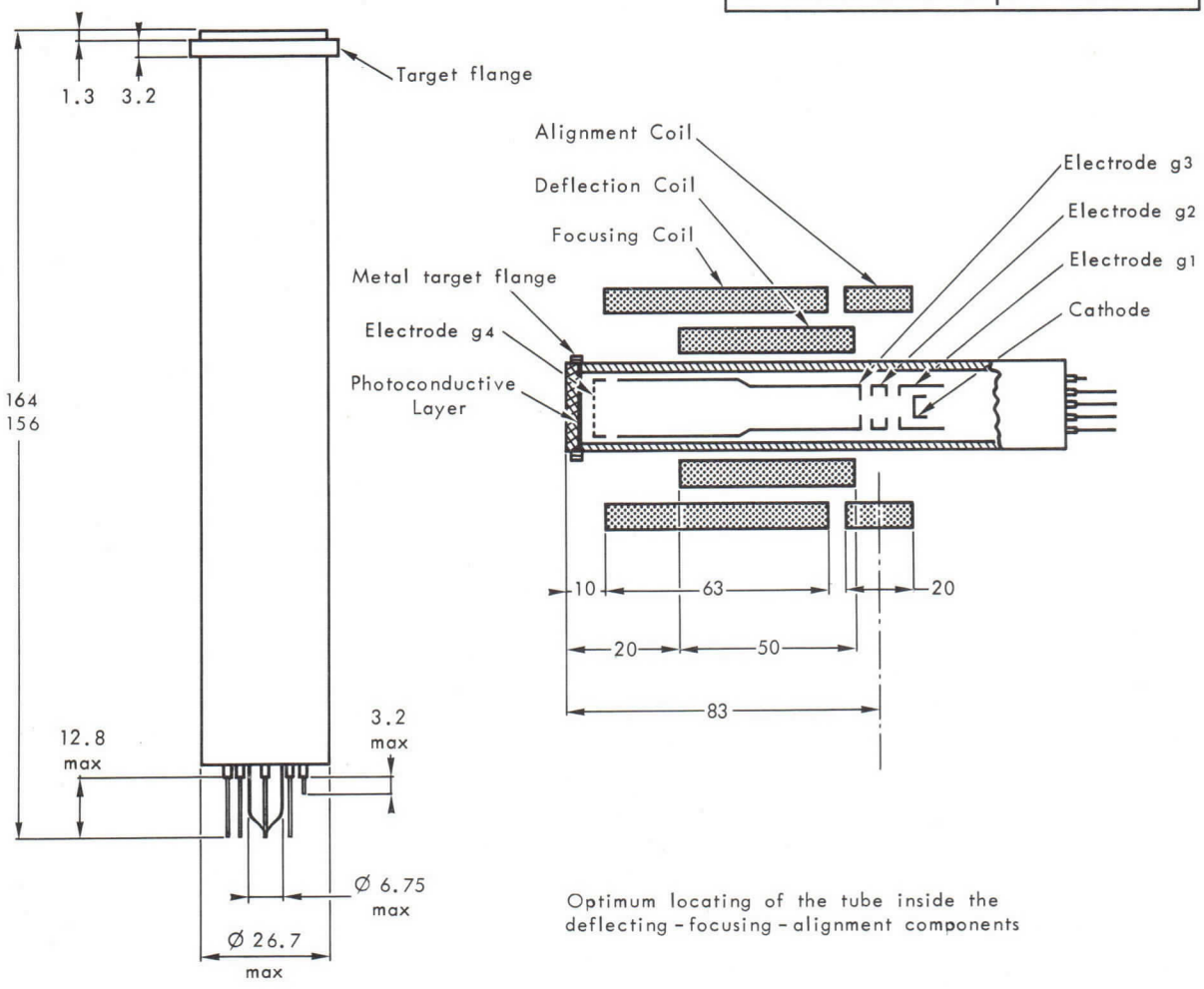
OUTLINE DRAWING



BASING DIAGRAM



1 - Heater	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode
4 - Internal connection	8 - Heater



Optimum locating of the tube inside the deflecting - focusing - alignment components

Dimensions in mm.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PROVISOIRE

TH 9893
VIDICON 1" A MEMOIRE
LECTURE EN 1 TRAME

- CONCENTRATION ET DEVIATION ELECTROMAGNETIQUES
- TEMPS D'INSCRIPTION ET D'EFFACEMENT BREFS
- TEMPS DE MEMOIRE : PLUSIEURS JOURS
- RESOLUTION : 600 LIGNES T.V.

Le TH 9893 est un vidicon permettant la mise en mémoire d'une image optique pendant plusieurs jours sous forme de charges électriques sans altération notable de résolution.

Ce tube possède une grande sensibilité d'inscription, des temps d'effacement et d'inscription brefs.

Ces caractéristiques rendent le tube adapté à la retransmission différée d'images instantanées.

Possédant une structure et une optique électronique semblables à celles d'un vidicon de 26 mm (1") le TH 9893 peut être utilisé avec les sources de tension, les bobines de concentration et de déviation servant pour le vidicon de 26 mm.

PERFORMANCES TYPIQUES

Courant de signal maximal	0, 2	µA
Temps d'inscription sur la surface entière de la cible	0, 2	s
Temps d'effacement :		
effacement de la totalité de l'image inscrite à moins de 10% résiduel	40	ms
Temps de mémoire sans lecture	plusieurs jours	
Temps de lecture	1	trame
Sensibilité : lumination pour l'obtention d'un signal de 0, 1 µA	2	lux.s
Résolution :		
initiale	600	lignes TV
après mémorisation (24 h)	500	lignes TV

CARACTERISTIQUES GENERALES

Electriques

Tension filament	6, 3	V
Courant filament	0, 15	A
Capacité de sortie	4, 5	pF
Mode de concentration	électromagnétique	
Mode de déviation	électromagnétique	

Mécaniques

Embase	(JEDEC E8 – 11) UTE 9 C 15	
Position de fonctionnement	indifférente	
Masse approximative	60	g
Dimensions	voir dessin	

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PROVISOIRE

CONDITIONS DE FONCTIONNEMENT TYPIQUES

Les tensions indiquées ci-dessous sont des valeurs typiques. Elles peuvent être à modifier selon les valeurs données dans la feuille de conditions de fonctionnement accompagnant chaque tube.

Tension filament	6,3 ± 10 %	V
Courant filament	0,15	A

	Effacement	Inscription	Developpement	Lecture	
Tension de cathode	0	0	0	0	V
Tension de grille g1 (wehnelt)	−50 à 0	−50 à 0	−100	−50 à 0	V
Tension de grille g2	300	300	300	300	V
Tension de grille g3	300	300	300	300	V
Tension de grille g4	400	400	400	400	V
Tension de cible	390	80	80	80	V

DESCRIPTION PHYSIQUE ET PRINCIPE DE FONCTIONNEMENT

Les principaux composants du tube sont un canon à électrons et une cible à mémoire.

Le canon à électrons comprend 4 électrodes : il est le même que celui d'un vidicon.

La cible est faite d'une couche continue de photoconducteur sur laquelle est déposée une couche continue de diélectrique. Une vue générale du tube est présentée à la figure 1.

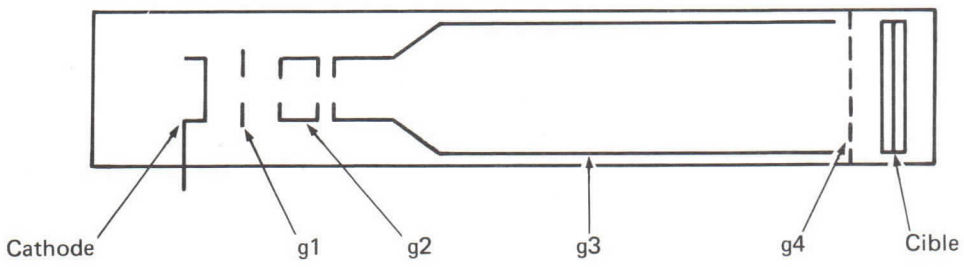


FIGURE 1

A l'inscription un relief de charges est créé sur la couche diélectrique en fonction de l'intensité lumineuse en chaque points ; à la lecture, le faisceau électronique lit le relief de charges existant sur la couche diélectrique et ramène celle-ci à un potentiel nul.

PROVISOIRE

Un exemple de fonctionnement et les séquences des opérations sont illustrés sur les schémas de la figure 2 ; les potentiels donnés constituent des valeurs caractéristiques.

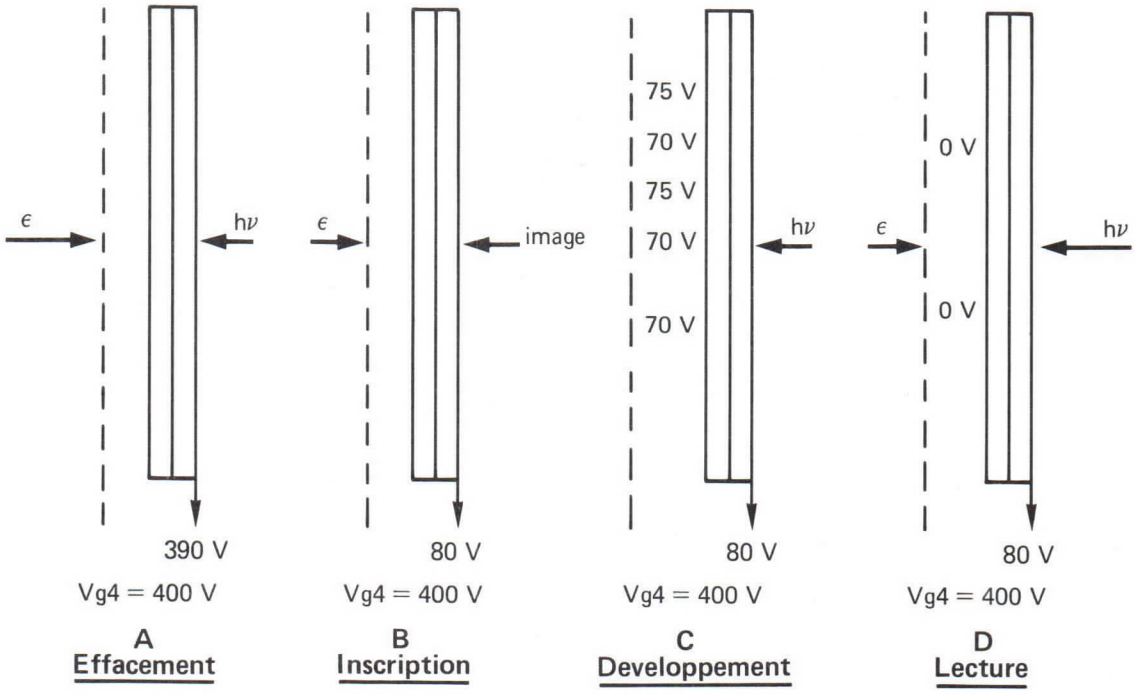


FIGURE 2

A = Effacement :

Il est nécessaire d'effacer toutes les charges de la couche diélectrique avant d'inscrire une image.

L'effacement peut être réalisé, sous éclairage uniforme (10^3 lux), en portant la cible à la tension de 390 V (pour Vg4 = 400 V) puis en redescendant son potentiel à 0 V. La face avant de la couche diélectrique par couplage capacitif se trouve ramenée à 0 V.

B = Inscription :

L'inscription de l'image se fait en portant le potentiel de cible à 80 V.

La face avant de la couche diélectrique est maintenue à 0 V par le faisceau électronique. Une différence de potentiel plus ou moins grande selon l'éclairement au point considéré apparait aux bornes de la couche diélectrique par la fuite du photoconducteur.

C = Developpement :

Le développement consiste, sans balayage par le faisceau électronique et par éclairement uniforme de la cible, à annuler la différence de potentiel aux bornes du photoconducteur tout en conservant celle qui se trouve aux bornes de la couche diélectrique. La face avant de la couche diélectrique se trouve ainsi chargée à des potentiels de 70 à 75 V selon qu'il s'agit d'un point éclairé ou noir.

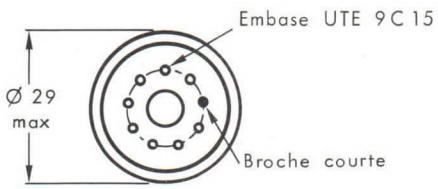
D = Lecture :

La lecture se fait sous éclairage uniforme en lisant le relief de charges de la couche diélectrique. Le faisceau électronique ramène à 0 V les potentiels de la face avant de la couche de diélectrique générant un signal correspondant à la différence des potentiels lus.

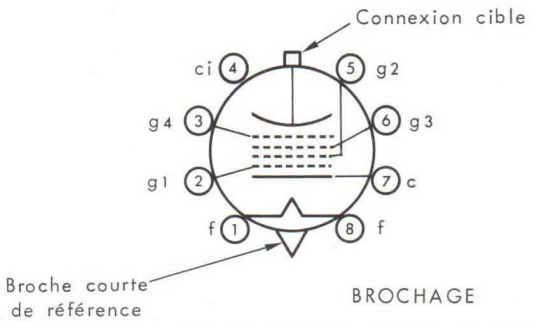
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PROVISOIRE

DESSIN D'ENCOMBREMENT

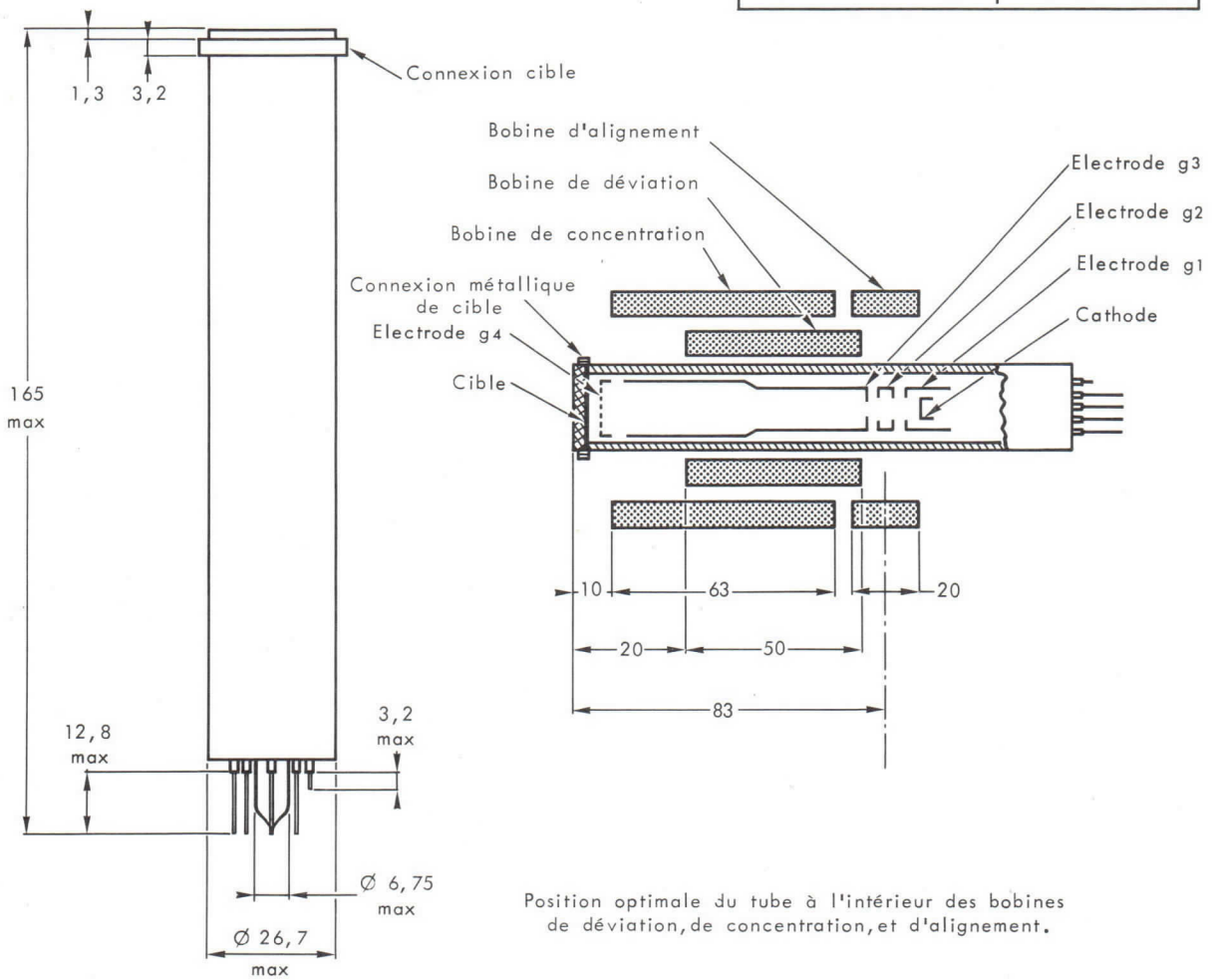


SCHEMA DE BASE



BROCHAGE

1 - Filament	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode
4 - Connexion interne	8 - Filament



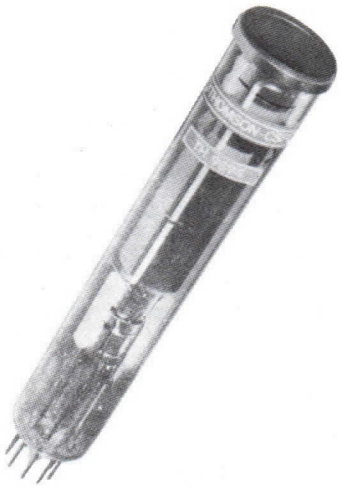
Position optimale du tube à l'intérieur des bobines de déviation, de concentration, et d'alignement.

Cotes en mm.

TH 9894
X RAY SENSITIVE 1" VIDICON

· ELECTROMAGNETIC FOCUS AND DEFLECTION
· HIGH RESOLUTION
· LOW LAG

The TH 9894 is a 1" magnetic focus and deflection X-ray sensitive Vidicon. It is intented for non destructive testing of components and assemblies by displaying an image of their structure on a T.V. monitor through direct conversion of X-ray incident on the faceplate into a video signal. It enables instantaneous inspection of stationary or in-motion phenomena.



The beryllium input window allows reduction of energy absorption : for 50 kV X-radiation, the absorption is about 4 %.

The operating principle of the TH 9894 is strictly similar to that of a conventional Vidicon with post-acceleration.

The electron beam is focused and deflected magnetically and collimated by the final grid so as to obtain a good uniformity of stabilization potential.

The limiting resolution is near to 35 lp/mm which corresponds to a dimension of the smallest detectable element of 15 to 20 μm.

A special design layer permits to obtain remarkable characteristics : for 50 V applied to the signal electrode, the dark current is about 3 nA. This value is sufficiently low so that its space variation does not introduce parasitic effect impairing the observation of low contrasts.

The characteristics of the TH 9894 make possible the design of inspection T.V. equipments with small focal spot X-ray sources.

This technique is of a great importance in many fields such as industrial applications (X radiation of high energy) medicine and biology (X radiation of low energy).

Detection characteristics

The spectrum of X-radiation, within which the tube can be used is that obtained from 8 to 200 kVp generator.

The detection power can be defined in the following way, with a fine spot source at 200 mm from the faceplate :

1 - Detection of 0.50 mm diameter hole in a 0.25 mm thick aluminum penetrameter placed on 10 mm thick aluminum.

2 - Resolution of 500 mesh stainless steel 25 μm thick wire screen.

TH 9894 tube due to the low lag layer is capable of monitoring stationary and in-motion phenomena, with a speed of about 2 mm/s relative to the faceplate. In this condition 250 mesh wire can be detected.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

GENERAL CHARACTERISTICS

Electrical

Heating	for unipotential cathode indirectly heated	
Heater : - Voltage	6.3 ± 10 %	V
- Current	0.15	A
Minimum preheating time	60	s
Output capacitance : Target to all other electrodes	4.5	pF
Deflecting method	Magnetic	
Focusing method	Magnetic	

Mechanical

Base	Ditetrar 8 pins (JEDEC N° E8-11) METOX N° 30.250	
Socket	GERHARD	
Deflecting yoke	See drawing	
Dimensions		
Photoconductive layer :		
- normal dimensions of image on target	12.7 x 9.5	mm
- maximum useful diagonal diameter (4 x 3 aspect ratio)	17	mm
- orientation scan parallel to the plane passing through the tube axis and short index pin.		
Maximum temperature of faceplate	60	°C
Operating position	Any	
Net weight, approximate	60	g

OPERATING CONDITIONS

Maximum ratings

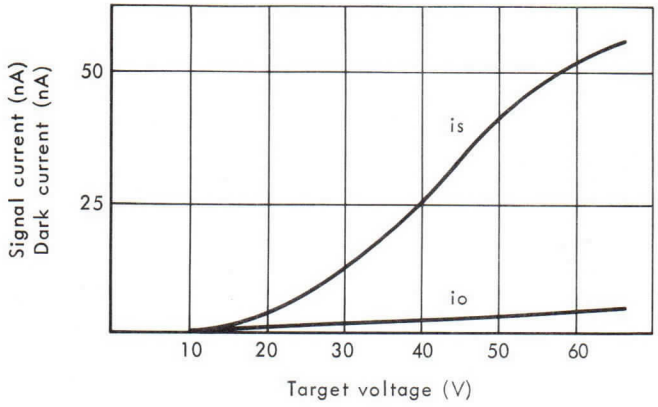
Scanned area 12.7 x 9.5 mm

Electrode g4 voltage (field electrode)	1000	V
Electrode g3 voltage (wall electrode)	1000	V
Electrode g2 voltage (accelerator)	700	V
Electrode g1 voltage (cut-off) :		
- negative bias value	125	V
- positive bias value	0	V
Signal electrode voltage	50	V
Dark current	5	nA
Peak output current	0.2	µA
Faceplate :		
- incident radiation	5000	R/mn
- temperature	45	°C

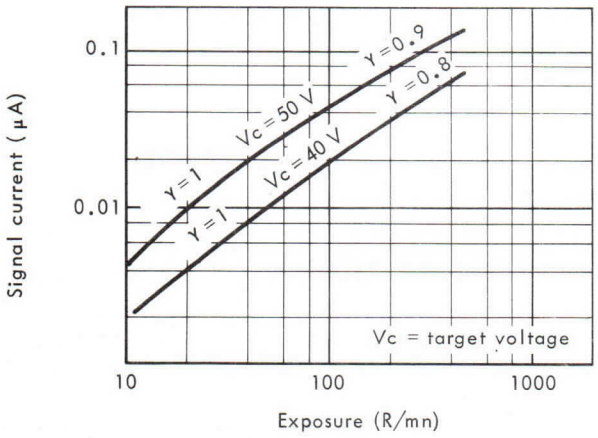
Typical operation

Scanned area 12.7 x 9.5 mm
Temperature of faceplate 25° C

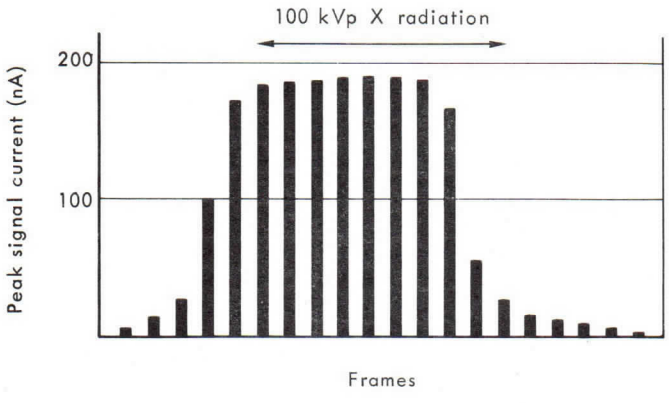
Electrode g4 voltage	750	V
Electrode g3 voltage	450	V
Electrode g2 voltage	300	V
Electrode g1 voltage	−45 to −110	V
Average gamma	0.95	
Minimum peak to peak blanking voltage :		
- applied to electrode g1	−75	V
- applied to cathode	+20	V
Axial magnetic focus field	50 ± 2	Gauss
Deflection peak current :		
- horizontal	200	mA
- vertical	24	mA
Alignment field	0 to 4	Gauss



SIGNAL AND DARK CURRENT CHARACTERISTICS



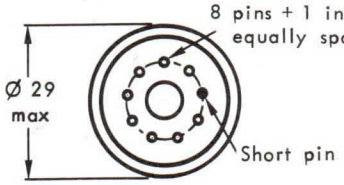
100 kVp X RADIATION ON FACEPLATE



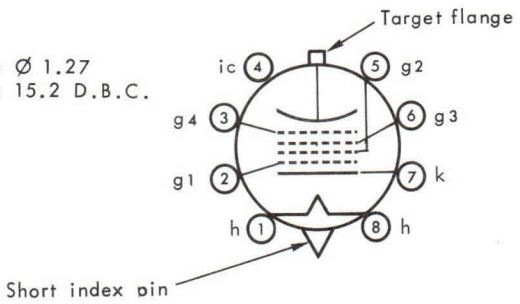
VARIATION OF SIGNAL CURRENT WHEN EXCITATION IS ETABLISHED AND SUPPRESSED

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

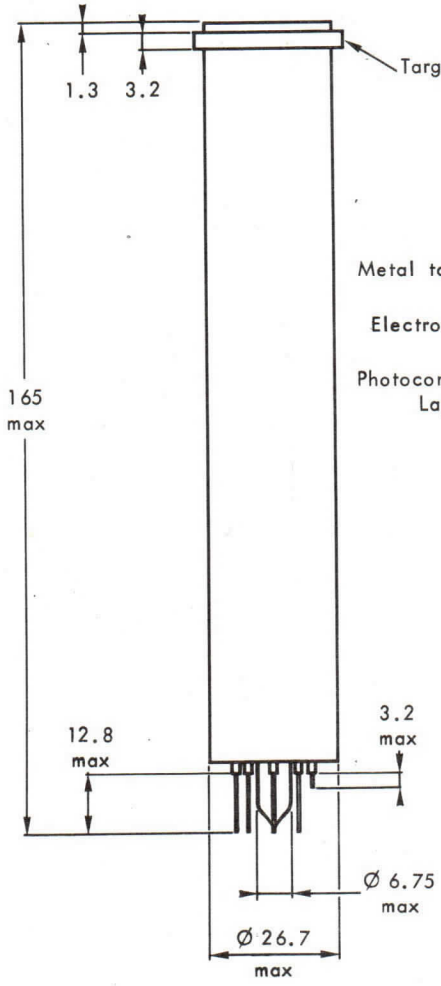
OUTLINE DRAWING

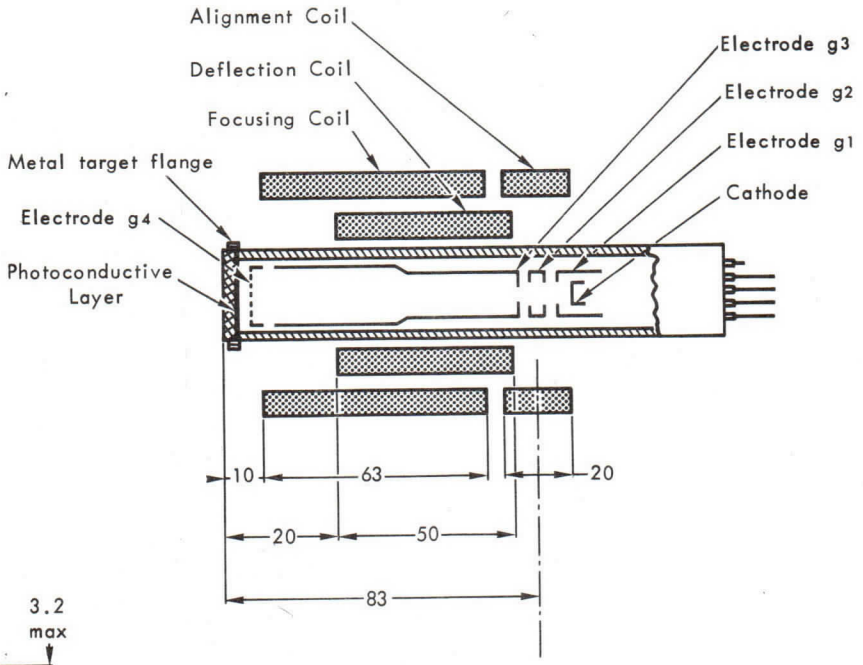


BASING DIAGRAM



1 - Heater	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode
4 - Internal connection	8 - Heater





Optimum locating of the tube inside the deflecting - focusing - alignment components

Dimensions in mm.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PROVISOIRE

TH 9895
VIDICON 1" A MEMOIRE
LECTURE NON DESTRUCTIVE

- CONCENTRATION ET DEVIATION ELECTROMAGNETIQUES
- TEMPS D'INSCRIPTION ET D'EFFACEMENT BREFS
- TEMPS DE LECTURE : 5 A 10 MINUTES
- TEMPS DE MEMOIRE : PLUSIEURS JOURS
- RESOLUTION A 50% DE MODULATION : 600 LIGNES T.V.

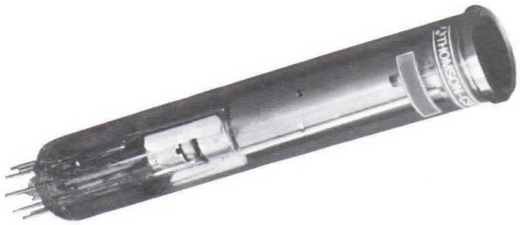
Le TH 9895 est un tube de prise de vues à mémoire permettant de mémoriser une image optique pendant plusieurs jours sous la forme d'un relief de charges.

De plus, il permet la lecture ultérieure de l'image enregistrée, pendant plusieurs minutes sans dégradation de l'information.

Ce tube possède des temps d'inscription et d'effacement brefs.

Ayant une structure et une optique électronique semblables à celles d'un vidicon de 26 mm (1"), le TH 9895 peut être utilisé avec les sources de tension et les bobines de concentration et de déviation servant pour le vidicon de 26 mm.

Ces caractéristiques rendent le tube particulièrement adapté à la visualisation de longue durée ou répétée d'une image fugitive.



PERFORMANCES TYPIQUES

Courant de sortie maximal	0, 1 µA
Temps d'inscription sur la surface entière de la cible	1 s
Temps d'effacement : effacement de la totalité de l'image inscrite à moins de 10 % résiduel	40 ms
Temps de mémoire sans lecture	plusieurs jours
Temps de lecture continue (0, 1 µA)	5 à 10 mn
Sensibilité ; lumination pour l'obtention d'un signal de 0,1 µA	20 lux. s
Résolution	600 lignes T.V.

CARACTERISTIQUES GENERALES

Electriques

Tension filament	6, 3 V
Courant filament	0, 15 A
Capacité de sortie	4, 5 pF
Mode de concentration	électromagnétique
Mode de déviation	électromagnétique

Mécaniques

Embase	UTE 9 C 15 (JEDEC E8 – 11)
Position de fonctionnement	indifférente
Masse approximative	60 g
Dimensions	voir dessin

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PROVISOIRE

CONDITIONS DE FONCTIONNEMENT TYPIQUES

Les tensions indiquées ci-dessous sont des valeurs typiques. Elles peuvent être à modifier selon les valeurs données dans la feuille de conditions de fonctionnement accompagnant chaque tube.

Tension filament	6,3 ± 10 %	V
Courant filament	0,15	A

	Effacement	Inscription	Développement	Lecture	
Tension de cathode	0	0	0	0	V
Tension de grille g1 (wehnelt)	–50 à 0	–50 à 0	–100	–50 à 0	V
Tension de grille g2	300	300	300	300	V
Tension de grille g3	300	300	300	300	V
Tension de grille g4	400	400	400	400	V
Tension de cible	400	60	60	20	V

DESCRIPTION PHYSIQUE ET PRINCIPES DE FONCTIONNEMENT

Les principaux composants du tube sont un canon à électrons et une cible à mémoire.
Le canon à électrons comprend 4 électrodes, il est le même que celui d'un vidicon.
La cible est faite d'une couche de photoconducteur sur laquelle sont déposés des plots de diélectrique.
Une vue générale du tube est présentée à la figure 1 ainsi qu'une vue agrandie de la cible à la figure 2.

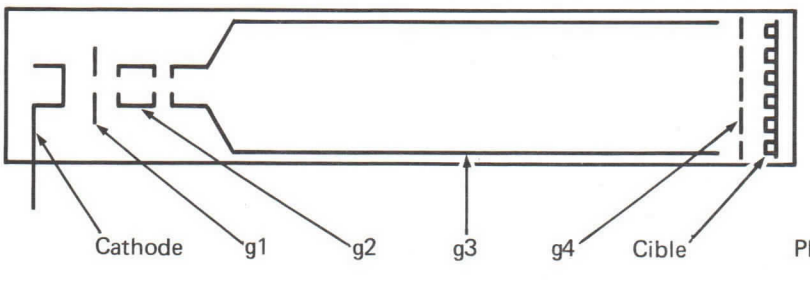


FIGURE 1

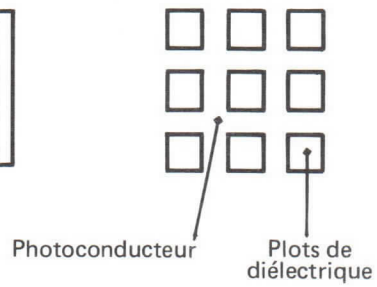


FIGURE 2

A l'inscription, un relief de charges négatives est créé sur les plots de diélectrique par l'intensité lumineuse incidente en chaque point; à la lecture le faisceau électronique de lecture est modulé par le potentiel négatif des plots d'isolant.

Un exemple de fonctionnement et les séquences des opérations sont illustrés par les schémas de la figure 3; les potentiels donnés constituent des valeurs caractéristiques.

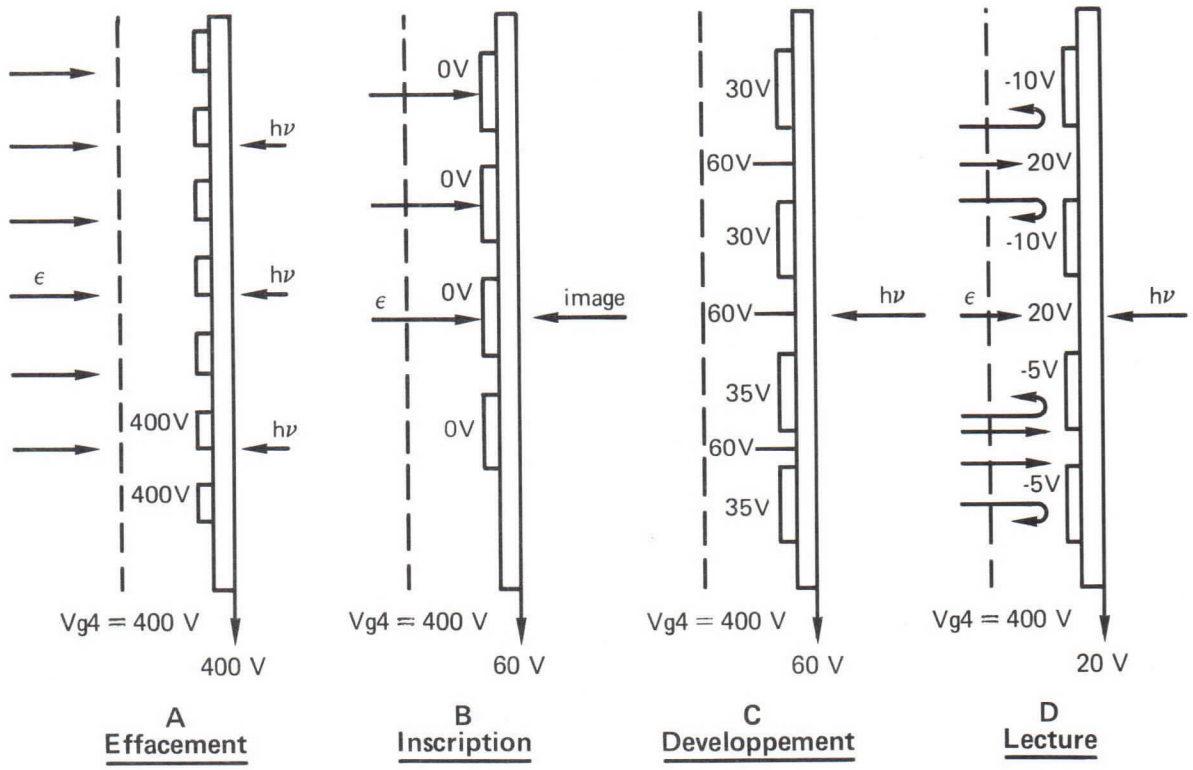


FIGURE 3

A = Effacement

Il est nécessaire d'effacer toutes les charges des plots de diélectrique avant d'inscrire une image. L'effacement peut être réalisé, sous éclairage uniforme (10^3 lux) en portant la cible à la tension de 400 V (pour Vg4 = 400 V) puis en redescendant son potentiel à 0 V. La face avant des plots de diélectrique par couplage capacitif se trouve ramenée à 0 V.

B = Inscription

L'inscription se fait en portant le potentiel de cible à 60 V. La face avant des plots de diélectrique est maintenue à 0 V par le faisceau électronique. Une différence de potentiel plus ou moins grande selon l'éclairement au point considéré apparait aux bornes des plots de diélectrique par la fuite du photoconducteur.

C = Développement

Le développement consiste sans balayage par le faisceau électronique et par éclairement uniforme de la cible, à annuler la différence de potentiel aux bornes du photoconducteur tout en conservant celle qui se trouve aux bornes des plots de diélectrique. En redescendant le potentiel de la cible à une tension inférieure (20 V par exemple), la face avant des plots de diélectrique est chargée à des potentiels négatifs allant de 0 à −10 V.

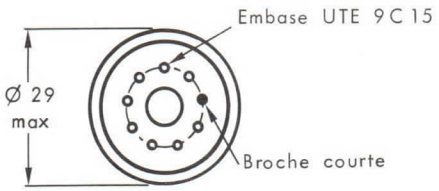
D = Lecture

A la lecture, le faisceau électronique est modulé par les potentiels négatifs des plots de diélectrique et le signal de sortie varie en correspondance exacte. Comme les potentiels des plots sont négatifs par rapport au potentiel de la cathode, il n'y a pas de dépot d'électrons du faisceau électronique sur les plots de diélectrique et la lecture est non destructive.

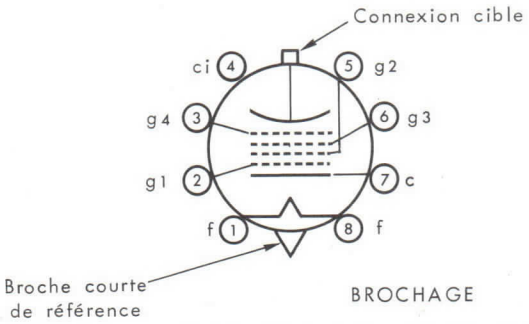
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PROVISOIRE

DESSIN D'ENCOMBREMENT

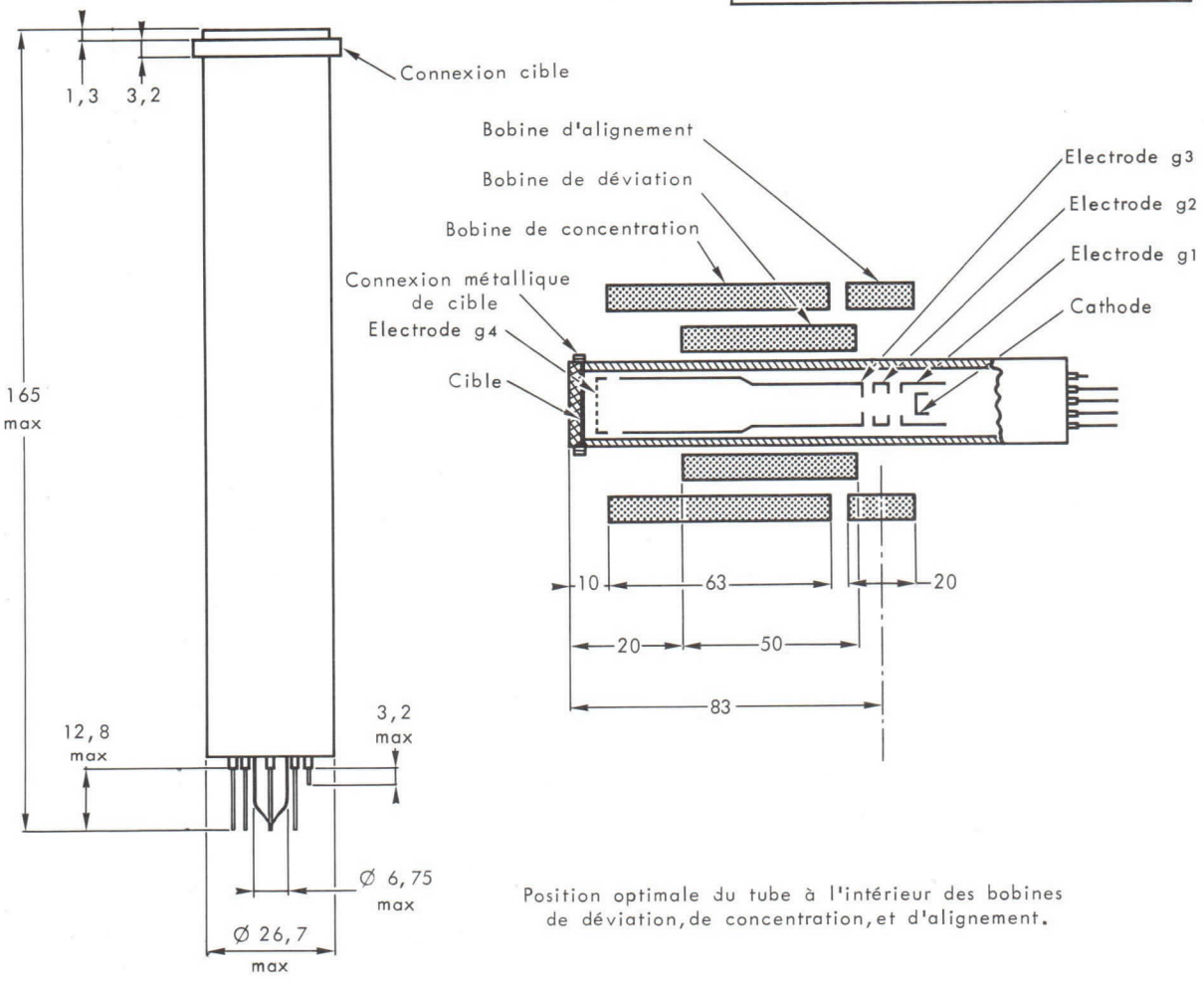


SCHEMA DE BASE



BROCHAGE

1 - Filament	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode
4 - Connexion interne	8 - Filament



Position optimale du tube à l'intérieur des bobines de déviation, de concentration, et d'alignement.

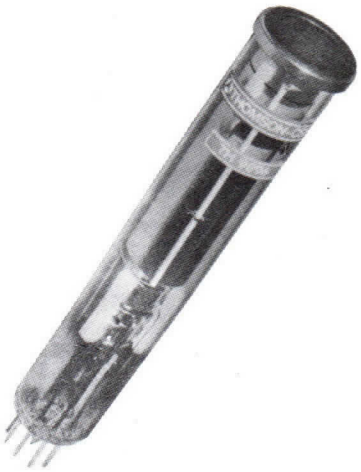
Cotes en mm.

TH 9896

ULTRA VIOLET SENSITIVE 1" VIDICON

- ELECTROMAGNETIC FOCUS AND DEFLECTION
- HIGH RESOLUTION
- LOW LAG

The TH 9896 is a magnetic focus and deflection 1" Vidicon designed for ultra-violet sensitive television cameras. It incorporates a quartz window and a special target allowing high sensitivity in the ultra-violet region of spectrum. The special response curve has a peak at 400 nm and the corresponding sensitivity is approximately 0.2 $\mu A/\mu W/cm^2$. At 250 nm the sensitivity is about 0.1 $\mu A/\mu W/cm^2$ while the sensitivity for wavelength beyond 600 nm is practically negligible.



Due to a low lag photoconductive layer featuring unity gamma, excellent images can be displayed on a television screen so making the tube to be recommended for use in ultra-violet television microscopy.

A post-acceleration electrode with separate external connection provides higher resolution, higher output signal capability as well as better resolution and signal uniformity than previous Vidicons. For optimum beam landing and resolution, the post-acceleration voltage should be adjusted at 1.5 to 1.6 times the wall electrode voltage.

Due to good design, high reliability is obtained all along tube life. Requirement for alignment field is reduced to a minimum owing to precise electron gun mounting. An extremely flat face plate avoids all optical distortions and enables the use of any high aperture lenses.

Low heater power consumption makes this Vidicon suitable for all transistorized equipment. The low heat dissipation improves the quality of image by lowering the operating temperature of the faceplate.

GENERAL CHARACTERISTICS

Electrical

Heating	for unipotential cathode indirectly heated	
Heater :		
- Voltage	6.3 ± 10 %	V
- Current	0.15	A
Minimum preheating time	60	s
Output capacitance :		
Target to all other electrodes	4.5	pF
Spectral response	See curve	
Deflecting method	Magnetic	
Focusing method	Magnetic	

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Mechanical

Base	Ditetrar 8 pins (JEDEC N° E8 - 11) METOX N° 30.250 GERHARD	
Socket		
Deflecting yoke	See drawing	
Dimensions		
Photoconductive layer :		
– normal dimensions of image on target	12. 7 x 9. 5	mm
– maximum useful diagonal diameter (4 x 3 aspect ratio)	17	mm
– orientation scan parallel to the plane passing through the tube axis and short index pin.		
Maximum temperature of faceplate	60	°C
Operating position	Any	
Net weight, approximate	60	g

OPERATING POSITION

Maximum ratings

Scanned area 12. 7 x 9. 5 mm

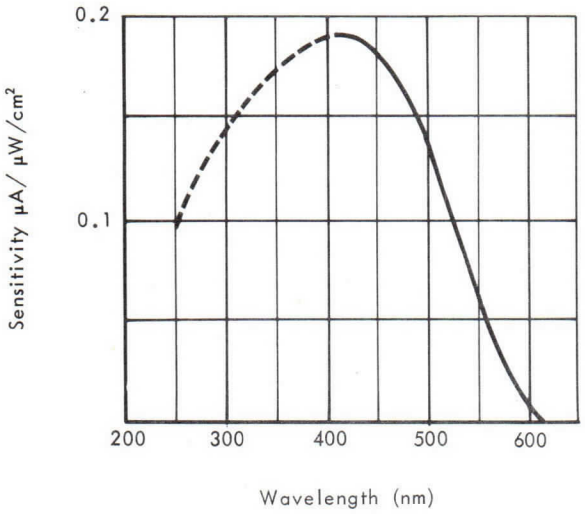
Electrode g4 voltage (post acceleration electrode)	1000	V
Electrode g3 voltage (wall electrode)	750	V
Electrode g2 voltage (acceleration)	700	V
Electrode g1 voltage (modulator) :		
– negative bias value	–150	V
– positive bias value	0	V
Target voltage	100	V
Dark current	0. 1	µA
Faceplate :		
– illumination	1000	f.c.
– temperature	60	°C

Typical operation

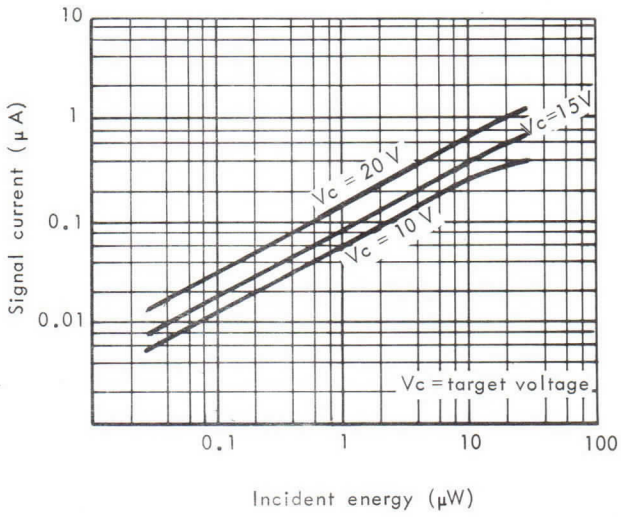
Scanned area 12. 7 x 9. 5 mm
Faceplate temperature 25 °C

Electrode g4 voltage	420 to –450	V
Electrode g3 voltage	280 to 300	V
Electrode g2 voltage	300	V
Electrode g1 voltage	–35 to –75	V
Minimum blanking peak to peak voltage :		
– applied to electrode g1	–75	V
– applied to cathode	+10	V
Limiting resolution at center of picture	800	TV lines
Limiting resolution at corner of picture	500	TV lines
Axial magnetic field	40	Gauss
Adjustable tranverse alignment field	± 4	Gauss
Signal electrode voltage	10 to 20	V
Dark current	0. 5	nA
Sensitivity		
– at 400 nm	0. 2	µA/µW/Cm^2
– at 250 nm	0. 1	µA/µW/Cm^2

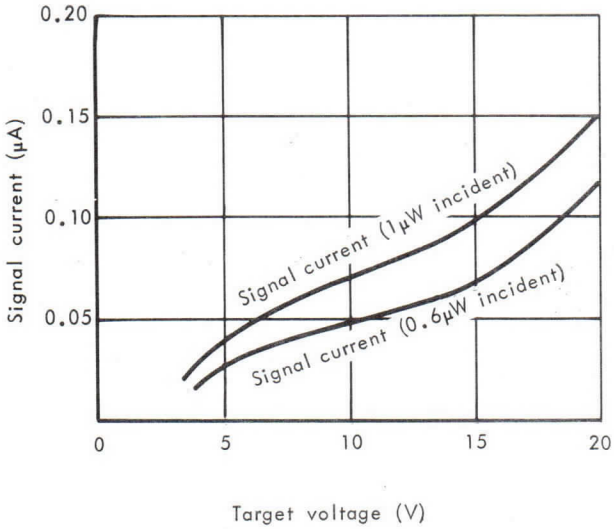
SPECTRAL RESPONSE



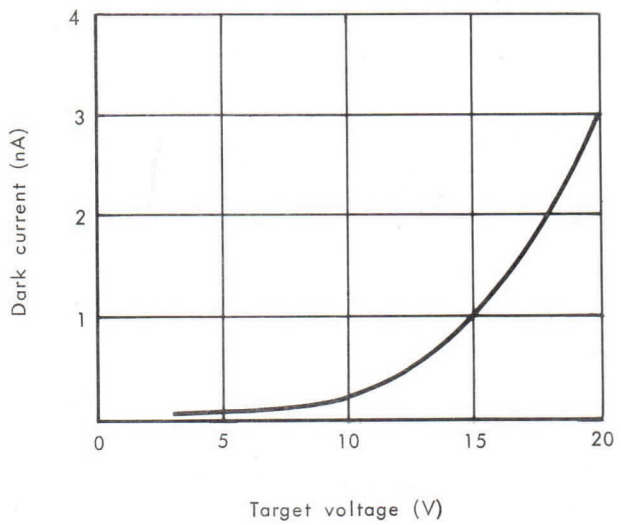
SIGNAL CURRENT VS INCIDENT ENERGY AT 253.7 nm



SIGNAL CURRENT VERSUS TARGET VOLTAGE

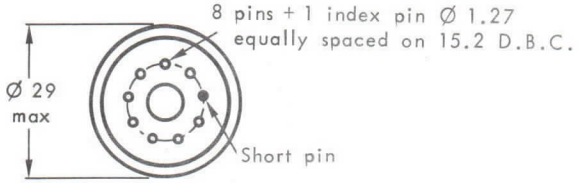


DARK CURRENT VERSUS TARGET VOLTAGE

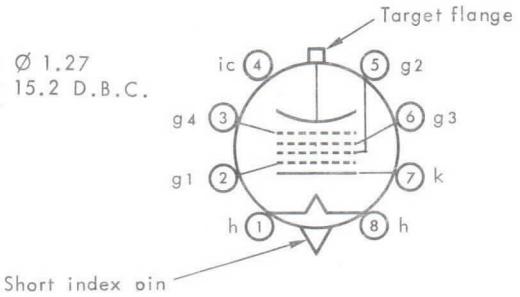


THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

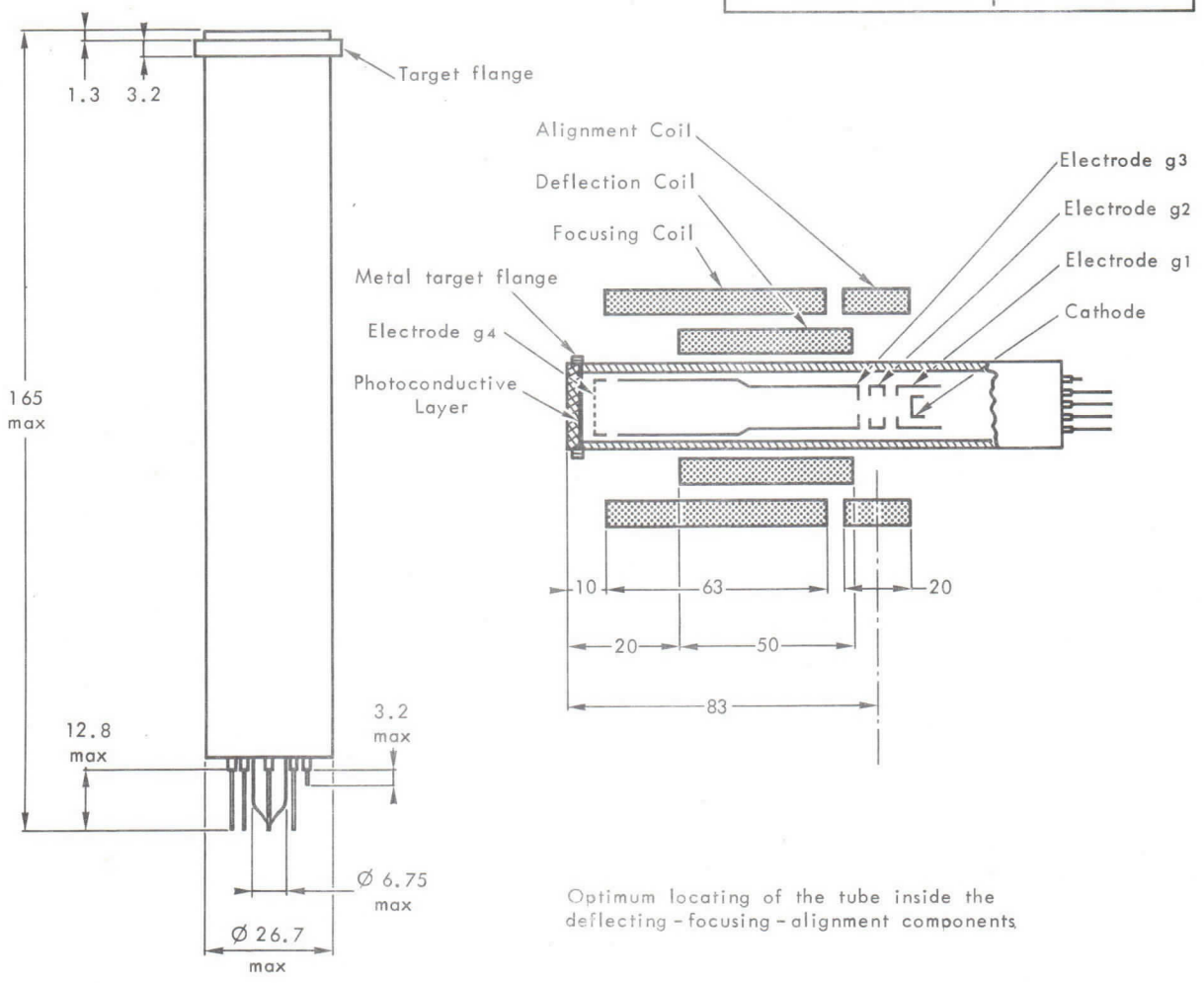
OUTLINE DRAWING



BASING DIAGRAM



1 - Heater	5 - Electrode g2
2 - Electrode g1	6 - Electrode g3
3 - Electrode g4	7 - Cathode
4 - Internal connection	8 - Heater



Optimum locating of the tube inside the deflecting - focusing - alignment components

Dimensions in mm.

THOMSON-CSF

GROUPEMENT TUBES ELECTRONIQUES

SPECIAL

VIDICONS

THOMSON - CSF has developed a wide range of SPECIAL VIDICONS to meet a great variety of television requirements :

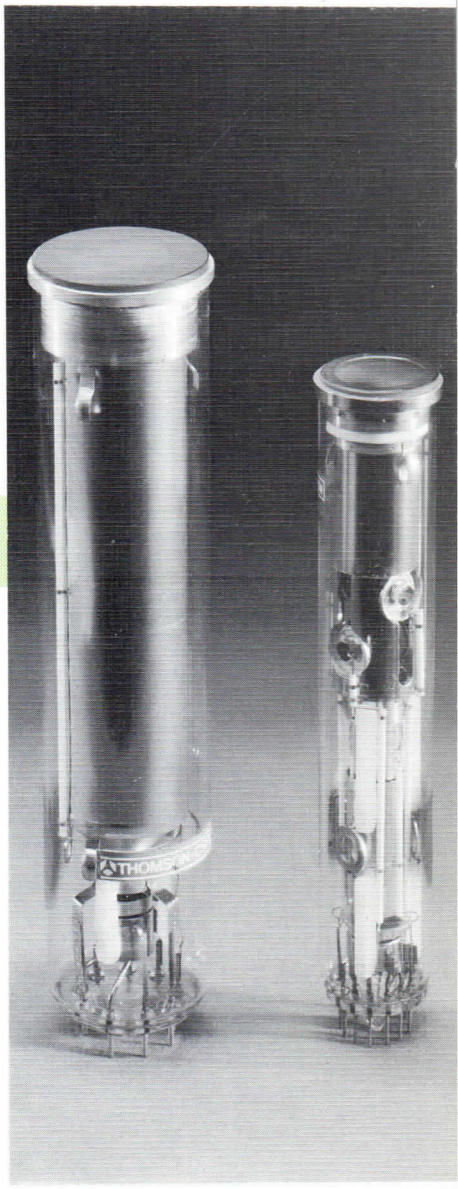
INDUSTRIAL - MEDICAL - NUCLEAR

SCIENTIFIC - MILITARY - SLOW SCAN and DELAYED T.V.

Depending on their focus and deflection modes, their photoconductive layers or their structure, these SPECIAL VIDICONS include 3 families :

- *VIDICONS WITH STANDARD PHOTOCONDUCTIVE LAYER having focus and deflection fully electrostatic or hybrid.*
- *VIDICONS WITH SPECIAL PHOTOCONDUCTIVE LAYER sensitive to IR, X or UV radiations.*
- *SLOW SCAN AND STORAGE VIDICONS.*

Furthermore, some VIDICONS can be equipped with F.O. face plate or with non browning radiation glass.



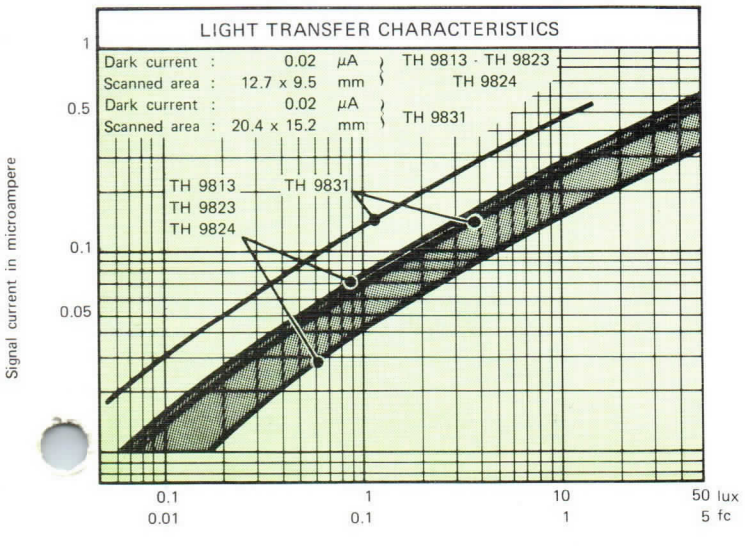
VIDICONS WITH STANDARD PHOTOCONDUCTIVE LAYER

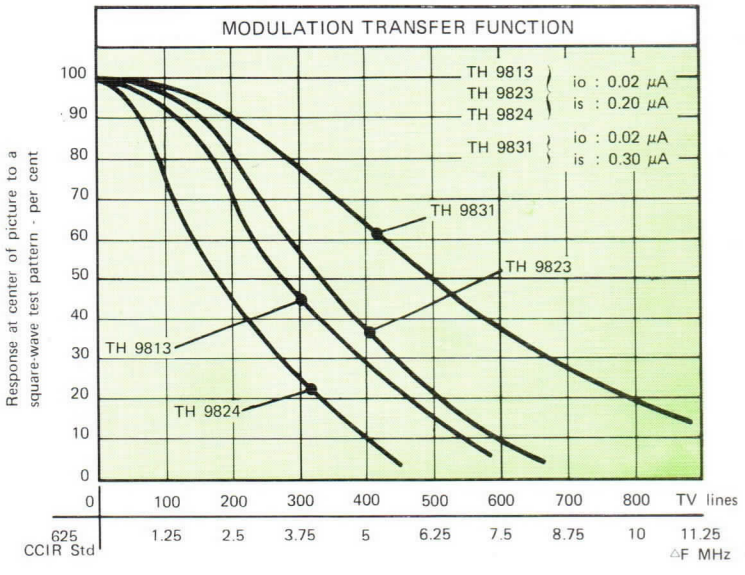
TH 9813 — **Magnetic deflection. Electrostatic focus.** Usable in 40 mm diameter camera. Excellent uniformity of resolution and good raster linearity. High quality of general characteristics : high sensitivity, low lag. Designed for all applications in **closed-circuit transistorized Television.**

TH 9823 — **Electrostatic deflection and magnetic focus** (when required by permanent magnet). High quality image due to magnetic focus and advantageous compactness due to electrostatic deflection. High resolution and excellent general performances. Especially intended for all **Television system** where **small size** and **high quality of image** are required.

TH 9824 — **Completely Electrostatic.** Stability in operation and essential characteristics of image even in the case of high variations of electrode potential. Good resolution and raster linearity. High performances : sensitivity, lag. Ideally suited for all industrial Television requirements . very significant reduction in the dimensions and weight of the camera. Especially designed for applications where very small size is essential : **Space Television, Military Television.**

TH 9831 — 1 1/2" Vidicon. **Magnetic deflection and electrostatic focus.** Designed for professional equipments of very high quality. Very high performances. Excellent image quality and maximum resolution. Recommended for **Black and White or color Broadcast Television, live scene pick-up** and **Telecine.**





VIDICONS WITH SPECIAL PHOTOCONDUCTIVE LAYER

TH 9890

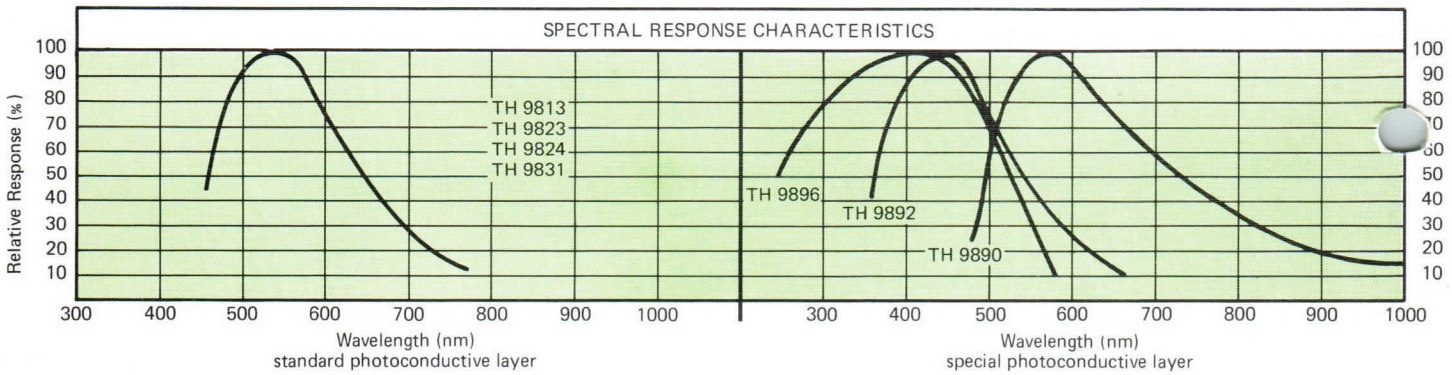
Magnetic focus and deflection. **Highly sensitive to infra-red radiation** with theshold wavelength extending over 2 μm. Suitable both for **Television operation in infra-red light and for observation of hot body temperature.**

TH 9894

Magnetic focus and deflection. **X-ray sensitive Vidicon.** Designed for **non-destructive testing of components and assemblies** Low lag layer capable of monitoring stationnary or in-motion phenomena. High resolution.

TH 9896

Magnetic focus and deflection. Designed for **ultra-violet sensitive T.V. cameras.** With quartz window and special target allowing for high sensitivity in U.V. region of spectrum. Recommended for use in industry **(flame observation in daylight, gas injection in boilers)** or in biology **(U.V. television microscopy).** . .



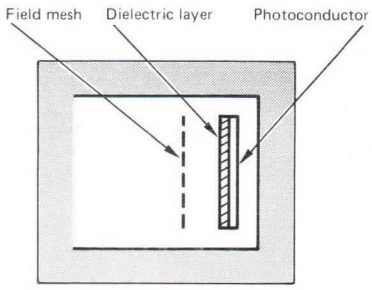
SLOW SCAN AND STORAGE VIDICONS

TH 9892

Magnetic focus and deflection. Designed for **slow scan or delayed readout.** Excellent light integration and storage characteristics. Suitable for slow scan pick-ups requiring high resolution such as for **space application.** Also suitable for narrow bandpass transmission **(high signal to noise ratio)** or very narrow bandpass **(transmission of video information over telephone lines).**

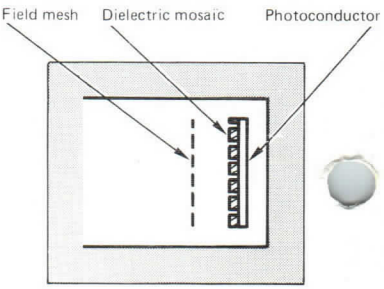
TH 9893

Magnetic focus and deflection. **Storage Vidicon with readout performed in one T.V. frame.** Storage time : several days. High resolution maintained after long storage time. Intended **for delayed transmission of transient phenomena.**



TH 9895

Magnetic focus and deflection. **Storage Vidicon with non-destructive readout** allowing for a 10 mn continuous reading. Excellent storage both in terms of resolution and duration of stored image. Intended for **long duration or repeated readout of high speed events.**



ESSENTIAL CHARACTERISTICS AND PERFORMANCES

General Characteristics

HEATER VOLTAGE . . . . . 6.3 ± 10% V

HEATER CURRENT . . . . . 0.15 A

TH 9813 - TH 9831 . . . . . Electrostatic focus - magnetic deflection
TH 9823 . . . . . Magnetic focus - electrostatic deflection
TH 9824 . . . . . Electrostatic focus and deflection
TH 9890 - TH 9892 - TH 9893
TH 9894 - TH 9895 - TH 9896 . . . . . Magnetic focus and deflection

PHOTOCONDUCTIVE LAYER SPECTRAL RESPONSE

TH 9813 - TH 9823 - TH 9824 - TH 9831
TH 9892 - TH 9895 . . . . . max at 550 nm
TH 9890 . . . . . extending up to 2400 nm
TH 9892 . . . . . max at 440 nm
TH 9894 . . . . . X - Ray sensitive
TH 9896 . . . . . max at 400 nm

Electrical Operation Modes

SCANNED AREA

TH 9813 - TH 9823 - TH 9824 - TH 9890
TH 9892 - TH 9893 - TH 9894 - TH 9895
TH 9896 . . . . . 12.7 x 9.5 mm
TH 9831 . . . . . 20.4 x 15.2 mm

ILLUMINATION . . . . . See light transfer curves.

TEMPERATURE . . . . . 25° ± 5° C

FOCUS

TH 9813 - TH 9824 - TH 9831 . . . . . Vg3 # 0.3 Vg4
TH 9823 . . . . . Coil or permanent magnet
TH 9890 - TH 9892 - TH 9893 - TH 9894
TH 9895 - TH 9896 . . . . . Focus coil

ALIGNMENT . . . . . Coil

SIGNAL CURRENT (max)

TH 9813 - TH 9823 - TH 9824 - TH 9890
TH 9892 - TH 9893 - TH 9894 - TH 9896 . . . . . 0.2 μA
TH 9895 . . . . . 0.1 μA
TH 9831 . . . . . 0.6 μA

ELECTRODE VOLTAGES

		Post acceleration Voltage		Wall electrode Voltage
TH 9813	Vg5	500 V	Vg4	300 V
TH 9823	Vg5	450 to 600 V	Vg4	300 to 400 V
TH 9824	Vg5	500 to 600 V	Vg4	300 V
TH 9831	Vg5	1400 to 1500 V	Vg4	800 to 1000 V
TH 9890	Vg4	250 to 300 V	Vg3	250 to 300 V
TH 9892	Vg4	450 V	Vg3	300 V
TH 9893 - TH 9895	Vg4	400 V	Vg3	300 V
TH 9894	Vg4	750 V	Vg3	450 V
TH 9896	Vg4	400 to 450 V	Vg3	280 to 300 V

Typical Operations

	TH 9813 TH 9823 - TH 9824	TH 9831	TH 9890	TH 9892	TH 9894	TH 9896
AVERAGE SENSITIVITY						
Face plate illumination	10 lux	10 lux	10 I.R. lux	1 lux/s	100 R/mn	0.5 μw
Target voltage	20 to 50 V	20 to 50 V	20 to 100 V	30 V	50 V	10 to 20 V
Dark current	20 nA	20 nA	20 nA	0.6 nA	2 nA	0.5 nA
Signal current	200 nA	350 nA	120 nA	20 nA (ti = 1s)	100 nA	50 nA
LAG						
Residual after 60 ms	20%	20%	45%	25%	–	–
Average gamma	0.65	0.65	0.65	0.9	0.9	0.9

Particular Performances

Allowed dimensional outline of the camera

DIAMETER

TH 9813 - TH 9823 . . . . . 40 mm
TH 9824 . . . . . 32 - 35 mm
TH 9831 . . . . . 60 mm

LENGTH . . . . . See mechanical characteristics

FOCUS

TH 9813 - TH 9824 - TH 9831 . . . . . Negligible energy

DEFLECTION (for electrode voltages defined in Electrical Operation Modes)

TH 9813 Requires power 3 to 4 times less than TH 9812 (Magnetic focus)
TH 9831 Requires power 3 to 4 times less than TH 9830 (Magnetic focus)

VIDICON+CAMERA ESTIMATED WEIGHT

TH 9813 . . . . . 300 g
TH 9824 . . . . . 160 g
TH 9823 . . . . . 250 g
TH 9831 . . . . . 620 g

RESOLUTION
(Electrical normal mode)

	Center limiting resolution (T.V. lines)	Percentage of modulation at 400 T.V. lines
TH 9813	650	25
TH 9823	800	40
TH 9824	450	15
TH 9831	1000	60
TH 9890	550	40
TH 9894	35 lp/mm	-
TH 9896	800	40
TH 9892	800	40
TH 9893	600	-
TH 9895	600	-

Mechanical Characteristics

LENGTH (A) (see drawing)

TH 9813 - TH 9824 - TH 9890 - TH 9892 - TH 9893
TH 9894 - TH 9895 - TH 9896 . . . . . max 165 mm
TH 9823 . . . . . max 112 mm
TH 9831 . . . . . max 265 mm

DIAMETER (B) (see drawing)

TH 9813 - TH 9824 - TH 9890 - TH 9892 - TH 9893
TH 9894 - TH 9895 - TH 9896 - TH 9823 . . . . . max 26.7 mm
TH 9831 . . . . . max 38.5 mm

RECTANGULAR IMAGE MAXIMUM DIAGONAL

TH 9813 - TH 9823 - TH 9824 - TH 9890 - TH 9892
TH 9893 - TH 9894 - TH 9895 - TH 9896 . . . . . 17 mm
TH 9831 . . . . . 25.4 mm

WEIGHT APPROXIMATE

TH 9813 - TH 9823 - TH 9824 - TH 9890 - TH 9892
TH 9893 - TH 9894 - TH 9895 - TH 9896 . . . . . 60 g
TH 9831 . . . . . 120 g

OPERATING POSITION . . . . . any

SOCKET

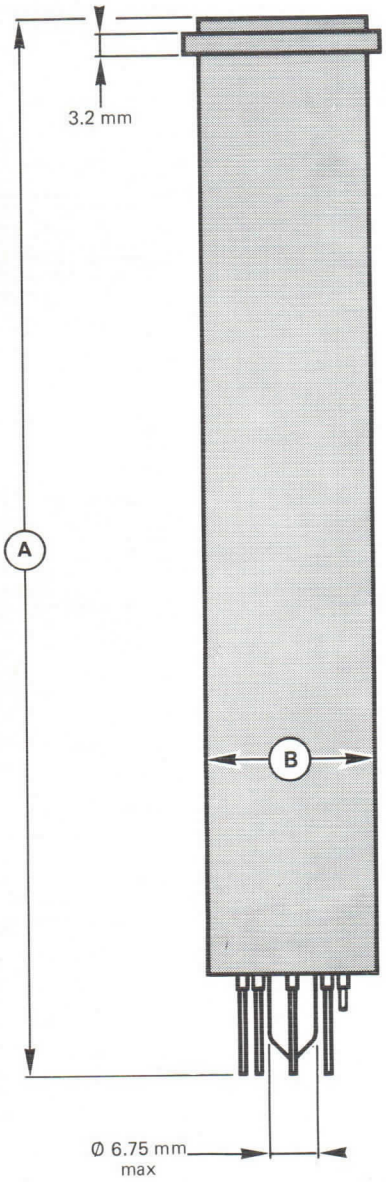
TH 9813 - TH 9890 - TH 9892 - TH 9893
TH 9894 - TH 9895 - TH 9896 . . . . . Metox n° 30.250
Cinch n° 133-98-11-015
TH 9824 . . . . . Cinch n° 203-62-13 031
or equivalent Metox
TH 9823 . . . . . E.F. Johnson C° n° 124 311.100
or equivalent Metox
TH 9831 . . . . . Alden n° 208 - SPEC
or equivalent Metox

DEFLECTION, FOCUS, ALIGNMENT COILS

TH 9813 . . . . . deflection and alignment assembly
Gerhard BV 150/41
Cleveland VYA 300
Celco TV 348-S450/352-F215-A280
TH 9831 . . . . . deflection and alignment assembly
Cleveland 15 VYA 333
Celco HV 356-S500/330 A280

TH 9890 - TH 9894 - TH 9896
TH 9892 - TH 9893 - TH 9895 . . . . deflection and focus assembly
Gerhard BV 200 1K1
alignment coil
Gerhard BV 80/3
deflection-focus-alignment assembly
Cleveland VYFA-355 2
Celco BV 232-S500/300-F240-A283

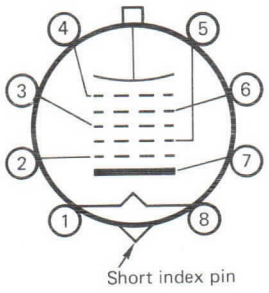
OUTLINE DRAWING



BASING DIAGRAMS (bottom view)

TH 9813

Base : Ditetrar 8 pins JEDEC E8-11

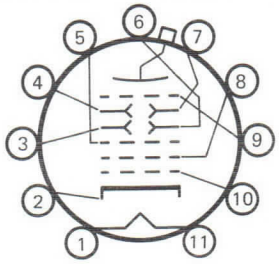


1 - Heater
2 - Electrode g1
3 - Electrode g3
4 - Electrode g5
5 - Electrode g2
6 - Electrode g4
7 - Cathode
8 - Heater

Flange : target

TH 9823

Base : Ditetrar 11 pins JEDEC E11-22

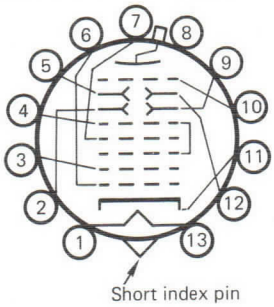


1 - Heater
2 - Cathode
3 - D1 - Deflector
4 - D4 - Deflector
5 - Electrode g3
6 - D2 - Deflector
7 - D3 - Deflector
8 - Electrode g2
9 - Electrode g4
10 - Electrode g1
11 - Heater

Flange : target

TH 9824

Base : Ditetrar 13 pins JEDEC E8-13

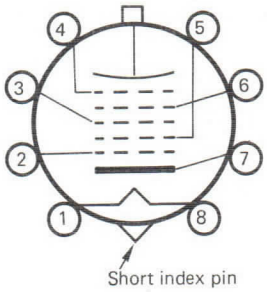


1 - Heater
2 - D1 - Horizontal deflector
3 - Electrode g2
4 - Electrode g4
5 - D4 - Vertical deflector
6 - Electrode g1
7 - Electrode g3
8 - Internal connection
9 - D2 - Horizontal deflector
10 - Electrode g5
11 - Cathode
12 - D3 - Vertical deflector
13 - Heater

Flange : target

TH 9831

Base : Super Ditetrar 8 pins JEDEC E8-78

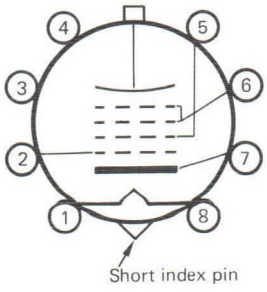


1 - Heater
2 - Electrode g1
3 - Electrode g3
4 - Electrode g5
5 - Electrode g2
6 - Electrode g4
7 - Cathode
8 - Heater

Flange : target

TH 9890

Base : Ditetrar 8 pins JEDEC E8-11

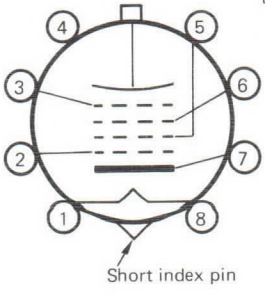


1 - Heater
2 - Electrode g1
3 - Internal connection
4 - Internal connection
5 - Electrode g2
6 - Electrodes g3 g4
7 - Cathode
8 - Heater

Flange : target

TH 9892 - TH 9893 - TH 9894 TH 9895 - TH 9896

Base : Ditetrar 8 pins JEDEC E8-11



1 - Heater
2 - Electrode g1
3 - Electrode g4
4 - Internal connection
5 - Electrode g2
6 - Electrode g3
7 - Cathode
8 - Heater

Flange : ta...

GTE 016/9-71

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PROVISOIRE

TH X458
INTENSIFICATEUR D'IMAGE LUMINEUSE
POUR VISION NOCTURNE

- FACTEUR DE CONVERSION ELEVE : 300 cd/m^2/lux
- FOCALISATION ELECTROSTATIQUE - TYPE TRIODE
- POIDS ET VOLUME REDUITS. ROBUSTESSE

Le tube TH X458 est un intensificateur d'image, de champ utile 33 mm, sensible dans le visible et le proche infra-rouge, destiné aux équipements d'aide à la vision nocturne opérant en lumière résiduelle. Ses caractéristiques le rendent bien adapté à la réalisation de lunettes monoculaires ou binoculaires de faible encombrement à grand champ et à haute sensibilité.

L'utilisation d'une photocathode du type S20 (sensibilité étendue dans le rouge) à grand rendement et d'un grandissement de 0,3 environ lui confèrent un facteur de conversion brillance-éclairement élevé. La conception de l'optique électronique et de l'écran de sortie permet l'obtention d'un pouvoir de résolution supérieur à 20 pl/mm sur la face d'entrée.

La simplicité d'utilisation du tube, son faible encombrement, son poids réduit et sa robustesse permettent de réaliser des équipements d'aide à la vision nocturne passive portables ou embarqués, de performances élevées et utilisables dans les environnements sévères. Il est donc particulièrement indiqué pour les équipements de conduite de véhicules militaires ou de conduite de tir, de jumelles pour vision nocturne, etc ....

CARACTERISTIQUES MECANIQUES

Longueur totale	79	mm
Diamètre maximal hors queusots	48	mm
Diamètre maximal queusots compris	60	mm
Poids approximatif	90	g

CARACTERISTIQUES ELECTRIQUES

Focalisation	électrostatique
Type	triode

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PROVISOIRE

CARACTERISTIQUES OPTIQUES

Photocathode

Type	S20 (sensibilité étendue dans le rouge)
Maximum de sensibilité spectrale	550 ± 100 nm
Fenêtre d'entrée	Plan concave
Diamètre utile maximal	33 mm

Ecran

Type	P20
Diamètre utile minimal	14 mm
Fluorescence et phosphorescence	Jaune - vert
Persistance	Moyenne

CARACTERISTIQUES D'UTILISATION

Valeurs limites d'utilisation

Tension entre photocathode et électrode g1 (focalisation)	max.	2	kV
Tension entre photocathode et écran	max.	18	kV
Courant de photocathode à la tension nominale		0, 2	µA
Eclairement de photocathode		1	lux
Température de stockage	max.	+68	°C
	min.	−34	°C
Température de fonctionnement	max.	+50	°C
	min.	−32	°C

Exemples de fonctionnement

Température ambiante	20 ± 5 °C

	Alimentation positive		Alimentation négative	
Tension nominale de photocathode	0	V	−16	kV
Tension nominale d'électrode g1 (focalisation)	1, 60 ± 0, 2	kV	14, 4 ± 0, 2	kV
Tension nominale d'électrode g2 (écran d'observation)	16	kV	0	V

Performances

	Min.	Typique	Max.	
Sensibilité de photocathode (note 1)	150	200	-	µA/lm
Facteur de conversion (note 2)	200	300	-	cd/m^2/lux
Résolution centrale (note 3)	20	23	-	pl/mm
Résolution périphérique (note 4)	12	15	-	pl/mm
Grandissement central (note 5)	0, 34	0, 35	0, 36	
Distorsion (note 6)	-	6	8	%
Eclairement d'entrée équivalent au bruit propre	-	2, 10^{-7}	10^{-6}	lux

NOTES

1 - Sensibilité de photocathode mesurée avec une lampe à filament de tungstène à la température de couleur standard de 2854° K.

2 - Facteur de conversion mesuré en cd/m^2 en sortie, rapporté à l'éclairement de la face d'entrée mesuré en lux.

3 - Résolutions mesurées au niveau de la photocathode, la résolution centrale typique mesurée sur l'écran est de 60 pl/mm.

4 - Résolution périphérique mesurée dans un cercle de diamètre 20 mm centré sur la photocathode.

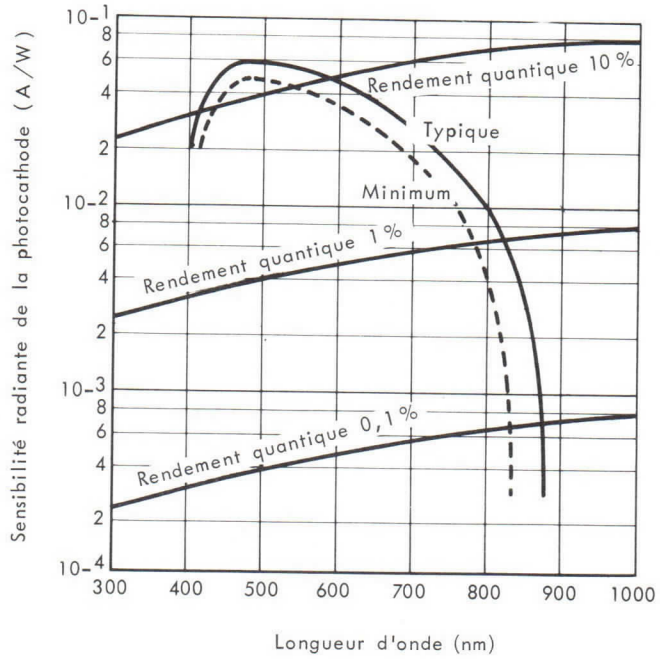
5 - Grandissement central mesuré dans un cercle de diamètre 5 mm centré sur la photocathode.

6 - Distorsion mesurée par : $D = \frac{Mp - Mc}{Mc} \times 100$

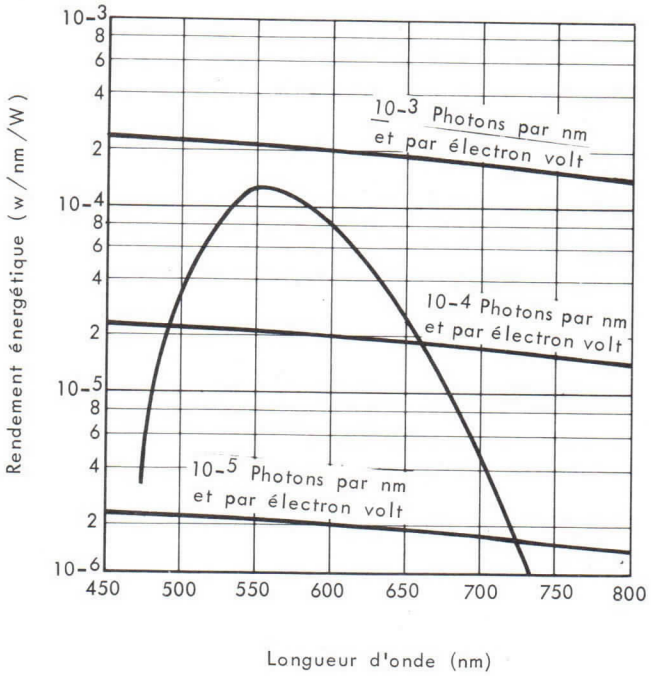
Mp grandissement périphérique pour un diamètre à l'entrée de 28 mm
Mc grandissement au centre selon note 5.

PROVISOIRE

REPONSE SPECTRALE DE LA PHOTOCATHODE S20
(étendue dans le rouge)



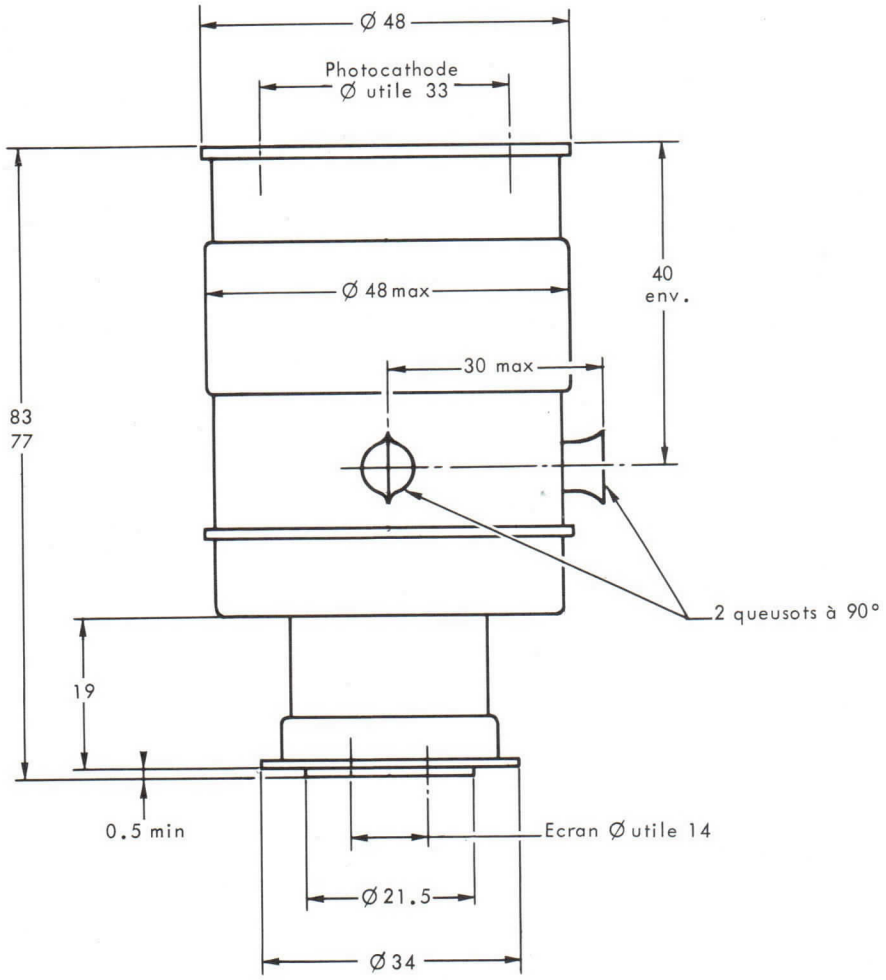
REPONSE SPECTRALE d'un ECRAN P20 ALUMINISE



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PROVISOIRE

DESSIN D'ENCOMBREMENT



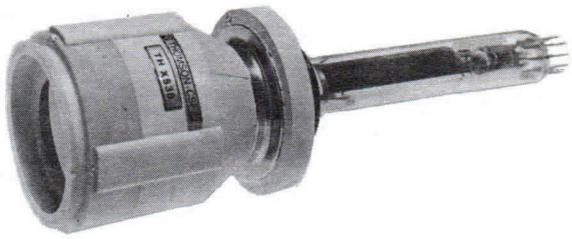
Cotes en mm.

THX538 ESICON

CAMERA TUBE FOR LOW LIGHT LEVEL T.V.

The TH X538 is a compact tube featuring high sensitivity, good resolution and low persistence. It is also characterized by a simplicity in operation and is designed to be used in systems which must operate under severe environmental conditions.

The TH X538 includes a photocathode deposited on the inner surface of a plano-concave fiber optics face-plate, an electrostatically focused diode image section, a high secondary emission photoelectron multiplier target and a reading gun similar to that of conventional Vidicons.



The target properties allow the tube to operate over a wide range of illuminations and specially at low light level (0.1 mf.c) where the low image persistence makes easier the viewing of moving scenes. Furthermore, regions of a scene which is sufficiently bright to cause saturation do not produce halation altering the surrounding information.

The very low dark current of the target enables excellent storage characteristics thus permitting the integration of low light level images for extended periods of time. The storage and integration characteristics permit its use in narrow bandwidth slow scan systems.

Because of those characteristics, the TH X538 makes possible a great number of applications in black and white or color camera.

The TH X538 can be used directly with an optical lens system or fiber optically coupled to an image intensifier in order to obtain an increased sensitivity or to convert X, U.V. or I.R. radiation to light image.

The tube requires only low scanning power and the accessories of conventional Vidicons can be used.

PERFORMANCE DATA

Spectral response and sensitivity

The TH X538 utilizes a S20 type photocathode the quantum efficiency of which is about 15 % at 440 nm. The high quantum efficiency of the photocathode combined with the high gain of the target permits to obtain a sensitivity in the order of 15 000 μA/lumen at 1 mf.c.

This sensitivity allows the tube to operate without any adjustment for input illumination from 0.1 to 10 mf.c. The gamma is 1 for light level between 0.5 and 1 mf.c and decreases to 0.6 for 10 mf.c.

The gain control can be achieved by varying the high voltage applied to the photocathode without significant loss of resolution. This provides a gain control range from 1 to 10 and allows a dynamic illumination range of about 2.10^3.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Persistence

The mechanism of charges generation, storage and neutralization on the target allows to obtain a very low image persistence which is only limited by the reading beam acceptance. In the third frame, the residual signal is typically 8 % for a signal current of 50 nA and 5 % for 100 nA.

Resolution

The limiting resolution is about 800 pts/line at center of image and 600 pts/line at corners. The corner resolution can be improved by dynamic focusing.

Furthermore, the lag characteristics allow to obtain a good resolution in moving scenes.

Integration and storage

The very high resistance of the target permits the integration of a signal for several minutes without the image being degraded by leakage currents. The stored signal can be read out a few hours after the high voltage has been removed. The integration period is limited only by spurious emission in the image section of the tube which can saturate the target.

When the photon noise is excessive, it is advisable to reduce the gain by reducing the high voltage and to operate with longer integration period.

OPERATING CONSIDERATIONS

Supplies and circuits

System requirements are those utilized for 1" magnetically focused and deflected Vidicons. Two additional voltages are required : one of −12 kV for the photocathode and one of 30 V for the suppressor grid g5.

In order to maximize the signal to noise ratio it is necessary to keep the input noise current of the preamplifier as low as possible. For a shunt capacity of 25 pF and a bandwidth of 7 MHz, a 4 nA RMS can be obtained (D3A tube, FET 2N 4416 transistor).

Environmental characteristics and life

1 - The tube is designed to offer good resistance to shock and vibration. However, care should be taken in the design of camera head so to avoid microphonics. The tube can be provided encapsulated in a silicone rubber compound which protects the image section from humidity and breakdown.

2 - The tube can be operated between −30 °C to +50 °C without any appreciable effect upon its performances. However, it is advisable to operate at room temperature.

3 - The average life time is in excess of 500 hours.

TUBE CHARACTERISTICS

Geometrical characteristics :

Length	225	mm
Max. diameter (potted type)	80	mm
Useful field	25	mm
Scanning section diameter	26	mm

General characteristics :

- Image section

Input window	fiber optics (6 μ elementary fiber)
Faceplate	Flat
Photocathode	S20
Image diameter	25 mm
Useful dimensions	15 x 20 mm^2
Focus	electrostatic (diode)

- Scanning section

Diameter of scanned target	17 mm
Focus and deflection	magnetic
Alignment	Gerhard 200/1K1 coils or equivalent Gerhard BV 80/3 or BV 80/7 coils or equivalent
Heater	6.3 V - 150 mA

OPERATING CONDITIONS

Absolute ratings

Photocathode PC voltage	−12	kV
Anode voltage	0	
Target voltage	40	V
Grid g5 voltage	30	V
Cathode C voltage	0	
Electrode g1 voltage	−150	V
Electrode g2 voltage	400	V
Electrode g3 voltage (to be adjusted)	400	V
Electrode g4 voltage	600	V
Heater voltage	6.9	V

Typical operation

Photocathode PC voltage	−8	kV
Anode voltage	0	
Target voltage	5 to 30	V
Grid g5 voltage	15	V
Cathode C voltage	0	
Electrode g1 voltage	−80	V
Electrode g2 voltage	300	V
Electrode g3 voltage (to be adjusted)	320	V
Electrode g4 voltage	360	V
Heater voltage	6.3	V
Blanking peak to peak voltage : applied to cathode	+30	V
applied to electrode g1	−80	V
Output capacitance (signal electrode to all other electrodes)	25	pF
Focusing magnetic field	40	Gausses

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Electronoptic performances

Absolute sensitivity		15 000	μA/lumen
Operating sensitivity		45	μA/f.c.
Maximum signal current		300	nA
Resolution (i_s = 150 nA)			
400 pts/line	amplitude response	40	%
600 pts/line	amplitude response	10	%
Persistence (i_s = 100 nA)			
3rd frame after illumination is removed		⩽ 5	%
10th frame after illumination is removed		< 1	%

OPERATING RECOMMENDATIONS

The Esicon is a rugged tube easy to use. However, care must be taken so to avoid all risk of damage to the tube liable to alter its performances.

Important recommendations

1 - A protecting device is supplied to limit the potential difference between the target and the suppressor.This should not be disconnected.

2 - The scanning voltages must be applied before electrode voltages. For shutdown, deflection power should be switched off only after the reading beam has been removed.

3 - When operating the tube, apply the high voltage in the last sequence. For shutdown, switch off the high voltage before other voltages.

4 - The tube should not be operated at exposure levels greater than those given in figure 1*.

5 - It is recommended not to exceed the given values for target and suppressor voltages**. If destabilization occurs, resulting in loss of gain and sometimes in negative image, reduce exposure level and set the suppressor grid to 5 V. Check eventually the beam current to make sure that it is sufficient to discharge the target. When the stabilization voltage becomes normal, the tube recovers its characteristics.

6 - The horizontal and vertical deflection power should be adjusted to assure that the target is either normally scanned, or over scanned. Avoid underscanning.

* *However, damage due to unduly high light exposure disappears in a few minutes if over exposure time is not too long.*

** *See Data Sheet accompanying the tube.*

Set up procedure

1- Install the tube in the camera head using focusing, deflection and alignment coils locations shown in figure page 8. If the tube is operated in horizontal position, the short index pin should be positioned in the horizontal plane parallel to the traces of line scannings. A mask of 15 x 20 mm dimensions can be used to prevent light reaching the unscanned zones of the photocathode.

2- Connect all electrodes.

3- Apply heater, focusing, deflection and alignment voltages.

4- Apply −120 V to g1. Then apply voltages to g2 ; g3, g4 electrodes.

5- Increase the grid g1 voltage up to −50 V and adjust g5 and target voltage to obtain recommended values.

6- Apply about 0.1 mf. c illumination to the faceplate.

7- Apply progressively the high voltage and adjust the g1 voltage until the beam current is sufficient to discharge the target.

8- Focus and center a pattern on the faceplate. The illumination level should be 1 mf. c.

9- Adjust the deflection amplitude such that the target ring is visible at the corners of image. Decrease the deflection power so to obtain the normal scanning area.

10- Adjust the focusing by varying g3 voltage and optimize the optical focus. The electrode g4 voltage should be maintained above that of electrode g3 by about 30 to 40 Volts.

11- Adjust alignment currents in the following manner :

- reduce g5 voltage to a value just above the threshold for beam landing ;
- adjust the alignment current to center the area over which the beam can land ;
- if more than 2 V on g5 is necessary for beam to land over the entire area, check the positions of focusing and deflection coils.

12- Shift g5 voltage to normal value, check g3 voltage and optical focus.

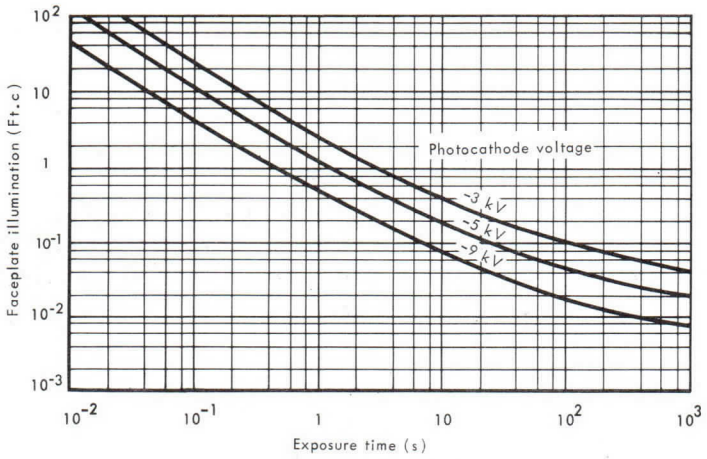


Fig 1 - Maximum exposure levels

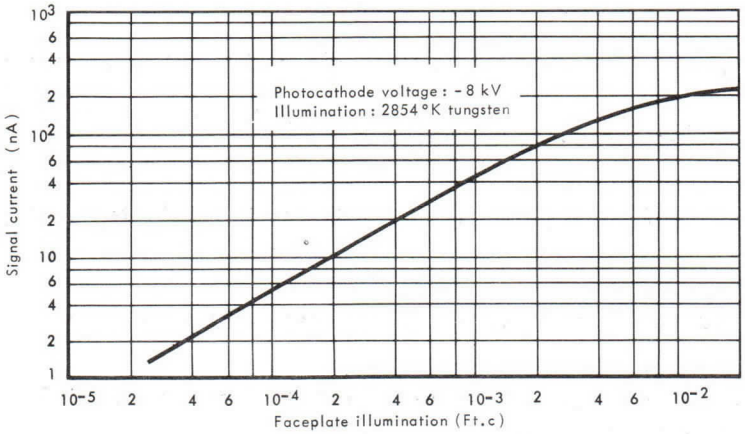


Fig 2 - Light transfer characteristic

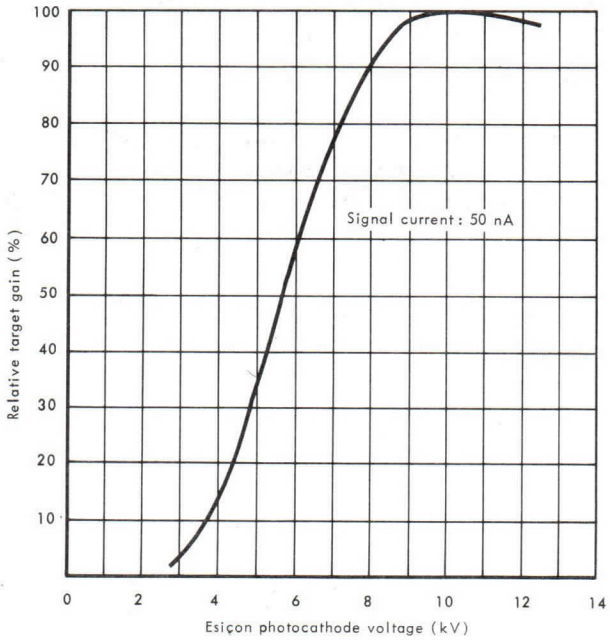


Fig 3 - Relative gain vs. photocathode voltage

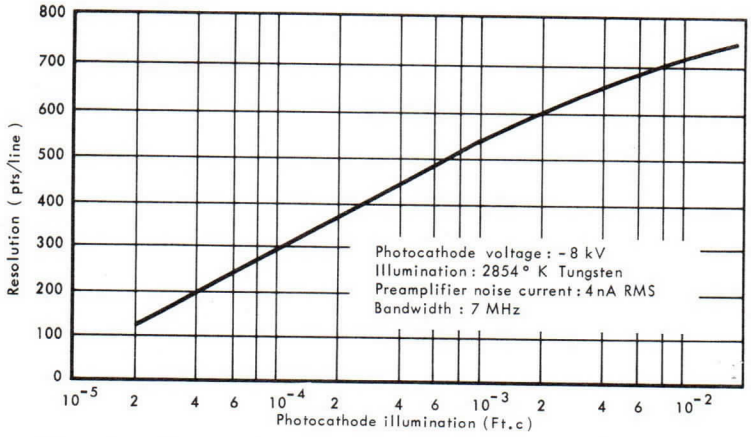


Fig 4 - Resolution vs photocathode illumination

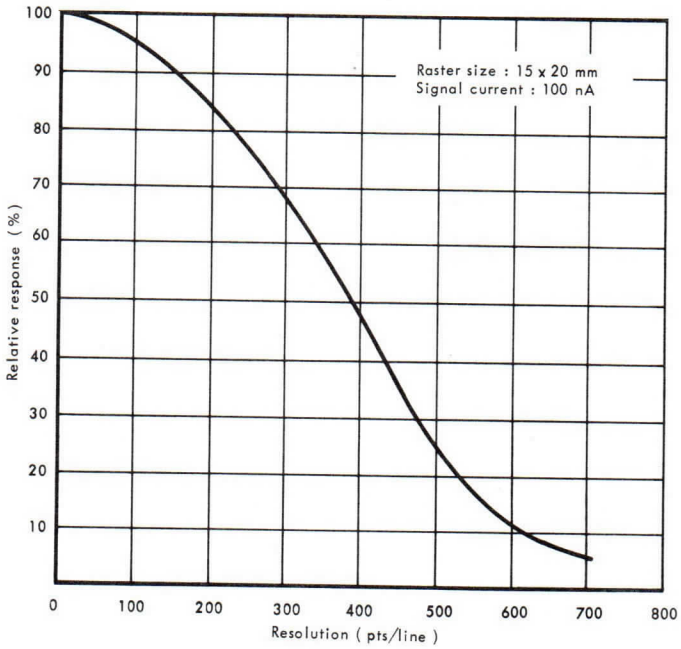


Fig 5 - Modulation transfer function

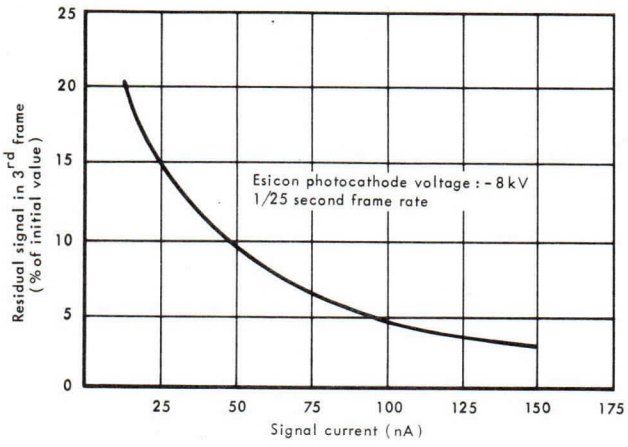


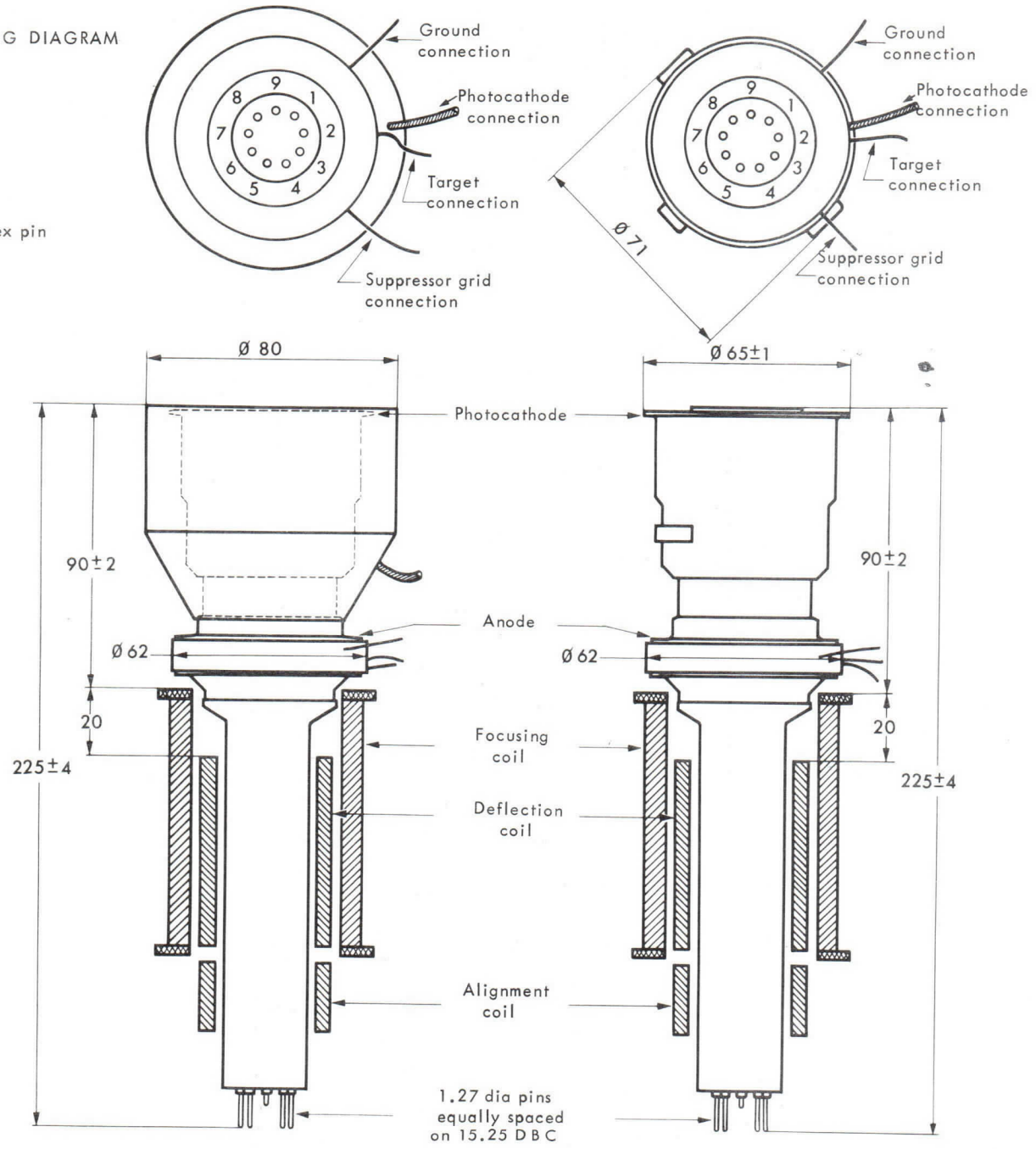
Fig 6 - Residual vs signal current

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING

BASING DIAGRAM

1 - F
2 - g1
3 - g4
4 - g1
5 - g2
6 - g3
7 - C
8 - F
9 - Index pin



Encapsulated tube

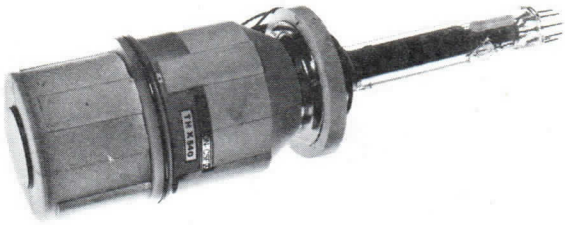
Tube not encapsulated

Dimensions in mm.

TH X540 SUPER ESICON

CAMERA TUBE FOR LOW LIGHT LEVEL T.V.

The TH X540 SUPER-ESICON is a very high sensitivity camera tube composed of an ESICON (TH X538) mechanically coupled by fiber optics with an electrostatic focus image intensifier (TH 9473).



The useful diameter of the flat input faceplate is 25 mm and the photocathode is of the S-25 type with a spectral response in visible spectrum extended to the near infrared.

The high gain secondary emission target allows the tube to operate over a wide range of illumination and specially at low light level where the low image persistence makes easier the viewing of moving scenes. Furthermore, regions of a scene which is sufficiently bright to cause saturation do not produce halation altering the surrounding information.

The very low dark current of the target enables excellent storage characteristics and permits the integration of low light level images for extended period of time. The TH X 540 also performs well at slow scanning rate as used with narrow bandwidth transmission channel.

The high voltages required for the Intensifier and the image section of the Esicon can be obtained from a small size modular power supply. The requirements for the scanning section electrodes and the scanning power supply are similar to those of a standard 1'' magnetically focused and deflected Vidicon.

PERFORMANCE DATA

Spectral response

The spectral response is that of a S25 type photocathode which is deposited on the fiber optics input window. The maximum quantum efficiency is 15 % and corresponding wavelength is 450 nm.

Typical sensitivities are 12 mA/W at 800 nm and 6 mA/W at 850 nm.

The photocathode has a white light sensitivity (2854 °K) in the order of 200 μA/lumen.

Overall sensitivity

High efficiency of the input photocathode combined with the gain of the Intensifier and the gain of the target permit a typical overall sensitivity of 2 mA/f.c (signal current/input illumination). With illuminated area of 15 x 20 mm^2, equivalent sensitivity is near to 700 mA/lumen.

Light transfer characteristics

The TH X540 can be used for photocathode illumination from 510^{-7} to 210^{-4} f.c. The gamma varies from 1 at very low light level to 0. 6 at 10^{-4} f.c. At higher light levels the target saturates at a potential near to that of the suppressor grid which provides a knee in the transfer curve. It is advisable not to exceed the indicated values because excessive illumination may cause temporary or permanent "burn-in". However, the tube can be safely operated at higher light levels by reducing the voltages applied to the intensifier and the Esicon. By combining these two parameters it is possible to cover a dynamic illumination range in the order of 5. 10^3.

Persistence

The signal generating mechanism of the target is essentially lagless due to the target design.
Typical residual signal at third frame is 5 % for a signal current of 100 nA.

Resolution

The limiting resolution is 650 pts/line at center of image for stationary scenes and 10^{-4} f.c. faceplate illumination. Because of the low lag characteristics, good dynamic resolution can be obtained : a typical value of limiting dynamic resolution is 500 pts/line for an object moving across the picture width in 10 seconds.

Integration and storage

A signal can be integrated over a period of several minutes without degradation due to target leakage. It can be stored for many hours provided the photocathode voltage is turned off. The maximum integration period is limited by the dark current of the intensifier and the transfer section of the Esicon and the low illumination due to the electron gun cathode.

If excessive photon noise occurs, it may be found advantageous to reduce the gain of the tube by reducing the high voltage and to operate the tube with longer integration periods.

OPERATING CONSIDERATIONS

Supplies and circuits

When using a basic Vidicon camera three additional voltage supplies are required :
– 25 kV to be applied to the Intensifier photocathode
– 12 kV to be applied to the Esicon photocathode
and 30 V to be applied to the suppressor grid.
In order to maximize the signal to noise ratio, it is necessary to keep the input noise current as low as possible. For a shunt capacity of 25 pF and a bandwidth of 7 MHz, a 4 nA R.M.S. noise current can be obtained with a preamplifier using D3A tube or FET 2N 4416 transistor.

Environmental characteristics and life

1 - The Super-Esicon is designed to offer good resistance to shock and vibration. However, care should be taken in the design of the camera head so to avoid microphonics. The tube can be provided encapsulated in a silicone rubber compound which protects the intensifier and the image section from humidity and break-down.

2 - The tube can be operated between –30 °C and + 50 °C without any appreciable effect upon its performances. However, it is advisable to operate at room temperature.

3 - The average life time is in excess of 500 hours.

TUBE CHARACTERISTICS

Geometrical characteristics

Length	285	mm
Maximum diameter (potted type)	80	mm
Useful field	25	mm
Scanning section diameter	26	mm

General characteristics

- Intensifier and image section	
Input window	flat fiber optics faceplate
Photocathode	S - 25
Image diameter	25 mm
Useful diameter	15 x 20 mm^2
Focus	Electrostatic
- Scanning section	
Diameter of scanned target	17 mm
Focus and deflection	Magnetic Gerhard 2001 K 1 coils or equivalent
Alignment	Gerhard BV 80/3 coils or BV 80/7 or equivalent
Filament	6. 3 V - 150 mA

OPERATING CONDITIONS

Absolute ratings

Intensifier photocathode voltage Vg9 (with respect to cathode)	−25	kV
Intensifier photocathode voltage (with respect to Esicon photocathode)	−15	kV
Esicon photocathode voltage Vg8 (with respect to cathode)	−12	kV
Esicon anode voltage Vg7	0	
Target voltage Vg6	40	V
Grid g5 voltage	30	V
Cathode voltage	0	
Electrode g1 voltage	−150	V
Electrode g2 voltage	400	V
Electrode g3 voltage	400	V
Electrode g4 voltage	600	V
Heater voltage	6. 9	V

Typical operation

Intensifier photocathode voltage Vg9 (with respect to cathode)	−23	kV
Esicon photocathode voltage Vg8 (with respect to cathode)	−8	kV
Esicon anode voltage Vg7	0	
Target voltage Vg6	5 to 30	V
Grid g5 voltage	15	V
Cathode voltage	0	
Electrode g1 voltage	−80	V
Electrode g2 voltage	300	V
Electrode g3 voltage	320	V
Electrode g4 voltage	360	V
Heater voltage	6. 3	V
Blanking peak to peak voltage		
- applied to cathode	+30	V
- applied to electrode g1	−80	V
Output capacitance (signal electrode to all other electrodes)	25	pF
Focusing magnetic field	40	Gausses

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Electronoptic performances

Overall sensitivity	2	mA/f.c.
Maximum signal current	300	nA
Resolution (i_s = 100 nA)		
300 pts/line . . . . . amplitude response.	40	%
600 pts/line . . . . . amplitude response.	5	%
Persistence (i_s = 100 nA)		
3rd frame after illumination is removed	$\leqslant 5$	%
10th frame after illumination is removed	< 1	%

OPERATING RECOMMENDATIONS

The SUPER-ESICON is a rugged tube easy to use. However care must be taken so to avoid all risk of damage to the tube.

Important recommendations

1 - A protecting device is supplied to limit the potential difference between the target and the suppressor. This should not be disconnected.

2 - The scanning voltages should be applied before electrode voltages applications. For shutdown, deflection power should be switched off only after the electron beam has been removed.

3 - When operating the tube, apply the high voltage in the last sequence. For shutdown, switch off the high voltage before the other voltages.

4 - The tube should not be operated at exposure levels greater than those given in figure 1*.

5 - It is recommended not to exceed the given values for target and suppressor voltages**. If destabilization occurs resulting in loss of gain and sometimes in negative image, reduce exposure level and set the suppressor grid to 5 Volts. Check eventually the beam current to make sure that it is sufficient to discharge the target. When the stabilization voltage becomes normal, the tube recovers its characteristics.

6 - The horizontal and vertical deflection power should be adjusted to assure that the target is either normally scanned or over scanned. Avoid underscanning.

7 - As high voltage is applied to the input faceplate a good design of the camera and particulary of lens fixture is necessary in order to prevent arcing and breakdown which would impair the fiber optics face plate or cause a high dark current equivalent illumination.

* *However, damage due to unduly high light exposure disappears in a few minutes if over exposure time is not too long.*

** *See Data Sheet accompanying the tube.*

Set up procedure

1 - Install the tube in the camera head using focusing, deflection and alignment coils locations shown in figure page 8. If the tube is operated in horizontal position, the short index pin should be positioned in the horizontal plane parallel to the traces of line scannings. A mask of 15 x 20 mm dimensions can be used to prevent light reaching the unscanned zones of the photocathode.

2 - Connect all electrodes.

3 - Apply heater, focusing, deflection and alignment voltages.

4 - Apply −120 V to g1. Then apply voltages to g2 , g3, g4 electrodes.

5 - Increase the grid g1 voltage up to −50 V and adjust g5 and target voltage to obtain recommended values.

6 - Apply about 0.01 mf.c. illumination to the faceplate.

7 - Apply progressively the high voltage and adjust the g1 voltage until the beam current is sufficient to discharge the target.

8 - Focus and center a pattern on the faceplate. The illumination level should be 0. 1 mf.c.

9 - Adjust the deflection amplitude such that the target ring is visible at the corners of image. Decrease the deflection power so to obtain the normal scanning area.

10 - Adjust the focusing by varying g3 voltage and optimize the optical focus. The electrode g4 voltage should be maintained above that of electrode g3 by about 30 to 40 Volts.

11 - Adjust alignment currents in the following manner :

- reduce g5 voltage to a value just above the threshold for beam landing ;
- adjust the alignment current to center the area over which the beam can land ;
- if more than 2 V on g5 is necessary for beam to land over the entire area, check the positions of focusing and deflection coils.

12 - Shift g5 voltage to normal value, check g3 voltage and optical focus.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

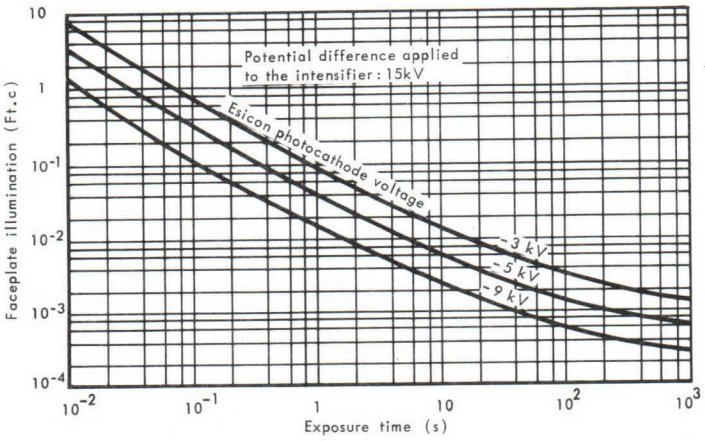


Fig1 - Maximum exposure levels.

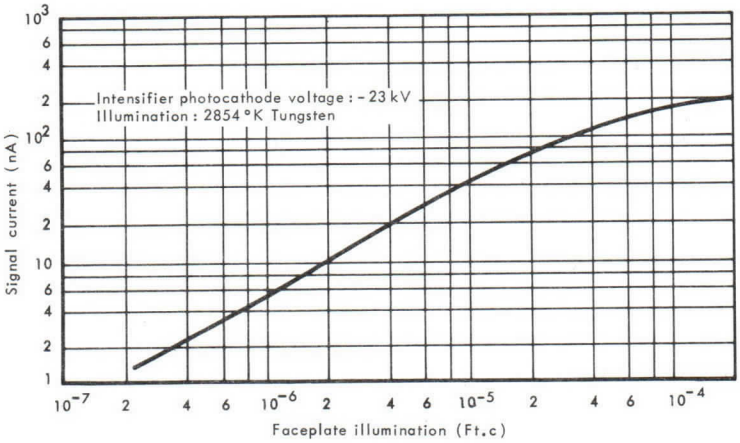


Fig 2 - Light transfer characteristic.

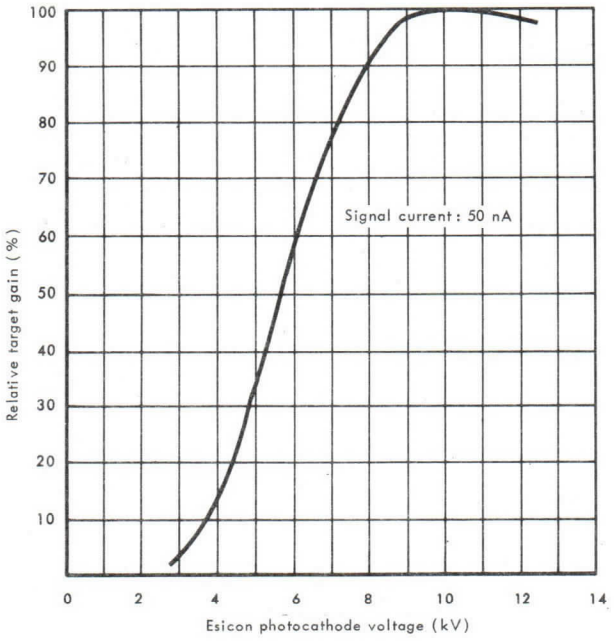


Fig 3 - Relative gain Vs. Esicon photocathode voltage.

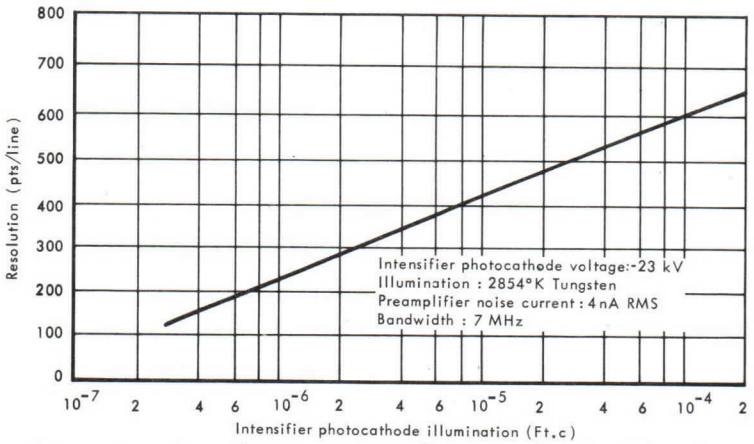


Fig. 4 - Resolution Vs. photocathode illumination.

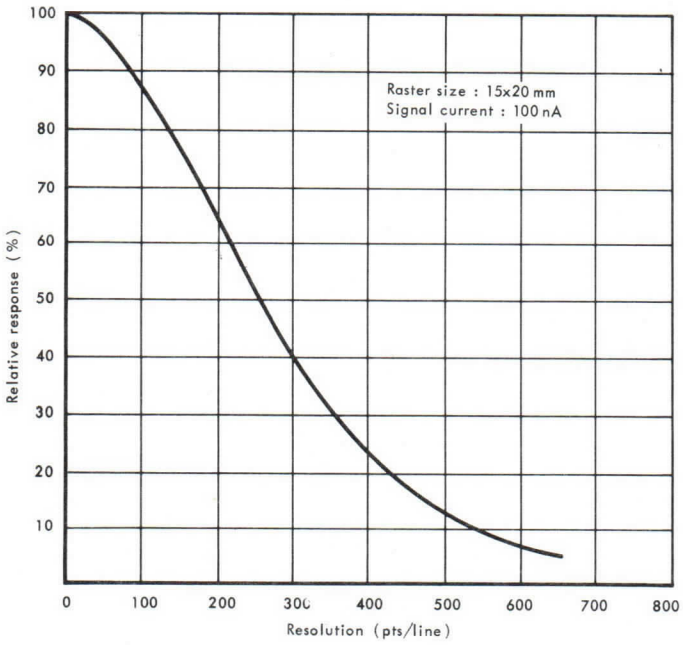


Fig. 5 - Modulation transfer function.

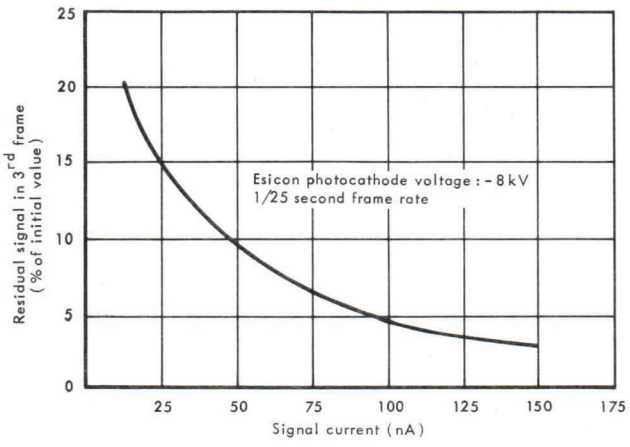
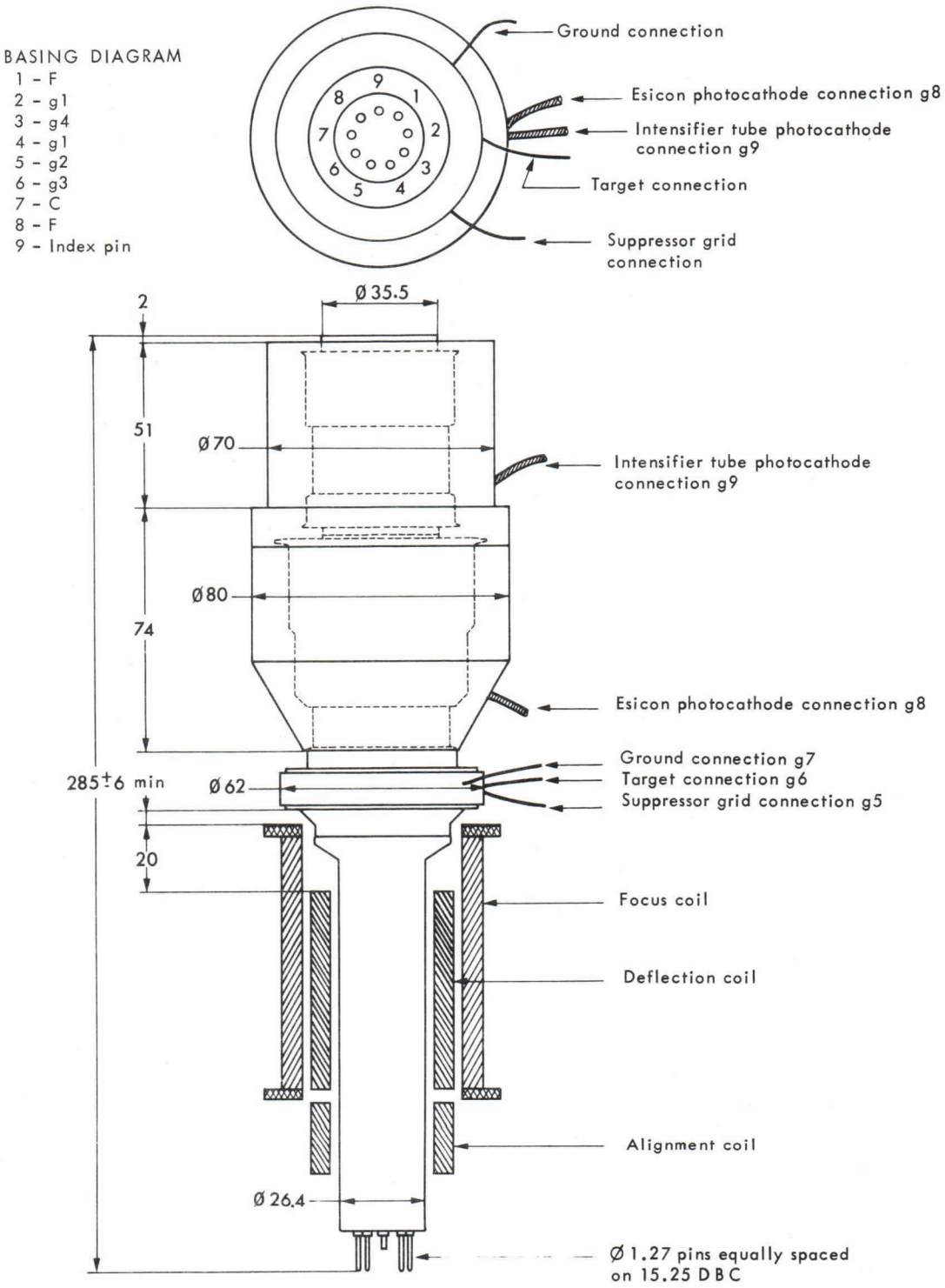


Fig. - Residual Vs. signal current.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING



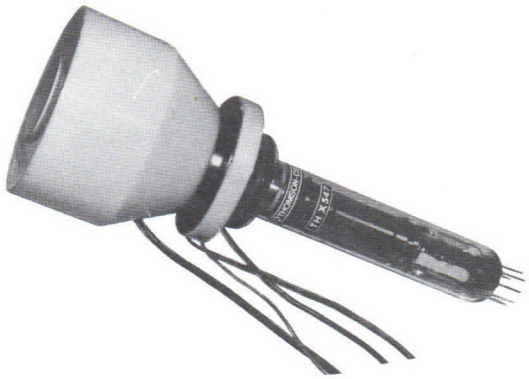
Encapsulated tube

Dimensions in mm.

ESICON TH X547
TUBE DE PRISE DE VUE
A BAS NIVEAU DE LUMIERE

- STRUCTURE RENFORCEE
- SENSIBILITE ELEVEE (15000 µA/lm)
- FAIBLE PERSISTANCE
- POSSIBILITE D'INTEGRATION ET DE MEMOIRE
- TELEVISION MILITAIRE ET SPATIALE

Le tube TH X547 est un tube compact de grande sensibilité pour prise de vue à des niveaux incidents aussi faibles que 1 mlux, à bon pouvoir de résolution et faible persistance d'image. Sa robustesse permet de l'utiliser dans des conditions d'environnement sévères (vibrations, secousses, température, ...)



Il comporte une photocathode tri-alcaline déposée sur une face d'entree à fibres optiques, plan-concave, une section de transfert électrostatique du type diode, une cible multiplicatrice à gain élevé et un canon de lecture du même type que celui des Vidicons classiques mais à structure renforcée qui destine plus particulièrement le TH X547 aux applications militaires et spatiales.

La cible utilisée permet un fonctionnement dans une grande dynamique d'éclairement et notamment aux faibles niveaux de lumière pour lesquels la très faible persistance d'image facilite l'observation des sujets mobiles. Par ailleurs, les parties d'image très brillantes causant une saturation du signal n'introduisent pas d'effets de redistribution détériorant la visibilité des détails dans les régions voisines de l'image.

Le très faible courant d'obscurité de cible permet d'obtenir d'excellentes propriétés d'accumulation, de mémoire et rend possible l'intégration d'images à très faibles niveaux lumineux pendant de longues périodes ainsi que le fonctionnement avec une faible cadence d'analyse.

Ces diverses caractéristiques permettent d'aborder une très grande variété d'applications en prise de vue noir et blanc et en couleur.

Le tube TH X547 peut être utilisé directement avec un système optique classique ou être couplé par optiques à fibres avec un intensificateur d'image augmentant la sensibilité de détection ou permettant la conversion d'images dans le domaine des rayons X, de l'ultraviolet ou de l'infrarouge. L'emploi de bobines de concentration et de déviation spécialement mises au point est indispensable pour l'utilisation du tube dans les conditions d'environnement sévères.

PERFORMANCES DU TUBE

Sensibilité et dynamique - Réponse spectrale

Le tube TH X547 utilise une photocathode type S20 déposée sur une fenêtre d'entrée à fibres optiques dont l'efficacité quantique est de l'ordre de 15 % à son maximum (440 nm). Cette grande efficacité, jointe au gain de la cible, permet d'obtenir une sensibilité de l'ordre de 15 000 µA/lumen à 10 mlux.

Cette sensibilité permet un fonctionnement correct sans ajustement du tube entre 1 et 100 mlux incidents sur la face d'entrée. Le gamma qui est unitaire entre 5 et 10 mlux décroit jusqu'à 0,6 vers 100 mlux.

La sensibilité peut être modifiée par variation de la haute tension appliquée à la photocathode sans perte appréciable de résolution, dans un rapport de l'ordre de 1 à 10. La dynamique d'éclairement qui en résulte est de l'ordre de 2.10^3.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Persistance

Le mécanisme de génération, d'accumulation et de neutralisation des charges électriques sur la cible permet l'obtention d'une très faible persistance d'image qui n'est limitée que par l'acceptation du faisceau de lecture. Le signal résiduel est typiquement, pour la troisième trame balayée, de 8 % pour un courant de signal de 50 nA et de 5 % pour un courant de signal de 100 nA.

Pouvoir de résolution

Sur image statique, la résolution limite est de l'ordre de 800 points par ligne au centre de l'image et de 600 points par ligne sur les bords avec possibilité de correction dynamique.

Les caractéristiques de persistance permettent, par ailleurs, de conserver un pouvoir de résolution très bon sur des scènes mobiles et confèrent au tube une sensibilité dynamique élevée.

Intégration et mémoire

Il est possible d'intégrer un signal lumineux pendant plusieurs minutes et de le lire quelques heures après avoir coupé la haute tension. Les limites d'intégration proviennent du courant d'obscurité de la section de transfert de l'Esicon et de l'éclairement de la cathode du canon.

Lorsque le bruit photonique est trop important, il peut être intéressant de réduire le gain du tube en diminuant la haute tension et de travailler avec des temps d'intégration plus longs.

RECOMMANDATIONS D'UTILISATION

Alimentation et circuits annexes

Les circuits d'alimentation sont ceux utilisés pour les Vidicons à focalisation et déflexion électromagnétiques. Deux tensions additionnelles sont nécessaires : l'une de −12 kV pour l'alimentation de la photocathode, l'autre pour la grille de stabilisation de 30 V qui peut être obtenue par diviseur à partir de l'alimentation normale.

Pour l'obtention d'un rapport signal/bruit satisfaisant, il est nécessaire d'associer un préamplificateur à faible bruit. Pour une capacité parallèle de 25 pF et une bande passante de 7 MHz, un courant de bruit équivalent quadratique moyen de 4 nA peut être obtenu (tube D3A - Transistor FET 2N 4416).

Environnement et durée de vie

1 - Le tube est conçu pour que les signaux parasites dus à des résonances mécaniques internes aient des niveaux très faibles. Il reste malgré tout important de veiller au montage du tube dans la caméra, de façon à ce que les amplitudes de vibration transmises soient aussi faibles que possible. Par ailleurs, le tube peut être fourni avec un enrobage isolant de la section image constituant une protection contre l'humidité et les amorçages éventuels.

2 - Le fonctionnement du tube reste correct dans un large domaine de température (−50 à +50 °C). Il est recommandé, malgré tout, de le faire fonctionner au voisinage de l'ambiance.

3 - La durée de vie moyenne est supérieure à 500 h.

CARACTERISTIQUES GENERALES

Mécaniques

Longueur hors-tout	225	mm
Diametre hors-tout :		
- tube non enrobé	71	mm
- tube enrobé	80	mm
Diamètre section analyse	26	mm
Embase	UTE 9 C 15 (JEDEC E8 - 11)	
Masse approximative :		
- tube non enrobé	280	g
- tube enrobé	450	g

Electriques

- SECTION IMAGE		
Concentration	électrostatique (diode)	
- SECTION ANALYSE		
Tension filament	6,3	V
Courant filament	150	mA
Capacité de sortie (entre électrode de signal et les autres électrodes)	25	pF
Concentration et déviation (note 1)	électromagnétiques	
Alignement (note 1)	électromagnétique	

Optiques

- SECTION IMAGE		
Fenêtre d'entrée	optique à fibres (fibre élémentaire 6 μ)	
Face d'entrée	plane	
Photocathode	S20	
Diamètre image	25	mm
Dimensions utiles	15 x 20	mm
- SECTION ANALYSE		
Diamètre de cible balayée	17	mm

Note 1 - Pour la vérification des performances électriques du tube ou pour son utilisation dans des conditions d'environnement peu sévères il est possible d'employer les bobines suivantes :

- *Concentration et déviation : bobines Gerhard 200 MKI ou équivalent ;*
- *Alignement : bobines Gerhard BV 80/3 ou BV 80/7 ou équivalent.*

Dans le cas d'environnement sévère et afin d'utiliser au mieux toutes les possibilités du tube, des bobines spécialement conçues, ayant les mêmes caractéristiques électriques que les bobines standard, seront nécessaires.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

CONDITIONS D'EMPLOI

Les tensions sont données par rapport à la masse, l'anode de la section image et la cathode de la section analyse étant reliées à la masse.

Valeurs limites d'utilisation

Tension de photocathode PC - valeur continue négative	max.	12 000	V
- valeur continue positive	max.	0	V
Tension anodique		0	V
Tension d'électrode de signal (cible)	max.	40	V
Tension de grille g5 (grille de stabilisation)	max.	30	V
Tension de cathode k		0	V
Tension de grille g1 (polarisation) - valeur continue négative	max.	150	V
- valeur continue positive	max.	0	V
Tension de grille g2 (accélération)	max.	400	V
Tension de grille g3 (de paroi)	max.	400	V
Tension de grille g4 (de champ)	max.	600	V
Tension de filament	max.	6, 9	V
	min.	5, 7	V
Tension entre filament et cathode :			
filament négatif par rapport à la cathode	max.	125	V
filament positif par rapport à la cathode	max.	10	V
Température ambiante - en stockage	max.	+85	°C
	min.	−62	°C
- en fonctionnement	max.	+50	°C
	min.	−50	°C

Valeurs typiques d'utilisation

Température	+20 à +30	°C
- SECTION IMAGE		
Tension de photocathode	−8000	V
Tension anodique	0	V
- SECTION ANALYSE		
Tension d'électrode de signal	5 à 30	V
Tension de grille g5	15	V
Tension de cathode k	0	V
Tension de grille g1	−80	V
Tension de grille g2	300	V
Tension de grille g3	320	V
Tension de grille g4	360	V
Tension de blocage crête-crête appliquée sur : la cathode	+30	V
la grille g1	−80	V
Champ magnétique de concentration	40	gauss

Performances electro-optiques

Sensibilité absolue	15 000	µA/lumen
Sensibilité d'exploitation	4, 5	µA/lux
Courant de signal maximal	300	nA
Résolution (I_s = 100 nA) - 400 points par ligne . . modulation	40	%
- 600 points par ligne . . modulation	10	%
Persistance (I_s = 100 nA) - 3ème trame balayée après extinction	$\leqslant 5$	%
- 10ème trame balayée après extinction	< 1	%

ESSAIS D'ENVIRONNEMENT

Le tube TH X547 supporte hors fonctionnement les essais d'environnement suivants. Après exécution de ces essais le tube doit satisfaire aux performances électronoptiques définies dans les conditions d'emploi.

ESSAI CLIMATIQUE

Le tube est soumis à 4 cycles de température entre −50 °C et +50 °C avec maintien aux températures extrêmes pendant 30 minutes. Chaque cycle est exploré avec une variation de l'ordre de 2 °C/mn.

ESSAI EN VIBRATIONS SINUSOIDALES

L'essai est conduit conformément à la spécification MIL-T-5422 E (ASG) courbe IV.

Exploration aller-retour de la gamme 5 - 500 Hz permettant un niveau d'accélération de 10 g dans la plage 72 à 500 Hz - Durée d'un cycle 15 minutes. - Réalisation de deux cycles suivant les trois axes du tube.

ESSAI DE SECOUSSES

L'essai est réalisé conformément à CCTU 01 - 01 A Essai 24 avec :

- accélération maximale : 25 g
- nombre de secousses suivant l'axe longitudinal du tube : 1000.

CONSIGNES D'UTILISATION

L'ESICON est un tube relativement robuste et facile à utiliser. Néanmoins, il est nécessaire d'observer un certain nombre de précautions pour éviter tout risque de détérioration.

Recommandations importantes

1 - Un système de protection enrobé limite la différence de potentiel qui peut exister entre la grille de stabilisation et la cible. Il est expressément recommandé de ne pas déconnecter cette protection.

2 - Les tensions de balayage de la section d'analyse doivent être appliquées avant les tensions d'électrodes. Lorsque les prises de vues sont terminées, elles doivent être coupées après les tensions d'électrodes.

3 - Au moment des prises de vues, appliquer la très haute tension en dernier lieu. Quand les prises de vues sont terminées, il faut au contraire couper en premier la très haute tension.

4 - Le tube ne doit pas être soumis à des niveaux lumineux supérieurs à ceux définis par les courbes de la figure 1*.

5 - Il est conseillé de ne pas dépasser les tensions de cible et de grille de stabilisation indiquées**. Si le tube destabilise (phénomène qui se traduit par une perte de sensibilité et parfois par l'apparition d'une image négative), réduire l'éclairement et mettre un instant la grille de stabilisation à 5 Volts environ. Vérifier éventuellement si le courant de faisceau est suffisant pour décharger la cible. Lorsque l'on revient à la tension de stabilisation normale, le tube doit retrouver aussitôt ses caractéristiques.

6 - Les amplitudes de balayage vertical et horizontal doivent être ajustées de manière à balayer la cible au cadre normal ou un peu plus. Il faut éviter de sous balayer la cible.

* *Toutefois, le marquage apparu en cas d'éclairement trop intense mais peu prolongé disparaît généralement en quelques minutes.*

** *Voir la feuille accompagnant le tube livré.*

Montage du tube ESICON et mise en oeuvre

1 - Installer le tube dans les bobines de la caméra comme il est indiqué sur la figure . Si le tube est placé en position horizontale, la broche courte du pied du canon doit être positionnée dans le plan horizontal parallèle aux traces du balayage ligne. Un masque de dimensions 15 x 20 mm^2 peut être placé sur la face d'entrée de manière à ne pas éclairer les zones de la photocathode qui sont en dehors du cadre de balayage.

2 - Connecter les différentes électrodes.

3 - Mettre en fonctionnement le chauffage du filament, l'ensemble de concentration, déviation et alignement.

4 - Appliquer une tension de −120 Volts sur la grille g1. Appliquer ensuite les tensions des électrodes g2, g3, g4.

5 - Augmenter la tension de grille g1 jusqu'à −50 V et ajuster la tension de grille de stabilisation puis de cible aux valeurs recommandées.

6 - Eclairer la face d'entrée du tube à un niveau d'environ 1 mlux.

7 - Mettre progressivement la très haute tension et régler le courant de faisceau (grille g1).

8 - Projeter une mire sur la face d'entrée à un niveau lumineux d'environ 10 mlux.

9 - Régler les amplitudes de balayage de manière à voir l'anneau de cible dans les coins de l'image et centrer la mire. Diminuer ensuite les amplitudes pour revenir au cadre normal de balayage.

10 - Ajuster la concentration en agissant sur la tension de l'électrode g3 et parfaire la mise au point optique. La tension de l'électrode g4 doit être normalement supérieure de 30 à 40 volts à celle de l'électrode g3.

11 - Alignement du faisceau : cette opération est très simple sur les tubes ESICON. Procéder de la façon suivante :
- réduire la tension de grille de stabilisation jusqu'à ne plus observer qu'une sorte de halo,
- ajuster les courants d'alignement pour centrer le halo,
- s'il faut plus de 2 volts de tension de stabilisation pour que le faisceau atteigne toute la cible, vérifier la position des bobines de focalisation et de déviation.

12 - Mettre la tension de stabilisation à sa valeur normale et vérifier la tension d'électrode g3 et la mise au point optique.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

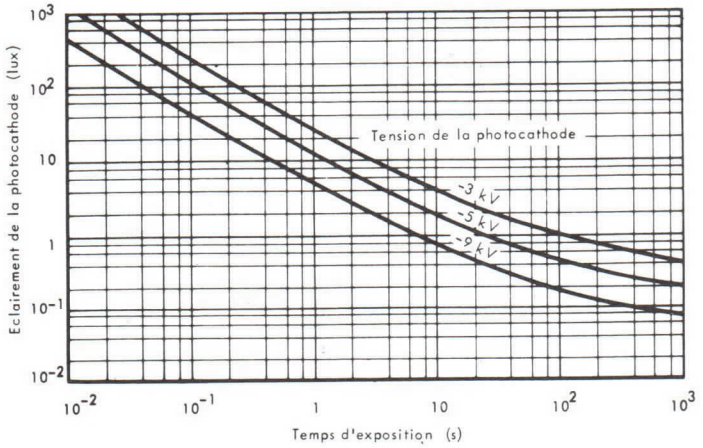


Fig 1 - Eclairements limites .

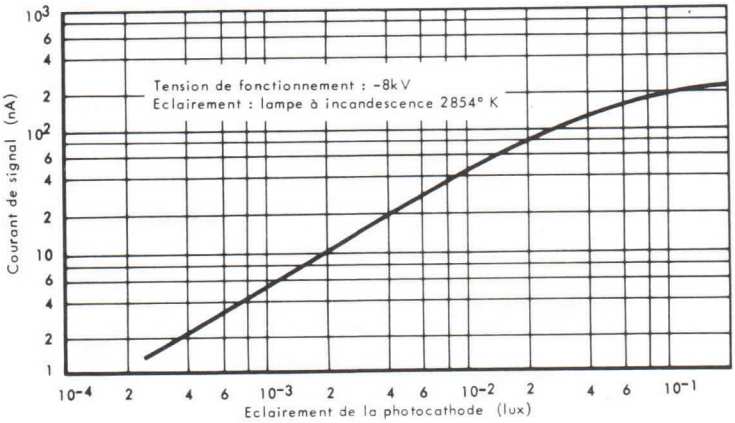


Fig 2 - Caractéristique signal - éclairement .

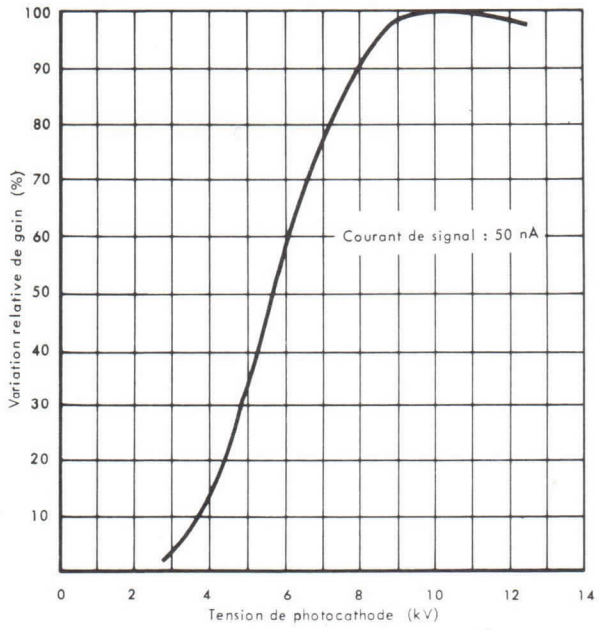


Fig 3 - Variation relative du gain de cible en fonction de la tension de la photocathode .

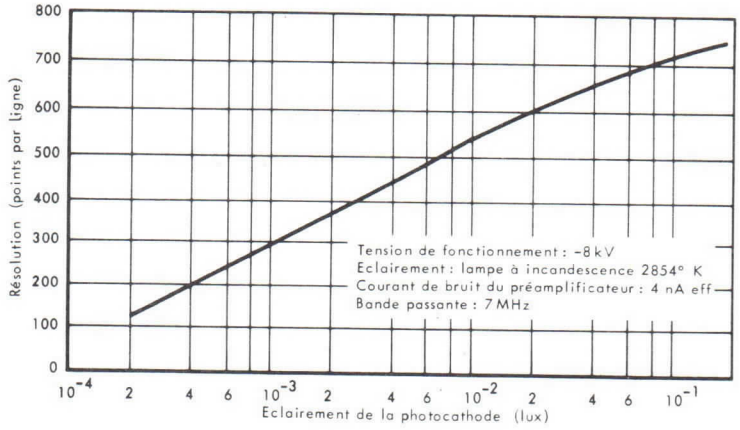


Fig 4 - Résolution statique en fonction de l'éclairement de la photocathode.

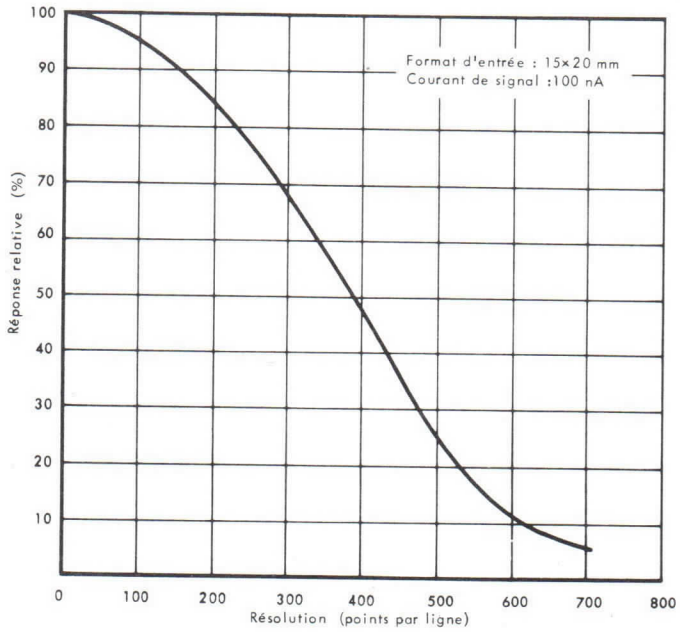


Fig 5 - Fonction de transfert de modulation

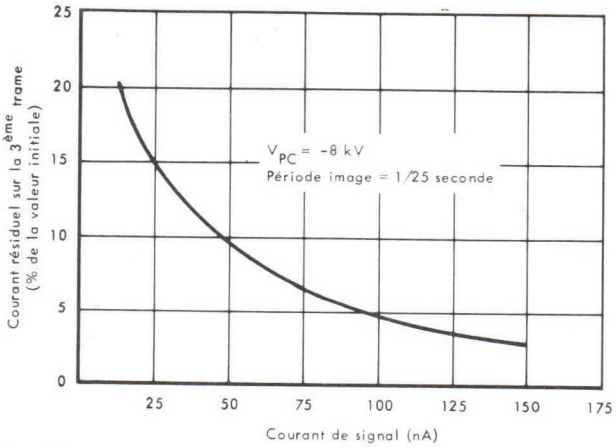
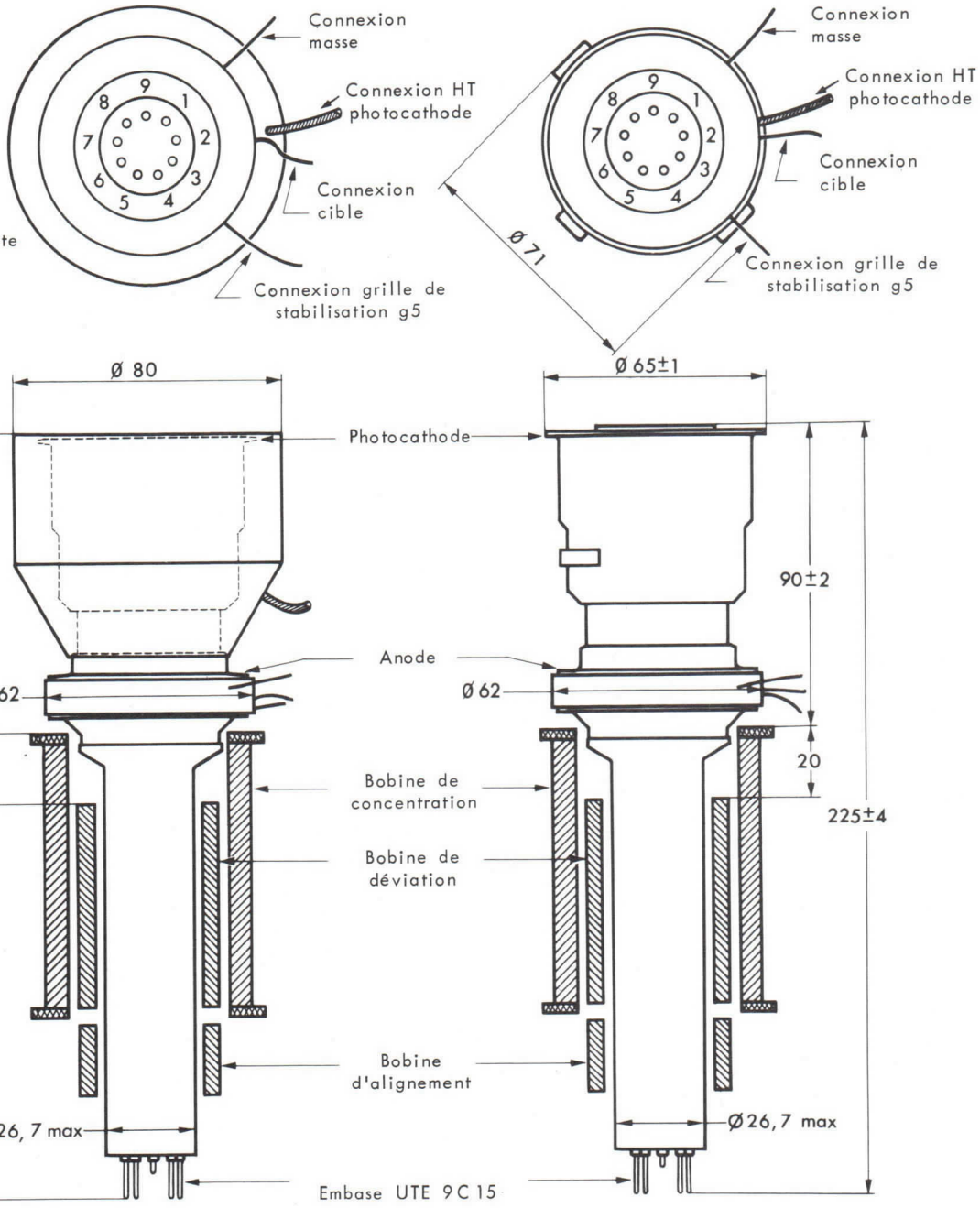


Fig 6 - Rémanence en fonction du courant de signal.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

DESSIN D'ENCOMBREMENT

BROCHAGE
1 - f
2 - g1
3 - g4
4 - g1
5 - g2
6 - g3
7 - k
8 - f
9 - Broche repère courte



Tube enrobé

Tube non enrobé

Cotes en mm.

TH 9610
VIDICON INTENSIFICATEUR

Le tube TH 9610 est un tube composite formé par couplage optique direct d'un intensificateur d'image sensible dans l'ultra-violet à un tube caméra de Télévision.

L'étage amplificateur est constitué par le tube TH 9477 de champ d'entrée 7 mm et de grandissement de l'ordre 2 à 3, comportant une photocathode au tellurure de césium déposée sur une face plane en silice fondue de haute pureté dont la transmission à la longueur d'onde de 250 nm est de 90 % environ. L'écran de sortie à fibres optiques a une émission spectrale centrée sur la région verte du spectre (P 20).

Le tube caméra est constitué par un Vidicon 1" type TH 9812 FO à face d'entrée en fibres optiques.

Ce Vidicon à focalisation et déflexion électro-magnétiques est un tube à haute sensibilité (100 nA de courant de signal pour 1 lux sur la face d'entrée à 50 nA du courant d'obscurité) et à grand pouvoir de résolution (400 pts/ligne pour un taux de modulation de 60 %).

L'ensemble ainsi réalisé constitue le tube de prise de vues TH 9610 sensible dans le proche ultra-violet pouvant fonctionner avec une caméra standard pour Vidicon légèrement modifiée (adjonction d'une source haute tension à faible débit et modification mécanique de la platine avant porte-objectif pour permettre le logement du tube intensificateur). Le tube TH 9610 permet d'obtenir une image de qualité satisfaisante avec une résolution de l'ordre de 500 points par ligne à un niveau d'énergie inférieur a 0,1 $\mu W/cm^2$ à 250 nm.

Le tube TH 9610 est fourni enrobé de résine silicone qui facilite le montage mécanique du tube dans la caméra et permet d'éviter des fuites extérieures lorsque les conditions d'humidité sont défavorables.

CARACTERISTIQUES DU TUBE

Caractéristiques mécaniques

Longueur	255	mm
Diamètre maximal	70	mm
Diamètre section d'analyse	26	mm

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Caractéristiques générales

SECTION INTENSIFICATRICE

- Glace d'entrée	Plane
Matériau de la face d'entrée	Silice fondue - épaisseur 2 mm
Photocathode	Tellurure de césium
Diamètre de l'image d'entrée	7 mm
- Glace de sortie	Plane - fibres optiques
- Type	Triode
- Focalisation	Electrostatique

SECTION D'ANALYSE

Dimensions de cible balayée	9, 5 x 12 7 mm
Focalisation	Magnétique
Deflexion	Magnétique
Filament	6, 3 V - 150 mA

CONDITIONS D'EMPLOI

Valeurs limites d'utilisation

Température ..... max .	50	°C

SECTION INTENSIFICATRICE

Tension de photocathode	−15	kV
Tension de l'électrode g1	−16	kV
Tension de l'écran	0	
Energie incidente sur la photocathode ..... max .	10	μW

SECTION D'ANALYSE

Tension de l'électrode g4 (de champ)	800	V
Tension de l'électrode g3 (de paroi)	400	V
Tension de l'électrode g2 (accélératrice)	600	V
Tension de l'électrode g1 (extinction de faisceau)	−150	V
Tension de polarisation :		
- negative ..... min .	−100	V
- positive ..... max .	0	V
Tension de l'électrode de signal	100	V
Tension filament	6, 9	V
Courant d'obscurité	100	nA
Courant de sortie crête	400	nA

Exemple de fonctionnement

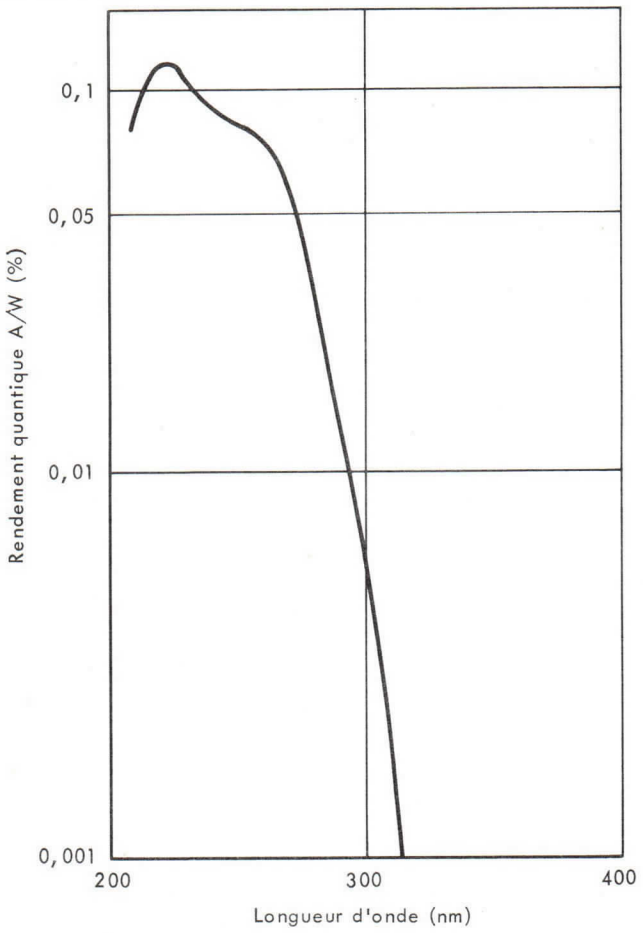
Température	25	°C
SECTION INTENSIFICATRICE		
Tension de photocathode	−12	kV
Tension de l'électrode g1	−12, 4	kV
Tension de l'écran	0	
SECTION D'ANALYSE		
Tension de l'électrode g4	600	V
Tension de l'électrode g3	300	V
Tension de l'électrode g2	300	V
Tension de l'électrode g1	−50	V
Tension crête de blocage :		
- appliquée sur g1	−30	V
- appliquée sur la cathode	10	V
Tension filament	6, 3	V

Performances électronoptiques

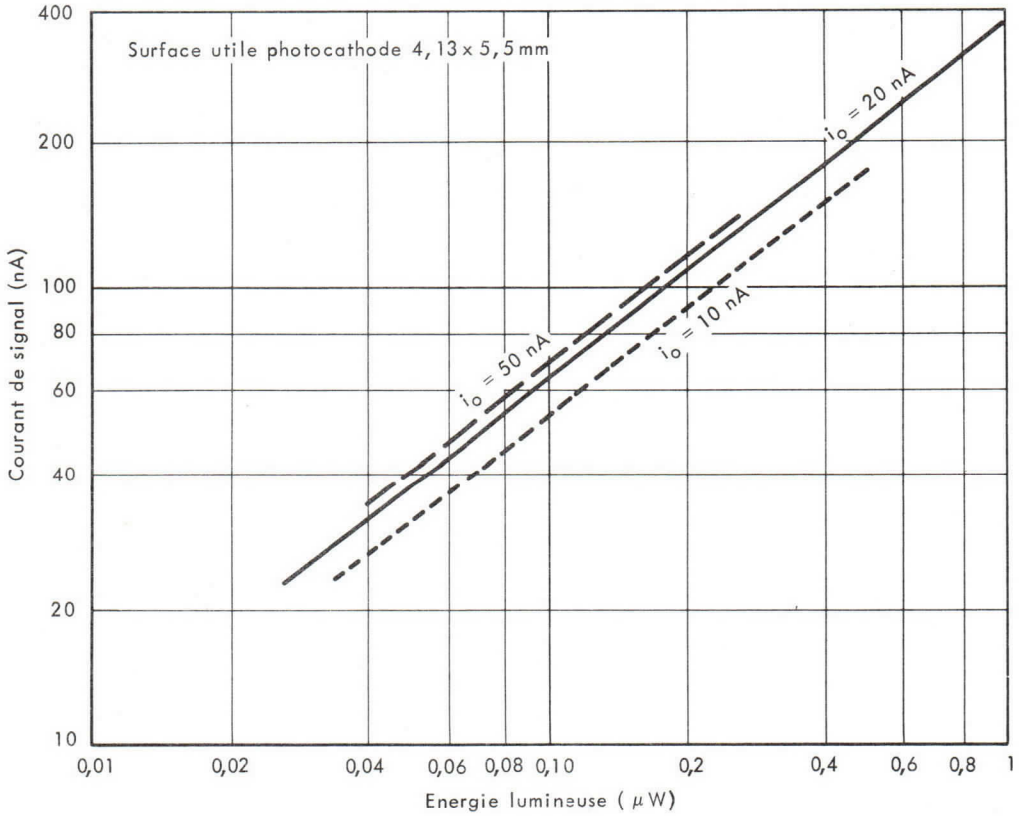
Image sur face d'entrée	4, 13 x 5, 5	mm^2
Image balayée	9, 5 x 12, 7	mm^2
Courant d'obscurité io	20	nA
Tension de l'électrode de signal	20 à 50	V
Courant de signal is	200	nA
Sensibilité (énergie à λ = 250 nm)	1	μW
Rémanence (signal résiduel 3e trame)	20	%
Gamma moyen	0, 65	
Résolution	33	pl/mm

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

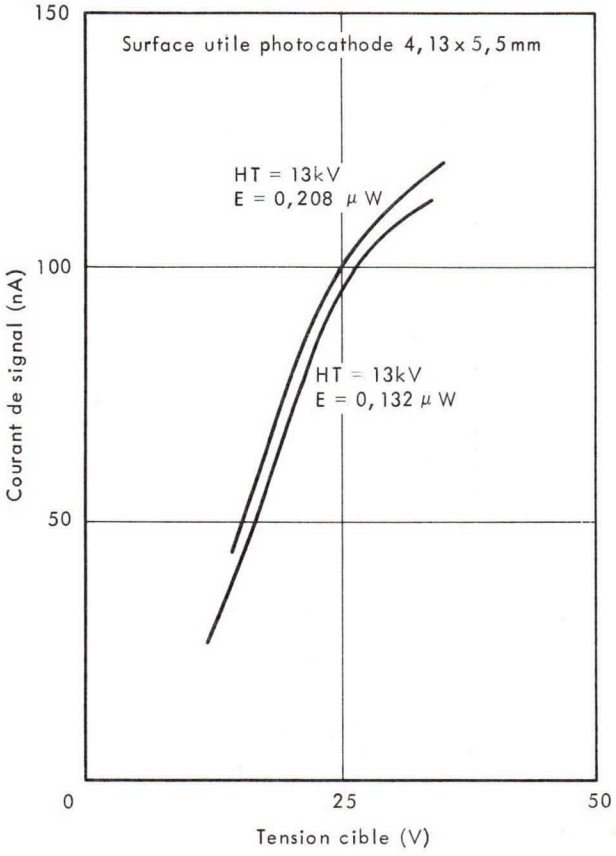
COURBE DE REPONSE SPECTRALE DE LA PHOTOCATHODE Cs2 - Te



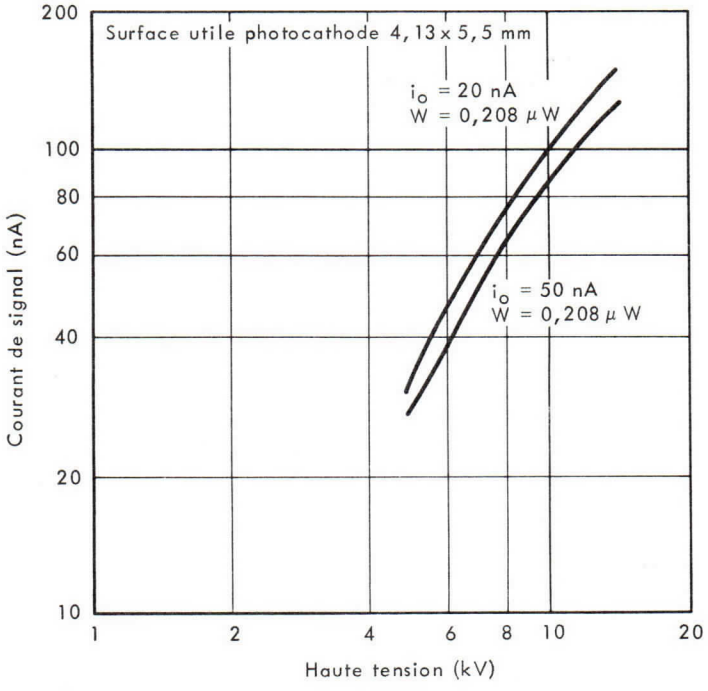
COURANT DE SIGNAL EN FONCTION DE L'ENERGIE LUMINEUSE UV



COURANT DE SIGNAL EN FONCTION DE LA TENSION CIBLE

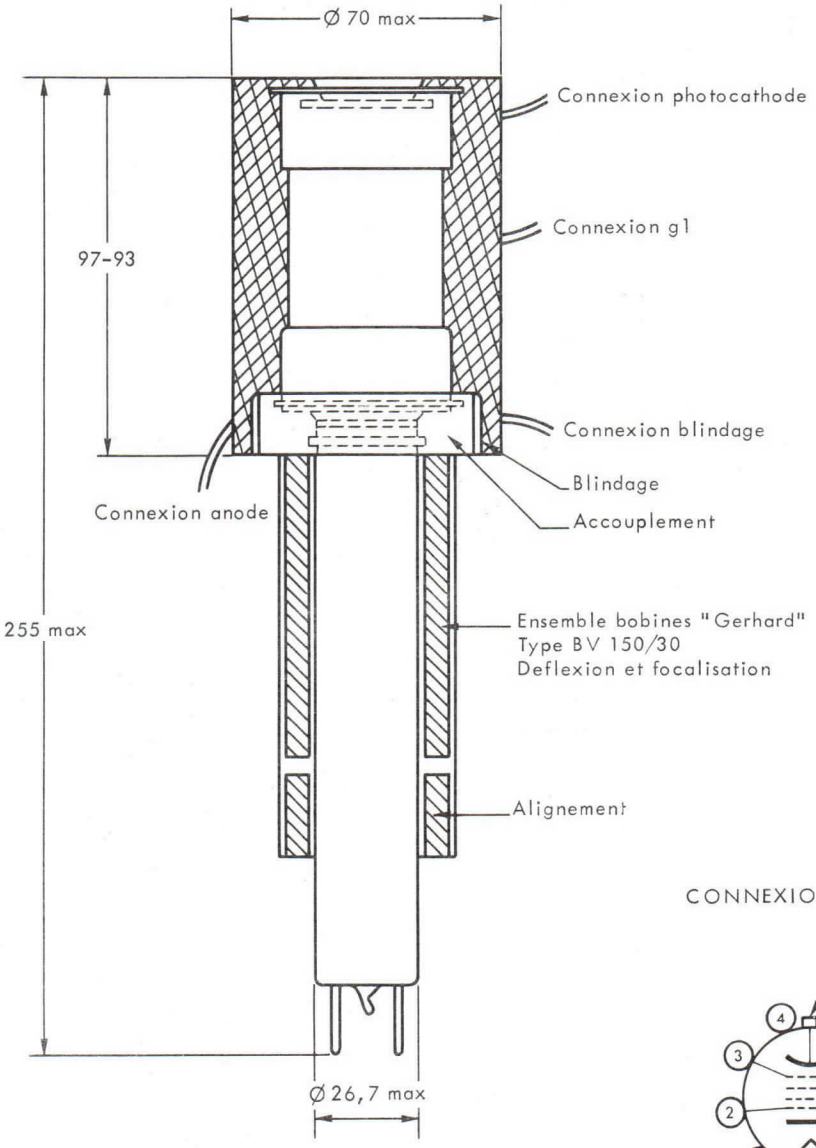


COURANT DE SIGNAL EN FONCTION DE LA HAUTE TENSION

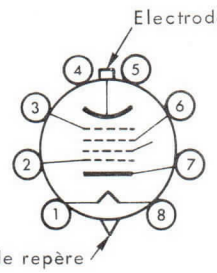


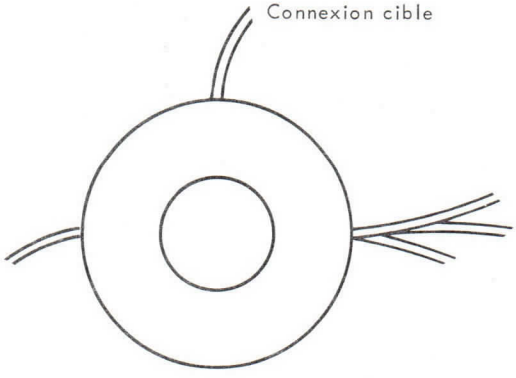
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

DESSIN D'ENCOMBREMENT



CONNEXIONS - Vue de dessous





1	F filament
2	g1 électrode
3	g4 électrode
4	connexion interne
5	g2 électrode
6	g3 électrode
7	C cathode
8	F filament

Cotes en mm.

TH 9650 ESICON*

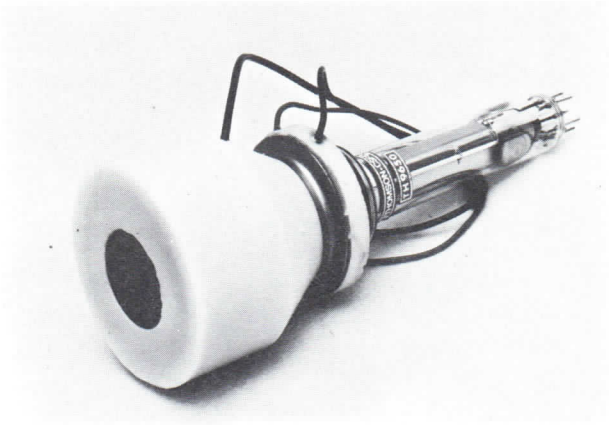
CAMERA TUBE FOR LOW LIGHT LEVEL T.V.

- S 20 PHOTOCATHODE (25 mm useful diameter)
- IMAGE SECTION : diode - electrostatic focus
- SCANNING SECTION : electromagnetic focus and deflection
- HIGH SENSITIVITY (15 000 μA/lm)
- LOW LAG
- INTEGRATION AND STORAGE CAPABILITY
- INDUSTRIAL AND SCIENTIFIC APPLICATIONS

The TH 9650 is a compact tube featuring high sensitivity, good resolution and low persistence. It is also characterized by a simplicity in operation and is designed to be used in systems which must operate under severe environmental conditions.

The TH 9650 includes a photocathode deposited on the inner surface of a plano-concave fiber optics faceplate, an electrostatically focused diode image section, a high secondary emission photoelectron multiplier target and a reading gun similar to that of conventional Vidicons.

The target properties allow the tube to operate over a wide range of illuminations and specially at low light level (1 mlux or 0.1 mfc) where the low image persistence makes easier the viewing of moving scenes. Furthermore, regions of a scene which is sufficiently bright to cause saturation do not produce halation altering the surrounding information.



The very low dark current of the target enables excellent storage characteristics thus permitting the integration of low light level images for extended periods of time. The storage and integration characteristics permit its use in narrow bandwidth slow scan systems.

Because of those characteristics, the TH 9650 makes possible a great number of applications in black and white or color camera.

The TH 9650 can be used directly with an optical lens system or fiber optically coupled to an image intensifier in order to obtain an increased sensitivity or to convert X, U.V. or I.R. radiation to light image

The tube requires only low scanning power and the accessories of conventional Vidicons can be used.

PERFORMANCE DATA

Spectral response and sensitivity

The TH 9650 utilizes a S20 type photocathode the quantum efficiency of which is about 15 % at 440 nm. The high quantum efficiency of the photocathode combined with the high gain of the target permits to obtain a sensitivity in the order of 15 000 μA/lumen at 10 mlux (1 mf.c.).

* Registered Trade Mark.

This sensitivity allows the tube to operate without any adjustment for input illumination from 1 to 100 mlux (0.1 to 10 mf.c.). The gamma is 1 for light level between 5 and 10 mlux (0.5 and 1 mf.c.) and decreases to 0.6 for 100 mlux (10 mf.c.).

The gain control can be achieved by varying the high voltage applied to the photocathode without significant loss of resolution. This provides a gain control range from 1 to 10 and allows a dynamic illumination range of about 2. 10^3.

Persistence

The mechanism of charges generation, storage and neutralization on the target allows to obtain a very low image persistence which is only limited by the reading beam acceptance. In the third frame, the residual signal is typically 8 % for a signal current of 50 nA and 5 % for 100 nA.

Resolution

The limiting resolution is about 600 T.V. lines at center of image and 450 T.V. lines at corners. The corner resolution can be improved by dynamic focusing.

Furthermore, the lag characteristics allow to obtain a good resolution in moving scenes.

Integration and storage

The very high resistance of the target permits the integration of a signal for several minutes without the image being degraded by leakage currents. The stored signal can be read out a few hours after the high voltage has been removed. The integration period is limited only by spurious emission in the image section of the tube which can saturate the target.

When the photon noise is excessive, it is advisable to reduce the gain by reducing the high voltage and to operate with longer integration period.

OPERATING CONSIDERATIONS

Supplies and circuits

System requirements are those utilized for 1'' magnetically focused and deflected Vidicons. Two additional voltages are required : one of −12 kV for the photocathode and one of 30 V for the suppressor grid g5 .

In order to maximize the signal to noise ratio it is necessary to keep the input noise current of the preamplifier as low as possible. For a shunt capacity of 25 pF and a bandwidth of 7 MHz, a 4 nA RMS can be obtained (D3A tube, FET 2N 4416 transistor).

Environmental characteristics and life

1 - The tube is designed to offer good resistance to shock and vibration. However, care should be taken in the design of camera head so to avoid microphonics. The tube can be provided encapsulated in a silicone rubber compound which protects the image section from humidity and breakdown.

2 - The tube can be operated between −30 °C to +50 °C without any appreciable effect upon its performances. However, it is advisable to operate at room temperature.

3 - The average life time is in excess of 500 hours.

GENERAL CHARACTERISTICS

Mechanical

Overall length	225	mm
Maximum diameter :		
- non potted type	71	mm
- potted type	80	mm
Diameter of scanning section	26	mm
Base (Ditetrar 8 pins)	UTE 9 C 15 (JEDEC E8 - 11)	
Socket (note 1)	METOX N° 30 520	
Deflecting yoke - Focus coil - Assembly (note 2)	GERHARD BV 200 - 1 k 1 or equivalent	
Alignment coil (note 2)	GERHARD BV 80/3 or equivalent	
or Deflecting yoke - Focusing and alignment coils - Assembly - (note 2)	CLEVELAND VYFA - 355.2 or equivalent	
Weight, approximate :		
- non potted type	280	g
- potted type	450	g
Operating position	any	

Electrical

– IMAGE SECTION :

Focus	electrostatic	
Type	diode	

– SCANNING SECTION :

Cathode	unipotential indirectly heated oxide coated	
Heater :		
- voltage	6.3	V
- current at 6.3 V	150 ± 10 %	mA
Minimum preheating time	60	s
Output capacitance (signal electrode to all other electrodes)	25	pF
Focus	electromagnetic	
Deflection	electromagnetic	

Optical

– IMAGE SECTION :

Photocathode	S 20	
Input window :		
- shape	circular - flat (1 μ flatness)	
- nature	fiber optics (6 μ elementary fibers)	
Useful diameter	25	mm
Useful area	4.9	cm^2
Useful size	20 mm x 15 mm	

– SCANNING SECTION :

Photoconductrice layer :		
- normal dimension of image on target	12.7 mm x 9.5 mm	
- maximum useful diameter (4 x 3 aspect ratio)	17	mm

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OPERATING CONDITIONS

Voltages are given with respect to ground, the anode of the image section and the cathode of the scanning section being grounded.

Maximum ratings (absolute values)

Ambient temperature :			
- storage	max.	+ 70	°C
	min.	− 55	°C
- operation	max.	+ 50	°C
	min.	− 30	°C
– SECTION IMAGE :			
Photocathode voltage :			
- negative value	max.	12 000	V
- positive value	min.	0	V
Anode voltage		0	V
– SCANNING SECTION :			
Signal electrode voltage (target)	max.	40	V
Grid g5 voltage (suppressor)	max.	30	V
Cathode k voltage		0	V
Grid g1 voltage (image cut-off) :			
- negative bias value	max.	150	V
- positive bias value	max.	0	V
Grid g2 voltage (accelerator)	max.	400	V
Grid g3 voltage (wall electrode)	max.	400	V
Grid g4 voltage (field electrode)	max.	600	V
Heater voltage	max.	6.9	V
	min.	5.7	V
Peak heater - cathode voltage :			
- heater negative with respect to cathode	max.	125	V
- heater positive with respect to cathode	max.	10	V
Signal current	max.	300	nA

Typical operation

Temperature (note 3)	+ 25	°C
– IMAGE SECTION :		
Photocathode voltage	− 8 000	V
Anode voltage	0	V
– SCANNING SECTION :		
Target voltage	5 to 30	V
Grid g5 voltage	15	V
Cathode k voltage	0	V
Grid g1 voltage (note 4)	− 80	V
Grid g2 voltage	300	V
Grid g3 voltage	320	V
Grid g4 voltage	360	V
Minimum blanking peak to peak voltage :		
- applied to cathode	+ 30	V
- applied to grid g1	− 80	V
Focus magnetic field	40	Gauss
Alignment magnetic field	0 to 4	Gauss

Electro-optical performances

Light sensitivity	15 000	µA/lumen
Operating sensitivity	4. 5	µA/lux
Image size on the photocathode	20 mm x 15 mm	
Photocathode illumination (2854 °K) (note 5)	0. 1	lux
Signal current	200	nA
Limiting resolution (note 6) :		
- at center of image	550	TV lines
- at periphery of image	400	TV lines
M.T.F. for 400 T.V. lines at center of image (note 7)	20	%
Persistence (note 8) :		
- 3rd frame after illumination is removed	< 5	%
- 10th frame after illumination is removed	< 1	%

NOTES

1 - METOX - 86, rue de Villiers de l'Isle Adam - 75020 PARIS - France.

2 - GERHARD KG - Reichelsheim/ODW - Germany.
CLEVELAND ELECTRONICS Inc. - 2000 Highland Road - TWINSBURG - OHIO - 44. 087.

3 - All the data are given for a temperature of the tube in the proximity of the target of 25 °C, the recommended temperature range for a good operation being 25 °C to 30 °C.

4 - Without blanking pulses applied to grid g1.

5 - All the above mentioned illuminations assume 2854 °K incandescent tungsten source.

6 - Practically the limiting resolution corresponds to the resolution measured with twin bar test card with a modulation ratio of 7 %.

7 - For the C.C.I.R. Standard - 625 lines, line duration being 52 µs (line suppression period not included), 400 T.V. lines correspond to a 5 MHz bandwidth.

8 - The persistence is defined as the ratio of the residual signal current measured at the n^{th} frame after excitation is removed to the initial signal current (100 nA) ; these values assume 50 fields/second scanning rate.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OPERATING RECOMMENDATIONS

The Esicon is a rugged tube easy to use. However, care must be taken so to avoid all risk of damage to the tube liable to alter its performances.

Important recommendations

1 - A protecting device is supplied to limit the potential difference between the target and the suppressor. This should not be disconnected.

2 - The scanning voltages must be applied before electrode voltages. For shutdown, deflection power should be switched off only after the reading beam has been removed.

3 - When operating the tube, apply the high voltage in the last sequence. For shutdown, switch off the high voltage before other voltages.

4 - The tube should not be operated at exposure levels greater than those given in figure 1*.

5 - It is recommended not to exceed the given values for target and suppressor voltages**. If destabilization occurs, resulting in loss of gain and sometimes in negative image, reduce exposure level and set the suppressor grid to 5 V. Check eventually the beam current to make sure that it is sufficient to discharge the target. When the stabilization voltage becomes normal, the tube recovers its characteristics.

6 - The horizontal and vertical deflection power should be adjusted to assure that the target is either normally scanned, or over scanned. Avoid underscanning.

* *However, damage due to unduly high light exposure disappears in a few minutes if over exposure time is not too long.*

** *See Data Sheet accompanying the tube.*

Set up procedure

1 - Install the tube in the camera head using focusing, deflection and alignment coils locations shown in figure page 10. If the tube is operated in horizontal position, the short index pin should be positioned in the horizontal plane parallel to the traces of line scannings. A mask of 15 mm x 20 mm dimensions can be used to prevent light reaching the unscanned zones of the photocathode.

2 - Connect all electrodes.

3 - Apply heater, focusing, deflection and alignment voltages.

4 - Apply – 120 V to g1. Then apply voltages to g2 ; g3 ; g4 electrodes.

5 - Increase the grid g1 voltage up to –50 V and adjust g5 and target voltage to obtain recommended values.

6 - Apply about 1 mlux (0. 1 mf.c.) illumination to the faceplate.

7 - Apply progressively the high voltage and adjust the g1 voltage until the beam current is sufficient to discharge the target.

8 - Focus and center a pattern on the faceplate. The illumination level should be 10 mlux (1 mf.c.).

9 - Adjust the deflection amplitude such that the target ring is visible at the corners of image. Decrease the deflection power so to obtain the normal scanning area.

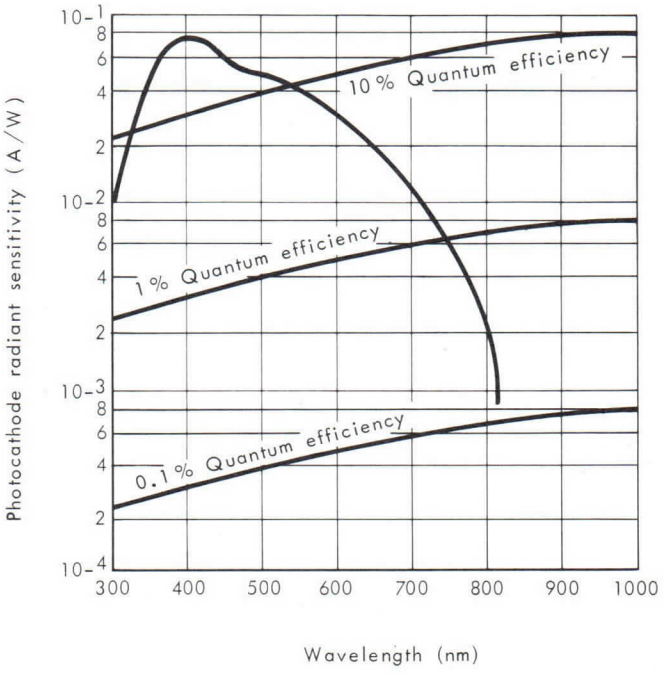
10- Adjust the focusing by varying g3 voltage and optimize the optical focus. The electrode g4 voltage should be maintained above that of electrode g3 by about 30 to 40 Volts.

11- Adjust alignment currents in the following manner :

- reduce g5 voltage to a value just above the threshold for beam landing ;
- adjust the alignment current to center the area over which the beam can land ;
- if more than 2 V on g5 is necessary for beam to land over the entire area, check the positions of focusing and deflection coils.

12- Shift g5 voltage to normal value, check g3 voltage and optical focus.

S 20 PHOTOCATHODE SPECTRAL RESPONSE



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

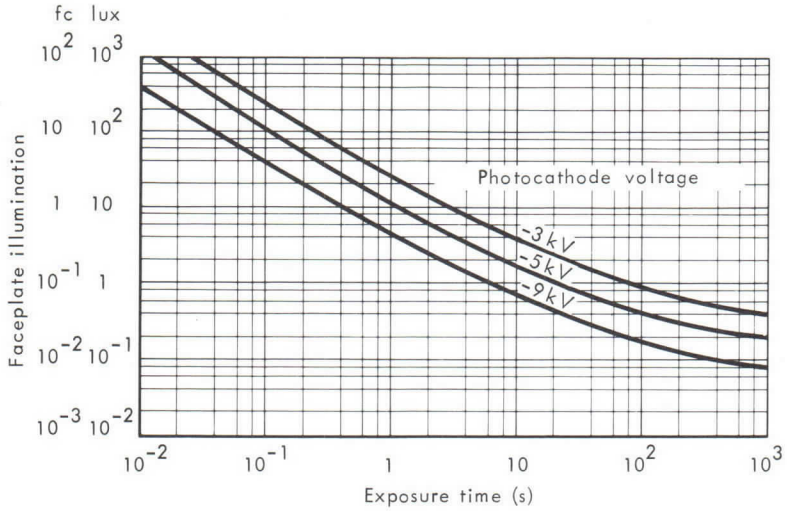


Fig. 1 - Maximum exposure levels

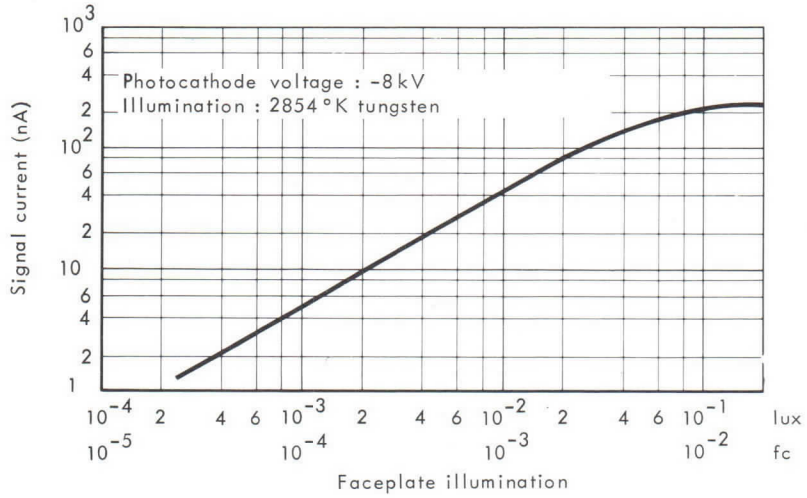


Fig. 2 - Light transfer characteristic

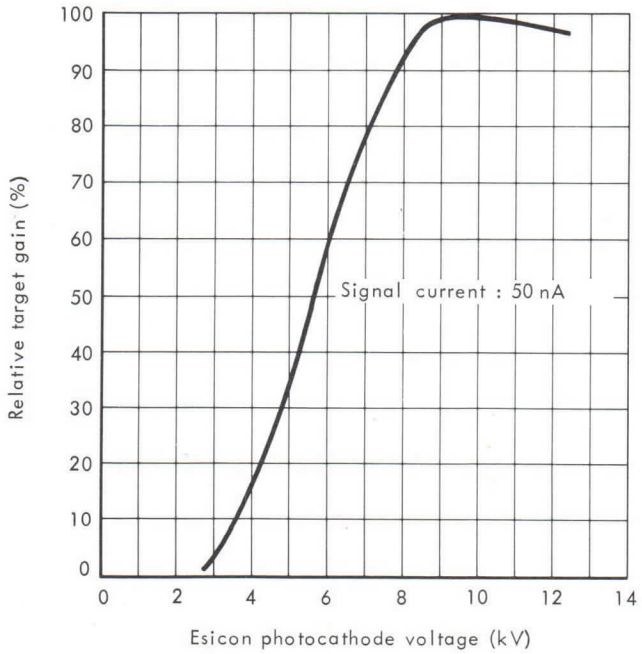


Fig. 3 - Relative gain vs. photocathode voltage

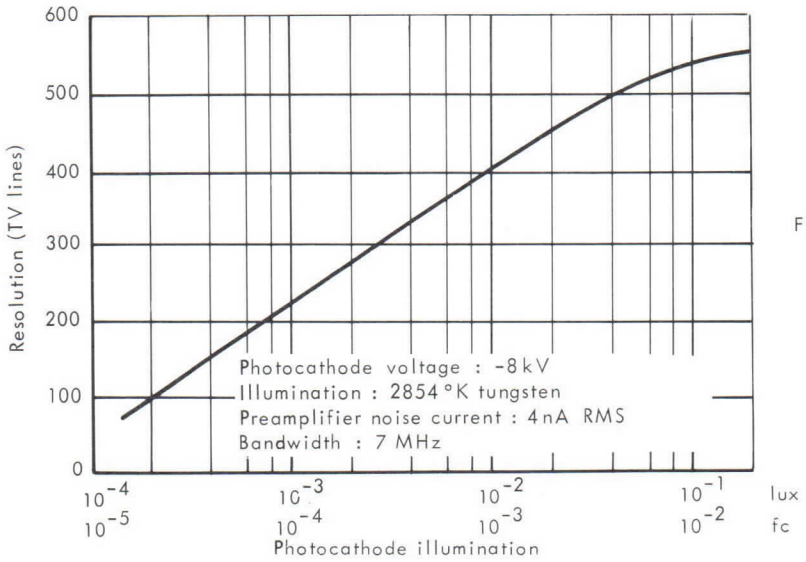


Fig. 4 - Resolution vs photocathode illumination

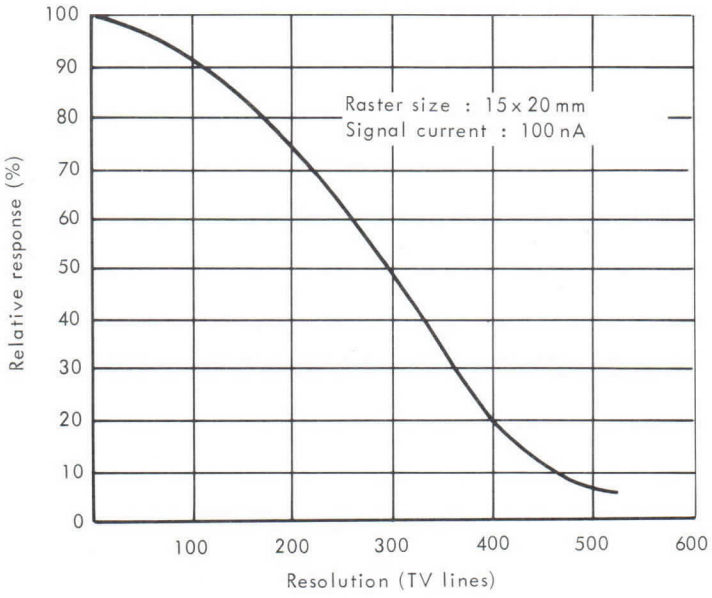


Fig. 5 - Modulation transfer function

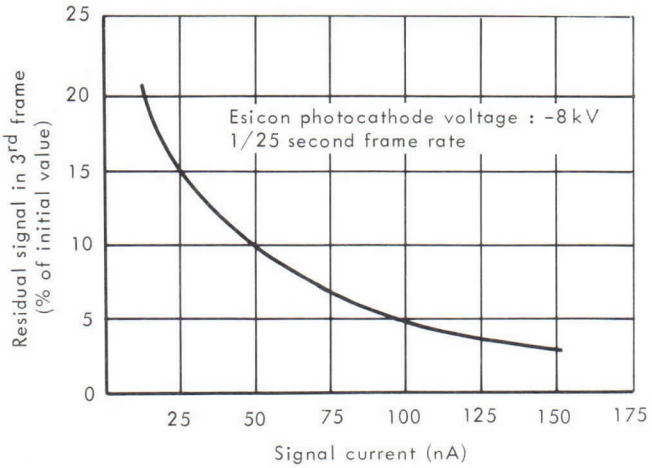
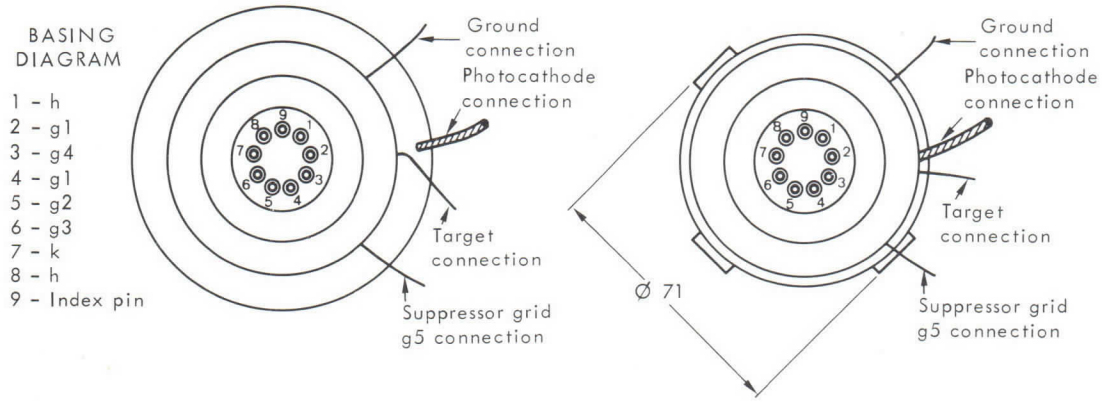
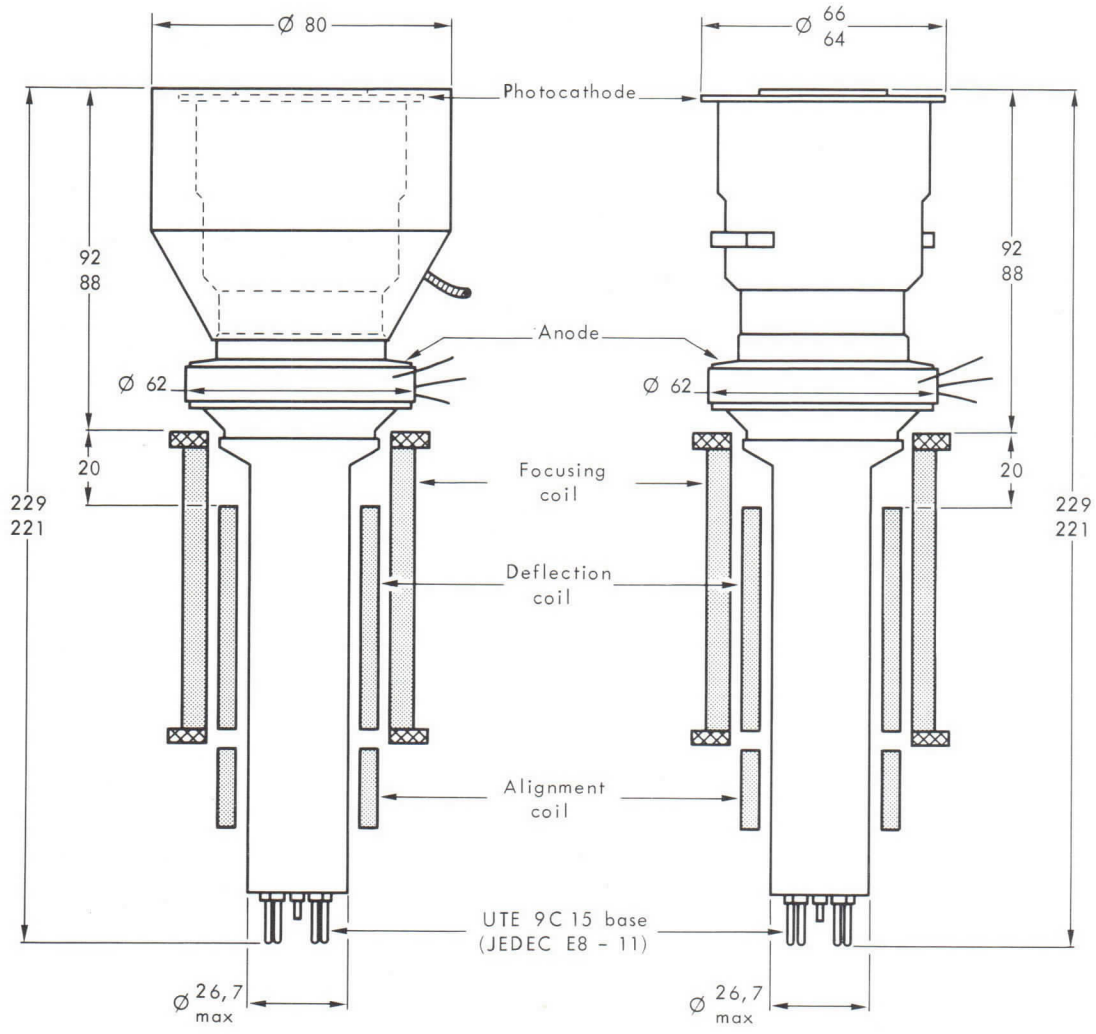


Fig. 6 - Residual vs signal current

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING





Potted type **Non potted type**

Dimensions in mm.

TH9651 SUPER-ESICON*

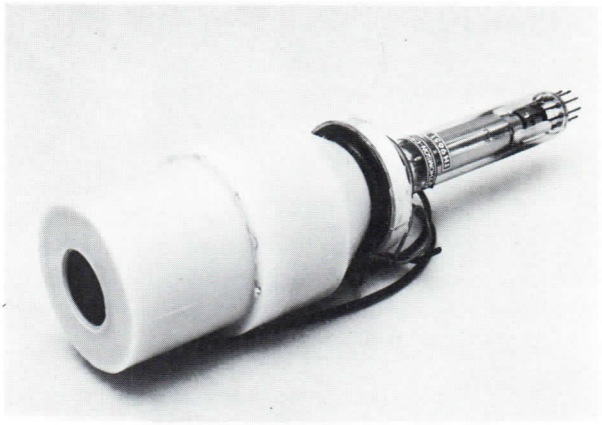
CAMERA TUBE FOR LOW LIGHT LEVEL T.V.

- S 20ER PHOTOCATHODE (25 mm useful diameter)
- INTENSIFIER AND IMAGE SECTION : diodes - electrostatic focus
- SCANNING SECTION : electromagnetic focus and deflection
- VERY HIGH SENSITIVITY (700 mA/lm)
- LOW LAG
- INTEGRATION AND STORAGE CAPABILITY
- INDUSTRIAL - SCIENTIFIC-NUCLEAR APPLICATIONS

The TH 9651 Super-Esicon is a very high sensitivity camera tube composed of an Esicon (TH 9650) mechanically coupled by fiber optics with an electrostatic focus image intensifier (TH 9473).

The useful diameter of the flat input faceplate is 25 mm and the photocathode is of the S 20ER type with a spectral response in visible spectrum extended to the near infrared.

The high gain secondary emission target allows the tube to operate over a wide range of illumintation and specially at low light level where the low image persistence makes easier the viewing of moving scenes. Furthermore, regions of a scene which is sufficiently bright to cause saturation do not produce halation altering the surrounding information.



The very low dark current of the target enables excellent storage characteristics and permits the integration of low light level images for extended period of time. The TH 9651 also performs well at slow scanning rate as used with narrow bandwidth transmission chanel.

The high voltages required for the intensifier and the image section of the Esicon can be obtained from a small size modular power supply. The requirements for the scanning section electrodes and the scanning power supply are similar to those of a standard 1" magnetically focused and deflected Vidicon.

PERFORMANCE DATA

Spectral response

The spectral response is that of a S 20ER type photocathode which is deposited on the fiber optics input window. The maximum quantum efficiency is 15 % and corresponding wavelength is 450 nm.

Typical sensitivities are 12 mA/W at 800 nm and 6 mA/W at 850 nm.

The photocathode has a white light sensitivity (2854 °K) in the order of 200 μA/lumen.

Overall sensitivity

High efficiency of the input photocathode combined with the gain of the intensifier and the gain of the target permit a typical overall sensitivity of 0.2 mA/lux (2 mA/fc). With illuminated area of 15 mm x 20 mm, equivalent sensitivity is near to 700 mA/lumen.

* Registered Trade Mark.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Light transfer characteristics

The TH 9651 can be used for photocathode illumination from 5.10^{-6} to 2.10^{-3} lux (5.10^{-7} to 2.10^{-4} fc). The gamma varies from 1 at very low light level to 0.6 at 10^{-3} lux (10^{-4} fc). At higher light levels the target saturates at a potential near to that of the suppressor grid which provides a knee in the transfer curve. It is advisable not to exceed the indicated values because excessive illumination may cause temporary or permanent "burn-in". However, the tube can be safely operated at higher light levels by reducing the voltages applied to the intensifier and the Esicon. By combining these two parameters it is possible to cover a dynamic illumination range in the order of $5.\ 10^3$.

Persistence

The signal generating mechanism of the target is essentially lagless due to the target design.
Typical residual signal at third frame is 5 % for a signal current of 100 nA.

Resolution

The limiting resolution is 500 TV lines at center of image for stationary scenes and 10^{-3} lux (10^{-4} fc) faceplate illumination. Because of the low lag characteristics, good dynamic resolution can be obtained : a typical value of limiting dynamic resolution is 400 TV lines for an object moving across the picture width in 10 seconds.

Integration and storage

A signal can be integrated over a period of several minutes without degradation due to target leakage. It can be stored for many hours provided the photocathode voltage is turned off. The maximum integration period is limited by the dark current of the intensifier and the transfer section of the Esicon and the low illumination due to the electron gun cathode.

If excessive photon noise occurs, it may be found advantageous to reduce the gain of the tube by reducing the high voltage and to operate the tube with longer integration periods.

OPERATING CONSIDERATIONS

Supplies and circuits

When using a basic Vidicon camera three additional voltage supplies are required :

- 25 kV to be applied to the intensifier photocathode
- 12 kV to be applied to the Esicon photocathode

and 30 V to be applied to the suppressor grid.

In order to maximize the signal to noise ratio, it is necessary to keep the input noise current as low as possible. For a shunt capacity of 25 pF and a bandwidth of 7 MHz, a 4 nA R.M.S. noise current can be obtained with a preamplifier using D3 tube or FET 2N 4416 transistor.

Environmental characteristics and life

1 - The Super-Esicon is designed to offer good resistance to shock and vibration. However, care should be taken in the design of the camera head so to avoid microphonics. The tube can be provided encapsulated in a silicone rubber compound which protects the intensifier and the image section from humidity and break-down.

2 - The tube can be operated between $-30\ ^\circ C$ and $+50\ ^\circ C$ without any appreciable effect upon its performances. However, it is advisable to operate at room temperature.

3 - The average life time is in excess of 500 hours.

GENERAL CHARACTERISTICS

Mechanical

Overall length	289	mm
Maximum diameter :		
- non potted type	71	mm
- potted type	80	mm
Diameter of scanning section	26	mm
Base (Ditetrar 8 pins)	UTE 9 C 15 (JEDEC E8 - 11)	
Socket (note 1)	METOX N° 30 520	
Deflecting yoke - Focus coil - Assembly (note 2)	GERHARD BV 200 - 1 k 1 or equivalent	
Alignment coil (note 2)	GERHARD BV 80/3 or equivalent	
or Deflecting yoke - Focusing and alignment coils - Assembly - (note 2)	CLEVELAND VYFA - 355.2 or equivalent	
Weight, approximate :		
- non potted type	450	g
- potted type	700	g
Operating position	any	

Electrical

– INTENSIFIER SECTION :

Focus	electrostatic
Type	diode

– IMAGE SECTION :

Focus	electrostatic
Type	diode

– SCANNING SECTION :

Cathode	unipotential indirectly heated oxide coated	
Heater :		
- voltage	6. 3	V
- current at 6. 3 V	150 ± 10 %	mA
Minimum preheating time	60	s
Output capacitance (target to all other electrodes)	25	pF
Focus	electromagnetic	
Deflection	electromagnetic	

Optical

– INTENSIFIER SECTION :

Photocathode	S 20 ER	
Input window (note 9) :		
- shape	circular - flat (1 μ flatness)	
- nature	fiber optics (6 μ elementary fibers)	
Useful diameter	25	mm
Useful area	4. 9	cm^2
Useful size	20 mm x 15	mm

– IMAGE SECTION :

Photocathode	S 20

– SCANNING SECTION :

Photoconductive layer :		
- normal dimension of image on target	12. 7 mm x 9. 5	mm
- maximum useful diameter (4 x 3 aspect ratio)	17	mm

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OPERATING CONDITIONS

Unless otherwise stated, voltages are given with respect to ground, the anode of the image section and the cathode of the scanning section being grounded.

Maximum ratings (absolute values) :

Ambient temperature :			
- storage	max.	+ 70	°C
	min.	− 55	°C
- operation	max.	+ 50	°C
	min.	− 30	°C
− INTENSIFIER SECTION :			
Photocathode voltage (with respect to cathode K) :			
- negative value	max.	25	kV
- positive value	max.	0	V
Photocathode voltage (with respect to Esicon photocathode) :			
- negative value	max.	15	kV
- positive value	min.	0	V
− IMAGE SECTION :			
Photocathode voltage (with respect to cathode K) :			
- negative value	max.	12	kV
- positive value	min.	0	V
Anode voltage		0	V
− SCANNING SECTION :			
Target voltage	max.	40	V
Grid g5 voltage (suppressor)	max.	30	V
Cathode K voltage		0	V
Grid g1 voltage (image cut-off) :			
- negative bias value	max.	150	V
- positive bias value	max.	0	V
Grid g2 voltage (accelerator)	max.	400	V
Grid g3 voltage (wall electrode)	max.	400	V
Grid g4 voltage (field electrode)	max.	600	V
Heater voltage	max.	6. 9	V
	min.	5. 7	V
Peak heater - cathode voltage :			
- heater negative with respect to cathode	max.	125	V
- heater positive with respect to cathode	max.	10	V
Signal current	max.	300	nA

Typical operation

Temperature (note 3)	+ 25	°C
− INTENSIFIER SECTION :		
Photocathode voltage (with respect to cathode K)	− 23	kV
− IMAGE SECTION :		
Photocathode voltage (with respect to cathode)	− 8	kV
Anode voltage	0	V
− SCANNING SECTION :		
Target voltage	5 to 30	V
Grid g5 voltage	15	V
Cathode K voltage	0	V
Grid g1 voltage (note 4)	− 80	V
Grid g2 voltage	300	V
Grid g3 voltage	320	V
Grid g4 voltage	360	V

Imprimé en France

Minimum blanking peak to peak voltage :		
- applied to cathode	+ 30	V
- applied to g1	− 80	V
Focus magnetic field	40	Gauss
Alignment magnetic field	0 to 4	Gauss

Electro-optical performances

Light sensitivity	700	mA/lumen
Operating sensitivity	200	µA/lux
Image size on the photocathode	20 mm x 15 mm	
Photocathode illumination (2854 °K) (note 5)	1	mlux
Signal current	200	n A
Limiting resolution (note 6) :		
- at center of image	500	TV lines
- at periphery of image	350	TV lines
M.T.F. for 400 T.V. lines at center of image (note 7)	10	%
Persistence (note 8) :		
- 3rd frame after illumination is removed	< 5	%
- 10th frame after illumination is removed	< 1	%

NOTES

1 - METOX - 86, rue de Villiers de l'Isle Adam - 75020 PARIS - France.

2 - GERHARD KG - Reichelsheim/ODW - Germany.
CLEVELAND ELECTRONICS Inc. - 2000 Highland Road - TWINSBURG - OHIO - 44. 087

3 - All the data are given for a temperature of the tube in the proximity of the target of 25 °C, the recommended temperature range for a good operation being 25 °C to 30 °C.

4 - Without blanking pulses applied to grid g1.

5 - All the above mentioned illuminations assume 2854 °K incandescent tungsten source.

6 - Practically the limiting resolution corresponds to the resolution measured with twin bar test card with a modulation ratio of 7 %.

7 - For the C.C.I.R. Standard - 625 lines, line duration being 52 µs (line suppression period not included), 400 T.V. lines correspond to a 5 MHz bandwidth.

8 - The persistence is defined as the ratio of the residual signal current measured at the n^{th} frame after excitation is removed to the initial signal current (100 nA) ; these values assume 50 fields/second scanning rate.

9 - One clear glass disc is bonded in front of optical fibers with conducting back face glass connected to the intensifier photocathode. This device permits to avoid flicker phenomena because fluctuating potential optical fibers face generated by electroctatic charges. On request, the Super-Esicon may be provided with quartz disc which is non-browning in nuclear environments.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OPERATING RECOMMENDATIONS

The Super-Esicon is a rugged tube easy to use. However care must be taken so to avoid all risk of damage to the tube.

Important recommendations

1 - A protecting device is supplied to limit the potential difference between the target and the suppressor. This should not be disconnected.

2 - The scanning voltages should be applied before electrode voltages applications. For shutdown, deflection power should be switched off only after the electron beam has been removed.

3 - When operating the tube, apply the high voltage in the last sequence. For shutdown, switch off the high voltage before the other voltages.

4 - The tube should not be operated at exposure levels greater than those given in figure 1*.

5 - It is recommended not to exceed the given values for target and suppressor voltages**. If destabilization occurs resulting in loss of gain and sometimes in negative image, reduce exposure level and set the suppressor grid to 5 Volts. Check eventually the beam current to make sure that it is sufficient to discharge the target. When the stabilization voltage becomes normal, the tube recovers its characteristics.

6 - The horizontal and vertical deflection power should be adjusted to assure that the target is either normally scanned or over scanned. Avoid underscanning.

7 - As high voltage is applied to the input faceplate a good design of the camera and particularly of lens fixture is necessary in order to prevent arcing and breakdown which would impair the fiber optics faceplate or cause a high dark current equivalent illumination.

* *However, damage due to unduly high light exposure disappears in a few minutes if over exposure time is not too long.*

** *See Data Sheet accompanying the tube.*

Set up procedure

1 - Install the tube in the camera head using focusing, deflection and alignment coils locations shown in figure page10. If the tube is operated in horizontal position, the short index pin should be positioned in the horizontal plane parallel to the traces of line scannings. A mask of 15 mm x 20 mm dimensions can be used to prevent light reaching the unscanned zones of the photocathode.

2 - Connect all electrodes.

3 - Apply heater, focusing, deflection and alignment voltages.

4 - Apply −120 V to g1. Then apply voltages to g2, g3, g4 electrodes.

5 - Increase the grid g1 voltage up to − 50 V and adjust g5 and target voltage to obtain recommended values.

6 - Apply about 0. 01 mfc illumination to the faceplate.

7 - Apply progressively the high voltage and adjust the g1 voltage until the beam current is sufficient to discharge the target.

8 - Focus and center a pattern on the faceplate. The illumination level should be 0. 1 mfc.

9 - Adjust the deflection amplitude such that the target ring is visible at the corners of image. Decrease the deflection power so to obtain the normal scanning area.

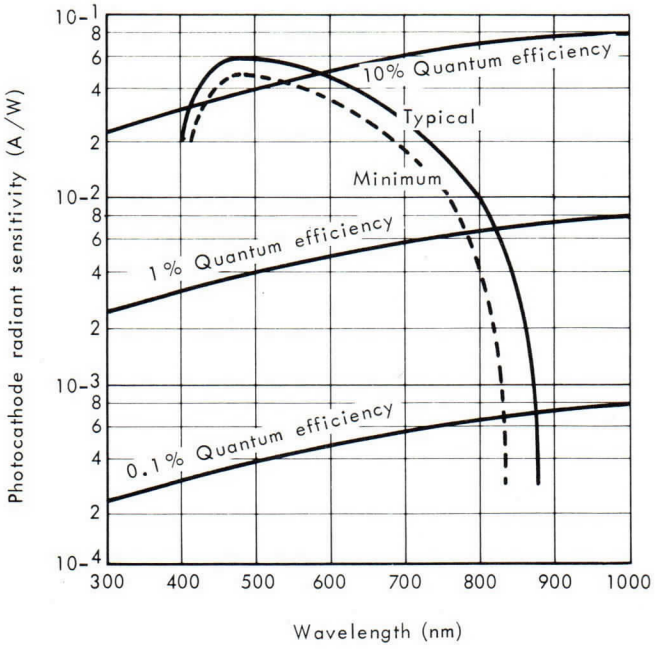
10- Adjust the focusing by varying g3 voltage and optimize the optical focus. The electrode g4 voltage should be maintained above that of electrode g3 by about 30 to 40 Volts.

11- Adjust alignment currents in the following manner :

- reduce g5 voltage to a value just above the threshold for beam landing ;
- adjust the alignment current to center the area over which the beam can land ;
- if more than 2 V on g5 is necessary for beam to land over the entire area, check the positions of focusing and deflection coils.

12- Shift g5 voltage to normal value, check g3 voltage and optical focus.

S20ER PHOTOCATHODE SPECTRAL RESPONSE
(with extended red sensitivity)



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

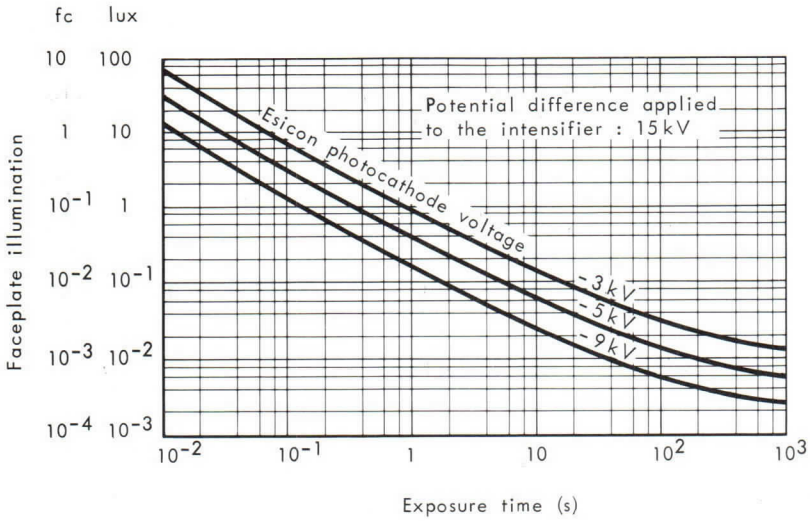


Fig. 1 - Maximum exposure levels.

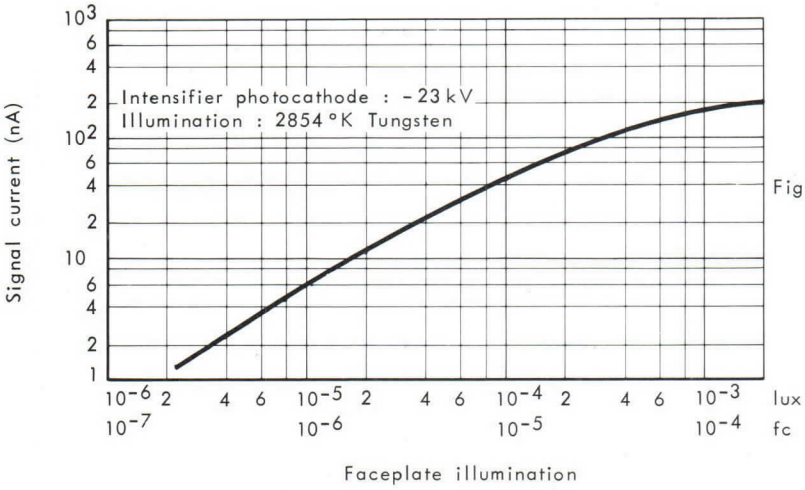


Fig. 2 - Light transfer characteristic.

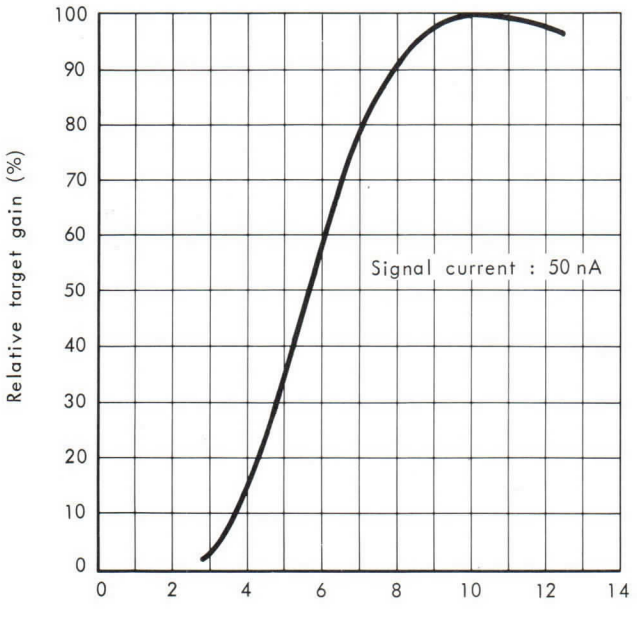


Fig. 3 - Relative gain vs.
Esicon photocathode voltage.

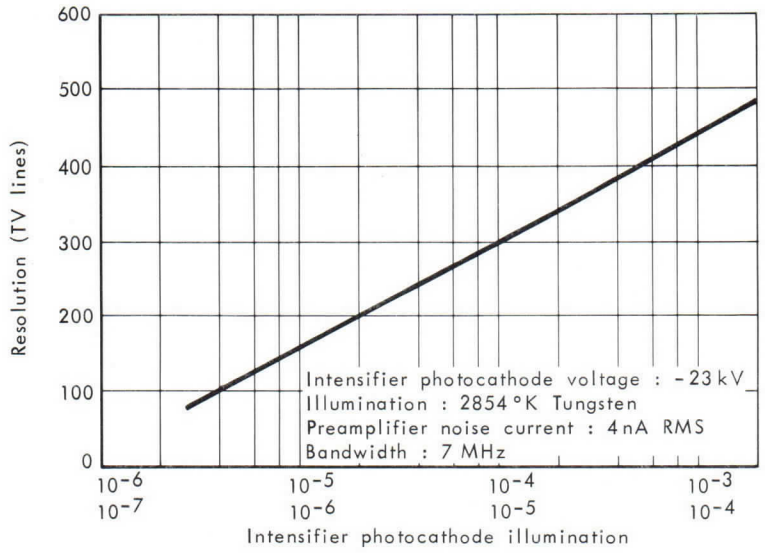


Fig. 4 - Resolution vs. photocathode illumination.

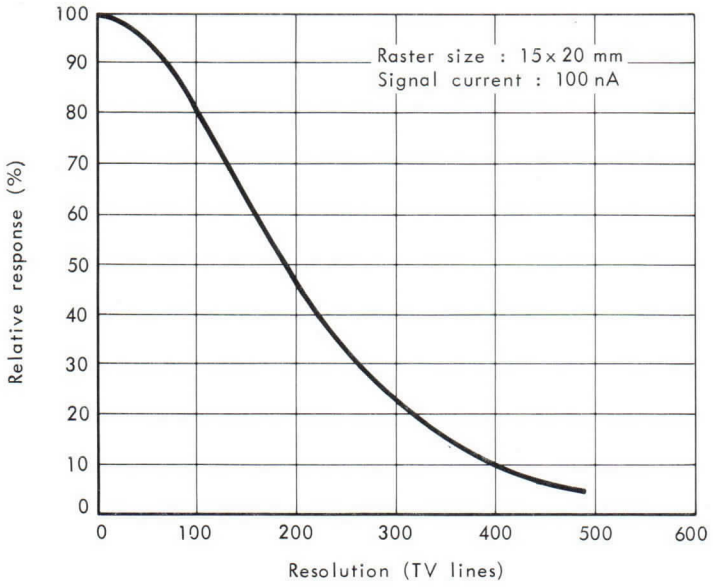


Fig. 5 - Modulation transfer function.

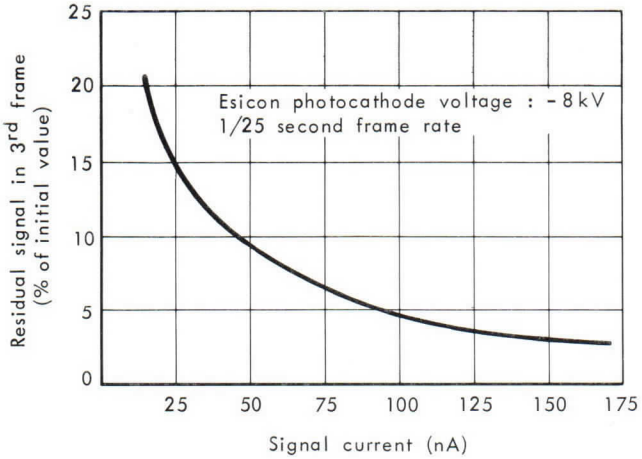


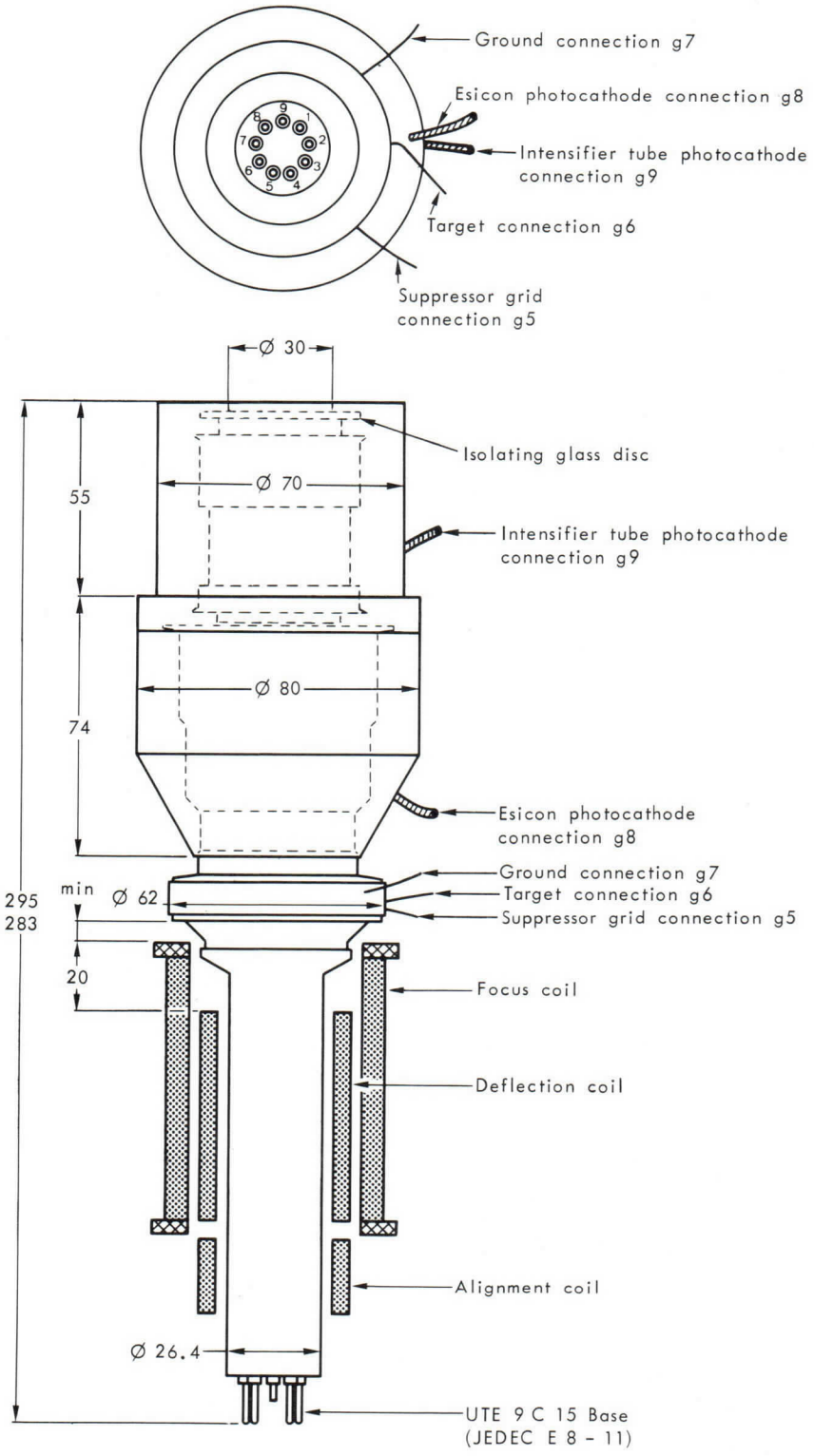
Fig. 6 - Residual vs. signal current.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING

BASING DIAGRAM

1 - h
2 - g1
3 - g4
4 - g1
5 - g2
6 - g3
7 - k
8 - h
9 - Index pin



Dimensions in mm.

Potted tube

ESICON* TH 9652
TUBE DE PRISE DE VUE
A BAS NIVEAU DE LUMIERE

- STRUCTURE ROBUSTE (normes militaires d'environnement)
- PHOTOCATHODE S20 (diamètre utile 25 mm)
- SECTION IMAGE : diode - focalisation électrostatique
- SECTION ANALYSE : concentration et déviation électromagnétiques
- SENSIBILITE ELEVEE (15 000 μA/lm)
- FAIBLE PERSISTANCE
- POSSIBILITE D'INTEGRATION ET DE MEMOIRE
- TELEVISION MILITAIRE ET SPATIALE

Le tube TH 9652 est un tube compact de grande sensibilité pour prise de vue à des niveaux incidents aussi faibles que 1 mlux, à bon pouvoir de résolution et faible persistance d'image. Sa robustesse permet de l'utiliser dans des conditions d'environnement sévères (vibrations, secousses, température, . . .).

Il comporte une photocathode tri-alcaline déposée sur une face d'entrée à fibres optiques, plan-concave, une section de transfert électrostatique du type diode, une cible multiplicatrice à gain élevé et un canon de lecture du même type que celui des Vidicons classiques mais à structure renforcée qui destine plus particulièrement le TH 9652 aux applications militaires et spatiales.

La cible utilisée permet un fonctionnement dans une grande dynamique d'éclairement et notamment aux faibles niveaux de lumière pour lesquels la très faible persistance d'image facilite l'observation des sujets mobiles. Par ailleurs, les parties d'image très brillantes causant une saturation du signal n'introduisent pas d'effets de redistribution détériorant la visibilité des détails dans les régions voisines de l'image.

Le très faible courant d'obscurité de cible permet d'obtenir d'excellentes propriétés d'accumulation, de mémoire et rend possible l'intégration d'images à très faibles niveaux lumineux pendant de longues périodes ainsi que le fonctionnement avec une faible cadence d'analyse.

Ces diverses caractéristiques permettent d'aborder une très grande variété d'applications en prise de vue noir et blanc et en couleur.

Le tube TH 9652 peut être utilisé directement avec un système optique classique ou être couplé par optiques à fibres avec un intensificateur d'image augmentant la sensibilité de détection ou permettant la conversion d'images dans le domaine des rayons X, de l'ultraviolet ou de l'infrarouge. L'emploi de bobines de concentration et de déviation spécialement mises au point est indispensable pour l'utilisation du tube dans les conditions d'environnement sévères.

* Marque déposée.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PERFORMANCES DU TUBE

Sensibilité et dynamique - Réponse spectrale

Le tube TH 9652 utilise une photocathode type S20 déposée sur une fenêtre d'entrée à fibres optiques dont l'efficacité quantique est de l'ordre de 15 % à son maximum (440 nm). Cette grande efficacité, jointe au gain de la cible, permet d'obtenir une sensibilité de l'ordre de 15 000 μA/lumen à 10 mlux.

Cette sensibilité permet un fonctionnement correct sans ajustement du tube entre 1 et 100 mlux incidents sur la face d'entrée. Le gamma qui est unitaire entre 5 et 10 mlux décroit jusqu'à 0, 6 vers 100 mlux.

La sensibilité peut être modifiée par variation de la haute tension appliquée à la photocathode sans perte appréciable de résolution, dans un rapport de l'ordre de 1 à 10. La dynamique d'éclairement qui en résulte est de l'ordre de $2.\ 10^3$.

Persistance

Le mécanisme de génération, d'accumulation et de neutralisation des charges électriques sur la cible permet l'obtention d'une très faible persistance d'image qui n'est limitée que par l'acceptation du faisceau de lecture. Le signal résiduel est typiquement, pour la troisième trame balayée, de 8 % pour un courant de signal de 50 nA et de 5 % pour un courant de signal de 100 nA.

Pouvoir de résolution

Sur image statique, la résolution limite est de l'ordre de 600 lignes T.V. au centre de l'image et de 450 lignes T.V. sur les bords avec possibilité de correction dynamique.

Les caractéristiques de persistance permettent, par ailleurs, de conserver un pouvoir de résolution très bon sur des scènes mobiles et confèrent au tube une sensibilité dynamique élevée.

Intégration et mémoire

Il est possible d'intégrer un signal lumineux pendant plusieurs minutes et de le lire quelques heures après avoir coupé la haute tension. Les limites d'intégration proviennent du courant d'obscurité de la section de transfert de l'Esicon et de l'éclairement de la cathode du canon.

Lorsque le bruit photonique est trop important, il peut être intéressant de réduire le gain du tube en diminuant la haute tension et de travailler avec des temps d'intégration plus longs.

RECOMMANDATIONS D'UTILISATION

Alimentation et circuits annexes

Les circuits d'alimentation sont ceux utilisés pour les Vidicons à concentration et déviation électromagnétiques. Deux tensions additionnelles sont nécessaires : l'une de −12 kV pour l'alimentation de la photocathode, l'autre pour la grille de stabilisation de 30 V qui peut être obtenue par diviseur à partir de l'alimentation normale.

Pour l'obtention d'un rapport signal/bruit satisfaisant, il est nécessaire d'associer un préamplificateur à faible bruit. Pour une capacité parallèle de 25 pF et une bande passante de 7 MHz, un courant de bruit équivalent quadratique moyen de 4 nA peut être obtenu (tube D3A - Transistor FET 2N 4416).

Environnement et durée de vie

1 - Le tube est conçu pour que les signaux parasites dus à des résonances mécaniques internes aient des niveaux très faibles. Il reste malgré tout important de veiller au montage du tube dans la caméra, de façon à ce que les amplitudes de vibration transmises soient aussi faibles que possible. Par ailleurs, le tube peut être fourni avec un enrobage isolant de la section image constituant une protection contre l'humidité et les amorçages éventuels.

2 - Le fonctionnement du tube reste correct dans un large domaine de température (−50 à +50 °C). Il est recommandé, malgré tout, de le faire fonctionner au voisinage de l'ambiance.

3 - La durée de vie moyenne est supérieure à 500 h.

CARACTERISTIQUES GENERALES

Mécaniques

Longueur hors-tout	225	mm
Diamètre hors-tout :		
- tube non enrobé	71	mm
- tube enrobé	80	mm
Embase (Ditetrar, 8 broches)	UTE 9 C 15 (JEDEC E 8 - 11)	
Support (note 1)	METOX N° 30 520	
Bloc bobines de déviation et de concentration (notes 2 et 9)	GERHARD BV 200 - 1 k 1 ou équivalent	
Bloc d'alignement (notes 2 et 9)	GERHARD BV 80/3 ou équivalent	
ou Bloc bobines de déviation, concentration et alignement (notes 2 et 9)	CLEVELAND VYFA - 355-2 ou équivalent	
Masse approximative :		
- tube non enrobé	280	g
- tube enrobé	450	g
Position de fonctionnement	indifférente	

Electriques

– SECTION IMAGE :		
Concentration	électrostatique	
Type	diode	
– SECTION ANALYSE :		
Cathode	équipotentielle chauffage indirect à oxydes	
Chauffage filament :		
- tension	6, 3	V
- courant à 6, 3 V	150 ± 10 %	mA
Temps minimal de préchauffage	60	s
Capacités de sortie (entre l'électrode de signal et les autres électrodes)	25	pF
Concentration	électromagnétique	
Déviation	électromagnétique	

Optiques

– SECTION IMAGE		
Photocathode	S 20	
Fenêtre d'entrée :		
- forme	plate et circulaire (planéité 1 μ)	
- nature	fibres optiques (fibres élémentaires 5 à 6 μ)	
Diamètre utile	25	mm
Surface utile	4, 9	cm^2
Format utile	20 mm x 15 mm	
– SECTION ANALYSE :		
Couche photoconductrice :		
- diamètre utile maximal (format 4 x 3)	17	mm
- format normal sur cible	12, 7 mm x 9, 5 mm	

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

CONDITIONS D'EMPLOI

Les tensions sont données par rapport à la masse, l'anode de la section image et la cathode de la section analyse étant reliées à la masse.

Valeurs limites d'utilisation (limites absolues) :

Température ambiante :			
- en stockage	max.	+85	°C
	min.	−62	°C
- en fonctionnement	max.	+50	°C
	min.	−50	°C
— SECTION IMAGE :			
Tension de la photocathode :			
- valeur continue négative	max.	12 000	V
- valeur continue positive	max.	0	V
Tension anodique	max.	0	V
— SECTION ANALYSE :			
Tension d'électrode de signal (cible)	max.	40	V
Tension de grille g5 (grille de stabilisation)	max.	30	V
Tension de cathode k	max.	0	V
Tension de grille g1 (extinction du faisceau) :			
- valeur continue négative	max.	150	V
- valeur continue positive	max.	0	V
Tension de grille g2 (accélération)	max.	400	V
Tension de grille g3 (de paroi)	max.	400	V
Tension de grille g4 (de champ)	max.	600	V
Tension de filament	max.	6, 9	V
	min.	5, 7	V
Tension entre filament et cathode :			
- filament négatif par rapport à la cathode	max.	125	V
- filament positif par rapport à la cathode	max.	10	V
Courant de signal	max.	300	nA

Valeurs typiques d'utilisation

Température (note 3)	25	°C
— SECTION IMAGE :		
Tension de la photocathode	−8 000	V
Tension anodique	0	V
— SECTION ANALYSE :		
Tension d'électrode de signal	5 à 30	V
Tension de grille g5	15	V
Tension de cathode k	0	V
Tension de grille g1 (note 4)	−80	V
Tension de grille g2	300	V
Tension de grille g3	320	V
Tension de grille g4	360	V
Tension crête minimale de blocage appliquée sur :		
- la cathode	+30	V
- la grille g1	−80	V
Champ magnétique de concentration	40	Gauss
Champ magnétique d'alignement	0 à 4	Gauss

Performances électro-optiques

Sensibilité lumineuse	15 000	µA/lumen
Sensibilité d'exploitation	4, 5	µA/lux
Format de l'image sur la photocathode	20 mm x 15 mm	
Eclairement de la photocathode (2854 °K) (note 5)	0, 1	lux
Courant de signal	200	nA
Résolution limite au centre de l'image (note 6)	550	lignes TV
Résolution limite sur les bords	400	lignes TV
Taux de modulation à 400 lignes TV, au centre de l'image (note 7)	20	%
Persistance (note 8) :		
- 3e trame balayée après extinction	$\leqslant 5$	%
- 10e trame balayée après extinction	< 1	%

ESSAIS D'ENVIRONNEMENT

Le tube TH 9652 supporte hors fonctionnement les essais d'environnement suivants. Après exécution de ces essais le tube doit satisfaire aux performances électronoptiques définies dans les conditions d'emploi.

Essai climatique

Le tube est soumis à 4 cycles de température entre −50 °C et + 50 °C avec maintien aux températures extrêmes pendant 30 minutes. Chaque cycle est exploré avec une variation de l'ordre de 2 °C/mn.

Essai en vibrations sinusoidales

L'essai est conduit conformément à la spécification MIL-T 5422 E (ASG) courbe IV.

Exploration aller-retour de la gamme 5 - 500 Hz permettant un niveau d'accélération de 10 g dans la plage 72 à 500 Hz. Durée d'un cycle 15 minutes. Réalisation de deux cycles suivant les trois axes du tube.

Essai de secousses

L'essai est réalisé conformément aux normes NF - C 93 - 001. - Essai 24 avec :

- accélération maximale : 25 g ;
- nombre de secousses suivant l'axe longitudinal du tube : 1000.

N O T E S

1 - METOX - 86, rue de Villiers de l'Isle Adam - 75020 PARIS - Téléphone : 636. 31-10.

2 - GERHARD KG - REICHELSHEIM/ODW Germany.
CLEVELAND Electronics Inc. - 2000 Highland Road - TWINSBURG - OHIO - 44 087.

3 - Toutes les caractéristiques sont données pour une température du tube, au voisinage de la cible, de 25 °C ; les limites de température recommandées pour un bon fonctionnement étant de 20 ° et 30 °C.

4 - Sans impulsion de blocage appliqué sur l'électrode g1.

5 - La source lumineuse est une lampe à filament de tungstène fonctionnant à une température de couleur de 2854 °K.

6 - Pratiquement, la résolution limite correspond, sur une mire de définition à lignes noires et blanches, à un taux de modulation voisin de 7 %.

7 - Pour le standard CCIR de 625 lignes, la durée d'une ligne est de 52 µs (temps de suppression exclu), 400 lignes T.V. correspondent à une fréquence de 5 MHz.

8 - La persistance s'exprime par le rapport en % du courant de signal résiduel mesuré à la fin de la ne trame balayée après extinction de l'excitation lumineuse, au courant de signal initial (100 nA). Les valeurs indiquées sont valables pour une cadence de balayage de 50 trames/seconde.

9 - Dans le cas d'environnement sévère et afin d'utiliser au mieux toutes les possibilités du tube, des bobines spécialement conçues, ayant les mêmes caractéristiques électriques que les bobines standard, seront nécessaires. Par exemple : Bloc bobines CLEVELAND VYFA - 164 - 2.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

CONSIGNES D'UTILISATION

L'ESICON est un tube relativement robuste et facile à utiliser. Néanmoins, il est nécessaire d'observer un certain nombre de précautions pour éviter tout risque de détérioration.

Recommandations importantes

1 - Un système de protection enrobé limite la différence de potentiel qui peut exister entre la grille de stabilisation et la cible. Il est expressément recommandé de ne pas déconnecter cette protection.

2 - Les tensions de balayage de la section d'analyse doivent être appliquées avant les tensions d'électrodes. Lorsque les prises de vues sont terminées, elles doivent être coupées après les tensions d'électrodes.

3 - Au moment des prises de vues, appliquer la très haute tension en dernier lieu. Quand les prises de vues sont terminées, il faut au contraire couper en premier la très haute tension.

4 - Le tube ne doit pas être soumis à des niveaux lumineux supérieurs à ceux définis par les courbes de la figure 1*.

5 - Il est conseillé de ne pas dépasser les tensions de cible et de grille de stabilisation indiquées**. Si le tube destabilise (phénomène qui se traduit par une perte de sensibilité et parfois par l'apparition d'une image négative), réduire l'éclairement et mettre un instant la grille de stabilisation à 5 Volts.environ. Vérifier éventuellement si le courant de faisceau est suffisant pour décharger la cible. Lorsque l'on revient à la tension de stabilisation normale, le tube doit retrouver aussitôt ses caractéristiques.

6 - Les amplitudes de balayage vertical et horizontal doivent être ajustées de manière à balayer la cible au cadre normal ou un peu plus. Il faut éviter de sous balayer la cible.

* *Toutefois, le marquage apparu en cas d'éclairement trop intense mais peu prolongé disparaît généralement en quelques minutes.*

** *Voir la feuille accompagnant le tube livré.*

Montage du tube ESICON et mise en oeuvre

1 - Installer le tube dans les bobines de la caméra comme il est indiqué sur la figure. Si le tube est placé en position horizontale, la broche courte du pied du canon doit être positionnée dans le plan horizontal parallèle aux traces du balayage ligne. Un masque de dimensions 15 mm x 20 mm peut être placé sur la face d'entrée de manière à ne pas éclairer les zones de la photocathode qui sont en dehors du cadre de balayage.

2 - Connecter les différentes électrodes.

3 - Mettre en fonctionnement le chauffage du filament, l'ensemble de concentration, déviation et alignement.

4 - Appliquer une tension de −120 Volts sur la grille g1. Appliquer ensuite les tensions des électrodes g2, g3, g4.

5 - Augmenter la tension de grille g1 jusqu'à −50 V et ajuster la tension de grille de stabilisation puis de cible aux valeurs recommandées.

6 - Eclairer la face d'entrée du tube à un niveau d'environ 1 mlux.

7 - Mettre progressivement la très haute tension et régler le courant de faisceau (grille g1).

8 - Projeter une mire sur la face d'entrée à un niveau lumineux d'environ 10 mlux.

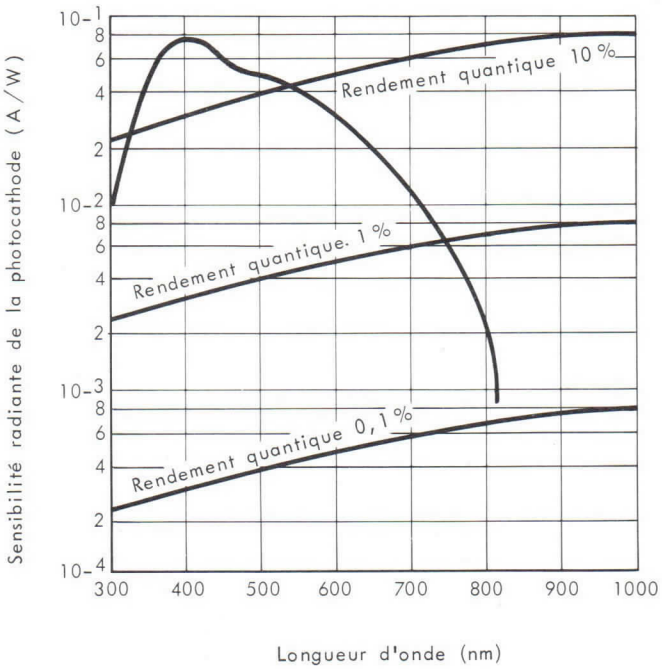
9 - Régler les amplitudes de balayage de manière à voir l'anneau de cible dans les coins de l'image et centrer la mire. Diminuer ensuite les amplitudes pour revenir au cadre normal de balayage.

10 - Ajuster la concentration en agissant sur la tension de l'électrode g3 et parfaire la mise au point optique. La tension de l'électrode g4 doit être normalement supérieure de 30 à 40 Volts à celle de l'électrode g3.

11 - Alignement du faisceau : cette opération est très simple sur les tubes ESICONS. Procéder de la façon suivante:
- réduire la tension de grille de stabilisation jusqu'à ne plus observer qu'une sorte de halo,
- ajuster les courants d'alignement pour centrer le halo,
- s'il faut plus de 2 volts de tension de stabilisation pour que le faisceau atteigne toute la cible, vérifier la position des bobines de concentration et de déviation.

12 - Mettre la tension de stabilisation à sa valeur normale et vérifier la tension d'électrode g3 et la mise au point optique.

REPONSE SPECTRALE DE LA PHOTOCATHODE S 20



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

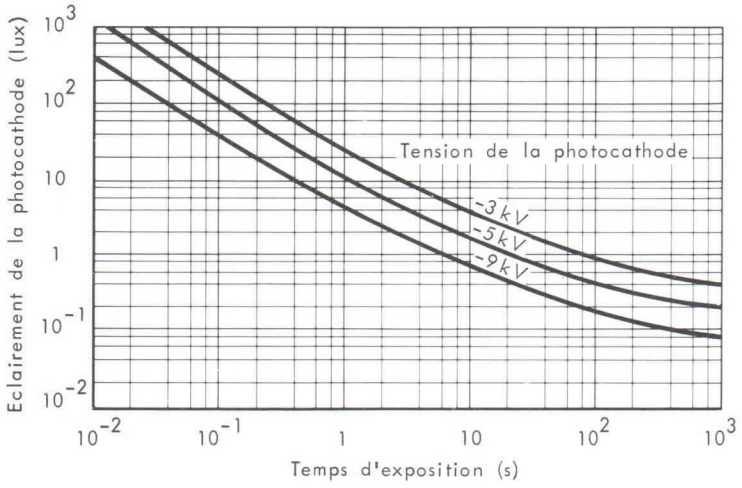


Fig. 1 - Eclairements limites.

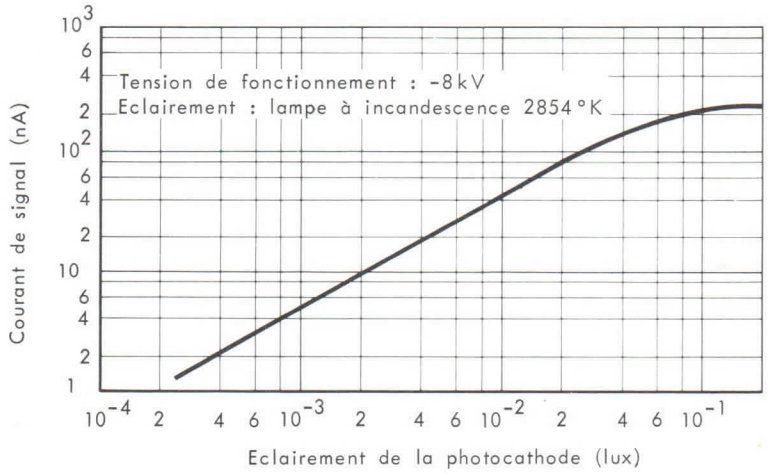


Fig. 2 - Caractéristiques signal - éclairement.

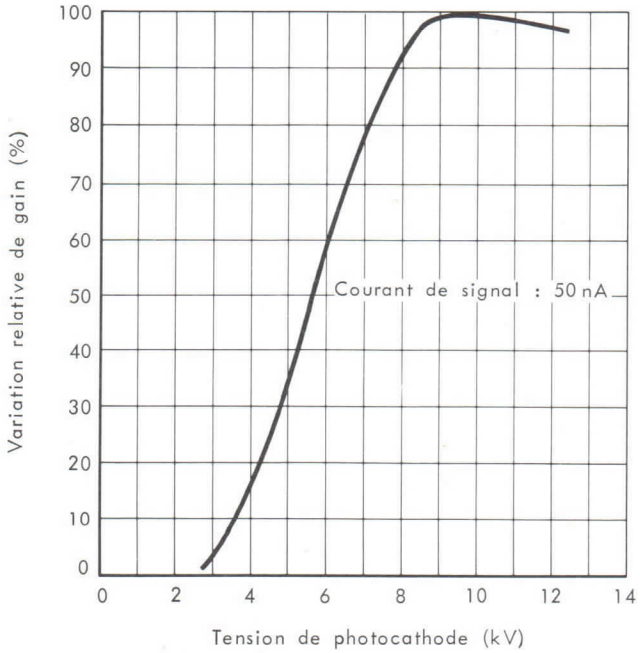


Fig. 3 - Variation relative du gain de cible en fonction de la tension de la photocathode.

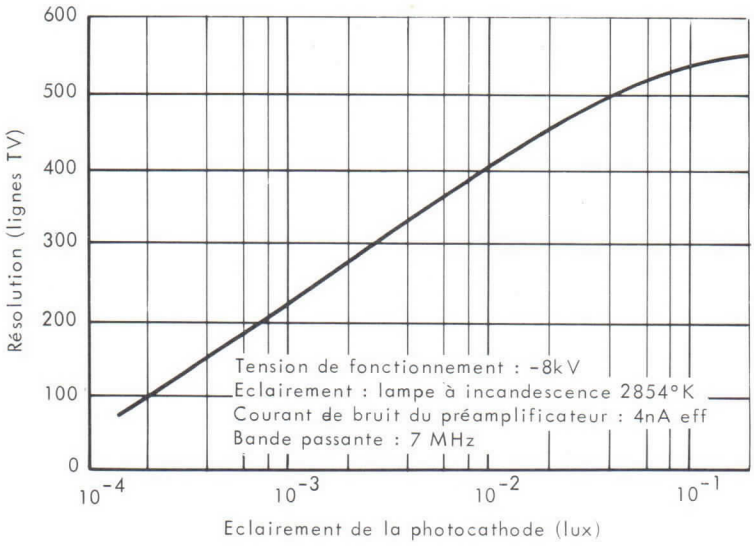


Fig 4 - Résolution statique en fonction de l'éclairement de la photocathode

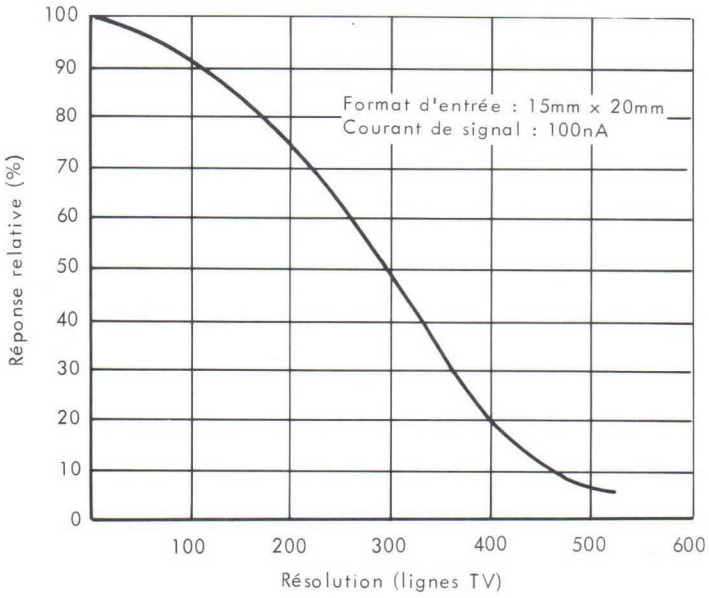


Fig 5 - Fonction de transfert de modulation

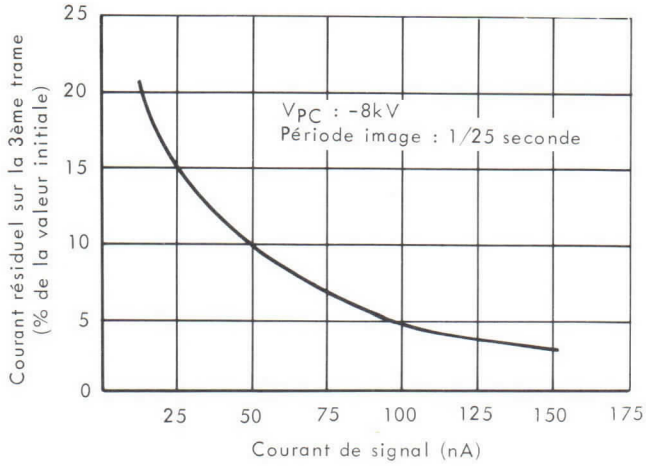


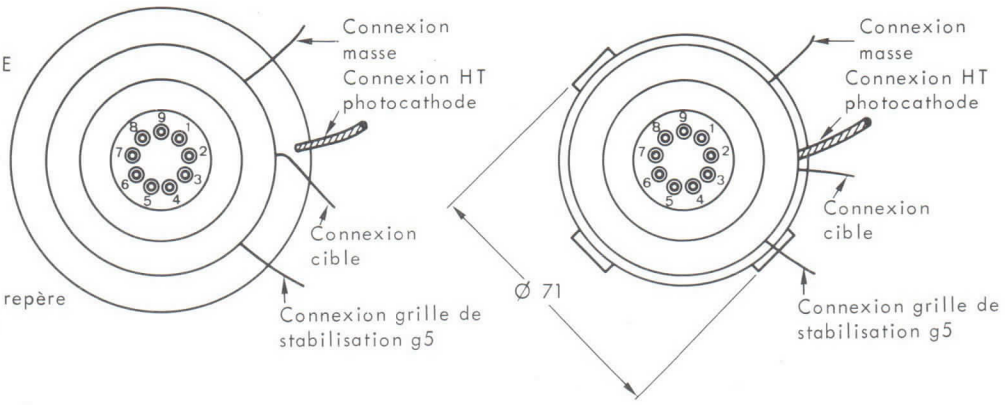
Fig 6 - Rémanence en fonction du courant de signal

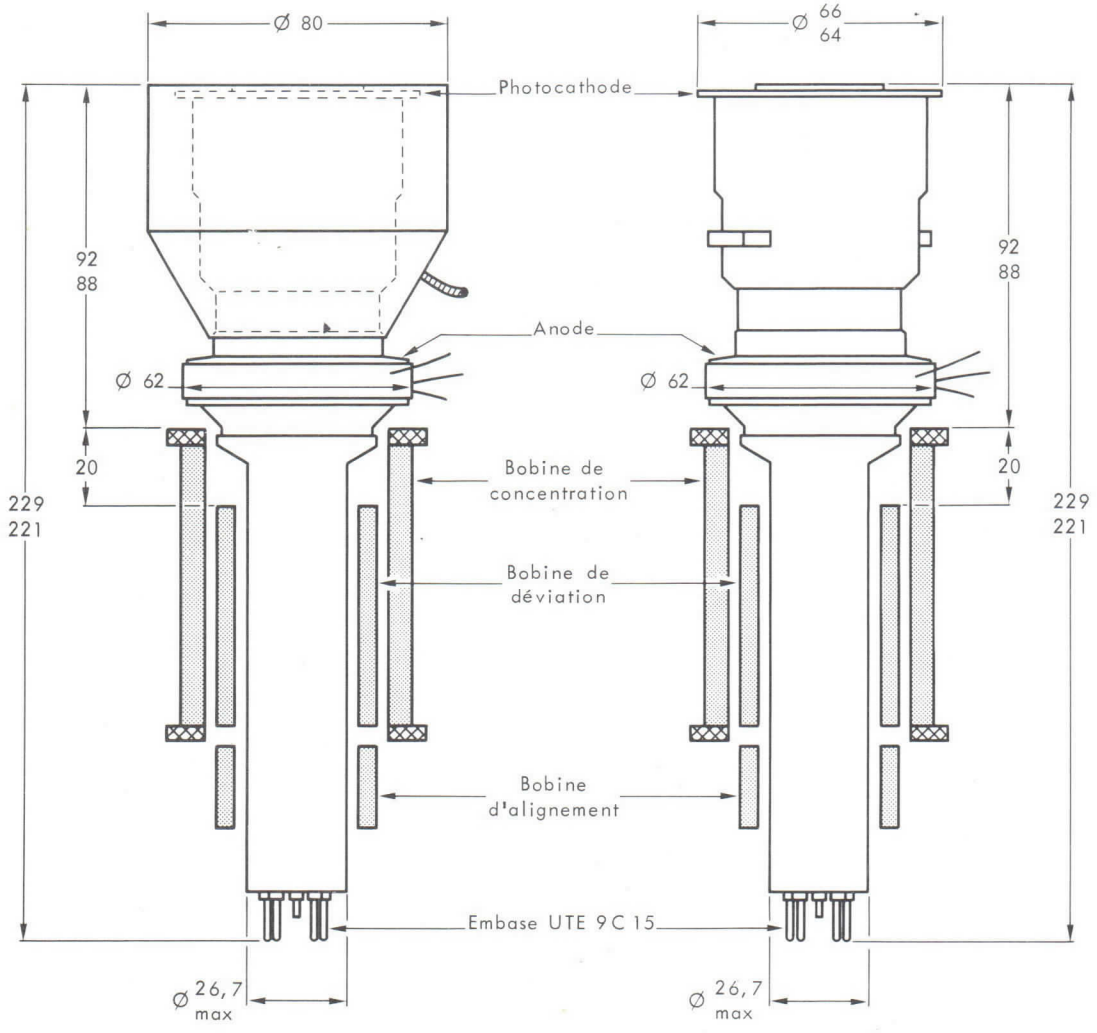
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

DESSIN D'ENCOMBREMENT

BROCHAGE

1 - f
2 - g1
3 - g4
4 - g1
5 - g2
6 - g3
7 - k
8 - f
9 - Broche repère courte





Tube enrobé

Tube non enrobé

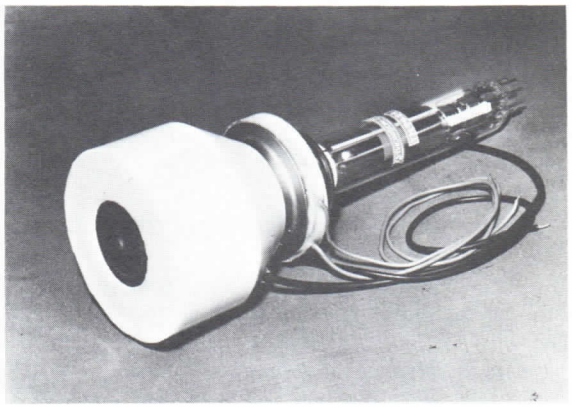
Cotes en mm.

ESICON TH9654
TUBE DE PRISE DE VUE

A BAS NIVEAU DE LUMIERE

- TUBE ROBUSTE
- A CIBLE SUR GRILLE
- SENSIBILITE ELEVEE (8000 μA/lumen)
- GRANDE RESISTANCE AUX ECLAIREMENTS INTENSES
  (sans destruction de la cible)
- POSSIBILITE D'INTEGRATION ET DE MEMOIRE
- TELEVISION NOCTURNE - PHYSIQUE NUCLEAIRE

Le tube TH 9654 est un tube compact de grande sensibilité pour prise de vue à des niveaux incidents aussi faibles que 1 mlux, à bon pouvoir de résolution et faible persistance d'image. Sa robustesse permet de l'utiliser dans des conditions d'environnement sévères (vibrations, secousses, température, ...).



Il comporte une photocathode tri-alcaline déposée sur une face d'entrée à fibres optiques, plan-concave, une section de transfert électrostatique du type diode, une cible multiplicatrice à gain élevé et un canon de lecture du même type que celui des Vidicons classiques mais à structure renforcée qui destine plus particulièrement le TH 9654 aux applications militaires et spatiales.

La cible utilisée permet un fonctionnement dans une grande dynamique d'éclairement et notamment aux faibles niveaux de lumière pour lesquels la très faible persistance d'image facilite l'observation des sujets mobiles. Les parties d'image très brillantes causant une saturation du signal n'introduisent pas d'effets de redistribution détériorant la visibilité des détails dans les régions voisines de l'image. Ces parties très brillantes, peuvent correspondre à des éclairements de la face d'entrée du tube de l'ordre de 10 lux à 100 000 lux, suivant les temps d'exposition (de 10 mn à 10^{-2} s) définis par la figure 1, sans modification des caractéristiques du tube.

Par ailleurs, les surexpositions accidentelles ne causent pas de détérioration définitive du tube ; elles se traduisent pour la partie d'image concernée par une perte de sensibilité d'environ 50 à 70 %.

Le très faible courant d'obscurité de cible permet d'obtenir d'excellentes propriétés d'accumulation, de mémoire et rend possible l'intégration d'images à très faibles niveaux lumineux pendant de longues périodes ainsi que le fonctionnement avec une faible cadence d'analyse.

Ces diverses caractéristiques permettent d'aborder une très grande variété d'applications en prise de vue noir et blanc et en couleur.

Le tube TH 9654 peut être utilisé directement avec un système optique classique ou être couplé par optiques à fibres avec un intensificateur d'image augmentant la sensibilité de détection ou permettant la conversion d'images dans le domaine des rayons X, de l'ultraviolet ou de l'infrarouge. L'emploi de bobines de concentration et de déviation spécialement mises au point est indispensable pour l'utilisation du tube dans les conditions d'environnement sévères.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PERFORMANCES DU TUBE

Sensibilité et dynamique - Réponse spectrale

Le tube TH 9654 utilise une photocathode type S20 déposée sur une fenêtre d'entrée à fibres optiques dont l'efficacité quantique est de l'ordre de 15 % à son maximum (440 nm). Cette grande efficacité, jointe au gain de la cible, permet d'obtenir une sensibilité de l'ordre de 8000 μA/lumen à 10 mlux.

Cette sensibilité permet un fonctionnement correct sans ajustement du tube entre 1 et 100 mlux incidents sur la face d'entrée. Le gamma qui est unitaire entre 5 et 10 mlux décroit jusqu'à 0, 6 vers 100 mlux.

La sensibilité peut être modifiée par variation de la haute tension appliquée à la photocathode sans perte appréciable de résolution, dans un rapport de l'ordre de 1 à 10. La dynamique d'éclairement qui en résulte est de l'ordre de $2.\ 10^3$.

Persistance

Le mécanisme de génération, d'accumulation et de neutralisation des charges électriques sur la cible permet l'obtention d'une très faible persistance d'image qui n'est limitée que par l'acceptation du faisceau de lecture. Le signal résiduel est typiquement, pour la troisième trame balayée, de 8 % pour un courant de signal de 50 nA et de 5 % pour un courant de signal de 100 nA.

Pouvoir de résolution

Sur image statique, la résolution limite est de l'ordre de 600 lignes T.V. au centre de l'image et de 450 lignes T.V. sur les bords avec possibilité de correction dynamique.

Les caractéristiques de persistance permettent, par ailleurs, de conserver un pouvoir de résolution très bon sur des scènes mobiles et confèrent au tube une sensibilité dynamique élevée.

Intégration et mémoire

Il est possible d'intégrer un signal lumineux pendant plusieurs minutes et de le lire quelques heures après avoir coupé la haute tension. Les limites d'intégration proviennent du courant d'obscurité de la section de transfert de l'Esicon et de l'éclairement de la cathode du canon.

Lorsque le bruit photonique est trop important, il peut être intéressant de réduire le gain du tube en diminuant la haute tension et de travailler avec des temps d'intégration plus longs.

RECOMMANDATIONS D'UTILISATION

Alimentation et circuits annexes

Les circuits d'alimentation sont ceux utilisés pour les Vidicons à concentration et déviation électromagnétiques. Deux tensions additionnelles sont nécessaires : l'une de −12 kV pour l'alimentation de la photocathode, l'autre de 30 V pour la grille de stabilisation qui peut être obtenue par diviseur à partir de l'alimentation normale.

Pour l'obtention d'un rapport signal/bruit satisfaisant, il est nécessaire d'associer un préamplificateur à faible bruit. Pour une capacité parallèle de 25 pF et une bande passante de 7 MHz, un courant de bruit équivalent quadratique moyen de 4 nA peut être obtenu (tube D3A - Transistor FET 2N 4416).

Environnement et durée de vie

1 - Le tube est conçu pour que les signaux parasites dus à des résonances mécaniques internes aient des niveaux très faibles. Il reste malgré tout important de veiller au montage du tube dans la caméra, de façon à ce que les amplitudes de vibration transmises soient aussi faibles que possible. Par ailleurs, le tube peut être fourni avec un enrobage isolant de la section image constituant une protection contre l'humidité et les amorçages éventuels.

2 - Le fonctionnement du tube reste correct dans un large domaine de température (−50 à +50 °C). Il est recommandé, malgré tout, de le faire fonctionner au voisinage de l'ambiance.

3 - La durée de vie moyenne est supérieure à 500 h.

CARACTERISTIQUES GENERALES

Mécaniques

Longueur hors-tout	225	mm
Diamètre hors-tout :		
- tube non enrobé	71	mm
- tube enrobé	80	mm
Diamètre section analyse	26	mm
Embase (Ditetrar, 8 broches)	UTE 9 C 15 (JEDEC E 8 - 11)	
Support (note 1)	METOX N° 30 520	
Bloc bobines de déviation et de concentration (note 2).	GERHARD BV 200 - 1 k 1 ou équivalent	
Bloc d'alignement (note 2)	GERHARD BV 80/3 ou équivalent	
ou Bloc bobines de déviation, concentration et alignement (note 2)	CLEVELAND VYFA - 355 2 ou équivalent	
Masse approximative :		
- tube non enrobé	280	g
- tube enrobé	450	g
Position de fonctionnement	indifférente	

Electriques

– SECTION IMAGE :		
Concentration	électrostatique	
Type	diode	
– SECTION ANALYSE :		
Cathode	équipotentielle chauffage indirect à oxydes	
Chauffage filament :		
- tension	6, 3	V
- courant à 6, 3 V	150 ± 10 %	mA
Temps minimal de préchauffage	60	s
Capacités de sortie (entre l'électrode de signal et les autres électrodes)	25	pF
Concentration	électromagnétique	
Déviation	électromagnétique	

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Optiques

– SECTION IMAGE :

Photocathode	S 20
Fenêtre d'entrée :	
- forme	plate et circulaire (planeité 1 μ)
- nature	fibres optiques (fibres élémentaires 5 à 6 μ)
Diamètre utile	25 mm
Surface utile	4, 9 cm^2
Format utile	20 mm x 15 mm

– SECTION ANALYSE :

Cible à grille :	
- diamètre utile maximal (format 4 x 3)	17 mm
- format normal sur cible	12, 7 mm x 9, 5 mm

CONDITIONS D'EMPLOI

Les tensions sont données par rapport à la masse, l'anode de la section image et la cathode de la section analyse étant reliées à la masse

Valeurs limites d'utilisation (limites absolues) :

Température ambiante - en stockage	max.	+85	°C
	min.	– 62	°C
- en fonctionnement	max.	+50	°C
	min.	– 50	°C

– SECTION IMAGE :

Tension de photocathode - valeur continue négative	max.	12 000	V
- valeur continue positive	max.	0	V
Tension anodique	max.	0	V

– SECTION ANALYSE :

Tension d'électrode de signal (cible)	max.	40	V
Tension de grille g5 (grille de stabilisation)	max.	30	V
Tension de cathode k	max.	0	V
Tension de grille g1 (extinction du faisceau) :			
- valeur continue négative	max.	150	V
- valeur continue positive	max.	0	V
Tension de grille g2 (accélération)	max.	400	V
Tension de grille g3 (de paroi)	max.	400	V
Tension de grille g4 (de champ)	max.	600	V
Tension de filament	max.	6, 9	V
	min.	5, 7	V
Tension entre filament et cathode :			
- filament négatif par rapport à la cathode	max.	125	V
- filament positif par rapport à la cathode	max.	10	V
Courant de signal	max.	200	nA

Valeurs typiques d'utilisation

Température (note 3)	25	°C
– SECTION IMAGE :		
Tension de la photocathode	−8 000	V
Tension anodique	0	V
– SECTION ANALYSE :		
Tension d'électrode de signal	5 à 30	V
Tension de grille g5	15	V
Tension de cathode k	0	V
Tension de grille g1 (note 4)	− 80	V
Tension de grille g2	300	V
Tension de grille g3	320	V
Tension de grille g4	360	V
Tension crête minimale de blocage appliquée sur :		
- la cathode	+30	V
- la grille g1	− 80	V
Champ magnétique de concentration	40	Gauss
Champ magnétique d'alignement	0 à 4	Gauss

Performances électro-optiques

Sensibilité lumineuse	8 000	µA/lm
Sensibilité d'exploitation	2, 5	µA/lux
Format de l'image sur la photocathode	20 mm x 15 mm	
Eclairement de la photocathode (2854 °K) (note 5)	0, 1	lux
Courant de signal	100	nA
Résolution limite au centre de l'image (note 6)	550	lignes TV
Résolution limite sur les bords	400	lignes TV
Taux de modulation à 400 lignes TV, au centre de l'image (note 7).	20	%
Persistance (note 8) :		
- 3e trame balayée après extinction	$\leqslant 5$	%
- 10e trame balayée après extinction	< 1	%

ESSAIS D'ENVIRONNEMENT

Le tube TH 9654 supporte hors fonctionnement les essais d'environnement suivants. Après exécution de ces essais le tube doit satisfaire aux performances électronoptiques définies dans les conditions d'emploi.

Essai climatique

Le tube est soumis à 4 cycles de température entre −50 °C et + 50 °C avec maintien aux températures extrêmes pendant 30 minutes. Chaque cycle est exploré avec une variation de l'ordre de 2 °C/mn.

Essai en vibrations sinusoidales

L'essai est conduit conformément à la spécification MIL-T5422 E (ASG) courbe IV.

Exploration aller-retour de la gamme 5 - 500 Hz permettant un niveau d'accélération de 10 g dans la plage 72 à 500 Hz. Durée d'un cycle 15 minutes. - Réalisation de deux cycles suivant les trois axes du tube.

Essai de secousses

L'essai est réalisé conformément aux normes NF - C 93 - 001. - Essai 24 avec :
- accélération maximale : 25 g ;
- nombre de secousses suivant l'axe longitudinal du tube : 1000.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

NOTES

1 - METOX - 86, rue de Villiers de l'Isle Adam - 75020 PARIS - Téléphone : 636. 31-10.

2 - GERHARD KG - REICHELSHEIM/ODW Germany.
CLEVELAND Electronics Inc. - 2000 Highland Road - TWINSBURG - OHIO - 44 087.

3 - Toutes les caractéristiques sont données pour une température du tube, au voisinage de la cible, de 25 °C ; les limites de température recommandées pour un bon fonctionnement étant de 20 ° et 30 °C.

4 - Sans impulsion de blocage appliqué sur l'électrode g1.

5 - La source lumineuse est une lampe à filament de tungstène fonctionnant à une température de couleur de 2854 °K.

6 - Pratiquement, la résolution limite correspond, sur une mire de définition à lignes noires et blanches, à un taux de modulation voisin de 7 %.

7 - Pour le standard CCIR de 625 lignes, la durée d'une ligne est de 52 μs (temps de suppression exclu), 400 lignes T.V. correspondent à une fréquence de 5 MHz.

8 - La persistance s'exprime par le rapport en % du courant de signal résiduel mesuré à la fin de la n^{e} trame balayée après extinction de l'excitation lumineuse, au courant de signal initial (100 nA). Les valeurs indiquées sont valables pour une cadence de balayage de 50 trames/seconde.

CONSIGNES D'UTILISATION

L'ESICON est un tube relativement robuste et facile à utiliser. Néanmoins, il est nécessaire d'observer un certain nombre de précautions pour éviter tout risque de détérioration.

Recommandations importantes

1 - Un système de protection enrobé limite la différence de potentiel qui peut exister entre la grille de stabilisation et la cible. Il est expressément recommandé de ne pas déconnecter cette protection.

2 - Les tensions de balayage de la section d'analyse doivent être appliquées avant les tensions d'électrodes. Lorsque les prises de vues sont terminées, elles doivent être coupées après les tensions d'électrodes.

3 - Au moment des prises de vues, appliquer la très haute tension en dernier lieu. Quand les prises de vues sont terminées, il faut au contraire couper en premier la très haute tension.

4 - Le tube ne doit pas être soumis à des niveaux lumineux supérieurs à ceux définis par les courbes de la figure 1*.

5 - Il est conseillé de ne pas dépasser les tensions de cible et de grille de stabilisation indiquées**. Si le tube destabilise (phénomène qui se traduit par une perte de sensibilité et parfois par l'apparition d'une image négative), réduire l'éclairement et mettre un instant la grille de stabilisation à 5 Volts.environ. Vérifier éventuellement si le courant de faisceau est suffisant pour décharger la cible. Lorsque l'on revient à la tension de stabilisation normale, le tube doit retrouver aussitôt ses caractéristiques.

6 - Les amplitudes de balayage vertical et horizontal doivent être ajustées de manière à balayer la cible au cadre normal ou un peu plus. Il faut éviter de sous balayer la cible.

* *Toutefois, le marquage apparu en cas d'éclairement trop intense mais peu prolongé disparaît généralement en quelques minutes.*

** *Voir la feuille accompagnant le tube livré.*

Montage du tube ESICON et mise en oeuvre

1 - Installer le tube dans les bobines de la caméra comme il est indiqué sur la figure. Si le tube est placé en position horizontale, la broche courte du pied du canon doit être positionnée dans le plan horizontal parallèle aux traces du balayage ligne. Un masque de dimensions 15 mm x 20 mm peut être placé sur la face d'entrée de manière à ne pas éclairer les zones de la photocathode qui sont en dehors du cadre de balayage.

2 - Connecter les différentes électrodes.

3 - Mettre en fonctionnement le chauffage du filament, l'ensemble de concentration, déviation et alignement.

4 - Appliquer une tension de −120 Volts sur la grille g1. Appliquer ensuite les tensions des électrodes g2, g3, g4.

5 - Augmenter la tension de grille g1 jusqu'à −50 V et ajuster la tension de grille de stabilisation puis de cible aux valeurs recommandées.

6 - Eclairer la face d'entrée du tube à un niveau d'environ 1 mlux.

7 - Mettre progressivement la très haute tension et régler le courant de faisceau (grille g1).

8 - Projeter une mire sur la face d'entrée à un niveau lumineux d'environ 10 mlux.

9 - Régler les amplitudes de balayage de manière à voir l'anneau de cible dans les coins de l'image et centrer la mire. Diminuer ensuite les amplitudes pour revenir au cadre normal de balayage.

10 - Ajuster la concentration en agissant sur la tension de l'électrode g3 et parfaire la mise au point optique. La tension de l'électrode g4 doit être normalement supérieure de 30 à 40 Volts à celle de l'électrode g3.

11 - Alignement du faisceau : cette opération est très simple sur les tubes ESICONS. Procéder de la façon suivante:
- réduire la tension de grille de stabilisation jusqu'à ne plus observer qu'une sorte de halo,
- ajuster les courants d'alignement pour centrer le halo,
- s'il faut plus de 2 volts de tension de stabilisation pour que le faisceau atteigne toute la cible, vérifier la position des bobines de concentration et de déviation.

12 - Mettre la tension de stabilisation à sa valeur normale et vérifier la tension d'électrode g3 et la mise au point optique.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

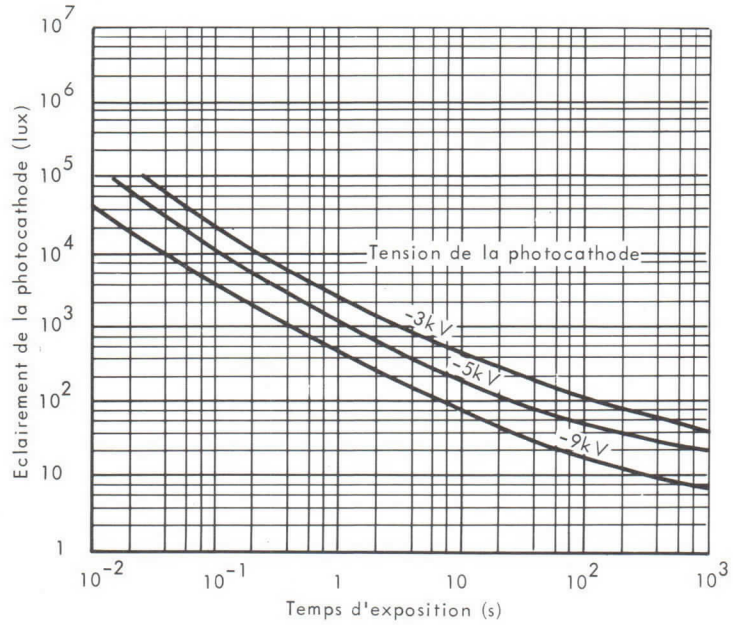


Fig1 - Eclairements limites

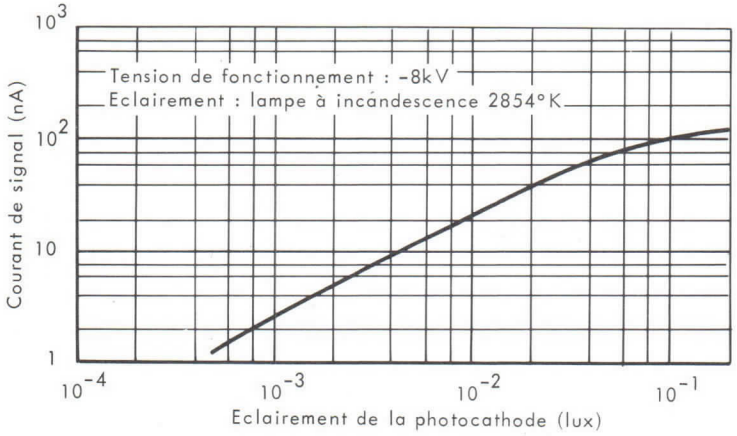


Fig 2 - Caractéristique signal-éclairement

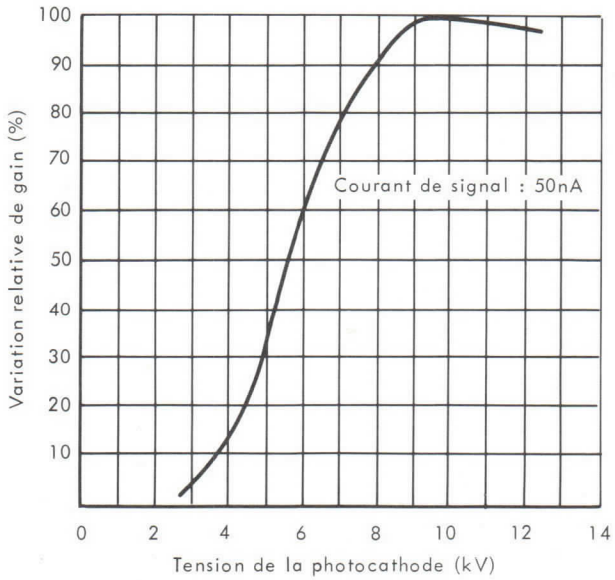


Fig 3 - Variation relative du gain de cible en fonction de la tension de la photocathode

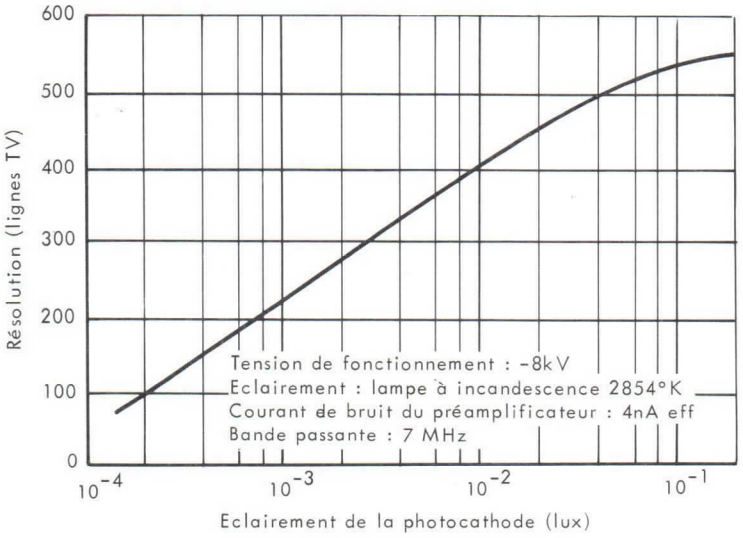


Fig 4 - Résolution statique en fonction de l'éclairement de la photocathode

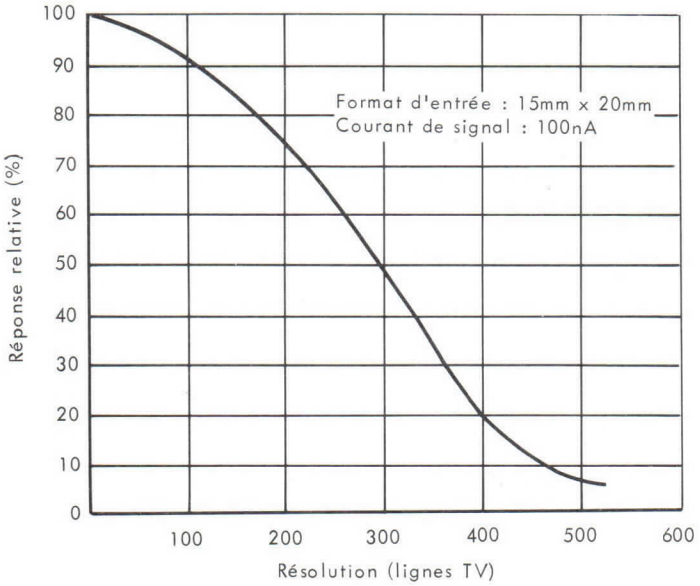


Fig 5 - Fonction de transfert de modulation

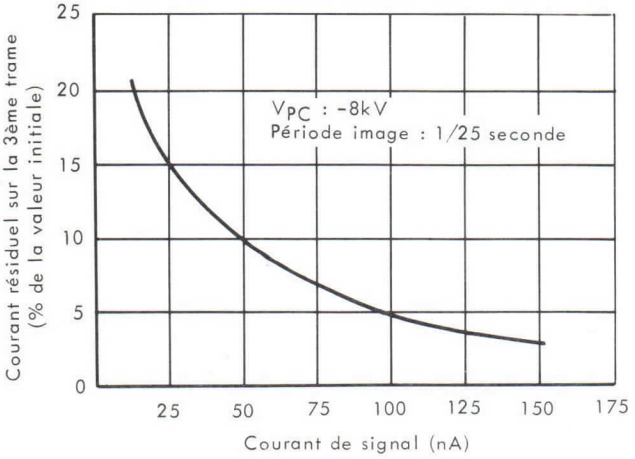
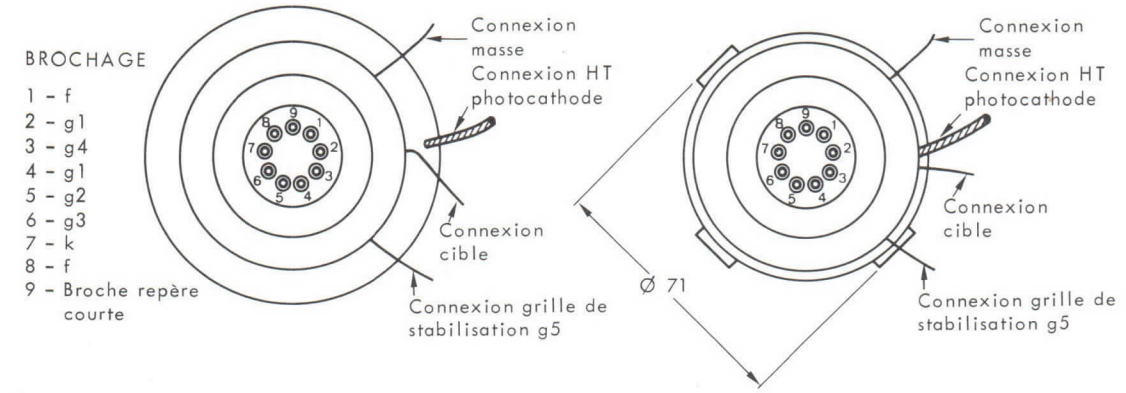
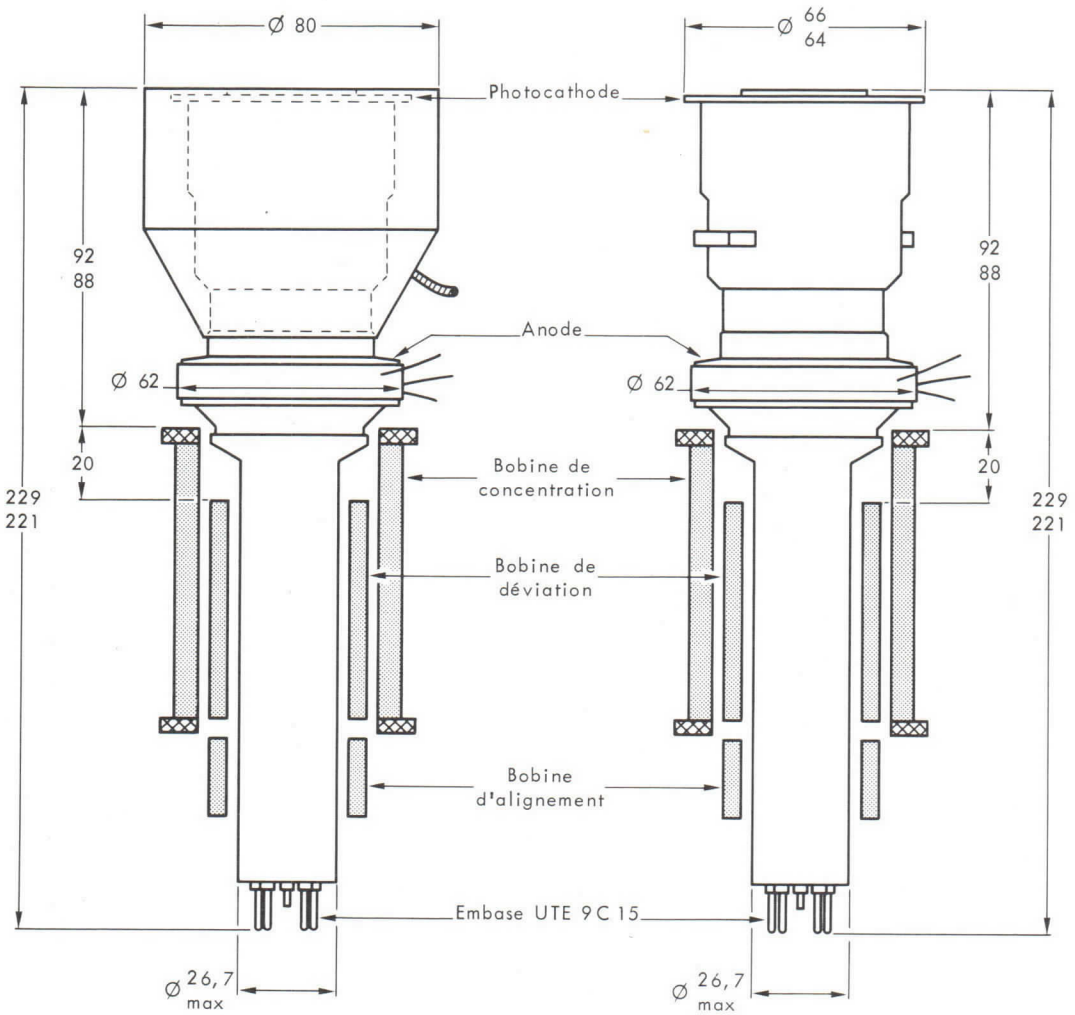


Fig 6 - Rémanence en fonction du courant de signal

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

DESSIN D'ENCOMBREMENT





Tube enrobé

Tube non enrobé

Cotes en mm.

TH 9655
NOCTICON*
LOW LIGHT LEVEL CAMERA TUBE

- FIBER OPTICS INPUT WINDOW : 25 mm diameter
- SILICON TARGET : 18 mm diameter
- LARGE SPECTRAL RESPONSE
- SENSITIVITY 300 mA/lumen
- LOW DARK CURRENT
- LOW LAG
- WIDE DYNAMIC RANGE (variable gain)
- COMPACT AND RUGGED STRUCTURE
- BURN RESISTANT

GENERAL CHARACTERISTICS

Electro-optics

The tube TH 9655 is a 25 mm input field, rugged tube especially designed for use in low light and very low light level T.V. applications.

This compact tube includes a photocathode deposited on a fiber optics flat window, a diode array silicon target and a scanning electron gun. Due to the high gain of the target, this tube exhibits excellent performances : each photo-electron, emitted by the photocathode and accelerated through approximately 10 kV, releases its energy in the silicon creating by ionization 1500 to 2000 electron-hole pairs. The image section performances can be achieved for a wide range of high voltage values whose variation enables to use the tube in a wide dynamic illumination range.

The TH 9655 can operate at light levels near the limits defined by photo-electron fluctuation noise ; this capability results from the use of the S20 or S20ER type photocathode with panchromatic response and the use of a high gain target.

The silicon target has been especially designed in order to obtain, in combination with the high performances of the electron gun, a high resolution and a low lag. This target can also withstand extreme overloads due to over illuminance of short duration without target burn or damage.

The sturdiness of TH 9655 is such that it can be implemented in systems operating in severe environmental conditions.

* Registered Trade Mark.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Different versions of the tube

The TH 9655 can be provided in a potted version (indentified by the suffix M) or in a non-potted version. The normal potting* is recommended for easier an safer use (see Fig. 11 and 12).

Other types can be realized for instance tubes provided with focusing - alignment coils, deflection yokes or with flying leads.

Tubes coupled to an image intensifier tube such as TH 9473, TH 9302 (25 mm gated tube) or TH 9479 (40 mm zoom - gated tube) can also be provided.

The TH 9655 tubes are normally available in the following classes :

Class A	TH 9655 NOR	(1)
	TH 9655 M/NOR	(2)
Class B	TH 9655 IND	(1)
	TH 9655 M/IND	(2)
Class C	TH 9655 AMR	(1)
	TH 9655 M/AMR	(2)

(1) Non-potted tube
(2) Potted tube

The TH 7118 high voltage supply can also be provided on request.

GENERAL DATA

Mechanical

Overall length	224 mm
Outer diameter :	
- non-potted type	71 mm
- potted type	80 mm
Scanning section, max.	26. 4 mm
Base	UTE 9 C 15 (JEDEC N° E8 - 11)
Socket (note 1)	METOX N° 30520
Deflection and focusing coils assembly (note 2)	GERHARD BV 200 Spez 47 or equivalent
Alignment coil (note 2)	GERHARD BV 80/3 or equivalent
or Deflection - focusing - alignment assembly (note 2)	THOMSON-CSF THX909 or equivalent
Weight, approx. :	
- non-potted tube	250 g
- potted tube	450 g
Operating position	any

* Other shapes of the potting can be provided upon request.

Electrical

– IMAGE SECTION

Focusing	electrostatic
Type	diode

– SCANNING SECTION

Cathode	equipotential indirect oxide coated
Heater :	
- voltage	6. 3 V
- current at 6. 3 V	0. 15 ± 10 % A
Minimum preheating time	60 s
Output capacitance (target to all other electrodes)	12 pF
Focus	electromagnetic
Deflection	electromagnetic
Alignment	electromagnetic

Optical

– IMAGE SECTION

Photocathode	S20 or S20ER
Spectral response	see curves fig. 1
Input window :	
- shape	flat
- type	fiber optics (6 μm-N.A. = 1)
Useful diameter	25 mm
Useful area - format 4 x 3	3 cm^2
Useful format	15 mm x 20 mm
Safety glass (for potted tube) :	
- thickness	2. 5 ± 0. 1 mm
- index (n_D)	1. 49

– SCANNING SECTION

Target :	
- maximum useful diameter (format 4 x 3)	18 mm
- normal format on the target	10. 8 mm x 14. 4 mm
- orientation of image (note 3) : horizontal scan parallel to the plane passing through the tube axis and the short index pin.	

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OPERATING CONDITIONS

The potentials are referred to ground, the anode of the image section and the cathode of the scanning section being grounded.

Maximum ratings (absolute values)

Ambient temperature - in storage	max.	+ 70	°C
	min.	− 55	°C
in operation	max.	+ 55	°C
	min.	− 40	°C

– IMAGE SECTION

Photocathode voltage (D.C. negative value)	max.	12	kV
	min.	0	V
Anode voltage		0	V
Faceplate illuminance (see curves fig. 2 and chapter 5 of operating recommendations)	max.	40 000	lux. s

– SCANNING SECTION

Signal electrode (target) voltage (note 4)	max.	300	V
Electrode g_4 (field) voltage (note 5)	max.	350	V
Electrode g_3 (wall) voltage (note 5)	max.	350	V
Electrode g_2 (acceleration) voltage	max.	350	V
Electrode g_1 (for picture cut-off) voltage :			
- negative bias voltage	max.	150	V
- positive bias voltage	max.	0	V
Cathode k voltage		0	V
Heater voltage	max.	6. 6	V
	min.	6. 0	V
Peak heater to cathode voltage:			
- heater negative with respect to cathode	max.	125	V
- heater positive with respect to cathode	max.	10	V
Target current	max.	750	nA

Typical operation

Operating conditions :

Temperature (note 7)		25	°C

– IMAGE SECTION

Photocathode voltage (D.C. negative value)		9	kV
Anode voltage		0	V

– SCANNING SECTION

Electrode signal voltage		8	V
Electrode g_4 voltage		340	V
Electrode g_3 voltage		290	V
Electrode g_2 voltage		300	V
Electrode g_1 voltage (for picture cut-off) (note 8)	min.	− 40	V
	max.	− 100	V
Minimum blanking peak-to-peak voltage :			
- applied to g_1		− 75	V
- applied to cathode		+ 20	V
Focus magnetic field		40	Gauss

Deflection peak current for BV 200/Spez 47 assembly :		
- horizontal	200	mA
- vertical	25	mA
Alignment field	0 to 4	Gauss

Electro-optical performances

Scanning standard	25 images/s 625 interlaced lines			
Image format on photocathode	15 mm x 20 mm			
	min.	avg.	max.	Units
Dark current (fig. 3)	–	10	20	nA
Overall sensitivity (note 9) :				
TH 9655 NOR and IND (fig. 4)	70	90	–	µA/lux
	235	300	–	mA/lm
TH 9655 AMR	55	80	–	µA/lux
	180	260	–	mA/lm
Average gamma for a signal current between 1 and 700 nA (note 10)	–	1	–	
Variation of gain for a photocathode voltage swing from – 3 kV to – 11 kV (fig. 5)	100	400	–	
Limiting resolution at center of image (note 11) (fig. 6 and 7)	–	750	–	T.V. lines
M.T.F. at 400 T.V. lines at center of image (note 12) (fig. 7)	30	35	–	%
Persistence (note 13) (fig. 8) on the 3rd frame	–	15	25	%

ENVIRONMENTAL TESTS

The TH 9655 is designed to withstand the following non operational environmental tests. After completion of the tests, the tube will meet all the characteristics specified under the "OPERATIONAL CHARACTERISTICS".

– TEMPERATURE TESTS

The tube is subjected to 4 temperature cycles within the range of – 55 °C and + 70 °C and held at these extremal values for 30 minutes. Temperature variation is in the order of 2 °C/mn.

– SINUSOIDAL VIBRATIONS

The tube shall be rigidly maintained at three points (photocathode collar, target flange and gun base) and subjected to vibrations along 3 orthogonal axes, one of which passing through the tube axis.

Vibration characteristics :

- amplitude : 0.4 mm from 10 to 110 Hz
- peak acceleration : 20 g from 110 to 500 Hz

Cycle duration : 10 Hz - 500 Hz - 10 Hz ; 30 mn for each axis

– BUMP TESTS

The test shall be made according to the specification NF C20 - 624 :

- maximum acceleration : 40 g
- total number of bumps : 2000 with 1000 along the longitudinal axis of the tube and 500 along each of the two orthogonal axes.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

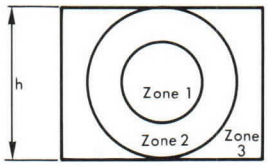
SPURIOUS SIGNAL TESTS

Measurement conditions

Photocathode voltage : V_{pc} = − 6 kV
Target voltage : V_c = 8 V
Signal current : I_s = 300 nA

The gain of the video amplifier and the control monitor are adjusted so as to obtain an optimum image (note 14).
The test is performed by using a uniformly diffused white test pattern that is separated into 3 zones of quality as shown in figure 9.

Figure 9



The quality zones are defined as follows, h being the image height :

- the zone 1 is inside a circle of h/2 diameter ;
- the zone 2 is between the two circles of h/2 and h diameters ;
- the zone 3 is outside the circle of h diameter.

CLASS A

Spots

Black and white spots,
Will actually be considered as defects, blemishes of contrast C ⩾ 10 % (note 15) in light ambience or in darkness.

Dimensions of defects "d" (note 16)		Number allowed					
		Zone 1		Zone 2		Zone 3	
% raster height	T.V. lines	White	Black	White	Black	White	Black
⩾ 1.8	⩾ 10	0	0	0	0	0	0
⩾ 1.25	⩾ 7	0	1	0	2	0	2
⩾ 0.8	⩾ 4	0	2	1	5	2	8
⩾ 0.6	⩾ 3	1	3	2	9	3	18
⩾ 0.2	⩾ 1	2	+	4	+	5	+
< 0.2	< 1	+	+	+	+	+	+

\+ Spots of this size are allowed unless concentration causes a smudge appearance.

Spots of contrast C < 10 % will not be counted.

Other defects

Smudges, streaks, mottled or grainy background (black and white) are not considered as defects if their contrast is C ⩽ 5 %.

Fiber optics block lines of contrast C ⩽ 10 % will not be counted.

CLASS B

Spots

Black and white spots.
Will actually be considered as defects, blemishes of contrast C $\geqslant$ 15 % (note 15) in light ambience or in darkness.

Dimensions of defects "d" (note 16)		Number allowed					
		Zone 1		Zone 2		Zone 3	
% raster height	T.V. lines	White	Black	White	Black	White	Black
$\geqslant$ 2.5	$\geqslant$ 13	0	0	0	0	0	0
$\geqslant$ 1.8	$\geqslant$ 10	0	0	0	1	0	2
$\geqslant$ 1.25	$\geqslant$ 7	0	1	0	3	1	3
$\geqslant$ 0.8	$\geqslant$ 4	1	2	2	6	3	9
$\geqslant$ 0.4	$\geqslant$ 2	4	7	7	10	9	20
$<$ 0.4	$<$ 2	+	+	+	+	+	+

+ Spots of this size are allowed unless concentration causes a smudge appearance.

Spots of contrast C $<$ 15 % will not be counted.

Other defects

Smudges, streaks, mottled or grainy background (black and white) are not considered as defects if their contrast is C $\leqslant$ 10 %.

Fiber optics block lines of contrast C $\leqslant$ 20 % will not be counted.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

CLASS C

Spots

Black and white spots
Will actually be considered as defects, blemishes of contrast C ⩾ 15 % (note 15) in light ambience or in darkness.

Dimensions of defects "d" (note 16)		Number allowed*		
		Zone 1	Zone 2	Zone 3
% raster height	T.V. lines			
⩾ 2.5	⩾ 13	0	0	0
⩾ 1.8	⩾ 10	0	1	2
⩾ 1.25	⩾ 7	1	3	4
⩾ 0.8	⩾ 4	3	8	12
⩾ 0.4	⩾ 2	11	17	25
< 0.4	< 2	+	+	+

* The mentioned numbers correspond to the total of allowed spots whether black or white.

\+ Spots of this size are allowed unless concentration causes a smudge appearance.

Spots of contrast C < 15 % will not be counted.

Other defects

Smudges, streaks, mottled or grainy background (black and white) are not considered as defects if their contrast is C ⩽ 20 %.

Fiber optics block lines of contrast C ⩽ 30 % will not be counted.

NOTES

1 - METOX - 86 rue de Villiers de l'Isle Adam - 75020 PARIS - Tel. 636 31 10.

2 - GERHARD KG - REICHELSHEIM/ODW Germany.

3 - It is necessary to ensure a correct positioning of the tube inside the coil assembly.

4 - In normal operation, the target voltage will not exceed 15 V.

5 - Grid N° 4 voltage must always be higher than grid N° 3. voltage.

6 - Target current is defined as the total current flowing through the load resistor connected to the signal electrode : signal current + dark current, the dark current being the current in the case of a non-illuminated photocathode.

The video amplifiers must be designed to handle target current of 1 μA in order to avoid supply overload or image distortions.

7 - All characteristics are given for a tube temperature of 25 °C in the vicinity of the target, the recommended temperature range required for a good operation being 20 °C to 30 °C.

The rise of temperature,in the vicinity of the target depends upon the ambient temperature as well as the thermal dissipation of the surrounding devices and the tube itself.

A temperature rise of the tube of 10 °C involves in dark current increase by a factor of 2.

8 - Without blanking pulse applied to electrode g_1.

9 - The light source is a tungsten filament at 2854 °K color temperature.

10 - The average "gamma" can be defined as the slope of the rectilinear part of the light transfer characteristic in log coordinates.

11 - Practically, the limiting resolution corresponds to the resolution measured with twin bar test card at about 7 % modulation.

12 - For 625 lines C.C.I.R. Standard, the line duration being 52 μs (line suppression period not included), 400 T.V. lines correspond to a frequency of 5 MHz.

13 - The persistence is defined as the percentage of the residual signal (measured on the n^{th} field after the illumination removal) to the initial signal.

This value assumes 50 frames/second scanning rate.

14 - The monitor is adjusted as the following :

- for the pedestal level (black), the luminance of the screen is set at cut-off.
- for the maximum level (white), the gain of the monitor is adjusted to obtain an optimum image depending on image content and ambient light.

15 - The contrast is defined as the percentage of increment in video current due to the blemish to the normal signal current.

16 - The dimensions of spots are expressed :

- by the d/h ratio where :
  d is the average diameter of the spot
  h is the raster height
- or by the equivalent T.V. lines for a 625 lines standard.

OPERATING INSTRUCTIONS

Important recommendations

1 - Non-potted tube

It is strictly recommended not to put metal parts in the proximity of the fiber optics faceplate and the photocathode flange since they are set at a very high potential up to – 12 kV with respect to ground.

At the faceplate level, micro-sparks between internal and external faces of fiber optics can give rise to flicker with resulting in luminous spots on the image.

In critical cases, a spark can cause permanent damage to the input face with loss of vacuum.

For the same reasons, care must be taken to protect the tube from humidity.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

2 - Potted tube

The potted tube allows an excellent safety in operation and makes easier the design of the camera head.

First, the potting insulates the photocathode flange from the surrounding. Furthermore, a glass of 2.5 ± 0.1 mm thickness and 1.49 index is bound on the faceplate of the tube. A transparent conductive layer is deposited on one face of this glass ; this conductive face is placed on the fiber optics input window and set at the photocathode potential in order to eliminate flickers and sparks at the photocathode level.

3 - The deflection voltages of the scanning section must be applied before any electrode voltages. For shutdown, the deflection voltages must be switched off only after electrode voltages have been turned off.

4 - When operating the tube, apply the high voltage in the last sequence. For shutdown, switch off the high voltage before the other voltages.

5 - The tube should not be operated at light levels higher than those given in curves of the fig. 2.

Illuminances of the photocathode exceeding the allowed values can cause permanent burn of the target involving in the loss of image quality.

When the tube is used under high variation illuminance conditions, it is recommended to provide : a servo-controlled photocathode voltage, filters and shutter in order to keep the signal current in the normal range (300 to 400 nA).

6 - Target voltage

The dark current and spurious signals increase when the voltage of the target is increased.

The sensitivity of the tube is not affected by the target potential (that is true from a certain value).

The optimum value of the target potential is the one which allows to obtain a maximum current (> 500 nA) and a minimum dark current.

This value is in the order of 8 to 10 Volts when the tube is used with the coil assembly mentionned in this Data.

When the target voltage is higher than 15 Volts, a destabilization of the target can occur which results in the impossibility to recharge the target by the beam.

In such a case, follow the recommended procedure below :

1 - Shut the optics ;
2 - Set V_{pc} to 0 V ;
3 - Scan the whole target ;
4 - Set V_{g1} at about -5 V ;
5 - Set target voltage V_c at 300 V during 1 to 2 secondes ;
6 - Cut-off the beam completely ($V_{g1} \geqslant V_{co}$ with V_{co} = cut-off potential).
7 - Reset target voltage to normal operating voltage : 8 to 10 V. ;
8 - Increase beam current to normal target discharge by adjusting V_{g1}.

The tube can then be operated normally.

7 - Beam alignment

Great care must be taken to align the electron beam.

The current in the alignment coil must be adjusted so that to obtain a maximum signal current higher than 500 nA in any part of the image and a uniform resolution.

Figure 1

TYPICAL SPECTRAL RESPONSES
OF S20 AND S20 ER PHOTOCATHODES

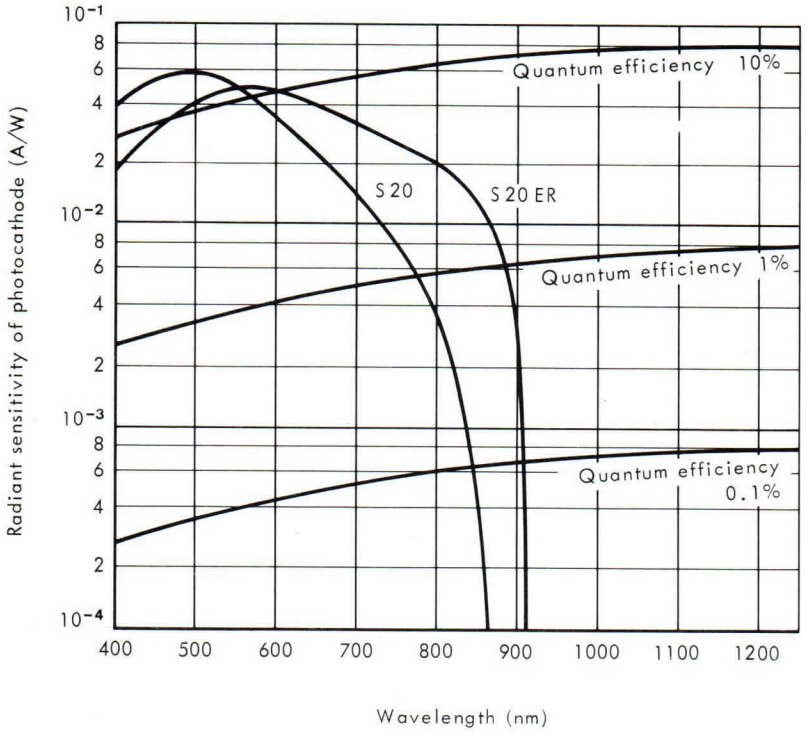
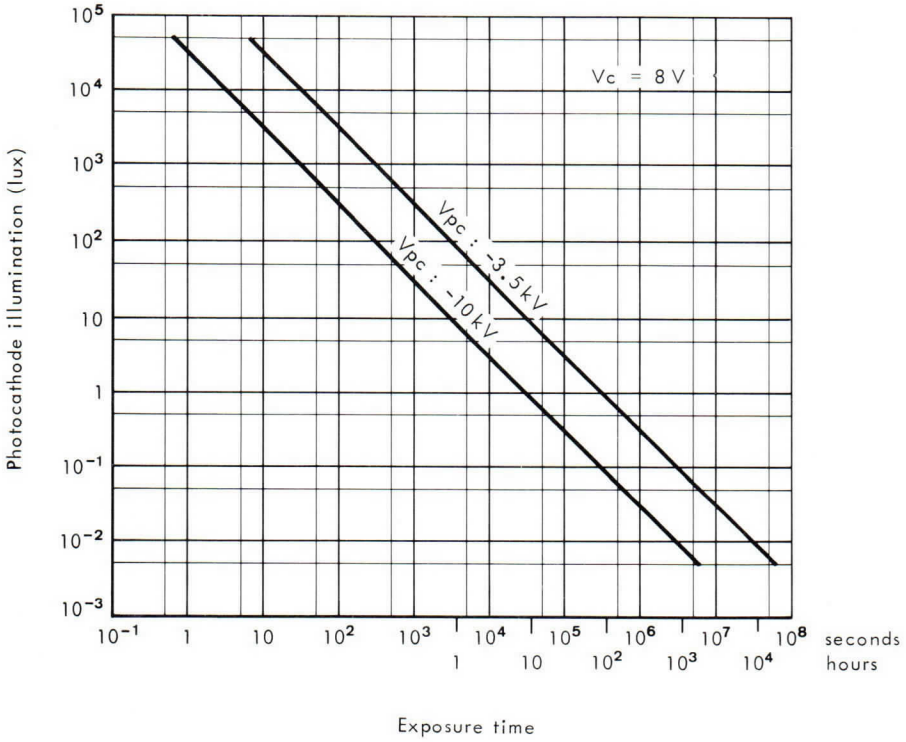


Figure 2

MAXIMUM EXPOSURE TIME



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Figure 3
DARK CURRENT VERSUS TARGET VOLTAGE

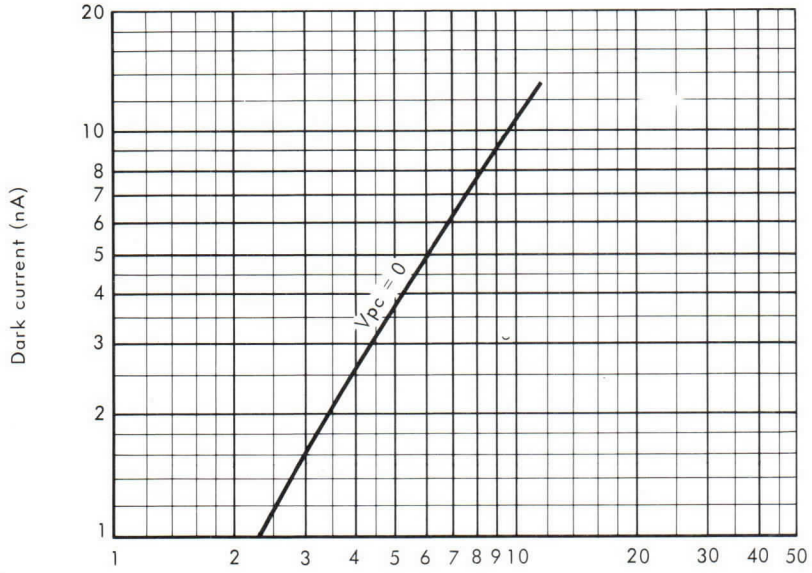


Figure 4
TYPICAL TRANSFER CHARACTERISTIC

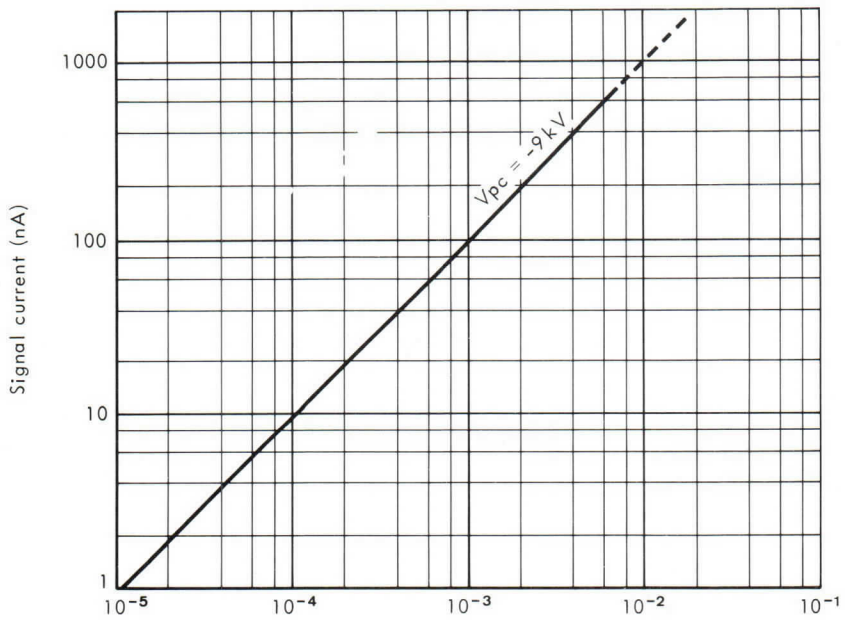


Figure 5

TYPICAL SENSITIVITY CHARACTERISTIC
VERSUS PHOTOCATHODE VOLTAGE

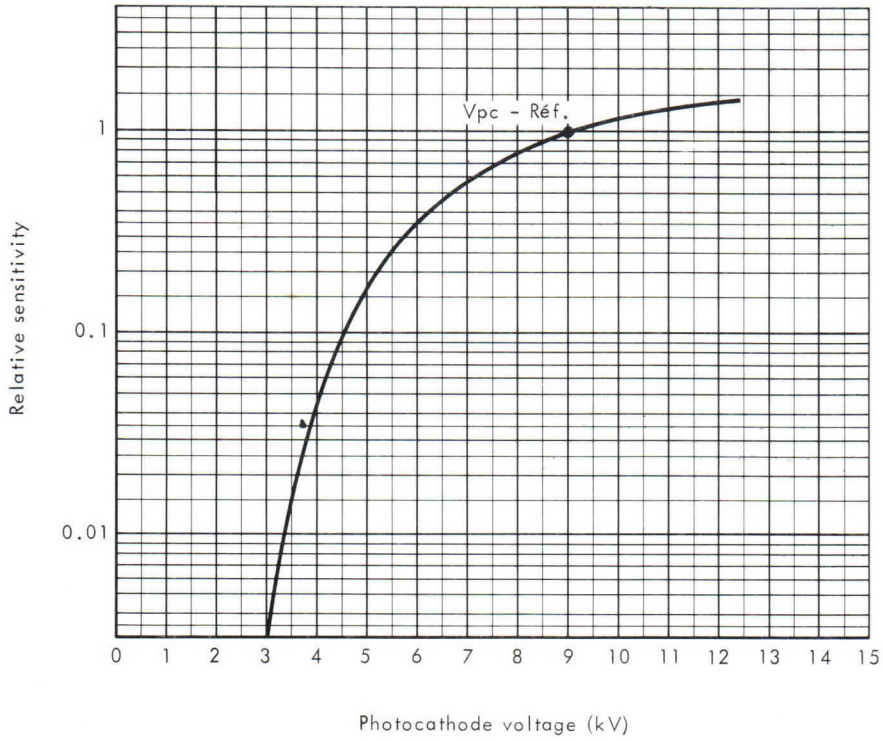
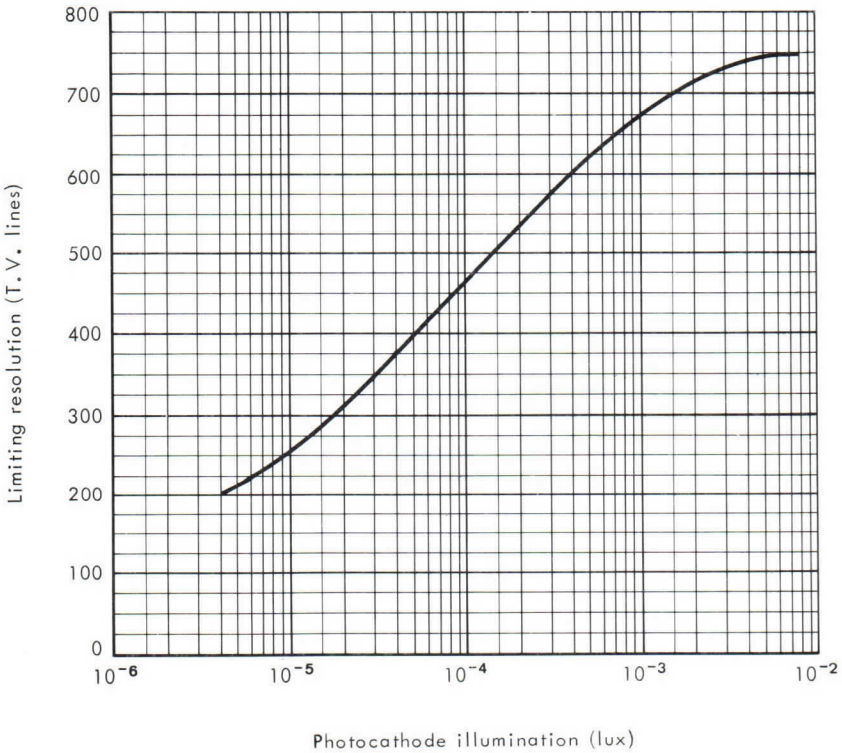


Figure 6

TYPICAL RESOLUTION CHARACTERISTIC



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Figure 7
TYPICAL MODULATION TRANSFER FUNCTION
(P 200 chart)

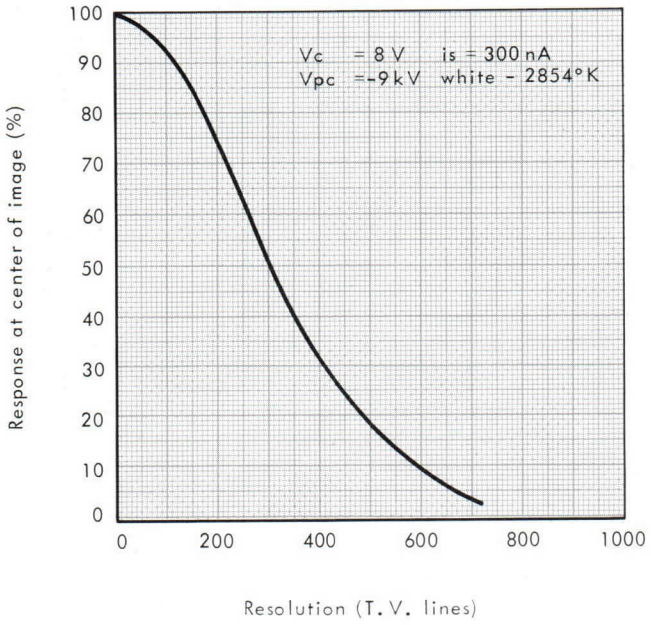
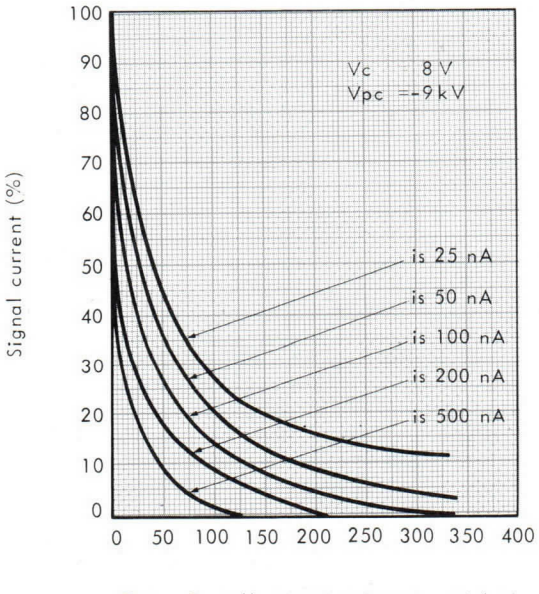
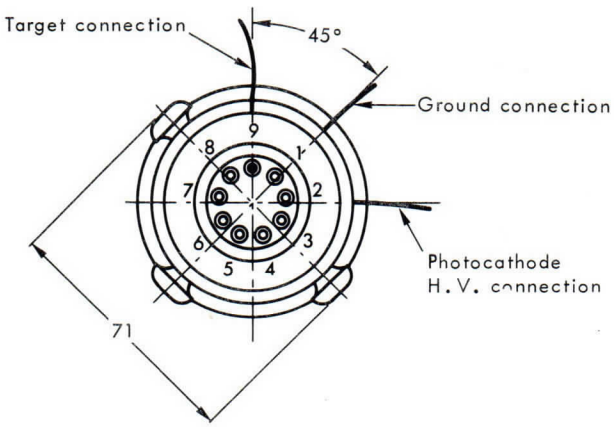


Figure 8
TYPICAL PERSISTENCE CHARACTERISTICS



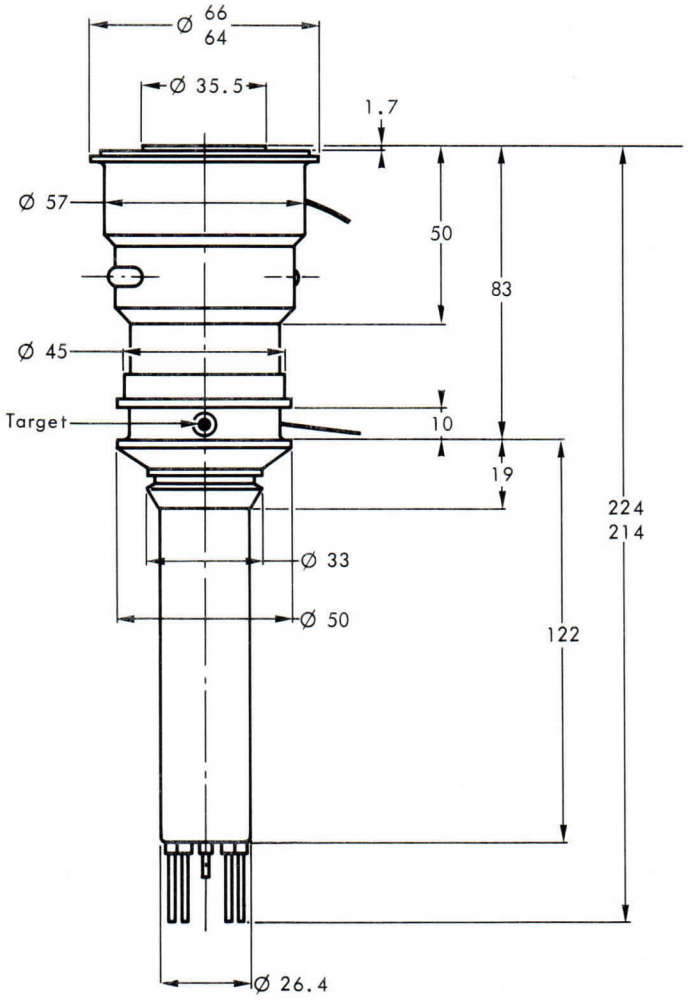
OUTLINE DRAWING

Non-potted tube



BASING DIAGRAM

1 = f
2 = g1
3 = g4
4 = ci
5 = g2
6 = g3
7 = k
8 = f
9 = short index pin



Dimensions in mm.

Figure 10

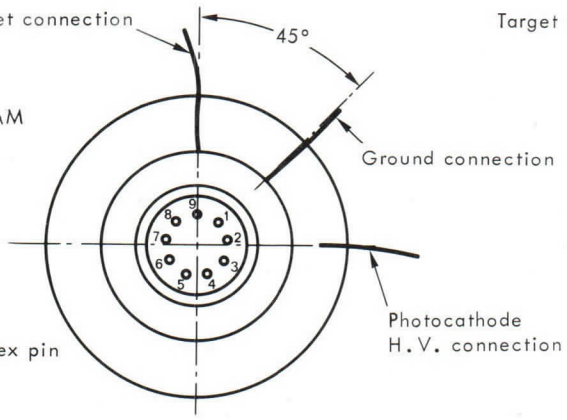
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

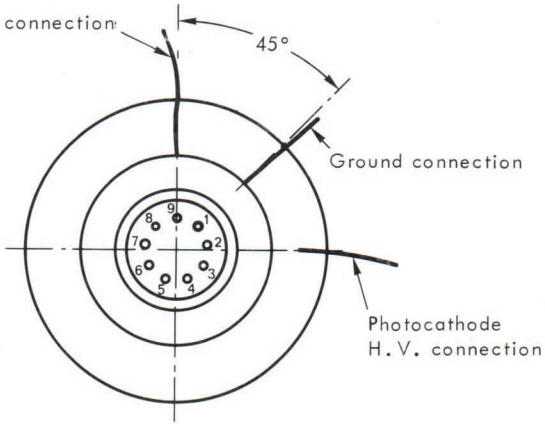
OUTLINE DRAWING

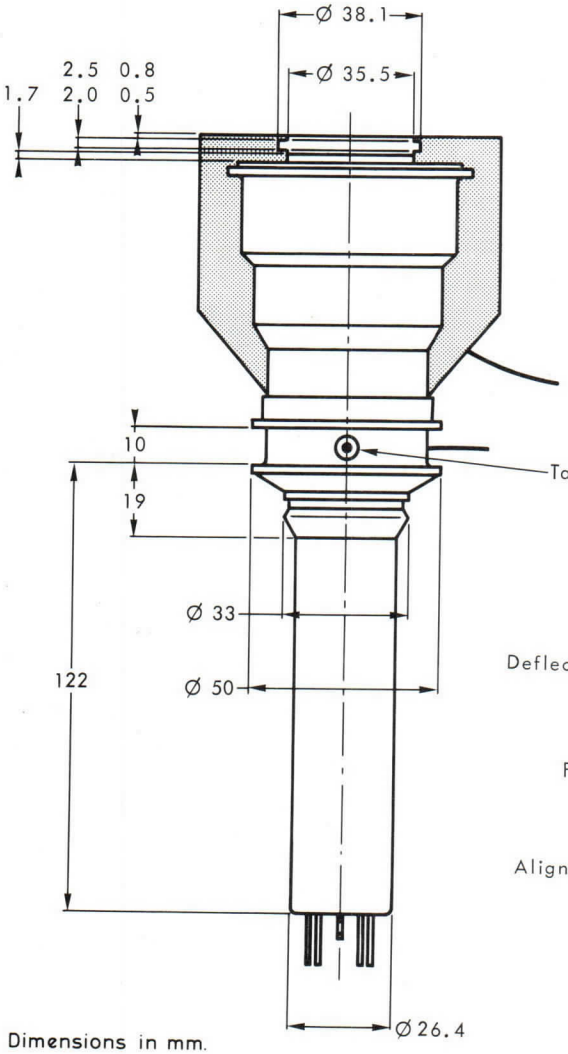
Potted tubes

BASING DIAGRAM

1 - f
2 - g1
3 - g4
4 - ci
5 - g2
6 - g3
7 - k
8 - f
9 - short index pin







Dimensions in mm.

Figure 11

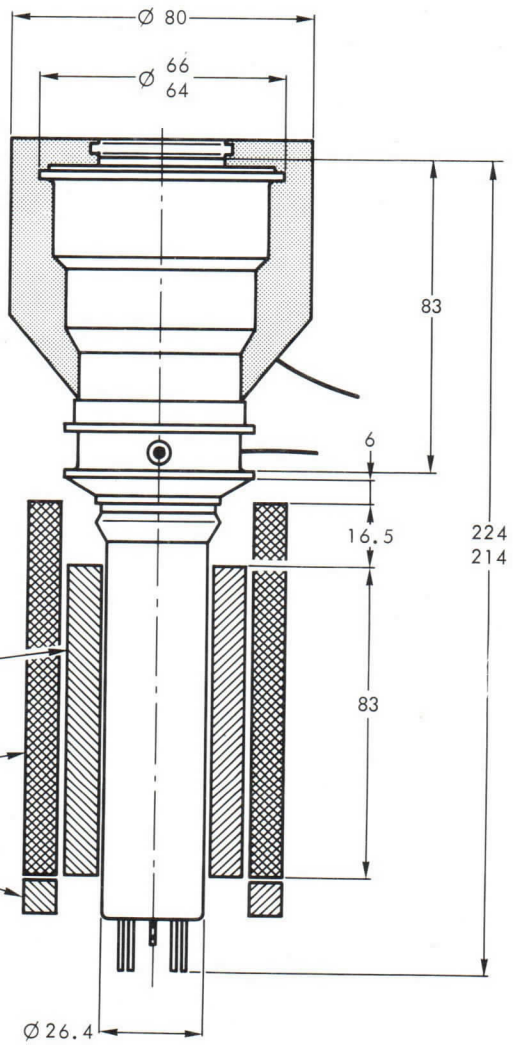


Figure 12

Imprimé en France

TH 9655

NOCTICON*

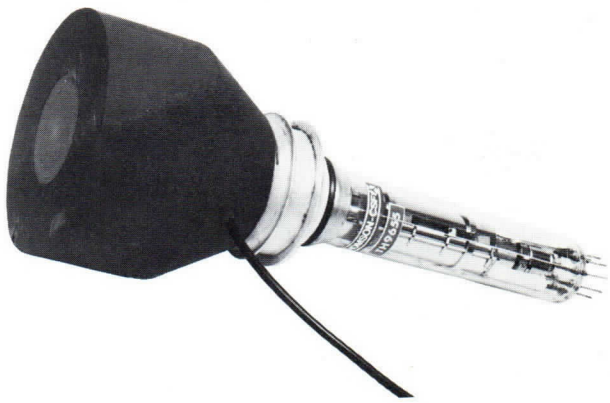
TUBE DE PRISE DE VUE A BAS NIVEAU DE LUMIERE (B.N.L.)

- FENETRE D'ENTREE A FIBRES OPTIQUES ϕ 25 mm
- CIBLE SILICIUM ϕ 18 mm
- LARGE REPONSE SPECTRALE
- SENSIBILITE 300 mA/lumen
- FAIBLE COURANT D'OBSCURITE
- FAIBLE REMANENCE
- GRANDE DYNAMIQUE (gain variable)
- COMPACT ET ROBUSTE
- RESISTANT AUX SUREXPOSITIONS

CARACTERISTIQUES GENERALES

Electro-optiques

Le tube TH 9655 a été conçu principalement pour les applications de télévision où le niveau de lumière disponible est faible ou très faible.



Ce tube compact et fiable comporte une photocathode sur une fenêtre plane à fibres optiques, une cible silicium à mosaïque de diodes et un canon de lecture. Ses hautes performances sont le fait du gain de multiplication fourni par la cible : chaque photoélectron issu de la photocathode et accéléré sous une tension de 10 kV environ, perd son énergie dans le silicium et crée par ionisation 1500 à 2000 paires électron-trou. La section image de hautes performances et d'utilisation simple permet un champ d'entrée de 25 mm ; ses qualités sont maintenues dans une large gamme de valeur de haute tension dont la variation permet d'utiliser le tube avec une grande dynamique d'éclairement.

Les photocathodes utilisées (S20 ou S20ER) de réponse panchromatique et le gain de cible permettent un fonctionnement à des niveaux d'éclairement proches des limites définies par le bruit de fluctuation des photoélectrons.

Les cibles silicium à mosaïque de diodes utilisées ont été conçues spécialement pour ce fonctionnement ; elles permettent conjointement, avec les hautes performances du canon, d'obtenir une haute résolution et une faible rémanence. Elles présentent également une remarquable résistance aux surcharges dûes aux suréclairements de courtes durées et ne sont pratiquement pas sujettes au marquage.

La conception entière du tube a été faite pour lui conférer une exceptionnelle robustesse et permettre de réaliser des matériels fonctionnant dans des environnements sévères.

* Marque déposée.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Présentation

Les tubes TH 9655 peuvent être fournis nus ou enrobés (suffixe M). L'enrobage normal décrit par ailleurs est recommandé pour la facilité et la sécurité d'utilisation* (voir fig. 11 et 12).

D'autres types de présentation peuvent être réalisés : les tubes peuvent, par exemple, être livrés avec les bobines de concentration et de déviation ou avec les connexions par fils souples sur le pied du canon.

Les tubes peuvent être également livrés couplés à un intensificateur de type TH 9473, TH 9302 (25 mm obturable) ou TH 9479 (40 mm Zoom obturable).

Les tubes TH 9655 sont normalement livrables dans les classes suivantes :

Classe A	TH 9655 NOR	(1)
	TH 9655 M/NOR	(2)
Classe B	TH 9655 IND	(1)
	TH 9655 M/IND	(2)
Classe C	TH 9655 AMR	(1)
	TH 9655 M/AMR	(2)

(1) Version tube nu
(2) Version tube enrobé

L'alimentation haute tension TH 7118 spécialement conçue pour ce tube peut être fournie.

CARACTERISTIQUES GENERALES

Mécaniques

Longueur hors-tout	224 mm
Diamètre hors-tout :	
- tube non enrobé	71 mm
- tube enrobé	80 mm
Diamètre section analyse, max.	26, 4 mm
Embase	UTE 9 C 15 (JEDEC N° E8 - 11)
Support (note 1)	METOX N° 30520
Bloc bobines de déviation et de concentration (note 2)	GERHARD BV 200 Spez 47 ou équivalent
Bobine d'alignement (note 2)	GERHARD BV 80/3 ou équivalent
ou Bloc bobines de déviation, concentration et alignement (note 2).	THOMSON-CSF THX909 ou équivalent
Masse approximative :	
- tube non enrobé	250 g
- tube enrobé	450 g
Position de fonctionnement	indifférente

* D'autres formes d'enrobage peuvent être réalisées sur demande.

Electriques

– SECTION IMAGE

Concentration	électrostatique
Type	diode

– SECTION ANALYSE

Cathode	équipotentielle chauffage indirect à oxydes
Chauffage filament :	
- tension	6.3 V
- courant à 6, 3 V	0, 15 ± 10 % A
Temps minimal de préchauffage	60 s
Capacité de sortie (entre électrode de signal et les autres électrodes).	12 pF
Concentration	électromagnétique
Déviation	électromagnétique
Alignement	électromagnétique

Optiques

– SECTION IMAGE

Photocathode	S20 ou S20ER
Réponse spectrale	voir courbe fig. 1
Fenêtre d'entrée :	
- forme	plane
- nature	fibre optique (6 μm-N.A. = 1)
Diamètre utile	25 mm
Surface utile au format 4 x 3	3 cm^2
Format utile	15 mm x 20 mm
Glace de protection (Tube enrobé) :	
- épaisseur	2, 5 ± 0, 1 mm
- indice du verre (n_D)	1, 49

– SECTION ANALYSE

Cible :	
- diamètre utile maximal (format 4 x 3)	18 mm
- format normal sur cible	10, 8 mm x 14, 4 mm
- orientation de l'image (note 3) : trace du balayage horizontal parallèle à un plan diamétral passant par la broche courte de l'embase.	

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

CONDITIONS D'EMPLOI

Les potentiels sont définis par rapport à la masse, l'anode de la section image et la cathode de la section analyse étant reliées à la masse.

Valeurs limites d'utilisation (limites absolues)

Température ambiante - en stockage	max.	+ 70	°C
	min.	− 55	°C
en fonctionnement	max.	+ 55	°C
	min.	− 40	°C
− SECTION IMAGE			
Tension de photocathode - valeur continue négative	max.	12	kV
	min.	0	V
Tension anodique		0	V
Lumination de la face d'entrée (voir courbes fig. 2 et paragraphe 5 des consignes d'utilisation)	max.	40 000	lux.s
− SECTION ANALYSE			
Tension d'électrode de signal (cible) (note 4)	max.	300	V
Tension de grille g4 (de champ) (note 5)	max.	350	V
Tension de grille g3 (de paroi) (note 5)	max.	350	V
Tension de grille g2 (accélération)	max.	350	V
Tension de grille g1 (extinction du faisceau) :			
- valeur continue négative	max.	150	V
- valeur continue positive	max.	0	V
Tension de cathode k		0	V
Tension de filament	max.	6, 6	V
	min.	6, 0	V
Tension entre filament et cathode :			
- filament négatif par rapport à la cathode	max.	125	V
- filament positif par rapport à la cathode	max.	10	V
Courant de cible (note 6)	max.	750	nA

Exemple de fonctionnement

Conditions de fonctionnement :			
Température (note 7)		25	°C
− SECTION IMAGE			
Tension de photocathode (valeur continue négative)		9	kV
Tension anodique		0	V
− SECTION ANALYSE			
Tension électrode de signal		8	V
Tension de grille g4		340	V
Tension de grille g3		290	V
Tension de grille g2		300	V
Tension de grille g1 (pour obtenir le cut-off de l'image) (note 8)	min.	− 40	V
	max.	− 100	V
Tension crête minimale de blocage :			
- appliquée sur la grille g1		− 75	V
- appliquée sur la cathode		+ 20	V
Champ magnétique de concentration		40	Gauss
Courant crête de déviation pour ensemble BV 200/Spez 47 :			
- horizontale		200	mA
- verticale		25	mA
Champ magnétique d'alignement		0 à 4	Gauss

Performances électro-optiques

Standard d'analyse de l'image			25 images/s 625 lignes entrelacées	
Format de l'image sur la photocathode			15 mm x 20 mm	
	min.	moy.	max.	Unités
Courant d'obscurité (fig. 3)	–	10	20	nA
Sensibilité globale (note 9) :				
TH 9655 NOR et IND (fig. 4)	70	90	–	µA/lux
	235	300	–	mA/lm
TH 9655 AMR	55	80	–	µA/lux
	180	260	–	mA/lm
Gamma moyen pour un courant de signal compris entre 1 et 700 nA (note 10)	–	1	–	
Variation du gain pour une excursion de la tension de photocathode comprise entre –3 kV et –11 kV (fig. 5).	100	400	–	
Résolution limite au centre de l'image (note 11) (fig. 6 et 7)	–	750	–	lignes TV
Taux de modulation à 400 lignes TV au centre de l'image (note 12) (fig. 7)	30	35	–	%
Persistance (note 13) (fig.8) sur la 3ème trame balayée .	–	15	25	%

ESSAIS D'ENVIRONNEMENT

Le tube TH 9655 supporte hors fonctionnement les essais d'environnement suivants. Après exécution de ces essais le tube doit satisfaire aux performances définies dans le paragraphe CONDITIONS D'EMPLOIS.

– ESSAI CLIMATIQUE

Le tube est soumis à 4 cycles de température entre – 55 °C et + 70 °C, avec maintien aux températures extrêmes pendant 30 mn. Chaque cycle est exploré avec une variation de l'ordre de 2 °C/mn.

– VIBRATIONS SINUSOIDALES

Le tube étant maintenu rigidement en trois points, collet photocathode, chambre cible et embase canon, est vibré suivant 3 axes orthogonaux dont l'un passe par l'axe du tube.

L'essai est conduit comme suit :

Niveaux d'excitation :
- amplitude de vibration : 0, 4 mm de 10 à 110 Hz
- accélération crête : 20 g de 110 à 500 Hz

Durée du cycle : 10 Hz - 500 Hz - 10 Hz : 30 mn par axe.

– SECOUSSES

L'essai est réalisé conformément à la norme NF C20 - 624. :

- accélération maximale : 40 g
- nombre total de secousses : 2000, dont 1000 suivant l'axe longitudinal du tube et 500 selon chacun des 2 autres axes orthogonaux.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

CARACTERISTIQUES D'ASPECT

Conditions de mesure

Tension de photocathode : $V_{pc} = -6$ kV
Tension de cible : $V_c = 8$ V
Courant de signal : $I_s = 300$ nA

Le gain de l'amplification vidéo et le récepteur de contrôle sont réglés pour obtenir une image optimale (note 14).
Les défauts d'aspect sont observés sur une mire blanche éclairée uniformément sur laquelle figurent les courbes délimitant les zones de qualité (fig. 9).

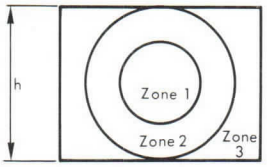


Figure 9

Les zones de qualité sont définies de la façon suivante, h représentant la hauteur de l'image :

- la zone 1 est limitée à l'intérieur du cercle de diamètre h/2 ;
- la zone 2 est comprise entre les cercles de diamètre h/2 et h ;
- la zone 3 représente la surface extérieure au cercle de diamètre h.

CLASSE A

Défauts ponctuels

Points noirs et blancs,
Seuls sont pris en considération les points dont le contraste est de $C \geqslant 10$ % (note 15) en lumière ou dans l'obscurité.

Dimensions du défaut "d" (note 16)		Nombre de défauts					
		Zone 1		Zone 2		Zone 3	
en % de h	Ligne TV	Blanc	Noir	Blanc	Noir	Blanc	Noir
$\geqslant$ 1, 8	$\geqslant$ 10	0	0	0	0	0	0
$\geqslant$ 1, 25	$\geqslant$ 7	0	1	0	2	0	2
$\geqslant$ 0, 8	$\geqslant$ 4	0	2	1	5	2	8
$\geqslant$ 0, 6	$\geqslant$ 3	1	3	2	9	3	18
$\geqslant$ 0, 2	$\geqslant$ 1	2	+	4	+	5	+
$<$ 0, 2	$<$ 1	+	+	+	+	+	+

\+ Ces défauts ne sont pas pris en considération si leur nombre ou leur concentration ne détériore pas la qualité de l'image.

Il en est de même pour les défauts de contraste $C < 10$ %.

Défauts non ponctuels

Les marbrures, granulations, taches et zones (blanches et noires) sont admises si leur contraste est $C \leqslant 5$ %.

Les défauts de compactage de fibre optique ne sont pas pris en considération si leur contraste est $C \leqslant 10$ %.

CLASSE B

Défauts ponctuels

Points noirs et blancs,
Seuls sont pris en considération les points dont le contraste est de C ⩾ 15 % (note 15) en lumière ou dans l'obscurité.

Dimensions du défaut "d" (note 16)		Nombre de défauts					
		Zone 1		Zone 2		Zone 3	
en % de h	Ligne TV	Blanc	Noir	Blanc	Noir	Blanc	Noir
⩾ 2, 5	⩾ 13	0	0	0	0	0	0
⩾ 1, 8	⩾ 10	0	0	0	1	0	2
⩾ 1, 25	⩾ 7	0	1	0	3	1	3
⩾ 0, 8	⩾ 4	1	2	2	6	3	9
⩾ 0, 4	⩾ 2	4	7	7	10	9	20
< 0, 4	< 2	+	+	+	+	+	+

\+ Ces défauts ne sont pas pris en considération si leur nombre ou leur concentration ne détériore pas localement la qualité de l'image.

Il en est de même pour les défauts de contraste C < 15 %.

Défauts non ponctuels

Les marbrures, granulation, taches et zones (blanches et noires) sont admises si leur contraste est C ⩽ 10 % .

Les défauts de compactage de fibre optique ne sont pas pris en compte si leur contraste est C ⩽ 20 %.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

CLASSE C

Défauts ponctuels

Points noirs et blancs.
Seuls sont pris en considération les points dont le contraste est de C ⩾ 15 % (note 15) en lumière ou dans l'obscurité.

Dimensions du défaut "d" (note 16)		Nombre de défauts*		
en % de h	Ligne TV	Zone 1	Zone 2	Zone 3
⩾ 2, 5	⩾ 13	0	0	0
⩾ 1, 8	⩾ 10	0	1	2
⩾ 1, 25	⩾ 7	1	3	4
⩾ 0, 8	⩾ 4	3	8	12
⩾ 0, 4	⩾ 2	11	17	25
< 0, 4	< 2	+	+	+

* Les défauts indiqués correspondent au nombre total de défauts admis sans distinction entre les points noirs et blancs.

\+ Ces défauts ne sont pas pris en considération si leur nombre ou leur concentration ne détériore pas localement la qualité de l'image.

Il en est de même pour les défauts de contraste C < 15 %.

Défauts non ponctuels

Les marbrures, granulations, taches et zones (blanches et noires) sont admises si leur contraste est C ⩽ 20 %.

Les défauts de compactage de fibre optique ne sont pas pris en compte si leur contraste est C ⩽ 30 %.

NOTES

1 - METOX - 86 rue de Villiers de l'Isle Adam - 75020 PARIS - Téléphone 636 31 10.

2 - GERHARD KG - REICHELSHEIM/ODW Germany.
THOMSON-CSF GTE - 8 rue Chasseloup-Laubat - 75737 PARIS CEDEX 15 - Téléphone 566 70 04.

3 - Il est indispensable de s'assurer de la position correcte du tube à l'intérieur des bobines.

4 - En fonctionnement normal, la tension cible ne dépassera pas 15 V.

5 - En aucun cas, la tension de la grille N° 3 ne sera supérieure à celle de la grille N° 4.

6 - On définit le courant de cible comme étant le courant total circulant dans la résistance de charge connectée à l'électrode de signal : courant de signal + courant d'obscurité, le courant d'obscurité étant le facteur subsistant dans le cas de la cible non éclairée.

Les amplificateurs vidéo doivent être calculés convenablement pour supporter des courants de cible de 1 μA afin d'éviter des surcharges d'alimentation ou des distorsions d'image.

7 - Toutes les caractéristiques sont données pour une température du tube de 25 °C au voisinage de la cible ; les limites de température recommandées pour un bon fonctionnement étant de 20 °C et 30 °C.

L'élévation de la température au voisinage de la cible est conditionnée à la fois par les variations de la température ambiante, par la dissipation thermique des dispositifs environnant et du tube lui-même.

Une élévation de la température du tube de 10 °C entraîne une variation du courant d'obscurité dans le rapport de 1 à 2.

8 - Sans impulsion de blocage appliquée sur l'électrode g1.

9 - La source lumineuse est une lampe à filament de tungstène fonctionnant à la température de couleur de 2854 °K.

10 - Le "gamma" moyen peut être défini comme la pente de la partie rectiligne de la caractéristique de transfert en coordonnées logarithmiques.

11 - Pratiquement, la résolution limite correspond, sur une mire de définition à lignes noires et blanches, à un taux de modulation voisin de 7 %.

12 - Pour le standard CCIR de 625 lignes, la durée d'une ligne est de 52 μs (temps de suppression exclu), 400 lignes TV correspondant à une fréquence de 5 MHz.

13 - La persistance s'exprime par le rapport en % du courant de signal résiduel, mesuré à la fin de la n^e trame balayée après extinction de l'excitation lumineuse, au courant de signal initial.

Les valeurs indiquées sont valables pour une cadence de balayage de 50 trames/seconde.

14 - Le réglage du récepteur est obtenu de la façon suivante :

- pour le niveau zéro (noir) la brillance de l'écran est réglée au point d'extinction de celui-ci.
- pour le niveau maximum (blanc), le gain du récepteur est ajusté pour obtenir une image optimale, fonction du contenu de l'image et de l'éclairage ambiant.

15 - Le contraste étant défini comme le rapport en % du signal vidéo délivré par le défaut sur le courant de signal normal délivré par le tube.

16 - Les dimensions des défauts d'aspect sont exprimées :

- par le rapport d/h où :
  d est le diamètre moyen du défaut
  h est la hauteur du cadre de l'image
- par le nombre équivalent de lignes TV pour un standard de 625 lignes.

CONSIGNES D'UTILISATION

Recommandations importantes

1 - Utilisation du tube non enrobé

Il est important de ne pas placer de pièces métalliques à proximité de la face avant à fibres optiques et du collet de photocathode, ceux-ci étant portés à un potentiel pouvant atteindre — 12 kV par rapport à la masse.

Au niveau de la face avant, des microclaquages entre les faces interne et externe des fibres optiques peuvent donner naissance à des scintillations. Celles-ci se traduisent sur l'image par l'apparition de points lumineux fluctuants.

A la limite, un claquage peut provoquer une détérioration de la face avant, accompagnée d'une entrée d'air.

Pour les mêmes raisons, des précautions doivent être prises pour protéger le tube contre l'humidité.

2 - Utilisation du tube enrobé

L'exploitation du tube en version enrobée apporte une excellente sécurité de fonctionnement et simplifie beaucoup la conception de la tête de la caméra.

En effet, d'une part, l'enrobage protège le collet de photocathode contre l'environnement immédiat ; d'autre part, une glace recouverte sur une face d'une couche conductrice transparente est collée sur la face avant du tube (épaisseur de la glace 2,5 ± 0,1 mm ; indice : 1,49). La face conductrice, placée contre la fibre optique, est reliée au potentiel de la photocathode afin d'éviter les scintillations et claquages éventuels au niveau de la photocathode.

3 - Les tensions de balayage de la section d'analyse doivent être appliquées avant les tensions d'électrodes.

Lorsque les prises de vue sont terminées, elles doivent être coupées après les tensions d'électrodes.

4 - Au moment des prises de vues, appliquer la très haute tension en dernier lieu. Quand les prises de vues sont terminées, il faut au contraire couper en premier la très haute tension.

5 - Le tube ne doit pas être soumis à des niveaux lumineux supérieurs à ceux définis par les courbes de la figure 2.

Des luminations de la photocathode supérieures à celles définies par les courbes de la figure 2 peuvent entraîner des marquages permanents de la cible pouvant détériorer notablement la qualité de l'image.

Il est conseillé, lors de l'exploitation avec de grandes variations de lumination, de prévoir : un asservissement de la tension de photocathode, l'interposition de filtres et une obturation du système optique afin de ramener le courant de signal à sa valeur normale (300 à 400 nA).

6 - Notes sur la tension de cible

Le courant d'obscurité et les défauts d'aspects de la cible augmentent avec la valeur de cette tension.

La sensibilité du tube est indépendante du potentiel de la cible à partir d'une certaine valeur.

La valeur optimale de la tension de cible est celle qui permet d'obtenir un courant de signal maximal (> 500 nA) et le courant d'obscurité minimal.

Cette valeur est de l'ordre de 8 à 10 volts avec les blocs de bobines mentionnés dans cette notice.

Une utilisation avec une tension de cible supérieure à 15 volts peut entraîner une destabilisation de la cible, rendant impossible la recharge de celle-ci par le faisceau.

Il est possible de restabiliser la cible en opérant un cycle de restauration comme suit :

1 - Boucher l'optique ;
2 - Ramener V_{pc} à 0 V ;
3 - Balayer toute la cible ;
4 - Ajuster Vg1 autour de − 5 volts ;
5 - Porter la tension de cible (V_c) à 300 volts pendant 1 à 2 secondes ;
6 - Polariser l'électrode g1 à la valeur de "cut-off" ou supérieure ($Vg1 \geqslant V_{co}$) ;
7 - Ramener V_c à sa valeur normale soit 8 à 10 volts ;
8 - Réajuster Vg1 pour obtenir un faisceau déchargeant normalement la cible.

Le tube est de nouveau prêt à fonctionner normalement.

7 - Note sur l'alignement du faisceau

Une attention particulière doit être portée à l'alignement correct du faisceau d'électrons.

Le réglage des courants dans les bobines d'alignement doit être effectué pour l'obtention d'un courant de signal maximal supérieur à 500 nA pour toutes les parties de l'image et un pouvoir de résolution homogène.

Figure 1

REPONSES SPECTRALES TYPIQUES
DES PHOTOCATHODES S20 ET S20ER

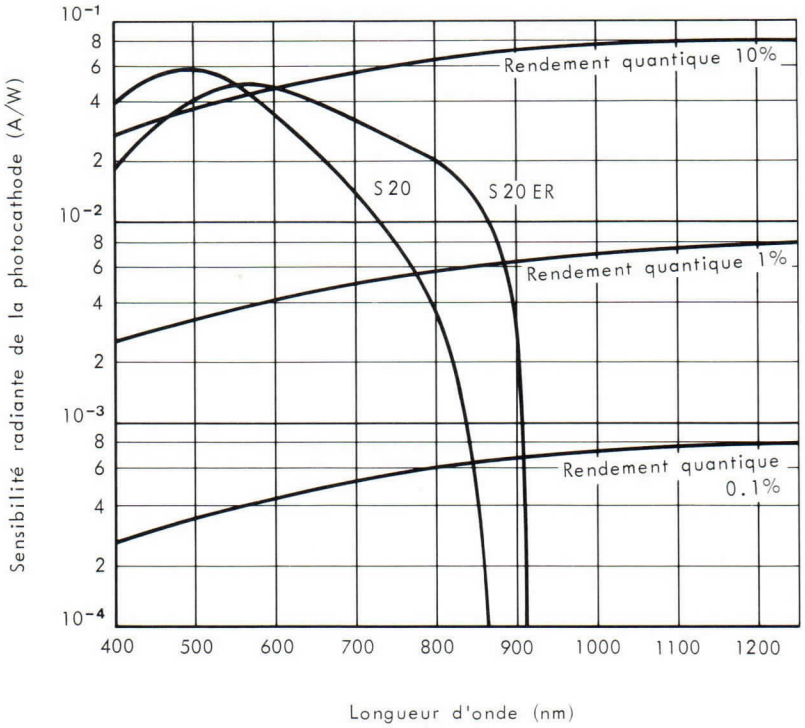
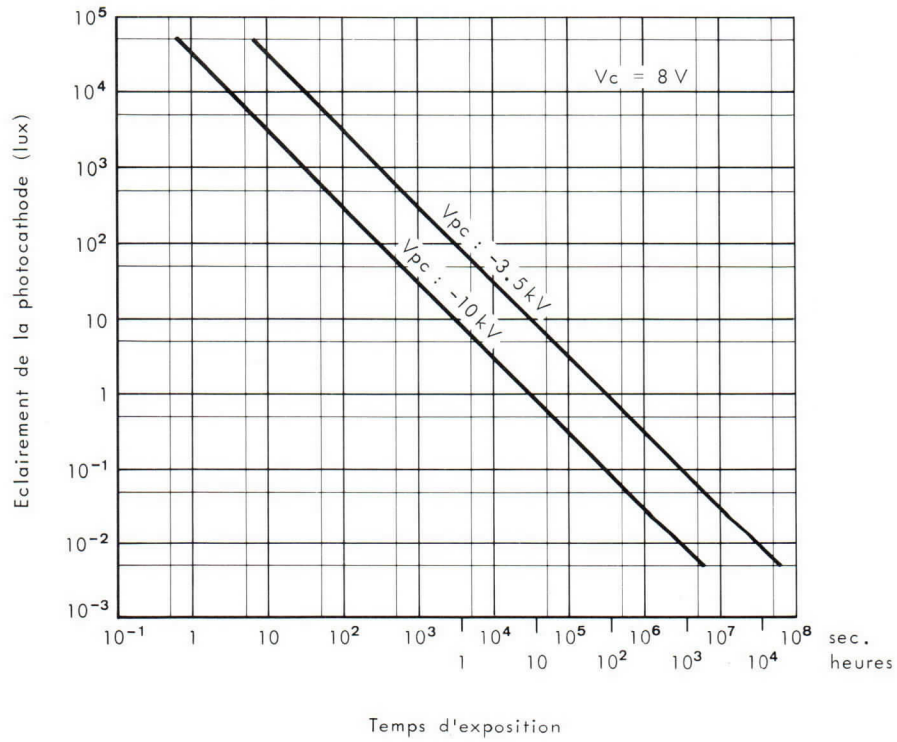


Figure 2

EXPOSITION LIMITE SUR LA PHOTOCATHODE



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Figure 3

COURANT D'OBSCURITE EN FONCTION
DE LA TENSION DE CIBLE

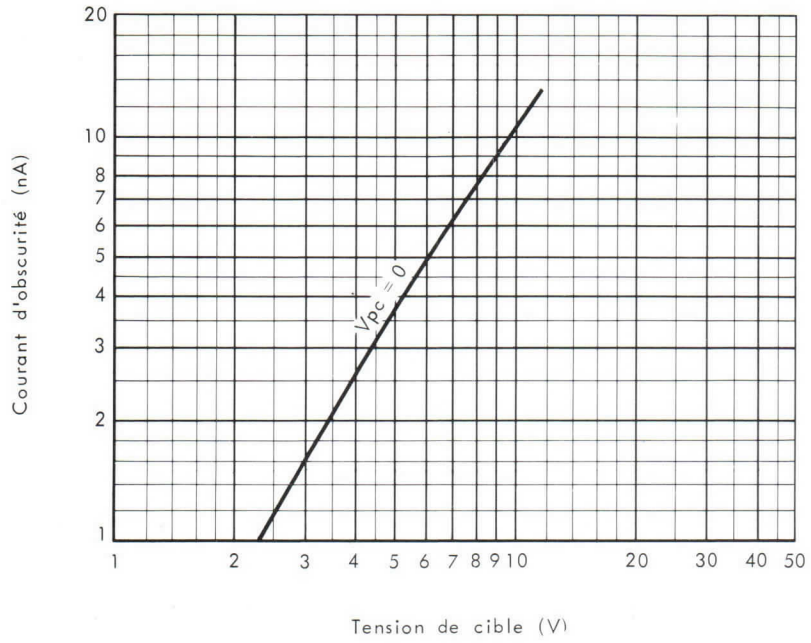


Figure 4

CARACTERISTIQUE DE TRANSFERT TYPIQUE

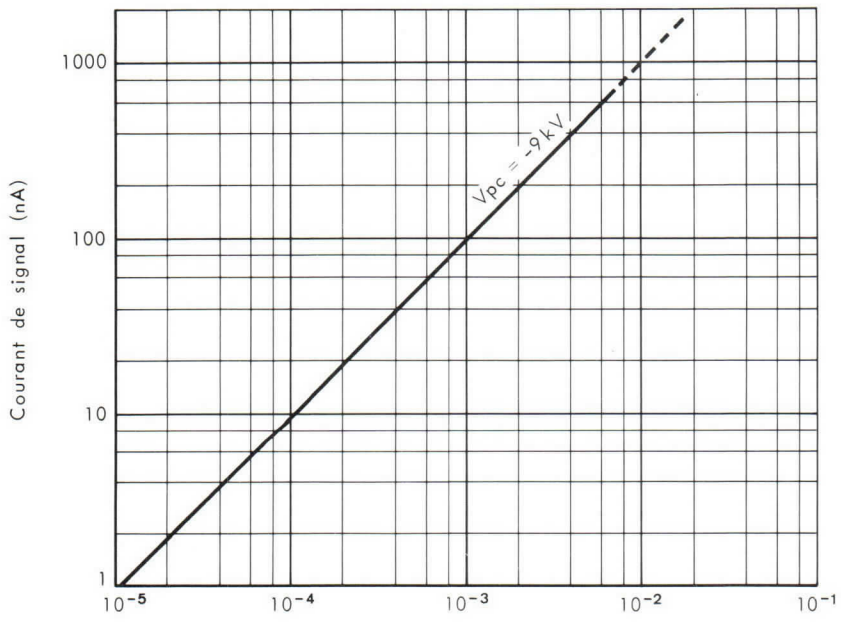
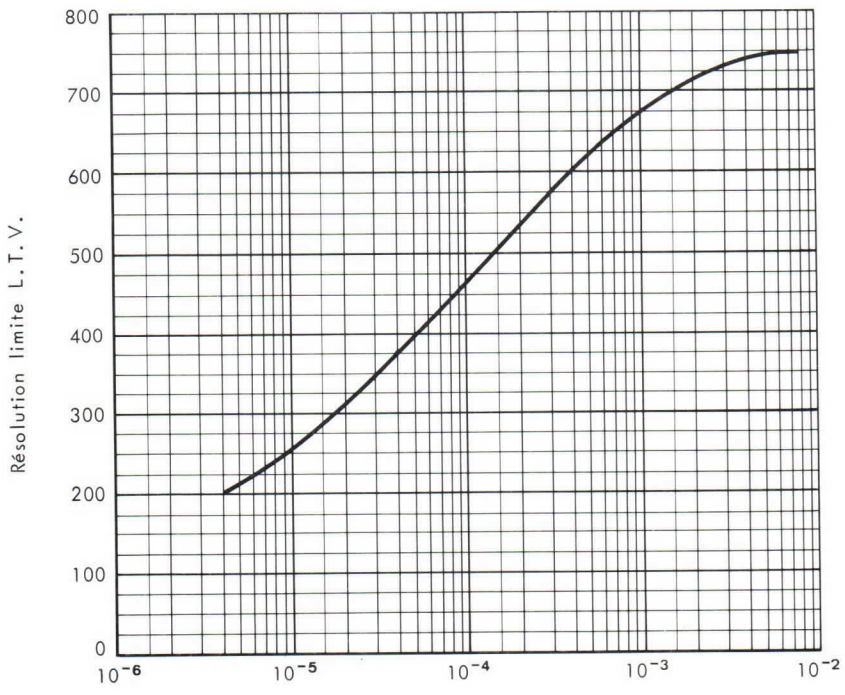


Figure 5

CARACTERISTIQUE TYPIQUE DE SENSIBILITE
EN FONCTION DE LA TENSION DE PHOTOCATHODE

Figure 6

CARACTERISTIQUE DE RESOLUTION TYPIQUE



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Figure 7

CARACTERISTIQUE TYPIQUE DE LA FONCTION DE TRANSFERT DE MODULATION (mire P200)

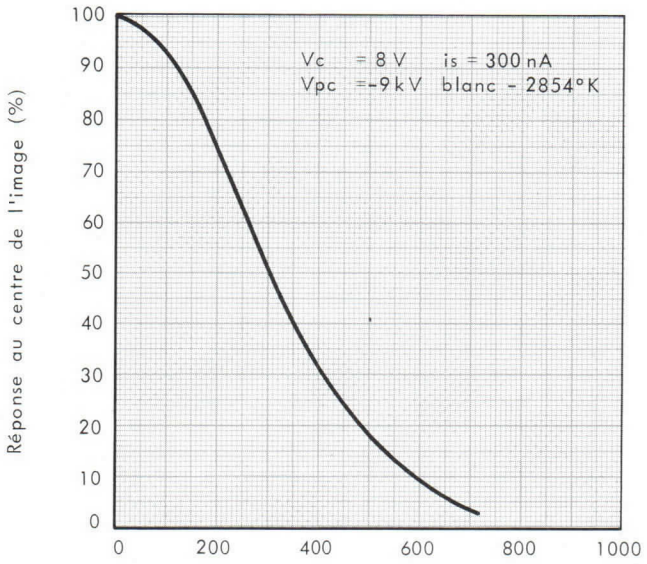
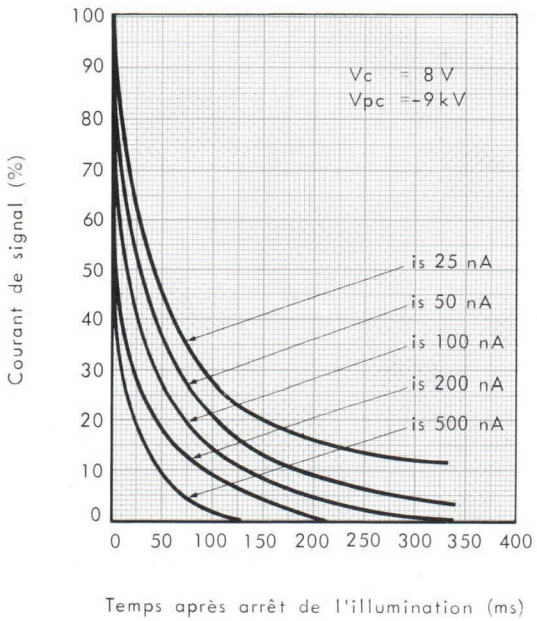


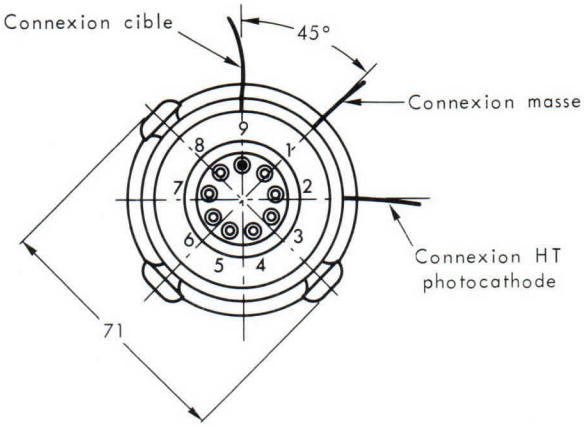
Figure 8

CARACTERISTIQUE DE REMANENCE TYPIQUE

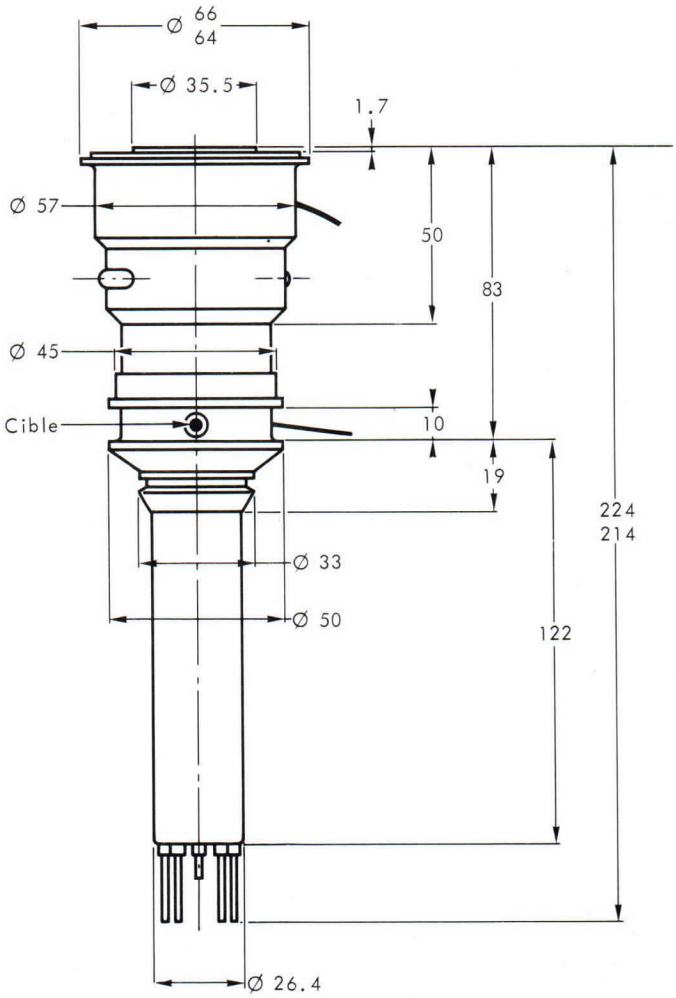


DESSIN D'ENCOMBREMENT

Tube non enrobé



BROCHAGE
1 = f
2 = g1
3 = g4
4 = ci
5 = g2
6 = g3
7 = k
8 = f
9 = broche repère courte



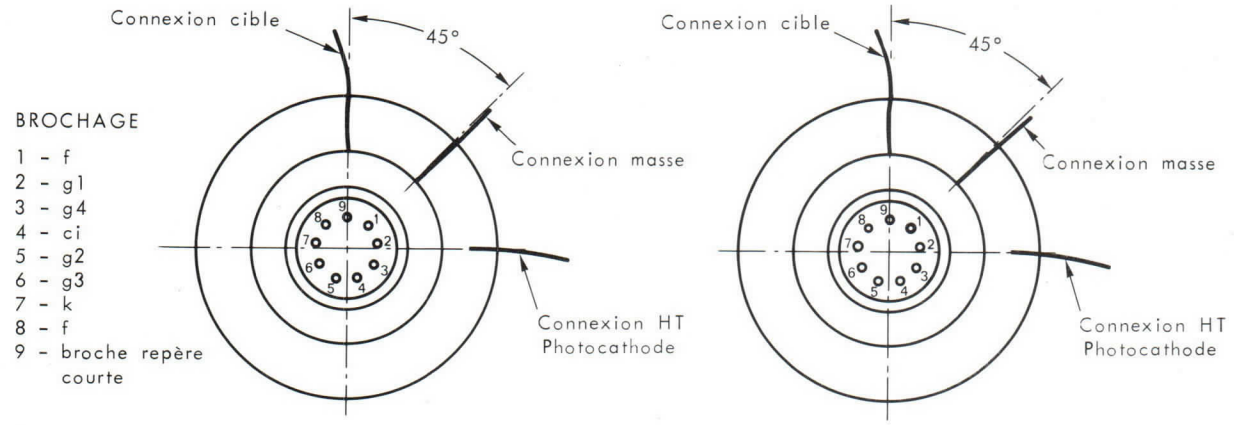
Cotes en mm.

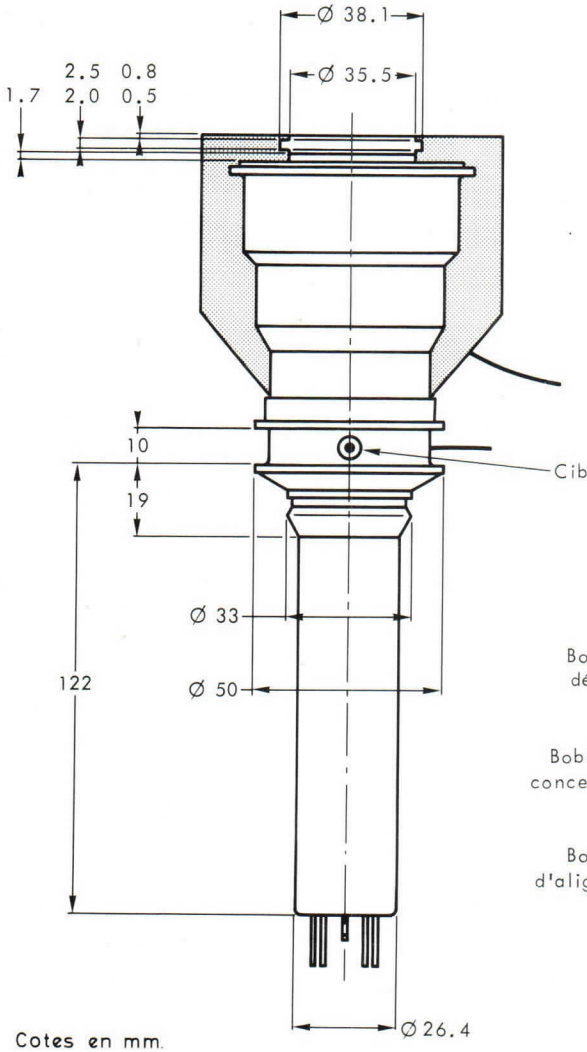
Figure 10

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

DESSIN D'ENCOMBREMENT

Tubes enrobés





Cotes en mm.

Figure 11

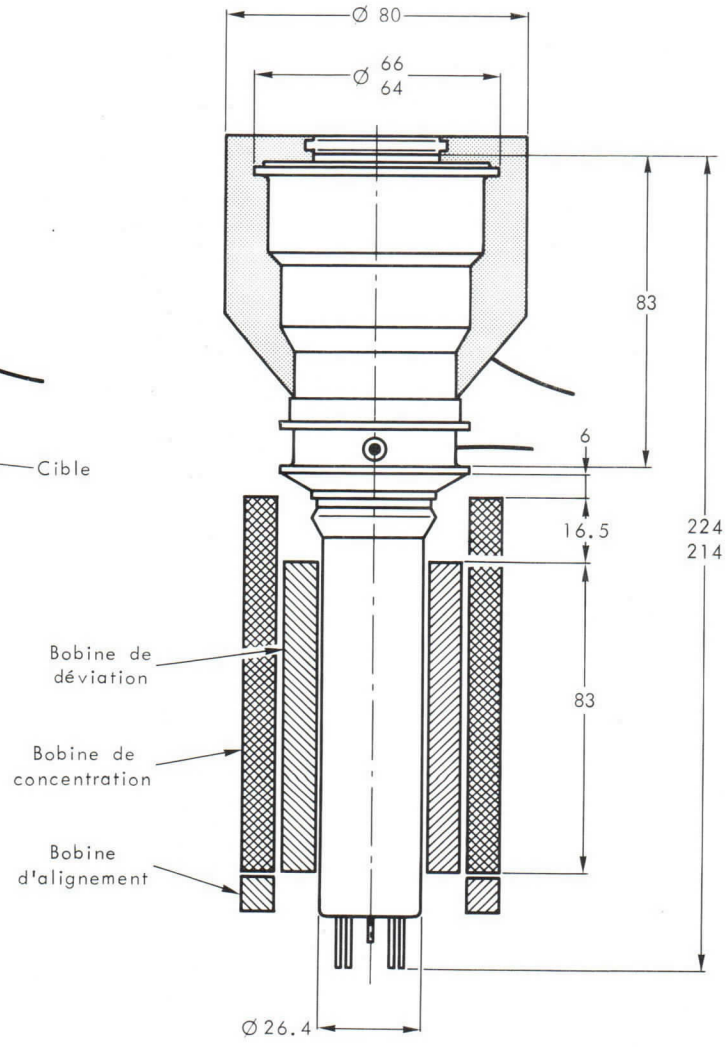


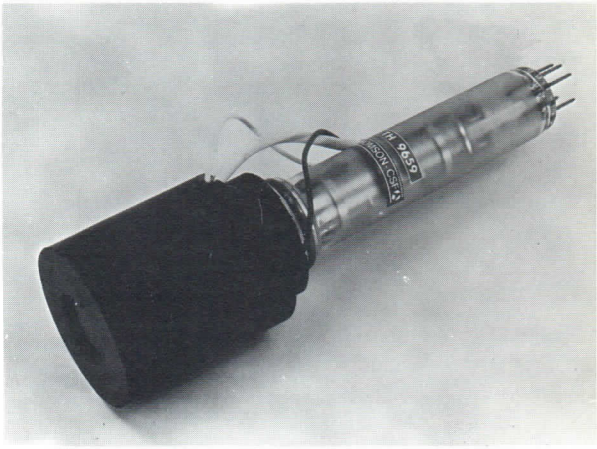
Figure 12

Imprimé en France

TH 9659
NOCTICON*

TUBE DE PRISE DE VUE A BAS NIVEAU DE LUMIERE

- FAIBLE EBLOUISSEMENT
- FENETRE D'ENTREE A FIBRES OPTIQUES ϕ 16 mm
- CIBLE SILICIUM ϕ 16 mm
- LARGE REPONSE SPECTRALE
- SENSIBILITE 200 mA/lumen
- FAIBLE COURANT D'OBSCURITE
- FAIBLE REMANENCE
- GRANDE DYNAMIQUE (gain variable)
- RESISTANT AUX SUREXPOSITIONS



Le tube TH 9659 est un tube sensible, de diamètre utile 16 mm, conçu pour fonctionner dans une large gamme d'éclairement.

Ce tube comprend une photocathode déposée sur une glace à fibres optiques, une cible silicium à mosaïque de diodes, et un canon d'analyse. Le gain élevé de la cible lui confère une très grande sensibilité : chaque photoélectron émis par la photocathode et accéléré sous 9 kV perd son énergie dans la cible en créant par ionisation 1500 à 2000 paires électrons-trous. Les performances constantes de la section image dans une large gamme de tensions d'accélération permettent la prise de vue avec une grande dynamique d'éclairement.

L'augmentation de sensibilité par simple action sur la tension de photocathode permet au TH 9659 de conserver, à des niveaux d'éclairement réduits, une faible rémanence et un rapport signal à bruit limité seulement par le bruit de fluctuation des photoélectrons.

La technologie de fabrication de la cible est spécialement prévue pour permettre avec le canon d'analyse à hautes performances, une résolution élevée et une rémanence faible.

La cible peut, par ailleurs, supporter d'importantes surcharges dues à des suréclairements très violents ponctuels ou étendus de courtes durées. Elle est en outre conçue pour minimiser l'éblouissement.

Du fait des hautes tensions nécessaires à l'alimentation de certaines électrodes, ce tube est normalement fourni avec enrobage afin de faciliter son emploi. Sur demande spéciale, le tube peut être fourni non enrobé.

Pour la réalisation d'équipements nouveaux, il est vivement conseillé d'utiliser l'ensemble des bobines de déviation-concentration-alignement TH 7200 et l'alimentation TH 7118 spécialement étudiés pour ce type de tube et qui associent un faible encombrement à de hautes performances.

Il existe une version robuste du TH 9659 possèdant les mêmes caractéristiques électro-optiques : le TH 9662, qui peut être utilisé dans des systèmes soumis à de sévères conditions d'environnement.

* Marque déposée.

CARACTERISTIQUES GENERALES

Mécaniques

Longueur hors-tout	190 mm
Diamètre hors-tout :	
- tube non enrobé	51 mm
- tube enrobé	53 mm
Diamètre section analyse	25, 75 mm
Embase	UTE 9 C 15 (JEDEC E 8 - 11)
Support (Note 1)	METOX N° 30520
Bloc bobines de déviation, concentration et alignement (Note 2)	TH 7200 ou équivalent
Alimentation haute tension (2)	TH 7118 ou équivalent
Masse, approximative :	
- tube non enrobé	160 g
- tube enrobé	260 g
Position de fonctionnement	indifférente

Electriques

– SECTION IMAGE

Concentration	électrostatique
Type :	
- tube non enrobé	triode
- tube enrobé	diode (connexion interne)
Résistance totale du pont diviseur	$1 \pm 0,2$ GΩ

– SECTION ANALYSE

Cathode	équipotentielle, chauffage indirect, à oxydes
Chauffage filament :	
- tension	6, 3 V
- courant à 6, 3 V	0, 09 A
Temps minimal de préchauffage	60 s
Puissance dissipable sur la grille g2	1 W
Capacité de sortie : (entre électrode de signal et les autres électrodes)	
- tube non enrobé	8 pF
- tube enrobé	10 pF
Concentration	électromagnétique
Déviation	électromagnétique
Alignement	électromagnétique

Optiques

– SECTION IMAGE

Photocathode	S20 ou S20ER
Réponse spectrale	voir courbe (Figure 1)
Fenêtre d'entrée :	
- forme	plane, circulaire
- nature	fibre optique (6 µm - NA = 1)
Diamètre utile	16 mm
Surface utile	1, 25 cm^2
Format utile	9, 6 mm x 12, 8 mm
Glace de protection (tube enrobé) :	
- nature	verre 801 - 51 SOVIREL (7056 Corning)
- indice (n_D)	1, 49
- épaisseur	$2,5 \pm 0,1$ mm

– ANALYSE SECTION

Orientation de l'image : trace du balayage horizontal parallèle à un plan diamétral passant par la broche courte de l'embase.

CONDITIONS D'EMPLOI

Les potentiels sont définis par rapport à la masse, l'anode de la section image et la cathode de la section analyse étant reliées à la masse.

Valeurs limites d'utilisation (limites absolues)

	Min.	Max.	
Température ambiante			
- en stockage	− 55	+ 70	°C
- en fonctionnement	− 55	+ 55	°C
− SECTION IMAGE			
Tension de photocathode g8 (valeur continue négative)	0	10	kV
Tension de l'électrode de focalisation g7 (valeur continue négative)	−	10	kV
Tension d'anode g6	−	0	V
Eclairement permanent de photocathode	−	$2,10^{-1}$	lux
Lumination de la face d'entrée (voir courbe Figure 2)	−	40 000	lux.s

	Min.	Max.	
− SECTION ANALYSE			
Tension d'électrode de signal g5 (cible) (Note 3)	6	300	V
Tension de grille g4 (de champ) (Note 4)	−	350	V
Tension de grille g3 (de paroi)	−	350	V
Tension de grille g2 (accélération)	−	350	V
Tension de grille g1 :			
- valeur continue négative	−	150	V
- valeur continue positive	−	0	V
Tension de cathode k	−	0	V
Tension de filament	6, 0	6, 6	V
Tension entre filament et cathode :			
- filament négatif par rapport à la cathode	−	125	V
- filament positif par rapport à la cathode	−	10	V
Courant de signal crête (Note 5)	−	750	nA

EXEMPLE DE FONCTIONNEMENT

Conditions de fonctionnement

Température (Note 6)	25 °C
Bloc bobines	TH 7200
Alimentation haute tension	TH 7118
Standard d'analyse de l'image : 625 lignes entrelacées, 25 images/s	
Format de l'image sur la photocathode	9, 6 mm x 12. 8 mm

− SECTION IMAGE

Tension de photocathode g8	−9 à −2, 5 kV
Tension de l'électrode de focalisation g7 (Note 7)	Vg7 ≅ 0, 98 Vg8 (à ajuster pour la meilleure focalisation)
Tension d'anode g6	0 V

− SECTION ANALYSE

Tension électrode de signal g5	8 V
Tension de grille g4	340 V
Tension de grille g3	230 V
Tension de grille g2	300 V
Tension de grille g1 (Note 8), typique	− 35 V
Tension crête minimale de blocage :	
- appliquée sur la grille g1	− 75 V
- appliquée sur la cathode	+ 20 V
Courant de signal dans les blancs de l'image	300 nA
Courant dans la bobine de concentration	90 mA
Courant crête de déviation :	
- horizontale	220 mA
- verticale	190 mA
Courant dans les bobines d'alignement	0 à 20 mA

Performances électro-optiques

		Min.	Moy.	Max.	
Courant d'obscurité (Figure 5)		–	4	15	nA
Sensibilité :					
- photocathode (Note 9)	Classes NOR et IND	130	160	–	µA/lm
	Classe AMR	100	150	–	µA/lm
- globale (Figure 6) (Note 9)	Classes NOR et IND	23	25	–	µA/lx
	Classe AMR	18	25	–	µA/lx
Gamma moyen pour un courant de signal compris entre 1 et 700 nA (Note 10)		–	1	–	
Gain de cible à –9 kV (Figure 3)		1100	1600	2000	
Dynamique de sensibilité entre –2, 5 kV et –9 kV		400	–	–	
Résolution limite au centre de l'image à : $V_{pc} = -8$ kV (Note 11) (Figures 4 et 8)		–	700	–	lignes TV
Taux de modulation à 400 lignes TV au centre de l'image (Note 12) (Figure 8)		25	30	–	%
Rémanence sur la 3ème trame balayée (Note 13) (Figure 9).		–	7	10	%
Distorsion géométrique (à 0, 6 du diamètre utile)		–	2	3	%

CARACTERISTIQUES D'ASPECT

Conventions

Un défaut ponctuel allongé est assimilé à un défaut ponctuel circulaire de diamètre équivalent "d" égal à :

$$\frac{\text{Longueur} + \text{largeur}}{2}$$

Le diamètre des défauts "d" est exprimé en pourcentage de la hauteur "h" de l'image.

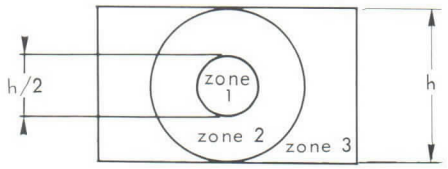
Conditions de mesure

PARAMETRES

Température	:	25 ± 2 °C
Format d'analyse	:	4/3
Tension de cible	:	8 V
Courant moyen de signal	:	300 nA
Bande passante vidéo	:	5 MHz

Mire divisant l'image en trois zones d'intérêt :

- zone 1 : surface intérieure d'un cercle central de diamètre h/2 ;
- zone 2 : surface annulaire comprise entre ce cercle et un autre de diamètre h concentrique du premier ;
- zone 3 : surface restante délimitée par le cadre analysé.



METHODE

Après optimisation des réglages du Nocticon, examen :

- des défauts "noirs" avec la mire éclairée uniformément ;
- des défauts "blancs" après supression de l'éclairement de la mire.

Défauts ponctuels

NOCTICON CLASSE NOR
L'examen est effectué pour 2 potentiels de photocathode : –3 kV et –8 kV.
Ne sont pris en compte que les défauts produisant un signal supérieur à 15 nA.

Dimension de défaut d/h en %	Nombre de défauts admissibles					
	Zone 1		Zone 2		Zone 3	
	Blanc	Total	Blanc	Total	Blanc	Total
$>1,2$	0	0	0	0	0	0
$>0,8$	0	2	0	4	0	4
$>0,2$	1	6	3	11	6	11
$\leqslant 0,2$	*	*	*	*	*	*

NOCTICON CLASSE IND
L'examen est effectué pour 2 potentiels de photocathode : –3 kV et –8 kV.
Ne sont pris en compte que les défauts produisant un signal supérieur à 30 nA.

Dimension de défaut d/h en %	Nombre de défauts admissibles					
	Zone 1		Zone 2		Zone 3	
	Blanc	Total	Blanc	Total	Blanc	Total
$>1,2$	0	0	0	0	0	0
$>0,8$	0	3	0	4	1	4
$>0,2$	2	6	5	14	8	14
$\leqslant 0,2$	*	*	*	*	*	*

NOCTICON CLASSE AMR
L'examen est effectué pour deux potentiels de photocathode : –4 et –8 kV.
Ne sont pris en compte que les défauts produisant un signal supérieur à 30 nA.

Dimension de défaut d/h en %	Nombre de défauts admissibles					
	Zone 1		Zone 2		Zone 3	
	Blanc	Total	Blanc	Total	Blanc	Total
$>2,4$	0	0	0	0	0	0
$>1,6$	0	0	0	1	0	2
$>1,2$	0	1	0	3	0	4
$>0,8$	0	3	1	8	1	9
$>0,4$	2	9	5	18	8	18
$\leqslant 0,4$	*	*	*	*	*	*

Défauts non ponctuels

Les marbrures, granulations, taches et zones (blanches ou noires) sont admises si elles produisent un signal inférieur ou égal à 30 nA.

Les défauts de compactage des fibres optiques sont tolérés si le signal résultant est inférieur ou égal à 90 nA.

* Ces défauts ne sont pas pris en compte si leur densité est telle qu'ils ne constituent pas une gêne pour l'observation.

NOTES

1 - METOX - 86, rue de Villiers de l'Isle Adam - 75020 PARIS Téléphone : 636 31 10.

2 - THOMSON-CSF, DTE - 38 rue Vauthier - 92100 BOULOGNE-BILLANCOURT - Téléphone : 604 81 75.

3 - En fonctionnement normal la tension cible ne dépassera pas 12 V. Elle ne descendra pas au-dessous de 6 V compte tenu de la chute ohmique dans la résistance de charge.

4 - En aucun cas la tension de la grille g3 ne sera supérieure à celle de la grille g4.

5 - Le courant de cible est le courant moyen circulant dans la résistance de charge connectée à l'électrode de signal ; il est la somme du courant de signal et du courant d'obscurité.

Les amplificateurs vidéo doivent être calculés convenablement pour supporter des courants de cible de 1 μA afin d'éviter des surcharges d'alimentation ou des distorsions d'image.

6 - Toutes les caractéristiques sont données pour une température de 25 °C au voisinage de la cible. La limite recommandée pour un bon fonctionnement est 30 °C.

Une élevation de la température de cible de 10 °C entraîne un doublement du courant d'obscurité.

7 - Pour la version enrobée du tube, la tension de l'électrode de focalisation est fixée par un diviseur résistif qui permet de maintenir la tension d'électrode g6 à un pourcentage constant de la tension de photocathode.

8 - Sans impulsion de blocage appliquée sur l'électrode g1.

9 - La source lumineuse est une lampe à filament de tungstène fonctionnant à la température de couleur de 2854 °K.

10 - Le gamma moyen est défini comme la pente de la caractéristique de transfert (courant de signal en fonction de l'éclairement) en coordonnées logarithmiques.

11 - La résolution limite correspond sur une mire à 100 % de contraste à un taux de modulation de 5 % environ, si l'éclairement est suffisant pour obtenir un bon rapport signal à bruit.

La résolution est limitée par le rapport signal à bruit aux bas niveaux lumineux. Voir courbe Figure 4.

12 - La mesure du taux de modulation est éventuellement corrigée par la FTM de l'optique et la bande passante des amplificateurs vidéo.

400 LTV correspondent, pour le standard CCIR 625 lignes, à une fréquence de 5 MHz.

13 - La grille g1 est réglée pour permettre de recharger un courant crête de 500 nA. La rémanence est le pourcentage de signal résiduel 3 trames après l'extinction pour un courant de signal initial de 200 nA.

Un mauvais réglage de l'alignement peut affecter considérablement cette caractéristique.

CONSIGNES D'UTILISATION

1 - Utilisation du tube non enrobé

Il est important de ne pas placer de pièces métalliques à proximité de la face avant à fibres optiques, du collet de photocathode, et de l'électrode de focalisation ceux-ci étant portés à un potentiel pouvant atteindre 10 kV par rapport à la masse.

Au niveau de la face avant, des microclaquages entre les faces internes et externes des fibres optiques peuvent donner naissance à des scintillations ; celles-ci se traduisent sur l'image par l'apparition de points lumineux fluctuants.

Un fonctionnement prolongé dans ces conditions peut conduire à une détérioration de la face avant accompagnée d'une entrée d'air.

Le potentiel de l'électrode de focalisation doit être ajusté pour une focalisation optimale et rester à un pourcentage constant de la tension de photocathode.

2 - Utilisation du tube enrobé

L'exploitation du tube en version enrobée apporte une excellente sécurité de fonctionnement et simplifie beaucoup la conception de la tête de caméra.

En effet, d'une part, l'enrobage isole le collet de photocathode et l'électrode de focalisation de l'environnement immédiat ; d'autre part, une glace conductrice en surface est collée sur la face avant du tube. La face conductrice étant reliée électriquement à la photocathode, la glace à fibres optiques n'est soumise à aucun champ électrique. De plus, les poussières éventuellement attirées électrostatiquement sur la face d'entrée sont suffisamment loin du plan de focalisation pour ne pas dégrader l'aspect d'image.

3 - Les tensions de balayage de la section analyse doivent être appliquées avant les tensions d'électrodes.

Lorsque les prises de vue sont terminées, elles doivent être coupées après les tensions d'électrodes.

4 - Au moment des prises de vue, appliquer la très haute tension en dernier lieu. Quand les prises de vue sont terminées, il faut au contraire couper en premier lieu la haute tension.

5 - Le tube ne doit pas être soumis à des luminations locales supérieures à celles définies par la courbe de la Figure 2.

Le non respect de ces limites peut entraîner des marquages permanents de la cible.

Des éclairements élevés donnant lieu à des courants de photocathode importants, peuvent abréger la durée de vie du tube.

En conséquence, les surexpositions de longue durée doivent être évitées au maximum par l'interposition de filtres, de système d'obturation et en dernier lieu par l'asservissement de la très haute tension, afin de ramener le courant de signal à une valeur normale.

6 - Notes sur la tension de cible.

La tension d'électrode de signal est nécessaire pour collecter les électrons du faisceau et polariser les diodes de la cible ; elle n'influe pas sur le gain.

La tension de cible optimale résulte du meilleur compromis entre :

- la dynamique de signal minimale, le courant d'obscurité,
- le nombre et le contraste de défauts d'aspects.

L'augmentation de la tension cible conduit à :

- une augmentation du courant d'obscurité,
- une augmentation du courant de signal maximal admissible,
- une diminution de la capacité de stockage de la cible donc de la rémanence,
- une augmentation du contraste des défauts d'aspects.

La tension de cible minimale est celle qui permet au faisceau de recharger correctement la cible dans les blancs de l'image.

Pour ce réglage, réduire la tension de cible de quelques volts jusqu'à ce que des blancs de l'image soient saturés. Régler alors l'alignement pour obtenir la symétrie des zones saturées.

Si une saturation préférentielle demeure sur la périphérie de l'image régler le rapport des tensions Vg4/Vg3, tout en conservant la focalisation, pour obtenir une saturation uniforme.

Le fonctionnement du tube peut être perturbé par un abaissement de quelques volts de la tension de cible par rapport à une tension de fonctionnement préalable. Dans ce cas procéder comme suit :

- augmenter l'amplitude des balayages,
- régler pour un courant de faisceau maximal (électrode $g1 \simeq 0$ V),
- appliquer 300 volts à la cible pendant 1 à 2 secondes
- bloquer le faisceau (électrode $g1 \simeq -100$ V),
- régler la tension de cible à 8 V,
- augmenter le courant de faisceau jusqu'à un fonctionnement correct.

Cette procédure est exceptionnelle et ne doit être utilisée que pour éliminer les charges stockées sur le diélectrique isolant les diodes, à la suite d'un fonctionnement à tension de cible trop élevée.

7 - Note sur l'alignement du faisceau.

Une attention particulière doit être portée à l'alignement correct du faisceau d'électrons.

Un mauvais réglage conduit à des erreurs d'atterrissage du faisceau dont il résulte une mauvaise uniformité des caractéristiques de l'image.

Figure 1

REPONSES SPECTRALES TYPIQUES
DES PHOTOCATHODES S20 ET S20ER

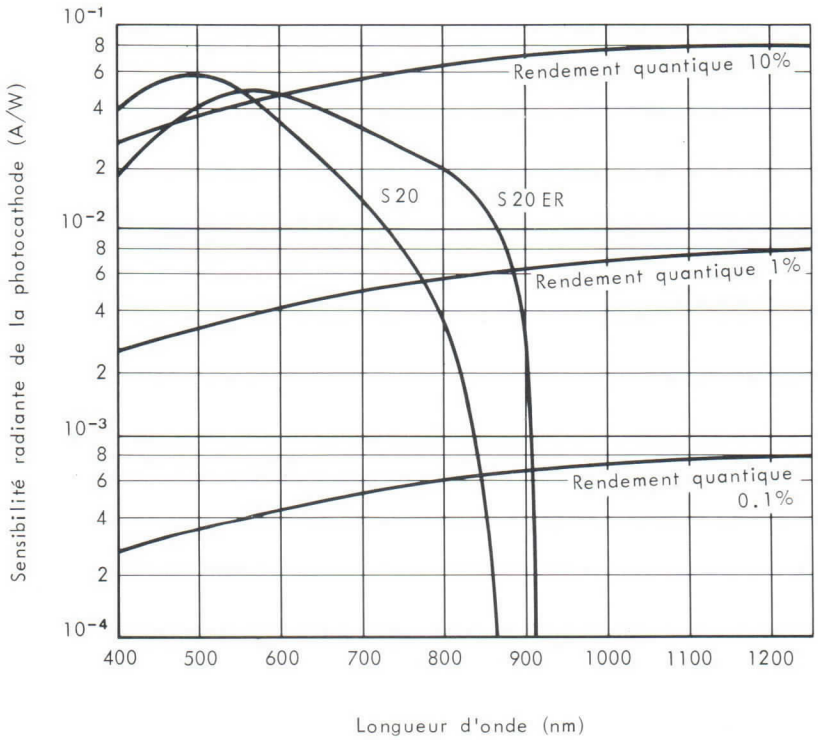


Figure 2

LUMINATION MAXIMALE

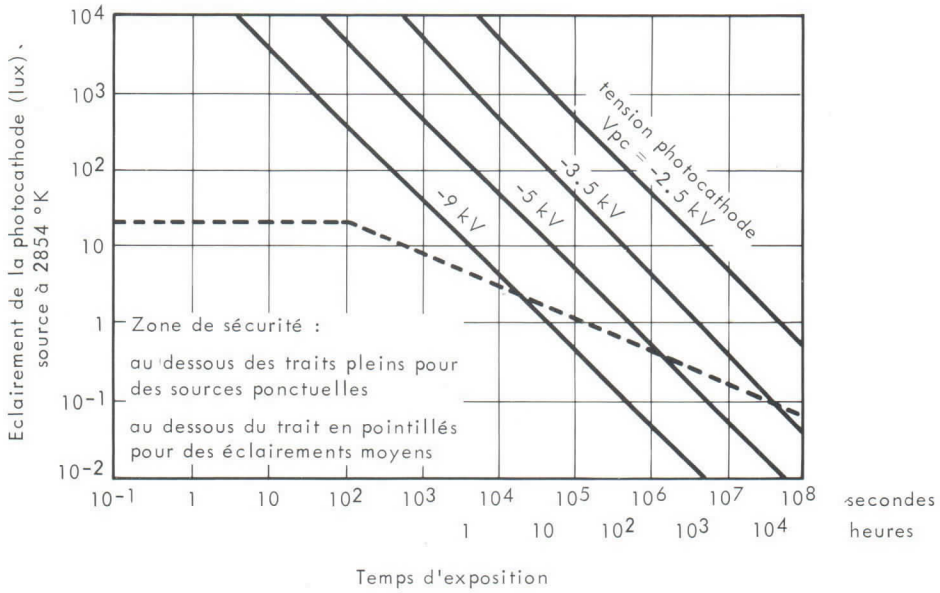


Figure 3

CARACTERISTIQUE TYPIQUE DU GAIN DE CIBLE
EN FONCTION DE LA TENSION DE PHOTOCATHODE

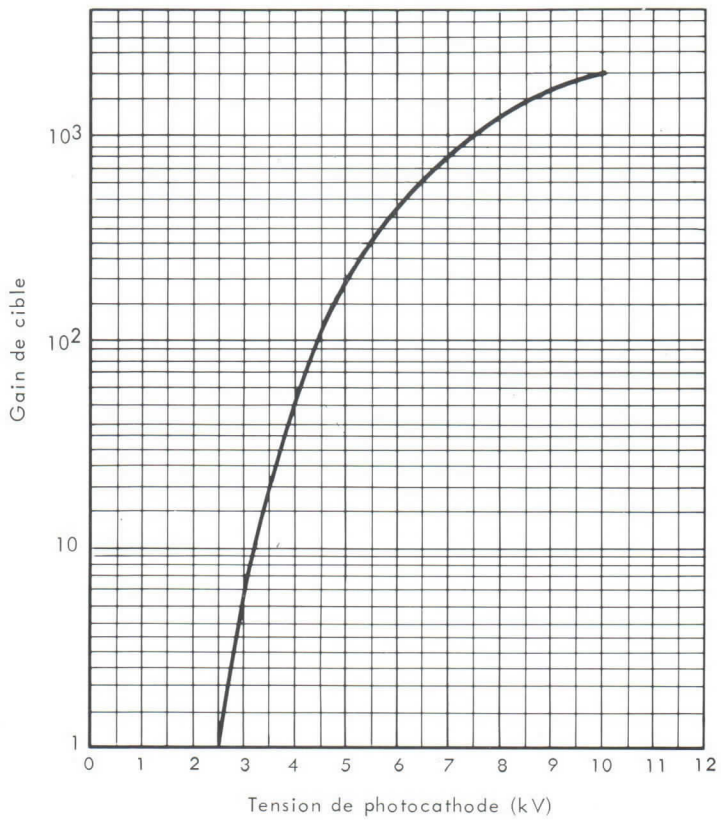


Figure 4

CARACTERISTIQUE TYPIQUE DE RESOLUTION LIMITE

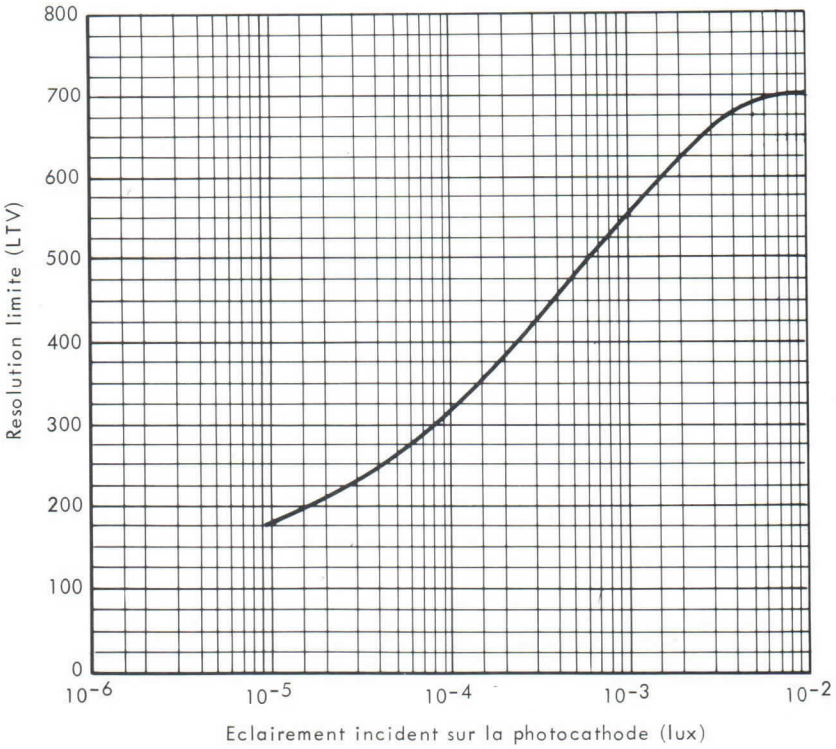


Figure 5

COURANT D'OBSCURITE TYPIQUE
EN FONCTION DE LA TENSION CIBLE

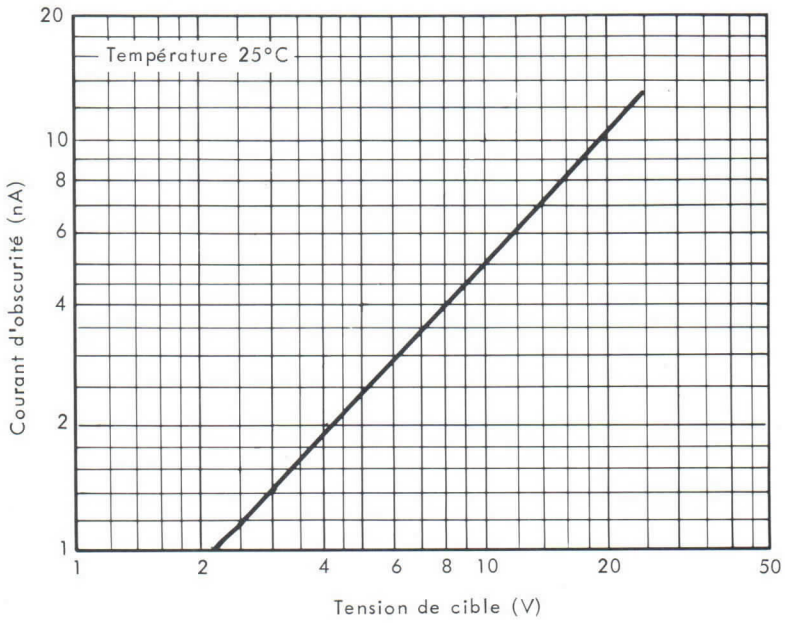


Figure 6

CARACTERISTIQUES DE TRANSFERT TYPIQUES

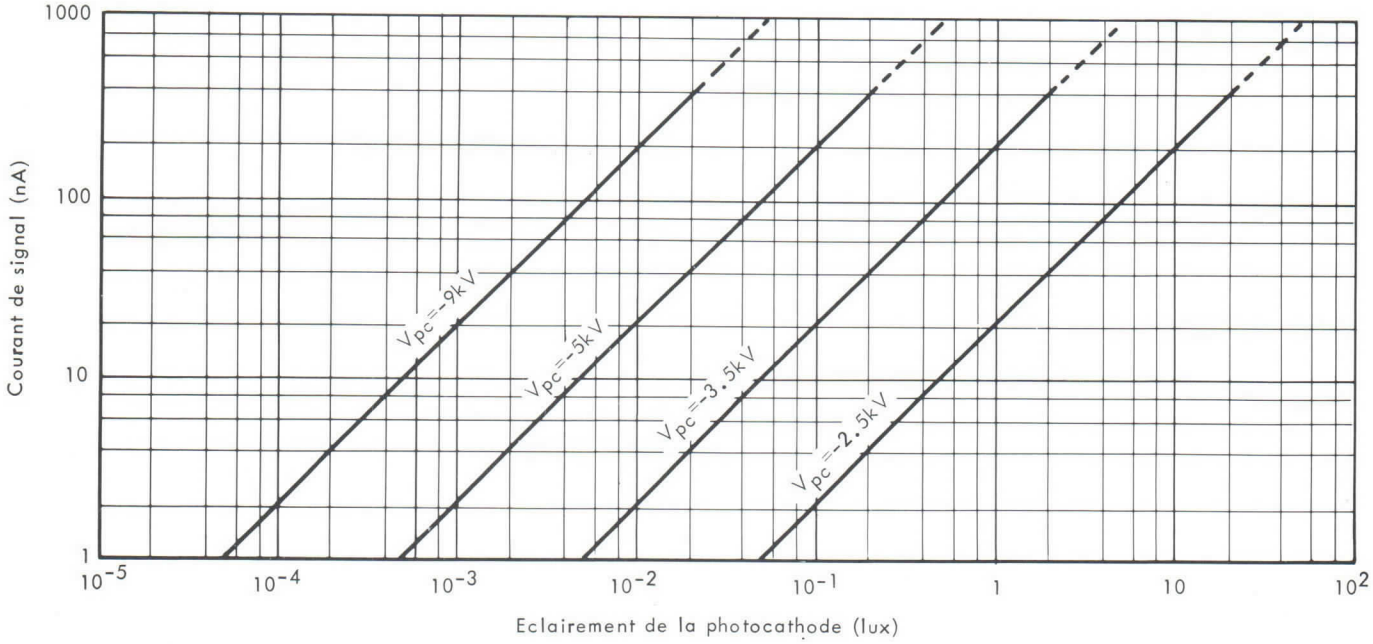


Figure 7

CARACTERISTIQUE TYPIQUE DE LA FONCTION
DE TRANSFERT DE MODULATION

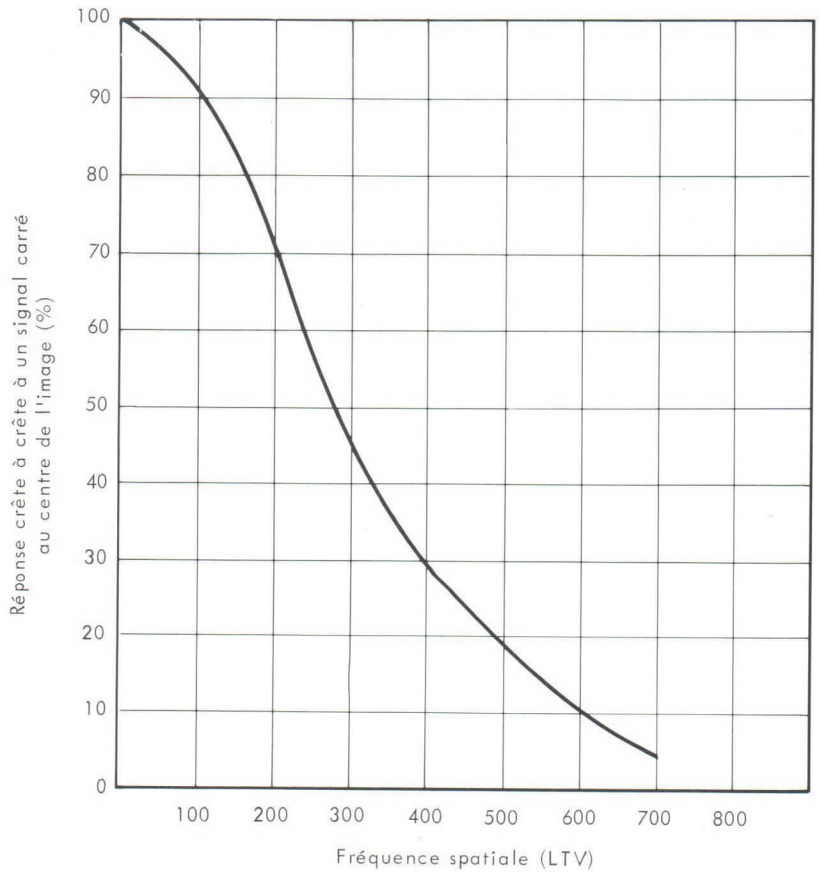


Figure 8

CARACTERISTIQUE D'EBLOUISSEMENT TYPIQUE

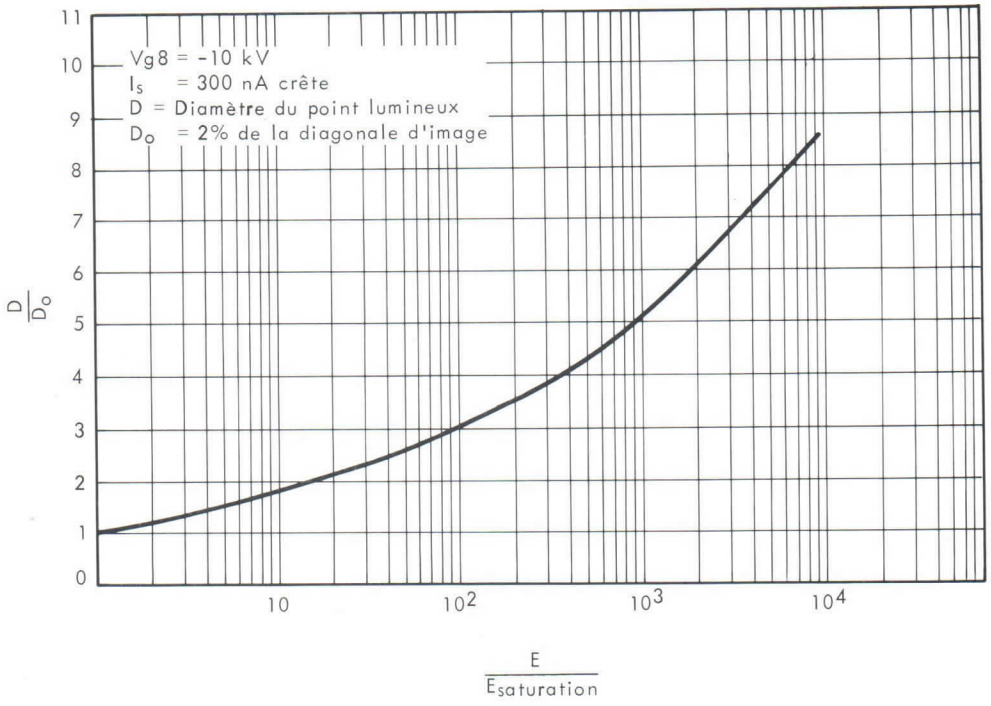
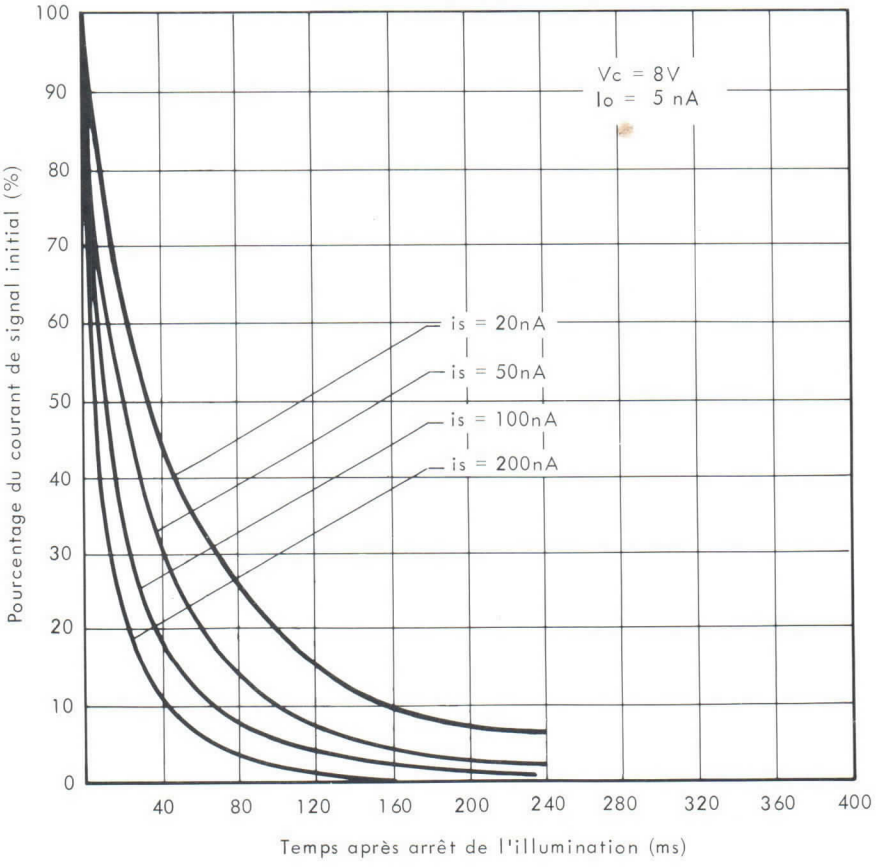


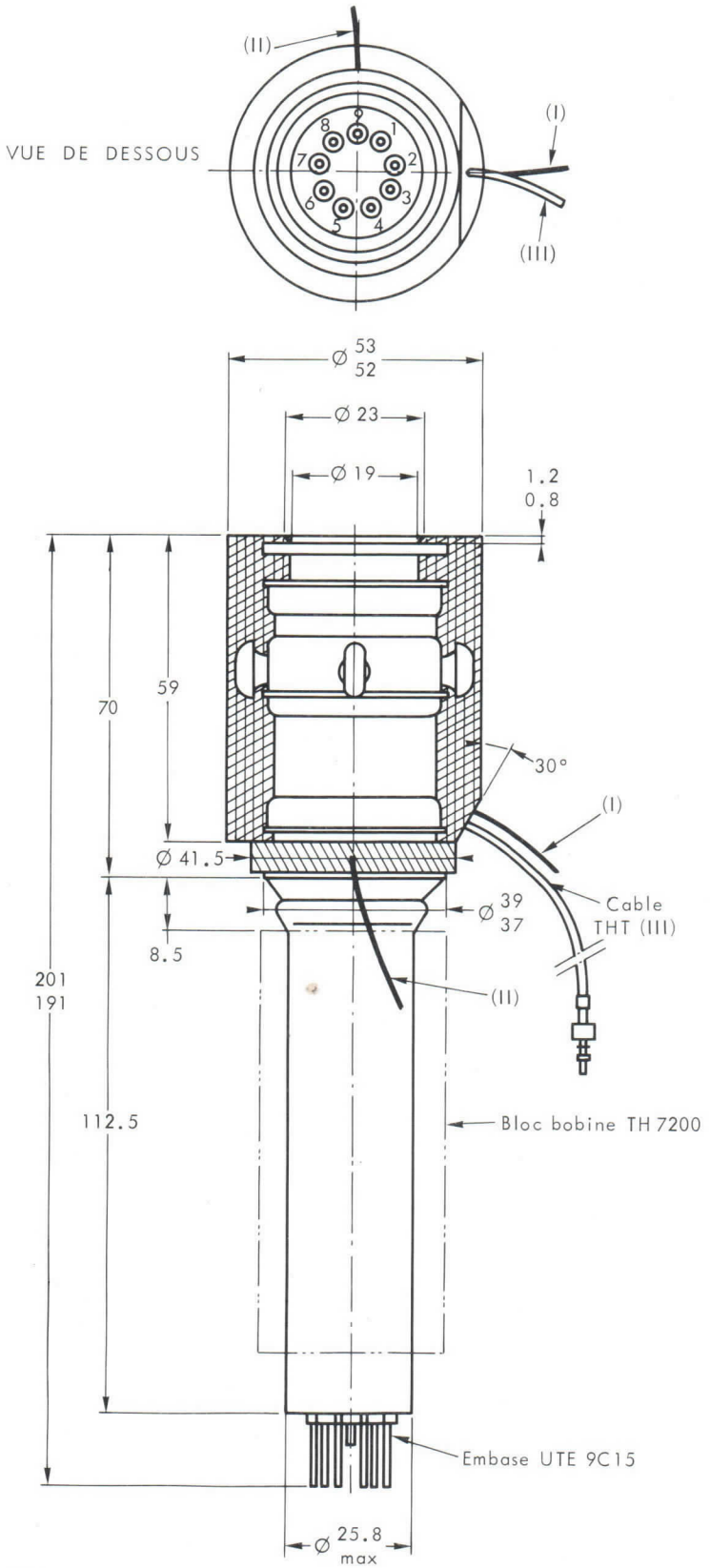
Figure 9

CARACTERISTIQUES TYPIQUES DE REMANENCE



DESSIN D'ENCOMBREMENT

TUBE ENROBE TYPE M19 + BLOC BOBINE



BROCHAGE	
Broche	Elément
1	f
2	g1
3	g4
4	ci
5	g2
6	g3
7	k
8	f
9	broche courte repère

(I) - Sortie anode (masse) : fil Taurisil rouge long. 100 mm.

(II) - Sortie cible : fil Taurisil blanc long. 75 mm.

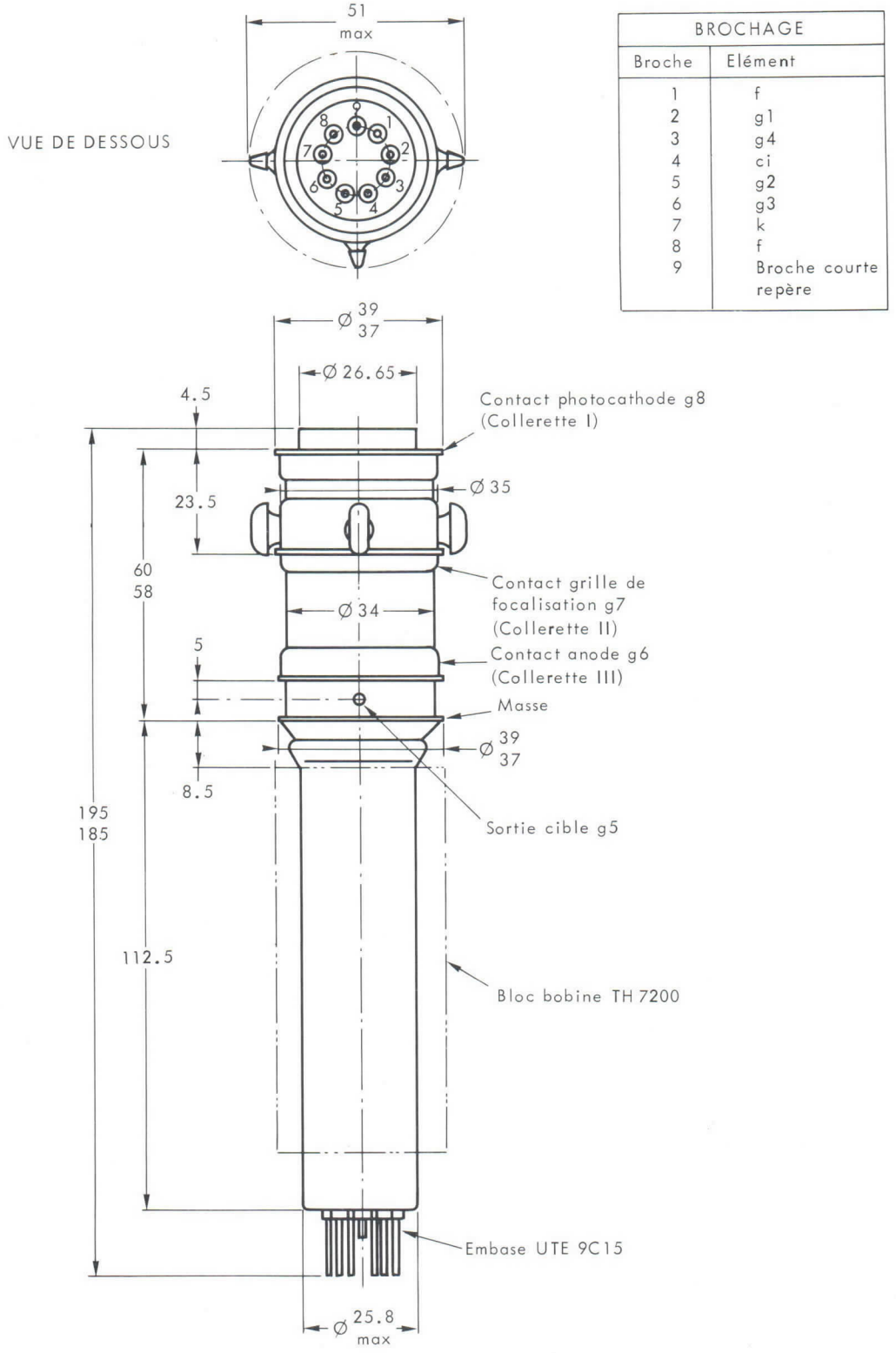
(III)- Sortie photocathode : connecteur AMP pour receptacle AMP-type LGH 1/2L long. 225 mm.

Cotes en mm.

Les cotes non tolérancées sont données à titre indicatif.

DESSIN D'ENCOMBREMENT

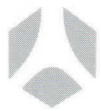
TUBE NON ENROBE + BLOC BOBINE



BROCHAGE	
Broche	Elément
1	f
2	g1
3	g4
4	ci
5	g2
6	g3
7	k
8	f
9	Broche courte repère

Cotes en mm.

Les cotes non tolérancées sont données à titre indicatif



THOMSON-CSF

DIVISION TUBES ELECTRONIQUES

TH X538-TH X540
ESICON and SUPER-ESICON
Image pick-up tubes for low light level T.V.

These notes describe the main characteristics of the Esicon and Super-Esicon camera tubes which are well suited to low light level television. The Super-Esicon is derived from the Esicon by adding an image intensifying section. The standard model has a photocathode whose response is matched to the residual illumination of the sky at night. Other models may exhibit a different spectral response making them fitter for special functions such as ultraviolet or near infrared detection (anti-camouflage).

At very low light levels, as the image resolution is limited by too few photons being received for each picture element, the quality of the signal may be increased (reduction of quantum fluctuation) through integration of several successive frames, by reducing the picture frequency This possibility is offered by the Esicon which has the advantage of very low persistence at low levels. This latter property is essential for examining motion scenes such as encountered in aerial reconnaissance. A major property of the Esicon is its satisfactory performance in the presence of local or general sources of very high level light, only requiring simple camera electronics while allowing a dynamic characteristic of 10,000/1 for the tube alone.

These notes are divided into 5 paragraphs relating to the Esicon and the Super-Esicon :

1. Introduction
2. Esicon and Super-Esicon camera tube definition
3. Principle of operation
4. Main characteristics of the Esicon
5. Main characteristics of the Super-Esicon

General information on the problems encountered in low light level vision or television will be found in the appendix.

A1. General characteristics of night vision
A2. Photoelectric detector devices
A3. Brief description of the various low light level camera tubes
A4. Main design problems for a low light level image detection system.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

1 - INTRODUCTION

Low light level television has long been limited to the transmission of dark outdoor day scenes in winter. The necessity for extending this limit and televising night scenes, particularly for surveillance purposes, has become an essential consideration in the design of various systems.

Although progress has been made of late years in the design of video amplifiers (increase in gain for the same noise level), such applications may not be contemplated for the vidicon and image orthicon tubes.

Pickup equipment for the detection and recognition of night scene elements must satisfy a number of criteria to be truly operational :

- High overall sensitivity in the visible range and the near infrared.
- Good signal-to-noise ratio and resolution.
- Very wide dynamic characteristic without image destabilisation, even partial.
- Fast response for picking up objects in motion.
- Simple, reliable operation.
- Low power consumption and small size.

The Esicon, a television camera tube of recent design, permits the implementation of equipment satisfying every such requirement and is therefore the ideal for such applications.

2 - ESICON TH X538 AND SUPER-ESICON TH X540 CAMERA TUBE DEFINITION

2.1. ESICON (Fig. 5)

The TH X538 tube is a television camera tube with a high sensitivity photocathode 25 mm in useful diameter, a high gain secondary emission target and a vidicon type scanning gun.

It features a high sensitivity, a good resolving power, a low remanence or image persistence, and is very easy to use.

An outstanding feature of this tube is that it employs a high secondary emission photoelectron multiplier target which makes it excellent at storing and integrating the charges, and permits the transformation of these charges into a video signal by a single scanning of each element by the scanning beam. The secondary emission effect is virtually linear and inertialess.

These properties permit the tube to be operated in a wide range of illumination levels and make it particularly fit for the detection and recognition of moving or stationary elements. The presence of scene areas with enough luminance to cause signal saturation does not produce halation and does not prevent the rest of the scene from being viewed.

This tube requires only low scanning power and the conventional accessories of the vidicon can be used with it. A high voltage of 12 kV max.; with very low current, is used to accelerate the electrons of the photocathode, and the slaving of this voltage to the video signal permits the tube sensitivity to be reduced and there by the dynamic characteristic to be increased.

This tube is designed for low light level television applications. A television camera employing it will provide high quality image at scene illumination levels of 10^{-3} to 1 lux.

2.2. SUPER-ESICON (fig. 7)

In applications where very high sensitivity is essential, an additional intensifier stage may be used in the form of a TH 9473 image intensifier. Simple physical juxtaposition is all that is necessary to couple the camera tube and the image intensifier : the intensifier has a fibre-optic output window and the Esicon has a fibre-optic input window. The camera tube thus obtained is called Super-Esicon TH X540.

The Super-Esicon has all the qualities of the Esicon and a sensitivity fifty times greater for the same input field , i.e. 25 mm. This tube permits the implementation of a camera well suited to night television under almost all conditions encountered in this type of application : values of illumination between 5.10^{-5} and 10^{-2} lux. The same camera as used for the standard Esicon may be used for the Super-Esicon by simply adding a modular power supply unit for the image intensifier. The use of the slaving features permits a total dynamic characteristic of 10,000/1 without any touching up a setting.

3 - PRINCIPLE OF OPERATION

A functional diagram of the Esicon tube is shown in figure 1 : the optical image is focused on the optically flat fibre-optic faceplate of the tube and transmitted to the inside photocathode deposited on a concave surface. The photoelectrons emitted by the photocathode in proportion to the light received are accelerated and focused on the target by the electrostatic lens consisting of the photocathode and a conical anode.

The target consisting of a dielectric with high secondary emission ratio is deposited on a thin metal electrode used as signal electrode. The photoelectrons accelerated under about 10 kV yield their energy by producing secondary emission of electrons from the target material, these electrons being collected by a collector electrode. The free area of the target, facing the electron gun, thus charges proportionally to the flux of photoelectrons received, the potential being all the more positive as the input photocathode is more illuminated.

The very high transverse and in depth resistivity of the target due to the nature of the material permits the charge configuration to be preserved for a long time. It also results in virtually zero signal current in darkness and therefore in a stable and uniform black level, which facilitates the observation of very low contrasts in the televised scenes.

A suppressor grid is provided opposite the target on the gun side. It is used to limit the potential reached by the target to the one which is applied to it : this potential is adjusted to a value slightly lower than the cross-over potential of the material, which prevents any destabilisation owing to excessive local or general illumination of the input photocathode.

The periodic passage of the scanning beam produced by the electron gun opposite permits the target to be restabilised at the potential of the cathode by neutralising the charges with electrons. The resulting current pulse constitutes the video signal which appears capacitively in the circuit of the signal electrode.

4 - MAIN CHARACTERISTICS OF THE ESICON

4.1. SPECTRAL RESPONSE AND SENSITIVITY

Depending on the particular application, various types of photocathodes may be used. The most commonly used photocathode is the S20 whose typical spectral response curve is shown in figure 2.

The maximum quantum efficiency is 15 to 20% and the corresponding wavelength is between 420 and 460 nm. The high quantum efficiency of the S20 photocathode, combined with the high gain of the target, permits a sensitivity in the order of 15,000 μA/lumen (i.e. about 5 μA/lux) to be obtained (illuminated area = 3 sq cm). For some applications, the near infrared sensitive S1 cathode may be preferred (camouflage detection).

4.2. SIGNAL-ILLUMINATION CHARACTERISTIC

The signal-illumination characteristic is plotted in figure 3 (a). The gamma of the tube is 1 for light levels less than 10^{-2} lux and decreases to about 0.6 above 10^{-1} lux. When the value of illumination increases, there exists a saturation of the signal determined by the potential of the grid g5. Excessive illumination may cause a momentary gain loss, and even a target burn, and it is advisable, in normal operation, not to exceed the values of illumination indicated on the curve in figure 4. Slaving the photocathode voltage to the signal current may help to reduce this burning effect.

4.3. RESOLUTION AND MODULATION TRANSFER

The modulation transfer curve for a square signal pattern with 100% contrast is shown in figure 3 (b). The values of contrast are in the order of 60% for 200 TV lines and 20% for 400 TV lines. The limit resolution of the tube is about 20 line pairs/mm, which corresponds to 600 lines (800 points per line).

The resolution varies little with the target voltage and the photocathode voltage if those do not become less than 5 V and 4 kV respectively, which permits the use of AGC without reducing the resolution.

Figure 4 (a) shows the limit resolution versus photocathode illumination. The resolution varies from 550 TV lines for 0.1 lux to 100 TV lines for 2.10^{-4} lux.

4.4. IMAGE PERSISTENCE

The image persistence of the Esicon is very low compared to that of most of the other camera tubes. The residual signal after the passage of the scanning beam is generally less than 10% of the value scanned. However, remanence increases a little at very low levels of light due to the incomplete absorption of the scanning beam by the layer (figure 3 (d)).

4.5. INTEGRATION AND STORAGE

The very high resistance of the Esicon target permits the integration of a signal for several minutes without the image being degraded by leakage currents. The exposure-light reciprocity is well verified and on some tubes it is possible to integrate a signal for 20 minutes. An integration of 60 seconds increases the detection sensitivity by a factor of 1500.

This integration can be achieved automatically by means of a simple electronic device. For examining slow moving objects, a rate of 1 to 4 pictures per second may be sufficient, which gives a gain in sensitivity (or in signal-to-noise ratio) of 25 to 6. To avoid flicker, the picture is displayed on a receiver equiped with a persistent cathode ray tube or an image retaining tube (DVST) or with the help of an electrical recording storage tube associated to a standard TV monitor.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

4.6. MAXIMUM LIGHT LEVEL

The curve in figure 4 (b) shows the limiting values of illumination versus exposure time. These limits depend also on the photocathode voltage : when the voltage decreases, the curve moves upwards.

If the energy dissipated in the target is too high, several phenomena result : apparition of a negative image, momentary gain loss, and even permanent layer burn. It is therefore recommended not to exceed the maximum values of illumination, although, in most cases, with values slightly in excess of those indicated, the tube will still recover its properties.

4.7. ENVIRONMENTAL LIMITATIONS AND LIFE

The tube can be operated between -30°C and +50°C without any appreciable effect upon its performance. The tube structure has been specially designed to offer good resistance to shock and vibration. However, precautions are necessary in designing the camera head to minimise spurious signals caused by internal vibration. Figure 5 shows the dimensional characteristics of the tube.

Under normal operating conditions, a life of several thousand hours may be expected without significant alteration of the characteristics.

5 - MAIN CHARACTERISTICS OF THE SUPER-ESICON

The result of coupling a TH 9473 image intensifier with a TH X538 Esicon tube of 25 mm input field is a camera tube 20 to 50 times more sensitive than the Esicon alone, with all the characteristics of the Esicon retained. Figure 7 shows the Super-Esicon. Optical coupling is accomplished through the fibre optics of the intensifier and of the Esicon. Physical coupling is obtained by means of a simple mechanical device which provides good rigidity.

The operating voltage is 25 kV distributed between the intensifier (15 kV) and the Esicon (10 kV). The EHT generator may take the form of modular elements with very small overall dimensions because very low power is involved. Another method of coupling employing an additional fibre-optic plate permits the total power supply voltage to be 15 kV only.

5.1. SPECTRAL RESPONSE

The input photocathode, which is that of the image intensifier, is in general of the S20 type, or still better of the S25 type, with a spectral response extended to the near infrared (see figure 2). Such a photocathode has a white-light sensitivity (2870°K) greater than 175 μA/lumen.

5.2. SIGNAL-ILLUMINATION CHARACTERISTIC

The curve in figure 6(a) shows target current versus photocathode illumination. The gamma of the tube ranges from 1 for the lowest levels of light to 0.6 between 10^{-4} and 10^{-3} lux. It is possible, by combining target voltage, photocathode voltage and beam current slaving to cover a dynamic illumination range in the order of 10,000.

5.3. RESOLUTION AND MODULATION TRANSFER

The resolution for the same signal current is slightly less than that of the Esicon because of unavoidable losses due to the coupling of the image intensifier and the Esicon. On the other hand, the resolution of the Super-Esicon is higher at low light levels. Typical values of resolution are 500 TV lines at 10^{-3} lux and 100 TV lines at 3.10^{-6} lux. The curve in figure 6(b) shows the resolution versus the number of TV lines for a highly contrasted square signal pattern.

5.4. IMAGE PERSISTENCE

The image persistence of the Super Esicon is the same as that of the Esicon (see fig. 3 (d)). The low remanence contributes to the high resolution qualities of the Esicon and Super-Esicon for objects in motion.

5.5. INTEGRATION AND STORAGE

As in the Esicon, it is possible to integrate a light signal for several minutes and to read it a few hours after removing the high voltage. Limitations are imposed on the integration by the dark current of the intensifier and the transfer section of the Esicon and low illuminations due to the electron gun cathode. With excessive photon noise, it may be found advantageous to reduce the gain of the tube by reducing the high voltage and to operate the tube with longer integration times.

5.6. MAXIMUM LIGHT LEVELS

The curve (d) in figure 6 shows, versus the exposure, the maximum value of illumination which the tube can withstand in normal operation. Values slightly in excess of those indicated will result in a gain loss, but the tube will generally recover its properties after a few minutes.

5.7. ENVIRONMENTAL LIMITATIONS AND LIFE

The Super-Esicon tube will operate satisfactorily between -30°C and + 50°C. It is rugged and offers good resistance to shock and vibration. However , camera heads should be constructed in such a way as to minimise vibration liable to cause microphonics.

APPENDIX

LOW LIGHT LEVEL TELEVISION

A1 - GENERAL CHARACTERISTICS OF NIGHT VISION

The human eye can distinguish highly contrasted objects at a level of light of about 10^{-4} lux. When the level of illumination is 2.10^{-1} lux, which is that provided by the full moon, vision is improved and it becomes possible to read say the headlines of a newspaper, but the colour detection threshold is not reached yet. At about 100 lux, which corresponds probably to the level of illumination of this sheet of paper, visual acuity becomes optimum.

In short, it may be considered that below 1 lux the human eye looses much of its resolving power and can no longer distinguish colours.

There are other limitations associated with the wavelength of radiation : the eye is sensitive to only a very narrow band of wavelengths (0.4 μ to 0.8 μ) in the electromagnetic spectrum. This consideration is important : the radiation emitted by the night sky is mainly in the red and infrared portions of the electromagnetic spectrum (figure 8). Furthermore, the shift to the infrared is accented by the variation of the reflection coefficient with the wavelength of many objects (figure 9).

It follows from the above that the use of dectection devices exhibiting higher sensitivity and wider spectral coverage than the human eye is very advantageous and permits contrasts to be observed by enhancing the luminance of the image at levels where the eye exhibits good resolving power and therefore good ability to detect picture elements. The eye responds to a minimum of 50 photons. This corresponds to a quantum efficiency of 0.02. Since the quantum efficiency of a good photocathode is about 0.1, a gain in the order of 5 is achieved. On the other hand, the photoelectrons emitted can be multiplied through secondary emission.

TABLE 1 : SCENE ILLUMINATION ACCORDING TO AMBIENT CONDITIONS

Ambient conditions	Scene illumination (lux)
Full moon - clear sky	2.10^{-1}
Half moon - clear sky	10^{-1}
Full moon - moderately covered sky	4.10^{-2}
Quarter - clear sky	10^{-2}
No moon - clear sky	10^{-3}
No moon - moderately covered sky	5.10^{-4}
No moon - heavy clouds	2.10^{-4}

A2. PHOTOELECTRIC DETECTOR DEVICES

The low light level electronic detector devices may be classified into two groups :

1. The image intensifiers.
2. The camera tubes.

According to the applications, one of these devices will be more or less appropriate. However, notwithstanding weight, bulk and handling considerations, it is obvious that the secondary category, which makes it possible to use all the techniques of television, offers a considerable advantage (remote display, multiple screen display, etc...).

Among the main pickup devices worth considering, let us mention : the image Orthicon, the Isocon and the Esicon. From a sensitivity standpoint, the performance of these three tubes may be improved by the addition of intensifier tubes.

A3. BRIEF DESCRIPTION OF THE VARIOUS LOW LIGHT LEVEL CAMERA TUBES

All these tubes are based on the same principle.

A flux of photons is detected by means of a photocathode well suited (quantum efficiency, spectral response) to night vision. This photocathode is generally a S20 or a S25 (figure 2).

The emitted photoelectrons are transferred to a target with an increase in energy permitting the emission of secondary electrons. Thus, at the level of the target, there is a multiplication of the number of charges corresponding to N incident photons; this multiplication is a function of the secondary emission coefficient.

In the image orthicon and the isocon, the secondary electrons leave the target and are collected by a grid. In the esicon, the secondary electrons are transferred through the pores of a target made of a material with a high secondary emission coefficient.

In the Image Orthicon, the reading of the charge configuration on the target is accomplished by means of an electron beam reflected by this target, and the current is inversely proportional to the level of illumination. The noise due to the Schottky effect is therefore high under these conditions. Despite improvements such as automatic beam control (A.B.C.) (set at the assumed electric charge to be read through complicated electronic devices), this problem has not been solved satisfactorily yet.

In the Isicon tube, this difficulty is obviated by using to generate the video signal only that portion of the beam which has been scattered (and not reflected) by the target. From the standpoint of noise, the performance are thus greatly improved, but adjustment of the tube is extremely critical and leads to an equipment little operational.

In the Esicon tube, the reading process is quite different. Reading is accomplished by recharging the capacitance formed by the target in a much similar way as in a conventional Vidicon, and the video current is constituted by the electrons moving directly in the target.

A4. MAIN DESIGN PROBLEMS FOR A LOW LIGHT LEVEL IMAGE DETECTION SYSTEM

Two kinds of problems are generally encountered :

1. Noise problems
2. Optical problems

The noise problem

The perception of scene elements is limited by noise. The Esicon has very low intrinsic noise and this noise is negligible compared to the noise of the associated video amplifier. With a preamplifier having a bandwidth of 7 MHz and 2 nA RMS noise referred to the input, a signal-to-noise ratio of 50 max. can be achieved in the case of the Esicon tube, which corresponds to a visual signal-to-noise ratio of 150, i.e. about 43 dB.

With high sensitivities, particularly when image intensifiers are used, photon fluctuation may intervene and limit the detection of scene elements.

The optical problem

To obtain maximum efficiency from a night pickup tube, it is necessary to collect a maximum number of photons, and most often the practical solution to this problem is reduced to price and size considerations.

With E_S being the illumination level of a scene, the illumination of the tube photocathode is given by the following formula :

$$Epc = \frac{B_S \; T}{4 \; f^2 \; (1 + m)^2}$$

Where B_S = RE_S, R being the reflection coefficient of the scene
T = transmission coefficient of the optical system
f = lens aperture
m = magnification

Typical results may be $E_{pc} = 0.2 \; B_S$ and if $R = 0.05$ (sea-water reflection), $E_{pc} = 10^{-2} \; E_S$. The advantage of having an image intensifier in front of the pickup tube appears now clearly, for with a gain of 100, the losses due to the low reflection coefficient of the scene and to the optical system will be compensated. Figure 10 shows the relations between the illumination of the photocathode and the illumination of the scene for various apertures and indicates the operating regions of the Esicon and Super-Esicon.

FUNCTIONAL DIAGRAM OF THE ESICON

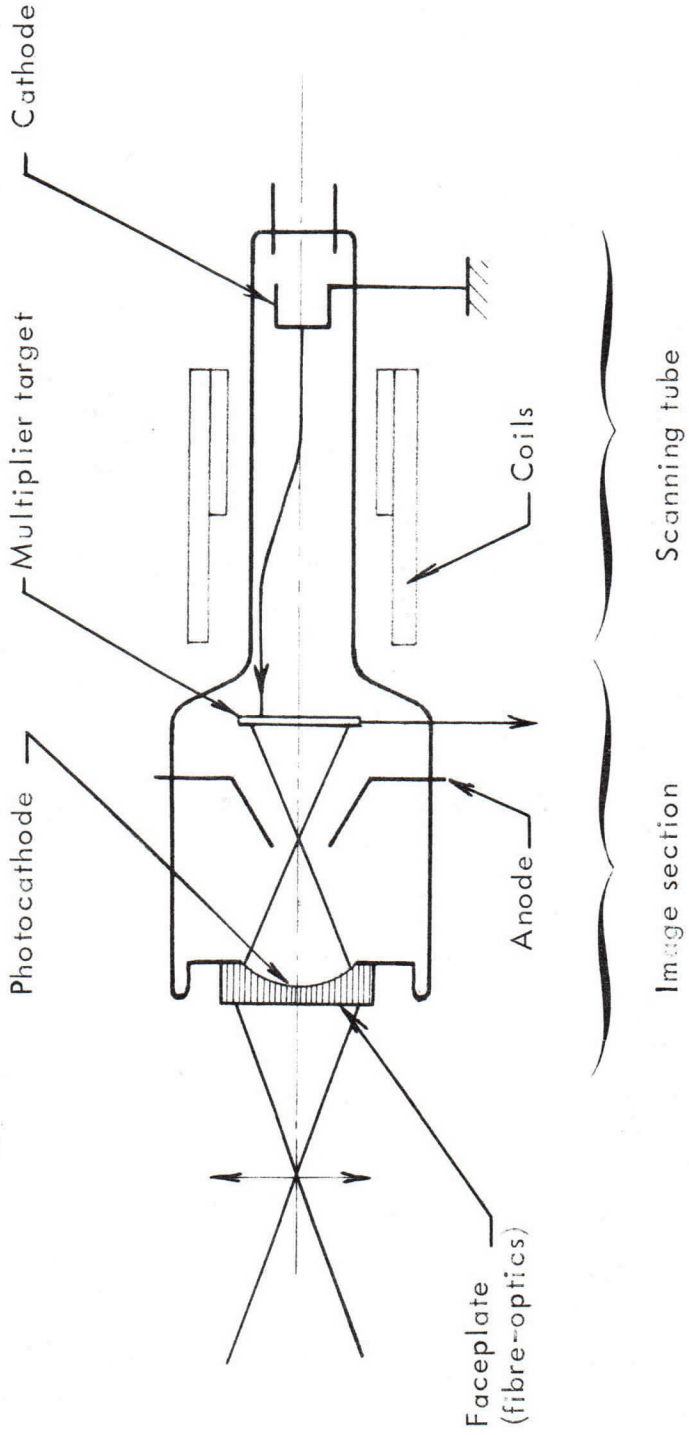


FIG. 1

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

TYPICAL PHOTOCATHODE SPECTRAL RESPONSES

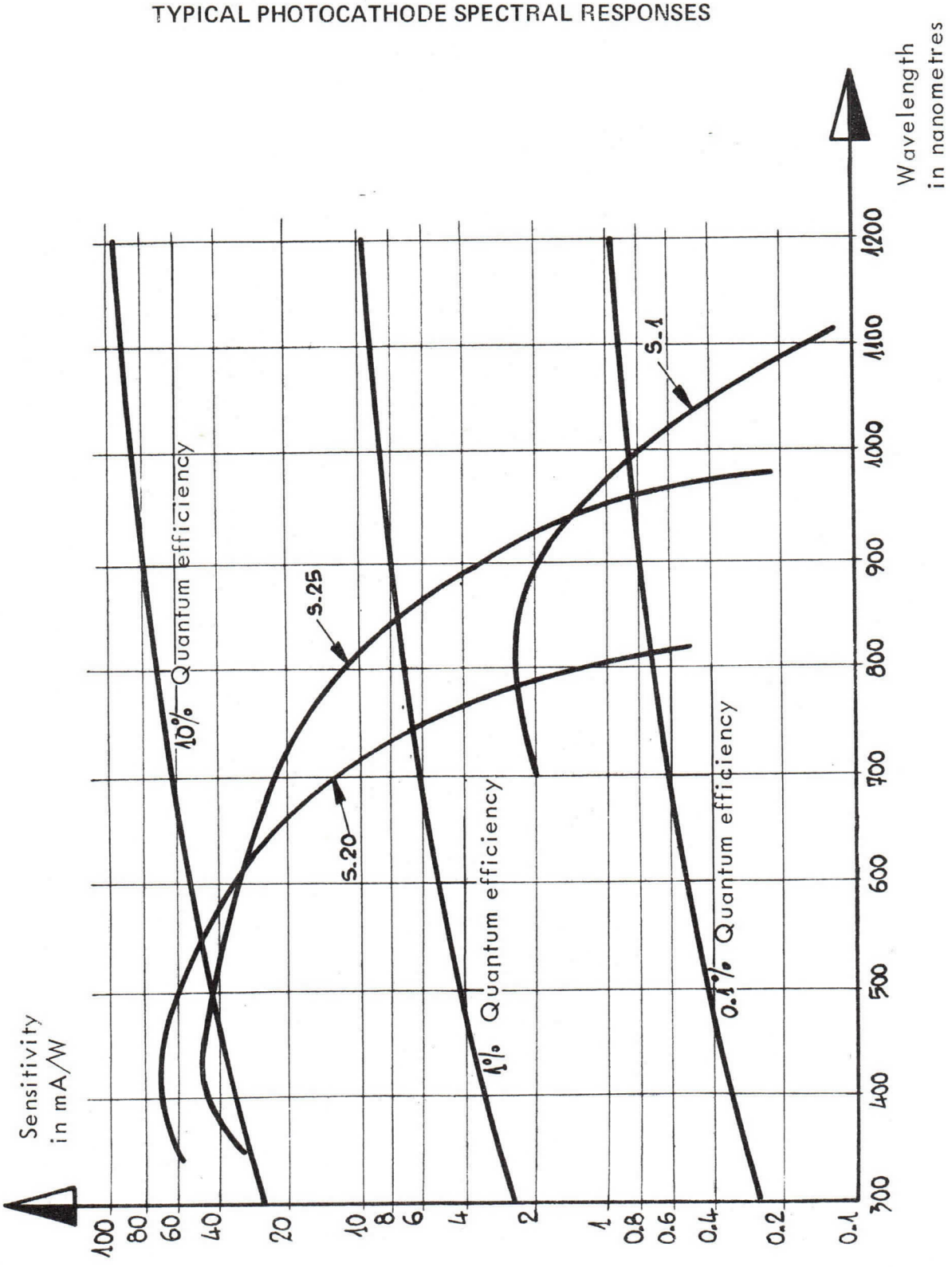


FIG.2

MAIN CHARACTERISTICS OF THE THX 538 - ESICON TUBE

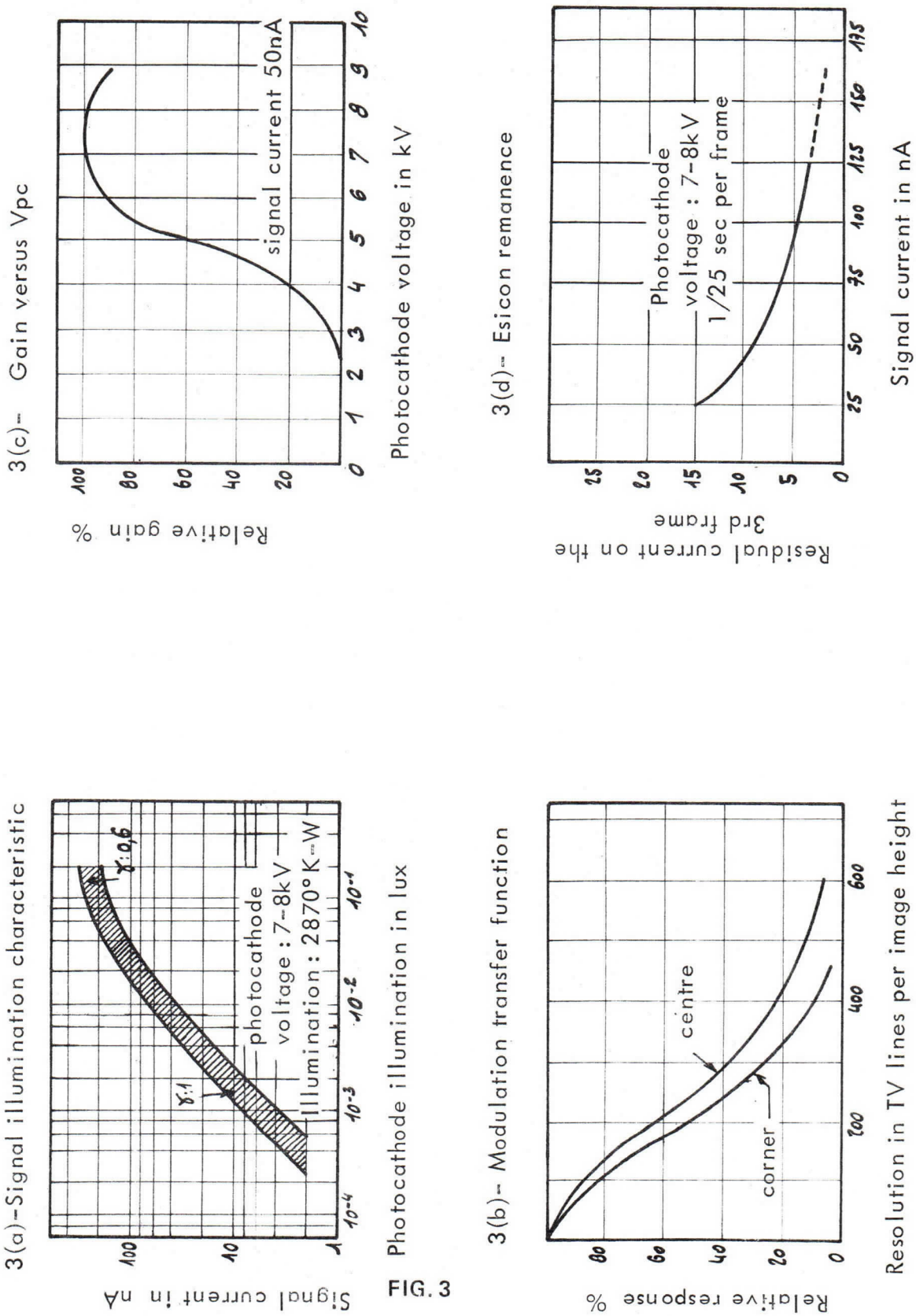
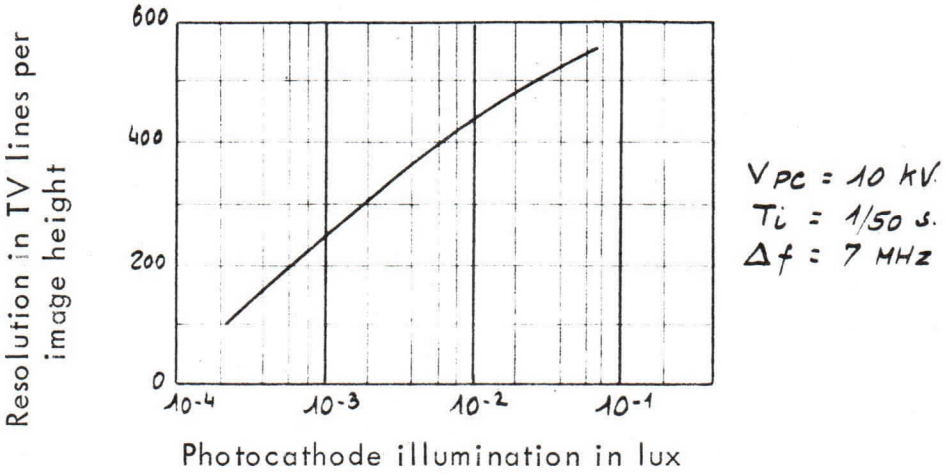


FIG. 3

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

CHARACTERISTICS OF THE X 538- ESICON

Resolution vs. illumination level



Maximum illumination level vs. exposure

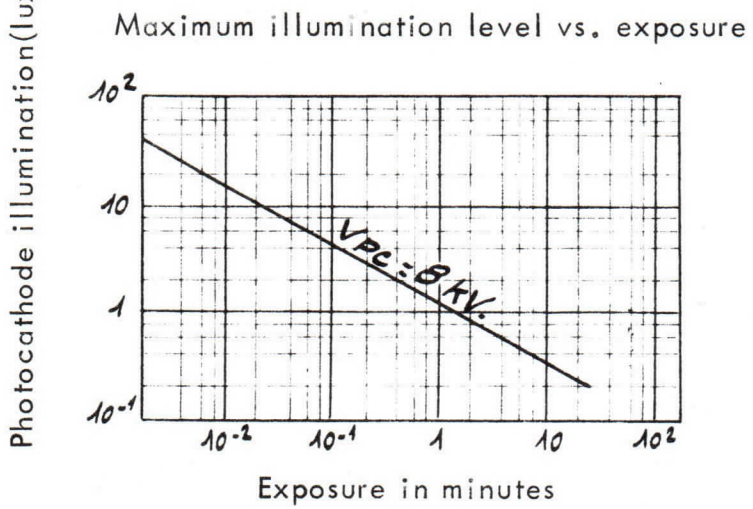


FIG. 4

THX 538 - DIMENSIONS

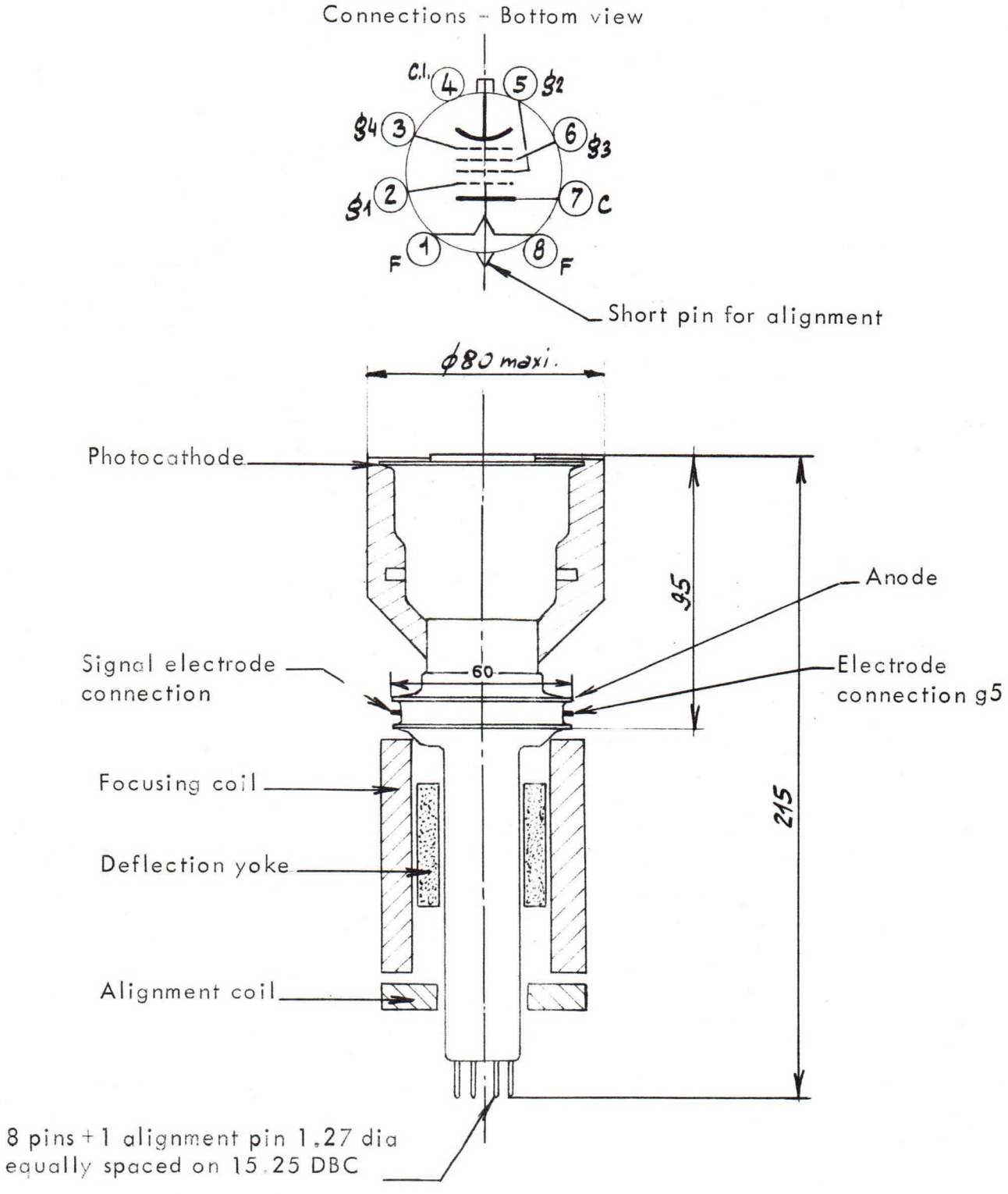
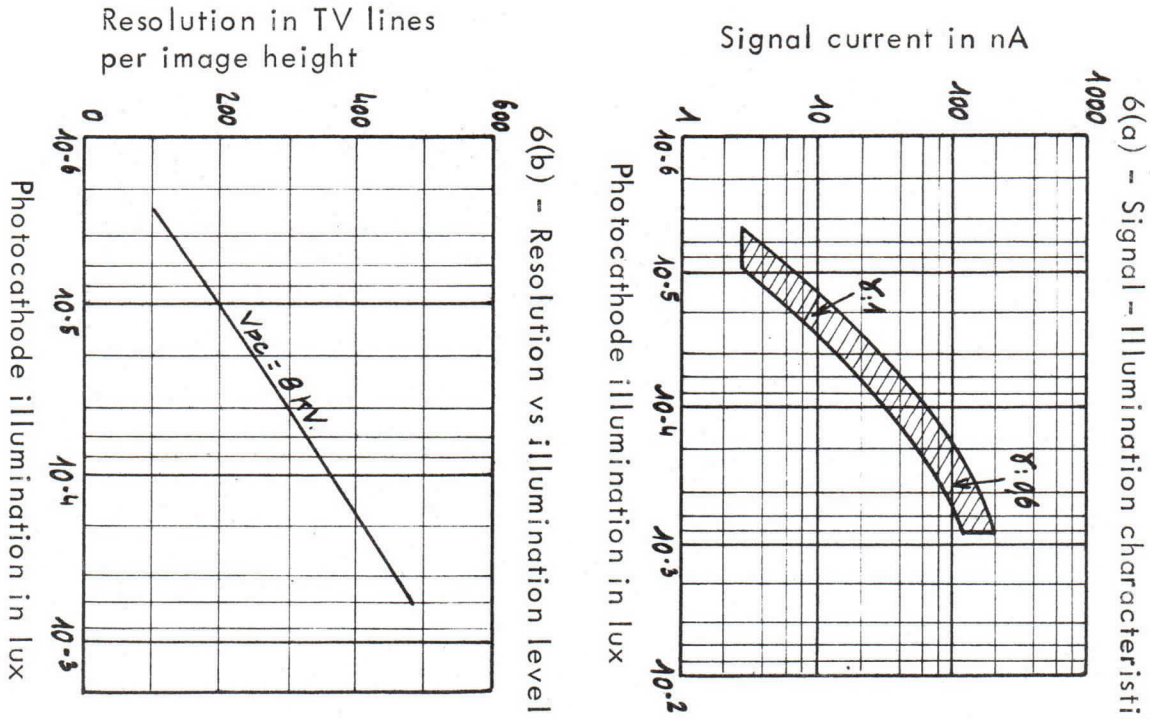


FIG. 5

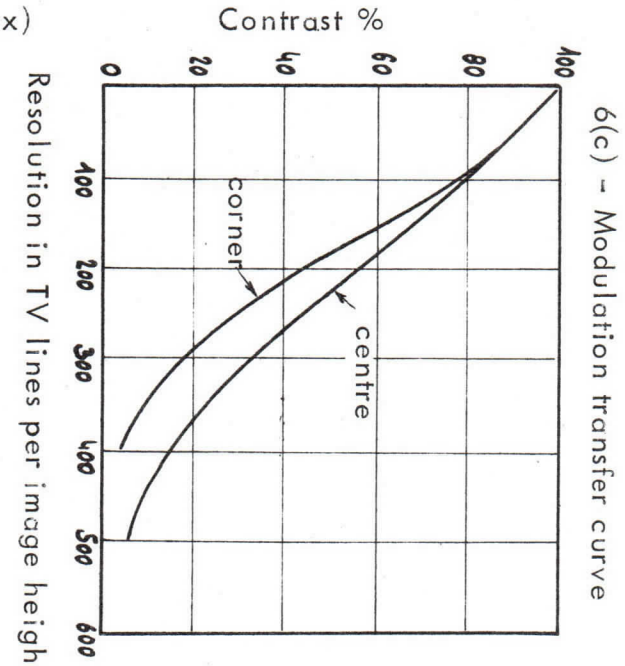
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

MAIN CHARACTERISTICS OF THE THX 540- SUPER ESICON TUBE

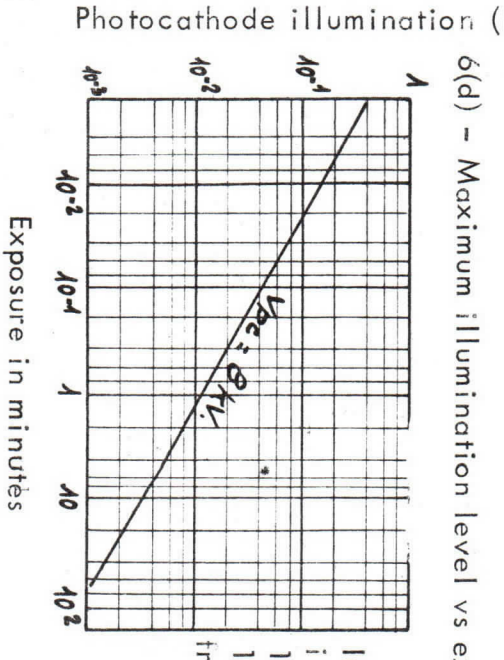


6(a) - Signal - Illumination characteristic

6(b) - Resolution vs illumination level



6(c) - Modulation transfer curve

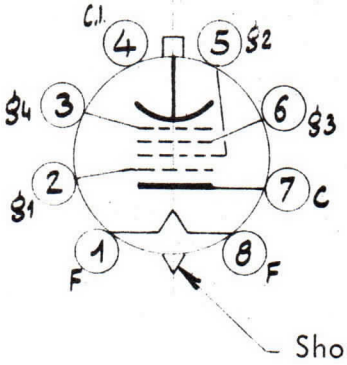


6(d) - Maximum illumination level vs exposure

FIG.6

THX 540 DIMENSIONS
(TUBES ENCAPSULATE D)

Connections - Bottom view



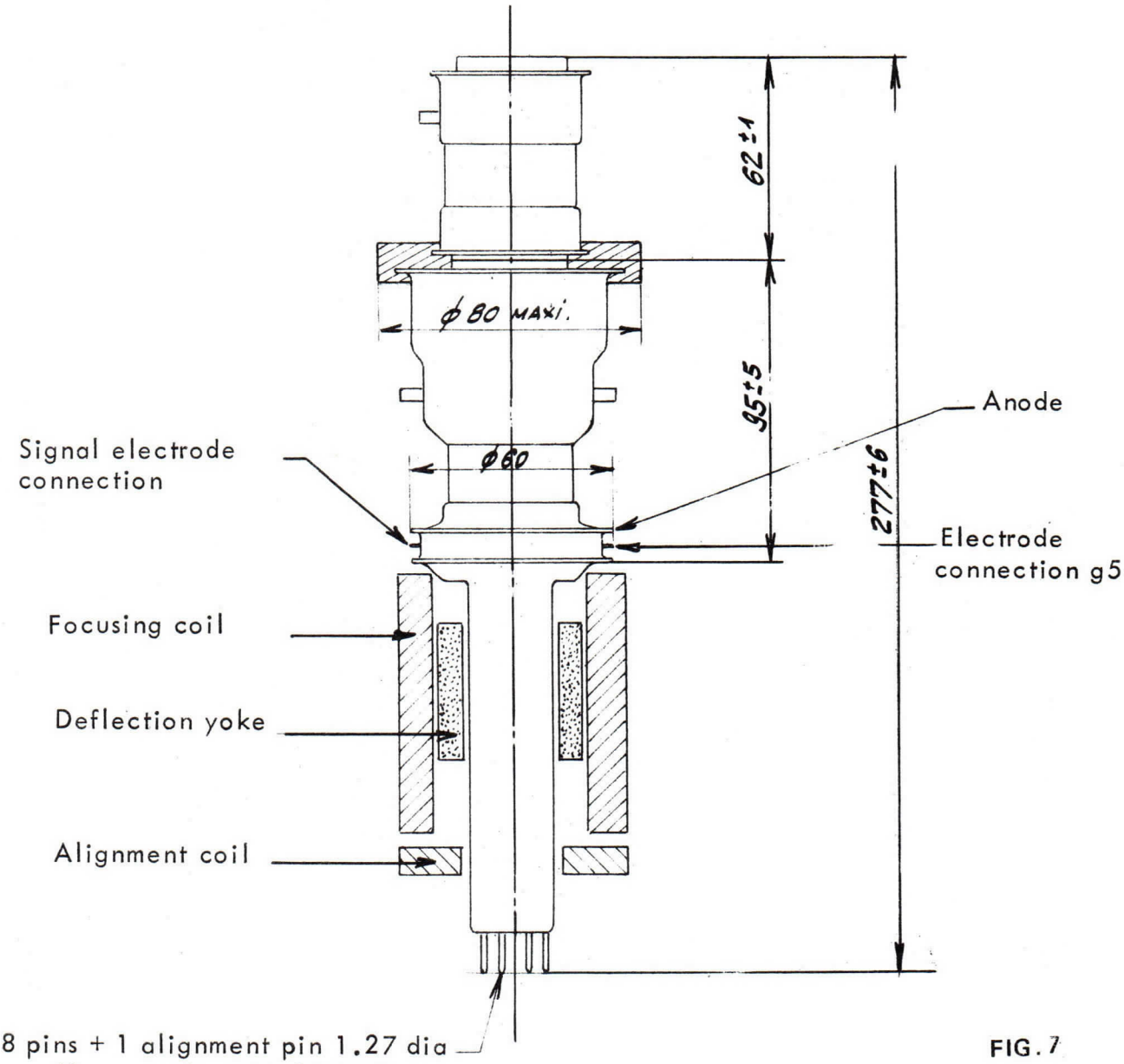


FIG. 7

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

SPECTRAL DISTRIBUTION OF NIGHT SKY LIGHT (AVERAGE OF 8 MEASUREMENTS)

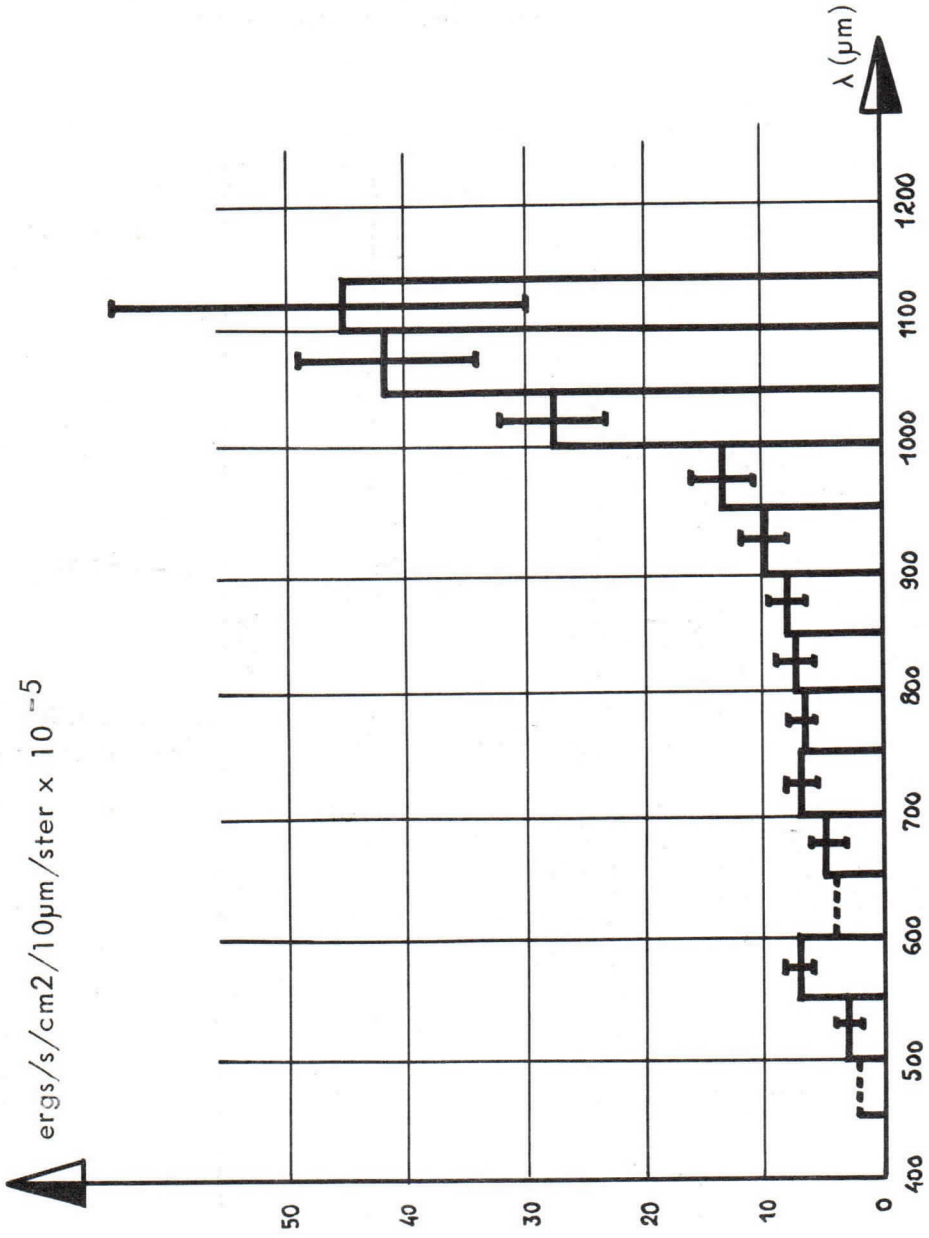


FIG.8

REFLECTANCE VS. WAVELENGTH

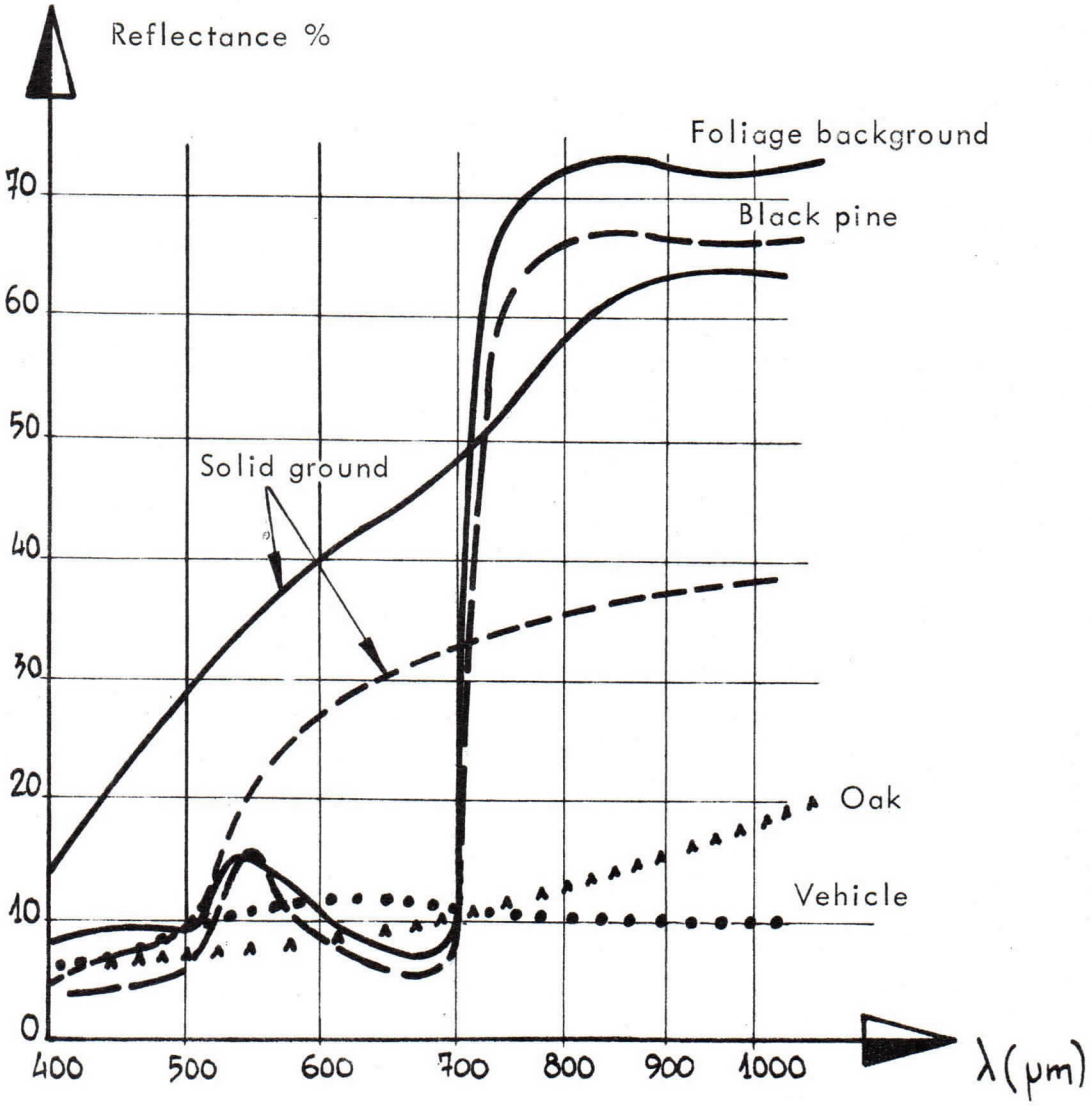
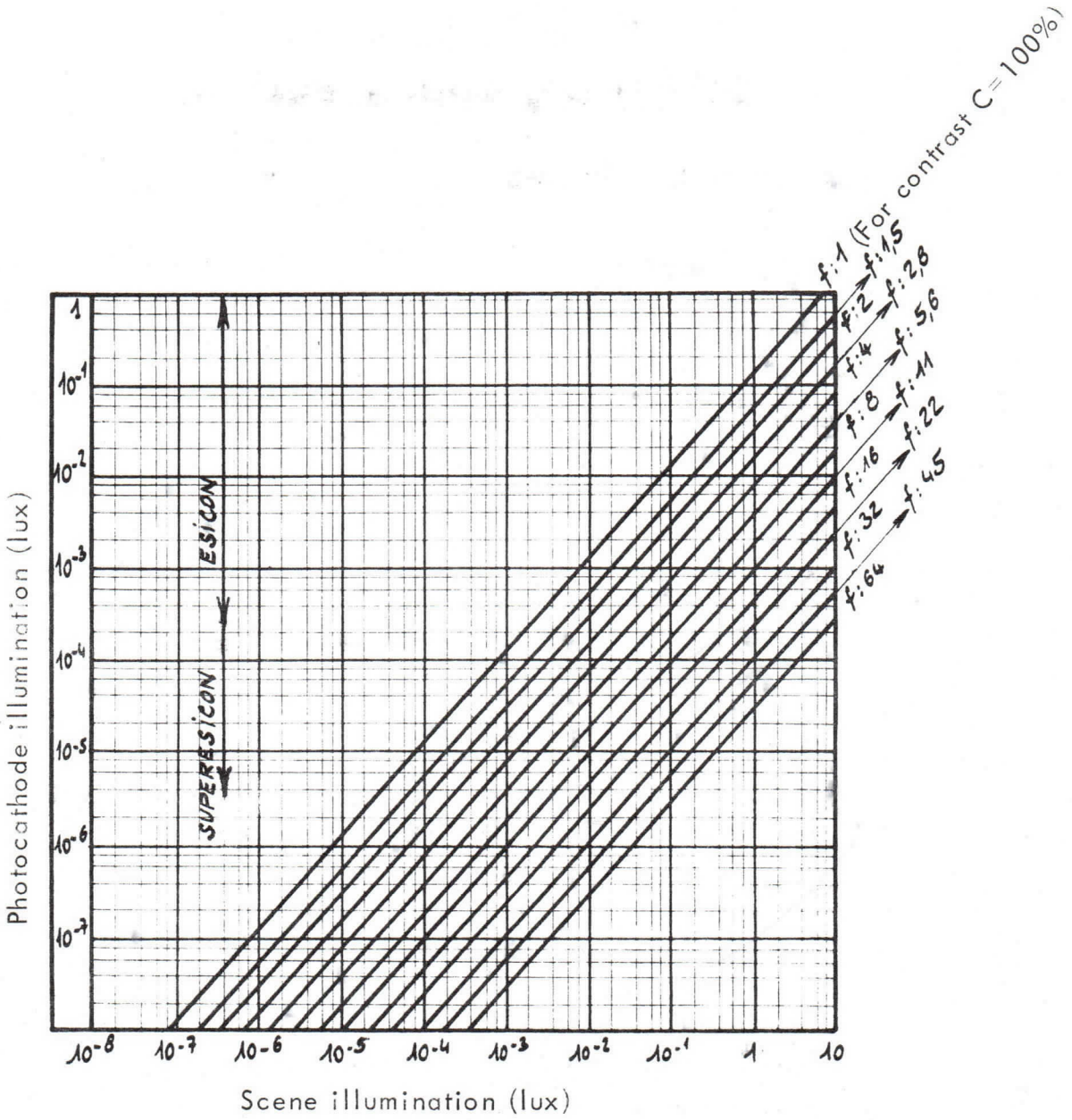


FIG. 9

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

CHART FOR LOW LIGHT LEVEL TELEVISION



Note : This chart assumes a transmission coefficient of the optical system of 80% and a scene reflection coefficient of 60% (m is neglected)

FIG. 10

TH X538 - TH X540
ESICON et SUPER-ESICON
Tubes de cameras
pour télévision à bas niveau de lumière

Cette présente note expose les caractéristiques principales des tubes de caméras Esicon et Super-Esicon, tubes particulièrement adaptés à la Télévision à faible niveau de lumière. Le Super-Esicon est dérivé de l'Esicon par adjonction d'une section intensificatrice d'image. Le modèle standard possède une photocathode dont la réponse est adaptée à l'éclairement résiduel du ciel nocturne. D'autres modèles peuvent présenter une réponse spectrale différente, les rendant plus aptes à des fonctions particulières telles la détection de l'UV ou du proche infra-rouge (anti-camouflage).

Aux très faibles niveaux lumineux, la résolution d'image étant limitée par l'insuffisance de photons reçus pour chaque élément d'image, il est possible d'accroître la qualité du signal (réduction de la fluctuation quantique) par intégration de plusieurs trames successives, en réduisant la cadence image d'examen. Cette possibilité est offerte par l'Esicon qui présente cependant l'intérêt d'une très faible persistance aux bas niveaux. Cette dernière propriété est fondamentale pour l'examen de scènes mobiles telles que rencontrées en reconnaissance aérienne. Une propriété majeure de l'Esicon est son comportement satisfaisant en présence de sources locales ou générales très lumineuses, comportement ne nécessitant qu'une électronique de caméra simple, tout en autorisant, pour le tube seul, une dynamique de 10 000/1.

Cette note est divisée en 5 paragraphes traitant de l'Esicon et du Super-Esicon :

1. Introduction
2. Définition des tubes Esicon et Super-Esicon
3. Principe de fonctionnement
4. Caractéristiques générales de l'Esicon
5. Caractéristiques générales du Super-Esicon.

L'annexe jointe fournit quelques informations générales sur les problèmes rencontrés pour la vision ou télévision à faible niveau de lumière.

A1. Caractéristiques générales de la vision nocturne
A2. Dispositifs de détection photoélectriques
A3. Description sommaire des divers tubes de prises de vues à bas niveau
A4. Principaux problèmes de conception d'un système de détection d'image à bas niveau lumineux.

1 - INTRODUCTION

Pendant longtemps, la prise de vues de télévision à bas niveau de lumière a été limitée à la retransmission de scènes extérieures par temps sombre de journée d'hiver. La nécessité de reculer cette limite et d'effectuer des prises de vues nocturnes aux fins, notamment, de surveillance, s'impose de plus en plus pour la réalisation de systèmes divers.

Si des progrès ont pu être réalisés ces dernières années dans la conception des amplificateurs à vidéo-fréquence (augmentation du gain pour un même niveau de bruit), ils ne permettent pas, malgré tout, d'envisager systématiquement une telle application avec les tubes Vidicon et Image-Orthicon.

Un équipement de prise de vues pour la détection et la reconnaissance d'éléments de scènes nocturnes doit satisfaire un certain nombre de critères pour être réellement opérationnel :

- Sensibilité globale élevée dans le domaine visible et le proche infra-rouge.
- Bon rapport signal/bruit et bonne résolution.
- Dynamique très large de bon fonctionnement, sans destabilisation, même partielle, de l'image.
- Réponse rapide pour l'observation des éléments mobiles.
- Fonctionnement simple et fiable.
- Encombrement et consommation électrique faibles.

L'Esicon, un tube de prise de vues de conception récente, permet de réaliser des équipements satisfaisant à chacun de ces critères et constitue donc une solution de choix pour une telle application.

2 - DEFINITION DES TUBES ESICON TH X538 ET SUPER-ESICON TH X540

2.1. ESICON (Fig. 5)

Le tube TH X538 est un tube de prise de vues possédant une photocathode de grande sensibilité de 25 mm de diamètre utile, une cible à émission secondaire à grand gain et un canon d'analyse du type Vidicon.

Il se caractérise par une grande sensibilité, un bon pouvoir de résolution, une faible rémanence ou persistance d'image et une grande simplicité d'utilisation.

Son trait dominant est l'utilisation d'une cible multiplicatrice des photo-électrons à émission secondaire élevée qui lui confère d'excellentes propriétés d'accumulation et d'intégration des charges, et permet la transformation de ces charges en signal vidéo en un seul balayage de chaque élément par le faisceau d'analyse. Le phénomène d'émission secondaire est par ailleurs, pratiquement linéaire et sans inertie.

Ces propriétés permettent de faire fonctionner le tube dans une large gamme d'éclairements et contribuent à un excellent pouvoir de détection et de reconnaissance d'éléments mobiles ou fixes. La présence de régions de scène de luminance suffisante pour causer une saturation du signal ne produit pas, par ailleurs, de halo et n'empêche pas l'observation du reste de la scène.

Son fonctionnement ne nécessite qu'une faible puissance de balayage et permet d'utiliser les accessoires classiques de Vidicon. Une haute tension de 12 kV max., de débit très faible, est utilisée pour accélérer les électrons de la photocathode et un asservissement de cette tension au signal vidéo permet de réduire la sensibilité du tube et d'augmenter ainsi la dynamique d'utilisation.

Ce tube a été conçu pour les applications de la télévision à bas niveau de lumière et permet la réalisation d'une caméra fournissant une image de bonne qualité pour des niveaux d'éclairement de scène de 10^{-3} à 1 lux.

2.2. SUPER-ESICON (Fig. 7)

Pour les applications nécessitant une très grande sensibilité, il est possible d'utiliser un étage d'intensification supplémentaire sous la forme d'un intensificateur d'images TH 9473. Le couplage est alors réalisé simplement par juxtaposition mécanique : cet intensificateur comporte, en effet, une glace de sortie à fibres optiques, et l'Esicon une glace à fibres optiques d'entrée. Le tube de prise de vues ainsi réalisé est dénommé Super-Esicon TH X540.

Il possède toutes les qualités du tube Esicon et une sensibilité environ 50 fois plus élevée pour un champ d'entrée identique, 25 mm. Ce tube permet de réaliser une caméra adaptée aux prises de vues nocturnes, dans presque toutes les conditions rencontrées dans ce type d'application : éclairement de $5\ 10^{-5}$ à 10^{-2} lux. La caméra peut être celle utilisée pour l'Esicon standard à laquelle un élément modulaire supplémentaire est adjoint pour l'alimentation de l'intensificateur. L'utilisation des asservissements permet enfin une dynamique totale d'utilisation de 10 000/1 sans retoucher aucun réglage.

3 – PRINCIPE DE FONCTIONNEMENT

Le principe du tube Esicon est schématisé sur la figure 1 : l'image fournie par l'objectif est focalisée sur la face plane à fibres optiques d'entrée du tube et transmise sur la photocathode intérieure déposée sur une face concave. Les photoélectrons émis par la photocathode, proportionnellement à la lumière reçue, sont accélérés et focalisés sur la cible par la lentille électrostatique constituée par la photocathode et une anode cônique.

La cible, constituée par un diélectrique à coefficient d'émission secondaire élevé est déposée sur une électrode métallique mince servant d'électrode de signal. Les photoélectrons accélérés sous environ 10 kV cèdent leur énergie en arrachant les électrons du matériau de cible, ces électrons étant captés par l'électrode de signal. La partie libre de la cible, vue par le canon à électrons, se charge ainsi proportionnellement aux flux de photo-électrons reçus, le potentiel étant d'autant plus positif que la photocathode d'entrée est éclairée.

Le passage périodique du faisceau d'électrons d'analyse créé par le canon situé à l'opposé permet de restabiliser la cible au potentiel de la cathode par neutralisation de ces charges par des électrons. L'impulsion de courant qui en résulte constitue le signal vidéo qui apparaît capacitivement dans le circuit de l'électrode de signal.

La très grande résistivité de la cible, due à la nature du matériau en profondeur et en surface permet de conserver intacte, pendant un temps long, la distribution spatiale des charges. Elle contribue, également, à l'obtention d'un courant de signal pratiquement nul dans l'obscurité, et par conséquent, à l'existence d'un niveau de noir stable et uniforme, qui facilite l'observation des très faibles contrastes d'image dans les scènes observées.

Une grille suppresseuse est disposée devant la cible du côté du canon. Elle a pour but de limiter le potentiel atteint par la cible à celui qui lui est appliquée : Il est réglé à une valeur légèrement inférieure au potentiel dit de : "cross-over" du matériau, ce qui permet d'éviter toute déstabilisation qui pourrait être provoquée par un éclairement local ou général trop intense de la photocathode d'entrée.

4 - CARACTERISTIQUES GENERALES DE L'ESICON

4.1. REPONSE SPECTRALE ET SENSIBILITE :

Suivant l'application recherchée, on peut réaliser différents types de photocathodes. La plus fréquemment utilisée est la photocathode S20 dont la courbe de réponse spectrale typique est représentée sur la figure 2. La valeur maximale d'efficacité quantique est de 15 à 20 % et la longueur d'onde correspondante est comprise entre 420 et 460 nm. La grande efficacité quantique de la photocathode S20, combinée au gain élevé de la cible permet d'obtenir une sensibilité de l'ordre de 15 000 µA/lumen, soit environ 5 µA/lux (surface éclairée = 3 cm^2.) Pour certaines applications, la cathode S1 sensible dans le proche infrarouge peut être préférée (détection de camouflage).

4.2. CARACTERISTIQUE SIGNAL-ECLAIREMENT :

La caractéristique signal-éclairement est tracée sur la figure 3 (a). Le gamma du tube est égal à 1 pour les niveaux lumineux inférieurs à 10^{-2} lux et décroît jusqu'à 0,6 environ au-dessus de 10^{-1} lux. Lorsque l'éclairement augmente, il existe une saturation du signal déterminée par la valeur du potentiel de la grille g5. Un éclairement trop intense peut causer une perte de gain momentanée, voire une brûlure de la cible, et il est conseillé, en fonctionnement normal, de ne pas dépasser les éclairements indiqués sur la courbe de la figure 4. L'asservissement de la tension de photocathode au courant de signal peut permettre de diminuer, malgré tout, cet effet de brûlage.

4.3. RESOLUTION ET TRANSFERT DE MODULATION :

La courbe de transfert de modulation pour une mire de signaux carrés à 100 % de contraste est donnée sur la figure 3 (b). Les valeurs de contraste sont de l'ordre de 60 % pour 200 lignes TV et 20 % pour 400 lignes TV. La résolution limite du tube se situe approximativement à 20 pl/mm, ce qui correspond à 600 lignes TV (800 points par ligne).

La résolution varie peu avec la tension cible et la tension de photocathode si celles-ci ne descendent pas respectivement en-dessous de 5 V et de 4 kV, ce qui permet de réaliser des asservissements par commande automatique du gain, sans diminuer la résolution.

Sur la figure 4 (a) est représentée la variation de la résolution limite en fonction de l'éclairement de la photocathode. La résolution varie de 550 lignes TV pour 0,1 lux à 100 lignes TV pour 2 10-4 lux.

4.4. PERSISTANCE D'IMAGE :

La persistance d'image de l'Esicon est très faible, comparée à celle de la plupart des autres tubes de prise de vues. Le signal résiduel, après passage du faisceau de lecture, est en général inférieur à 10 % de la valeur lue. Toutefois, la rémanence augmente un peu aux très faibles niveaux lumineux par suite de l'acceptation incomplète du faisceau de lecture par la couche (figure 3 (d)).

4.5. INTEGRATION ET MEMOIRE :

La très grande résistivité de la cible Esicon permet d'intégrer un signal pendant plusieurs minutes sans que l'image soit dégradée par des courants de fuite. La réciprocité temps d'exposition-lumière est bien vérifiée et sur certains tubes, on peut intégrer un signal pendant 20 minutes. Une intégration de 60s accroît la sensibilité de détection d'un facteur 1500.

Cette intégration peut être réalisée automatiquement à l'aide d'un dispositif électronique simple. Pour l'examen d'objets peu mobiles, on peut se satisfaire d'une cadence image de 1 à 4 images par seconde, ce qui permet un gain de sensibilité (ou de rapport signal/bruit) de 25 à 6. Afin d'éviter un effet de papillotement, l'image est affichée sur un récepteur équipé d'un tube cathodique rémanent ou d'un tube à entretien d'image.

4.6. NIVEAU LUMINEUX MAXIMAL :

La courbe de la figure 4 (b) indique la limite d'éclairement à ne pas dépasser pour un temps d'exposition donné. Cette limite dépend aussi de la tension de photocathode : lorsque la tension diminue, la courbe se déplace vers le haut.

Si l'énergie dissipée dans la cible est trop grande, il en résulte plusieurs phénomènes : apparition d'une image négative, perte de gain momentanée, voire brûlure permanente de la couche. Il est donc conseillé de ne pas dépasser les niveaux d'éclairements maximaux, quoique, dans la plupart des cas, le tube récupère quand même ses propriétés après un léger dépassement des valeurs indiquées.

4.7. ENVIRONNEMENT ET DUREE DE VIE :

Le tube fonctionne entre -30 °C et +50 °C sans que ses performances soient considérablement modifiées. La structure du tube a été particulièrement étudiée pour offrir une bonne résistance aux chocs et aux vibrations mécaniques. Toutefois, des précautions dans la conception de la tête de la caméra sont nécessaires pour limiter les signaux parasites dus à des vibrations internes du tube. La figure 5 représentenles caractéristiques dimensionnelles du tube.

Dans des conditions normales d'exploitation, une durée de vie de plusieurs milliers d'heures peut être escomptée sans modification importante des caractéristiques.

5 - CARACTERISTIQUES GENERALES DU SUPER ESICON TH X540

En couplant un intensificateur d'image du type TH 9473 avec un tube Esicon TH X 538 de champ d'entrée 25 mm, on obtient un tube de prise de vues 20 à 50 fois plus sensible que l'Esicon seul, tout en conservant les qualités de l'Esicon. La figure 7 représente le schéma du Super-Esicon. La liaison optique entre les deux éléments est réalisée par les optiques à fibres de l'intensificateur et de l'Esicon. Le couplage mécanique est obtenu au moyen d'un système mécanique simple qui assure à l'ensemble une bonne rigidité.

La tension de fonctionnement est de 25 kV, répartie en 15 kV sur l'intensificateur et 10 kV sur l'Esicon. Le générateur de très haute tension peut se présenter sous la forme d'éléments modulaires dont l'encombrement est minime car les puissances mises en jeu sont finalement très faibles. Un autre mode de couplage par lame à fibres optiques additionnelle permet de réduire la tension d'alimentation totale à 15 kV.

5.1. - REPONSE SPECTRALE :

La photocathode d'entrée, qui est celle de l'intensificateur, est, en général, du type S20, ou mieux, S25, à réponse spectrale étendue dans le proche infra-rouge (voir la figure 2). Une telle photocathode a une sensibilité en lumière blanche (2870° K) supérieure à 175 µA/lumen.

5.2. CARACTERISTIQUE SIGNAL-ECLAIREMENT :

La courbe donnant le courant de cible en fonction de l'éclairement de la photocathode est présentée sur la figure 6 (a). Le gamma du tube passe de 1 pour les plus bas niveaux lumineux à 0,6 entre 10^{-4} et 10^{-3} lux. Il est possible, en combinant les asservissements de tension-cible, de tension de photocathode et de courant de faisceau, de couvrir une dynamique d'éclairement de l'ordre de 10.000.

5.3. RESOLUTION ET TRANSFERT DE MODULATION :

La résolution à courant de signal identique est légèrement inférieure à celle du tube Esicon, par suite des pertes inévitables dues au couplage de l'intensificateur et de l'Esicon. Par contre, aux faibles niveaux de l'éclairement, le pouvoir de résolution du Super-Esicon est plus élevé. Les valeurs typiques de résolution sont 500 lignes TV à 10^{-3} lux et 100 lignes TV et 3 10^{-6} lux. La courbe de la figure 6 (b) donne la résolution d'image en fonction du nombre de lignes TV pour une mire à signaux carrés de fort contraste.

5.4. PERSISTANCE D'IMAGE :

La persistance d'image est analogue à celle de l'Esicon seul (voir la figure 3 (d). Les faibles valeurs de rémanence confèrent à l'Esicon et au Super-Esicon de bonnes qualités de résolution pour les objets mobiles.

5.5. INTEGRATION ET MEMOIRE :

Il est possible, comme dans l'Esicon, d'intégrer un signal lumineux pendant plusieurs minutes et de le lire quelques heures après avoir coupé la haute tension. Les limites d'intégration proviennent du courant d'obscurité de l'intensificateur, de la section de transfert de l'Esicon et des faibles éclairements de la cathode du canon. Lorsque le bruit photonique est trop important, il peut être intéressant de réduire le gain du tube en diminuant la haute tension et de travailler avec des temps d'intégration plus longs.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

5.6. NIVEAUX LUMINEUX MAXIMUM :

La courbe 6 (d) de la figure 6 indique, en fonction du temps d'exposition, l'éclairement maximum que le tube peut tolérer en fonctionnement normal. Un léger dépassement entraîne une perte de gain, toutefois, le tube récupère généralement ses propriétés au bout de quelques minutes.

5.7. ENVIRONNEMENT ET DUREE DE VIE :

Le tube Super-Esicon fonctionne correctement entre -30 °C et +50 °C. Le Super-Esicon est robuste et résiste bien aux chocs et aux vibrations mécaniques. Les têtes de caméra doivent cependant être construites de manière à limiter les vibrations susceptibles de causer des phénomènes de microphonie.

ANNEXE

La télévision à bas niveau de lumière

A1 - CARACTERISTIQUES GENERALES DE LA VISION NOCTURNE :

L'oeil humain peut discerner des objets fortement constratés avec un niveau de lumière de l'ordre de 10^{-4} lux. Lorsque l'éclairement est de $2\ 10^{-1}$ lux, c'est le cas de l'éclairement fourni par la pleine lune, la vision s'améliore et il devient possible de lire, par exemple, les gros titres d'un journal, mais le seuil de détection des couleurs n'est pas encore atteint, Vers 100 lux, ce qui correspond probablement à l'éclairement de cette feuille de papier, l'acuité visuelle devient optimale.

En bref, on peut considérer qu'en-dessous de 1 lux, l'oeil humain perd une grande partie de son pouvoir de résolution et ne peut plus discerner les couleurs.

Il existe d'autres limites, reliées à la longueur d'onde des radiations lumineuses : l'oeil ne peut saisir qu'une partie très étroite du spectre électromagnétique comprise entre les longueurs d'onde 0,4 µ et 0,8 µ. Ce point a son importance : en effet, les radiations émises par le ciel nocturne sont principalement réparties dans le rouge et l'infra-rouge (figure 8). De plus, ce phénomène de décalage vers l'infra-rouge est accentué par la variation du coefficient de réflexion avec la longueur d'onde de nombreux objets (figure 9).

De ces faits, il résulte que l'utilisation de dispositifs de détection présentant une meilleure sensibilité et une réponse spectrale mieux adaptée que celle de l'oeil est très intéressante et permet une visualisation des contrastes en renforçant la luminance de l'image à des niveaux où l'oeil présente un bon pouvoir de résolution et par conséquent, une bonne détectabilité d'éléments d'image. L'oeil réagit à l'arrivée d'un minimum de 50 photons. Ceci correspond à une efficacité quantique de 0,02. Or, l'ordre de grandeur de l'efficacité quantique d'une bonne photocathode est 0,1, d'où un gain de l'ordre de 5. D'autre part, les photoélectrons émis peuvent être multipliés par utilisation du phénomène d'émission secondaire.

TABLEAU n°1 - ILLUMINATION DE SCENE EN FONCTION DES CONDITIONS D'AMBIANCE

Conditions d'ambiance	Illumination de scène (lux)
Pleine lune - ciel clair	$2.\ 10^{-1}$
Demi-lune - ciel clair	10^{-1}
Pleine lune - ciel modérément nuageux	$4.\ 10^{-2}$
Quartier de lune - ciel clair	10^{-2}
Pas de lune - ciel clair	10^{-3}
Pas de lune - ciel modérément nuageux	$5.\ 10^{-4}$
Pas de lune - gros nuages	$2.\ 10^{-4}$

A2. DISPOSITIFS DE DETECTION PHOTOELECTRIQUE ET DESCRIPTION DES DIVERS TUBES DE PRISE DE VUE A BAS NIVEAU :

On peut diviser l'ensemble des dispositifs électroniques de détection à bas niveau de lumière en deux groupes :

1. - les intensificateurs d'images.
2. - Les tubes de prise de vue.

Selon les applications, un de ces dispositifs sera plus ou moins adapté. Cependant sauf conditions de poids, d'encombrement, de maniabilité, etc ...., il est évident que la seconde catégorie, qui permet l'utilisation de toutes les techniques de la télévision, présente un énorme intérêt (affichage à distance, affichage sur écrans multiples . . .).

Parmi les principaux dispositifs de prise de vue envisageables, on peut citer : le tube image orthicon, l'isocon et l'ésicon. Les performances, du point de vue de la sensibilité, de ces trois tubes peuvent être améliorées par l'adjonction de tubes intensificateurs.

A3. DESCRIPTION SOMMAIRE DES DIVERS TUBES DE PRISES DE VUE A BAS NIVEAU :

Le principe de tous ces tubes est identique.

Un flux de photons est détecté par l'intermédiaire d'une photocathode, particulièrement bien adaptée (efficacité quantique, réponse spectrale) au problème de la vision nocturne. Cette photocathode est en général une S20 ou une S25 (figure 2).

Les photoélectrons émis sont transférés sur une cible avec une augmentation de leur énergie permettant l'émission des électrons secondaires. Il y a ainsi, multiplication au niveau de la cible du nombre de charges correspondant à N photons incidents, multiplication qui dépend du coefficient d'émission secondaire.

Dans les cas de l'image orthicon et de l'isocon, les électrons secondaires sortent de la cible et sont collectés sur une grille. Pour l'ésicon, les électrons secondaires se propagent dans les porosités d'une cible constituée par un matériau à fort coefficient d'émission secondaire.

Pour le tube image orthicon, la lecture de la répartition de charges sur la cible se fait à l'aide d'un faisceau électronique réfléchi par cette cible, et le courant est d'autant plus élevé que le niveau d'éclairement est faible. Le bruit dû à la fluctuation Schottky du courant est donc élevé dans ces conditions. Malgré les améliorations telles que le contrôle automatique du niveau du faisceau de lecture (à la charge électrique à lire), par l'intermédiaire de dispositifs électroniques complexes, ce problème n'a pas été bien résolu.

Le tube isocon cherche à contourner cette difficulté en utilisant, pour générer le signal vidéo, seulement la partie du faisceau qui a été diffusée (et non pas réfléchie) par la cible. Les performances du point de vue du bruit sont alors grandement améliorées mais le réglage du tube est extrêmement critique et conduit à un matériel peu opérationnel.

Dans le tube ésicon, le processus de lecture est tout autre. La lecture se fait par recharge de la capacité constituée par la cible de manière tout à fait analogue au procédé utilisé dans un tube Vidicon classique, et le courant vidéo est constitué par les électrons se déplaçant directement sur la cible.

A4. PRINCIPAUX PROBLEMES DE CONCEPTION D'UN SYSTEME DE DETECTION D'IMAGES A BAS NIVEAU LUMINEUX :

Il se pose, en général, deux sortes de problèmes :

1 - Problème de bruit

2 - Problème optique.

Problème du bruit :

La perception des éléments de scène est limitée par le bruit. L'Esicon a un bruit propre très faible et ce bruit est négligeable devant le bruit de l'amplificateur vidéo qui lui est associé. Avec un préamplificateur dont la bande passante est 7 MHz et dont le bruit efficace ramené à l'entrée est 2 nA, on peut obtenir, dans le cas d'un tube Esicon, un rapport signal/bruit maximum de 50, ce qui correspond à un rapport signal/bruit sur le plan visuel égal à 150 soit environ 43 dB.

Lorsqu'une sensibilité importante est atteinte, en particulier avec des intensificateurs d'image, la fluctuation photonique peut intervenir et limiter la détection des éléments de scène.

Problème optique :

Pour obtenir le meilleur rendement d'un tube de prise de vue nocturne, il est nécessaire de collecter le maximum de photons, et bien souvent, la résolution pratique de ce problème se ramène à des questions de prix et d'encombrement.

Si E_S est l'éclairement d'une scène, l'éclairement de la photocathode du tube est donné par :

$$Epc = \frac{B_S \; T}{4 f^2 \; (1+m)^2}$$

Avec $B_S = RE_S$, R étant le coefficient de réflexion de la scène,
T = coefficient de transmission du système optique utilisé ;
f = ouverture de l'objectif
m = grandissement.

Typiquement, on peut trouver : $Epc = 0,2\ B_S$ et si $R = 0,05$ (réflexion de l'eau de mer), $Epc = 10^{-2}\ Es$. On voit, dès lors, l'intérêt de l'intensificateur d'image placé devant le tube de prise de vue car avec un gain de 100, on compensera les pertes liées au faible coefficient de réflexion de la scène et au système optique. La figure 10 permet de relier l'éclairement de la photocathode à l'illumination de la scène pour diverses ouvertures et indique les zones d'utilisation de l'Esicon et du Super-Esicon.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

SCHEMA DE PRINCIPE DE L'ESICON

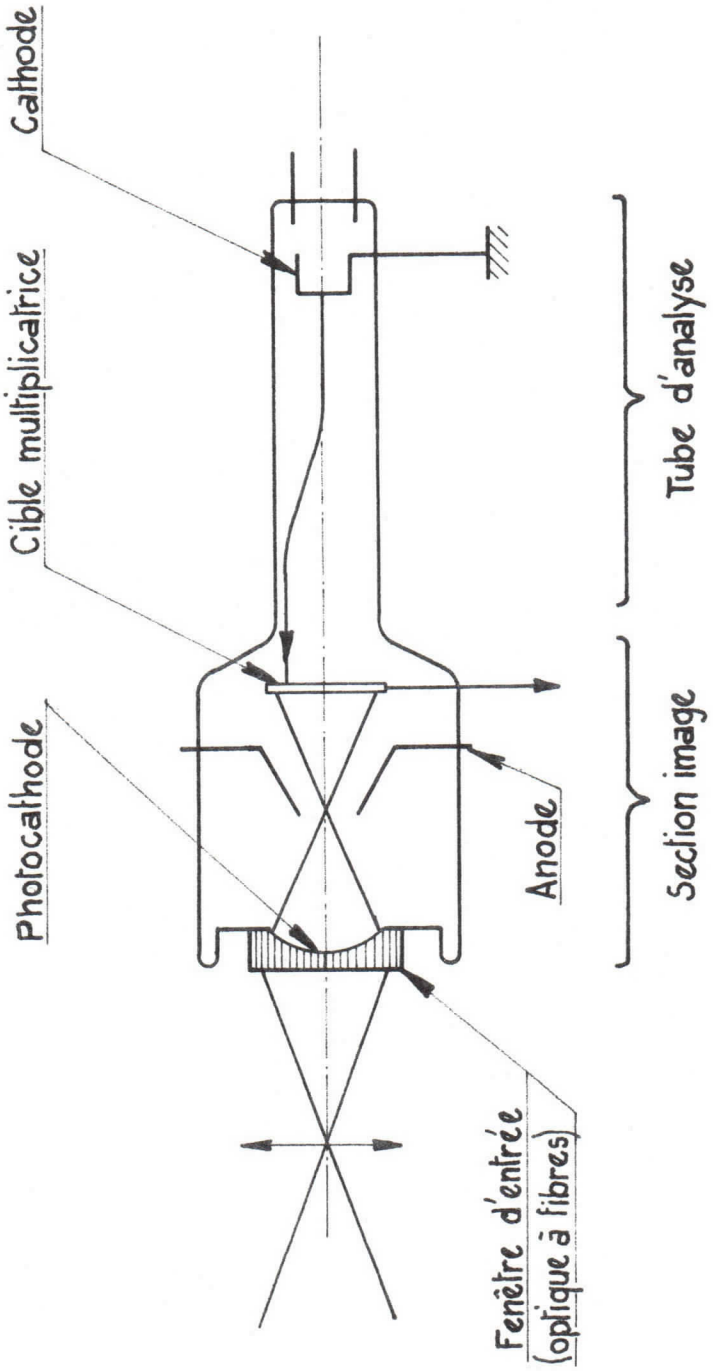


FIG. 1

REPONSES SPECTRALES TYPIQUES DE PHOTOCATHODE

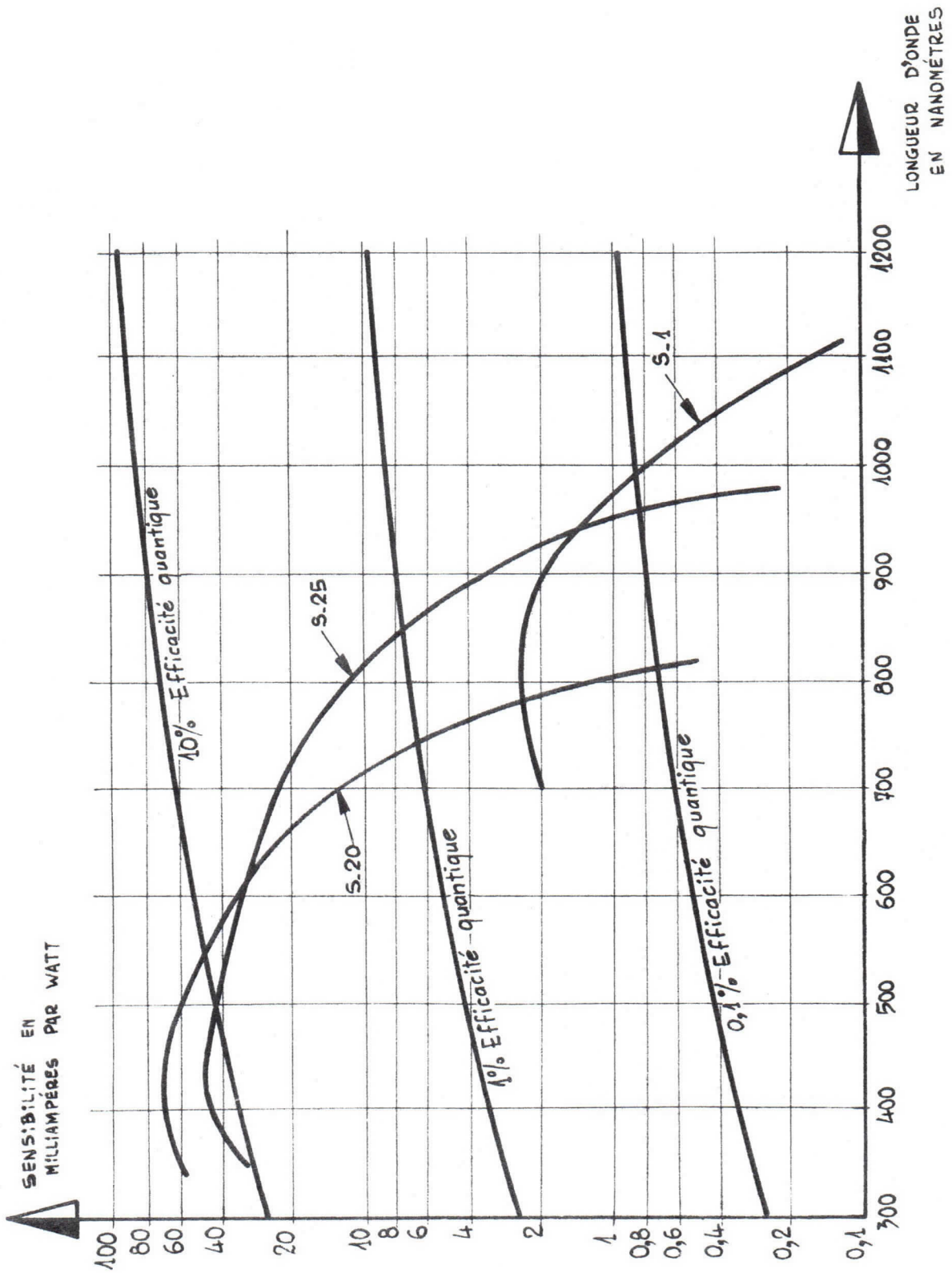
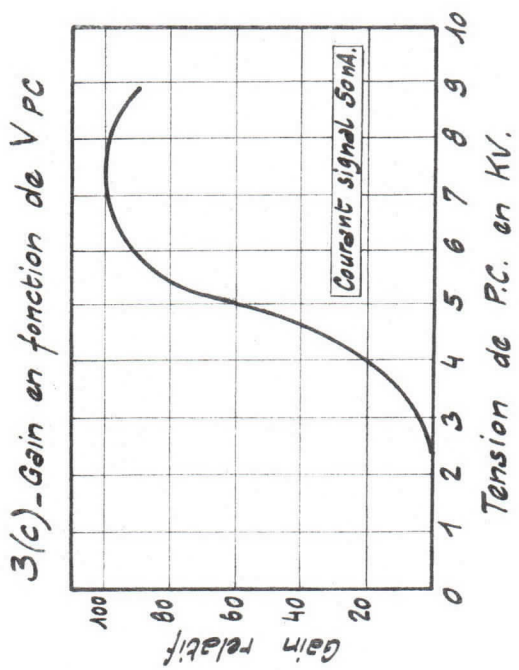
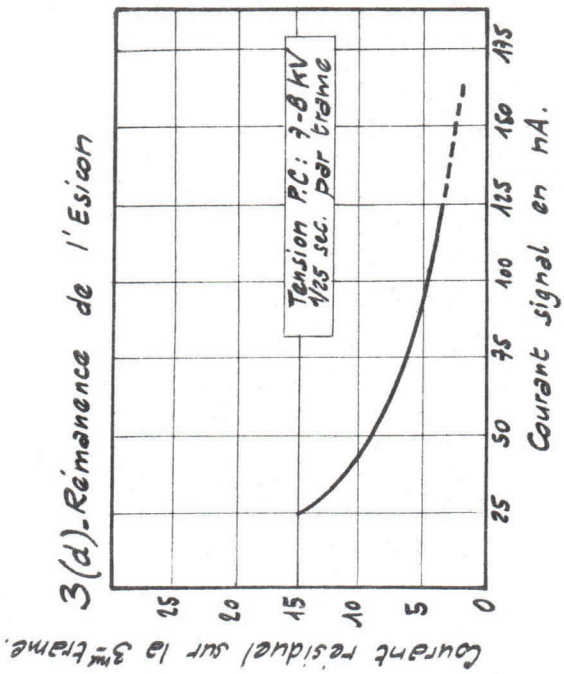


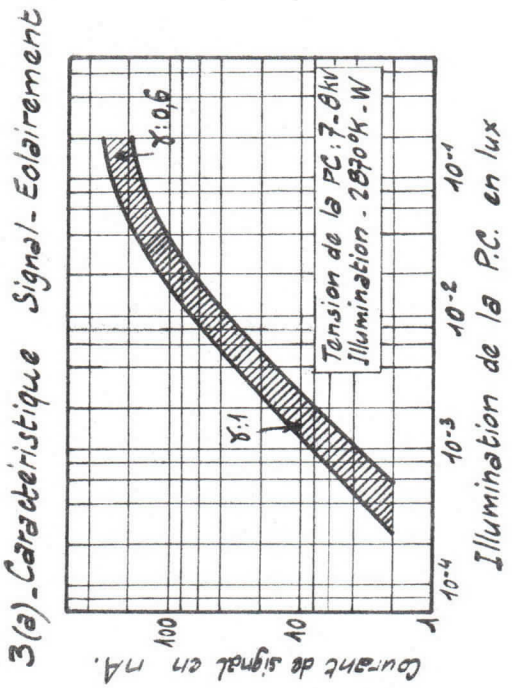
FIG.2

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PRINCIPALES CARACTERISTIQUES DU TUBE ESICON X538







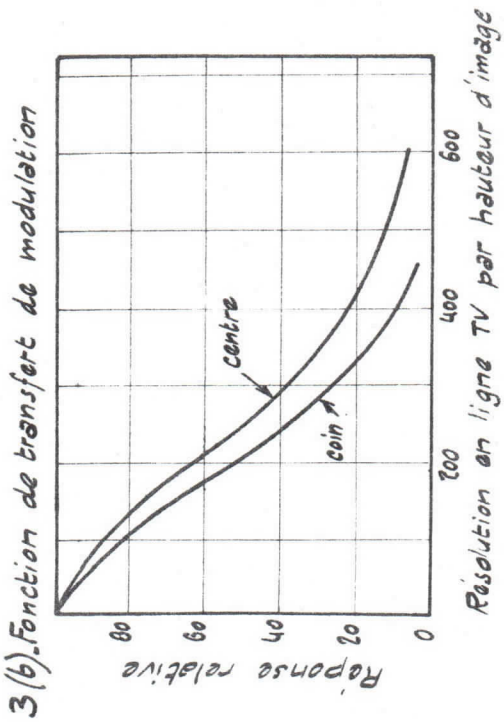
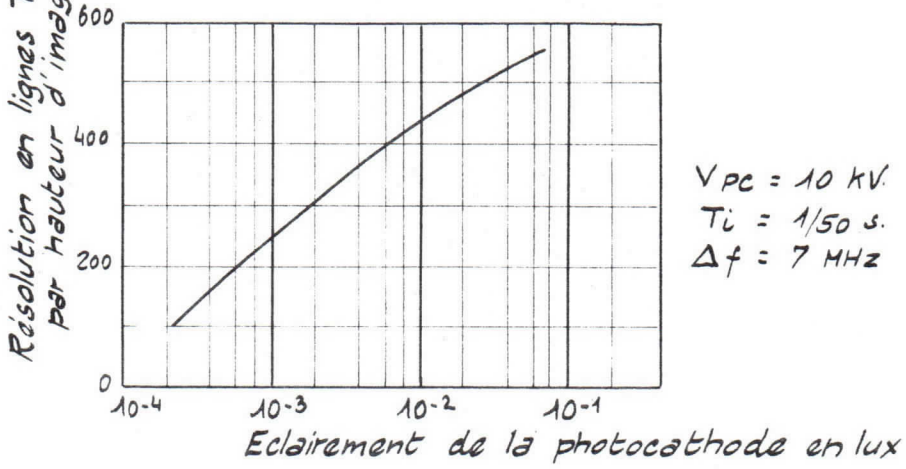


FIG.3

CARACTERISTIQUES DE L'ESICON X538

4(a) Résolution en fonction de l'éclairement



4(b) Niveau d'éclairement maximun en fonction du temps d'exposition

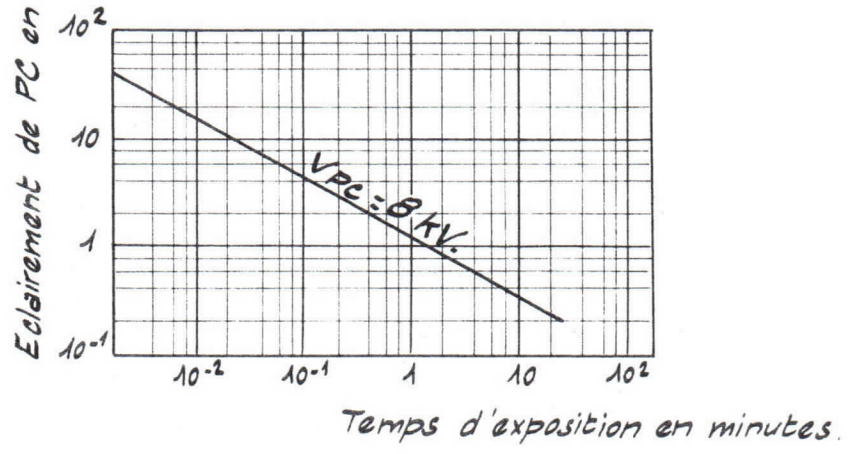


FIG.4

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

ENCOMBREMENT ESICON

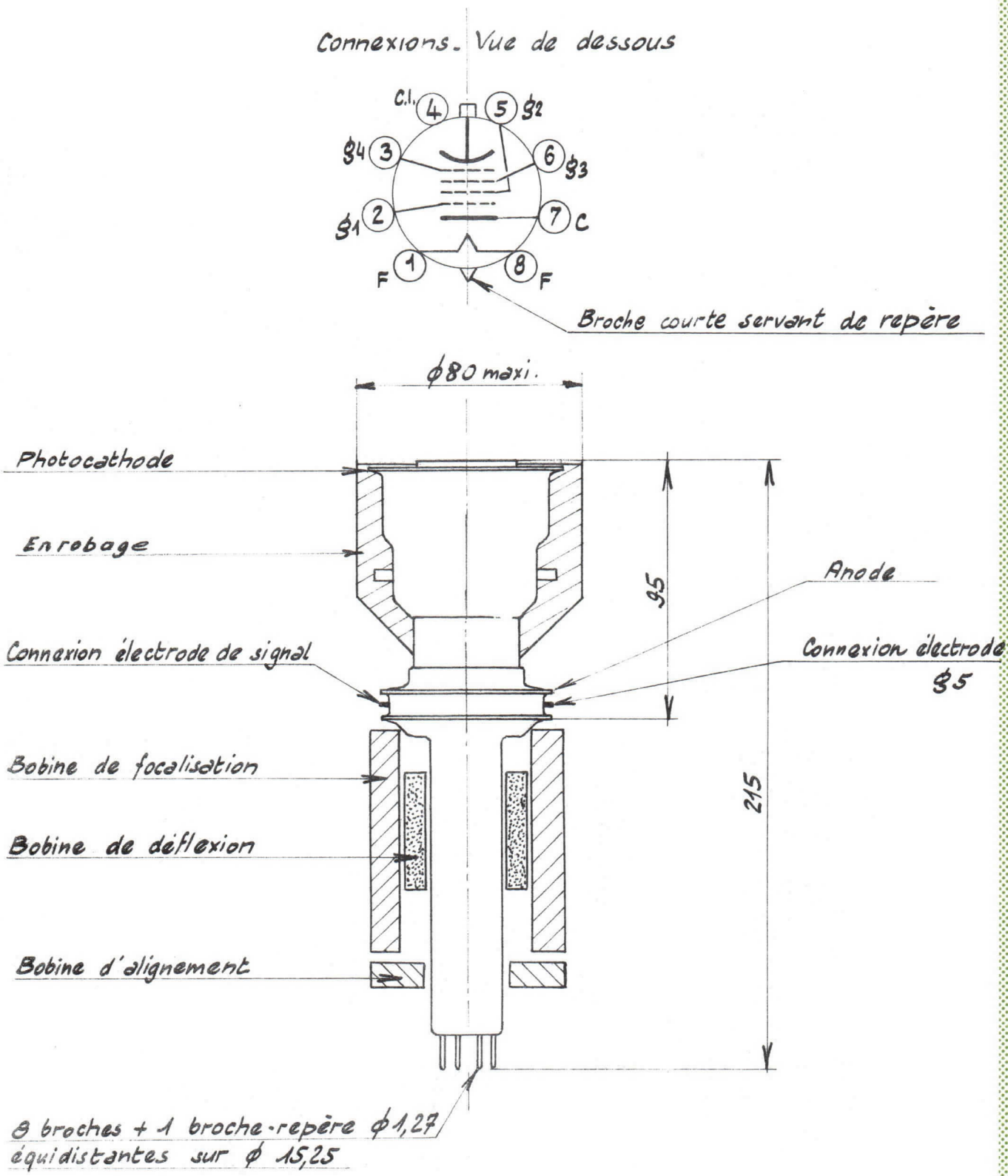


FIG.5

PRINCIPALES CARACTERISTIQUES DU TUBE SUPER-ESICON TH X540

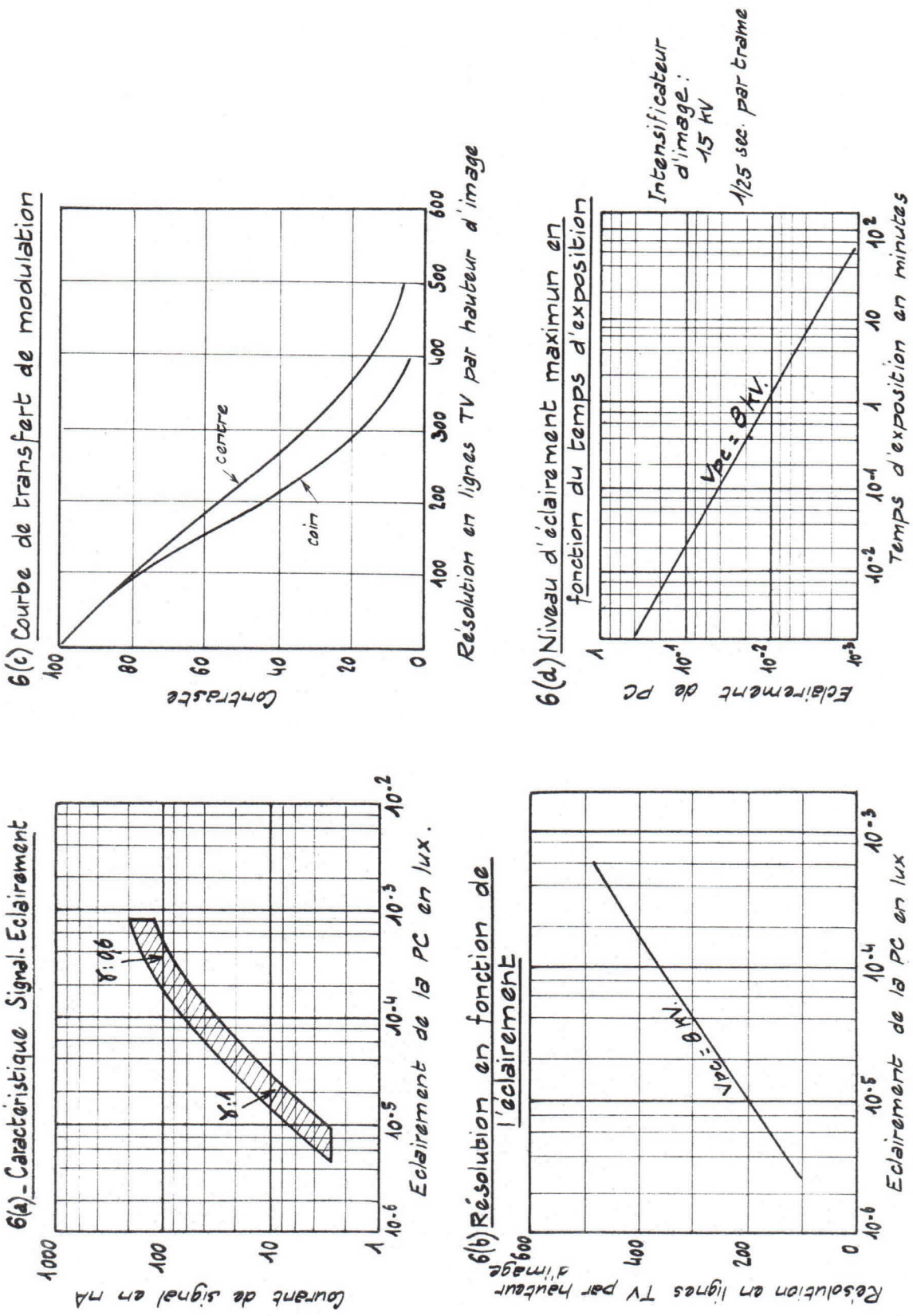
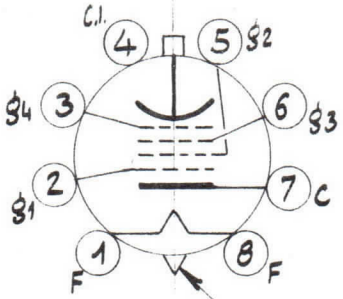


FIG. 6

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

ENCOMBREMENT TH X540

Connexions - Vue de dessous



Broche courte servant de repère

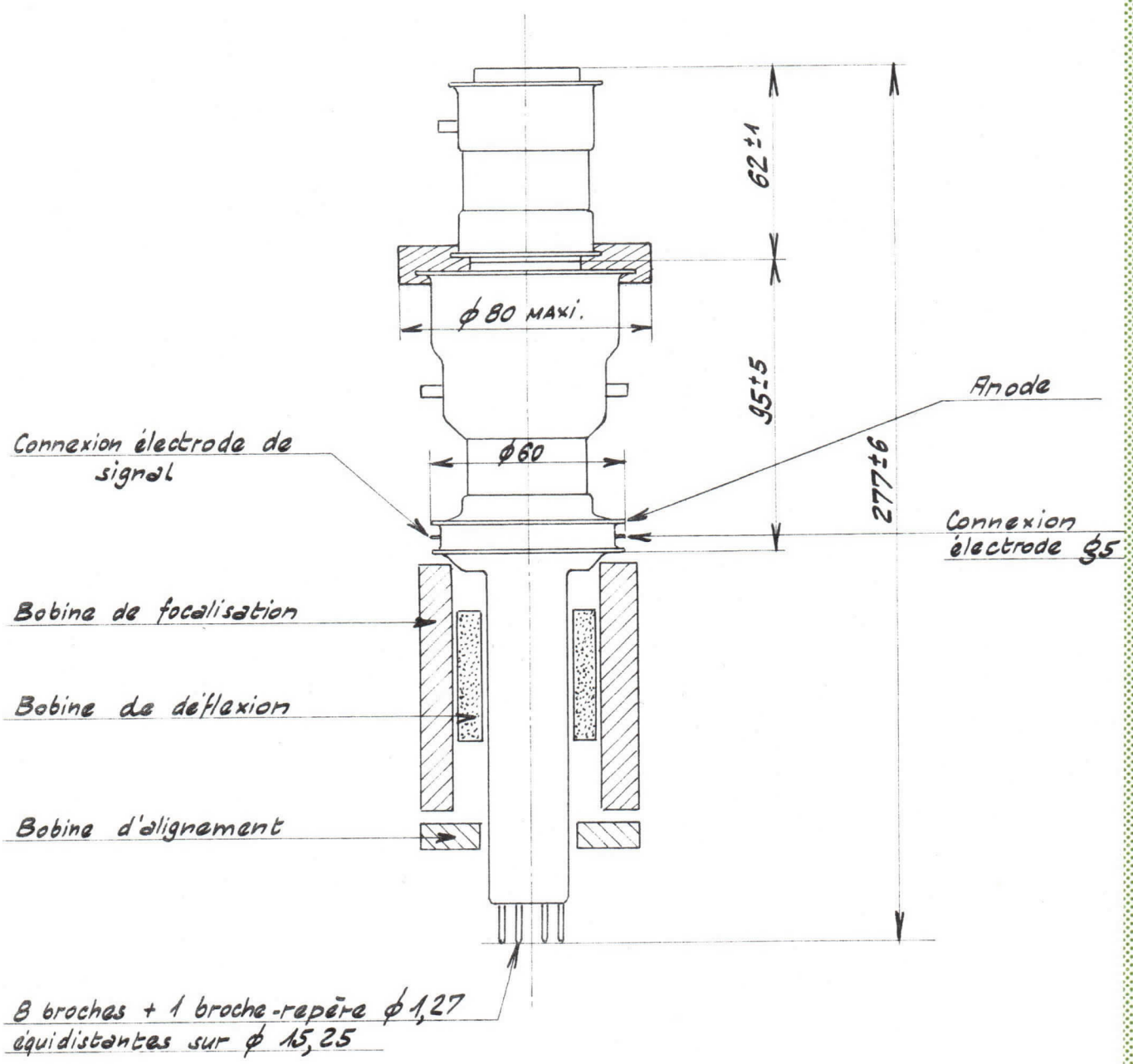


FIG.7

DISTRIBUTION SPECTRALE DE LA LUMIERE DU CIEL NOCTURNE

(Moyenne de 8 mesures)

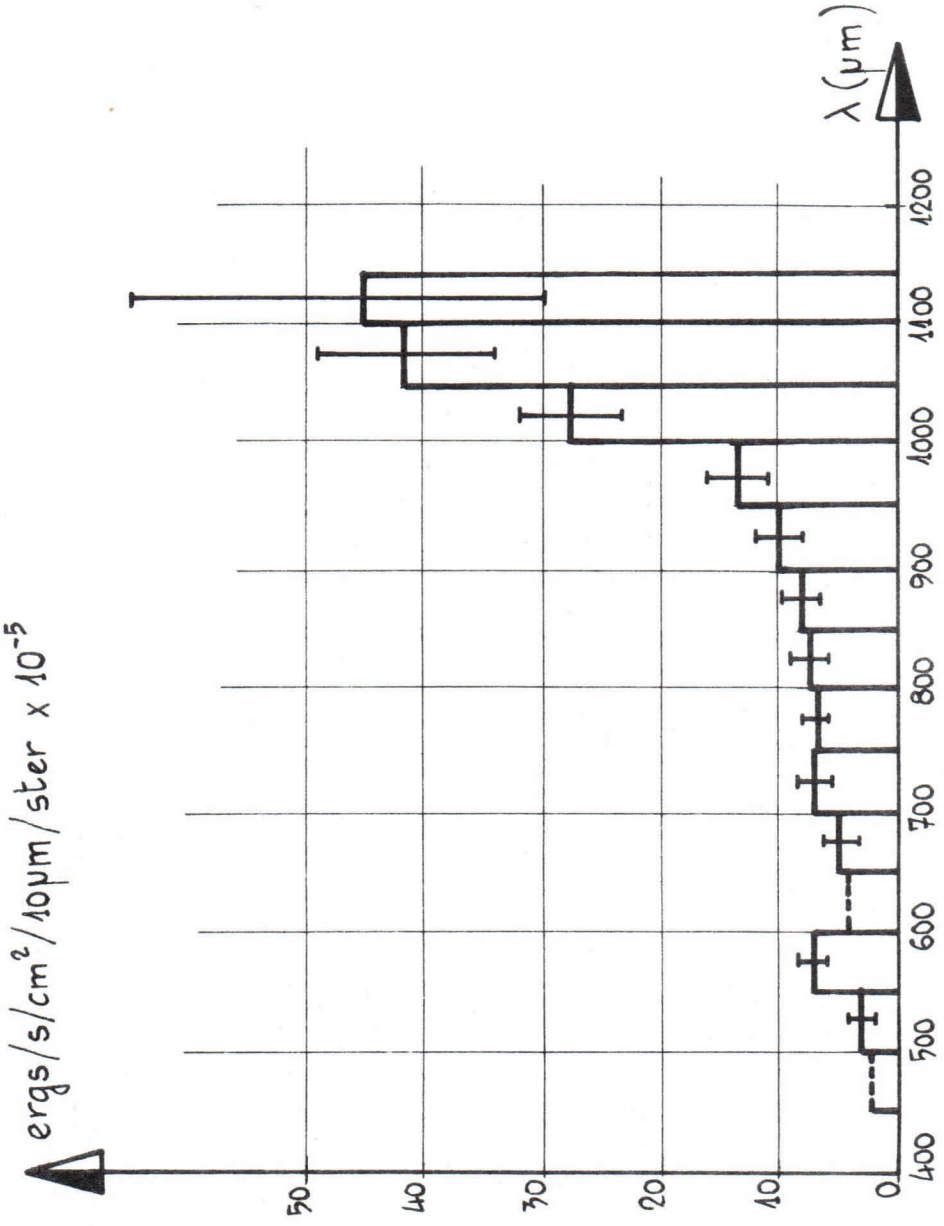


FIG.8

VARIATION DE LA REFLECTANCE AVEC LA LONGUEUR D'ONDE

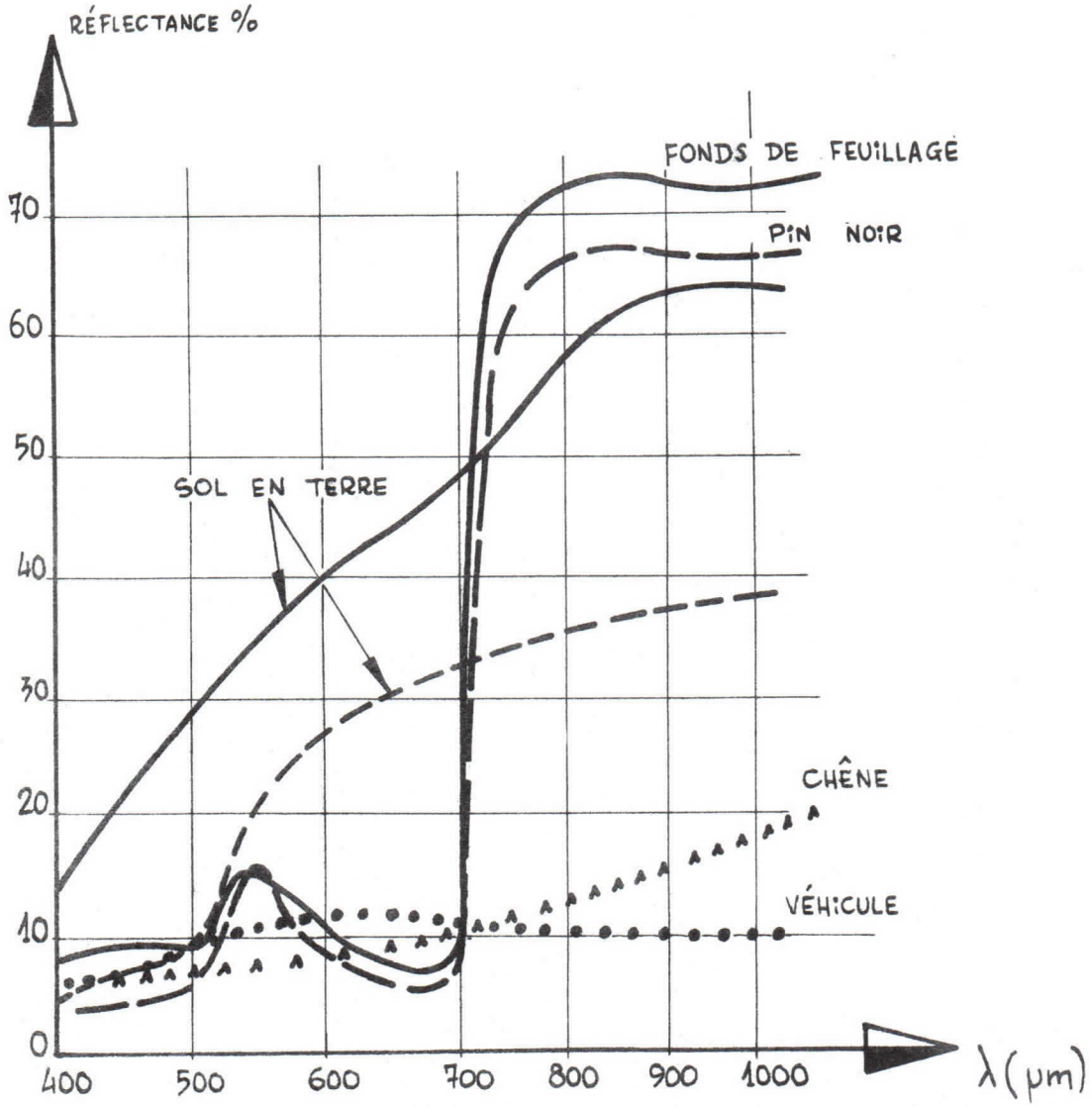
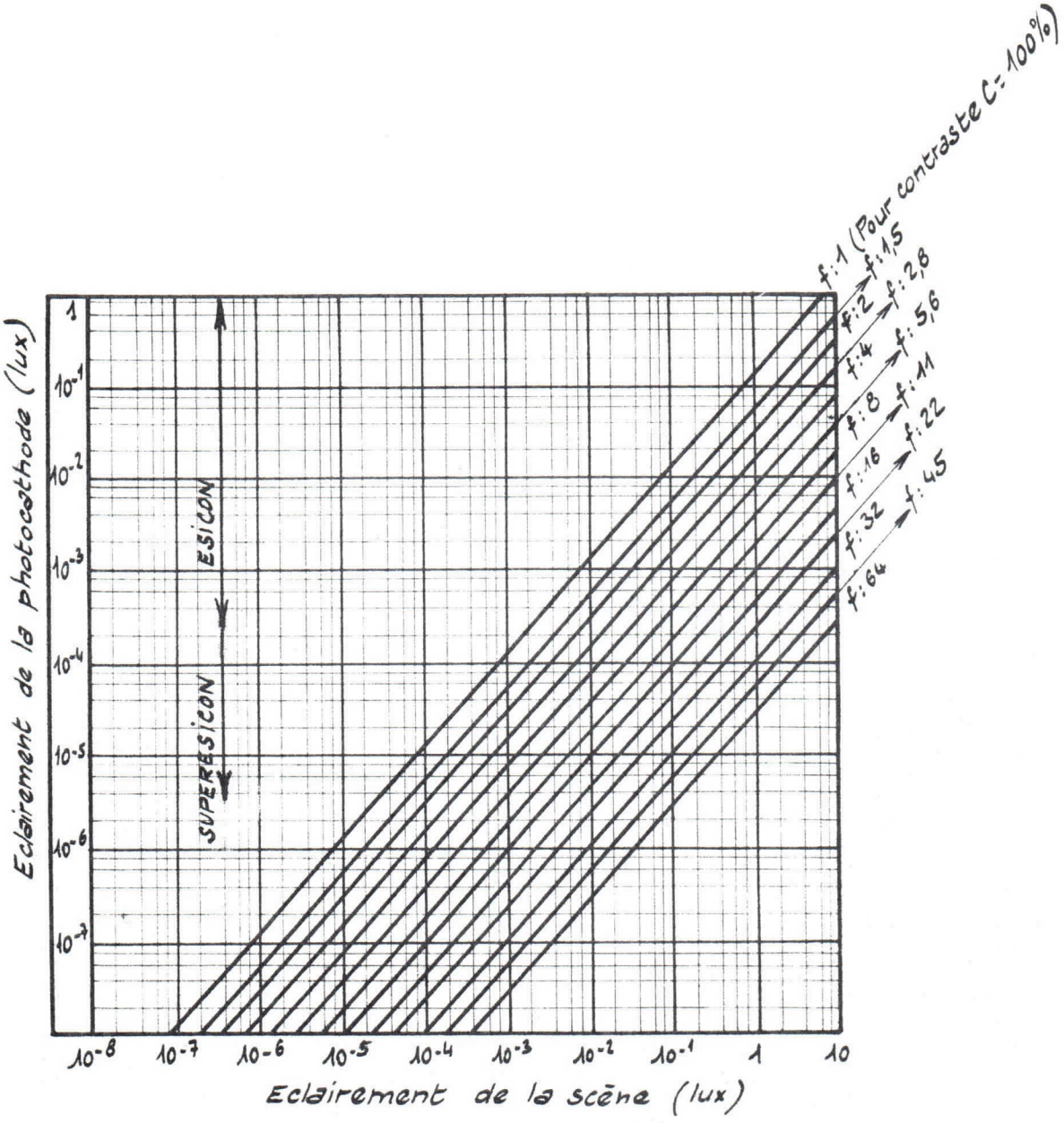


FIG.9

ABAQUE POUR TELEVISION A BAS NIVEAU DE LUMIERE



NOTE : Dans cet abaque, il est tenu compte d'une transmission de l'objectif de 80 % et d'un coefficient de réflexion de la scène de 60% (m est négligé).

FIG.10

THOMSON-CSF

GROUPEMENT TUBES ELECTRONIQUES

6914 (D 16)

INFRA-RED IMAGE CONVERTER TUBE

- SMALL SIZE
- ELECTROSTATIC SELF-FOCUSING
- MONOVOLTAGE
- HIGH RESOLUTION
- S 1 PHOTOCATHODE
- NIGHT VISION

The 6914 (D 16) is a monovoltage type, self-focusing image converter tube used in infra-red viewing system to convert near infra-red radiation to visible light.

The infra-red image is focused by means of an optical objective onto the photocathode of the tube which converts incident radiation into electrons. These electrons are electrostatically accelerated and focused onto the fluorescent screen and the image produced on the viewing screen may be viewed through an optical magnifier. The tube has a typical center resolution of 40 line pairs/mm and a typical peripheral resolution of 15 line pairs/mm.

The tube is self-focusing and requires only 16 kV high voltage supply.

Features of the 6914 include small size and weight, low power requirements, good shock and vibrations characteristics, making it very useful in portable equipments.

GENERAL CHARACTERISTICS

Mechanical

Operating position	any
Overall length	74. 4 mm
Greatest diameter	48 mm
Weight, approximate	105 g

Electrical

Focusing method	electrostatic
Nominal tube voltage	16 kV
Direct interelectrode capacitance, approximate	5 pF

Optical

Photocathode :	
- Type	S1
- Peak spectral response	800 ± 100 nm
- Limit spectral response	1200 nm
- Minimum useful diameter	25. 4 mm
Fluorescent screen :	
- Type	P 20 aluminized
- Minimum useful diameter	21. 8 mm
- Fluorescence	Yellow-green
- Phosphorescence	Yellow-green
- Persistence	Medium-short

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

MAXIMUM RATINGS

(Absolute values)

Anode voltage			
- continuous operation	max.	17 000	V
-	min.	10 000	V
- intermittent operation (max. duration 10 s)	max.	18 000	V
Photocathode current at nominal voltage (note 1)			
- average (continuous operation)	max.	0. 35	µA
- peak (intermittent operation) (note 2)	max.	3. 5	µA
Maximum allowed photocathode illumination level for I.R filtered (I.R.F.)			
- continuous operation	max.	10	lux
- intermittent operation (note 2)	max.	300	lux
Ambient temperature range (see operational instructions)			
- storage	max.	+ 68	°C
	min.	− 54	°C
- operating	max.	+ 50	°C
	min.	− 32	°C

OPERATING CHARACTERISTICS

Test conditions		
- Ambient temperature	20 ± 5	°C
- Anode voltage	16 000	V
- Anode circuit resistance	100	MΩ
- Color temperature of unfiltered radiation source	2854	°K

Performances	min.	typical	max.	
Conversion index (note 3)	15	30	-	
Conversion factor (note 4)	0. 6	1. 2	-	Cd/lm
Resolution (note 5)				
- at center	25	40	-	lp/mm
peripheral	12	15	-	lp/mm
Electronoptical magnification (note 6)				
- at center (note 7) Mc	0. 735	-	0. 785	
- peripheral (note 8) Mp	-	-	-	
Distortion (note 9)	8. 5	-	12. 5	%
Dark current	-	-	0. 02	µA
Back ground equivalent illumination (note 10)	-	0. 004	0. 025	lux I.R.F.

NOTES

1 - For the whole photocathode area.

2 - Assuming duration shorter than 2 mn and not repeated more than ten times during tube life.

3 - C.I. $= \frac{Fe}{Fi \cdot T}$ where.

Fe = total luminous flux in lumen emitted by the viewing screen.

Fi = unfiltered luminous flux (2854 °K tungsten lamp) in lumen, incident on the photocathode.

T = filter transmittance of infra-red standard filter (E.I.A.) CS 94 (Corning type n° 2540. Melt n° 1613) of 2. 61 mm thickness

4 - $L = \frac{Je}{Fi}$ where Je is the luminous intensity of the viewing screen.

5 - Center resolution : in a 1/6 useful minimum diameter concentric circle on photocathode.
Peripheral resolution : belween a 1/6 minimal useful diameter, and 1/2 useful minimum diameter concentric circles on photocathode.

6 - Magnification is defined as the ratio of the separation of the two image lines to the separation of corresponding object lines, the latter being located on a diameter and equidistant from the tube axis.

7 - Center magnification shall be measured with a separation of object lines of 1/6 of the useful minimum photocathode diameter.

8 - Peripheral magnification shall be measured with a separation of object lines of 4/5 of the useful minimum photocathode diameter.

9 - Percentage distortion shall be determired by the following formula

$$D = \frac{Mp - Mc}{Mc} \times 100$$

10 - This is the value of equivalent input illumination (I.R.F.) required to give an increase of luminance on the screen equal to the background luminance.

ENVIRONMENTAL TESTS

(in accordance with MIL - E - 1/1049 D)

The image converter 6914 is designed to withstand the following non operational, environmental tests. After completion of those tests tubes will meet the performances specified under operating characteristics.

Thermal test

The tube shall be subjected to a temperature cycling with extremal values, +68 °C and –54 °C and held at these limits for at least 1 hour.

Vibration test

The tube shall be rigidly mounted in a vertical position with photocathode end up and subjected to ;
1 - A sinusoidal vibration having an amplitude of 1. 5 mm, at a frequency of 30 Hz, for a period of 2. 1/2 minutes.
2 - A sinusoidal vibration having an amplitude of 1. 0 mm, at a frequency of 50 Hz, for a period of 2 minutes.

Shock test

The tube shall be subjected to a 75 g peak half-sine shock with six shock pulses paraliel to, and six shock pulses perpendicular to, its longitudinal axis. The duration of each shock pulse should be 6 ms ± 2 ms.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OPERATIONAL INSTRUCTIONS

Temperature

Storage temperature should not exceed 68 °C. The period the tube is submitted to this limit temperature must be as short as possible. Failure to follow this recommendation would result in decreasing life and sensitivity of the tube due to partial deterioration of photocathode.

Incident radiation level

It is recommended not to expose the photocathode to high intensity radiation such as direct sun radiation even when no voltage is applied on(for instance during transport and handling).

During operation, radiation level should not exceed the maximum values given in characteristics data.

Amounting arrangement

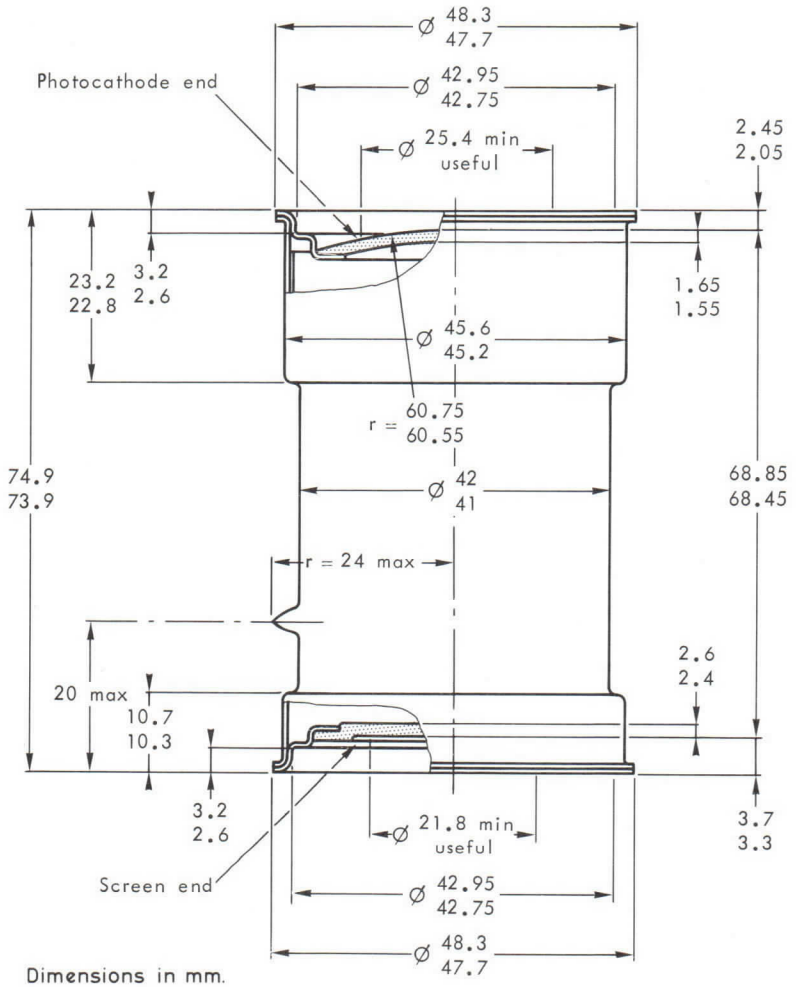
Amounting arrangement for the tube may be provided by clamp arrangement on either end. Avoid mechanical efforts which should damage the glass metal seals.

Power supply

Voltage should be applied to the tube through the metal rings located at both end of the tube. Connections to the terminals of the tube must not be soldered but should be made by either spring clips or clamps.

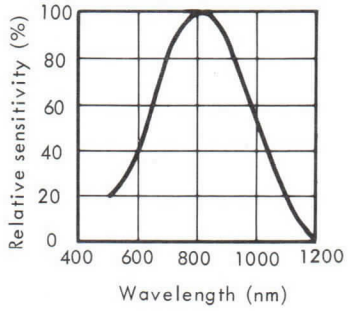
The source positive terminal must be connected to screen end ring, ground connection may be made to either ring.

Outline drawing



Dimensions in mm.

Spectral sensitivity of the photocathode



TH 9301

TH 9301 A* - TH 9301 B* - TH 9301 AB* - TH 9301 C*

CONVERTISSEUR D'IMAGE ULTRA-VIOLET EN IMAGE VISIBLE

- FENETRE D'ENTREE PLANE EN MgF_2
- PHOTOCATHODE TeCs - ϕ utile : 21, 2 mm
- FENETRE DE SORTIE PLANE EN FIBRES OPTIQUES - ECRAN P20
- GRANDISSEMENT VARIABLE DE 0, 75 à 0, 9
- TUBE MONOETAGE - TETRODE - FOCALISATION ELECTROSTATIQUE
- RESOLUTION ELEVEE
- FAIBLE DISTORSION
- TUBE OBTURABLE ELECTRONIQUEMENT

Le tube TH 9301 est un intensificateur d'image permettant la conversion d'image ultra-violet en une image lumineuse visible. Ce tube monoétage est du type tétrode et possède une focalisation entièrement électrostatique. Il est spécialement adapté aux applications de physique et d'astrophysique dans le domaine U.V. proche ou lointain.

La fenêtre d'entrée du convertisseur est constituée par une lame plane en fluorure de magnésium ; la photocathode du type Te Cs dont le diamètre utile est de 21, 2 mm assure la détection des radiations dont la longueur d'onde est comprise entre 110 nm et 310 nm avec un rendement quantique élevé.

La fenêtre de sortie est constituée par une optique à fibres extérieurement plane qui permet le couplage par simple accolement avec un intensificateur d'image ou un tube de prise de vue ou l'application directe de films photographiques. L'écran luminescent est du type P20 dont le rayonnement jaune - vert est le mieux adapté à l'observation visuelle.

L'ajustement du potentiel des électrodes g1 et g2 permet d'obtenir une image de résolution élevée dont le grandissement peut être variable entre 0, 75 et 0, 9. La distorsion, très faible, est inférieure à 2, 5 %.

Le transfert électronique entre photocathode et écran peut être interrompu par application d'impulsions négatives sur l'électrode g2, le tube fonctionnant ainsi comme obturateur rapide.

Le courant d'obscurité naturellement très faible des photocathodes TeCs, joint à un procédé de réalisation de ces photocathodes par une méthode de transfert, confère au tube TH 9301 une luminance d'obscurité très faible. Le rapport signal/bruit qui en résulte permet la détection des sources U.V. de faible radiance, en particulier par intégration du signal de sortie sur une plaque photographique ou une cible de tube de prise de vue.

* Ces différentes versions du tube correspondent à des fenêtres d'entrée, des photocathodes et des écrans de sortie de types différents (voir détails dans le texte). Le modèle standard TH 9301 comporte une fenêtre d'entrée en MgF_2, une photocathode TeCs et un écran P20. Les autres modèles sont fournis sur demande.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Le tube TH 9301 peut être aussi fourni sur demande dans des versions comprenant une fenêtre d'entrée, une photocathode ou un écran de types différents. Ainsi une photocathode ICs confère au tube une sensibilité élevée dans l'ultra-violet lointain et un écran du type P11 présente une rémanence plus courte pour l'enregistrement d'objets en mouvement. Une fenêtre de silice fondue présente une plus grande insensibilité à l'altération par des agents chimiques (vapeur d'eau notamment). Le tableau ci-dessous résume des versions possibles du type TH 9301.

Désignation	Fenêtre d'entrée	Photocathode	Domaine spectral (nm)	Ecran
TH 9301	MgF_2	Te Cs	110 – 310	P20
TH 9301 A	MgF_2	I Cs	110 – 180	P20
TH 9301 B	MgF_2	Te Cs	110 – 310	P11
TH 9301 AB	MgF_2	I Cs	110 – 180	P11
TH 9301 C	SiO_2	Te Cs	200 – 310	P20

Enfin, le tube TH 9301, développé en vue d'applications spatiales, présente une grande résistance aux conditions d'environnement compatible avec ces applications.

CARACTERISTIQUES MECANIQUES

Longueur totale maximale	93, 8	mm
Diamètre maximal	69, 95	mm
Masse approximative	310	g
Orientation	indifférente	

CARACTERISTIQUES ELECTRIQUES

Focalisation	électrostatique	
Type	tétrode	
Capacité entre la grille g2 et les autres électrodes	15	pF

CARACTERISTIQUES OPTIQUES

Fenêtre d'entrée

Matériau	SiO_2*	MgF_2
Forme	plane et circulaire	
Diamètre minimal utile	21, 2	mm
Epaisseur	2, 1 ± 0, 1	mm

Photocathode

Type	ICs*	Te Cs
Réponse spectrale	voir figure 1	

* Fourni sur demande.

Ecran

Type	P11*	P20
Fluorescence et phosphorescence	bleue	jaune - vert
Réponse spectrale	voir figure 2	
Persistence	courte	moyenne

Fenêtre de sortie

Matériau	optique à fibre
Diamètre des fibres	5, 5 μ
Forme	plane et circulaire
Diamètre minimal utile	12 mm

* Fourni sur demande.

CARACTERISTIQUES D'UTILISATION

Valeurs limites d'utilisation (limites absolues) :

	min.	max.	
Tension entre photocathode et écran	0	+ 17	kV
Tension entre photocathode et électrode g1	0	+ 4	kV
Tension entre photocathode et électrode g2	− 2	+ 1	kV
Température de stockage	− 55	+ 60	°C
Température d'utilisation	− 50	+ 50	°C
Eclairement de photocathode	−	10^{-5}	W/cm^2
Luminance de sortie	−	200	cd/m^2

Conditions nominales de fonctionnement

Température	20 ± 5	°C
Tension d'écran	+ 15	kV
Tension de l'électrode g1 (note 1)	3, 6 ± 0, 2	kV
Tension de l'électrode g2 (note 2)	0, 5 ± 0, 1	kV
Tension de blocage sur l'électrode g2	− 1, 6	kV
Tension de photocathode	0	

Performances (note 3)

	min.	typique	max.	
Résolution au centre (note 4)	50	55	−	pl/mn
FTM au centre	−	figure 4	−	
Résolution périphérique (note 5)	25	28	−	pl/mn
Grandissement au centre (note 6)	0, 78	0, 79	−	
Distorsion (note 7)	−	2	2, 5	%
Rendement quantique de photocathode (note 8)	0, 05	0, 06	−	électrons/photon
Gain photonique (note 9)	8	10	−	
Flux photonique équivalent au bruit propre (note 10)	−	5, 10^3	−	photon/cm^2/s
Uniformité de luminance (note 11)	0, 8	−	1, 2	
Facteur d'obturation (note 12)	10^4	−	−	

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

ESSAIS D'ENVIRONNEMENT

Le tube TH 9301 supporte hors fonctionnement les essais d'environnement suivants. Après exécution de ces essais le tube doit satisfaire aux performances définies dans le paragraphe CARACTERISTIQUES D'UTILISATION.

– ESSAIS CLIMATIQUES

Le tube est soumis à quatre cycles de température entre – 55 °C et +60 °C avec maintien aux températures extrêmes pendant 30 mn. Chaque cycle est exploré avec une variation de l'ordre de 2 °C/mn.

– VIBRATIONS

Le tube étant fixé rigidement sur la table vibrante, est vibré parallèlement et perpendiculairement à l'axe optique. Pour la réalisation de l'essai, le tube est positionné de telle façon que sa face d'entrée ne soit jamais dirigée vers le bas.

L'essai est conduit comme suit :

1 - Direction parallèle à l'axe optique :

Fréquence variable de 15 Hz à 2000 Hz avec :

- Amplitude de vibration	4, 0	mm	de	15	Hz	à	35	Hz
- Accélération crête	20	g	de	35	Hz	à	200	Hz
- Accélération crête	10	g	de	200	Hz	à	2000	Hz

2 - Deux directions perpendiculaires à l'axe optique :

Fréquence variable de 15 Hz à 2000 Hz avec :

- Amplitude de vibration	2, 0	mm	de	15	Hz	à	35	Hz
- Accélération crête	10	g	de	35	Hz	à	200	Hz
- Accélération crête	6	g	de	200	Hz	à	2000	Hz

Pour chaque direction, l'exploration de la gamme de fréquences se faisant à la vitesse de deux octaves par minute.

– CHOCS

Le tube est soumis à cinq chocs dans chacune de trois directions orthogonales, l'une étant parallèle à l'axe optique du tube. Chaque choc à une amplitude de 100 g (onde semi-sinusoïdale) et une durée de 5 ms ± 1 ms.

NOTES

1 - Les performances sont mesurées après avoir ajusté le grandissement total de l'image à 0,8 (note 7) par réglage de la tension de polarisation de l'électrode g1 dans la fourchette indiquée.

Par ailleurs, le grandissement du TH 9301 peut être ajusté entre 0,75 et 0,9 par réglages des tensions sur les électrodes g1 et g2 ainsi qu'il est indiqué sur la figure 3.

2 - La tension de l'électrode g2 est ajustée dans la fourchette indiquée pour obtenir un maximum de définition au centre de l'image. Pour certaines applications, la résolution au bord du champ peut être augmentée au détriment de la définition au centre. Une homogénéité optimale sur l'ensemble du champ peut aussi être obtenue en réduisant de 50 à 100 volts la polarisation de l'électrode g2.

3 - Les performances sont mesurées dans les conditions nominales ci-dessus. La source de lumière monochromatique à $\lambda = 254$ nm, est constituée par une lampe à vapeur de mercure et un filtre interférentiel ($\Delta\lambda = 20$ nm).

4 - La résolution au centre est mesurée par projection au centre de la photocathode d'une mire du type USAF 1951.

5 - La résolution périphérique est mesurée comme ci-dessus sur un cercle de 17 mm de diamètre centré sur la photocathode.

6 - Le grandissement au centre Mc est obtenu en mesurant l'image d'un segment linéaire de 2 mm centré sur la photocathode.

7 - Le grandissement total Mp est obtenu comme dans la note 6 mais avec un segment linéaire objet de 17 mm. La distorsion est donnée par :

$$D = \frac{Mp - Mc}{Mc} \times 100$$

les tensions de focalisation du convertisseur sont ajustées pour que $Mp = 0,8$.

8 - Rendement quantique de photocathode mesurée à $\lambda = 254$ nm.

9 - Le gain photonique est le rapport du nombre total de photons radiés par l'écran au nombre de photons incidents sur la photocathode ; ce gain est mesuré pour un flux photonique incident voisin de 4, 10^{11} photons/cm^2/s.

10 - Le flux photonique incident équivalent au bruit propre est celui qui produirait une luminance de sortie égale à celle mesurée lorsque la photocathode n'est pas exitée et le tube alimenté.

11 - Les valeurs indiquées sont les valeurs extrêmes tolérées entre la luminance locale sur l'écran de sortie (à l'intérieur d'un cercle de 1 mm de diamètre) et la luminance moyenne de l'écran de sortie, à l'intérieur d'un cercle de 13, 5 mm.

12 - Le facteur d'obturation est le rapport de la luminance de l'écran de sortie mesurée lorsque le tube, uniformément éclairé, est polarisé normalement, à cette même luminance lorsque le tube est obturé électroniquement.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Fig. 1 - Réponses spectrales typiques des photocathodes TeCs et ICs sur fenêtres en MgF_2.

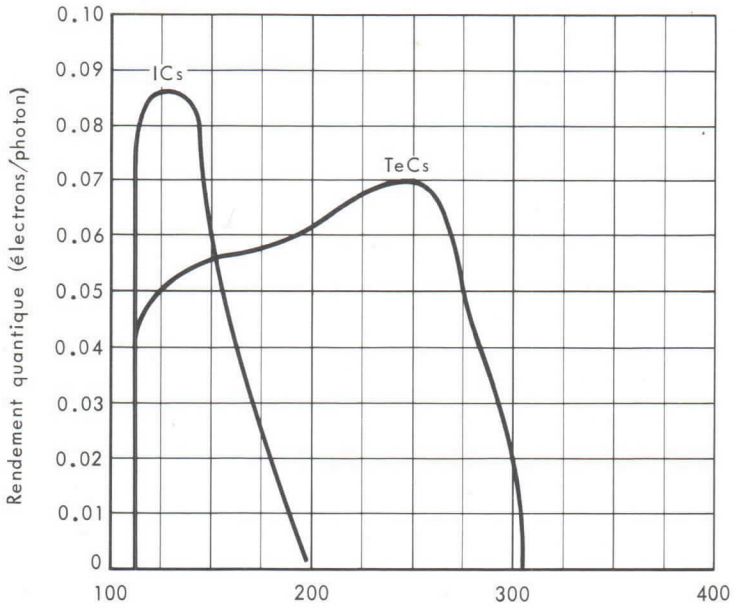


Fig. 2 - Courbe de distribution spectrale des écrans de type P20 et P11

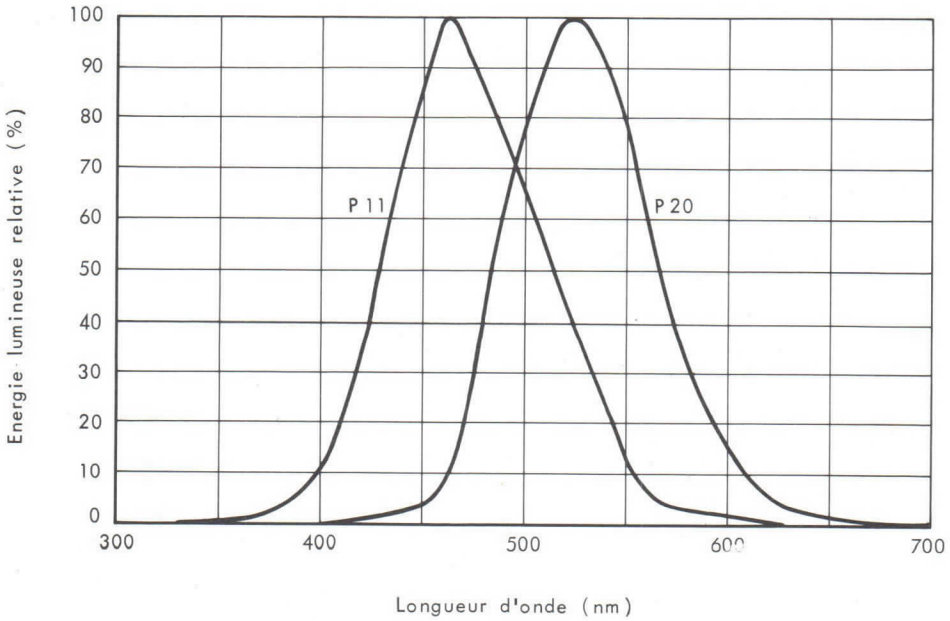


Fig. 3 - Variation du grandissement électronoptique en fonction de la polarisation de l'électrode g1 et de la valeur de Vg2 correspondante assurant la focalisation.

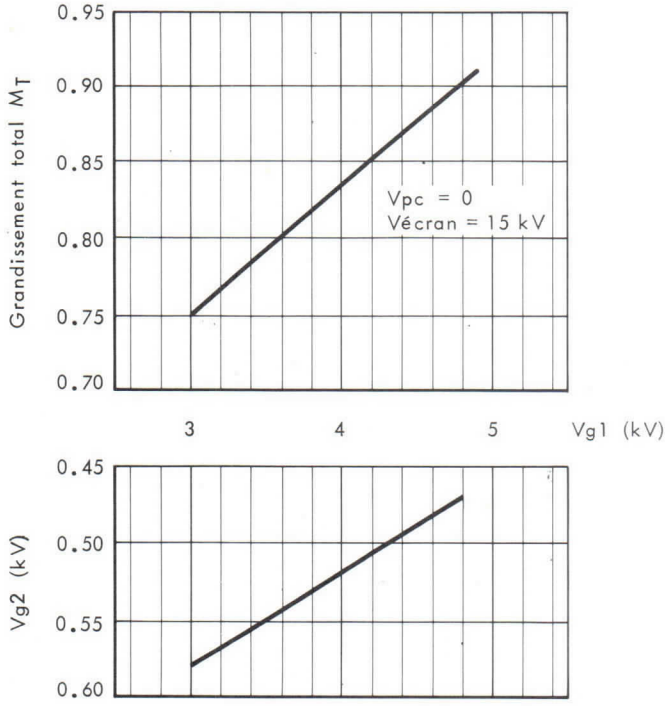
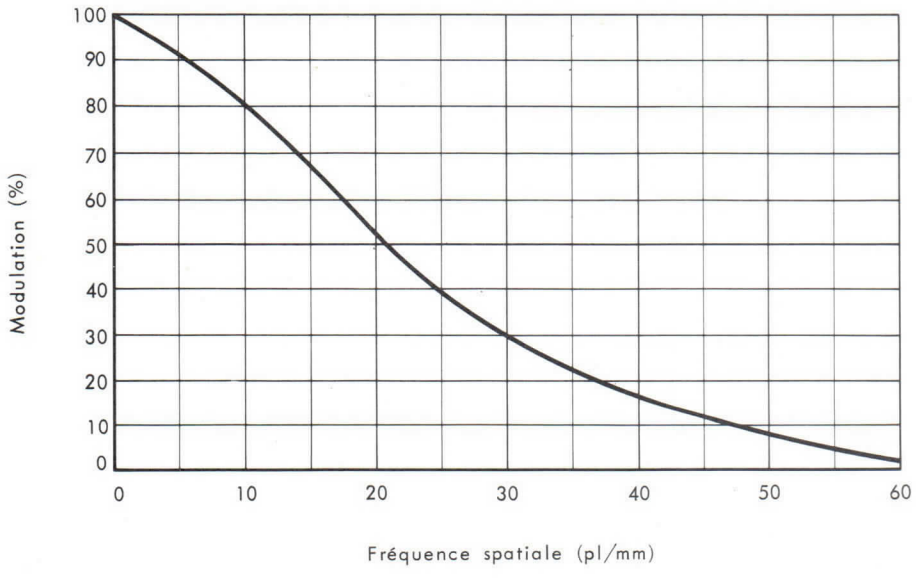
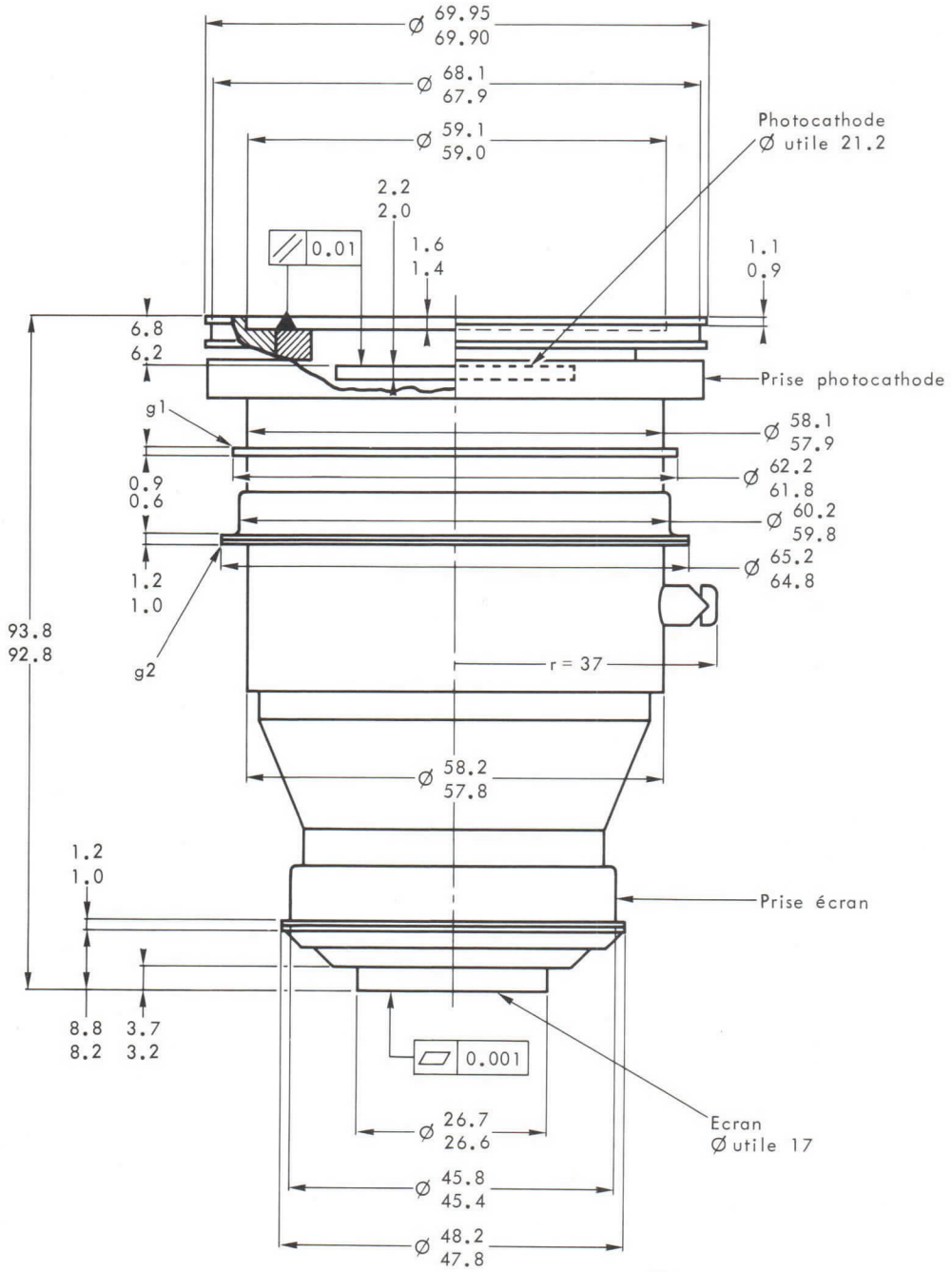


Fig. 4 - FTM mesurée au niveau de la photocathode (valeurs typiques)



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

DESSIN D'ENCOMBREMENT



Cotes en mm.

TH 9302

TH 9302 A*- TH 9302 B*- TH 9302 AB*

INTENSIFICATEURS D'IMAGE LUMINEUSE OBTURATEURS RAPIDES

- FENETRES FIBRES OPTIQUES
- PHOTOCATHODE ϕ 25 mm
- IMAGE DE SORTIE ϕ 25 mm
- MONOETAGE - TRIODE - ELECTROSTATIQUE
- OBTURATION ELECTRONIQUE
- GRANDE SENSIBILITE (230 μA/lm)
- FAIBLE DISTORSION
- ROBUSTESSE

Le tube TH 9302 est un intensificateur d'image à focalisation électrostatique de champ utile 25 mm, de grandissement 1, sensible dans le visible et le proche infra-rouge ; il est en outre doté d'une électrode permettant l'obturation électronique par des impulsions de tension de faible amplitude. Il peut fonctionner isolément ou constituer l'étage de tête d'un tube intensificateur d'image en cascade ou d'un tube de prise de vue à fenêtre d'entrée à fibres optiques ; il confère à l'ensemble les qualités nécessaires à la vision, ou la télévision, en éclairement nocturne résiduel.

La possibilité de fonctionnement en obturateur rapide permet, par un choix approprié de la durée et du moment où le tube est rendu actif, la réception synchrone d'échos lumineux provenant de scènes illuminées par des sources de lumière pulsées (laser, diodes Ga As,...), améliorant considérablement le contraste et la résolution des systèmes de vision et de télévision par élimination de la lumière diffusée entre la scène et le système électro-optique ; cette utilisation, la tomovision, est spécialement intéressante en présence de milieux très diffusants : brouillard, observation sous-marine, etc. . . .

La possibilité de fonctionnement en obturateur rapide trouve aussi une application dans la visualisation de phénomènes lumineux - ou illuminables - très brefs, ou rapidement évolutifs ; en particulier le tube est bien adapté à la photographie ultra-rapide à haute résolution et grande brillance d'image, et le rendement optique peut être excellent si le film est appliqué sur la face à fibres optiques de sortie.

Le tube peut également être utilisé pour la protection quasi instantannée de détecteurs électro-optiques susceptibles de dégradation par des sur-éclairements.

* *Ces différentes versions du tube correspondent à des photocathodes d'entrée et des écrans de sortie de types différents (voir détails dans le texte). Le modèle standard TH 9302 comporte une photocathode S20ER et un écran P20 ; les autres modèles sont fournis sur demande.*

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

L'utilisation d'une photocathode multialcaline, dont la sensibilité est étendue dans le rouge et d'un écran de type P20 à grand rendement, confère au tube TH 9302 un facteur de conversion luminance/éclairement élevé. Pour des applications particulières, le tube TH 9302 peut être fourni sur demande dans des versions comprenant une photocathode ou un écran de types différents ; en particulier, il peut être réalisé avec une photocathode de type S1 dont la sensibilité dans l'infra-rouge s'étend jusqu'à 1100 nm environ, ou avec un écran du type P11 dont la rémanence est inférieure à celle des écrans P20. La combinaison des photocathodes S1 et S20ER avec les écrans P11 et P20 permet la réalisation de différentes versions du tube TH 9302 comme l'indique le tableau suivant :

REFERENCE	PHOTOCATHODE	ECRAN
TH 9302	S20ER	P20
TH 9302A	S1 (Ag - O - Cs)	P20
TH 9302B	S20ER	P11
TH 9302AB	S1 (Ag - O - Cs)	P11

Pour des applications comme tube obturateur, avec des durées de fonctionnement débloqué inférieures à 1 μs, le tube TH 9302 peut être fourni sur spécification avec une photocathode à grande conductibilité de surface. Une telle photocathode permet d'éviter la défocalisation due à un éclairement intense de brève durée.

La simplicité d'utilisation du tube, son faible encombrement, sa compatibilité comme élément complémentaire d'intensificateurs en cascade ou de tubes de prise de vue, sa robustesse, permettent la réalisation d'équipements de vision et de tomovision utilisables dans des environnements sévères.

CARACTÉRISTIQUES MÉCANIQUES

Longueur totale maximale	81, 5	mm
Diamètre maximal, queusots exclus	49, 4	mm
Diamètre maximal, queusots compris	59	mm
Masse approximative	162	g
Orientation	indifférente	

CARACTÉRISTIQUES ÉLECTRIQUES

Focalisation	électrostatique	
Type	triode	
Capacité entre la grille et les autres électrodes	15	pF

CARACTÉRISTIQUES OPTIQUES

Photocathode

Type	S1**	S20ER
	sensibilité jusqu'à 1100 nm	sensibilité étendue dans le rouge
Réponse spectrale	voir figure 1	voir figure 1
Diamètre minimal utile		25 mm
Fenêtre d'entrée :		
- forme		plane et circulaire
- nature		optique à fibres

** Fourni sur demande.

Ecran

	P11**	P20
Type		
Fluorescence et phosphorescence	bleue	jaune - vert
Réponse spectrale	voir figure 2	voir figure 2
Persistance	courte	moyenne
Diamètre minimal utile		25 mm
Fenêtre de sortie :		
- forme		plane et circulaire
- nature		optique à fibres

CARACTÉRISTIQUES D'UTILISATION

Valeurs limites d'utilisation : (limites absolues)

	min.	max.	
Tension entre écran et photocathode	–	16	kV
Tension entre grille et photocathode	– 1800	+ 400	V
Courant de photocathode à la tension nominale (1)	–	0, 5	µA
Température de stockage	– 55	+ 70	°C
Température d'utilisation	– 50	+ 50	°C

Exemple de fonctionnement

Température ambiante	20 ± 5	°C
Tension de photocathode	0	V
Tension de grille en fonctionnement normal	175 ± 50	V
Tension de grille en fonctionnement obturé	– 1, 60 ± 0, 2	kV
Tension écran	15	kV

Performances (2)

	min.	typique	max.	
Résolution au centre (paraxiale) (3)	60	70	–	pl/mm
F.T.M. au centre (4)	–	fig. 3	–	
Résolution périphérique (5)	50	55	–	pl/mm
Grandissement au centre (paraxial) (6)	0, 95	0, 97	0, 99	
Distorsion (7)	–	3, 5	4	%
Sensibilité de photocathode (8)	175	230	–	µA/lm
Gain énergique (9)	30	45	–	
Coefficient de conversion (10)	28	40	–	cd/m²/lux
Eclairement équivalent au bruit propre (11)	–	10^{-11}	210^{-11}	lm/cm²
Flux énergétique équivalent au bruit propre (12).	–	$2, 510^{-14}$	510^{-14}	W/cm²
Uniformité de luminance (13)	–	–	1, 7	
Facteur d'obturation (14)	10^4	–	–	

ESSAIS D'ENVIRONNEMENT

Le tube TH 9302 supporte hors fonctionnement les essais d'environnement suivants. Après exécution de ces essais le tube doit satisfaire aux performances définies dans le paragraphe CARACTERISTIQUES D'UTILISATION.

– ESSAI CLIMATIQUE

Le tube est soumis à 4 cycles de températures entre – 55 °C et + 70 °C avec maintien aux températures extrêmes pendant 30 mn. Chaque cycle est exploré avec une variation de l'ordre de 2 °C/mn.

– VIBRATIONS

Le tube étant fixé rigidement, en position verticale, la cathode dirigée vers le haut, est vibré parallèlement et perpendiculairement à l'axe optique.

** Fourni sur demande.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

L'amplitude des vibrations sinusoidales est de 1,30 mm crête et la fréquence varie de façon continue de 10 Hz à 55 Hz et de 55 Hz à 10 Hz. Chaque cycle dure 1 minute. L'essai comporte 10 cycles suivant chaque direction.

– CHOCS

Le tube est soumis à 6 chocs parallèlement et perpendiculairement à l'axe optique, chaque choc ayant une amplitude de 75 g (onde semi-sinusoidale) et une durée de 6 ms ± 2 ms.

NOTES

1 - La valeur indiquée est un courant maximal autorisé débité par la photocathode uniformément éclairée.

2 - Les performances sont mesurées après optimisation de la focalisation par ajustement du potentiel de grille.

3 - La résolution paraxiale est mesurée à l'aide d'une mire du type USAF 1951 à l'intérieur d'un cercle de 2, 5 mm de diamètre, centré sur la photocathode.

4 - La fonction de transfert de modulation d'amplitude est mesurée à l'aide du dispositif EROS 110 (Ealing - Beck).

5 - La résolution périphérique est mesurée sur un cercle de 20 mm de diamètre, centré sur la photocathode, avec mire indiquée dans la note 3.

6 - Le grandissement paraxial Mc correspond à la mesure sur l'écran d'un segment de 2 mm projeté au centre de la photocathode.

7 - Le grandissement périphérique Mp est mesuré comme dans la note 6 avec un segment de 20 mm. La distorsion D est donnée par :

$$D = \frac{Mp - Mc}{Mc} \times 100$$

8 - Sensibilité de photocathode mesurée avec une lampe à filament de tungstène standard à la température de couleur de 2854 °K.

9 - Le gain énergétique est le rapport de l'énergie totale radiée par l'écran à l'énergie incidente sur la photocathode à la longueur d'onde correspondant au maximum de réponse spectrale.

10 - Le coefficient de conversion est le rapport de la luminance de l'écran à l'éclairement de la photocathode. La lumière incidente provient de la même source que dans la note 8.

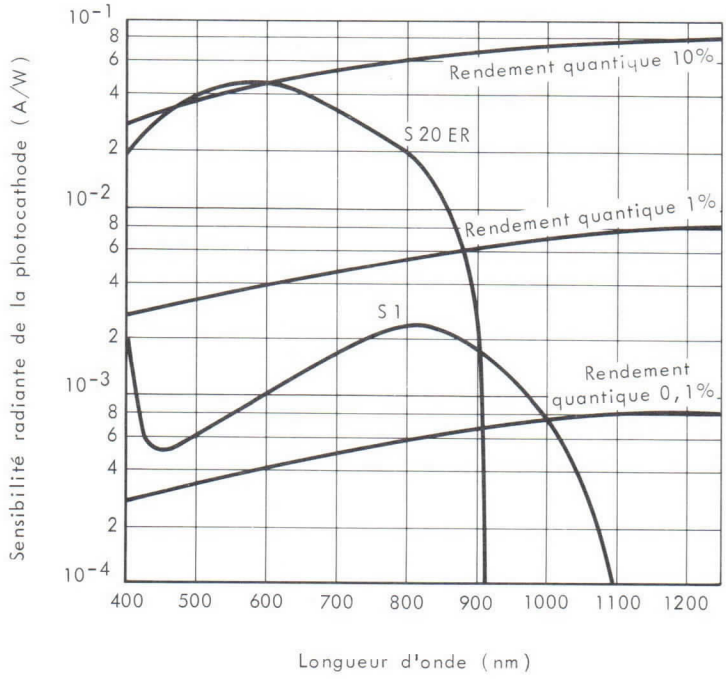
11 - L'éclairement de photocathode équivalent au bruit propre est celui qui produirait une luminance de l'écran égale à celle mesurée quand le tube intensificateur est alimenté et non éclairé.

12 - Le flux énergétique équivalent au bruit propre est l'éclairement énergétique de la photocathode à la longueur d'onde au maximum de réponse spectrale, qui produirait une luminance de l'écran égale à celle mesurée quand le tube est alimenté et non éclairé.

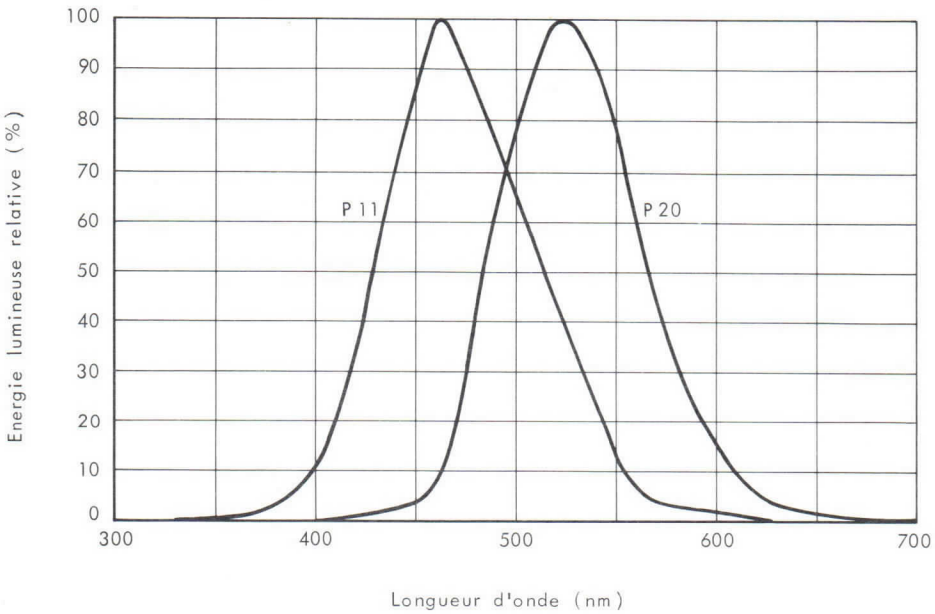
13 - La photocathode étant uniformément éclairée par une lampe à filament de tungstène à la température de couleur de 2854 °K, le facteur d'uniformité de luminance indique le rapport de la luminance des zones les plus brillantes aux zones les plus sombres, à l'intérieur d'un cercle de 20 mm de diamètre centré sur l'écran.

14 - La photocathode est uniformément éclairée comme ci-dessus. Le facteur d'obturation est le rapport de la luminance moyenne de l'écran, le tube étant focalisé normalement à la luminance moyenne de l'écran, le tube étant obturé électroniquement.

REPONSES SPECTRALES TYPIQUES
DES PHOTOCATHODES S 1 ET S 20 ER

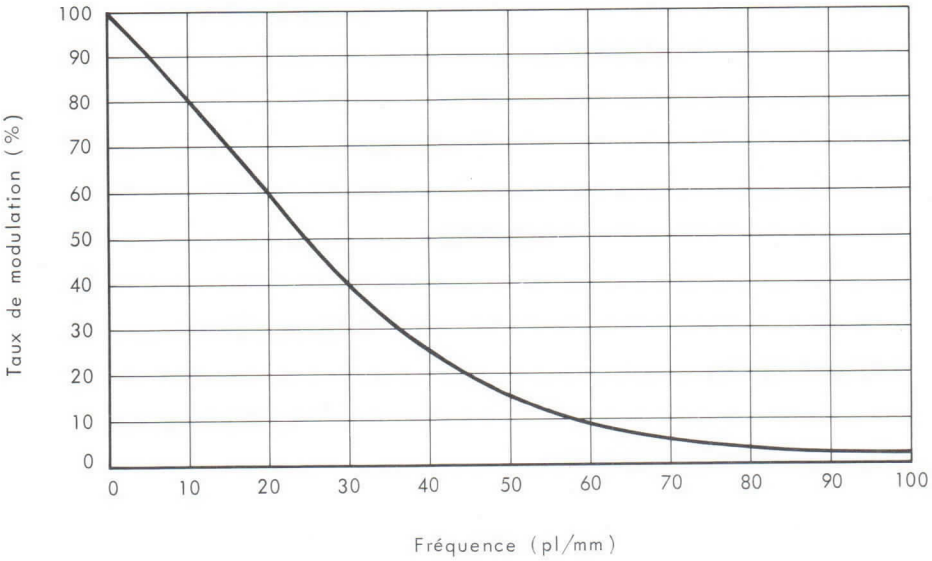


COURBE DE DISTRIBUTION SPECTRALE
DES ECRANS DE TYPE P 20 ET P 11

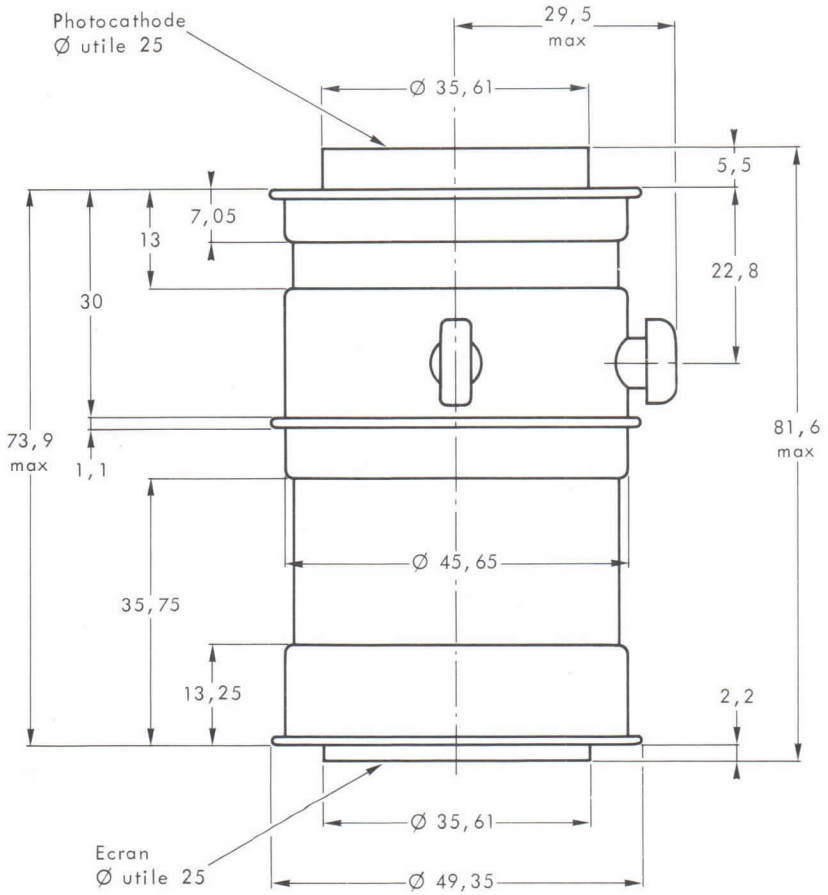


THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

FONCTION DE TRANSFERT DE MODULATION



DESSIN D'ENCOMBREMENT



Cotes en mm.

TH 9303
IMAGE-INTENSIFIER TUBE WITH AUTOMATIC BRIGHTNESS CONTROL

- RUGGED CONSTRUCTION
- EXTENDED RED PHOTOCATHODE, ϕ 25 mm
- VERY HIGH LUMINANCE GAIN : 25 000 cd/m^2/lux (80 000 fL/fc)
- VIEWING SCREEN OF 25-mm DIAMETER
- INTEGRAL OSCILLATOR AND MULTIPLIER
- ELECTROSTATIC FOCUS
- THREE CASCADED STAGES
- FIBER-OPTICS FACEPLATES

The TH 9303 is a 25-mm high performance image-intensifier tube designed to meet the most stringent military specifications.

This tube is a rugged, three-cascade-stage, electrostatic-focus image intensifier, having flat fiber-optics input and output faceplates.

It is supplied with an integral high-voltage supply, potted in a silicone compound inside a precision plastic cylinder, with mechanical references for tube mounting.

The oscillator requires a dc voltage of 6.25 V (Note 1). Each stage operates with approximately 15 kVdc from the multiplier.

To avoid dazzling the observer, the design of the supply is such that luminance gain and output brightness vary with input illumination. This gain is constant up to 10^{-2} lux and decreases from 10^{-2} to 10^{2} lux incident illumination. The fast-recovery (3 seconds) characteristics of the tube allow an almost uninterrupted efficient observation whatever the illumination conditions may be.

The photocathode is of S20 ER type (extended red sensitivity) and the yellow-green fluorescent P20 phosphor exhibits a high energy efficiency.

GENERAL DATA

Mechanical

Overall length	194	mm
Maximum diameter	69. 8	mm
Weight, approximate	950	g
Mounting position		Any

Electrical

Focusing method	Electrostatic
Type	Three module-diodes (coupling in cascade)

Optical

PHOTOCATHODE

Type	S20 ER (extended red sensitivity)
Spectral response	See Figure 1
Minimum useful diameter	23 mm
Input face :	
- shape	Flat to within 2.5 μ
- diameter	35.55 mm
- nature	Fiber - optics

SCREEN

Phosphor	P20, aluminized
Spectral distribution	See Figure 2
Minimum useful diameter	25 mm
Fluorescence	Yellow-green
Phosphorescence	Yelow-green
Persistence	Medium
Output face :	
- shape	Flat to within 2.5 μ
- diameter	32.90 mm
- nature	Fiber - optics with external flat glass protective window

OPERATING CONDITIONS

Maximum ratings (absolute limits)

Battery dc input voltage (for 6.25 V nominal) (Note 1)	max.	6.5	V
Battery current	max.	40	mA
Photocathode illumination	max.	100	lux
Storage temperature	max.	+ 68	°C
	min.	−54	°C
Operating temperature	max.	+ 52	°C
	min.	−54	°C

TYPICAL OPERATION

Operational conditions

Ambient temperature	23 ± 3	°C
Battery dc input voltage (Note 1)	6.25	V
Battery current (Note 2)	30	mA
Photocathode voltage	0	V
Color temperature of incident light source	2854	°K

Performance

	Min.	Typical	Max.	Units
Photocathode sensitivity (Note 3)				
- luminous at 2854 °K	175	225	–	μA/lm
- radiant at 800 nm	8	15	–	mA/W
at 850 nm	3	10	–	mA/W
Conversion factor (Note 4)	10^4	2.5×10^4	–	cd/m²/lux
Equivalent background illumination (Note 5)	–	–	2×10^{-7}	lux
Resolution :				
- paraxial (Note 6)	25	30	–	lp/mm
- peripheral (Note 7)	23	25	–	lp/mm
Modulation transfer function (Figure 3) :				
- for 5 lp/mm	85	–	–	%
- for 10 lp/mm	65	–	–	%
- for 15 lp/mm	35	–	–	%
Magnification:				
- paraxial (Note 8)	0.82	0.88	–	
- peripheral (Note 9)	–	1.02	1.06	
Distortion (Note 10)	–	14	20	%
Image alignment (Note 11)	–	0.4	0.8	mm
Screen luminance	–	–	500	cd/m²
Luminance uniformity (Note 12)	–	–	4	
Tube life	–	3000	–	h

ENVIRONMENTAL TESTS

The TH 9303 is designed to withstand the following environmental tests without mechanical damage or electrical failure. After completion of the tests the tube will meet all the performance characteristics specified above.

SHOCK TESTS

The tube is subjected to a 75 g peak half-sine-wave shock of 6 ±2 ms duration. Six xhock pulses are applied in each of two perpendicular directions, one of which shall be parallel to the optical axis of the tube.

VIBRATION TESTS

The tube is vertically mounted with the photocathode end up and is subjected to sine wave vibrations of 1.30 mm amplitude for a vibration cycle having a duration of 1 minute during which time the frequency is varied from 10 to 55 Hz and back to 10 Hz.

Ten frequency sweeps are performed in each of three mutually perpendicular directions, one of which shall be parallel to the optical axis of the tube.

TEMPERATURE TESTS

The tube is subjected to a temperature cycle within the + 52 °C to –54 °C range and is held at these maximum and minimum values during 2 hours.

NOTES

1 - On request, the tube can be factory-adjusted for use with batteries producing a nominal voltage of 6. 75 V.

2 - This current is constant between 10^{-4} and 100 lux.

3 - The photocathode sensitivity is measured on a surface of 3 cm^2 with a flux of 0. 01 lumen.

At 800 nm and 850 nm, the radiant sensitivity is measured with the incident light being filtered before falling on the photocathode. At 800 nm the interposed filter delivers 280 μW/lm and at 850 nm, it delivers 260 μW/lm.

4 - The conversion factor or luminance gain is measured at 10^{-4} lux incident illumination for a photocathode surface of 3 cm^2. It is the ratio of the output luminance in cd/m^2 to the input illumination in lux.

5 - Equivalent background illumination is the value of input illumination required to give an increase in screen luminance equivalent to the background luminance.

6 - The resolution, both horizontal and vertical, is determined with a test pattern consisting of alternate black and white lines of equal width. Any two adjacent lines are designated as a line pair.

Paraxial resolution is measured at the center of the photocathode.

7 - Peripheral resolution is measured at a distance of 10 mm from the optical axis of the tube.

8 - The center magnification Mc is defined as the ratio of the distance of two image points on the screen to the distance of the two corresponding points on the photocathode. The points on the photocathode are separated by a distance of 2 mm centered on the tube axis.

9 - The peripheral magnification Mp is measured as is Mc, except that the distance between two points of the photocathode is 20 mm.

10 - The per-cent distortion D is defined by the equation :

$$D = \frac{Mp - Mc}{Mc} \times 100$$

11 - A spot of 0. 1 mm is produced at the center of the photocathode. The center of the image on the screen will fall within a circle centered on the optical axis and having a 0. 8 mm diameter.

12 - Luminance uniformity is defined as the ratio of the maximum and minimum screen luminances over a 20-mm diameter concentric area on the image screen, for uniform photocathode illumination.

CATHODE AND SCREEN BLEMISHES

The size and quantities of blimishes are observed on the screen and shall not exceed the values shown in the table. The screen is viewed with the radiation level on the photocathode adjusted to obtain best blemish contrast.

Size of Blemishes	Number of Blemishes		
	Zone 1	Zone 2	Zone 3
$\geqslant$ 0. 4 mm	0	0	0
0. 25 mm to less than 0. 4 mm	0	4	10
0. 15 mm to less than 0. 25 mm	0	12	26
0. 08 mm to less than 0. 15 mm	3	Min	Min
less than 0. 08 mm	Min	Min	Min

"Zone 1" is defined as the area within a 7. 5-mm diameter circle, concentric to the optical axis of the tube.

"Zone 2" is defined as the area bounded by a 7. 5-mm diameter circle and a 20-mm diameter circle, both of which are concentric to the optical axis of the tube.

' Zone 3" is defined as the area bounded by a 20-mm diameter circle and a 24. 5-mm diameter circle, both of which are concentric to the optical axis of the tube.

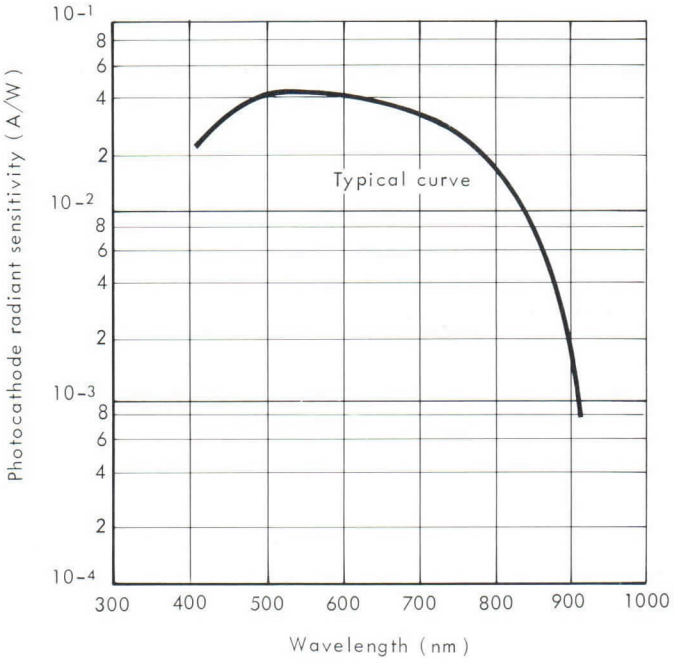


Figure 1 - S20 ER photocathode spectral response.
(extended red sensitivity)

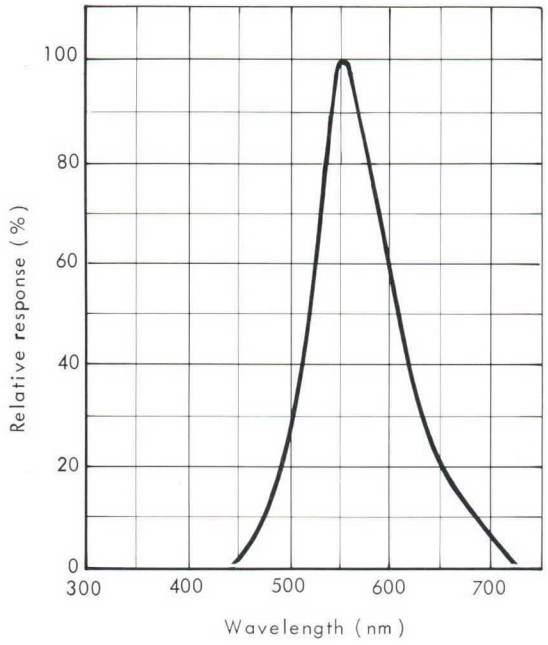


Figure 2 - Spectral efficiency characteristics of aluminized P20 phosphor screen.

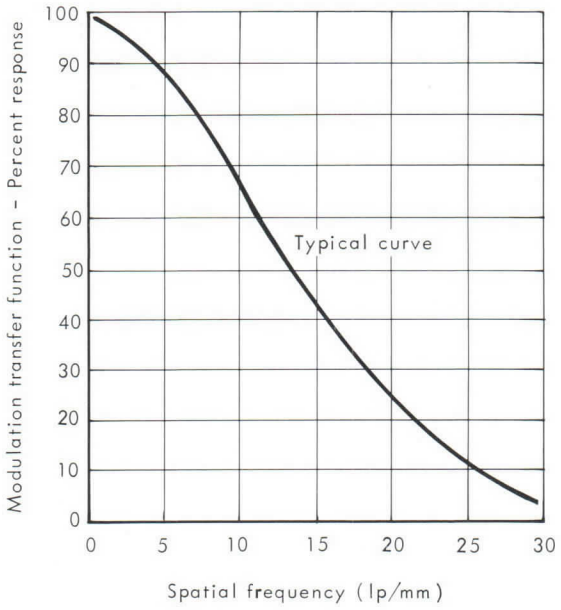


Figure 3 - Modulation transfer function.

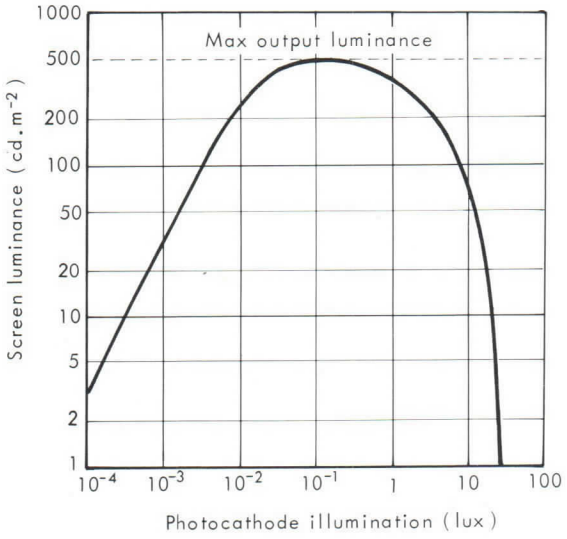
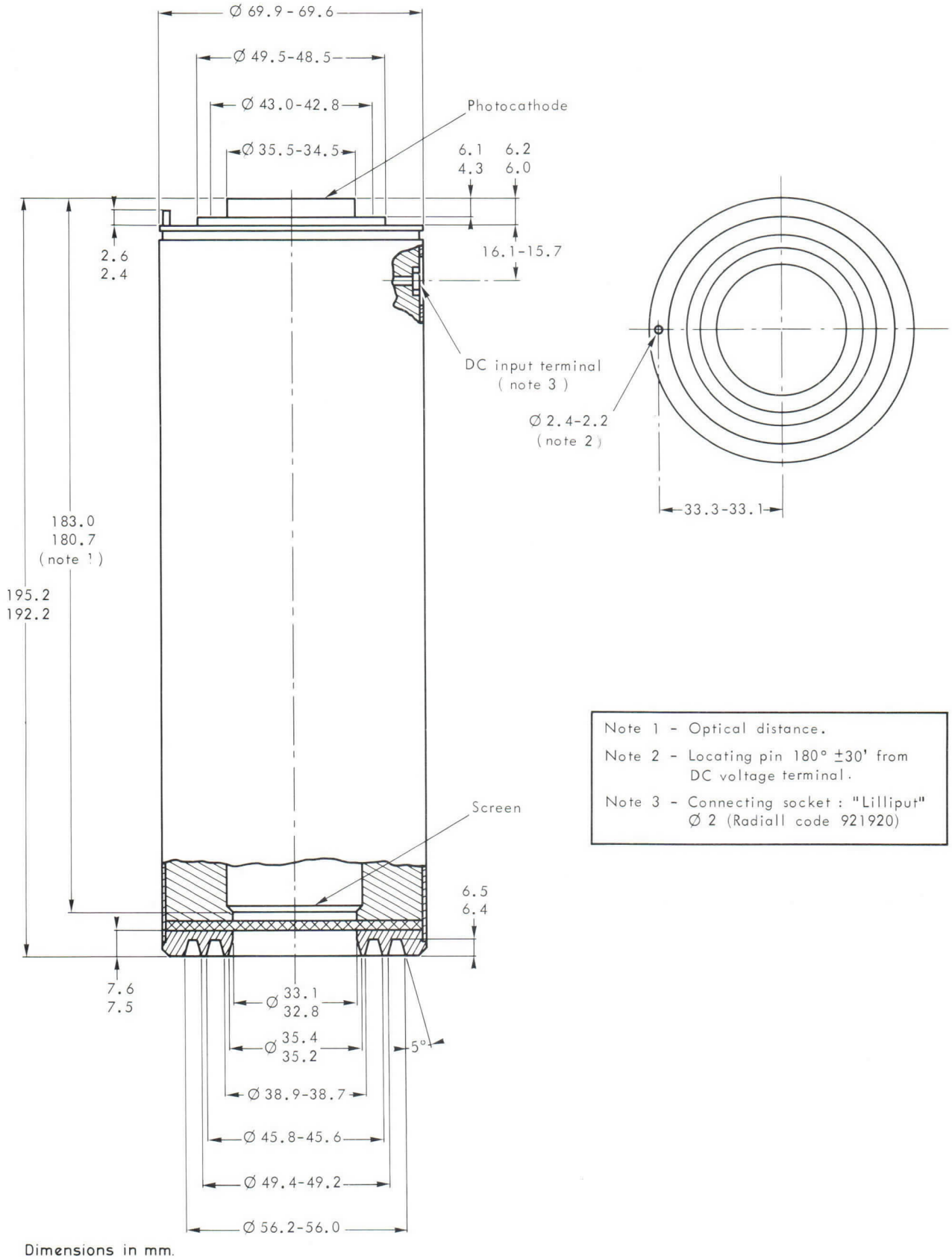


Figure 4 - Typical screen luminance as a function of photocathode illumination.

OUTLINE DRAWING



Note 1 - Optical distance.

Note 2 - Locating pin 180° ±30' from DC voltage terminal.

Note 3 - Connecting socket : "Lilliput" Ø 2 (Radiall code 921920)

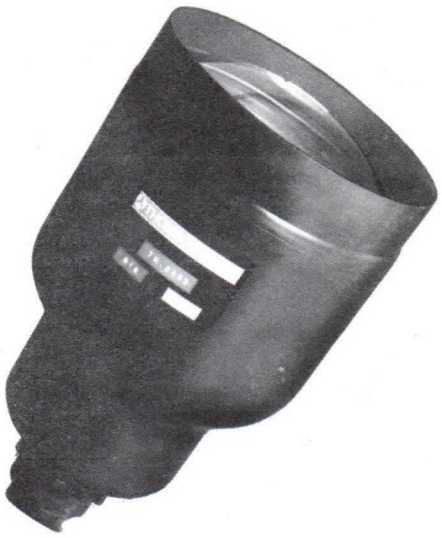
Dimensions in mm.

THOMSON-CSF

DIVISION TUBES ELECTRONIQUES

ELECTRONIC ZOOM
LIGHT IMAGE INTENSIFIER TUBE TH 9463

- FOR LOW LIGHT LEVEL APPLICATIONS
- HIGH ENERGY GAIN
- HIGH RESOLUTION
- LARGE INPUT FIELDS = 22 cm to 18 cm



The TH 9463 is a light image intensifier tube providing an important brightness gain from very low light level image. The photocathode is of S20 type with a spectral response in visible spectrum extended to the near ultra-violet.

A large area photoemissive layer located behind the front end of the tube converts the incident light into electrons. The photoelectrons thus produced are accelerated and focused by appropriate electric fields before impinging on a fluorescent screen which delivers an inverted image of smaller dimensions and considerably higher brightness than the input image.

The image provided by the tube may be observed through an optical system, recorded onto a photographic support or transferred to a T.V. monitor.

Magnification can be adjusted from 1/9 to 1/11 by proper choice of voltage applied to focusing electrodes ; thereby, input image diameter being of 22 cm, corresponding output image diameter varies from 24.5 to 20 mm respectively. Alternatively, the output image being kept to the fixed diameter of 20 mm, the input field can be varied from 22 cm to 18 cm.

Due to its high brightness gain, and to the low dark emission of its photocathode, the TH 9463 is designed for low light level examination. It is especially suitable for nuclear medicine when used with an external scintillator coupled to the faceplate.

GENERAL CHARACTERISTICS

Mechanical

Dimensions		see drawing
Mounting position		any
Operating temperature	min.	+ 5 °C
	max.	+35 °C
Storage temperature	min.	+ 5 °C
	max.	+50 °C
Net weight, approximate		4 kg

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Optical

Input field diameter	max.			22	cm
Output image diameter	min.			19.5	mm
	max.			25	mm
Electronoptic magnification			1/11 to	1/9	
Corresponding input resolution (note 1)					
- central			30	40	lp/cm
- peripheral			20	30	lp/cm
Photocathode					
- type				S20	
- wavelength at maximum sensitivity				420	nm
- minimum sensitivity (2854 °K light source)				120	μA/lumen
Viewing screen					
- type		P 11	P 16	P 24	
- persistence (note 2)	max.	100	0.2	2	μs
Energy gain (note 3)	min.	100	45	25	watts/watt
Conversion index at 1/11 magnification (2854 °K) (note 4)	min.	1300	105	900	$\frac{cd/m^2}{lux}$
Equivalent photocathode dark emission (note 5)	max.		200		$\frac{electrons}{cm^2\ s}$

MAXIMUM RATINGS AND TYPICAL OPERATION

Maximum ratings

Photocathode C voltage		0	V
Electrode g1 voltage		0.3	kV
Electrode g2 voltage		2	kV
Electrode g3 voltage		5	kV
Anode A voltage		28	kV
Action getter voltage :	anode g4	3.5	kV
	cathode E	0	V
Photocathode C maximum current		0.5	μA
Electrode g1 maximum current		1	μA
Electrode g2 maximum current		1	μA
Electrode g3 maximum current		1	μA
Electrode g4 maximum current		10	μA
Anode A maximum current		2	μA

Typical operation (note 6)

Magnification	1/11	1/9	
Photocathode C voltage	0	0	
Electrode g1 voltage	100 ± 50	100 ± 50	V
Electrode g2 voltage	700 ± 300	450 ± 200	V
Electrode g3 voltage	3 ± 0.5	4 ± 0.5	kV
Anode A voltage	25	25	kV
Active getter voltage : anode g4	2.5 to 3	2.5 to 3	kV
cathode E	0	0	

NOTES

1 - The resolution is determined with a pattern consisting of alternate transparent and opaque lines of equal width, positionned on the input glass-window. Any two adjacent lines are designated as a line pair. The central zone is within a circle having a diameter equal to 70 % of the input field diameter. Peripheral zone is within circles 70 % and 90 % of the input field diameter.

2 - Defined as the time for initial luminance to decay to 10 % point.

3 - The energy gain is the ratio of the total power radiated by the output screen to the input power of a monochromatic radiation at a wavelength corresponding to the maximum of sensitivity of the photocathode.

4 - The conversion index is the ratio of the luminance of the output screen (in candelas per square meter) to the illumination of the input glass-window (in lux).

5 - The equivalent dark emission of the photocathode is calculated from the measurement of the output screen background luminance, the tube being operated with no input illumination. The equivalent dark emission of the photocathode (in electrons per square centimeter and per second) is the value required to produce the same output luminance.

6 - g1 electrode controls the brightness homogeneity for the whole field. g2 electrode (or focus electrode) controls the image sharpness. Ripple voltage must not exceed 0.5 %.
It is necessary to let work the active getter when tube is under operation.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

STARTING PROCEDURES

Tube mounting

The tube should be protected against external stray fields by a magnetic shield. A 1 mm thickness of highly magnetic metal (mumetal) must be used around the cylindrical part of the tube.

The dark container in which the tube is set must be waterproof and dehydrated. The waterproofing is necessary to eliminate all moisture which could facilitate sparking detrimental to the proper tube operation. It is necessary, moreover to prevent any dust on the viewing face of the tube.

The tube may be held by its cylindrical part or between two flanges mounted on the metallic front collar and the glass shoulder. In any case very low hardness rubber gaskets shall be interposed.

Connections

Voltage on the different electrodes should be properly set. The connection to the electrostatic screen E should not be forgotten.

A 10 MΩ minimum resistance should be connected between the anode A of the tube and the high voltage power supply in order to protect the tube in case of electric discharge in the feeding circuits.

Voltage application

Check insulation of the anode high voltage conductor and connecting terminal of the tube to any sharp edged object at earth potential (distance greater than 15 mm).

Apply the high voltage progressively : anode voltage should be set in about 10 seconds to avoid any discharge inside the tube.

Tube adjustment

Focus a low brightness image on the input faceplate of the tube.

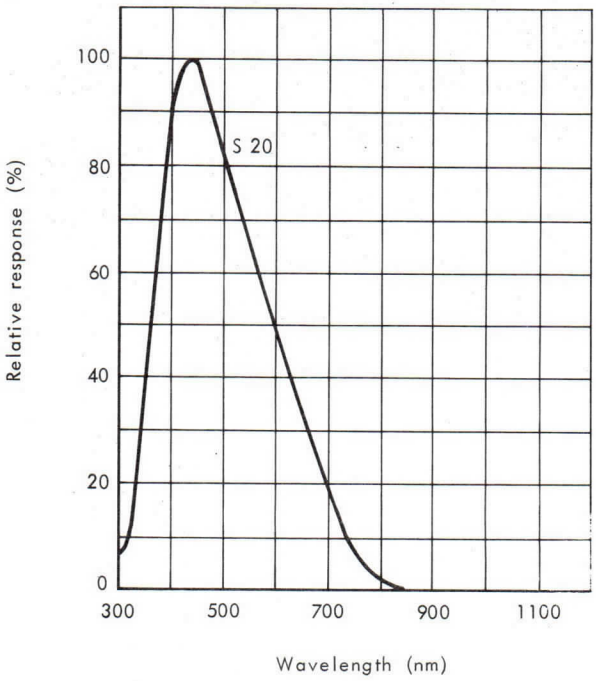
1 - Adjust the g1 voltage in order to obtain an image as homogeneous as possible in brightness.

2 - Adjust the g2 voltage in order to obtain a maximum resolution.

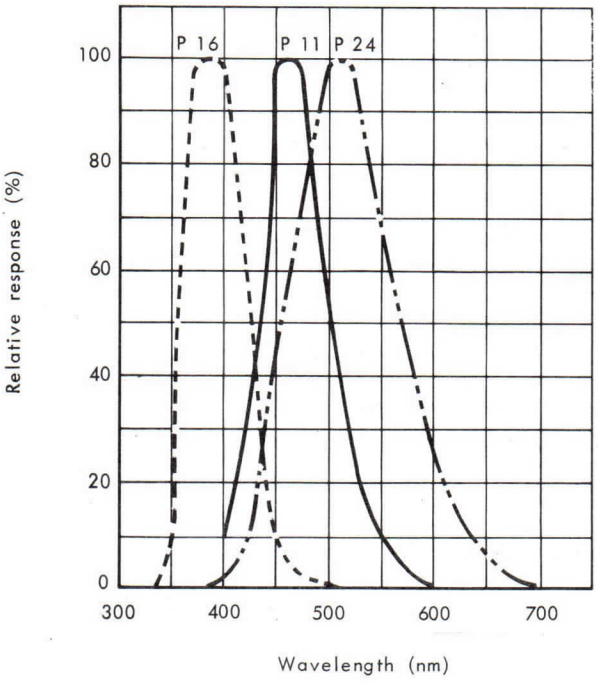
3 - Optimize the g1 voltage is necessary.

After adjustment is made it is possible to vary linearly the electrode voltages of the tube without changing the focusing of the picture.

S 20 PHOTOCATHODE SPECTRAL RESPONSE

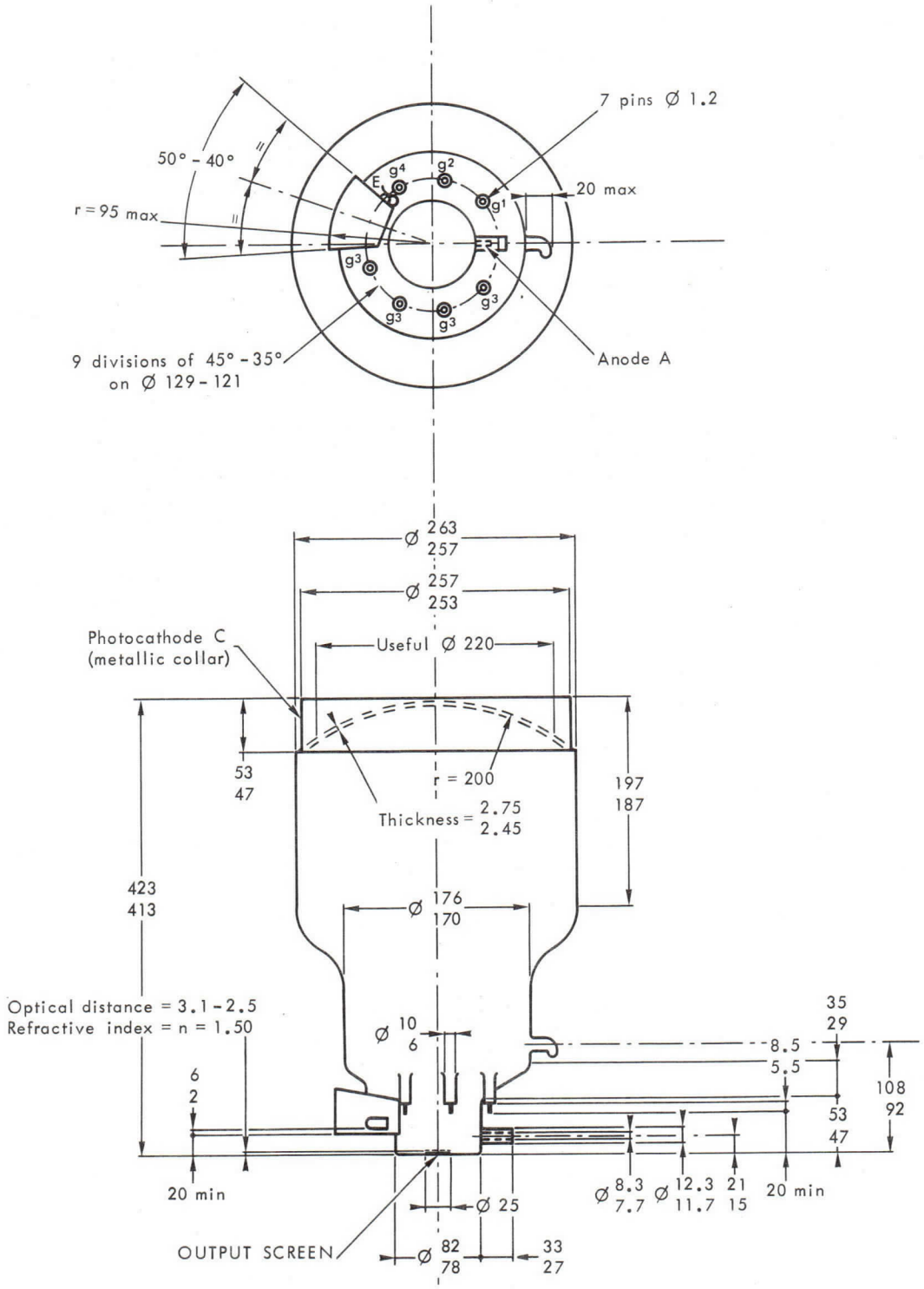


RELATIVE SPECTRAL RESPONSE OF
P 11 - P 16 - P 24 PHOSPHORS



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING



Dimensions in mm.

TH 9473.T1 – TH9473.T2
INTENSIFICATEURS d'IMAGE LUMINEUSE

- FENETRES FIBRES–OPTIQUES
- PHOTOCATHODE ϕ 25 mm
- TUBE MONOETAGE DIODE
- FOCALISATION ELECTROSTATIQUE
- RESOLUTION ELEVEE (65 pl/mm)
- GRANDE SENSIBILITE
- ROBUSTESSE

Les tubes intensificateurs d'image TH 9473 sont du type mono tension à focalisation électrostatique et fenêtres d'entrée et sortie planes à fibres optiques. Leur champ utile est de 25 mm et le grandissement d'image est de 1. La planéité des surfaces de ces fenêtres permet l'utilisation de ces tubes avec des objectifs conçus pour des champs plats ou en couplage optique direct avec des plaques photographiques ou avec d'autres intensificateurs ou tubes de prise de vues comportant également une fenêtre à fibres optiques plane.

En particulier ces tubes peuvent être assemblés pour la réalisation des triplets TH 9475 utilisés pour les lunettes de vision nocturne. Les tubes TH 9473 . T1 et TH 9473 . T2 comportent une photocathode multialcaline du type S20 et un écran d'observation vert du type P20.

Le tube TH 9473 . T1 comporte en outre les caractéristiques suivantes :

- Réponse spectrale étendue dans le rouge (850 nm).
- Très faible bruit de fond.

Des variantes de ces tubes peuvent être réalisées avec une réponse spectrale différente (S1) ou un autre type d'écran d'observation (P11). Ces tubes peu encombrants, robustes et de grande simplicité de fonctionnement sont utilisés dans des domaines scientifiques très divers comme : l'astronomie, l'océanographie, la biologie, la médecine et également dans les applications de surveillance ou de visée lorsque le niveau de lumière ambiante est faible

CARACTERISTIQUES MECANIQUES

Longueur maximale hors tout	61	mm
Diamètre maximal hors queusot	49, 3	mm
Diamètre maximal queusot compris	59, 4	mm
Masse, approximative	150	g
Orientation	indifférente	

CARACTERISTIQUES ELECTRIQUES

Focalisation	électrostatique
Type	diode

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

CARACTERISTIQUES OPTIQUES

PHOTOCATHODE

	TH 9473 . T1	TH 9473 . T2
Type	S 20 (sensibilité étendue dans le rouge)	S 20
Nature	Na, K, Cs, Sb (multialcaline)	
Surface minimale	4, 9 cm^2	
Diamètre minimal utile	25 mm	
Fenêtre d'entrée :		
Forme	Plate et circulaire (planéité 1 μ)	
Diamètre	35, 6 mm	
Nature	Fibres optiques (fibres élémentaires 5 à 6 μ)	

ECRAN FLUORESCENT

Type	P 20
Surface minimale	5, 3 cm^2
Diamètre minimal utile	27 mm
Fluorescence et phosphorescence	jaune – vert
Persistance	moyenne
Fenêtre de sortie :	
Forme	Plate et circulaire (planéité 1 μ)
Diamètre	35, 6 mm
Nature	Fibres optiques (fibres élémentaires 5 à 6 μ)

CARACTERISTIQUES D'UTILISATION

VALEURS LIMITES D'UTILISATION

Tension entre écran et photocathode (note 12)	max.	16	kV
	min.	6	kV
Luminance de sortie	max.	400	cd/m^2
Température de stockage	max.	+70	°C
	min.	–55	°C
Température de fonctionnement	max.	+50	°C
	min.	–50	°C

CONDITIONS D'ESSAIS

Température ambiante	20 ± 5	°C
Tension d'anode	15	kV
Température de couleur de la source de lumière incidente	2854	°K

PERFORMANCES

	TH 9473 . T1			TH 9473 . T2			
	min.	typique	max.	min.	typique	max.	
Résolution :							
Centrale (note 1)	55	65	–	55	65	–	pl/mm
Périphérique (note 2)	50	60	–	50	60	–	pl/mm
Gain en luminance à 2854 °K (note 3)	30	35	–	–	–	–	cd/m²/lx
Gain en lumière verte (note 4)	–	–	–	20	25	–	W/W
Eclairement d'entrée équivalent au bruit propre (note 5)	–	–	2.10^{-7}	–	–	30.10^{-7}	lx
Sensibilité photocathode (note 6)							
Lumineuse à 2854 °K	175	200	–	–	150	–	µA/lm
Radiante à 800 nm	6.10^{-3}	–	–	–	–	–	A/W
Radiante à 850 nm	1.10^{-3}	–	–	–	–	–	A/W
Uniformité de luminance	–	30 (note 7)	40	–	30 (note 8)	40	%
Grandissement central (note 9)	0.94	–	1	0.94	–	1	
Distorsion (note 10)	–	–	8	–	–	8	%
Alignement d'image (note 11)	–	–	0.3	–	–	0.3	mm

ESSAIS D'ENVIRONNEMENT

Les tubes sont conçus pour une utilisation dans des conditions d'environnement sévères; les essais auxquels ils peuvent être soumis sont les suivants :

TEMPERATURE

Les tubes sont essayés en fonctionnement à + 50 °C et –50 °C. Ils sont maintenus à ces températures pendant 1 heure sans éclairement et examinés électriquement.

Ils sont ensuite ramenés à la température ambiante en 15 minutes et examinés à nouveau.

VIBRATIONS

Le tube étant fixé rigidement, en position verticale, la cathode dirigée vers le haut, est vibré parallèlement et perpendiculairement à l'axe optique.

L'amplitude des vibrations sinusoidales est de 1, 30 mm crête et la fréquence varie de façon continue de 10 Hz à 55 Hz et de 55 Hz à 10 Hz. Chaque cycle dure 1 minute.

L'essai comporte 10 cycles suivant chaque direction.

CHOCS

Le tube est en fonctionnement. La tension de fonctionnement est de 15 kV et la cathode reçoit un éclairement inférieur à 10^{-3} lux.

Le tube est soumis à 6 chocs parallèlement et perpendiculairement à l'axe optique chaque choc ayant une amplitude de 75 g (onde semi-sinusoidale) et une durée de 6 ms ± 2 ms.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

NOTES

1 – La résolution est mesurée horizontalement et verticalement avec une mire composée alternativement de traits noirs et blancs.
2 lignes adjacentes forment une "paire de lignes".

2 – La résolution périphérique est mesurée à 10 mm de l'axe optique du tube.

3 – La source lumineuse est une lampe à filament de tungstène dont la température de couleur est de 2854 °K. Le gain est mesuré avec un éclairement incident de 10^{-4} lux sur la photacathode.

4 – Ce gain est mesuré en interposant entre la lampe à filament de tungstène et la photocathode deux filtres MTO DA 545 C +DH 549 C' pour simuler un écran P 20.

5 – C'est la valeur du flux lumineux d'une lampe au tungstène opérant à 2854 °K qui provoquerait une augmentation de la luminance de sortie de l'écran égale au bruit de fond du tube intensificateur.

6 – La sensibilité de photocathode est mesurée sur une surface de π cm^2 avec un flux de 10^{-2} lumen. Pour mesurer la sensibilité radiante à 800 nm et 850 nm on interpose entre la source lumineuse et le tube des filtres qui délivrent 280 μW/lm et 260 μW/lm.

7 – L'uniformité de luminance est mesurée en lumière blanche avec une lampe à filament de tungstène dont la température de couleur est 2854 °K.

8 – L'uniformité de luminance est mesurée en lumière verte en interposant les filtres MTO DA 545 C et DH 549 C' entre la source et le tube.

9 – Le grandissement central est défini comme étant le rapport de la distance D_{PC} de 2 points dont on forme l'image sur la photocathode à la distance D_E de ces 2 points sur l'écran de sortie. Les 2 points sur la photocathode sont distants de 2 mm et sont situés à égale distance de l'axe optique du tube.

$$M_C = \frac{D_E}{D_{PC}}$$

10 – On définit le grandissement périphérique en faisant la même mesure que dans la note 9 en prenant $D'_{PC} = 20$ mm

On définit alors : $M_p = \frac{D'E}{D'_{PC}}$

La distorsion est alors :

$$D\,\% = \frac{M_p - Mc}{Mc} \times 100$$

11 – Une image d'un diamètre $\phi = 0{,}1$ mm est formée sur la photocathode. L'image obtenue sur l'écran de sortie doit tomber à l'intérieur d'un cercle concentrique de diamètre $\phi = 0{,}3$ mm.

12 – Au dessous de 6 kV la résolution du tube décroit rapidement.

POINTS D'ECRAN ET DE PHOTOCATHODE

Diamètre des points noirs d'écran ou de photocathode	"Zone 1" (note 1)	"Zone 2" (note 2)	"Zone 3" (note 3)
$\geqslant$ 0,4 mm	0	0	0
0,25 mm $\leqslant$ d $<$ 0,4 mm	0	1	3
0,15 $\leqslant$ d $<$ 0,25 mm	0	3	5
0,08 mm $\leqslant$ d $<$ 0,15 mm	1	6	Minimum *
d $<$ 0,08 mm	Minimum *	Minimum *	Minimum *

NOTES

1 – La surface 1 est celle d'un cercle de 7,6 mm de diamètre centré sur l'axe optique du tube.

2 – La surface 2 est celle d'une couronne comprise entre le cercle de 7,6 mm de diamètre et le cercle de 20 mm de diamètre.

3 – La surface 3 est celle d'une couronne comprise entre le cercle de 20 mm de diamètre et le cercle de 25 mm de diamètre.

* – Les points, dont le nombre est défini comme "Minimum" ne sont pas comptés, cependant leur densité ne doit pas être trop importante.

CONDITIONS D'UTILISATION

1 – L'alimentation en tension continue de ces tubes peut être effectuée à l'aide d'une unité d'alimentation haute tension de débit 1 μA environ constituée d'un oscillateur et d'un multiplicateur comportant plusieurs étages de diode capacité. De telles alimentations peuvent être achetées dans le commerce.

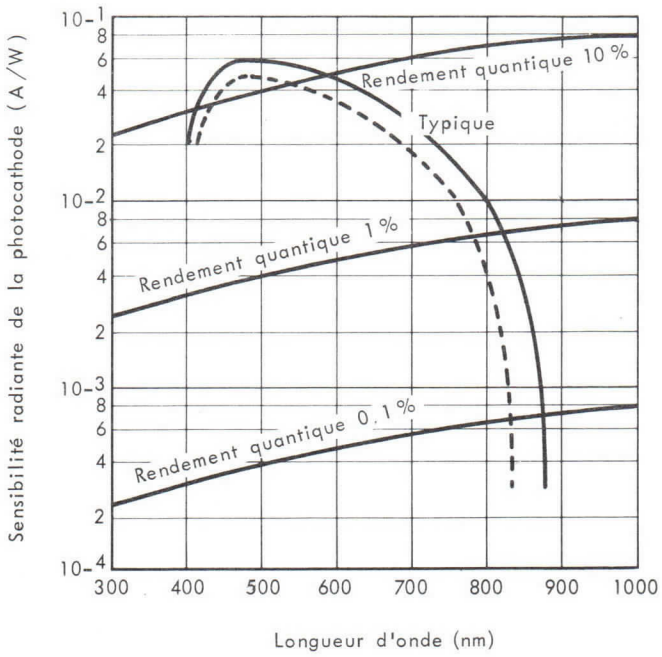
Pour éviter les effets corona il est recommandé d'éviter une humidité élevée et de soigner les fils de connexion de la haute tension. Sur demande ces tubes peuvent être livrés encapsulés dans un élastomére silicone.

2 – BLINDAGE MAGNETIQUE

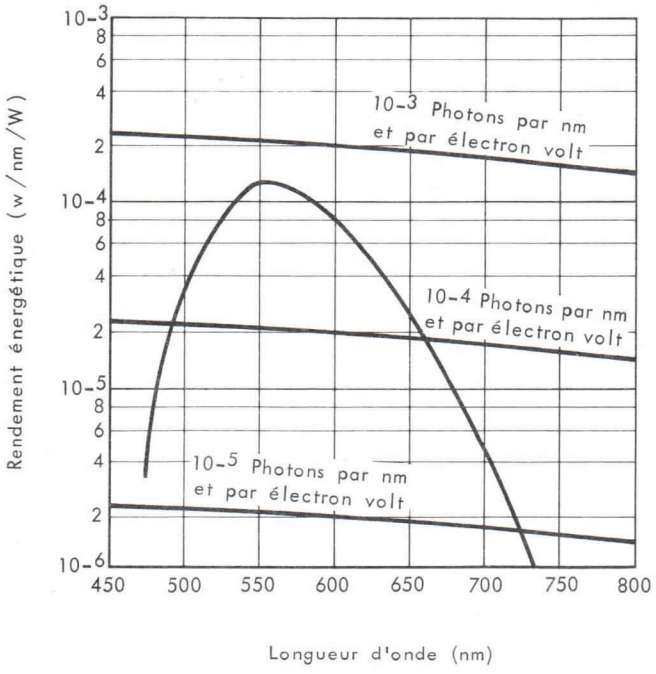
Un blindage peut être nécessaire pour éviter l'effet des champs magnétiques parasites sur la qualité d'image. Les champs alternatifs peuvent en particulier détériorer notablement le pouvoir de résolution.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

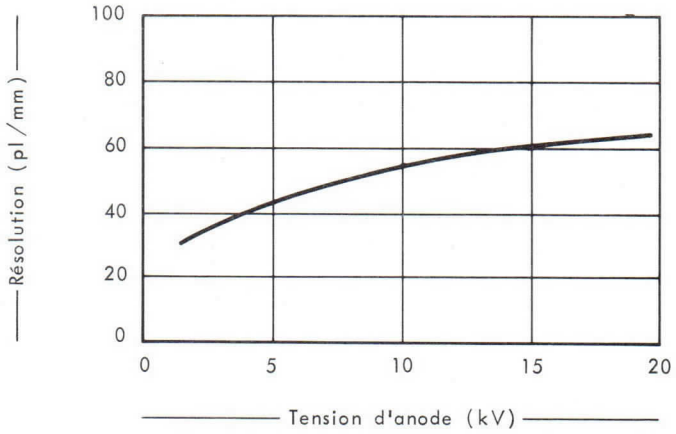
REPONSE SPECTRALE DE LA PHOTOCATHODE S20
(étendue dans le rouge)



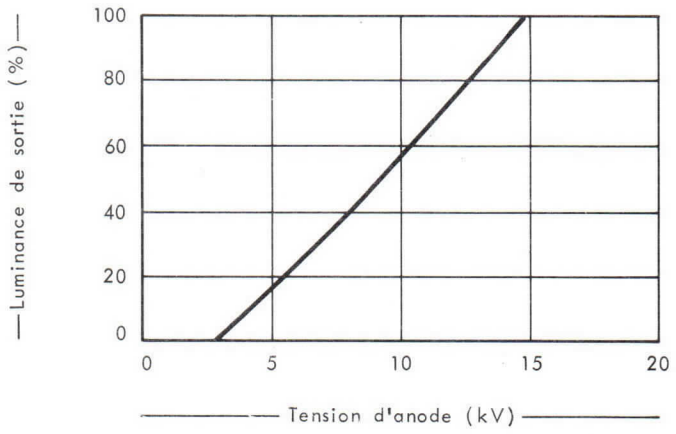
REPONSE SPECTRAL D'UN ECRAN P20 ALUMINISE



VARIATION DE LA RESOLUTION AU CENTRE
EN FONCTION DE LA HAUTE TENSION

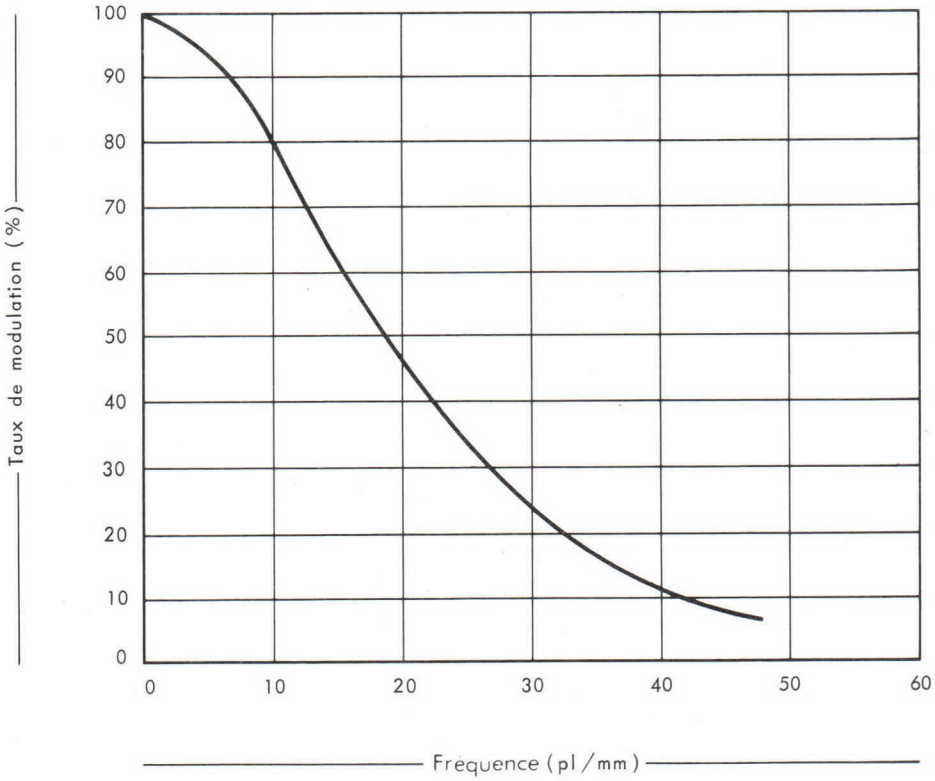


VARIATION RELATIVE DE LA LUMINANCE DE SORTIE
EN FONCTION DE LA HAUTE TENSION

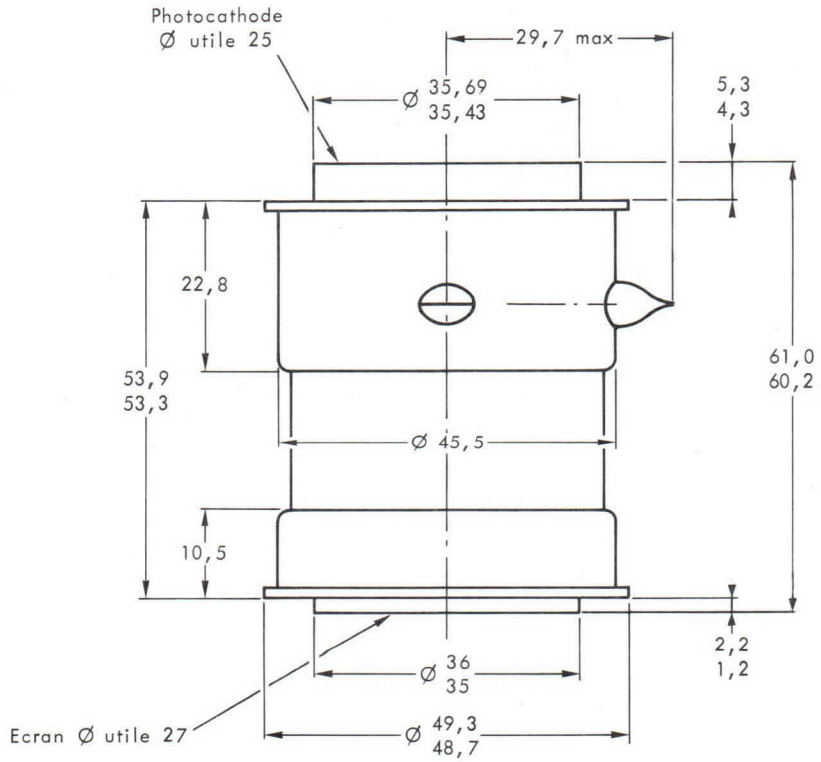


THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

FONCTION DE TRANSFERT DE MODULATION



DESSIN D'ENCOMBREMENT



Cotes en mm.

TH 9475 (F 9475)
THREE CASCADED STAGES LIGHT IMAGE INTENSIFIER TUBE

The TH 9475 (F 9475) is a light image intensifier tube with very high gain designed for night viewing systems. It can be used either for realization of direct viewing night vision system or as intensifier stage optically coupled to a T.V. camera tube.

The photocathode is of S20 type with extended red sensitivity and the yellow-green fluorescent P20 phosphor exhibits a high energy efficiency.

The TH 9475 is composed of three electrostatic self-focused image intensifier modules having photocathode and screen useful diameter of 25 mm. These cascaded stages are mechanically and optically coupled through fiber-optics windows. Each module, of diode type, requires only one potential of 15 kV to be applied across the unit. Thereby the tube is operated with 45 kV applied to the viewing screen while the photocathode is at zero potential. This d.c. high voltage is provided by an integral multistage voltage multiplier requiring a sine wave 1500 Hz external supply.

The assembly (tube and voltage multiplier) is encapsulated in a silicone compound with mechanical references for tube mounting.

This tube of ruggedized construction is designed to be operated under severe environmental conditions : vibration, shock and temperature exposure.

GENERAL CHARACTERISTICS

Focusing method	electrostatic
Photocathode :	
type	S20 with extended red sensitivity
face	flat - fibers-optics - elementary fiber 5 μ
minimum useful diameter	25 mm
Viewing screen :	
type	P20 aluminized
Fluorescence	yellow-green
face	flat - fiber optics- elementary fiber 5 μ
minimum useful diameter	25 mm
Numerical aperture of fiber optics, approx.	1
External surfaces (input and output windows)	flat to within 2.5μ
Operating position	any
Overall length	193. 5 mm
Maximum diameter	69. 8 mm
Weight, approximate	800 g

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

MAXIMUM RATINGS

(Absolute values)

Voltage supply (sine wave - peak to peak)	max.	2800	V
Frequency of voltage supply	max.	2000	Hz
	min.	1400	Hz
Photocathode illumination (note 1)	max.	5.10^{-3}	lux
Storage temperature	max.	+68	°C
	min.	−54	°C
Operating temperature	max.	+52	°C
	min.	−54	°C

OPERATIONAL CHARACTERISTICS

Operating conditions

Normal ambient temperature	20 ± 5	°C
Voltage supply (sine wave - peak to peak)	2700	V
Frequency of voltage supply	1500	Hz
Photocathode potential	0	V
Viewing screen potential	45	kV
Colour temperature of incident light source	2854	°K

Performance

	min.	Typical	max.	
Photocathode sensitivity (note 2)				
– luminous at 2854 °K	150	200	–	µA/lm
– radiant at 800 nm	6	10	–	mA/W
at 850 nm	1	3	–	mA/W
Luminance gain (note 3)	104	2.10^4	–	$(cd/m^2)/lx$
Background equivalent illumination	–	$0.5.10^{-7}$	2.10^{-7}	lx
Resolution :				
– center	23	25	–	lp/mm
– peripheral	18	20	–	lp/mm
Modulation transfer function :				
– for 5 lp/mm	75	85	–	%
– for 10 lp/mm	45	60	–	%
– for 15 lp/mm	20	35	–	%
Magnification				
– center Mc (note 4)	0.82	0.85	–	
– peripheral Mp (note 5)		1.01	1.06	
Distortion (note 6)	–	20	25	%
Image alignment	–	0.4	0.8	mm
Tube life	–	3000	–	h

ENVIRONMENTAL TESTS

The tube TH 9475 is designed to withstand the following environmental tests without mechanical damage and electrical failure. After completion of the tests the tube will meet all the characteristics specified under " operational characteristics ".

SHOCK TESTS

The tube is subjected to a 75 g peak hafl sine-wave shock of 6 ± 2 ms duration. Six shock pulses are performed in each of two perpendicular directions, one of which shall be parallel to optical axis of the tube.

VIBRATION TESTS

The tube is vertically mounted with the photocathode end up and is subjected to sine wave vibrations of 1. 30 mm amplitude for a vibration cycle having a duration of 1 minute during which time the frequency is varied from 10 to 55 Hz and back to 10 Hz.

Ten frequency sweeps are performed in each of three mutually perpendicular directions, one of which shall be parallel to optical axis of the tube.

TEMPERATURE TESTS

The tube is subjected to a temperature cycle within + 52 °C to −54 °C range and is held at these maximum and minimum values during 2 hours.

NOTES

1 - Maximum illumination allowed for the photocathode in permanent operating condition. Intermittent illumination (duration less than 10 s) up to 15. 10^{-3} lux is allowed.

The tube should not be operated in daylight.

2 - The photocathode sensitivity is measured on a surface of π cm^2 with a flux of 0. 01 lumen.

At 800 nm and 850 nm the radiant sensitivity is measured with the incident light being filtered before falling on the photocathode. At 800 nm the interposed filter delivers 280 μW/lm and at 850 nm, it delivers 260 μW/lm.

3 - The luminance gain is measured at 10^{-4} lux incident illumination for a photocathode surface of π cm^2

4 - The center magnification Mc is defined as the ratio of the distance of two image points on the screen to the distance of the two corresponding points on the photocathode. The points on the photocathode are separated by a distance of 2 mm centered on tube axis.

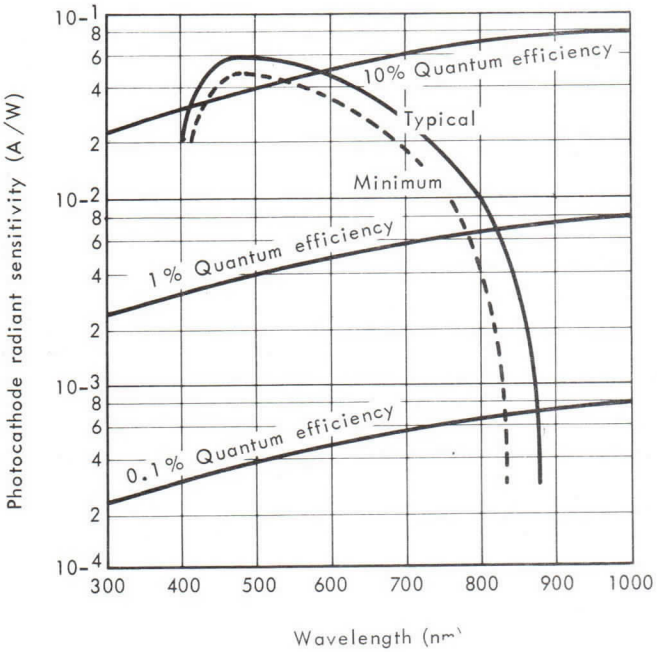
5 - The peripheral magnification Mp is measured in the same conditions as stated above except that the distance between two points on the photocathode is 20 mm.

6 - The per-cent distortion D is defined by the equation :

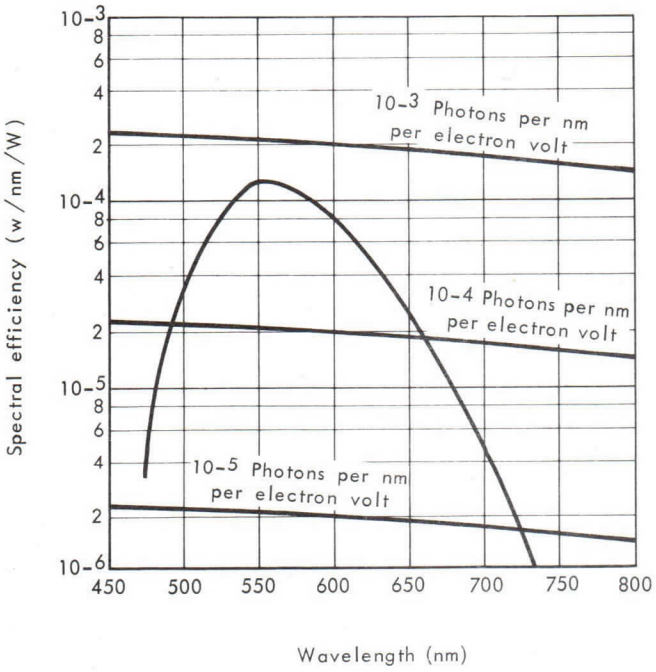
$$D = \frac{Mp - Mc}{Mc} \times 100$$

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

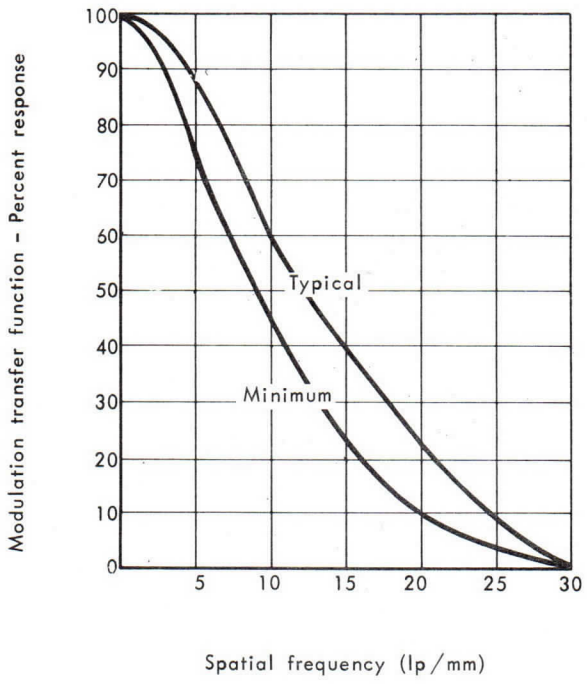
S 20 PHOTOCATHODE SPECTRAL RESPONSE
(with extended red sensitivity)



SPECTRAL EFFICIENCY CHARACTERISTICS OF
ALUMINIZED P20 PHOSPHOR SCREEN

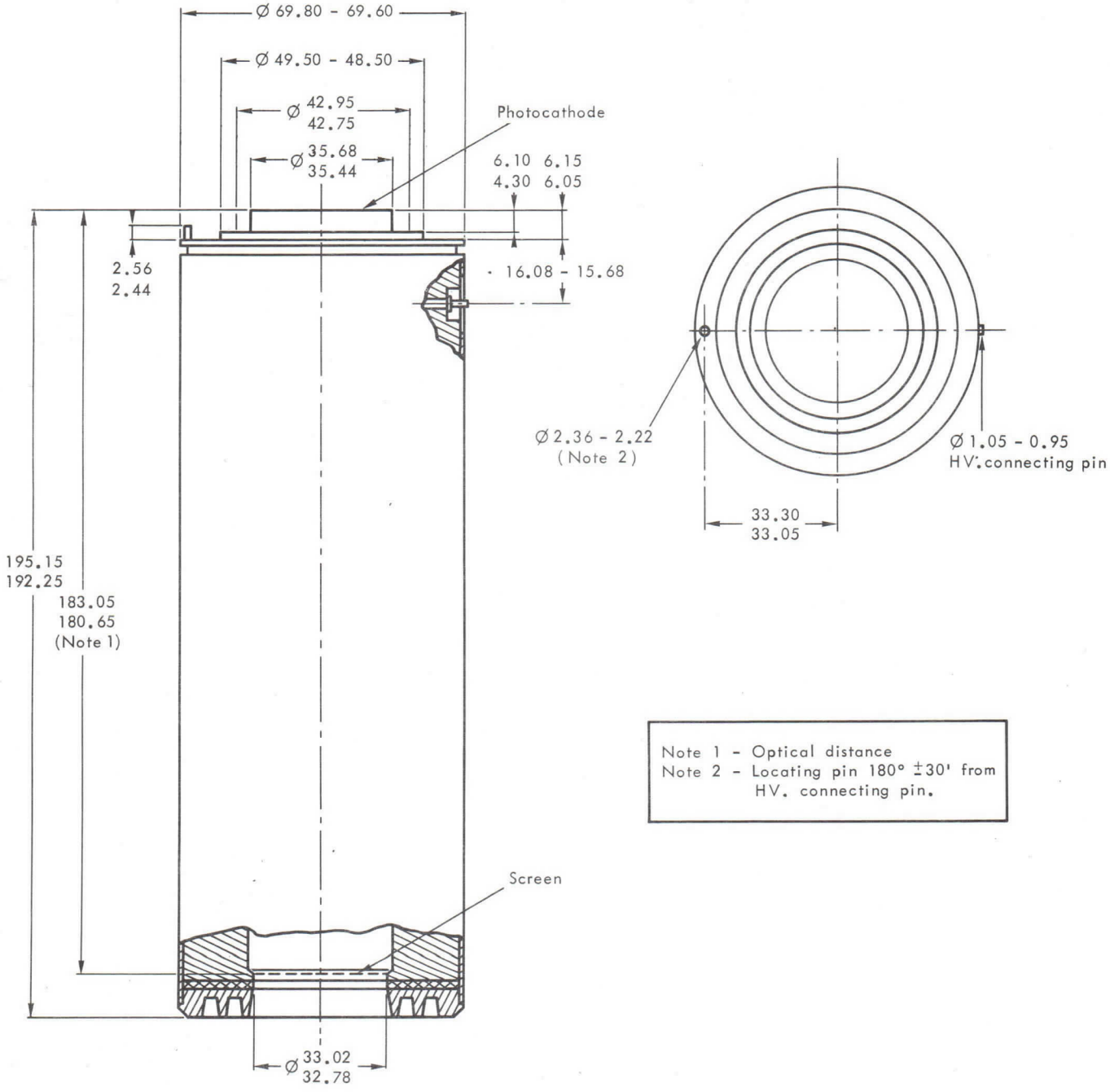


MODULATION TRANSFER FUNCTION



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING



Note 1 - Optical distance
Note 2 - Locating pin 180° ±30' from HV. connecting pin.

Dimensions in mm.

TH 9476
INTENSIFICATEUR D'IMAGE LUMINEUSE
POUR VISION NOCTURNE

- FENETRES FIBRES OPTIQUES
- PHOTOCATHODE ϕ 25 mm
- TUBE MONOETAGE DIODE
- FOCALISATION ELECTROSTATIQUE
- GRANDE SENSIBILITE (200 μA/lm)
- FAIBLE DISTORSION
- ROBUSTESSE

Le tube TH 9476 est un intensificateur d'image du type mono-tension à focalisation électrostatique de champ utile 25 mm, sensible dans le visible et le proche infra-rouge, destiné principalement aux équipements d'aide à la vision (ou télévision) nocturne opérant en lumière résiduelle.

Les fenêtres d'entrée et de sortie planes à fibres optiques permettent d'envisager son utilisation conjointe avec des tubes de prise de vue ou d'autres intensificateurs d'image.

L'utilisation d'une photocathode du type S20 (sensibilité étendue dans le rouge) et d'un grandissement de 0,8 environ lui confèrent un facteur de conversion brillance-éclairement élevé. La conception de l'optique électronique permet l'obtention d'une résolution supérieure à 40 pl/mm sur la face d'entrée avec une distorsion d'image faible d'environ 3 %.

Des variantes de ce tube peuvent être réalisées avec un autre type d'écran d'observation (P22 B) ou une glace de sortie plane normale (sans fibres optiques).

La simplicité d'utilisation du tube ainsi que sa robustesse permettent son incorporation dans des équipements d'aide à la vision nocturne pouvant être embarqués et susceptibles d'être utilisés dans des conditions d'environnements sévères.

APPLICATIONS

Du fait de son gain élevé, le tube TH 9476 peut être utilisé isolément dans beaucoup d'applications : réalisation de lunettes pour vision nocturne et utilisation dans des domaines scientifiques comme la microscopie électronique, l'astronomie ou la physique nucléaire.

Avec un écran de conversion déposé sur la fenêtre d'entrée à fibres optiques il peut servir à la détection des rayons - X, gamma ou des images de neutrons lents.

La fenêtre de sortie à fibres optiques permet également l'insolation directe de films photographiques.

Lorsqu'une plus grande intensification est nécessaire le TH 9476 peut être couplé avec un autre intensificateur comme le TH 9473.

Par association avec un tube de prise de vue à face d'entrée à fibres optiques (Vidicons TH 9812 FO ou TH 9830 FO) des applications similaires en télévision peuvent être envisagées et notamment la surveillance nocturne.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

CARACTERISTIQUES MECANIQUES

Longueur totale	92	mm
Diamètre maximal hors queusots	65, 1	mm
Diamètre maximal queusots compris	68	mm
Masse approximative	170	g
Orientation	indifférente	

CARACTERISTIQUES ELECTRIQUES

Focalisation	électrostatique
Type	diode

CARACTERISTIQUES OPTIQUES

PHOTOCATHODE

Type	S20 (sensibilité étendue dans le rouge)	
Réponse spectrale	voir fig. 1	
Diamètre utile maximal	25	mm
Fenêtre d'entrée :		
- forme	plate et circulaire (planéité 1μ)	
- diamètre	35, 55	mm
- nature	(fibres élémentaires 5 à 6 μ)	

ECRAN FLUORESCENT

Type	P 20	
Diamètre utile minimal	20	mm
Fluorescence et phosphorescence	jaune - vert	
Persistance	moyenne	
Fenêtre de sortie :		
- forme	plate et circulaire (planéité 1 μ)	
- diamètre	27	mm
- nature	fibres optiques (fibres élémentaires 5 à 6 μ)	

CARACTERISTIQUES D'UTILISATION

VALEURS LIMITES D'UTILISATION

Tension entre photocathode et écran	max.	18	kV
Courant de photocathode à la tension nominale	max.	0, 1	μA
Eclairement de photocathode	max.	1	lux
Température de stockage	max.	+68	°C
	min.	−34	°C
Température de fonctionnement	max.	+50	°C
	min.	−32	°C

EXEMPLES DE FONCTIONNEMENT (Note 1)

Température ambiante	20 ± 5		°C
	Alimentation positive	Alimentation négative	
Tension nominale photocathode	0	−16	kV
Tension nominale écran	16	0	kV

PERFORMANCES

	min.	typique	max.	
Sensibilité de photocathode (note 2)	175	200	—	µA/lm
Facteur de conversion (note 3)	60	80	—	cd/m²/lux
Résolution centrale (note 4)	40	45	—	pl/mm
Résolution périphérique (note 5)	28	32	—	pl/mm
Grandissement central (note 6)	0, 70	0, 72	0, 74	
Distorsion (note 7)	—	3	3, 5	%
Eclairement d'entrée équivalent au bruit propre .	—	—	$2, 10^{-7}$	lux

ESSAIS D'ENVIRONNEMENT

Le tube TH 9476 supporte hors fonctionnement les essais d'environnement suivants. Après exécution de ces essais le tube doit satisfaire aux performances définies dans le paragraphe CARACTERISTIQUES D'UTILISATION.

ESSAI CLIMATIQUE

Le tube est soumis à 4 cycles de température entre −34 °C et +68 °C avec maintien aux températures extrêmes pendant 30 minutes. Chaque cycle est exploré avec une variation de l'ordre de 2 °C/mn .

ESSAI EN VIBRATIONS SINUSOIDALES

L'essai est conduit conformément à la spécification MIL - STD 810 B, Méthode 514, courbe Z.

Exploration aller-retour de la gamme 5 - 500 Hz permettant un niveau d'accélération de 10 g dans la plage 74 à 500 Hz. Durée d'un cycle 15 minutes. Réalisation de deux cycles suivant chacun des trois axes du tube.

ESSAI DE SECOUSSES

L'essai est réalisé conformément à NF C93 - 001. Essai 24 avec :

- accélération maximale : 25 g
- nombre de secousses suivant l'axe longitudinal du tube : 1000.

NOTES

1 - Pour l'association d'un tube TH 9476 et d'un tube de prise de vue type Vidicon, il est impératif d'utiliser une source d'alimentation haute tension négative (écran à la masse).

2 - Sensibilité de photocathode mesurée avec une lampe à filament de tungstène à la température de couleur de 2854 °K sur un cercle de 20 mm de diamètre centré sur la photocathode.

3 - Facteur de conversion mesuré en cd/m² en sortie, rapporté à l'éclairement de la face d'entrée mesuré en lux. Les valeurs indiquées correspondent à des tubes à fenêtre de sortie constituée par une glace claire.

4 - Résolution mesurée au niveau de la photocathode dans un cercle de 2,5 mm de diamètre centré sur la fenêtre d'entrée. Mesurée au niveau de l'écran, la résolution centrale typique est de 60 pl/mm.

5 - Résolution périphérique mesurée sur un cercle de 20 mm de diamètre centré sur la photocathode.

6 - Grandissement central mesuré dans un cercle de diamètre 2,5 mm centré sur la photocathode.

7 - Distorsion mesurée par $D = \frac{Mp - Mc}{Mc} \times 100$

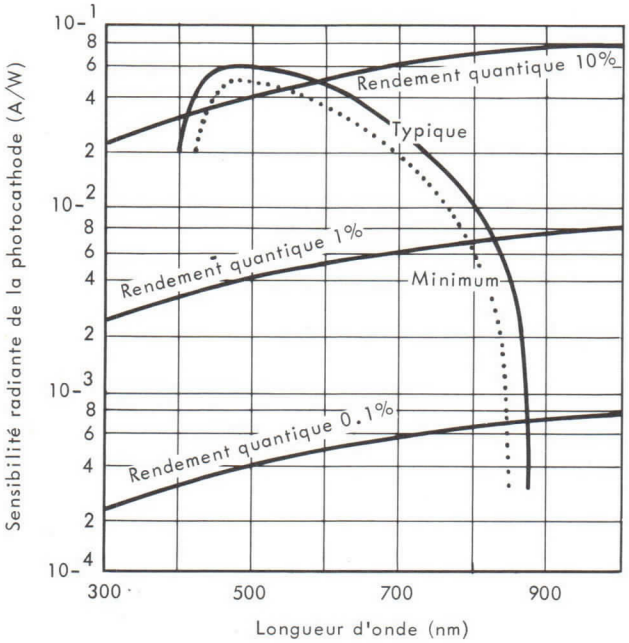
Mp ; grandissement périphérique pour un diamètre à l'entrée de 20 mm.

Mc : grandissement au centre selon note 6.

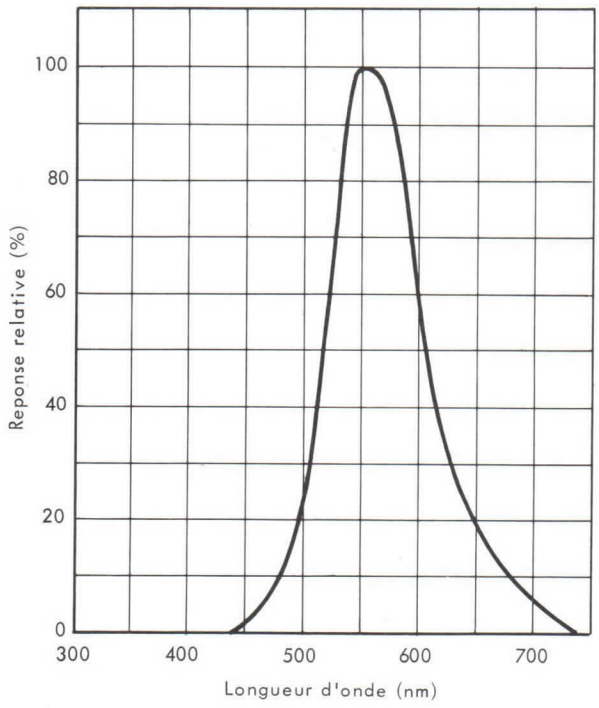
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

REPONSE SPECTRALE DE LA PHOTOCATHODE S 20

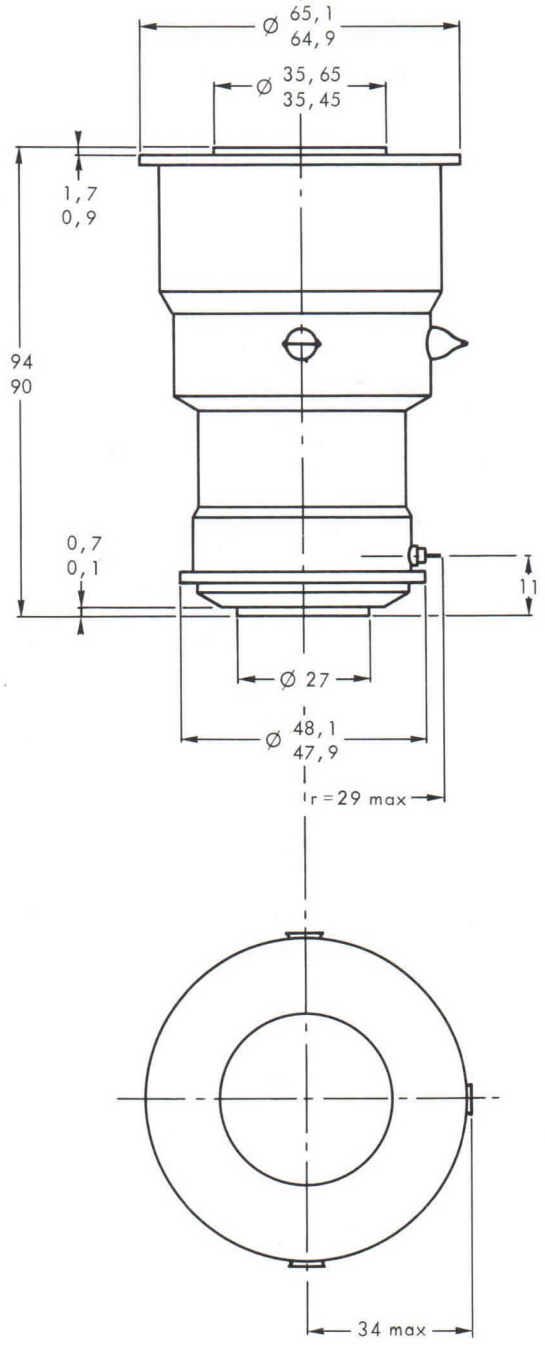
(étendue dans le rouge)



DISTRIBUTION SPECTRALE DE L'ECRAN P 20



DESSIN D'ENCOMBREMENT



Cotes en mm.

TH 9476

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

THOMSON-CSF

U.V

TH 9477
INTENSIFICATEUR D'IMAGE SENSIBLE DANS L'ULTRAVIOLET

Le tube TH 9477 est un intensificateur d'image à concentration électrostatique de champ utile 7 mm et de grandissement électronique 2, 3, sensible dans le domaine du proche ultraviolet et pratiquement insensible dans tout le spectre visible.

Il comporte une photocathode au tellurure de césium déposée sur une glace plane en silice fondue de haute pureté, dont la transmission à la longueur d'onde de 250 nm est de l'ordre de 90 % .

L'optique électronique de transfert des photo-éléctrons est du type triode et l'écran de sortie a une émission spectrale centrée sur la région verte du spectre (P 20).

Ce tube permet d'observer des distributions spatiales de rayonnement ultraviolet de 200 à 300 nm d'énergie 1 μ W/ cm2 du fait de leur transformation en rayonnement visible. Il peut être utilisé pour des applications diverses, et notamment en microscopie en ultraviolet, pour l'observation de sources lumineuses diverses, et plus particulièrement en astronomie. Une des caractéristiques intéressantes est que ce tube constitue un système de conversion UV-visible quasi linéaire et peut permettre d'effectuer des mesures de niveau d'énergie dans une bande de longueur d'onde étroite.

Son pouvoir de résolution est de l'ordre de 50 pl/mm ramené à la photocathode d'entrée.

Par ailleurs, le tube TH 9477 peut être livré avec une glace de sortie à fibres optiques (TH 9477 FO), en vue de permettre son couplage optique direct avec un Vidicon comportant également une face d'entrée à fibres optiques (TH 9812 FO ou TH 9813 FO, par exemple).

L'ensemble, ainsi réalisé, constitue un tube de prise de vue sensible dans le proche ultraviolet, pouvant fonctionner dans les caméras standards Vidicon légèrement modifiées, (adjonction d'une source haute tension à faible débit et modification mécanique de la platine avant de la caméra pour permettre le logement du tube convertisseur). Un tel ensemble peut permettre d'obtenir une image de qualité satisfaisante avec une résolution de l'ordre 500 points par ligne, pour un niveau d'énergie à 250 nm inférieur à 0 , 1 μ W/ cm2.

CARACTERISTIQUES DU TUBE

Caractéristiques géométriques

	Tube nu	Tube enrobé	
Longueur	90	92	mm
Diamètre maximal	65	70	mm

Caractéristiques générales

—Glace d'entrée	Silice fondue-plane (épaisseur 2 mm ± 0, 2 mm)
Photocathode	Tellurure de césium
Réponse spectrale	voir figure 1.
Maximum de photosensibilité	250 nm
Diamètre de l'image d'entrée	7 mm

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

—Glace de sortie	Plane-standard ou fibres optiques
Ecran fluorescent	P. 20
Fluorescence et phosphorescence	Jaune-Vert (max. à 550 nm)
Diamètre de l'image de sortie	16, 5 mm

Caractéristiques électriques

Concentration	électrostatique
Type	triode

CONDITIONS D'EMPLOI

Valeurs limites d'utilisation

	Alimentation positive	Alimentation négative	
Tension de la photocathode	0	−15	kV
Tension de l'électrode g1	−1	−16	kV
Tension de l'écran	15	0	kV
Energie incidente sur la photocathode . max	100 μ W/ cm^2 à 250 nm		
Température max	70 °C		

Exemples de fonctionnement

	Alimentation positive	Alimentation négative	
Tension de la photocathode	0	−12	kV
Tension de l'électrode g1	−0, 4 ± 0, 1	−12, 4 ± 0, 1	kV
Tension de l'écran	12	0	kV

Performances électrooptiques

Sensibilité photocathode	(λ = 250 nm)	10^{-2} μ A/ μW min.
Sensibilité photocathode	(λ = 350 nm)	10^{-4} μ A/ μW max.
Facteur de conversion	(λ = 250 nm)	0, 2 cd/ m^2/μ A
Pouvoir de résolution pour 1 μW/ cm^2 incident		50 pl/ mm ramené à la face d'entrée

EXEMPLE D'ASSOCIATION D'UN TUBE TH 9477 FO à un VIDICON

Le tube TH 9610 résulte de l'association du tube TH 9477 FO à sortie fibres optiques au Vidicon TH 9812 FO à face d'entrée à fibres optiques (concentration et déviation électromagnétiques).

Les conditions de fonctionnement et les caractéristiques individuelles des deux tubes accouplés restant valables, le couplage des deux tubes peut être effectué sous la responsabilité du client. Il est cependant préférable de le faire exécuter par le fournisseur. La section TH 9477 FO peut, à ce stade, être fournie, enrobée d'un élastomère silicone, ce qui peut faciliter le montage mécanique du tube dans la caméra, et éviter des fuites extérieures lorsque les conditions d'humidité sont défavorables.

Remarques :

Pour l'association d'un tube à glace de sortie à fibres optiques (TH 9477 FO) et d'un tube de prise de vue type Vidicon, il est impératif d'utiliser une source d'alimentation haute tension négative (anode à la masse).

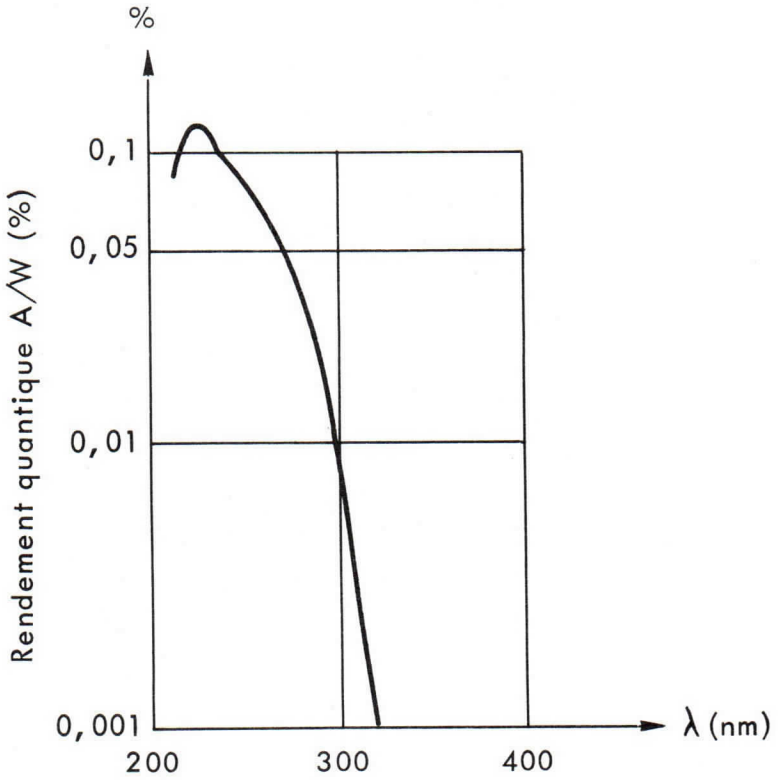
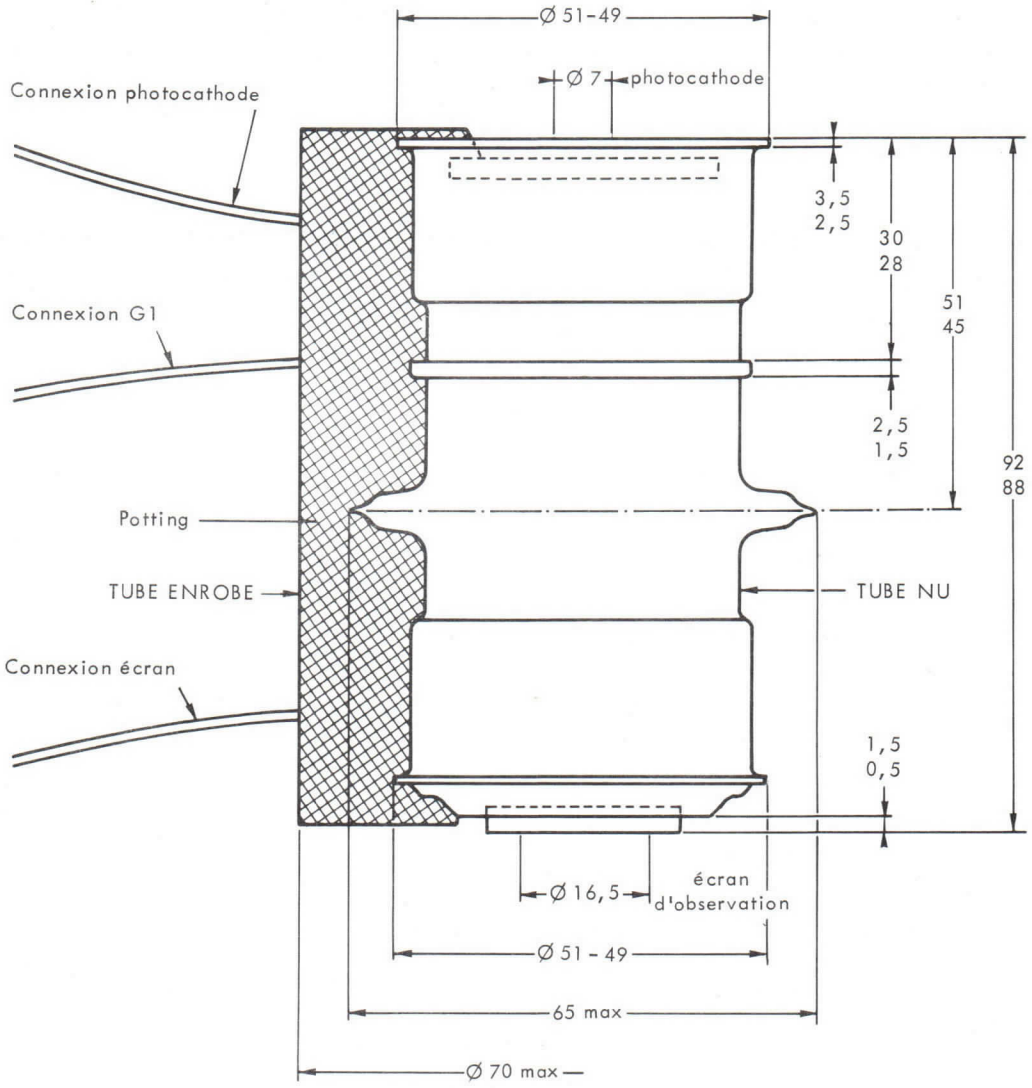


Fig. 1 - Courbe de réponse spectrale de la photocathode Cs_2 Te

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

DESSIN D'ENCOMBREMENT



Cotes en mm.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PROVISOIRE

TH 9478
INTENSIFICATEUR D'IMAGE LUMINEUSE
POUR VISION NOCTURNE

- FACTEUR DE CONVERSION ELEVE : 400 cd/m^2/lux
- FOCALISATION ELECTROSTATIQUE – TYPE TETRODE
- POIDS ET VOLUME REDUITS. ROBUSTESSE

Le tube TH 9478 est un intensificateur d'image, de champ utile 34 mm, sensible dans le visible et le proche infra-rouge, destiné aux équipements d'aide à la vision nocturne opérant en lumière résiduelle. Ses caractéristiques le rendent bien adapté à la réalisation de lunettes monoculaires ou binoculaires de faible encombrement à grand champ et à haute sensibilité.

L'utilisation d'une photocathode du type S20 (sensibilité étendue dans le rouge) à grand rendement et d'un grandissement de 0,3 environ lui confèrent un facteur de conversion brillance-éclairement élevé. La conception de l'optique électronique et de l'écran de sortie permet l'obtention d'un pouvoir de résolution supérieur à 25 pl/mm sur la face d'entrée.

La simplicité d'utilisation du tube, son faible encombrement, son poids réduit et sa robustesse permettent de réaliser des équipements d'aide à la vision nocturne passive portables ou embarqués, de performances élevées et utilisables dans les environnements sévères. Il est donc particulièrement indiqué pour les équipements de conduite de véhicules militaires ou de conduite de tir, de jumelles pour vision nocturne, etc . . .

CARACTERISTIQUES MECANIQUES

Longueur totale	79	mm
Diamètre maximal hors queusots	48	mm
Diamètre maximal queusots compris	60	mm
Poids approximatif	90	g

CARACTERISTIQUES ELECTRIQUES

Focalisation	électrostatique
Type	tétrode

CARACTERISTIQUES OPTIQUES

PHOTOCATHODE

Type	S20 (sensibilité étendue dans le rouge)
Réponse spectrale	Voir fig. 1
Fenêtre d'entrée	Plan concave
Diamètre utile maximal	34 mm

ECRAN

Type	P 20
Diamètre utile minimal	12, 3 mm
Fluorescence et phosphorescence	Jaune - Vert
Persistance	Moyenne

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PROVISOIRE

CARACTERISTIQUES D'UTILISATION

Valeurs limites d'utilisation

Tension entre photocathode et électrode g1	max.	0, 5	kV
Tension entre photocathode et électrode g2	max.	2	kV
Tension entre photocathode et écran	max.	18	kV
Courant de photocathode à la tension nominale		0, 1	µA
Eclairement de photocathode		0, 5	lux
Température de stockage	max.	+68	°C
	min.	–34	°C
Température de fonctionnement	max.	+50	°C
	min.	–32	°C

Exemple de fonctionnement (note 1)

Température ambiante	20 ± 5	°C
Tension nominale de photocathode	0	V
Tension nominale d'électrode g1	0, 35 ± 0, 05	kV
Tension nominale d'électrode g2	1, 65 ± 0, 1	kV
Tension nominale d'écran	16	kV

Performances

	Min.	Typique	Max.	
Sensibilité de photocathode (note 2)	150	200	–	µA/lm
Facteur de conversion (note 3)	300	400	–	cd/m^2 /lux
Résolution centrale (note 4)	25	30	–	pl/mm
Résolution périphérique (note 5)	13	15	–	pl/mm
Grandissement central (note 6)	0, 34	0, 35	0, 36	
Distorsion (note 7)	–	3, 5	5	%
Eclairement d'entrée équivalent au bruit propre	–	$2, 10^{-7}$	10^{-6}	lux

NOTES

1 – Les tensions de polarisation sont des valeurs relatives, le potentiel 0 V pouvant être indifféremment celui des électrodes g1 ou g2, ou celui de l'écran, les différences de potentiel indiquées étant conservées entre les différentes électrodes.

2 – Sensibilité de photocathode mesurée avec une lampe à filament de tungstène à la température de couleur standard de 2854 °K.

3 – Facteur de conversion mesuré en cd/m^2 en sortie, rapporté à l'éclairement de la face d'entrée mesuré en lux.

4 – Résolution mesurée au niveau de la photocathode dans un cercle de 3,5 mm de diamètre centré sur la fenêtre d'entrée, la résolution centrale typique mesurée sur l'écran est de 70 pl/mm.

5 – Résolution périphérique mesurée dans un cercle de diamètre 27 mm centré sur la photocathode.

6 – Grandissement central mesuré dans un cercle de diamètre 3, 5 mm centré sur la photocathode.

7 – Distorsion mesurée par :

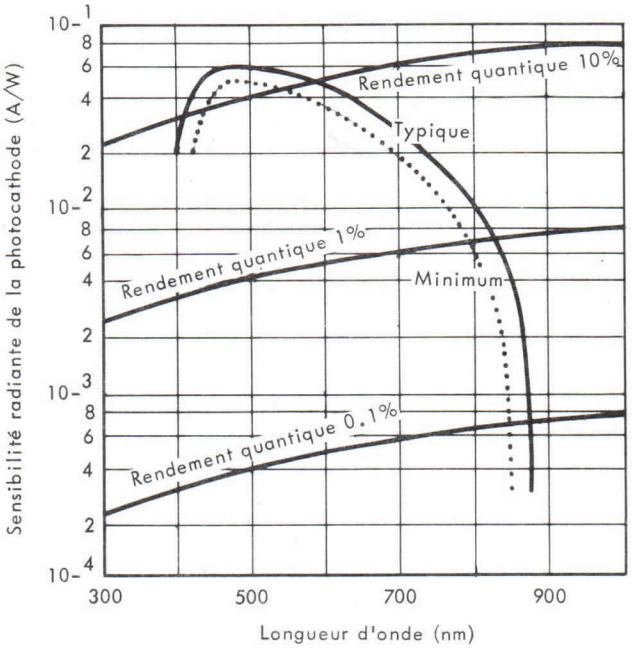
$$D = \frac{Mp - Mc}{Mc} \times 100$$

Mp grandissement périphérique pour un diamètre à l'entrée de 27 mm
Mc grandissement au centre selon note 6

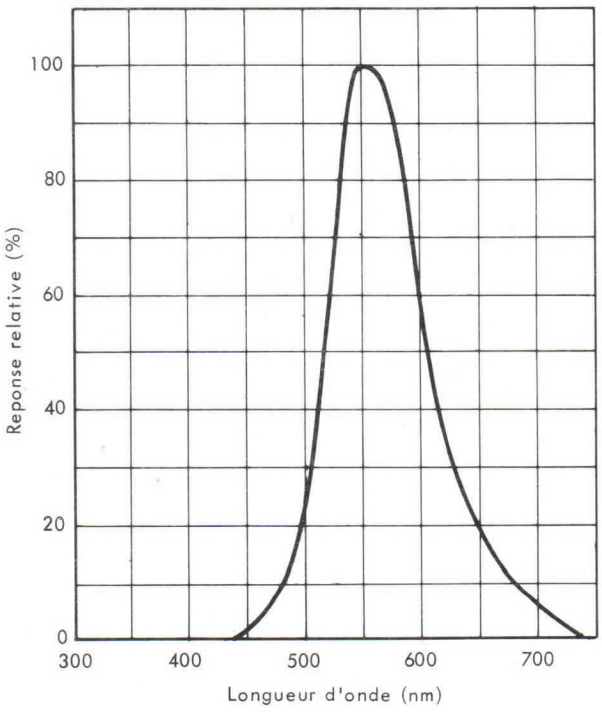
PROVISOIRE

REPONSE SPECTRALE DE LA PHOTOCATHODE S 20

(étendue dans le rouge)



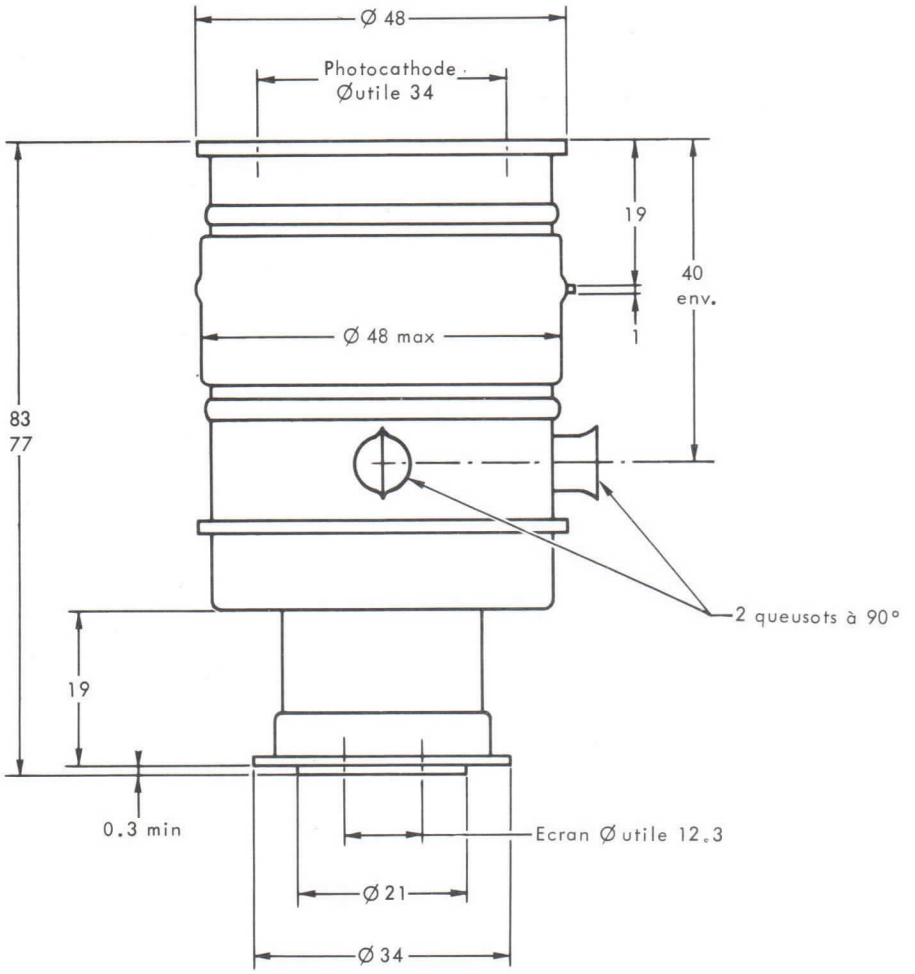
DISTRIBUTION SPECTRALE DE L'ECRAN P 20

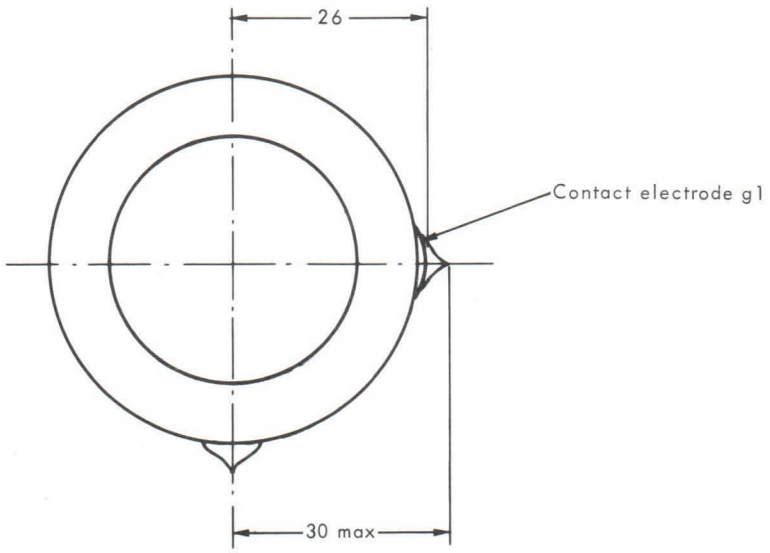


THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PROVISOIRE

DESSIN D'ENCOMBREMENT





Cotes en mm.

TH 9478

LIGHT IMAGE INTENSIFIER TUBE FOR NIGHT VISION

- HIGH LUMINANCE GAIN : 400 cd/m^2 /lux (1250 fL/fc)
- ELECTROSTATIC FOCUS - TETRODE TYPE
- LIGHT WEIGHT, COMPACT AND RUGGEDIZED TUBE

The TH 9478 is a light image intensifier of 34 mm useful input field, sensitive in the visible and near infra-red range, designed for night vision equipment operating at low light levels.

The characteristics of this tube are well matched to the use in compact, large field and high sensitivity monocular or binocular telescopes.

A high luminance gain is achieved by the implementation of a S20ER type photocathode (with red extended sensitivity) and a magnification of about 0.3. The electronoptics and the output screen are designed so as to enable a high resolution of 30 lp/mm on the photocathode.

Simplicity of operation, small size, reduced weight and rugged structure are the other characteristics which make it suitable for portable or airborne high performance night vision systems operating in severe environmental conditions such as : car driving periscopes, night viewing binoculars ...

GENERAL CHARACTERISTICS

Mechanical

Overall length	78	mm
Maximum diameter :		
— exhaust tip included	56	mm
— exhaust tip not included	48	mm
Weight, approx.	90	g

Electrical

Focus	electrostatic
Type	tetrode

Optical

PHOTOCATHODE

Type	S20ER (extended sensitivity to the red)
Spectral response	see figure 1
Input face	plane - concave
Maximum useful diameter	34 mm

SCREEN

Type	P 20
Minimum useful diameter	12,3 mm
Fluorescence and phosphorescence	yellow - green
Persistence	medium

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OPERATING CONDITIONS

Maximum ratings (absolute values)

Photocathode to electrode g1 voltage	max.	0. 4	kV
Photocathode to electrode g2 voltage	max.	2	kV
Photocathode to screen voltage	max.	18	kV
Photocathode current at nominal voltage		0. 1	μA
Photocathode illumination		0. 5	lux
Storage temperature	max.	+68	°C
	min.	−54	°C
Operating temperature	max.	+50	°C
	min.	−32	°C

Typical operation (note 1)

Ambient temperature	20 ± 5	°C
Photocathode nominal voltage	0	V
Electrode g1 nominal voltage	0. 20 ± 0. 05	kV
Electrode g2 nominal voltage	1. 35 ± 0. 1	kV
Screen nominal voltage	16	kV

Performance

	min.	typical	max.	
Photocathode sensitivity (note 2)	175	225	-	μA/lm
Luminance gain (note 3)	300	400	-	cd/m²/lux
Central resolution (note 4)	25	30	-	lp/mm
Peripheral resolution (note 5)	15	18	-	lp/mm
Central magnification (note 6)	0. 34	0. 35	0. 36	
Distortion	-	3. 5	5	%
Background equivalent illumination	-	2.10^{-7}	10^{-6}	lux

ENVIRONMENTAL TESTS

The tube TH 9478 is designed to withstand the following environmental tests without mechanical damage and electrical failure. After completion of the tests the tube will meet all the characteristics specified under the "operational characteristics".

Thermal test

The tube shall be subjected to a temperature cycling with extremal values, +68 °C and −54 °C and held at these limits for at least 1 hour.

Vibration test

The tube shall be rigidly mounted in a vertical position with photocathode end up and subjected to :

1 – A sinusoidal vibration having an amplitude of 1.5 mm, at a frequency of 30 Hz, for a period of 2.1/2 minutes.
2 – A sinusoidal vibration having an amplitude of 1.0 mm, at a frequency of 50 Hz, for a period of 2 minutes.

Shock test

The tube shall be subjected to a 75 g peak half-sine shock with six shock pulses parallel to, and six shock pulses perpendicular to, its longitudinal axis. The duration of each shock pulse should be 6 ms ± 2 ms.

NOTES

1 - The above mentioned voltages are relative values ; the OV potential may be that of electrode g1, electrode g2 or screen provided that the indicated potential differences between the electrodes are maintained.

2 - Photocathode sensitivity is measured by using a tungsten filament at 2854 °K color temperature.

3 - Luminance gain is the ratio of the output luminance in cd/m^2 to the input illumination in lux.

4 - Resolution measured on the photocathode in a centered circle of 3.5 mm diameter ; the typical central resolution measured on the screen is 70 lp/mm.

5 - Peripheral resolution measured on the photocathode in a centered circle of 27 mm diameter.

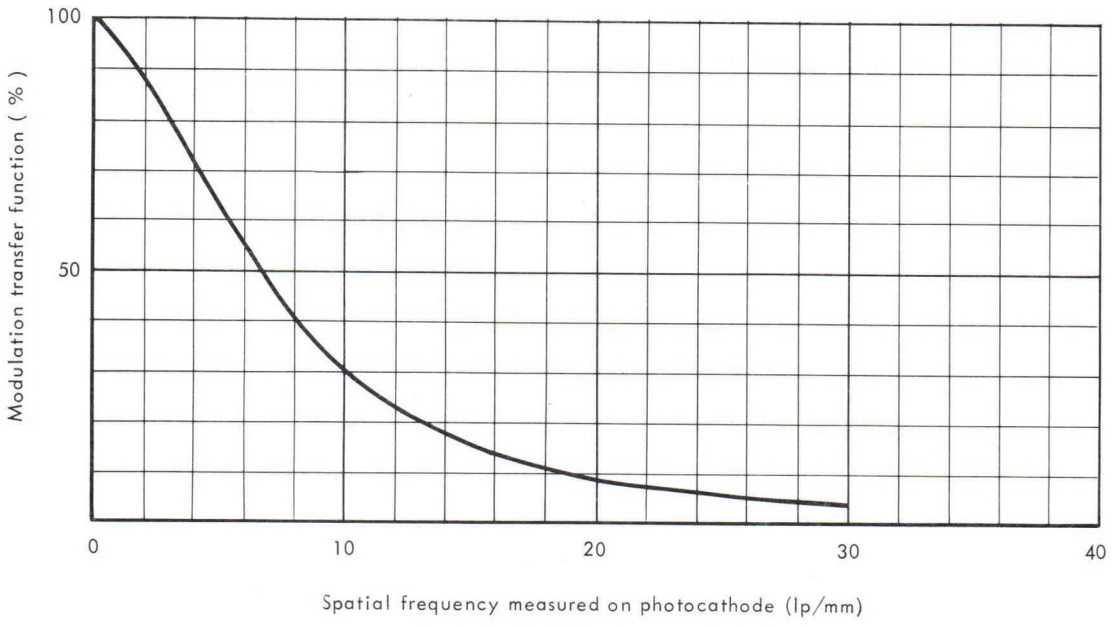
6 - Central magnification measured on the photocathode in a centered circle of 3.5 mm diameter.

7 - Distortion is given by

$$D = \frac{Mp - Mc}{Mc} \times 100$$

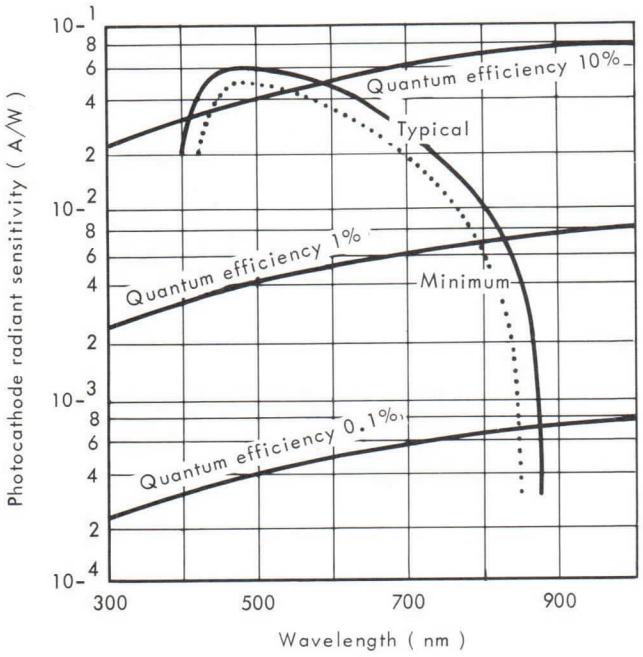
Mp = peripheral magnification for an input diameter of 27 mm.
Mc = central magnification defined in note 6.

TYPICAL MODULATION TRANSFER FUNCTION

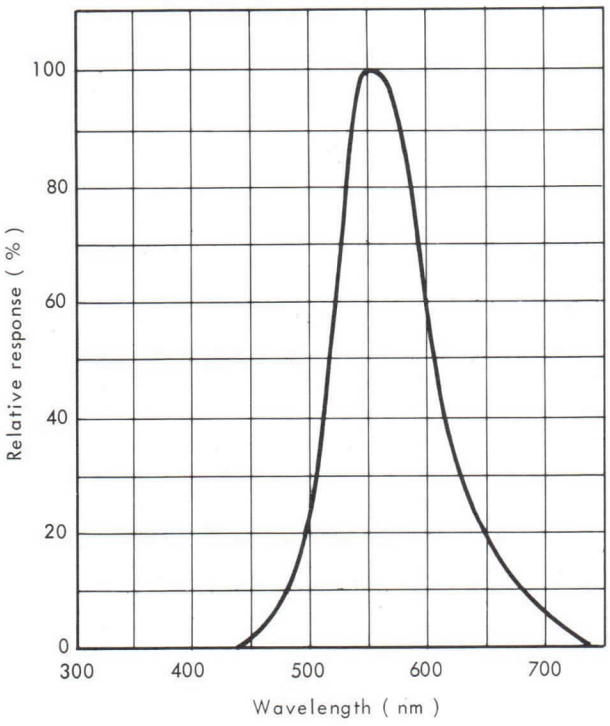


THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

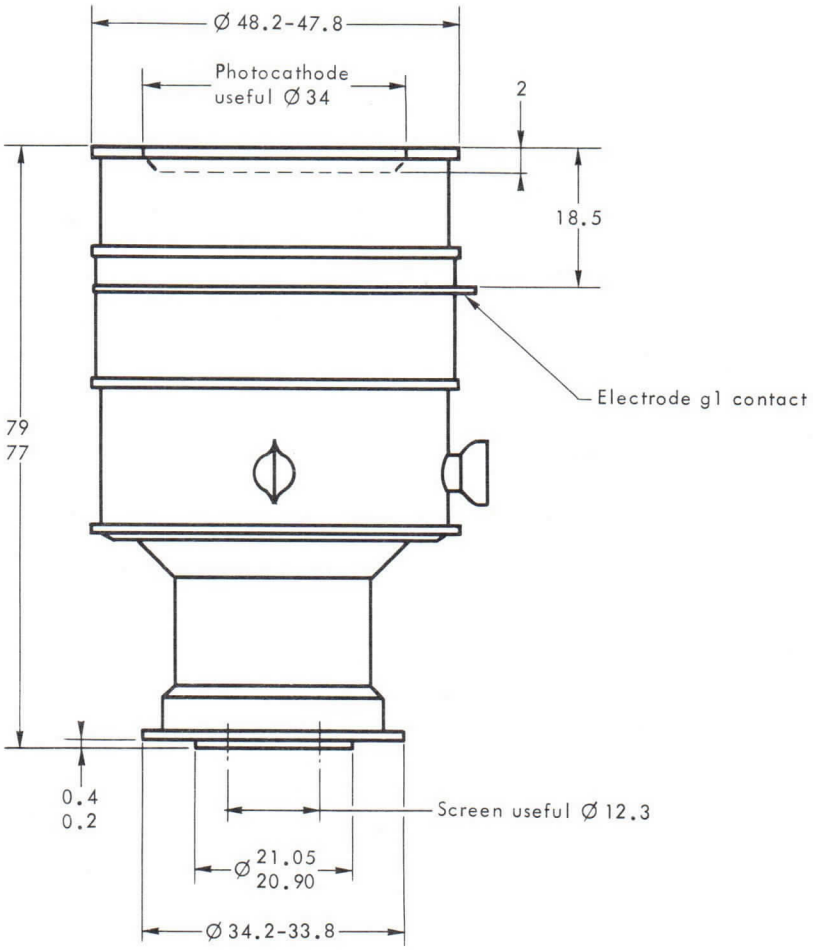
SPECTRAL RESPONSE OF S 20 PHOTOCATHODE
(extended to the red)

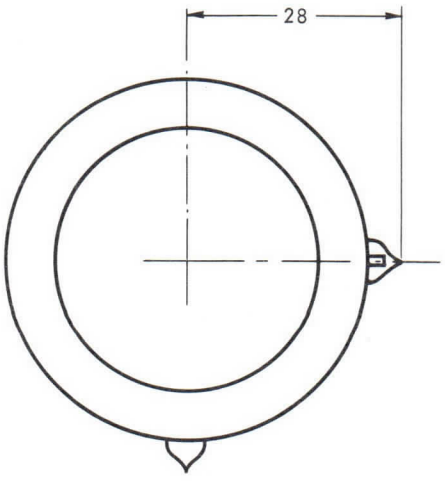


SPECTRAL DISTRIBUTION OF P 20 SCREEN



OUTLINE DRAWING





Dimensions in mm.

TH 9478

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

THOMSON-CSF

TH 9479
INTENSIFICATEUR D'IMAGE LUMINEUSE
ZOOM ELECTRONIQUE - OBTURATEUR RAPIDE

- FENETRES FIBRES OPTIQUES
- DIAMETRE UTILE DE PHOTOCATHODE 40 mm (type S20ER)
- DIAMETRE DE L'IMAGE DE SORTIE 25 mm (luminophore P20)
- MONOETAGE - TETRODE - ELECTROSTATIQUE
- OBTURATEUR ELECTRONIQUE
- GRANDISSEMENT VARIABLE
- GRANDE SENSIBILITE (225 μA/lm)
- FAIBLE DISTORSION
- ROBUSTESSE

Le tube TH 9479 est un intensificateur d'image du type tétrode à focalisation électrostatique. Le champ d'entrée a un diamètre de 40 mm, le champ de sortie un diamètre de 25 mm. La sensibilité de la photocathode du tube (type S20ER) s'étend dans le visible et le proche infra-rouge ; l'écran fluorescent est du type P20.

Ce tube est principalement destiné aux équipements d'aide à la vision - ou télévision - en lumière nocturne résiduelle.

Les fenêtres d'entrée et de sortie sont constituées par des optiques à fibres extérieurement planes permettant le couplage direct du tube TH 9479 avec d'autres intensificateurs d'image modulaires, ou avec des tubes de prise de vue, et l'utilisation des objectifs à champ plan.

La modification du potentiel de l'une des électrodes (g2) et la correction de focalisation par l'électrode g1 permettent d'obtenir un grandissement électronoptique continûment variable entre 0,62 (mode normal) et 1,28 (mode loupe). Cette modification de grandissement procure en particulier un gain de luminance élevé en mode normal autorisant l'observation à grand champ de scènes faiblement éclairées et une très bonne résolution des détails de l'image en mode loupe. La variation continue du champ observable permet le cadrage exact de la scène observée par l'intermédiaire de l'intensificateur d'image.

Le tube TH 9479 peut aussi fonctionner comme obturateur rapide, l'occultation de l'image étant obtenue par des impulsions négatives de tension de 2 kV appliquées entre l'électrode g1 et la photocathode. Le tube peut ainsi être utilisé dans les applications de tomoscopie.

Des versions optionnelles du tube TH 9479 peuvent être réalisées comportant un écran du type P11 ou une photocathode du type S1 pour des applications particulières.

Enfin, la robustesse du tube TH 9479 permet son incorporation dans des systèmes de vision ou de télévision fonctionnant dans des conditions d'environnement sévères.

CARACTERISTIQUES GENERALES

Mécaniques

Longueur maximale	114 mm
Diamètre maximal (tube nu)	76 mm
Masse approximative	300 g
Position de fonctionnement	indifférente

Electriques

Focalisation	électrostatique
Type	tétrode

Optiques

Photocathode :

Type	S20ER (sensibilité étendue dans le proche I-R)
Réponse spectrale	voir figure 1
Diamètre utile maximal	40 mm
Fenêtre d'entrée :	
- forme	plane et circulaire
- diamètre	53, 4 mm
- nature	optique à fibres

Ecran fluorescent :

Type	P20
Fluorescence et phosphorescence	jaune - vert
Réponse spectrale	voir figure 2
Persistance	moyenne
Diamètre utile minimal	25 mm
Fenêtre de sortie :	
- forme	plane et circulaire (planéité 1 μ)
- diamètre	35, 5 mm
- nature	optique à fibres

CONDITIONS D'EMPLOI

Valeurs limites d'utilisation (limites absolues)

	min.	max.	
Tension entre photocathode et écran	–	18	kV
Tension entre photocathode et électrode g1	– 3, 0	+ 1, 0	kV
Tension entre photocathode et électrode g2	+ 3, 0	+ 16	kV
Eclairement de photocathode à 2854 °K	–	1	lux
Température de stockage	– 35	+ 60	°C
Température de fonctionnement	– 30	+ 50	°C

Exemple de fonctionnement (note 1)

Température ambiante	20 ± 5 °C		
Mode de fonctionnement	mode normal	mode loupe	
Tension de photocathode	0	0	V
Tension de l'électrode g1 en fonctionnement	0, 9	0, 15	kV
Tension de l'électrode g1 en obturation	– 0, 5	– 2, 1	kV
Tension de l'électrode g2	3, 25	15	kV
Tension d'écran	15	15	kV

Performances typiques

Mode de fonctionnement	mode normal	mode loupe	
Grandissement au centre (note 2 et fig. 3)	0, 62	1, 28	
Distorsion (note 3)	1	2, 2	%
Résolution limite au centre de l'image (note 4)	45	71	pl/mm
Résolution limite au bord de l'image (note 5)	36	30	pl/mm
F.T.M. au centre de l'image (note 6 et fig. 4) :			
- à 5 pl/mm	85	93	%
- à 10 pl/mm	65	82	%
- à 20 pl/mm	31	55	%
Indice de conversion (note 7)	100	25	$cd/m^2/lux$
Eclairement équivalent au bruit propre (note 7)	10^{-11}	10^{-11}	lm/cm^2
Tension de blocage (note 8 et fig. 3)	1, 4	2, 2	kV
Facteur d'obturation (note 9)	10^4	–	
Sensibilité de photocathode (note 7)	225		µA/lm
Gain énergétique, max. (note 10)	34		

ESSAIS D'ENVIRONNEMENT

Le tube TH 9479 supporte hors fonctionnement les essais d'environnement suivants. Après exécution de ces essais le tube doit satisfaire aux performances définies dans le paragraphe CONDITIONS D'EMPLOI.

– ESSAI CLIMATIQUE

Le tube est soumis à 4 cycles de températures entre – 35°C et + 60°C avec maintien aux températures extrêmes pendant 30 mn. Chaque cycle est exploré avec une variation de l'ordre de 2°C/mn.

– VIBRATIONS

Le tube étant fixé rigidement, en position verticale, la cathode dirigée vers le haut, est vibré parallèlement et perpendiculairement à l'axe optique.

L'amplitude des vibrations sinusoïdales est de 1,30 mm crête et la fréquence varie de façon continue de 10 Hz à 55 Hz et de 55 Hz à 10 Hz. Chaque cycle dure 1 minute. L'essai comporte 10 cycles suivant chaque direction.

– CHOCS

Le tube est soumis à 6 chocs parallèlement et perpendiculairement à l'axe optique, chaque choc ayant une amplitude de 75 g (onde semi-sinusoïdale) et une durée de 6 ms $\pm$ 2 ms.

NOTES

1 - Le tube TH 9479 peut être utilisé avec l'écran à la masse et une source de haute tension négative pour l'alimentation des autres électrodes. Ce mode d'alimentation est impératif lorsque le TH 9479 est couplé à un tube de prise de vue du type vidicon.

2 - Le grandissement au centre Mc est mesuré à l'intérieur du cercle de 2, 5 mm de diamètre sur l'écran.

3 - La distorsion est mesurée par :

$$D = \frac{Mp - Mc}{Mc} \times 100$$

Mc : grandissement au centre selon la note 2
Mp : grandissement périphérique pour un diamètre d'entrée de 32 mm en mode normal et 16 mm en mode loupe.

4 - La résolution paraxiale est mesurée en projetant au centre de la photocathode un élément de mire du type USAF 1951.

5 - La résolution périphérique est mesurée comme ci-dessus sur un cercle centré sur la photocathode de 32 mm de diamètre pour le mode normal et de 16 mm de diamètre en mode loupe.

6 - La F.T.M. est mesurée au centre de l'image. Les fréquences spatiales sont indiquées au niveau de la photocathode.

7 - Les mesures de sensibilité de photocathode, d'éclairement d'entrée équivalent au bruit propre, et d'indice de conversion, sont effectuées en éclairant uniformément la photocathode à l'aide d'une lampe à filament de tungstène à la température de couleur de 2854°K.

8 - La tension de blocage est la valeur minimale occultant totalement le transfert électronique entre photocathode et écran. Cette valeur est l'excursion du potentiel de l'électrode g1 entre la valeur assurant la focalisation du tube et la valeur provoquant l'occultation.

9 - Le facteur d'obturation est le rapport de la brillance moyenne de l'écran, la photocathode étant uniformément éclairée et le tube normalement focalisé, à la brillance résiduelle d'écran lorsque le tube est obturé électroniquement.

10 - Le gain énergétique maximal est le rapport de l'énergie totale radiée par l'écran à l'énergie incidente sur la photocathode à la longueur d'onde correspondant au maximum de la réponse spectrale.

Figure 1
REPONSES SPECTRALES TYPIQUES
DES PHOTOCATHODES S1 ET S20ER

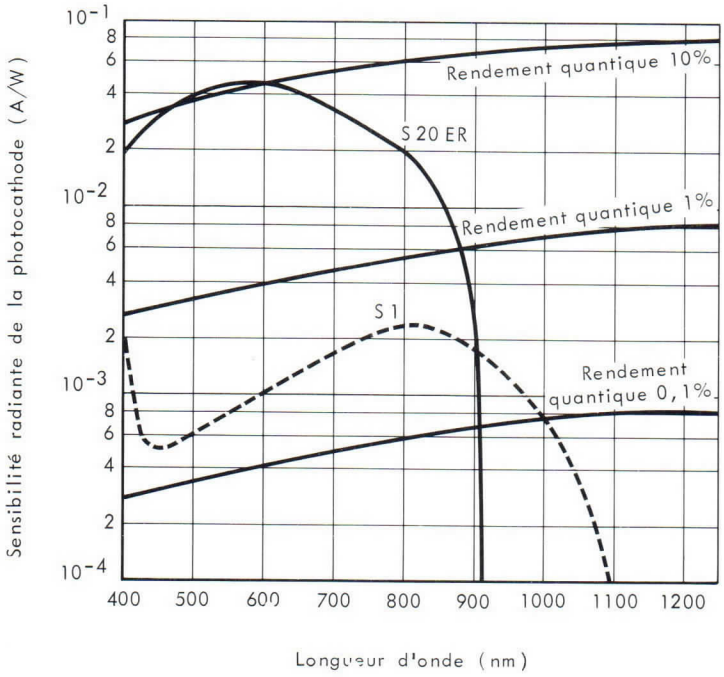


Figure 2
COURBE DE DISTRIBUTION SPECTRALE
DES ECRANS DE TYPE P20 ET P11

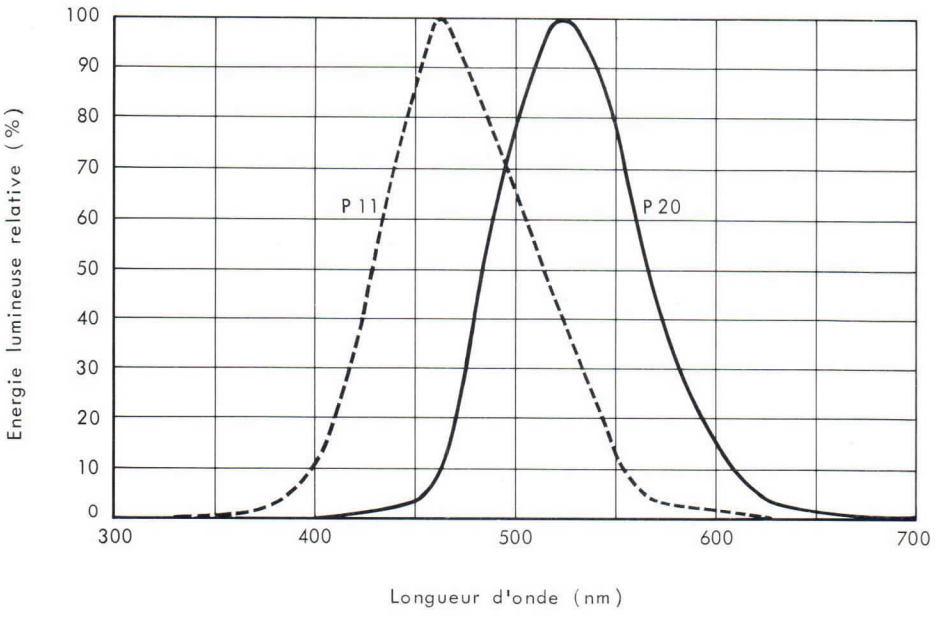


Figure 3

TENSIONS DE FOCALISATION ET D'OBTURATION EN FONCTION DU GRANDISSEMENT
($V_{pc} = 0$, $V_{écran} = 15$ kV)

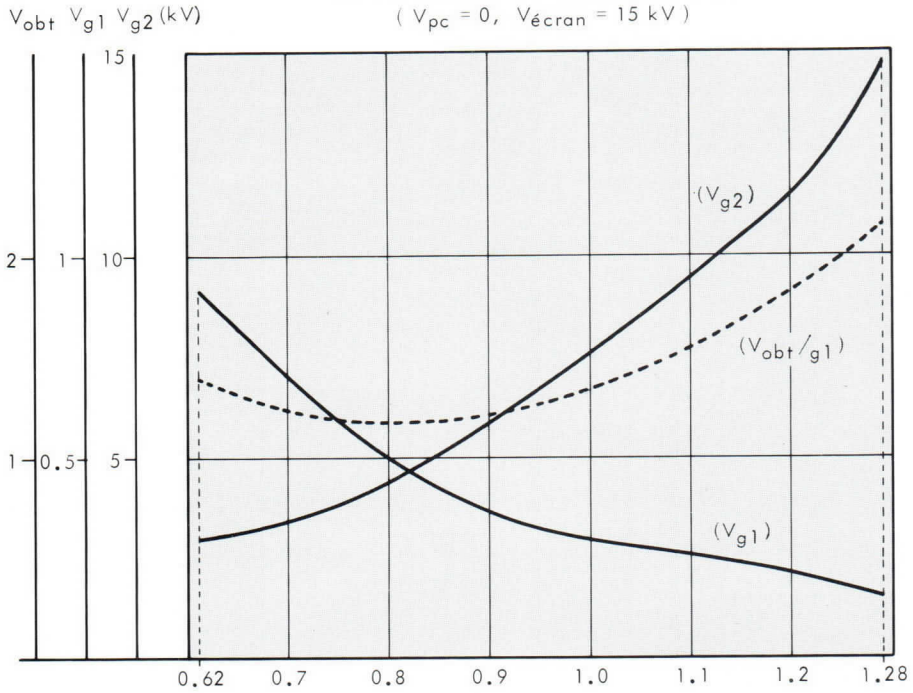
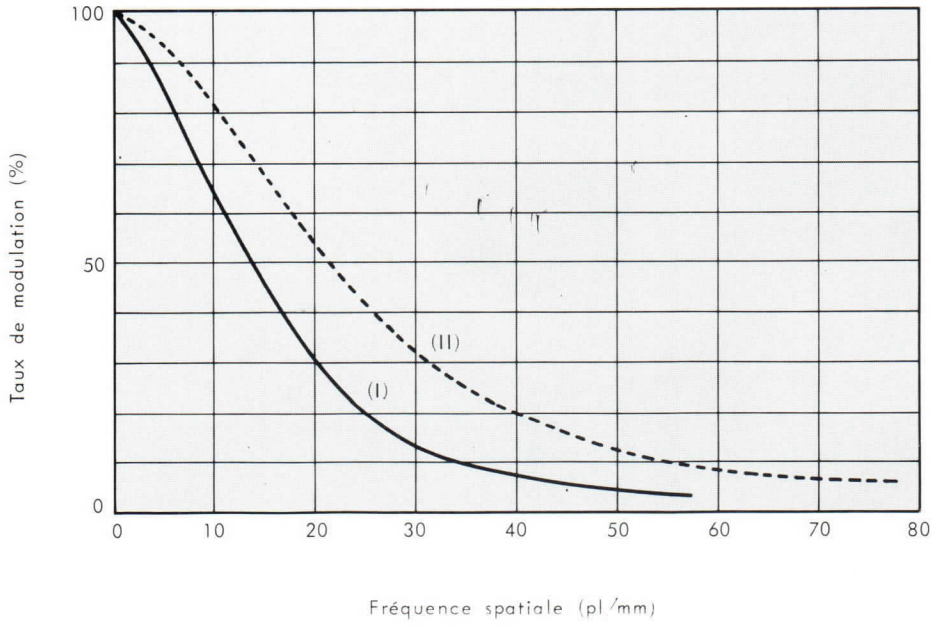
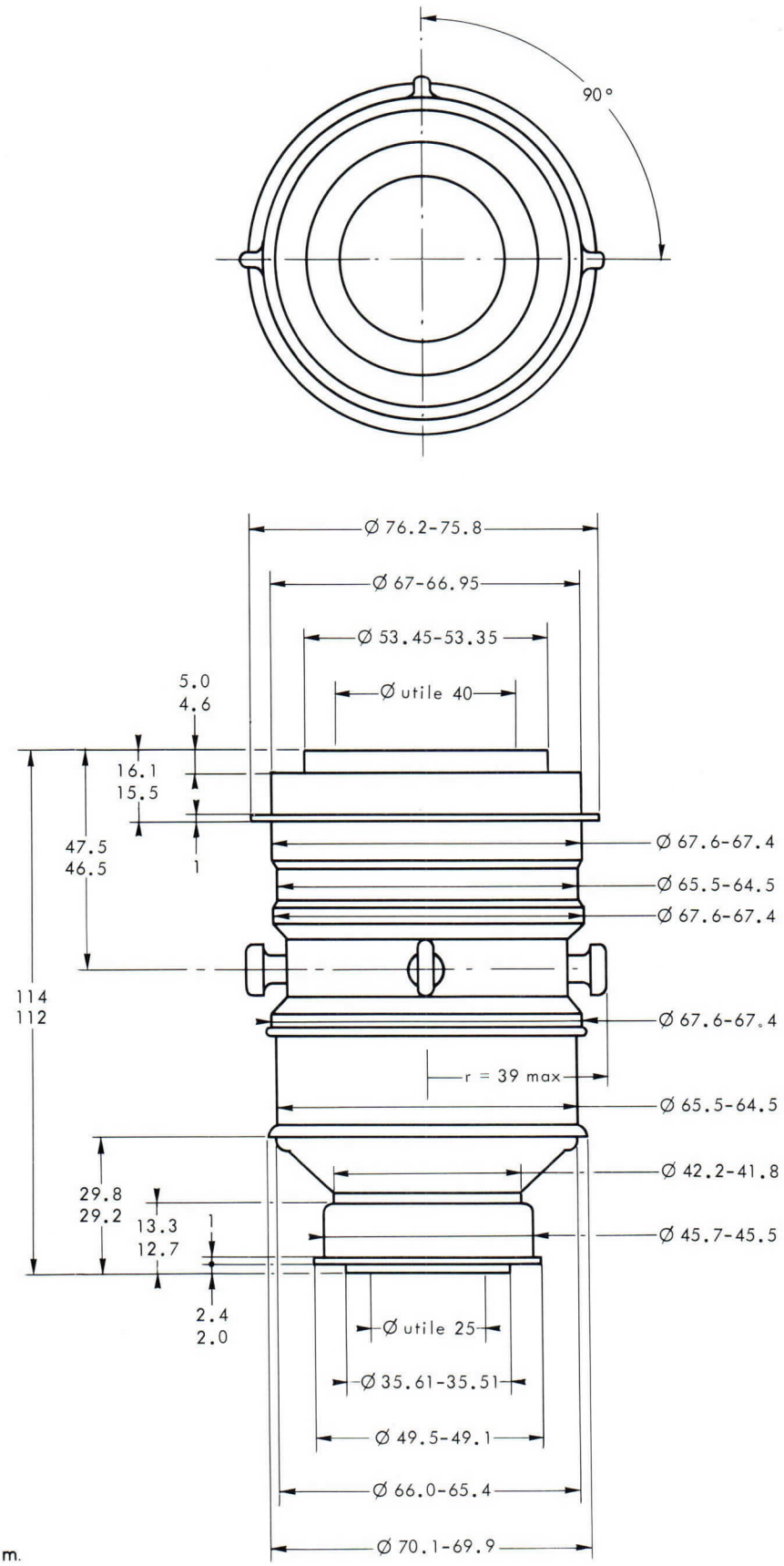


Figure 4

FONCTIONS DE TRANSFERT DE MODULATION EN MODE NORMAL (I) ET MODE LOUPE (II)



DESSIN D'ENCOMBREMENT



Cotes en mm.

TH 9479

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Imprimé en France

X-RAY IMAGE INTENSIFIER TUBES
OPERATING INSTRUCTIONS FOR VACUUM TEST AND GETTERING OPERATION

1. OBJECT

The purpose of this operation is to test the vacuum of an X-ray image intensifier tube. This operation is carried out by the use of an active getter which, in post-gettering operation, enables in addition to pump residual gas as this gap helps the forming of an ion spot when voltages are applied to the tube. This operation is carried out differently according to the way the tube is stored at the supplier's or installed at the radiologist's.

- At the supplier's, it enables to make sure that the tube has a good vacuum on receipt at the supplier's and on delivery to the user's.

- At the radiologist's, it permits , after a long rest period, to maintain the quality of vacuum.

2. PRINCIPLE OF PROCEEDING

Gettering is achieved by starting an ion pump incorporated in the image intensifier tube. The cathode and anode connections of this getter are designed with reference marks on the Data Sheet corresponding to each tube. The ion pump starts automatically as soon as a 2500 V to 3000 V is applied between its electrodes. Applied D.C. voltage must be smoothed and the residual ripple voltage must be less than 5%. Gettering is effected by feeding the electrodes of the ion pump, the other electrodes of the tube being disconnected.

- POST-GETTERING :

When residual gas is present, as indicated by the getter current, the post-gettering is effected by maintaining the voltages on the electrodes of the ion pump.

- REMARK 1 :

Putting the electrodes of the tube under voltage is not detrimental to the life and performances of the tube inasmuch as the latter is kept in complete darkness. It should be noticed that gettering performed at the radiologist's corresponds to same conditions. The tube set up in its housing is in complete darkness as far as it is not irradiated by the radiological equipment.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

- REMARK 2 :

When voltage is applied to all tube electrodes (such is the case when the tube is set in its housing at the radiologist's), the ion pump starts automatically when vacuum is not sufficient. Plasma inside the ion pump produces light reaching the tube photocathode. A crescent-shaped fluorescent area located approximately 5 hours from the diametral plane meeting the anode contact, may occasionally appear on the observation screen of some tubes. That light area disappears after a few minutes' gettering. It must not be considered a defect.

- REMARK 3 :

The power supply necessary for the gettering must provide 3000 V maximum off-load and 2500 V minimum with a 100 μA load current. In order to protect the power supply and the tube, the internal impedance must be designed so as to limit the short-circuit current to 500 μA. A micro ammeter with appropriate rating should be used to measure the value of getter current mentioned in chapter 3.

3. VACUUM TEST AND POST-GETTERING ON RECEIPT OF THE TUBE

3.1. Vacuum test on receipt of the tube

This operation enables to make sure that the tube has a good vacuum after shipment.

This first test should be done within 1 week after the date of arrival at the purchaser's. To do this, the ion pump should be energized according to instructions given in chapter 2 and getter current should be noted before the starting of gettering operation.

- the getter current exceeds 50 μA : send the tube back to the manufacturer.

- the getter current is lower or equal to 50 μA : effect the gettering operation (see chapter 3-2).

3.2. Post-gettering on receipt of the tube

This operation which can last from one to four hours should be done according to the following proceeding :

After 1 hour post-gettering :

- the getter current exceeds 20 μA : send the tube back to the manufacturer.

- the getter current is below 1 μA : stop the post-gettering, the vacuum is sufficient.

- the getter current is higher than 1 μA but lower or equal to 20 μA : keep on the gettering during 3 hours more.

After 3 hours supplementary post-gettering :

- the getter current exceeds 10 μA : send back the tube to the manufacturer.

- the getter current is below or equal to 10 μA : the tube has sufficient vacuum.

3.3 - Report of getter current

The values of getter current measured in different operations defined in chapter 3-1, 3-2, 3-3, must be reported on the Warranty sheet and the Service Report sheet accompanying the tube.

4. VACUUM TEST AND POST-GETTERING OPERATION OF TUBES IN STORAGE

It is not necessary to effect the post-gettering on stored tubes. Nevertheless, it is recommended to effect a vacuum test and a post-gettering operation during 1 hour after a long period of storage (6 months).

5. VACUUM TEST AND POST-GETTERING OPERATION WHEN SENDING TUBE TO THE RADIOLOGIST'S

In order to make sure that the tube has not been damaged during shipment, it is advisable for the supplier to effect a vacuum test and a post-gettering operation of the tube before sending and on receipt at the radiologist's. For this, follow the proceeding as described in chapter 3-2.

The value of the measured current should be noted down on the Warranty sheet and the Service Report sheet accompanying the tube.

6. RECOMMENDATIONS FOR THE RADIOLOGIST

After a long rest period of several weeks (holiday period, for example) it is recommended to carry on a post pompage operation by applying voltages during about 30 minutes before any X-ray radiation. This operation enables to maintain the performances of the tube.

TEV 3119

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

THOMSON-CSF

INTENSIFICATEURS D'IMAGES RADIOLOGIQUES

Consignes pour le contrôle du vide et le post-pompage.

1 - OBJET du CONTROLE du VIDE :

Cette opération a pour objet de contrôler la qualité du vide du tube intensificateur d'images radiologiques. Elle est effectuée à l'aide d'une jauge-pompe ionique ou getter actif. Ce getter, en opération de post-pompage, permet, en outre, de pomper les gaz résiduels dont la présence pourrait contribuer à la formation d'une tache ionique lorsque le tube est sous tension.

Cette opération est conduite différemment suivant que le tube est conservé chez le revendeur ou installé chez l'utilisateur.

- Chez le revendeur, elle permet de s'assurer à la réception et à la livraison chez l'utilisateur que le tube a toujours un vide correct.

- Chez l'utilisateur, l'opération permet, après un repos du tube prolongé, de maintenir la qualité du vide.

2 - PRINCIPE ET REALISATION du CONTROLE du VIDE et du POST-POMPAGE :

L'opération de contrôle du vide est effectuée à l'aide de la jauge ionique ou "getter actif" incorporé au tube amplificateur de luminance. Les connexions de cathode et d'anode de la jauge sont désignées dans les notices individuelles particulières au tube amplificateur de luminance considéré.

Cette jauge se met automatiquement en fonctionnement lorsqu'une tension de 2500 V à 3000 V lui est appliquée.

La tension continue appliquée doit être filtrée et l'ondulation résiduelle inférieure à 5 %.

Pour effectuer l'opération de contrôle du vide, il suffit d'alimenter uniquement les électrodes du getter, les autres électrodes du tube étant déconnectées.

POST-POMPAGE :

Pour effectuer le pompage des gaz résiduels dont la présence éventuelle est déterminée par l'indication du courant de jauge, il suffit de maintenir sous tension les électrodes de la jauge-pompe.

REMARQUE 1 -

La mise sous tension complémentaire des électrodes du tube n'est pas préjudiciable à la vie et aux performances du tube pour autant que celui-ci soit placé dans l'obscurité totale. Il convient de remarquer que l'opération de post-pompage, qui peut être effectuée chez le radiologue, correspond précisément à ce mode d'opération, le tube étant monté dans sa gaine d'utilisation est dans l'obscurité absolue pour autant qu'il ne soit pas irradié par les rayons X de l'équipement radiogène.

REMARQUE 2 -

Lorsque toutes les électrodes du tube sont sous tension, ce qui est le cas lorsque le tube est monté dans sa gaine d'utilisation, chez le radiologue, le getter actif se met automatiquement en fonctionnement lorsque le vide est de qualité insuffisante. Le plasma situé à l'intérieur de la pompe ionique émet de la lumière qui excite la photocathode du tube. Il apparaît occasionnellement sur l'écran d'observation de certains tubes, une lunule située sensiblement à 5 heures par rapport au plan méridien passant par le contact anodique. Cette zone lumineuse disparaît après quelques minutes de pompage et ne doit pas être considérée comme un défaut.

REMARQUE 3 -

L'alimentation de mesure doit pouvoir délivrer une tension maximale à vide de 3000 V et une tension minimale de 2500 V avec un courant de charge de 100 µA. En vue de protéger cette alimentation et le tube, l'impédance interne doit limiter le courant de court-circuit à 500 µA. Pour effectuer un contrôle, l'alimentation doit comporter un appareil de mesure convenablement protégé permettant la mesure des courants mentionnés dans le § 3.

3 - MODALITES d'EXECUTION du CONTROLE du VIDE et POST-POMPAGE RECEPTION.

3.1 - Contrôle du vide de réception :

Cette opération permet de s'assurer que le tube a un vide correct, après le transport.

Ce contrôle doit être effectué dans un délai inférieur à 1 semaine à partir de la date d'arrivée du tube. Dans ce but il faut alimenter le tube comme il est indiqué au § 2 et noter le courant de getter.

Deux cas peuvent se produire :

- le courant de getter est supérieur à 50 µA : retourner le tube au fournisseur;

- le courant de getter est inférieur ou égal à 50 µA : effectuer le "post-pompage de réception" (voir 3-2).

3.2 - Post-pompage de réception :

Cette opération qui peut durer, suivant les tubes, de une à quatre heures, doit être faite conformément au processus suivant :

Après une heure de post-pompage :

- le courant de getter est supérieur à 20 µA : retourner le tube au fournisseur.

- le courant de getter est inférieur à 1 µA : arrêter le post-pompage, le tube ayant un bon vide.

- le courant de getter est supérieur à 1 µA mais inférieur ou égal à 20 µA : poursuivre l'opération de post-pompage pendant 3 heures de plus.

Après 3 heures de post-pompage supplémentaires :

- Le courant de getter reste supérieur à 10 µA : le tube doit être retourné au fournisseur.

- Le courant de getter est inférieur ou égal à 10 µA : le tube doit être considéré comme ayant un bon vide.

3.3 - Notation des observations de post-pompage :

Les valeurs de courant mesurées au cours des opérations définies en 3-1, 3-2, 3-3 doivent être reportées sur la fiche de garantie et d'utilisation accompagnant le tube.

4 - CONTROLE de VIDE et POST-POMPAGE des TUBES STOCKES :

Il n'est pas nécessaire d'effectuer l'opération de post-pompage sur les tubes en cours de stockage.

Toutefois, il est recommandé d'effectuer un contrôle du vide et un post-pompage d'une heure après une période de stockage prolongée (6 mois).

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

5 - CONTROLE du VIDE et POST-POMPAGE LORS d'EXPEDITION du TUBE CHEZ l'UTILISATEUR :

En vue de vérifier que les opérations de transfert du tube entre le revendeur et l'utilisateur final se sont déroulées normalement, il est demandé au revendeur de procéder à un contrôle du vide et un post-pompage du tube avant expédition et à réception chez l'utilisateur. Les modalités de cette opération sont identiques à celles définies au § 3.2.

Les valeurs de courant mesurées au cours de cette opération doivent être reportées sur la fiche de garantie et d'utilisation accompagnant le tube.

6 - RECOMMANDATIONS pour l'UTILISATEUR :

Après une période de repos prolongée de plusieurs semaines (période de vacances, par exemple), il est recommandé d'effectuer un post-pompage par mise sous tension du tube pendant une durée de l'ordre de 30 minutes, préalablement à toute irradiation X.

Cette opération garantit à l'utilisateur le maintien des performances du tube.

TH 9412B

X-RAY IMAGE INTENSIFIER TUBE

- INPUT FIELD : 16 cm
- OUTPUT IMAGE NOMINAL DIAMETER : 14. 2 mm
- HIGH RESOLUTION - HIGH CONTRAST
- LUMINANCE GAIN : 10 000

The TH 9412B is a X-ray image intensifier tube which converts the X-ray pattern into a light image of high brightness and good contrast.

The X-ray beam emerging from the subject being examined first passes through the tube's input window, made up of special low absorption glass. Next, the X-rays reach the input fluorescent screen where the X-ray photons are converted to light photons. A photocathode, coupled to the input screen is excited by these light photons, which are thus converted to electrons. The emitted electrons are accelerated and focused by appropriate electric fields and then impinge on the output fluorescent screen. This screen's phosphor coating reconverts the electrons back to light photons providing an exceptionnally bright output image. This brightness gain is obtained partly from the energy imparted to the electrons during their acceleration and partly from the reduction in diameter of the tube's output image as compared to the input image. In fact, this image is several thousand times brighter than would have been that of a conventional radioscopic screen substituted for the tube's input window.

Many improvements in the design of the TH 9412B have benifited from THOMSON-CSF wide experience and considerable expertise in the field of X-ray image intensifier tubes. The TH 9412B has the same dimensions and electrode voltages as the previous model TH 9412A ; it can directly replace the latter with improved image performance.

The TH 9412B uses the caesium iodide (CsI) base as the detector screen material which associates an improved absorption of the incident radiation to a fast time response.

The P20 phosphor is selected in order that its spectral response coincides with the optimum correction range of the optical systems thus minimizing the reflections and loss of resolution and contrast in these optical systems ; on the other hand, the P20 phosphor is matched to 35 mm film, 100 or 70 mm spot films or to CCTV camera tubes.

The "dark output screen" also enables to minimize all light reflection (internal or due to the optical system) and thus improves the image contrast.

The TH 9412B incorporates an automatic "active getter" which ensures a very high vacuum along tube's life avoiding the development of an ion spot or alteration of contrast resolution.

Power supply

Since the TH 9412B performs very high resolution, the power supply must be carefully designed and especially ripple voltages must not exceed 0. 3 %.

The TH 7127 THOMSON-CSF power supply designed especially for use with the TH 9412B is highly recommended. It delivers 0. 1 % regulated voltages for all electrodes and is directly energized from 110/220 V - 50/60 Hz line supply.

GENERAL CHARACTERISTICS

Mechanical (see Note 1 and drawing)

The tube is delivered in a metal housing which ensures the function of mechanical support ; nevertheless, it is necessary to maintain the assembly by sustaining the entrance plane.

In this housing, the tube is mounted so as to facilitate the precise location of the optical devices as regard to the reference plane. This shell protects the tube against stray magnetic field and cannot be considered as an efficient shield against X-radiations. A lead plate of 2 mm thickness is provided at the output plane of the housing.

Aluminum housing

The tube can be optionally provided in an aluminum housing including lead and mumetal lining.

In this version, it provides personel protection which satisfies the most rigorous international regulations. It also permits the direct mounting of the tube on the equipment by means of the output plane.

Operating position	any
Shipment position	tube axis horizontal
Operating and storage temperature :	
- maximum	+50 °C
- minimum	+ 5 °C
Net weight, approx.	4. 5 kg
Dimensions	see drawing

Optical

Input screen diameter	16 ± 0. 5	cm
Output image diameter	14. 2 ± 0. 5	mm
Input screen spectral response	X-rays	
	30 to 250 kVp generator	
Veiwing screen :		
- type	P20 (λ max. = 520 nm)	
- fluorescence and phosphorescence	yellow - green	
Electrostatic focus - Inverted image :		
Input field diameter	16	cm
Magnification	1/11	
Typical resolution (Note 2) :		
- central	38	lp/cm
- peripheral	34	lp/cm
Detection sensitivity (Note 3) measured with JEDEC - penetrometer	2. 1	%
Typical contrast ratio (Note 4)	11/1	
Minimum conversion factor (Note 5)	100	$\frac{cd/m^2}{mR/s}$
or	500	$\frac{fL}{R/mn}$
Minimum luminance gain (Note 6)	10 000	
Maximum background luminance (Note 7)	0. 06	cd/m^2
or	0. 02	fL
Maximum distortion (Note 8)	10	%
Maximum persistence at 10 ms (Note 9)	10	%

OPERATING CONDITIONS

Maximum ratings

Photocathode pc voltage	0 V
Electrode g1 voltage	0. 3 kV
Electrode g2 voltage	4. 0 kV
Anode a voltage	32. 0 kV
Active getter voltage :	
- anode g4	3. 5 kV
- cathode k	0 V
Photocathode pc maximum current	0. 5 µA
Electrode g1 maximum current	1 µA
Electrode g2 maximum current	1 µA
Electrode g4 maximum current (after post-gettering operation)	10 µA
Anode a maximum current (without X-radiation)	2 µA

Typical operation

Input diameter for 14. 2 mm output image	16 cm
Photocathode pc voltage	0 V
Electrode g1 voltage*	150 to 300 V
Electrode g2 voltage*	2700 to 3700 V
Anode a voltage	30. 0 kV
Active getter voltage :	
- anode g4	2. 5 to 3. 0 kV
- cathode k	0 V

Ripple voltages must not exceed 0. 3 %.

* g1, g2 voltages are given for an anode voltage of 30. 0 kV.

STARTING PROCEDURE

Important

For tube handling, always prescribe use of security goggles (implosion risk).

Tube mounting

Set tube inside a proper metal housing to protect operator against X-radiation.

Check for darkness of the tube housing (would the tube be checked without container, it should then be placed in a completely dark room).

The housing in which the tube is contained must be humidity proof and deshydrated. This condition is necessary to eliminate all moisture which could initiate coronas and sparks detrimental to tube operation. Moreover, it prevents dust electrostatic attraction on the viewing face.

Connections

All the connections necessary for tube supply are made through flexible wires with color reference marks.

A 10 Megohms resistance protecting the tube against discharge must be inserted in series in the anode circuit inside the housing. Time constant thus produced with tube capacitance contributes to ripple voltage filtering.

In series between each voltage supply and corresponding tube connection, insert in the same way a few Megohms protection resistance.

Electrode voltages

The tube is delivered with an individual Test Report giving the optimum focus voltages measured in factory.

It may occur that the given values do not give the optimum focus because of the measurement instrument calibration errors. As the tube features very high resolution performance, a variation of electrode voltages of 1 % can alter the image quality.

It results from this remark that it is recommended to adjust the tube voltages as follows in order to obtain the best focus.

Focusing adjustments

- Voltages supplies can be applied to the electrodes in a short time but with a slope not exceeding 5 kV/ms.
- Let tube at rest with voltages applied for potential stabilization before adjusting it. (10 s minimum).
- Set a 0. 2 mm spaced metal wire mesh of 2/10 mm diameter (stainless steel, copper) in front of the tube and apply X-rays beam.
- Apply electrode voltages given in Test Report.
- Adjust g1 voltage in order to obtain an image as homogeneous as possible in luminance.
- Adjust g2 voltage in order to obtain the optimum resolution.
- Optimize g1 voltage if necessary.
- Electrode voltages in the Test Report are given for an anode voltage of 30 kV. If the tube is operated at a lower anode voltage, the adjustment process is identical except that the voltages of the other electrodes must be consequently reduced.

Gettering operation

In order to assure a high reliability in operation and to maintain optimum performances of the tube, Instructions for Gettering operation should be stricty applied as defined in a separate Data.

The purpose of this operation is to pump residual gas in the tube resulting in an ion spot which lowers the image contrast and resolution.

NOTES

1 - **The mounting** of the tube in its housing (see page 2 and drawing) secures the positioning of the viewing screen at a determined optical distance from the mechanical pilot plane on which may be fixed the optical system. This distance is 20 ± 0.25 mm. This housing assures a parallelism of the two planes with a precision higher than 1/800 radian. It assures a center of image within 0.50 mm from perpendicular axis of the pilot plane defined by an aperture of 120, 10 ± 0.05 mm diameter.

2 - **The resolution** (as referred to input screen) is measured by using square lead pattern consisting of alternate black and white lines of equal width. Any two adjacent lines are designated as a line pair. The impinging X-radiation is produced by a generator operating at 65 kV and with a 2.5 mm aluminum filter. The central resolution is given for 70 % of the input field diameter and the peripheral resolution is given for the area between circles of 70 % and 90 % of the input field diameter.

3 - **The detection sensitivity** is defined as the differential thickness which can be detected when using a JEDEC penetrometer. This penetrometer consists in an aluminum disc of 20 mm thickness presenting holes of 6 mm diameter. The depth of those holes vary from 1.5 to 7 % of the thickness of the disc. The differential thickness (expressed in %) of the hole having the minimum depth which can be detected defines the minimum contrast. X-ray conditions : 80 kVp - HVL 7 ± 0.2 mm Al-input dose rate 100 mR/mn.

4 - **The contrast ratio** is measured by inserting a lead disc of 6 mm thickness in the center of the tube's input field and covering 10 % of the input field. The contrast ratio is expressed by the ratio $CR = \frac{B_2}{B_1}$

where : B_1 = luminance of the viewing screen measured at the center of the disc.
B_2 = luminance of the viewing screen measured on the light area.

5 - **The conversion factor** is the value of the viewing screen luminance corresponding to a determined X-ray dose rate.

X-ray conditions : 80 kVp - 20 mm Al filter - HVL 7 ± 0.2 mm Al.
The luminance is measured by a photometer which matches the human vision.
The conversion factor is defined as :

$$C.F. = \frac{\text{Luminance}}{\text{dose rate}} = \frac{\text{Candela/square meter}}{\text{milli Roentgen/second}} \quad \text{or} \quad \frac{\text{foot Lambert}}{\text{Roentgen/minute}}$$

6 - **The luminance gain** is the ratio of luminance of the image intensifier to the luminance of a PATERSON - CB2 type fluoroscopic screen. Both are irradiated in the same conditions : 80 kVp - 20 mm Al filter - HVL 7 ± 0.2 mm Al. The luminance is measured by a photometer which matches the human vision.

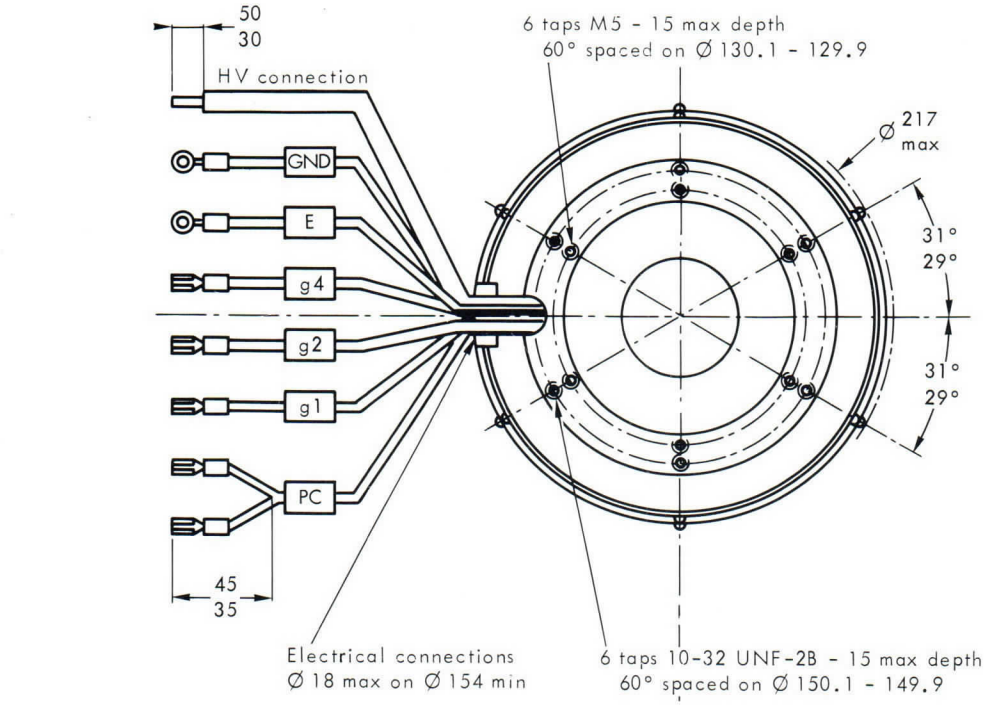
7 - **The background luminance** is the luminance of output screen when normal operating voltages are applied to the tube and X-rays are off at normal ambient temperature.

8 - **The distortion** is measured by $D = \frac{M_p - M_c}{M_c} \times 100$

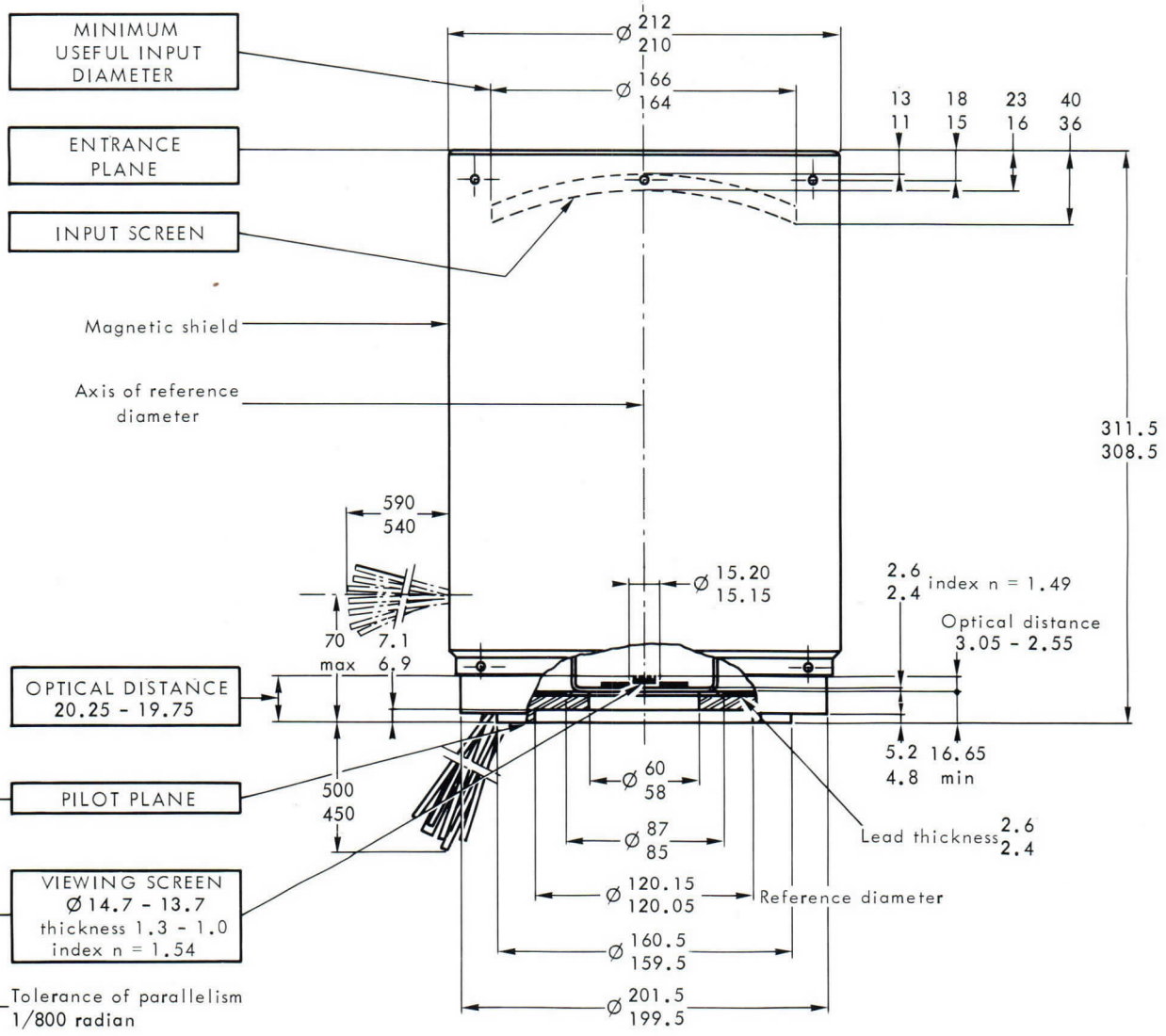
where : M_p = magnification measured on a circle covering 90 % of the input field.
M_c = magnification measured on a 2 cm diameter circle centered on the input field.

9 - **The image persistence** is the residual luminance measured at a determined time after removal of X-radiation.

OUTLINE DRAWING



ELECTRICAL CONNECTIONS		
Cathode	PC	Black
Field electrode	g1	Green
Focusing electrode	g2	Black
Active getter +	g4	Black
Active getter -	E	Blue
Ground	GND	Grey
Anode	A	White



Dimensions in mm.

THOMSON-CSF

DIVISION TUBES ELECTRONIQUES

ELECTRONIC ZOOM
X-RAY IMAGE INTENSIFIER TUBE TH 9415

HIGH RESOLUTION COMPACT TUBE

BRIGHTNESS GAIN : 6000 X

INPUT FIELDS : 16 cm (6") and 10 cm (4")

TH 9415 is a 16 cm X-ray image intensifier which converts the X-ray pattern into a light image of high brightness and good contrast.

Technological improvements concerning input screen, electronoptics and viewing screen allow for higher resolution than that of older types TH 9411 and TH 9412.

In addition, TH 9415 has an adjustable magnification so to display to the user input fields of 16 cm and 10 cm. The output image is delivered on the output screen with a 14, 2 mm diameter. Magnification can be adjusted from 1/8 to 1/11 by a proper choice of voltages applied to only two focusing electrodes. Output image luminance which is proportional to the energy gain of the intensifier and to the square of the electronic magnification varies from 3000 X to 6000 X.

The "active getter" provides a very high vacuum all along tube's life avoiding the development of an ion spot and alteration of contrast and resolution. The getter needs no extra installation and operates automatically as the tube is energized.

TH 9415 is delivered in a shell which permits mechanical mounting, protects the tube from stray magnetic field and secures a precise positioning of the associated optical system.

Applications

As a result of the high brightness gain it is possible to operate the tube with a very low input dose rate which reduces health hazards. This point is very important in medical radiology since this device enables a significant reduction of X-ray radiation as well on the patient as on the operator.

The high gain allows a good matching with television camera. Such an equipment enables examination of any part of the human body, which gives substantial improvement with respect to conventional X-ray examinations.

Fields of applications in industrial radiology are considerably extended by the use of the tube TH 9415 which allows the use of low power X-rays sources for non destructive testing of very opaque materials.

GENERAL CHARACTERISTICS

Mechanical - (See note 1 and drawing)

The tube is delivered mounted in a metallic shell which permits mechanical fixation : nevertheless it is necessary to maintain the assembly by sustaining the entrance plane. Two types of tapped holes are provided for International or U.S. Standard.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

In this shell the tube is fixed so as to facilitate the precise localization of the optical device as regard to the reference plane. This shell protects the tube against stray magnetic field and cannot be considered as an efficient shield against X-radiations. A lead shield of 2 mm thick is provided at the output plane of the shell.

Dimensions		See drawing
Net weight, approximate		4. 5 kg
Mounting position		any
Shipment position		tube axis horizontal
Operating and stocking temperature	max.	+50° C
	max.	+ 5° C

Optical

Input screen diameter	16 ± 0. 5 cm
Output image diameter (O. I.)	14. 2 ± 0. 5 mm
Input spectral response	X-rays (30 to 250 kVp generator)
Viewing screen	
Type	P 20 (λ = 520 nm)
Fluorescence and phosphorescence	Yellow - green
Electrostatic focus - Inverted image	

Operating modes :	Normal	Magnified	
Input field diameter	16	10	cm
Magnification	1/11	1/8	
Minimum resolution (note 2)			
- central	20	22	lp/cm
- peripheral	18	20	lp/cm
Minimum contrast (note 3) measured with JEDEC penetrameter	3	2. 5	%
Minimum conversion factor (note 4)	70	35	Cd/m2 per mR/s
or	350	175	ft. L per R/mn
Minimum luminance gain (note 5)	6000	3000	X
Maximum background luminance (note 6)	0. 06	0. 06	Cd/m2
or	0. 02	0. 02	ft. L.
Maximum distortion (note 7)	20	5	%
Maximum persistence at 10 ms (note 8)	10	10	%

MAXIMUM RATINGS AND TYPICAL OPERATION

Maximum ratings

Photocathode C voltage	0	V
Electrode g1 voltage	0. 3	kV
Electrode g2 voltage	2	kV
Electrode g3 voltage	7. 5	kV
Anode A voltage	32	kV
Active getter voltage (anode g4	3. 5	kV
Active getter voltage (cathode E	0	V
Photocathode C maximum current	0. 5	µA
Electrode g1 maximum current	7	µA
Electrode g2 maximum current	1	µA
Electrode g3 maximum current	1	µA
Electrode g4 maximum current (after post-gettering operation)	10	µA
Anode A maximum current	2	µA

Typical operation (see Starting Procedures)

Operating modes	Normal	Magnified	
Input diameter for 14, 2 mm O. I.	16	10	cm
Photocathode C voltage	0	0	V
Electrode g1 voltage*	100 to 250	100 to 250	V
Electrode g2 voltage*	400 to 1000	0 to 500	V
Electrode g3 voltage*	3. 0 to 3. 5	6. 0 to 6. 5	kV
Anode A voltage	28 to 30	28 to 30	kV
Active getter voltage (anode g4	2. 5 to 3	2. 5 to 3	kV
Active getter voltage (cathode E	0	0	V

Ripple votage must not exceed O, 5 %

* g1 g2 g3 voltages are defined for an anode voltage of 30 kV.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

STARTING PROCEDURE

Important

For tube handling, always prescribe use of security goggles (implosion risk).

Tube mounting

Set tube inside a proper metallic housing to protect operator against X-radiation.

Check for darkness of the tube housing (would the tube be checked without container, it should then be placed in a completely dark room).

The housing in which the tube is contained must be humidity proof and deshydrated. This condition is necessary to eliminate all moisture which could initiate coronas and sparks detrimental to tube operation. Moreover, it prevents dust electrostatic attraction on the viewing face.

Connections

All the connections necessary for tube supply (even for the anode) are made through flexible wires with reference marks.

A 10 Megohms resistance protecting the tube against discharge is provided inside the shell in the anode circuit. Time constant thus produced with tube capacitance contributes to ripple voltage filtering.

In series between each voltage supply and corresponding tube connection, insert in the same way a few Megohms protective resistance.

Focusing adjustments

Voltages supplies can be applied to the electrodes in a short time but with a slope not exceeding 5 kV/ms.

Let tube at rest with voltages applied for potential stabilization before adjusting it. (10 s minimum).

Set a 2 mm spaced metallic wire mesh of 5/10 mm diameter or equivalent (stainless steel, copper) in front of the tube and apply X-rays beam.

For each selected operating mode, electrode g3 voltage must be predetermined, the value of which should be within the limits specified in typical operation. For example g3 = 3.2 kV for normal mode and g3 = 6.2 kV for magnified mode.

Electrode g3 voltage being selected, adjust electrode g1 and g2 voltages within the specified range. The focusing adjustment shall be made as follows :

- Adjust g1 voltage in order to obtain an image as homogeneous as possible in luminance.
- Adjust g2 voltage in order to obtain the optimum resolution.
- Optimize g1 voltage if necessary.

Focusing adjustments are made respectively for "normal mode" and "magnified mode" . It is to notice that a single g1 voltage value can be selected for both modes. This property is valid when photocathode current is used to monitor automatic brightness control device.

Gettering operation

In order to assure a high reliability in operation and to maintain optimum performances of the tube, Instructions for Gettering operation should be stricty applied as defined in separate Data TEV 3006.

The purpose of this operation is to pump residual gas in the tube resulting in an ion spot which lowers the image contrast and resolution.

NOTES

(1) - The mounting of the tube in its shell (see page 2 and drawing) secures the positioning of the viewing screen at a determined optical distance from the mechanical plane of reference on which may be fixed the optical system. This distance is 20 mm ± 0.25. This shell assures a parallelism of the two planes with a precision higher than 1/800 radian. It assures a center of image within 0.5 mm from perpendicular axis of the reference plane defined by an aperture of 120.10 ± 0.05 mm diameter.

(2) - The resolution (as referred to input screen) is measured by using square lead pattern consisting in alternate black and white lines of equal width. Any two adjacent lines are designated as a line pair. The impinging X-radiation is produced by a generator operating at 65 kV and with a 2.5 mm aluminum filter. The resolution decreases gradually from the center to the edge of image. The central zone is within a circle having a diameter equal to 70 % of the input diameter. Peripheral zone is within circles 70 and 90 % of the input diameter.

(3) - The contrast is defined as the differential thickness which can be detected when using a JEDEC penetrameter. This penetrameter consists in an aluminum disc of 20 mm thickness presenting holes of 6 mm diameter. The depth of those holes vary from 1.5 to 7 % of the thickness of the disc. The differential thickness (expressed in %) of the hole having the minimum depth which can be detected defines the minimum contrast. X-ray conditions : 80 kVp - HVL 7 ± 0.2 mm Al-input dose rate 20 mR/mn.

(4) - The conversion factor is the value of the viewing screen luminance corresponding to a determined X-ray dose rate.
X-ray conditions : 80 kVp - 20 mm Al filter - HVL 7 ± 0.2 mm Al.
The luminance is measured by a photometer which matches the human vision.
The conversion factor is defined as :

$$\text{C. F.} = \frac{\text{Luminance}}{\text{dose rate}} = \frac{\text{Candela/square meter}}{\text{milli Roentgen/second}} \quad \text{or} \quad \frac{\text{foot Lambert}}{\text{Roentgen/minute}}$$

(5) - The luminance gain is the ratio of luminance of the image intensifier to the luminance of a Massiot - Fluor - Sirius fluoroscopic screen having a luminance of 0.012 cd/m^2 per mR/s. Both are irradiated in the same conditions : 80 kVp - 20 mm Al filter - HVL 7 ± 0.2 mm Al. The luminance is measured by a photometer which matches the human vision.

(6) - The background luminance is the luminance of output screen when normal operating voltages are applied to the tube and X-rays are off at normal ambient temperature.

(7) - The distortion is measured by putting an object of 1 cm length at the center and then at the edge of the field. The dimensions of the images measured on the viewing screen are respectively l_1 and l_2. The distortion is given by :

$$D = \frac{l_2 - l_1}{l_1}$$

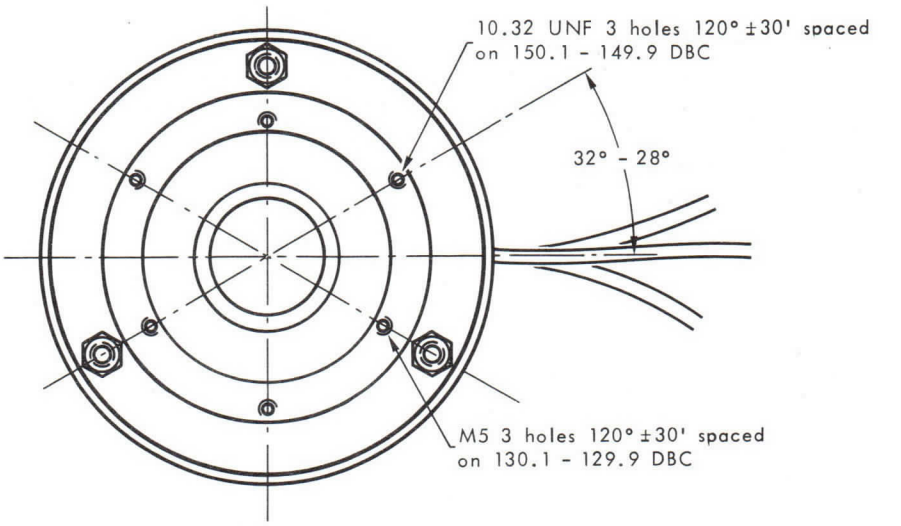
(8) - The image persistence is the residual luminance measured at a determined time after removal of X-ray radiations.

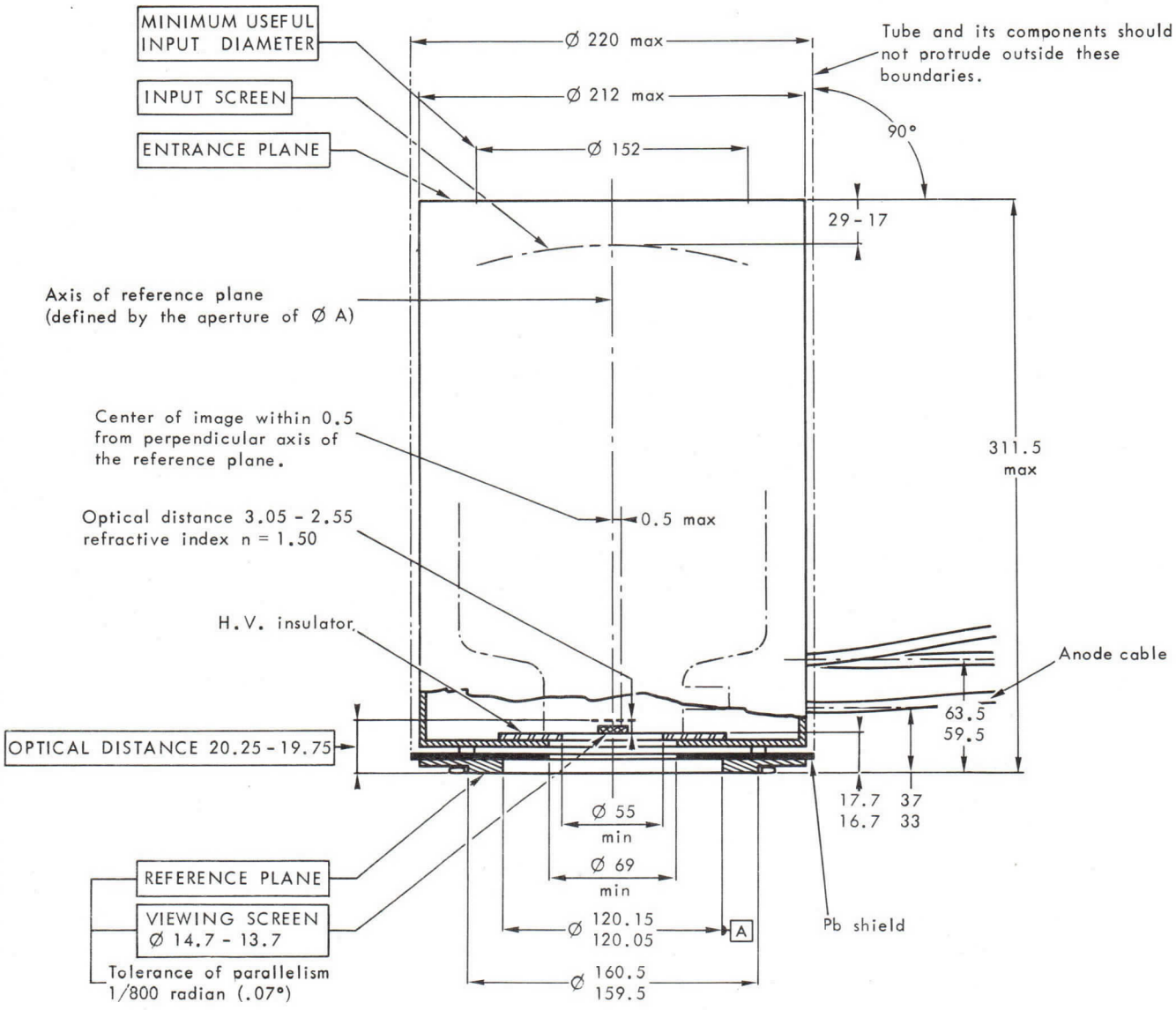
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING

ELECTRICAL CONNECTIONS		
Cathode	C	Black
Electrode	g1	Black
Electrode	g2	Black
Electrode	g3	Black
Getter (+)	g4	Black
Getter (-)	E	Blue
Earth	G	Black
Anode	A	White

Cable length 450 about





Dimensions in mm.

TH 9417
INTENSIFICATEUR D'IMAGE RADIOLOGIQUE ZOOM ELECTRONIQUE*

- DOUBLE CHAMP D'ENTREE : 15 cm et 10 cm
- DIAMETRE NOMINAL DE L'IMAGE DE SORTIE : 14, 5 mm
- HAUTE RESOLUTION - HAUT CONTRASTE
- GAIN EN LUMINANCE : x 7000

Le tube TH 9417 est un intensificateur d'images transformant le relief de rayonnement X formé derrière le sujet en une image à haute luminance et excellent contraste.

Le relief de rayonnement X est tout d'abord transformé en image lumineuse au sein d'un écran mince scintillateur situé à l'intérieur du tube, à proximité du plan d'entrée. L'image lumineuse excite à son tour une couche photoélectrique accolée à l'écran fluorescent. Les rayons X sont ainsi transformés en photoélectrons, lesquels sont accélérés et focalisés au moyen de champs électriques appropriés. Ces électrons viennent frapper un écran d'observation fluorescent disposé à proximité de la face de sortie, provoquant ainsi la formation d'une image secondaire inversée, de dimensions réduites, mais dont la luminance et la définition sont grandement améliorées par rapport à celles obtenues avec les meilleurs écrans utilisés en radiologie.

Les nombreux perfectionnements apportés à la conception du tube TH 9417 résultent de l'expérience acquise dans le domaine des tubes intensificateurs d'images radiologiques.

Le tube TH 9417 incorpore un écran détecteur à base d'iodure de Cesium, lequel associe un pouvoir d'absorption élevé permettant un excellent rendement de détection, et une réponse temporelle rapide autorisant l'observation des phénomènes évoluant rapidement.

L'écran de sortie utilise un matériau fluorescent composé de cristaux très fins de l'ordre du micron, déposés suivant une technologie hautement élaborée, permettant la présentation d'images à haute résolution sur un diamètre de 14,5 mm et rendant ainsi le tube d'un usage compatible avec les meilleurs systèmes optiques développés à ce jour.

L'écran de sortie du type P20 est sélectionné, d'une part de façon à ce que sa réponse spectrale coïncide avec la bande optimale de correction des systèmes optiques pour minimiser toutes réflexions et pertes de résolution et de contraste dans ces systèmes optiques, et d'autre part pour être bien adapté aux films utilisés en cinéma 35 mm, en radio-photo de 70 ou 100 mm, ou aux tubes de prise de vue des caméras de télévision.

Cet écran de sortie d'apparence sombre ("Ecran Noir") permet également de minimiser toute réflexion lumineuse interne ou provenant du système optique, et d'assurer ainsi le maximum de contraste d'image.

Le tube TH 9417 permet, par un choix des tensions appliquées aux électrodes de focalisation, d'obtenir un grandissement variable ou "Zoom électronique". L'image de sortie de diamètre 14,5 mm permet la présentation des images du plan d'entrée occupant respectivement des diamètres de 15 cm et 10 cm. Cette propriété est particulièrement intéressante chaque fois que l'utilisateur recherche le maximum de détails et de contraste dans l'image, par exemple pour l'examen de l'enfant, les examens chirurgicaux en crâniographie, les examens cardio-vasculaires etc... Elle permet de s'affranchir au maximum des imperfections de résolution des systèmes optiques de couplage et des dispositifs associés d'enregistrement ou de visualisation tels que films photographiques et Télévision.

* Marque déposée.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Compte tenu des performances de résolution élevées présentées par le tube intensificateur, l'alimentation haute tension, fournissant les tensions d'électrodes du tube, doit être réalisée avec soin ; en particulier, l'ondulation résiduelle sur les électrodes ne doit pas excéder 0, 3 %.

Le tube TH 9417 incorpore un dispositif de pompage automatique, getter actif, qui permet d'assurer une longue durée d'utilisation avec maintien des performances en éliminant tout défaut du genre tache ionique, point de gaz ou autre altération de résolution de contraste ou de gain de luminance.

CARACTERISTIQUES GENERALES

Mécaniques (voir note 1 et dessin)

Le tube est livré monté dans une gaine métallique assurant la fixation mécanique, cependant il est nécessaire de maintenir l'ensemble par un support au niveau de la face d'entrée.

Dans la gaine le tube est fixé de façon à faciliter le montage précis du système optique par rapport au plan de référence. Cette gaine protège le tube contre les champs magnétiques parasites mais ne peut pas être considérée comme une protection efficace contre les rayonnements X, Une plaque de plomb de 2 mm d'épaisseur est prévue au niveau de la face de sortie de la gaine.

Position de fonctionnement	indifférente
Position durant le transport	axe du tube horizontal
Température de fonctionnement et de stockage :	
- maximum	+50 °C
- minimum	+ 5 °C
Poids net approximatif	3 kg
Dimensions	voir dessin

Optiques

Diamètre de l'écran d'entrée	15 ± 0, 5 cm
Diamètre de l'image de sortie	14, 5 ± 0, 5 mm
Réponse spectrale de l'écran d'entrée	rayons X générateur de 30 à 250 kVp
Ecran d'observation :	
- type	P20 (λ max = 520 nm)
- fluorescence et phosphorescence	jaune - vert
Focalisation	électrostatique image inversée

Modes de fonctionnement	Normal	Loupe	
Diamètre du champ d'entrée	15	10	cm
Grandissement	1/11	1/8	
Résolution typique (note 2) :			
- centrale	38	45	pl/cm
- périphérique	34	40	pl/cm
Contraste minimal (note 3) mesuré avec pénétramètre JEDEC	2, 1	2, 1	%
Facteur de conversion minimal (note 4)	70	35	$\frac{cd/m^2}{mR/s}$
ou	350	150	$\frac{fL}{R/mn}$
Gain en luminance minimal (note 5)	7000	3500	
Bruit de fond maximal (note 6)	0, 06	0, 06	cd/m^2
ou	0, 02	0, 02	fL
Distorsion maximale (note 7)	10	7	%
Persistance maximale à 10 ms (note 8)	10	10	%

CONDITIONS DE FONCTIONNEMENT

Valeurs limites

Tension de photocathodes pc	0	V
Tension d'électrode g1	0, 5	kV
Tension d'électrode g2	2, 0	kV
Tension d'électrode g3	9, 5	kV
Tension d'anode a	32, 0	kV
Tension de getter actif :		
- anode g4	3, 5	kV
- cathode e	0	V
Courant maximal de photocathode pc	0, 5	µA
Courant maximal d'électrode g1	5	µA
Courant maximal d'électrode g2	1	µA
Courant maximal d'électrode g3	1	µA
Courant maximal d'électrode g4 (après post-pompage)	10	µA
Courant maximal d'anode a	2	µA

Modes de fonctionnement

Modes de fonctionnement :	Normal	Loupe	
Diamètre d'entrée pour une image de 14, 5 mm	15	10	cm
Tension de photocathode pc	0	0	V
Tension d'électrode g1*	100 à 350	100 à 350	V
Tension d'électrode g2*	1000 à 1600	1000 à 1600	V
Tension d'électrode g3*	3, 8	8, 0	kV
Tension d'anode a	30, 0	30, 0	kV
Tension de getter actif			
- anode g4	2, 5 à 3, 0	2, 5 à 3, 0	kV
- cathode e	0	0	V

Les tensions doivent présenter un taux d'ondulation inférieur à 0, 3 %.

* Les tensions g1, g2, g3 sont données pour une tension d'anode de 30 kV.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

CONSIGNES DE MISE EN SERVICE

Important

Pour toute manipulation du tube, imposer le port de lunettes de sécurité (risque d'implosion).

Montage du tube

Monter le tube à l'intérieur d'une gaine métallique convenablement blindée aux rayons X pour assurer la protection de l'observateur.

Vérifier l'obscurité de la gaine dans laquelle le tube est placé (si le tube est essayé occasionnellement sans gaine, une quasi obscurité est nécessaire dans la pièce où l'on opère).

La gaine dans laquelle le tube est placé doit être étanche et déshydratée. Cette précaution est nécessaire pour éliminer toute trace d'humidité pouvant provoquer des effluves électriques préjudiciables au bon fonctionnement du tube. Elle est de plus utile pour empêcher l'empoussièrage de la face d'observation du tube (attraction électrostatique).

Branchement des connexions

Toutes les connexions nécessaires à l'alimentation du tube (y compris l'anode) doivent être effectuées par l'intermédiaire de fils souples repérés d'après leurs couleurs.

Une résistance de 10 MΩ destinée à protéger le tube contre les décharges électriques est insérée en série dans le circuit anodique à l'intérieur de la gaine. Grâce à la capacité du tube, cette résistance permet de filtrer les fluctuations rapides de tension d'alimentation.

Intercaler de la même manière une résistance de protection de quelques Megohms entre les différentes sources d'alimentation et les électrodes correspondantes.

Réglages du tube

Les tensions d'alimentation peuvent être appliquées rapidement aux électrodes sans cependant dépasser 5 kV par ms. Laisser les tensions se stabiliser (10 s minimum) avant d'effectuer les réglages.

Placer une grille constituée de fils métalliques (inox, cuivre) de 5/10 mm de diamètre espacés de 2 mm devant la face d'entrée du tube et irradier aux rayons X.

Pour chaque mode de fonctionnement la tension de l'électrode g3, dont la valeur se situe dans les limites spécifiées dans les conditions de fonctionnement, doit être prédéterminée.

La tension de l'électrode g3 étant choisie, régler les tensions des électrodes g1 et g2 dans les limites spécifiées comme suit :

- régler la tension g1 pour obtenir une image aussi homogène que possible en luminance.
- régler la tension g2 pour obtenir la résolution optimale.
- optimiser la tension g1 si nécessaire.

Les réglages doivent être faits respectivement pour le mode normal et le mode loupe.

Opération de post-pompage

Afin d'assurer une bonne stabilité de fonctionnement du tube et d'obtenir ses performances optimales, il est nécessaire d'observer scrupuleusement les instructions de post-pompage définies dans une Notice séparée.

Cette opération a pour but de pomper les gaz résiduels du tube dont la présence occasionnelle contribue à la formation d'une tache ionique qui diminue le contraste et la résolution de l'image.

NOTES

1 - Le montage du tube dans sa gaine (voir figure) permet la localisation du plan de l'écran d'observation à une distance optique déterminée du plan mécanique de référence sur lequel vient prendre appui le système de couplage optique ; cette distance est de 25 ± 0, 25 mm.

La gaine assure un parallèlisme de ces deux plans à moins de 1/800 radian près. Il garantit un écart maximal de 0, 25 mm entre l'axe de l'image et l'axe du système mécanique de référence, défini par l'ouverture de 100,11 ± 0,04 mm de diamètre.

2 - La résolution, rapportée à l'écran d'entrée, est mesurée à l'aide d'une mire constituée de lignes équidistantes alternativement opaques et transparentes au rayonnement X. Deux lignes adjacentes constituent une paire de lignes. Le rayonnement X est fourni par un générateur travaillant à 65 kV et possèdant un filtre additionnel de 2, 5 mm d'aluminium. La valeur indiquée s'entend dans 70 % de la surface d'entrée.

3 - Le contraste correspond à la dose de rayonnement différentiel que l'on peut détecter avec un fantôme de quelques centimètres carrés. Le rayonnement X est fourni par un générateur travaillant à 80 kV et possèdant un filtre additionnel de 20 mm d'aluminium. (Valeur de la demi-dose : 7 mm).

4 - Le facteur de conversion représente la valeur de la luminance de l'écran d'observation pour une dose de rayonnement incident déterminée, issu d'un générateur travaillant à 80 kV avec un filtre d'aluminium interposé de 20 mm (épaisseur de demi-dose : 7 mm environ). La luminance est mesurée avec un photomètre possèdant la même courbe de réponse que celle de l'oeil. Le facteur de conversion est égal à :

$$\frac{\text{luminance}}{\text{dose de rayonnement}} = \frac{\text{Candela/mètre carré}}{\text{Milliroentgen/seconde}} \quad \text{ou} \quad \frac{\text{foot Lambert}}{\text{Roentgen/minute}}$$

5 - Le gain en luminance est le rapport de la luminance de l'écran d'observation du tube amplificateur à la luminance d'un écran radioscopique type Massiot-Fluor Sirius. Ecran et tube sont irradiés dans les mêmes conditions par un générateur travaillant à 80 kV et avec un filtre interposé de 20 mm d'aluminium (épaisseur de demi-dose : 7 mm environ). La luminance est mesurée avec un photomètre possèdant la même courbe de réponse que celle de l'oeil.

6 - Le bruit de fond est exprimé par la luminance de l'écran de sortie, quand le tube est alimenté sous tensions normales sans être soumis aux rayons X dans les conditions de température ambiante normales.

7 - La distorsion est mesurée par $D = \frac{Mp - Mc}{M_c} \times 100$

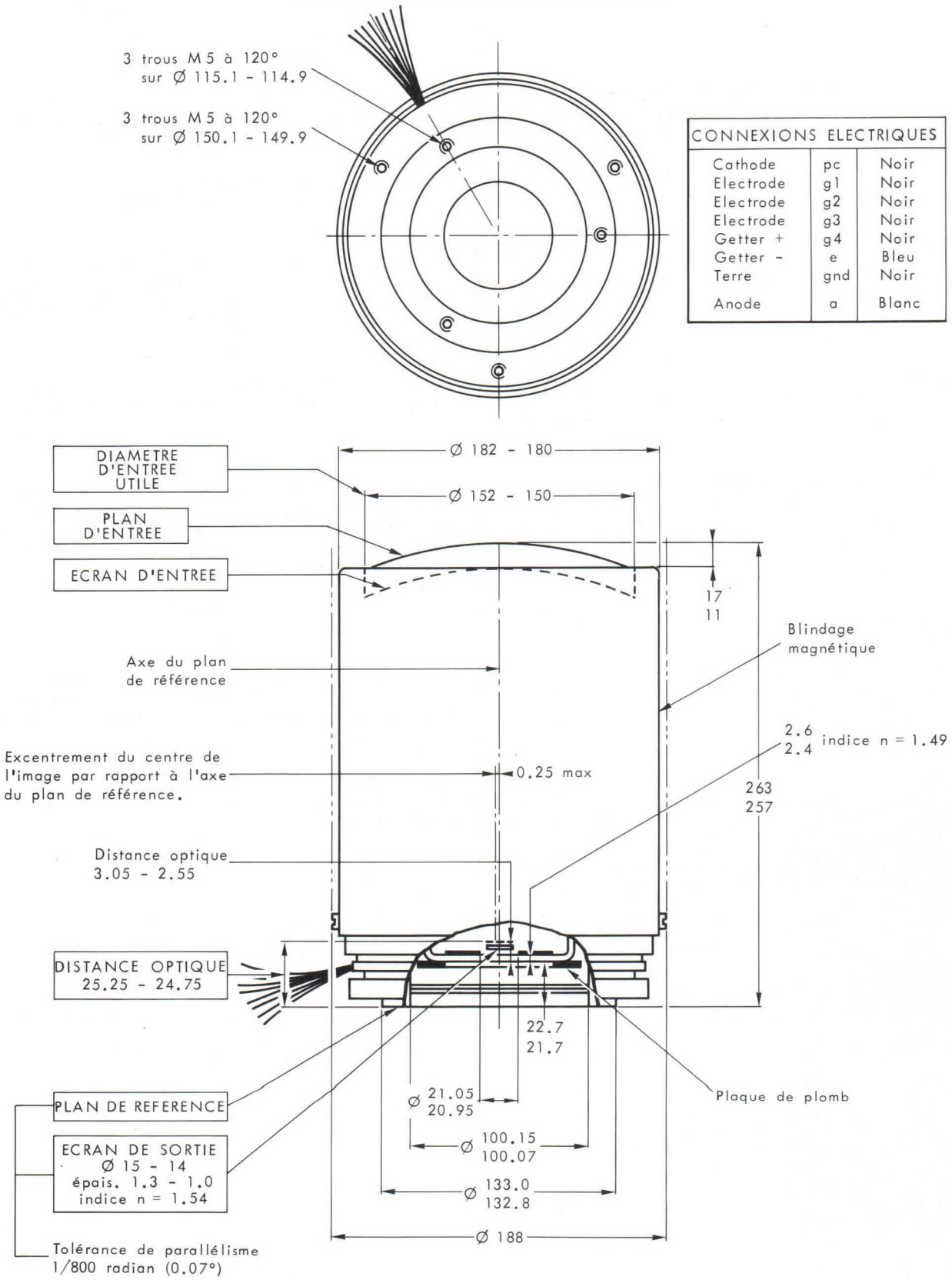
avec M_p = grandissement mesuré sur un cercle couvrant 95 % du champ d'entrée.

M_c = grandissement mesuré sur un cercle de 2 cm centré sur l'axe du champ d'entrée.

8 - La persistance d'image est la luminance résiduelle mesurée au bout d'un temps donné après extinction des radiations X.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

DESSIN D'ENCOMBREMENT



CONNEXIONS ELECTRIQUES		
Cathode	pc	Noir
Electrode	g1	Noir
Electrode	g2	Noir
Electrode	g3	Noir
Getter +	g4	Noir
Getter -	e	Bleu
Terre	gnd	Noir
Anode	a	Blanc

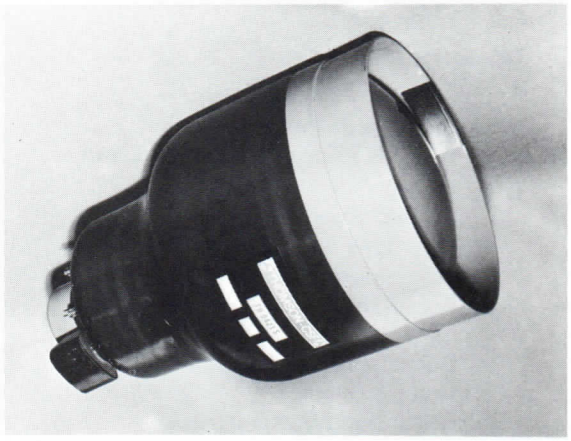
Cotes en mm.

TH 9421 S
INTENSIFICATEUR D'IMAGE RADIOLOGIQUE

- CHAMP D'ENTREE : 22 cm
- DIAMETRE NOMINAL DE L'IMAGE DE SORTIE : 20 mm
- HAUT CONTRASTE
- GAIN EN LUMINANCE : x 6000

Le tube TH 9421 S est un intensificateur d'images transformant le relief de rayonnement X formé derrière le sujet en une image à haute luminance et excellent contraste.

Le relief de rayonnement X est tout d'abord transformé en image lumineuse au sein d'un écran mince scintillateur situé à l'intérieur du tube, à proximité du plan d'entrée. L'image lumineuse excite à son tour une couche photoélectrique accolée à l'écran fluorescent. Les rayons X sont ainsi transformés en photoélectrons, lesquels sont accélérés et focalisés au moyen de champs électriques appropriés. Ces électrons viennent frapper un écran d'observation fluorescent disposé à proximité de la face de sortie, provoquant ainsi la formation d'une image secondaire inversée, de dimensions réduites, mais dont la luminance et la définition sont grandement améliorées par rapport à celles obtenues avec les meilleurs écrans utilisés en radiologie.



Les nombreux perfectionnements apportés à la conception du tube TH 9421 S résultent de l'expérience acquise dans le domaine des tubes intensificateurs d'images radiologiques.

Le tube TH 9421 S incorpore un écran détecteur à base d'iodure de Cesium, lequel associe un pouvoir d'absorption élevé permettant un excellent rendement de détection, et une réponse temporelle rapide autorisant l'observation des phénomènes évoluant rapidement.

L'écran de sortie utilise un matériau fluorescent composé de cristaux très fins,de l'ordre du micron, déposés suivant une technologie hautement élaborée, permettant la présentation d'images à haute résolution sur un diamètre de 20 mm et rendant ainsi le tube d'un usage compatible avec les meilleurs systèmes optiques développés à ce jour.

L'écran de sortie du type P20 est sélectionné d'une part, de façon à ce que sa réponse spectrale coïncide avec la bande optimale de correction des systèmes optiques pour minimiser toutes réflexions et pertes de résolution et de contraste dans ces systèmes optiques, et d'autre part pour être bien adapté aux films utilisés en cinéma 35 mm, en radio photo de 70 ou 100 mm, ou aux tubes de prise de vue des caméras de Télévision.

Cet écran de sortie d'apparence sombre ("Ecran noir") permet également de minimiser toute réflexion lumineuse interne ou provenant du système optique, et d'assurer ainsi le maximum de contraste d'image.

Compte tenu des performances présentées par le tube intensificateur, l'alimentation haute tension, fournissant les tensions d'électrodes du tube, doit être réalisée avec soin ; en particulier, l'ondulation résiduelle sur les électrodes ne doit pas excéder 0, 5 %.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Le tube TH 9421 S incorpore un dispositif de pompage automatique, getter actif, qui permet d'assurer une longue durée d'utilisation avec maintien des performances en éliminant tout défaut du genre tache ionique, point de gaz ou autre altération de résolution de contraste ou de gain de luminance.

CARACTERISTIQUES GENERALES

Mécaniques

Position de fonctionnement	indifférente	
Position durant le transport	axe du tube horizontal	
Température de fonctionnement et de stockage — max.	+ 50	°C
min.	+ 5	°C
Poids net approximatif	4	kg
Dimensions	voir dessin	

Optiques

Diamètre de l'écran d'entrée	22 ± 0,5	cm
Diamètre de l'image de sortie	20 ± 0,5	mm
Réponse spectrale de l'écran d'entrée	rayons X générateur de 30 à 250 kVp	
Ecran d'observation :		
- type	P20 (λ max = 520 nm)	
- fluorescence et phosphorescence	jaune - vert	
Focalisation	électrostatique image inversée	
Diamètre du champ d'entrée	22	cm
Grandissement	1/11	
Résolution typique (note 1) :		
- centrale	20	pl/cm
- périphérique	18	pl/cm
Contraste minimal (note 2) mesuré avec pénétramètre JEDEC	2,5	%
Facteur de conversion minimal (note 3)	60	$\frac{cd/m^2}{mR/s}$
ou	300	$\frac{fL}{R/mn}$
Gain en luminance minimal (note 4)	6000	
Bruit de fond maximal (note 5)	0,06	cd/m^2
ou	0,02	fL
Distorsion maximale (note 6)	10	%
Persistance maximale à 10 ms (note 7)	10	%

CONDITIONS DE FONCTIONNEMENT

Valeurs limites

Tension de photocathodes p.c.	0	V
Tension d'électrode g1	0,3	kV
Tension d'électrode g2	4,0	kV
Tension d'électrode g3	6.0	kV
Tension d'anode a	32	kV
Tension de getter actif :		
- anode g4	3,5	kV
- cathode e	0	V
Courant maximal de photocathode p.c.	0,5	μA
Courant maximal d'électrode g1	1	μA
Courant maximal d'électrode g2	1	μA
Courant maximal d'électrode g3	1	μA
Courant maximal d'électrode g4 (après post-pompage)	10	μA
Tension d'anode a	2	μA

Exemples de fonctionnement

Diamètre d'entrée pour une image de 20 mm	22	cm
Tension de photocathode p.c.	0	V
Tension d'électrode g1*	60 à 180	V
Tension d'électrode g2*	400 à 1200	V
Tension d'électrode g3*	2, 4 à 3, 4	kV
Tension d'anode a	30, 0	kV
Tension de getter actif		
- anode g4	2, 5 à 3, 0	kV
- cathode e	0	V

Les tensions doivent présenter un taux d'ondulation inférieur à 0, 5 %.

* Les tensions g1, g2, g3 sont données pour une tension d'anode de 30 kV.

CONSIGNES DE MISE EN SERVICE

Important

Pour toute manipulation du tube, imposer le port de lunettes de sécurité (risque d'implosion).

Montage du tube

Monter le tube à l'intérieur d'une gaine métallique convenablement blindée aux rayons X pour assurer la protection de l'observateur.

Vérifier l'obscurité de la gaine dans laquelle le tube est placé (si le tube est essayé occasionnellement sans gaine, une quasi obscurité est nécessaire dans la pièce où l'on opère).

La gaine dans laquelle le tube est placé doit être étanche et déshydratée. Cette précaution est nécessaire pour éliminer toute trace d'humidité pouvant provoquer des effluves électriques préjudiciables au bon fonctionnement du tube. Elle est de plus utile pour empêcher l'empoussièrage de la face d'observation du tube (attraction électrostatique).

Branchement des connexions

Il est indispensable de raccorder correctement les électrodes aux sources d'alimentation correspondantes. Ne pas omettre les connexions e et g4 du getter actif.

Intercaler entre la source de tension anodique et l'anode a une résistance d'au moins 10 MΩ destinée à protéger le tube contre les décharges électriques. Grâce à la capacité du tube, cette résistance permet de filtrer les fluctuations rapides de la tension d'alimentation.

Intercaler de la même manière une résistance de protection de quelques Megohms entre les différentes sources d'alimentation et les électrodes correspondantes.

Réglages du tube

Les tensions d'alimentation peuvent être appliquées rapidement aux électrodes sans cependant dépasser 5 kV par ms. Laisser les tensions se stabiliser (10 s minimum) avant d'effectuer les réglages.

Placer une grille constituée de fils métalliques (inox, cuivre) de 5/10 mm de diamètre espacés de 2 mm devant la face d'entrée du tube et irradier aux rayons X.

Pour chaque mode de fonctionnement la tension de l'électrode g3, dont la valeur se situe dans les limites spécifiées dans les conditions de fonctionnement, doit être prédéterminée.

La tension de l'électrode g3 étant choisie, régler les tensions des électrodes g1 et g2 dans les limites spécifiées comme suit :

- régler la tension g1 pour obtenir une image aussi homogène que possible en luminance ;
- régler la tension g2 pour obtenir la résolution optimale ;
- optimiser la tension g1 si nécessaire.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Opération de post-pompage

Afin d'assurer une bonne stabilité de fonctionnement du tube et d'obtenir ses performances optimales, il est nécessaire d'observer scrupuleusement les instructions de post-pompage définies dans une Notice séparée.

Cette opération a pour but de pomper les gaz résiduels du tube dont la présence occasionnelle contribue à la formation d'une tache ionique qui diminue le contraste et la résolution de l'image.

NOTES

1 - La résolution, rapportée à l'écran d'entrée, est mesurée à l'aide d'une mire constituée de lignes équidistantes alternativement opaques et transparentes au rayonnement X. Deux lignes adjacentes constituent une paire de lignes. Le rayonnement X est fourni par un générateur travaillant à 65 kV et possèdant un filtre additionnel de 2, 5 mm d'aluminium. La valeur indiquée s'entend dans 70 % de la surface d'entrée.

2 - Le contraste correspond à la dose de rayonnement différentiel que l'on peut détecter avec un fantôme de quelques centimètres carrés. Le rayonnement X est fourni par un générateur travaillant à 80 kV et possèdant un filtre additionnel de 20 mm d'aluminium. (Valeur de la demi-dose : 7 mm).

3 - Le facteur de conversion représente la valeur de la luminance de l'ecran d'observation pour une dose de rayonnement incident déterminée, issu d'un générateur travaillant à 80 kV avec un filtre d'aluminium interposé de 20 mm (épaisseur de demi-dose : 7 mm environ). La luminance est mesurée avec un photomètre possèdant la même courbe de réponse que celle de l'oeil. Le facteur de conversion est égal à :

$$\frac{\text{luminance}}{\text{dose de rayonnement}} = \frac{\text{Candela/mètre carré}}{\text{Milliroentgen/seconde}} \quad \text{ou} \quad \frac{\text{foot Lambert}}{\text{Roentgen/minute}}$$

4 - Le gain en luminance est le rapport de la luminance de l'écran d'observation du tube amplificateur à la luminance d'un écran radioscopique type Massiot-Fluor Sirius. Ecran et tube sont irradiés dans les mêmes conditions par un générateur travaillant à 80 kV et avec un filtre interposé de 20 mm d'aluminium (épaisseur de demi-dose : 7 mm environ). La luminance est mesurée avec un photomètre possèdant la même courbe de réponse que celle de l'oeil.

5 - Le bruit de fond est exprimé par la luminance de l'écran de sortie, quand le tube est alimenté sous tensions normales sans être soumis aux rayons X dans les conditions de température ambiante normales.

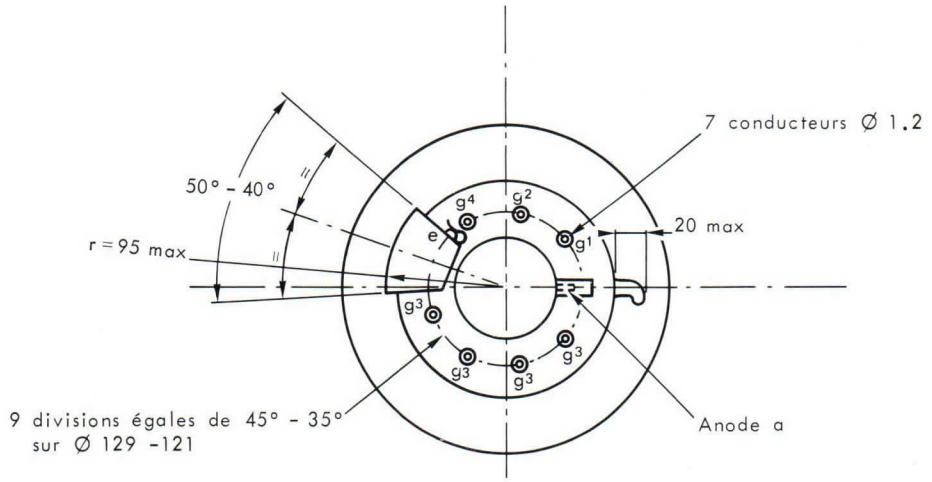
6 - La distorsion est mesurée par $D = \frac{M_p - M_c}{M_c} \times 100$

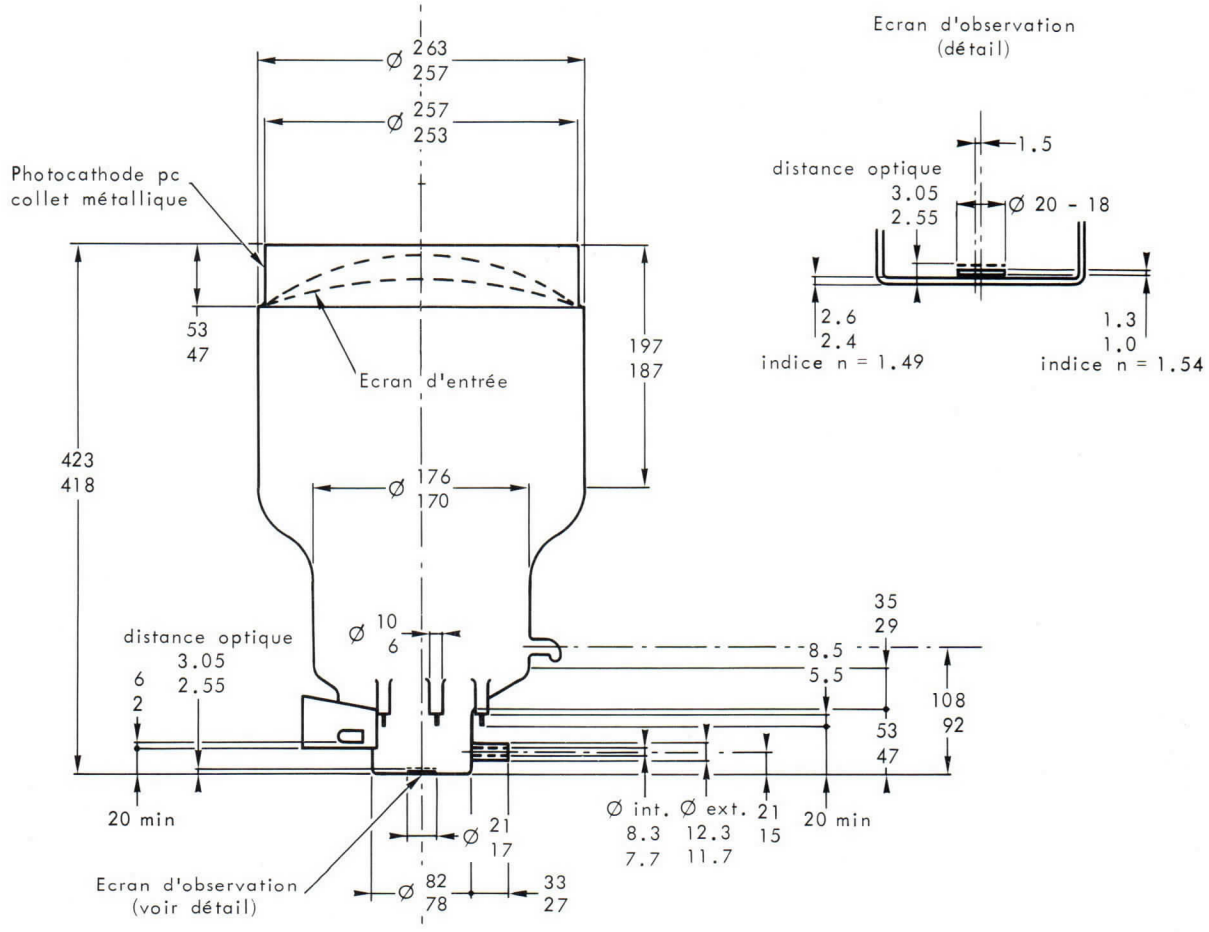
avec M_p = grandissement mesuré sur un cercle couvrant 95 % du champ d'entrée.

M_c = grandissement mesuré sur un cercle de 2 cm centré sur l'axe du champ d'entrée.

7 - La persistance d'image est la luminance résiduelle mesurée au bout d'un temps donné après extinction des radiations X.

DESSIN D'ENCOMBREMENT





Cotes en mm.

TH 9421 S

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

ELECTRONIC ZOOM
X-RAY IMAGE INTENSIFIER TUBE TH 9426

HIGH RESOLUTION COMPACT TUBE

BRIGHTNESS GAIN : 6000 X

INPUT FIELDS : 22 cm (9") - 16 cm (6") - 11.5 cm (4.5")

TH 9426 is a 22 cm X-ray image intensifier which converts the X-ray pattern into a light image of high brightness and good contrast.

Technological improvements concerning input screen, electronoptics and viewing screen allow for higher resolution than that of older types TH 9421 A and TH 9423. Moreover, TH 9426 length is shorter by 8 cm than that of those older types.

In addition, TH 9426 has an adjustable magnification so to display to the user input fields of 22 cm - 16 cm and 11.5 cm. The image is delivered on the output screen with 20 mm diameter. Magnification can be adjusted from 1/5.5 - 1/8 to 1/11 by a proper choice of voltages applied to the three focusing electrodes. Output image luminance which is proportional to the energy gain of the intensifier and to the square of the electronic magnification varies from 1500 X - 3000 X to 6000 X.

The "active getter" provides a very high vacuum all along tube's life avoiding the development of an ion spot and alteration of contrast and resolution. The getter needs no extra installation and operates automatically as the tube is energized.

TH 9426 is delivered in a shell which permits mechanical mounting, protects the tube from stray magnetic field and secures a precise positioning of the associated optical system.

Applications

As a result of the high brightness gain it is possible to operate the tube with a very low input dose rate which reduces health hazards. This point is very important in medical radiology since this device enables a significant reduction of X-ray radiation as well on the patient as on the operator.

The high gain allows a good matching with television camera. Such an equipment enables examination of any part of the human body, which gives substantial improvement with respect to conventional X-ray examinations. Field of applications in industrial radiology are considerably extended by the use of the tube TH 9426 which allows the use of low power X-rays sources for non destructive testing of very opaque materials.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

GENERAL CHARACTERISTICS

Mechanical - (see note 1 and drawing)

The tube is delivered mounted in a metallic shell which permits mechanical fixation : nevertheless it is necessary to maintain the assembly by sustaining the entrance plane.

In this shell the tube is fixed so as to facilitate the precise localization of the optical device as regard to the reference plane. This shell protects the tube against stray magnetic field and cannot be considered as an efficient shield against X-radiations. A lead shield of 2 mm thick is provided at the output plane of the shell.

Dimensions	See drawing
Net weight, approximate	9 kg
Mounting position	any
Shipment position	tube axis horizontal
Operating and stocking temperature. . max.	+50 °C
min.	+ 5 °C

Optical

Input screen diameter	22 ± 0. 5 cm
Output image diameter (O. I.)	20 ± 0. 5 mm
Input spectral response	X-rays (30 to 250 kVp generator)
Viewing screen	
Type	P 20 (λ = 520 nm)
Fluorescence and phosphorescence	Yellow - green
Electrostatic focus - Inverted image	

Operating modes :	Normal	Magn. 1	Magn. 2	
Input field diameter	22	16	11. 5	cm
Magnification	1/11	1/8	1/5. 5	
Minimum resolution (note 2)				
- central	18	20	22	lp/cm
- peripheral	16	18	20	lp/cm
Minimum contrast (note 3) measured with JEDEC penetrameter	3	2. 5	2	%
Minimum conversion factor (note 4)	70	35	18	Cd/m^2 per mR/s
or	350	175	90	ft. L per R/mn
Minimum luminance gain (note 5)	6000	3000	1500	
Maximum background luminance (note 6)	0. 06	0. 06	0. 06	Cd/m^2
or	0. 02	0. 02	0. 02	ft. L
Maximum distortion (note 7)	30	15	10	%
Maximum persistence at 10 ms (note 8)	10	10	10	%

MAXIMUM RATINGS AND TYPICAL OPERATION

Maximum ratings

Photocathode C voltage		0	V
Electrode g1 voltage		0. 50	kV
Electrode g2 voltage		3. 0	kV
Electrode g3 voltage		11. 0	kV
Anode A		32	kV
Active getter voltage	(anode g4	3. 5	kV
	(cathode E	0	V
Photocathode C maximum current		0. 5	µA
Electrode g1 maximum current		5	µA
Electrode g2 maximum current		1	µA
Electrode g3 maximum current		1	µA
Electrode g4 maximum current (after post-gettering operation)		10	µA
Anode A maximum current		2	µA

Typical operation (see starting procedures)

Operating modes :		Normal	Magn. 1	Magn. 2	
Input diameter for 20 mm O.I.		22	16	11. 5	cm
Photocathode C voltage		0	0	0	V
Electrode g1 voltage *		0 to 250	0 to 250	0 to 250	V
Electrode g2 voltage *		450 to 850	300 to 700	300 to 700	V
Electrode g3 voltage *		3. 2	5. 7	10	kV
Anode A voltage		28 to 30	28 to 30	28 to 30	kV
Active getter voltage	(anode g4	2. 5 to 3	2. 5 to 3	2. 5 to 3	kV
	(cathode E	0	0	0	V

Ripple voltage must not exceed 0. 5 %

** g1 g2 g3 voltages are defined for an anode voltage of 30 kV.*

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

STARTING PROCEDURE

Important

For tube handling, always prescribe use of security goggles (implosion risk).

Tube mounting

Set tube inside a proper metallic housing to protect operator against X-radiation.

Check for darkness of the tube housing (would the tube be checked without container, it should then be placed in a completely dark room).

The housing in which the tube is contained must be humidity proof and deshydrated. This condition is necessary to eliminate all moisture which could initiate coronas and sparks detrimental to tube operation. Moreover, it prevents dust electrostatic attraction on the viewing face.

Connections

All the connections necessary for tube supply (even for the anode) are made through flexible wires with reference marks.

A 10 Megohms resistance protecting the tube against discharge is provided inside the shell in the anode circuit. Time constant thus produced with tube capacitance contributes to ripple voltage filtering.

In series between each voltage supply and corresponding tube connection, insert in the same way a few Megohms protective resistance.

Focusing adjustments

Voltages supplies can be applied to the electrodes in a short time but with a slope not exceeding 5 kV/ms.

Let tube at rest with voltages applied for potential stabilization before adjusting it. (10 s minimum).

Set a 2 mm spaced metallic wire mesh of 5/10 mm diameter or equivalent (stainless steel, copper) in front of the tube and apply X-rays beam.

For each selected operating mode, electrode g3 voltage must be predetermined, the value of which should be within the limits specified in typical operation. For example g3 = 3. 2 kV for normal mode, g3 = 5. 7 kV for magnified mode 1 and g3 = 10 kV for magnified mode 2.

Electrode g3 voltage being selected, adjust electrode g1 and g2 voltages within the specified range. The focusing adjustment shall be made as follows :

- Adjust g1 voltage in order to obtain an image as homogeneous as possible in luminance.
- Adjust g2 voltage in order to obtain the optimum resolution.
- Optimize g1 voltage if necessary.

Focusing adjustments are made respectively for "normal mode", "magnified mode 1" and "magnified mode 2".

REMARK - Typical operation voltages correspond to selected operating mode of 22 cm - 16 cm and 11.5 cm. For particular use, any input field between 22 cm and 11.5 cm can be selected : please contact manufacturer for information.

Gettering operation

In order to assure a high reliability in operation and to maintain optimum performances of the tube, Instructions for Gettering operation should be strictly applied as defined in separate Data TEV 3006.

The purpose of this operation is to pump residual gas in the tube resulting in an ion spot which lowers the image contrast and resolution.

NOTES

(1) - The mounting of the tube in its shell (see page 2 and drawing) secures the positioning of the viewing screen at a determined optical distance from the mechanical plane of reference on which may be fixed the optical system. This distance is 20 mm ± 0.25. This shell assures a parallelism of the two planes with a precision higher than 1/800 radian. It assures a center of image within 0.5 mm from perpendicular axis of the reference plane defined by an aperture of 120.10 ± 0.05 mm diameter.

(2) - The resolution (as referred to input screen) is measured by using square lead pattern consisting in alternate black and white lines of equal width. Any two adjacent lines are designated as a line pair. The impinging X-radiation is produced by a generator operating at 65 kV and with a 2.5 mm aluminum filter. The resolution decreases gradually from the center to the edge of image. The central zone is within a circle having a diameter equal to 70 % of the input diameter. Peripheral zone is within circles 70 and 90 % of the input diameter.

(3) - The contrast is defined as the differential thickness which can be detected when using a JEDEC penetrameter. This penetrameter consists in an aluminum disc of 20 mm thickness presenting holes of 6 mm diameter. The depth of those holes vary from 1.5 to 7 % of the thickness of the disc. The differential thickness (expressed in %) of the hole having the minimum depth which can be detected defines the minimum contrast. X-ray conditions : 80 kVp - HVL 7 ± 0.2 mm Al-input dose rate 20 mR/mn.

(4) - The conversion factor is the value of the viewing screen luminance corresponding to a determined X-ray dose rate.
X-ray conditions : 80 kVp - 20 mm Al filter - HVL 7 ± 0.2 mm Al.
The luminance is measured by a photometer which matches the human vision.
The conversion factor is defined as :

$$\text{C. F.} = \frac{\text{Luminance}}{\text{dose rate}} = \frac{\text{Candela/square meter}}{\text{milli Roentgen/second}} \quad \text{or} \quad \frac{\text{foot Lambert}}{\text{Roentgen/minute}}$$

(5) - The luminance gain is the ratio of luminance of the image intensifier to the luminance of a Massiot - Fluor - Sirius fluoroscopic screen having a luminance of 0.012 cd/m^2 per mR/s. Both are irradiated in the same conditions : 80 kVp - 20 mm Al filter - HVL 7 ± 0.2 mm Al. The luminance is measured by a photometer which matches the human vision.

(6) - The background luminance is the luminance of output screen when normal operating voltages are applied to the tube and X-rays are off at normal ambient temperature.

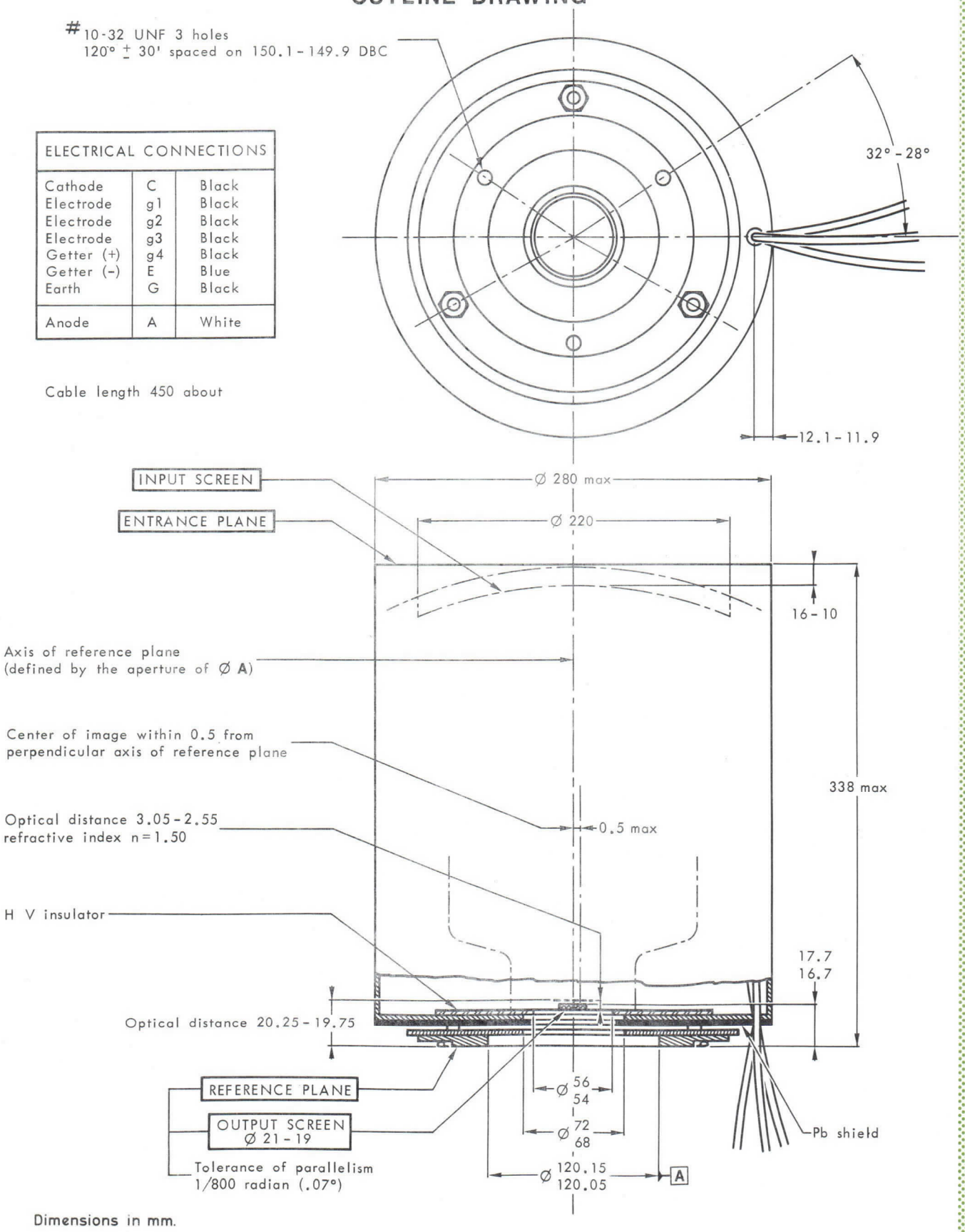
(7) - The distortion is measured by putting an object of 1 cm length at the center and then at the edge of the field. The dimensions of the images measured on the viewing screen are respectively l_1 and l_2. The distortion is given by :

$$D = \frac{l_2 - l_1}{l_1}$$

(8) - The image persistence is the residual luminance measured at a determined time after removal of X-ray radiations.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING



ELECTRICAL CONNECTIONS		
Cathode	C	Black
Electrode	g1	Black
Electrode	g2	Black
Electrode	g3	Black
Getter (+)	g4	Black
Getter (-)	E	Blue
Earth	G	Black
Anode	A	White

Cable length 450 about

Dimensions in mm.

X_RAY IMAGE INTENSIFIER TUBE TH 9427

HIGH RESOLUTION COMPACT TUBE

BRIGHTNESS GAIN : 6000 X

INPUT FIELD : 22 cm (9")

TH 9427 is a 22 cm X-ray image intensifier which converts the X-ray pattern into a light image of high brightness and good contrast.

Technological improvements concerning input screen, electronoptics and viewing screen allow for higher resolution than that of older types TH 9412 A and TH 9423. Moreover, TH 9426 length is shorter by 8 cm than that of those older types.

The "active getter" provides a very high vacuum all along tube's life avoiding the development of an ion spot and alteration of contrast and resolution. The getter needs no extra installation and operates automatically as the tube is energized.

TH 9427 is delivered in a shell which permits mechanical mounting, protects the tube from stray magnetic field and secures a precise positioning of the associated optical system.

Applications

As a result of the high brightness gain it is possible to operate the tube with a very low input dose rate which reduces health hazards. This point is very important in medical radiology since this device enables a significant reduction of X-ray radiation as well on the patient as on the operator.

The high gain allows a good matching with television camera. Such an equipment enables examination of any part of the human body, which gives substantial improvement with respect to conventional X-ray examinations.

Fields of applications in industrial radiology are considerably extended by the use of the tube TH 9427 which allows the use of low power X-rays sources for non destructive testing of very opaque materials.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

GENERAL CHARACTERISTICS

Mechanical - (see note 1 and drawing)

The tube is delivered mounted in a metallic shell which permits mechanical fixation : nevertheless it is necessary to maintain the assembly by sustaining the entrance plane.

In this shell the tube is fixed so as to facilitate the precise localization of the optical device as regard to the reference plane. This shell protects the tube against stray magnetic field and cannot be considered as an efficient shield against X-radiations. A lead shield of 2 mm thick is provided at the output plane of the shell.

Dimensions		see drawing
Net weight, approximate		9 kg
Mounting position		any
Shipment position		tube axis horizontal
Operating and stocking temperature	max.	+50 °C
	min.	+ 5 °C

Optical

Input screen diameter		22 ± 0. 5 cm
Output image diameter (O.I.)		20 ± 0. 5 mm
Input spectral response		X-rays (30 to 250 kVp generator)
Viewing screen		
Type		P 20 (λ max = 520 nm)
Fluorescence and phosphorescence		yellow - green
Electrostatic focus - Inverted image		
Input field diameter		22 cm
Magnification		1/11
Minimum resolution (note 2)		
- central		18 lp/cm
- peripheral		16 lp/cm
Minimum contrast (note 3) measured with JEDEC penetrameter		3 %
Minimum conversion factor (note 4)		70 Cd/m^2 per mR/s
	or	350 ft. L per R/mn
Minimum luminance gain (note 5)		6000
Maximum background luminance (note 6)		0. 06 Cd/m^2
	or	0. 02 ft. L.
Maximum distortion (note 7)		30 %
Maximum persistence at 10 ms (note 8)		10 %

MAXIMUM RATINGS AND TYPICAL OPERATION

Maximum ratings

Photocathode C voltage		0	V
Electrode g1 voltage		0. 50	kV
Electrode g2 voltage		3. 0	kV
Electrode g3 voltage		3. 5	kV
Anode A		32	kV
Active getter voltage	(anode g4	3. 5	kV
	(cathode E	0	V
Photocathode C maximum current		0. 5	µA
Electrode g1 maximum current		5	µA
Electrode g2 maximum current		1	µA
Electrode g3 maximum current		1	µA
Electrode g4 maximum current (after post-gettering operation)		10	µA
Anode A maximum current		2	µA

Typical operation (see starting procedures)

Input diameter for 20 mm O.I.		22	cm
Photocathode C voltage		0	V
Electrode g1 voltage*		0 to 250	V
Electrode g2 voltage*		450 to 850	V
Electrode g3 voltage*		3. 2	kV
Anode A voltage		28 to 30	kV
Active getter voltage	(anode g4	2. 5 to 3	kV
	(cathode E	0	V

Ripple voltage must not exceed 0, 5 %

** g1 g2 g3 voltages are defined for an anode voltage of 30 kV.*

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

STARTING PROCEDURE

Important

For tube handling, always prescribe use of security goggles (implosion risk).

Tube mounting

Set tube inside a proper metallic housing to protect operator against X-radiation.

Check for darkness of the tube housing (would the tube be checked without container, it should then be placed in a completely dark room).

The housing in which the tube is contained must be humidity proof and deshydrated. This condition is necessary to eliminate all moisture which could initiate coronas and sparks detrimental to tube operation. Moreover, it prevents dust electrostatic attraction on the viewing face.

Connections

All the connections necessary for tube supply (even for the anode) are made through flexible wires with reference marks.

A 10 Megohms resistance protecting the tube against discharge is provided inside the shell in the anode circuit. Time constant thus produced with tube capacitance contributes to ripple voltage filtering.

In series between each voltage supply and corresponding tube connection, insert in the same way a few Megohms protective resistance.

Focusing adjustments

Voltages supplies can be applied to the electrodes in a short time but with a slope not exceeding 5 kV/ms.

Let tube at rest with voltages applied for potential stabilization before adjusting it. (10 s minimum).

Set a 2 mm spaced metallic wire mesh of 5/10 mm diameter or equivalent (stainless steel, copper) in front of the tube and apply X-rays beam.

Electrode g3 voltage being selected :

- Adjust g1 voltage in order to obtain an image as homogeneous as possible in luminance.
- Adjust g2 voltage in order to obtain the optimum resolution.
- Optimize g1 voltage if necessary.

After adjustment is made, proportional variations of potentials within certain limits do not change the focusing adjustment.

Gettering operation

In order to assure a high reliability in operation and to maintain optimum performances of the tube, Instructions for Gettering operation should be strictly applied as defined in separate Data TEV 3006.

The purpose of this operation is to pump residual gas in the tube resulting in an ion spot which lowers the image contrast and resolution.

NOTES

(1) - The mounting of the tube in its shell (see page 2 and drawing) secures the positioning of the viewing screen at a determined optical distance from the mechanical plane of reference on which may be fixed the optical system. This distance is 20 mm ± 0.25. This shell assures a parallelism of the two planes with a precision higher than 1/800 radian. It assures a center of image within 0.5 mm from perpendicular axis of the reference plane defined by an aperture of 120.10 ± 0.05 mm diameter.

(2) - The resolution (as referred to input screen) is measured by using square lead pattern consisting in alternate black and white lines of equal width. Any two adjacent lines are designated as a line pair. The impinging X-radiation is produced by a generator operating at 65 kV and with a 2.5 mm aluminum filter. The resolution decreases gradually from the center to the edge of image. The central zone is within a circle having a diameter equal to 70 % of the input diameter. Peripheral zone is within circles 70 and 90 % of the input diameter.

(3) - The contrast is defined as the differential thickness which can be detected when using a JEDEC penetrameter. This penetrameter consists in an aluminum disc of 20 mm thickness presenting holes of 6 mm diameter. The depth of those holes vary from 1.5 to 7 % of the thickness of the disc. The differential thickness (expressed in %) of the hole having the minimum depth which can be detected defines the minimum contrast. X-ray conditions : 80 kVp - HVL 7 ± 0.2 mm Al-input dose rate 20 mR/mn.

(4) - The conversion factor is the value of the viewing screen luminance corresponding to a determined X-ray dose rate.
X-ray conditions : 80 kVP - 20 mm Al filter - HVL 7 ± 0.2 mm Al.
The luminance is measured by a photometer which matches the human vision.
The conversion factor is defined as :

$$CF = \frac{\text{Luminance}}{\text{dose rate}} = \frac{\text{Candela/square meter}}{\text{milli Roentgen/second}} \quad \text{or} \quad \frac{\text{foot Lambert}}{\text{Roentgent/minute}}$$

(5) - The luminance gain is the ratio of luminance of the image intensifier to the luminance of a Massiot - Fluor - Sirius fluoroscopic screen having a luminance of 0.012 cd/m^2 per mR/s. Both are irradiated in the same conditions : 80 kVp - 20 mm Al filter - HVL 7 ± 0.2 mm Al. The luminance is measured by a photometer which matches the human vision.

(6) - The background luminance is the luminance of output screen when normal operating voltages are applied to the tube and X-rays are off at normal ambient temperature.

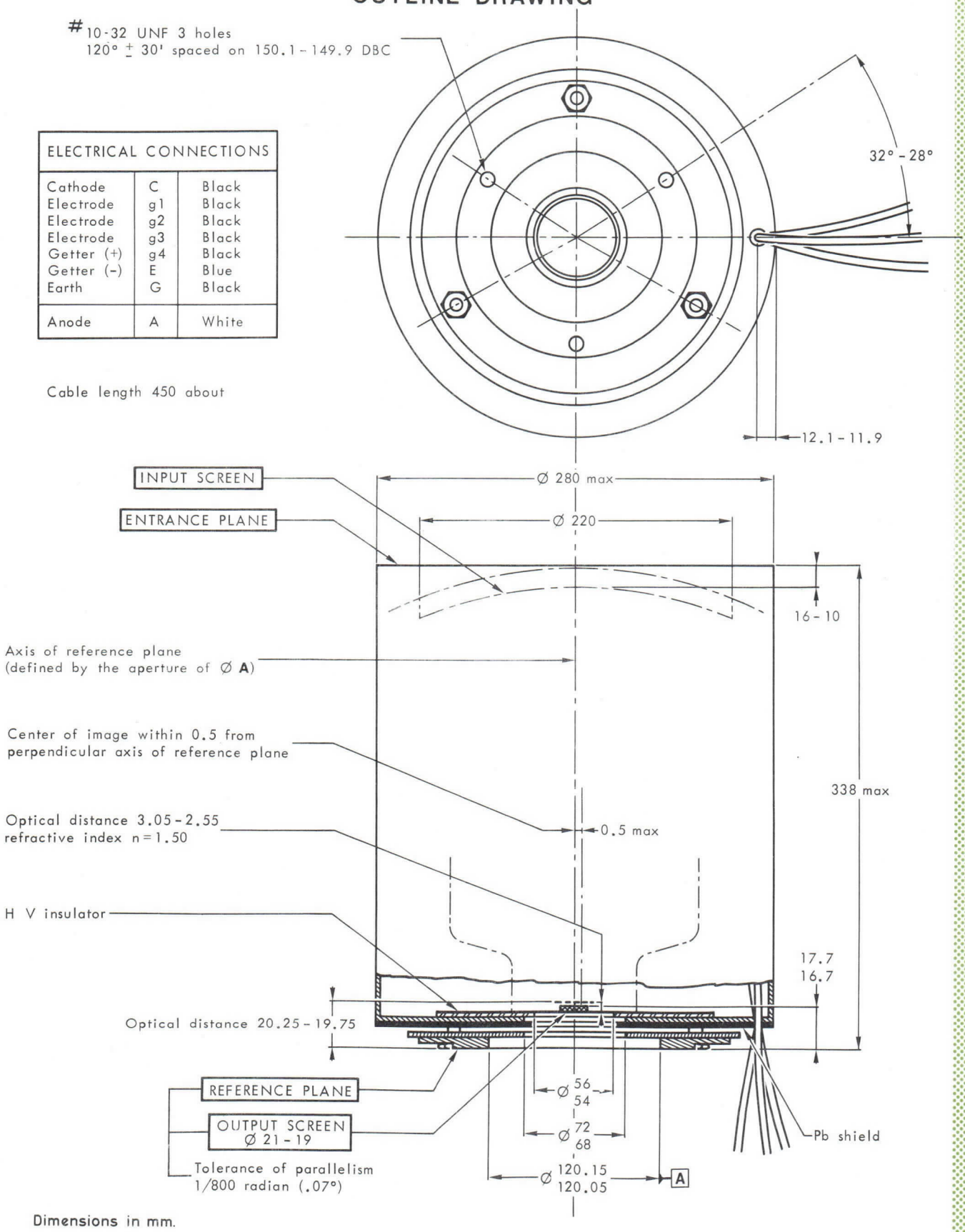
(7) - The distortion is measured by putting and object of 1 cm length at the center and then at the edge of the field. The dimensions of the images measured on the viewing screen are respectively I1 and I2. The distortion is given by :

$$D = \frac{I_2 - I_1}{I_1}$$

(8) - The image persistence is the residual luminance measured at a determined time after removal of X-ray radiations.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING



ELECTRICAL CONNECTIONS		
Cathode	C	Black
Electrode	g1	Black
Electrode	g2	Black
Electrode	g3	Black
Getter (+)	g4	Black
Getter (-)	E	Blue
Earth	G	Black
Anode	A	White

Cable length 450 about

Dimensions in mm.

TH 9428
INTENSIFICATEUR D'IMAGE RADIOLOGIQUE ZOOM ELECTRONIQUE*

- TRIPLE CHAMP D'ENTREE : 22 cm - 16 cm - 11, 5 cm
- DIAMETRE NOMINAL DE L'IMAGE DE SORTIE : 20 mm
- HAUT CONTRASTE
- GAIN EN LUMINANCE : x 7000

Le tube TH 9428 est un intensificateur d'images transformant le relief de rayonnement X formé derrière le sujet en une image à haute luminance et excellent contraste.

Le relief de rayonnement X est tout d'abord transformé en image lumineuse au sein d'un écran mince scintillateur situé à l'intérieur du tube, à proximité du plan d'entrée. L'image lumineuse excite à son tour une couche photoélectrique accolée à l'écran fluorescent. Les rayons X sont ainsi transformés en photoélectrons, qui sont accélérés et focalisés au moyen de champs électriques appropriés. Ces électrons viennent frapper un écran d'observation fluorescent disposé à proximité de la face de sortie, provoquant ainsi la formation d'une image secondaire inversée, de dimensions réduites, mais dont la luminance et la définition sont grandement améliorées par rapport à celles obtenues avec les meilleurs écrans utilisés en radiologie.

Les nombreux perfectionnements apportés à la conception du tube TH 9428 résultent de l'expérience acquise dans le domaine des tubes intensificateurs d'images radiologiques.

Le tube TH 9428 incorpore un écran détecteur à base d'iodure de Cesium, qui associe un pouvoir d'absorption élevé permettant un excellent rendement de détection, et une réponse temporelle rapide autorisant l'observation des phénomènes évoluant rapidement.

L'écran de sortie utilise un matériau fluorescent composé de cristaux très fins, de l'ordre du micron, déposés suivant une technologie hautement élaborée, permettant la présentation d'images à haute résolution sur un diamètre de 20 mm et rendant ainsi le tube compatible avec les meilleurs systèmes optiques développés à ce jour.

L'écran de sortie du type P20 est sélectionné, d'une part de façon à ce que sa réponse spectrale coïncide avec la bande optimale de correction des systèmes optiques pour minimiser toutes réflexions et pertes de résolution et de contraste dans ces systèmes optiques, et d'autre part pour être bien adapté aux films utilisés en cinéma 35 mm, en radio-photo de 70 ou 100 mm, ou aux tubes de prise de vue des caméras de télévision.

Cet écran de sortie d'apparence sombre ("Ecran Noir") permet également de minimiser toute réflexion lumineuse interne ou provenant du système optique, et d'assurer ainsi le maximum de contraste d'image.

Le tube TH 9428 permet, par un choix des tensions appliquées aux électrodes de focalisation, d'obtenir un grandissement variable ou "Zoom électronique". L'image de sortie, de diamètre 20 mm, permet la présentation des images du plan d'entrée occupant respectivement des diamètres de 22 cm, 16 cm et 11,5 cm. Cette propriété est particulièrement intéressante chaque fois que l'utilisateur recherche le maximum de détails et de contraste dans l'image, par exemple pour l'examen de l'enfant, les examens chirurgicaux en crâniographie, les examens cardiovasculaires etc... Elle permet de s'affranchir au maximum des imperfections de résolution des systèmes optiques de couplage et des dispositifs associés d'enregistrement ou de visualisation tels que films photographiques et Télévision.

* Marque déposée.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Compte tenu des performances de résolution élevées, présentées par le tube TH 9428, l'alimentation haute tension, fournissant les tensions d'électrodes du tube, doit être réalisée avec soin ; en particulier, l'ondulation résiduelle sur les électrodes ne doit pas excéder 0, 5 %.

Le tube TH 9428 incorpore un dispositif de pompage automatique, getter actif, qui permet d'assurer une longue durée d'utilisation avec maintien des performances en éliminant tout défaut du genre tache ionique, point de gaz ou autre altération de résolution de contraste ou de gain de luminances.

CARACTERISTIQUES GENERALES

Mécaniques (voir note 1 et dessin)

Le tube est livré monté dans une gaine métallique assurant la fixation mécanique, cependant il est nécessaire de maintenir l'ensemble par un support au niveau de la face d'entrée.

Dans la gaine le tube est fixé de façon à faciliter le montage précis du système optique par rapport au plan de référence. Cette gaine protège le tube contre les champs magnétiques parasites mais ne peut pas être considérée comme une protection efficace contre les rayonnements X, toutefois une feuille de plomb de 2 mm d'épaisseur est incluse au niveau de la face de sortie de la gaine.

Position de fonctionnement	indifférente
Position durant le transport	axe du tube horizontal
Température de fonctionnement et de stockage :	
- maximum	+50 °C
- minimum	+ 5 °C
Poids net approximatif	9 kg
Dimensions	voir dessin

Optiques

Diamètre de l'écran d'entrée	22 ± 0, 5 cm
Diamètre de l'image de sortie	20 ± 0, 5 mm
Réponse spectrale de l'écran d'entrée	rayons X générateur de 30 à 250 kVp
Ecran d'observation :	
- type	P20 (λ max = 520 nm)
- fluorescence et phosphorescence	jaune - vert
Focalisation	électrostatique image inversée

Modes de fonctionnement :	Normal	Loupe 1	Loupe 2	
Diamètre du champ d'entrée	22	16	11, 5	cm
Grandissement	1/11	1/8	1/5, 5	
Résolution typique (note 2) :				
- centrale	24	26	28	pl/cm
- périphérique	20	22	24	pl/cm
Contraste minimal (note 3) mesuré avec pénétramètre JEDEC	2, 1	2, 1	2, 1	%
Facteur de conversion minimal (note 4)	70	35	18	$\frac{cd/m^2}{mR/s}$
ou	350	175	90	$\frac{fL}{R/mn}$
Gain en luminance minimal (note 5)	7000	3500	1800	
Bruit de fond maximal (note 6)	0, 07	0, 07	0, 07	cd/m^2
ou	0, 02	0, 02	0, 02	fL
Distorsion maximale (note 7)	10	8	6	%
Persistance maximale à 10 ms (note 8)	10	10	10	%

CONDITIONS DE FONCTIONNEMENT

Valeurs limites

Tension de photocathodes p.c.	0	V
Tension d'électrode g1	0, 5	kV
Tension d'électrode g2	3, 0	kV
Tension d'électrode g3	12, 0	kV
Tension d'anode a	32, 0	kV
Tension de getter actif :		
- anode g4	3, 5	kV
- cathode e	0	V
Courant maximal de photocathode p.c.	0, 5	µA
Courant maximal d'électrode g1	1	µA
Courant maximal d'électrode g2	1	µA
Courant maximal d'électrode g3	1	µA
Courant maximal d'électrode g4 (après post-pompage)	10	µA
Courant maximal d'anode a	2	µA

Modes de fonctionnement

Modes de fonctionnement :	Normal	Loupe 1	Loupe 2	
Diamètre d'entrée pour une image de sortie de 20 mm	22	16	11, 5	cm
Tension de photocathode p.c.	0	0	0	V
Tension d'électrode g1*	100 à 300	100 à 300	100 à 300	V
Tension d'électrode g2*	450 à 850	400 à 800	450 à 850	V
Tension d'électrode g3*	3, 2	6, 5	10, 0	kV
Tension d'anode a	30, 0	30, 0	30, 0	kV
Tension de getter actif :				
- anode g4	2, 5 à 3, 0	2, 5 à 3, 0	2, 5 à 3, 0	kV
- cathode e	0	0	0	V

Les tensions doivent présenter un taux d'ondulation inférieur à 0, 5 %.

* Les tensions g1, g2, g3 sont donnée pour une tension d'anode de 30 kV.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

CONSIGNES DE MISE EN SERVICE

Important

Pour toute manipulation du tube, imposer le port de lunettes de sécurité (risque d'implosion).

Montage du tube

Monter le tube à l'intérieur d'une gaine métallique convenablement blindée aux rayons X pour assurer la protection de l'observateur.

Vérifier l'obscurité de la gaine dans laquelle le tube est placé (si le tube est essayé occasionnellement sans gaine, une quasi obscurité est nécessaire dans la pièce où l'on opère.

La gaine dans laquelle le tube est placé doit être étanche et déshydratée. Cette précaution est nécessaire pour éliminer toute trace d'humidité pouvant provoquer des effluves électriques préjudiciables au bon fonctionnement du tube. Elle est de plus utile pour empêcher l'empoussièrage de la face d'observation du tube (attraction électrostatique).

Branchement des connexions

Toutes les connexions nécessaires à l'alimentation du tube (y compris l'anode) doivent être effectuées par l'intermédiaire de fils souples repérés d'après leurs couleurs.

Une résistance de 10 MΩ destinée à protéger le tube contre les décharges électriques est insérée en série dans le circuit anodique à l'intérieur de la gaine. Grâce à la capacité du tube, cette résistance permet de filtrer les fluctuations rapides de tension d'alimentation.

Intercaler de la même manière une résistance de protection de quelques Megohms entre les différentes sources d'alimentation et les électrodes correspondantes.

Réglages du tube

Les tensions d'alimentation peuvent être appliquées rapidement aux électrodes sans cependant dépasser 5 kV par ms. Laisser les tensions se stabiliser (10 s minimum) avant d'effectuer les réglages.

Placer une grille constituée de fils métalliques (inox, cuivre) de 5/10 mm de diamètre espacés de 2 mm devant la face d'entrée du tube et irradier aux rayons X.

Pour chaque mode de fonctionnement la tension de l'électrode g3, dont la valeur se situe dans les limites spécifiées dans les conditions de fonctionnement, doit être prédéterminée.

La tension de l'électrode g3 étant choisie, régler les tensions des électrodes g1 et g2 dans les limites spécifiées comme suit :

- régler la tension g1 pour obtenir une image aussi homogène que possible en luminance.
- régler la tension g2 pour obtenir la résolution optimale.
- optimiser la tension g1 si nécessaire.

Les réglages doivent être faits respectivement pour le mode normal, le mode loupe 1 et le mode loupe 2.

REMARQUE : Les exemples de fonctionnement donnent des tensions correspondant au mode choisi de 22 cm, 16 cm et 11, 5 cm.
Pour toute utilisation particulière, des champs d'entrée intermédiaires entre 22 cm et 11,5 cm peuvent être choisis, prière de nous consulter pour information.

Opération de post-pompage

Afin d'assurer une bonne stabilité de fonctionnement du tube et d'en obtenir les performances optimales, il est nécessaire d'observer scrupuleusement les instructions de post-pompage définies dans une Notice séparée.

Cette opération a pour but de pomper les gaz résiduels du tube dont la présence occasionnelle contribue à la formation d'une tache ionique qui diminue le contraste et la résolution de l'image.

NOTES

1 - Le montage du tube dans sa gaine (voir figure) permet la localisation du plan de l'écran d'observation à une distance optique déterminée du plan mécanique de référence sur lequel vient prendre appui le système optique. Cette distance est de $20 \pm 0,25$ mm.

La gaine assure un parallèlisme de ces deux plans à moins de 1/800 radian près. Il garantit un écart maximal de 0,25 mm entre l'axe de l'image et l'axe du système mécanique de référence, défini par les trois trous de fixation positionnés sur une circonférence de 150 mm de diamètre.

2 - La résolution, rapportée à l'écran d'entrée, est mesurée à l'aide d'une mire constituée de lignes équidistantes alternativement opaques et transparentes au rayonnement X. Deux lignes adjacentes constituent une paire de lignes. Le rayonnement X est fourni par un générateur travaillant à 65 kV et possèdant un filtre additionnel de 2,5 mm d'aluminium. La valeur indiquée s'entend dans 70 % de la surface d'entrée.

3 - Le contraste correspond à la dose de rayonnement différentiel que l'on peut détecter avec un fantôme de quelques centimètres carrés. Le rayonnement X est fourni par un générateur travaillant à 80 kV et possèdant un filtre additionnel de 20 mm d'aluminium. (Valeur de demi-dose = 7 mm).

4 - Le facteur de conversion représente la valeur de la luminance de l'écran d'observation pour une dose de rayonnement incident déterminée, issu d'un générateur travaillant à 80 kV avec un filtre d'aluminium interposé de 20 mm (épaisseur de demi-dose = 7 mm environ). La luminance est mesurée avec un photomètre possèdant la même courbe de réponse que celle de l'oeil. Le facteur de conversion est égal à :

$$\frac{\text{luminance}}{\text{dose de rayonnement}} = \frac{\text{Candela/mètre carré}}{\text{Milliroentgen/seconde}} \text{ ou } \frac{\text{foot Lambert}}{\text{Roentgen/minute}}$$

5 - Le gain en luminance est le rapport de la luminance de l'écran d'observation du tube amplificateur à la luminance d'un écran radioscopique type Massiot-Fluor Sirius. Ecran et tube sont irradiés dans les mêmes conditions par un générateur travaillant à 80 kV et avec un filtre interposé de 20 mm d'aluminium (épaisseur de demi-dose = 7 mm environ). La luminance est mesurée avec un photomètre possèdant la même courbe de réponse que celle de l'oeil.

6 - Le bruit de fond est exprimé par la luminance de l'écran de sortie, quand le tube est alimenté sous tensions normales sans être soumis aux rayons X dans les conditions de température ambiante normales.

7 - La distorsion est mesurée par $D = \frac{M_p - M_c}{M_c} \times 100$

avec M_p = grandissement mesuré sur un cercle couvrant 95 % du champ d'entrée.

M_c = grandissement mesuré sur un cercle de 2 cm centré sur l'axe du champ d'entrée.

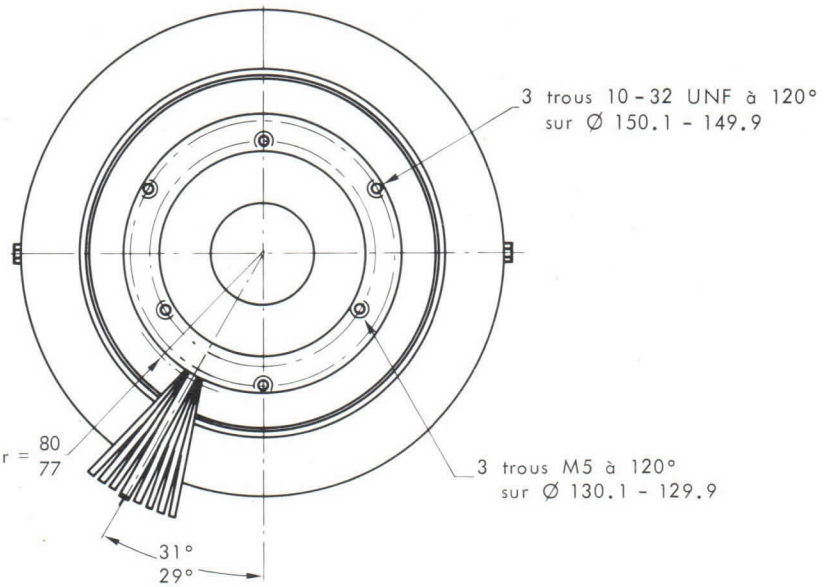
8 - La persistance d'image est la luminance résiduelle mesurée au bout d'un temps donné après extinction des radiations X.

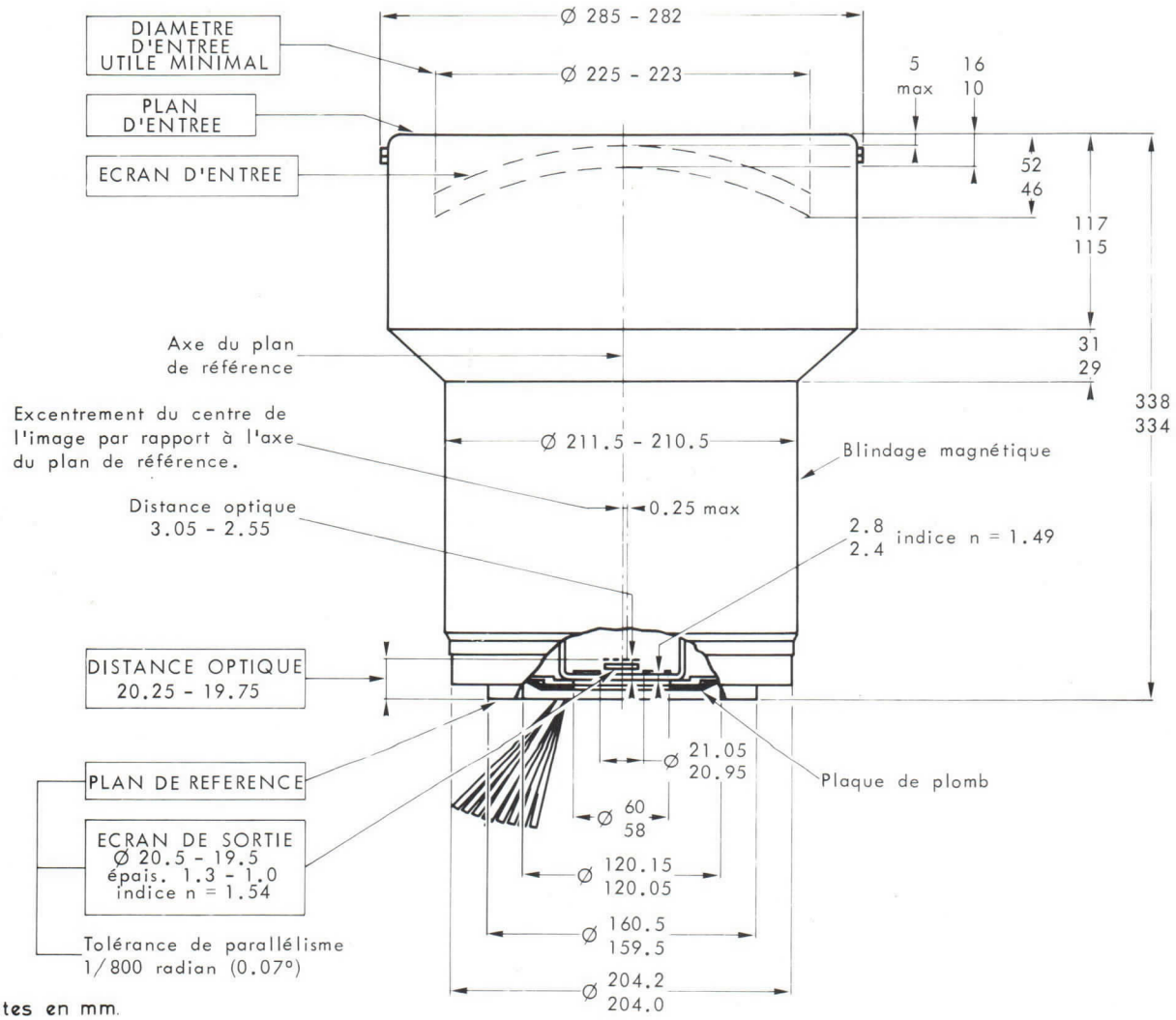
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

DESSIN D'ENCOMBREMENT

CONNEXIONS ELECTRIQUES		
Cathode	pc	Noir
Electrode de champ	g1	Noir
Electrode de focalisation	g2	Noir
Electrode de focalisation	g3	Noir
Getter actif +	g4	Noir
Getter actif -	e	Bleu
Terre	gnd	Noir
Anode	a	Blanc

Longueur des câbles : 450





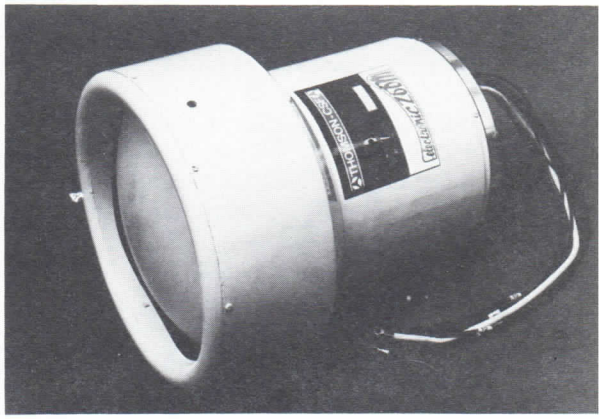
Cotes en mm.

Imprimé en France

TH 9428 A
INTENSIFICATEUR D'IMAGE RADIOLOGIQUE ZOOM ELECTRONIQUE *

- TRIPLE CHAMP D'ENTREE : 22 cm - 16 cm - 11. 5 cm
- DIAMETRE NOMINAL DE L'IMAGE DE SORTIE : 20 mm
- HAUTE RESOLUTION - HAUT CONTRASTE
- GAIN EN LUMINANCE : x 7000

Le tube TH 9428A est un intensificateur d'images transformant le relief de rayonnement X formé derrière le sujet en une image à haute luminance et excellent contraste.



Le relief de rayonnement X est tout d'abord transformé en image lumineuse au sein d'un écran mince scintillateur situé à l'intérieur du tube, à proximité du plan d'entrée. L'image lumineuse excite à son tour une couche photoélectrique accolée à l'écran fluorescent. Les rayons X sont ainsi transformés en photoélectrons, qui sont accélérés et focalisés au moyen de champs électriques appropriés. Ces électrons viennent frapper un écran d'observation fluorescent disposé à proximité de la face de sortie, provoquant ainsi la formation d'une image secondaire inversée, de dimensions réduites, mais dont la luminance et la définition sont grandement améliorées par rapport à celles obtenues avec les meilleurs écrans utilisés en radiologie.

Les nombreux perfectionnements apportés à la conception du tube TH 9428A résultent de l'expérience acquise dans le domaine des tubes intensificateurs d'images radiologiques.

Le tube TH 9428A incorpore un écran détecteur à base d'iodure de Cesium, qui associe un pouvoir d'absorption élevé permettant un excellent rendement de détection, et une réponse temporelle rapide autorisant l'observation des phénomènes évoluant rapidement.

L'écran de sortie utilise un matériau fluorescent composé de cristaux très fins, de l'ordre du micron, déposés suivant une technologie hautement élaborée, permettant la présentation d'images à haute résolution sur un diamètre de 20 mm et rendant ainsi le tube compatible avec les meilleurs systèmes optiques développés à ce jour.

L'écran de sortie du type P20 est sélectionné, d'une part de façon à ce que sa réponse spectrale coïncide avec la bande optimale de correction des systèmes optiques pour minimiser toutes réflexions et pertes de résolution et de contraste dans ces systèmes optiques, et d'autre part pour être bien adapté aux films utilisés en cinéma 35 mm, en radio-photo de 70 ou 100 mm, ou aux tubes de prise de vue des caméras de télévision.

Cet écran de sortie d'apparence sombre (''Ecran Noir'') permet également de minimiser toute réflexion lumineuse interne ou provenant du système optique, et d'assurer ainsi le maximum de contraste d'image.

Le tube TH 9428A permet, par un choix des tensions appliquées aux électrodes de focalisation, d'obtenir un grandissement variable ou ''Zoom électronique''. L'image de sortie, de diamètre 20 mm, permet la présentation des images du plan d'entrée occupant respectivement des diamètres de 22 cm, 16 cm et 11,5 cm. Cette propriété est particulièrement intéressante chaque fois que l'utilisateur recherche le maximum de détails et de contraste dans l'image, par exemple pour l'examen de l'enfant, les examens chirurgicaux en crâniographie, les examens cardiovasculaires etc... Elle permet de s'affranchir au maximum des imperfections de résolution des systèmes optiques de couplage et des dispositifs associés d'enregistrement ou de visualisation tels que films photographiques et Télévision.

* Marque déposée.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Compte tenu des performances de résolution élevées, présentées par le tube TH 9428A, l'alimentation haute tension, fournissant les tensions d'électrodes du tube, doit être réalisée avec soin ; en particulier, l'ondulation résiduelle sur les électrodes ne doit pas excéder 0, 5 %.

Le tube TH 9428A incorpore un dispositif de pompage automatique, getter actif, qui permet d'assurer une longue durée d'utilisation avec maintien des performances en éliminant tout défaut du genre tache ionique, point de gaz ou autre altération de résolution de contraste ou de gain de luminance.

CARACTÉRISTIQUES GÉNÉRALES

Mécaniques (voir note 1 et dessin)

Le tube est livré monté dans une gaine métallique assurant la fixation mécanique, cependant il est nécessaire de maintenir l'ensemble par un support au niveau de la face d'entrée.

Dans la gaine le tube est fixé de façon à faciliter le montage précis du système optique par rapport au plan de référence. Cette gaine protège le tube contre les champs magnétiques parasites mais ne peut pas être considérée comme une protection efficace contre les rayonnements X, toutefois une feuille de plomb de 2 mm d'épaisseur est incluse au niveau de la face de sortie de la gaine.

Position de fonctionnement	indifférente	
Position durant le transport	axe du tube horizontal	
Température de fonctionnement et de stockage :		
- maximum	+50	°C
- minimum	+ 5	°C
Poids net approximatif	9	kg
Dimensions	voir dessin	

Optiques

Diamètre de l'écran d'entrée	22 ± 0, 5	cm
Diamètre de l'image de sortie	20 ± 0, 5	mm
Réponse spectrale de l'écran d'entrée	rayons X générateur de 30 à 250 kVp	
Ecran d'observation :		
- type	P20 (λ max = 520 nm)	
- fluorescence et phosphorescence	jaune - vert	
Focalisation	électrostatique image inversée	

Modes de fonctionnement :	Normal	Loupe 1	Loupe 2	
Diamètre du champ d'entrée	22	16	11, 5	cm
Grandissement	1/11	1/8	1/5, 5	
Résolution typique (note 2) :				
- centrale	35	40	45	pl/cm
- périphérique	31	36	41	pl/cm
Contraste minimal (note 3) mesuré avec pénétramètre JEDEC	2, 1	2, 1	2, 1	%
Facteur de conversion minimal (note 4)	70	35	18	$\frac{cd/m^2}{mR/s}$
ou	350	175	90	$\frac{fL}{R/mn}$
Gain en luminance minimal (note 5)	7000	3500	1800	
Bruit de fond maximal (note 6)	0, 07	0, 07	0, 07	cd/m^2
ou	0, 02	0, 02	0, 02	fL
Distorsion maximale (note 7)	10	8	6	%
Persistance maximale à 10 ms (note 8)	10	10	10	%

CONDITIONS DE FONCTIONNEMENT

Valeurs limites

Tension de photocathodes C	0	V
Tension d'électrode G_1	0, 5	kV
Tension d'électrode G_2	3, 0	kV
Tension d'électrode G_3	12	kV
Tension d'anode A	32	kV
Tension de getter actif :		
- anode G_4	3, 5	kV
- cathode E	0	V
Courant maximal de photocathode C	0, 5	µA
Courant maximal d'électrode G_1	1	µA
Courant maximal d'électrode G_2	1	µA
Courant maximal d'électrode G_3	1	µA
Courant maximal d'électrode G_4 (après post-pompage)	10	µA
Courant maximal d'anode A	2	µA

Modes de fonctionnement

Modes de fonctionnement :	Normal	Loupe 1	Loupe 2	
Diamètre d'entrée pour une image de sortie de 20 mm	22	16	11, 5	cm
Tension de photocathode C	0	0	0	V
Tension d'électrode G_1*	100 à 300	100 à 300	100 à 300	V
Tension d'électrode G_2*	450 à 850	400 à 800	450 à 850	V
Tension d'électrode G_3*	3, 2	6, 5	10	kV
Tension d'anode A	30	30	30	kV
Tension de getter actif :				
- anode G_4	2, 5 à 3, 0	2, 5 à 3, 0	2, 5 à 3, 0	kV
- cathode E	0	0	0	V

Les tensions doivent présenter un taux d'ondulation inférieur à 0, 5 %.

* Les tensions G_1, G_2, G_3 sont données pour une tension d'anode de 30 kV.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

CONSIGNES DE MISE EN SERVICE

Important

Pour toute manipulation du tube, imposer le port de lunettes de sécurité (risque d'implosion).

Montage du tube

Monter le tube à l'intérieur d'une gaine métallique convenablement blindée aux rayons X pour assurer la protection de l'observateur.

Vérifier l'obscurité de la gaine dans laquelle le tube est placé (si le tube est essayé occasionnellement sans gaine, une quasi obscurité est nécessaire dans la pièce où l'on opère).

La gaine dans laquelle le tube est placé doit être étanche et déshydratée. Cette précaution est nécessaire pour éliminer toute trace d'humidité pouvant provoquer des effluves électriques préjudiciables au bon fonctionnement du tube. Elle est de plus utile pour empêcher l'empoussièrage de la face d'observation du tube (attraction électrostatique).

Branchement des connexions

Toutes les connexions nécessaires à l'alimentation du tube (y compris l'anode) doivent être effectuées par l'intermédiaire de fils souples repérés d'après leurs couleurs.

Une résistance de 10 MΩ destinée à protéger le tube contre les décharges électriques est insérée en série dans le circuit anodique à l'intérieur de la gaine. Grâce à la capacité du tube, cette résistance permet de filtrer les fluctuations rapides de tension d'alimentation.

Intercaler de la même manière une résistance de protection de quelques Megohms entre les différentes sources d'alimentation et les électrodes correspondantes.

Réglages du tubes

Les tensions d'alimentation peuvent être appliquées rapidement aux électrodes sans cependant dépasser 5 kV par ms. Laisser les tensions se stabiliser (10 s minimum) avant d'effectuer les réglages.

Placer une grille constituée de fils métalliques (inox, cuivre) de 5/10 mm de diamètre espacés de 2 mm devant la face d'entrée du tube et irradiés aux rayons X.

Pour chaque mode de fonctionnement la tension de l'électrode G_3, dont la valeur se situe dans les limites spécifiées dans les conditions de fonctionnement, doit être prédéterminée.

La tension de l'électrode G_3 étant choisie, régler les tensions des électrodes G_1 et G_2 dans les limites spécifiées comme suit :

- régler la tension G_1 pour obtenir une image aussi homogène que possible en luminance.
- régler la tension G_2 pour obtenir la résolution optimale.
- optimiser la tension G_1 si nécessaire.

Les réglages doivent être faits respectivement pour le mode normal, le mode loupe 1 et le mode loupe 2.

REMARQUE : Les exemples de fonctionnement donnent des tensions correspondant au mode choisi de 22 cm, 16 cm et 11, 5 cm.
Pour toute utilisation particulière, des champs d'entrée intermédiaires entre 22 cm et 11,5 cm peuvent être choisis, prière de nous consulter pour information.

Opération de post-pompage

Afin d'assurer une bonne stabilité de fonctionnement du tube et d'en obtenir les performances optimales, il est nécessaire d'observer scrupuleusement les instructions de post-pompage définies dans une Notice séparée.

Cette opération a pour but de pomper les gaz résiduels du tube dont la présence occasionnelle contribue à la formation d'une tache ionique qui diminue le contraste et la résolution de l'image.

NOTES

1 - Le montage du tube dans sa gaine (voir figure) permet la localisation du plan de l'écran d'observation à une distance optique déterminée du plan mécanique de référence sur lequel vient prendre appui le système de optique. Cette distance est de $20 \pm 0,25$ mm.

La gaine assure un parallèlisme de ces deux plans à moins de 1/800 radian près. Il garantit un écart maximal de 0,25 mm entre l'axe de l'image et l'axe du système mécanique de référence, défini par les trois trous de fixation positionnés sur une circonférence de 150 mm de diamètre.

2 - La résolution, rapportée à l'écran d'entrée, est mesurée à l'aide d'une mire constituée de lignes équidistantes alternativement opaques et transparentes au rayonnement X. Deux lignes adjacentes constituent une paire de lignes. Le rayonnement X est fourni par un générateur travaillant à 65 kV et possèdant un filtre additionnel de 2, 5 mm d'aluminium. La valeur indiquée s'entend dans 70 % de la surface d'entrée.

3 - Le contraste correspond à la dose de rayonnement différentiel que l'on peut détecter avec un fantôme de quelques centimètres carrés. Le rayonnement X est fourni par un générateur travaillant à 80 kV et possèdant un filtre additionnel de 20 mm d'aluminium. (Valeur de demi-dose = 7 mm).

4 - Le facteur de conversion représente la valeur de la luminance de l'écran d'observation pour une dose de rayonnement incident déterminée, issu d'un générateur travaillant à 80 kV avec un filtre d'aluminium interposé de 20 mm (épaisseur de demi-dose 7 mm environ). La luminance est mesurée avec un photomètre possèdant la même courbe de réponse que celle de l'œil. Le facteur de conversion est égal à :

$$\frac{\text{luminance}}{\text{dose de rayonnement}} = \frac{\text{Candela/mètre carré}}{\text{Milliroentgen/seconde}} \text{ ou } \frac{\text{foot Lambert}}{\text{Roentgen/minute}}$$

5 - Le gain en luminance est le rapport de la luminance de l'écran d'observation du tube amplificateur à la luminance d'un écran radioscopique type Massiot-Fluor Sirius. Ecran et tube sont irradiés dans les mêmes conditions par un générateur travaillant à 80 kV et avec un filtre interposé de 20 mm d'aluminium (épaisseur de demi-dose = 7 mm environ). La luminance est mesurée avec un photomètre possèdant la même courbe de réponse que celle de l'œil.

6 - Le bruit de fond est exprimé par la luminance de l'écran de sortie, quand le tube est alimenté sous tensions normales sans être soumis aux rayons X dans les conditions de température ambiante normales.

7 - La distorsion est mesurée par $D = \frac{M_p - M_c}{M_c} \times 100$

avec M_p = grandissement mesuré sur un cercle couvrant 95 % du champ d'entrée.

M_c = grandissement mesuré sur un cercle de 2 cm centré sur l'axe du champ d'entrée.

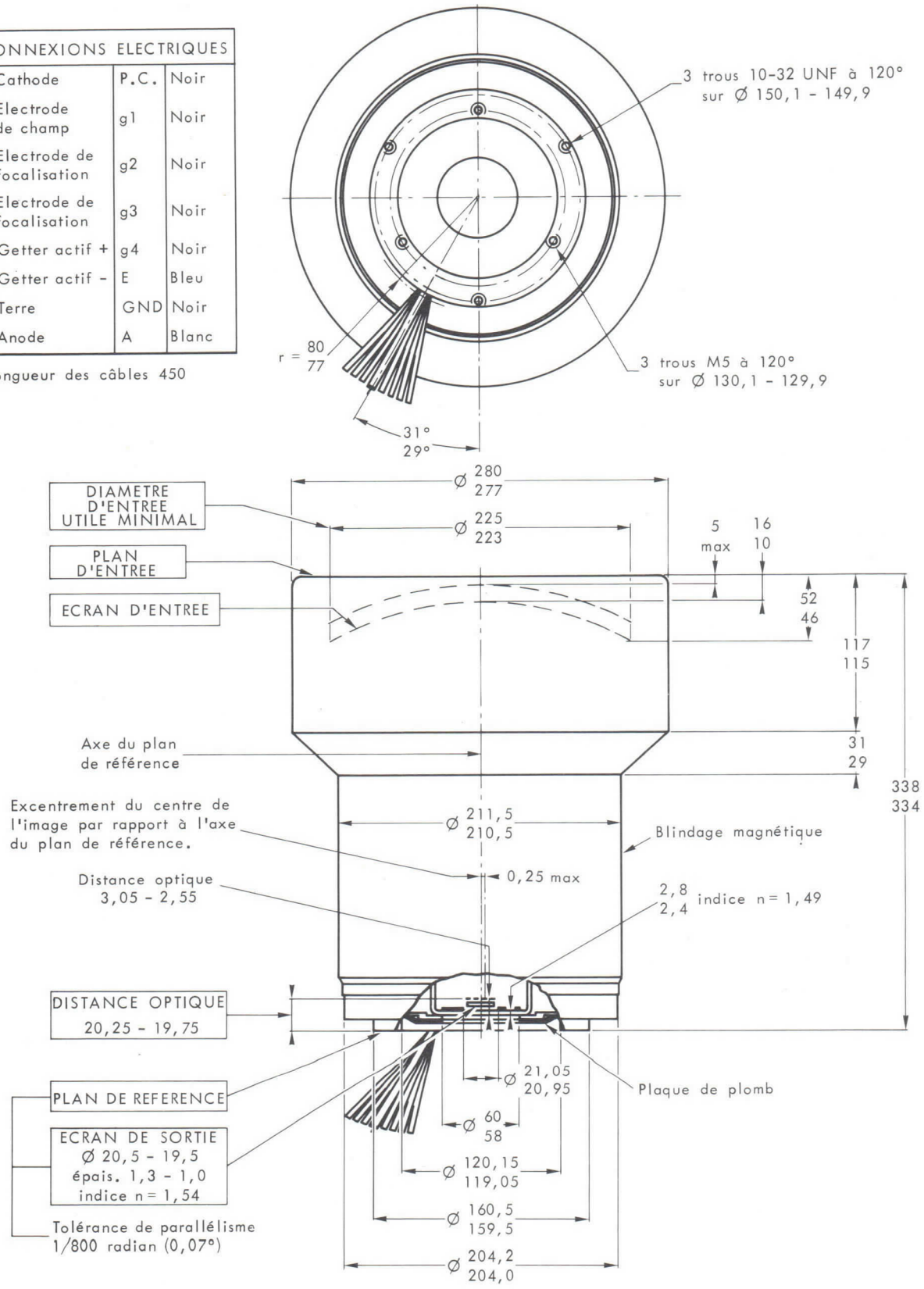
8 - La persistance d'image est la luminance résiduelle mesurée au bout d'un temps donné après extinction des radiations X.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

DESSIN D'ENCOMBREMENT

CONNEXIONS ELECTRIQUES		
Cathode	P.C.	Noir
Electrode de champ	g1	Noir
Electrode de focalisation	g2	Noir
Electrode de focalisation	g3	Noir
Getter actif +	g4	Noir
Getter actif -	E	Bleu
Terre	GND	Noir
Anode	A	Blanc

Longueur des câbles 450



Cotes en mm.

TH 9432
X-RAY IMAGE INTENSIFIER TUBE
ELECTRONIC ZOOM *

- TRIPLE INPUT FIELD : 32 cm - 23 cm - 17 cm
- OUTPUT IMAGE NOMINAL DIAMETER : 24. 5 mm
- HIGH RESOLUTION - HIGH CONTRAST
- LUMINANCE GAIN : x 10 000

The TH 9432 is an X-ray image intensifier tube which converts the X-ray pattern into a light image of high brightness and good contrast.

The X-ray beam emerging from the subject being examined first passes through the tube's input window, made up of special low absorption glass. Next, the X-rays reach the input fluorescent screen where the X-ray photons are converted to light photons. A photocathode, coupled to the input screen is excited by these light photons, which are thus converted to electrons. The emitted electrons are accelerated and focused by appropriate electric fields and then impinge on the output fluorescent screen. This screen's phosphor coating reconverts the electrons back to light photons providing an exceptionnally bright output image. This brightness gain is obtained partly from the energy imparted to the electrons during their acceleration and partly from the reduction in diameter of the tube's output image as compared to the input image. In fact, this image is several thousand times brighter than would have been that of a conventional radioscopic screen substituted for the tube's input window.

Many improvements in the design of the TH 9432 have benifited from THOMSON-CSF wide experience and considerable expertise in the field of X-ray image intensifier tubes.

The TH 9432 uses the caesium iodide (CsI) base as the detector screen material which associates an improved absorption of the incident radiation to a fast time response.

The output screen uses a fluorescent material made of very fine crystals (in the order of the micron) ; thanks to a sophisticated technology, this screen allows to display a high resolution image of 24.5 mm diameter thus making the tube to match with the best quality optical devices presently available.

The P20 phosphor is selected in order that its spectral response coincides with the optimum correction range of the optical systems thus minimizing the reflections and loss of resolution and contrast in these optical systems ; on the other hand, the P20 phosphor is matched to 35 mm film, 100 or 70 mm spot films or to CCTV camera tubes.

The "dark output screen" also enables to minimize all light reflection (internal or due to the optical system) and thus improves the image contrast.

* Registered Trade Mark.

By a proper selection of electrode voltages, the TH 9432 can operate as an "Electronic Zoom" i.e. with adjustable magnification. The maximum field 32 cm (normal mode) is used when the overall resolution sought is not critical, for centering the subject for example, while the minimum field 17 cm or intermediate field 23 cm is selected for detailed examination. The "magnified modes" enable to reduce the input field and therefore to adapt the useful bandwidth containing the image information to the available bandwidth, the latter being limited by the "pass-band" of the information transmission channel. Thus, the tube permits to obtain higher resolution and better image contrast when operated in magnified modes.

The TH 9432 is designed to visualize radioscopic images with CCTV or to record images on film or large size spot film (100 mm). For the latter applications (movies or photos), the tube can be irradiated in pulse operation by high intensity and short duration X-rays (a few ms) without loss of resolution.

The TH 9432 is delivered with an integral housing which ensures the mechanical mounting on the equipment, the protection against stray magnetic field as well as the shielding against X-radiations.

Since the TH 9432 performs very high resolution, the power supply must be carefully designed and especially ripple voltages must not exceed 0. 3 %.

The TH 9432 incorporates an automatic "active getter" which ensures a very high vacuum along tube's life avoiding the development of an ion spot or alteration of contrast and resolution.

GENERAL CHARACTERISTICS

Optical

Input screen diameter			32 ± 0. 5	cm
Output image diameter			24. 5 ± 0. 5	mm
Input screen spectral response			X-rays	
			30 to 250 kVp generator	
Viewing screen :				
- type			P20 (λ max. = 520 nm)	
- fluorescence and phosphorescence			yellow - green	
Electrostatic focus - Inverted image :				
Operating modes	Normal	Magn. 1	Magn. 2	
Input field diameter	32	23	17	cm
Magnification	1/13	1/9	1/7	
Typical resolution (Note 2) :				
- central	32	36	40	lp/cm
- peripheral	24	28	32	lp/cm
Minimum contrast (Note 3) measured with JEDEC - penetrameter	2. 5	2. 5	2. 5	%
Minimum conversion factor (Note 4)	100	50	30	$\frac{cd/m^2}{mR/s}$
or	500	250	150	$\frac{fL}{R/mn}$
Minimum luminance gain (Note 5)	10 000	5000	3000	
Maximum background luminance (Note 6)	0. 06	0. 06	0. 06	cd/m^2
or	0. 02	0. 02	0. 02	fL
Maximum distortion (Note 7)	10	5	5	%
Maximum persistence at 10 ms (Note 8)	10	10	10	%

Mechanical (see Note 1 and Drawing)

In addition to the shielding function against stray magnetic field and X-radiations, the housing permits :

- the mechanical mounting of the tube on the equipment. The tube can be fixed eitheir by the entrance plane or by the output plane.
- the precise mounting and positioning of the associated optical system.

Operating position	any	
Shipment position	tube axis horizontal	
Operating and storage temperature :		
- maximum	+ 50	°C
- minimum	+ 5	°C
Net weight, approx.	20	kg
Dimensions	see drawing	

OPERATING CONDITIONS

Maximum ratings

Photocathode c voltage	0	V
Electrode g1 voltage	0. 5	kV
Electrode g2 voltage	3. 0	kV
Electrode g3 voltage	12. 0	kV
Anode a voltage	32. 0	kV
Active getter voltage :		
- anode g4	3. 5	kV
- cathode k	0	V
Photocathode c maximum current (continuous operation)	1	μA
Electrode g1 maximum current	5	μA
Electrode g2 maximum current	1	μA
Electrode g3 maximum current	1	μA
Electrode g4 maximum current (after post-gettering operation)	10	μA
Anode a maximum current (without X radiation)	2	μA

Typical operation (see Starting Procedures)

Operating modes	Normal	Magn. 1	Magn. 2	
Input diameter for 24. 5 mm output image	32	23	17	cm
Photocathode c voltage	0	0	0	V
Electrode g1 voltage*	100 to 200	100 to 200	100 to 200	V
Electrode g2 voltage*	0. 5 to 1. 0	0. 5 to 1. 0	0. 5 to 1. 0	kV
Electrode g3 voltage*	3. 2	6. 5	10. 0	kV
Anode a voltage	30. 0	30. 0	30. 0	kV
Active getter voltage :				
- anode g4	2. 5 to 3. 0	2. 5 to 3. 0	2. 5 to 3. 0	kV
- cathode k	0	0	0	V

Ripple voltages must not exceed 0. 3 %.

* g1, g2, g3 voltages are given for an anode voltage of 30. 0 kV.

STARTING PROCEDURES

Connections

All the connections necessary for tube supply (even for the anode) are made through flexible wires with reference marks.

A 10 Megohms resistance protecting the tube against discharge must be inserted in the anode circuit. Time constant thus produced with tube capacitance contributes to ripple voltage filtering.

In series between each voltage supply and corresponding tube connection, insert in the same way a few Megohms protective resistance.

Focusing adjustments

Voltages supplies can be applied to the electrodes in a short time but with a slope not exceeding 5 kV/ms.

Let tube at rest with voltages applied for potential stabilization before adjusting it. (10 s minimum).

Set a 2 mm spaced metallic wire mesh of 5/10 mm diameter or equivalent (stainless steel, copper) in front of the tube and apply X-rays beam.

For each selected operating mode, electrode g3 voltage must be predetermined, the value of which should be within the limits specified in typical operation.

Electrode g3 voltage being selected, adjust electrode g1 and g2 voltages within the specified range. The focusing adjustment shall be made as follows :

- Adjust g1 voltage in order to obtain an image as homogeneous as possible in luminance.
- Adjust g2 voltage in order to obtain the optimum resolution.
- Optimize g1 voltage if necessary.

Focusing adjustments are made respectively for "normal mode","magnified mode 1" and "magnified mode 2".

REMARK - *Typical operation voltages correspond to selected operating mode of 32 cm - 23 cm - 17 cm. For particular use, any input field between 32 cm and 17 cm can be selected : please contact manufacturer for information.*

Gettering operation

In order to assure a high reliability in operation and to maintain optimum performances of the tube, Instructions for Gettering operation should be strictly applied as defined in separate Data.

The purpose of this operation is to pump residual gas in the tube resulting in an ion spot which lowers the image contrast and resolution.

NOTES

1 - The mounting of the tube in its housing (see page 2 and drawing) secures the positioning of the viewing screen at a determined optical distance from the mechanical plane of reference on which may be fixed the optical system. This distance is 10.40 ± 0. 25 mm. This housing assures a parallelism of the two planes with a precision higher than 1/800 radian. It assures a center of image within 0.25 mm from perpendicular axis of the reference plane defined by 6 fixing holes located on a circle of 171.50 ± 0.12 mm diameter.

2 - The resolution (as referred to input screen) is measured by using square lead pattern consisting in alternate black and white lines of equal width. Any two adjacent lines are designated as a line pair. The impinging X-radiation is produced by a generator operating at 65 kV and with a 2. 5 mm aluminum filter.

3 - The contrast is defined as the differential thickness which can be detected when using a JEDEC penetrameter. This penetrameter consists in an aluminum disc of 20 mm thickness presenting holes of 6 mm diameter. The depth of those holes vary from 1.5 to 7% of the thickness of the disc. The differential thickness (expressed in %) of the hole having the minimum depth which can be detected defines the minimum contrast. X-ray conditions : 80 kVp - HVL 7 ± 0. 2 mm Al-input dose rate 100 mR/mn.

4 - The conversion factor is the value of the viewing screen luminance corresponding to a determined X-ray dose rate.

X-ray conditions : 80 kVp - 20 mm Al filter - HVL 7 ± 0. 2 mm Al.
The luminance is measured by a photometer which matches the human vision.
The conversion factor is defined as :

$$\text{C. F.} = \frac{\text{Luminance}}{\text{dose rate}} = \frac{\text{Candela/square meter}}{\text{milli Roentgen/second}} \text{ or } \frac{\text{foot Lambert}}{\text{Roentgen/minute}}$$

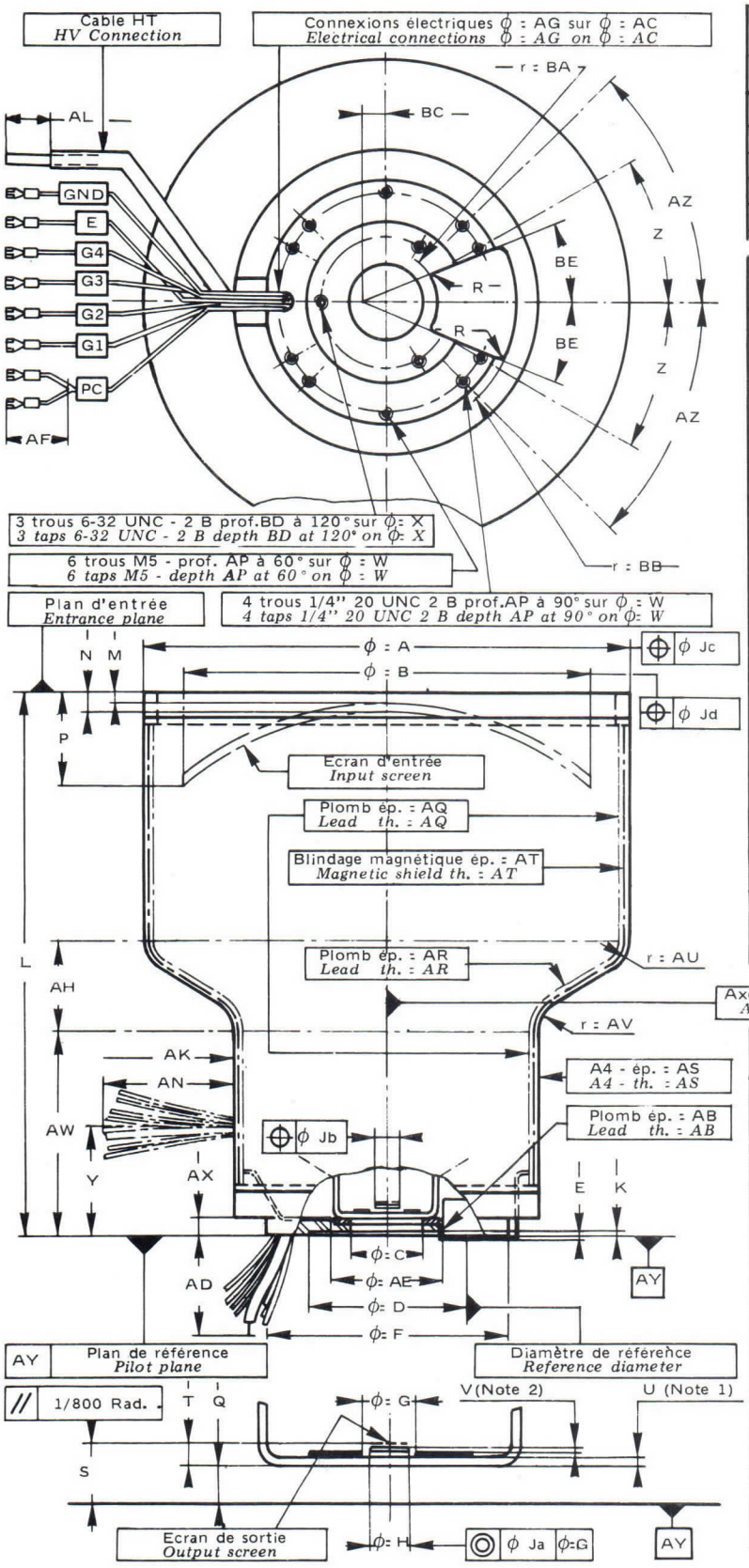
5 - The luminance gain is the ratio of luminance of the image intensifier to the luminance of a Massiot - Fluor - Sirius fluoroscopic screen having a luminance of 0.010 cd/m² per mR/s. Both are irradiated in the same conditions : 80 kVp - 20 mm Al filter - HVL 7 ± 0. 2 mm Al. The luminance is measured by a photometer which matches the human vision.

6 - The background luminance is the luminance of output screen when normal operating voltages are applied to the tube and X-rays are off at normal ambient temperature.

7 - The distortion is measured by $D = \frac{M_p - M_c}{M_c} \times 100$

where M_p = magnification measured on a circle covering 90 % of the input field.
M_c = magnification measured on a 2 cm diameter circle centered on the input field axis.

8 - The image persistence is the residual luminance measured at a determined time after removal of X-ray radiations.



Dimensions en millimètres Angles en unités sexagésimales *Dimensions in millimeters* *Angles in sexagesimal units*					
	MIN	MAX		MIN	MAX
A	378	381	AB	2,4	2,6
B	323	325	AC	155	-
C	57,15	57,23	AD	450	500
D	120,45	120,85	AE	85	87
E	0	3	AF	35	45
F	135,5	186,5	AG	-	16,1
G	26,95	27,05	AH	72	76
H	24	25	AK	224	226
K	1,27	1,77	AL	30	50
L	430	435	AN	540	590
M	2	10	AP	-	8
N	11	21	AQ	1,2	1,5
P	71	82	AR	1,5	1,8
Q	7,05	-	AS	1,8	2,0
R	3	-	AT	0,7	0,9
*S	10,15	10,65	AU	24	28
*T	2,55	3,05	AV	22	26
U	2,4	2,6	AW	157	162
V	1,0	1,3	AX	7	9
W	171,38	171,62	AY		
X	104,66	104,90	AZ	44°	46°
Y	-	80	BA	39	-
Z	29°	31°	BB	-	99
			BC	-	18,51
			BD	-	6,5
Jd	7		BE	-	22°
Jc	3				
Jb	1				
Ja	0,5				

Note 1 : Indice - *Index* : 1,49
Note 2 : Indice - *Index* : 1,54
* : Distances optiques - *Optical distances*

Connexions électriques - Long. : AD ou AN *Electrical connections - Length : AD or AN*			
REP *MARK*	FILS *CABLE*		CONNECTEUR *TERMINAL*
P C	Noir *Black*	Coaxial RG 174 U	AMP.61255-1
G 1	Vert *Green*	Wire 600 V	AMP.42628-2
G 2	Noir *Black*	Belden 8869	AMP.42628-2
G 3	Noir *Black*	Belden 8869	AMP.42628-2
G 4	Noir *Black*	Belden 8869	AMP.61255-1
E	Bleu *Blue*	Wire 600 V	AMP.31889
GND	Gris *Grey*	Wire 600 V	AMP.31889
A	Blanc *White*	50 kV dc 18 AWG BOSTON 2841 LG 18	

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

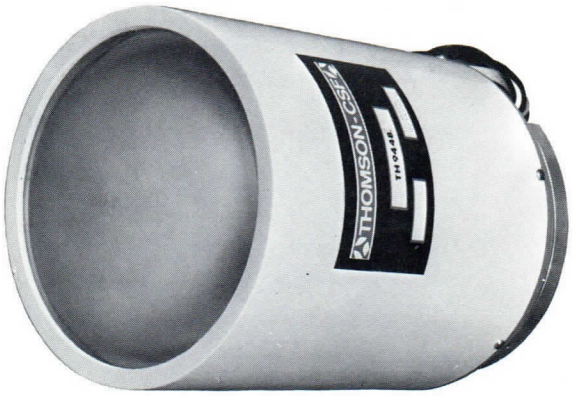
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Imprimé en France

TH 9448
X-RAY IMAGE INTENSIFIER TUBE

- INPUT FIELD : 15 cm
- OUTPUT IMAGE NOMINAL DIAMETER : 14. 5 mm
- HIGH RESOLUTION - HIGH CONTRAST
- LUMINANCE GAIN : x 10 000

The TH 9448 is a X-ray image intensifier tube which converts the X-ray pattern into a light image of high brightness and good contrast.



The X-ray beam emerging from the subject being examined first passes through the tube's input window, made up of special low absorption glass. Next, the X-rays reach the input fluorescent screen where the X-ray photons are converted to light photons. A photocathode, coupled to the input screen is excited by these light photons, which are thus converted to electrons. The emitted electrons are accelerated and focused by appropriate electric fields and then impinge on the output fluorescent screen. This screen's phosphor coating reconverts the electrons back to light photons providing an exceptionnally bright output image. This brightness gain is obtained partly from the energy imparted to the electrons during their acceleration and partly from the reduction in diameter of the tube's output image as compared to the input image. In fact, this image is several thousand times brighter than would have been that of a conventional radioscopic screen substituted for the tube's input window.

Many improvements in the design of the TH 9448 have benifited from THOMSON-CSF wide experience and considerable expertise in the field of X-ray image intensifier tubes.

The TH 9448 uses the caesium iodide (CsI) base as the detector screen material which associates an improved absorption of the incident radiation to a fast time response.

The output screen uses a fluorescent material made of very fine crystals (in the order of the micron) ; thanks to a sophisticated technology, this screen allows to display a high resolution image of 14. 5 mm diameter thus making the tube to match with the best quality optical devices presently available.

The P20 phosphor is selected in order that its spectral response coincides with the optimum correction range of the optical systems thus minimizing the reflections and loss of resolution and contrast in these optical systems; on the other hand, the P20 phosphor is matched to 35 mm film, 100 or 70 mm spot films or to CCTV camera tubes.

The "dark output screen" also enables to minimize all light reflection (internal or due to the optical system) and thus improves the image contrast.

The TH 9448 incorporates an automatic "active getter" which ensures a very high vacuum along tube's life avoiding the development of an ion spot or alteration of contrast resolution.

Power supply

Since the TH 9448 performs very high resolution, the power supply must be carefully designed and especially ripple voltages must not exceed 0. 3 %.

The TH 7122 THOMSON-CSF power supply designed especially for use with the TH 9448 is highly recommended. It delivers 0. 1 % regulated voltages for all electrodes and is directly energized from 110/220 V - 50/60 Hz line supply.

GENERAL CHARACTERISTICS

Mechanical (see Note 1 and drawing)

The tube is delivered in a metal housing which ensures the function of mechanical support ; nevertheless, it is necessary to maintain the assembly by sustaining the entrance plane.

In this housing, the tube is mounted so as to facilitate the precise location of the optical devices as regard to the reference plane. This shell protects the tube against stray magnetic field and cannot be considered as an efficient shield against X-radiations. A lead plate of 2 mm thickness is provided at the output plane of the housing.

Aluminum housing

The tube can be optionally provided in an aluminum housing including lead and mumetal lining.

In this version, it provides personel protection which satisfies the most rigorous international regulations. It also permits the direct mounting of the tube on the equipment by means of the output plane.

Operating position	any
Shipment position	tube axis horizontal
Operating and storage temperature :	
- maximum	+50 °C
- minimum	+ 5 °C
Net weight, approx.	3 kg
Dimensions	see drawing

Optical

Input screen diameter	15 ± 0. 5	cm
Output image diameter	14. 5 ± 0. 5	mm
Input screen spectral response	X-rays	
	30 to 250 kVp generator	
Veiwing screen :		
- type	P20 (λ max. = 520 nm)	
- fluorescence and phosphorescence	yellow - green	
Electrostatic focus - Inverted image :		
Input field diameter	15	cm
Magnification	1/11	
Typical resolution (Note 2) :		
- central	38	lp/cm
- peripheral	34	lp/cm
Detection sensitivity (Note 3) measured with JEDEC - penetrometer	2. 1	%
Typical contrast ratio (Note 4)	12/1	
Minimum conversion factor (Note 5)	100	$\frac{cd/m^2}{mR/s}$
or	500	$\frac{fL}{R/mn}$
Minimum luminance gain (Note 6)	10 000	
Maximum background luminance (Note 7)	0. 06	cd/m^2
or	0. 02	fL
Maximum distortion (Note 8)	10	%
Maximum persistence at 10 ms (Note 9)	10	%

OPERATING CONDITIONS

Maximum ratings

Photocathode pc voltage	0 V
Electrode g1 voltage	0. 5 kV
Electrode g2 voltage	2. 0 kV
Electrode g3 voltage	5. 0 kV
Anode a voltage	32. 0 kV
Active getter voltage :	
- anode g4	3. 5 kV
- cathode k	0 V
Photocathode pc maximum current	0. 5 µA
Electrode g1 maximum current	5 µA
Electrode g2 maximum current	1 µA
Electrode g3 maximum current	1 µA
Electrode g4 maximum current (after post-gettering operation)	10 µA
Anode a maximum current (without X-radiation)	2 µA

Typical operation

Input diameter for 14. 5 mm output image	15 cm
Photocathode pc voltage	0 V
Electrode g1 voltage*	100 to 350 V
Electrode g2 voltage*	1000 to 1600 V
Electrode g3 voltage*	3. 8 kV
Anode a voltage	30. 0 kV
Active getter voltage :	
- anode g4	2. 5 to 3. 0 kV
- cathode k	0 V

Ripple voltages must not exceed 0. 3 %.

* g1, g2, g3 voltages are given for an anode voltage of 30. 0 kV.

STARTING PROCEDURE

Important

For tube handling, always prescribe use of security goggles (implosion risk).

Tube mounting

Set tube inside a proper metal housing to protect operator against X-radiation.

Check for darkness of the tube housing (would the tube be checked without container, it should then be placed in a completely dark room).

The housing in which the tube is contained must be humidity proof and deshydrated. This condition is necessary to eliminate all moisture which could initiate coronas and sparks detrimental to tube operation. Moreover, it prevents dust electrostatic attraction on the viewing face.

Connections

All the connections necessary for tube supply are made through flexible wires with color reference marks.

A 10 Megohms resistance protecting the tube against discharge must be inserted in series in the anode circuit inside the housing. Time constant thus produced with tube capacitance contributes to ripple voltage filtering.

In series between each voltage supply and corresponding tube connection, insert in the same way a few Megohms protection resistance.

Electrode voltages

The tube is delivered with an individual Test Report giving the optimum focus voltages measured in factory.

It may occur that the given values do not give the optimum focus because of the measurement instrument calibration errors. As the tube features very high resolution performance, a variation of electrode voltages of 1 % can alter the image quality.

It results from this remark that it is recommended to adjust the tube voltages as follows in order to obtain the best focus.

Focusing adjustments

- Voltages supplies can be applied to the electrodes in a short time but with a slope not exceeding 5 kV/ms.
- Let tube at rest with voltages applied for potential stabilization before adjusting it. (10 s minimum).
- Set a 0. 2 mm spaced metal wire mesh of 2/10 mm diameter (stainless steel, copper) in front of the tube and apply X-rays beam.
- Apply electrode voltages given in Test Report.
- Adjust g1 voltage in order to obtain an image as homogeneous as possible in luminance.
- Adjust g2 voltage in order to obtain the optimum resolution.
- Optimize g1 voltage if necessary.
- Electrode voltages in the Test Report are given for an anode voltage of 30 kV. If the tube is operated at a lower anode voltage, the adjustment process is identical except that the voltages of the other electrodes must be consequently reduced.

Gettering operation

In order to assure a high reliability in operation and to maintain optimum performances of the tube, Instructions for Gettering operation should be stricty applied as defined in a separate Data.

The purpose of this operation is to pump residual gas in the tube resulting in an ion spot which lowers the image contrast and resolution.

NOTES

1 - **The mounting** of the tube in its housing (see page 2 and drawing) secures the positioning of the viewing screen at a determined optical distance from the mechanical pilot plane on which may be fixed the optical system. This distance is 25 ± 0.25 mm. This housing assures a parallelism of the two planes with a precision higher than 1/800 radian. It assures a center of image within 0.25 mm from perpendicular axis of the pilot plane defined by an aperture of 100, 11 ± 0. 04 mm diameter.

2 - **The resolution** (as referred to input screen) is measured by using square lead pattern consisting of alternate black and white lines of equal width. Any two adjacent lines are designated as a line pair. The impinging X-radiation is produced by a generator operating at 65 kV and with a 2.5 mm aluminum filter. The given values are valid for 70 % of the input field area.

3 - **The detection sensitivity** is defined as the differential thickness which can be detected when using a JEDEC penetrometer. This penetrometer consists in an aluminum disc of 20 mm thickness presenting holes of 6 mm diameter. The depth of those holes vary from 1.5 to 7 % of the thickness of the disc. The differential thickness (expressed in %) of the hole having the minimum depth which can be detected defines the minimum contrast. X-ray conditions : 80 kVp - HVL 7 ± 0. 2 mm Al-input dose rate 100 mR/mn.

4 - **The contrast ratio** is measured by inserting a lead disc of 6 mm thickness in the center of the tube's input field and covering 10 % of the input field. The contrast ratio is expressed by the ratio $CR = \frac{B_2}{B_1}$

where : B_1 = luminance of the viewing screen measured at the center of the disc.
B_2 = luminance of the viewing screen measured on the light area.

5 - **The conversion factor** is the value of the viewing screen luminance corresponding to a determined X-ray dose rate.

X-ray conditions : 80 kVp - 20 mm Al filter - HVL 7 ± 0. 2 mm Al.
The luminance is measured by a photometer which matches the human vision.
The conversion factor is defined as :

$$C.F. = \frac{\text{Luminance}}{\text{dose rate}} = \frac{\text{Candela/square meter}}{\text{milli Roentgen/second}} \quad \text{or} \quad \frac{\text{foot Lambert}}{\text{Roentgen/minute}}$$

6 - **The luminance gain** is the ratio of luminance of the image intensifier to the luminance of a PATERSON - CB2 type fluoroscopic screen. Both are irradiated in the same conditions : 80 kVp - 20 mm Al filter - HVL 7 ± 0.2 mm Al. The luminance is measured by a photometer which matches the human vision.

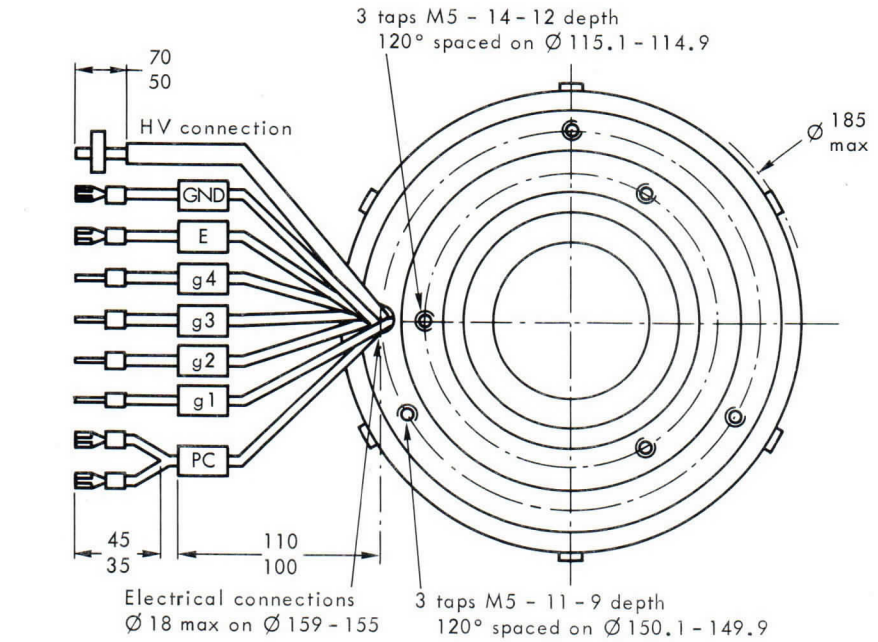
7 - **The background luminance** is the luminance of output screen when normal operating voltages are applied to the tube and X-rays are off at normal ambient temperature.

8 - **The distortion** is measured by $D = \frac{M_p - M_c}{M_c} \times 100$

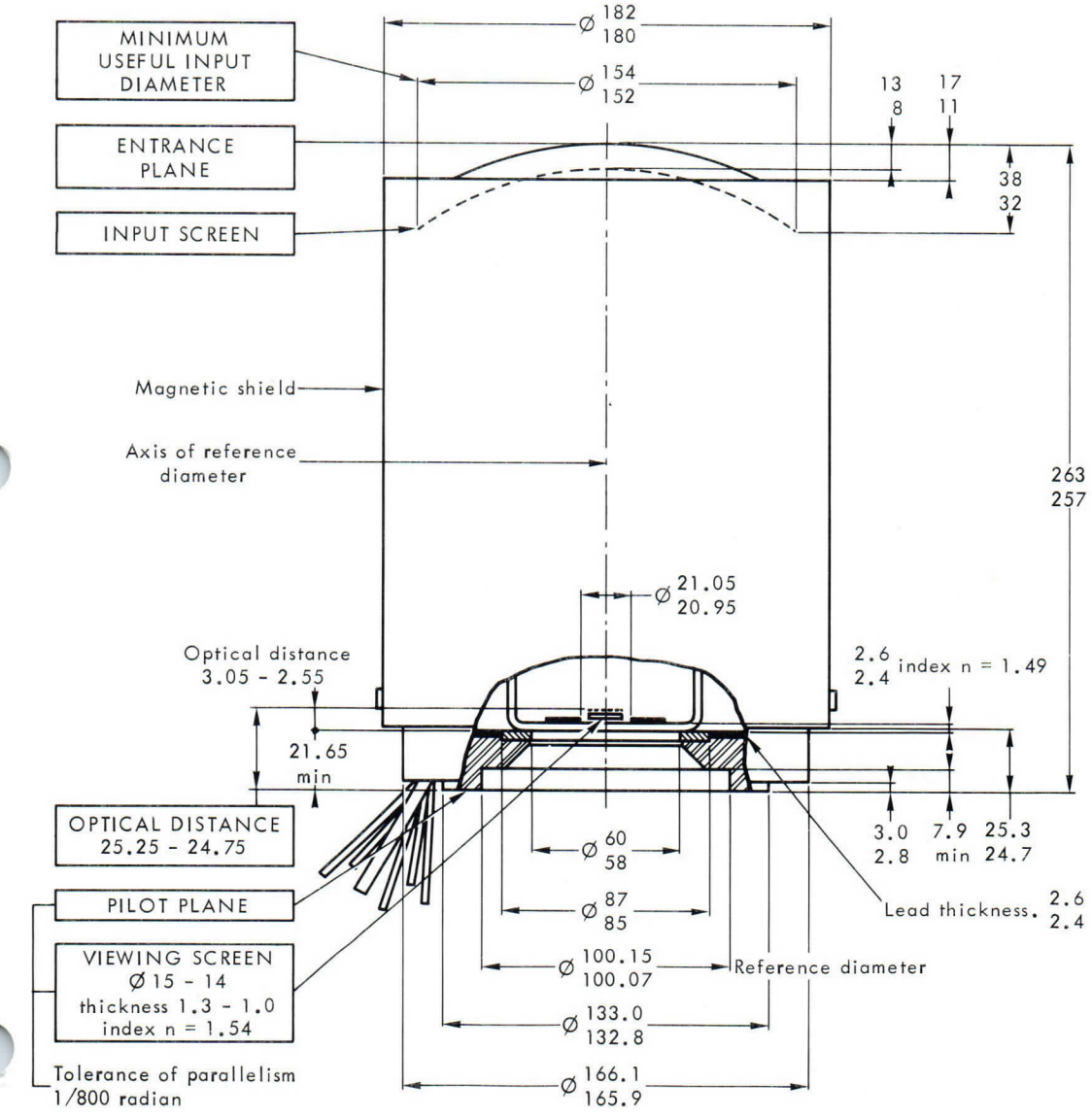
where : M_p = magnification measured on a circle covering 90 % of the input field.
M_c = magnification measured on a 2 cm diameter circle centered on the input field.

9 - **The image persistence** is the residual luminance measured at a determined time after removal of X-radiation.

OUTLINE DRAWING



ELECTRICAL CONNECTIONS		
Cathode	PC	Black
Field electrode	g1	Green
Focusing electrode	g2	Black
Focusing electrode	g3	Black
Active getter +	g4	Black
Active getter -	E	Blue
Ground	GND	Grey
Anode	A	White



Dimensions in mm.

THOMSON-CSF
DIVISION TUBES ELECTRONIQUES

Mr Durra

TMA.406 (F8080)

DOUBLE ENDED ELECTROMAGNETIC DEFLECTION
SCAN CONVERTER STORAGE TUBE

The TMA.406 is a dual gun, electrical signal storage tube. The writing beam deposits, by induced conductivity, electron charges on a thin semi-conducting target. The recorded signals are read by the reading beam by use of secondary emission effects during a large and adjustable number of reading frames.

The TMA.406 scan converter tube allows :

- simultaneous writing and reading without crosstalk
- writing in a mode of scanning and reading in a different mode
- adjustment of the storage time
- fast erasure of the written signals
- superposition of several kinds of information.

The symetrical deflections and the absence of collimation of the TMA.406 make it free from geometrical distortion.

TYPICAL APPLICATIONS

Air traffic control (conversion of P.P.I. radar scan to T.V. scan)

In radar bright display equipments this tube allows :

- display on a T.V. monitor of a bright, sharp picture in high ambient lighting conditions,
- visual target tracking by means of the tube storage characteristics,
- retransmission and multiple display of the radar picture.

Remote transmission of radar or T.V. informations over narrow bandwidth channels.

Signal to noise enhancement by integration.

Superposition of several types of input data.

TYPICAL PERFORMANCES

Output signal current	0. 8 µA
Output capacitance	15 pF
Resolution	180 P.P.I. range rings at 50 % modulation (equivalent to approximately 1000 T.V. lines)
Storage time with continuous read-out*	adjustable from 1 to 30 s at 50 % residual
Gray levels	7
Fast erasing time, max.	5 s

* *Other ranges of storage time on request.*

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OPERATING CONDITIONS

Unless otherwise stated, voltages are given with respect to ground.

Absolute ratings

WRITING GUN - Electrostatic focusing, electromagnetic deflection.				
Heater voltage (note 1)			6.3 ± 10 %	V
Cathode k' voltage			−9	kV
Voltage between heater and cathode			±150	V
Control grid g'1 voltage (w. r. t. cathode)	0	to	−100	V
Anode g'2 voltage			0	V
Focusing g'3 voltage	0	to	−9	kV
READING GUN - Electrostatic focusing, electromagnetic deflection.				
Heater voltage (note 2)			6.3 ± 10 %	V
Cathode k voltage			−2	kV
Voltage between heater and cathode			±150	V
Control grid g1 voltage (w. r. t. cathode)	0	to	−100	V
Anode g2 voltage	0	to	−50	V
Erasing g3 voltage	0	to	−2.5	kV
Focusing g4 voltage	0	to	−2	kV

Typical operation

WRITING GUN				
Heater voltage			6.3	V
Heater current, approx.			0.6	A
Cathode k' voltage			−8	kV
Voltage between heater and cathode			0	V
Control grid g'1 voltage for cut-off (w.r.t. cathode)	−30	to	−90	V
Anode g'2 voltage			0	V
Focusing g'3 voltage	−5	to	−6	kV
READING GUN				
Heater voltage			6.3	V
Heater current, approx.			0.6	A
Cathode k voltage			−1.5	kV
Voltage between heater and cathode			0	V
Control grid g1 voltage for cut-off (w.r.t. cathode)	−30	to	−90	V
Anode g2 voltage	−10	to	−30	V
Erasing g3 voltage — reading mode			0	V
Erasing g3 voltage — erasing mode	−1.5	to	−1.9	kV
Focusing g4 voltage	−1.1	to	−1.4	kV
STORAGE ASSEMBLY				
Target voltage — reading mode			0	V
Target voltage — erasing mode	+200	then	−200	V
Collector voltage	0	to	40	V
Shading corrector voltage	0	to	60	V

NOTES

1 - Heater insulated for 10 kV w.r.t. ground
2 - Heater insulated for 3 kV w.r.t. ground

OPERATING RECOMMENDATIONS

1 - The writing beam should never be motionless on the storage surface which might be damaged. Too high writing beam current density must be avoided.
2 - The reading beam should never be motionless.
3 - Provide a suitable shield in order to protect the tube from stray electric and magnetic fields.

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE

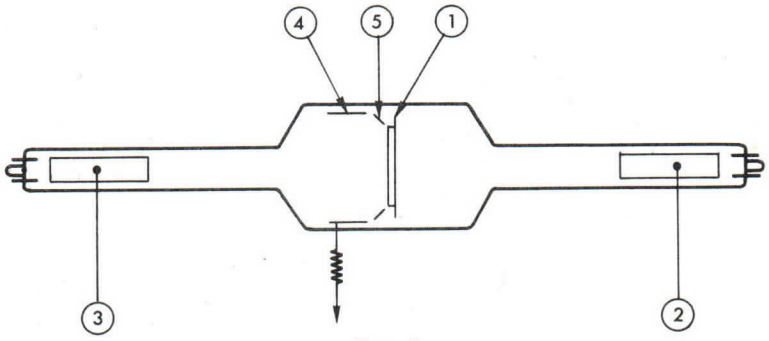


Fig. 1

The TMA.406 essentially consists of (see fig. 1):

- a storage target (1) made of a dielectric layer deposited on a thin metallic backplate (the metallic side facing the writing gun)
- a writing gun (2)
- a reading gun (3)
- a collecting assembly made of two electrodes (4) and (5).

Due to its high velocity, the writing beam is able to penetrate the metal backplate and to create charges in the dielectric by induced conductivity (EBIC). These charges are stored on the surface of the target facing the reading gun. The quantity of stored charges depends on the scanning speed and current density.

The reading beam scanning the storage surface, each scan is removing a portion of the charge pattern by secondary electron emission.

The secondaries collected by the output electrode (4) give rise to a video signal progressively decreasing.

Typical decay curves given in fig. 2 are obtained by changing both collector voltage and/or reading current.

When fast erasure is required, tube should be operated as indicated in fig. 3.

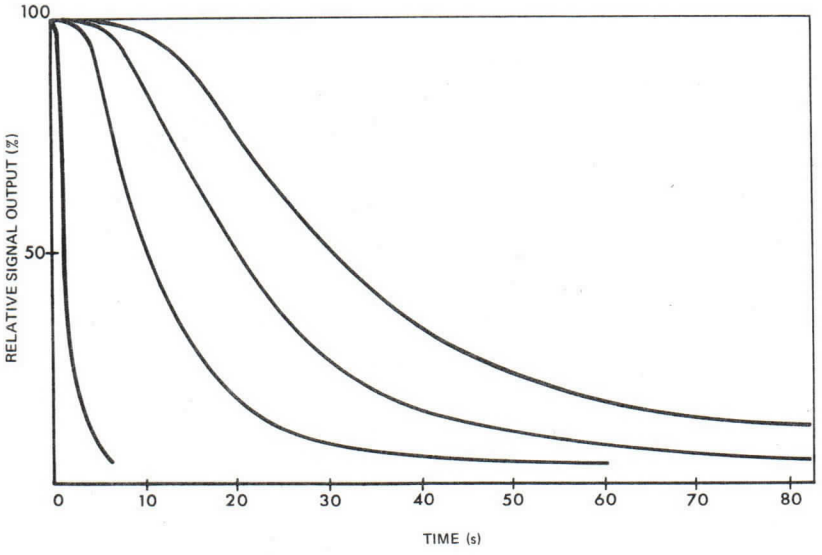


Fig. 2

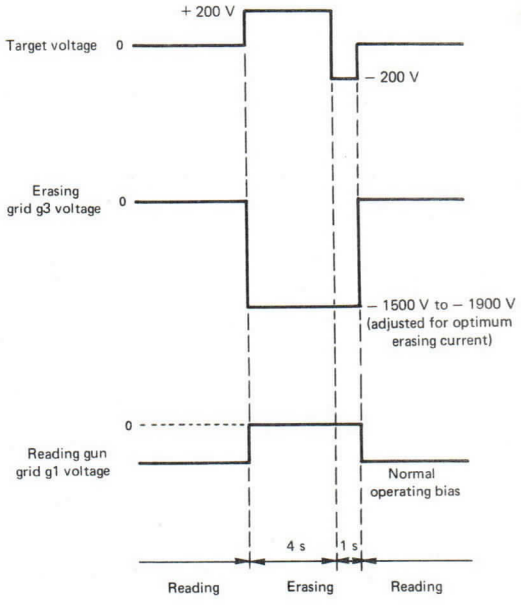
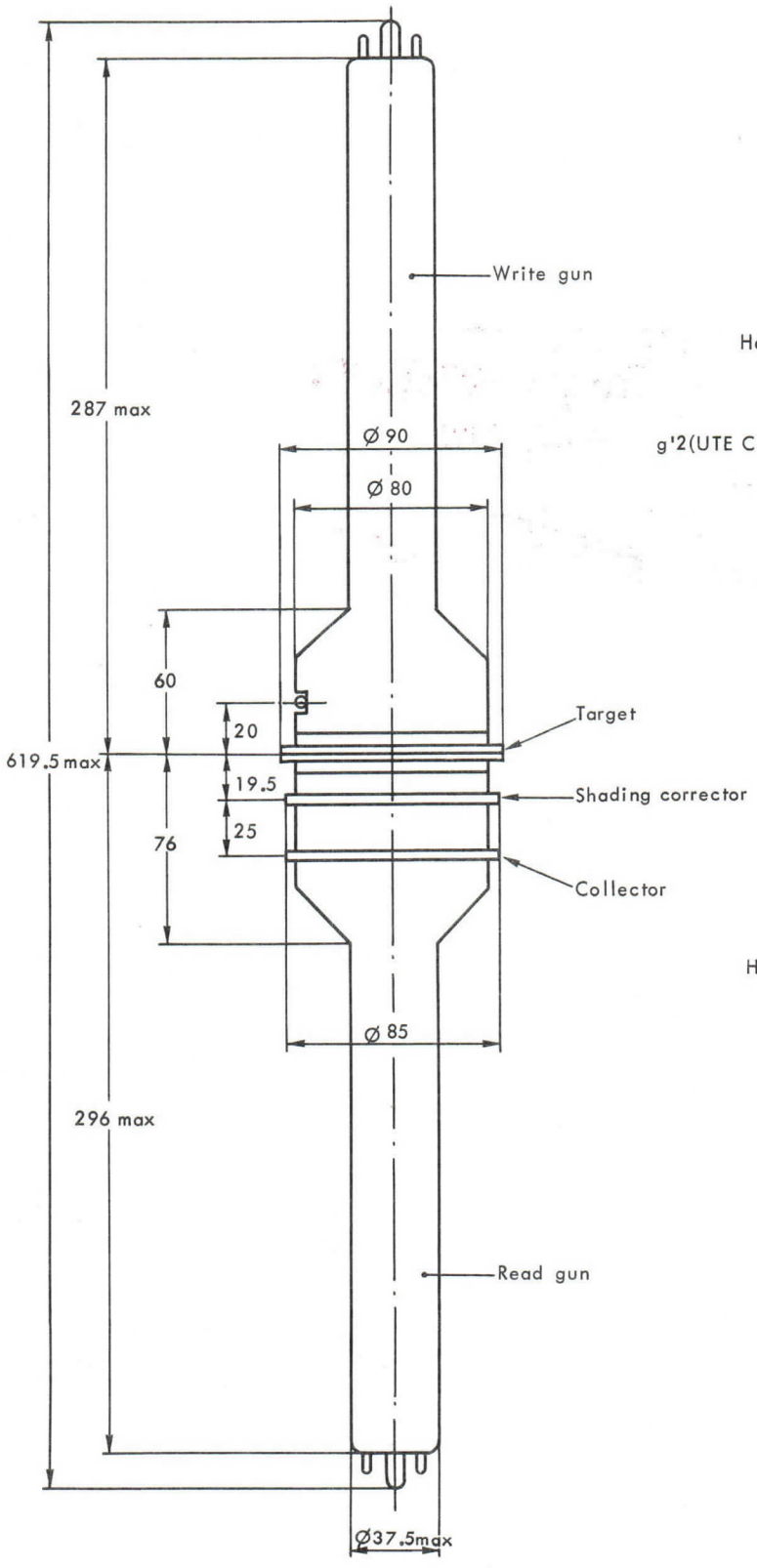
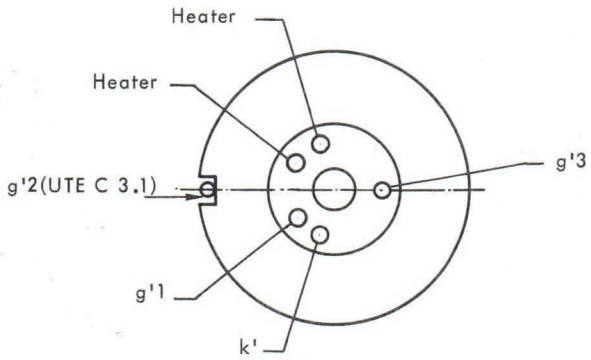


Fig. 3

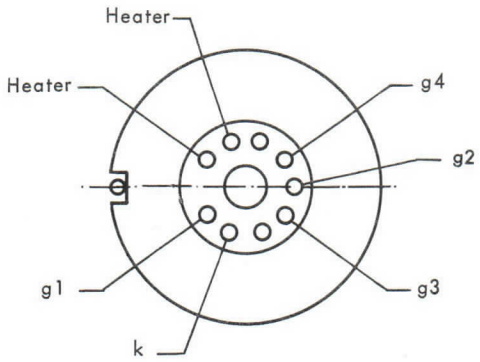
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING





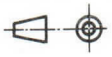
Write basing
(UTE 9C 18 Magnoval)



Read basing
(UTE 9C 18 Magnoval)

Weight : 650 gr.

Dimensions in mm



TMA.408 (F8060)

DOUBLE ENDED ELECTROMAGNETIC DEFLECTION MINIATURIZED

SCAN CONVERTER STORAGE TUBE

The TMA.408 is a miniaturized dual gun, electrical signal storage tube. The writing beam deposits, by induced conductivity, electron charges on a thin semi-conducting target. The recorded signals are read by the reading beam by use of secondary emission effects during a large and adjustable number of reading frames.

The TMA.408 scan converter tube allows :

- simultaneous writing and reading without crosstalk
- writing in a mode of scanning and reading in a different mode
- adjustment of the storage time
- fast erasure of the written signals
- superposition of several kinds of information.

Owing to its very small size, rugged construction and low weight the TMA.408 is specially suitable for use in transistorized ground or airborne equipment. Its symetrical deflections and the absence of collimation make it free from geometrical distortion.

TYPICAL APPLICATIONS

Air traffic control (conversion of P.P.I. radar scan to T.V. scan)

In radar bright display equipments this tube allows :

- display on a T.V. monitor of a bright, sharp picture in high ambient lighting conditions,
- visual target tracking by means of the tube storage characteristics,
- retransmission and multiple display of the radar picture.

Remote transmission of radar or T.V. informations over narrow bandwidth channels.

Signal to noise enhancement by integration.

Superposition of several types of input data.

TYPICAL PERFORMANCES

Output signal current	0.5	µA
Output capacitance	10	pF
Resolution	150 P.P.I. range rings at 50 % modulation (equivalent to approximately 800 T.V. lines)	
Storage time with continuous read-out*	adjustable from 0.5 to 20 s at 50 % residual	
Gray levels	7	
Fast erasing time, max.	2	s

* *Other ranges of storage time on request.*

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OPERATING CONDITIONS

Unless otherwise stated, voltages are given with respect to ground.

Absolute ratings

WRITING GUN - Electrostatic focusing, electromagnetic deflection.		
Heater voltage (note 1)	6.3 ± 10 %	V
Cathode k' voltage	−7	kV
Voltage between heater and cathode	±150	V
Control grid g'1 voltage (w. r. t. cathode)	0 to −100	V
Anode g'2 voltage	connected to target	
Focusing g'3 voltage	0 to −7	kV
READING GUN - Electromagnetic focusing and deflection.		
Heater voltage (note 2)	6.3 ± 10 %	V
Cathode k voltage	−1.5	kV
Voltage between heater and cathode	±150	V
Control grid g1 voltage (w. r. t. cathode)	0 to −100	V
Anode g2 voltage	0 to −100	V
Erasing g4 voltage	0 to −1.7	kV

Typical operation

WRITING GUN			
Heater voltage		6.3	V
Heater current, approx.		0.6	A
Cathode k' voltage		−6	kV
Voltage between heater and cathode		0	V
Control grid g'1 voltage for cut-off (w.r.t. cathode)		−30 to −90	V
Anode g'2 voltage		connected to target	
Focusing g'3 voltage		−4 to −5	kV
READING GUN			
Heater voltage		6.3	V
Heater current, approx.		0.6	A
Cathode k voltage		−1.2	kV
Voltage between heater and cathode		0	V
Control grid g1 voltage for cut-off (w.r.t. cathode)		−20 to −60	V
Anode g2 voltage		−10 to −100	V
Erasing g4 voltage	reading mode	0	V
	erasing mode	−1.2 to −1.5	kV
STORAGE ASSEMBLY			
Target voltage	reading mode	0	V
	erasing mode	+150 then −150	V
Collector voltage		0 to 40	V
Shading corrector voltage		0 to 60	V

NOTES

1 - Heater insulated for 8 kV w.r.t. ground
2 - Heater insulated for 2 kV w.r.t. ground

OPERATING RECOMMENDATIONS

1 - The writing beam should never be motionless on the storage surface which might be damaged. Too high writing beam current density must be avoided.
2 - The reading beam should never be motionless.
3 - Provide a suitable shield in order to protect the tube from stray electric and magnetic fields.

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE

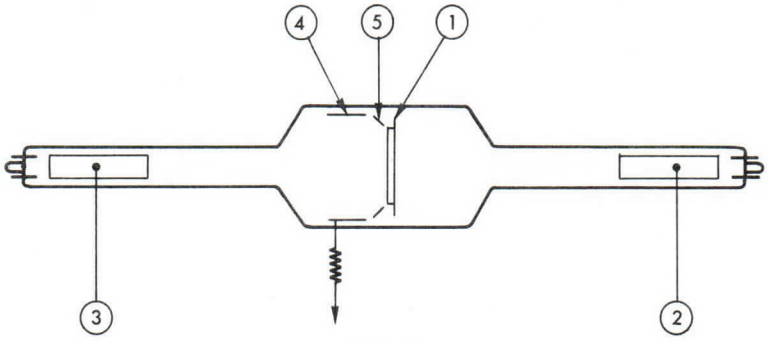


Fig. 1

The TMA.408 essentially consists of (see fig. 1) ;

- a storage target (1) made of a dielectric layer deposited on a thin metallic backplate (the metallic side facing the writing gun)
- a writing gun (2)
- a reading gun (3)
- a collecting assembly made of two electrodes (4) and (5).

Due to its high velocity, the writing beam is able to penetrate the metal backplate and to create charges in the dielectric by induced conductivity (EBIC). These charges are stored on the surface of the target facing the reading gun. The quantity of stored charges depends on the scanning speed and current density.

The reading beam scanning the storage surface, each scan is removing a portion of the charge pattern by secondary electron emission.

The secondaries collected by the output electrode (4) give rise to a video signal progressively decreasing.

Typical decay curves given in fig. 2 are obtained by changing both collector voltage and/or reading current.

When fast erasure is required, tube should be operated as indicated in fig. 3.

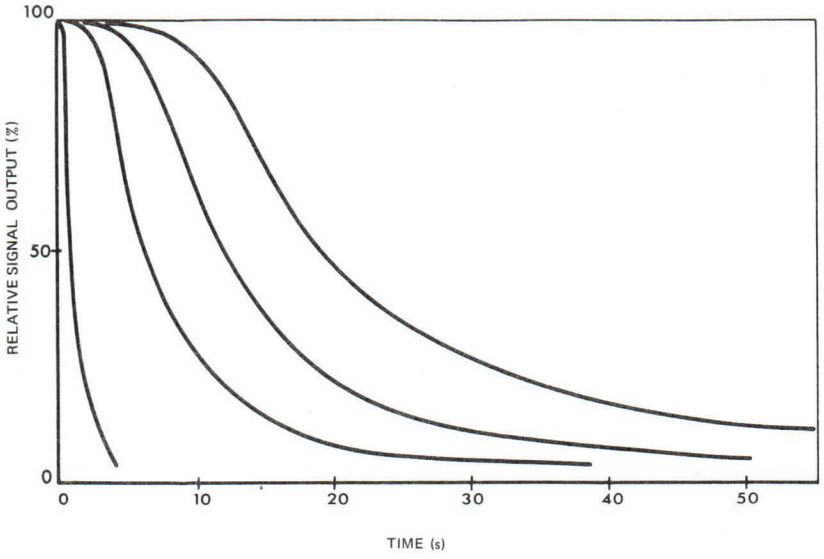


Fig. 2

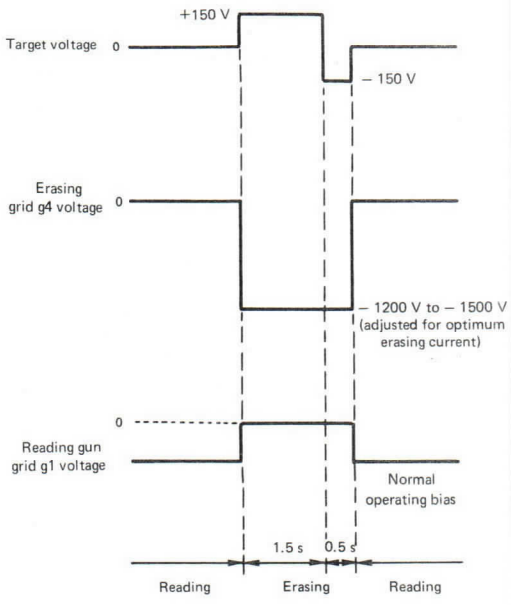
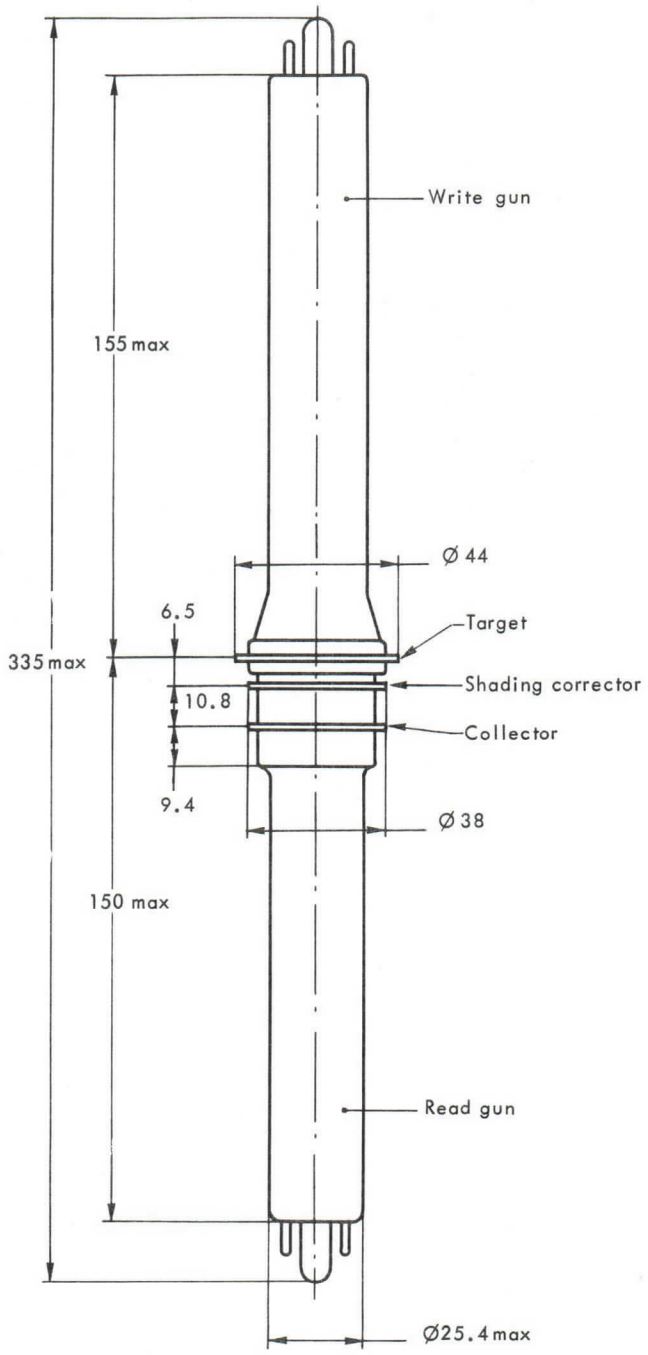
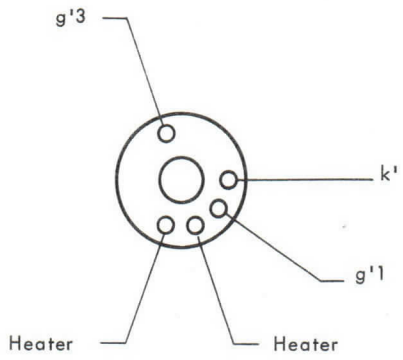


Fig. 3

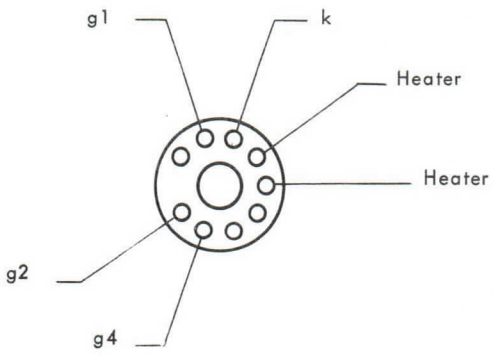
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING





Write basing
(UTE 9C 12 Noval)



Read basing
(UTE 9C 12 Noval)

Weight : 150 gr.

Dimensions in mm.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

TENTATIVE

TMA 410
SCAN CONVERTER STORAGE TUBE

- SMALL NECKS – SHORT LENGTH
- DOUBLE ENDED
- ELECTROMAGNETIC DEFLECTION.
- HIGH RESOLUTION : 1 600 T.V. LINES AT 50% MODULATION.

The TMA 410 is a small size dual gun, electrical signal storage tube. The writing beam deposits, by induced conductivity, electron charges on a thin semi-conducting target. The recorded signals are read by the reading beam by use of secondary emisssion effects during a large and adjustable number of reading frames.

The TMA 410 scan converter tube allows :

– simultaneous writing and reading without crosstalk,
– writing in a mode of scanning and reading in a different mode,
– adjustment of the storage time,
– superposition of several kinds of information.

Owing to its very small size, rugged construction and light weight the TMA 410 is specially suitable for use in transistorized ground or airborne equipment. Its symetrical deflections and the absence of collimation make it free from geometrical distortion.

TYPICAL APPLICATIONS

Air traffic control (conversion of P.P.I. radar scan to T.V. scan)

In radar bright display equipments this tube allows :
– display on a T.V. monitor of a bright, sharp picture in high ambient lighting conditions,
– visual target tracking by means of the tube storage characteristics,
– retransmission and multiple display of the radar picture.

Remote transmission of radar or T.V. informations over narrow bandwidth channels.
Signal to noise enhancement by integration.
Superposition of several types of input data.

TYPICAL PERFORMANCES

Output signal current	0.2	to	2.0	µA
Output capacitance			12	pF
Resolution	300 P.P.I. range rings at 50% modulation (equivalent to approximately 1600 T.V. lines)			
Storage time with continuous read-out*	adjustable from 0.1 to 10 s at 50% residual			
Gray levels			7	
Erasing time		max.	5	s

** Other ranges of storage time on request.*

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

TENTATIVE

OPERATING CONDITIONS

Unless otherwise stated, voltages are given with respect to ground.

ABSOLUTE RATINGS

WRITING GUN - Electrostatic focusing, electromagnetic deflection.				
Heater voltage (note 1)			6.3 ± 10 %	V
Cathode k' voltage			−8	kV
Voltage between heater and cathode			± 150	V
Control grid g'1 voltage (w.r.t. cathode)	0	to	−150	V
Anode g'2 voltage			0	V
Focusing g'3 voltage	−4	to	−8	kV
READING GUN - Electrostatic focusing, electromagnetic deflection.				
Heater voltage (note 2)			6.3 ± 10 %	V
Cathode k voltage			−1.5	kV
Voltage between heater and cathode			± 150	V
Control grid g1 voltage (w.r.t. cathode)	0	to	−150	V
Anode g2 voltage	−50	to	+ 50	V
Focusing g3 voltage	0	to	−1.5	kV

TYPICAL OPERATION

WRITING GUN				
Heater voltage			6.3	V
Heater current, approx.			0.15	A
Cathode k' voltage			−7.5	kV
Voltage between heater and cathode			0	V
Control grid g'1 voltage for cut-off (w.r.t. cathode)	−40	to	−100	V
Anode g'2 voltage			0	V
Focusing g'3 voltage	−5.5	to	−7.5	kV
READING GUN				
Heater voltage			6.3	V
Heater current, approx.			0.15	A
Cathode k voltage			−1.2	kV
Voltage between heater and cathode			0	V
Control grid g1 voltage for cut-off (w.r.t. cathode)	−40	to	−100	V
Anode g2 voltage	−40	to	+20	V
Focusing g3 voltage	−0.8		−1.2	kV
STORAGE ASSEMBLY				
Target voltage			0	V
Collector voltage	0	to	40	V
Shading corrector voltage	0	to	60	V

NOTES

1 - Heater insulated for 8 kV w. r. t. ground.
2 - Heater insulated for 2 kV w. r. t. ground.

OPERATING RECOMMENDATIONS

1 – The writing beam should never be motionless on the storage surface which might be damaged. Too high writing beam current density must be avoided.
2 – The reading beam should never be motionless.
3 – Provide a suitable shield in order to protect the tube from stray electric and magnetic fields.

TENTATIVE

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE

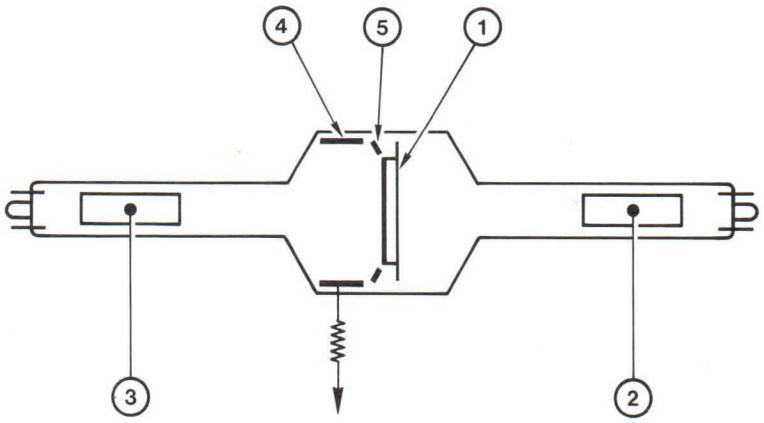


Fig. 1

The TMA 410 essentially consists of (see fig. 1) :

- a storage target (1) made of a dielectric layer deposited on a thin metallic backplate (the metallic side facing the writing gun)
- a writing gun (2)
- a reading gun (3)
- a collecting assembly made of two electrodes (4) and (5).

Due to its high velocity, the writing beam is able to penetrate the metal backplate and to create charges in the dielectric by induced conductivity (EBIC). These charges are stored on the surface of the target facing the reading gun. The quantity of stored charges depends on the scanning speed and current density.

The reading beam scanning the storage surface, each scan is removing a portion of the charge pattern by secondary electron emission.

The secondaries collected by the output electrode (4) give rise to a video signal progressively decreasing.

Typical decay curves given in fig. 2 are obtained by changing both collector voltage and/or reading current.

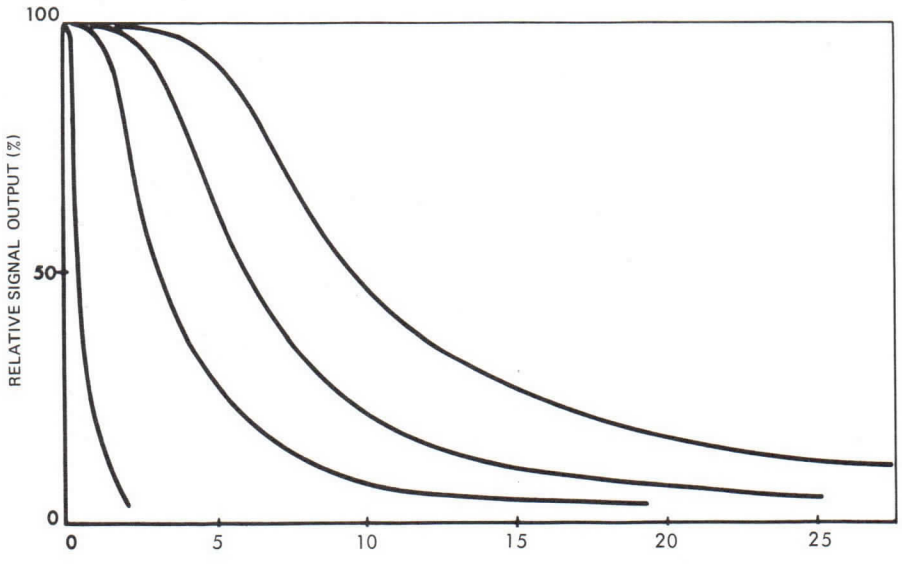
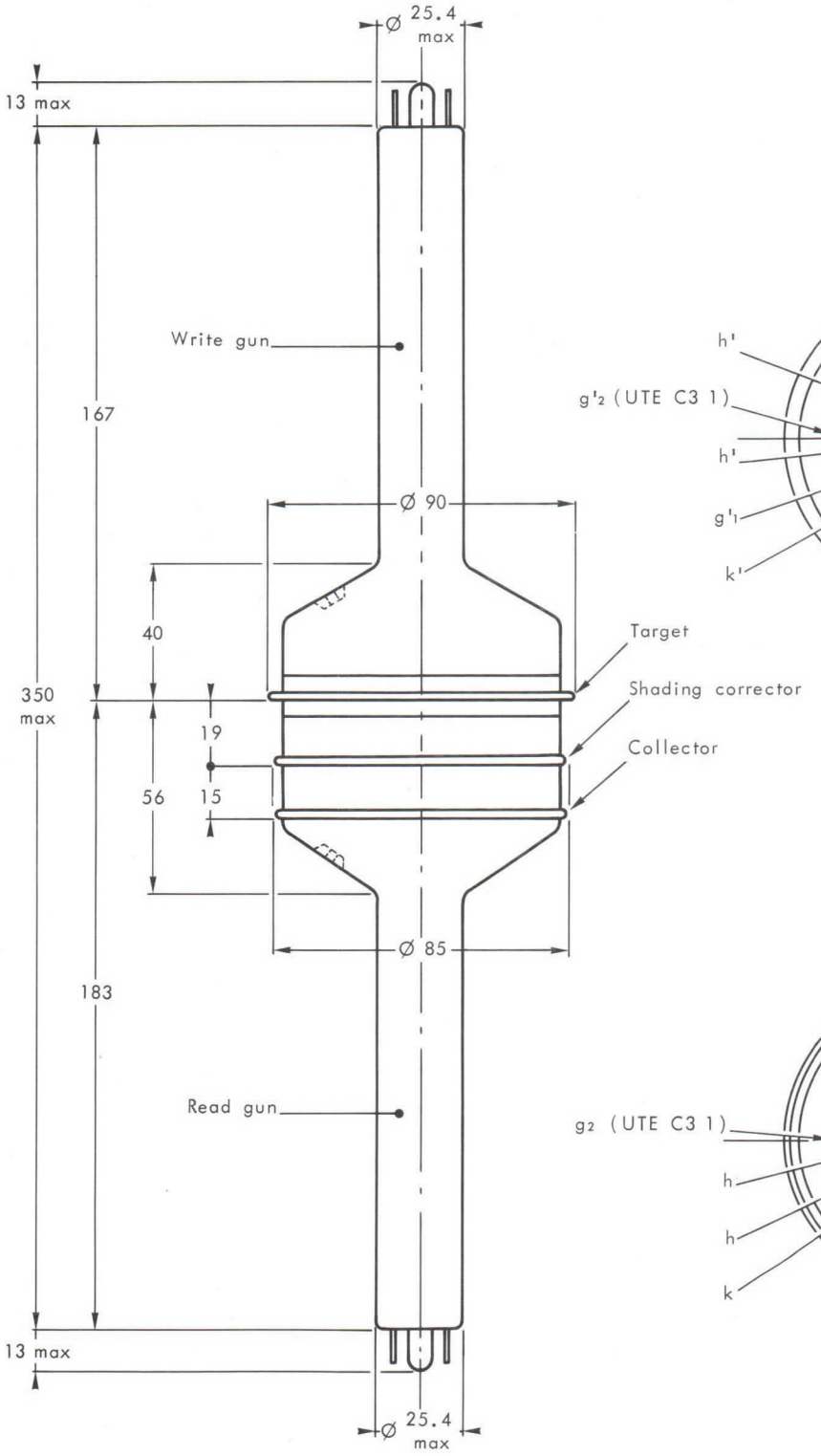


Fig. 2

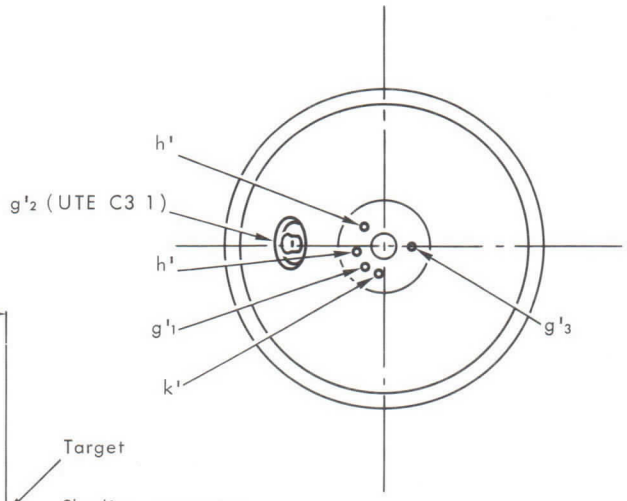
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

TENTATIVE

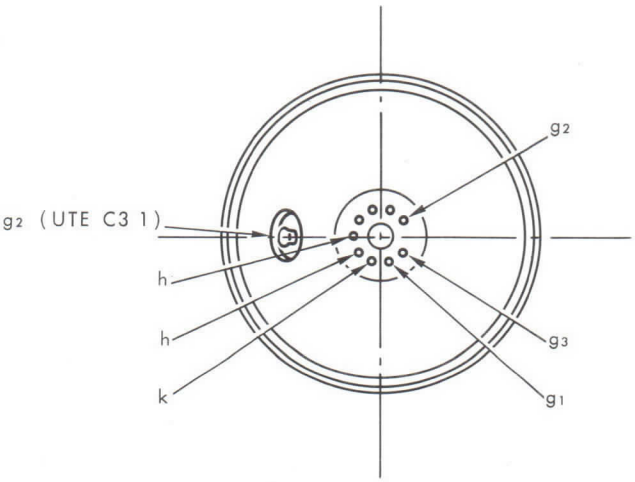
OUTLINE DRAWING



WRITE BASING
(UTE 9C 12 Noval)



READ BASING
(UTE 9C 12 Noval)



Dimensions in mm.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

TENTATIVE

TMA 426

SCAN CONVERTER STORAGE TUBE

SPECIALLY DESIGNED FOR SHORT RANGE RADAR

- HIGH WRITING SPEED
- SHORT STORAGE TIME
- DOUBLE ENDED
- ELECTROMAGNETIC DEFLECTION

The TMA 426 is a dual gun, electrical signal storage tube. The writing beam creates, by induced conductivity, electron charges on a thin semi-conducting target. The recorded signals are read by the reading beam by use of secondary emission effects.

The TMA 426 scan converter tube allows :

- simultaneous writing and reading without crosstalk
- writing in a mode of scanning and reading in a different mode
- adjustment of the storage time
- fast erasure of the written signals
- superimposition of several kinds of information.

The symmetrical deflections and the absence of collimation of the TMA 426 make it free from geometrical distortion.

TYPICAL APPLICATIONS

Conversation of PPI radar scan to T.V. scan (Radar Bright Display Equipment) in all applications where high writing and short storage time are needed (Surface Radar, Parking Radar, any Short Range Radar).
In Radar Bright Display Equipment, it allows :

- display on a T.V. monitor of a bright, sharp picture in high ambient lighting conditions,
- remote transmission and multiple display of the radar picture.

Signal to noise enhancement by integration.

Superimposition of several types of input data.

TYPICAL PERFORMANCES

Output signal current	0.5 to 2 µA
Output capacitance	15 pF
Resolution	180 P.P.I. range rings at 50% modulation (equivalent to approximately 1000 T.V. lines)
Storage time with continuous read-out	adjustable from 0.5 to 10 s at noise level
Gray levels	7
Fast erasing time, max.	1 s

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

TENTATIVE

OPERATING CONDITIONS

Unless otherwise stated, voltages are given with respect to ground.

ABSOLUTE RATINGS

WRITING GUN - Electrostatic focusing, electromagnetic deflection.				
Heater voltage (note 1)			6.3 ± 10%	V
Cathode k' voltage			−8	kV
Voltage between heater and cathode			±150	V
Control grid g'1 voltage (w.r.t. cathode)	0	to	−100	V
Anode g'2 voltage			0	V
Focusing g'3 voltage	0	to	−8	kV
READING GUN - Electrostatic focusing, electromagnetic deflection.				
Heater voltage (note 2)			6.3 ± 10%	V
Cathode k voltage			−2	kV
Voltage between heater and cathode			±150	V
Control grid g1 voltage (w.r.t. cathode)	0	to	−100	V
Anode g2 voltage	0	to	−50	V
Erasing g3 voltage	0	to	−2.5	kV
Focusing g4 voltage	0	to	−2	kV

TYPICAL OPERATION

WRITING GUN				
Heater voltage			6.3	V
Heater current, approx.			0.6	A
Cathode k' voltage			−7	kV
Voltage between heater and cathode			0	V
Control grid g'1 voltage for cut-off (w.r.t. cathode)	−30	to	−90	V
Anode g'2 voltage			0	V
Focusing g'3 voltage	−5	to	−6	kV
READING GUN				
Heater voltage			6.3	V
Heater current, approx.			0.6	A
Cathode k voltage			−1.5	kV
Voltage between heater and cathode			0	V
Control grid g1 voltage for cut-off (w.r.t. cathode)	−30	to	−90	V
Anode g2 voltage	−10	to	−30	V
Erasing g3 voltage — reading mode			0	V
Erasing g3 voltage — fast erasing mode	−1.5	to	−1.9	kV
Focusing g4 voltage	−1.1	to	−1.4	kV
STORAGE ASSEMBLY				
Target voltage — reading mode			0	V
Target voltage — fast erasing mode	+200	then	−200	V
Collector voltage	0	to	40	V
Shading corrector voltage	0	to	60	V

NOTES

1 - Heater insulated for 10 kV w.r.t. ground
2 - Heater insulated for 3 kV w.r.t. ground

OPERATING RECOMMENDATIONS

1 - The writing beam should never be motionless on the storage surface which might be damaged. Too high writing beam current density must be avoided.
2 - The reading beam should never be motionless.
3 - Provide a suitable shield in order to protect the tube from stray electric and magnetic fields.

TENTATIVE

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE

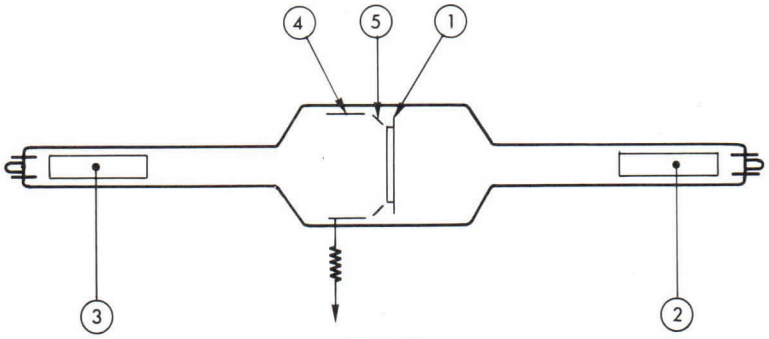


Fig. 1

The TMA 426 essentially consists of (see fig. 1) :

- a storage target (1) made of a dielectric layer deposited on a thin metallic backplate (the metallic side facing the writing gun)
- a writing gun (2)
- a reading gun (3)
- a collecting assembly made of two electrodes (4) and (5).

Due to its high velocity, the writing beam is able to penetrate the metal backplate and to create charges in the dielectric by induced conductivity (EBIC). These charges are stored on the surface of the target facing the reading gun. The quantity of stored charges depends on the scanning speed and current density.

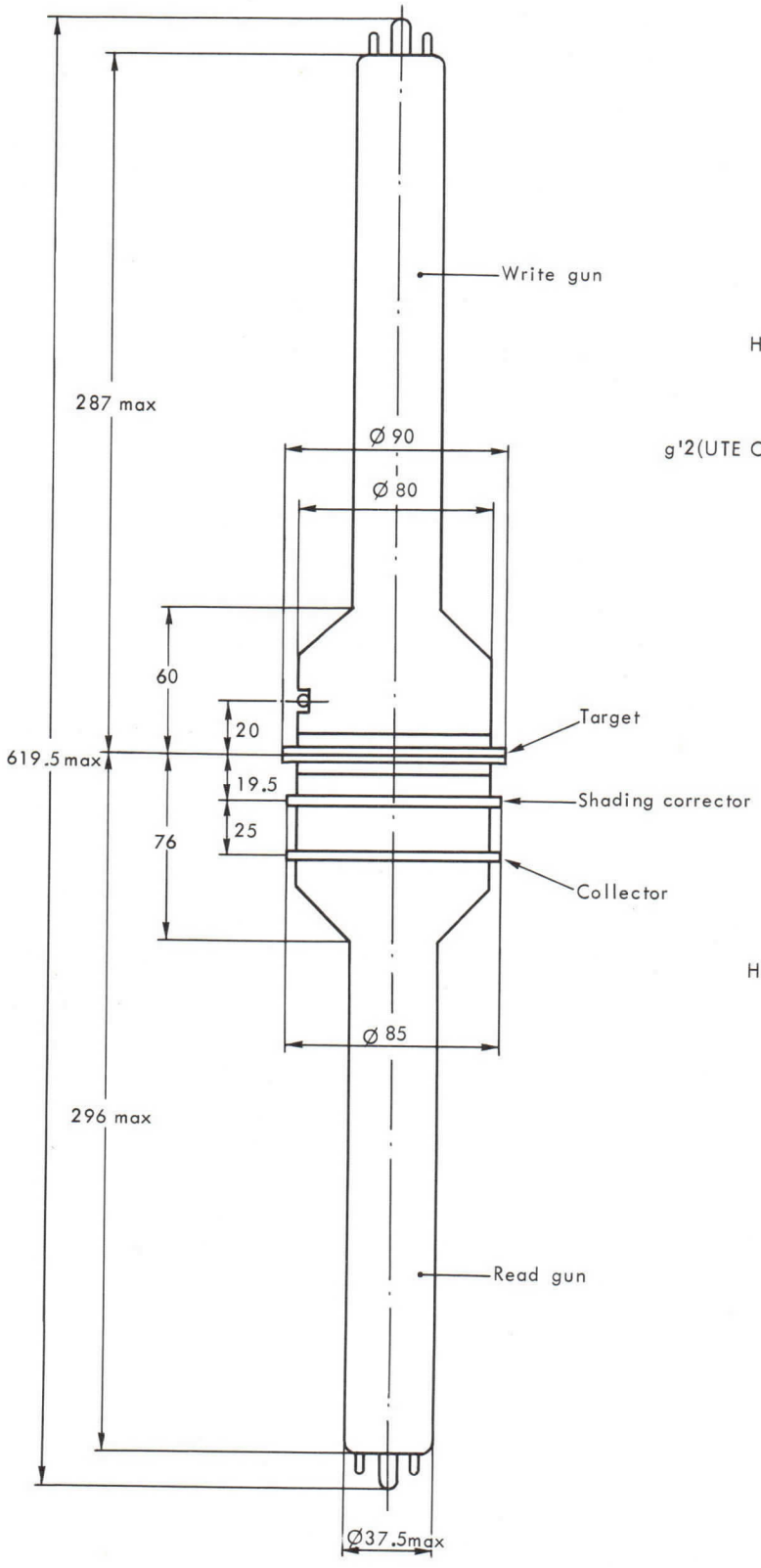
The reading beam scanning the storage surface, each scan is removing a portion of the charge pattern by secondary electron emission.

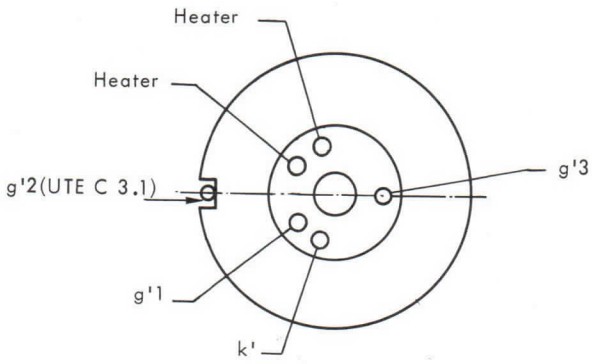
The secondaries collected by the output electrode (4) give rise to a video signal progressively decreasing.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

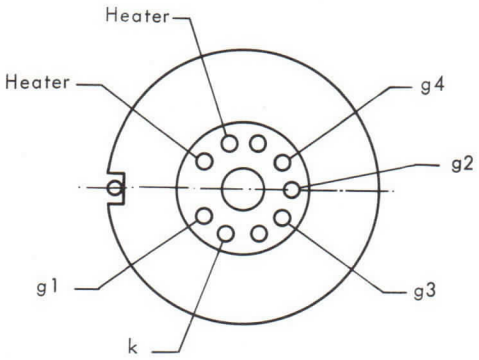
TENTATIVE

OUTLINE DRAWING





Write basing
(UTE 9C 18 Magnoval)



Read basing
(UTE 9C 18 Magnoval)

Weight : 650 gr.

Dimensions in mm.

TEI 1114 (F8094)

DARK FACE DIRECT VIEW STORAGE TUBE

The TEI.1114 is an electrostatic focus and deflection direct view storage tube capable of providing bright, uniform display over a 101. 5 mm (4") diameter screen.

The tube has a dark face for contrast enhancement in high ambient light location and is supplied with magnetic shield.

Applications include fire control radar, airborne radar displays for weather and navigational purposes.

The tube is specially designed for airborne equipment and can be operated unpressurized at high altitude. The rugged structure makes it particularly resistant to vibration.

TYPICAL PERFORMANCES

Writing speed		1 to 10	mm/μs
Resolution (note 1)	min.	21	lines/cm
Viewing time	min.	30	s
Erasing time	max.	250	ms
Brightness (sreen voltage = 10 kV)	min.	720	cd/m^2
		or 210	Ft-Lamberts
Contrast ratio (note 2)	min.	9. 2	
Half tones		5	

GENERAL CHARACTERISTICS

Electrical

Flood and writing gun :			
Heater voltage		6. 3	V
Heater current		0. 6	A
Writing gun :			
Focusing method		Electrostatic	
Deflection method		Electrostatic	
Number of writing gun		1	
Interelectrode capacitance :			
Writing gun cathode k to all internal elements	max.	25	pF
Writing gun grid g1 to all internal elements	max.	25	pF
x 1 to x 2 (or D1 to D2)	max.	20	pF
y 1 to y 2 (or D3 to D4)	max.	20	pF

Optical

Phosphor :	
Type	P 20 aluminized
Fluorescence	Yellow - green
Phosphorescence	Yellow - green
Dark face	Flat

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Mechanical

Minimum useful viewing diameter	101. 5 mm (4")
Mounting position	any
Dimensions	see drawing
Plugs	see drawing
Weight	3 kg (6. 7 Lb)

OPERATING CONDITIONS

Absolute ratings

Unless otherwise stated, voltages are given with respect to ground.

FLOOD GUN

Heater f' voltage		5. 7 to 6. 9	V
Cathode k' voltage		0	V
Grid g'1 voltage (control grid or Wehnelt)		0 to -125	V
Grid g'2 voltage (accelerating electrode)	max.	150	V
Grid g'3 voltage (first collimating electrode)	max.	200	V
Grid g'4 voltage (second collimating electrode)	max.	300	V
Grid g'5 voltage (collecting electrode)	max.	300	V
Grid g'6 voltage (backing electrode)	max.	20	V
Viewing screen g'7 voltage	max.	11. 0	kV

WRITING GUN

Heater f voltage		5. 7 to 6. 9	V
Cathode k voltage negative value	max.	3. 0	kV
	min.	1. 0	kV
Grid g1 voltage (control grid or Wehnelt) (note 3)		0 to -125	V
Grids g2 and g4 voltage (accelerating electrodes)		connected to g'2	
Grid g3 voltage (focusing electrode) (note 3)	max.	3. 0	kV
Peak heater to cathode voltage		± 180	V

Typical operation

Unless otherwise stated, voltages are given with respect to ground.

FLOOD GUN

Cathode k' voltage		0	V
Grid g'1 voltage	adjust	0 to -30	V
Grid g'2 voltage		100	V
Grid g'3 voltage	adjust	15 to 40	V
Grid g'4 voltage	adjust	25 to 50	V
Grid g'5 voltage		120	V
Grid g'6 voltage		2. 0	V
Viewing screen g'7 voltage		10. 0	kV

WRITING GUN

Cathode k voltage		-2. 0	kV
Grid g1 voltage (for cut-off) (note 3)	adjust	30 to - 60	V
Grids g2 and g4 voltage		connected to g'2	
Grid g3 voltage (note 3)	adjust	280 to 660	V
Deflection factor :			
Horizontal		9. 0 to 15. 4	V/cm
Vertical		9. 0 to 15. 4	V/cm

NOTES

1 - *Resolution measured by shrinking raster method with a written brightness of 75 % of maximum brightness.*

2 - *Contrast ratio is defined as equilibrium brightness of a trace divided by background brightness, the viewing screen operating under 10 000 lux illumination.*

3 - *With respect to writing gun cathode.*

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE

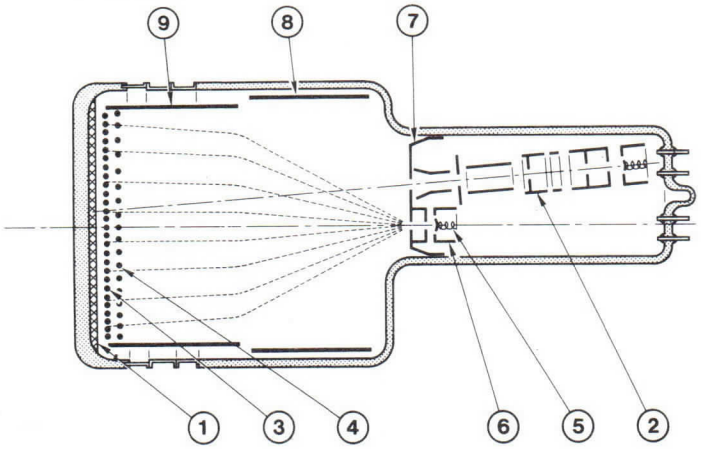
The TEI.1114 consists of four basic assemblies :

1 - The storage unit
the components of which are a collecting electrode and a fine metallic mesh called the backing electrode on which is deposited a dielectric material.

2 - The viewing screen
made of aluminized P 20 phosphor, provides the visual output.

3 - The writing gun
located in the neck of the tube generates fast electrons. The high velocity beam scans the storage surface and creates a charge pattern by secondary emission from the dielectric material.
Electrostatic focusing and deflection are employed.

4 - The flood gun
does not scan the screen but produces a wide angle low velocity electron beam which approaches the storage mesh normally and at a constant current density over the useful area owing to the collimation electrodes.



1 - Viewing screen
2 - Writing gun
3 - g'6 (backing electrode)
4 - g'5 (collecting electrode)
5 and 6 - Flood gun
7 - g'2 (accelerating electrode)
8 - g'3 (1 st collimating electrode)
9 - g'4 (2 nd collimating electrode)

In the unwritten state, the dielectric surface of the backing electrode is negatively charged and the low energy flood electrons issued from the flood gun are repelled back to the collecting electrode.

In writing operation, the writing gun scans the storage surface and creates positive charges pattern by secondary emission of the dielectric material, the secondary electrons being attracted to the collecting electrode.

Low velocity electrons from the flood gun approach the storage surface normally and flood the entire useful area. They penetrate through the backing electrode in areas where pattern has been written and are then accelerated to the viewing screen where they produce a corresponding picture on the phosphor.

Since the number of electrons passing through the backing electrode is determined by the amount of written charges, intermediate gray shades may be reproduced.

The image can be erased by applying a short positive pulse to the backing electrode. The display decay may be controlled by varying duration, amplitude and rate of continuous series of positive pulses.

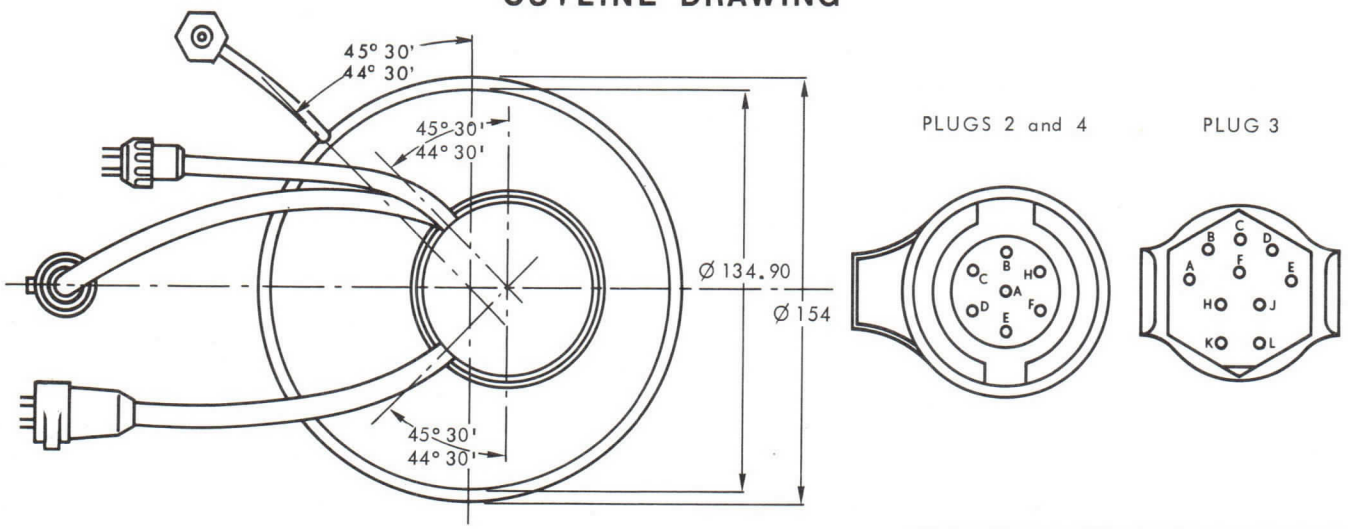
OPERATIONAL RECOMMENDATIONS

1 - The writing gun cannot be allowed to write continuously without appropriate erasure otherwise the storage surface may be damaged.

2 - The tube should be handled screen upwards to avoid particles falling on the storage elements.

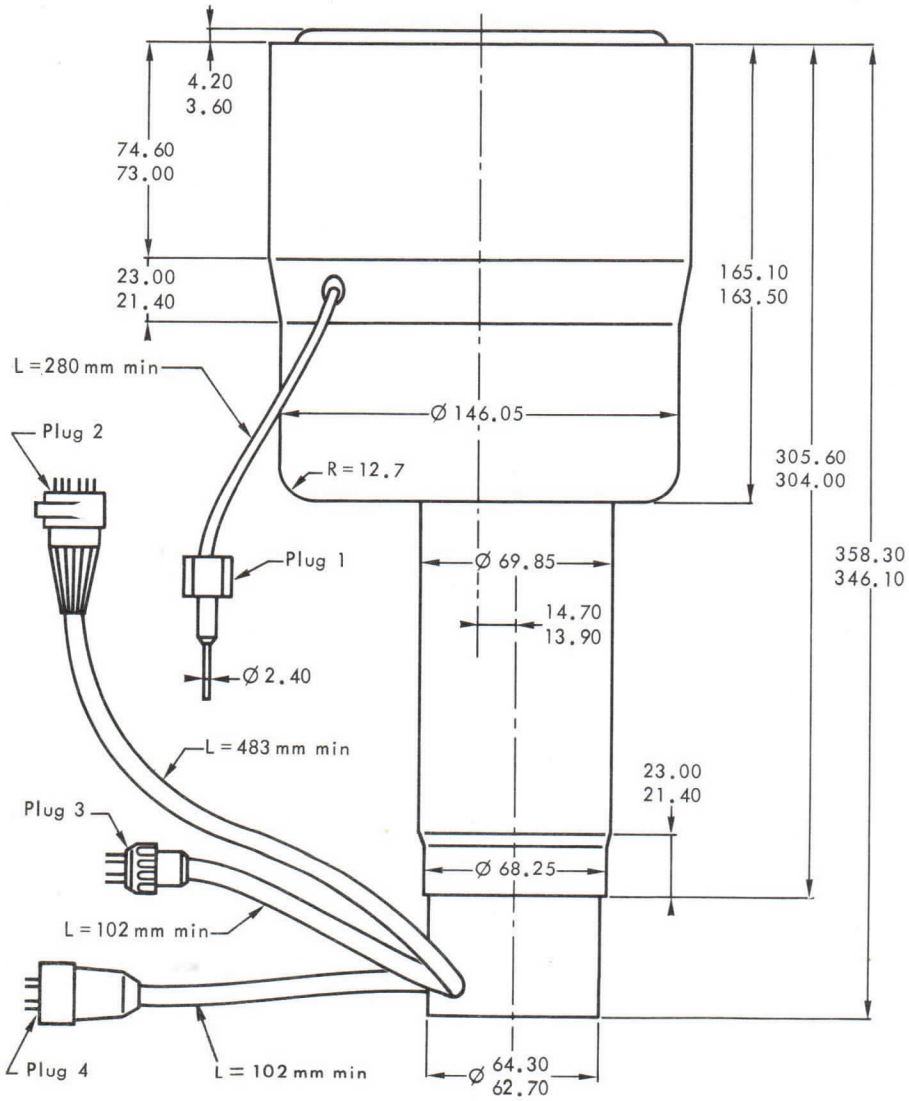
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING



PLUGS 2 and 4

PLUG 3



PLUGS IDENTIFICATION
Plug 1 :
g'7 Viewing screen
Plug 2 :
A : k' Flood gun cathode
B : g'6 Backing electrode
C : g'5 Collecting electrode
D : g'3 1st collimating electrode
E : g'4 2nd collimating electrode
F : g2 + g4 + g'2 Writing and flood guns accelerating electrodes
H : g'1 Flood gun control electrode
Plug 3 :
A : y2 Vertical deflection plate
B : y1 Vertical deflection plate
D : x2 Horizontal deflection plate
E : x1 Horizontal deflection plate
K : f' k' Flood gun heater and cathode
L : f' Flood gun heater
Plug 4 :
B : k Writing gun cathode
C : g1 Writing gun control electrode
D : g3 Writing gun focusing electrode
E : f Writing gun heater
F : f Writing gun heater

Dimensions in mm.

TEI 1187

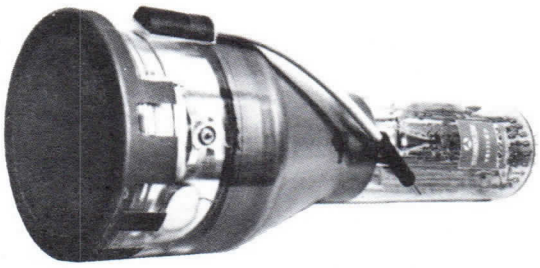
DARK FACE DIRECT VIEW STORAGE TUBE

The TEI 1187 is a direct view storage tube including two writing guns permitting simultaneous writing of two signals. Electrostatic focusing and deflection are utilized.

The tube has a dark face for contrast enhancement in high ambient light locations.

Performances include good resolution, bright and uniform display over the entire 102 mm (4") diameter screen. It is designed to provide brilliant displays of information ranging from transients to half-tone pictures.

The TEI 1187 is particulary suitable for such applications as airborne fire control radar, weather radar, transient studies and is recommended for applications where vibrations and low pressure conditions are encountered.



TYPICAL PERFORMANCES

Writing speed	min.	5	mm/μs
Written line width (200 cd/m2 light output)(note 1)		0.4	mm
Viewing time	min.	10	s
Erasing time	max.	0.5	s
Brightness (screen voltage = 10 kV)	min.	800	cd/m^2
		or 240	Ft. Lamberts
Contrast ratio (note 2)	min.	12	
Half-tone		5	

GENERAL CHARACTERISTICS

Electrical

Flood and writing guns :			
Heater voltage		6.3	V
Heater current		0.6	A
Writing guns			
Focusing method		Electrostatic	
Deflection method		Electrostatic	
Number of writing guns		2	
Interelectrode capacitance :			
Writing gun cathode k to all internal elements	max.	15	pF
Writing gun grid g1 to all internal elements	max.	15	pF
x1 to x2 (or D1 to D2)	max.	10	pF
y1 to y2 (or D3 to D4)	max.	10	pF

Optical

Phosphor :	
Type	P20 aluminized
Fluorescence	Yellow Green
Phosphorescence	Yellow Green
Dark face	Flat

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Mechanical

Minimum useful viewing diameter	102 mm (4")
Mounting position	any
Base	UTE 14/22A 35/54.5
Dimensions	see drawing
Weight (approx.)	1.3 kg (2.9 Lbs)

OPERATING CONDITIONS

Absolute ratings

Unless otherwise stated, voltages are given with respect to ground.

FLOOD GUN

Heater f' voltage	5.7 to 6.9	V
Cathode k' voltage	0	V
Grid g'1 voltage (control grid or Wehnelt)	0 to –200	V
Grid g'2 voltage (accelerating electrode) max.	200	V
Grid g'3 voltage (first collimating electrode) max.	200	V
Grid g'4 voltage (second collimating electrode) max.	300	V
Grid g'5 voltage (collecting electrode) max.	300	V
Grid g'6 voltage (backing electrode) max.	20	V
Viewing screen g'7 voltage max.	11	kV
Peak heater to cathode voltage	± 125	V

WRITING GUNS

Heater f voltage	5.7 to 6.9	V
Cathode k voltage (negative value) max.	2.7	kV
Grid g1 voltage (control grid or Wehnelt)(note 3)	0 to –200	V
Grids g2 and g4 voltage (accelerating electrodes)	Connected to g' 2	
Grid g3 voltage (focusing electrode) (note 3) max.	1.2	kV
Peak heater to cathode voltage	± 125	V

Typical operation

Unless otherwise stated, voltages are given with respect to ground.

FLOOD GUN

Cathode k' voltage		0	V
Grid g'1 voltage	adjust	0 to –150	V
Grid g'2 voltage		100	V
Grid g'3 voltage	adjust	20 to 40	V
Grid g'4 voltage	adjust	40 to 100	V
Grid g'5 voltage		210	V
Grid g'6 voltage		2	V
Viewing screen g'7 voltage		10	kV

WRITING GUNS

Cathode k voltage		–2	kV
Grid g1 voltage (max. for cut-off)(note 3)		–90	V
Grids g2 and g4 voltage		Connected to g' 2	
Grid g3 voltage (note 3) adjust.		400 to 600	V
Deflection factor			
horizontal		24 to 32	V/cm
vertical		16 to 24	V/cm

NOTES

1 - *Measured by shrinking raster method.*

2 - *Contrast ratio is defined as equilibrium brightness of a trace divided by background brightness, the viewing screen operating under 10. 000 lux illumination.*

3 - *With respect to writing gun cathode.*

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE

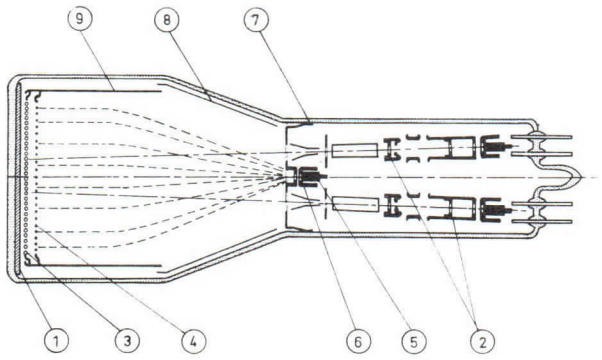
The TEI 1187 consists of four basic assemblies :

1 - The storage unit
the components of which are a collecting electrode and a fine metallic mesh called the backing electrode on which is deposited a dielectric material.

2 - The viewing screen
made of aluminized P 20 phosphor, provides the visual output.

3 - Two writing guns
located in the neck of the tube generate fast electrons. The high velocity beams scan the storage surface and create a charge pattern by secondary emission from the dielectric material.
Electrostatic focusing and deflection are employed.

4 - The flood gun
does not scan the screen but produces a wide angle low velocity electron beam which approaches the storage mesh normally and at a constant current density over the useful area owing to the collimation electrodes.



1 - Viewing screen
2 - Writing guns
3 - g'6 (backing electrode)
4 - g'5 (collecting electrode)
5 and 6 - Flood gun
7 - g'2 (accelerating electrode)
8 - g'3 (1st collimating electrode)
9 - g'4 (2nd collimating electrode)

In the unwritten state, the dielectric surface of the backing electrode is negatively charged and the low energy flood electrons issued from the flood gun are repelled back to the collecting electrode.

In writing operation, the writing guns scan the storage surface and create positive charges pattern by secondary emission of the dielectric material, the secondary electrons being attracted to the collecting electrode.

Low velocity electrons from the flood gun approach the storage surface normally and flood the entire useful area. They penetrate through the backing electrode in area where pattern has been written and are then accelerated to the viewing screen where they produce a corresponding picture on the phosphor.

Since the number of electrons passing through the backing electrode is determined by the amount of written charges, intermediate gray shades may be reproduced.

The image can be erased by applying a short positive pulse to the backing electrode. The display decay may be controlled by varying duration, amplitude and rate of continuous series of positive pulses.

OPERATIONAL RECOMMENDATIONS

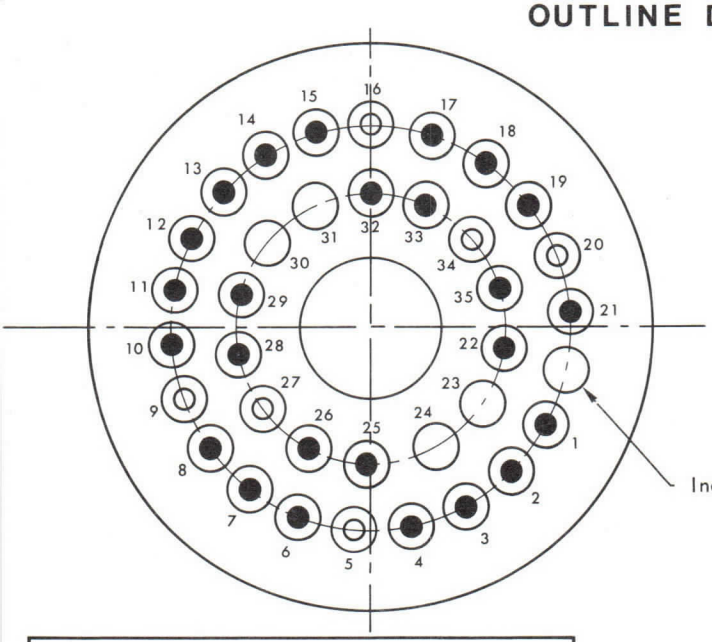
1 - The writing guns can not be allowed to write continuously without appropriate erasure otherwise the storage surface may be damaged.

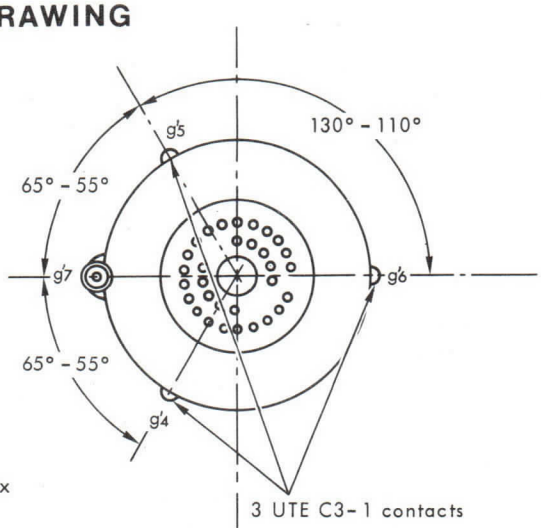
2 - Magnetic shield is necessary to prevent stray magnetic fields altering the trajectories of low velocity flood beam.

3 - The tube should be handled screen upwards to avoid particles falling on the storage elements.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING

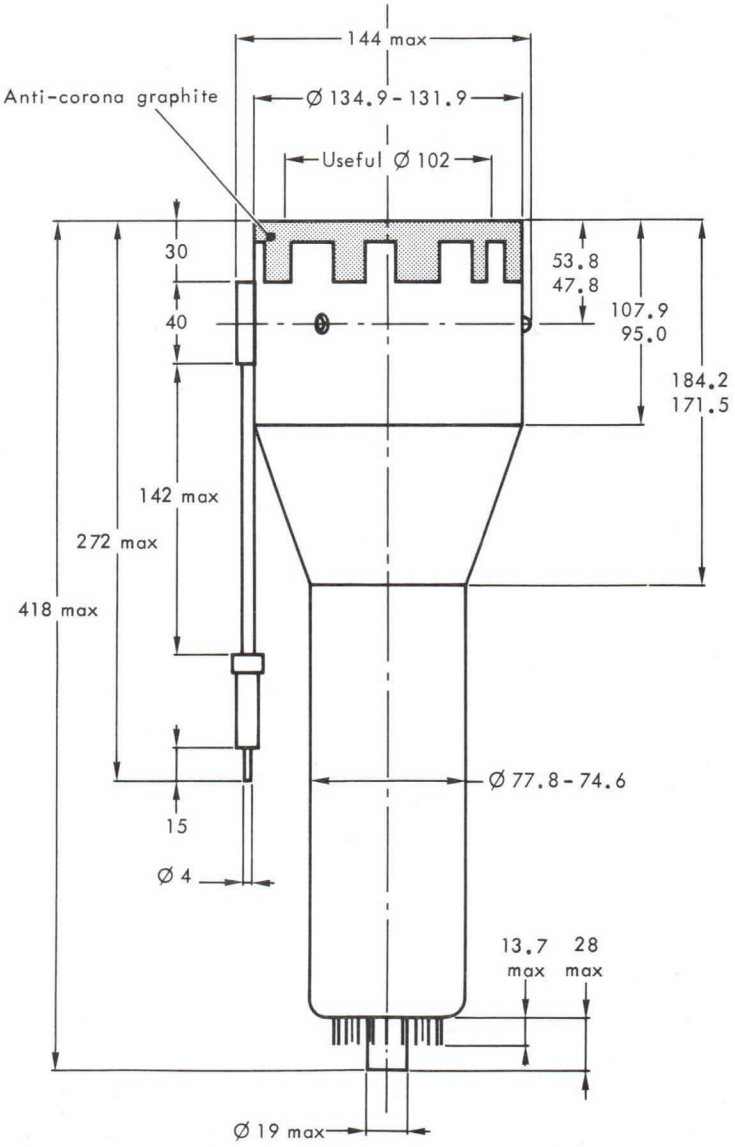




BASING DIAGRAM

-	-	Index
1	f'	Flood gun heater
2	k'	Flood gun cathode
3	x1	Horizontal deflection plate (a)
4	x2	Horizontal deflection plate (a)
5	-	No connection
6	g3	Writing gun focusing electrode (a)
7	g1	Writing gun control electrode (a)
8	f	Writing gun heater (a)
9	-	No connection
10	y1	Vertical deflection plate (a)
11	g2+g4+g'2	Writing and flood guns accelerating electrodes
12	g'3	1st collimating electrode
13	-	Internal connection
14	x1	Horizontal deflection plate (b)
15	x2	Horizontal deflection plate (b)
16	-	No connection
17	g3	Writing gun focusing electrode (b)
18	g1	Writing gun control electrode (b)
19	f	Writing gun heater (b)
20	-	No connection
21	y1	Vertical deflection plate (b)
22	f'	Flood gun heater
23	-	No pin
24	-	No pin
25	k	Writing gun cathode (a)
26	f	Writing gun heater (a)
27	-	No connection
28	y2	Vertical deflection plate (a)
29	g'1	Flood gun control electrode
30	-	No pin
31	-	No pin
32	k	Writing gun cathode (b)
33	f	Writing gun heater (b)
34	-	No connection
35	y2	Vertical deflection plate (b)

Note : References (a) and (b) indentify constitutive elements of each writing gun.



Dimensions in mm.

TME 1238
1" NON DESTRUCTIVE READ-OUT STORAGE TUBE

The TME 1238 is a low cost, single-ended, high resolution, non destructive read out storage tube capable of storing and reading-out information in the form of electrical signals. Continuous read-out can be achieved for a few minutes without degradation of the stored-information.

The tube features fast writing and erasing, high resolving power, large storage and integration capability and selective erasure possibility. When gradual erasure of the stored information is necessary, it is possible to erase during line or image retrace in order to obtain the desired decay.

These characteristics make it particularly suitable for numerous applications such as : slow scan T.V., data recording and storage, scan conversion, integration of low level video signals... In addition, the tube is specially designed for applications where precise write-read registration is required.

Owing to its structure and electronoptics similar to those of 1" Vidicon, the TME 1238 can use supplies, focusing and deflecting coils designed for this Vidicon type.

TYPICAL PERFORMANCES

Peak output current	0. 2	μA
Writing time :		
writing over the whole target area	40	ms (1 T.V. frame)
writing of one target diameter	50	μs
Erasing time :		
erasing of the whole written image to residual less than 10 %	40	ms (1 T.V. frame)
Storage time :		
several days without reading		
Reading time :		
for continuous read-out	5 to 10	mn
Decay :		
by line retrace erasure, adjustable	from 1s to 10	mn
Resolution :		
by orthogonal writing and reading at 50 % modulation. . .	800	T.V. lines per diameter

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

GENERAL CHARACTERISTICS

Electrical

Heater voltage	6.3 V
Heater current	0.6 A
Output capacitance	5 pF
Focusing method	electromagnetic
Deflecting method	electromagnetic

Mechanical

Base	JEDEC E8 - 11
Operating position	any
Weight, approx.	100 g
Dimensions	see drawing

TYPICAL OPERATING CONDITIONS

Voltages listed hereunder are typical values. They may have to be modified according to values given in the Operating Data Sheet accompanying each tube.

Heater voltage	6.3 ± 10 %	V
Heater current	0.6	A

	Erase mode	Write mode	Read mode	
Cathode voltage	0	0	0	V
Grid G1 (Wehnelt) voltage	0	to be adjusted	to be adjusted	
Cut-off voltage : − 50 V to − 100 V				
Grid G2 (accelerator) voltage	450	450	450	V
Grid G3 (erasing) voltage	normal fast			
	450 0 to −30	450	450	V
Grid G4 (focus) voltage	450	440	450	V
		to be adjusted		
Grid G5 (decelerator) voltage	650	650	650	V
Target voltage	15 to 30	200	3 to 10	V

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE

The main components of the tube are an electron gun and a storage target assembly.

The electron gun includes an additional erasing electrode which enables two erasing modes depending on low or high beam current.

The target is made of a storage backplate on which the storage dielectric is deposited.

A general cross-view of the tube is given on fig. 1 and magnified view of the target on fig. 2.

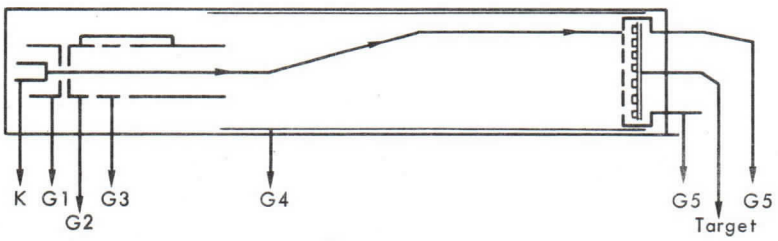


Figure 1

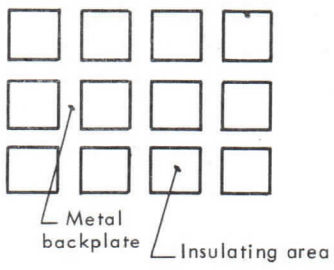


Figure 2

The principle of operation is the charge or discharge of the storage surface, according to the velocity of the primary electron beam through secondary emission of the storage surface.

Typical values (with respect to cathode) in erasing, writing and reading modes are given on fig. 3 as an example of operating conditions.

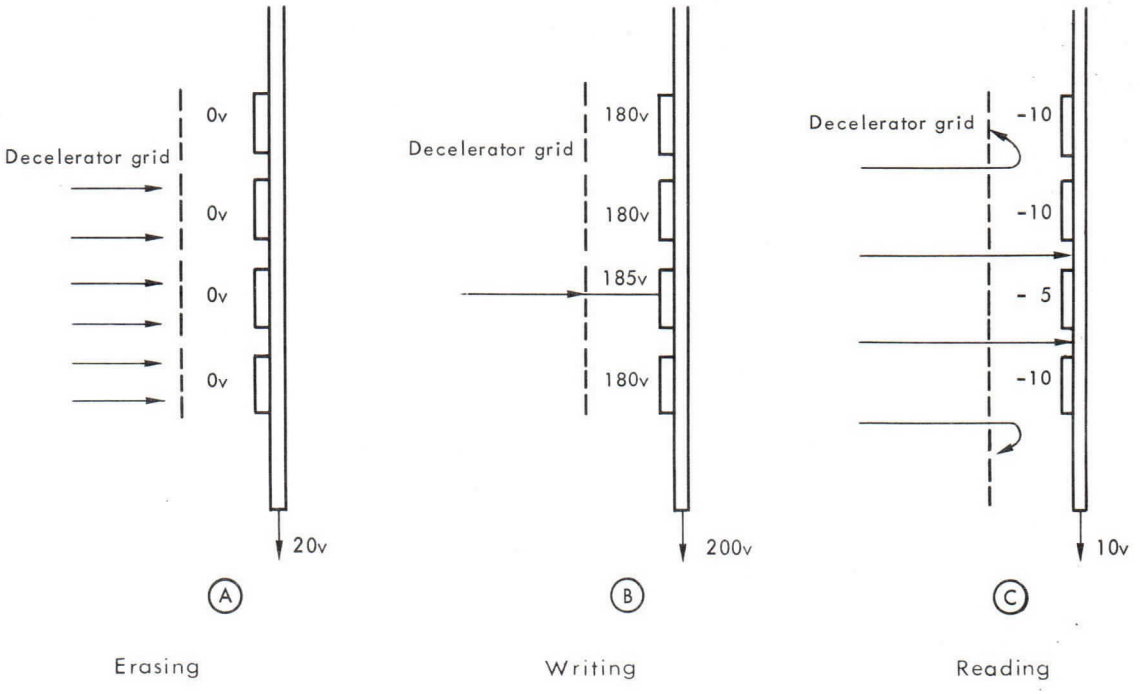


Figure 3

A - ERASE-PRIME

It is necessary to erase residual charges at the storage surface prior to writing. Erasure can be done by shifting the backplate voltage to 20 V. The capacitive coupling and the low energy electron beam cause the dielectric to be charged down to OV through secondary emission ratio less than 1.

B - WRITE

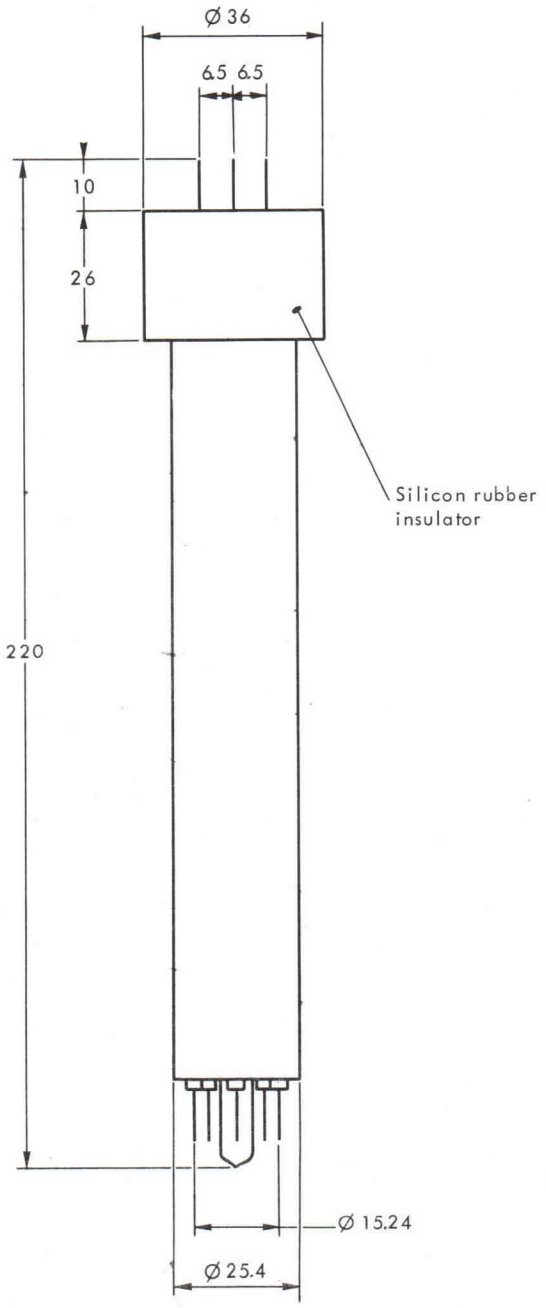
Storage backplate voltage is shifted to +200 V. Storage surface voltage is shifted to 180 V by capacitive coupling. When the electron beam modulated by the video input signal scans the storage surface, secondary emission ratio is then greater than 1 and positive charges are deposited on the dielectric areas, shifting their potential from 180 V to a few volts more positive values (185 V for example).

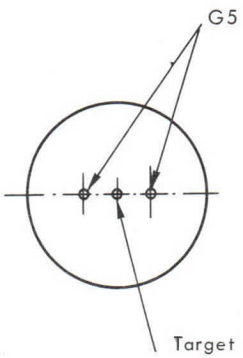
C - READ

Once the charge pattern has been written it can be read out by dropping the storage backplate voltage from 200 V to 10 V and by scanning it with an unmodulated beam. Depending on the written charge pattern the storage surface voltage varies within OV and − 10 V and signal output varies in exact correspondance. Since the storage surface voltages are negative with respect to gun cathode voltage, the reading beam has no adverse effect on the pattern and the read-out is non destructive. On the other hand, the most negative areas of the dielectric can completely cut off the electron beam while various gray shades can be obtained in areas where the dielectric is less negative.

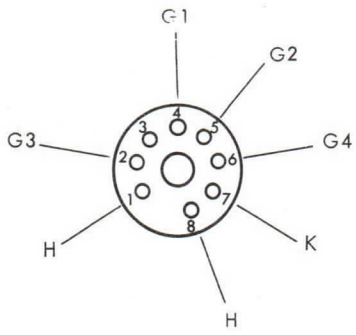
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING





Base JEDEC E8-11



Dimensions in mm

TME 1238A
1" RECORDING STORAGE TUBE

- HIGH RESOLUTION (limiting resolution : 2000 TV lines/diameter)
- SINGLE-ENDED, ELECTROMAGNETIC FOCUS AND DEFLECTION
- NON-DESTRUCTIVE READOUT
- FAST-ERASING (1 TV frame)
- GRAY-SCALE CAPABILITY

The TME 1238A is a low-cost, single-ended, high resolution, non-destructive readout storage tube capable of storing and reading-out information in the form of electrical signals. It is fully interchangeable with the previous TME 1238 in all its applications.

As compared with the latter, it offers a significant increase in resolution under the same operating conditions. In the orthogonal read-write mode, the resolution at 50 % modulation reaches 1100 TV lines/diameter (instead of 800). Up to 1400 TV lines/diameter at 50 % modulation are obtained in a higher voltage mode. The low voltage mode is to be used in applications where uniformity and low consumption are predominant while the high voltage mode is to be chosen when maximum resolution is of prime importance.

Continuous readout can be achieved for a few minutes without degradation of the stored information. The tube features fast writing and erasing, large storage and integration capability and selective erasure possibility. When gradual erasure of the stored information is required, it is possible to erase during line or image retrace in order to obtain the desired decay.

All these characteristics make the TME 1238A particularly suitable for numerous applications such as : T.V. frame-freeze, slow-scan T.V., data recording and storage, scan conversion, integration of low level video signals, accurate write-read registration.

Owing to its structure and electronoptics similar to 1" Vidicon, the TME 1238A can use supplies and coil assemblies designed for this Vidicon type.

To achieve the best performances of the tube, the user is advised to refer to the "Operating Instructions" given in the relevant Data Sheet TEV 3140.

The TME 1238A can be implemented in the TH 7501 Storage Unit manufactured by THOMSON-CSF. and described in Data TEV 3204.

TYPICAL PERFORMANCES

Peak output current	0.2 μA
Writing time :	
- writing over the whole target area	33 - 40 ms (1 T.V. frame)
- writing of one target diameter	50 μs
Erasing time :	
- erasing of the whole written image to residual less than 5 %	33 - 40 ms (1 T.V. frame)
- selective erasing of one target diameter	300 μs
Decay by line retrace erasure	adjustable from 1 s to 10 mn
Reading time for continuous readout	5 to 10 mn
Storage time without readout	several days
Center resolution by orthogonal writing and reading at 50 % modulation (See Figure 1)	normal voltage mode 1100 T.V. lines/diameter high voltage mode 1400 T.V. lines/diameter

GENERAL CHARACTERISTICS

Electrical

Heater voltage	6.3	V
Heater current	0.6	A
Output capacitance (target to all other electrodes)	7	pF
Input capacitance (grid g1 to all other electrodes)	10	pF
Focusing method	electromagnetic	
Deflecting method	electromagnetic	
Coil assembly (focus - deflection - alignment)* or equivalent	TH 7200 or TH 7203 (GERHARD BV-200-1 A, or CLEVELAND VY, or CELCO BV-232)	

* In any case permanent ring magnet sometimes delivered with vidicon coil assembly must be removed.

Mechanical

Base	UTE 9 C 15, (JEDEC E8 - 11)
Operating position	any
Weight, approx.	100 g
Dimensions	see drawing

MAXIMUM RATINGS

(absolute values)

Unless otherwise stated, voltages are given with respect to cathode potential.

Grid g5 voltage	1200	V
Grid g4 voltage	800	V
Grid g3 voltage	800	V
Grid g2 voltage	800	V
Grid g1 voltage :		
- negative bias value	−180	V
- positive bias value	0	V
Peak heater cathode voltage :		
- heater negative with respect to cathode	−150	V
- heater positive with respect to cathode	+150	V
Target voltage	1200	V

TYPICAL OPERATIONS

Unless otherwise stated, voltages are given with respect to cathode potential.

Heater voltage	6.3 ± 10 %	V
Heater current	0.6	A

Normal voltage mode

	Erase mode	Write mode	Read mode	
Cathode voltage	0	0	0	V
Grid g1 (wehnelt) voltage	0	to be adjusted	to be adjusted	V
- cut-off voltage : −50 V to −100 V				
Grid g2 (accelerator) voltage	450	450	450	V
Grid g3 (erasing) voltage	normal / fast			
	450 / 0 to −30	450	450	V
Grid g4 (focus) voltage*	350 to 450	350 to 450	350 to 450	V
Grid g5 (decelerator) voltage	650	650	650	V
Target voltage	10 to 30	200	3 to 10	V
Resolution (Figure 1)			curve 1	

High voltage mode

	Erase mode	Write mode	Read mode	
Cathode voltage	0	0	0	V
Grid g1 (wehnelt) voltage	0	to be adjusted	to be adjusted	V
- cut-off voltage : −75 V to −150 V				
Grid g2 (accelerator) voltage	700	700	700	V
Grid g3 (erasing) voltage	normal / fast			
	700 / 0 to −30	700	700	V
Grid g4 (focus) voltage*	550 to 700	550 to 700	550 to 700	V
Grid g5 (decelerator) voltage	1000	1000	1000	V
Target voltage	10 to 30	200	3 to 10	V
Resolution (Figure 1)			curve 2	

* These values can vary depending on the type of coil assembly used. To obtain the best resolution, a slight correction of grid g4 potential (about −10 V) is needed in writing mode.

For best operation of readout preamplifier it is recommended to connect a by-pass capacitor between g4 and ground (for example 0.1 μF) on g4 pin located in front of the tube.

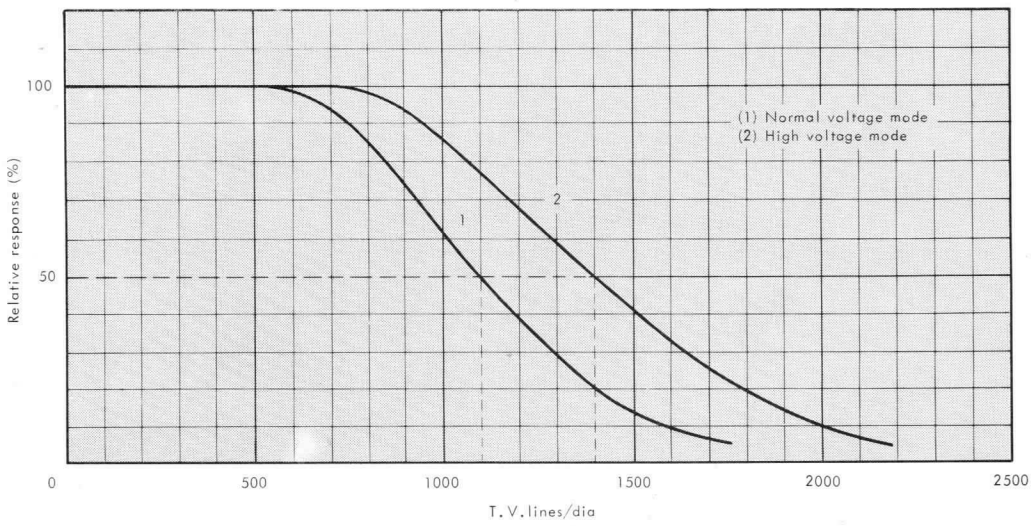


Figure 1 - Resolution characteristics

The above curves give the modulation measured by orthogonal read/write method. In practice, the values of resolution at 10 % modulation in sinusoidal writing and colinear reading (M.T.F.) is about 1.1 times the values of resolution at 50 % modulation in orthogonal writing and reading.

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE**

The main components of the tube are an electron gun and a storage target assembly.
The electron gun includes an additional erasing electrode which enables two erasing modes, normal or fast, depending on low or high beam current.
The target is made of a storage backplate on which the storage dielectric is deposited.
A general cross-view of the tube is given on fig. 2 and magnified view of the target on fig. 3.

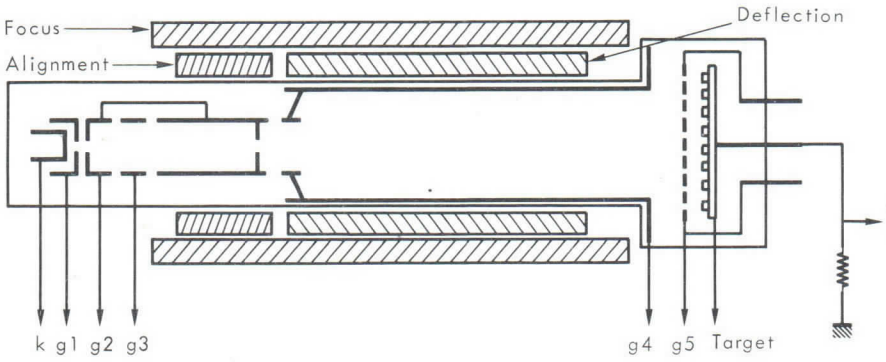


Figure 2

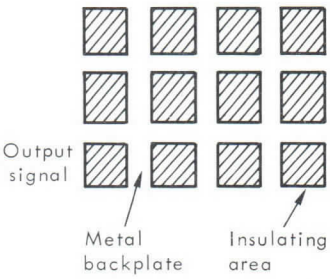


Figure 3

The principle of operation is the charge and discharge of the storage surface, according to the velocity of the primary electron beam through secondary emission of the storage surface.
Typical values (with respect to cathode) in erasing, writing and reading are given in fig. 4 as an example of operating conditions.

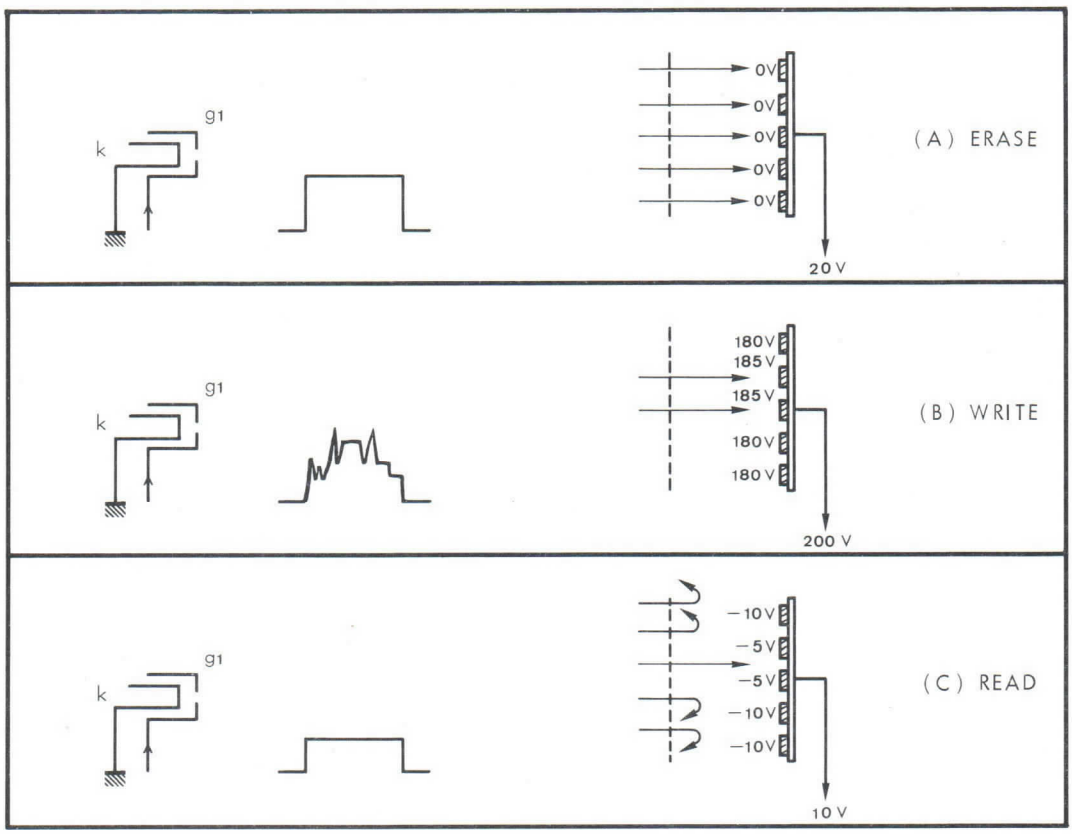


Figure 4

** Detailed considerations about "Recording Storage Tubes" principles and operations are given in the Technical Information DATA TEV 6013 which we ask the user to refer to.

A - ERASE-PRIME

It is necessary to erase residual charges at the storage surface prior to writing. Erasure can be done by shifting the backplate voltage to 20 V. The capacitive coupling and the low energy electron beam cause the dielectric to be charged down to 0 V through secondary emission ratio less than 1.

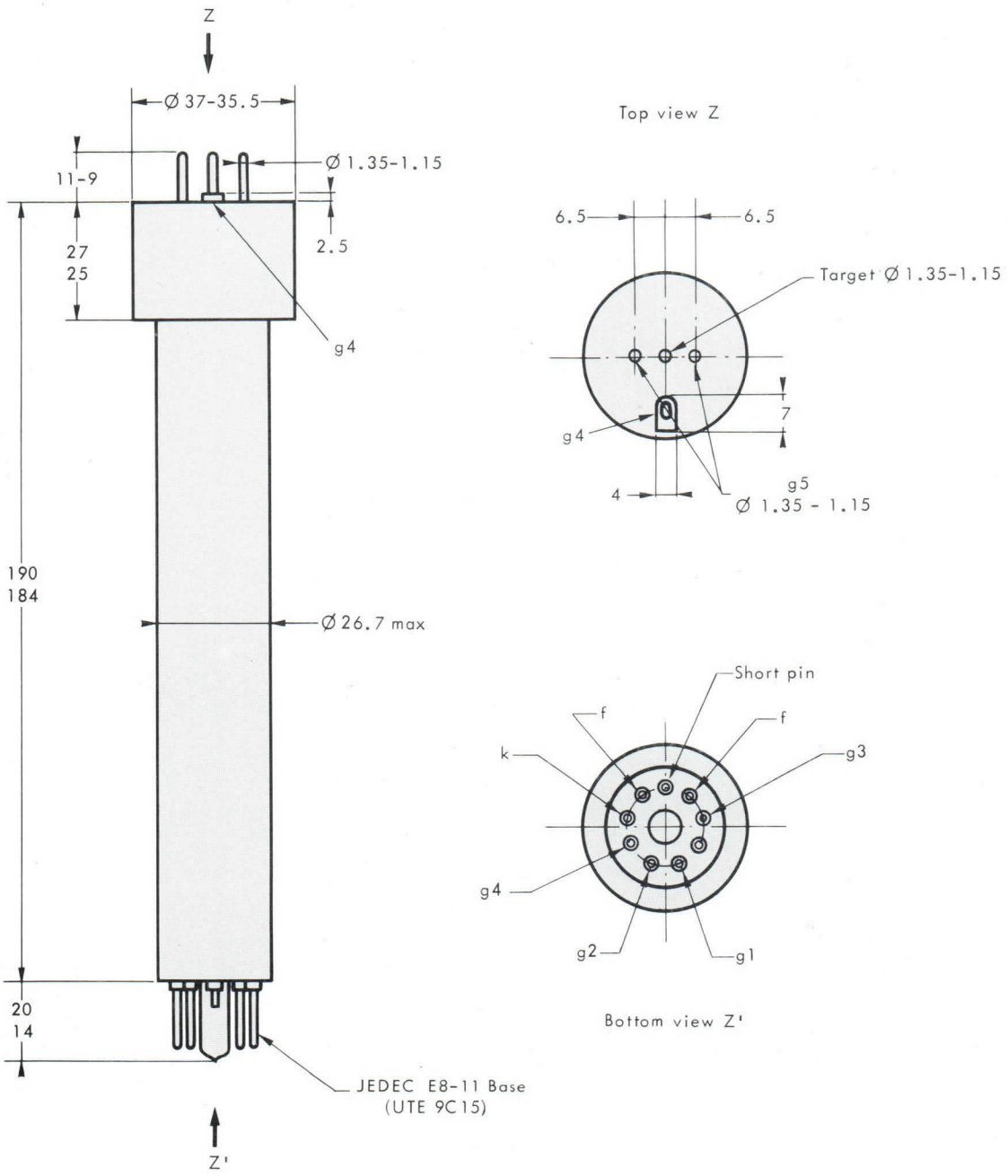
B - WRITE

Storage backplate voltage is shifted to + 200 V. Storage surface voltage is shifted to 180 V by capacitive coupling. When the electron beam modulated by the video input signal scans the storage surface, secondary emission ratio is then greater than 1 and positive charges are deposited on the dielectric areas, shifting their potential from 180 V to a few volts more positive values (185 V for example).

C - READ

Once the charge pattern has been written it can be readout by dropping the storage backplate voltage from 200 V to 10 V and by scanning it with an unmodulated beam. Depending on the written charge pattern the storage surface voltage varies between 0 V and − 10 V and signal output varies in exact correspondance. The most negative areas of the dielectric can completely cut-off the electron beam while various gray shades can be obtained in areas where the dielectric is less negative. Since the storage surface voltages are negative with respect to gun cathode voltage the reading beam has no adverse effect on the pattern and the readout is non destructive.

OUTLINE DRAWING



Dimensions in mm.

TME 1239
1 1/2 " NON DESTRUCTIVE READ-OUT STORAGE TUBE

The TME 1239 is a low cost, single-ended, high resolution, non destructive read out storage tube capable of storing and reading-out information in the form of electrical signals. Continuous read-out can be achieved for a few minutes without degradation of the stored-information.

This tube features fast writing and erasing, high resolving power, large storage and integration capability and selective erasure possibility. When gradual erasure of the stored information is necessary, it is possible to erase during line or image retrace in order to obtain the desired decay.

These characteristics make it particularly suitable for numerous applications such as : slow scan T.V., data recording and storage, scan conversion, integration of low level video signals.... In addition, the tube is specially designed for applications where precise write-read registration is required.

Owing to its structure and electronoptics similar to those of 1 1/2" Vidicon, the TME 1239 can use supplies, focusing and deflecting coils designed for this Vidicon type.

TYPICAL PERFORMANCES

Peak output current	0.2	µA
Writing time :		
writing over the whole target area	40	ms (1 T.V. frame)
writing of one target diameter	50	µs
Erasing time :		
erasing of the whole written image to residual less than 10 %	40	ms (1 T.V. frame)
Storage time :		
several days without reading		
Reading time :		
for continuous read-out	10 to 15	mn
Decay :		
by line retrace erasure, adjustable	from 1 s to 15	mn
Resolution :		
by orthogonal writing and reading at 50 % modulation	1200	T.V. lines per diameter

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

GENERAL CHARACTERISTICS

Electrical

Heater voltage	6.3	V
Heater current	0.6	A
Output capacitance	10	pF
Focusing method	electromagnetic	
Deflecting method	electromagnetic	

Mechanical

Base	JEDEC E8 - 11
Operating position	any
Weight, approx.	200 g
Dimensions	see drawing

TYPICAL OPERATING CONDITIONS

Voltages listed hereunder are typical values. They may have to be modified according to values given in the Operating Data Sheet accompanying each tube.

Heater voltage	6.3 ± 10%	V
Heater current	0.6	A

	Erase mode	Write mode	Read mode	
Cathode voltage	0	0	0	V
Grid G1 (Wehnelt) voltage	0	to be adjusted	to be adjusted	
Cut-off voltage : −50 V to −100 V				
Grid G2 (accelerator) voltage	450	450	450	V
Grid G3 (erasing) voltage	normal 450 / fast 0 to −30	450	450	V
Grid G4 (focus) voltage	450	440 to be adjusted	450	V
Grid G5 (decelerator) voltage	750	750	750	V
Target voltage	15 to 30	200	3 to 10	V

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE

The main components of the tube are an electron gun and a storage target assembly.

The electron gun includes an additional erasing electrode which enables two erasing modes depending on low or high beam current.

The target is made of a storage backplate on which the storage dielectric is deposited.

A general cross-view of the tube is given on fig. 1 and magnified view of the target on fig. 2.

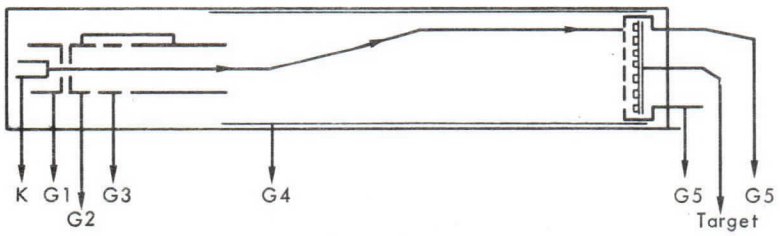


Figure 1

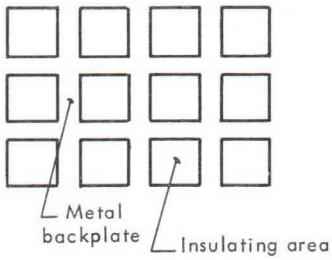


Figure 2

The principle of operation is the charge or discharge of the storage surface, according to the velocity of the primary electron beam through secondary emission of the storage surface.

Typical values (with respect to cathode) in erasing, writing and reading modes are given on fig. 3 as an example of operating conditions.

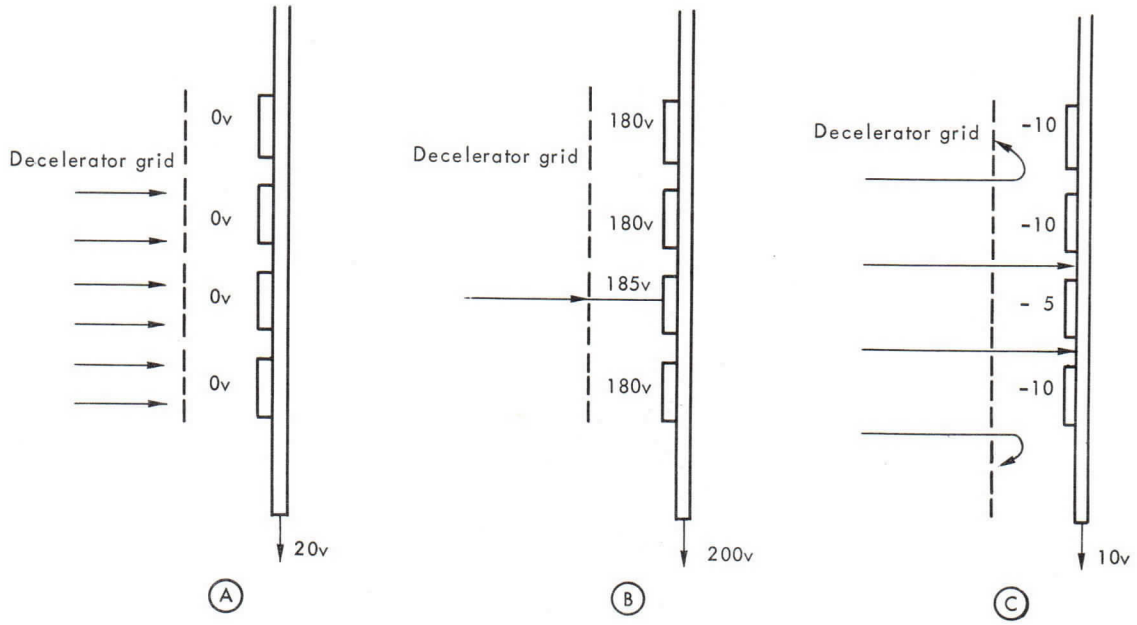


Figure 3

A - ERASE-PRIME

It is necessary to erase residual charges at the storage surface prior to writing. Erasure can be done by shifting the backplate voltage to 20 V. The capacitive coupling and the low energy electron beam cause the dielectric to be charged down to OV through secondary emission ratio less than 1.

B - WRITE

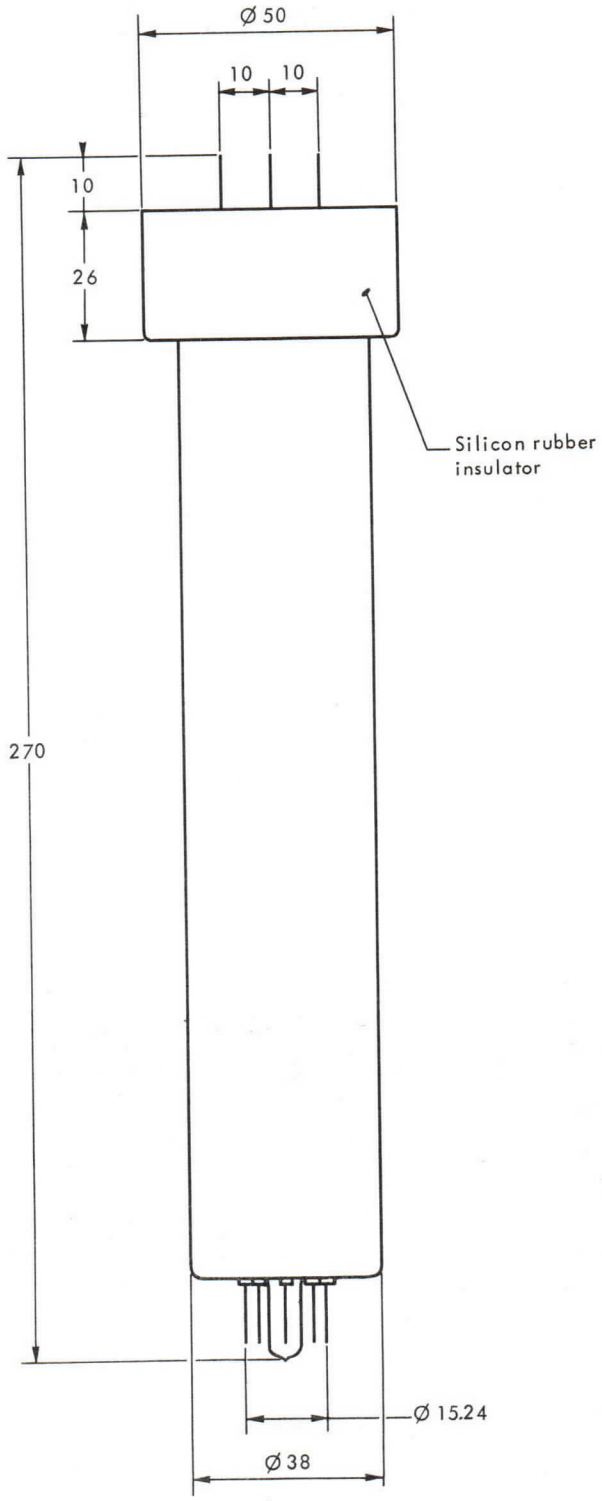
Storage backplate voltage is shifted to +200 V. Storage surface voltage is shifted to 180 V by capacitive coupling. When the electron beam modulated by the video input signal scans the storage surface, secondary emission ratio is then greater than 1 and positive charges are deposited on the dielectric areas, shifting their potential from 180 V to a few volts more positive values (185 V for example).

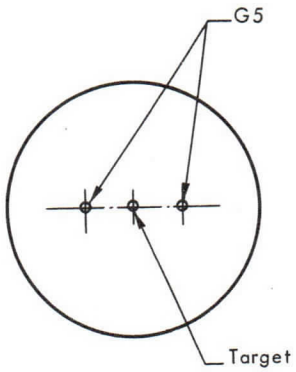
C - READ

Once the charge pattern has been written it can be read out by dropping the storage backplate voltage from 200 V to 10 V and by scanning it with an unmodulated beam. Depending on the written charge pattern the storage surface voltage varies within OV and – 10 V and signal output varies in exact correspondance. Since the storage surface voltages are negative with respect to gun cathode voltage, the reading beam has no adverse effect on the pattern and the read-out is non destructive. On the other hand, the most negative areas of the dielectric can completely cut off the electron beam while various gray shades can be obtained in areas where the dielectric is less negative.

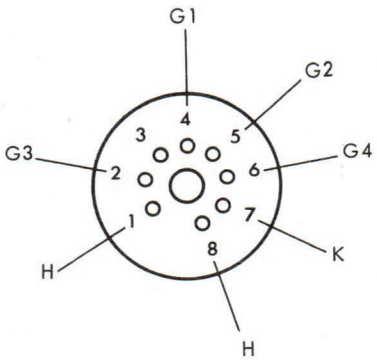
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING





Base JEDEC E8-11



Dimensions in mm

PRESENTATION OF A NEW FAMILY OF STORAGE TUBES

TME 1238 - TME 1239

B. COURTAN

THOMSON-CSF

Groupement Tubes Electroniques

38 - St-Egrève - France

This paper was presented in French at the

XXth AGARD AVIONIC PANEL TECHNICAL SYMPOSIUM

ON

DATA HANDLING DEVICES

ISTANBUL - June 2, 1970

PRESENTATION OF A NEW FAMILY OF STORAGE TUBES

TME 1238 - TME 1239

B. COURTAN
THOMSON - CSF
Groupement Tubes Electroniques
38 - St-EGREVE - FRANCE

1 - INTRODUCTION

In numerous applications where it is necessary to store information, the storage tube offers an ideal solution, because of the high speed access capability of the electron beam and because of the excellent ratio between quantity of stored information and related systems size.

There are potentially large requirements for systems utilizing storage tubes if the following conditions can be met :

- Simple systems operation
- Low price
- Small size
- Long tube life

Until now, these criteria could not be met by existing storage tubes.

The new family of TME's just developed by THOMSON-CSF meet requirements set forth above, that is they are simple to operate, rugged, inexpensively priced and long lived. They can also be used in a broad range of applications.

Storage tubes can be classified in a variety of ways depending upon their principle of operation, the display mode and/or the internal geometry. The TME type features the following :

- Electrical input - electrical output :

Information input is an electrical signal and information output is also an electrical signal, either identical but shifted in time, or processed according to a predetermined function.

- Single gun :

The various functions of storage (writing, reading, erasing and rewriting) are sequential because of the single gun geometry. This limitation is however seldom a problem, and it offers a considerable reduction in the price of the overall system. It should be noted that for applications where simultaneous writing and reading are necessary, it is often possible to design a lower cost systems by using two single-ended tubes instead of one of the double-ended type.

- Non-destructive reading :

The reading function of the TME's is normally non-destructive, however where required, it is possible to operate them in a destructive read-out mode.

2 - DESCRIPTION

2.1 General

Figure 1 shows the exterior of the tubes. Their size is comparable to standard vidicons (1" for the TME 1238 and 1.5" for the TME 1239). Focusing and deflection are magnectic and they use standard vidicon hardware. The pin configuration is also similar to a vidicon.
Furthermore, the capacitance of the output signal electrode is such that it allows for the use of

vidicon-type preamplifiers. Thus, the associated electronics are quite similar to those used widely and inexpensively for vidicons.

2.2 Internal construction

Figure 2 shows the inside geometry of the TME's. Essentially, they include an electron gun and a storage target.

2.2.1 Electron gun

The electron gun consists of a cathode, a control grid G1, an acceleration electrode G2, a so-called erasing electrode G3 (the operation of which is explained later), a focusing electrode G4 and a field mesh G5. This 20 to 40 wire/mm field mesh is located in very close proximity to the storage target.

2.2.2 Storage target

The target is made of a silicon structured wafer, manufactured by integrated circuit technology.

This structure offers significant advantages in terms of simplicity and ruggedness and has none of the disadvantages of the more standard storage tube, using a grid as the storage element. In addition to its insensitivity to vibrations, the TME is also unaffected by temperature variations which makes it highly suitable for airborne and shipborne environments.

3 - OPERATING PRINCIPLES

3.1 General

If a target is bombarded by electrons, two possibilities may arise. Either the electron energy is small, in which case the surface of the insulated target will become negatively charged because the secondary emission coefficient is lower than one, or the energy of the impinging electrons is higher, and then the surface of the target will become positively charged because the secondary emission is greater than one. Typically, the cross-over voltage at which the secondary emission coefficient changes from a value lower than one to a value greater than one is in the order of a few tens of volts.

3.2 Operation of the TME

For both the TME 1238 and TME 1239, the cathode is kept at ground potential and the target voltage is adjusted to change from operation with a secondary emission coefficient lower than one to a coefficient greater than one.

The input signal, corresponding to the information to be stored, is applied to the Wehnelt grid G1.

After magnetic focus and deflection, the electron beam is collimated so that the electron trajectories are perpendicular to the surface of the target.

The metal back-plate of the target is used as the output signal electrode.

Figure 4 shows the operation of the tube for the following modes :

3.2.1 Erasing (Figure 4 a)

In this mode, a constant-current electron beam scans the target uniformly, for instance according to a TV standard.

The cathode is grounded and the target is placed at a voltage lower than the cross-over value previously mentioned, for instance at 15 Volts. The secondary emission coefficient being lower than one, the target becomes negatively charged and the potential of its surface goes down to a level which is approximately the cathode potential, value below which no further electron reaches the target.

3.2.2 Writing (Figure 4 b)

The voltage of the target back-plate is raised from 15 V to 200 V. This increase of 185 Volts is capacitively transmitted to the surface of the target and causes the secondary emission coefficient to become greater than one. Positive charges are therefore deposited on the target when the electron beam scans it, and the potential of each point of the surface becomes dependent upon the intensity of the writing electrom beam which impinges on it. For instance, after a writing sequence the potential of certain "strongly written" points will be at 190 V and the "non-written" points will have stayed at the 185 V level. Thus, it can be seen that the target potential reproduces faithfully the signal to be stored.

3.2.3 Reading (Figure 4 c)

The potential of the metal target back-plate is now lowered to 5 V, which represents a decrease of 195 V with respect to the writing level. This decrease is again transmitted capacitively to the insulating surface of the target. The "strongly written" points are now at the 0 V level, the "less strongly written" points are at -5 Volts and the "non-written" points are at -10 Volts. A constant-current reading beam which can be of any scanning standard will therefore be locally modulated by the potential of the area it impinges upon. In areas where the potential is -10 Volts (non written points) the electrons will be repelled by the target and subsequently captured by the G5 grid. In the "strongly written" areas where the potential is 0 Volt, a large number of electrons will reach the metal back-plate which is, as noted earlier, at +5 V potential. In intermediate cases ("less strongly written" points) certain electrons will be repelled by the target and captured by the G5 grid, and only part of the reading electron beam will reach the back-plate.

It can be seen that the current reaching the back-plate will faithfully reproduce the stored information. In fact, the insulating surface of the target acts upon the reading beam as the grid of a conventional triode.

The output signal current develops a proportionate voltage through a load resistance, voltage which after amplification is applied to a standard display tube (TV monitor or other) where the stored image is displayed.

It is important to note that the scanning of the target by the reading beam has not modified the electrostatic image deposited on the target during the writing mode, since the potential of the insulating surface is always lower than 0 Volt and, therefore, cannot be reached by any electrons. Successive readings will then generate identical signals, which gives the TME its so-called non-destructive readout characteristics.

It can also be noted that the electrons of the constant-current reading beam which do not reach the target are captured by the G5 grid. The signal on G5 is therefore complementary of the target signal. For certain applications, it can be of interest to use this particularity of operation and pick-up the output signal current from the G5 grid which is always at a fixed potential instead of picking it up from the target, the potential of which varies during the various cycles of operation.

3.2.4. Retention time

The retention time, as noted earlier, is theoretically infinite. In practice, it is limited by two different phenomena :

- progressive discharge of the dielectric target because of inherent dielectric leakage current. Considering that the dielectric used for the target is of high quality and its thickness is large in comparison to the low voltage existing between the surface of the target and the back-plate, this phenomenon has usually a negligible effect upon the retention time.

- creation of ions by the reading beam :
Vacuum is not perfect inside the tube, and the electrons of the reading beam ionize some molecules of residual gas. The positive ions created in the G5 grid-target space are attracted by the negatively charged areas of the dielectric surface and progressively neutralize the electrostatically stored information. We will see later how this factor limits the retention time.

3.2.5 Fast erasing

Erasing time is a function, on one hand, of the capacitance of the storage dielectric target, and on the other hand, of the intensity of the erasing beam. Electrode G3 permits increasing the erasing current in large proportion, when fast erasing is required.

In the reading mode, electrode G3 is at the potential of the acceleration electrode G2 and has no effect on the beam ; the diaphragm is therefore fully efficient and only a low-current fine spot size beam emerges from the electron gun. For fast erasing, the G3 electrode potential is modified in such a way that all the current is focused on the diaphragm. The latter is therefore not effective anymore and the beam current emerging from the gun is increased by a factor ranging from 10 to 30, thereby achieving a fast erasing.

4 - PERFORMANCES

4.1. Performances of the TME 1238 and TME 1239 are as follows :

	TME 1238	TME 1239
Writing speed		
- for the overall target area	33 ms	33 ms
- for one target diameter	50 μs	50 μs
Storage time with reading beam turned-off	several weeks	several weeks
Output signal current for performance as follows:	200 nA	200 nA
Output capacitance	5 pF	5 pF
Resolution measured by the orthogonal read-write technique at a 50 % relative response.	800 TV lines per diameter	1200 TV lines per diameter
Gray scale :		
- Number of half-tone levels.	10	10
Retention time with constant reading :		
- for a gray scale image	5 mn min.	10 mn min.
- for a black and white image	10 mn min.	15 mn min.
Erasing time :		
- fast erasing, by switching of the erasing electrode, down to noise level	33 ms	33 ms
- normal erasing, with no switching of the erasing electrode, down to 10 % of the original signal level.	120 ms	250 ms

4.2 The values mentioned in the above chart call for the following comments :

4.2.1 Writing speed

It refers to the writing of a signal up to the saturation level. Significantly higher speeds can be achieved at a lower writing level in the case of a black and white image.

4.2.2 Output signal current

The 200 nA current is capable of achieving an equivalent visual signal/noise ratio of 200 with a 3 nA RMS noise - 7 MHz bandwidth amplifier. Higher values of output current are possible with a slight degradation of both the resolution and the retention time, whereas lower values of output current will have the opposite effect. Extreme values are typically 20 nA and 1 μA.

4.2.3 Resolution

It corresponds to a 50 % modulation of the output signal at the center of the target. Figure 5 shows the modulation transfer characteristic at the center of the target, as well as the 50 % modulation resolution at a 0.8 x radius distance from the center.

4.2.4 Gray scale

Figure 6 permits a more precise evaluation of gray scale reproduction. It shows the overall read-write response of the tube.

4.2.5 Retention time

Figures 7a and 7b show the output signal characteristics of the TME 1238 and TME 1239 as a function of time during a standard TV read-out mode for saturation-written and non-written areas. The rise of the "black" current corresponding to non-written areas is caused by positive ions discharging the surface of the target.

4.2.6 Uniformity

Figures 8a and 8b show a picture stored in a TME and displayed on a TV monitor. They give a qualitative idea of background and signal uniformity, as well as of the reproduction of shades of gray which is quite similar to a camera tube. Figure 9 shows a two-level picture application where a TME is used to store and display alphanumerics. Figure 10 demonstrates the possibility of local and precise erasing offered by the TME's.

5 - POSSIBLE FUNCTIONS AND APPLICATIONS

Performance that has been previously described permits the TME's to achieve several types of "memory functions". These will be discussed hereunder, along with the corresponding applications.

5.1 Non-destructive read-out storage function

In this case, information is written and it is subsequently read with no expected degradation.

5.1.1 Writing and reading with same TV standard

There is only a time shift between writing and reading of the information and it can be called video frame storage. It must be noted that it is entirely possible to read only one part of the stored image (zoom effect : figure 11).

Two possible applications :

- capture of high-speed events :

The image of a mobile object frozen by a light flash is picked-up by a TV camera, written on a TME and then displayed for the necessary time.

- comparison of images :

A real time image is compared to a stored image in order to analyze differences, if any.

5.1.2 Reading and writing in two different TV standards

It is possible to write information in a certain TV standard and read it in a different standard. This results in either bandwidth compression or expansion. It is interesting to note that the output signal amplitude of a TME does not depend on the speed of the reading beam ; this permits enhancing of the signal to noise ratio by using a slow-scan reading beam.

This function permits bandwidth reduction of a video signal (normal TV standard writing-slow scan reading) to transmit signals on a telephone line, the bandwidth expansion being achieved after transmission by using an inverse process with a second tube (slow scan writing-normal TV standard reading).

5.1.3 Non-TV scanning

It is of course possible to use scannings different from a TV type, for instance :

- Random scan : For presentation of alphanumerics or graphics on a display terminal. For this application, a precise local erasing permits the removal of one letter or a group of letters and its replacement by other information.

- PPI Scan for Radar or Sonar : It may sometimes be necessary to shorten the transmitting time as much as possible to avoid detection. An image generated during one rotation of the antenna can be stored on the TME and looked at for a long time, using either a TV scan or any other for the reading process.

5.2 Integration function

Figure 12 shows the amplitude of the output signal versus the number of writing scans at low level. A point of interest is the excellent linearity of the useful part of the curve. Two applications of this property can be mentioned :

- through integration of several images generated by a TV camera, it is possible to display a very low light level scene.

- a number n of recurrent radar scannings will enhance the signal by a factor n whereas the noise will only increase by $\sqrt{n}$. Useful signals can then be distinguished from high-noise level environment.

5.3 Destructive read-out function

In many Radar and Sonar applications, it is necessary to gradually erase the "old" information so that it does not interfere with the "new" one. This function can be achieved quite easily with a TME by performing partial erasing during the non-reading periods (for instance, line returns in the case of a TV scan). Figure 13 shows that progressiveness of erasing can be varied in large proportions by adjusting the erasing current.

5.4 Memory function

We have already seen that the only cause for degradation of stored information is the reading beam itself because of the ionization of the residual gas it produces. When the reading beam is turned-off, it is therefore possible to store information during long periods of time.

An important application is the use of a TME as part of a computer central memory. The precision of accessing is presently 0.2 % of the target diameter, which corresponds to about 100 000 bits of information stored in a square area. The combination price, capacity and access time (approx. 1 μs) is already interesting and the future looks very promising.

This memory function can also be used where a non-recurrent event has a probability to happen when no personnel is on duty. A recording by the TME will allow examination in convenient time (Grounds & Building Surveillance - Electrical Lines Surveillance).

5.5 Other functions

5.5.1 Mixing

It is quite possible to write sequentially on the target of one tube informations generated by various sensors such as TV, radar, cockpit instruments and to display them simultaneously.

5.5.2 Permanent memory

A mask reproducing a certain pattern can be used during the manufacturing of the target, so this pattern becomes permanently "printed" upon it. For example, the terrain surrounding an airport can be printed on a TME target and the corresponding image may be super-imposed on the radar image.

6 - COST

Three different elements have to be taken into account for cost purposes :

6.1 Tube cost

Because of their simple structure and a good manufacturing yield, cost of the TME's in quantity production is equivalent to quality vidicons.

6.2 Cost of associated electronics

Power supplies, deflection yokes and preamplifiers manufactured for vidicons in large quantities can be used, resulting in basic equipment low cost.

6.3 Hourly cost

Life expectancy of vidicons is typically a few thousand hours. Two factors will concur in giving the TME"s a longer life expectancy :

- better processing than the vidicons (exhaust to a lower vacuum pressure and baking-out at higher temperature).

- the storage target is not altered by the electron beam scanning.

In fact, failure of a tube will normally occur when its cathode is exhausted and, for special applications, it is envisaged to fit the TME's with extra long life cathodes.

7 - CONCLUSION

A new family of miniaturized storage tubes has been developed, which offers a good price-performance combination.

THOMSON-CSF scientists are working actively to further improve on these new developments, especially in the areas of :

- TME's with electrostatic deflection for memory scopes and equipments withstanding severe environmental conditions.

- TME's with better resolution and more precise addressing for large-capacity memories.

- tubes with optical input, but using the storage and reading principles of the TME's.

- TME's of the double-ended configuration to allow for simultaneous writing and reading.

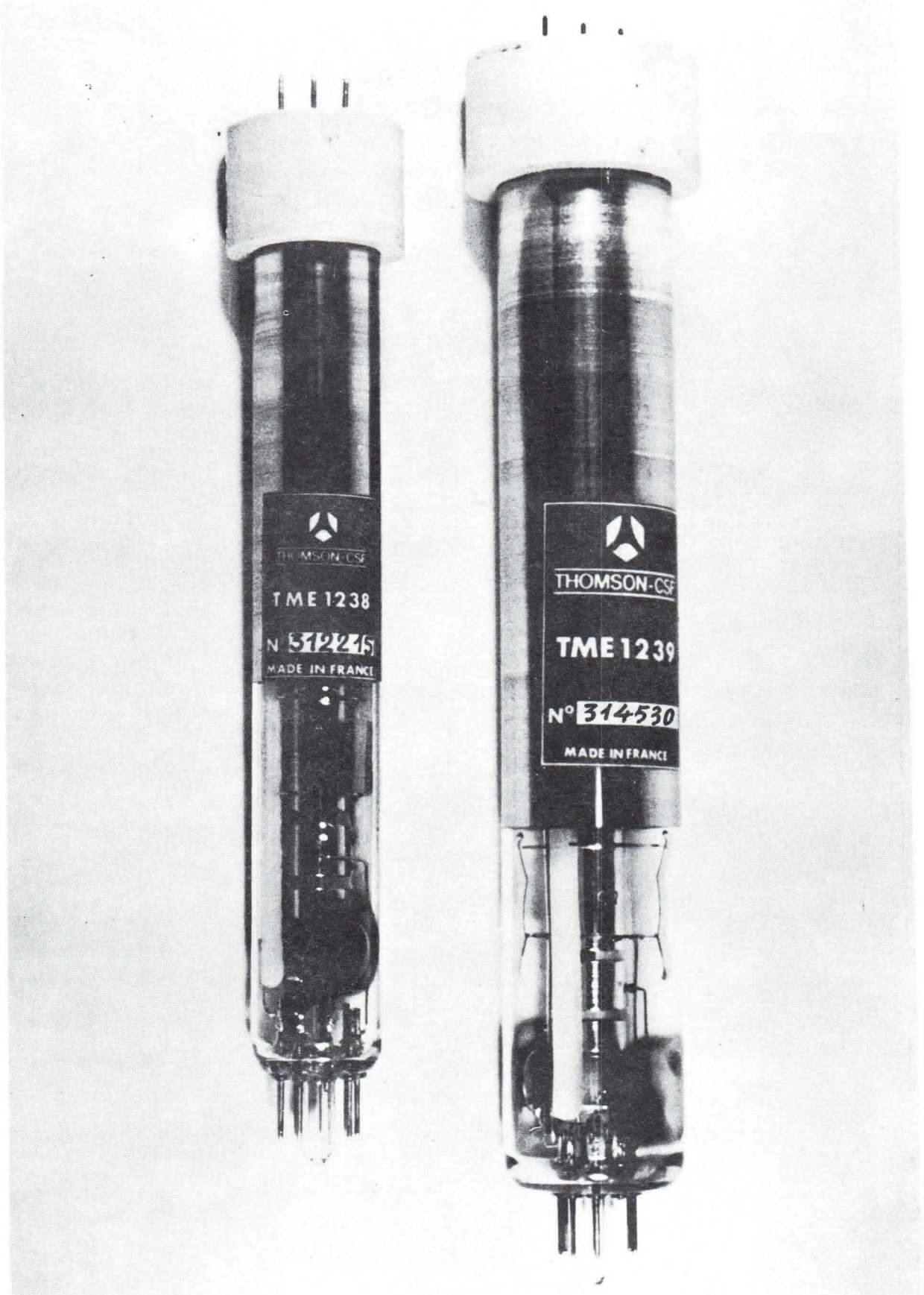


Fig. 1 : Miniaturized Storage Tubes TME 1238 and TME 1239

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Fig. 2 : Electrode configuration

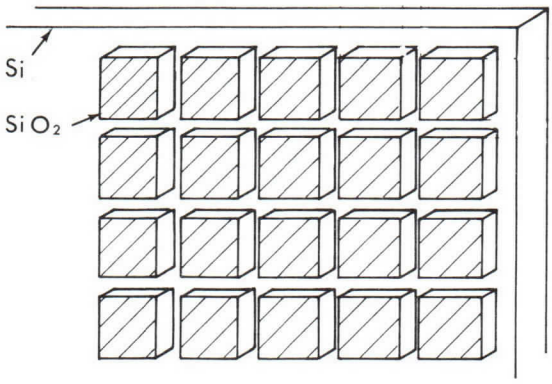


Fig. 3 : Target Layout

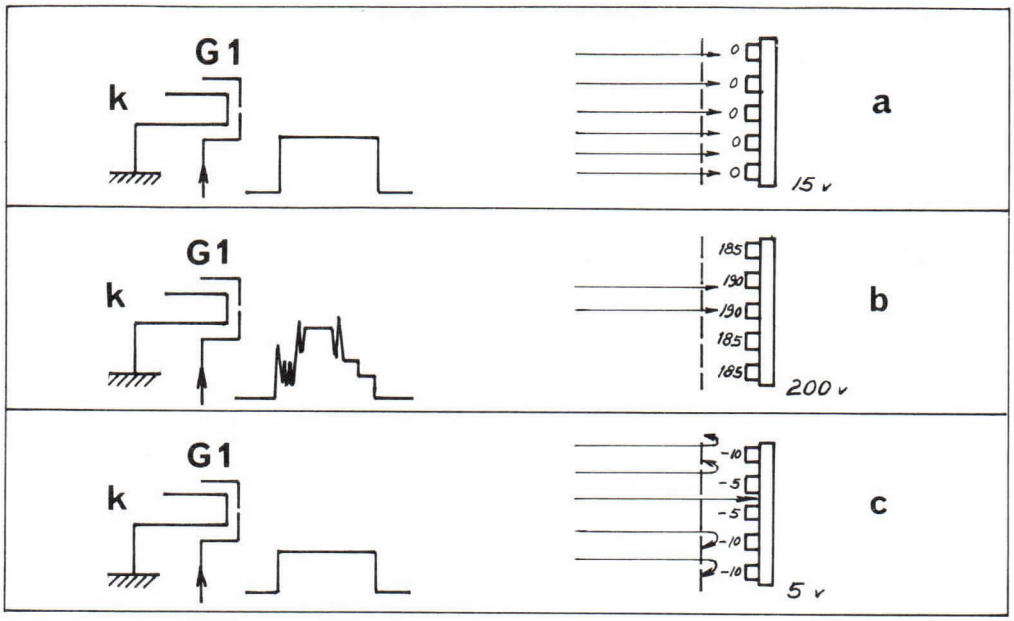


Fig. 4: Operation principle

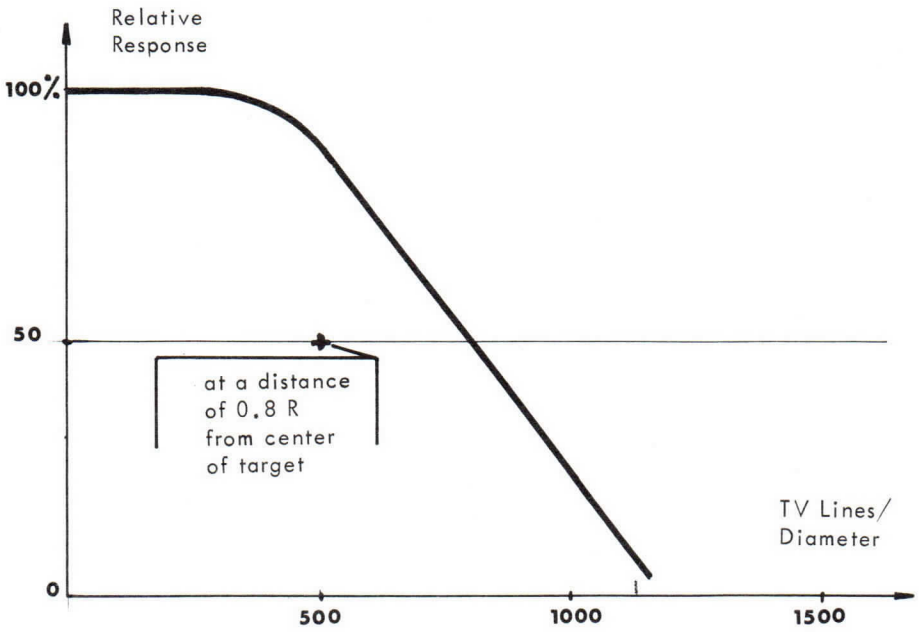


Fig. 5a : Modulation Transfer Characteristics TME 1238

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

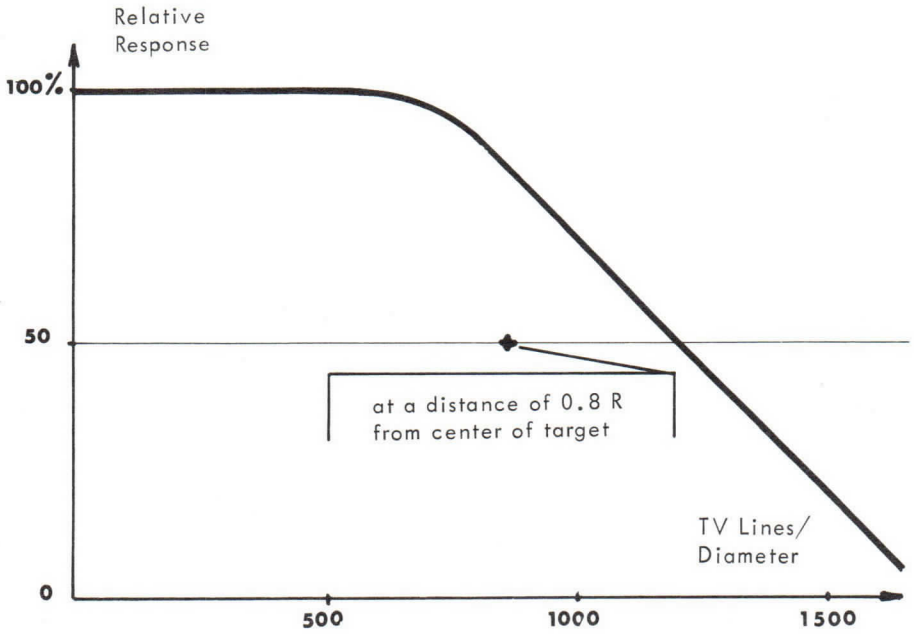


Fig. 5b : Modulation Transfer Characteristics TME 1239

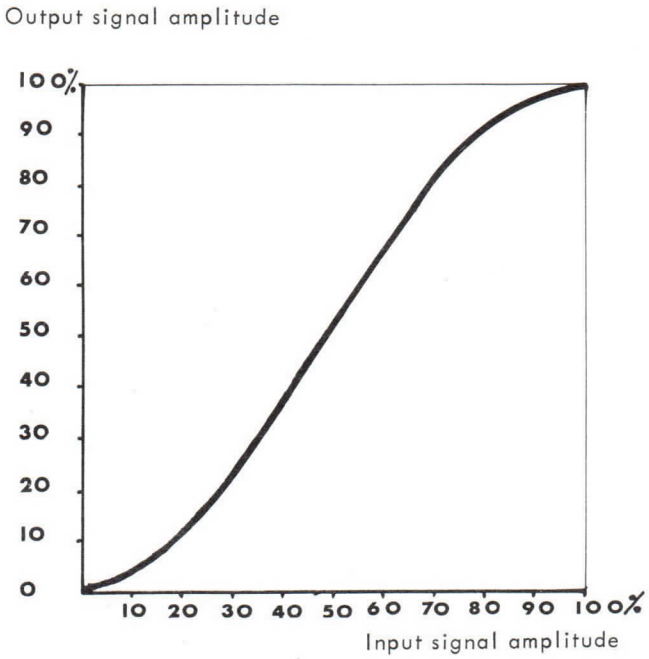


Fig. 6 : Read-Write Overall Response

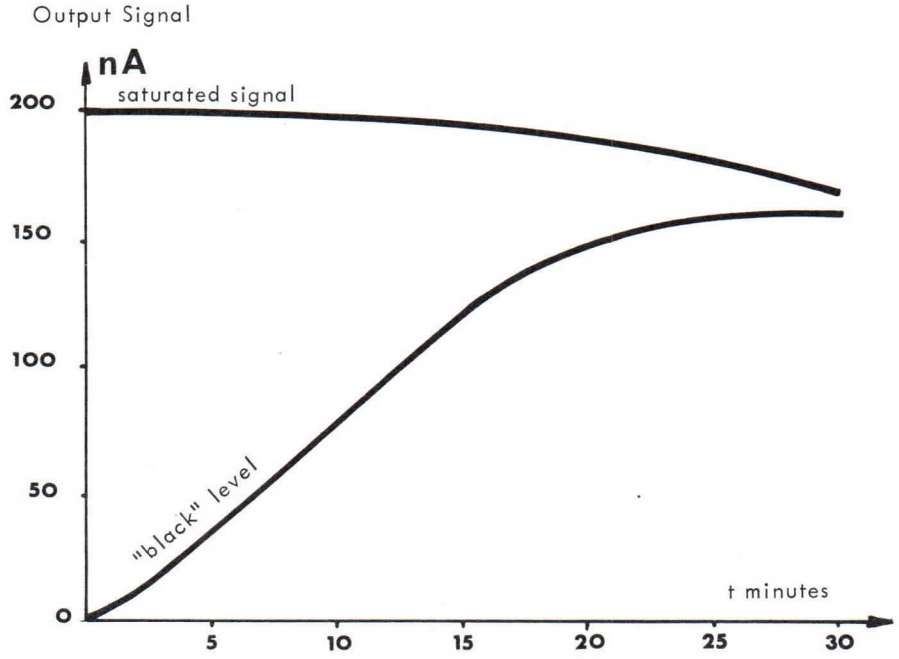


Fig. 7a : Retention Time TME 1238

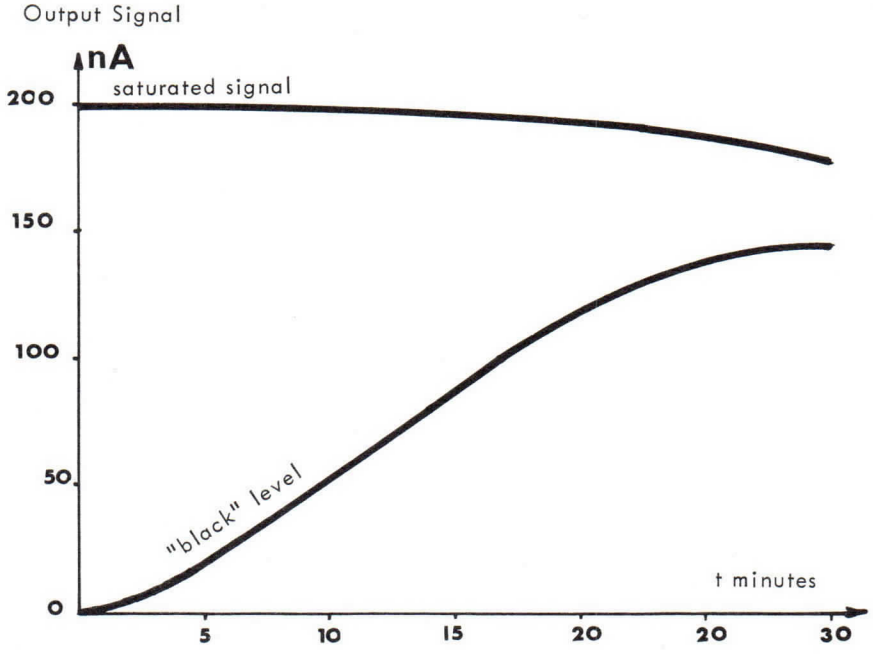
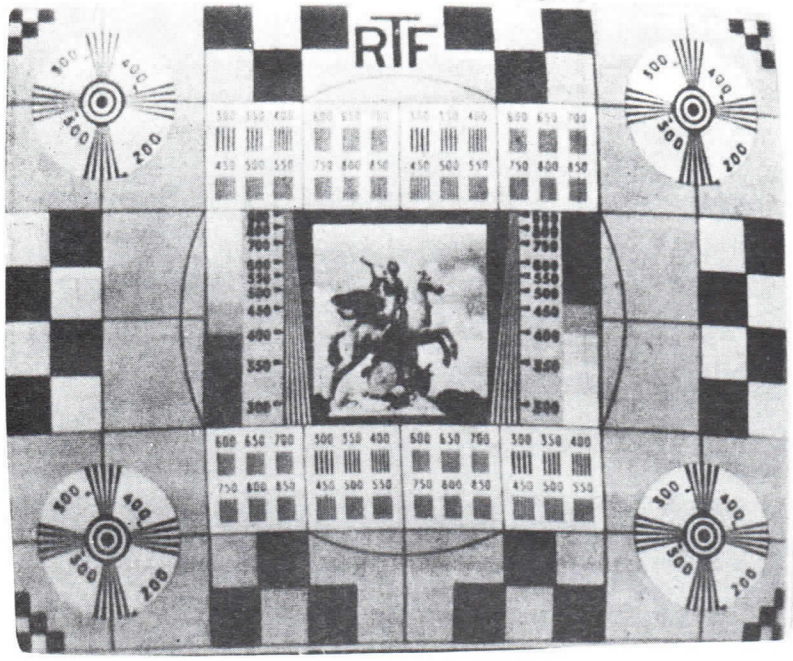


Fig. 7b : Retention Time TME 1239

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES



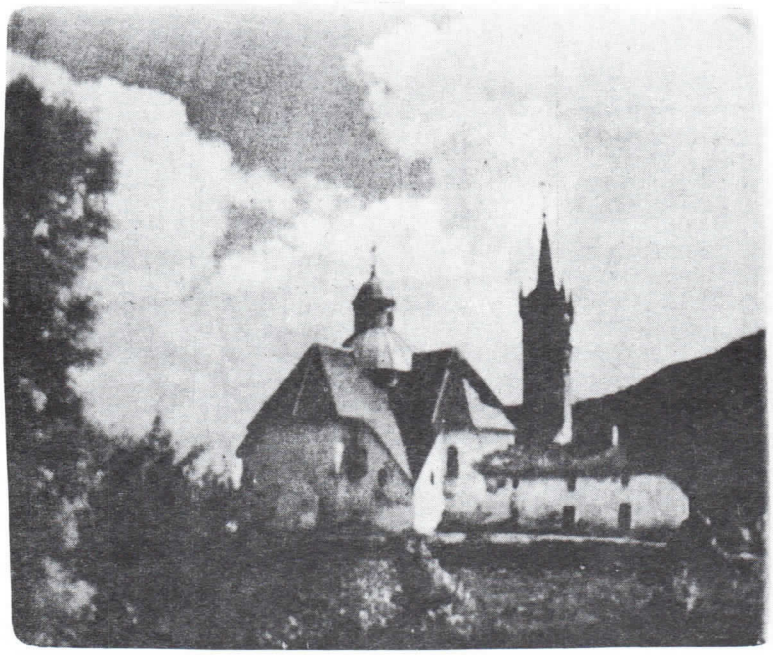


Fig. 8a & 8b : Gray-Scale Image Reproduction

Fig. 9 : Two-Level Image

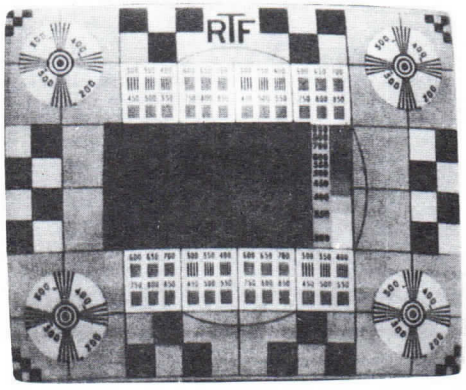


Fig. 10 : Selective Erasing

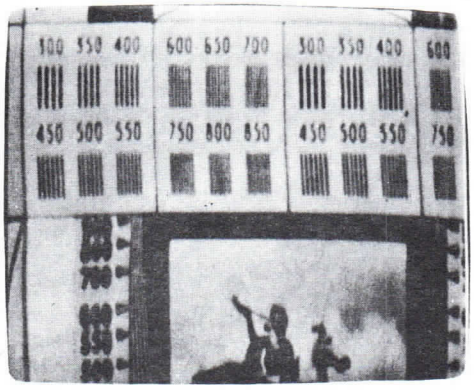


Fig. 11 : Zoom Effect

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

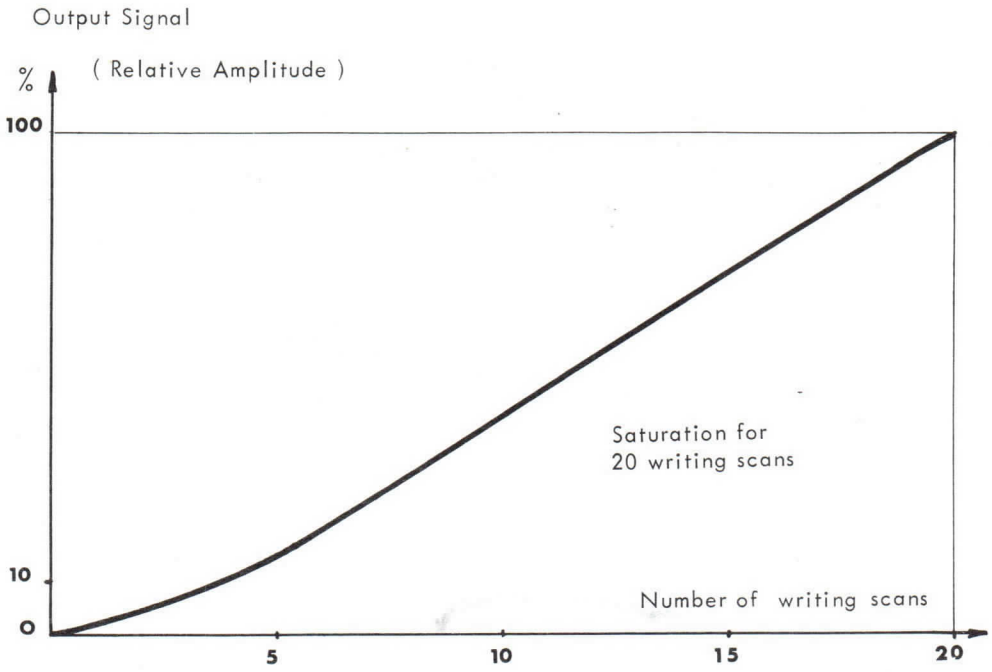


Fig. 12 : Integration of Weak Signals

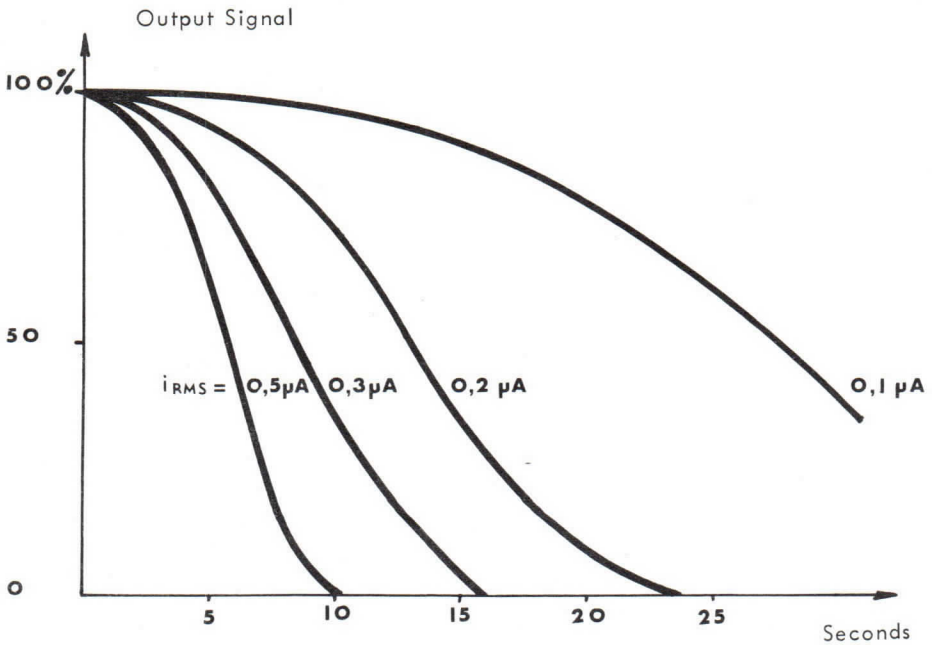


Fig. 13 : Controlled decay

TME

RECORDING STORAGE TUBES

B. COURTAN

J. DESCHAMPS

THOMSON-CSF

THOMSON - CSF - GROUPEMENT TUBES ELECTRONIQUES 8, rue Chasseloup - Laubat - 75 - Paris 15e - Tél.: 566.70.04

THOMSON - CSF ELECTRON TUBES, INC. 50 Rockefeller Plaza - New-York, N.Y. 10020, U.S.A. Telephone (212) 489 0400

CONTENTS

I - General

II - Basic operating principles of TME's

II - 1 Equilibrium potential of a dielectric through secondary emission

II - 1 - 1 Secondary emission ratio

II - 1 - 2 Equilibrium potential

II - 2 Non destructive read-out through coplanar control target

II - 2 - 1 Coplanar control target

II - 2 - 2 Principle of coplanar control target

II - 2 - 3 Characteristics of coplanar control reading

II - 3 Positive or negative charge deposit on a dielectric (erasing, writing)

II - 3 - 1 Erasing - Priming

II - 3 - 2 Writing

II - 3 - 3 Case of a thin target

III - Single gun TME's

III - 1 General

III - 2 TME 1238 and TME 1239 types

III - 2 - 1 Physical description

III - 2 - 2 Operating principle

III - 2 - 3 Performance

III - 3 Other types of single gun TME's

III - 3 - 1 TME 1348

III - 3 - 2 TME with enhanced resolution

III - 3 - 3 TME with high writing speed

IV - TME's with thin target

IV - 1 General

IV - 2 TME 1496 type

IV - 2 - 1 Physical description

IV - 2 - 2 Operating principle

IV - 2 - 3 Performance

IV - 3 Other types of TME's with thin target

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

SUMMARY

The TME's are recording storage tubes with electrical output and non-destructive read-out. After a description and an analysis of the reading mode (coplanar control reading), different processes of storage target charging (writing and erasing) are described. The charges can be deposited either on the side of the storage target facing the reading gun or on the opposite side in the case of a very thin target. Practically speaking, these two writing modes correspond to 2 types of tubes :

- Single-ended tube type where erasing, writing and reading sequences are accomplished with a single gun ;
- Double-ended tube type where writing and reading are simultaneously performed by corresponding guns located on both sides of a thin target ; erasing can be performed by either one or the other gun.

Detailed considerations related to single gun tubes are then given for types currently available (TME 1238 and TME 1239) and for developmental tubes (electrostatic deflection tube, high writing speed tube, high resolution tube . . . . .).

The operating principle and technology of developmental dual-gun tubes are also described with technical data concerning a tube of this family the TME 1496.

I - GENERAL

Storage tubes are C. R. T. ' s which receive and store information in the form of charge patterns and deliver this information in the form of a light image or an electrical signal.

The TME's or Recording Storage Tubes represent a particular category of this family presenting the two following characteristics :

1/ the stored information is delivered in the form of an electrical signal ;
2/ the read-out is non-destructive i. e. retention time is theoretically infinite.

In order to have a clearer concept of this, it is of interest to explain the difference between TME's and other storage tubes :

- The D. V. S. T. has a non-destructive read-out like the TME's but delivers a light output.
- The EBIC scan converter delivers an electrical output like the TME's but has a destructive read-out.

The storage target of TME's can be made either of a storage mesh modulating the reading beam or of a planar target allowing coplanar control reading.

In this paper, only the second technique is considered since it is the technique which makes possible the development of high performance tubes, and therefore constitutes the major part of our studies.

We must express here our acknowledgements to the"Service Technique des Telecommunications de l'Armée de l'Air"which has partly supported this work from its beginning.

II - BASIC OPERATING PRINCIPLES OF TME's

The basic characteristic of the TME's (single or double-ended types) consists of using a coplanar control target in order to obtain a non-destructive read-out of the recorded signal.

Before examining the detailed mechanism of the non-destructive read-out, it is necessary to remember briefly the charge and discharge process of an insulating surface through secondary emission.

II - 1 Equilibrium potential of an insulator by secondary emission

II - 1 - 1 Secondary emission ratio

When a material is bombarded by primary electrons, secondary electrons are emitted from its surface. The ratio between the number of secondary electrons and the number of primary or incident electrons is called the secondary emission ratio δ. Depending on the material, δ can differ but for a given material it is a function of primary electrons energy eV_{pr}. Figure 1 shows the variation of δ as a function of Vpr, the shape of the curve being the same for any material. δ is small for low energies, increases rapidly to a maximum, then decreases more slowly with further increase of primary energy. The two points where $\delta = 1$ correspond to the cross-over potentials Vpr_1 and Vpr_2 and are of particular interest.

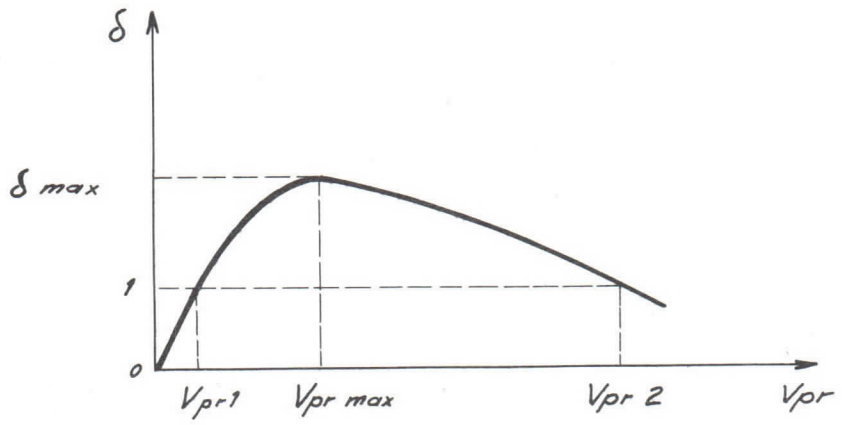


Fig 1 : Variation of secondary emission ratio δ versus energy of incident electrons

In fact, two cases are to be considered :

- $\delta < 1$ for $Vpr < Vpr_1$ or $Vpr > Vpr_2$

δ being lower than unity, the amount of secondary electrons is lower than the amount of primary electrons. In the case of an insulator, its surface is negatively charged.

- $\delta > 1$ for $Vpr_1 < Vpr < Vpr_2$

δ being higher than unity, the amount of secondary electrons is higher than the amount of primary electrons. In the case of an insulator, its surface is positively charged. Practically Vpr1 is of the order of 50 V and Vpr2 of the order of several kV. As for δ maximum, it can vary within a large range depending on the material.

II - 1 - 2 Equilibrium potential

In TME's, primary electrons are accelerated so that Vpr varies from 0 to Vpr max. (the acceleration of primary electrons is the potential difference between the bombarded material and the emissive cathode).

2 operatings modes can be considered :

- the so-called "low velocity electron" mode where $Vpr < Vpr1$ and $\delta < 1$
- the so-called "high velocity electron" mode where $Vpr > Vpr1$ and $\delta > 1$

In the case of a dielectric, the result will be that the surface of the dielectric will be charged in a negative or a positive direction according to the mode used.

In the case of a dielectric bombarded by low velocity electrons ($\delta < 1$), the potential of the surface decreases down to 0 V. For this value, an equilibrium is established since the dielectric potential being at the cathode potential, the primary electrons cannot reach the dielectric. The equilibrium potential of a dielectric material bombarded by low velocity electrons is then zero (this is true at first approximation when the thermal energy of electrons is not taken into account).

It is to be noted that, when the equilibrium potential is reached, the dielectric is no longer bombarded by electrons and it is obvious that this will be the same if the dielectric surface is shifted to a negative potential with respect to the cathode. This characteristic is properly used in non-destructive read-out tubes.

It is also to be noted that in the case when high velocity electron bombardment is used, the equilibrium potential reached is that of the collector electrode ; in this case the dielectric is constantly bombarded by the primary electrons whatever the potential of the target may be with respect to the equilibrium potential.

II - 2 Non destructive read-out by coplanar control

This reading mode is roughly characterized by :

- the use of an electron beam called the reading beam, having a constant density and approaching the target orthogonally over its surface.
- the use of a planar target with a fine periodic structure including dielectric and conductive areas alternatively.
- the presence on the dielectric areas of a charge pattern deposited by the writing beam.

The recorded charge pattern gives rise, on the target surface, to a potential pattern which modifies the trajectories of the reading electron beams in the vicinity of the target.

II - 2 - 1 Coplanar control target

This is a fine periodic structure target consisting of alternate dielectric and conductive elements which can be shifted to different potentials. Two versions of such a target are shown in fig. 2a and 2b.

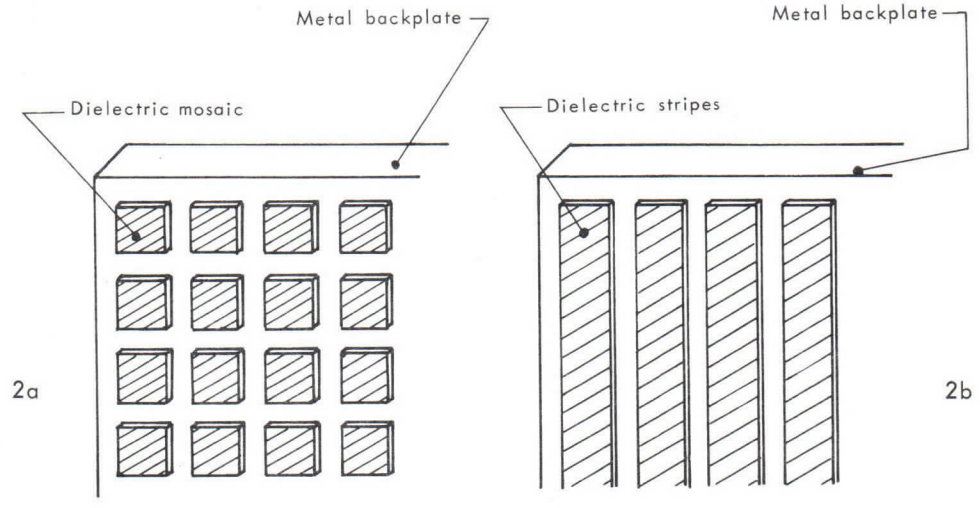


Fig 2 : Schematic views of coplanar control target

The target shown in fig. 2a consists of a mosaïc of dielectric deposited on a conductive material ; the target shown in fig. 2b consists of dielectric stripes deposited on a conductive material. In both cases the target may be considered as a planar structure since the dielectric thickness is negligible with respect to the surface dimensions of the elements. The simple symmetry of the structure shown in fig. 2b makes theoretical considerations easier and will be taken as an example for further discussion.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

II - 2 - 2 Principle of coplanar control

The coplanar control utilizes the electrostatic interaction between neighbouring elements localized in the same plane in order to control the reading electrons incident on discrete elements of the target.

In the following discussion of the mechanism described here after, the reference potential (0) is that of the reading gun cathode and the target potential V_c is that of its conductive elements which are all at the same potential since they constitute a single metal backplate. This potential V_c can be controlled by an external voltage supply and will be shifted, in reading mode, to a low value, for example $V_c = + 5$ V.

The surface potential of the dielectric being v and assuming as a first step that the dielectric areas of the target have not received any charge, the target potential is then uniform over the whole surface and $v = V_c$.

Due to the presence of a field mesh located in front of the planar target and close to it, a uniform decelerating field is established in the grid-target space when this grid is shifted to a high potential of about + 500 V. The equipotential lines in this space are shown in fig. 3 in the vicinity of the target.

The reading electrons, although arriving at reduced speed, have a sufficiently high energy to reach the target.

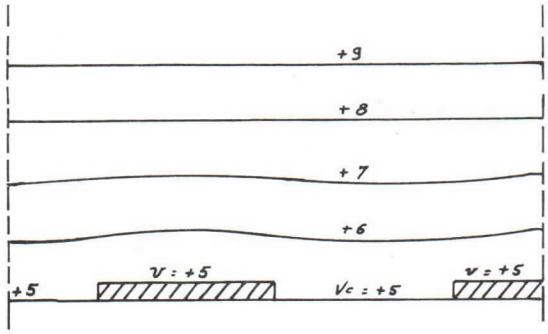


Fig 3 : Equipotentials in the vicinity of the target in the case of a non charged dielectric

Assuming, as a second step, that the dielectric areas of the target have been charged at a negative potential for example $v = - 5$ V , equipotential lines obtained in the vicinity of the target are given in fig. 4.

This negative potential of the dielectric strongly disturbs the equipotential lines and as a result the electron trajectories are modified.

The electrons of the reading beam are repelled by this negative potential and no electrons land on the dielectric. A fraction of the electrons is reflected back to the field grid and the remainder will reach the conductive areas of the target.

Figure 5 shows the modifications of the electron trajectories due to the negative potential of the dielectric. These trajectories have been calculated by computer.

The equipotential lines (fig. 4) and the electron trajectories (fig. 5) show the phenomena in the vicitiny of the target for + 5 V on the target and - 5 V on the dielectric. For other values of the dielectric potential it is obvious that the fraction of reflected electrons will increase when the dielectric potential is more negative.

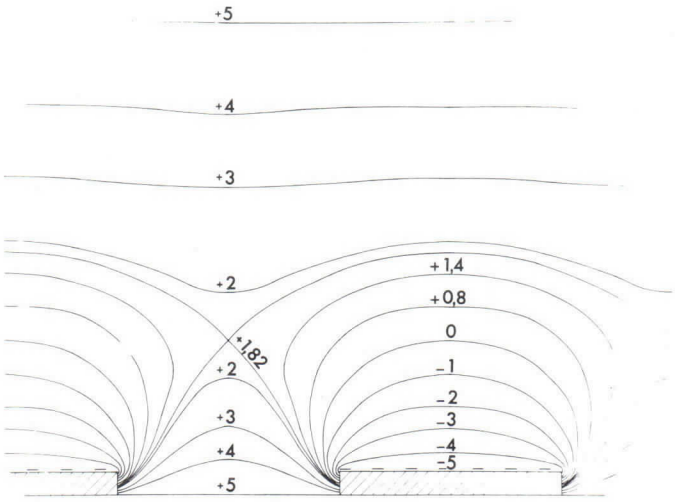


Fig 4 : Equipotentials in the vicinity of the target in the case of a charged dielectric (Vc = +5V ; v = -5V)

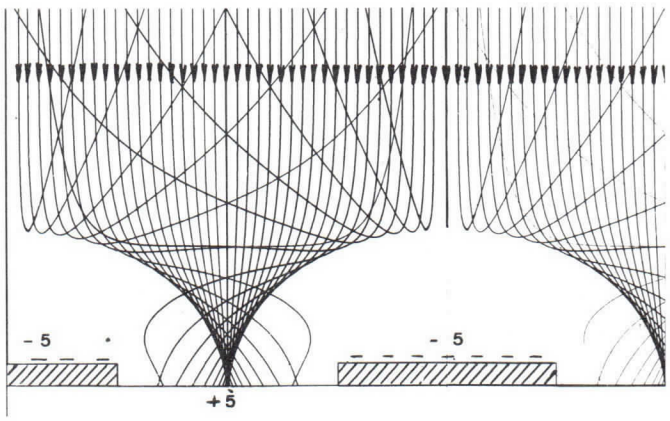


Fig 5 : Electron trajectories in the vicinity of the target in the case of fig 4

We can notice, on fig. 4, a saddle point in the potential distribution where the equipotential lines cross over.

For a dielectric potential V_{CO} sufficiently negative (target cut-off potential), the potential of this saddle point can decrease to 0 V . In this case and for all dielectric potentials more negative, no electron will be able to reach any point of the target.

The influence of the dielectric potential on the number of electrons able to reach the target is illustrated by fig. 6 . The curves give the signal current (proportional to the number of electrons landing on the target) as a function of the dielectric potential v for different values of target potential V_C.

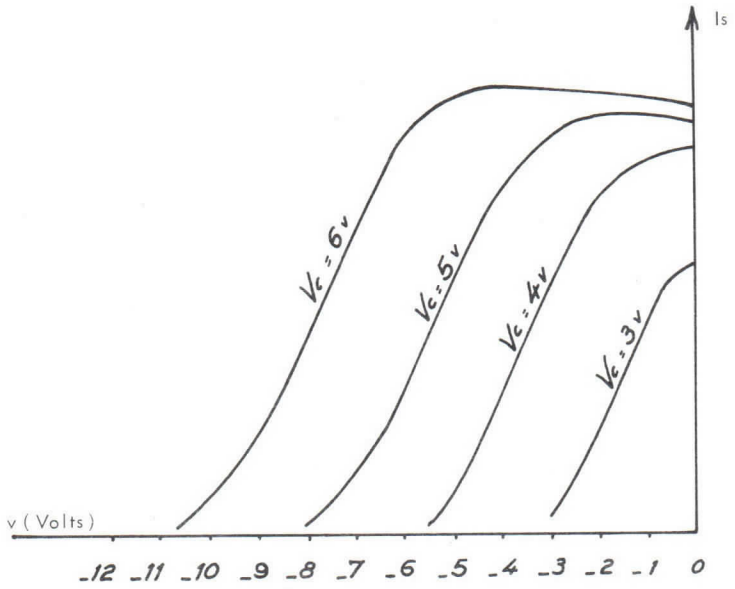


Fig 6 : Output signal amplitude versus Vc and v

II - 2 - 3 Reading characteristics by coplanar control

From the preceding considerations the results are that :

- the more or less negative potential established on the dielectric within a given zone of the target enables the control of the number of electrons landing on the conductive area of this zone.
- the control can be continuously varied from the cut-off to the maximum signal ; stored information can thus be released at different levels and half-tones be produced in the output.
- the dielectric which stores the information and also acts upon the reading beam as a control grid is at a negative potential and the electrons can never land on the dielectric : the stored information is not degraded by the reading beam (non destructive read-out).
- the reading electrons which are unable to land on the target are reflected towards the field grid ; a complementary signal can therefore be collected on this grid and it can be of interest to use this particularity for certain applications.

II - 3 - Negative or positive charge deposit on the dielectric - Erasing and writing (See figure 7).

The mechanism of non-destructive read-out assumes, as described hereabove, that the dielectric is at a negative potential with respect to the cathode which emits reading electrons. This potential can vary from target cut-off voltage v_{co} to 0 V depending on the information recorded on the point considered.

The negative pattern potential is established on the dielectric surface by the erasing and writing operations.

Only the operating principle is described in the following chapter, additional particular operating conditions will be given in the chapter concerning each type of tube.

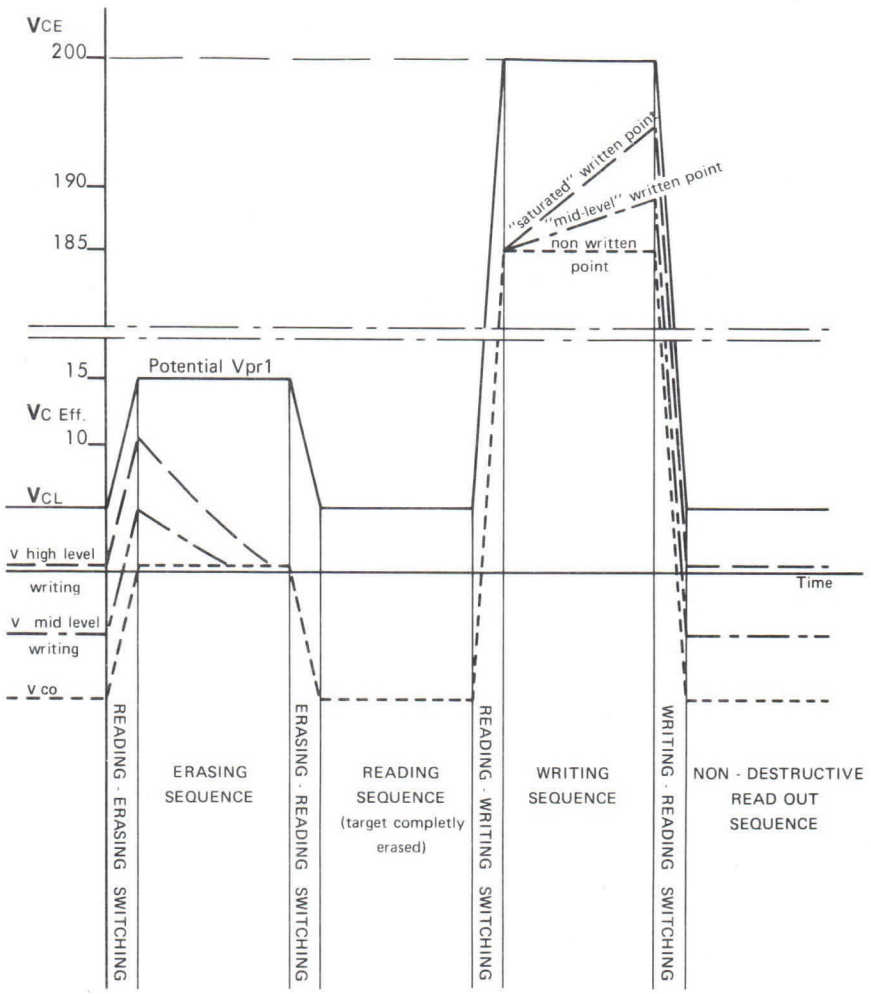


Fig 7 : Operating principle = erasing - writing - reading sequences

We shall design by :

V_{CL}	target potential in reading mode
V_{CEff}	target potential in erasing mode
V_{CE}	target potential in writing mode
v	dielectric surface potential in the considered element ΔS
v_{co}	target cut-off potential
c	target capacitance per unit area.

First of all, it is necessary to define the relation between dielectric potential v and target potential V_C.

An element of dielectric surface ΔS presents an elementary capacitance $c\Delta S$ with respect to the surroundings which is here the conductive area of the target.

Assuming this element ΔS to have a charge ΔQ , its potential v will be

$$v = V_C + \frac{\Delta Q}{c\,\Delta S}$$ with respect to the cathode emitting reading electrons.

It can be deduced from this relation that :

- the potential v of a dielectric element will directly depend upon the target potential V_C.
- it is possible to modify the dielectric potential in a positive or negative direction by depositing positive or negative charges ΔQ.

These two phenomena are used in the mechanism of erasing and writing. Indeed the local variation of dielectric potential is always obtained by deposited charges, charges which are caused by electrons impinging on the dielectric. As we know (see chapter II-1) the impact of electrons can bring negative or positive charges depending on the potential of the dielectric with respect to the emissive cathode.

II - 3 - 1 - Erasing - Priming

This operation consists of shifting all points of the dielectric surface to the negative cut-off potential v_{co} whatever the former state may be. The dielectric is thus ready to receive new writing information.

For this end V_{CL} is switched to $V_{CEff} = V_{CL} - v_{co}$ and during this process, the dielectric potential is modified but the dielectric charges remain unchanged.

This potential which can be, before target potential switching, between 0 (saturated written point) and v_{co} (non written point), will take a value between $V_{CEff} - V_{CL}$ and $V_{CEff} - (V_{CL} - v_{co}) = 0$, with V_{CEff} and V_{CL} verifying the conditions $0 < V_{CEff} - V_{CL} < Vpr_1$ therefore, over the whole dielectric surface, the impinging electrons will bring the potential of different points down to the equilibrium potential 0 V.

If the target potential is then shifted from V_{CEff} to V_{CL}, the dielectric surface potential will become $0 - (V_{CEff} - V_{CL}) = v_{co}$.

It is then important to notice that by just the switching of the target potential from V_{CL} to V_{CEff} and again to V_{CL}, the potential of the dielectric surface has been made uniform and brought to v_{co} by the electron beam.

II - 3.2. Writing

For this purpose, the dielectric potential is brought to a value between v_{co} and 0 assuming the dielectric potential to be $v = v_{co}$ which is obtained by erasing operation as described above.

Since the potential v must be brought to a higher value, it is necessary to deposit positive charges which is possible if v (during writing) is higher than Vpr_1. V_{CE} is shifted to a high positive value so that $v = V_{CE} - V_{CEff} > Vpr_1$.

When the element ΔS is bombarded by electrons, ΔQ is positive and its potential v will become :

$$V_{CE} - V_{CEff} + \frac{\Delta Q}{c \Delta S}$$

If the target potential is then shifted from V_{CE} to V_{CL}, the dielectric potential will be :

$$V_{CE} - V_{CEff} + \frac{\Delta Q}{c \Delta S} - (V_{CE} - V_{CL}) = v_{co} + \frac{\Delta Q}{c \Delta S}$$

The dielectric potential is thus brought (after writing) to a potential exceeding v_{co} by a quantity proportional to ΔQ.

Remarks :

1/ If ΔQ is sufficiently high v can become positive but this corresponds to an unstable state since the reading electrons will bring the potential v down to the equilibrium potential v = 0 ; on the other hand a coplanar effect, which is not discussed here, will limit ΔQ to a value slightly higher than $v_{co} \cdot c \Delta S$

2/ In the mechanism described above, switching of the target potential is utilized to bring the dielectric potential to the erasing condition ($v < Vpr_1$, deposition of negative charges) or the writing condition ($v > Vpr_1$, deposition of positive charges). But it is important to notice that, since primary electron energy is given by the potential difference between the dielectric and the emissive cathode those different operations can be obtained either by switching of cathode potential or without any switching by using several cathodes at different potentials.

3/ The target capacitance c is a fundamental characteristics since it binds the variations of the dielectric potential Δv to the amount of deposited charges ΔQ. This will have a direct influence on erasing speed, writing speed and remanence For a given charge ΔQ, the lower the target capacitance, the higher the corresponding Δv ; a low target capacitance will correspond to a high erasing speed, high writing speed and a low remanence.

II - 3. 3. - Case of a thin target able to accept charges from both sides = dual-gun target

Although the mechanism described above can be applied to this case, it is necessary to give some more information about the operating principle of a target used in dual-gun tubes.

A sample of this target is shown in fig. 8.

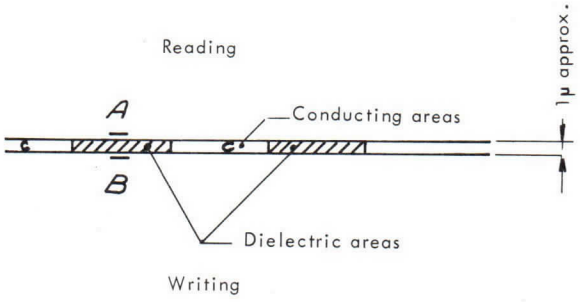


Fig 8 : Schematic view of thin target structure

It will be noticed that, on the reading side, the target presents the same conductor-dielectric periodical structure ; it will be sufficient to establish on this side of the dielectric a negative potential pattern ranging from v_{co} to 0 to obtain a coplanar control target.

The potential pattern is also obtained by depositing charges by either of the two guns.

In the case where charges are deposited by the reading beam, the operating principle is exactly the same as previously described.

In the case where charges are deposited by the writing gun, the mechanism is the following.

Let us consider a charge ΔQ deposited on the element B of surface ΔS . The potential of B varies then by a quantity $\Delta v_B = \frac{\Delta Q}{C_B}$, C_B being the capacitance of the element B with respect to the surroundings. Because of the geometrical dimensions of the target (very low thickness) the major part of Δv_B will be found in A . It is not our purpose to present here the calculation made for the quantitative evaluation of this phenomenon but as an approximation, we can estimate that the potential of the dielectric facing the writing gun is transferred on the reading side by capacitive division. This capacitive division between elements B, A and C is such that $C_{BA} \gg C_{AC}$ and practically $\Delta v_A \simeq \Delta v_B$

The structure of a target shown in figure 8 enables, provided the target is thin, to obtain a coplanar control target on which charges can be deposited on either side.

III - SINGLE GUN TME's

III - 1 General

The realization of single-ended TME's is based on the writing mode described in chapter II-3-2 (writing and reading performed on the same side of the target).

The target is made of a dielectric mosaïc deposited on a metallic plate (fig. 9 a). A single gun is sequentially used for erasing, writing and reading. The target capacitance per unit area (c) is determined only by the dielectric thickness and does not depend upon the mosaïc pitch and obviously upon the metal thickness.

A variant of the target (fig. 9 b) can consist of a metallic mesh deposited on a dielectric block. In this case the capacitance is determined by the pitch of the metallic wires and is practically independent of the dielectric thickness.

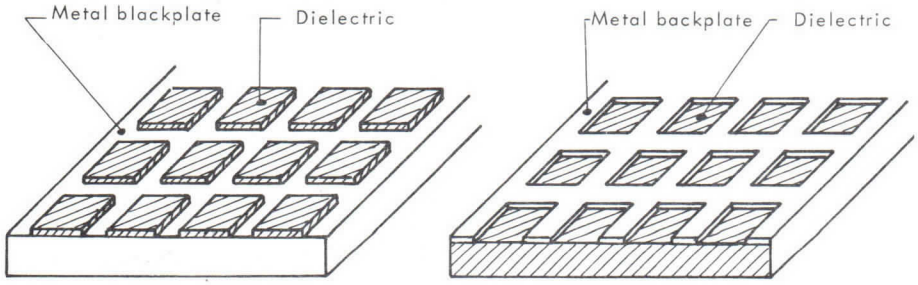


Fig 9 : Schematic view of single gun tube targets

The tubes described hereunder utilize essentially a target having the structure shown in fig. 9 a.

III - 2 TME 1238 and TME 1239

These single ended tubes are especially intended to store information provided as T. V. video signals or alphanumeric characters.

Their size is similar to that of a 1" Vidicon for TME 1238 and 1" 1/2 Vidicon for TME 1239 (see fig. 10). They employ electromagnetic focus and deflection and therefore can be used with standard Vidicon hardware.

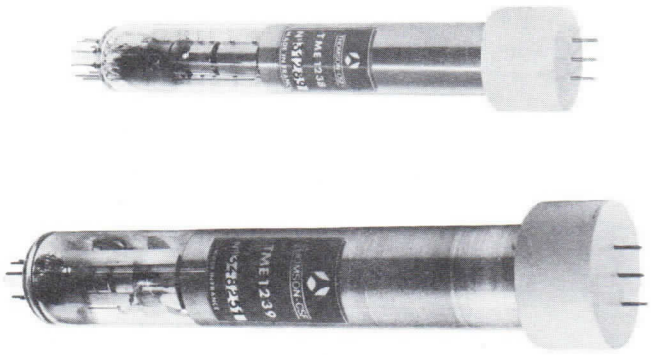


Fig 10 : TME 1238 and TME 1239

The pin configuration is also similar to a Vidicon. Furthermore the capacitance of the output signal electrode is such that it allows for the use of Vidicon type amplifiers. Thus, the associated electronics are quite similar to those used widely and inexpensively for Vidicons.

III - 2 - 1 Internal construction

Figure 11 shows the inside geometry of TME's . Essentially, they include an electron gun and a storage target.

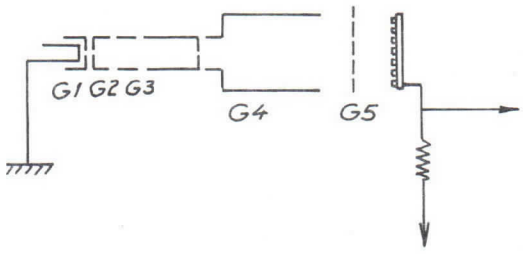


Fig 11 : Schematic view of single gun TME's

The electron gun consists of a cathode, a control grid G_1 , an accelerating electrode G_2 , a so-called erasing electrode G_3 (the operation of which is explained later), a focusing electrode G_4 and a field mesh G_5

This fine mesh (20 to 40 wires per mm) is located at close proximity to the storage target.

The target shown in fig. 9a is made of a heavily doped Silicon backplate on which silica is deposited. Square areas of insulating material have about 10 µm size equally spaced by 15 µm from each other. This target is made from a thin Silicon plate by using well-known integrated circuit technology.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

a - Silica deposited on the Silicon by a thermal oxidation process, has a uniform thickness of about 1 to 2 µm ;

b - Silica is covered by a photosensitive resin ;

c - Insolation is achieved by a photographic mask ;

d - The operations of skinning, silica etching and resin dissolving are achieved by using conventional processes.

This will give a silicon plate covered by squares of very compact, uniform and adhesive silica.

This structure offers significant advantages in terms of simplicity and ruggedness In addition the storage characteristics are unaffected by temperature variations.

III - 2 - 2 - Operating principle

During the different sequences (erasing - writing - reading) the cathode is constantly maintained at ground potential and δ ratio is modified by acting on the target potential.

The input signal, corresponding to the information to be stored, is applied to the control grid G_1.

The electron beam is magnetically focused and deflected then collimated so that the electron trajectories are perpendicular to the surface of the target. The metal backplate is used as the output signal electrode.

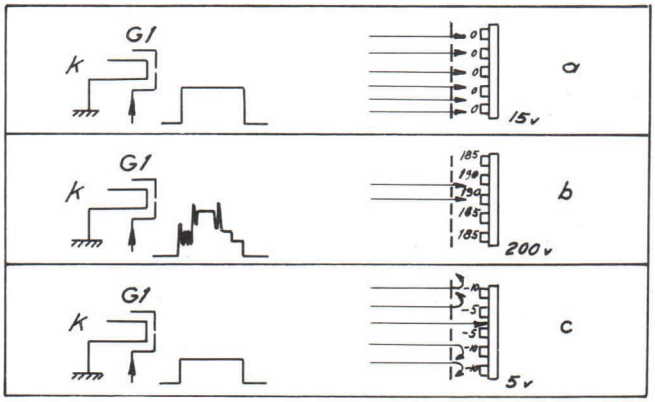


Fig 12 : Operating principle of single gun TME's

Figure 12 shows the potentials established on the metal and the dielectric during the three sequences of a complete cycle. It is important to remember that :

- in the erasing mode δ is lower than unity and the stabilized dielectric potential is OV i. e. the cathode potential ;

- in the writing mode δ is greater than unity and the potentials of dielectric zones bombarded by the electrons will increase by a few volts ;

- in reading mode, the scanning beam is modulated by the charge pattern stored on the target. Only electrons impinging on written points generate an output signal reproducing faithfully the stored information.

The signal output current develops a proportionate voltage through a load resistance, voltage which after amplification is applied to a standard display tube (T. V. monitor or other) where the stored image is displayed.

The retention time, as noted earlier, is theoretically infinite. In proctice, it is limited by two phenomena :

- progressive discharge of the dielectric target because of dielectric leakage current. Considering that the dielectric used is of high quality and its thickness is large in comparison to the low voltage applied to the target, this phenomenon usually has a negligible effect;

- creation of ions by the reading beam. Vacuum is not perfect inside the tube and the electrons of the reading beam ionize some molecules of residual gas. The positive ions created in the G_5 grid-target space are attracted by the negatively charged areas of the dielectric surface and progressively neutralize the stored charges.

The retention times given in the table below have a definite value limited by this secondary effect.

One of the key features of this tube is its capability of fast erasing of the stored image. Erasing time is a function, on one hand, of the capacitance of the storage dielectric and on the other hand of the intensitity of the erasing beam. Electrode G_3 permits increasing the erasing current in large proportion, when fast erasing is required.

In the reading mode, electrode G_3 is at the potential of the accelerating electrode G_2 and has no effect on the beam ; the diaphragm is therefore fully efficient and only a low current fine spot size beam emerges from the electron gun.

For fast erasing, the G_3 electrode potential is modified in such a way that all the current is focused on the diaphragm. The, latter is therefore not effective anymore and the beam current emerging from the gun is increased by a factor ranging from 10 to 30, thereby achieving the fast erase characteristic.

Remarks

- Destructive read-out

In many applications, it is necessary to gradually erase the "old" information so that it does not interfere with the "new". This function can be easily achieved with a TME by performing partial erasure during the non-reading periods (for instance during line retrace in the case of T.V. scan). Figure 13 shows that progressiveness of erasing can be varied in large proportions by adjusting the erasing current.

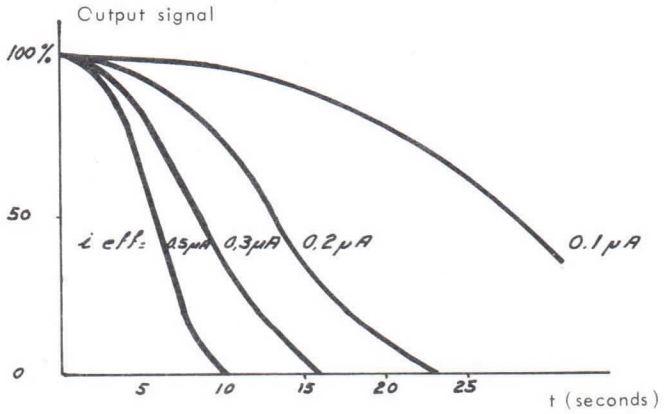


Fig 13 : Progressive erasure of stored signal

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

- Permanent memory.

A mask reproducing a certain pattern can be used during the manufacturing of the target, so this pattern becomes permanently "printed" on it. For example, the terrain surrounding an airport can be printed on a TME target and the corresponding image can be superimposed on the radar image. The permanent memory can also be a map, reference points, characters and the like.

III - 2. 3. - Performance

Performance of TME 1238 and TME 1239 are as follows :

	TME 1238	TME 1239
Writing speed		
- For overall target area in standard T. V. scan	33 to 40 ms (1 T. V. frame)	33 to 40 ms (1 T. V. frame)
- for one target diameter	50 µs	50 µs
Storage time		
- with reading beam turned-off	a month	a month
Output signal current		
- for performance as follows	0. 2 µA	0. 2 µA
Output capacitance (target)	5 pF	10 pF
Resolution		
- measured by orthogonal read-write at 50 % modulation	800 T. V. lines per diameter	1200 T. V. lines per diameter
Gray scale		
- Number of half-tone levels	10	10
Retention time with constant reading in standard T. V. scan		
- for a gray scale image	min. 5 mn	min. 10 mn
- for a black and white image	min. 10 mn	min. 15 mn
Erasing time		
- fast erasing, by switching of the erasing electrode, down to noise level	33 to 40 ms (1 T. V. frame)	33 to 40 ms (1 T. V. frame)
- normal erasing, with no switching of the erasing electrode, down to 10 % of the initial signal level	120 ms	250 ms

The values mentioned in the above table call for the following comments :

- Writing speed

It refers to the writing of a signal up to the saturation level. Significantly higher speeds can be achieved at a lower writing level. It is then possible to increase this level especially when only two tones are desired (black and white).

- Retention time

The degradation of stored information occurs only when reading, it is possible, without reading (beam cut-off) to store it for a month.

- Output signal current

The 200 nA current is capable of achieving an equivalent signal/noise ratio of 200 with a 3 nA RMS noise - 7 MHz bandwidth amplifier. Higher values of output current are possible with a slight degradation of both the resolution and the retention time, whereas lower values of output current will have the opposite effect. Extreme values are typically 20 nA and 1 µA.

- Resolution

It corresponds to a 50 % modulation of the output signal at the center of the target. Fig. 14 shows the modulation transfer function at the center of target.

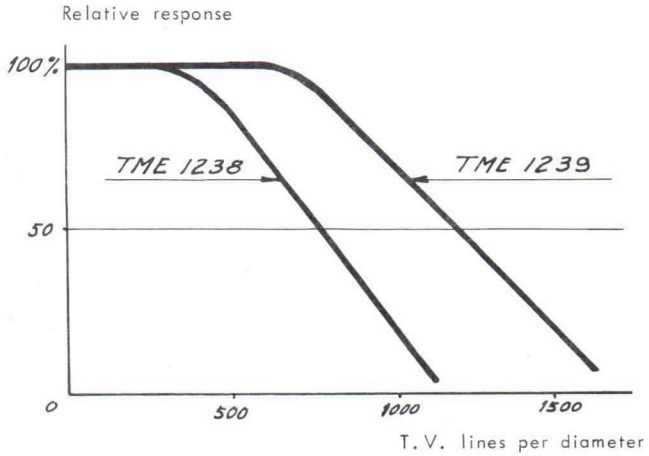


Fig 14 : Modulation transfer function of TME 1238 and TME 1239

- Gray scales

Figure 15 permits a more precise evaluation of the gray scale reproduction. It shows the overall read-write response of the tube.

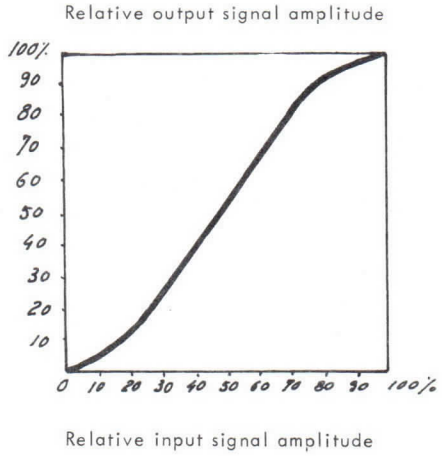


Fig 15 : Signal - Signal transfer function

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

- Reading time (with continuous reading)

Figure 16 shows the output signal characteristics of the TME 1238 and TME 1239 as a function of time during a standard T. V. read-out mode for saturation-written and non-written areas. The rise of the "black" current corresponding to non-written areas is caused by positive ions discharging the surface of the target.

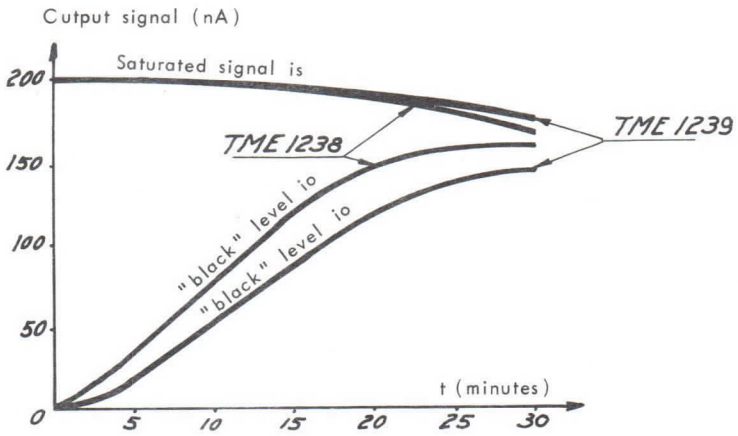


Fig 16 : Variation of signal versus time, remanence

- Uniformity

Figure 17a shows a picture stored in a TME and displayed on a T. V. monitor It gives a qualitative idea of background and signal uniformity as well as of the reproduction of gray shades which is quite similar to a camera tube. It must be noted that it is possible to read only one part of the stored image (Zoom effect) as shown in figure 17b.

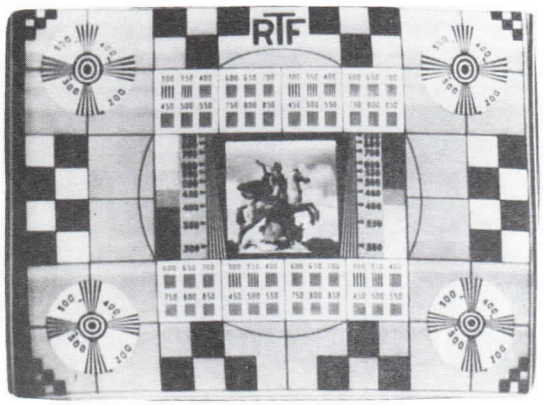


Fig 17a : Recorded image on the TME 1239

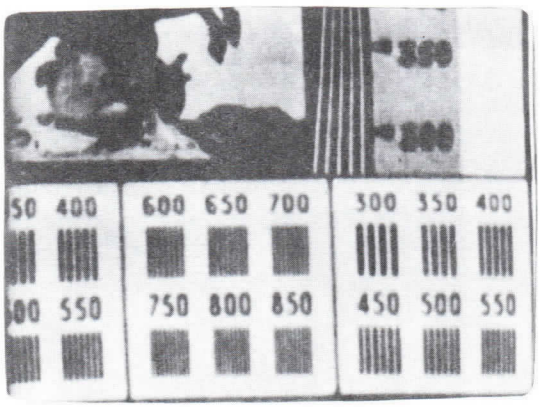


Fig 17b : "Zoom" effect : portion of the image shown in fig 17a

Figure 18 shows a two level picture application where a TME is used to store and display alphanumerics.

Figure 19 demonstrates the possibility of local and precise erasing offered by the TME's (line marked by an arrow on fig. 18 is erased on fig. 19).

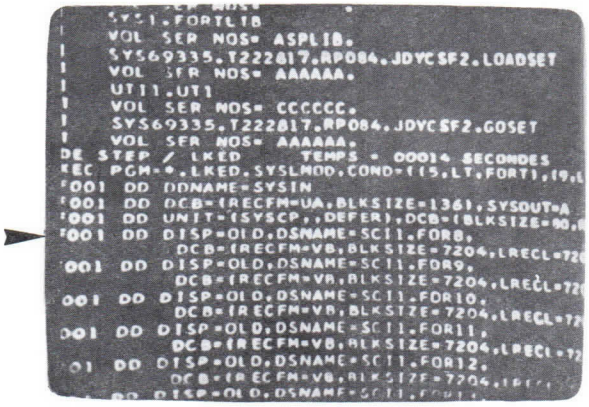


Fig 18 : Character recording

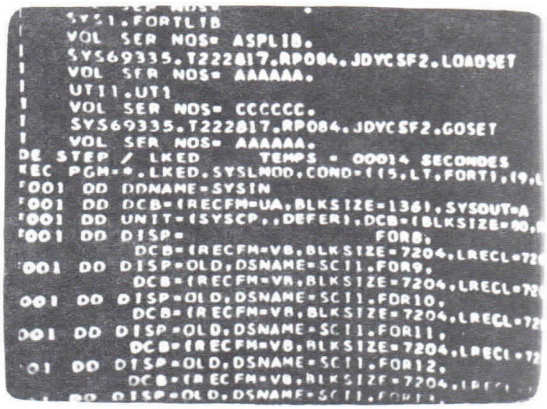


Fig 19 : Selective erasure of some characters

- Integration

Figure 20 shows the amplitude of the output signal versus the number of writing scans at low level. A point of interest is the excellent linearity of the useful part of the curve.

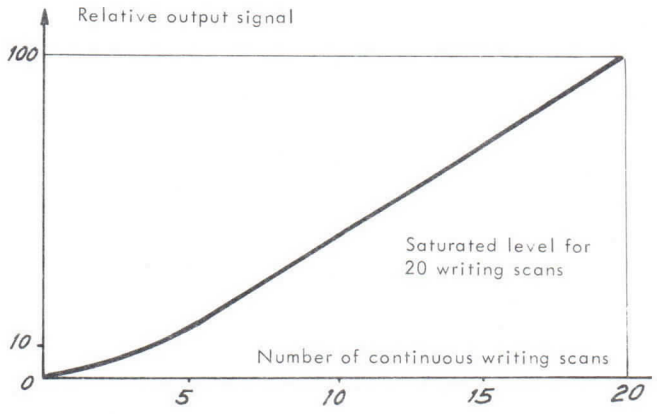


Fig 20 : Integration characteristic

III - 3 - Other single-gun TME's

Several tubes based on the same principle as the TME 1238 and TME 1239 have been or are being developed. Scientists are working actively to develop especially : an electrostatic focus and deflection tube, a high writing speed tube and a high resolution tube.

III. 3.1 - Fully electrostatic TME 1348

This tube has a size similar to the TME 1239 but utilizes electrostatic focus and deflection. The main advantages of this system are the following :

- Reduction of equipment weight by the elimination of coils.
- Reduction of focusing and scanning power resulting in further reduction of equipment weight.
- More precision in positioning a "read point" from a stored image (more precise addressing).
- Better image raster.

On the other hand, those advantages result in decreased resolution (600 T. V. lines at 50 % modulation) which is only the half of the resolution obtained with a corresponding electromagnetic TME.

III. 3.2 - TME with better resolution

The resolution of a TME depends upon :

- the spot size
- the fineness of target mosaïc
- the overall surface of the target.

It is possible, by optimizing these 3 parameters, to improve the resolution which is now 1200 T. V. lines for the TME 1239. Work is now underway which will increase the useful area of the target and improve the fineness of the mosaïc ; the problem is the fact that it is difficult to maintain a fine spot size over a greater target area. The use of Silicon plates of 60 mm diameter allows for a resolution of 2000 to 2500 T. V. lines at 50 % modulation.

III. 3.3 - TME with high writing speed

The target capacitance c (see chapter II. 3) of the TME 1238 and TME 1239 allows for the writing and erasing of the target in 40 ms and a retention time in the order of 10 mn with continuous read-out. These tubes are specially intended to store T. V. images.

It is however possible, by modifying the capacitance c of the target, to increase the writing and erasing speed if a less long retention time is required.

Tubes of this type, offering lower target capacitance are now being developed. The reduction of c capacitance by increasing the dielectric thickness will however involve a less fine structure of the mosaïc thereby altering the resolution. The writing speed can also be increased by increasing the beam current which also will involve a decrease of resolution, since the spot diameter will increase in accordance with the beam current.

Although the development of these tubes is not over, it seems that it offers considerable promise for obtaining a writing speed of 1 µs per target diameter with a resolution of 600 T. V. lines per diameter (this speed is 50 µs for TME 1238 and TME 1239).

IV - TME's WITH THIN TARGET

IV - 1 General

The properties of a thin target described in chapter II. 3. 3 are used for the realization of TME's ; specially for dual-gun tubes which permit simultaneous writing and reading . We will specially describe hereafter the TME 1496 the development of which is now completed.

IV. 2 - TME 1496

IV. 2.1 - Construction

The TME 1496 shown in figure 21 is a double-ended tube of small size, operating at low voltage mode and requiring associated electronics relatively simple and inexpensive.

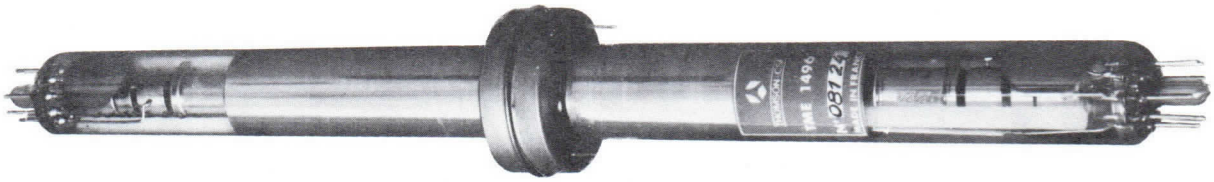


Fig 21 : Double gun TME 1496

It includes two electromagnetic focus and deflection guns and can use standard 1" Vidicon hardware.

Schematic view of its structure is shown in figure 22. It includes on both sides of the thin target, 2 field meshes and two guns quite similar to that of TME 1238 described in chapter III. 2.1.

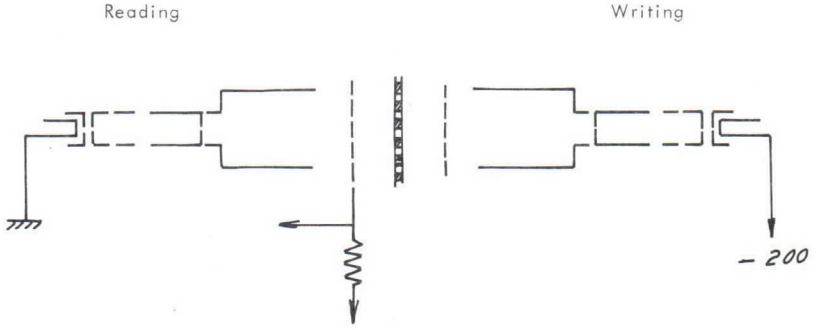


Fig 22 : Schematic view of the TME 1496

IV. 2.2 - Operating principle

Operating principles of this tube are illustrated in figure 23.

- Writing (fig. 23 a)

We assume that, after an earlier erasing, the dielectric surface facing the reading side is at -10 V and the writing electron beam scans the target with an intensity modulated by the signal applied to the wehnelt.

Considering that the potential difference between the target and the writing cathode is high enough (about 200 V) to have a coefficient $\delta > 1$, positive charges are deposited which increase the potential of the written point by +5 V on the writing side.

By capacitive coupling the potential of the corresponding point on the reading side will increase by a value of about 5 V and thereby its potential is shifted from -10 V to -5 V.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

- Reading (fig. 23 b)

The reading is performed by scanning the target by an unmodulated beam as described in chapter III. 2.2. for single ended tubes.

- Erasing

This can be done by using either the writing beam (fig. 23 c) or the reading beam (fig. 23 d).

In the first case, the target is at -185 V ; the writing electrons landing on the dielectric (writing side) with an energy of 15 eV and giving rise to a secondary emission ratio $\delta < 1$, the dielectric is then brought, after bombardment, to an equilibrium potential of -200 V that is -15 V with respect to the target metal backplate.

In the second case, the erasing is achieved by a mechanism identical to the single-gun TME's.

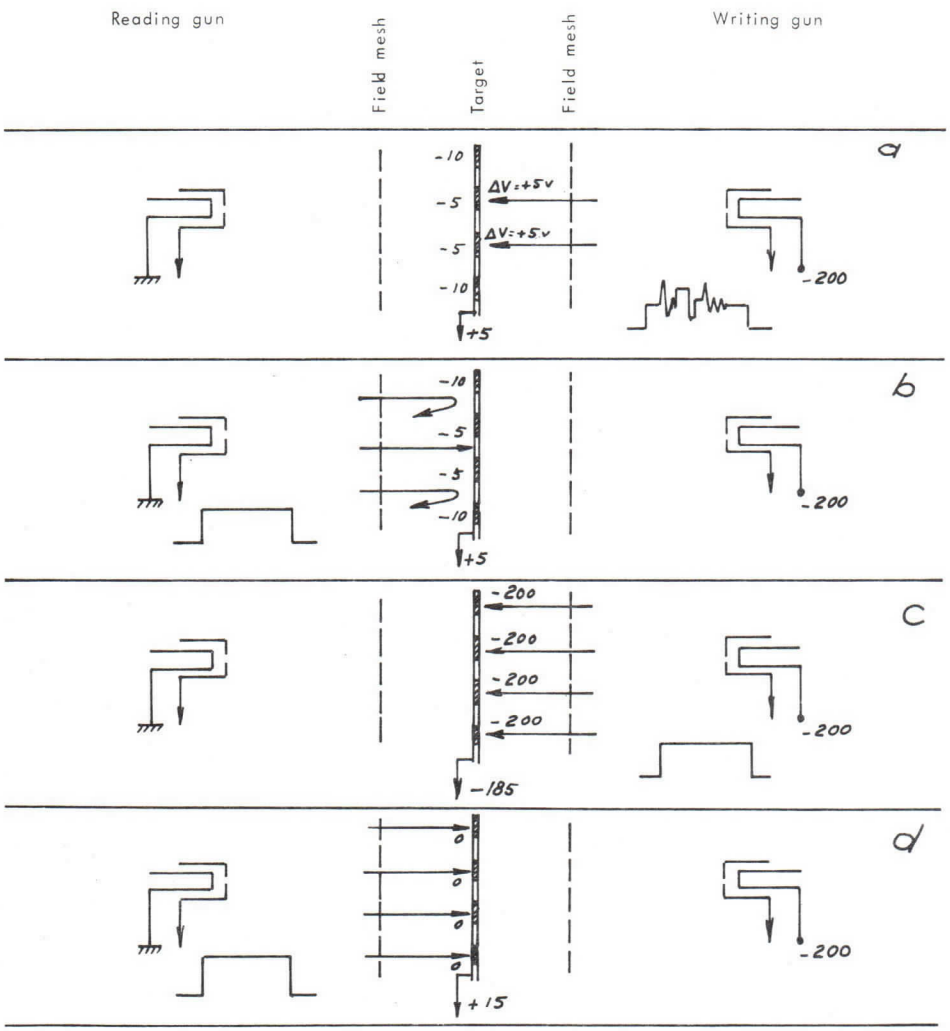


Fig 23 : Operating principle of the TME 1496

Only the major operations are described here since this tube exhibits many variations of operation which can respond to any desired application.

For example, only the writing mode achieved by the writing gun has been described. It is obvious that this operation may be achieved by the reading gun by switching, for example, of the target voltage. It is also possible to conceive, for a radar application, a gradual variable erasing by the writing gun and automatic switching in writing mode just as the echoes begin to appear.

Furthermore, it must be noted that there will be no crosstalk thanks to the effective isolation between the reading and writing sections. For this purpose, the signal is not collected on the target but on the field mesh located at the reading side, as shown in chapter II. 2. 3.

VI. 2. 3 - Performance

Performance of TME 1496 are as follows :

- Writing speed : for the overall target area	33 to 40 ms (1 T. V. frame)
- Storage time with reading beam turned-off	a month
- Output signal current	0. 2 µA
- Output capacitance (target or field mesh)	approx. 10 pF
- Resolution measured by orthogonal read-write at 50 % modulation	800 T. V. lines/diameter
- Retention time with continuous read-out	5 to 10 mn
- Erasing time for the overall target with erasing by either gun	33 to 40 ms (1 T. V. frame)

The examination of the above mentioned performance characteristics demonstrates that the results obtained from the dual-ended TME 1496 are very similar to those mentioned in chapter III. 2. 3. concerning the TME 1238.

Figure 24 shows an image stored by a TME 1496 ; the black zones have been selectively erased in the right upper corner by the reading gun and in the left lower corner by the writing gun.

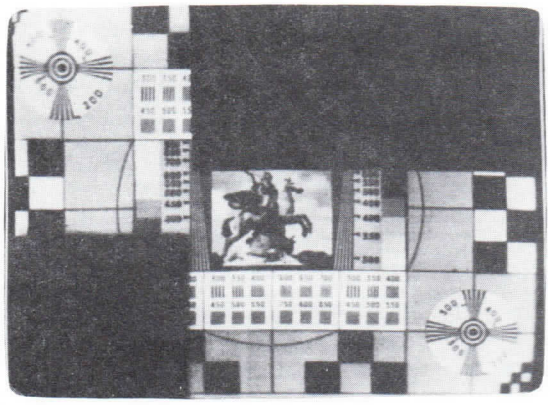


Fig 24 : Image recorded on the TME 1496 and selectively erased by both guns

IV. 3 - Other TME's with thin target

Although the studies of these tubes are not yet completed, it is of interest to note the development of two tubes of this type.

First, a tube having a structure similar to the TME 1496 but exhibiting higher resolution. We are working especially to increase the useful target diameter in order to reach a resolution ranging from 1000 to 1500 T. V. lines per diameter.

The second developmental tube has a structure and a utilization slightly different, since the input is a luminous signal. In this tube the writing gun is replaced by a photocathode associated to an image transfer. Such a tube can permit the integration and the storage of low light level images by using the integration properties of the TME targets.

THOMSON-CSF

TME 1239 A
1½" RECORDING STORAGE TUBE

- HIGH RESOLUTION (limiting resolution : 2700 TV lines/diameter)
- SINGLE-ENDED, ELECTROMAGNETIC FOCUS AND DEFLECTION
- NON-DESTRUCTIVE READOUT
- FAST-ERASING (1 TV frame)
- GRAY-SCALE CAPABILITY

The TME 1239A is a low-cost, single-ended, high resolution, non-destructive readout storage tube capable of storing and reading-out information in the form of electrical signals. It is fully interchangeable with the previous TME 1239 in all its applications.

As compared with the latter, it offers a significant increase in resolution under the same operating conditions. In the orthogonal read-write mode, the resolution at 50 % modulation reaches 1500 TV lines/diameter (instead of 1200). Up to 1900 TV lines/diameter at 50 % modulation are obtained in a higher voltage mode. The low voltage mode is to be used in applications where uniformity and low consumption are predominant while the high voltage mode is to be chosen when maximum resolution is of prime importance.

Continuous readout can be achieved for a few minutes without degradation of the stored information. The tube features fast writing and erasing, large storage and integration capability and selective erasure possibility. When gradual erasure of the stored information is required, it is possible to erase during line or image retrace in order to obtain the desired decay.

All these characteristics make the TME 1239A particularly suitable for numerous applications such as : T.V. frame-freeze, slow-scan T.V., data recording and storage, scan conversion, integration of low level video signals, accurate write-read registration.

Owing to its structure and electronoptics similar to 1 1/2" Vidicon, the TME 1239A can use supplies and coil assemblies designed for this Vidicon type.

To achieve the best performances of the tube, the user is advised to refer to the "Operating Instructions" given in the relavant Data Sheet TEV 3140.

The TME 1239A can be implemented in the TTV 3900A Storage Unit manufactured by THOMSON-CSF, and described in Data TEV 3185.

TYPICAL PERFORMANCES

Peak output current	0.2 μA
Writing time :	
- writing over the whole target area	33 - 40 ms (1 T.V. frame)
- writing of one target diameter	50 μs
Erasing time :	
- erasing of the whole written image to residual less than 5 %	33 - 40 ms (1 T.V. frame)
- selective erasing of one target diameter	300 μs
Decay by line retrace erasure	adjustable from 1 s to 15 mn
Reading time for continuous readout	10 to 15 mn
Storage time without readout	several days
Center resolution by orthogonal writing and reading at 50 % modulation (See Figure 1)	normal voltage mode 1500 T.V. lines/diameter high voltage mode 1900 T.V. lines/diameter

GENERAL CHARACTERISTICS

Electrical

Heater voltage	6.3 V
Heater current	0.6 A
Output capacitance (target to all other electrodes)	11 pF
Input capacitance (grid g1 to all other electrodes)	10 pF
Focusing method	electromagnetic
Deflecting method	electromagnetic
Coils assembly (focus - deflection - alignement)*	TH 7205 or equivalent (CELCO TV 348, or CLEVELAND 15 VFA 259 - 15 VY or PENN - TRAN)

* In any case permanent ring magnet sometimes delivered with vidicon coil assembly must be removed.

Mechanical

Base	UTE 9 C 15, (JEDEC E8 - 11)
Operating position	any
Weight, approx.	200 g
Dimensions	see drawing

MAXIMUM RATINGS

(absolute values)

Unless otherwise stated, voltages are given with respect to cathode potential.

Grid g5 voltage	1200 V
Grid g4 voltage	800 V
Grid g3 voltage	800 V
Grid g2 voltage	800 V
Grid g1 voltage :	
- negative bias value	−180 V
- positive bias value	0 V
Peak heater cathode voltage :	
- heater negative with respect to cathode	−150 V
- heater positive with respect to cathode	+150 V
Target voltage	1200 V

TYPICAL OPERATIONS

Unless otherwise stated, voltages are given with respect to cathode potential.

Heater voltage	6.3 ± 10 %	V
Heater current	0.6	A

Normal voltage mode

	Erase mode	Write mode	Read mode	
Cathode voltage	0	0	0	V
Grid g1 (wehnelt) voltage	0	to be adjusted	to be adjusted	V
- cut-off voltage : −50 V to −100 V				
Grid g2 (accelerator) voltage	450	450	450	V
Grid g3 (erasing) voltage	normal / fast			
	450 / 0 to −30	450	450	V
Grid g4 (focus) voltage*	350 to 450	350 to 450	350 to 450	V
Grid g5 (decelerator) voltage	750	750	750	V
Target voltage	10 to 30	200	3 to 10	V
Resolution (Figure 1)			curve 1	

High voltage mode

	Erase mode	Write mode	Read mode	
Cathode voltage	0	0	0	V
Grid g1 (wehnelt) voltage	0	to be adjusted	to be adjusted	V
- cut-off voltage : −75 V to −150 V				
Grid g2 (accelerator) voltage	700	700	700	V
Grid g3 (erasing) voltage	normal / fast			
	700 / 0 to −30	700	700	V
Grid g4 (focus) voltage*	550 to 700	550 to 700	550 to 700	V
Grid g5 (decelerator) voltage	1100	1100	1100	V
Target voltage	10 to 30	200	3 to 10	V
Resolution (Figure 1)			curve 2	

* These values can vary depending on the type of coil assembly used. To obtain the best resolution, a slight correction of grid g4 potential (about −10 V) is needed in writing mode.

For best operation of readout preamplifier it is recommended to connect a by-pass capacitor between g4 and ground (for example 0.1 µF) on g4 pin located in front of the tube.

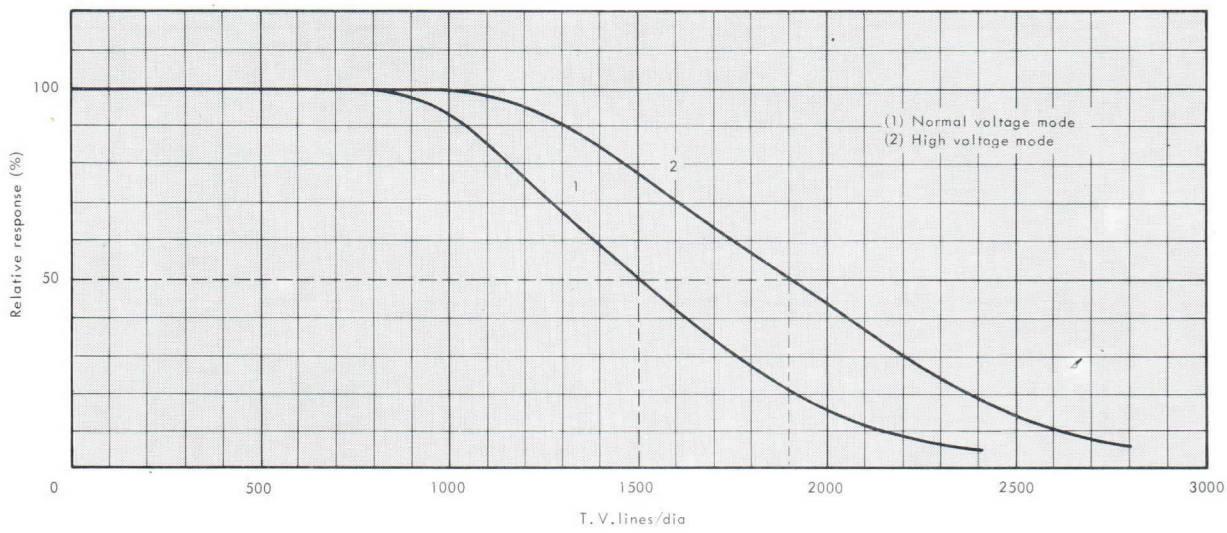


Figure 1 - Resolution characteristics

The above curves give the modulation measured by orthogonal read/write method. In practice, the values of resolution at 10 % modulation in sinusoidal writing and colinear reading (M.T.F.) is about 1.1 times the values of resolution at 50 % modulation in orthogonal writing and reading.

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE**

The main components of the tube are an electron gun and a storage target assembly.
The electron gun includes an additional erasing electrode which enables two erasing modes, normal or fast, depending on low or high beam current.
The target is made of a storage backplate on which the storage dielectric is deposited.
A general cross-view of the tube is given on fig. 2, and magnified view of the target on fig. 3.

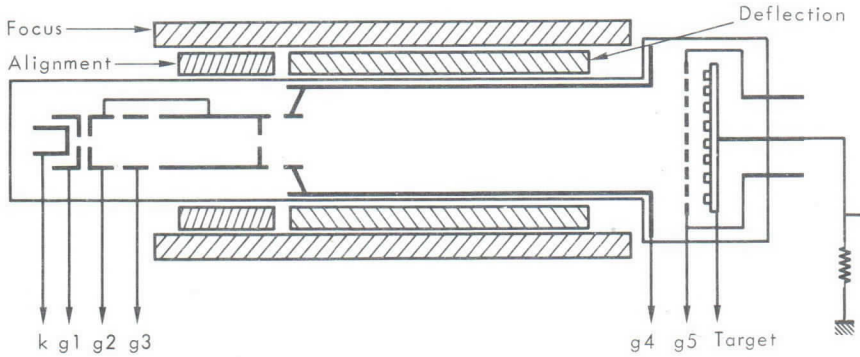


Figure 2

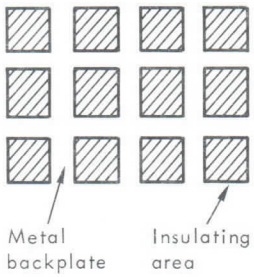


Figure 3

The principle of operation is the charge and discharge of the storage surface, according to the velocity of the primary electron beam through secondary emission of the storage surface.
Typical values (with respect to cathode) in erasing, writing and reading are given in fig. 4 as an example of operating conditions.

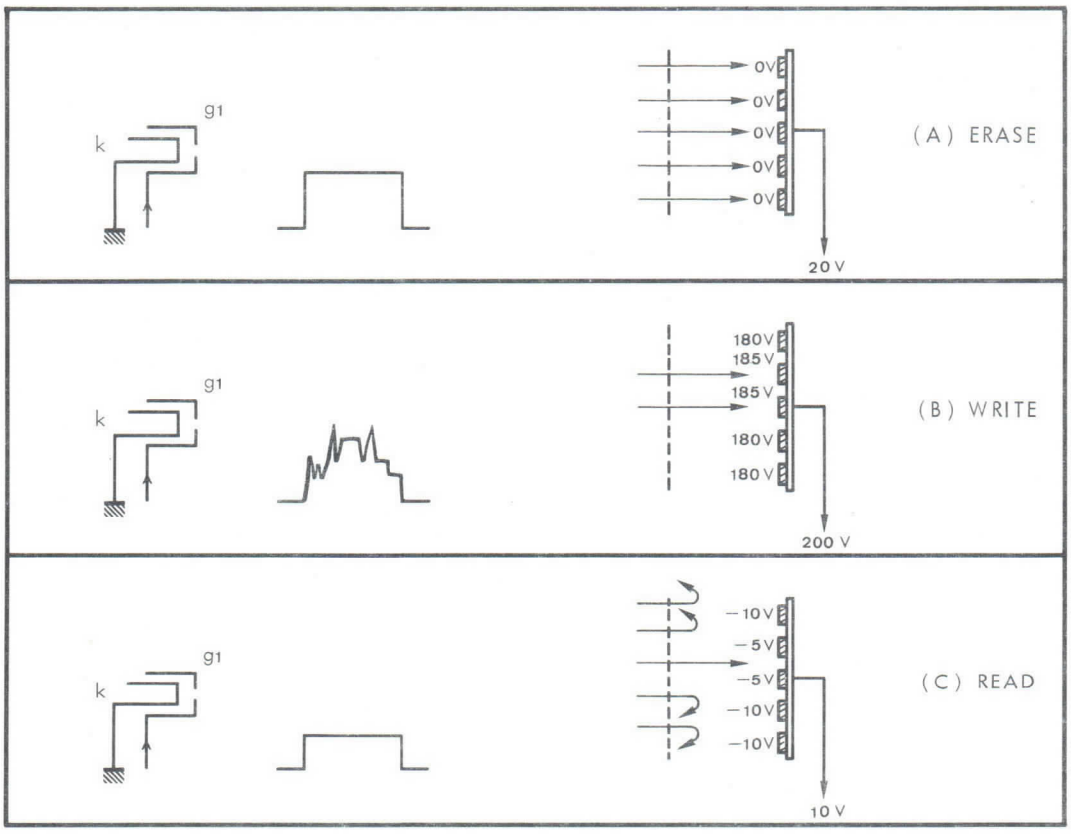


Figure 4

** Detailed considerations about "Recording Storage Tubes" principles and operations are given in the Technical Information DATA TEV 6013 which we ask the user to refer to.

A - ERASE-PRIME

It is necessary to erase residual charges at the storage surface prior to writing. Erasure can be done by shifting the backplate voltage to 20 V. The capacitive coupling and the low energy electron beam cause the dielectric to be charged down to 0 V through secondary emission ratio less than 1.

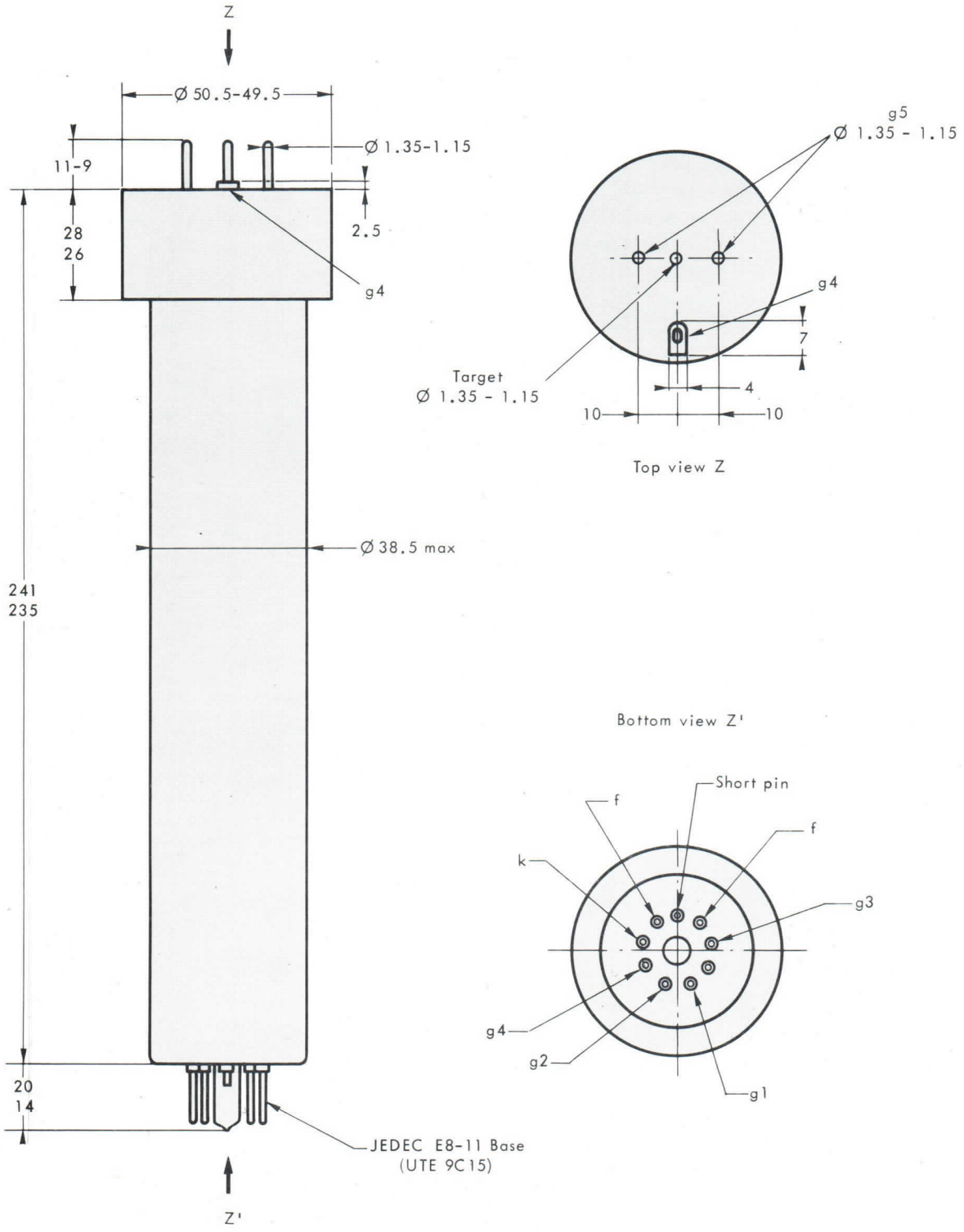
B - WRITE

Storage backplate voltage is shifted to + 200 V. Storage surface voltage is shifted to 180 V by capacitive coupling. When the electron beam modulated by the video input signal scans the storage surface, secondary emission ratio is then greater than 1 and positive charges are deposited on the dielectric areas, shifting their potential from 180 V to a few volts more positive values (185 V for example).

C - READ

Once the charge pattern has been written it can be readout by dropping the storage backplate voltage from 200 V to 10 V and by scanning it with an unmodulated beam. Depending on the written charge pattern the storage surface voltage varies between 0 V and − 10 V and signal output varies in exact correspondance. The most negative areas of the dielectric can completely cut-off the electron beam while various gray shades can be obtained in areas where the dielectric is less negative. Since the storage surface voltages are negative with respect to gun cathode voltage the reading beam has no adverse effect on the pattern and the readout is non destructive.

OUTLINE DRAWING



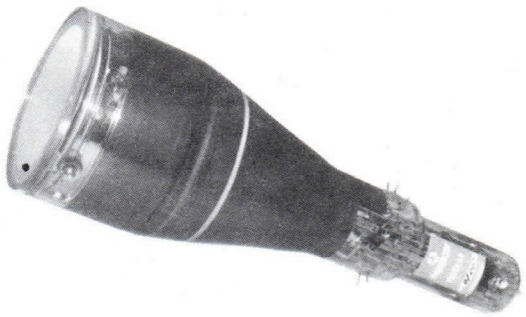
Dimensions in mm.

TEI 1323
DIRECT VIEW STORAGE TUBE
FOR OSCILLOSCOPIC APPLICATIONS

- 8 x 10 DIVISIONS GRATICULATED FLAT FACE
- HIGH WRITING SPEED : UP TO 10 mm/µs
- LONG STORAGE TIME : UP TO 2 HOURS

The TEI 1323 is a direct view storage cathode ray tube with a 102 mm (4") useful screen diameter designed for high frequency (50 MHz bandwidth) storage oscilloscope use.

The flat circular screen of P 31 type includes a graticule (90 mm x 72 mm) having the pattern shown in the dimensional outline. The two flood guns symetrically located with respect to tube axis enable to obtain bright display of information over the entire useful area. The on-axis writing gun features high resolution and high deflection sensitivity without geometrical distortion ; it is electrostatically focused and deflected.



The horizontal and vertical deflection voltages are supplied through pins located on tube neck which assure shorter connections with resulting in significant reduction of plate capacitances.

This tube is suitable for storage oscilloscope services with controllable viewing time and controllable persistence. In addition, it will operate as a P.D.A. oscilloscope C.R.T. without storage.

TYPICAL PERFORMANCES

Writing speed *	max.	10	mm/µs
Line width at center		0. 4	mm
Viewing time*	adjustable up to	60	mn
Erasing time*	max.	0. 5	s
Brightness * (screen voltage 8 kV)	adjustable up to	1500	cd/m^2

* *Those characteristics can be varied within wide ranges of values depending on specific application. In order to achieve full capability of the tube, please refer to " operating modes " described hereafter.*

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

GENERAL CHARACTERISTICS

Electrical

Flood guns :			
Number		2	
Heater voltage		6.3 d.c.	V
Heater current		2 x 0.3	A
Writing gun :			
Heater voltage		6.3 a.c.	V
Heater current		0.6	A
Focusing method		Electrostatic	
Deflection method		Electrostatic	
Interelectrode capacitances :			
g1 to all other electrodes	max.	15	pF
k to all other electrodes	max.	6	pF
x1 or x2 to all other electrodes	max.	8	pF
y1 or y2 to all other electrodes	max.	5	pF
x1 to x2	max.	4	pF
y1 to y2	max.	3	pF

Optical

Phosphor :	
Type	P31 aluminized
Fluorescence	Green
Phosphorescence	Green
Faceplate	Flat

Mechanical

Minimum useful diameter		102 mm (4")
Overall length	max.	450 mm (17.7")
Base (14 pins)		UTE 14 C 25 (IEC 67 - I - 46 a)
Mounting position		any
Weight, approximate		1 kg (2.4 Lb)

OPERATING CONDITIONS

Maximum values (absolute ratings)

Unless otherwise stated, voltages are given with respect to ground.

FLOOD GUNS

Heater h' voltage	5.7 to 6.9	d.c.	V
Cathode k' voltage	0		V
Grid g'1 voltage (control grid or Wehnelt)	0 to −200		V
Grid g'2 voltage (accelerating electrode) max.	200		V
Grid g'3 voltage (collimating electrode) max.	200		V
Grid g'5 voltage (collecting electrode) max.	300		V
Grid g'6 voltage (backing electrode) max.	−50 to +20		V
Viewing screen g'7 voltage max.	9		kV
Peak heater to cathode voltage :			
- heater negative with respect to cathode max.	125		V
- heater positive with respect to cathode max.	125		V

WRITING GUN

Heater h voltage	5.7 to 6.9	a.c.	V
Cathode k voltage (negative value) max.	2.5		kV
Grid g1 voltage** (control grid or Wehnelt)	0 to −200		V
Grid g2 voltage (accelerating electrode) max.	200		V
Grid g3 voltage (beam centering electrode) max.	200		V
Grid g4 voltage** (focusing electrode) max.	1.2		kV
Grid g5 voltage (astigmatism) max.	200		V
Grid g6 (geometry) max.	200		V
Peak heater to cathode voltage :			
- heater negative with respect to cathode max.	125		V
- heater positive with respect to cathode max.	125		V

** *With respect to writing gun cathode.*

Typical operation

Unless otherwise stated, voltages are given with respect to ground.

FLOOD GUNS

Heater voltage	6.3	d.c.	V
Cathode h' voltage	0		V
Grid g'1 voltage	−30 to 0		V
Grid g'2 voltage	+40		V
Grid g'3 voltage	50 to 90		V
Grid g'5 voltage	200		V
Grid g'6 voltage :			
- store mode	0 to +5		V
- non-store mode	−50		V
Viewing screen g'7 voltage	8		kV

WRITING GUN

Heater h voltage	6.3	a.c.	V
Cathode k voltage	−1800		V
Grid g1 voltage** (for cut-off)	−100 to −40		V
Grid g2 voltage	+40		V
Grid g3 voltage	0 to 80		V
Grid g4 voltage**	200 to 600		V
Grid g5 voltage	0 to 80		V
Grid g6 voltage	0 to 80		V

** *With respect to writing gun cathode.*

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PHYSICAL DESCRIPTION

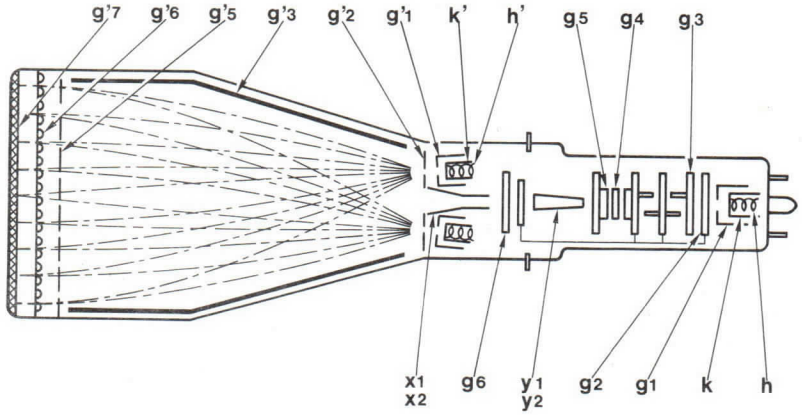
The TEI 1323 consists of 4 basic assemblies :

1 - The storage unit
the component of which are a collecting electrode and a fine metallic mesh called the backing electrode upon which the dielectric storage surface is deposited.

2 - The viewing screen
made of P31 phosphor, provides the visual output.

3 - The writing gun
located in the neck of the tube generates a high velocity electron beam electrostatically focused and deflected.

4 - The flood guns
produce wide angle low velocity electron beams which flood the storage mesh normally and at a constant current density over the useful area owing to the collimating electrode.



Flood guns

h' - heater
k' - cathode
g'1 - wehnelt
g'2 - accelerating electrode
g'3 - collimating electrode

Storage unit

screen

g'5 - collecting electrode
g'6 - backing electrode
g'7 - viewing screen

Writing gun

h - heater
k - cathode
g1 - wehnelt
g2 - accelerating electrode
g3 - beam centering electrode
g4 - focusing electrode
g5 - astigmatism
y1 y2 - vertical deflection plates
g6 - geometry
x1 x2 - horizontal deflection plates

OPERATING MODES

Depending on the specific applications, the TEI 1323 can be used : - in non-store mode
- in store mode

1 - Non-store mode

The tube can be operated without storage in the same way as a conventional C.R.T. ; for doing so, a voltage of –50 V is to be applied on the backing electrode g'6. The flood gun electrons are repelled back by the storage surface and cannot reach the viewing screen while the high energy writing electrons pass through the backing electrode and can display information on the viewing screen.

It is to notice that, in this mode, the flood gun electron beams should be normally established.

Conventional oscilloscopic performances

Resolution (note 1)	0.4	mm
Spot position, focused and undeflected (deviation from center)	9	mm
Deflection characteristics :		
x plates deflection factor	10 ± 10 %	V per division
y plates deflection factor	6 ± 10 %	V per division
Useful screen area (internal graticule) :		
x axis (10 divisions of 9 mm)	90	mm
y axis (8 divisions of 9 mm)	72	mm
Trace alignment :		
angle between x and y traces	89 to 91	°
angle between x trace and horizontal axis of graticule (note 2)	±5	°
Pattern distortion (note 3)		

NOTES

1 - Line width measured for beam current of 5 μA by the shrinking raster method, in non-store mode.

2 - Without magnetic correction.

The parallelism between x trace and xx' axis on graticule can be obtained by adjusting the current of a magnetic flat coil located around the bulb.

3 - An overlay consisting of two concentric squares of 72 x 72 mm and 70 x 70 mm is centered on the face of the tube. An inscribed line should lie between this interval of 1 mm. Because of the trace width, one single line edge should be taken into account.

2 - Store mode

Erasing

Erasure of stored information is made by charging the storage surface in a negative direction. This is done by the flood gun whose low beam energy results in secondary emission ratio less than unity. A positive pulse ΔV is applied to the backing electrode. Due to capacitive coupling, the storage surface potential will rise and shifted to the same positive potential ΔV ; the flood electrons are attracted by the storage surface and charge it toward flood gun cathode potential i.e. OV. When the pulse ΔV is removed from backing electrode the storage surface potential drops by the same value by capacitive coupling and the dielectric is uniformly carried to a negative potential $-\Delta V$: the flood gun electrons can not reach the screen and the stored information is completely erased.

Writing

In writing operation, the high energy writing beam scans the storage surface and creates positive charges pattern by secondary emission from the dielectric material (secondary emission ratio greater than unity). Each storage element scanned by the modulated writing beam is brought to a less negative potential and let pass through the flood electrons.

Viewing

The amount of flood electrons which pass through each storage element is depending on the local potential of each point. Thus an information can be visualized on the viewing screen which corresponds to the charge pattern written on the storage surface.

Storage performances :

a - CONTROLLABLE VIEWING TIME

Although the viewing is not destructive, the retention or viewing time is limited by residual gas molecules in the tube. Due to collision between flood electrons and these molecules, positive ions are formed which charge gradually the storage surface in a positive direction with resulting in gradual brightening of display background and corresponding loss of display constrast.

Nevertheless, it is possible to extend the viewing time by employing flood gun pulse techniques. In this mode, ion charging rate is decreased by reducing the average electron density of flood beam in exchange of decreasing light output.

The table shown below gives the storage characteristics as a function of the writing speed and the light output.

	Writing speed 1 mm/μs	Writing speed 10 mm/μs
Storage (brightness : 800 cd/m2)	6 mn	2 mn
Long storage (brightness : 40 cd/m2)	120 mn	40 mn

b - CONTROLLABLE PERSISTENCE

Erasure can be accomplished by a single pulse as described above. If persistence is to be controlled, gradual erasure can be performed by applying a train of short pulses to the backing electrode g'6. Depending on rate and duration of pulses, required visual output decay can be obtained. The viewing time can decrease down to 200 ms from the values indicated in the table above.

c - LONG TERM STORAGE

In this mode, the flood beams are established only for viewing then removed. Written information is not degraded by ion charging and can be stored for up to many days.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OPERATIONAL RECOMMENDATIONS

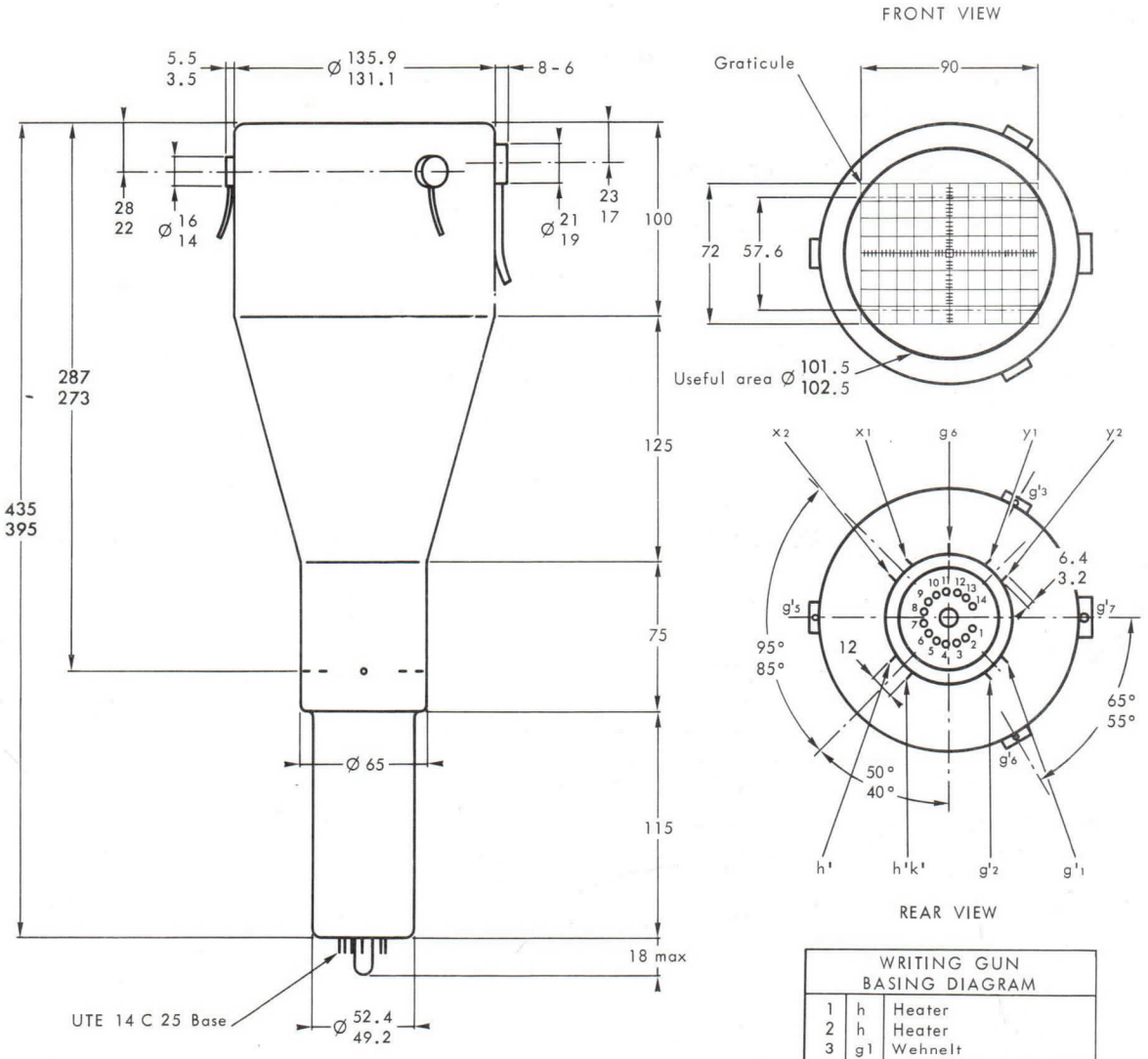
1 - The writing gun can not be allowed to write continuously without appropriate erasure otherwise the storage surface may be damaged.

2 - In the non-store mode (normal C.R.T. operating) the flood gun electron beams should be normally established otherwise the dielectric surface will be brought to a high potential detrimental to tube life.

3 - Magnetic shield is necessary to prevent stray magnetic fields altering the trajectories of low velocity flood beams.

4 - The tube should be handled screen upwards to avoid particles falling on the storage elements.

OUTLINE DRAWING



FLOOD GUNS AND STORAGE UNIT	
h'	Heater
h'k'	Heater cathode
g'1	Wehnelt
g'2	Accelerating electrode
g'3	Collimating electrode
g'5	Collecting electrode
g'6	Backing electrode
g'7	Viewing screen

WRITING GUN BASING DIAGRAM		
1	h	Heater
2	h	Heater
3	g1	Wehnelt
4	g2	Accelerating electrode
5	g1	Wehnelt
6	-	
7	g4	Focusing electrode
8	g3	Beam centering
9	-	
10	g1	Wehnelt
11	-	
12	g5	Astigmatism
13	g1	Wehnelt
14	k	Cathode
	g6	Geometry
x1 x2		Horizontal deflection plates
y1 y2		Vertical deflection plates

Dimensions in mm.

TENTATIVE DATA

TEI 1347

5 INCH BICOLOR HALFTONE DIRECT VIEW STORAGE TUBE

The TEI 1347 is a direct view storage tube providing in two colors brilliant display of stored informations.

The tube includes two writing guns permitting simultaneous writing of two signals.

The informations written by the first gun are stored and visualized in green at variable brightnesses.

The informations written by the second gun are similarly treated in red.

Applications include :

- bicolor storage oscilloscopy
- bicolor presentation of stored characters in peripherals
- radar bright display improvement by visualizing in two colors :
  - map and targets
  - "friends" and "enemies"
  - targets at different altitudes

TYPICAL PERFORMANCES

Writing speed	5	mm/μs
Written line width	0.5	mm
Viewing time	60	s
Brightness (either in green or in red)	10 to 50	Foot Lambert
Stored colors	- green - red - yellow by combination of red and green	

GENERAL CHARACTERISTICS

Electrical

- Flood and writing guns		
Heater voltage	6.3	V
Heater current	0.6	A
- Writing guns		
Number	2	
Focusing method	electrostatic	
Deflection method	electrostatic	

This developmental tube is intended for engineering evaluation. This given data is subject to change unless otherwise arranged. No obligations are assumed for notice of change or future manufacture of this tube.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Optical

Phosphors type	green P 22 aluminized red P 22 aluminized deposited in parallel stripes 0.25 mm in width

Mechanical

Minimum useful diameter	4"
Dimensions	see drawing

OPERATING CONDITIONS

Absolute ratings

Unless otherwise stated, voltages are given with respect to ground.

FLOODING GUN				
Heater f' voltage	5.7	to	6.9	V
Cathode k' voltage			0	V
Grid g'1 voltage (control grid or Wehnelt)			-200	V
Grid g'2 voltage (accelerating electrode)			200	V
Grid g'3 voltage (first collimating electrode)			200	V
Grid g'4 voltage (second collimating electrode)			300	V
Grid g'5 voltage (collecting electrode)			300	V
Grid g'6 voltage (backing electrode)			20	V
Viewing screen g'7 voltage			11	kV
WRITING GUNS				
Heater f voltage	5.7	to	6.9	V
Cathode k voltage			- 2.9	kV
Grid g1 voltage (control grid or Wehnelt) w.r.t.k.	0	to	- 200	V
Grids g2 and g4 voltage (accelerating electrodes)	Connected to g'2			
Grid g3 voltage (focusing electrode) w.r.t.k.			1.2	kV

Typical operation

Unless otherwise stated, voltages are given with respect to ground.

FLOODING GUN				
Cathode k' voltage			0	V
Grid g'1 voltage	adjust 0	to	-150	V
Grid g'2 voltage			60	V
Grid g'3 voltage	adjust 20	to	40	V
Grid g'4 voltage	adjust 40	to	100	V
Grid g'5 voltage			210	V
Grid g'6 voltage			- 6	V
Viewing screen g'7 voltage			10	kV
WRITING GUNS				
Cathode k voltage			- 2	kV
Grid g1 voltage (max. for cut-off) w.r.t.k.			-90	V
Grids g2 and g4 voltages	Connected to g'2			
Grid g3 voltage w.r.t.k.	adjust 400	to	600	V

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE

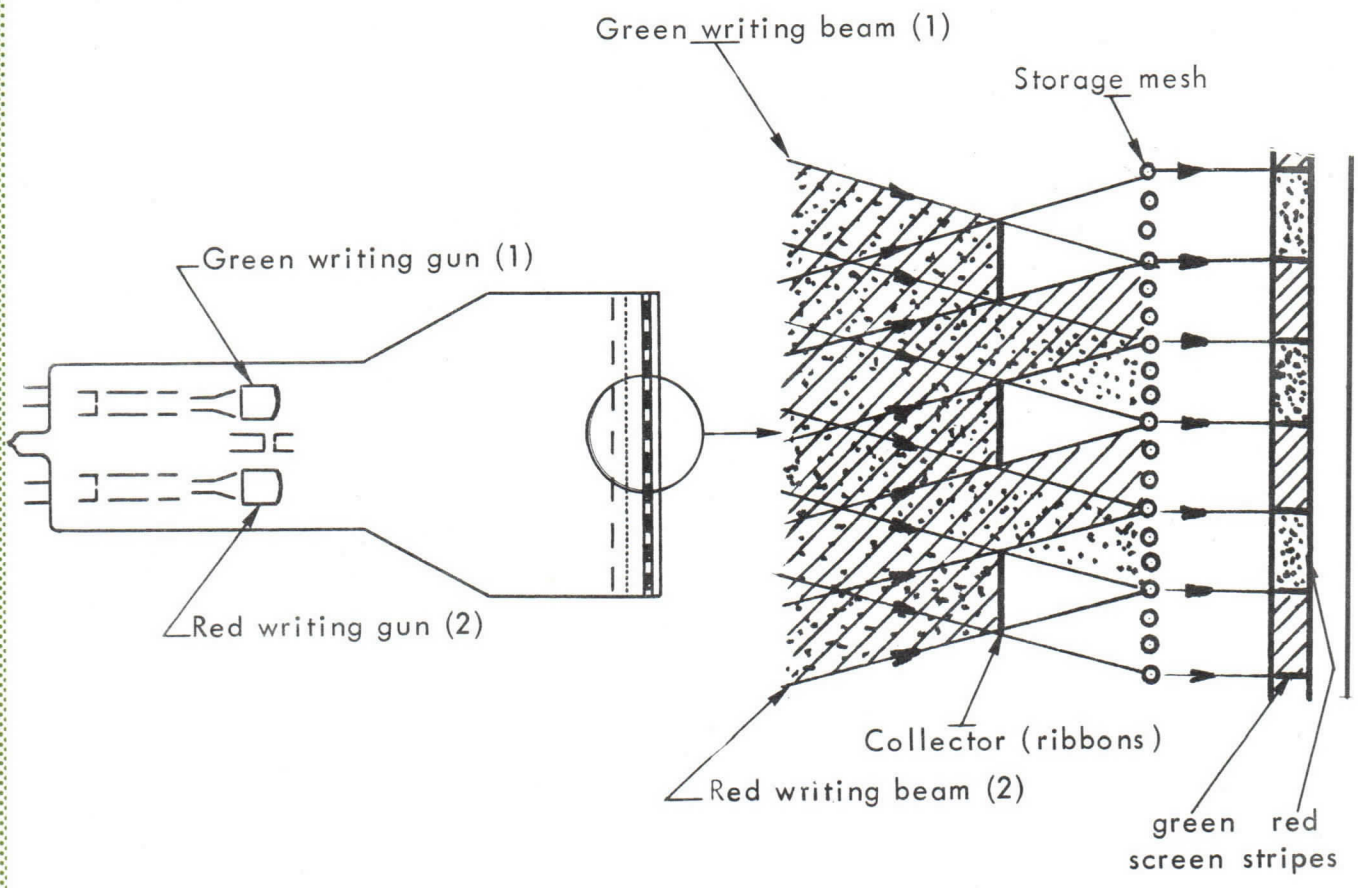
The TEI 1347 consists of four basic assemblies (1) :

1 - The storage unit
the components of which are a fine metallic mesh called the backing electrode on which is deposited a dielectric material and a special collector mesh described below.

2 - The viewing screen
made of parallel stripes of phosphors alternatively red and green, each stripe being 0.25 mm in width.

3 - The flooding gun
produces a wide angle low velocity electron beam and is ended by a collector mesh made of parallel ribbons registered with the parallel stripes of phosphor.

4 - Two writing guns
generating fast electrons which create a charge pattern on the regions of the storage mesh which are not masked for them by the collector, ribbon-shaped, mesh.



(1) THOMSON-CSF patents.

The operating principle of standard direct view storage tubes is described in Data sheets TEV 3021 - 3022.

In this bicolor storage tube the principle is quite similar but writing gun number 1, due to the collector mesh acting as a shadow mask, is able to write on the storage mesh only on certain areas. Writing gun number 2 is able for the same reason to write only on the complementary areas of the storage mesh.

The flood electrons may cross the storage mesh through the written areas and strike the screen on green stripes if the mesh has been written on by gun 1 and on red stripes if the mesh has been written on by gun 2.

Thus data are stored and visualized in green if they are delivered to gun 1 and in red if they are delivered to gun 2.

Erasing is accomplished as in a standard DVST, either completely or progressively by pulses on the backing electrode of the storage unit.

OPERATIONAL RECOMMENDATIONS

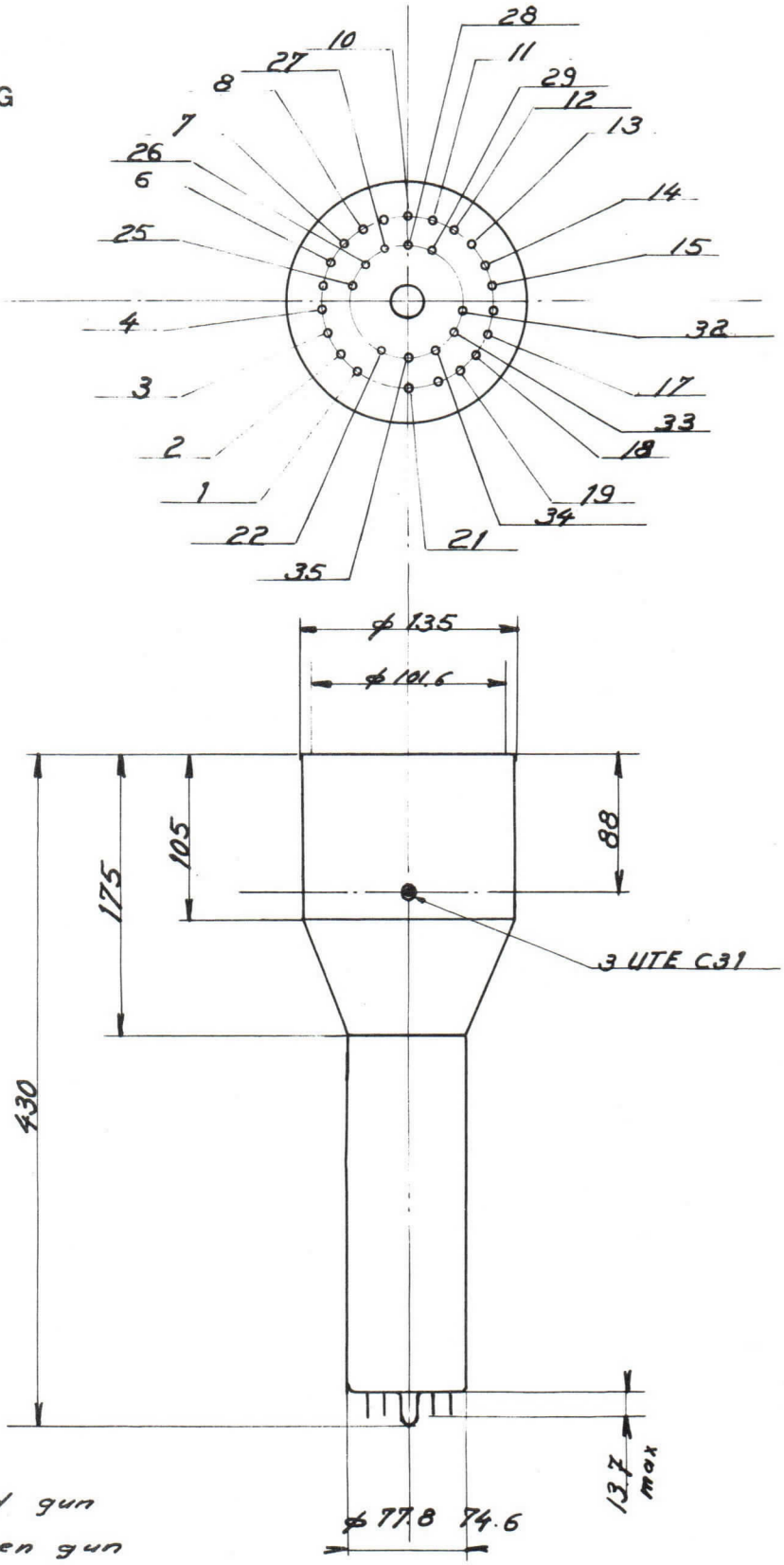
1 - The writing guns can not be allowed to write continuously without appropriate erasure otherwise the storage surface may be damaged.

2 - Magnetic shields is necessary to prevent stray magnetic fields altering the trajectories of low velocity flood beam.

3 - The tube should be handled screen upwards to avoid particles falling on the storage elements.

OUTLINE DRAWING

1		Flood gun heater
2		Flood gun cathode
3	R	Horizontal deflection plate
4	R	Horizontal deflection plate
5		
6	R	Writing gun focusing electrode
7	R	Writing gun control electrode
8	R	Writing gun heater
9		
10	R	Vertical deflection plate
11		Writing and flood guns
12		accelerating electrodes
12		1st collimating electrode
13		Internal connection
14	G	Horizontal deflection plate
15	G	Horizontal deflection plate
16		
17	G	Writing gun focusing electrode
18	G	Writing gun control electrode
19	G	Writing gun heater
20		
21	G	Vertical deflection plate
22		Flood gun heater
23		
24		
25	R	Writing gun cathode
26	R	Writing gun heater
27		No connection
28	R	Vertical deflection plate
29		Flood gun control electrode
30		
31		
32	G	Writing gun cathode
33	G	Writing gun heater
34		No connection
35	G	Vertical deflection plate



(R) : Red gun
(G) : Green gun

Dimensions in mm.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

TME 1348

FULLY ELECTROSTATIC RECORDING STORAGE TUBE

- SINGLE ENDED STORAGE TUBE
- NON DESTRUCTIVE READ OUT
- FAST WRITING AND ERASING

The TME 1348 is a low cost, single-ended, non destructive read out storage tube capable of storing and reading-out information in the form of electrical signals. Continuous read-out can be achieved for a few minutes without degradation of the stored-information.

This tube features fast writing and erasing, large storage and integration capability and selective erasure possibility. When gradual erasure of the stored information is necessary, it is possible to erase during line or image retrace in order to obtain the desired decay.

These characteristics make it particularly suitable for numerous applications such as : slow scan T.V., data recording and storage, scan conversion, integration of low level video signals. . . . .
In addition, the tube is specially designed for applications where power, weight and volume are all of prime consideration.

The scanning electron beam is focused by a separate electrode operating at an appropriate potential. The deflection is ensured by two crossed pairs of deflection plates. These characteristics allow for suppressing the focus and deflection coils.

TYPICAL PERFORMANCES

Peak output current	0.2	µA
Writing time :		
writing over the whole target area	33 to 40	ms (1 T.V. frame)
writing of one target diameter	50	µs
Erasing time :		
erasing of the whole written image to residual less than 10 %	33 to 40	ms (1 T.V. frame)
Storage time :		
several days without reading		
Reading time :		
for continuous read-out	10 to 15	mn
Decay :		
by line retrace erasure, adjustable	from 1 s to 15	mn
Resolution :		
by orthogonal writing and reading at 50 % modulation . .	600	T.V. lines per diameter

This developmental tube is intended for engineering evaluation. This given data is subject to change unless otherwise arranged. No obligations are assumed for notice of change or future manufacture of this tube.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

GENERAL CHARACTERISTICS

Electrical

Heater voltage	6.3	V
Heater current	0.150	A
Output capacitance	10	pF
Focusing method	electrostatic	
Deflecting method	electrostatic	

Mechanical

Base	CEI 67 - 1 - 37 a
Operating position	any
Weight, approx.	200 g
Dimensions	see drawing

TYPICAL OPERATING CONDITIONS (1)

Voltages listed hereunder are typical values. They may have to be modified according to values given in the operating Data Sheet accompanying each tube.

Heater voltage	6.3 ± 10 %	V
Heater current	0.135 to 0.165	A

	Erasing mode	Writing mode	Reading mode	
Cathode voltage	0	0	0	V
Grid g1 (Wehnelt) voltage cut-off voltage −50 V to −100 V	0	to be adjusted	to be adjusted	V
Grid g2 (accelerator) voltage	750	750	750	V
Grid g3 (erasing) voltage	normal fast 750 0	750	750	V
Grid g4 (focus) voltage (2)	to be adjusted 100 to 150	to be adjusted 100 to 150	to be adjusted 100 to 150	V
Deflection D.C. voltages (3) :				
x1 − x2 or D1 − D2	870 to 930	870 to 930	870 to 930	V
y1 − y2 or D3 − D4	870 to 930	870 to 930	870 to 930	V
Peak to peak deflection voltages (4)				
x1 − x2 or D1 − D2	2 x 45	2 x 45	2 x 45	V
y1 − y2 or D3 − D4	2 x 35	2 x 35	2 x 35	V
Grid g5 (decelerator) voltage	1400	1400	1400	V
Grid g6 (wall electrode) voltage	900	900	900	V
Target voltage	10 to 25	200	3 to 10	V

MAXIMUM ELECTRODE CURRENTS

	Writing and reading modes		Fast erasing mode	
Cathode current	1	mA	3	mA
g1 current	5	µA	5	µA
g2 current	1	mA	3	mA
g3 current	50	µA	50	µA
g4 current	10	µA	10	µA
x1 plate current	10	µA	10	µA
x2 plate current	10	µA	10	µA
y1 plate current	10	µA	10	µA
y2 plate current	10	µA	10	µA
g5 current	10	µA	500	µA
g6 current	10	µA	100	µA
Target current	10	µA	100	µA

NOTES

1 - Optimum resolution and uniformity of signal are reached when the tube is protected on its entire length by a double metallic shield made with suitable magnetic permeability materials which is designed to prevent external magnetic and electric fields from impairing the resolving capability of TME 1348.

2 - For optimum resolution, g4 voltage during write mode must be slightly smaller (around 5 V) than g4 voltage during read mode.

3 - D.C. voltages are applied on the deflection plates. These adjustable voltages compensate the geometrical distortions due to electron beam or to imperfect mounting of the deflecting plates. The optimum values to be applied on each pair of deflection plates which correspond to a minimum astigmatism of the beam can be different for the x and y deflection plates and are given on the operating Data sheet accompanying each tube.

4 - The deflection voltages are symmetrically applied on each plate of the deflecting system. Indicated values are for each electrode the peak to peak voltages necessary to deflect on the whole diameter of the target.

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE

The main components of the tube are an electron gun and a storage target assembly.

The electron gun includes an additional erasing electrode which enables two erasing modes depending on low or high beam current.

The target is made of a storage backplate on which the storage dielectric is deposited.

A general cross-view of the tube is given on fig. 1 and magnified view of the target on fig. 2.

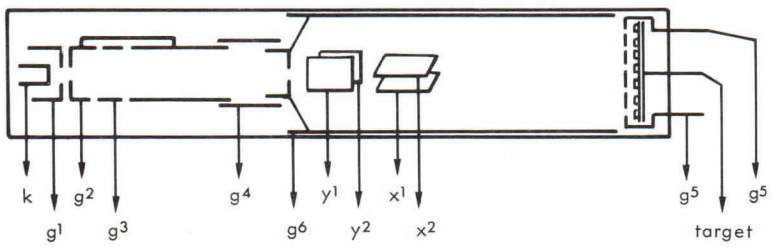


Figure 1

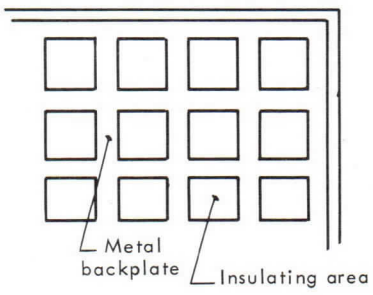


Figure 2

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

The principle of operation is the charge or discharge of the storage surface, according to the velocity of the primary electron beam through secondary emission of the storage surface.

Typical values (with respect to cathode) in erasing, writing and reading modes are given on fig. 3 as an example of operating conditions.

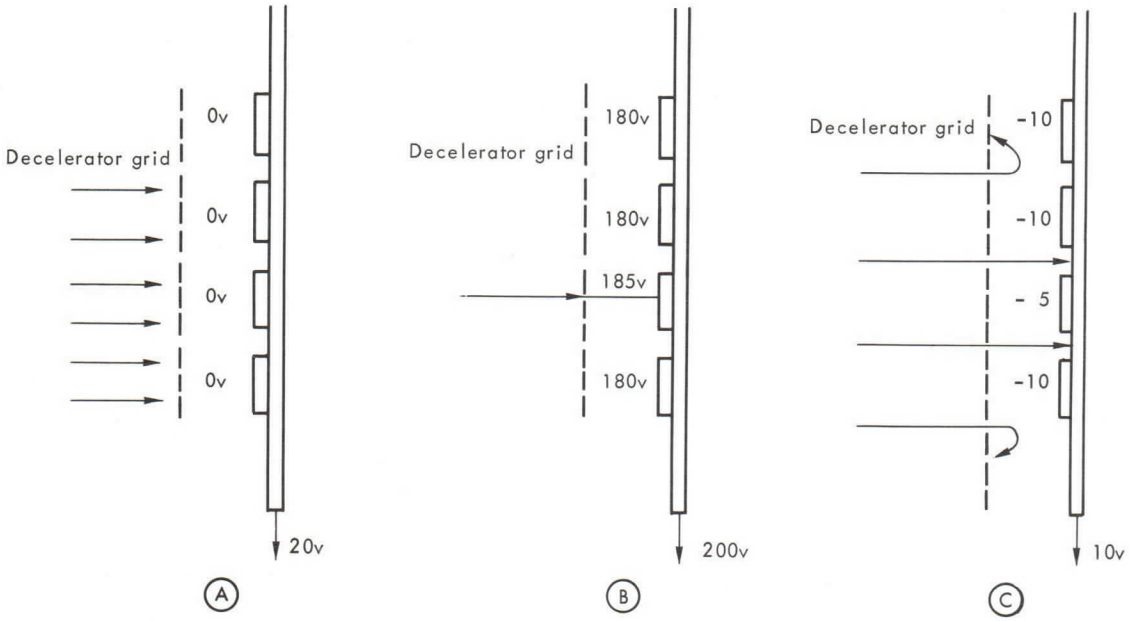


Figure 3

A - ERASE-PRIME

It is necessary to erase residual charges at the storage surface prior to writing. Erasure can be achieved by shifting the backplate voltage to 20 V. The capacitive coupling and the low energy electron beam cause the dielectric to be charged down to 0 V through secondary emission ratio less than 1.

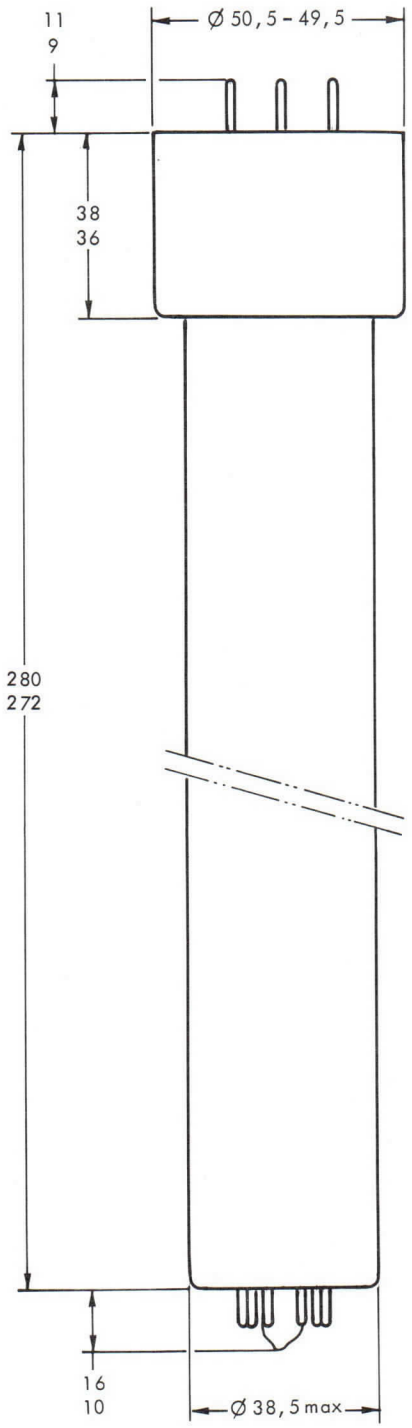
B - WRITE

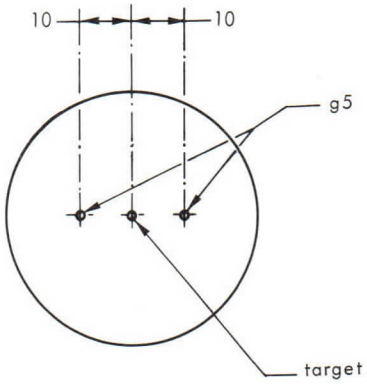
Storage backplate voltage is shifted to +200 V. Storage surface voltage is shifted to 180 V by capacitive coupling. When the electron beam modulated by the video input signal scans the storage surface, secondary emission ratio is then greater than 1 and positive charges are deposited on the dielectric areas, shifting their potential from 180 V to a few volts more positive values (185 V for example).

C - READ

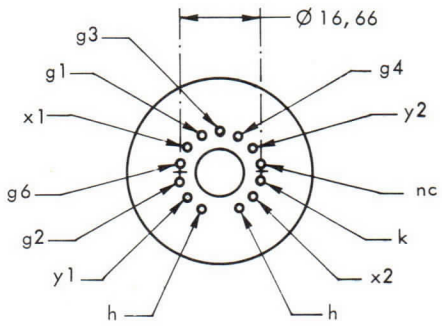
Once the charge pattern has been written it can be reat out by dropping the storage backplate voltage from 200 V to 10 V and by scanning it with an unmodulated beam. Depending on the written charge pattern the storage surface voltage varies between OV and – 10V and signal output varies in exact correspondance. The most negative areas of the dielectric can completely cut off the electron beam while various gray shades can be obtained in areas where the dielectric is less negative. Since the storage surface voltages are negative with respect to gun cathode voltage the reading beam has no adverse effect on the pattern and the read-out is non destructive.

OUTLINE DRAWING





Base 13 pins CEI - 67-1 - 37a



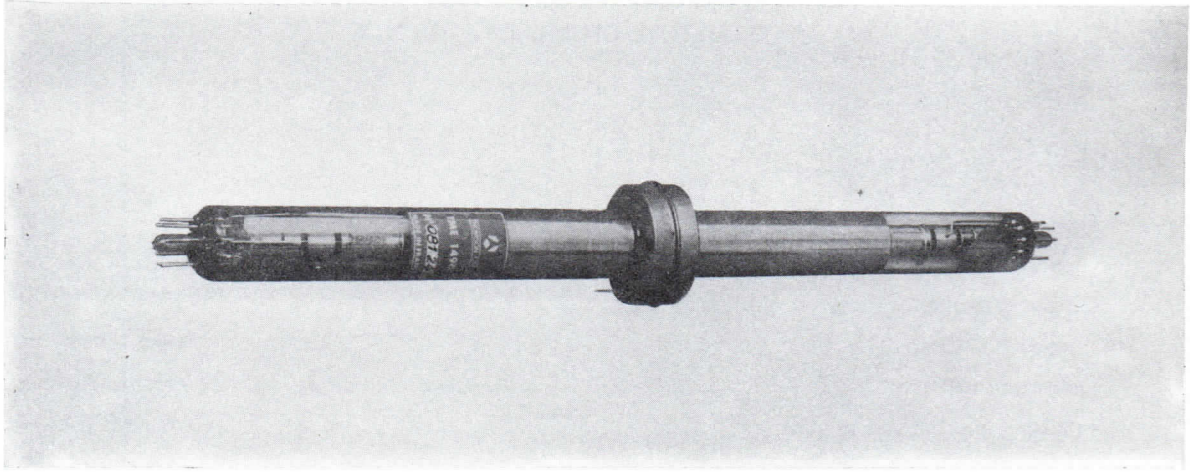
Dimensions in mm.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

THOMSON-CSF

TME 1496
DOUBLE-ENDED STORAGE TUBE

- 1" diameter dual gun miniarurized tube
- Electro - magnetic focus and deflection
- Non destructive read - out
- Simultaneous writing and reading without cross - talk
- Resolution : 800 T.V. lines at 50% modulation
- Major application : scan conversion



The TME 1496 is a low cost, miniaturized, double - ended storage tube ; it is intended for electrical-input, electrical - output with high resolution, non destructive read - out.

The TME 1496 enables numerous operating combinations while maintaining the interesting characteristics of the single - ended TME 1238 :

- continuouns read - out for a few minutes without degradation of the stored information.
- simultaneous writing and reading without cross - talk (effective isolation between reading and writing sections)
- complete or selective erasure by either writing or reading gun
- possibility of erasing during line or image retrace by either writing or reading gun in order to obtain gradual erasure
- possibility of writing by either writing or reading gun.

The TME 1496 is primarily intended for scan conversion but can be used in many other applications such as image rebuilt of slow scanned pictures, buffer memory for data recording, storage, handling and display, signal to noise ratio enhancement by integration of weak video signals.

Other significant features of the TME 1496 are its great simplicity of operation and low voltage supply requirement. It can, in addition, use for both guns : supplies, focusing and deflecting coils designed for 1 " Vidicons.

TENTATIVE

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

TYPICAL PERFORMANCES

Peak output current		0.2	µA
Writing time	- writing over the whole target area	40	ms
	- writing of one target diameter	50	µs
Erasing time	(erasing performed by either reading or writing gun)		
	- erasing of the whole written image to residual less than 10 %	40	ms
Decay by line retrace erasure (by either reading or writing gun)		adjustable from 1 s to 10 mn	
Storage time	- without read-out (beam cut-off)	several days	
Reading time	- for continuous read-out	5 to 10	mn
Resolution	- by orthogonal writing and reading at 50 % modulation	800	TV lines

TENTATIVE

GENERAL CHARACTERISTICS

Electrical : for both sides

Heater voltage	6.3	V
Heater current	0.6	A
Output capacitance (target or grid g5)	10	pF
Focusing method	electromagnetic	
Deflecting method	electromagnetic	
Focusing and deflecting coils	Gerhard BV-200-1 A	
	or	Cleveland VY
	or	Celco BV-232
	or	equivalent

Mechanical

Base (for both ends)	UTE 9 C 15 (JEDEC E8 - 11)
Operating position	any
Weight, approximate	200 g
Dimensions	see drawing

TYPICAL OPERATING CONDITIONS

Unless otherwise stated, voltages are given with respect to reading cathode i.e O.V

Reading gun

Heater :		
voltage	6.3 ± 10 %	V
current	0.6	A
Cathode k voltage	0	V
Grid g1 voltage (wehnelt) (for cut-off)	−50 to −100	V
Grid g2 (accelerator) voltage	+450	V
Grid g3 (erasing) voltage :		
normal	+450	V
fast	0 to −30	V
Grid g4 (focus) voltage	+450	V
Grid g5 (decelerator, collector) voltage	+650	V

Writing gun

Heater :		
voltage	6.3 ± 10 %	V
current	0.6	A
Cathode k' voltage	−200	V
Grid g'1 voltage (wehnelt) w.r.t.k' (for cut-off)	−50 to −100	V
Grid g'2 (accelerator) voltage	+450	V
Grid g'3 (erasing) voltage :		
normal	+450	V
fast	0 to −30	V
Grid g'4 (focus) voltage	+400	V
Grid g'5 (decelerator) voltage	+650	V

Target voltage ..... +5 V

Simultaneous writing and reading are performed with the voltages listed above.

TENTATIVE

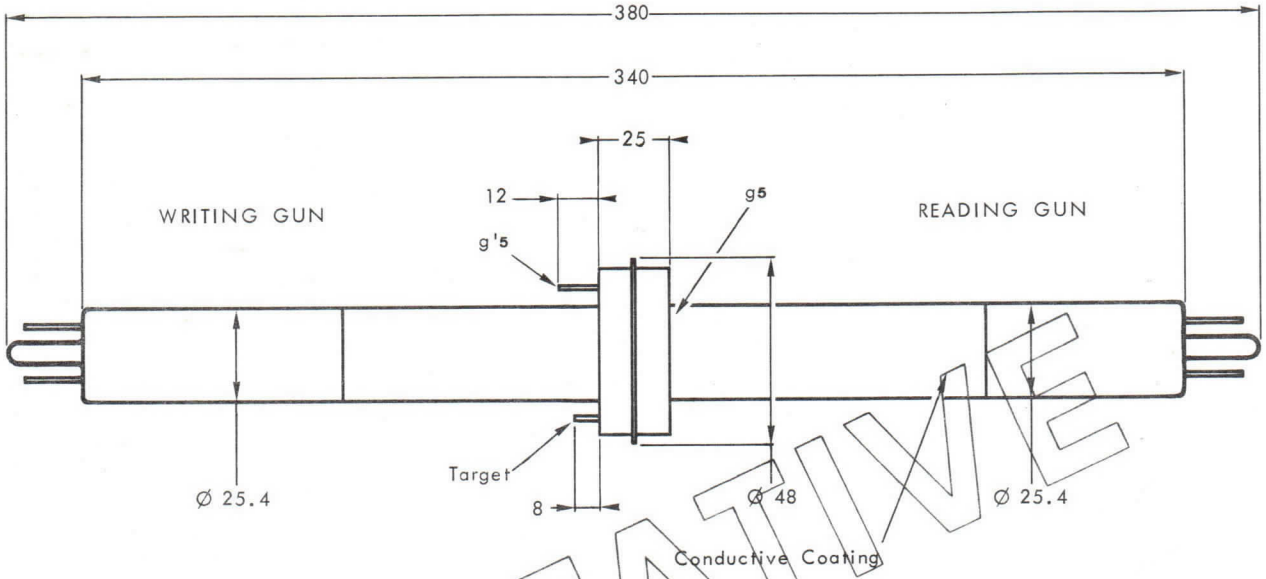
Other operating modes can be considered for which target voltage must be switched as follows :

Modes	Erasing by reading gun	Erasing by writing gun	Writing by reading gun
Target voltage	+ 15 V	− 185 V	+ 200 V

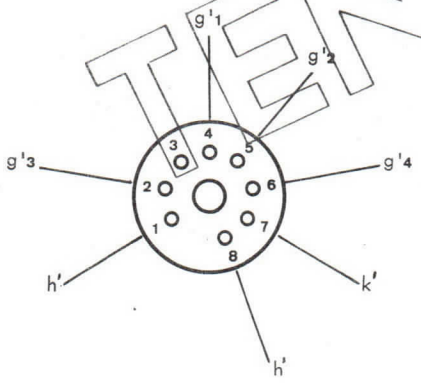
Still another possibility consists in maintaining target at fixed potential (+5 V) and in switching the cathode voltage of the operating gun.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING

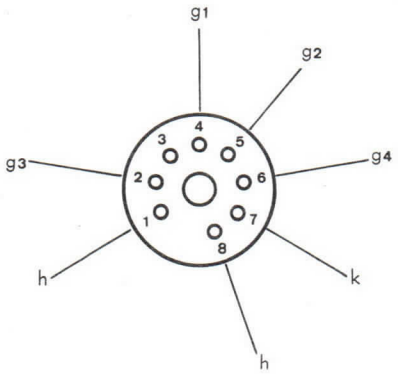


TENTATIVE



WRITING GUN BASING

(JEDEC E8-11)



READING GUN BASING

(JEDEC E8-11)

Dimensions in mm.

TME 1496
DOUBLE-ENDED STORAGE TUBE

- 1" DIAMETER DUAL GUN MINIATURIZED SCAN-CONVERTER TUBE
- ELECTROMAGNETIC FOCUS AND DEFLECTION
- NON-DESTRUCTIVE READOUT
- SIMULTANEOUS WRITING AND READING WITHOUT CROSS-TALK
- FAST ERASING BY EITHER WRITING OR READING GUN
- RESOLUTION AT 50 % MODULATION : 800 T.V. lines per diameter
- MAJOR APPLICATION : SCAN CONVERSION

The TME 1496 is a low cost, miniaturized, double-ended storage tube ; it is intended for electrical-input, electrical-output with high resolution, non-destructive readout.

The TME 1496 enables numerous operating combinations :

- continuous readout for a few minutes without degradation of the stored information,
- simultaneous writing and reading without cross-talk (due to effective isolation between writing and reading sections),
- complete or selective erasure by either writing or reading gun,
- possibility of erasing during line or image retrace by either writing or reading gun in order to obtain gradual erasure,
- possibility of writing by either writing or reading gun.

The TME 1496 is intended for scan conversion applications such as image rebuilt of slow-scanned pictures, buffer memory for data recording, storage, handling and display, signal to noise ratio enhancement by integration of weak video signals...

Other significant features of the TME 1496 are its great simplicity of operation and low voltage supply requirement. It can, in addition, use for both guns : supplies, focusing and deflection coils designed for 1" Vidicons.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

TYPICAL PERFORMANCES

Peak output current	0. 2 - 0. 4 μA
Writing time :	
- writing over the whole target area	33 - 40 ms (1 T.V. frame)
- writing of one target diameter	50 μs
Erasing time : (erasing performed by either writing or reading gun)	
- erasing of the whole written image to residual less than 5 %	33 - 40 ms (1 T.V. frame)
- selective erasing of one target diameter	300 μs
Reading time (for continuous readout) min.	10 mn
Decay by line retrace erasure (by either writing or reading gun)	adjustable from 1 s to 10 mn
Storage time (without readout)	several days
Resolution (by orthogonal writing and reading at 50 % modulation)	800 T.V. lines/dia.

GENERAL CHARACTERISTICS

Electrical for both sides

Heater voltage	6. 3 V
Heater current	0. 15 A
Output capacitances :	
- target to all other electrodes	15 pF
- grid g5 to all other electrodes	10 pF
Input capacitance :	
- grid g'1 to all other electrodes	10 pF
Focusing method	electromagnetic
Deflecting method	electromagnetic
Focusing and deflecting coil *	GERHARD BV. 200 - 1 A or CLEVELAND VY or CELCO BV - 232 or equivalent

Mechanical

Base (for both ends)	UTE 9 C 15 (JEDEC E8 - 11)
Operating position	any
Weight, approx.	200 g
Dimensions	see drawing

* It is important for best uniformity to connect focusing coils in such a manner that both magnetic fields (writing and reading) be in the same direction (see fig. 1).

MAXIMUM RATINGS
(Absolute values)

Unless otherwise stated, voltages are given with respect to reading cathode potential.

Reading gun			Writing gun		
Cathode k voltage	0	V	Cathode k' voltage	− 200	V
Peak heater-cathode voltage :			Peak heater-cathode voltage :		
- heater negative w.r.t. k	125	V	- heater negative w.r.t. k'	125	V
- heater positive w.r.t. k	125	V	- heater positive w.r.t. k'	125	V
Grid g1 voltage :			Grid g1' voltage (w.r.t. k') :		
- negative bias value	180	V	- negative bias value	180	V
- positive bias value	0	V	- positive bias value	0	V
Grid g2 voltage	600	V	Grid g'2 voltage	400	V
Grid g3 voltage	600	V	Grid g'3 voltage	400	V
Grid g4 voltage	600	V	Grid g'4 voltage	400	V
Grid g5 voltage	700	V	Grid g' 5 voltage	500	V

Target voltage ..... 700 V

TYPICAL OPERATING CONDITIONS

Unless otherwise stated, voltages are given with respect to reading cathode potential.

Reading gun			Writing gun		
Heater :			Heater :		
- voltage	6.3 ± 10 %	V	- voltage	6.3 ± 10 %	V
- current	0.15	A	- current	0.15	A
Cathode k voltage	0	V	Cathode k' voltage	− 150	V
Grid g1 (Wehnelt) voltage (for cut-off)	− 50 to − 100	V	Grid g'1 (Wehnelt) voltage w.r.t. k' (for cut-off)	− 50 to − 100	V
Grid g2 (accelerator) voltage	+ 450	V	Grid g'2 (accelerator) voltage	+ 300	V
Grid g3 (erasing) voltage :			Grid g'3 (erasing) voltage :		
normal	+ 450	V	normal	+ 300	V
fast	0 to − 30	V	fast	− 150	V
Grid g4 (focus) voltage	+ 450	V	Grid g'4 (focus) voltage	+ 300	V
Grid g5 (decelerator, collector) voltage	+ 600	V	Grid g'5 (decelerator) voltage*	+ 380 to + 420	V

Target voltage + 5 V

For erasing which can be performed by either writing or reading gun it is necessary to establish a difference of potential of + 15 V between target and the cathode of the operating gun. This can be done

- either by switching the target voltage to + 15 V (erasing by reading gun)
  or to −135 V (erasing by writing gun)
- or by maintaining target voltage at +5 V and switching the cathode voltage $V_k = -10$ V (erasing by reading gun)
  $V_{k'} = -10$ V (erasing by writing gun)

* The grid g'5 voltage value can vary depending on the type of coil assembly used. This value must be adjusted to achieve the best uniformity.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE *

The main components of the tube are 2 electron guns (writing and reading) located on each side of a storage target assembly (Fig. 1).

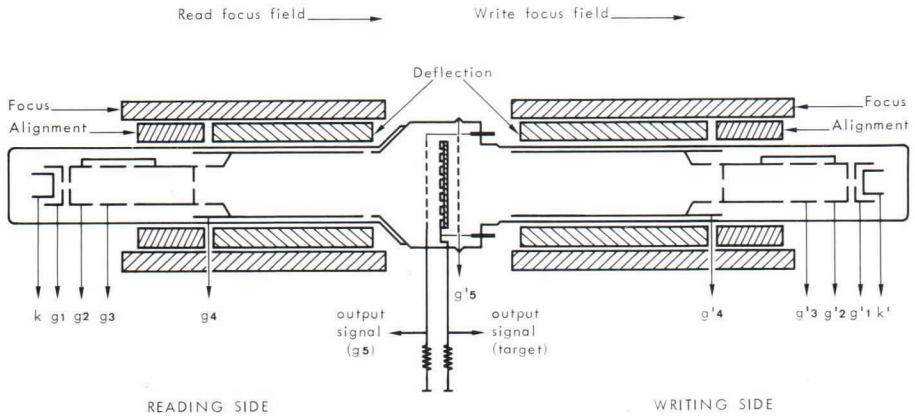


Fig. 1

The electron guns employ electromagnetic focus and deflection. They both include an additional erasing electrode which enables 2 erasing modes (normal or fast) depending on low or high beam current.

The target is of the membrane type a schematic view of which is given in Figure 2.

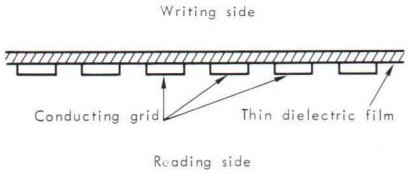


Fig. 2

The principle of operation is the charge or discharge of the storage surface according to the velocity of the primary electron beam through secondary emission of the storage surface.

The structure of the target enables coplanar control mechanism on the reading side when charges have been deposited on either side i.e. by the writing or the reading gun.

The detailed mechanism of the different operations is illustrated in the Figure 3.

WRITING (Fig. 3a)

We assume that, after a previous erasing, the dielectric surface facing the reading side is at – 10 V (see erasing) and that the writing beam scans the target with an intensity modulated by the signal applied to the Wehnelt.

Considering that the potential difference between the target and the writing cathode is sufficiently high (about 150 V) to get a coefficient $\delta > 1$, positive charges are deposited which increase the potential of the written point by + 5 V for example, on the writing side. By capacitive coupling, the potential of the corresponding point on the reading side will increase by a value of about 5 V and thereby its potential is shifted from – 10 V to – 5 V.

* Detailed considerations about "Recording Storage Tubes" principles and operations are given in the Technical Information TEV 6013 which we ask the user to refer to.

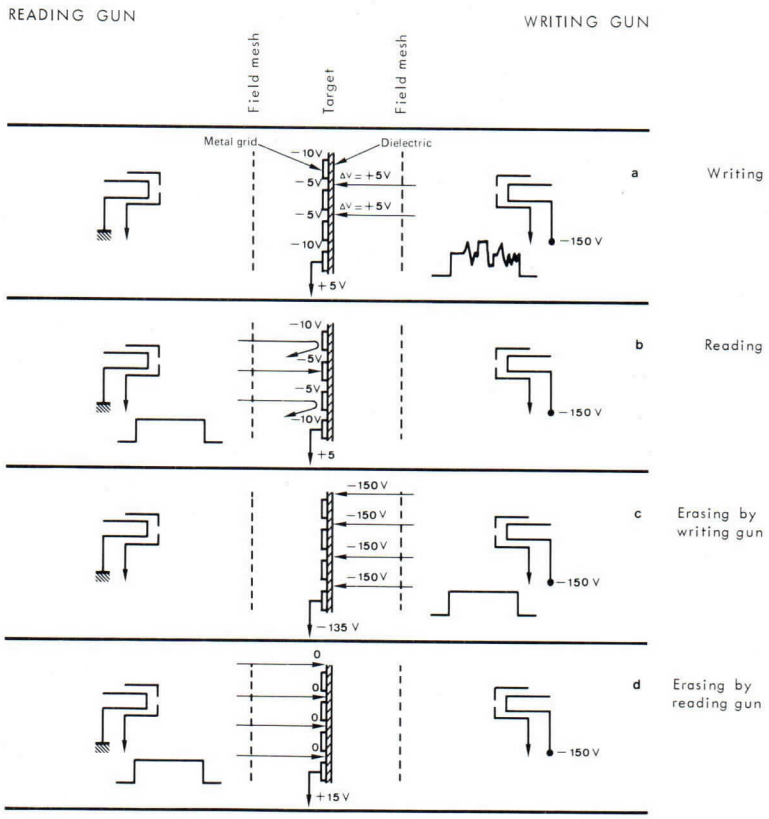


Fig. 3

READING (Fig. 3b)

The reading is performed by scanning the target by the unmodulated reading beam. Depending on the written charge pattern the surface storage voltage varies between 0 and − 10 V and output signal varies in exact correspondance. The most negative areas of the dielectric can completely cut-off the electron beam while various gray shades can be obtained in areas where the dielectric is less negative. Since the storage surface voltages are negative with respect to the read cathode voltage, the reading beam has no adverse effect on the pattern and the readout is non-destructive.

ERASING

This can be done by using either the writing beam (Fig. 3c) or the reading beam (Fig. 3d).

In the first case, the target is at − 135 V ; the writing electrons landing on the dielectric (writing side) with an energy of 15 eV and giving rise to secondary emission ratio $\delta < 1$, the dielectric is then brought, after bombardment, to an equilibrium potential of − 150 V. After switching target voltage back to + 5 V, dielectric surface in then brought to a potential of − 10 V.

In the second case, the target is shifted to + 15 V. The capacitive coupling and the low energy electron beam causes the dielectric to be charged down to 0 V through secondary emission ratio $\delta < 1$. After switching target voltage back to + 5 V dielectric surface is then brought to a potential of − 10 V.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OTHER OPERATING MODES

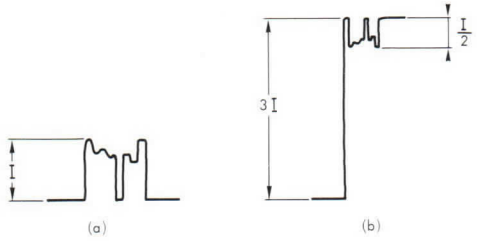
Only the major operations are described above since this tube can perform other operations corresponding to any desired application.

For example, only the writing mode achieved by the writing gun has been described. It is obvious that this operation may be achieved through the reading gun by switching, for example, of the target voltage.

It is also possible to conceive, for a radar application, a gradual variable erasure by the writing gun and automatic switching in writing mode just as the echoes begin to appear.

OUTPUT SIGNAL (Fig. 4)

The output signal can be picked-up through either the target or the reading gun grid g5 but these signals are different from each other as shown in the Figures 4a and 4b.



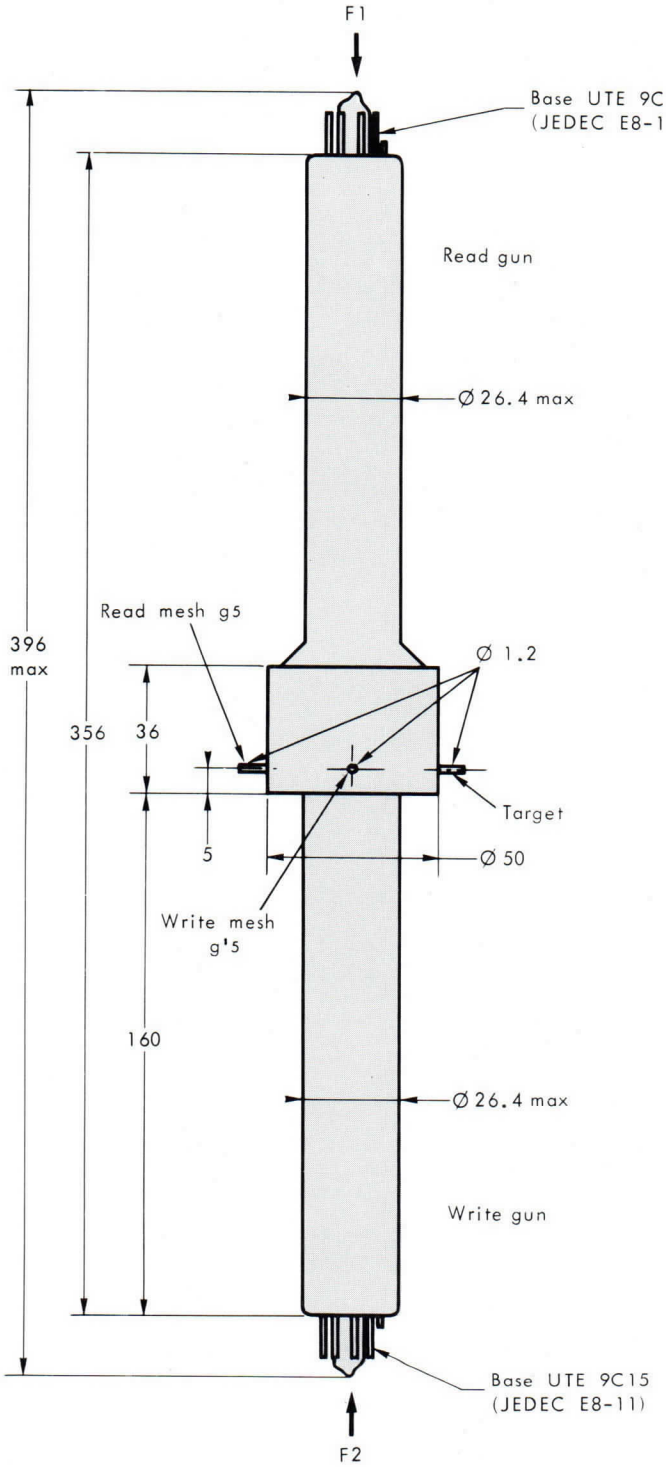
(a) output signal from target
(b) output signal from grid g5

Fig. 4

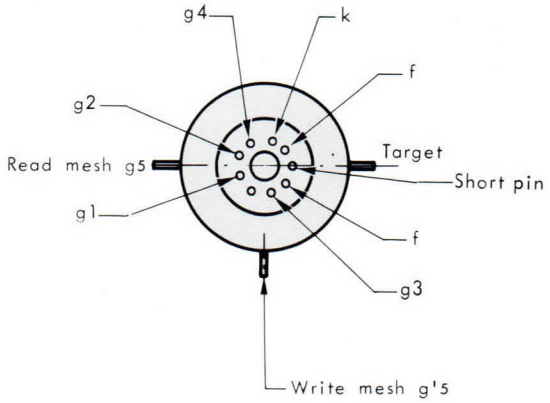
As compared to the target signal, the grid g5 signal is of reversed polarity and is less convenient since it presents a pedestal level (about 3 times I) and has only about half dynamic amplitude $\frac{I}{2}$

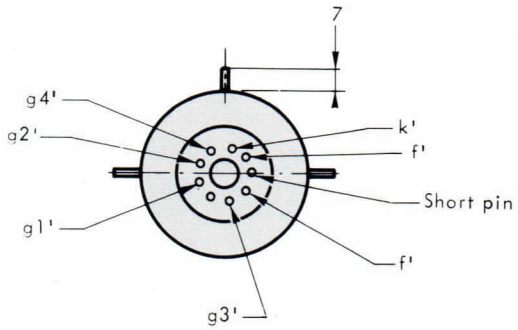
According to the above considerations, it is preferable to use the target as collector except when the crosstalk reaches an uncomfortable level.

OUTLINE DRAWING



View F1





View F2

Dimensions in mm.

TME 1496

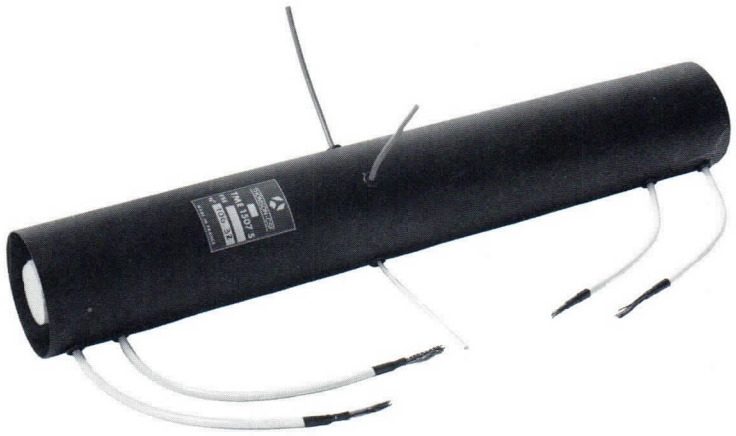
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Imprimé en France

TME 1507 S
RUGGEDIZED DOUBLE-ENDED STORAGE TUBE
HIGH RESOLUTION POTTED AND SHIELDED TUBE WITH INTEGRAL COILS FOR AIRBORNE EQUIPMENT

- 1 1/2" DIAMETER DUAL GUN SCAN CONVERTER TUBE
- ELECTROMAGNETIC FOCUS AND DEFLECTION
- NON-DESTRUCTIVE READOUT
- ADJUSTABLE DECAY
- SIMULTANEOUS WRITING AND READING WITHOUT CROSS-TALK
- FAST ERASING BY THE READING GUN
- LIMITING RESOLUTION : 2000 TV lines per diameter



The TME 1507S is a complete assembly including :

- a high resolution double-ended storage tube operating at low voltages ;
- two special printed circuit, low impedance coils TH 7205 ;
- a shield ensuring magnetic protection and mechanical fixture.

The special design of the TME 1507S allows to obtain a compact assembly (length 480 mm, outer diameter 76 mm) intended for airborne scan converter operating under severe environmental conditions such as encountered in military and space applications (see "Environmental Performances" page 2).

Due to the double-ended storage tube properties, the TME 1507S enables numerous operating combinations :

- continuous readout for a few minutes without degradation of the stored information ;
- simultaneous writing and reading without cross-talk due to effective isolation between writing and reading sections ;
- complete or selective erasure by either writing or reading gun ;
- possibility of erasing during line retrace by either writing or reading gun in order to obtain gradual erasure ;
- very fast erasing by reading gun due to patented gun design ;
- possibility of writing by either writing or reading gun.

ENVIRONMENTAL PERFORMANCES

The TME 1507S is designed to withstand the following operational and non-operational environmental tests.

Rejection criteria

After completion of the environmental tests, the tube meets the characteristics specified under typical operation data.

Operational tests

1 - **Vibration** - Specification NF - C20 - 616 (CEI - 68 - 2 - 6)
The tube shall be mechanically connected to the vibration generator by means of a fixture. It shall be vibrated in 3 mutually perpendicular axis in turn.
The tube is subjected to sinusoidal vibration from 5 to 60 Hz (with constant amplitude of 0. 125 mm) then from 60 Hz to 500 Hz (with constant acceleration of 2g).
Cycle duration : 15 minutes.
Number of cycles per direction : 5.

2 - **Dry heat** - Specification NF - C20 - 602 (CEI - 68 - 2. 2 - Bd)
Temperature : + 85 °C
Duration : 16 hours

3 - **Cold** - Specification NF - C20 - 601 (CEI - 68 - 2. 1 - Ad)
Temperature : –55 °C
Duration : 16 hours

4 - **Low air pressure** - Specification NF - C20 - 606 (CEI - 68 - 2 - 13)
Pressure : 20 mbar
Temperature : – 55 °C
Duration : 12 hours

5 - **Accelerated damp heat** - Specification NF - C20 - 604 (CEI - 68 - 2 - 4)
Temperature : + 55 °C
Relative humidity > 95 %
Duration : 1 cycle of 24 hours

Non-operational tests

1 - **Bump** - Specification NF - C20 - 624 (CEI - 68 - 2 - 29)
Peak acceleration : 25 g
Pulse duration : 6 ms (half-sine wave)
Number of bumps : 1000 in each direction
Rate : 1 to 3 bumps per second

2 - **Change of temperature** - Specification NF - C20 - 605 (CEI - 68 - 2 - 14)
One-chamber method
Low temperature : – 55 °C
High temperature : + 85 °C
Temperature change : 1 °C per minute
Exposure duration each extremal temperature : 3 hours
Number of cycles : 3

3 - **Salt mist** - Specification NF - C20 - 611 (CEI - 68 - 2 - 11)
Temperature : + 35 °C
Duration : 96 hours

TYPICAL PERFORMANCES

Peak output current	0. 3 µA
Writing time :	
- writing over the whole target area	33 - 40 ms (1 TV frame)
- writing of one target diameter	50 µs
Erasing time :	
- erasing of the whole written image to residual less than 5 % (by reading gun)	33 - 40 ms (1 TV frame)
- selective erasing of one target diameter (by writing or reading gun)	300 µs
Reading time (for continuous readout),	10 mn
Decay by line retrace erasure (by either writing or reading gun)	adjustable from 0. 1 s to 10 mn
Retention time (without readout)	several days
Resolution by orthogonal writing and reading :	
- at 50 % modulation	1200 TV lines/dia
- limiting	2000 TV lines/dia

GENERAL CHARACTERISTICS

Electrical

– TUBE

Heater voltage	6. 3 V
Heater current (for each gun)	0. 15 A
Output capacitances :	
- target to all other electrodes	25 pF
- grid g5 to all other electrodes	15 pF
Input capacitance :	
- grid g1' to all other electrodes	15 pF
Focusing method (both gun)	electromagnetic
Deflection method (both gun)	electromagnetic

– COILS

The same TH 7205 coils assembly is used on both sides (writing and reading)

Focusing coil :	
- resistance	85 Ω
Alignment coil :	
- resistance	300 Ω
Deflection yoke (vertical or horizontal) :	
- resistance	6 Ω
- inductance	125 µH

Mechanical

Overall length, max.	480 mm
Outer diameter, max.	76 mm
Weight, approx.	3. 5 kg

All electrode and coil connections are made through flying leads as indicated in the drawing.

MAXIMUM RATINGS
(absolute values)

TUBE

Unless otherwise stated, voltages are given with respect to reading cathode potential.

Reading gun		
Cathode k voltage	0	V
Peak heater-cathode voltage :		
- heater negative w.r.t.k.	125	V
- heater positive w.r.t.k.	125	V
Grid g1 voltage :		
- negative bias value	180	V
- positive bias value	0	V
Grid g2 voltage	600	V
Grid g3 voltage	600	V
Grid g4 voltage	600	V
Grid g5 voltage	700	V

Writing gun		
Cathode k' voltage	−200	V
Peak heater-cathode voltage :		
- heater negative w.r.t.k'	125	V
- heater positive w.r.t.k'	125	V
Grid g1' voltage (w.r.t.k') :		
- negative bias value	180	V
- positive bias value	0	V
Grid g2' voltage	400	V
Grid g4' voltage	400	V
Grid g5' voltage	500	V

Target voltage . . . . . 700 V

COILS

Voltage	250	V
Voltage between coils and ground	250	V
Focusing coil :		
- current	0.3	A
Alignement coil (each coil) :		
- current	0.1	A
Deflection coil (each horizontal or vertical yoke) :		
- D.C. current	0.5	A
- peak current	1	A

TYPICAL OPERATING CONDITIONS

Unless otherwise stated, voltages are given with respect to reading cathode potential.

Reading gun		
Heater :		
- voltage	6.3 ± 10 %	V
- current	0.15	A
Cathode k voltage	0	V
Grid g1 (Wehnelt) voltage (for cut-off)	−50 to −100	V
Grid g2 (accelerator) voltage	+ 450	V
Grid g3 (erasing) voltage :		
normal	+ 450	V
fast	0 to −30	V
Grid g4 (focus) voltage	+ 450	V
Grid g5 (decelerator, collector) voltage	+ 750	V

Writing gun		
Heater :		
- voltage	6.3 ± 10 %	V
- current	0.15	A
Cathode k' voltage	− 150	V
Grid g1' (Wehnelt) voltage w.r.t. k' (for cut-off)	−50 to −100	V
Grid g2' (accelerator) voltage	+ 300	V
Grid g4' (focus) voltage	+ 300	V
Grid g5' (decelerator)	+ 400	V

Target voltage . . . . . + 5 V

For erasing which can be performed by either writing or reading gun it is necessary to establish a difference of potential of + 15 V between target and the cathode of the operating gun. This can be done

- either by switching the target voltage to + 15 V (erasing by reading gun)
  or to − 135 V (erasing by writing gun)
- or by maintaining target voltage at + 5 V and switching the cathode voltage V_k = − 10 V (erasing by reading gun)
  $V_{k'}$ = − 10 V (erasing by writing gun)

COILS

Focusing coil :

- current . . . . . 0. 075 A

Alignment coil (each coil) :

- current . . . . . adjustable from − 0. 015 to + 0. 015 A

Deflection coil (each horizontal or vertical yoke) :

- peak to peak current per target diameter . . . . . 0. 800 A

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE*

The main components of the tube are 2 electron guns (writing and reading) located on each side of a storage target assembly (Fig. 1).

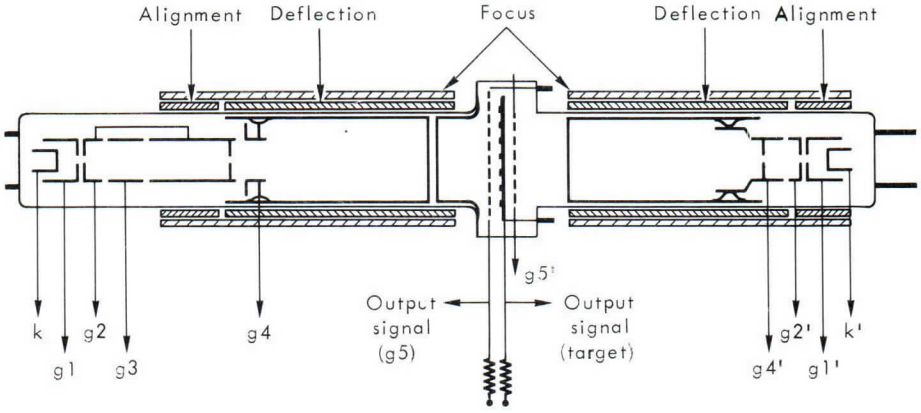


Figure 1

The electron guns employ electromagnetic focus and deflection. The reading gun includes an additional erasing electrode which enables 2 erasing modes (normal or fast) depending on low or high beam current.

The target is of the membrane type,a schematic view of which is given in Figure 2.

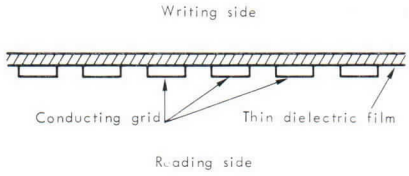


Fig. 2

The principle of operation is the charge or discharge of the storage surface according to the velocity of the primary electron beam through secondary emission of the storage surface.

The structure of the target enables coplanar control mechanism on the reading side when charges have been deposited on either side i.e. by the writing or the reading gun.

The detailed mechanism of the different operations is illustrated in the Figure 3.

WRITING (Fig. 3a)

We assume that, after a previous erasing, the dielectric surface facing the reading side is at −10 V (see erasing) and that the writing beam scans the target with an intensity modulated by the signal applied to g1'.

* Detailed considerations about "Recording Storage Tubes" principles and operations are given in the Technical Information TEV 6013 which we ask the user to refer to.

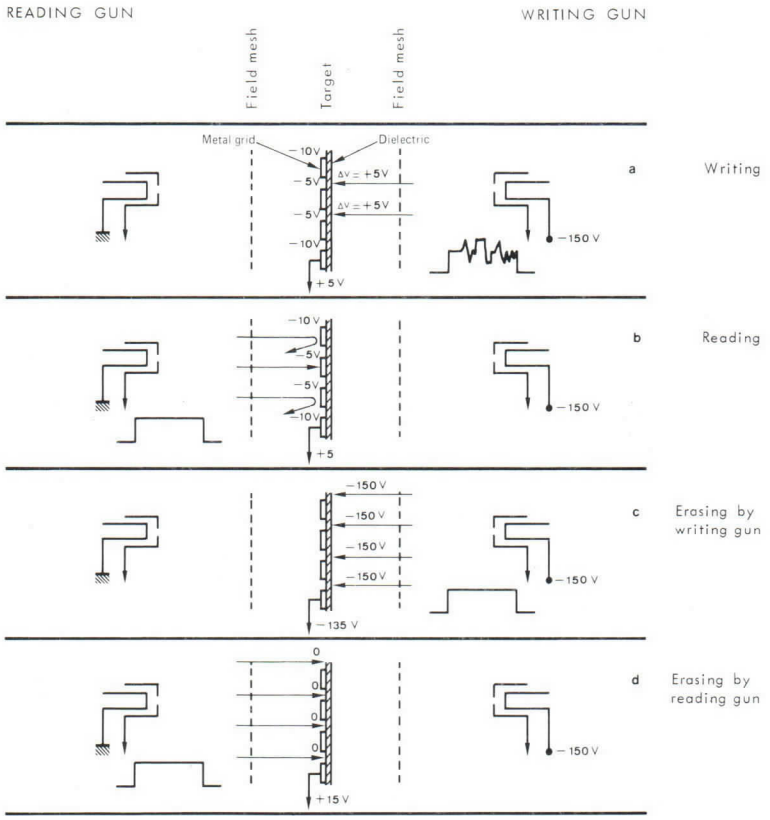


Fig. 3

Considering that the potential difference between the target and the writing cathode is sufficiently high (about 150 V) to get a coefficient $\delta > 1$, positive charges are deposited which increase the potential of the written point by + 5 V for example, on the writing side. By capacitive coupling, the potential of the corresponding point on the reading side will increase by a value of about 5 V and thereby its potential is shifted from −10 V to −5 V.

READING (Fig. 3b)

The reading is performed by scanning the target by the unmodulated reading beam. Depending on the written charge pattern the surface storage voltage varies between 0 and −10 V and output signal varies in exact correspondance. The most negative areas of the dielectric can completely cut-off the electron beam while various gray shades can be obtained in areas where the dielectric is less negative. Since the storage surface voltages are negative with respect to the read cathode voltage, the reading beam has no adverse effect on the pattern and the readout is non-destructive.

ERASING

This can be done by using either the writing beam (Fig. 3c) or the reading beam (Fig. 3d).

In the first case, the target is at −135 V ; the writing electrons landing on the dielectric (writing side) with an energy of 15 eV and giving rise to secondary emission ratio $\delta < 1$, the dielectric is then brought, after bombardment, to an equilibrium potential of −150 V. After switching target voltage back to + 5 V, dielectric surface in then brought to a potential of −10 V.

In the second case, the target is shifted to + 15 V. The capacitive coupling and the low energy electron beam causes the dielectric to be charged down to 0 V through secondary emission ratio $\delta < 1$. After switching target voltage back to + 5 V dielectric surface is then brought to a potential of −10 V.

OTHER OPERATING MODES

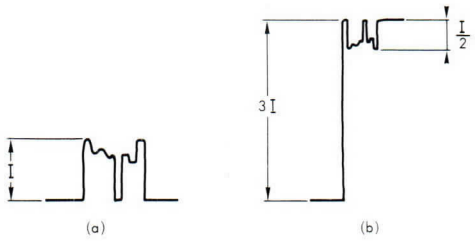
Only the major operations are described above since this tube can perform other operations corresponding to any desired application.

For example, only the writing mode achieved by the writing gun has been described. It is obvious that this operation may be achieved through the reading gun by switching, for example, of the target voltage.

It is also possible to conceive, for a radar application, a gradual variable erasure by the writing gun and automatic switching in writing mode just as the echoes begin to appear (THOMSON-CSF patent).

OUTPUT SIGNAL (Fig. 4)

The output signal can be picked-up through either the target or the reading gun grid g5 but these signals are different from each other as shown in the Figures 4a and 4b.



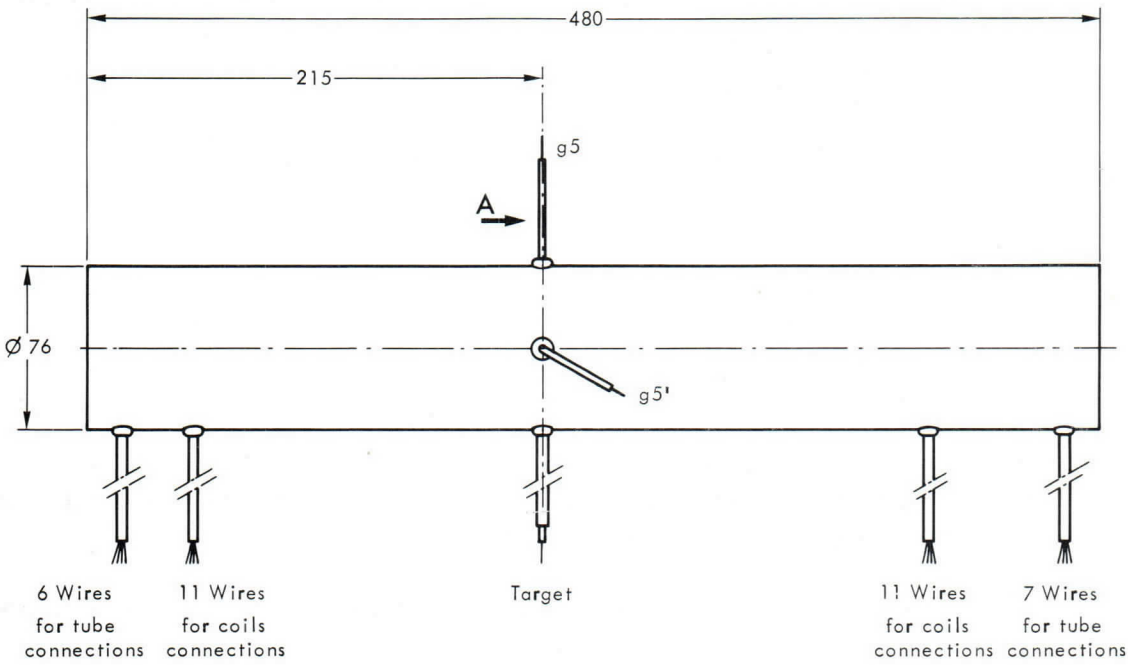
(a) output signal from target
(b) output signal from grid g5

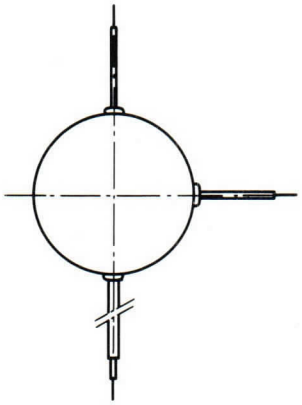
Fig. 4

As compared to the target signal, the grid g5 signal is of reversed polarity and is less convenient since it presents a pedestal level (about 3 times I) and has only about half dynamic amplitude $\frac{I}{2}$

According to the above considerations, it is preferable to use the target as collector except when the crosstalk reaches an uncomfortable level.

OUTLINE DRAWING





View on A

WRITE

Tube connections		Coils connections	
h'	black	Line scanning	red
h'	black	Field scanning	black green
k'	yellow		white
g1'	green	Focusing	orange (-) brown (+)
g2'	blue	Alignment 1	blue
g4'	brown	Alignment 2	purple yellow
		Ground	black/white grey

READ

Tube connections		Coils connections	
h	black	Line scanning	red
h	black	Field scanning	black green
k	yellow		white
g1	green	Focusing	orange (+) brown (-)
g2	blue	Alignment 1	blue
g3	red	Alignment 2	purple Yellow
g4	brown	Ground	black/white grey

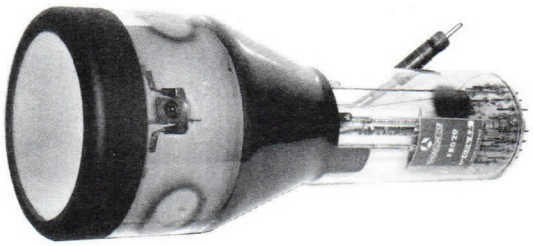
Dimensions in mm.

F 8029
BRIGHT DISPLAY DIRECT VIEW STORAGE TUBE

The F8029 is an electrostatic focus and deflection direct view storage tube capable of providing bright, uniform display over a 3.6" diameter screen. It is intended for direct study of fast transient or random phenomena with a controllable image retention.

Applications include fire control radar, airborne radar displays for weather and navigational purposes, transient studies.

The tube is specially designed for airborne equipment and can be operated unpressurized at high altitude. The rugged structure makes it particularly resistant to vibration.



TYPICAL PERFORMANCES

Writing speed	>5	mm/μs
Written spot diameter	0.5	mm
Viewing time	>10	s
Erasing time	<0.5	s
Brightness (screen voltage = 10 kV)	>1600	Ft. Lamberts
Half tones	5	

GENERAL CHARACTERISTICS

Electrical

Flood and write guns :		
Heater voltage	6.3	V
Heater current	0.6	A
Write gun :		
Focusing method	Electrostatic	
Deflection method	Electrostatic	
Number of writing gun	1	
Interelectrode capacitance :		
Writing gun cathode k to all internal elements	<10	pF
Writing gun grid g1 to all internal elements	<10	pF

Optical

Phosphor :	
Type	P 20 aluminized
Fluorescence	Yellow - green
Phosphorescence	Yellow - green
Faceplate	Flat

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Mechanical

Minimum useful viewing diameter	3.6"
Mounting position	any
Dimensions	see drawing

OPERATING CONDITIONS

Absolute ratings

Unless otherwise stated, voltages are given with respect to ground.

FLOODING GUN

Heater f' voltage	5.7	to	6.9	V
Cathode k' voltage			0	V
Grid g'1 voltage (control grid or Wehnelt)			−200	V
Grid g'2 voltage (accelerating electrode)			200	V
Grid g'3 voltage (first collimating electrode)			200	V
Grid g'4 voltage (second collimating electrode)			300	V
Grid g'5 voltage (collecting electrode)			300	V
Grid g'6 voltage (backing electrode)			20	V
Viewing screen g'7 voltage			11	kV

WRITING GUN

Heater f voltage	5.7	to	6.9	V
Cathode k voltage			−2.9	kV
Grid g1 voltage (control grid or Wehnelt) w,r.t.k.	0	to	−200	V
Grids g2 and g4 voltage (accelerating electrodes)		connected to g'2		
Grid g3 voltage (focusing electrode) w.r.t.k.			1.2	kV

Typical operation

Unless otherwise stated, voltages are given with respect to ground.

FLOODING GUN

Cathode k' voltage				0	V
Grid g'1 voltage	adjust	0	to	−150	V
Grid g'2 voltage				100	V
Grid g'3 voltage	adjust	20	to	40	V
Grid g'4 voltage	adjust	40	to	100	V
Grid g'5 voltage				210	V
Grid g'6 voltage				2	V
Viewing screen g'7 voltage				10	kV

WRITING GUN

Cathode k voltage				− 2	kV
Grid g1 voltage (max. for cut-off) w.r.t.k.				−90	V
Grids g2 and g4 voltage			connected to g'2		
Grid g3 voltage w.r.t.k.	adjust	400	to	600	V

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE

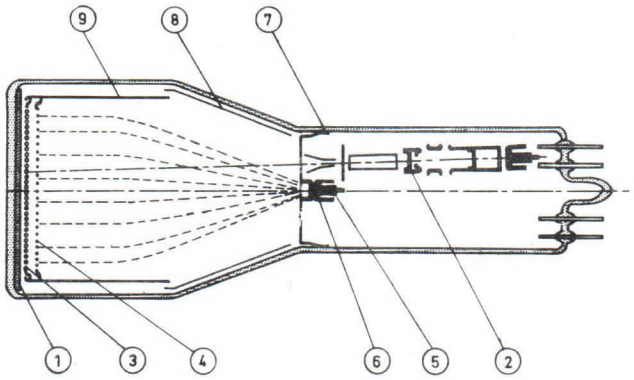
The F8029 consists of four basic assemblies :

1 - The storage unit
the components of which are a collector electrode and a fine metallic mesh called the backing electrode on which is deposited a dielectric material.

2 - The viewing screen
made of aluminized P 20 phosphor, provides the visual output.

3 - The writing gun
located in the neck of the tube generates fast electrons. The high velocity beam scans the storage surface and creates a charge pattern by secondary emission from the dielectric material.
Electrostatic focusing and deflection are employed.

4 - The flooding gun
does not scan the screen but produces a wide angle low velocity electron beam which approaches the storage mesh normally and at a constant current density over the useful area owing to the collimation electrodes.



1 - View screen
2 - Write gun
3 - g'6 (backing electrode)
4 - g'5 (collecting electrode)
5 and 6 - Flood gun
7 - g'2 (accelerating electrode)
8 - g'3 (1st collimating electrode)
9 - g'4 (2nd collimating electrode)

In the unwritten state, the dielectric surface of the backing electrode is negatively charged and the low energy flood electrons issued from the flood gun are repelled back to the collecting electrode.

In writing operation, the writing gun scans the storage surface and creates positive charges pattern by secondary emission of the dielectric material, the secondary electrons being attracted to the collecting electrode.

Low velocity electrons from the flood gun approach the storage surface normally and flood the entire useful area. They penetrate through the backing electrode in areas where pattern has been written and are then accelerated to the viewing screen where they produce a corresponding picture on the phosphor screen.

Since the number of electrons passing through the backing electrode is determined by the amount of written charges, intermediate gray shades may be reproduced.

The image can be erased by applying a small positive pulse to the backing electrode. The display decay may be controlled by varying duration, amplitude and rate of continuous series of positive pulses.

OPERATIONAL RECOMMENDATIONS

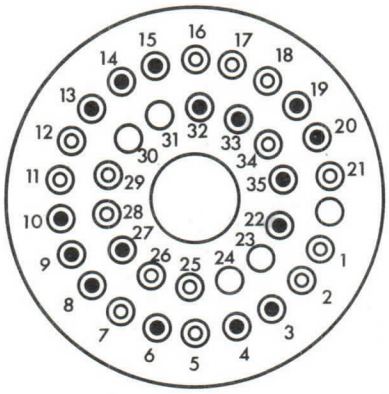
1 - The writing gun can not be allowed to write continuously without appropriate erasure otherwise the storage surface may be damaged.

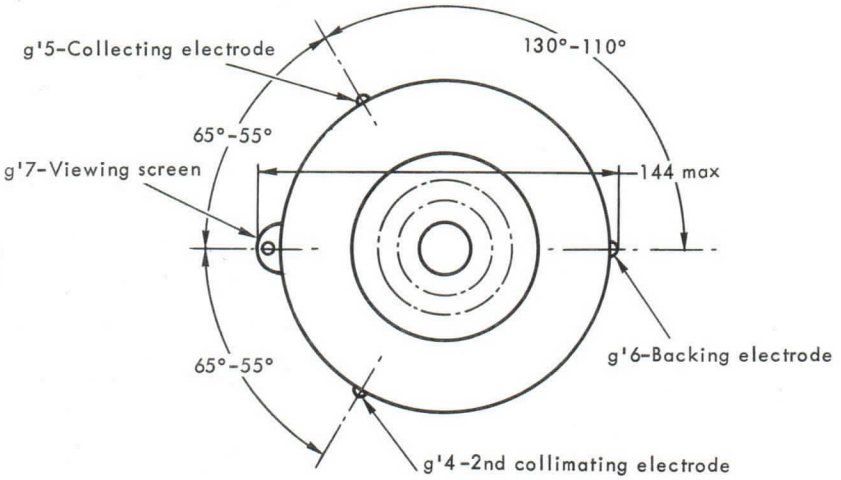
2 - Magnetic shield is necessary to prevent stray magnetic fields altering the trajectories of low velocity flood beam.

3 - The tube should be handled screen upwards to avoid particles falling on the storage elements.

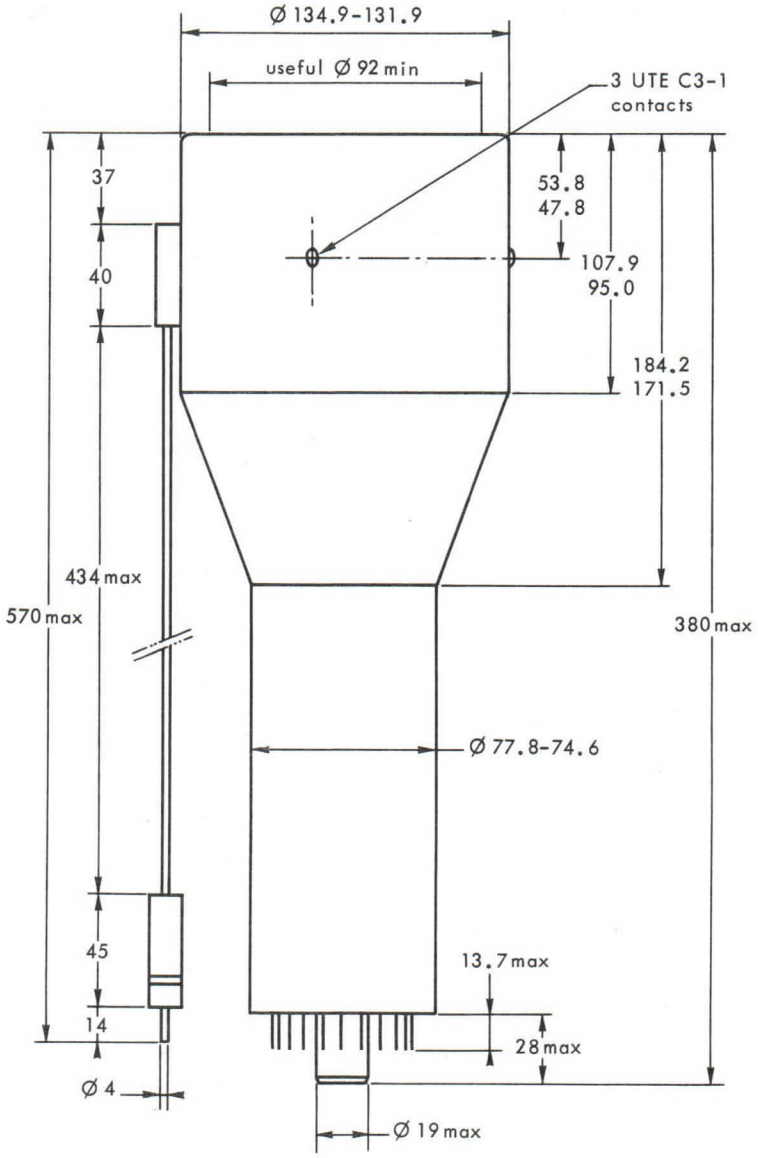
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING





BASING DIAGRAM		
-	-	Index
1	-	No connection
2	-	No connection
3	x1	Horizontal deflection plate
4	x2	Horizontal deflection plate
5	-	No connection
6	g3	Writing gun focusing electrode
7	-	No connection
8	f	Writing gun heater
9	f	Writing gun heater
10	g1	Writing gun control electrode
11	-	No connection
12	-	No connection
13	y1	Vertical deflection plate
14	y2	Vertical deflection plate
15	g2+g4+g'2	Flood and writing guns accelerating electrodes
16	-	No connection
17	-	No connection
18	-	No connection
19	g'3	1st collimating electrode
20	-	Internal connection
21	-	No connection
22	f'	Flooding gun cathode
23	-	No pin
24	-	No pin
25	-	No connection
26	-	No connection
27	k	Writing gun cathode
28	-	No connection
29	-	No connection
30	-	No pin
31	-	No pin
32	g'1	Flooding gun control electrode
33	k'	Flooding gun cathode
34	-	No connection
35	f'	Flooding gun heater



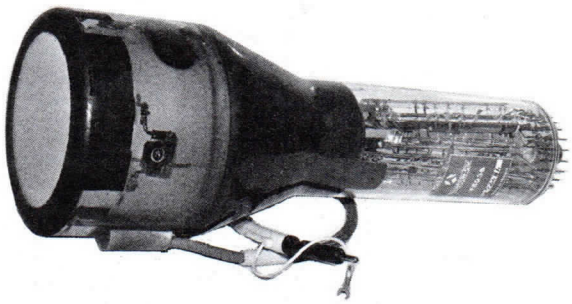
Dimensions in mm.

F 8036
BRIGHT DISPLAY DIRECT VIEW STORAGE TUBE

The F 8036 is a direct view storage tube including two writing guns permitting simultaneous writing of two signals. Electrostatic focusing and deflection are utilized.

Performances include good resolution, bright and uniform display over the entire 3.6" diameter screen. It is designed to provide brilliant displays of information ranging from transients to half-tone pictures.

The F 8036 is particulary suitable for such applications as airborne fire control radar, weather radar, transient studies and is recommended for applications where vibrations and low pressure conditions are encountered.



TYPICAL PERFORMANCES

Writing speed	>5	mm/µs
Written spot diameter	0.5	mm
Viewing time	>10	s
Erasing time	<0.5	s
Brightness (screen voltage =10 kV)	>1600	Ft. Lamberts
Half tones	5	

GENERAL CHARACTERISTICS

Electrical

Flood and write guns :		
Heater voltage	6.3	V
Heater current	0.6	A
Write gun :		
Focusing method	Electrostatic	
Deflection method	Electrostatic	
Number of writing gun	2	
Interelectrode capacitance :		
Writing gun cathode k to all internal elements	<10	pF
Writing gun grid g1 to all internal elements	<10	pF

Optical

Phosphor :	
Type	P 20 aluminized
Fluorescence	Yellow Green
Phosphorescence	Yellow Green
Faceplate	Flat

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Mechanical

Minimum useful viewing diameter	3.6"
Mounting position	Any
Dimensions	See drawing

OPERATING CONDITIONS

Absolute ratings

Unless otherwise stated, voltages are given with respect to ground.

FLOODING GUN

Heater f' voltage	5.7	to	6.9	V
Cathode k' voltage			0	V
Grid g'1 voltage (control grid or Wehnelt)			− 200	V
Grid g'2 voltage (accelerating electrode)			200	V
Grid g'3 voltage (first collimating electrode)			200	V
Grid g'4 voltage (second collimating electrode)			300	V
Grid g'5 voltage (collecting electrode)			300	V
Grid g'6 voltage (backing electrode)			20	V
Viewing screen g'7 voltage			11	kV

WRITING GUNS

Heater f voltage	5.7	to	6.9	V
Cathode k voltage			− 2.9	kV
Grid g1 voltage (control grid or Wehnelt) w.r.t. k	0	to	− 200	V
Grids g2 and g4 voltage (accelerating electrodes)			Connected to g'2	
Grid g3 voltage (focusing electrode) w.r.t. k			1.2	kV

Typical operation

Unless otherwise stated, voltages are given with respect to ground.

FLOODING GUN

Cathode k' voltage			0	V
Grid g'1 voltage	adjust 0	to	−150	V
Grid g'2 voltage			100	V
Grid g'3 voltage	adjust 20	to	40	V
Grid g'4 voltage	adjust 40	to	100	V
Grid g'5 voltage			210	V
Grid g'6 voltage			2	V
Viewing screen g'7 voltage			10	kV

WRITING GUNS

Cathode k voltage			− 2	kV
Grid g1 voltage (max. for cut-off) w.r.t. k			− 90	V
Grids g2 and g4 voltage			Connected to g'2	
Grid g3 voltage w.r.t. k	adjust 400	to	600	V

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE

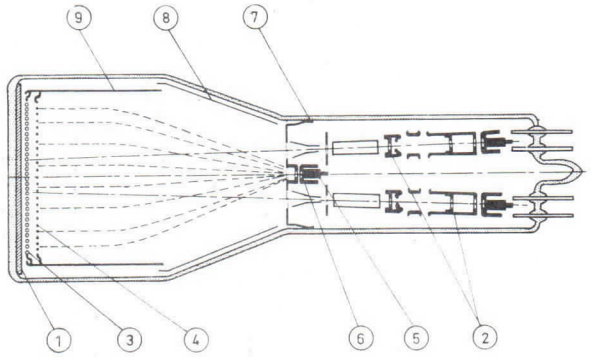
The F8036 consists of four basic assemblies :

1 - The storage unit
the components of which are a collector electrode and a fine metallic mesh called the backing electrode on which is deposited a dielectric material.

2 - The viewing screen
made of aluminized P 20 phosphor, provides the visual output.

3 - Two writing guns
located in the neck of the tube generate fast electrons. The high velocity beams scan the storage surface and create a charge pattern by secondary emission from the dielectric material.
Electrostatic focusing and deflection are employed.

4 - The flooding gun
does not scan the screen but produces a wide angle low velocity electron beam which approaches the storage mesh normally and at a constant current density over the useful area owing to the collimation electrodes.



1 - View screen
2 - Write guns
3 - g'6 (backing electrode)
4 - g'5 (collecting electrode)
5 and 6 - Flood gun
7 - g'2 (accelerating electrode)
8 - g'3 (1st collimating electrode)
9 - g'4 (2nd collimating electrode)

In the unwritten state, the dielectric surface of the backing electrode is negatively charged and the low energy flood electrons issued from the flood gun are repelled back to the collecting electrode.

In writing operation, the writing guns scan the storage surface and create positive charges pattern by secondary emission of the dielectric material, the secondary electrons being attracted to the collecting electrode.

Low velocity electrons from the flood gun approach the storage surface normally and flood the entire useful area. They penetrate through the backing electrode in area where pattern has been written and are then accelerated to the viewing screen where they produce a corresponding picture on the phosphor screen.

Since the number of electrons passing through the backing electrode is determined by the amount of written charges, intermediate gray shades may be reproduced.

The image can be erased by applying a small positive pulse to the backing electrode. The display decay may be controlled by varying duration, amplitude and rate of continuous series of positive pulses.

OPERATIONAL RECOMMENDATIONS

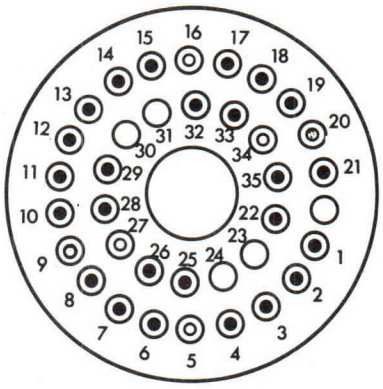
1 - The writing guns can not be allowed to write continuously without appropriate erasure otherwise the storage surface may be damaged.

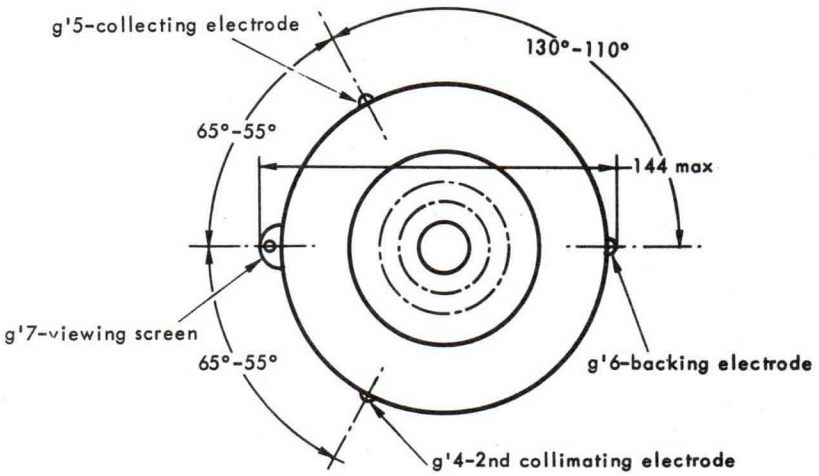
2 - Magnetic shield is necessary to prevent stray magnetic fields altering the trajectories of low velocity flood beam.

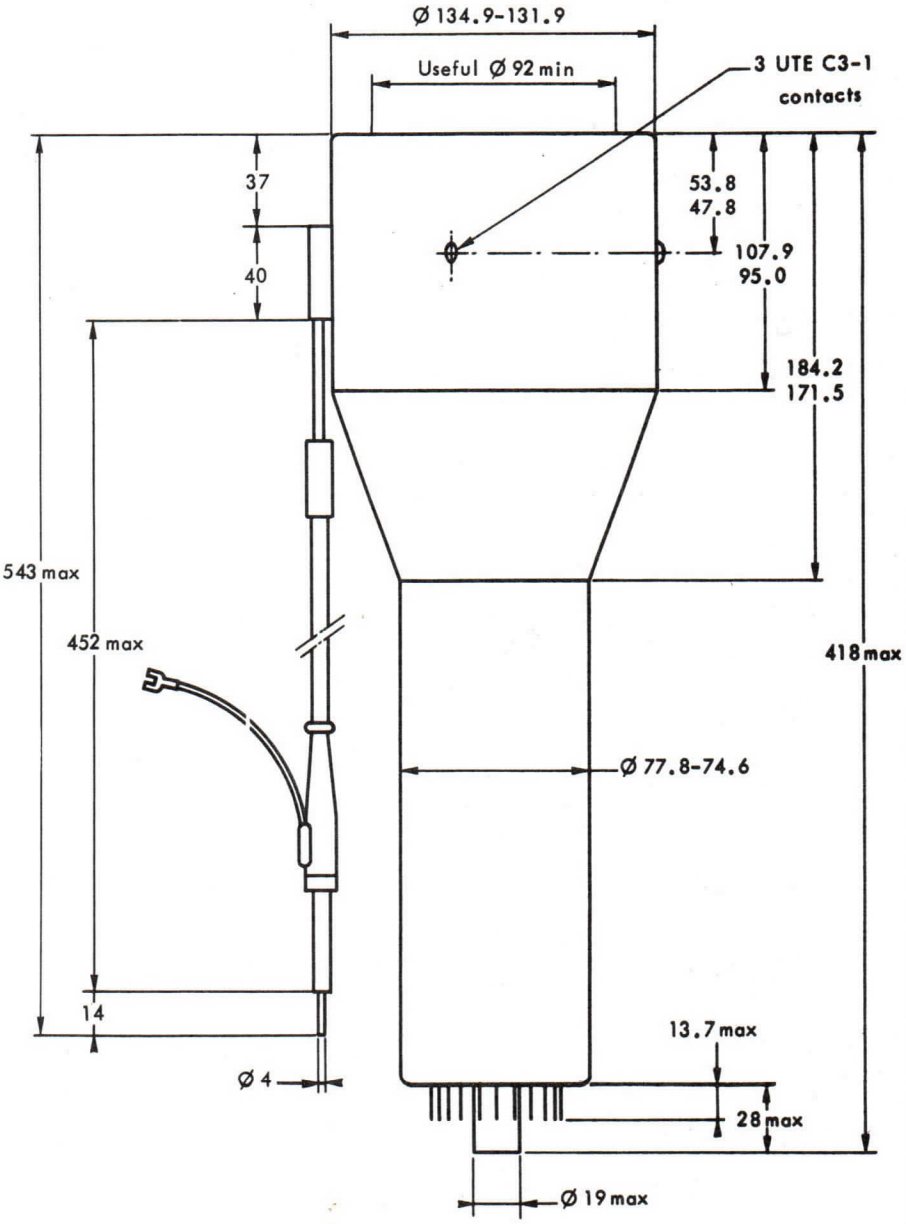
3 - The tube should be handled screen upwards to avoid particles falling on the storage elements.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OUTLINE DRAWING







BASING DIAGRAM		
-	-	Index
1	f'	Flood gun heater
2	k'	Flood gun cathode
3	x1	Horizontal deflection plate (a)
4	x2	Horizontal deflection plate (a)
5	-	No connection
6	g3	Writing gun focusing electrode (a)
7	g1	Writing gun control electrode (a)
8	f	Writing gun heater (a)
9	-	No connection
10	y1	Vertical deflection plate (a)
11	g2+g4+g'2	Writing and flood guns accelerating electrodes
12	g'3	1st collimating electrode
13	-	Internal connection
14	x1	Horizontal deflection plate (b)
15	x2	Horizontal deflection plate (b)
16	-	No connection
17	g3	Writing gun focusing electrode (b)
18	g1	Writing gun control electrode (b)
19	f	Writing gun heater (b)
20	-	No connection
21	y1	Vertical deflection plate (b)
22	f'	Flood gun heater
23	-	No pin
24	-	No pin
25	k	Writing gun cathode (a)
26	f	Writing gun heater (a)
27	-	No connection
28	y2	Vertical deflection plate (a)
29	g'1	Flood gun control electrode
30	-	No pin
31	-	No pin
32	k	Writing gun cathode (b)
33	f	Writing gun heater (b)
34	-	No connection
35	y2	Vertical deflection plate (b)

NOTA : Suffixes (a) and (b) indentify constitutive elements of each writing gun.

Dimensions in mm.

F 8055

BRIGHT DISPLAY DIRECT VIEW STORAGE TUBE

The F8055 is a short-type (8" length) direct view storage tube.

The writing beam is electrostatically focused and electromagnetically deflected. The on-axis writing gun makes the tube free from geometrical distortion.

The P 20 aluminized viewing-screen of 4" diameter provides brilliant displays of information ranging from transients to half tone pictures.

The tube is designed for airborne equipments. It can be operated unpressurized at high altitude and can meet severe mechanical vibration requirements.

TYPICAL PERFORMANCES

Writing speed	>10	mm/μs
Written spot diameter	<0. 4	mm
Viewing time	>10	s
Erasing time	<0. 5	s
Brightness (screen voltage = 9 kV)	1200	Ft. Lamberts
Half tones	5	

GENERAL CHARACTERISTICS

Electrical

Flood and write guns :		
Heater voltage	6. 3	V
Flood heater current	0. 8	A
Write heater current	0. 6	A
Write gun :		
Focusing method	electrostatic	
Deflection method	electromagnetic	
Number of writing gun	1	

Optical

Phosphor :	
Type	P 20 aluminized
Fluorescence	Yellow - green
Phosphorescence	Yellow - green
Faceplate	Flat

Mechanical

Minimum useful viewing diameter	4"
Mounting position	any
Dimensions	see drawing

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OPERATING CONDITIONS

Absolute ratings

FLOODING GUN

Unless otherwise stated, voltages are given with respect to cathode k' i.e. to ground

Heater f' voltage	5.7 to	6.9	V
Cathode k' voltage (grounded)		0	V
Grid g'1 voltage (control grid or Wehnelt)		−200	V
Grid g'2 voltage (accelerating electrode)		200	V
Grid g'4 voltage (collimating electrode)		50	V
Grid g''5 voltage (uniformity electrode)		20	V
Grid g'5 voltage (collecting electrode)		600	V
Grid g'6 voltage (backing electrode)		20	V
Viewing screen g'7 voltage		9	kV

WRITING GUN

Unless otherwise stated, voltages are given with respect to cathode k

Heater f voltage	5.7 to	6.9	V
Cathode k voltage w.r.t. ground		−2.9	kV
Grid g1 voltage (control grid or Wehnelt)		−200	V
Grid g2 voltage (first accelerating electrode)		2.9	kV
Grid g3 voltage (focusing electrode)		500	V
Grid g4 voltage (second accelerating electrode)	connected to g'4		

Typical operation

FLOODING GUN

Unless otherwise stated, voltages are given with respect to cathode k' i.e. to ground

Heater f' voltage		6.3		V
Heater f' current		0.8		A
Cathode k' voltage (grounded)		0		V
Grid g'1 voltage	adjust	0 to	−50	V
Grid g'2 voltage	"	50 to	80	V
Grid g'4 voltage	"	0 to	10	V
Grid g''5 voltage	"	0 to	10	V
Grid g'5 voltage	"	200 to	300	V
Grid g'6 voltage	"	−10 to	+10	V
Viewing screen g'7 voltage	"	6 to	9	kV

WRITING GUN

Unless otherwise stated, voltages are given with respect to cathode k

Heater f voltage		6.3		V
Heater f current		0.6		A
Cathode k voltage w.r.t. ground		−1200		V
Grid g1 voltage	adjust	0 to	−100	V
Grid g2 voltage		600		V
Grid g3 voltage	adjust	−100 to	+100	V
Grid g4 voltage		connected to g'4		

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE

The F8055 consists of four basic assemblies :

1 - The storage unit
the components of which are a collector electrode and a fine metallic mesh called the backing electrode on which is deposited a dielectric material.

2 - The viewing screen
made of aluminized P 20 phosphor, provides the visual output.

3 - The writing gun
located in the neck of the tube generates fast electrons. The high velocity beam scans the storage surface and creates a charge pattern by secondary emission from the dielectric material.
Electrostatic focusing and electromagnetic deflection are employed.

4 - The flooding gun
composed of four elements and an additionnal uniformity grid produces a wide angle low electron beam which approaches the storage mesh normally and at a constant current density over the useful area.

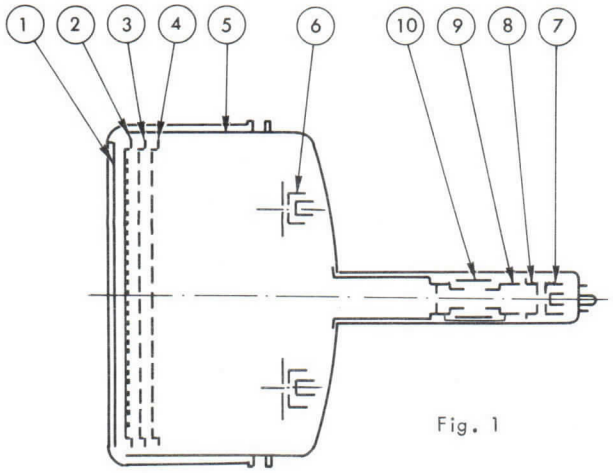


Fig. 1

1 - Screen	View screen	
2 - g'6	Backing electrode	
3 - g'5	Collecting electrode	
4 - g''5	Uniformity electrode	
5 - g'4	Collimating electrode	
6 - f' k' g'1 g'2	Flood guns	
7 - f k g1	Heater, cathode, Wehnelt	Writing gun
8 - g2	First accelerating electrode	
9 - g4	Second accelerating electrode	
10 - g3	Focusing electrode	

In the unwritten state, the dielectric surface of the backing electrode is negatively charged and the low energy flood electrons issued from the flood gun are repelled back to the collecting electrode.

In writing operation, the writing gun scans the storage surface and creates positive charges pattern by secondary emission of the dielectric material, the secondary electrons being attracted to the collecting electrode.

Low velocity electrons from the flood gun approach the storage surface normally and flood the entire useful area. They penetrate through the backing electrode in areas where pattern has been written and are then accelerated to the viewing screen where they produce a corresponding picture on the phosphor screen.

Since the number of electrons passing through the backing electrode is determined by the amount of written charges, intermediate gray shades may be reproduced.

ERASING

Erasing a written signal by making the potential of the insulating surface uniform can be obtained by raising the backing electrode for a fraction of a second to a potential higher by a few volts than its working potential.

Continuous erasure is obtained by applying positive pulse train on the backing electrode as defined in fig. 2.

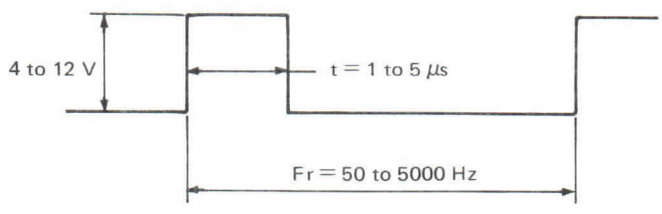


Fig. 2

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OPERATING INSTRUCTIONS

SET UP INSTRUCTIONS

a - Voltages should be applied on flood gun electrodes, storage unit and viewing screen after 30 s minimum preheating time of the heaters.

All the voltages applied to the g'2, g'4. g''5 and g'5 electrodes can be adjusted. However in order to reduce the number of combinations it is advisable to fix the voltages of g'1, g'2, g'5 and g'6.

For example : Vg'1 = 0 V - Vg'2 = 60 V - Vg'5 = 200 V - Vg'6 = 2 V

Adjust then Vg'4 and Vg''5 to achieve optimum uniformity.

b - Make sure that the control grid of the writing gun is at cut off potential before application of voltages to the writing gun electrodes.

The writing gun can not be allowed to write with a too high beam intensity otherwise the storage surface may be damaged

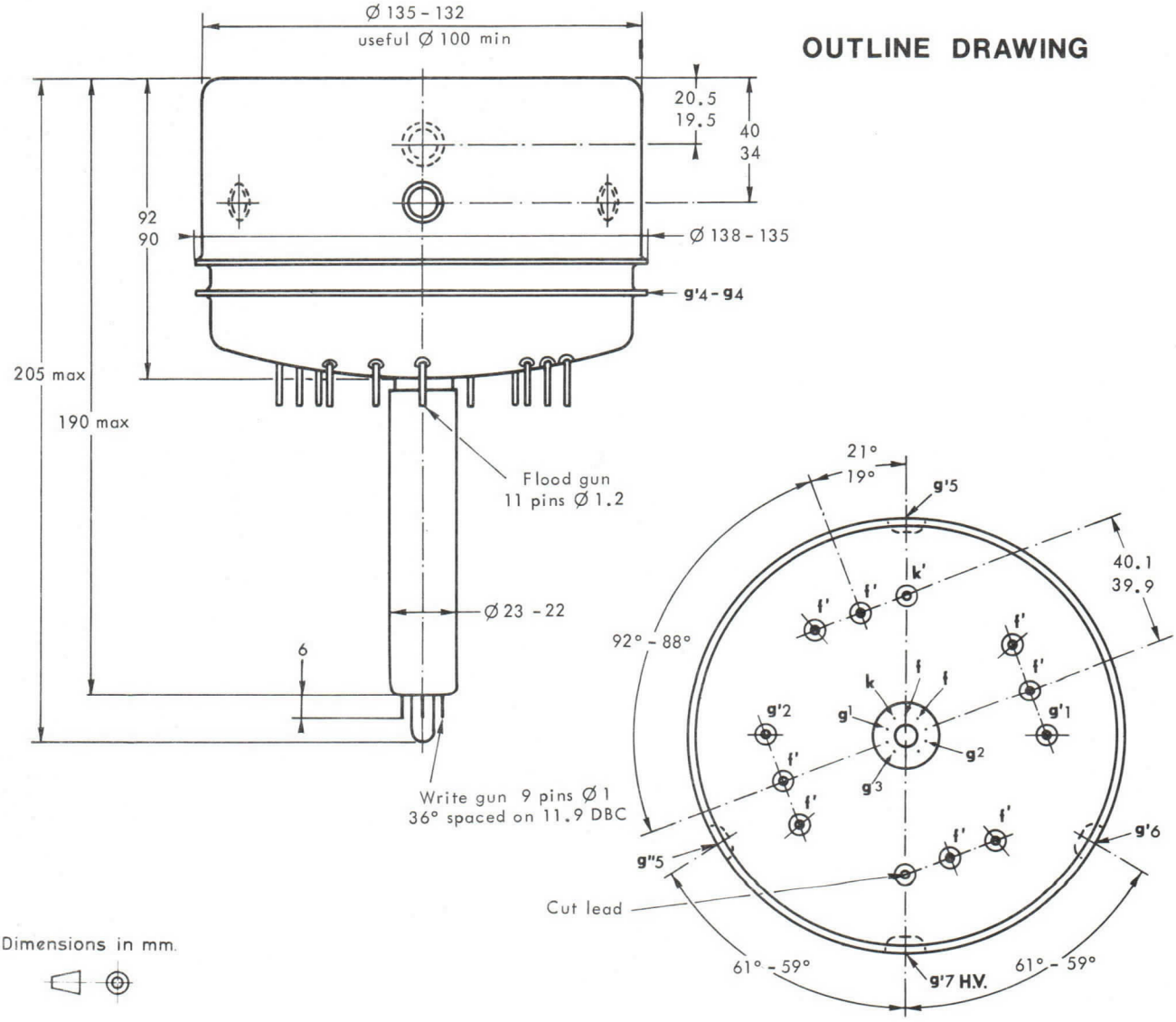
IMPORTANT RECOMMENDATIONS

1 - The writing gun cathode is at a high D.C. potential. The insulation of the heater transformer with have to be designed to suit since the heater-cathode insulation is insufficient to withstand this voltage. When the heater can not be connected to the cathode, care should be taken to ensure that the maximum allowed voltage between heater and cathode is not exceeded.

2 - A magnetic shield is necessary to protect the tube from stray magnetic field altering the trajectories of low velocity electron beam. A high permeability (mumetal) cylindrical shield of about 1 mm thick surrounding the tube throughout its length from the screen to the base will be suitable.

3 - It is imperative to handle and transport the tube with its screen upwards to prevent particles falling on the storage element.

OUTLINE DRAWING



Dimensions in mm.

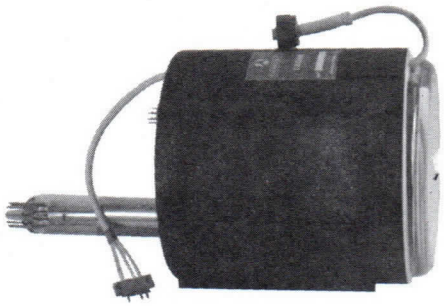
F 8086
DIRECT VIEW STORAGE TUBE

- HIGH RESOLUTION
- INTEGRAL MAGNETIC SHIELD
- FOR OFF-CENTERED P.P.I.

The F 8086 is an electrostatic focus and electromagnetic deflection direct view storage tube capable of providing bright, uniform display over a 101. 5 mm (4") diameter screen. Geometrical position of writing gun is making the tube specially intended for radar display with off-centered PPI.

Applications include airborne radar display for weather and navigational purposes.

The tube is specially designed for airborne equipment and can be operated unpressurized at high altitude. High voltage leads are encapsulated to prevent Corona, The rugged structure makes it particularly resistant to vibration.



This tube is supplied with magnetic shield.

TYPICAL PERFORMANCES

Writing speed	min.	5	mm/μs
Written line width (1700 cd/m^2 output) (note 1)		0. 3	mm
Viewing time	min.	10	s
Erasing time	max.	0. 5	s
Brightness (screen voltage = 8 kV)	min.	4100	cd/m^2
		or 1200	Ft. Lambert
Half tones		5	

GENERAL CHARACTERISTICS

Electrical

Flood and writing guns :			
Heater voltage		6. 3	V
Heater current		0. 6	A
Writing guns :			
Focusing method		Electrostatic	
Deflection method		Electromagnetic	
Number of writing gun		1	
Interelectrode capacitance :			
Writing gun cathode k to all internal elements (approx.) .		8	pF
Writing gun grid 1 to all internal elements (approx.) . .		7	pF

Optical

Phosphor :	
Type	P 20 aluminized
Fluorescence	Yellow-green
Phosphorescence	Yellow-green
Faceplate	Flat

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Mechanical

Minimum useful viewing diameter	101.5 mm (4")
Mounting position	any
Dimensions	see drawing
Basesand plugs	see drawing
Weight (approx.)	2 kg (4.4 Lbs)

OPERATING CONDITIONS

Absolute ratings

Unless otherwise stated, voltages are given with respect to ground.

FLOOD GUN

Heater h' voltage	5.7	to	6.9	V
Cathode k' voltage			0	V
Grid g'1 voltage (control grid or Wehnelt)	0	to	−125	V
Grid g'2 voltage (accelerating electrode) max.			200	V
Grid g'3 voltage (first collimating electrode) max.			200	V
Grid g'4 voltage (second collimating electrode) max.			300	V
Grid g'5 voltage (collecting electrode) max.			300	V
Grid g'6 voltage (backing electrode) max.			20	V
Viewing screen g'7 voltage max.			10.0	kV
Peak heater to cathode voltage				
Heater negative with respect to cathode max.			150	V
Heater positive with respect to cathode max.			150	V

WRITING GUN

Heater k voltage	5.7	to	6.9	V
Cathode k voltage, negative value max.			3.0	kV
Grid g1 voltage (control grid or Whenelt)(note 2)	0	to	−125	V
Grids g2 and grid g4 voltage (accelerating electrode)	connected to g'3			
Grid g3 voltage (focusing electrode)negative value max.			3.0	kV
Peak heater to cathode voltage				
Heater negative with respect to cathode max.			180	V
Heater positive with respect to cathode max.			180	V

Typical operation

Unless otherwise stated, voltages are given with respect to ground.

FLOOD GUN

Heater h' voltage				6.3	V
Cathode k' voltage				0	V
Grid g'1 voltage adjust.	0	to	−30	V
Grid g'2 voltage				80	V
Grid g'3 voltage				8	V
Grid g'4 voltage adjust.	20	to	40	V
Grid g'5 voltage				120	V
Grid g'6 voltage adjust.	0	to	5	V
Viewing screen g'7 voltage				8.0	kV

WRITING GUN

Heater h voltage				6.3	V
Cathode k voltage				−2.5	kV
Grid g1 voltage (for cut-off)(note 2) adjust.	−35	to	−60	V
Grids g2 and g4 voltage	connected to g'3			
Grid g3 voltage (note 2) adjust.	350	to	750	V

NOTES

1 - Measured by shrinking raster method.

2 - With respect to writing gun cathode.

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE

The F 8086 consists of four basic assemblies :

1 - The storage unit

The components of which are a collecting electrode and a fine metallic mesh called the backing electrode on which is deposited a dielectric material.

2 - The viewing screen

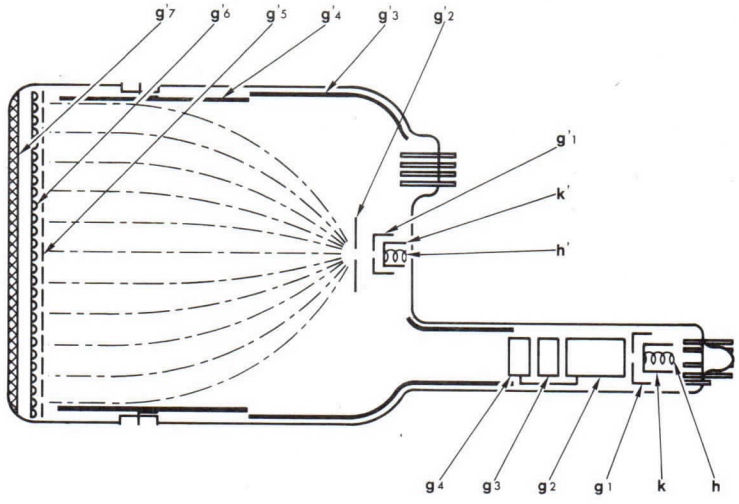
made of aluminized P 20 phosphor, provides the visual output.

3 - The writing gun

located in the neck of the tube generates fast electrons. The high velocity beam scans the storage surface and creates a charge pattern by secondary emission from the dielectric material.
Electrostatic focusing and electromagnetic deflection are employed.

4 - The flood gun

does not scan the screen but produces a wide angle low velocity electron beam which approaches the storage mesh normally and at a constant current density over the useful area owing to the collimating electrodes.



WRITING GUN

h	heater
k	cathode
g1	wehnelt
g2 g4	accelerating electrodes
g3	focusing electrode

FLOOD GUN

h'	heater
k'	cathode
g'1	wehnelt
g'2	accelerating electrode
g'3	1st collimating electrode
g'4	2nd collimating electrode

STORAGE UNIT SCREEN

g'5	Collecting electrode
g'6	Backing electrode
g'7	Viewing screen

In the unwritten state, the dielectric surface of the backing electrode is negatively charged and the low energy flood electrons issued from the flood gun are repelled back to the collecting electrode.

In writing operation, the writing gun scans the storage surface and creates positive charges pattern by secondary emission of the dielectric material, the secondary electrons being attracted to the collecting electrode.

Low velocity electrons from the flood gun approach the storage surface normally and flood the entire useful area. They penetrate through the backing electrode in areas where pattern has been written and are then accelerated to the viewing screen where they produce a corresponding picture on the phosphor screen.

Since the number of electrons passing through the backing electrode is determined by the amount of written charges, intermediate gray shades may be reproduced.

The image can be erased by applying a short positive pulse to the backing electrode. The display decay may be controlled by varying duration, amplitude and rate of positive pulse train.

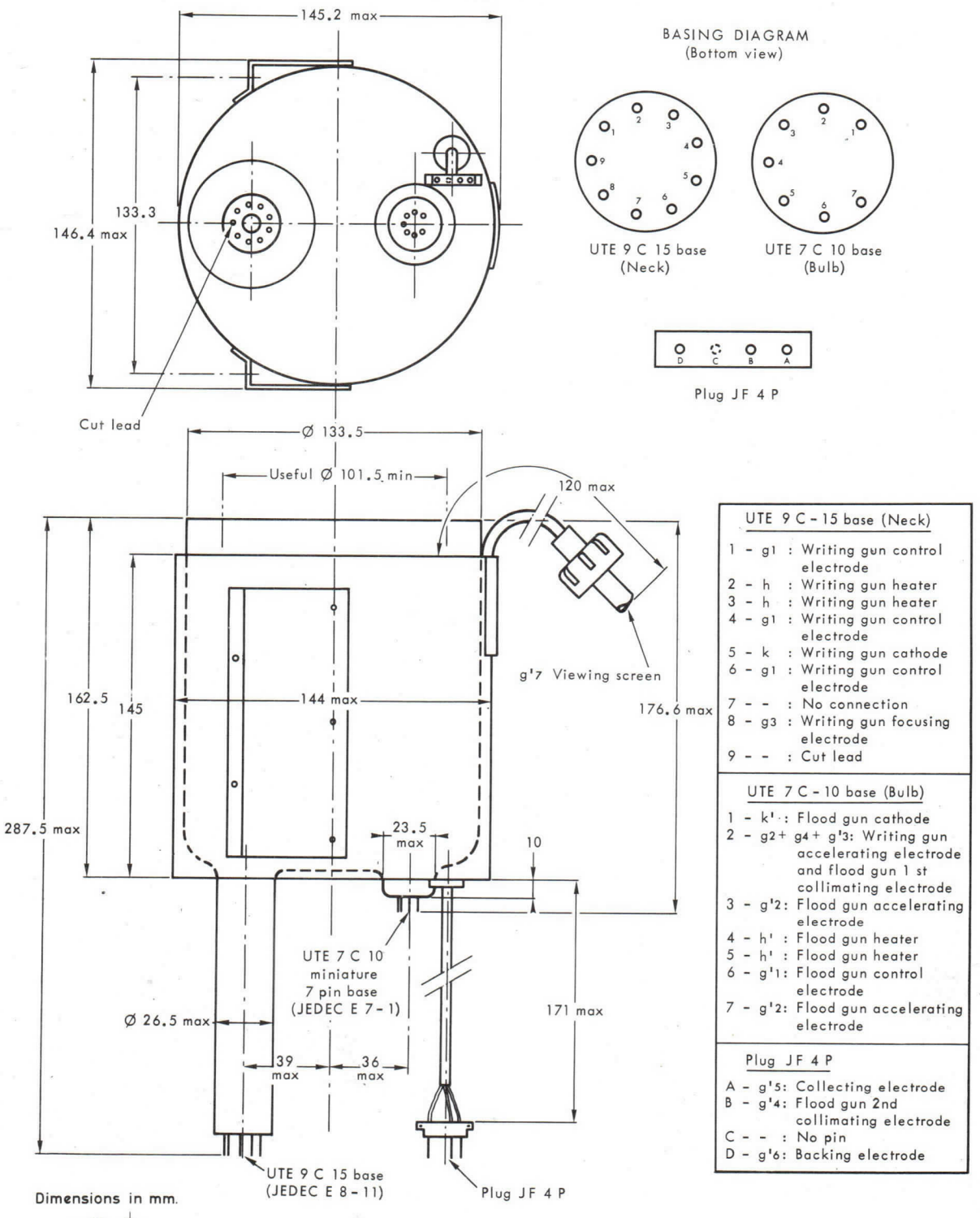
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

OPERATIONNAL RECOMMENDATIONS

1 - The writing gun can not be allowed to write continuously without appropriate erasure otherwise the storage surface may be damaged.

2 - The tube should be handled screen upwards to avoid particles falling on the storage elements.

OUTLINE DRAWING



UTE 9 C - 15 base (Neck)

1 - g1 : Writing gun control electrode
2 - h : Writing gun heater
3 - h : Writing gun heater
4 - g1 : Writing gun control electrode
5 - k : Writing gun cathode
6 - g1 : Writing gun control electrode
7 - - : No connection
8 - g3 : Writing gun focusing electrode
9 - - : Cut lead

UTE 7 C - 10 base (Bulb)

1 - k' : Flood gun cathode
2 - g2+ g4+ g'3: Writing gun accelerating electrode and flood gun 1 st collimating electrode
3 - g'2: Flood gun accelerating electrode
4 - h' : Flood gun heater
5 - h' : Flood gun heater
6 - g'1: Flood gun control electrode
7 - g'2: Flood gun accelerating electrode

Plug JF 4 P

A - g'5: Collecting electrode
B - g'4: Flood gun 2nd collimating electrode
C - - : No pin
D - g'6: Backing electrode

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PROVISOIRE

TH 8802
TUBE A MEMOIRE ANALYSEUR (TMA)

- TUBE BICANON ELECTROSTATIQUE
- GRANDE VITESSE D'INSCRIPTION
- POUR MISE EN MEMOIRE DE PHENOMENES ULTRA-RAPIDES.

Le tube TH 8802 est un tube à mémoire électrostatique à deux canons permettant d'enregistrer et de mémoriser des phénomènes transitoires extrêmement rapides.

Le tube TH 8802 est adapté à l'enregistrement des signaux d'entrée d'une durée inférieure à 500 ns. Les charges transférées à travers la cible par conductibilité induite (EBIC) sont lues par un second canon suivant un mode de balayage totalement indépendant de celui employé à l'inscription.

Le temps de mémoire en lecture continue est d'environ 1/3 de seconde et permet aussi bien de visualiser l'information stockée sur un moniteur que de l'enregistrer sur un film photographique à faible vitesse.

Grâce à sa très grande vitesse d'inscription, ce tube est spécialement adapté aux équipements destinés à l'enregistrement des phénomènes transitoires rapides tels que : essai de choc et vibration, analyse des explosions, enregistrement des impacts à grande vitesse, analyse des signaux sonar et radar, analyse des plasmas ....

Grâce à ses caractéristiques de lecture, le tube convient particulièrement bien au stockage temporaire avant digitalisation pour traitement en ordinateur et stockage permanent d'informations transitoires très rapides.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

PROVISOIRE

CARACTERISTIQUES GENERALES

Caractéristiques électriques (1)

VALEURS TYPIQUES

CANON D'INSCRIPTION		
Mode de concentration	électrostatique	
Mode de déviation	électrostatique	
Tension de chauffage	−6, 3	V
Courant de chauffage	450	mA
Tension de cathode	−10 000	V
Tension de grille de contrôle * (au blocage) (2)	−50 à −150	V
Tension de grille * n° 2	+150	V
Tension de concentration * (2)	+3000 à +3500	V
Sensibilité de déviation (3)		
- Horizontale	225	V
- Verticale	81	V
CANON DE LECTURE (4)		
Mode de concentration	électrostatique	
Mode de déviation	électrostatique	
Tension de chauffage	6, 3	V
Courant de chauffage	450	mA
Tension de cathode	−1500	V
Tension de grille de contrôle * (au blocage) (2)	−30 à −120	V
Tension de concentration * (2)	+200 ±200	V
Sensibilité de déviation (3)		
- Horizontale	225	V
- Verticale	150	V
POTENTIELS DE CIBLE A MEMOIRE		
Electrode de support de cible	0	V
Collecteur (2)	0 à 25	V
Electrode d'uniformité (2)	0 à 25	V

Performance

Résolution (3)	340	lignes TV
Sensibilité	2	largeurs de trace / V
Vitesse d'inscription	$> 10^{10}$	largeurs de trace / s
Bande passante du déviateur côté inscription	200	MHz

Notes

(1) - Toutes les tensions sont données par rapport au potentiel de cible, sauf celles marquées d'un astérisque qui sont données par rapport au potentiel de la cathode.

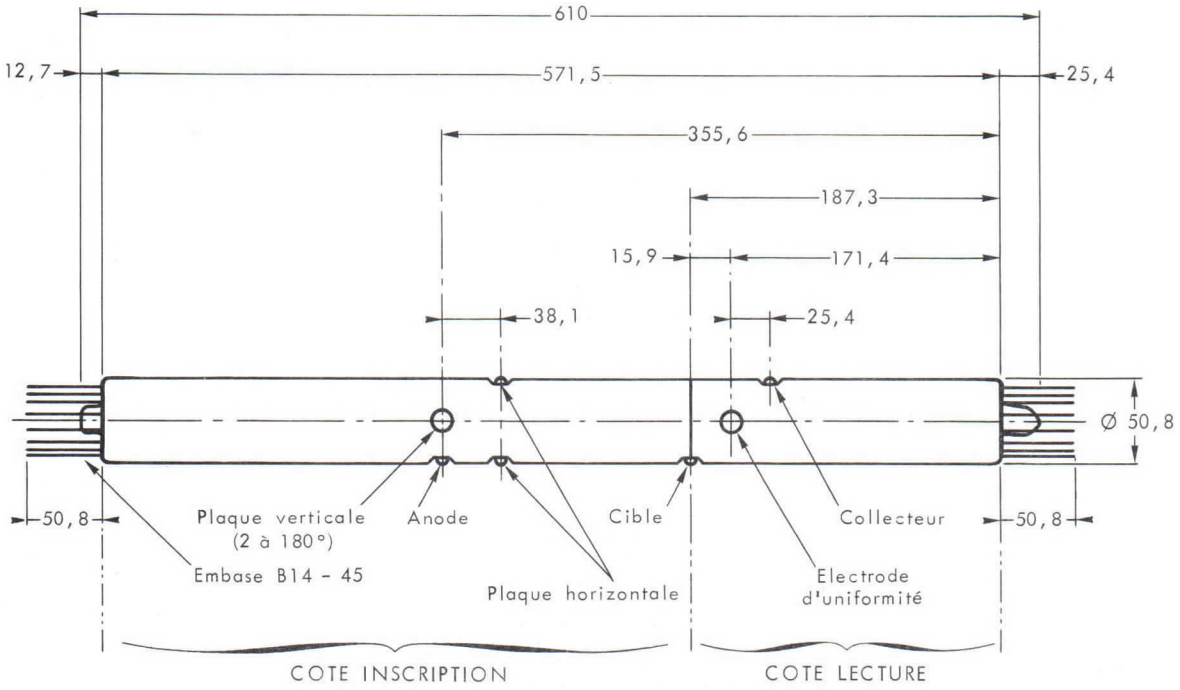
(2) - A ajuster suivant le tube.

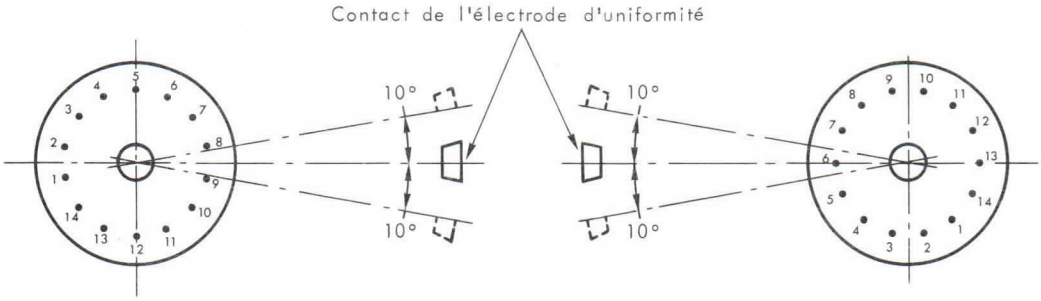
(3) - La résolution et la sensibilité sont mesurées pour un diamètre utile de cible de 22 mm environ.

(4) - Canon triode (pas de grille n° 2).

PROVISOIRE

DESSIN D'ENCOMBREMENT





BROCHAGE	
Côté inscription	Côté lecture
Embase B14 - 45	Embase B14 - 45
Broches : 1 - Non connecté	Broches : 1 - Déviateur vertical D-3
" : 2 - Non connecté	" : 2 - Déviateur vertical D-4
" : 3 - Grille 2	" : 3 - Non connecté
" : 4 - Non connecté	" : 4 - Non connecté
" : 5 - Grille 1	" : 5 - Grille 1
" : 6 - Non connecté	" : 6 - Non connecté
" : 7 - Cathode	" : 7 - Cathode
" : 8 - Filament	" : 8 - Filament
" : 9 - Filament	" : 9 - Filament
" : 10 - Non connecté	" : 10 - Concentration
" : 11 - Non connecté	" : 11 - Non connecté
" : 12 - Non connecté	" : 12 - Déviateur horizontal D-1
" : 13 - Concentration	" : 13 - Déviateur horizontal D-2
" : 14 - Non connecté	" : 14 - Anode

Cotes en mm.

TH 8802

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

THOMSON-CSF

TH 8803
2" VERY HIGH RESOLUTION RECORDING STORAGE TUBE

- SINGLE-ENDED STORAGE TUBE
- NON DESTRUCTIVE READ-OUT
- VERY HIGH RESOLUTION (limiting resolution 4300 T.V. lines)
- MAGNETIC FOCUS AND DEFLECTION

The TH 8803 is a low cost, single-ended, non destructive read out storage tube capable of storing and reading-out information in the form of electrical signals. Continuous read-out can be achieved for a few minutes without degradation of the stored-information.

This tube features fast writing and erasing, very high resolving power, large storage and integration capability and selective erasure possibility. When gradual erasure of the stored information is necessary, it is possible to erase during line or image retrace in order to obtain the desired decay.

These characteristics make it particularly suitable for numerous applications such as : slow scan T.V., data recording and storage, scan conversion, integration of low level video signals . . .
In addition, the tube is specially designed for applications where precise write-read registration is required.

One of the key features of the TH 8803 as compared to other 1" and 1 1/2" Recording Storage Tubes is its very high resolution making it suitable for use in any application where the production of fine details is required for instance in producing hard copy.

Owing to its structure and electronoptics similar to those of 2" Vidicon, the TH 8803 can employ supplies, focusing coil* and deflecting yoke* designed for this Vidicon type.

TYPICAL PERFORMANCES

Peak output current	0. 3	µA
Writing time :		
- over the whole target area	120	ms
- one target diameter	80	µs
Erasing time :		
- erasing of the whole target to residual less than 10 %	120	ms
Reading time :		
- for continuous read-out	20	mn
Storage time :		
- without reading	several days	
Resolution by orthogonal writing and reading (see curve) :		
- at 50 % modulation	2700	T.V. lines
- limiting	4300	T.V. lines

* For instance : PENN-TRAN N° 1496 Yoke - Alignment, N° 1497 Focus coil. -- PENN-TRAN C° Bellefonte - P.A.

GENERAL CHARACTERISTICS

Electrical

Heater voltage	6.3	V
Heater current	0.6	A
Input capacitance	11	pF
Output capacitance	20	pF
Focusing method	electromagnetic	
Deflecting method	electromagnetic	

Mechanical

Base	JEDEC E8 - 11	
Operating position	any	
Weight, approximate	400	g
Dimensions	see drawing	

OPERATING CONDITIONS

Maximum ratings (absolute values)

Unless otherwise stated, voltages are given with respect to cathode potential.

Target voltage	1800	V
Grid g6 voltage	1800	V
Grid g5 voltage	1800	V
Grid g4' voltage	1800	V
Grid g4 voltage	1800	V
Grid g3 voltage	1800	V
Grid g2 voltage	600	V
Grid g1 voltage :		
- negative bias value	− 180	V
- positive bias value	0	V
Peak heater cathode voltage :	− 150	V
- heater negative with respect to cathode	− 150	V
- heater positive with respect to cathode	+ 150	V

Typical operation

Voltages listed hereunder are typical values. They may have to be modified according to values given in the operating Data Sheet accompanying each tube.

Heater voltage	6.3 ± 10 %	V
Heater current	0.6	A

	Erasing mode		Writing mode	Reading mode	
Cathode voltage	0		0	0	V
Grid g1 (wehnelt) voltage (cut-off voltage −50 to −100 V).	to be adjusted		to be adjusted	to be adjusted	
Grid g2 (first accelerating voltage)	450		450	450	V
Grid g3 (erasing voltage)	fast	normal			
	0 to + 100	1400	1400	1400	V
Grid g4 (second accelerating voltage)	1400		1400	1400	V
Grid g4' (main accelerating voltage)	1400		1400	1400	V
Grid g5 (collimating voltage)	1200		1200	1200	V
Grid g6 (decelarator voltage)	1500		1500	1500	V
Target voltage	10 to 30		200	3 to 10	V

NOTE : g4' bias value can vary depending on the type of coil assembly used. To obtain the best resolution, a slight correction of g4' potential (about −10 V) is needed in writing mode.
External connection between g4' and g4 is possible to use one bias supply only.

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE*

The main components of the tube are an electron gun and a storage target assembly.

The electron gun includes an additional erasing electrode which enables two erasing modes depending on low or high beam current.

The target is made of a storage backplate on which the storage dielectric is deposited.

A general cross-view of the tube is given on Fig. 1 and magnified view of the target on Fig. 2.

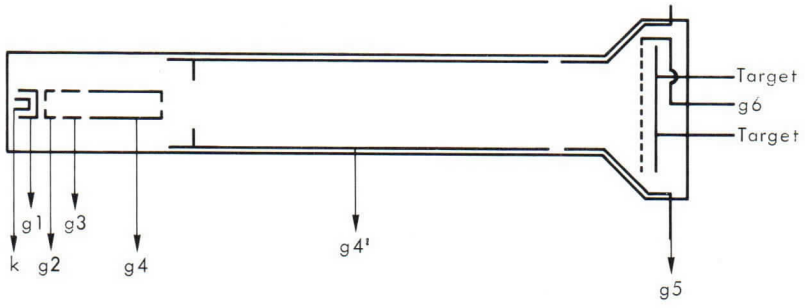


Figure 1

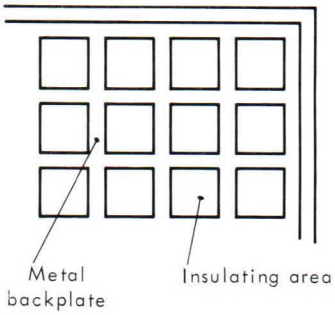


Figure 2

The principle of operation is the charge or discharge of the storage surface, according to the velocity of the primary electron beam through secondary emission of the storage surface.

Typical values (with respect to cathode) in erasing, writing and reading modes are given on Fig. 3 as an example of operating conditions.

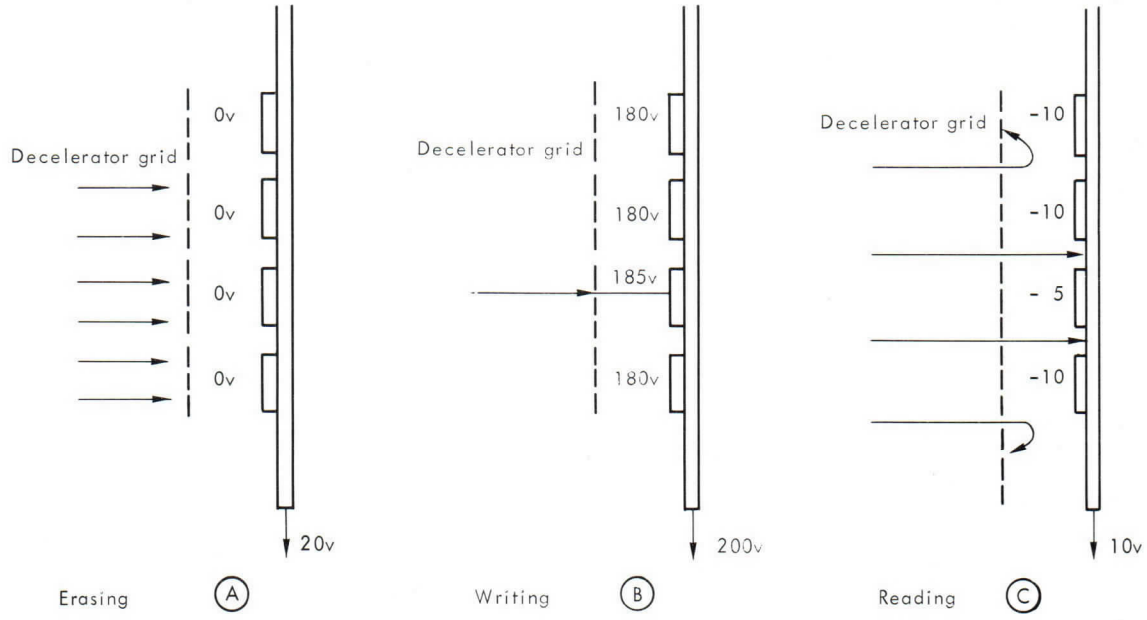


Figure 3

* Detailed considerations about "Recording Storage Tubes" principles and operations are given in the Technical Information Data TEV 6013 which we ask the user to refer to.

A – ERASE-PRIME

It is necessary to erase residual charges at the storage surface prior to writing. Erasure can be achieved by shifting the backplate voltage to 20 V. The capacitive coupling and the low energy electron beam cause the dielectric to be charged down to 0 V through secondary emission ratio less than 1.

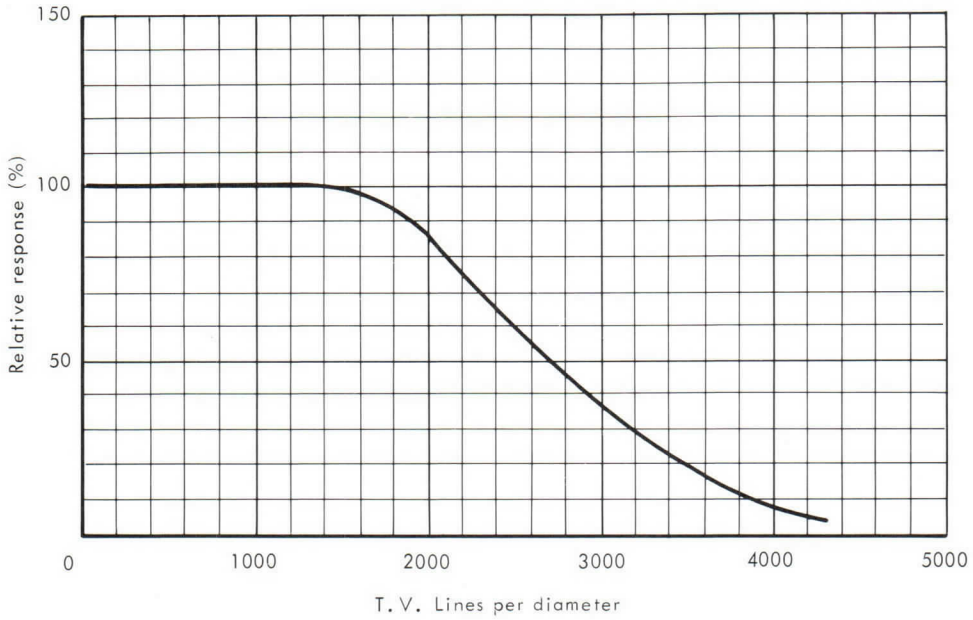
B – WRITE

Storage backplate voltage is shifted to + 200 V. Storage surface voltage is shifted to 180 V by capacitive coupling. When the electron beam modulated by the video input signal scans the storage surface, secondary emission ratio is then greater than 1 and positive charges are deposited on the dielectric areas, shifting their potential from 180 V to a few volts more positive values (185 V for example).

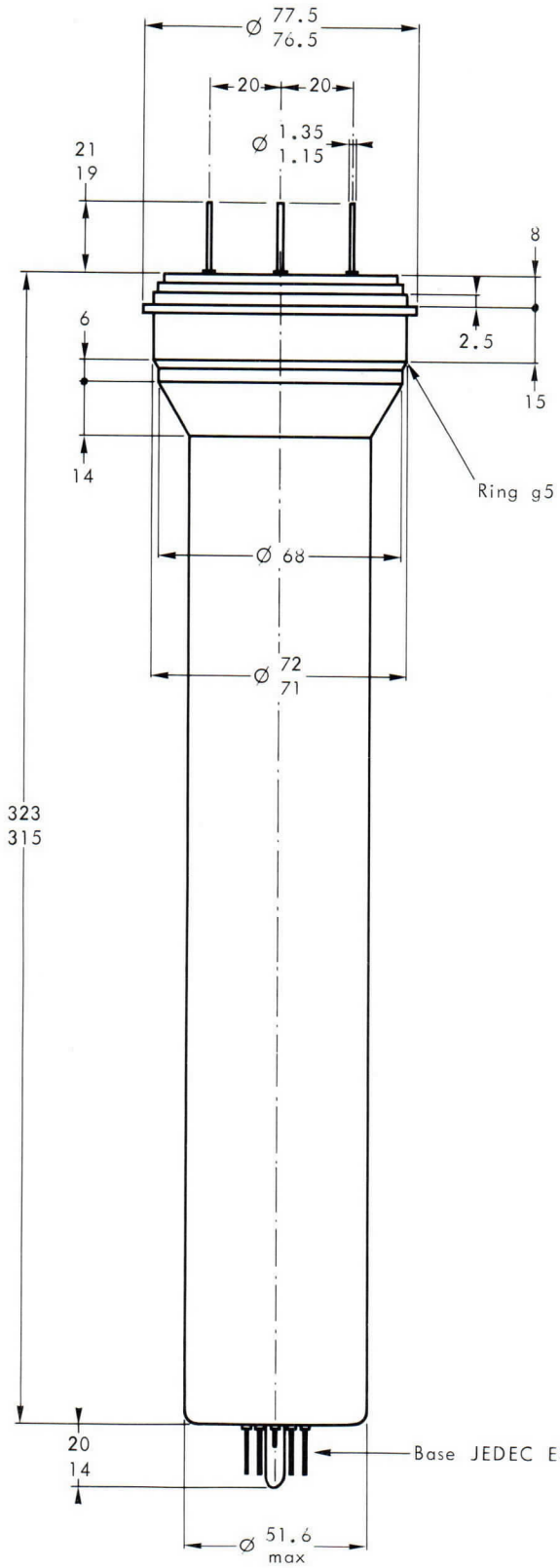
C – READ

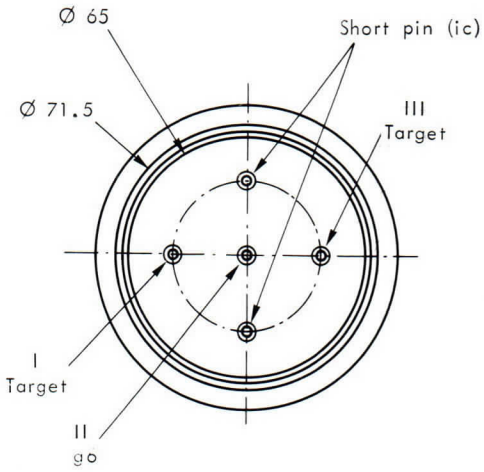
Once the charge pattern has been written it can be read out by dropping the storage backplate voltage from 200 V to 10 V and by scanning it with an unmodulated beam. Depending on the written charge pattern the storage surface voltage varies between 0 V and −10 V and signal output varies in exact correspondance. The most negative areas of the dielectric can completely cut-off the electron beam while various gray shades can be obtained in areas where the dielectric is less negative. Since the storage surface voltages are negative with respect to gun cathode voltage the reading beam has no adverse effect on the pattern and the read-out is non destructive.

MODULATION TRANSFER FUNCTION

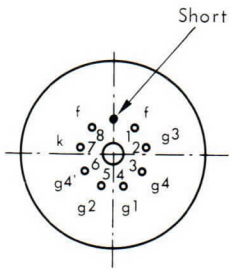


OUTLINE DRAWING





TOP VIEW



BOTTOM VIEW

Dimensions in mm, nominal except for those marked "max."

TH 8803

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

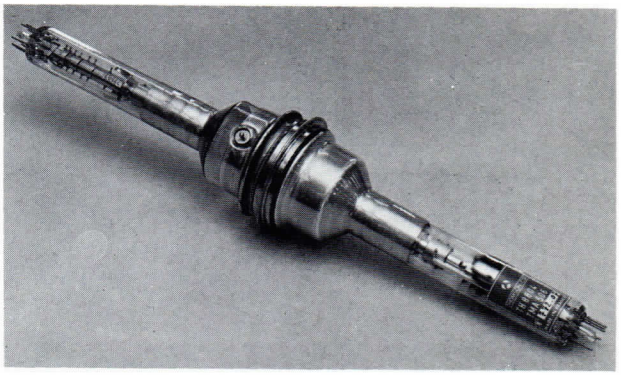
Imprimé en France

TENTATIVE

TH 8804
SCAN CONVERTER STORAGE TUBE

- SMALL SIZE
- HIGH RESOLUTION
- DOUBLE ENDED
- MAGNETIC DEFLECTIONS

The TH 8804 (TMA 506) is a small size, dual gun, electrical signal storage tube. The writing beam deposits, by induced conductivity, electrons on a thin semi-conducting target. The recorded signals are read by the reading beam by use of secondary emission effects during a large and adjustable number of reading frames.



The TH 8804 (TMA 506) scan converter tube allows :

- simultaneous writing and reading without crosstalk ;
- writing in a mode of scanning and reading in a different mode ;
- adjustment of the storage time ;
- fast erasure of the written signals ;
- superimposition of several kinds of information.

Owing to its small size the TH 8804 (TMA 506) can, if necessary, be integrated into the display console.

Due to its rugged construction and low weight it may be used as well for ground, naval or airborne equipments. Its symmetrical electromagnetic deflections and the absence of collimation make it free from geometrical distortion.

TYPICAL APPLICATIONS

- Radar Bright Display (conversion of radar scan to T.V. scan) :
  - display on a T.V. monitor of a bright, sharp picture in high ambient lighting conditions.
  - visual target tracking by means of the tube storage characteristics.
  - retransmission and multiple display of the radar picture.
- Remote transmission of radar or T.V. informations over narrow bandwidth channels.
- Signal to noise enhancement by integration.
- Superimposition of several types of input data.

* This developmental tube is intended for engineering evaluation.
The given data are subject to change, unless otherwise arranged with user.
No obligations are assumed for notice of change or future manufacture of this tube.

TYPICAL PERFORMANCES

- Output signal current . . . . . 0. 5 to 2 μA
- Output capacitance . . . . . 8 pF
- Resolution . . . . . 250 P.P.I. range rings at 50 % modulation (equivalent to approximately 1300 T.V. lines)
- Decay time (50 % residual)* . . . . . adjustable from 0. 1 to 20 s
- Retention time (to noise)* . . . . . 1 s to several minutes
- Gray levels 7
- Fast erasing time

* Other ranges of storage time on request.

OPERATING CONDITIONS

Unless otherwise stated, voltages are given with respect to ground.

Absolute ratings

– WRITING GUN

Electrostatic focusing, electromagnetic deflection

Heater voltage (Note 1)	6. 1 to 6. 5	V
Cathode k' voltage	– 8	kV
Voltage between heater and cathode	± 150	V
Control grid g'1 voltage (w.r.t. cathode)	– 180 to 0	V
Anode g'2 voltage	connected to target	
Focusing g'3 voltage	– 7 to 0	kV

– READING GUN

Electromagnetic focusing and deflection

Heater voltage (Note 2)	6. 1 to 6. 5	V
Cathode k voltage	– 1. 5	kV
Voltage between heater and cathode	± 150	V
Control grid g1 voltage (w.r.t. cathode)	– 180 to 0	V
Anode g2 voltage	– 100 to 0	V
Erasing g3 voltage	– 1. 5 to 0	kV
Focusing g4 voltage	– 1. 5 to 0	kV

Typical operation

– WRITING GUN

Heater voltage	6. 3	V
Heater current, approx.	0. 3	A
Cathode k' voltage	– 7	kV
Voltage between heater and cathode	0	V
Control grid g'1 voltage for cut-off (w.r.t. cathode)	– 90 to – 30	V
Anode g'2 voltage	connected to target	
Focusing g'3 voltage	– 5. 7 to – 5. 3	kV

– READING GUN

Heater voltage	6.3	V
Heater current, approx.	0.3	A
Cathode k voltage	– 1.2	kV
Voltage between heater and cathode	0	V
Control grid g1 voltage for cut-off (w.r.t. cathode)	– 90 to – 30	V
Anode g2 voltage	– 40 to 0	V
Erasing g3 voltage :		
- reading mode	0	V
- erasing mode	– 1.05 to – 0.85	kV
Focusing g4 voltage	– 1.2 to – 1.0	kV

– STORAGE ASSEMBLY

Target voltage :		
- reading mode	0	V
- erasing mode	+ 200 then – 200	V
Collector voltage	0 to 40	V
Shading corrector voltage (w.r.t. collector voltage)	0 to 20	V

NOTES :

1 - Heater insulated for 8 kV w.r.t. ground.
2 - Heater insulated for 2 kV w.r.t. ground.

OPERATING RECOMMENDATIONS

1 - The writing beam should never be motionless on the storage surface which might be damaged. Too high writing beam current density must be avoided.

2 - The reading beam should never be motionless.

3 - Provide a suitable shield in order to protect the tube from stray electric and magnetic fields.

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE

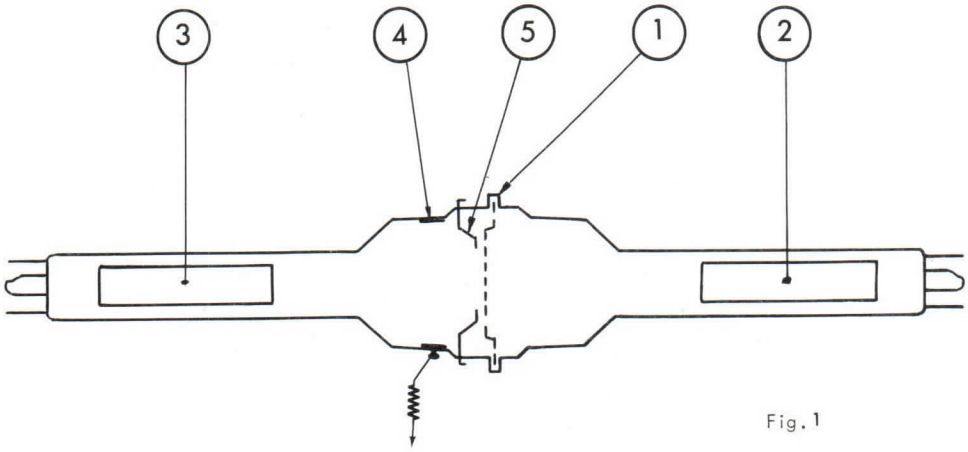


Fig. 1

The TH 8804 (TMA 506) essentially consists of (see Fig. 1) :

- a storage target (1) made of a dielectric layer deposited on a thin metallic backplate (the metallic side facing the writing gun).
- a writing gun (2).
- a reading gun (3).
- a collecting assembly made of two electrodes (4) and (5).

Due to its high velocity, the writing beam is able to penetrate the metal backplate and to create charges in the dielectric by induced conductivity (EBIC). These charges are stored on the surface of the target facing the reading gun. The quantity of stored charges depends on the scanning and current density.

The reading beam scanning the storage surface, each scan is removing a portion of the charge pattern by secondary electron emission.

The secondaries collected by the output electrode (4) give rise to a video signal progressively decreasing.

Typicall decay curves given in Fig. 2 are obtained by changing both collector voltage and/or reading current.

When fast erasure is required, tube should be operated as indicated in Fig. 3.

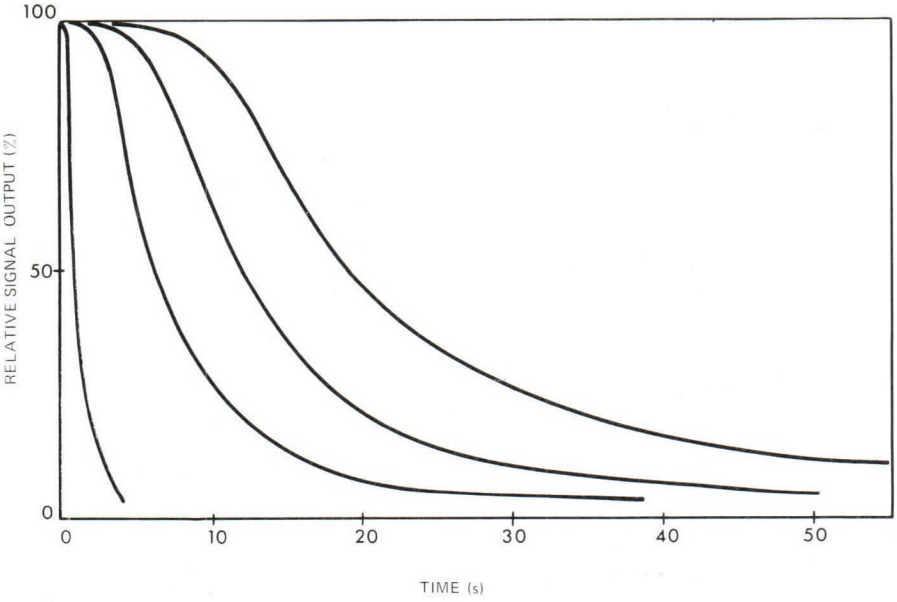


Fig. 2

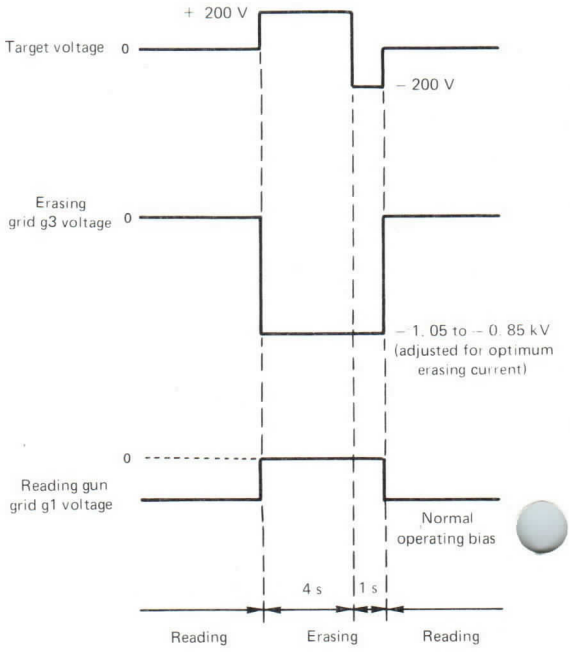
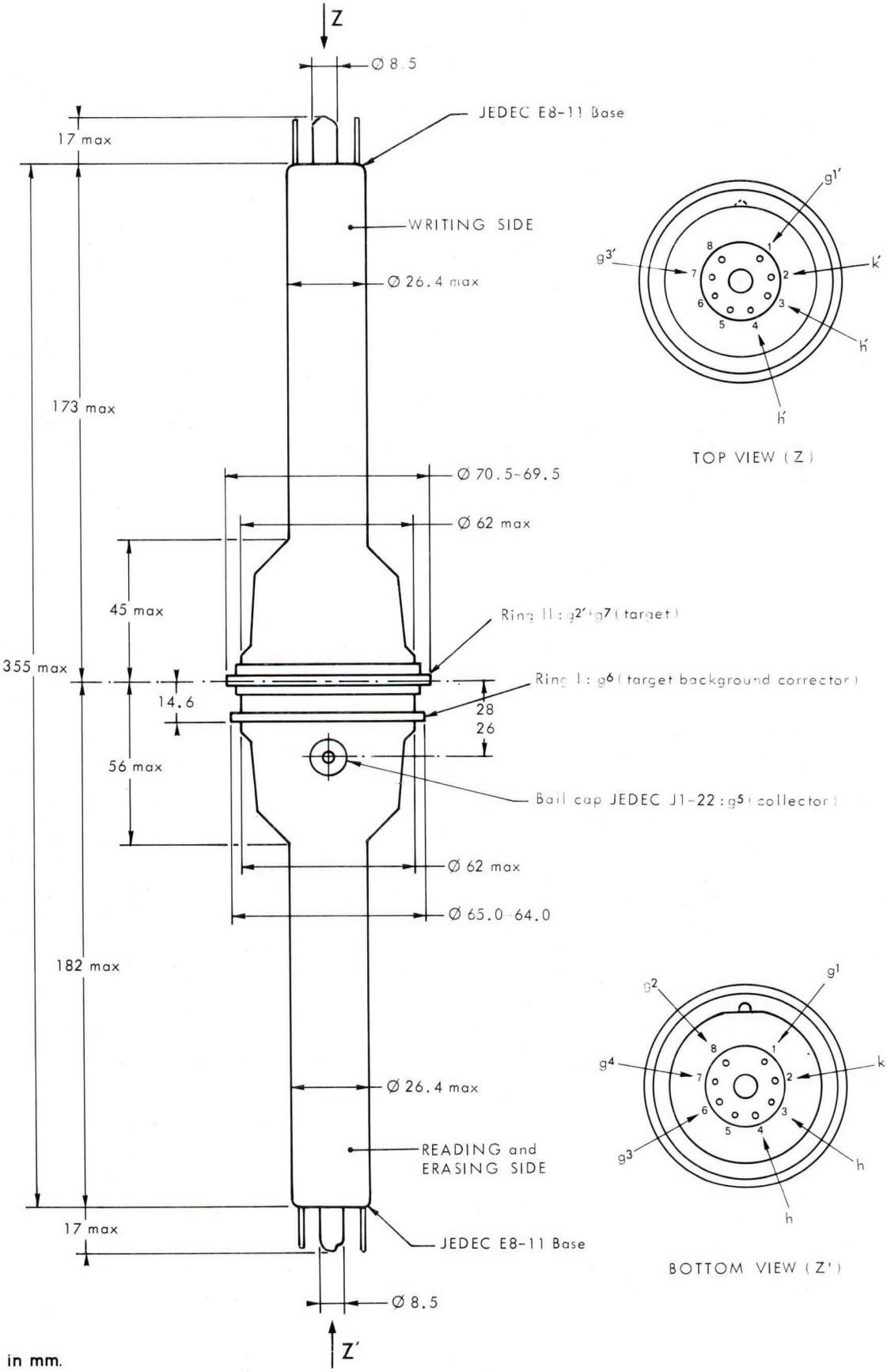


Fig. 3

OUTLINE DRAWING



Dimensions in mm.

TH 8804 (TMA 506)

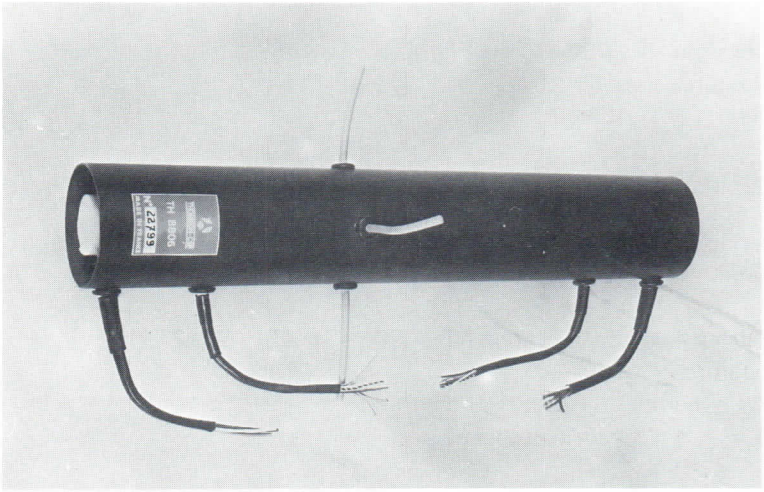
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Imprimé en France

TH 8806
RUGGEDIZED DOUBLE-ENDED STORAGE TUBE
MINIATURIZED POTTED AND SHIELDED TUBE
WITH INTEGRAL COILS
FOR AIRBORNE EQUIPMENT

- 1" DIAMETER DUAL GUN SCAN CONVERTER TUBE
- ELECTROMAGNETIC FOCUS AND DEFLECTION
- NON-DESTRUCTIVE READOUT
- ADJUSTABLE DECAY
- SIMULTANEOUS WRITING AND READING WITHOUT CROSS-TALK
- FAST ERASING BY THE READING GUN
- LIMITING RESOLUTION : 1300 TV lines per diameter



The TH 8806 is a complete assembly including :

- a miniaturized double-ended storage tube operating at low voltages ;
- two special printed circuit, low impedance coils TH 7203 ;
- a shield ensuring magnetic protection and mechanical fixture.

The special design of the TH 8806 allows to obtain a miniaturized assembly (length 290 mm, outer diameter 52 mm) intended for compact airborne scan converter operating under severe environmental conditions such as encountered in military and space applications (see "Environmental Performances" page 2).

Due to the double-ended storage tube properties, the TH 8806 enables numerous operating combinations :

- continuous readout for a few minutes without degradation of the stored information ;
- simultaneous writing and reading without cross-talk due to effective isolation between writing and reading sections ;
- complete or selective erasure by either writing or reading gun ;
- possibility of erasing during line retrace by either writing or reading gun in order to obtain gradual erasure ;
- very fast erasing by reading gun due to a patented gun design ;
- possibility of writing by either writing or reading gun.

ENVIRONMENTAL PERFORMANCES

The TH 8806 is designed to withstand the following operational and non-operational environmental tests.

Rejection criteria

After completion of the environmental tests, the tube meets the characteristics specified under typical operation data.

Operational tests

1 - **Vibration** - Specification NF - C20 - 616 (CEI - 68 - 2 - 6)
The tube shall be mechanically connected to the vibration generator by means of a fixture. It shall be vibrated in 3 mutually perpendicular axis in turn.
The tube is subjected to sinusoidal vibration from 5 to 60 Hz (with constant amplitude of 0. 125 mm) then from 60 Hz to 500 Hz (with constant acceleration of 2g).
Cycle duration : 15 minutes.
Number of cycles per direction : 5.

2 - **Dry heat** - Specification NF - C20 - 602 (CEI - 68 - 2. 2 - Bd)
Temperature : + 85 °C
Duration : 16 hours

3 - **Cold** - Specification NF - C20 - 601 (CEI - 68 - 2. 1 - Ad)
Temperature : – 55 °C
Duration : 16 hours

4 - **Low air pressure** - Specification NF - C20 - 606 (CEI - 68 - 2 - 13)
Pressure : 20 mbar
Temperature : – 55 °C
Duration : 12 hours

5 - **Accelerated damp heat** - Specification NF - C20 - 604 (CEI - 68 - 2 - 4)
Temperature : + 55 ° C
Relative humidity > 95 %
Duration : 1 cycle of 24 hours

Non-operational tests

1 - **Bump** - Specification NF - C20 - 624 (CEI - 68 - 2 - 29)
Peak acceleration : 25 g
Pulse duration : 6 ms (half-sine wave)
Number of bumps : 1000 in each direction
Rate : 1 to 3 bumps per second

2 - **Change of temperature** - Specification NF - C20 - 605 (CEI - 68 - 2 - 14)
One-chamber method
Low temperature : – 55 °C
High temperature : + 85 °C
Temperature change : 1 °C per minute
Exposure duration to each extremal temperature : 3 hours
Number of cycles : 3

3 - **Salt mist** - Specification NF - C20 - 611 (CEI - 68 - 2 - 11)
Temperature : + 35 °C
Duration : 96 hours

TYPICAL PERFORMANCES

Peak output current	0. 2 μA
Writing time :	
- writing over the whole target area	33 - 40 ms (1 TV frame)
- writing of one target diameter	50 μs
Erasing time :	
- erasing of the whole written image to residual less than 5 % (by reading gun)	33 - 40 ms (1 TV frame)
- selective erasing of one target diameter (by writing or reading gun)	300 μs
Reading time (for continuous readout)	10 mn
Decay by line retrace erasure (by either writing or reading gun)	adjustable from 0. 1 s to 10 mn
Retention time (without readout)	several days
Resolution by orthogonal writing and reading :	
- at 50 % modulation	800 TV lines/dia
- limiting	1300 TV lines/dia

GENERAL CHARACTERISTICS

Electrical

– TUBE

Heater voltage	6. 3 V
Heater current (for each gun)	0. 15 A
Output capacitances :	
- target to all other electrodes	17 pF
- grid g5 to all other electrodes	11 pF
Input capacitance :	
- grid g1' to all other electrodes	13 pF
Focusing method (both gun)	electromagnetic
Deflection method (both gun)	electromagnetic

– COILS

The same TH 7203 coils assembly is used on both sides (writing and reading)

Focusing coil :	
- resistance	50 Ω
Alignment coil :	
- resistance	70 Ω
Deflection yoke (vertical or horizontal) :	
- resistance	6 Ω
- inductance	90 μH

Mechanical

Overall length, max.	290 mm
Outer diameter, max.	52 mm
Weight, approx.	1. 2 kg

All electrode and coil connections are made through flying leads as indicated in the drawing.

MAXIMUM RATINGS

(absolute values)

TUBE

Unless otherwise stated, voltages are given with respect to reading cathode potential.

Reading gun		
Cathode k voltage	0	V
Peak heater-cathode voltage :		
- heater negative w.r.t. k	125	V
- heater positive w.r.t. k	125	V
Grid g1 voltage :		
- negative bias value	180	V
- positive bias value	0	V
Grid g2 voltage	600	V
Grid g3 voltage	600	V
Grid g4 voltage	600	V
Grid g5 voltage	700	V

Writing gun		
Cathode k' voltage	− 200	V
Peak heater-cathode voltage :		
- heater negative w.r.t. k'	125	V
- heater positive w.r.t. k'	125	V
Grid g1' voltage (w.r.t. k') :		
- negative bias value	180	V
- positive bias value	0	V
Grid g2' voltage	400	V
Grid g4' voltage	400	V
Grid g5' voltage	500	V

Target voltage ..... 700 V

COILS

Voltage between coils	250	V
Voltage between coils and ground	250	V
Focusing coil :		
- current	0. 3	A
Alignment coil (each coil) :		
- current	0. 1	A
Deflection coil (each horizontal or vertical yoke) :		
- D.C. current	0. 5	A
- peak current	1	A

TYPICAL OPERATING CONDITIONS

Unless otherwise stated, voltages are given with respect to reading cathode potential.

Reading gun		
Heater :		
- voltage	6. 3 ± 10 %	V
- current	0. 15	A
Cathode k voltage	0	V
Grid g1 (Wehnelt) voltage (for cut-off)	−50 to −100	V
Grid g2 (accelerator) voltage	+ 450	V
Grid g3 (erasing) voltage :		
- normal	+ 450	V
- fast	0 to −30	V
Grid g4 (focus) voltage	+ 450	V
Grid g5 (decelerator, collector) voltage	+ 650	V

Writing		
Heater :		
- voltage	6. 3 ± 10 %	V
- current	0. 15	A
Cathode k' voltage	− 150	V
Grid g1' (Wehnelt) voltage w.r.t. k' (for cut-off)	−50 to −100	V
Grid g2' (accelerator) voltage	+ 300	V
Grid g4' (focus) voltage	+ 300	V
Grid g5' (decelerator) voltage	+ 400	V

Target voltage ..... + 5 V

For erasing which can be performed by either writing or reading gun it is necessary to establish a difference of potential of + 15 V between target and the cathode of the operating gun. This can be done

- either by switching the target voltage to + 15 V (erasing by reading gun)
  or to − 135 V (erasing by writing gun)
- or by maintaining target voltage at + 5 V and switching the cathode voltage V_k = −10 V (erasing by reading gun)
  $V_{k'}$ = −10 V (erasing by writing gun)

COILS

Focusing coil :

- current . . . . . 0. 090 A

Alignment coil (each coil) :

- current . . . . . adjustable from – 0. 015 to + 0. 015 A

Deflection coil (each horizontal or vertical yoke) :

- peak to peak current per target diameter . . . . . 0. 800 A

PHYSICAL DESCRIPTION AND OPERATING PRINCIPLE*

The main components of the tube are 2 electron guns (writing and reading) located on each side of a storage target assembly (Fig. 1).

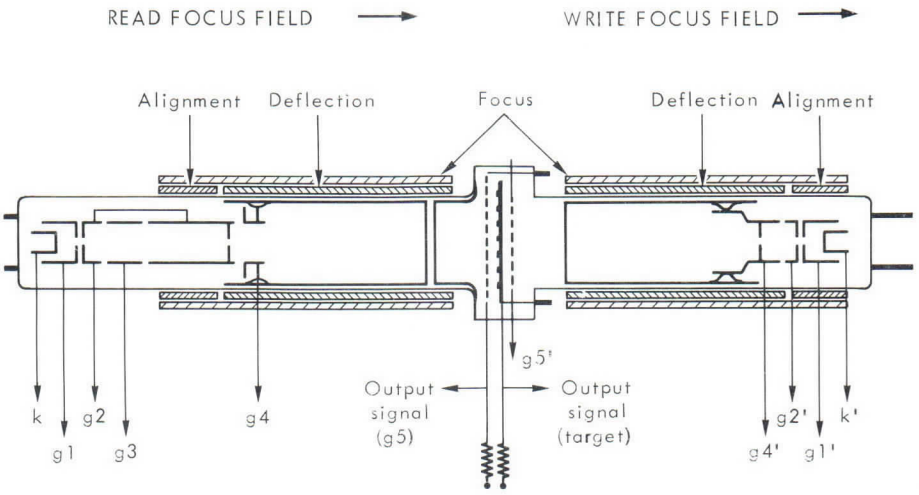


Figure 1

The electron guns employ electromagnetic focus and deflection. The reading gun includes an additional erasing electrode which enables 2 erasing modes (normal or fast) depending on low or high beam current.

The target is of the membrane type,a schematic view of which is given in Figure 2.

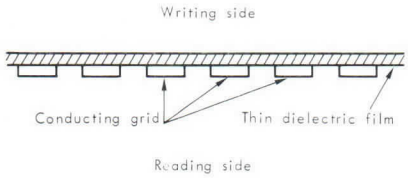


Fig. 2

The principle of operation is the charge or discharge of the storage surface according to the velocity of the primary electron beam through secondary emission of the storage surface.

The structure of the target enables coplanar control mechanism on the reading side when charges have been deposited on either side i.e. by the writing or the reading gun.

The detailed mechanism of the different operations is illustrated in the Figure 3.

WRITING (Fig. 3a)

We assume that, after a previous erasing, the dielectric surface facing the reading side is at –10 V (see erasing) and that the writing beam scans the target with an intensity modulated by the signal applied to g1'.

* Detailed considerations about "Recording Storage Tubes" principles and operations are given in the Technical Information.TEV 6013 which we ask the user to refer to.

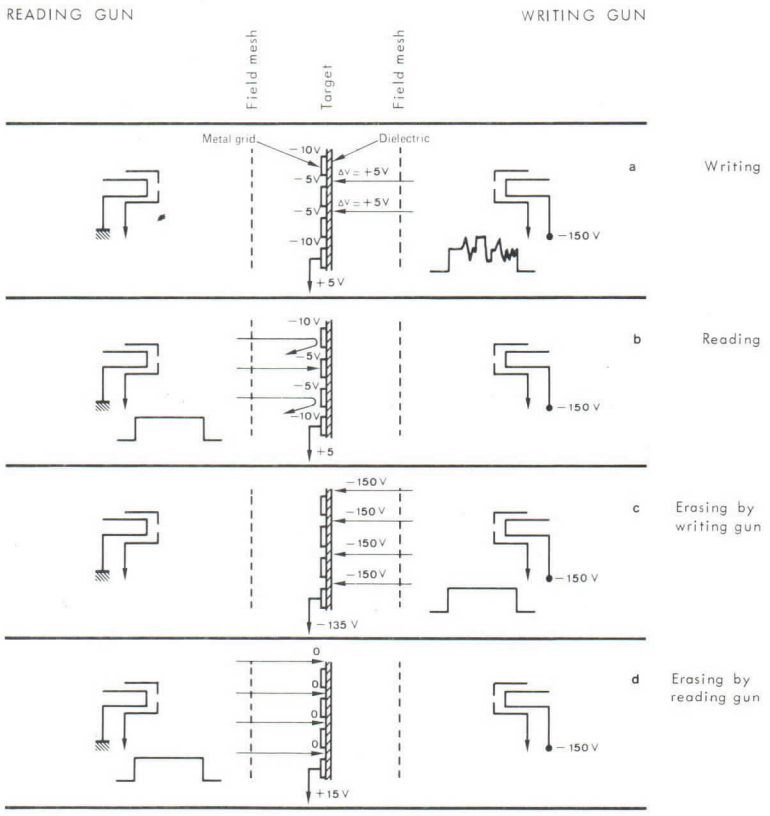


Fig. 3

Considering that the potential difference between the target and the writing cathode is sufficiently high (about 150 V) to get a coefficient $\delta > 1$, positive charges are deposited which increase the potential of the written point by + 5 V for example, on the writing side. By capacitive coupling, the potential of the corresponding point on the reading side will increase by a value of about 5 V and thereby its potential is shifted from −10 V to −5 V.

READING (Fig. 3b)

The reading is performed by scanning the target by the unmodulated reading beam. Depending on the written charge pattern the surface storage voltage varies between 0 and −10 V and output signal varies in exact correspondance. The most negative areas of the dielectric can completely cut-off the electron beam while various gray shades can be obtained in areas where the dielectric is less negative. Since the storage surface voltages are negative with respect to the read cathode voltage, the reading beam has no adverse effect on the pattern and the readout is non-destructive.

ERASING

This can be done by using either the writing beam (Fig. 3c) or the reading beam (Fig. 3d).

In the first case, the target is at −135 V ; the writing electrons landing on the dielectric (writing side) with an energy of 15 eV and giving rise to secondary emission ratio $\delta < 1$, the dielectric is then brought, after bombardment, to an equilibrium potential of −150 V. After switching target voltage back to + 5 V, dielectric surface in then brought to a potential of −10 V.

In the second case, the target is shifted to + 15 V. The capacitive coupling and the low energy electron beam causes the dielectric to be charged down to 0 V through secondary emission ratio $\delta < 1$. After switching target voltage back to + 5 V dielectric surface is then brought to a potential of −10 V.

OTHER OPERATING MODES

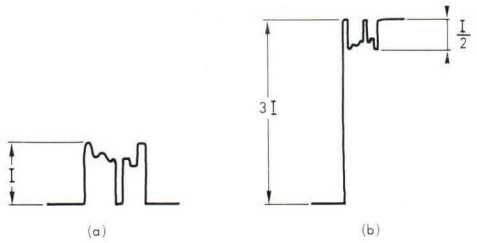
Only the major operations are described above since this tube can perform other operations corresponding to any desired application.

For example, only the writing mode achieved by the writing gun has been described. It is obvious that this operation may be achieved through the reading gun by switching, for example, of the target voltage.

It is also possible to conceive, for a radar application, a gradual variable erasure by the writing gun and automatic switching in writing mode just as the echoes begin to appear (THOMSON-CSF patent).

OUTPUT SIGNAL (Fig. 4)

The output signal can be picked-up through either the target or the reading gun grid g5 but these signals are different from each other as shown in the Figures 4a and 4b.



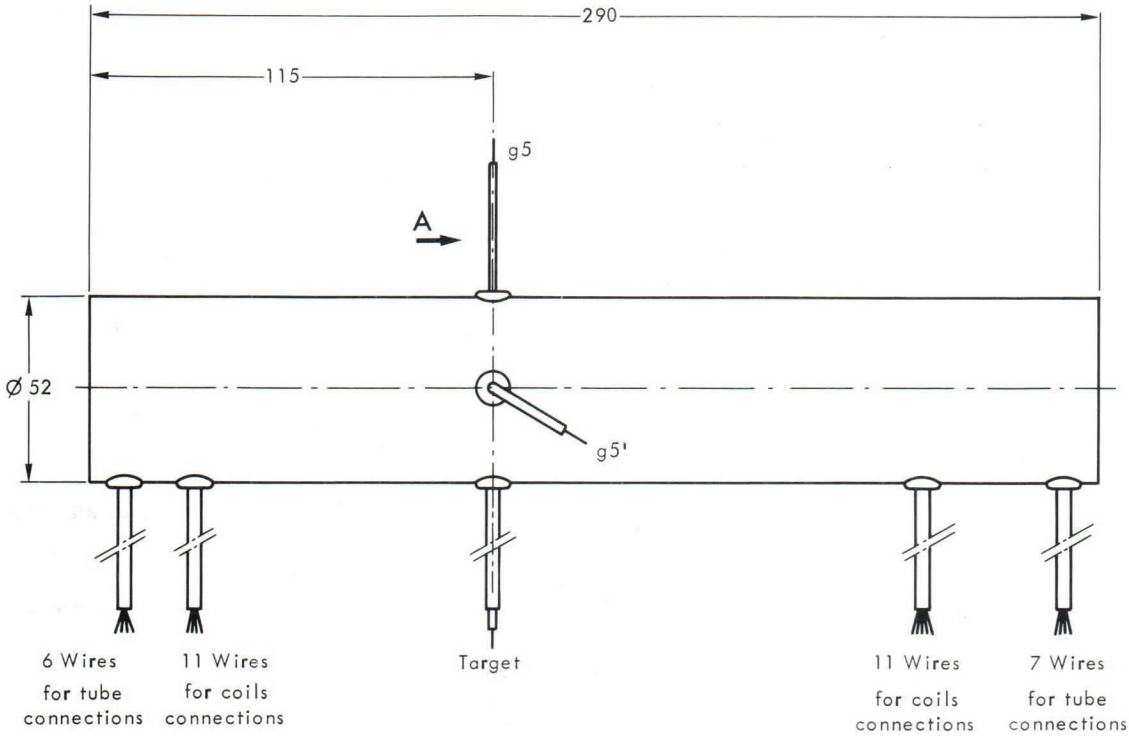
(a) output signal from target
(b) output signal from grid g5

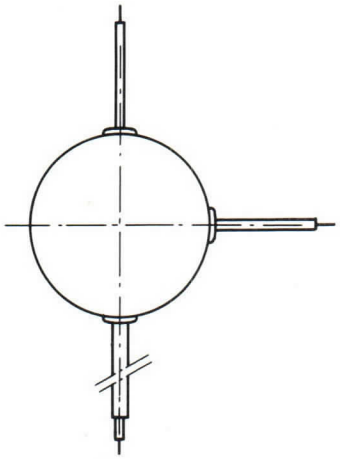
Fig. 4

As compared to the target signal, the grid g5 signal is of reversed polarity and is less convenient since it presents a pedestal level (about 3 times I) and has only about half dynamic amplitude $\frac{I}{2}$

According to the above considerations, it is preferable to use the target as collector except when the crosstalk reaches an uncomfortable level.

OUTLINE DRAWING





View on A

Dimensions in mm.

WRITE

Tube connections		Coils connections	
h'	black	Line scanning	red
h'	black	Field scanning	black green
k'	yellow		white
g1'	green	Focusing	orange (-) brown (+)
g2'	blue	Alignment 1	blue
g4'	brown	Alignment 2	purple yellow black/white
		Ground	grey

READ

Tube connections		Coils connections	
h	black	Line scanning	red
h	black	Field scanning	black green
k	yellow		white
g1	green	Focusing	orange (+) brown (-)
g2	blue	Alignment 1	blue
g3	red	Alignment 2	purple Yellow
g4	brown		black/white
		Ground	grey

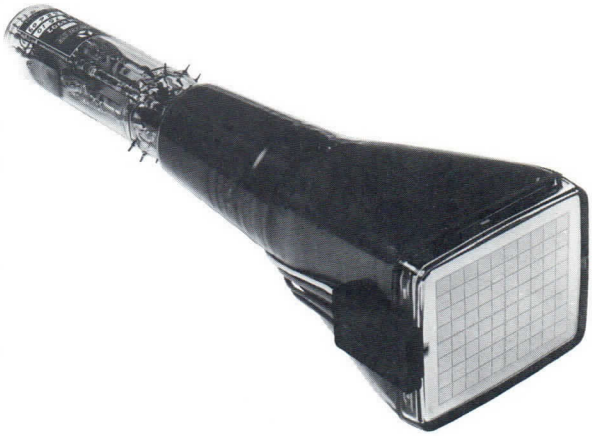
TH 8902
DIRECT VIEW STORAGE TUBE FOR STORAGE OSCILLOSCOPE

- VARIABLE PERSISTENCE
- HIGH WRITING SPEED
- 8 x 10 DIVISIONS ILLUMINABLE GRATICULE
- FLAT RECTANGULAR FACEPLATE
- 100 MHz BANDWIDTH
- BURN RESISTANT

The TH 8902 is a direct view storage tube having a rectangular faceplate, especially designed for high frequency (100 MHz bandwidth) storage oscilloscope applications.

The flat screen (P31 phosphor) includes a 8 x 10 divisions internal illuminable graticule. The two flood guns symetrically located with respect to the tube axis enable to obtain bright display of information over the entire useful area. The writing gun features high resolution and high deflection sensitivity.

The TH 8902 is suitable for storage oscilloscope application being able to display stored information with or without persistence and non-stored information.



TYPICAL PERFORMANCE

Writing speed* (Note 14)	100	cm/μs
Linewidth at center	0. 4	mm
Viewing time* (see page 4)		variable
Luminance*	400	$cd.m^{-2}$

* These values being closely corelated can be adjusted within a wide range depending on specific applications.

GENERAL CHARACTERISTICS

Electrical

– FLOOD GUNS

Number	2
Heater voltage (D.C.)	6. 3 V
Heater current	2 x 0. 3 A

– WRITING GUN

Heater voltage	6. 3 V
Heater current	0. 6 A
Focusing method	electrostatic
Deflection method	electrostatic

– INTERELECTRODE CAPACITANCE

g1 to all other electrodes,	max.	15	pF
k to all other electrodes	max.	6	pF
x_1 to all other electrodes (except x_2)	max.	8	pF
y_1 to all other electrodes (except y_2)	max.	5	pF
x_1 to x_2	max.	4	pF
y_1 to y_2	max.	3	pF

Optical

Phosphor :
- type . . . . . P31 aluminized
- fluorescence and phosphorescence . . . . . blue - green

Faceplate . . . . . flat

Mechanical

Faceplate dimensions	100 mm x 120 mm
Graticule dimensions	72 mm x 90 mm
Overall length	450 mm
Neck diameter	50 mm
Base	UTE 14 C 25 (IEC 67-1-46 a)
Neck pins	see drawing
Encapsulated leads	see drawing
Net weight, approx.	1. 4 kg

OPERATING CONDITIONS

Maximum values (absolute ratings)

Unless otherwise stated, voltages are given with respect to ground potential.

– FLOOD GUNS

Heater h' voltage (D.C.)		5. 7 to 6. 9	V
Cathode k_1' and k_2' voltages	max.	50	V
Peak heater to cathode voltage :			
- heater negative with respect to cathode	max.	150	V
- heater positive with respect to cathode	max.	150	V
Grid g_1' voltage (control grid)		– 200	V
Grid g_2' voltage (accelerating electrode)		– 50 to +50	V
Grid g3' voltage (collimating electrode)	max.	100	V

– STORAGE UNIT AND VIEWING SCREEN

Grid g_5' voltage (collecting electrode)	max.	150	V
Grid g_6' voltage (backing electrode)		– 150 to + 1600	V
Viewing screen g_7' voltage	max.	8	kV

– WRITING GUN

Heater h voltage		5. 7 to 6. 9	V
Cathode voltage	max.	– 3. 6	kV
Peak heater to cathode voltage :			
- heater negative with respect to cathode	max.	150	V
- heater positive with respect to cathode	max.	150	V
Grid g_1 voltage** (control grid)		– 300	V
Grid g_2 voltage (accelerating voltage)	max.	50	V
Grid g_3 voltage (focusing electrode)	max.	– 3	kV
Grid g_4 voltage (astigmatism)	max.	100	V
Grid g_5 voltage (geometry)	max.	100	V

** With respect to writing gun cathode.

Typical operation

Unless otherwise stated, voltages are given with respect to ground potential.

– FLOOD GUNS

Heater h' voltage (D.C.)	6.3 ± 10 %	V
Cathode k_1' voltage (Note 1)	0 to +3	V
Cathode k_2' voltage (Note 1)	0 to +3	V
Grid g_1' voltage (control grid)	0	V
Grid g_2' voltage (accelerating electrode) (Note 2)	see table below	
Grid g_3' voltage (collimating electrode) (Note 2)	30 to 70	V

– STORAGE UNIT AND VIEWING SCREEN

Grid g_5' voltage (collecting electrode)	see table below
Grid g_6' voltage (backing electrode) (Notes 4 and 7)	see table below
Viewing screen g_7' voltage (Note 8)	see table below

Modes	g_2'	g_5'	g_6'	g_7'
Non-storage	– 6 V	0 V	– 30 V	7 kV
Variable persistence	20 to 40 V	100 V	Note 5	7 kV
Normal storage	20 to 40 V	100 V	1 to 3 V	7 kV
Long storage	Note 3	100 V	1 to 3 V	7 kV
Long-term retention	– 6 V	0 V	– 30 V	0 kV
Erase	20 to 40 V	100	Note 6	7 kV

– WRITING GUN

Heater h voltage	6.3 ± 10 %	V
Cathode k voltage (Note 14)	– 1700	V
Grid g_1 voltage (for cut-off) (w.r.t. V_k)	– 100 to – 40	V
Grid g_2 voltage (acceleration)	40	V
Grid g_3 voltage (focus)	–1400 to –1000	V
Grid g_4 voltage (astigmatism)	10 to 70	V
Grid g_5 voltage (geometry) (w.r.t. x plates mean potential)	– 30 to +30	V
x plates mean potential	20 to 60	V
y plates mean potential	40	V

– MAXIMUM ELECTRODE CURRENTS

Flood guns :		
- heater current (D.C.) at $V_{h'}$ = 6.3 V	0.66	A
- cathode k_1' current	1.5	mA
- cathode k_2' current	1.5	mA
- grid g_2' current	1	mA
- grid g_3' current	2	mA
Storage unit and viewing screen :		
- grid g_5' current	0.5	mA
- grid g_6' current	0.5	mA
- grid g_7' current	0.2	mA
Writing gun :		
- heater current at V_h = 6.3 V	0.66	mA
- cathode current	3.5	mA
- grid g_2 current	3	mA

REMARKS :

1 - *A high permeability shield (mumetal) is necessary to protect the tube against external electrostatic and magnetic fields.*

2 - *For the writing gun, a heater transformer with insulated secondary coil must be used (4 kV insulation minimum).*

PERFORMANCE

I - Non-store mode

Resolution (Note 9) . . . . . 0. 4 mm
Spot position (Note 10) . . . . . 9 mm
Deflection sensitivity :
- x plates deflection factor (Note 14) . . . . . 10 V ± 10 % per division
- y plates deflection factor (Note 14) . . . . . 4. 7 V ± 10 % per division
- deflection factor uniformity . . . . . see Note 11

Trace alignment . . . . . see Note 12
Pattern distortion . . . . . see Note 13

II - Store mode

– MAXIMUM LUMINANCE

The luminance for a saturated written trace is over 400 $cd.m^{-2}$.

– WRITING SPEED (Note 14)

100 cm/µs speed (the background is not dark but the contrast is sufficient to make the trace visible).

– VIEWING TIME

The viewing time mentioned in the following table is given as a function :
1 - of the writing speed (0. 1 div/µs - 5 div/µs - 100 div/µs)
2 - of the duty rate of the flood gun ; when the duty rate decreases, the viewing time increases with resulting in loss of luminance.

Example of duty rate of flood guns	1			1/3			1/10		
Writing speed (div/µs)	0. 1	5	100	0. 1	5	100	0. 1	4	100
Typical viewing time*	1 mn	20 s	10 s	3 mn	1 mn	30 s	10 mn	3 mn	100 s

* Time beyond which the written trace cannot be discerned on the background.

– VARIABLE PERSISTENCE

Depending on the rate and duration of pulses applied to the backing electrode g6', required visual output decay can be adjusted from 0. 2 s to the values indicated in the table above.

– LONG TERM

When the flood beams are cut off and the screen voltage at 0 V potential, the written information is not degraded by ion charging and can be stored for up to many days.

NOTES

1 - The two flood gun cathodes are to be separately adjusted in order to obtain the best uniformity.

2 - The g2' and g3' voltages are to be adjusted in order to obtain the best uniformity.

3 - In the long-storage mode, g2' voltage is set at −6 V, then a positive pulse train of 26 to 46 V amplitude is applied.

4 - In store mode, the g6' voltage must never exceed 8 V. The impedance of the g6' circuit must be as low as possible and not exceed 1000 Ω.

5 - In variable persistence mode, a positive pulse train of 4 V amplitude is applied to grid g6'.

6 - In erase mode, the grid g6' potential must be raised from store-mode potential (i.e. 1 to 3 V) to + 1500 V for about 1 second and then be returned to its store-mode potential. A positive pulse of 12 V amplitude maximum is then applied for 500 milliseconds.

7 - In changing the operating from the "non-store" to the "store" mode, the g6' voltage must be raised from −30 V to the proper positive voltage (1 to 3 V) in 2 seconds. This will prevent the storage surface to be damaged.

8 - To avoid permanent damage to the tube, insert a 30 MΩ minimum resistance in series in the supply circuit of g7' screen.

9 - Measurement is made by the shrinking raster method with a beam current of 5 μA. The linewidth is 0.4 mm max. at center and does not exceed 0.8 mm on any point of the useful screen area.

10 - Distance of the focused and undeflected spot from geometric center of the screen.

11 - Measurement is made according to "I.E.C." specifications.

12 - Angle between x and y traces is adjusted by means of the orthogonality coil. Angle between x trace and the horizontal axis of graticule is adjusted by using the rotation coil.

13 - Vertical and horizontal traces must fall within the boundaries of the two following squares centered on the screen :

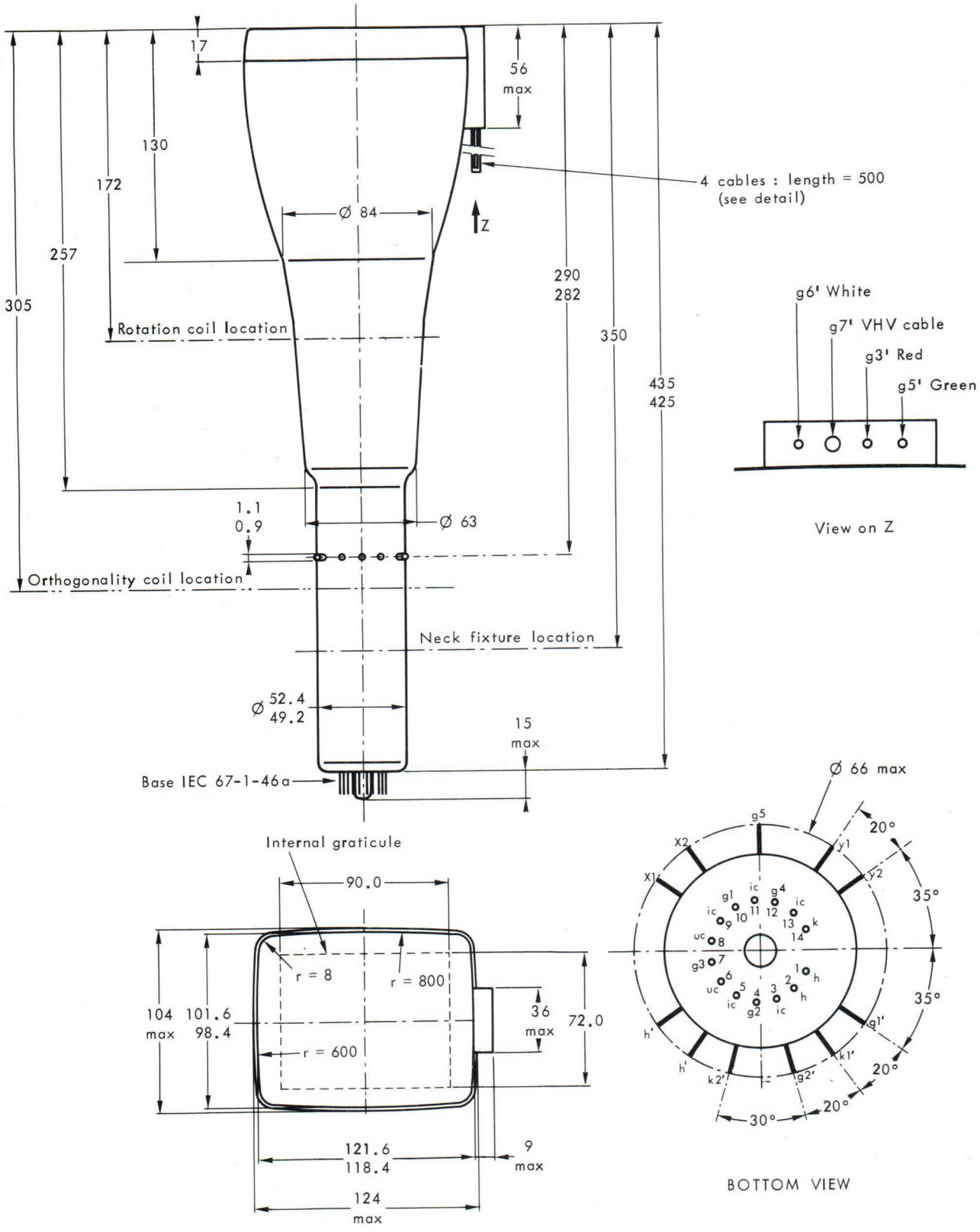
- outer square : 8 x 8 divisions central square on the graticule (72 mm x 72 mm) ;
- inner square : 70 mm x 70 mm (sides parallel to outer square).

Because of the width of the trace, only one edge of the trace is to be taken into account.

14 - The limiting writing speed measured in normal ambient lighting conditions is 100 cm/μs. It is defined as the limiting discernibility of the trace on a slightly luminous background. The writing speed can reach 200 or 300 cm/μs in particular viewing conditions : optimum adjustment of the storage mesh potential, low ambient light level.
In addition, this limiting writing speed can be further multiplied by a factor of 2 or 3 by doubling the acceleration voltage of the writing gun (V_k = − 3400 V). In this case :

S_x = 20 V ± 10 % per division
S_y = 9. 4 V ± 10 % per division

OUTLINE DRAWING



BOTTOM VIEW

Dimensions in mm.

Note 1 - Nominal untoleranced dimensions given for general information.

TH 9510 (KM2433)
PHOTOMULTIPLICATEUR

Le tube TH 9510 est un tube à 10 étages, comportant une photocathode semitransparente frontale du type multialkali ayant une sensibilité minimale de 90 microampères/lumen et une réponse spectrale du type S20.

Le tube TH 9510 trouve son emploi en spectrophotométrie et dans des applications où une grande sensibilité à la lumière rouge ou à la lumière blanche est nécessaire.

CARACTERISTIQUES GENERALES

Electriques

	Min.	Typique	Max.	Unités
Réponse spectrale		S20		
Sensibilité cathodique à 210 Volts (continu) entre la cathode et toutes les autres électrodes (Note 1)	90	130	–	µA/lumen
Sensibilité au rouge (Note 2)	25	30	–	µA/lumen
Sensibilité anodique lumineuse à 105 Volts entre étages (continu)	15	25	–	A/lumen
Sensibilité cathodique, au maximum de sensibilité et à 210 Volts entre la cathode et toutes les autres électrodes	0, 058	–	–	µA/µW
Courant de bruit anodique (Note 3)	–	–	0, 01	µA/µW
Amplification de courant à 105 V de tension inter-électrodes	–	200. 000		
Capacités interélectrodes :				
- Anode/toutes électrodes réunies	–	3, 3	–	pF
- Anode/dernière dynode	–	1, 3	–	pF
Longueur d'onde au maximum de réponse spectrale	–	420	–	nm

Mécaniques

Diamètre utile minimal de photocathode	44	mm
Distance entre l'embase et la fenêtre d'entrée	124 ± 5	mm
Diamètre du tube	50 ± 2	mm
Longueur hors tout	143 ± 5	mm
Embase	B 14 - 38	
Diamètre maximal	58	mm
Position d'utilisation	indifférente	
Indice de réfraction de la fenêtre	1, 5	

VALEURS LIMITES

	Max.	
Courant cathodique de crête (Note 4)	10	µA
Courant anodique moyen (Note 5)	1	mA
Tension maximale entre l'anode et la cathode (tension continue, ou valeur de crête de tension alternative)	1800	V
Tension maximale entre la dernière dynode et l'anode (tension continue ou valeur de crête de tension alternative)	500	V
Tension maximale entre la cathode et la première dynode (tension continue ou valeur de crête de tension alternative)	500	V
Tension d'électrode de focalisation (Note 6)		
Température ambiante maximale	85	°C

NOTES

1 - Mesuré avec une lampe à filament de tungstène chauffée à la température de couleur de 2870°K.

2 - La réponse dans le rouge est mesurée de la façon suivante : la sortie de lumière de la lampe à filament de tungstène à 2870°K est ajustée de façon qu'un flux de 0,01 lumen frappe la cathode du tube. Le filtre rouge (C.S.2-62 type Corning 2418) est alors interposé dans le faisceau puis il est procédé à la mesure de courant cathodique.

3 - Mesuré à la tension totale qui donne une sensibilité anodique de 15 A/lumen à 25°C, après une adaptation au noir de 10 minutes.

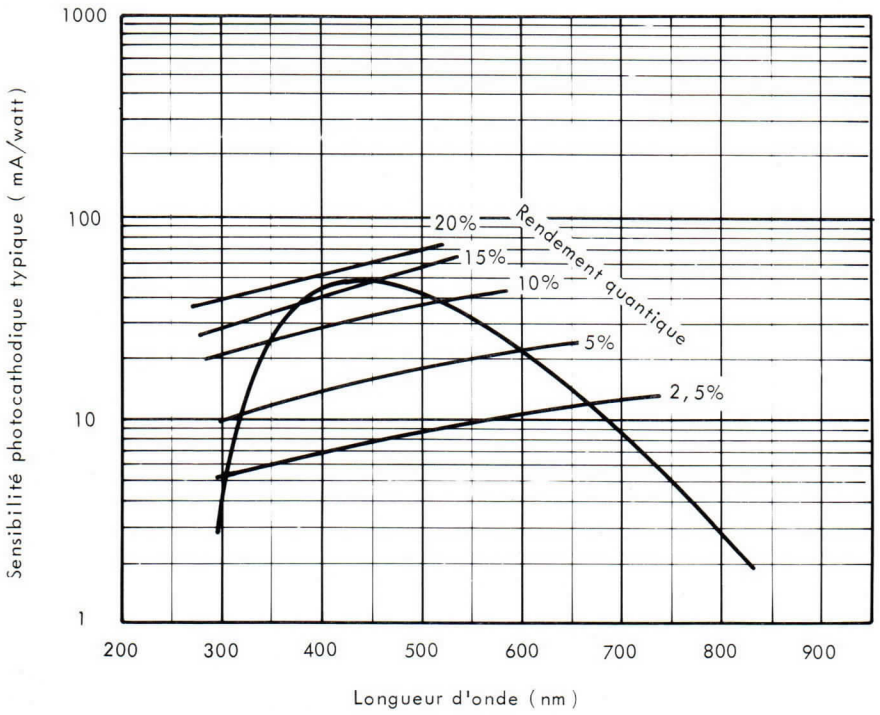
4 - La valeur du courant cathodique donnée ici est celle à partir de laquelle, du fait de la résistance de la photocathode, la réponse du courant cathodique cesse d'être linéaire en fonction de l'intensité lumineuse.

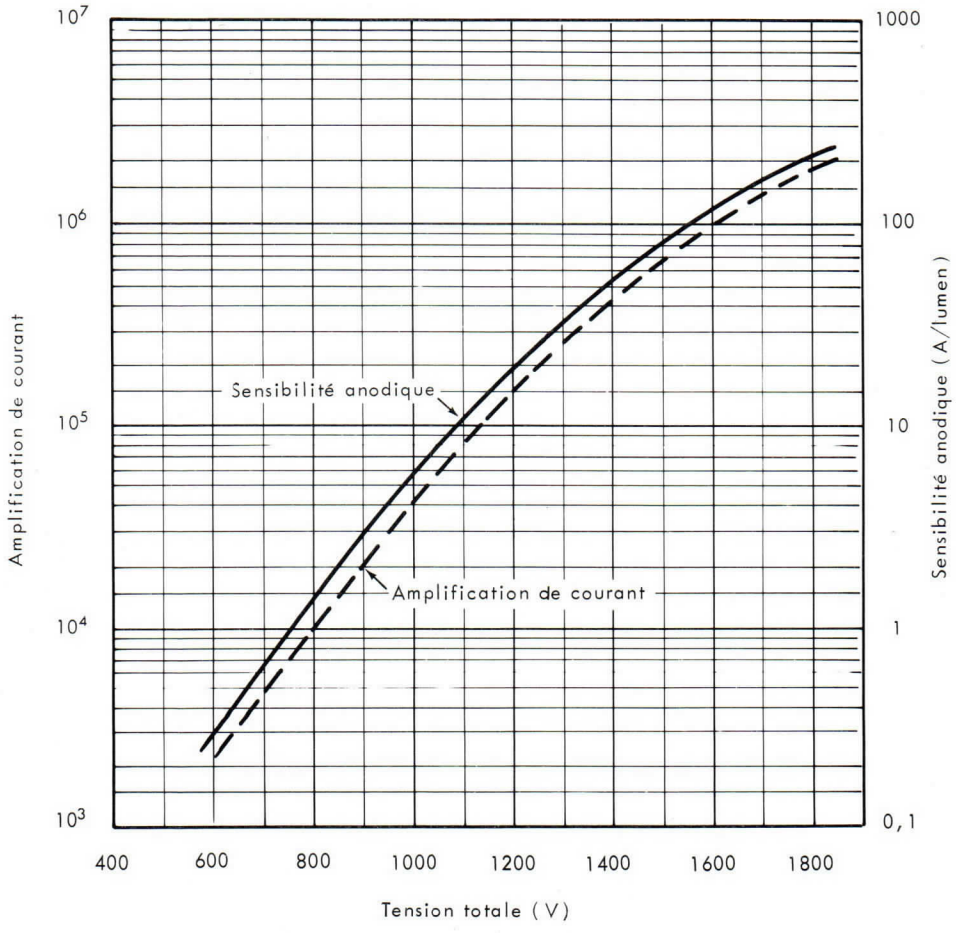
Afin de ne pas excéder la valeur limite de courant anodique, le courant cathodique doit en général être maintenu à une valeur bien inférieure à la présente limite.

5 - Période maximale d'intégration : 30 secondes.

6 - Le potentiel de l'électrode de focalisation doit être ajustée à une valeur comprise entre celles de la cathode et la première dynode pour obtenir l'efficacité optimale de collection des photoélectrons. Bien que variable d'un tube à l'autre, il est en général de quelques volts supérieur à celui de la cathode.

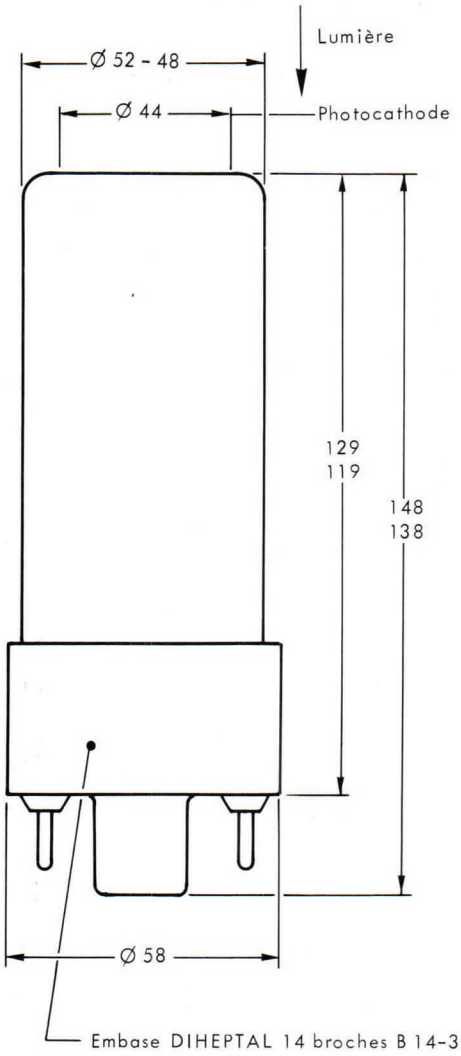
REPONSE SPECTRALE Type S20

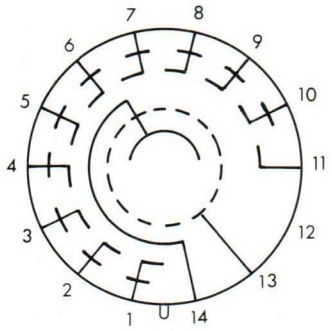




THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

DESSIN D'ENCOMBREMENT





VUE ARRIERE

Broche n°	Eléments
1	1ère dynode
2	2 "
3	3 "
4	4 "
5	5 "
6	6 "
7	7 "
8	8 "
9	9 "
10	10 "
11	Anode
12	C.I.
13	Focalisatrice
14	Cathode

Imprimé en France

CIRCUITS DE COMMANDE POUR LUMIPLAQUES*

I - TENSION D'ALIMENTATION

Les conditions d'alimentation des Lumiplaques (tension, fréquence, forme d'onde) influencent directement leurs caractéristiques essentielles : durée de vie, luminance. Il est donc recommandé d'utiliser :

- pour un affichage à commutation lente, une source sinusoïdale de 220 V efficace (valeur maximale) dont la fréquence, 50 Hz ou 400 Hz, est adaptée au type de Lumiplaque envisagé.
- pour un affichage à commutation rapide, une alimentation à fréquence plus élevée 4 kHz ou même 8 kHz sous certaines conditions qui seront précisées dans le paragraphe I - 2.

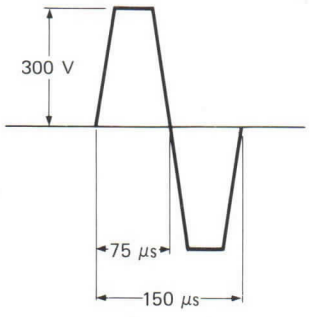
La commande des Lumiplaques se fait en général par un dispositif mécanique : interrupteur, relais. Cependant certaines applications exigent un contrôle précis du temps de commutation ; il est dans ce cas utile de commander les Lumiplaques par des circuits électroniques.

En pratique, deux cas peuvent se produire :

I - 1 - Temps d'application du signal grand devant la période du réseau : utilisation d'une source sinusoïdale (50 Hz ou 400 Hz) avec emploi d'un interrupteur électronique, par exemple le thyristor planar Silicium type E20 ou E200 adapté à la commutation des tensions alternatives élevées par commande au niveau logique de 5 V - TTL.

I - 2 - Temps d'application du signal très court. Ce cas se rapporte essentiellement aux petites surfaces commandées par multiplexage. On peut alors utiliser une alimentation de fréquence plus élevée, 4 kHz et même 8 kHz, délivrant une tension de forme rectangulaire à condition :

- que la tension crête ne dépasse pas 300 V ;
- que le taux de travail ne dépasse pas 10 % (à 4 kHz).



A titre d'exemple : Signaux rectangulaires

Front de montée	:	0, 2 µs
Longueur d'impulsion	:	75 µs (soit période 150 µs)
Taux de travail	:	10 % (1 période toutes les 1, 5 ms)
Tension crête	:	300 V

II - DISPOSITIF DE COMMUTATION

Ce dispositif doit posséder les caractéristiques suivantes :

- bonne tenue à la tension appliquée à ses bornes et très faible courant de fuite ($\leqslant$ 500 nA) pendant le temps de coupure (mode ouvert "cut-off") ;
- conduction bidirectionnelle pendant le mode fermé "on".

II - 1. - Commutation lente : interrupteurs électroniques sous tension sinusoïdale 50 Hz ou 400 Hz.

Les doubles thyristors planar au Silicium type EL20 ou EL200 sont réalisés spécialement pour la commutation en alternatif haute tension (200 V eff). Il conviennent particulièrement à la commande des Lumiplaques.

* Marque déposée - Pour les plaques électroluminescentes à effet Destriau fabriquées par THOMSON-CSF, voir détails du principe de fonctionnement et des caractéristiques dans le document GTE 015.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

II - 1. 1 - THYRISTOR TYPE EL20*

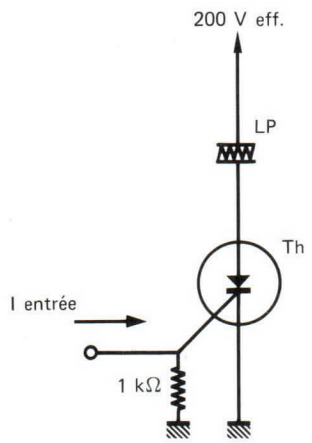


Fig. 1A

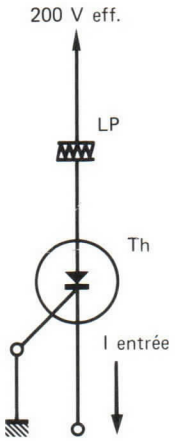


Fig. 1B

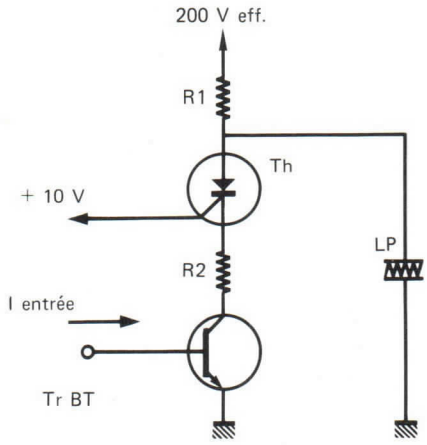


Fig. 1C

Fig. 1 A - Commande série par la gachette du thyristor - Dans ce cas la logique d'attaque est positive (lumiplaque allumée par un signal d'entrée de polarité positive).

Fig. 1 B - Commande série par la cathode - Dans ce cas la logique d'attaque est négative.

Fig. 1 C - Commande parallèle par la cathode - Dans ce cas on supprime l'influence des capacités parallèles de sortie (courant de repos nul). La logique de commande est positive.

NOTE : Dans les cas 1 B et 1 C, on bénéficie du gain en courant du thyristor.

II - 1. 2 - THYRISTOR TYPE EL200*

C'est un circuit intégré monté en boitier TO-100 comportant quatre voies de commutation.

Type EL 200

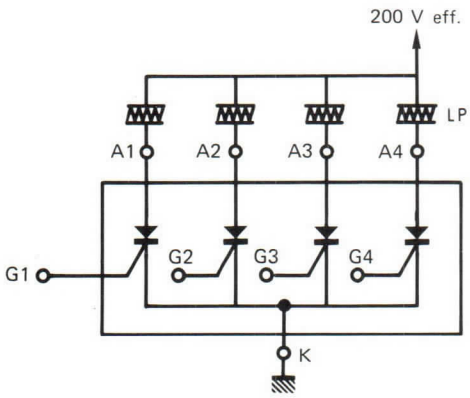


Fig. 2A

Type EL 200 G

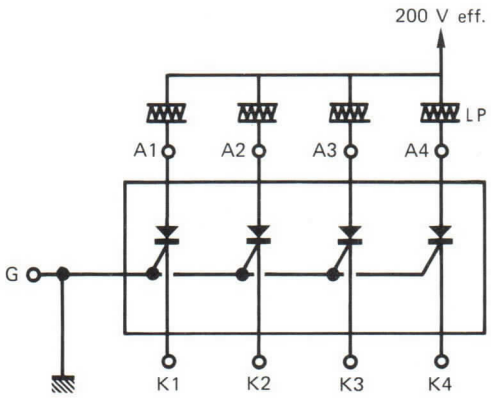


Fig. 2B

Fig. 2 A - Circuits intégrés quatre voies : commande série positive par la gachette.

Fig. 2 B - Circuits intégrés quatre voies : commande série négative par la cathode.
Le circuit de la figure 1 C (commande parallèle positive par la cathode) peut se transposer à ce type de thyristor pour la commutation à quatre voies.

* **FOURNISSEURS** : *SSPI (Solid State Products) division de Unitrode Corporation.*

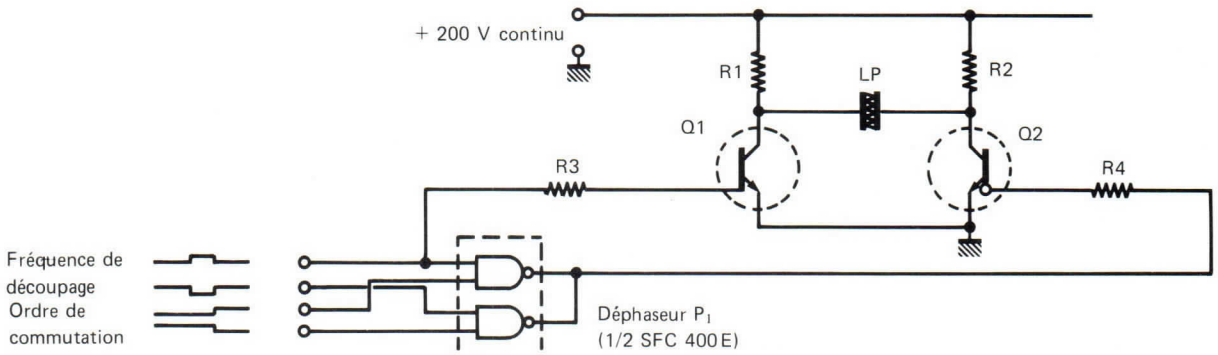
II - 1. 3 - LOGIQUE D'ATTAQUE

Elle sera négative ou positive suivant le montage de commande en série ou en parallèle au niveau de 5 V, compatible avec les TTL.

II - 2 - Commutation rapide

Elle s'applique pour un grand nombre d'éléments électroluminescents de petite surface (affichage numérique, barregraphe, synoptique). La commutation peut se faire par l'emploi de circuits de commutation utilisant des éléments électroniques courants peu onéreux.

II - 2. 1 - PRINCIPE



Les transistors Q1 et Q2 connectent à la masse les deux électrodes de l'élément électroluminescent LP (lumiplaque), simultanément ou en opposition de phase suivant l'ordre de commutation délivré au déphaseur de commande et au rythme de la fréquence de découpage appliquée à ce même déphaseur.

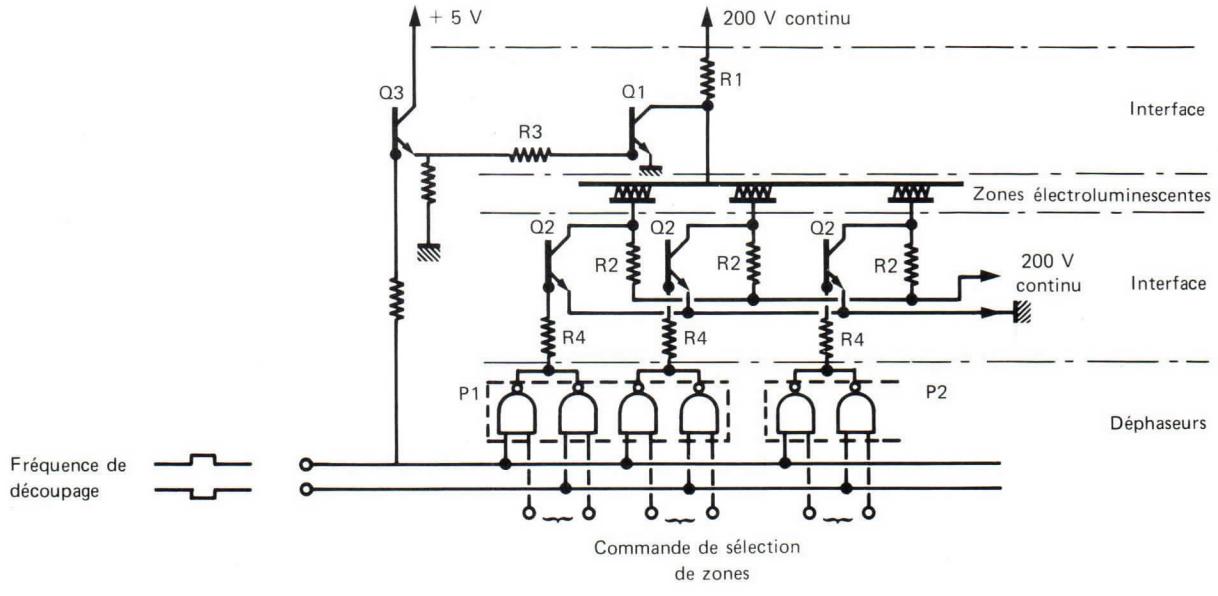
Les résistances R1 et R2 portent ces électrodes à + 200 V lorsque Q1 ou Q2 est bloqué. Elles doivent être calculées pour que la constante de temps de charge du condensateur C équivalent à l'élément électroluminescent soit faible (5 à 10 fois par exemple) devant la demi période de découpage. La puissance $\frac{U^2}{R}$ perdue au moment de l'ouverture de Q1 ou Q2 limite l'utilisation de ce principe aux faibles valeurs de C. Pour une fréquence de découpage de 400 Hz on a T = 2, 5 ms.

Si on admet $\tau = \frac{T}{10}$, on aura $\tau =$ 0, 25 ms.

Pour U = 200 V et une capacité C = 500 pF/cm^2, la puissance consommée sera de :

$$\frac{U^2}{R} = \frac{U^2\ C}{\tau} = \frac{(200)^2\ 5,\ 10^{-10}}{2,\ 5.\ 10^{-4}} = 0,\ 08\ W/cm^2 \text{ ou } 80\ mW/cm^2$$

II - 2. 2 - SCHEMAS DE COMMUTATION A n VOIES SUR 1 LUMIPLAQUE
(1 électrode commune à n zones)



THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

R1 est calculée pour obtenir une constante de temps R1 Ct tenant compte de la capacité totale de la lumiplaque (toutes les zones allumées).

La constante de temps R2 Cz tient compte de la seule capacité d'une zone par rapport à l'électrode commune.

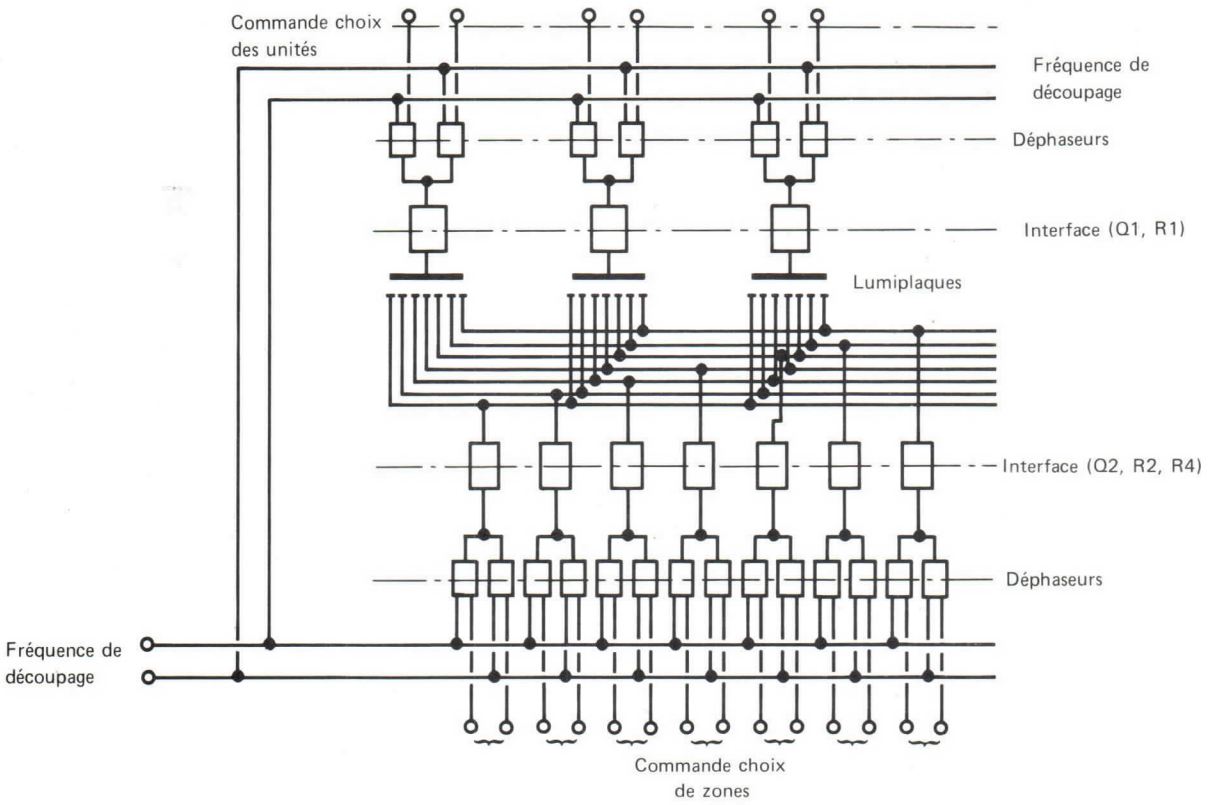
Les déphaseurs P1, P2 . . . sont des portes "nand", par exemple : SFC 400 E.

Q1, Q2 sont des transistors à haut isolement collecteur/émetteur, par exemple : BF 259 de SESCOSEM (V_{CE} = 300 V).

NOTE : La fréquence de découpage doit être choisie suivant les consignes du paragraphe I - 2. d'après le mode de sélection de zones.
Par exemple : 400 Hz pour un affichage permanent ou 4 kHz pour un taux de travail de 10 %.

II - 2. 3 - CAS DE PLUSIEURS LUMIPLAQUES A n ZONES

Le multiplexage sur plusieurs unités est possible et aboutit au schéma suivant :



NOTE : Même remarque que précédemment (II - 2. 2.). On peut monter la fréquence jusqu'à 8 kHz pour un taux de travail de 5 %. On est cependant limité par la puissance consommée (abaissement de la constante de temps RC).

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

Notice TEV 3027

Mai 1970 - Page 1/6

MODULE DE COMPTAGE 1000 Hz
TYPE 46617

THOMSON-CSF - GROUPEMENT TUBES ELECTRONIQUES 8, rue Chasseloup-Laubat - 75-Paris 15e - Tél.: 566.70.04

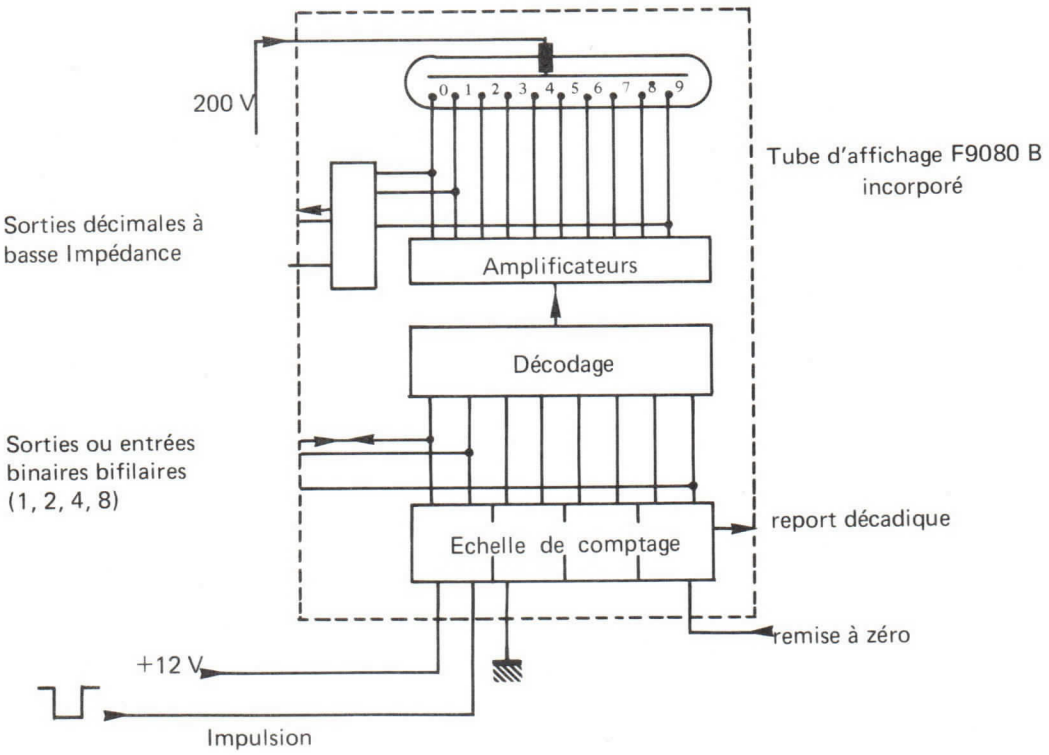
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

MODULE DE COMPTAGE 1000 Hz
TYPE 46617

Ce module réalise le comptage d'impulsions aléatoires ou synchrones avec :

- Affichage sur tube à cathodes froides
- Sorties binaires
- Sorties décimales (46617 D - sur option)
- Report décadique pour la commande des étages supérieurs
- Remise à zéro

DIAGRAMME de FONCTIONS

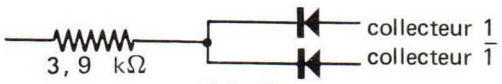


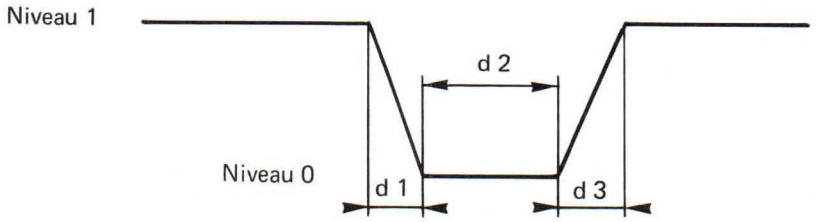
CARACTERISTIQUES GENERALES DE FONCTIONNEMENT

- Une seule source BT . . . . . 12 V ± 10 % - 60 mA
- HT . . . . . 200 V ± 10 % - 2, 5 mA
(par exemple 140 V eff. redressés - double alternance - avec filtrage)

Entrée : Borne E

- Impédance d'entrée . . . . . 3, 9 kΩ
- Impédance d'attaque . . . . . ⩽ 5 kΩ
- Signal d'entrée . . . . . Impulsion négative





+24 V

Niveau 1	⩾ +12 V - 10 %	
Niveau 0	⩽ +0, 3 V à 1000 Hz	
	⩽ +1 V à 100 Hz	

Durée minimale du palier au niveau 0 :	10 µs
Durée maximale	quelconque
Intervalle minimal entre deux impulsions	800 µs
Fronts : - d 1	⩽ 150 µs
- d 2	⩾ 10 µs
- d 3	quelconque

- Fréquence maximale . . . . . 1000 Hz
- Immunité au bruit d'entrée :
  - Niveau . . . . . 8 V (pour un niveau 1 à 12 V)
  - Durée . . . . . 2 µs

REMARQUE

Eventuellement, si le fil d'entrée est assez court pour ne pas capter de parasites, il est possible de laisser l'entrée en l'air, l'application du niveau 0 donnant directement l'information de comptage.

REPORT DECADIQUE

(Borne X en parallèle sur sortie binaire $\overline{8}$)

Cette sortie est normalement prévue pour la commande directe X ⟶ E d'une décade électronique de rang supérieur.

Le courant maximal sur cette sortie - en commun avec la sortie binaire $\overline{8}$ - est de : 2, 2 mA (5, 6 kΩ minimum sous 12 V).

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

REMISE A ZERO

(Borne Z)

Impulsion de ..... +12 V sur la borne Z (front de montée quelconque)
Durée ..... $\geqslant$ 2 ms quel que soit le nombre de décades utilisées.

SORTIES BINAIRES

(Bornes 1, $\overline{1}$, 2, $\overline{2}$, 4, $\overline{4}$, 8, $\overline{8}$)

Code : 1 - 2 - 3 - 4

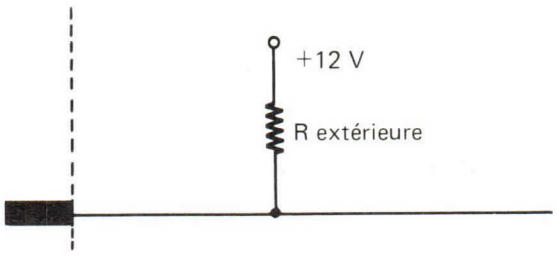
		AFFICHAGE										Poids affecté
		0	1	2	3	4	5	6	7	8	9	
SORTIES	$\overline{1}$	0	1	0	1	0	1	0	1	0	1	$2^0 = 1$
	$\overline{2}$	0	0	1	1	0	0	1	1	0	0	$2^1 = 2$
	$\overline{4}$	0	0	0	0	1	1	1	1	0	0	$2^2 = 4$
	$\overline{8}$	0	0	0	0	0	0	0	0	1	1	$2^3 = 8$

NIVEAU 0 ; +0, 3 V

NIVEAU 1 : +11 V

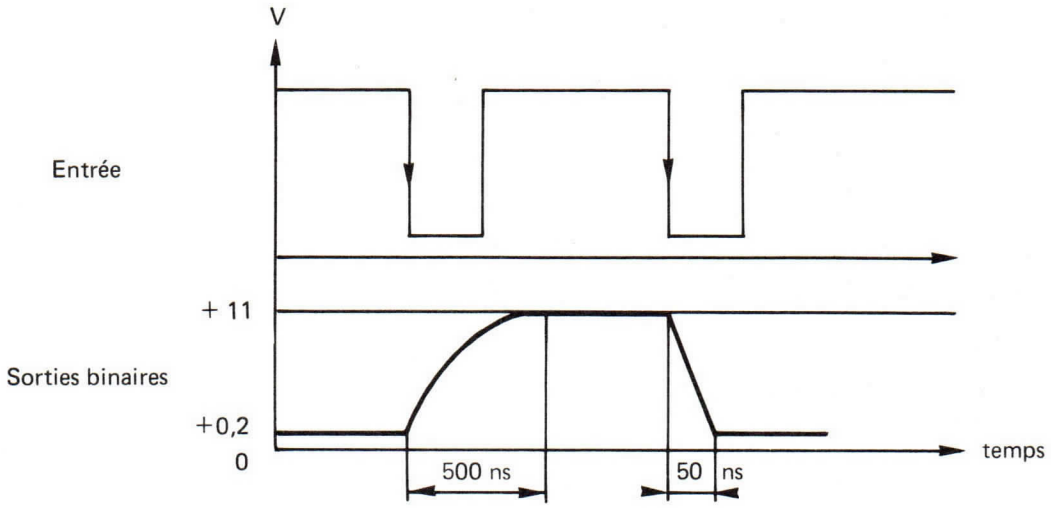
Les données sont bifilaires :

Sorties $\overline{1}$, $\overline{2}$, $\overline{4}$, $\overline{8}$ et leur complément 1, 2, 4, 8



Résistance de charge minimale ..... 5, 6 kΩ
Courant maximal disponible ..... 2, 2 mA

Temps d'établissement du signal



Possibilité de prépositionnement :

Il est possible de prépositionner le module sur un chiffre choisi en imposant aux bascules de l'échelle de comptage l'etat d'equilibre correspondant. Cet état est obtenu par l'application extérieure, sur les sorties binaires, des niveaux logiques adéquats donnés par le tableau de vérité.

(cf. schémathèque)

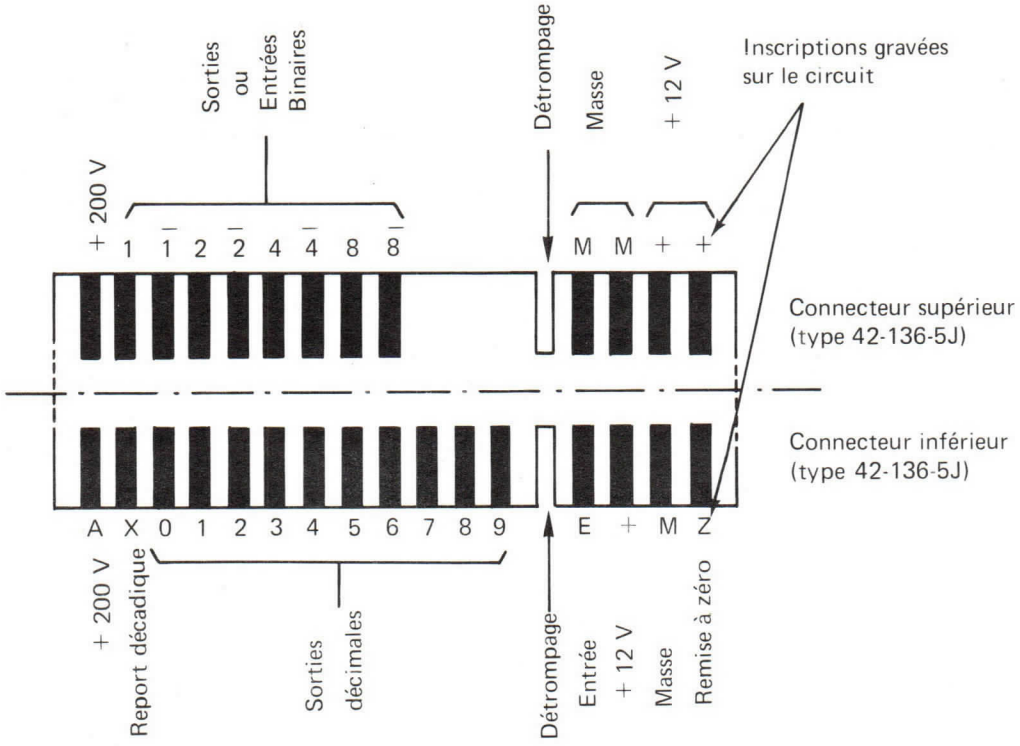
GAMME DE TEMPERATURE

Fonctionnement	−10	+55	°C
Stockage	−40	+85	°C

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

SCHEMA DE RACCORDEMENT

(voir "Généralités")



Connecteur 17 contacts (dont un détrompeur) au pas de 2, 54 mm, type 42 - 136 - 5J.

PROTECTION CONTRE LES PARASITES SECTEUR TRANSMIS PAR L'ALIMENTATION

Le module présente une notable insensibilité aux parasites secteur transmis par l'alimentation.

Pour une utilisation en présence de relais susceptibles d'introduire des parasites, il convient cependant :

- de découpler soigneusement les lignes d'alimentation
- de blinder le fil d'entrée des impulsions
- de prévoir deux sources séparées, l'une pour les circuits logiques, l'autre pour les circuits de puissance.
- de ne raccorder les polarités communes qu'en un seul point.
- de placer une capacité minimale de 1 μF à l'entrée du bloc de comptage, entre les bornes + et M de l'alimentation.
- éventuellement, il peut y avoir intérêt à blinder et à découpler par capacité la ligne de remise à zéro.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

DECODEURS ELECTRONIQUES

à circuits intégrés

THOMSON-CSF - GROUPEMENT TUBES ELECTRONIQUES 8, rue Chasseloup-Laubat - 75-Paris 15e - Tél.: 566.70.04

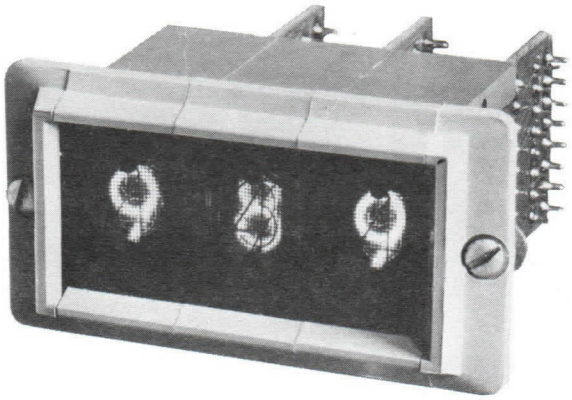
THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

DECODEURS ELECTRONIQUES A CIRCUITS INTEGRES

MODULE 46620

Définition :

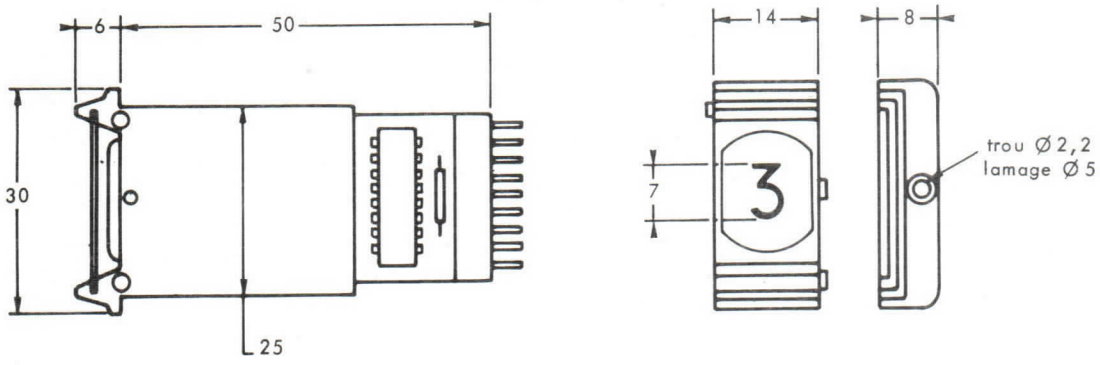
Ce module est une mono décade électronique à circuit intégré TTL dont l'indication lumineuse est donnée par un tube à cathodes froides F 9131 à chiffres de 7 mm de haut.



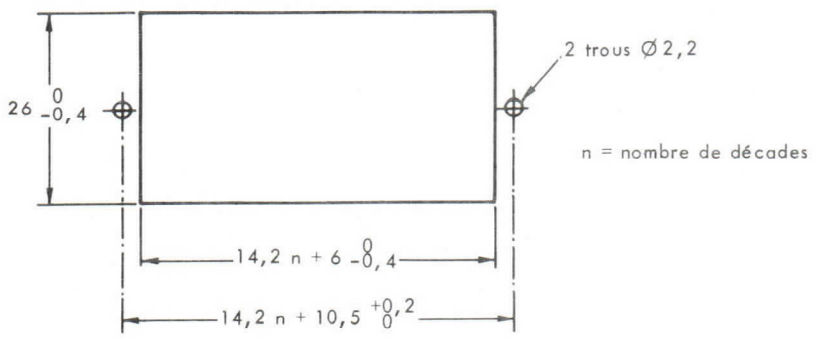
Présentation :

Le tube F 9131 est inclus dans un boitier en matière plastique. Pour composer des éléments d'affichage à plusieurs chiffres, il suffit de juxtaposer le nombre correspondant de modules. Deux flasques latéraux viennent terminer le bloc fonctionnel ainsi constitué. Ces boitiers et les flasques comportent une rainure dans laquelle vient se glisser un filtre teinté. L'ensemble est introduit par la face avant, la nervure s'appuyant sur la tôle, deux trous dans les flasques permettant la fixation.

PRESENTATION DE L'ELEMENT ACTIF



DECOUPE DANS LA TOLE



Spécifications électriques :

Tensions d'alimentation :	HT	200 V ±	10 V	(1,5 mA)
	BT	5 V ±	0,25 V	(21 mA)
Niveau logique 0		<	0,8 V	
Niveau logique 1		2 à	5 V	

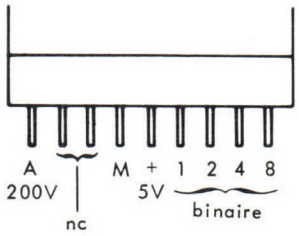
Tableau de vérité :

	0	1	2	3	4	5	6	7	8	9
1	0	1	0	1	0	1	0	1	0	1
2	0	0	1	1	0	0	1	1	0	0
4	0	0	0	0	1	1	1	1	0	0
8	0	0	0	0	0	0	0	0	1	1

Raccordement électrique :

Les sorties sont disponibles sur la barrette arrière au pas de 2, 54 mm avec fûts à souder.

BROCHAGE
(vu du côté opposé au cuivre du circuit imprimé)



Sur option, il est possible d'équiper le module 46620 d'une barrette orthogonale permettant le soudage direct sur circuit intégré ou l'enfichage dans des embases "OUEST ELECTRONIC CONNECTEUR ref. RCBR254"

Conditions d'environnement :

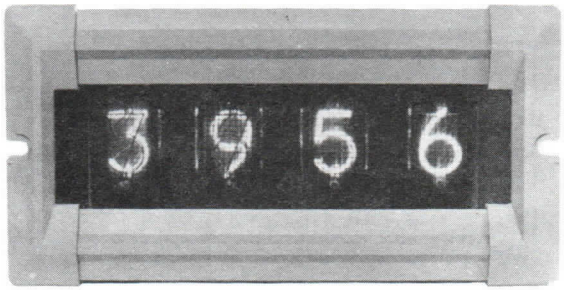
Température de fonctionnement	0	+70 °C
Température de stockage	–55	+150 °C

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

MODULE 46625

Définition :

Ce module est une mono décade électronique à circuit intégré TTL dont l'indication lumineuse est donnée par un tube à cathodes froides du type F 9080 et ses dérivés (TAF 1093 - TAF 1317) à chiffres de 13 mm de haut.

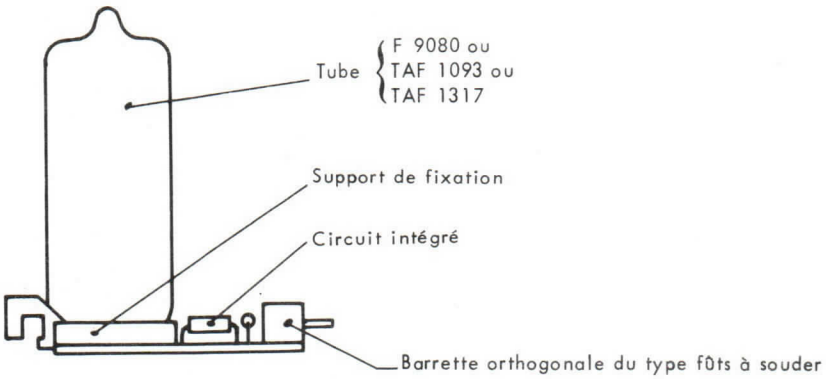


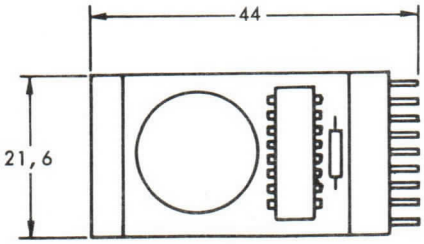
Présentation :

Chaque module monodécadique est maintenu sur les moulures par encliquetage :

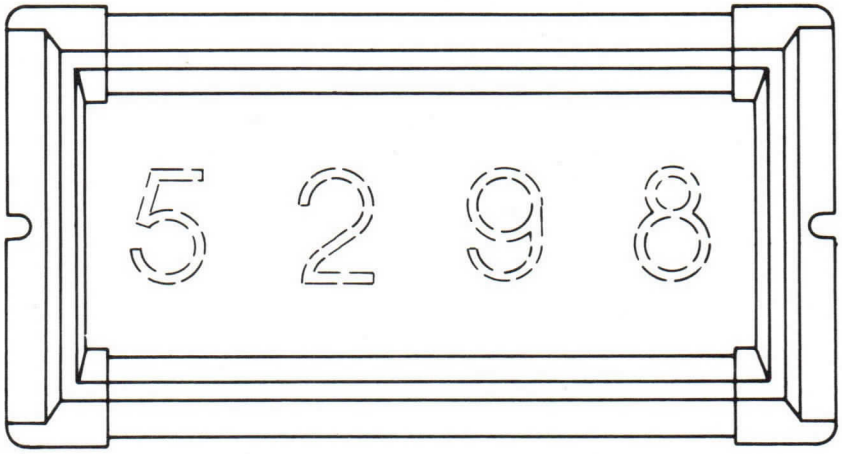
- en bas par son propre support ;
- en haut par un support similaire qui s'appuie sur le dôme du tube d'affichage.

PRESENTATION DE L'ELEMENT ACTIF

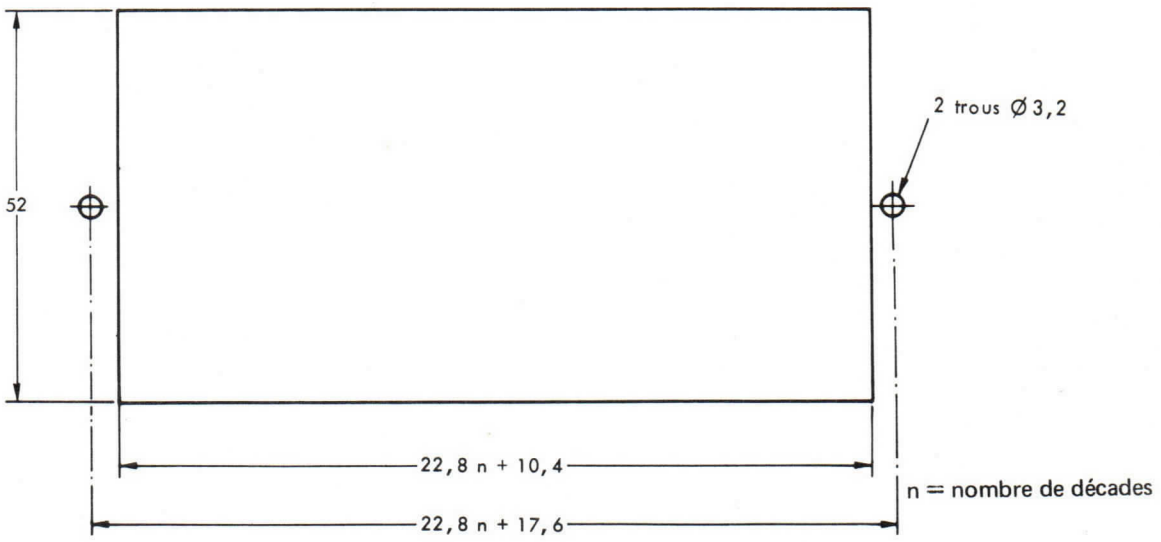




CACHE DE FIXATION
Ref. 46712 et 46713



DECOUPE DANS LA TOLE



Spécifications électriques :

Le décodage et la commande du tube d'affichage sont effectués par un circuit intégré TTL SESCOSEM SFC 441 E.

Tension d'alimentation :	HT	200 V ± 10 V	(2 mA)
	BT	5 V ± 0,25 V	(21 mA)
Niveau logique 0		< 0,8 V	
Niveau logique 1		2 à 5 V	

La commande du point décimal s'effectue en reliant au niveau 0 la borne P correspondante.

THOMSON-CSF
GROUPEMENT TUBES ELECTRONIQUES

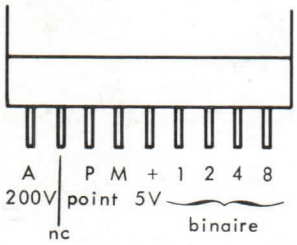
Tableau de vérité : Code BCD 1. 2. 4. 8.

	0	1	2	3	4	5	6	7	8	9
1	0	1	0	1	0	1	0	1	0	1
2	0	0	1	1	0	0	1	1	0	0
4	0	0	0	0	1	1	1	1	0	0
8	0	0	0	0	0	0	0	0	1	1

Raccordement électrique :

Les sorties sont disponibles sur la barrette arrière au pas de 2, 54 mm avec fûts à souder.

BROCHAGE
(vu du côté opposé au cuivre du circuit imprimé)



Sur option, il est possible d'équiper le module 46625 d'une barrette orthogonale permettant le soudage direct sur circuit intégré ou l'enfichage dans des embases "OUEST ELECTRONIC CONNECTEUR ref. RCBR254"

Conditions d'environnement :

Température de fonctionnement	0	+70	°C
Température de stockage	−55	+150	°C

DECODEUR A MEMOIRE COMMANDEE 46621

Un complément décodeur à mémoire commandée ref. 46621 peut être adjoint aux décodeurs 46620 et 46625.

Spécifications électriques complémentaires :

Commande de porte : Niveau logique 1	0, 4	V