10-STAGE PHOTOMULTIPLIER TUBES

The XP2008 and XP2008UB are 32 mm useful diameter head-on photomultiplier tubes with a flat window and a semi-transparent Super A photocathode. The tubes are intended for use in applications such as scintillation counting, laboratory and industrial photometry and large volume calorimeter experiments. Their CuBe dynode system offers a high stability. The XP2008 is provided with a 12-pin plastic base; the XP2008UB has a 14-pin all-glass base.

QUICK REFERENCE DATA

Spectral sensitivity characteristic		Super A	
Useful diameter of the photocathode	>	32	mm
Spectral sensitivity of the photocathode at 437 nm	≈	70	mA/W
Supply voltage for luminous sensitivity N_a = 60 A/lm		1180	V
Pulse amplitude resolution for ^{137}Cs	≈	8	%
Mean anode sensitivity deviation	≈	1	%
Anode pulse rise time (with voltage divider B)	≈	2,5	ns
Linearity			
with voltage divider A	up to ≈	100	mA
with voltage divider B	up to ≈	200	mA

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

GENERAL CHARACTERISTICS

Window

Shape	plano-plano
Material	lime glass
Refractive index at 550 nm	1,52

Photocathode

Semi-transparent, head-on			
Material	Sb-Cs		
Useful diameter	>	32	mm
Spectral sensitivity characteristic (Fig. 3)	type Super A		
Maximum sensitivity at	420 ± 30		nm
Luminous sensitivity	typ.	80	μA/lm
	>	40	μA/lm
Spectral sensitivity at 437 ± 5 nm	≈	70	mA/W

For BBQ light the typical integral quantum efficiency is 13% and can be measured on request.

Electron optical input system

This system consists of: the photocathode, k; a metallized part of the glass envelope, internally connected to the photocathode; an accelerating electrode, acc, internally connected to S 1.

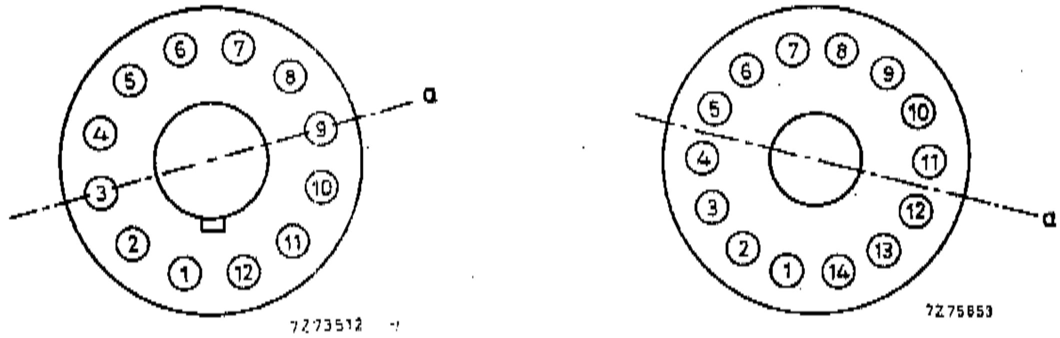
Multiplier system

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_b = 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. below);
– 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.



XP2008 XP2008UB

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

RECOMMENDED CIRCUITS

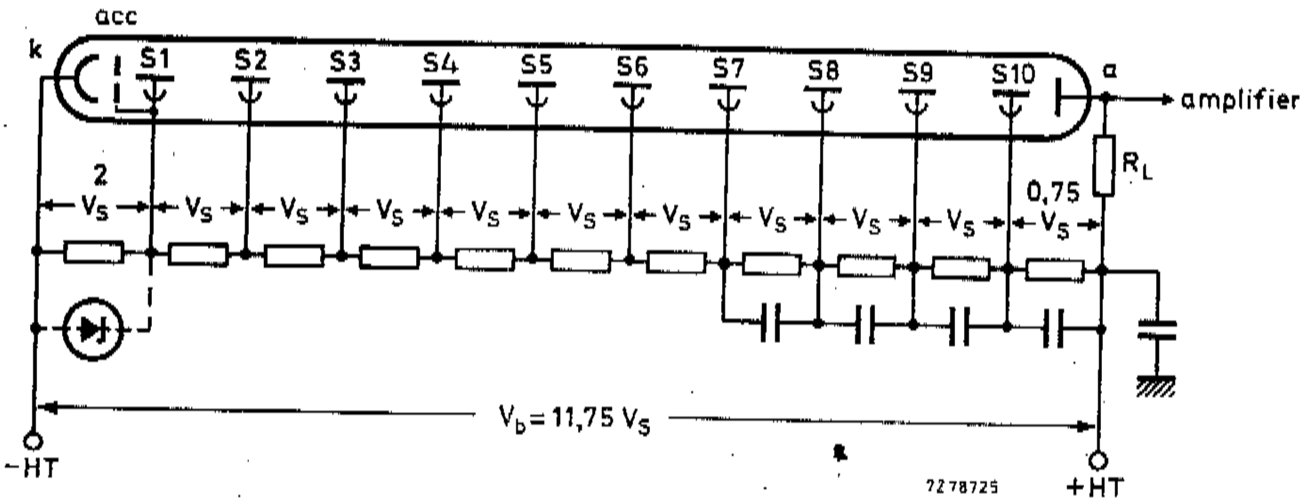


Fig. 1 Voltage divider A.

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

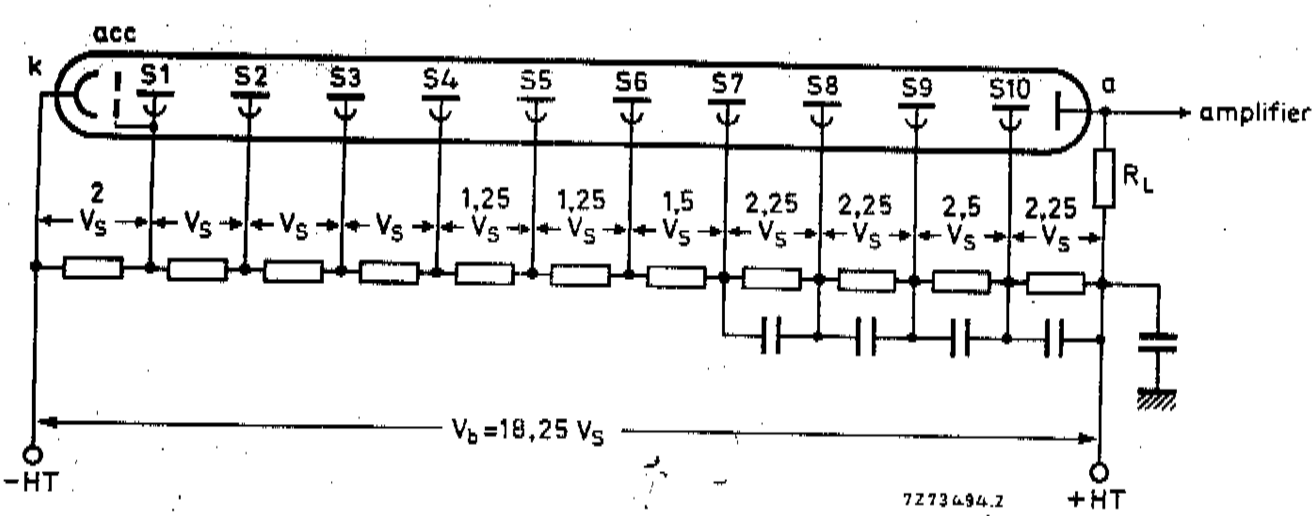


Fig. 2 Voltage divider B.

k = cathode
acc = accelerating electrode
S_n = dynode no. n
a = anode
R_L = load resistor

Typical values of capacitors: 10 nF

TYPICAL CHARACTERISTICS

	note		
With voltage divider A (Fig. 1)	1		
Supply voltage for an anode luminous sensitivity N_a = 60 A/lm (Fig. 5)		< typ.	1500 V 1180 V
Anode dark current at an anode luminous sensitivity N_a = 60 A/lm (Fig. 5)	2,3	< typ.	50 nA 5 nA
Pulse amplitude resolution for ^{137}Cs at N_a = 10 A/lm	4	≈	8 %
Mean anode sensitivity deviation at V_b = 1200 V	5		
long term		≈	1 %
after change of count rate		≈	1 %
Anode current linear within 2% at V_b = 1700 V		up to ≈	100 mA
With voltage divider B (Fig. 2)			
Anode luminous sensitivity at V_b = 1700 V (Fig. 5)		≈	150 A/lm
Anode pulse rise time at V_b = 1700 V	6	≈	2,5 ns
Anode pulse duration at half height at V_b = 1700 V	6	≈	6 ns
Signal transit time at V_b = 1700 V	6	≈	26 ns
Anode current linear within 2% at V_b = 1700 V		up to ≈	200 mA

LIMITING VALUES (Absolute maximum rating system)

Supply voltage	7	max.	1800 V
Continuous anode current	11	max.	0,2 mA
Voltage between first dynode and photocathode	8	max. min.	500 V 150 V
Voltage between consecutive dynodes		max.	300 V
Voltage between anode and final dynode	9	max. min.	300 V 30 V
Ambient temperature range			
Operational (for short periods of time)	10	max. min.	+80 °C −30 °C
Continuous operating and storage		max. min.	+50 °C −30 °C

Notes see page 5.

Notes

1. To obtain a peak pulse current greater than that obtainable with divider A, it is necessary to increase the inter-dynode voltage of the stages 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 after consulting the supplier.

2. Wherever possible, the photomultiplier 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, erratic noise and dark current are generally increased and unstable, particularly immediately after application of voltage. The glass envelope of the tube should be supported only by isolators having an insulation resistance of $> 10^{15}\ \Omega$.

3. Dark current is measured at ambient temperature, after a stabilization period of the tube in darkness ($\approx$ 1/4 h).

4. 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 $\approx 10^4$ c/s.

5. The mean anode sensitivity 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 scintillator count rate is $\approx 10^4$ c/s corresponding to an average anode current of $\approx$ 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 average anode current of $\approx 1\ \mu$A and $\approx 0{,}1\ \mu$A respectively.
   Both tests are carried out according to ANSI–N42–9–1972 of IEEE recommendations.

6. 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 attains its maximum. Rise time, pulse duration and transit time vary as a function of high tension supply voltage V_b, approximately as $V_b^{-1/2}$.

7. Total HT supply voltage or the voltage at which the tube has an anode luminous sensitivity of 600 A/lm, whichever is lower.

8. Minimum value to obtain good collection in the input optics.

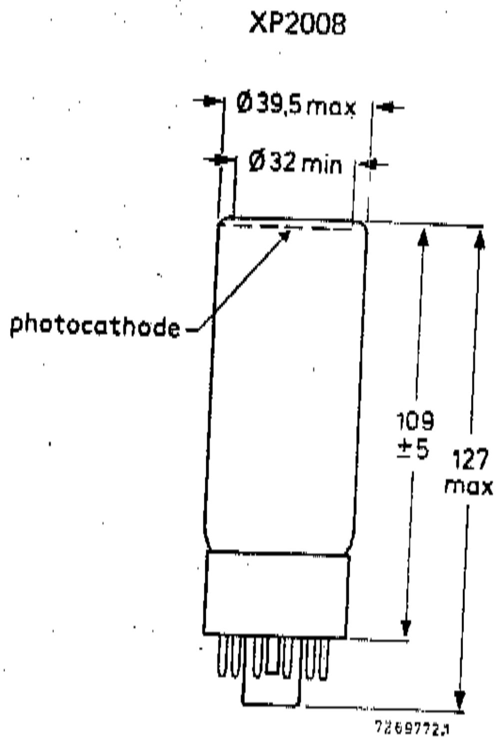
9. When calculating the anode voltage the voltage drop across the load resistor should be taken into account.

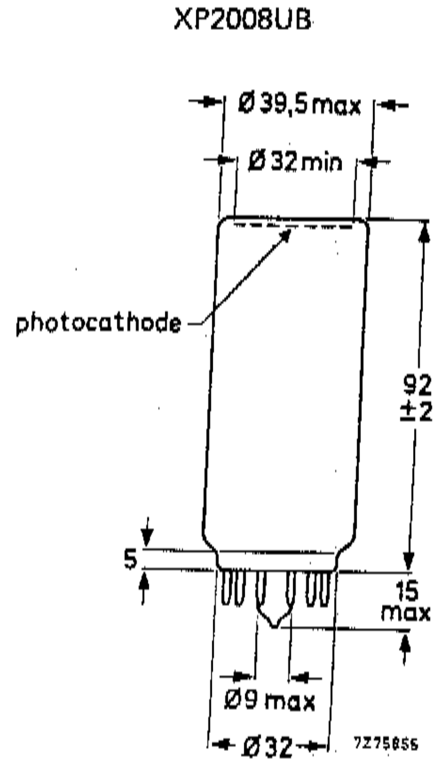
10. For type XP2008 this range of temperatures is limited principally by stresses in the sealing layer of the base to the glass bulb. Where low temperature operation is contemplated, the supplier should be consulted.

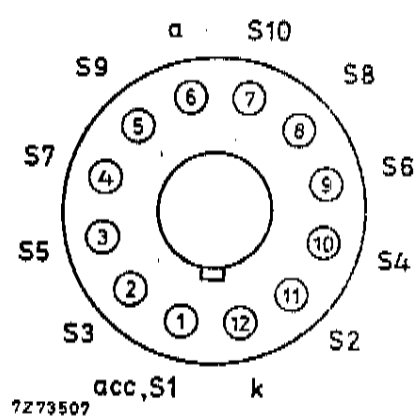
11. A value of $< 10\ \mu$A is recommended for applications requiring good stability.

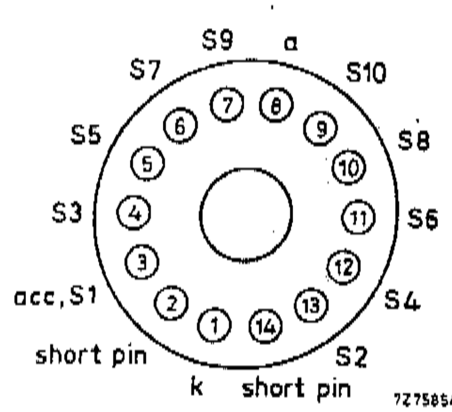
MECHANICAL DATA

Dimensions in mm









Base: 12-pin (JEDEC B12-43)

Net mass: 72 g

Base: 14-pin all-glass

Net mass: 54 g

ACCESSORIES

Socket:

for XP2008 type FE1012
for XP2008UB type FE1112

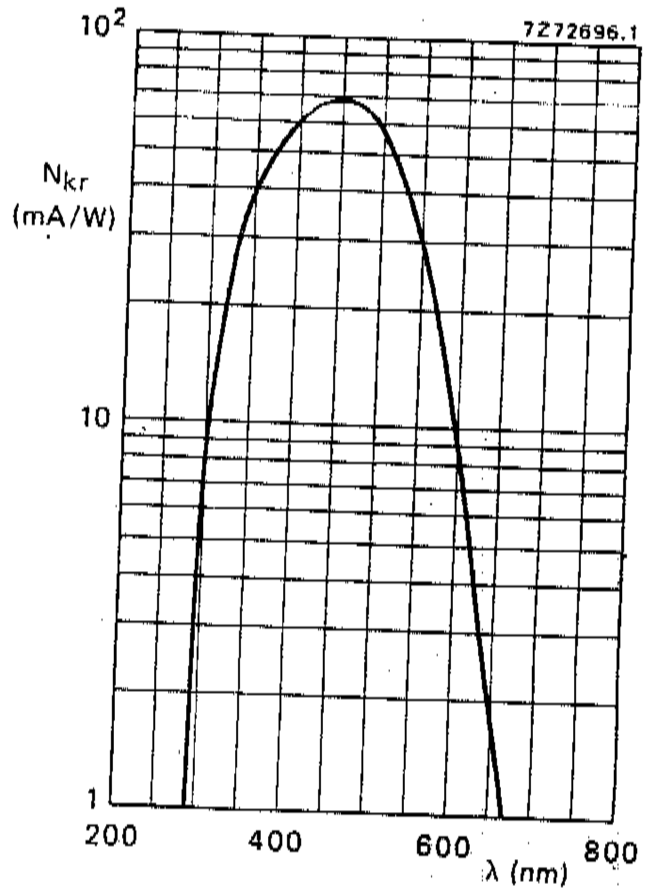


Fig. 3 Spectral sensitivity characteristic.

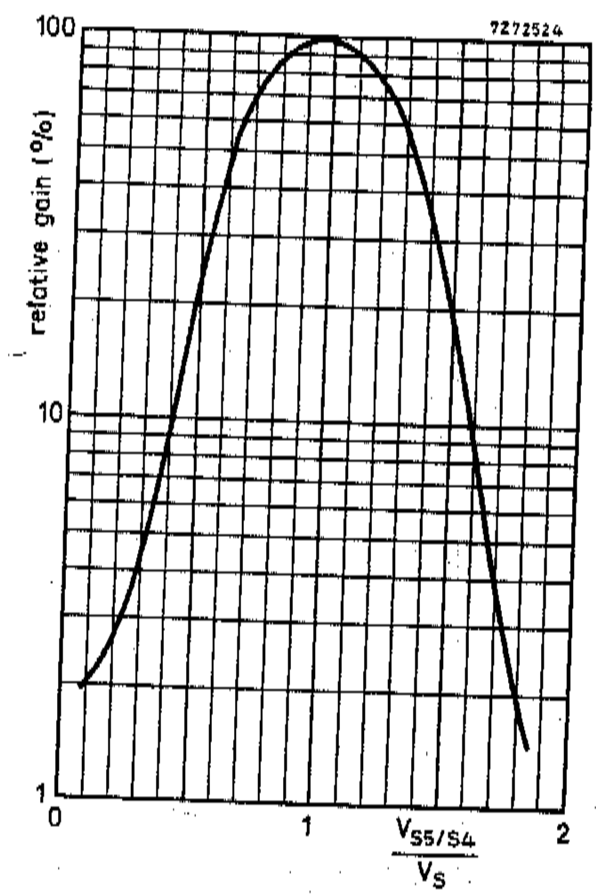


Fig. 4 Relative gain as a function of the voltage between S5 and S4, normalized to V_S. $V_{S6/S4}$ constant.

Note: Gain regulation by changing the voltage between S5 and S4 may cause a degradation of other parameters such as stability and linearity.

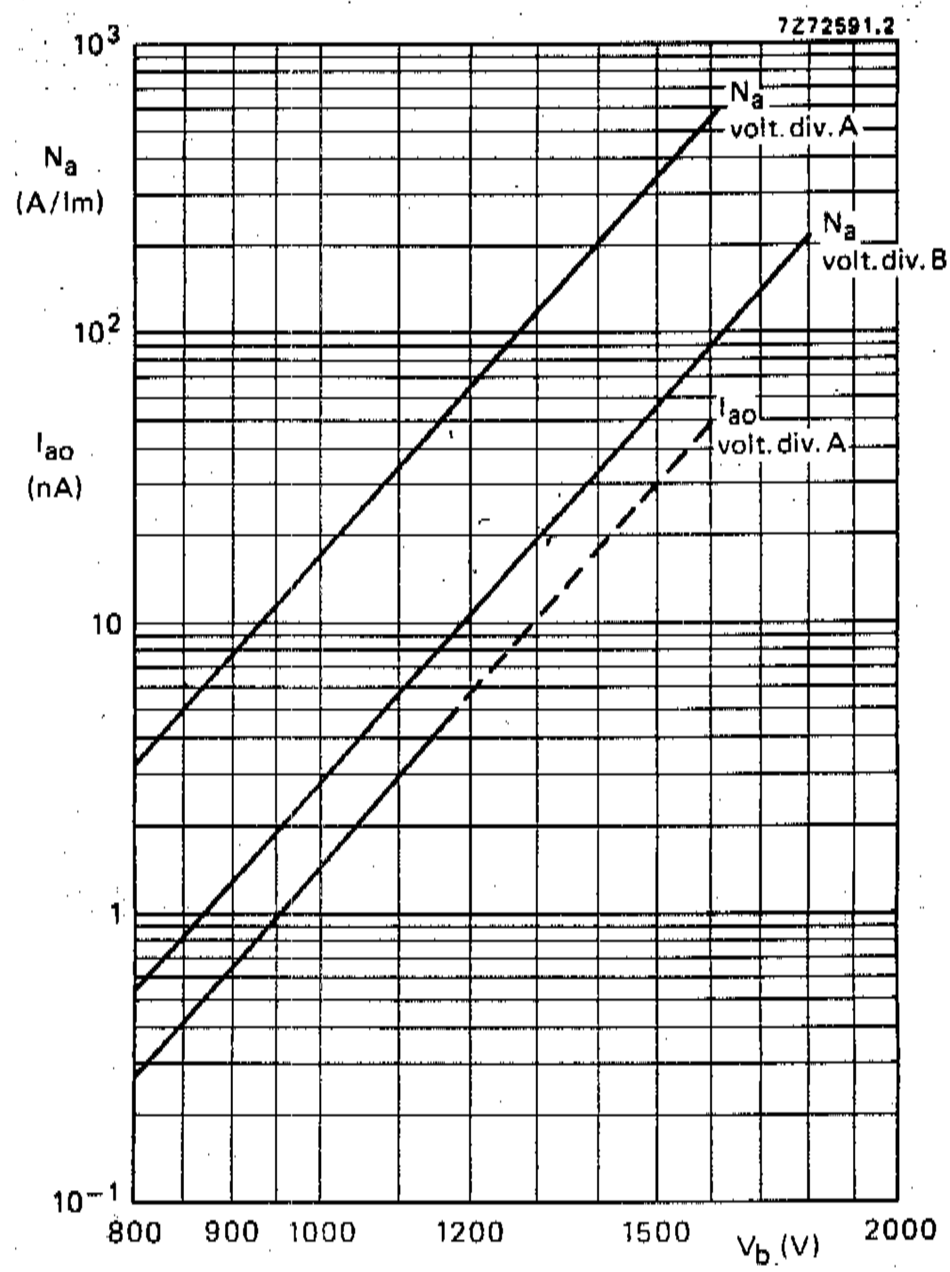


Fig. 5 Anode luminous sensitivity, N_a, and anode dark current, I_{ao}, as a function of supply voltage V_b.

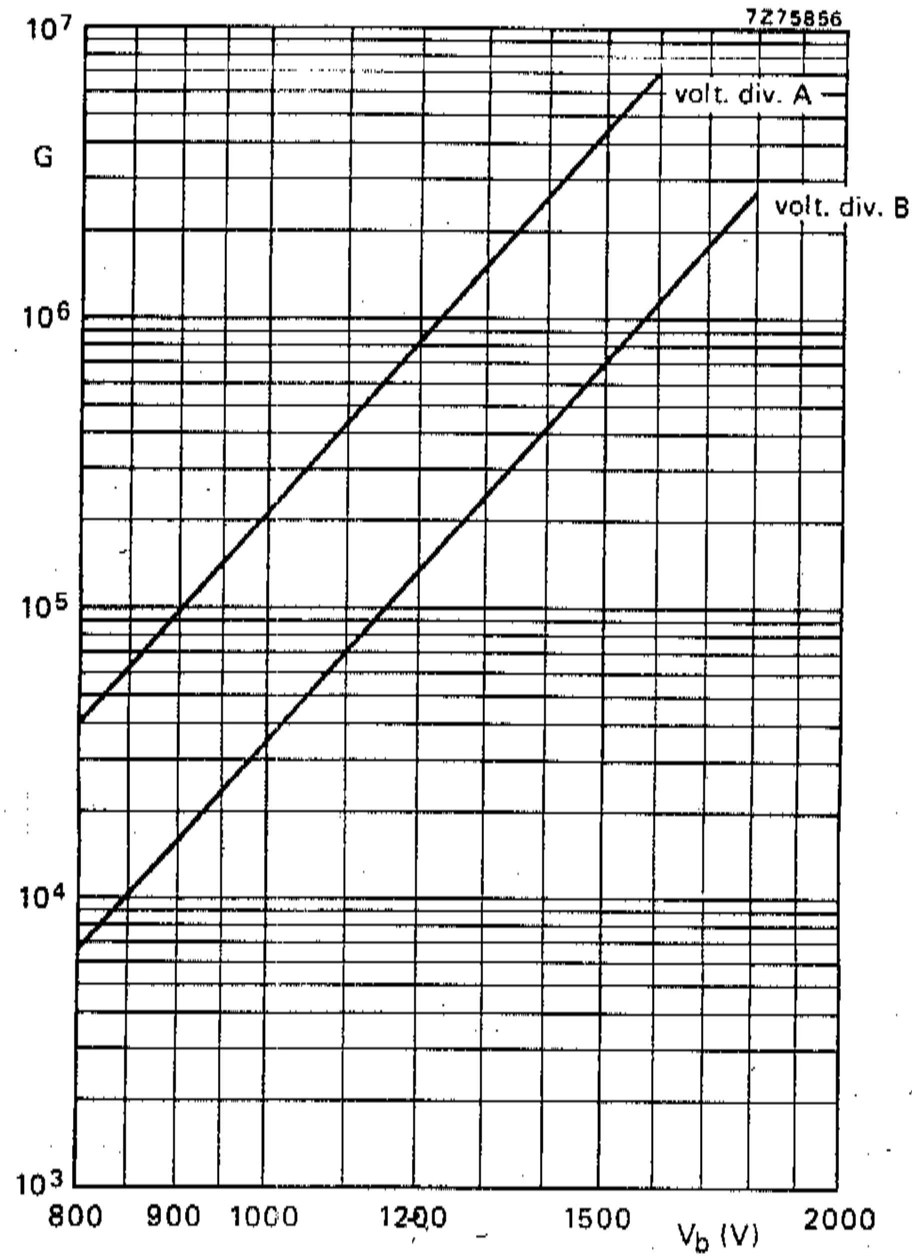


Fig. 6 Gain G as a function of supply voltage V_b.