PHOTOMULTIPLICATEUR (PM NOIR)

- 34 mm useful diameter head-on type
- flat window
- semi-transparent bi-alkaline photocathode
- high stability
- good linearity
- for laboratory and industrial photometry
- XP2012 has a 14-pin all-glass base; XP2012B has a 12-pin plastic base

QUICK REFERENCE DATA

Radiant sensitivity characteristic	bi-alkaline
Useful diameter of the photocathode	> 34 mm
Cathode blue sensitivity	11,5 μA/lmF
Supply voltage for anode blue sensitivity = 7,5 A/lmF	1350 V
Pulse amplitude resolution for ^{55}Fe	≈ 42%
Mean anode sensitivity deviation	≈ 1%
Anode pulse rise time	≈ 2,5 ns
Linearity (with voltage divider B)	up to ≈ 200 mA

To be read in conjunction with *General Operational Recommendations Photomultiplier Tubes.*

GENERAL CHARACTERISTICS

		notes
Window		
Material	lime glass	
Shape	plano-plano	
Refractive index at 400 nm	1,54	
Photocathode		1
Semi-transparent, head-on		
Material	bi-alkaline	
Useful diameter	> 34 mm	
Radiant sensitivity characteristic	see Fig. 6	
Maximum radiant sensitivity	400 ± 30 nm	
Luminous sensitivity	≈ 70 μA/lm	
Blue sensitivity	typ. 11,5 μA/lmF > 10 μA/lmF	
Radiant sensitivity at 400 nm	≈ 90 mA/W	

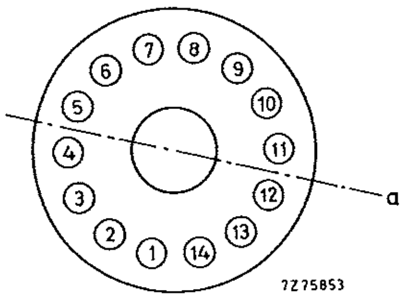
Multiplier system

Number of stages	10
Dynode structure	linear focused
Dynode material	Cu Be
Capacitances	
Anode to all	≈ 5 pF
Anode to final dynode	≈ 3 pF

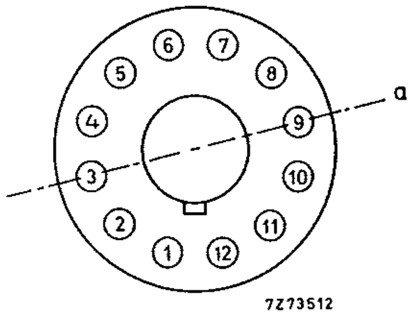
Magnetic field

When the photocathode is illuminated uniformly the anode current is halved (at V_{ht} = 1200 V, voltage divider A):
– at a magnetic flux density of 0,6 mT in the direction of the longitudinal axis;
– at a magnetic flux density of 0,35 mT perpendicular to axis a (see Fig.1);
– at a magnetic flux density of 0,15 mT parallel to axis a.

It is recommended that the tube be screened against the influence of magnetic fields by a mu-metal shield protruding > 15 mm beyond the photocathode.



XP2012



XP2012B

Fig. 1 Axis a with respect to base pins (bottom view).

RECOMMENDED CIRCUITS

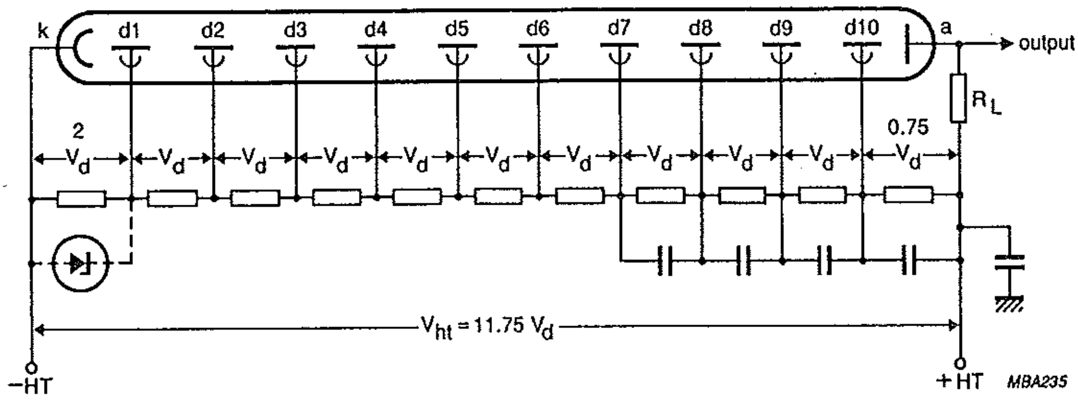


Fig. 2 Voltage divider A.

For optimum peak amplitude resolution it is recommended that the voltage between the first dynode and the photocathode be maintained at ≈ 200 V, e.g. by means of a voltage regulator diode.

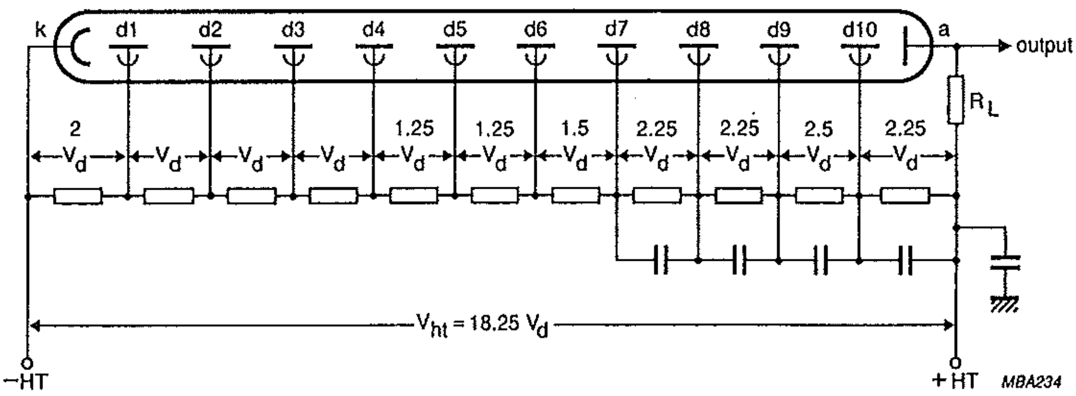


Fig. 3 Voltage divider B.

Typical values of capacitors: 10 nF

k = cathode
dn = dynode no
a = anode
R_L = load resistor

TYPICAL CHARACTERISTICS

				notes
With voltage divider A (Fig. 2)				2
Supply voltage for an anode blue sensitivity of 7,5 A/lmF (Fig. 8)		< typ.	1600 V 1350 V	
Gain at V_{ht} = 1350 V (Fig. 9)		≈	6,5 x 10^5	
Anode dark current at an anode blue sensitivity of 7,5 A/lmF (Fig. 8)		< typ.	10 nA 1 nA	3,4
Pulse amplitude resolution for ^{137}Cs at an anode blue sensitivity of 1,5 A/lmF		≈	7,2 %	5
Pulse amplitude resolution for ^{55}Fe at an anode blue sensitivity of 7,5 A/lmF		≈	42 %	6
Peak-to-valley ratio for ^{55}Fe at an anode blue sensitivity of 7,5 A/lmF		≈	34	6
Mean anode sensitivity deviation				13
long term (16 h)		≈	1 %	
after change of count rate		≈	1 %	
versus temperature between 0 and + 40 °C at 450 nm		≈	0,2 %/K	
Anode current linear within 2% at V_{ht} = 1350 V	up to	≈	65 mA	
With voltage divider B (Fig. 3)				2
Anode blue sensitivity at V_{ht} = 1700 V (Fig. 8)		≈	6,5 A/lmF	
Anode pulse rise time at V_{ht} = 1700 V		≈	2,5 ns	7
Anode pulse duration at half height at V_{ht} = 1700 V		≈	6 ns	7
Signal transit time at V_{ht} = 1700 V		≈	26 ns	7
Anode current linear within 2% at V_{ht} = 1700 V	up to	≈	200 mA	

LIMITING VALUES (Absolute maximum rating system)

			notes
Supply voltage	max.	1800 V	8
Continuous anode current	max.	0,2 mA	9
Voltage between first dynode and photocathode	max. min.	500 V 100 V	10
Voltage between consecutive dynodes	max.	300 V	
Voltage between anode and final dynode	max. min.	300 V 30 V	11
Ambient temperature range			
Operational (for short periods of time)	max. min.	+ 80 °C –30 °C	12
Continuous operating and storage	max. min.	+ 50 °C –30 °C	

Notes

1. The bialkaline photocathode has a significant resistance which increases rapidly with reducing temperature. It is thus recommended that it should not be subjected to light of too great an intensity; the cathode current should be limited, for example, to 1 nA at room temperature or 0,1 nA at −30 °C. If too high a photocurrent is passed, the cathode can no longer be considered to be an equipotential surface, and the focusing of electrons onto the first dynode will be affected, resulting in departures of linearity.
2. To obtain a peak pulse current greater than that obtainable with divider A, it is necessary to increase the inter-dynode voltage progressively. Divider circuit B is an example of a progressive divider, giving a compromise between gain, speed and linearity. Other dividers can be conceived to achieve other compromises. It is generally recommended that the voltage ratio between two successive stages is less than 2.
3. Wherever possible, the power supply should be arranged so that the cathode is earthed and the anode is at +HT. However, it is sometimes necessary to supply the tube with the anode earthed and the cathode at -HT; under these circumstances, noise and dark current will generally increase and become erratic, particularly after application of voltage. The glass envelope of the tube should be supported only by insulators with an insulating resistance greater than 10^{15} Ω. If a metal shield is used, it should be kept at the cathode potential.
4. Dark current is measured at ambient temperature, after the tube has been in darkness for approximatively 1 min. Lower value can be obtained after a longer stabilisation period in darkness (approx. 30 min.).
5. Pulse amplitude resolution for ^{137}Cs is measured with an NaI (Tl) cylindrical scintillator with a diameter of 32 mm and a height of 32 mm. The count rate used is ≈ 10^3 c/s.
6. Pulse amplitude resolution for ^{55}Fe is measured with an NaI (Tl) cylindrical scintillator with a diameter of 25 mm and a height of 1 mm provided with a beryllium window. The count rate used is 2 x 10^3 c/s.
7. Measured with a pulsed-light source, with a pulse duration (FWHM) of < 1 ns, the cathode being completely illuminated. The rise time is determined between 10% and 90% of the amplitude of the anode pulse. The signal transit time is measured between the instant at which the illuminating pulse at the cathode becomes maximum, and the instant at which the anode pulse reaches its maximum. Rise time, pulse duration and transit time vary as a function of high tension supply voltage V_{ht}, approximately as $V_{ht}^{-1/2}$.
8. Or the voltage at which the tube has an anode spectral sensitivity of 75 A/lmF (voltage given on test certificate for an anode blue sensitivity of 7,5 A/lmF, multiplied by 1,4), whichever is the lower.
9. A value of < 10 μA is recommended for applications requiring high stability.
10. Minimum value to obtain good collection in the input optics.
11. When calculating the anode voltage the voltage drop across the load resistor should be taken into account.
12. For types with plastic base this range of temperatures is limited principally by stresses in the sealing layer of the base to glass bulb.
13. The mean pulse amplitude deviation is measured by coupling an NaI (Tl) scintillator to the window of the tube. Long term (16 h) deviation is measured by placing a ^{137}Cs source at a distance from the scintillator such that the count rate is ≈ 10^4 c/s corresponding to an anode current of ≈ 300 nA.
    Mean pulse amplitude deviation after change of count rate is measured with a ^{137}Cs source at a distance of the scintillator such that the count rate can be changed from 10^4 c/s to 10^3 c/s corresponding to an anode current of ≈ 1 μA and ≈ 0,1 μA respectively.
    Both tests are carried out according to ANSI–N42–9–1972 of IEEE recommendations.

MECHANICAL DATA

Dimensions in mm

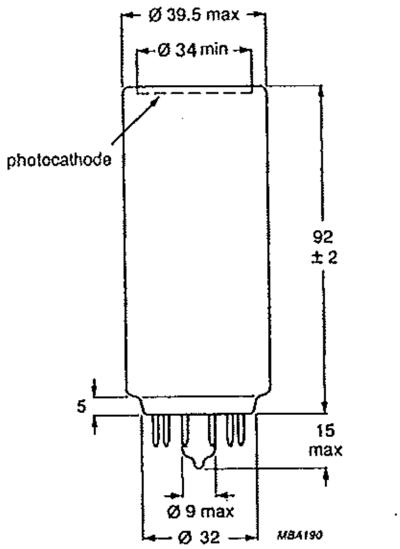
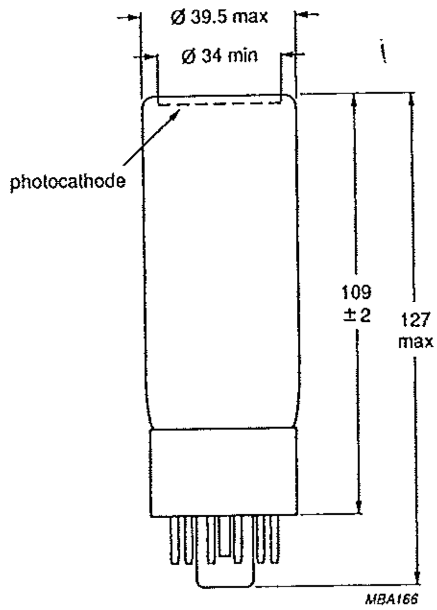


Fig. 4 XP2012

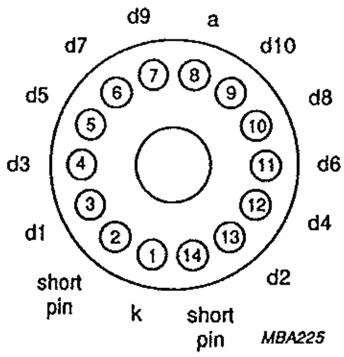


XP2012B

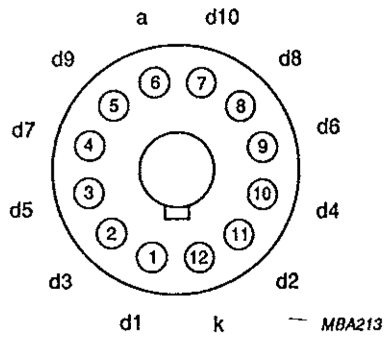
Base: 14-pin all-glass
Net mass: 54 g

Base: 12-pin (JEDEC B12-43)
Net mass: 72 g

PIN CONNECTIONS



XP2012



XP2012B

ACCESSORIES

Socket
for XP2012 type FE1112
for XP2012B type FE1012
Mu-metal shield type 56609

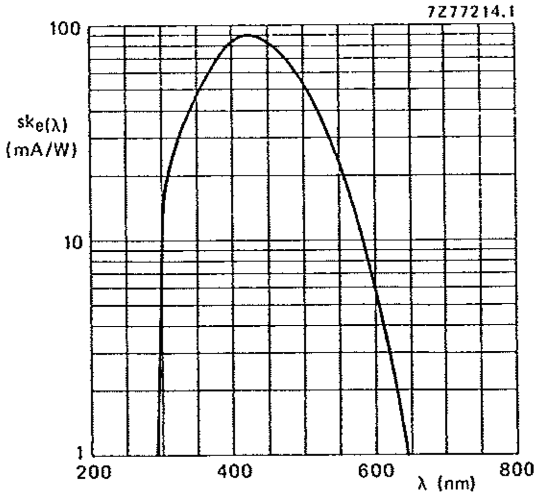


Fig. 6 Radiant sensitivity characteristic.

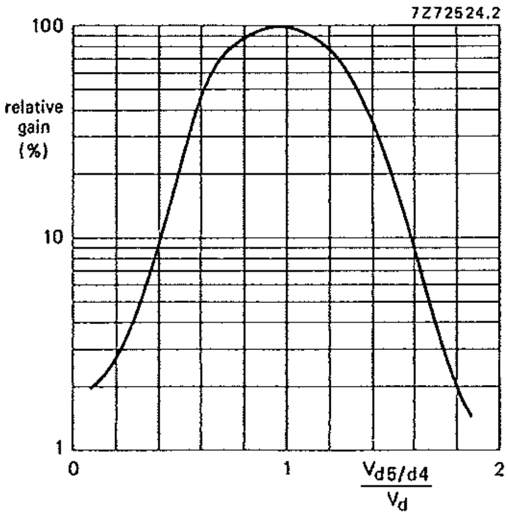


Fig. 7 Relative gain as a function of the voltage between d5 and d4, normalized to V_d; $V_{d6/d4}$ constant.

Note: Gain regulation by changing the voltage between d5 and d4 may cause a degradation of other parameters such as stability and linearity.

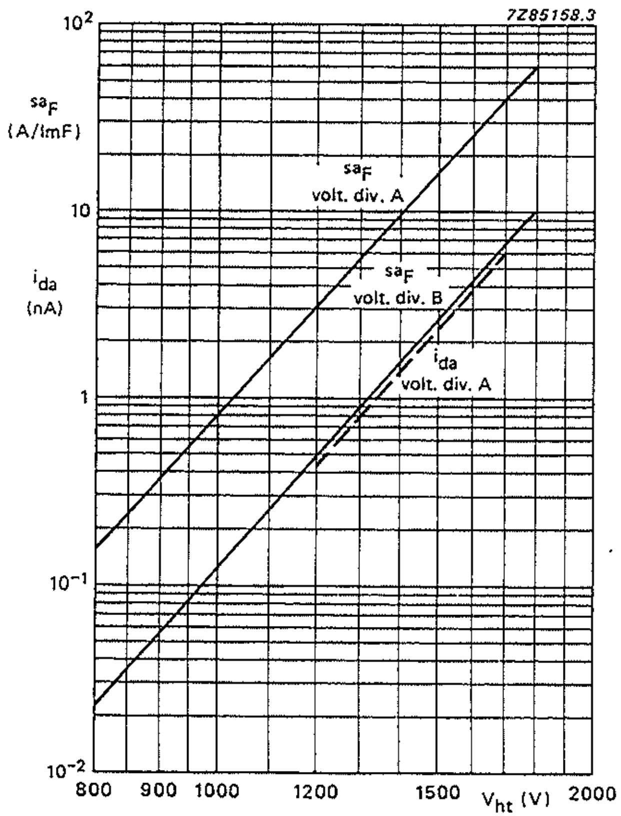


Fig. 8 Anode blue sensitivity, sa_F, and anode dark current, i_{da}, as a function of supply voltage V_{ht}.

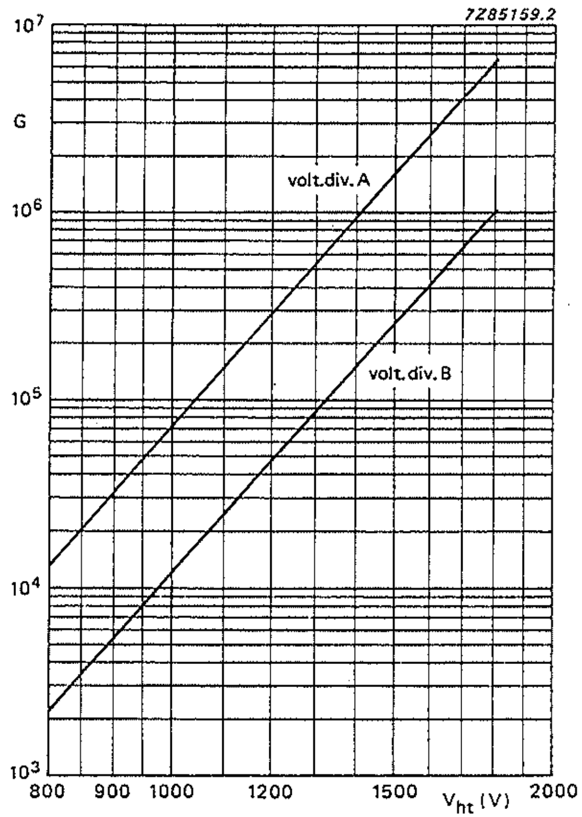


Fig. 9 Gain G as a function of supply voltage V_{ht}.

x RTC N76 1977

photomultiplicateurs

→ (PM Noir)

Diam. utile de photocathode min. (mm)	Type	Nombre d'étages	Réponse spectrale (courbe page 16)	Sensibilité de cathode Val. moy. — En lumière blanche (µA.lm⁻¹)	Sensibilité de cathode Val. moy. — En lumière monochr. (mA.W⁻¹) (1)	Sensibilité anodique ou gain — Sensibilité A.lm⁻¹ ou kA.W⁻¹ (1)	Sensibilité anodique ou gain — Gain	Sensibilité anodique ou gain — Pour tension (val. moy.) (V)	Courant d'obscurité — Val. moy. (nA)	Courant d'obscurité — Pour sensibilité (A.lm⁻¹) Gain (10 ou HT (V
14	PM 1910	10	A (S 11)	60	60	30 kA.W⁻¹		1 400	1,5	30 kA.W
	PM 1912	12	D		75		10^7	1 700	2	10^7
	PM 1920	6	A (S 11)	60	60	0,2		800	2	0,2
	XP 1110	10	A (S 11)	60	60	30		1 400	1,5	30
	XP 1113	6	A (S 11)	60	60	0,2		820	2	0,2
	XP 1116	10	C (S 1)	20	1,6	10		1 650	5.10^3	10
	XP 1117	9	T (S 20)	140	13	30		1 520	10.	30
	XP 1118	10	U (S 13)	60	60	30		1 400	2	30
22	PM 1980	10	A (S 11)	75	70	30 kA.W⁻¹		1 400	2	30 kA.W
	PM 1982	11	D		80	250 kA.W⁻¹		1 450	2,5	250 kA.V
32	150 CVP	10	C (S 1)	20	1,4	10		1 600	2.10^3	10
	150 UVP	10	U (S 13)	85	75	60		1 500	10	60
	PM 2012	10	D		77	60 kA.W⁻¹		1 350	1	60 kA.V
	XP 1011	10	SUPER A	90	80	60		1 500	10	60
	XP 1016	10	T (S 20)	160	16	60		1 460	3	60
	XP 1017	10	S 20 R	210	6,5	60		1 470	2	60
	XP 2008	10	SUPER A	80	70	60		1 180	5	60
	XP 2010	10	SUPER A	90	80	60		1 180	2	60
44	56 AVP	14	A (S 11)	60	60		3.10^7	1 800	20	3.
	56 CVP	10	C (S 1)	20	1,4	10		1 800	4.10^3	10
	56 DVP	14	D		80		3.10^7	1 900	6	3.
	56 DUVP	14	DU		80		3.10^7	1 900	6	3
	56 SBUVP	14	SB		20		3.10^7	2 050	30	3
	56 TVP	14	T (S 20)	150	15		3.10^7	2 050	60	3
	56 TUVP	14	TU	150	15		3.10^7	2 050	60	3.
	PM 2232 (2)	12	D		80		3.10^7	1 900	7	3.
	XP 1230	12	D		90		3.10^7	2 300	7	3.
	XP 2020	12	D		85		3.10^7	2 200	7	3.
	XP 2230 (2)	12	D		90		3.10^7	2 300	7	3.
	XP 1002	10	T (S 20)	165	16	60		1 460	3	60
	XP 1003	10	TU	165	16	60		1 460	5	60
	XP 1004	10	U (S 13)	80	70	60		1 450	10	60
	XP 2000 (3)	(6) 10 P	D		90	10 kA.W⁻¹		1 250	1	1 500
68	PM 2312 (2)	12	D		80		3.10^7	2 300	15	3
	XP 2030 (3)	(6) 10 P	D		105	10 kA.W⁻¹		1 220	1	1 500
110	XP 2040 (4)	14	A (5)	70	70		3.10^7	2 000	200	3
	XP 2041 (4)	14	D (5)		85		3.10^7	2 200	30	3
	XP 2050	(6) 10 P	D		95	10 kA.W⁻¹		1 220	2	1 500
200	60 DVP (7)	12	D		70		3.10^7	3 000	6	3
10 cm²	PM 555 (4)	7	bialcaline $SbNa_2K$		45		10^6	6 200	10	1(

remplace le 150 AVP (→ XP 2008 / XP 2010)

(1) Longueur d'onde de mesure : T et TU : λ = 698 nm
C : λ = 903 nm
SB : λ = 250 nm
S 20 R : λ = 858 nm
A, super A et U : λ = 437 nm
D et DU : λ = 401 nm.
$SbNa_2K$: λ = 404 nm.

(2) Tubes avec pied en verre pouvant être fournis avec culot sous l'appellation XP .... B ou PM .... B.

(3) Tubes avec culot pouvant être fournis sans culot sous l'appellation
(4) Tube avec habillage.
(5) Etendue jusqu'à 200 nm grâce à un verre transparent à l'ultraviolet.
(6) P = Dynodes « persiennes ».
(7) Tube ne pouvant être livré avec habillage sur demande (60 DVP
(8) Spécifiée pour chaque tube sur sa feuille de caractéristiques.
(9) Sortie coaxiale 50 Ω par connecteur General Radio GR 874.
(10) Support livré avec le tube.
(11) Dans les conditions optimales de répartition de tensions.

	Cara[ctér]iques de rapidité			Valeurs à ne pas dépasser (limites absolues)		Dimensions			Nombre de broches	Type de support (voir page 22)	Type
... ou))	Tem[ps de] tra[nsit] (n[s])	Temps de montée (ns)	Ecart centre-bord (ns)	T.H.T. (V)	Courant continu d'anode (mA)	Long. max. (mm)	Long. max. sans les broches (mm)	Diam. max. verrerie (mm)			
$^{-1}$		2,5		1 900	0,2	105	88	20	12	FE 1004	**PM 1910**
		2,5		2 000	0,2	100	90	20	14 fils	sortie par fils	**PM 1912**
		2		1 200	0,2	70	60	20	12	FE 1004	**PM 1920**
	3	3,5		1 900	0,2	105	88	20	12	FE 1004	**XP 1110**
	1	3,5		1 200	0,2	70	60	20	9	noval	**XP 1113**
	3	3,5		1 900	0,01	105	91	20,5	12	FE 1004	**XP 1116**
	2	3,5		1 900	0,2	105	91	20,5	12	FE 1004	**XP 1117**
	3	3,5		1 900	0,2	105	91	20	12	FE 1004	**XP 1118**
$/^{-1}$		3		1 900	0,2	98	88	26,5	13	B 8700 67	**PM 1980**
$/^{-1}$		2,5		2 000	0,2	98	88	29	14		**PM 1982**
	3	3,5		1 800	0,02	127	114	39,5	12	FE 1002	**150 CVP**
	3	3,5		1 800	0,2	127	114	39,5	12	FE 1002	**150 UVP**
$/^{-1}$		3,5		1 800	0,2	127	114	39,5	12	FE 1002	**PM 2012**
	3	3,5		1 800	0,2	127	114	39,5	12	FE 1002	**XP 1011**
	3	3,5		1 800	0,2	127	114	39,5	12	FE 1002	**XP 1016**
	3	3,5		1 800	0,2	127	114	39,5	12	FE 1002	**XP 1017**
	3	3,5		1 800	0,2	127	114	39,5	12	FE 1002	**XP 2008**
		3,6		1 800	0,2	127	114	39,5	12	FE 1002	**XP 2010**
0^7		2,1	0,5	2 500	0,2	192	175	52,5	20	FE 1003	**56 AVP**
		2,1	0,5	3 000	0,02	174	157	52,5	20	FE 1003	**56 CVP**
10^7		2,1	0,5	2 500	0,2	192	175	53,5	20	FE 1003	**56 DVP**
10^7		2,1	0,5	2 500	0,2	192	175	53,5	20	FE 1003	**56 DUVP**
10^7		2,1	0,5	2 500	0,2	192	175	53,5	20	FE 1003	**56 SBUVP**
0^7		2,1	0,5	2 750	0,2	192	175	53,5	20	FE 1003	**56 TVP**
10^7		2,1	0,5	2 750	0,2	192	175	53,5	20	FE 1003	**56 TUVP**
10^7		2,2	0,6	3 000	0,2	139	122	53,5	19	FE 2019	**PM 2232**
10^7		1,6	0,6	3 000	0,2	145	128	53,5	21	FE 2003	**XP 1230**
10^7		1,5	0,25	3 000	0,2	192	175	53,5	20	FE 1003	**XP 2020**
10^7		1,6	0,6	3 000	0,2	145	128	53,5	21	FE 2003	**XP 2230 (2)**
		4		1 800	0,2	148	127	52,5	14	FE 1001	**XP 1002**
		4		1 800	0,2	148	128	53,5	14	FE 1001	**XP 1003**
		4		1 800	0,2	148	128	53,5	14	FE 1001	**XP 1004**
/		9		2 000	0,2	148	129	52,5	14	FE 1001	**XP 2000 (3)**
10^7		2,5	1	3 000	0,2	184	166	77,5	19	FE 2019	**PM 2312**
V		0		2 000	0,2	159	140	77,5	14	FE 1001	**XP 2030 (3)**
$.10^7$		2	1	3 000	0,2	281 (4)	264 (4)	136,5 (4)	20	FE 1003	**XP 2040 (4)**
$.10^7$		2	1	3 000	0,2	281 (4)	264 (4)	136,5 (4)	20	FE 1003	**XP 2041 (4)**
V		6		2 000	0,2	195	176	130	14	FE 1001	**XP 2050**
$.10^7$		2,1	2	3 700	0,2	318 (7)	301 (7)	231,5 (7)	20	FE 1003	**60 DVP (7)**
5		1,5		(8)	0,05	170 (4)		112 (4)	(9)	(10)	**PM 555 (4)**

. . . . UB.

H).

Définitions des sélections

Sélection 03 : Tubes sélectionnés pour faible bruit de fond. Sélections standards : 56 DVP/03 et 56 DUVP/03.

Sélection A : Tubes ayant une sensibilité anodique identique, pour des tensions d'alimentation les plus voisines possibles. Sélections standards : 56 DVP/A, 56 DUVP/A, XP 2230/A, XP 1230/A et XP 2020/A.

Les caractéristiques des photomultiplicateurs référencés PM . . . . sont celles de tubes en développement et n'impliquent pas qu'elles restent identiques pour les tubes de série mis en fabrication.