PROFESSIONAL COMPONENTS

DATA HANDBOOK

Electron Multipliers

BOOK PC12 1991

Philips Components

PHILIPS

ELECTRON MULTIPLIERS

page

DISCRETE DYNODE ELECTRON MULTIPLIERS

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of this specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	

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Philips Components

Data sheet	
status	Preliminary specification
date of issue	September 1990

XP1600 series
16-stage electron multipliers

FEATURES

- High gain
- Integral voltage divider
- Short response time
- Can be baked

The XP1600 electron multiplier is supplied in 4 versions differing by the Mechanical Data details.

APPLICATIONS

- Ultraviolet spectroscopy (max. $\lambda \approx 140$ nm)
- Detection of electrons in the energy range 100 eV to 10 keV
- Detection of heavy ions (min. 1 keV energy)

QUICK REFERENCE DATA

Photocathode (or ion converter)	
Material	CuBe, opaque, formed by the first dynode
Useful area	see Mechanical Data
Supply voltage for a gain of 10^7	typ. 2500 V
Anode pulse rise time	≈ 3 ns
Quantum efficiency at 68 nm (see Fig.8)	≈ 20 %
Maximum spectral sensitivity	68 ± 10 nm
Multiplier	
Number of dynodes	16
Dynode structure	linear focused
Dynode material	CuBe
Capacitance	
anode to last dynode	≈ 3 pF
anode to all	≈ 5 pF

MECHANICAL DETAILS

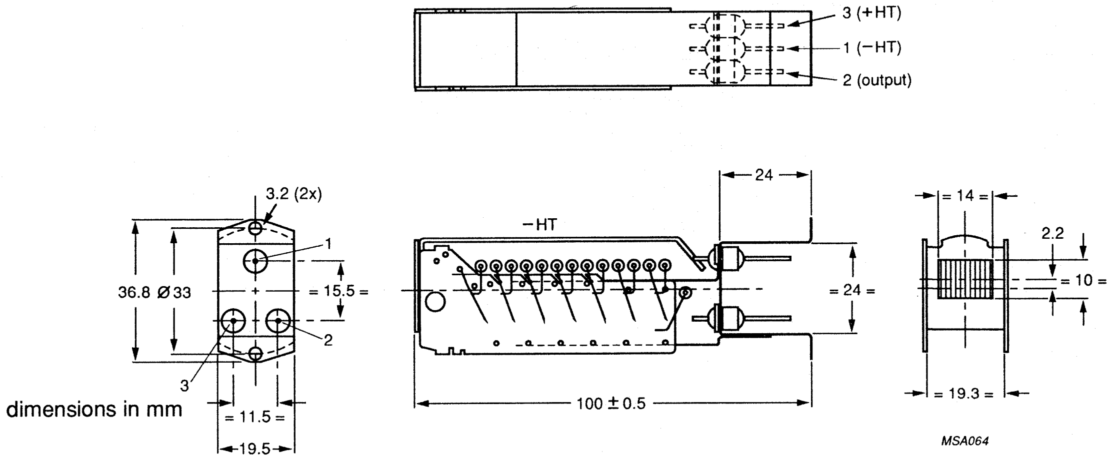


Fig.1 XP1600 mechanical details.

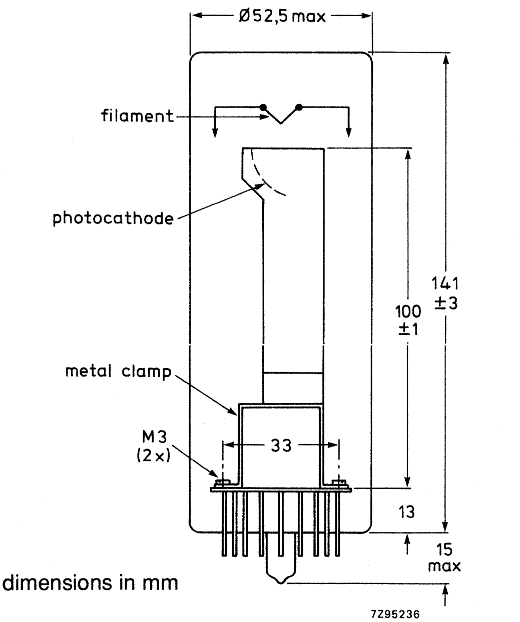
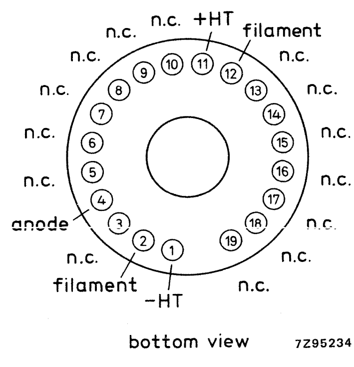


Fig.2 XP1600 in its original glass envelope.



Recommended socket: type FE2019

Fig.3 Pinning details of version XP1600

16-stage electron multipliers

XP1600 series

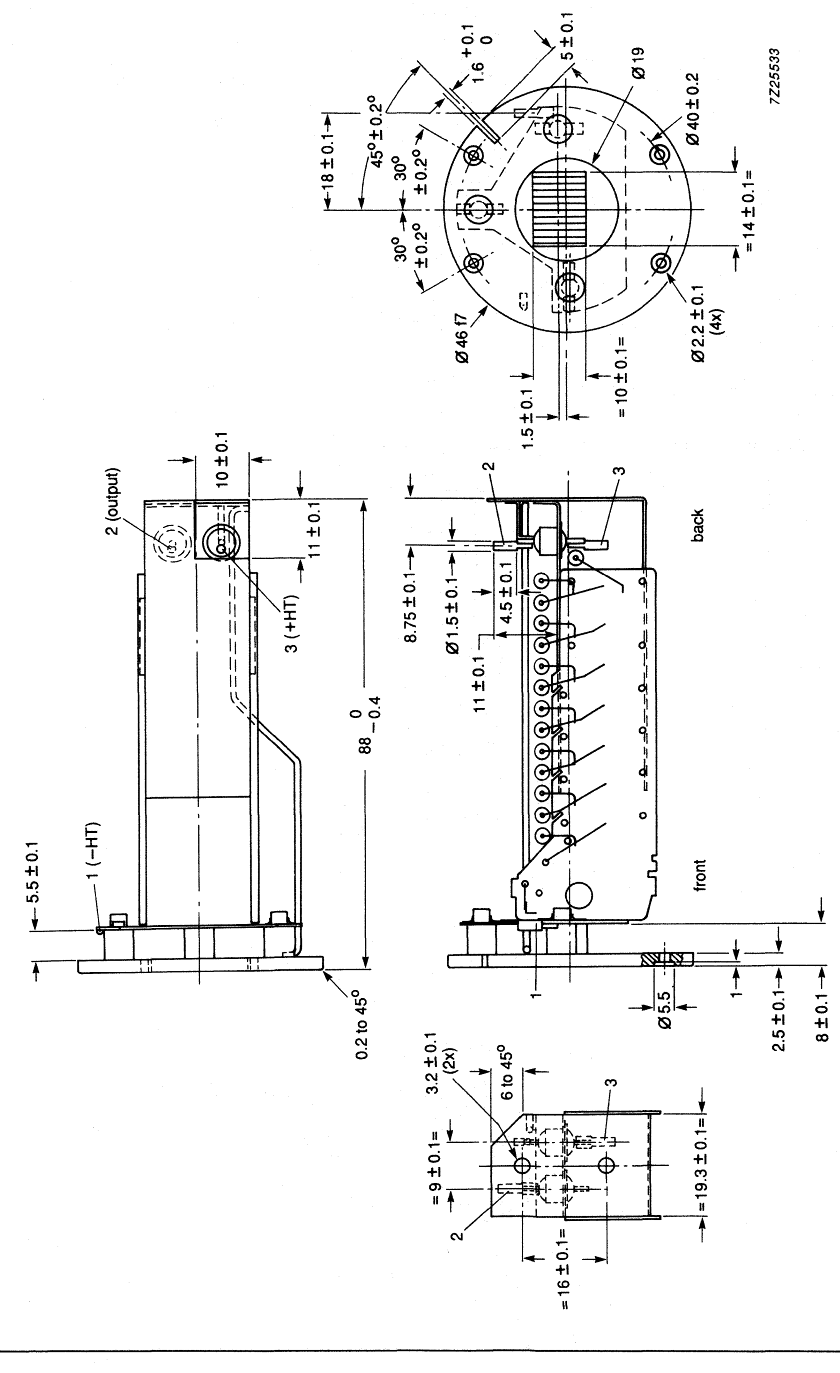


Fig.4 XP1600/12 mechanical details.

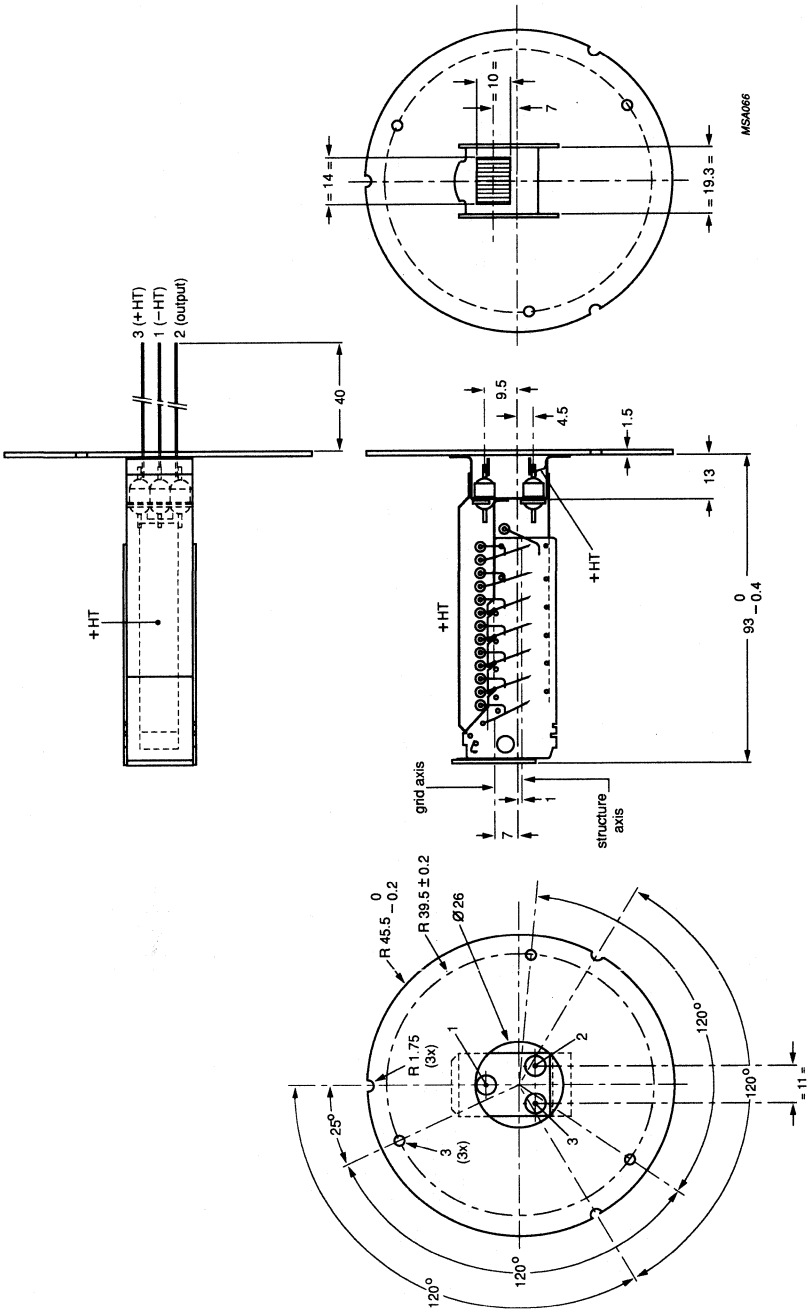


Fig.5 XP1600/14 mechanical details.

dimensions in mm

16-stage electron multipliers XP1600 series

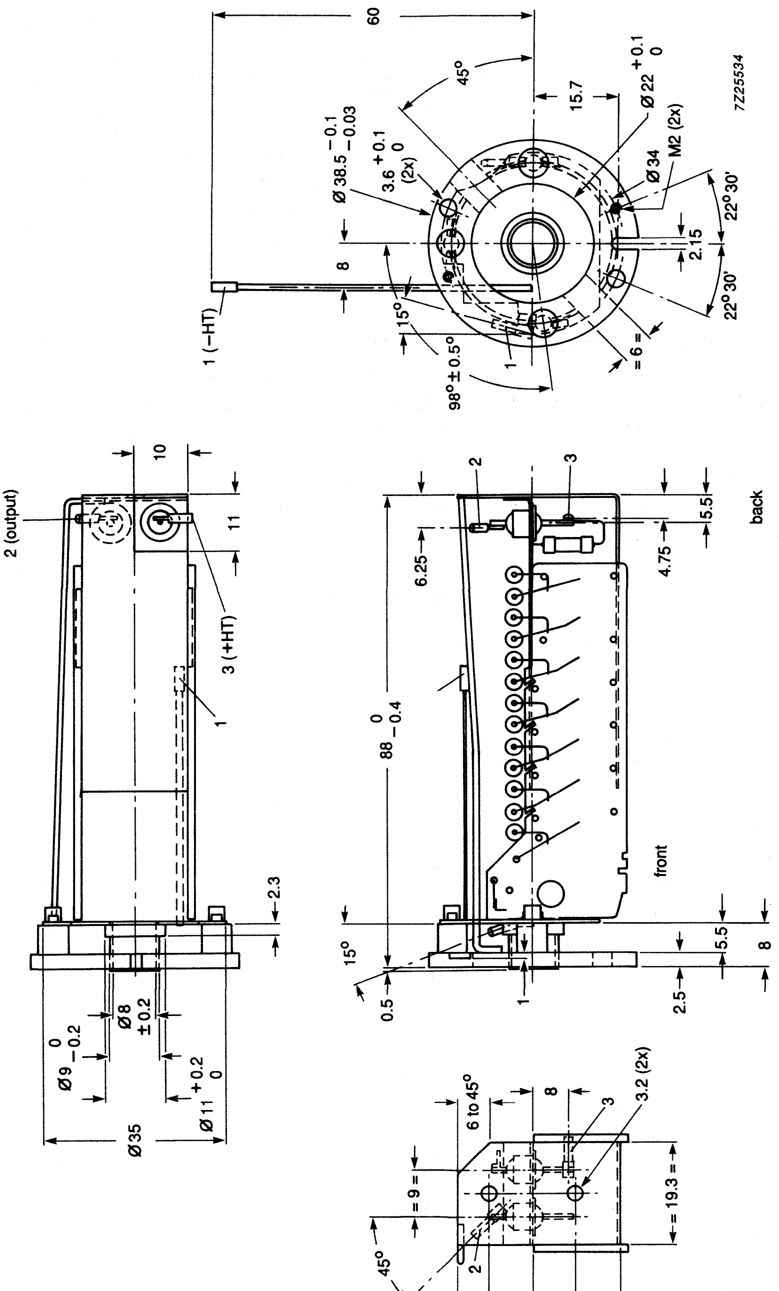


Fig.6 XP1600/17 mechanical details.

dimensions in mm

MECHANICAL DATA

PARAMETER	TYPE				UNIT
	XP1600	XP1600/12	XP1600/14	XP1600/17	
Useful input aperture	5 x 10	10 x 14	10 x 14	8 ∅	mm
Resistor R value (see note 1)	1000	500	1000	500	kΩ
Fixing flange	rear	front and rear	rear	front and rear	
Packing (see note 3)	see note 2	argon filled screw-top glass jar			
Net mass	35	55	55	65	g

Notes

1. Resistor R has a glass coating for types XP1600/12, XP1600/14 and XP1600/17.
2. The XP1600 is delivered in an evacuated cylindrical glass envelope to be opened just before installation. A 19-pin glass base supports the multiplier structure and provides for electrical connections (preferably with a FE2019 socket). An emitting filament is also incorporated which may be used for measurement of gain by heating it to a dull red with a current of ≈ 1 A. To open the envelope, scribe the pumping stem with a file and touch the scribe mark with the heated end of a glass rod to break the stem cleanly. The envelope can then be cut with a hot wire, either to extract the multiplier with its base, or to seal the opened envelope to a vacuum chamber. Open the envelope only in a clean, dry atmosphere, preferably dry nitrogen.
3. Oil vapour contaminates the dynodes which results in loss of gain. When evacuating the chamber in which the device is to be used, the vacuum pump should be fitted with a liquid nitrogen trap. Short exposure to clean, dry air does not harm the dynodes, but humidity will. Prolonged storage should be in a dry, neutral atmosphere, in a vacuum or in a protection gas (argon).

LIMITING VALUES

Limiting values in accordance with Absolute Maximum System (IEC 134)

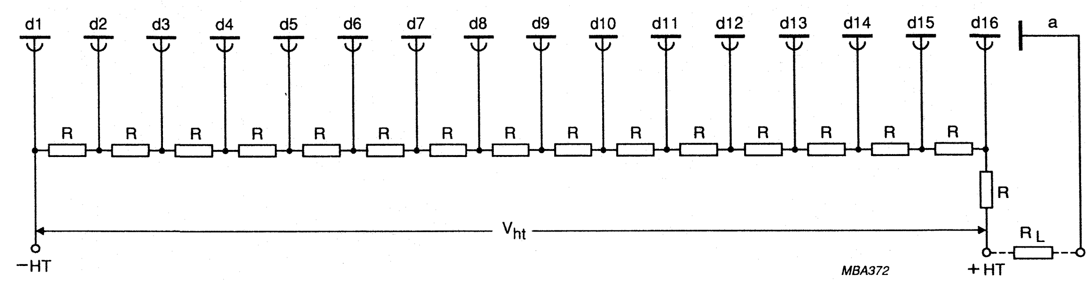
PARAMETER	MIN.	MAX.	UNIT
Supply voltage			
XP1600 and XP1600/14	–	3500	V
XP1600/12 and XP1600/17	–	3200	V
Continuous anode current (see notes 1,2)	–	50	μA
Operating ambient pressure	–	1×10^{-3}	Pa
Baking temperature	–	300	°C

Notes

1. When operating conditions are such that the converter (first dynode) emits less than 1000 electrons per second ($< 1.6 \times 10^{-16}$ A), it will be necessary to operate the device in the pulse mode. Due to statistical fluctuations, direct current measurements are not practical at such low currents.
2. A maximum of 10 μA is recommended in applications requiring good stability.

VOLTAGE DIVIDER

The voltage divider is made from special resistors designed for use in a vacuum and are soldered directly to the dynode structure.



dn = dynode number

a = anode

R = resistor (value in Mechanical Data ± 5%)

Fig.7 Voltage divider.

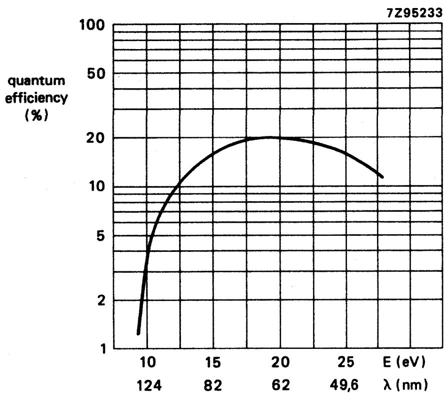
OUTPUT CHARACTERISTICS

at gain = 10^7

PARAMETER	MIN.	TYP.	MAX.	UNIT
Supply voltage (see Fig.9 and notes 1,2)	–	2500	3000	V
Anode dark current	–	–	0.1	nA
Background noise (see note 2)	–	–	5	c/s
Anode pulse rise time at V_{ht} = 2500 V	–	≈ 3	–	ns
Anode pulse duration at half height at V_{ht} = 2500 V	–	≈ 5	–	ns
Signal transit time at V_{ht} = 2500 V	–	≈ 30	–	ns

Notes

1. Use a well stabilized high-voltage power supply. A one percent (1%) change of voltage will result in greater than ten percent (10%) change in gain (see Fig.9).
2. Gain and background noise are measured with a multichannel analyser by the single electron method, with a threshold corresponding to 0.3 photoelectron. This test is made before the glass bulb used for the process is removed and the device being in the original vacuum.



E = Energy; λ = wavelength.

Fig.8 Quantum efficiency of CuBe in the ultraviolet.

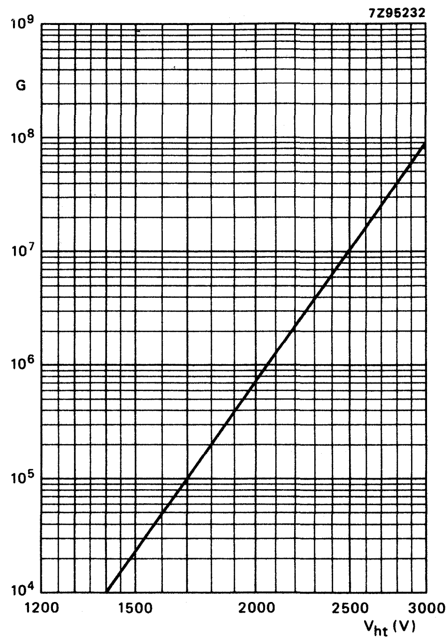


Fig.9 Gain as a function of supply voltage.

SINGLE CHANNEL ELECTRON MULTIPLIERS

SELECTION GUIDE

type no.	input* configuration	dimensions (nom.) mm	resistance (typ.) Ω	application mode	page
B310AL/01**	circular	ϕ 1.25	3.0×10^9	pulse	
B310BL/01**	circular	ϕ 1.25	3.0×10^9	pulse	
B312AL/01**	rectangular	2 x 8	3.0×10^9	pulse	
B312BL/01**	rectangular	2 x 8	3.0×10^9	pulse	
B314AL/01**	rectangular	2 x 8	3.0×10^9	pulse	
B314BL/01**	rectangular	2 x 8	3.0×10^9	pulse	
B318AL/01**	conical	ϕ 5	3.0×10^9	pulse	
B318BL/01**	conical	ϕ 5	3.0×10^9	pulse	
B410AL/01**	circular	ϕ 2.2	3.0×10^9	pulse	
B410BL/01**	circular	ϕ 2.2	3.0×10^9	pulse	
B413AL/01**	rectangular	3.5 x 15.5	3.0×10^9	pulse	
B413BL/01**	rectangular	3.5 x 15.5	3.0×10^9	pulse	
B419AL/01**	conical	ϕ 10	3.0×10^9	pulse	
B419BL/01**	conical	ϕ 10	3.0×10^9	pulse	
X630AL,CL	elliptical	19 x 16	1.2×10^8	pulse and analog	25
X636AL,CL	elliptical	12.5 x 11.5	1.2×10^8	pulse and analog	27
X640AL,CL	elliptical	19 x 16	8.0×10^7	analog	29
X646AL,CL	elliptical	12.5 x 11.5	8.0×10^7	analog	31
X651	mounted X646		8.0×10^7	analog	33
X652	mounted X646		8.0×10^7	analog	35
X655	mounted X636		1.2×10^8	pulse and analog	37
X657	mounted X636		1.2×10^8	pulse and analog	39
X710AL,BL	circular	ϕ 2.2	3.0×10^8	pulse	41
X713AL,BL	rectangular	3.5 x 15.5	3.0×10^8	pulse	45
X714AL,BL	rectangular	3.5 x 15.5	3.0×10^8	pulse	49
X719AL,BL	conical	ϕ 10	3.0×10^8	pulse	53
X810AL,BL	circular	ϕ 1.25	6.0×10^8	pulse	57
X812AL,BL	rectangular	2 x 8	6.0×10^8	pulse	59
X814AL,BL	rectangular	2 x 8	6.0×10^8	pulse	61
X818AL,BL	conical	ϕ 5	6.0×10^8	pulse	63
X910AL,BL	circular	ϕ 2.2	6.0×10^8	pulse	65
X913AL,BL	rectangular	3.5 x 15.5	6.0×10^8	pulse	69
X914AL,BL	rectangular	3.5 x 15.5	6.0×10^8	pulse	73
X919AL,BL	conical	ϕ 10	6.0×10^8	pulse	77
X951AL,BL	conical	ϕ 19	6.0×10^8	pulse	81
X955AL,BL	conical	ϕ 13	6.0×10^8	pulse	85
X959AL,BL	conical	ϕ 15	6.0×10^8	pulse	89

* Alternative input configurations may be produced on request.
** Maintenance types. Can be made to special order.

SINGLE CHANNEL ELECTRON MULTIPLIERS
GENERAL EXPLANATORY NOTES

PRINCIPLES OF OPERATION

A single channel electron multiplier is a small, curved, glass tube, the inside wall of which has a high surface resistance. If a potential is applied between the ends of the tube, the resistive surface becomes a continuous dynode, electrically analogous to the separate dynodes of a conventional photomultiplier together with the resistive chain used to establish the separate dynode potentials.

The channel electron multiplier operates in a vacuum. For space research, the environmental vacuum is sufficient. In the laboratory, the multiplier must be used in a vacuum chamber.

An electron entering the low-potential end of the channel multiplier generates secondary electrons on collision with the wall of the tube. These are accelerated along the tube until they strike the wall again, where they generate further secondary electrons. This avalanching process produces a large number of electrons at the positive end of the tube. This is illustrated in Fig.1.

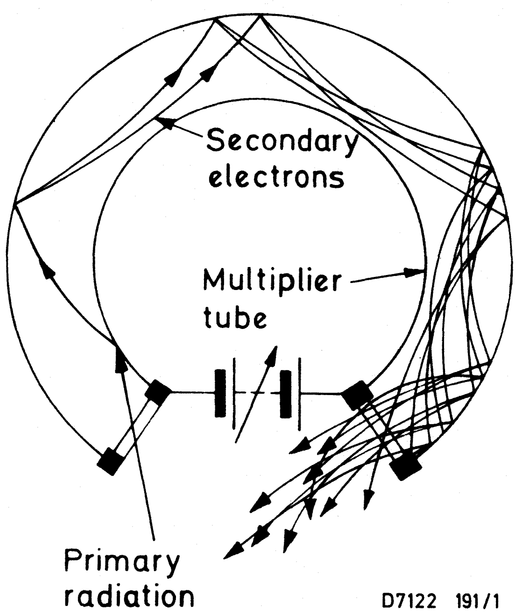


Fig.1 Electron multiplication

A channel multiplier thus responds to an input of one electron by producing an output pulse of charge. This pulse may contain up to about 10^8 electrons and its duration (full width at half height) is about 10 nanoseconds. The amplitude of the resulting voltage pulse depends, of course, upon the values of resistance and capacitance in the anode circuit of the multiplier. The gain (Fig.4) is an exponential and very steep function of voltage for values below 10^7. Above 10^7, saturation effects are observed which are discussed later.

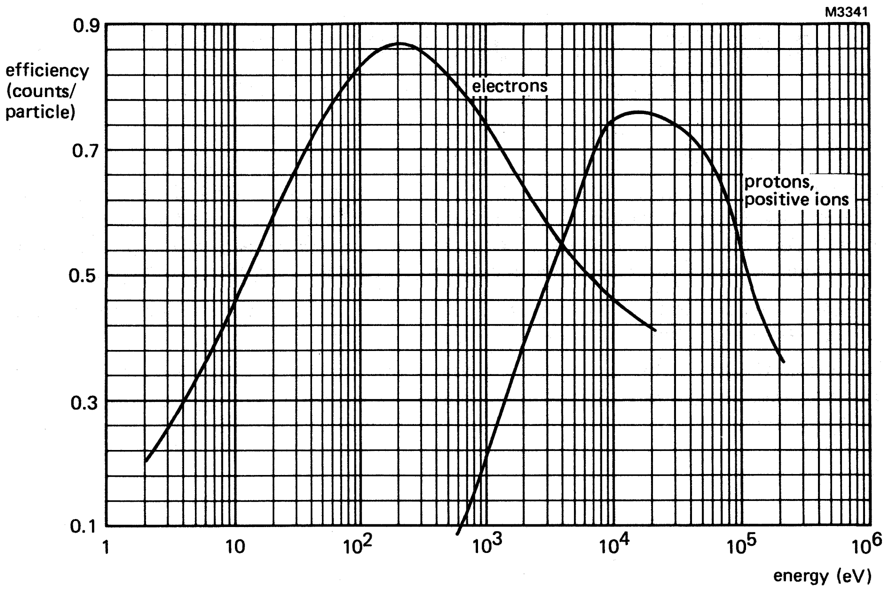


Fig.2 Typical detection efficiencies for electrons, protons and positive ions

Note: The curve for electrons is based on information contained in a paper by M.P. Seah of the National Physical Laboratory, Teddington, UK. titled "Channel Electron Multipliers: Quantitative Intensity Measurement" which is to be published in the Journal of Electron Spectroscopy. The efficiency is dependent on the mode of operation of the multiplier and the paper gives the theoretical background of these variations.

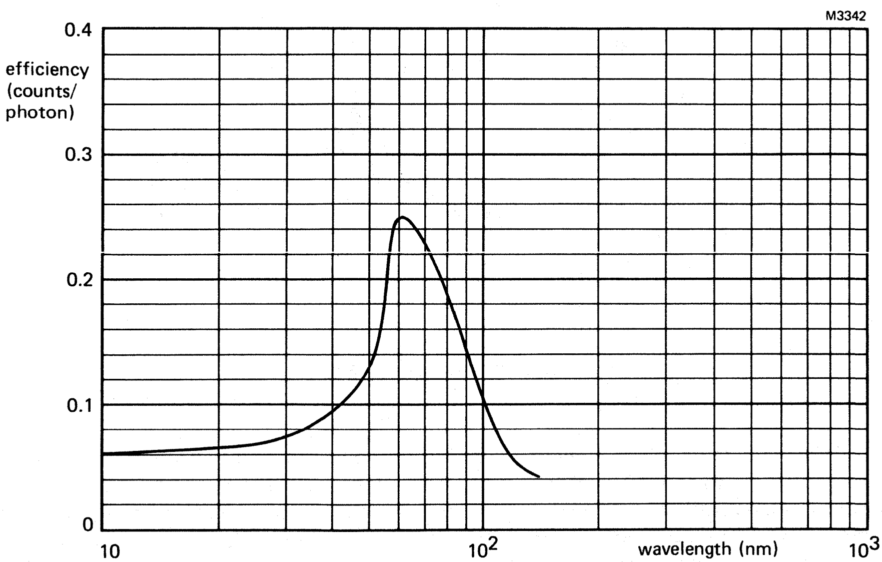


Fig.3 Typical detection efficiency for ultraviolet radiation

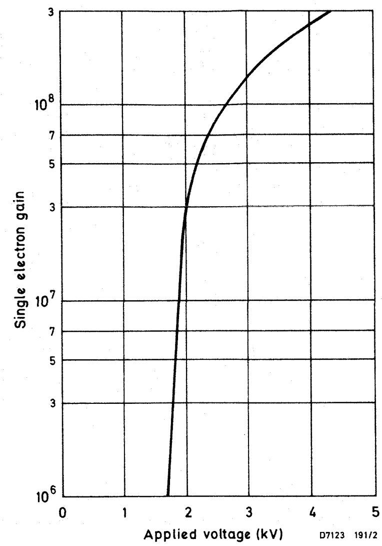


Fig.4 Typical variation of gain as a function of applied voltage

The multiplier will also respond to ions, β particles, X-rays, ultraviolet, or any other sufficiently energetic radiation. The detection efficiency of a channel multiplier is different for different forms and energies of excitation, but any particle or quantum capable of exciting an electron from the dynode surface has a finite probability of detection, (see Figs 2 and 3).

Since the resistive coating is continuous, many electron paths are possible, and the number of stages of multiplication is thus indeterminate. The electron trajectories are scaled in proportion to the dimensions of the channel for a given applied voltage. Thus, if the length-to-diameter ratio is preserved, the same multiplication processes go on, and the same gain is achieved, irrespective of the absolute length of the channel. In practice, it is necessary for the length-to-diameter ratio to exceed about 30:1. Channels are almost invariably curved, and the gain is then less critically dependent on the length-to-diameter ratio. The ratios generally used are between 50:1 and 100:1.

IONIC FEEDBACK

The tube forming the channel multiplier is curved because the gain of a straight tube would be sensitive to changes in ambient pressure. When the first cloud of electrons nears the output end of the multiplier, it is sufficiently dense to ionise a considerable number of the residual gas atoms in the tube. These positive ions drift under the influence of the applied field towards the more negative potential at the input end of the channel.

If the channel is straight, the ions may acquire considerable energy before they collide with the wall of the tube. Consequently they may release from the wall electrons which initiate a further process of multiplication through the tube, resulting in a spurious output pulse. This process is repeated, and thus a sequence of 'after pulses' may be observed. This pulse train lasts typically for about a microsecond until the capacity of the channel is exhausted and the pulse train dies out.

In a curved tube, the ions strike the wall of the tube before they have acquired sufficient energy to release secondary electrons. Electron multiplication is unaffected however since electrons need acquire an energy of only about 50 eV to release secondary electrons from the wall. The output of the curved multiplier is therefore independent of the ambient pressure, provided it does not exceed 50 $mN.m^{-2}$ *. Above this pressure, spurious pulses occur, and effects similar to those seen with straight channels are observed.

*50 mPa or 5 x 10^{-4} mbar

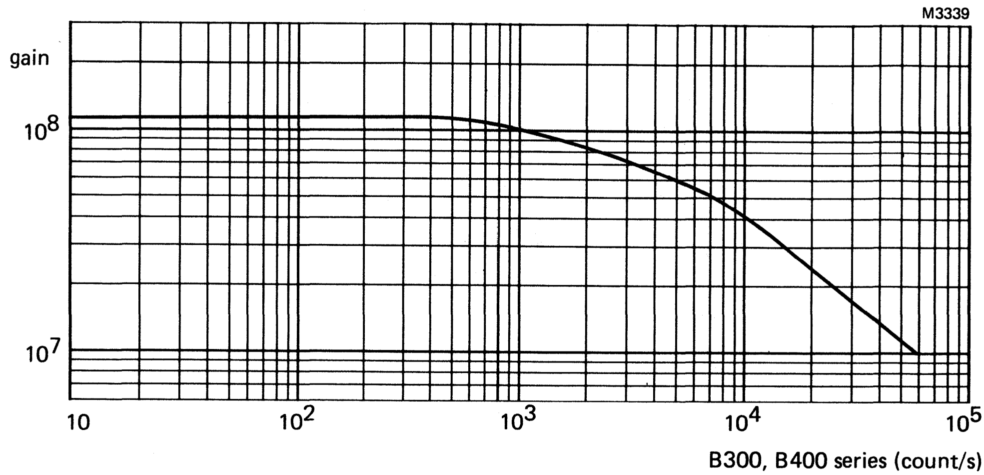


Fig.5 Typical gain as a function of counting rate for B300 and B400 series single channel electron multipliers.
Operating voltage = 3.0 kV for B300 series
= 2.5 kV for B400 series

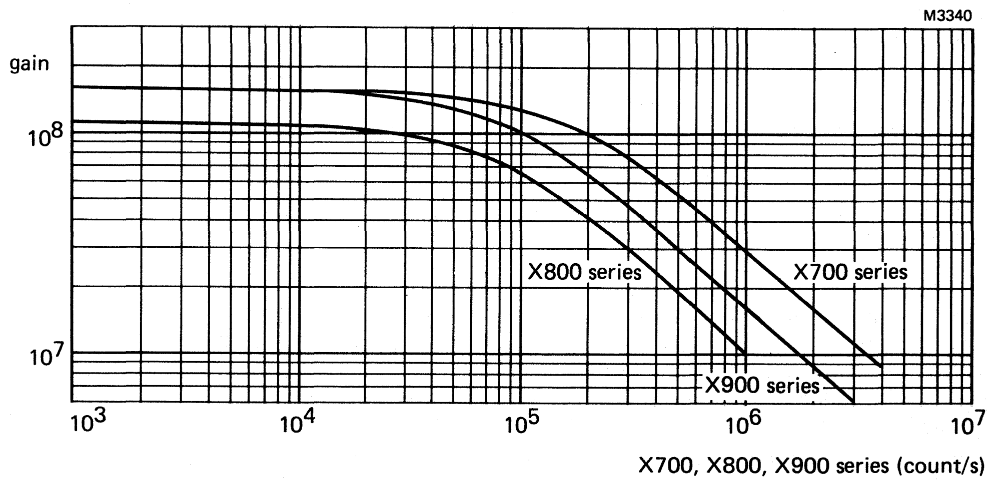


Fig.6 Typical gain as a function of counting rate for X700, X800 and X900 series single channel electron multipliers.
Operating voltage = 2.5 kV

SATURATION DUE TO SPACE CHARGE

One of the more significant aspects of the behaviour of a channel multiplier is the saturation effect caused by space-charge limitation. When the total amount of charge in the electron cloud in a channel multiplier reaches nearly 10^9 electrons, the gain cannot increase further.The space-charge repels the emitted-secondary electrons so that they strike the wall before acquiring sufficient energy from the field to make useful multiplying collisions. The space-charge limit is unaffected by the channel diameter. Increasing the applied voltage increases the amplitude of those pulses which would not otherwise have reached $\approx 10^9$ electrons, but as the maximum charge output cannot exceed this level, the amplitude of all pulses tends to the same value. The multiplier thus has a narrow pulse-height distribution. When it is operated in the saturated mode, it is analogous to a Geiger counter, producing a pulse of a given amplitude irrespective of the manner of its excitation. It is unable in this condition to give information about the number of particles simultaneously striking the input or about their energy.

When the multiplier is not operated in its saturated mode, that is when the gain is less than 10^7, there is some proportionality between input and output. However, there is a spread of pulse amplitudes because of the many possible electron paths through the multiplier. The pulse-amplitude distribution is exponential: smaller pulses are more probable then larger ones by an amount exponentially dependent on the amplitude.

SATURATION DUE TO FIELD DISTORTION

In a straight channel, ionic feedback gives rise to a pulse train about 1 microsecond in duration which may contain a total charge of more than 10^9 electrons. The pulse train dies out only when the field inside the channel is distorted by wall-charging to such an extent that the multiplication process can no longer sustain feedback.

The field is restored during a 'dead time', after which an output pulse can again be observed. The dead time depends on the resistance of the channel and may be some tens of microseconds.

The dead-time effect may be caused by a single event in a straight channel. This is not possible, however, in curved channels because the probability of ionic feedback is very low, and the pulse train is replaced by a single pulse of about 10 nanoseconds duration which is space-charge limited to about 10^9 electrons. Consequently, the curved channel may produce two pulses of the same amplitude separated in time only by the pulse duration. However, if the mean pulse repetition rate is high, the field inside the channel is distorted. A state of dynamic equilibrium is achieved: the mean gain is reduced so that the average rate of flow of charge in the output pulses is less than the current flowing in the channel wall, (see Figs 5 and 6).

The same considerations apply when a channel multiplier is used as a current amplifier. The amplification is generally linear up to a maximum of 5% of the standing (wall) current. For example, a channel of resistance $5 \times 10^8\ \Omega$ operated at 2.5 kV should maintain a linear current-transfer characteristic up to a maximum output of 0.25 μA.

RESISTANCE

For convenience the resistance of a channel electron multiplier is measured between input and output terminals at atmospheric pressure and at room temperature with no space current flow; this resistance has the same value in vacuum.

BACKGROUND OR SPONTANEOUS PULSE COUNTING RATE

The background or spontaneous pulse counting rate is the number of pulses detected per second above a specified equivalent threshold when the input end of the multiplier is closed. The equivalent threshold is the amount of charge produced by the multiplier which, when amplified, just appears above the threshold of the discriminator used for pulse counting. The count is made with a multiplier voltage and equivalent threshold as specified in the data.

STARTING VOLTAGE

As the voltage applied to the channel is increased, the gain rises and the output pulses become larger. The pulses are not all the same size, but as the gain increases, more of them exceed the equivalent threshold. The process continues until all the pulses are above the threshold. The observed counting rate is shown as a function of voltage in Fig.7 and this graph shows a steeply rising portion followed by a plateau.

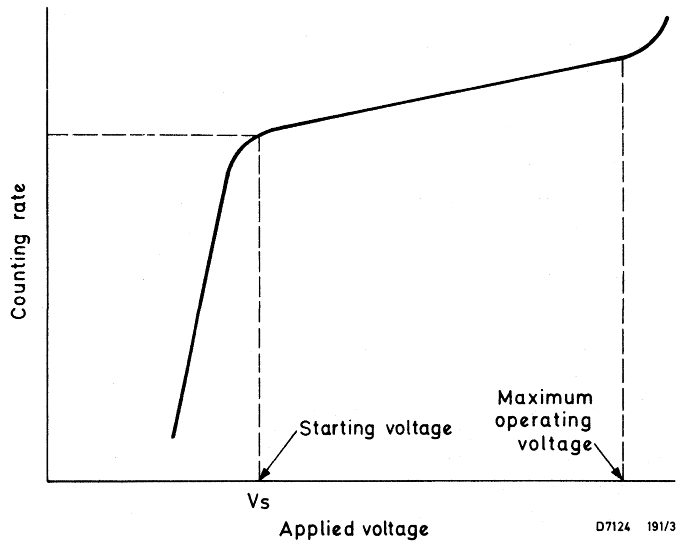


Fig.7 Definition of starting voltage

The starting voltage is the voltage at which the pulse counting rate is 90% of the plateau counting rate, where the plateau is defined as the region over which the counting rate changes by less than 3% for each 100 V increment.

The starting voltage is measured using an input source adjusted to give a fixed counting rate at a high applied voltage. The counting rate and voltage, together with the equivalent threshold, are given in the data.

PULSE GAIN

The output pulses resulting from input particles or quanta (events) will show a statistical spread. Due to saturation effects in the multiplier this spread is approximately Gaussian and the gain is defined as its median value.

The resistance of the multiplier glass limits the counting rate below which the gain is constant, (see Figs 5 and 6).

PULSE HEIGHT DISTRIBUTION IN SATURATED MODE

The nominal gain of a channel multiplier will not be achieved every time an event produces an output pulse; there is a variation in gain because of the statistical nature of the multiplication process. However, the spread is not usually very great at high values of gain and it is expressed in terms of the resolution of the pulse height distribution.

A typical pulse distribution is given in Fig.8. This is seen to be Gaussian. The resolution is defined as the ratio of the full width of the distribution at half maximum frequency (FWHM) to the modal pulse height. The resolution depends on applied voltage and gain. Values for various multipliers are quoted in the data.

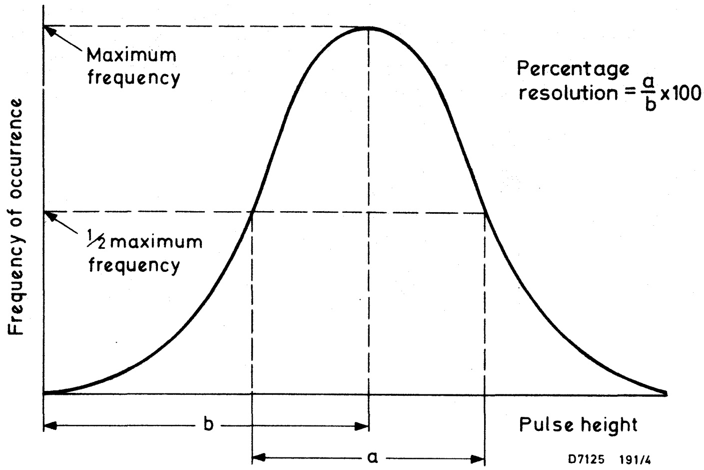


Fig.8 Definition of resolution of pulse height distribution

INPUT APERTURE

Larger input apertures may be achieved without increasing the overall dimensions of the multiplier by fitting a cone-shaped or flared end. Because the response of a channel multiplier depends on the angle of incidence of the input flux, it is not practicable to quote dimensions of effective apertures which are valid in all situations. The effective aperture of standard multipliers is not necessarily the same as the geometric aperture, but may be smaller.

OUTPUT PULSE

The output pulse corresponding to one input electron will consist of G electrons (G = gain). The corresponding charge in the output pulse will thus be G x 1.6 x 10^{-19} coulombs, where 1.6 x 10^{-19} coulombs is the electron charge. The charge in the output pulse raises the potential across the input capacitance of a pulse amplifier and this voltage change is referred to as the pulse height (usually in millivolts).

This expression of output as a voltage is common practice, but the capacitance to be charged must also be known.

MODE OF OPERATION

The multiplier is most commonly used with pulse counting circuits to detect individual particles or quanta. For this application closed end multipliers are recommended. A typical circuit is shown in Fig.9. The output pulse is capacitively coupled into a suitable charge sensitive pulse amplifier and discriminator.

The multiplier may also be used as a current amplifier. In this case an open-ended multiplier is necessary, the output being collected at a separate electrode. This electrode should be biased positively with respect to the ouptut end of the multiplier to ensure collection of all output electrons. Fig.10 shows the basic circuit for open ended (AL) versions of pulse multipliers and Fig.11 shows the circuit for the analogue or pulse/analogue types. For these the bias voltage is provided by a resistive layer on the outer wall (bias resistance in Fig.11) which is about 5% of the total resistance. The CL versions of analogue multipliers are supplied with a collector assembly which incorporates a guard ring to eliminate any leakage currents from the collector current.

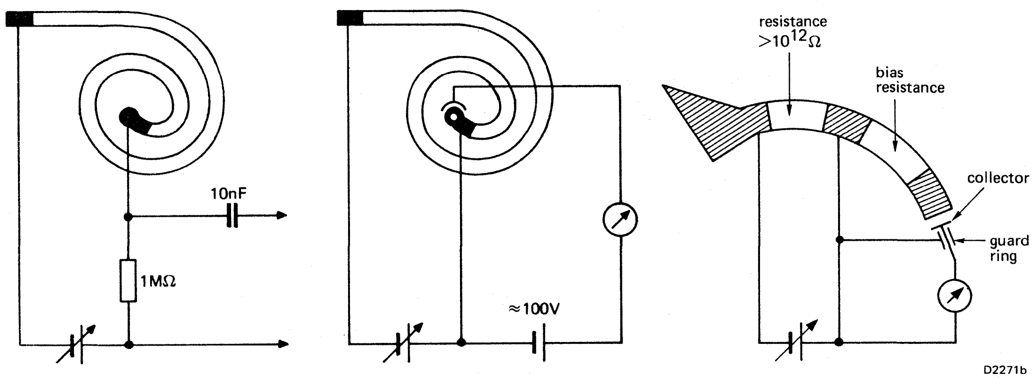


Fig.9 Fig.10 Fig.11

OPERATIONAL NOTES

Mounting

It is recommended that the leads are not used for mounting the device as sustained vibration may result in fracture of electrical connections.

The outer surface of the device is also a conductor and supports to the glass must be insulated.

To avoid contamination these devices must only be handled with gloved hands or tweezers.

Vacuum environment and storage

Normal vacuum precautions must be observed. In particular, gross contamination with hydrocarbon vapours will cause rapid loss of gain and should be avoided.

The device is stable in dry air and may be vacuum cycled repeatedly without damage. If it has to be stored at atmospheric pressure it is advisable to use a desiccator as high humidity can cause loss of gain. When stored in the unopened dessicated pack the shelf life of the multiplier should be at least two years.

Baking conditions

The specified baking conditions apply only when the device is under vacuum. The temperature must not exceed that specified in the data. A voltage must not be applied to the device during bake-out.

Thermal stability

Due to the negative temperature coefficient of resistance of multipliers, thermal runaway is possible. Operation below the maximum voltage and temperature limits specified will ensure that this does not occur.

Choice of operating voltage

For pulse multipliers, use of an operating voltage approximately 500 volts greater than the starting voltage should ensure that all output pulses exceed the threshold. If, as a result of prolonged use, the median gain of the multiplier falls, the operating voltage may be increased in order to restore the gain to its original value.

For analogue multipliers the voltage may be set to give the gain required in the application.

Operational life

The life of a channel multiplier is very dependent on the environment in which it is operated, also on the total accumulated output charge. The end of life is reached when the applied voltage cannot be increased any further to maintain the required gain, or when the background noise increases to an unacceptable level.

In a clean vacuum the gain slowly falls as shown in Fig.12, but the life expectancy is well in excess of 50 coulombs total output charge. In contaminated systems the life could be appreciably shorter and for this reason single channel electron multipliers cannot be guaranteed unconditionally for a specified period of time.

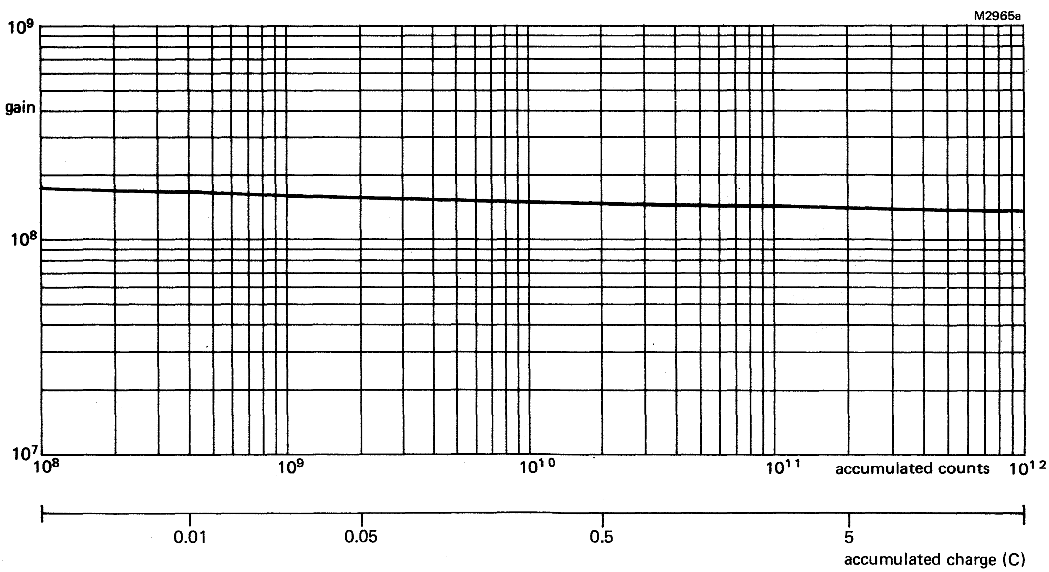


Fig.12 Typical gain as a function of accumulated counts and accumulated charge for the X900 series of single channel electron multipliers.
Operating voltage = 2.5 kV, ambient pressure = 0.02 mN.m^{-2} (2 x 10^{-7} mbar), counting rate = 3 x 10^4 counts/s, source: electrons.

SINGLE CHANNEL ELECTRON MULTIPLIERS

The X630AL is a high current single channel electron multiplier designed mainly for use in mass spectrometers in the analogue or pulse counting mode.
It has an open-ended output and to ensure efficient collection of electrons a collector should be used, biased approximately 100 V positive with respect to the multiplier output. This bias can be provided by means of the resistive layer on the outside wall of the multiplier (see Mechanical Data).
The X630CL is identical but is supplied with a collector assembly and stainless steel strips for the HT and earth connections

QUICK REFERENCE DATA

Typical gain at 2.0 kV		5×10^7	
Typical resistance		1.2×10^8	Ω
Operating voltage	max.	3.0	kV
Output current (continuous)	max.	5	μA
Output current for linear gain	max.	2	μA

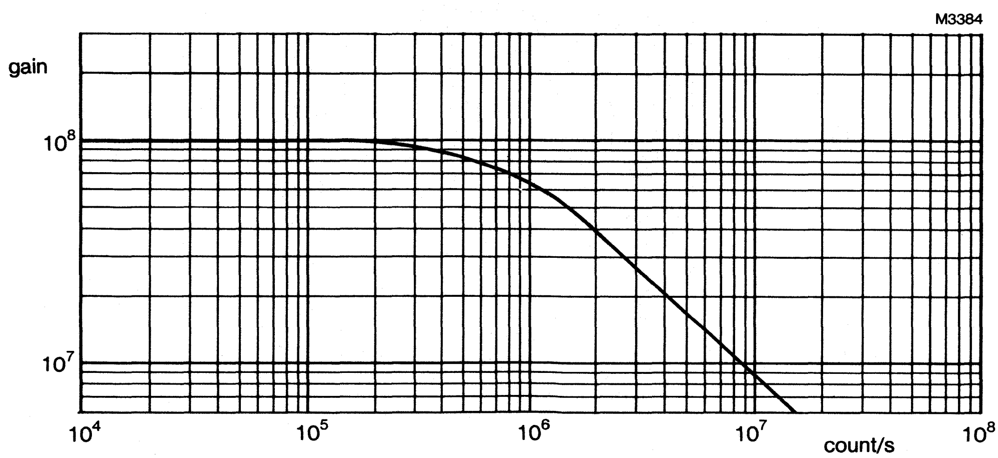
RATINGS

Temperature (operating and storage)	max.	70	°C
Bake temperature in vacuo	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

Note: Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

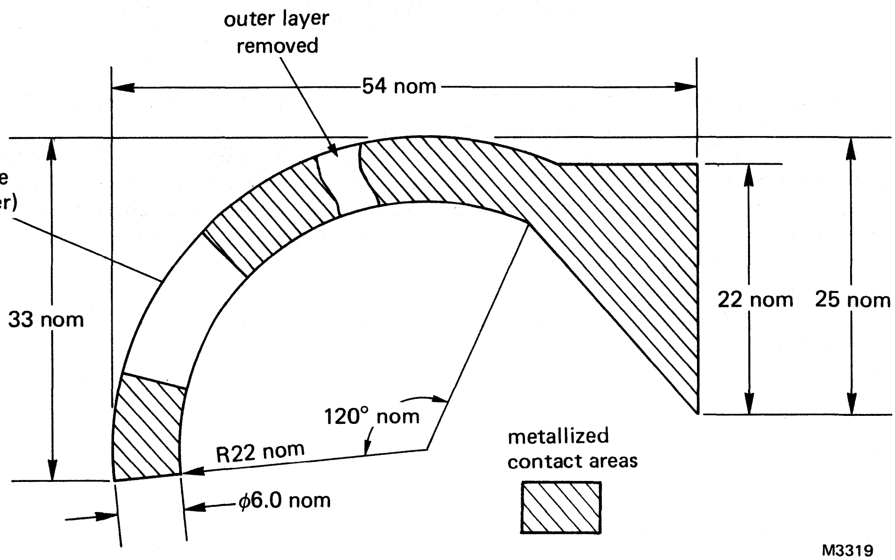
TYPICAL GAIN AS A FUNCTION OF COUNTING RATE

Operating voltage = 2.5 kV



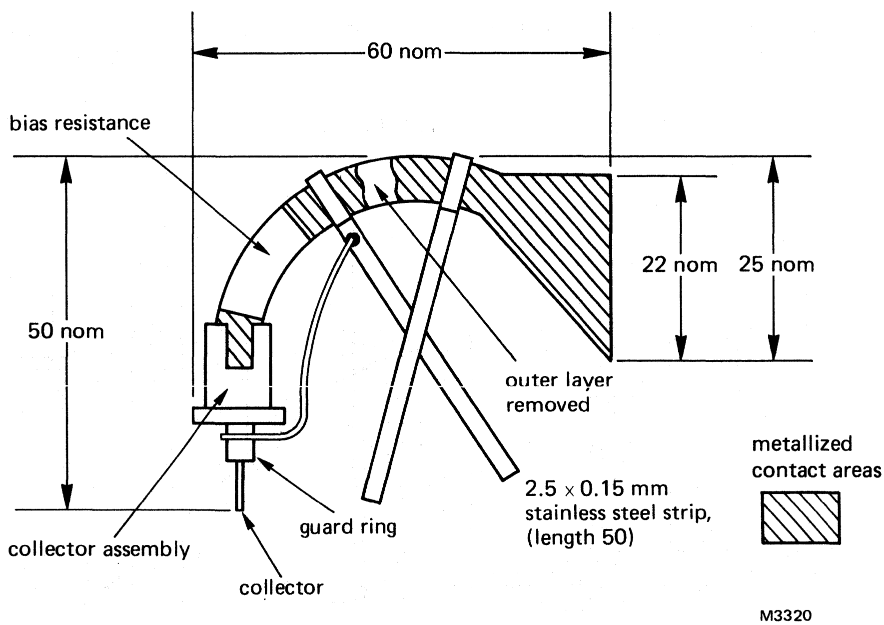
MECHANICAL DATA X630AL

Dimensions in mm



MECHANICAL DATA X630CL

Dimensions in mm



Other dimensions as X630AL

SINGLE CHANNEL ELECTRON MULTIPLIERS

The X636AL is a high current single channel electron multiplier designed mainly for use in mass spectrometers in the analogue or pulse counting mode.
It has an open-ended output and to ensure efficient collection of electrons a collector should be used, biased approximately 100 V positive with respect to the multiplier output. This bias can be provided by means of the resistive layer on the outside wall of the multiplier (see Mechanical Data).
The X636CL is identical but is supplied with a collector assembly and stainless steel strips for the HT and earth connections.

QUICK REFERENCE DATA

Typical gain at 2.0 kV		5×10^7	
Typical resistance		1.2×10^8	Ω
Operating voltage	max.	3.0	kV
Output current (continuous)	max.	5	μA
Output current for linear gain	max.	2	μA

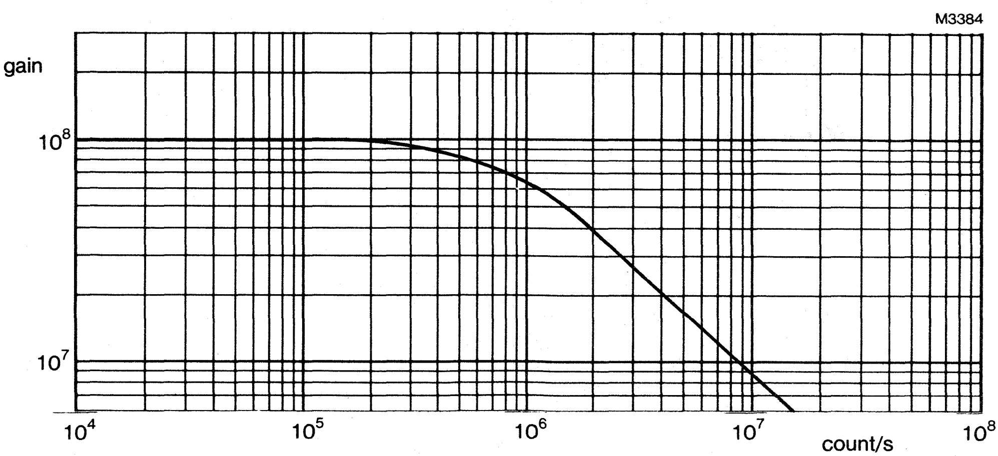
RATINGS

Temperature (operating and storage)	max.	70	°C
Bake temperature in vacuo	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

Note: Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

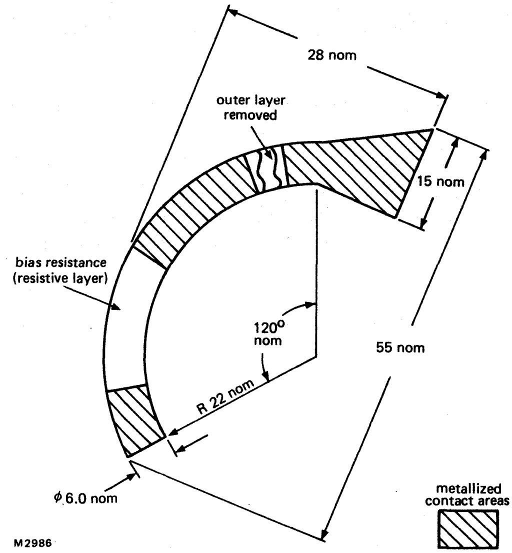
TYPICAL GAIN AS A FUNCTION OF COUNTING RATE

Operating voltage = 2.5 kV



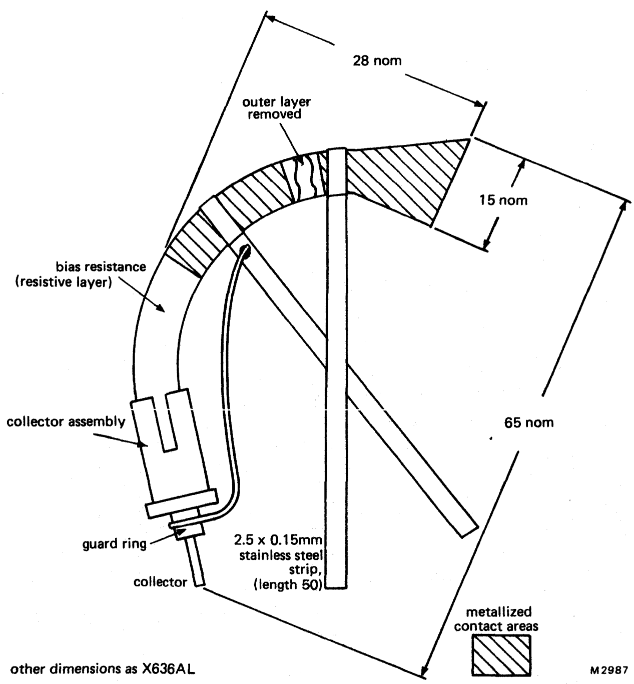
MECHANICAL DATA X636AL

Dimensions in mm



MECHANICAL DATA X636CL

Dimensions in mm



SINGLE CHANNEL ELECTRON MULTIPLIERS

The X640AL is a high current single channel electron multiplier designed mainly for use in mass spectrometers in the analogue mode.
It has an open-ended output and to ensure efficient collection of electrons a collector should be used, biased approximately 100 V positive with respect to the multiplier output. This bias can be provided by means of the resistive layer on the outside wall of the multiplier (see Mechanical Data).
The X640CL is identical but is supplied with a collector assembly and stainless steel strips for the HT and earth connections.

QUICK REFERENCE DATA

Typical gain at 2.0 kV		5.0×10^6	
Typical resistance		8.0×10^7	Ω
Operating voltage	max.	3.0	kV
Output current (continuous)	max.	5	μA
Output current for linear gain	max.	2	μA

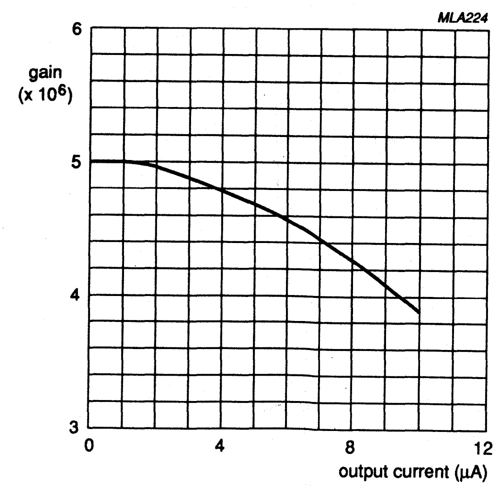
RATINGS

Temperature (operating and storage)	max.	70	°C
Bake temperature in vacuo	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

Note: Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

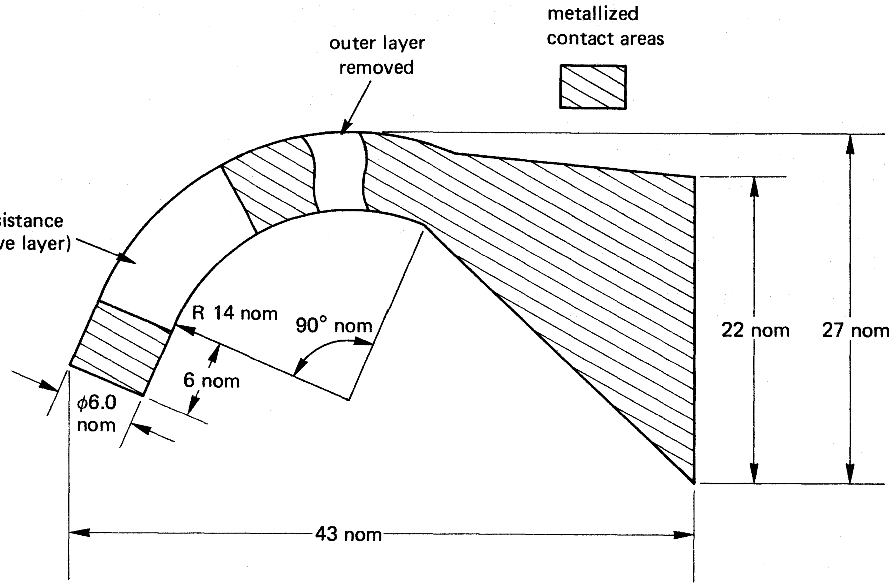
TYPICAL GAIN AS A FUNCTION OF CURRENT

Operating voltage = 2.0 kV



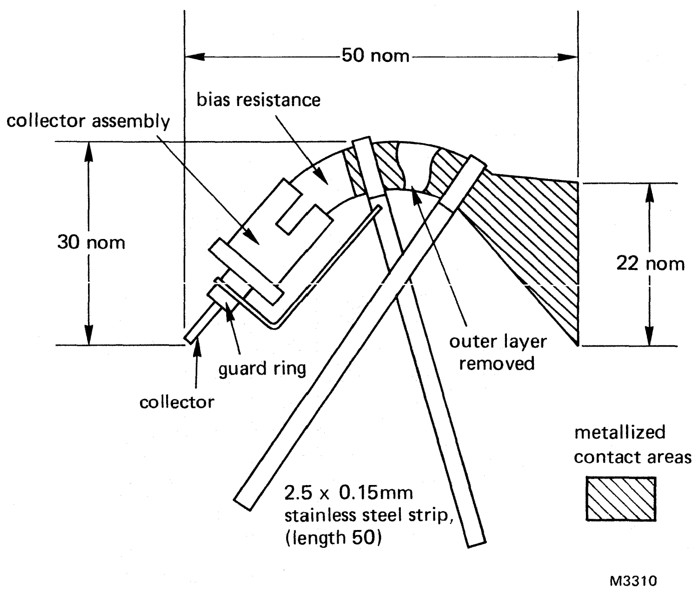
MECHANICAL DATA X640AL

Dimensions in mm



MECHANICAL DATA X640CL

Dimensions in mm



other dimensions as X640AL

SINGLE CHANNEL ELECTRON MULTIPLIERS

The X646AL is a high current single channel electron multiplier designed mainly for use in mass spectrometers in the analogue mode.
It has an open-ended output and to ensure efficient collection of electrons a collector should be used, biased approximately 100 V positive with respect to the multiplier output. This bias can be provided by means of the resistive layer on the outside wall of the multiplier (see Mechanical Data).
The X646CL is identical but is supplied with a collector assembly and stainless steel strips for the HT and earth connections.

QUICK REFERENCE DATA

Typical gain at 2.0 kV		5.0×10^6	
Typical resistance		8.0×10^7	Ω
Operating voltage	max.	3.0	kV
Output current (continuous)	max.	5	μA
Output current for linear gain	max.	2	μA

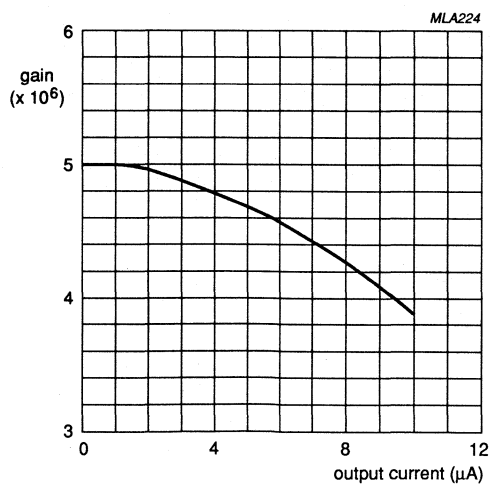
RATINGS

Temperature (operating and storage)	max.	70	°C
Bake temperature in vacuo	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

Note: Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

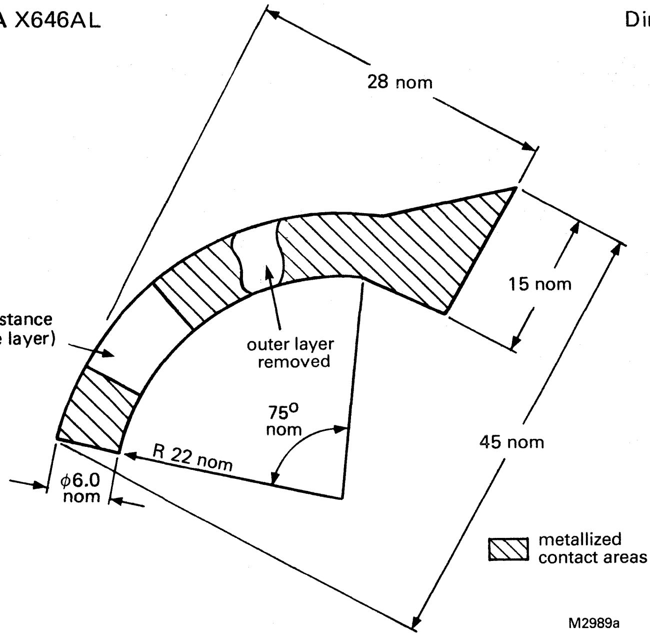
TYPICAL GAIN AS A FUNCTION OF OUTPUT CURRENT

Operating voltage = 2.0 kV



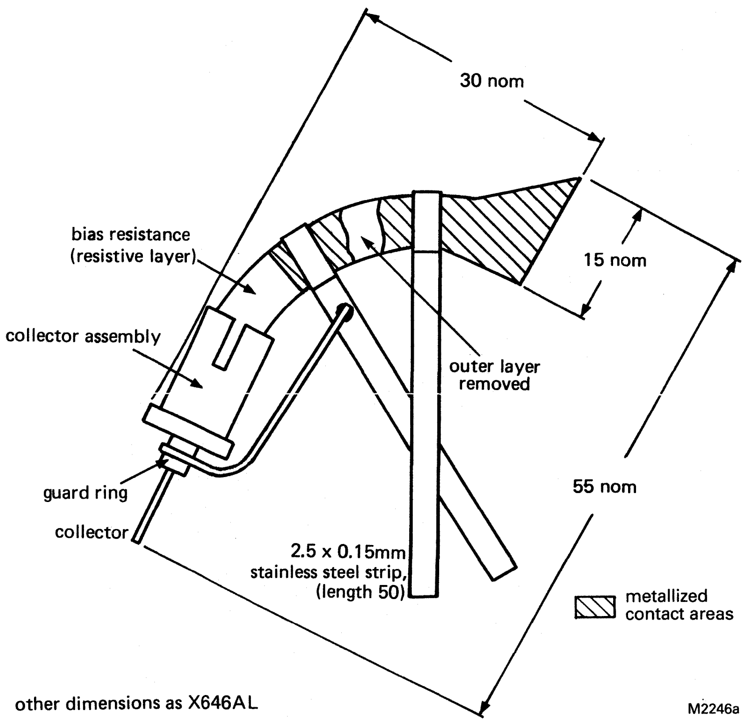
MECHANICAL DATA X646AL

Dimensions in mm



MECHANICAL DATA X646CL

Dimensions in mm



other dimensions as X646AL

SINGLE CHANNEL ELECTRON MULTIPLIER

The X651 is a mounted version of the X646 high current single channel electron multiplier designed mainly for use in mass spectrometers in the analogue mode. It incorporates a Faraday Cup connected to the collector.

QUICK REFERENCE DATA

Typical gain at 2.0 kV		5.0×10^6	
Typical resistance		8.0×10^7	Ω
Operating voltage	max.	3.0	kV
Output current (continuous for 10 minutes)	max.	10	μA
Output current (continuous)	max.	5	μA
Output current for linear gain	max.	2	μA

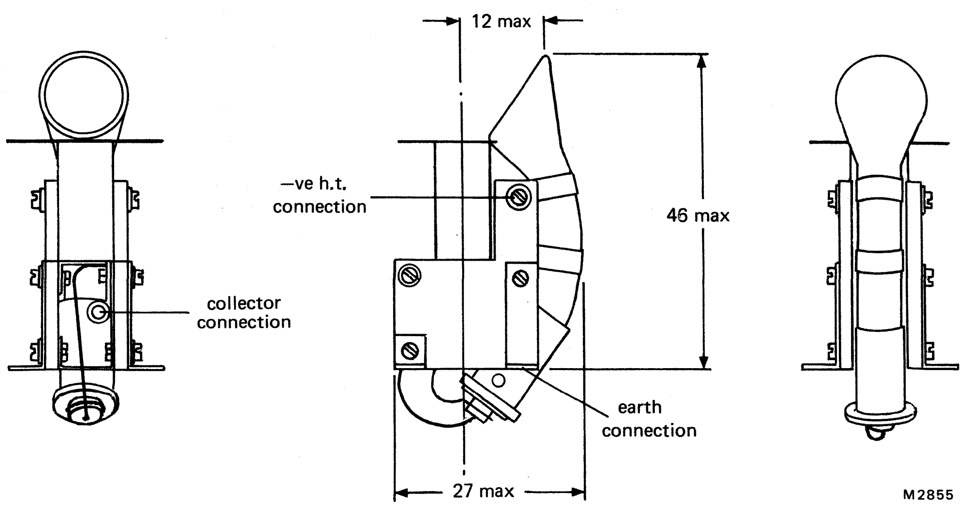
RATINGS

Temperature (operating and storage)	max.	70	°C
Bake temperature in vacuo	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

Note: Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

MECHANICAL DATA

Dimensions in mm



SINGLE CHANNEL ELECTRON MULTIPLIER

The X652 is a mounted version of the X646 high current single channel electron multiplier designed mainly for use in mass spectrometers in the analogue mode.
Alternative mount configurations may be produced on request.

QUICK REFERENCE DATA

Typical gain at 2.0 kV		5.0×10^6	
Typical resistance		8.0×10^7	Ω
Operating voltage	max.	3.0	kV
Output current (continuous for 10 minutes)	max.	10	μA
Ouput current (continuous)	max.	5	μA
Output current for linear gain	max.	2	μA

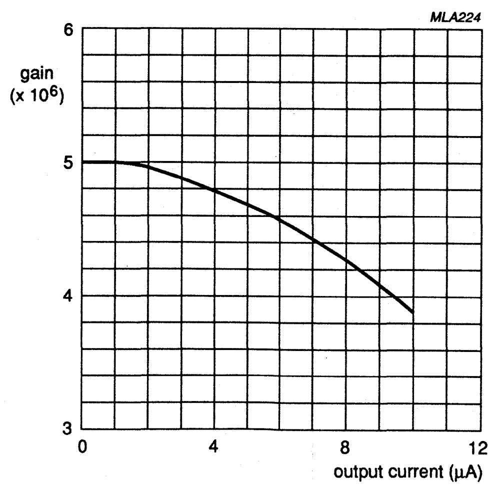
RATINGS

Temperature (operating and storage)	max.	70	°C
Bake temperature in vacuo	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

Note: Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

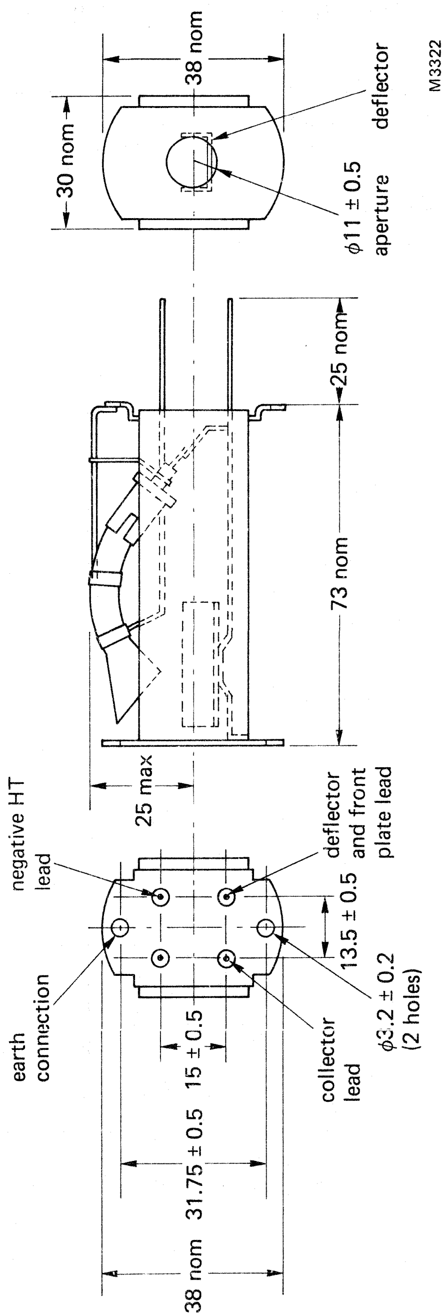
TYPICAL GAIN AS A FUNCTION OF OUTPUT CURRENT

Operating voltage = 2.0 kV



MECHANICAL DATA

Dimensions in mm



SINGLE CHANNEL ELECTRON MULTIPLIER

The X655 is a mounted version of the X636AL high current single channel electron multiplier designed mainly for use in mass spectrometers in the analogue or pulse counting mode.
Alternative mount configurations may be produced on request.

QUICK REFERENCE DATA

Typical gain at 2.0 kV		5.0×10^7	
Typical resistance		1.2×10^8	Ω
Operating voltage	max.	3.0	kV
Ouput current (continuous)	max.	5	μA
Output current for linear gain	max.	2	μA

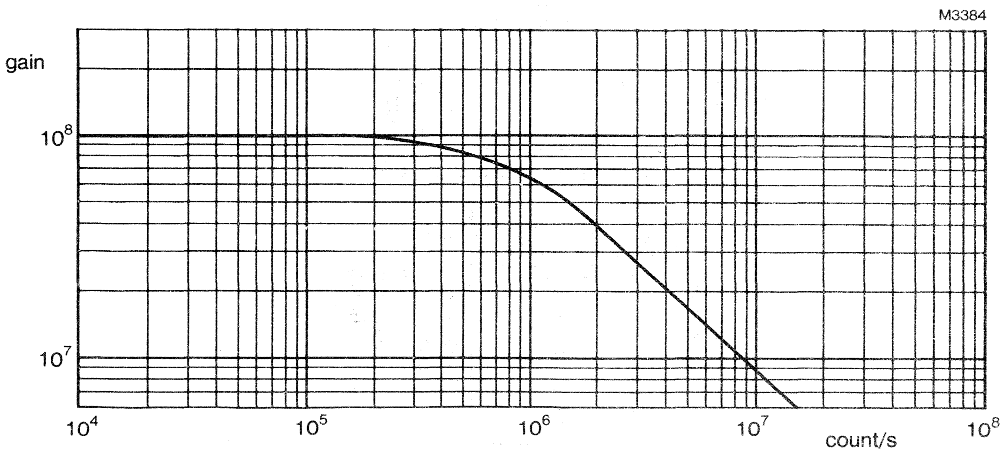
RATINGS

Temperature (operating and storage)	max.	70	°C
Bake temperature in vacuo	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

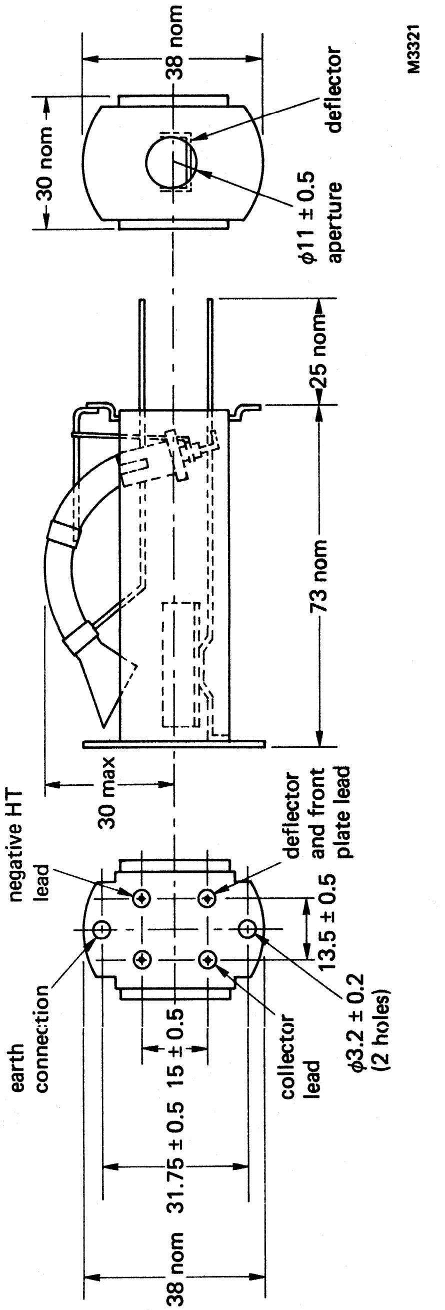
Note: Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

TYPICAL GAIN AS A FUNCTION OF COUNTING RATE

Operating voltage = 2.5 kV



MECHANICAL DATA Dimensions in mm



SINGLE CHANNEL ELECTRON MULTIPLIER

The X657 is a mounted version of the X636AL high current single channel electron multiplier designed mainly for use in mass spectrometers in the analogue or pulse counting mode.
Alternative mount configurations may be produced on request.

QUICK REFERENCE DATA

Typical gain at 2.0 kV		5.0×10^7	
Typical resistance		1.2×10^8	Ω
Operating voltage	max.	3.0	kV
Ouput current (continuous)	max.	5	μA
Output current for linear gain	max.	2	μA

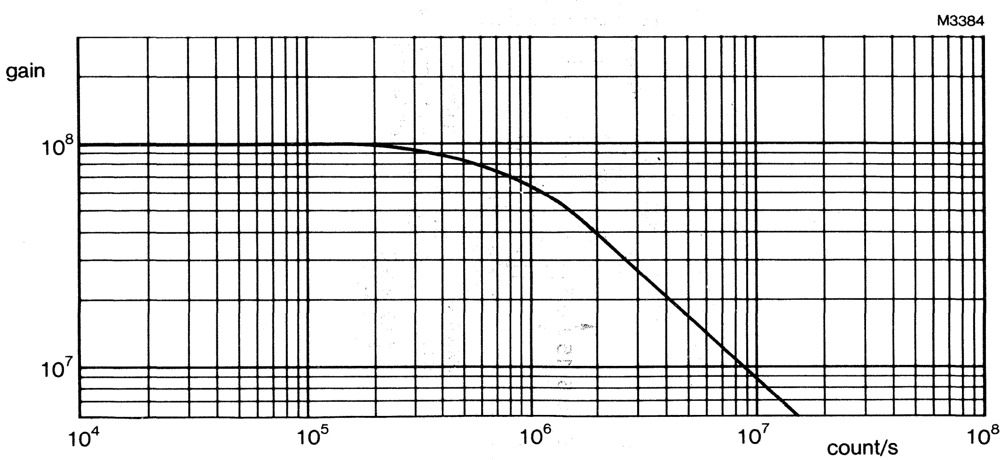
RATINGS

Temperature (operating and storage)	max.	70	°C
Bake temperature in vacuo	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

Note: Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

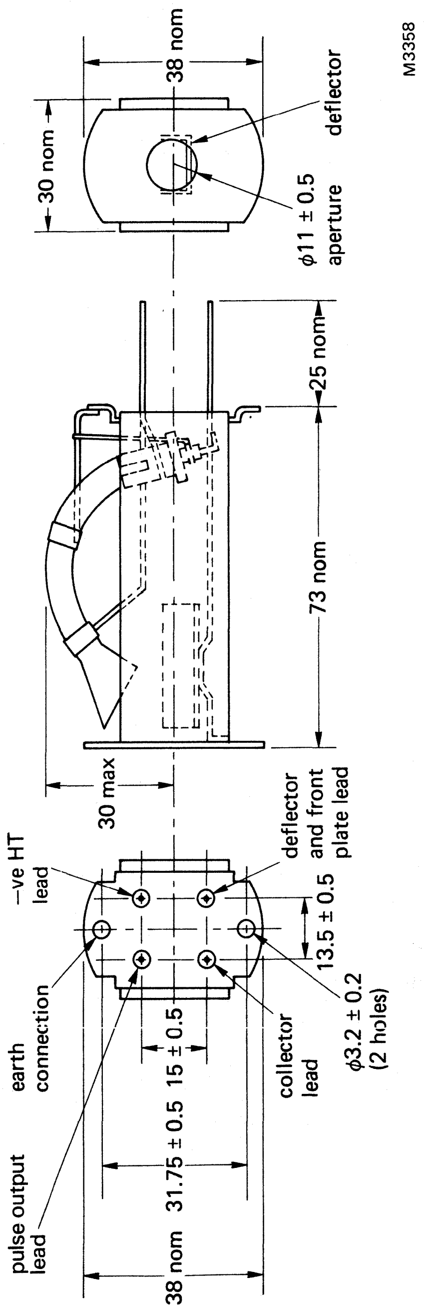
TYPICAL GAIN AS A FUNCTION OF COUNTING RATE

Operating voltage = 2.5 kV



MECHANICAL DATA

Dimensions in mm



SINGLE CHANNEL ELECTRON MULTIPLIERS

Single channel electron multipliers in the form of a glass planar spiral tube.
The X710AL has an open-ended output. To ensure efficient collection of electrons, a collector should be used, biased at 100 to 200 V positive with respect to the multiplier output.
The X710BL has a closed output.

QUICK REFERENCE DATA

Typical gain at 2.5 kV		1.5×10^8	
Typical resistance		3.0×10^8	Ω
Operating voltage	max.	3.5	kV

Unless otherwise stated, data is applicable to both types.
This data should be read in conjunction with GENERAL EXPLANATORY NOTES – SINGLE CHANNEL ELECTRON MULTIPLIERS

CHARACTERISTICS (measured at 2.5 kV and 10 000 pulse/s where applicable)

	Min.	Typ.	Max.	
Resistance	2.0	3.0	4.0	$\times 10^8$ Ω
Gain (note 1)	1.0	1.5	–	$\times 10^8$
Background above an equivalent threshold of 2.0×10^6 electrons	–	0.05	0.20	pulse/s
Starting voltage with an equivalent threshold of 2.0×10^6 electrons	1.4	1.6	1.8	kV
Resolution (F.W.H.M.) at a modal gain of 1.8×10^8	–	50	70	%
Effective input diameter	2.0	2.2	–	mm

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Operating voltage	max.	3.5	kV
Temperature operating and storage	max.	70	°C
Bake temperature in vacuo (note 2)	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

MASS 4.0 g

MOUNTING POSITION

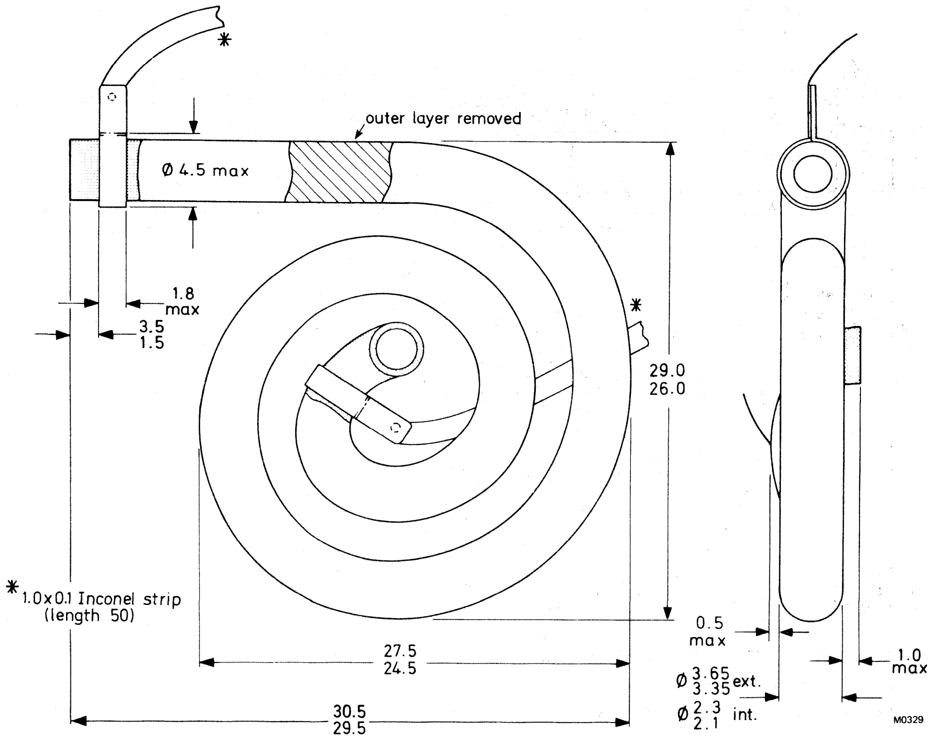
Any. In environments where vibration may be encountered, the device must not be supported by the leads alone.

NOTES

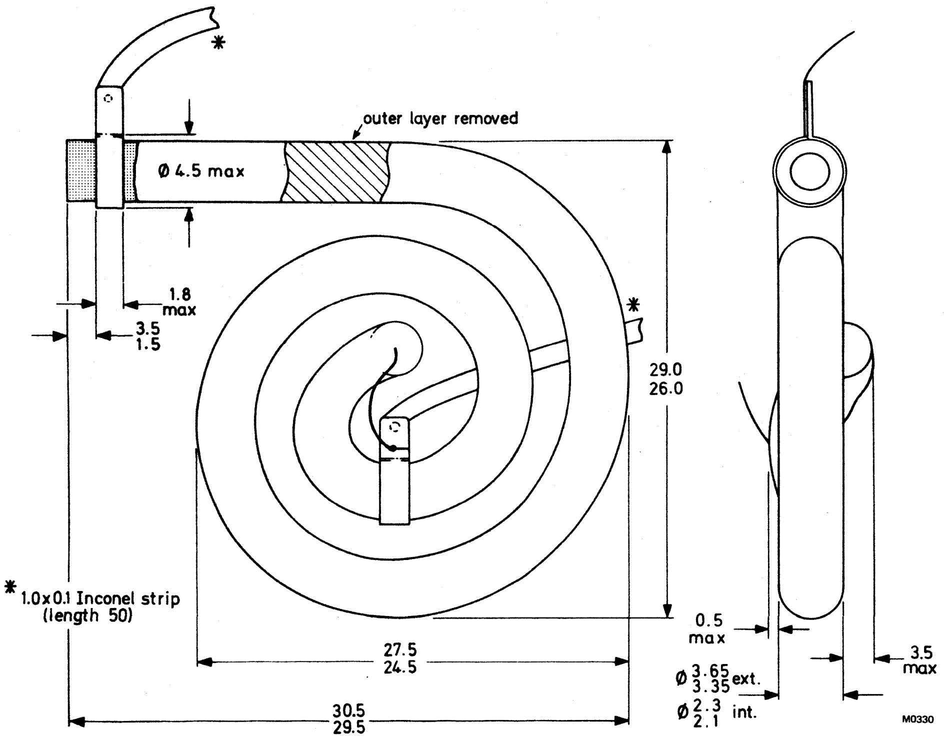
1. The gain of a typical multiplier will increase by a factor of approx. 2 for an increase of operating voltage of 500 V.
2. Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

MECHANICAL DATA X710AL

Dimensions in mm



MECHANICAL DATA X710BL



SINGLE CHANNEL ELECTRON MULTIPLIERS

Single channel electron multipliers in the form of a glass planar spiral tube with a rectangular section input cone 3.5 x 15.5 mm.
The X713AL has an open-ended output. To ensure efficient collection of electrons, a collector should be used, biased at 100 to 200 V positive with respect to the multiplier output.
The X713BL has a closed output.

QUICK REFERENCE DATA

Typical gain at 2.5 kV		1.5×10^8	
Typical resistance		3.0×10^8	Ω
Operating voltage	max.	3.5	kV

Unless otherwise stated, data is applicable to both types.
This data should be read in conjunction with GENERAL EXPLANATORY NOTES – SINGLE CHANNEL ELECTRON MULTIPLIERS

CHARACTERISTICS (measured at 2.5 kV and 10 000 pulse/s where applicable)

	Min.	Typ.	Max.	
Resistance	2.0	3.0	4.0	$\times 10^8$ Ω
Gain (note 1)	1.0	1.5	–	$\times 10^8$
Background above an equivalent threshold of 2.0×10^6 electrons	–	0.05	0.20	pulse/s
Starting voltage with an equivalent threshold of 2.0×10^6 electrons	1.4	1.6	1.8	kV
Resolution (F.W.H.M.) at a modal gain of 1.8×10^8	–	50	70	%
Effective input aperature	3.0 x 14.5	3.5 x 15.5	5.0 x 17	mm

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Operating voltage	max.	3.5	kV
Temperature operating and storage	max.	70	°C
Bake temperature in vacuo (note 2)	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

MASS 4.0 g

MOUNTING POSITION

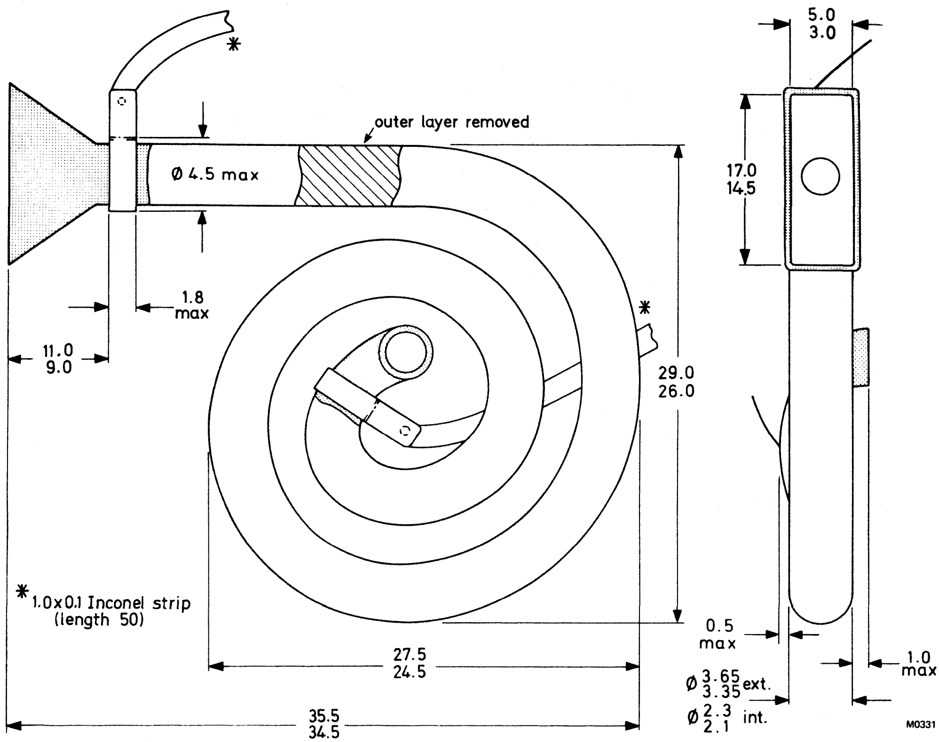
Any. In environments where vibration may be encountered, the device must not be supported by the leads alone.

NOTES

1. The gain of a typical multiplier will increase by a factor of approx. 2 for an increase of operating voltage of 500 V.
2. Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

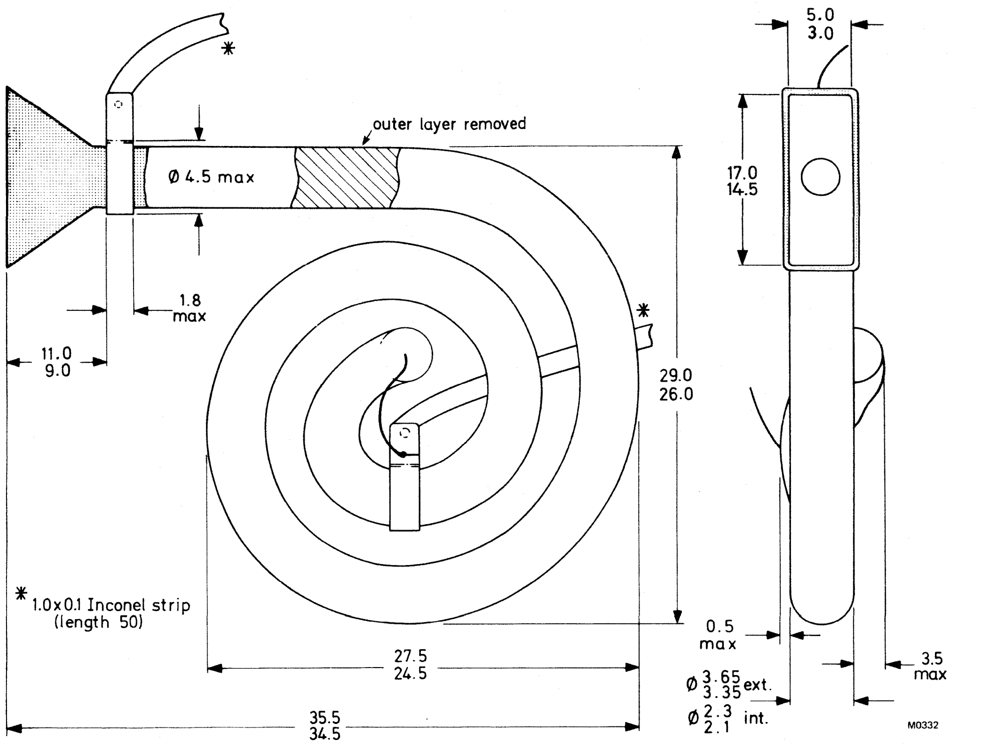
MECHANICAL DATA X713AL

Dimensions in mm



MECHANICAL DATA X713BL

Dimensions in mm



SINGLE CHANNEL ELECTRON MULTIPLIERS

Single channel electron multipliers in the form of a glass planar spiral tube with a rectangular section input cone 3.5 x 15.5 mm.
The X714AL has an open-ended output. To ensure efficient collection of electrons, a collector should be used, biased at 100 to 200 V positive with respect to the multiplier output.
The X714BL has a closed output.

QUICK REFERENCE DATA

Typical gain at 2.5 kV		1.5×10^8	
Typical resistance		3.0×10^8	Ω
Operating voltage	max.	3.5	kV

Unless otherwise stated, data is applicable to both types.
This data should be read in conjunction with GENERAL EXPLANATORY NOTES – SINGLE CHANNEL ELECTRON MULTIPLIERS

CHARACTERISTICS (measured at 2.5 kV and 10 000 pulse/s where applicable)

	Min.	Typ.	Max.	
Resistance	2.0	3.0	4.0	$\times 10^8$ Ω
Gain (note 1)	1.0	1.5	–	$\times 10^8$
Background above an equivalent threshold of 2.0×10^6 electrons	–	0.05	0.20	pulse/s
Starting voltage with an equivalent threshold of 2.0×10^6 electrons	1.4	1.6	1.8	kV
Resolution (F.W.H.M.) at a modal gain of 1.8×10^8	–	50	70	%
Effective input aperture	3.0 x 14.5	3.5 x 15.5	5.0 x 17	mm

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Operating voltage	max.	3.5	kV
Temperature operating and storage	max.	70	°C
Bake temperature in vacuo (note 2)	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

MASS 4.0 g

MOUNTING POSITION

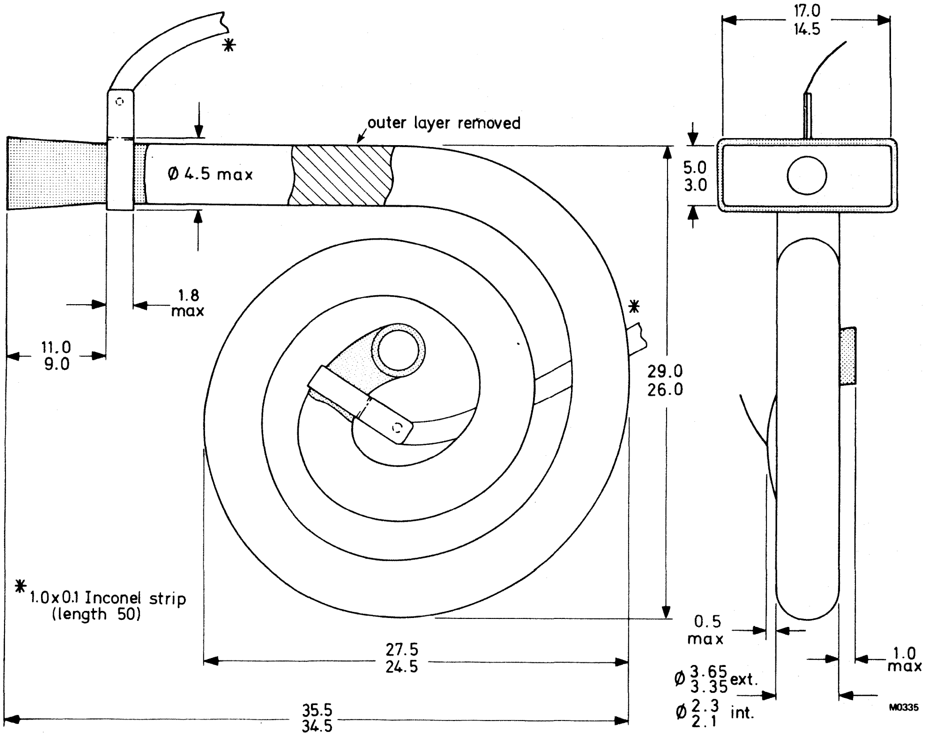
Any. In environments where vibration may be encountered, the device must not be supported by the leads alone.

NOTES

1. The gain of a typical multiplier will increase by a factor of approx. 2 for an increase of operating voltage of 500 V.
2. Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

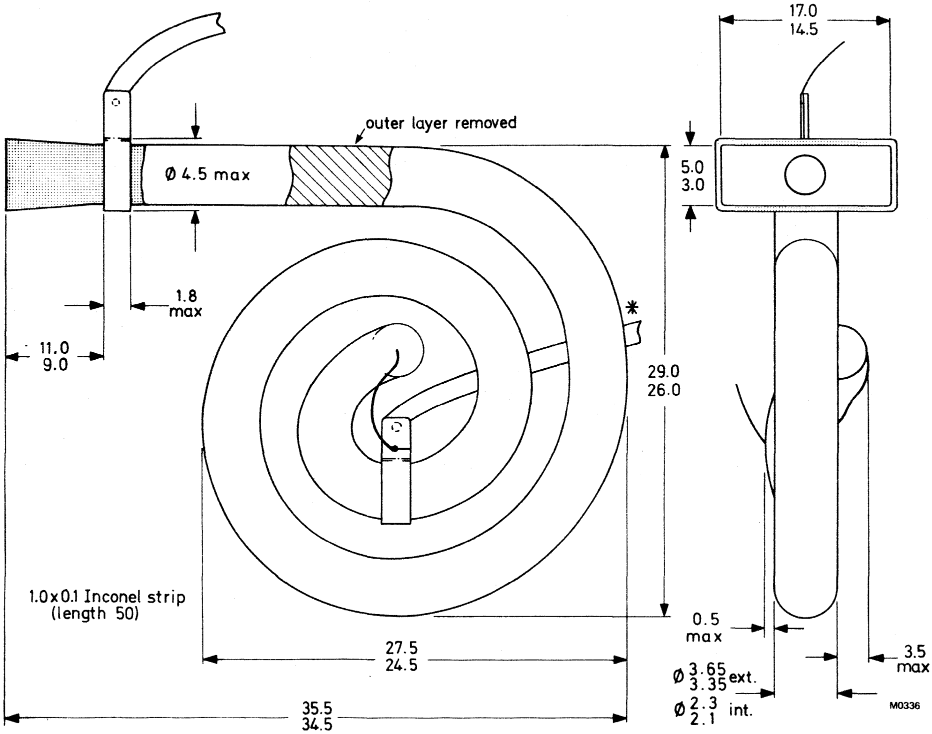
MECHANICAL DATA X714AL

Dimensions in mm



MECHANICAL DATA X714BL

Dimensions in mm



SINGLE CHANNEL ELECTRON MULTIPLIERS

Single channel electron multipliers in the form of a glass planar spiral tube with a 10 mm diameter input cone.
The X719AL has an open-ended output. To ensure efficient collection of electrons, a collector should be used, biased at 100 to 200 V positive with respect to the multiplier output.
The X719BL has a closed output.

QUICK REFERENCE DATA

Typical gain at 2.5 kV		1.5×10^8	
Typical resistance		3.0×10^8	Ω
Operating voltage	max.	3.5	kV

Unless otherwise stated, data is applicable to both types.
This data should be read in conjunction with GENERAL EXPLANATORY NOTES – SINGLE CHANNEL ELECTRON MULTIPLIERS

CHARACTERISTICS (measured at 2.5 kV and 10 000 pulse/s where applicable)

	Min.	Typ.	Max.	
Resistance	2.0	3.0	4.0	$\times 10^8$ Ω
Gain (note 1)	1.0	1.5	–	$\times 10^8$
Background above an equivalent threshold of 2.0×10^6 electrons	–	0.05	0.20	pulse/s
Starting voltage with an equivalent threshold of 2.0×10^6 electrons	1.4	1.6	1.8	kV
Resolution (F.W.H.M.) at a modal gain of 1.8×10^8	–	50	70	%
Effective input diameter	9.0	10	–	mm

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Operating voltage	max.	3.5	kV
Temperature operating and storage	max.	70	°C
Bake temperature in vacuo (note 2)	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

MASS 4.0 g

MOUNTING POSITION

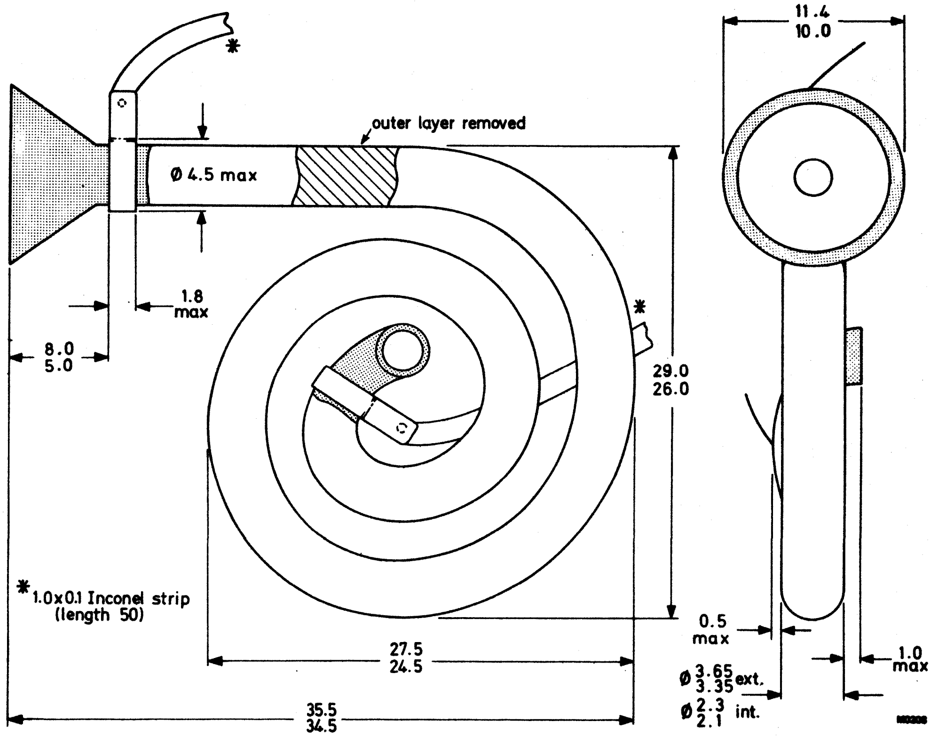
Any. In environments where vibration may be encountered, the device must not be supported by the leads alone.

NOTES

1. The gain of a typical multiplier will increase by a factor of approx. 2 for an increase of operating voltage of 500 V.
2. Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

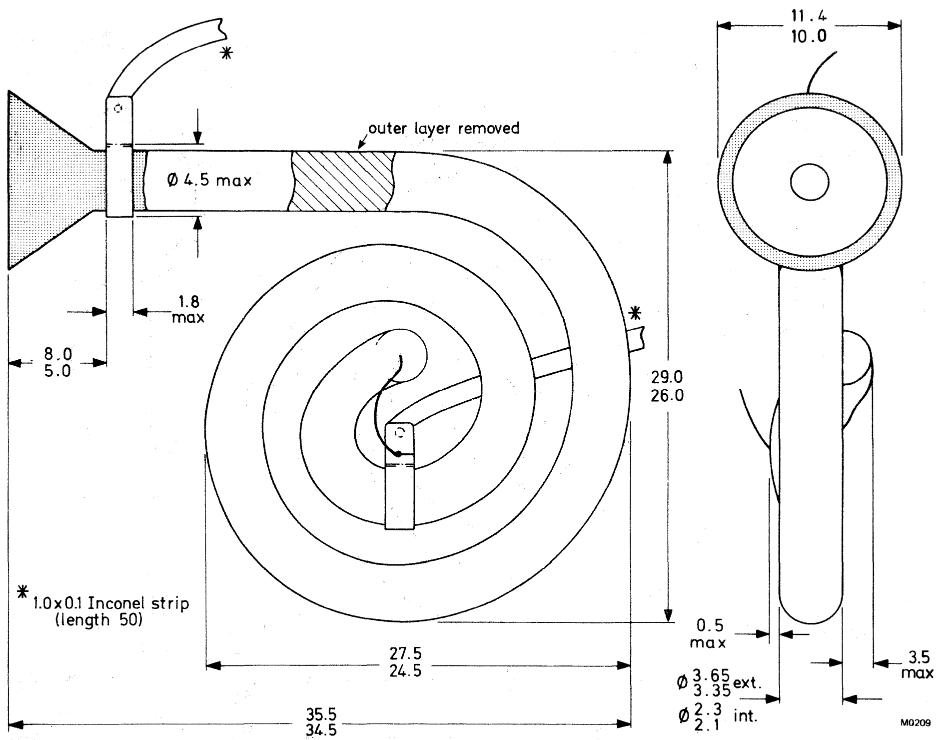
MECHANICAL DATA X719AL

Dimensions in mm



MECHANICAL DATA X719BL

Dimensions in mm



SINGLE CHANNEL ELECTRON MULTIPLIERS

Single channel electron multipliers in the form of a glass planar spiral tube.
The X810AL has an open-ended output. To ensure efficient collection of electrons, a collector should be used, biased at 100 to 200 V positive with respect to the multiplier output.
The X810BL has a closed output.
Alternative output configurations may be considered on request.

QUICK REFERENCE DATA

Typical gain at 2.5 kV		1.2×10^8	
Typical resistance		6.0×10^8	Ω
Operating voltage	max.	3.5	kV

This data should be read in conjunction with GENERAL EXPLANATORY NOTES – SINGLE CHANNEL ELECTRON MULTIPLIERS

CHARACTERISTICS (measured at 2.5 kV and 10 000 pulse/s where applicable)

	Min.	Typ.	Max.	
Resistance	4.0	6.0	8.0	$\times 10^8$ Ω
Gain (note 1)	0.8	1.2	–	$\times 10^8$
Background above an equivalent threshold of 2.0×10^6 electrons	–	0.05	0.20	pulse/s
Starting voltage with an equivalent threshold of 2.0×10^6 electrons	1.2	1.6	2.0	kV
Resolution (F.W.H.M.) at a modal gain of 10^8	–	40	70	%
Effective input diameter	1.1	1.25	–	mm

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Operating voltage	max.	3.5	kV
Temperature, operating and storage	max.	70	°C
Bake temperature in vacuo (note 2)	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

MASS 1.0 g

MOUNTING POSITION

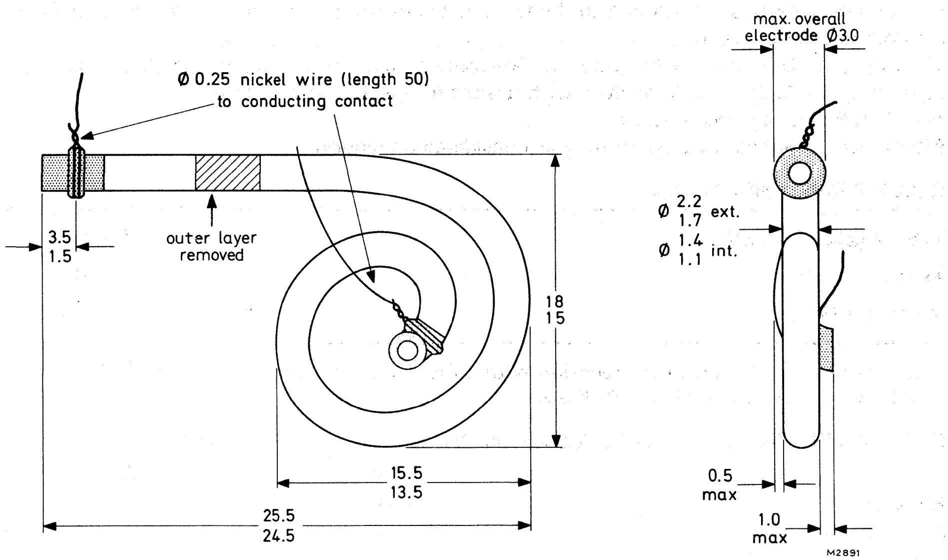
Any. In environments where vibration may be encountered, the device must not be supported by the leads alone.

NOTES

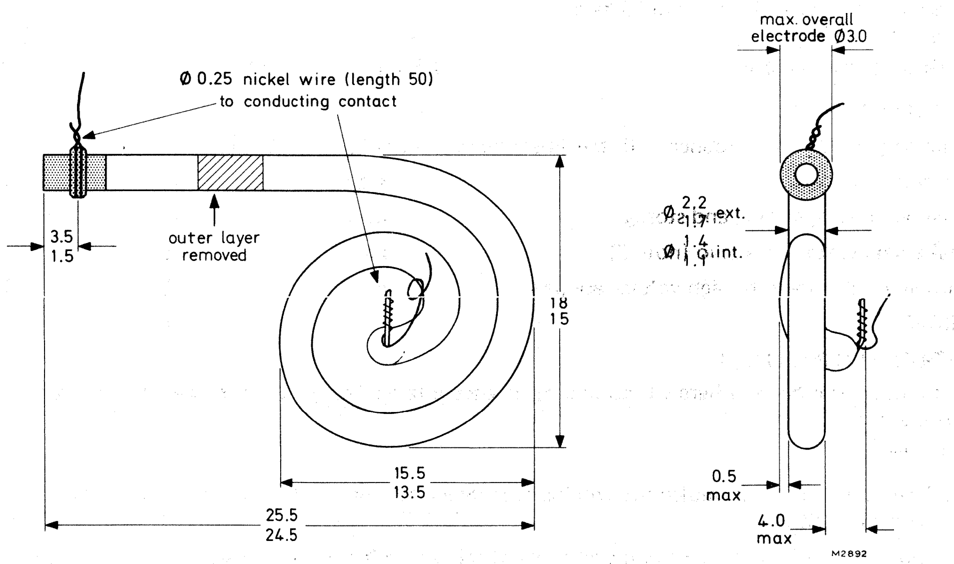
1. The gain of a typical multiplier will increase by a factor of approx. 2 for an increase of operating voltage of 500 V.
2. Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

MECHANICAL DATA Dimensions in mm

X810AL



X810BL



SINGLE CHANNEL ELECTRON MULTIPLIERS

Single channel electron multipliers in the form of a glass planar spiral tube with a rectangular section input cone 2.0 x 8.0 mm.
The X812AL has an open-ended output. To ensure efficient collection of electrons, a collector should be used, biased at 100 to 200 V positive with respect to the multiplier output.
The X812BL has a closed output.
Alternative output configurations may be considered on request.

QUICK REFERENCE DATA

Typical gain at 2.5 kV		1.5×10^8	
Typical resistance		6.0×10^8	Ω
Operating voltage	max.	3.5	kV

This data should be read in conjunction with GENERAL EXPLANATORY NOTES – SINGLE CHANNEL ELECTRON MULTIPLIERS

CHARACTERISTICS (measured at 2.5 kV and 10 000 pulse/s where applicable)

	Min.	Typ.	Max.	
Resistance	4.0	6.0	8.0	$\times 10^8$ Ω
Gain (note 1)	1.0	1.5	–	$\times 10^8$
Background above an equivalent threshold of 2.0×10^6 electrons	–	0.05	0.20	pulse/s
Starting voltage with an equivalent threshold of 2.0×10^6 electrons	1.2	1.6	2.0	kV
Resolution (F.W.H.M.) at a modal gain of 5.0×10^7	–	40	70	%
Effective input aperture	1.5 x 7.5	2.0 x 8.0	–	mm

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Operating voltage	max.	3.5	kV
Temperature operating and storage	max.	70	°C
Bake temperature in vacuo (note 2)	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$
MASS		1.0	g

MOUNTING POSITION

Any. In environments where vibration may be encountered, the device must not be supported by the leads alone.

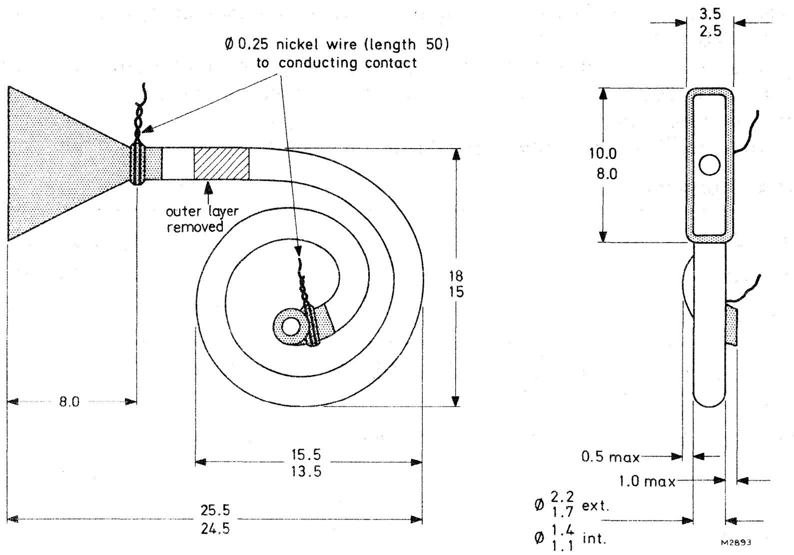
NOTES

1. The gain of a typical multiplier will increase by a factor of approx. 2 for an increase of operating voltage of 500 V.
2. Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

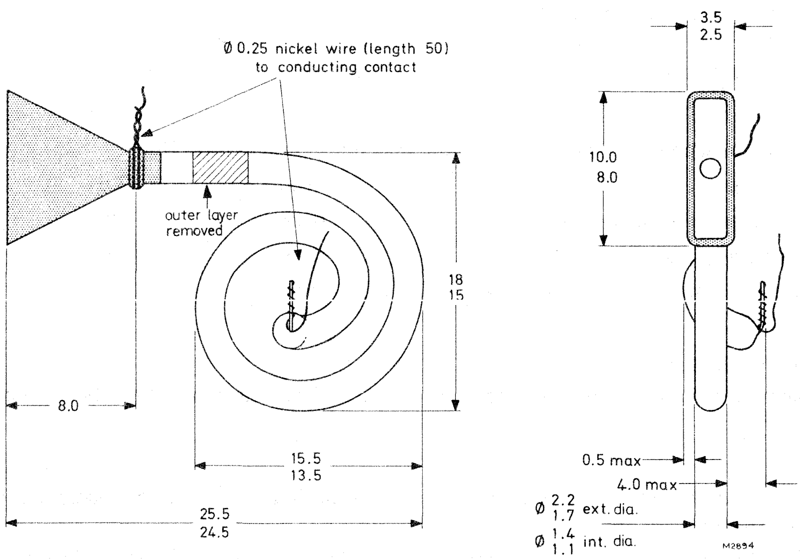
MECHANICAL DATA

Dimensions in mm

X812AL



X812BL



SINGLE CHANNEL ELECTRON MULTIPLIERS

Single channel electron multipliers in the form of a glass planar spiral tube with a rectangular section input cone 2.0 x 8.0 mm.
The X814AL has an open-ended output. To ensure efficient collection of electrons, a collector should be used, biased at 100 to 200 V positive with respect to the multiplier output.
The X814BL has a closed output.
Alternative output configurations may be considered on request.

QUICK REFERENCE DATA

Typical gain at 2.5 kV		1.5×10^8	
Typical resistance		6.0×10^8	Ω
Operating voltage	max.	3.5	kV

This data should be read in conjunction with GENERAL EXPLANATORY NOTES – SINGLE CHANNEL ELECTRON MULTIPLIERS

CHARACTERISTICS (measured at 2.5 kV and 10 000 pulse/s where applicable)

	Min.	Typ.	Max.	
Resistance	4.0	6.0	8.0	$\times 10^8$ Ω
Gain (note 1)	1.0	1.5	–	$\times 10^8$
Background above an equivalent threshold of 2.0×10^6 electrons	–	0.05	0.20	pulse/s
Starting voltage with an equivalent threshold of 2.0×10^6 electrons	1.2	1.6	2.0	kV
Resolution (F.W.H.M.) at a modal gain of 5.0×10^7	–	40	70	%
Effective input aperture	1.5 x 7.5	2.0 x 8.0	–	mm

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Operating voltage	max.	3.5	kV
Temperature operating and storage	max.	70	°C
Bake temperature in vacuo (note 2)	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

MASS

1.0 g

MOUNTING POSITION

Any. In environments where vibration may be encountered, the device must not be supported by the leads alone.

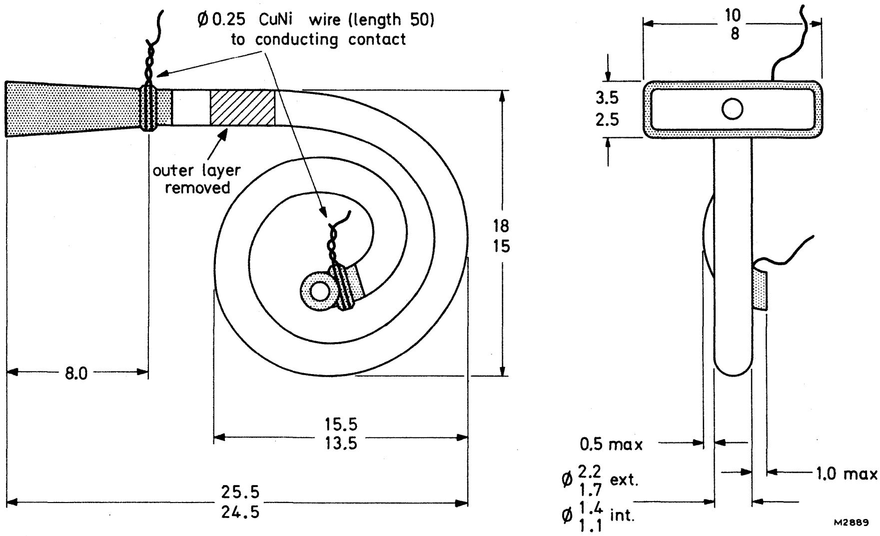
NOTES

1. The gain of a typical multiplier will increase by a factor of approx. 2 for an increase of operating voltage of 500 V.
2. Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

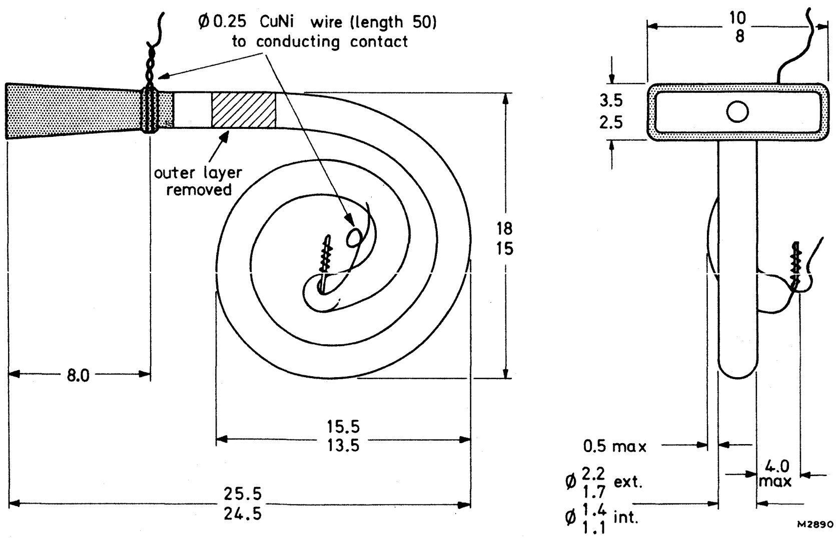
MECHANICAL DATA

Dimensions in mm

X814AL



X814BL



SINGLE CHANNEL ELECTRON MULTIPLIERS

Single channel electron multipliers in the form of a glass planar spiral tube with a 5.0 mm diameter input cone.
The X818AL has an open-ended output. To ensure efficient collection of electrons, a collector should be used, biased at 100 to 200 V positive with respect to the multiplier output.
The X818BL has a closed output.
Alternative output configurations may be considered on request.

QUICK REFERENCE DATA

Typical gain at 2.5 kV		1.5×10^8	
Typical resistance		6.0×10^8	Ω
Operating voltage	max.	3.5	kV

This data should be read in conjunction with GENERAL EXPLANATORY NOTES – SINGLE CHANNEL ELECTRON MULTIPLIERS

CHARACTERISTICS (measured at 2.5 kV and 10 000 pulse/s where applicable)

	Min.	Typ.	Max.	
Resistance	4.0	6.0	8.0	$\times 10^8$ Ω
Gain (note 1)	1.0	1.5	–	$\times 10^8$
Background above an equivalent threshold of 2.0×10^6 electrons	–	0.05	0.2	pulse/s
Starting voltage with an equivalent threshold of 2.0×10^6 electrons	1.2	1.6	2.0	kV
Resolution (F.W.H.M.) at a modal gain of 5.0×10^7	–	40	70	%
Effective input diameter	4.0	5.0	–	mm

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Operating voltage	max.	3.5	kV
Temperature operating and storage	max.	70	°C
Bake temperature in vacuo (note 2)	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

MASS 1.0 g

MOUNTING POSITION

Any. In environments where vibration may be encountered, the device must not be supported by the leads alone.

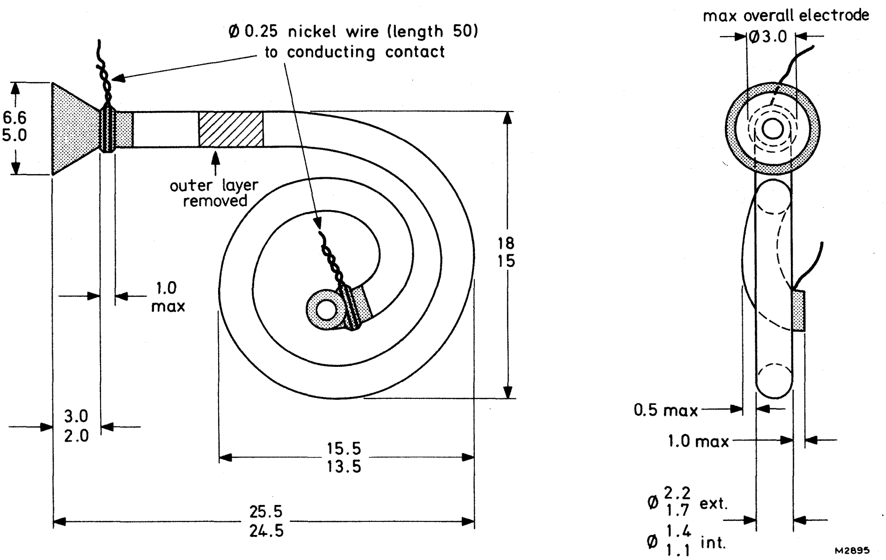
NOTES

1. The gain of a typical multiplier will increase by a factor of approx. 2 for an increase of operating voltage of 500 V.
2. Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

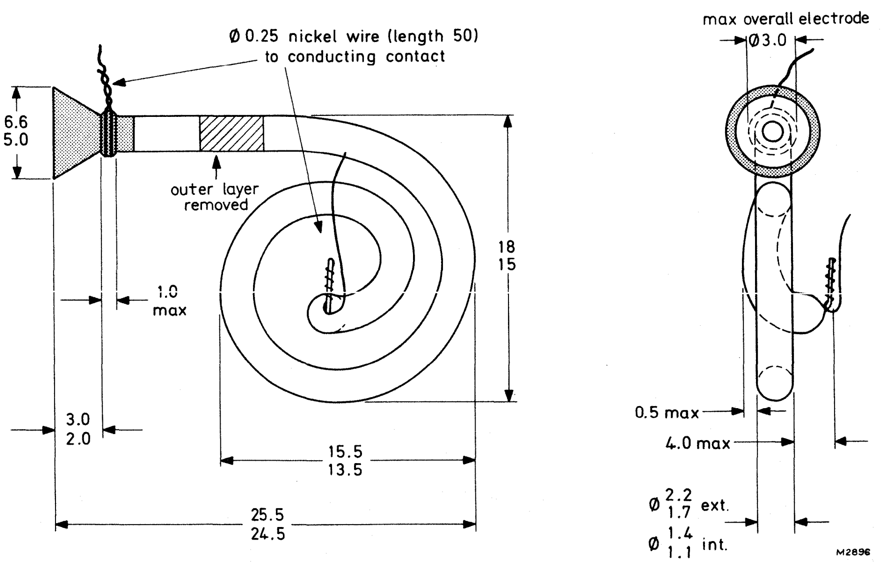
MECHANICAL DATA

Dimensions in mm

X818A'



X818BL



SINGLE CHANNEL ELECTRON MULTIPLIERS

Single channel electron multipliers in the form of a glass planar spiral tube.
The X910AL has an open-ended output. To ensure efficient collection of electrons, a collector should be used, biased at 100 to 200 V positive with respect to the multiplier output.
The X910BL has a closed output.

QUICK REFERENCE DATA

Typical gain at 2.5 kV		1.5×10^8	
Typical resistance		6.0×10^8	Ω
Operating voltage	max.	4.0	kV

Unless otherwise stated, data is applicable to both types.
This data should be read in conjunction with GENERAL EXPLANATORY NOTES – SINGLE CHANNEL ELECTRON MULTIPLIERS

CHARACTERISTICS (measured at 2.5 kV and 10 000 pulse/s where applicable)

	Min.	Typ.	Max.	
Resistance	4.0	6.0	8.0	$\times 10^8$ Ω
Gain (note 1)	1.0	1.5	–	$\times 10^8$
Background above an equivalent threshold of 2.0×10^6 electrons	–	0.05	0.20	pulse/s
Starting voltage with an equivalent threshold of 2.0×10^6 electrons	1.4	1.6	1.8	kV
Resolution (F.W.H.M.) at a modal gain of 1.8×10^8	–	50	70	%
Effective input diameter	2.0	2.2	–	mm

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Operating voltage	max.	4.0	kV
Temperature operating and storage	max.	70	°C
Bake temperature in vacuo (note 2)	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

MASS	4.0	g

MOUNTING POSITION

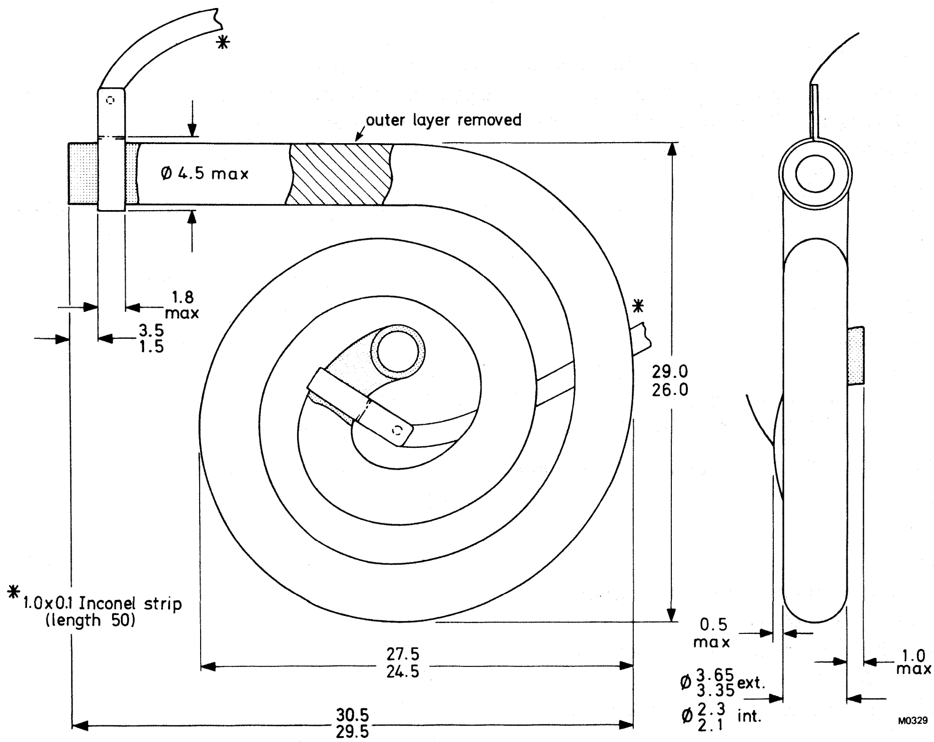
Any. In environments where vibration may be encountered, the device must not be supported by the leads alone.

NOTES

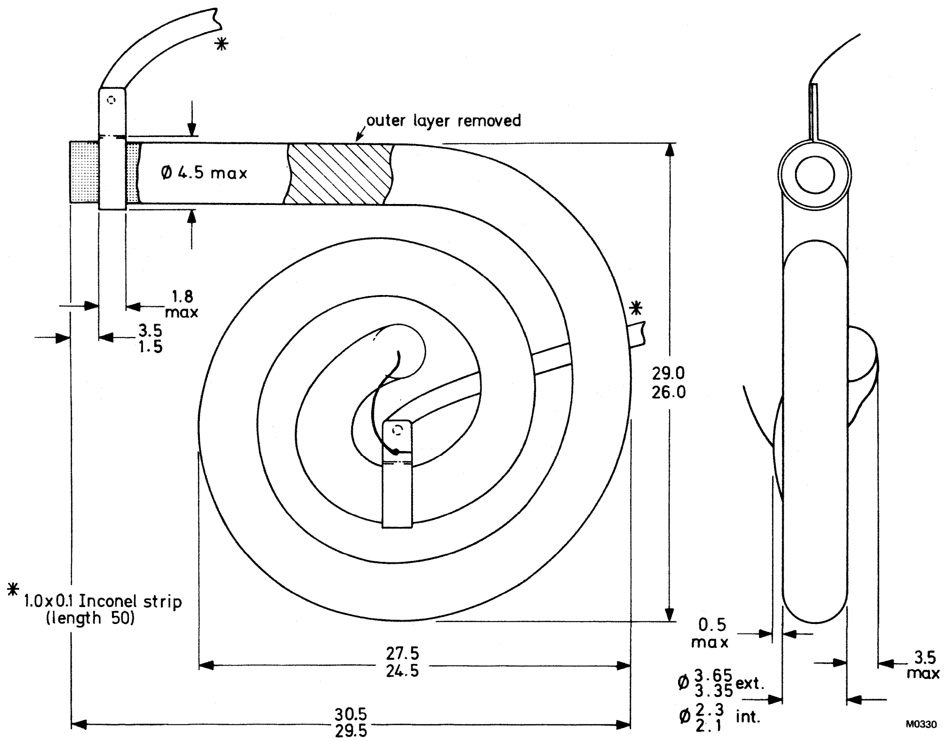
1. The gain of a typical multiplier will increase by a factor of approx. 2 for an increase of operating voltage of 500 V.
2. Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

MECHANICAL DATA X910AL

Dimensions in mm



MECHANICAL DATA X910BL



SINGLE CHANNEL ELECTRON MULTIPLIERS

Single channel electron multipliers in the form of a glass planar spiral tube with a rectangular section input cone 3.5 x 15.5 mm.
The X913AL has an open-ended output. To ensure efficient collection of electrons, a collector should be used, biased at 100 to 200 V positive with respect to the multiplier output.
The X913BL has a closed output.

QUICK REFERENCE DATA

Typical gain at 2.5 kV		1.5×10^8	
Typical resistance		6.0×10^8	Ω
Operating voltage	max.	4.0	kV

Unless otherwise stated, data is applicable to both types.
This data should be read in conjunction with GENERAL EXPLANATORY NOTES – SINGLE CHANNEL ELECTRON MULTIPLIERS

CHARACTERISTICS (measured at 2.5 kV and 10 000 pulse/s where applicable)

	Min.	Typ.	Max.	
Resistance	4.0	6.0	8.0	$\times 10^8$ Ω
Gain (note 1)	1.0	1.5	–	$\times 10^8$
Background above an equivalent threshold of 2.0×10^6 electrons	–	0.05	0.20	pulse/s
Starting voltage with an equivalent threshold of 2.0×10^6 electrons	1.4	1.6	1.8	kV
Resolution (F.W.H.M.) at a modal gain of 1.8×10^8	–	50	70	%
Effective input aperature	3.0 x 14.5	3.5 x 15.5	5.0 x 17	mm

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Operating voltage	max.	4.0	kV
Temperature operating and storage	max.	70	°C
Bake temperature in vacuo (note 2)	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

MASS 4.0 g

MOUNTING POSITION

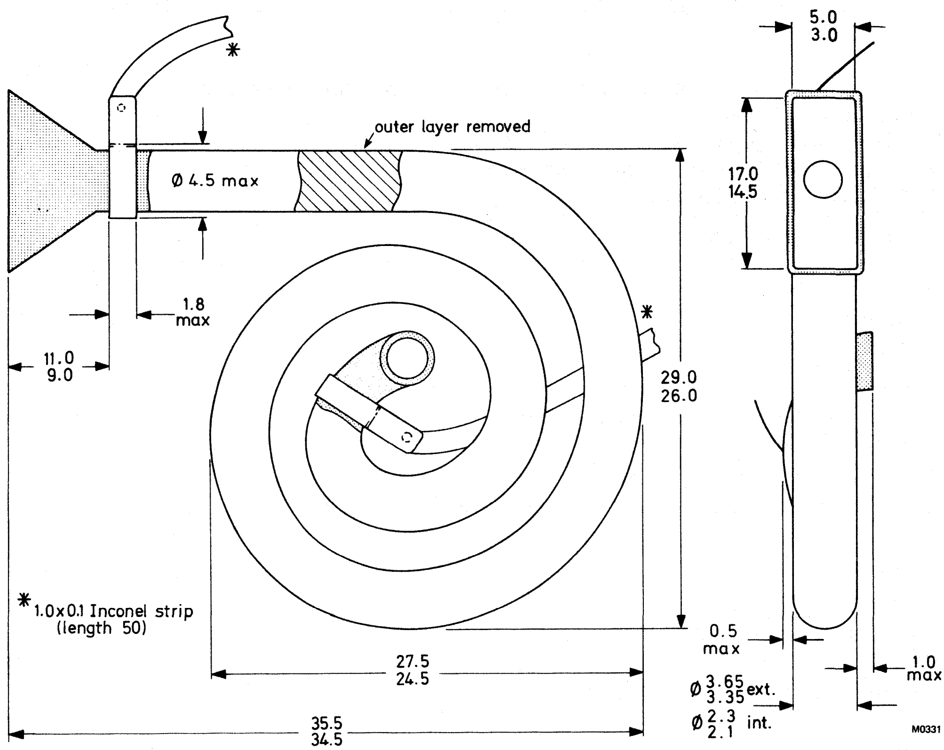
Any. In environments where vibration may be encountered, the device must not be supported by the leads alone.

NOTES

1. The gain of a typical multiplier will increase by a factor of approx. 2 for an increase of operating voltage of 500 V.
2. Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

MECHANICAL DATA X913AL

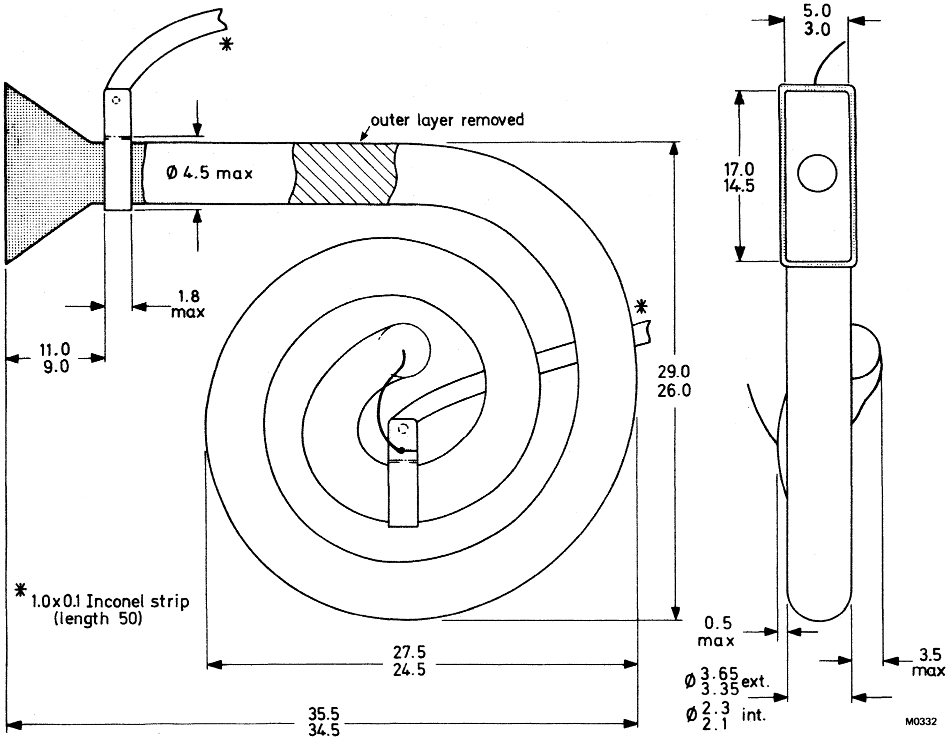
Dimensions in mm



* 1.0 x 0.1 Inconel strip (length 50)

MECHANICAL DATA X913BL

Dimensions in mm



SINGLE CHANNEL ELECTRON MULTIPLIERS

Single channel electron multipliers in the form of a glass planar spiral tube with a rectangular section input cone 3.5 x 15.5 mm.
The X914AL has an open-ended output. To ensure efficient collection of electrons, a collector should be used, biased at 100 to 200 V positive with respect to the multiplier output.
The X914BL has a closed output.

QUICK REFERENCE DATA

Typical gain at 2.5 kV		1.5×10^8	
Typical resistance		6.0×10^8	Ω
Operating voltage	max.	4.0	kV

Unless otherwise stated, data is applicable to both types.
This data should be read in conjunction with GENERAL EXPLANATORY NOTES – SINGLE CHANNEL ELECTRON MULTIPLIERS

CHARACTERISTICS (measured at 2.5 kV and 10 000 pulse/s where applicable)

	Min.	Typ.	Max.	
Resistance	4.0	6.0	8.0	$\times 10^8$ Ω
Gain (note 1)	1.0	1.5	–	$\times 10^8$
Background above an equivalent threshold of 2.0×10^6 electrons	–	0.05	0.20	pulse/s
Starting voltage with an equivalent threshold of 2.0×10^6 electrons	1.4	1.6	1.8	kV
Resolution (F.W.H.M.) at a modal gain of 1.8×10^8	–	50	70	%
Effective input aperture	3.0 x 14.5	3.5 x 15.5	5.0 x 17	mm

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Operating voltage	max.	4.0	kV
Temperature operating and storage	max.	70	°C
Bake temperature in vacuo (note 2)	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

MASS

4.0 g

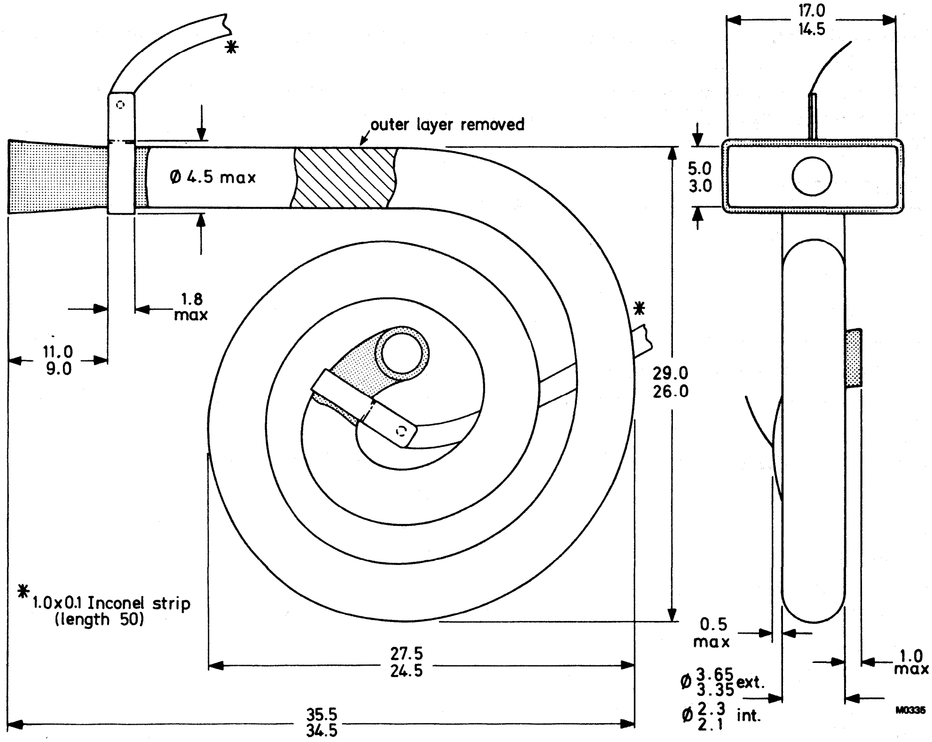
MOUNTING POSITION

Any. In environments where vibration may be encountered, the device must not be supported by the leads alone.

NOTES

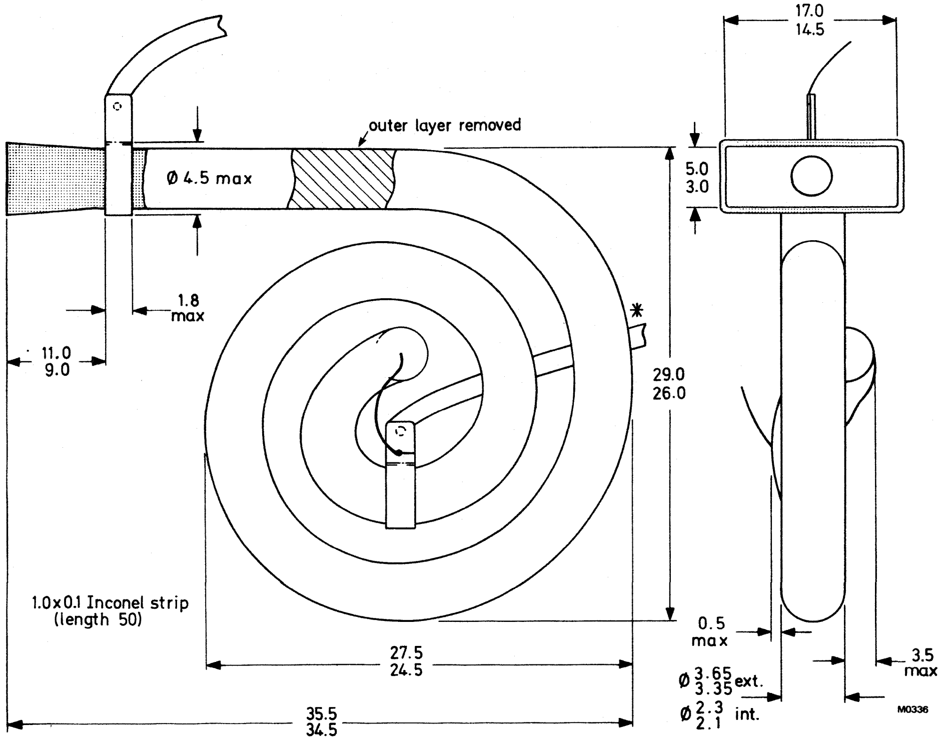
1. The gain of a typical multiplier will increase by a factor of approx. 2 for an increase of operating voltage of 500 V.
2. Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

MECHANICAL DATA X914AL Dimensions in mm



MECHANICAL DATA X914BL

Dimensions in mm



SINGLE CHANNEL ELECTRON MULTIPLIERS

Single channel electron multipliers in the form of a glass planar spiral tube with a 10 mm diameter input cone.
The X919AL has an open-ended output. To ensure efficient collection of electrons, a collector should be used, biased at 100 to 200 V positive with respect to the multiplier output.
The X919BL has a closed output.

QUICK REFERENCE DATA

Typical gain at 2.5 kV		1.5×10^8	
Typical resistance		6.0×10^8	Ω
Operating voltage	max.	4.0	kV

Unless otherwise stated, data is applicable to both types.
This data should be read in conjunction with GENERAL EXPLANATORY NOTES – SINGLE CHANNEL ELECTRON MULTIPLIERS

CHARACTERISTICS (measured at 2.5 kV and 10 000 pulse/s where applicable)

	Min.	Typ.	Max.	
Resistance	4.0	6.0	8.0	$\times 10^8$ Ω
Gain (note 1)	1.0	1.5	–	$\times 10^8$
Background above an equivalent threshold of 2.0×10^6 electrons	–	0.05	0.20	pulse/s
Starting voltage with an equivalent threshold of 2.0×10^6 electrons	1.4	1.6	1.8	kV
Resolution (F.W.H.M.) at a modal gain of 1.8×10^8	–	50	70	%
Effective input diameter	9.0	10	–	mm

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Operating voltage	max.	4.0	kV
Temperature operating and storage	max.	70	°C
Bake temperature in vacuo (note 2)	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

MASS 4.0 g

MOUNTING POSITION

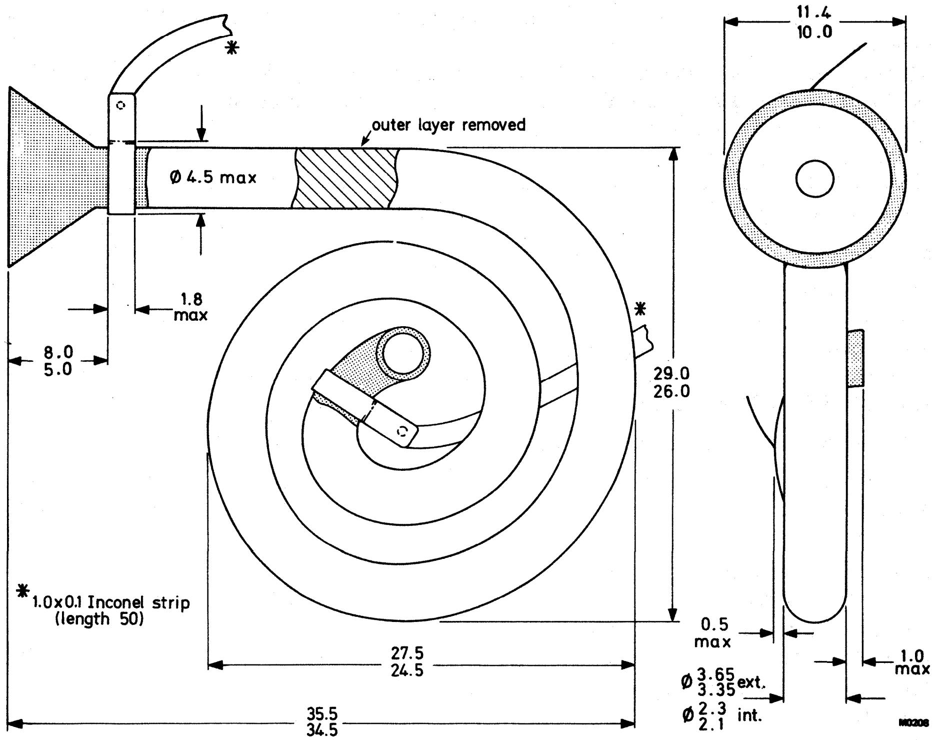
Any. In environments where vibration may be encountered, the device must not be supported by the leads alone.

NOTES

1. The gain of a typical multiplier will increase by a factor of approx. 2 for an increase of operating voltage of 500 V.
2. Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

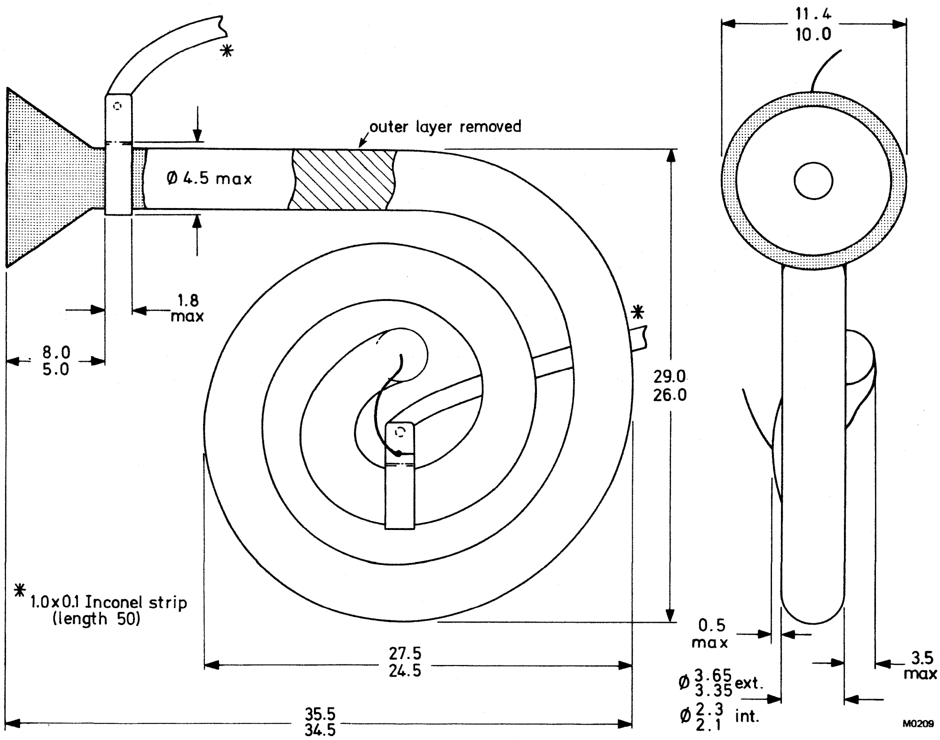
MECHANICAL DATA X919AL

Dimensions in mm



MECHANICAL DATA X919BL

Dimensions in mm



SINGLE CHANNEL ELECTRON MULTIPLIERS

Single channel electron multipliers in the form of a glass planar spiral tube with a 20 mm diameter input cone.
The X951AL has an open-ended output. To ensure efficient collection of electrons, a collector should be used, biased at 100 to 200 V positive with respect to the multiplier output.
The X951BL has a closed output.

QUICK REFERENCE DATA

Typical gain at 2.5 kV		1.5×10^8	
Typical resistance		6.0×10^8	Ω
Operating voltage	max.	4.0	kV

Unless otherwise stated, data is applicable to both types.
This data should be read in conjunction with GENERAL EXPLANATORY NOTES – SINGLE CHANNEL ELECTRON MULTIPLIERS

CHARACTERISTICS (measured at 2.5 kV and 10 000 pulse/s where applicable)

	Min.	Typ.	Max.	
Resistance	4.0	6.0	8.0	$\times 10^8$ Ω
Gain (note 1)	1.0	1.5	–	$\times 10^8$
Background above an equivalent threshold of 2.0×10^6 electrons	–	0.05	0.20	pulse/s
Starting voltage with an equivalent threshold of 2.0×10^6 electrons	1.4	1.6	1.8	kV
Resolution (F.W.H.M.) at a modal gain of 1.8×10^8	–	50	70	%
Effective input diameter	18	19	–	mm

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Operating voltage	max.	4.0	kV
Temperature operating and storage	max.	70	°C
Bake temperature in vacuo (note 2)	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

MASS 4.0 g

MOUNTING POSITION

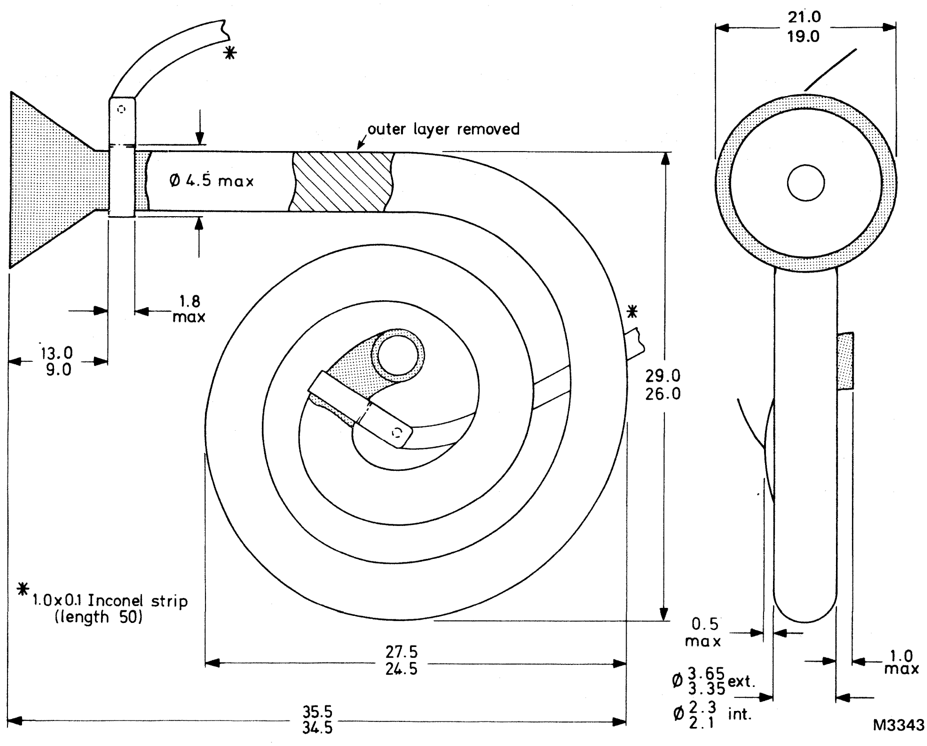
Any. In environments where vibration may be encountered, the device must not be supported by the leads alone.

NOTES

1. The gain of a typical multiplier will increase by a factor of approx. 2 for an increase of operating voltage of 500 V.
2. Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

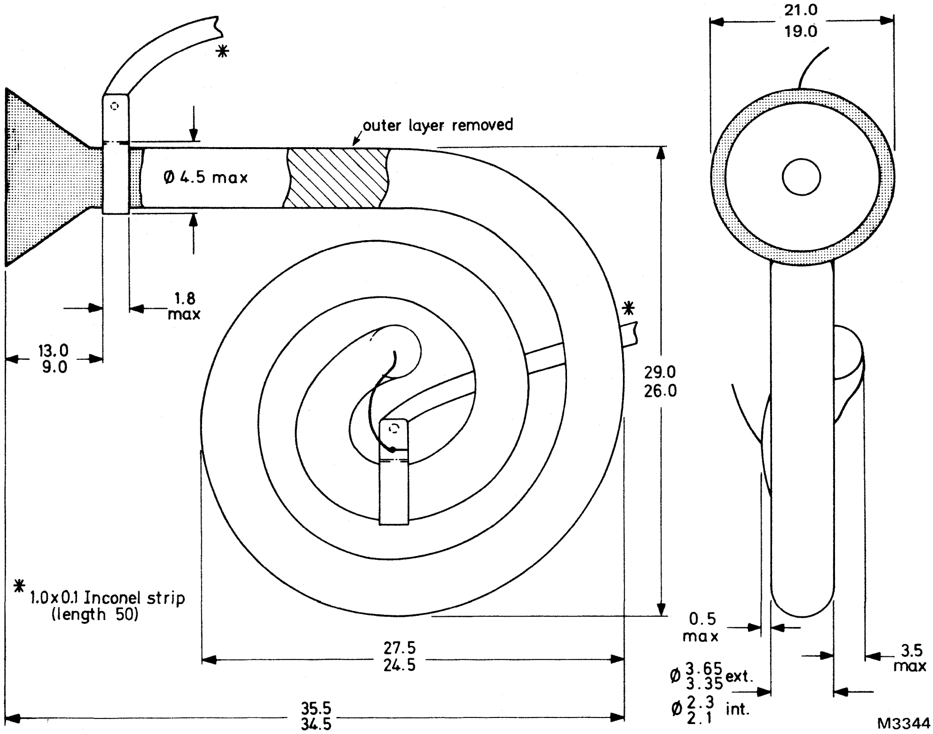
MECHANICAL DATA X951AL

Dimensions in mm



MECHANICAL DATA X951BL

Dimensions in mm



SINGLE CHANNEL ELECTRON MULTIPLIERS

Single channel electron multipliers in the form of a glass planar spiral tube with a 13 mm diameter input cone.
The X955AL has an open-ended output. To ensure efficient collection of electrons, a collector should be used, biased at 100 to 200 V positive with respect to the multiplier output.
The X955BL has a closed output.

QUICK REFERENCE DATA

Typical gain at 2.5 kV		1.5×10^8	
Typical resistance		6.0×10^8	Ω
Operating voltage	max.	4.0	kV

Unless otherwise stated, data is applicable to both types.
This data should be read in conjunction with GENERAL EXPLANATORY NOTES – SINGLE CHANNEL ELECTRON MULTIPLIERS

CHARACTERISTICS (measured at 2.5 kV and 10 000 pulse/s where applicable)

	Min.	Typ.	Max.	
Resistance	4.0	6.0	8.0	$\times 10^8$ Ω
Gain (note 1)	1.0	1.5	–	$\times 10^8$
Background above an equivalent threshold of 2.0×10^6 electrons	–	0.05	0.20	pulse/s
Starting voltage with an equivalent threshold of 2.0×10^6 electrons	1.4	1.6	1.8	kV
Resolution (F.W.H.M.) at a modal gain of 1.8×10^8	–	50	70	%
Effective input diameter	12.0	13.0	–	mm

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Operating voltage	max.	4.0	kV
Temperature operating and storage	max.	70	°C
Bake temperature in vacuo (note 2)	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

MASS 4.0 g

MOUNTING POSITION

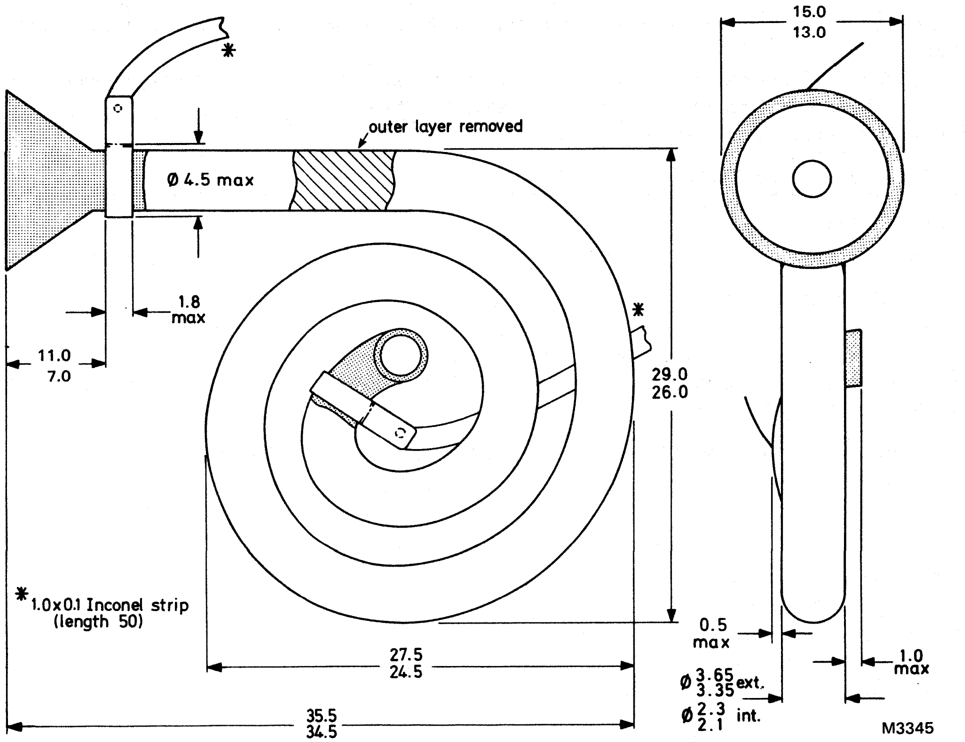
Any. In environments where vibration may be encountered, the device must not be supported by the leads alone.

NOTES

1. The gain of a typical multiplier will increase by a factor of approx. 2 for an increase of operating voltage of 500 V.
2. Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

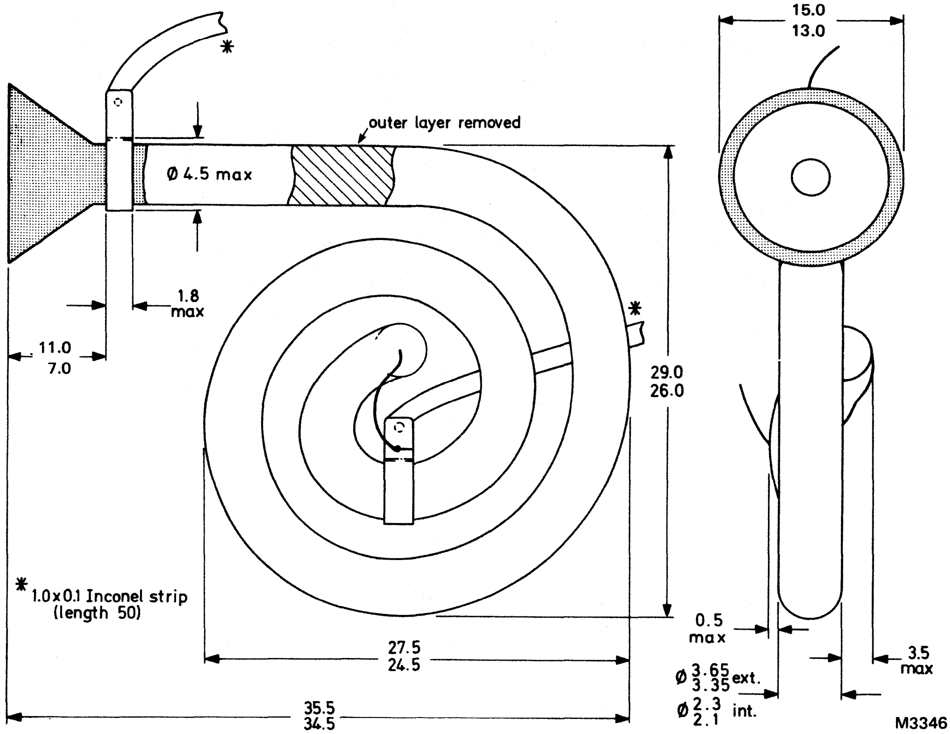
MECHANICAL DATA X955AL

Dimensions in mm



MECHANICAL DATA X955BL

Dimensions in mm



SINGLE CHANNEL ELECTRON MULTIPLIERS

Single channel electron multipliers in the form of a glass planar spiral tube with a 15 mm diameter input cone.
The X959AL has an open-ended output. To ensure efficient collection of electrons, a collector should be used, biased at 100 to 200 V positive with respect to the multiplier output.
The X959BL has a closed output.

QUICK REFERENCE DATA

Typical gain at 2.5 kV		1.5×10^8	
Typical resistance		6.0×10^8	Ω
Operating voltage	max.	4.0	kV

Unless otherwise stated, data is applicable to both types.
This data should be read in conjunction with GENERAL EXPLANATORY NOTES – SINGLE CHANNEL ELECTRON MULTIPLIERS

CHARACTERISTICS (measured at 2.5 kV and 10 000 pulse/s where applicable)

	Min.	Typ.	Max.	
Resistance	4.0	6.0	8.0	$\times 10^8$ Ω
Gain (note 1)	1.0	1.5	–	$\times 10^8$
Background above an equivalent threshold of 2.0×10^6 electrons	–	0.05	0.20	pulse/s
Starting voltage with an equivalent threshold of 2.0×10^6 electrons	1.4	1.6	1.8	kV
Resolution (F.W.H.M.) at a modal gain of 1.8×10^8	–	50	70	%
Effective input diameter	14	15	–	mm

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Operating voltage	max.	4.0	kV
Temperature operating and storage	max.	70	°C
Bake temperature in vacuo (note 2)	max.	400	°C
Ambient pressure with high voltage applied	max.	50	$mN.m^{-2}$

MASS

4.0 g

MOUNTING POSITION

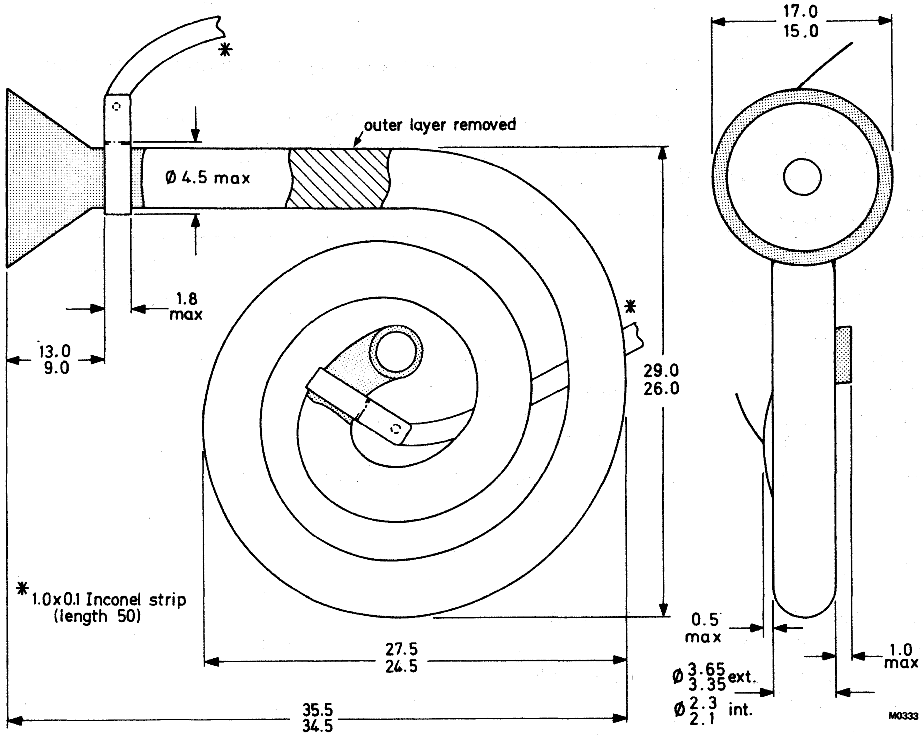
Any. In environments where vibration may be encountered, the device must not be supported by the leads alone.

NOTES

1. The gain of a typical multiplier will increase by a factor of approx. 2 for an increase of operating voltage of 500 V.
2. Baking will cause a permanent slight loss of gain and it is advisable to keep the baking time to a minimum, for example, baking for 16 hours at 400 °C could reduce the gain by approximately a factor of 2.

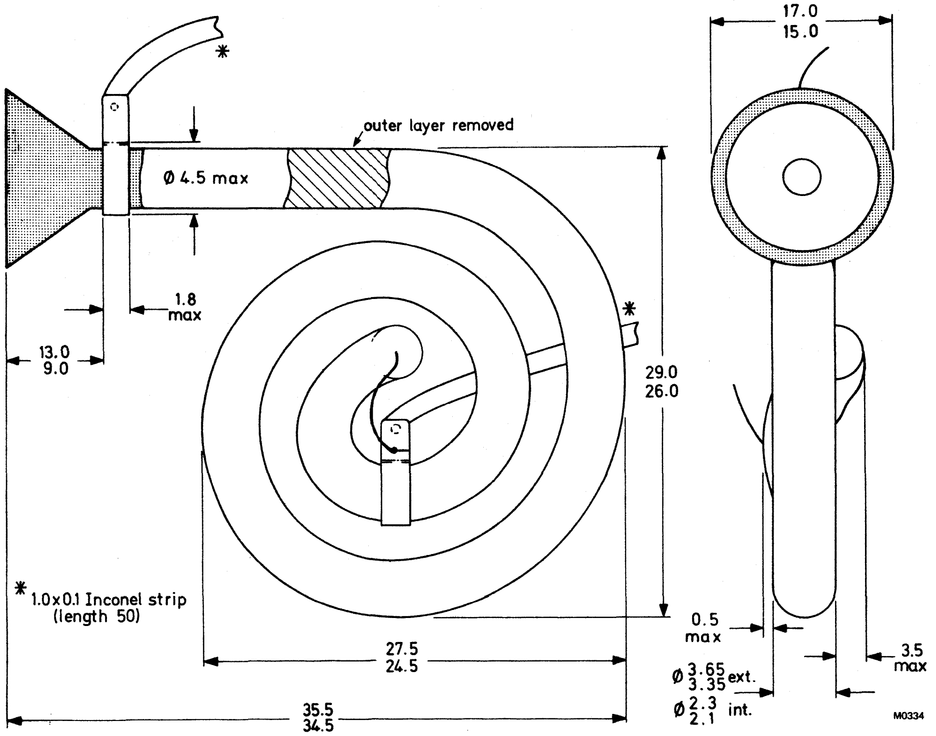
MECHANICAL DATA X959AL

Dimensions in mm



MECHANICAL DATA X959BL

Dimensions in mm



CHANNEL ELECTRON MULTIPLIER PLATES

SELECTION GUIDE

type no.	plate dimensions mm	channel diameter µm	channel angle degrees	page
G10-25SE	ϕ 25	10	6	99
G10-25SE/A	ϕ 25	10	6	99
G12-20X50	20 x 50	12.5	13	103
G12-25SE	ϕ 25	12.5	13	107
G12-25SE/A	ϕ 25	12.5	13	107
G12-36	ϕ 36	12.5	13	111
G12-36/A	ϕ 36	12.5	13	111
G12-36DT/0	ϕ 36	12.5	0	115
G12-36DT/13	ϕ 36	12.5	13	115
G12-46	ϕ 46	12.5	13	119
G12-46/A	ϕ 46	12.5	13	119
G12-46DT/0	ϕ 46	12.5	0	123
G12-46DT/13	ϕ 46	12.5	13	123
G12-70DT	ϕ 70	12.5	13	127
G25-25	ϕ 27	25	13	131
G25-25/A	ϕ 27	25	13	131
G25-50	ϕ 53	25	13	135
G25-70	ϕ 70	25	13	139

*SE = solid edge, DT = double thickness, A = matched pair of plates.

SPECIAL PLATES SIZES

Special plates such as squares, rectangles, discs with apertures, sectors, quadrants and plates with spherically profiled surfaces can be manufactured with dimensions up to 100 mm (some applications requiring larger plates can be considered).
Plate sizes for which manufacturing jigs exist are listed below.

Circular discs with outside diameters of: 18, 25, 27.1, 32.7, 36, 46, 53, 70, 80, 84, 96 and 100 mm.

Square plates with sides of 100 mm.

Rectangular plates with sides of: 20 x 50, 25 x 90, and 92 x 112 mm.

Plates can be manufactured in either of two types of glass which have differing surface resistances and can have a channel diameter of 10, 12.5 and 25 microns with a range of bias angles and plate thicknesses.

Choice of plate thickness is determined by mechanical and electrical considerations. As plate size increases, thickness should also be increased to preserve mechanical strength and flatness. Electrically, for operation of a single plate in unsaturated mode, Fig.2 illustrates computed universal curves showing that a thicker plate at a higher voltage can give a higher gain. When several plates are used in cascade to detect charged particles or photons, high gain is needed to drive the stack into saturation. Double-thickness plates (DT types) having a length to diameter ratio of 80:1 are often used for this purpose.

Please contact Philips Components for more information on special plates.

CHANNEL ELECTRON MULTIPLIER PLATES
GENERAL EXPLANATORY NOTES

PRINCIPLES OF OPERATION

Multi-channel plates depend on the same physical phenomenon as single channel electron multipliers. They comprise a plate of special glass through which pass a large number of channels. The walls of the holes are specially processed to coat them with a high resistance material which also has a coefficient of secondary emission greater than 1. If a potential is applied between opposite faces of the plate each channel becomes a continuous dynode analogous to the separate dynodes of a photomultiplier together with its resistive chain.

As with single channel electron multipliers, the channel plate operates in a vacuum. It is important that the vacuum should be better than 13.3 $mN.m^{-2}$. An electron entering the low voltage end of one of the channels will generate secondary electrons upon striking the wall. These in turn will be accelerated by the axial field and will again strike the wall, producing a further increase in the number of secondaries and so on. The avalanching process produces a large burst of electrons at the output end of the channel, corresponding to each input electron. As illustrated in Fig.1 there is a statistical variation in pulse size depending on several factors. The channels are set at an angle to the face of the plate to ensure that electrons approaching the plate normally will not fail to strike the wall. The output contains about 10^3 electrons for each input electron. The gain is a steep function of the applied voltage and the supply should be well regulated for stability of operation.

The multiplier is usually used to amplify the electrons emitted from a photocathode placed close to the input face and excites a phosphor screen placed close to the output, preserving the spatial resolution and making an amplified image of the information on the photocathode. The input of the channel is also sensitive to ions, beta particles, X-rays, or any radiation of a suitable energy and this extends its use to many other applications. Since the resistive path is continuous, many electron paths are possible and the number of stages of amplification is indeterminate. The electron trajectories are scaled in proportion to the dimensions of the channel for a given applied voltage. Thus if the length to diameter ratio is kept constant the gain per channel remains constant, irrespective of the absolute length of the channel. For most applications the spatial resolution is important and in order to achieve the highest resolutions the channel diameters and the walls between channels are kept as small as possible.

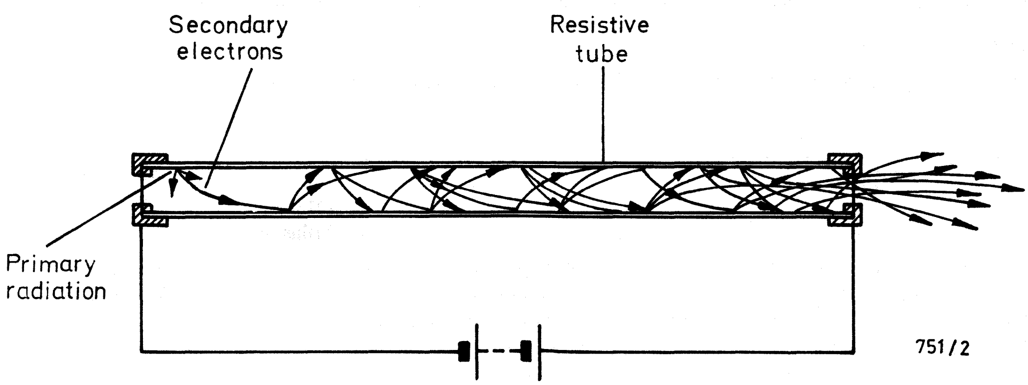


Fig.1 Electron multiplication.

IONIC FEEDBACK

The electron cloud at the output of the plate is sufficiently intense to generate an appreciable number of ions and these drift towards the input of the channel and, upon striking the wall, can produce a further burst of secondary electrons. This pulse, starting near the output, will be smaller than the first pulse, but may also generate ions which will drift backwards, so that a train of pulses is generated. This train of pulses alters the charge on the wall, which reduces the gain. This effect limits the voltage that can be applied to the plate and thus the gain that can be achieved. By placing two plates in cascade with the channels angled in opposite directions, ions fed back from the output plate cannot enter the input plate and high gain can be achieved without excessive ion feedback and consequent loss of linearity.

SATURATION DUE TO SPACE CHARGE

If the charge in the output pulse reaches about 10^8 electrons, the gain cannot increase further. The space charge in the output end of the channel repels secondary electrons, causing them to return to the wall without generating further electrons. When this occurs with an imaging application it will cause poor highlights and loss of detail. Imaging plates usually operate at gains of around 10^3.

SATURATION DUE TO FIELD DISTORTION

When the current in the output averages more than 10% of the total current, the voltage gradient in the wall is no longer linear and the gain falls so that there is a loss of linearity between input and output currents and a loss of highlights in the image.

SATURATION DUE TO FIELD EMISSION

It is important to keep channel plates scrupulously clean. Particles lodging in a channel can give rise to field emission which is multiplied in the channel and produces a permanently saturated condition. This is known as a switched-on channel and is a condition extremely difficult to correct.

RESISTANCE

The resistance of a channel plate is the value measured in vacuo between electrodes applied to the input and output faces.

OVERLOAD PROTECTION

Due to the characteristics of the glass, it is essential the power supplies should not be capable of delivering a current in excess of 1 mA. This can be achieved by the use of a series current limiting resistor, the value of which may be calculated as follows: R = operating voltage (max.) x 10^3 Ω.

DARK CURRENT

Dark current is generally very low, much less than 1 count/sec/cm^2 of plate area.

OPEN AREA

Open area is the total cross section of all the channels in the plate expressed as a percentage of the total area of the plate.

GAIN

Gain in the linear region of operation is defined as the output current divided by the input current. This is always better than 1000 for 1000 volts applied to the plate and increases one order for each 200 V increase in applied voltage. The recommended operating voltage is 800 to 1200 V. Outside these limits spatial non-uniformity can become a problem.

MOUNTING

The opposite faces of channel plates are ground flat and parallel during manufacture. As the devices are fragile, care must be taken to ensure that they are not stressed unduly when mounting them in systems. It is recommended that they are placed between perfectly flat polished stainless steel rings spring loaded only sufficiently to ensure reliable connections to the metallized faces of the plate. A loading of 300 gms per cm of periphery has been found adequate. Care must be taken to minimize the possibility of leakage or other currents between the contact rings when the working voltage is applied.

OPERATING TEMPERATURE AND OUTGASSING

The devices can be operated up to maximum of 55 ^{o}C and degassed up to a maximum of 300 ^{o}C. Further evolution of gas may take place during operation. The pressure should never be allowed to rise above 13.3 $mN.m^{-2}$ while the operating voltage is applied, but exposure to the atmosphere for a few hours at a time does not cause any loss of performance. It is prudent to store devices in a well desiccated container if they have to be removed from the vacuum environment for longer periods. The devices may be damaged permanently if exposed to gross contamination by hydrocarbon vapours.

If the output is to be detected by means of a phosphor screen, it is desirable to place it as close to the channel plate as can be arranged, commensurate with voltage and mechanical considerations. The electrons leave the outputs over a very wide angle, and detail can be lost if the spacing is excessive. For similar reason a photocathode input source should be placed close to the input face.

A suitable distance for the channel plate-screen gap is 1 mm, with a potential between screen and channel plate output of about 5 kV. Either the screen distance or the screen potential may be adjusted in order to optimize the resolution of the system.

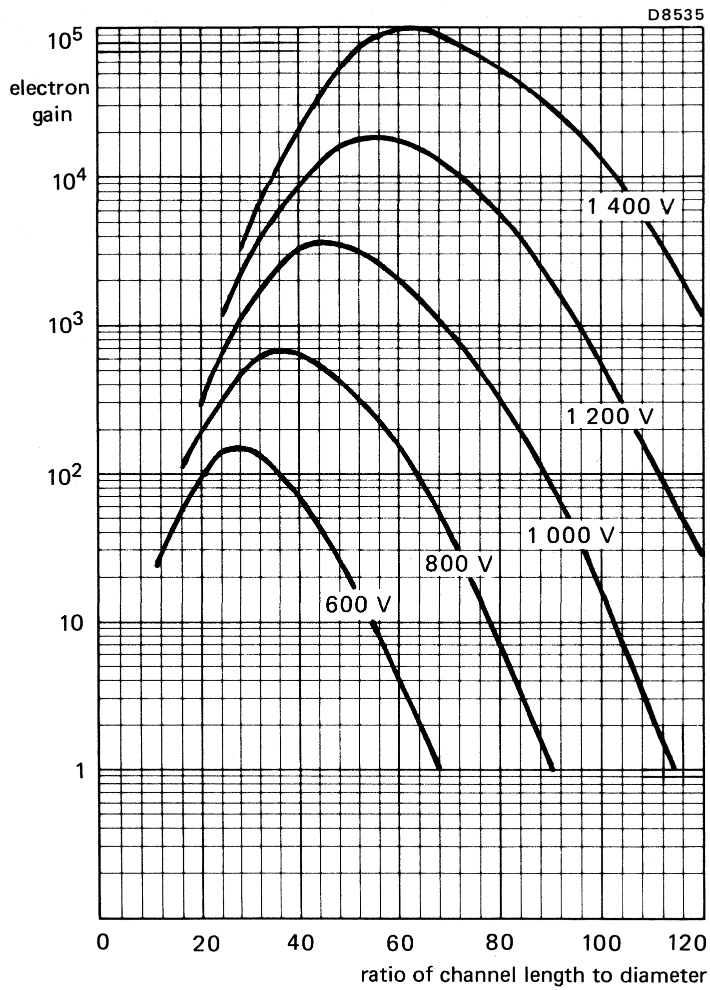

D8535
10^5
electron gain
10^4
10^3
10^2
10
1
1 400 V
1 200 V
1 000 V
800 V
600 V
0
20
40
60
80
100
120
ratio of channel length to diameter

Fig.2

SOLID EDGE CHANNEL ELECTRON MULTIPLIER PLATE

This consists of an array of channel electron multipliers fused into the shape of a disc with a solid edge. The multipliers are electrically connected in parallel by means of nickel-chromium electrodes evaporated on to the faces of the disc.

SPECIFICATION

Disc diameter		24.80 ± 0.05	mm
Useful diameter	min.	18.8	mm
Disc thickness		0.43 ± 0.02	mm
Channel diameter	nom.	10	μm
Channel pitch	nom.	12.5	μm
Open area	min.	60	%
Electrode material		nickel-chromium	
Electrical resistance between electrodes		60 to 230	MΩ
Current gain at 1.0 kV (see Fig.1)	min.	1000	
Angle of channel to perpendicular axis of disc		6	degrees

For a linear relationship between input and output, the output current must not exceed 0.1 of the standing current.

APPLICATIONS

This device must operate in a vacuum and may be used to detect electrons, ions, soft X-rays and ultra-violet photons falling in the input face of the disc by producing electron pulses from the output face of the corresponding channel.

For space experiments, the environmental vacuum is adequate for its operation and it has considerable potential in the field of X-ray and ultra-violet astronomy from rockets and satellites. In laboratory use it must be incorporated in a vacuum chamber, where it will have important applications in field ion microscopy, electron microscopy and allied areas of research.

Such applications are fully discussed by P. Lecomte and V. Perez-Mendez in I.E.E.E. Transactions on Nuclear Science, Vol. NS—25, No. 2 April 1978 — 'Channel Electron Multipliers: Properties, Development and Applications' and 'X-ray detectors in Astronomy' by G. W. Fraser, Cambridge Astrophysics Series, 1989 — Cambridge University Press, ISBN 052132663X.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC134)

Operating voltage	max.	1.5	kV
Temperature** (operating)	max.	55	^{o}C
Bake temperature	max.	300	^{o}C
Ambient pressure with high voltage applied	max.	13.3 (1.0×10^{-4} torr)	$mN.m^{-2}$

* The suffix /A denotes a pair of plates which are resistance matched for applications requring two plates in cascade, (see Fig.2).

** The plate should be stored in a dry or vacuum environment at a temperature below 70 ^{o}C.

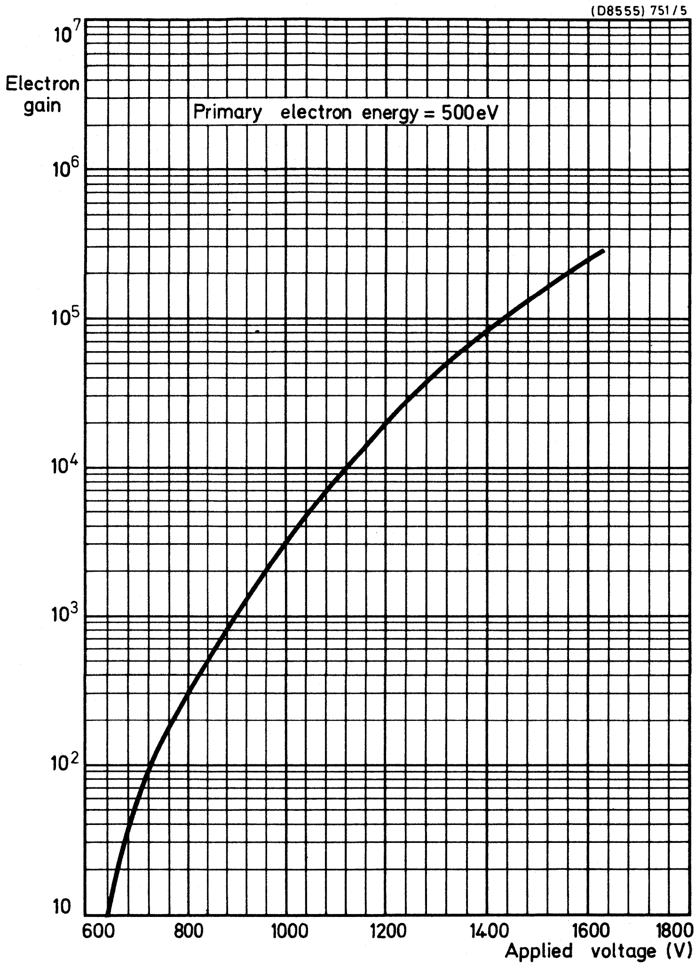


Fig.1 Typical current gain as a function of applied voltage.

MOUNTING

A channel plate is fragile and great care must be taken to ensure that it is not unduly stressed when mounted in the vacuum system. It is recommended that the plate is mounted between clean polished stainless steel rings, giving noise-free electrical contacts. The device will withstand a contact pressure of at least 10^4 $N.m^{-2}$ (corresponding to a load of ~1 g per mm^2) applied via screws pushing against small helical springs. Polished annular shims, about 1.5 mm wide and 50 μm thick, are recommended for insertion between plates operating in cascade.

OVERLOAD PROTECTION

Due to the glass characteristics, it is essential that power supplies should not be capable of delivering a current in excess of 1 mA. This can be achieved by the use of a series current limiting resistor, the value of which may be calculated as follows:

$$R_p = \text{operating voltage (max.)} \times 10^3\ \Omega.$$

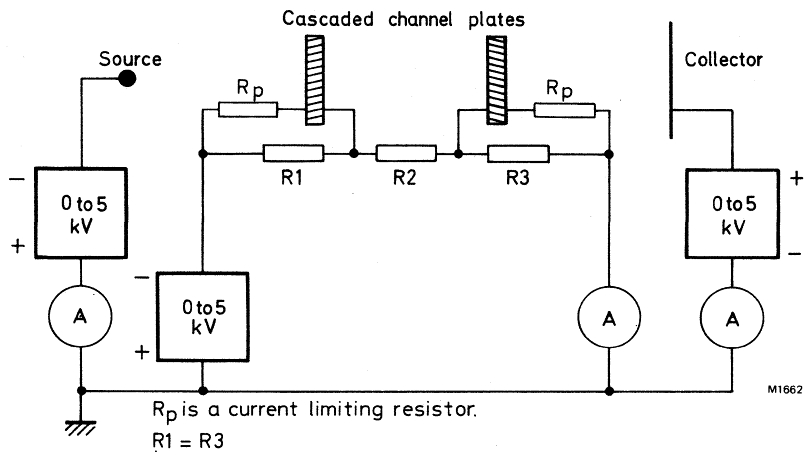


Fig.2 Circuit for cascaded channel plates

CHANNEL ELECTRON MULTIPLIER PLATE

This consists of an array of channel electron multipliers fused into the shape of a rectangle. The multipliers are electrically connected in parallel by means of nickel-chromium electrodes evaporated on to the faces of the plate.

SPECIFICATION

Area of plate		$20^{+0}_{-0.2} \times 50^{+0}_{-0.2}$	mm
Useful area	min.	18.8 x 48.8	mm
Plate thickness		0.5 ± 0.1	mm
Channel diameter		12.5	μm
Channel pitch		15.0	μm
Open area	min.	60	%
Electrode material		nickel-chromium	
Electrical resistance between electrodes		80 to 300	MΩ
Current gain at 1.0 kV	min.	10^3	
Angle of channel to perpendicular axis of plate		13	degrees

APPLICATIONS

This device must operate in a vacuum and may be used to detect electrons, ions, soft X-rays and ultra-violet photons falling on the input face of the plate, by producing electron pulses from the output face of the corresponding channel.

For space experiments, the environmental vacuum is adequate for its operation and it has considerable potential in the field of X-ray and ultra-violet astronomy from rockets and satellites. In laboratory use it must be incorporated in a vacuum chamber, where it will have important applications in field ion microscopy, electron microscopy and allied areas of research.

Such applications are fully discussed by P. Lecomte and V. Perez-Mendez in I.E.E.E. Transactions on Nuclear Science, Vol. NS–25, No.2 April 1978 – 'Channel Electron Multipliers: Properties, Development and Applications' and 'X-ray detectors in Astronomy' by G. W. Fraser, Cambridge Astrophysics Series, 1989 – Cambridge University Press, ISBN 052132663X.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC134)

Operating voltage	max.	1.5	kV
Temperature* (operating)	max.	55	°C
Bake temperature	max.	300	°C
Ambient pressure with high voltage applied	max.	13.3 1.0×10^{-4}	$mN.m^{-2}$ torr

*The plate should be stored in a dry or vacuum environment at a temperature below 70 °C.

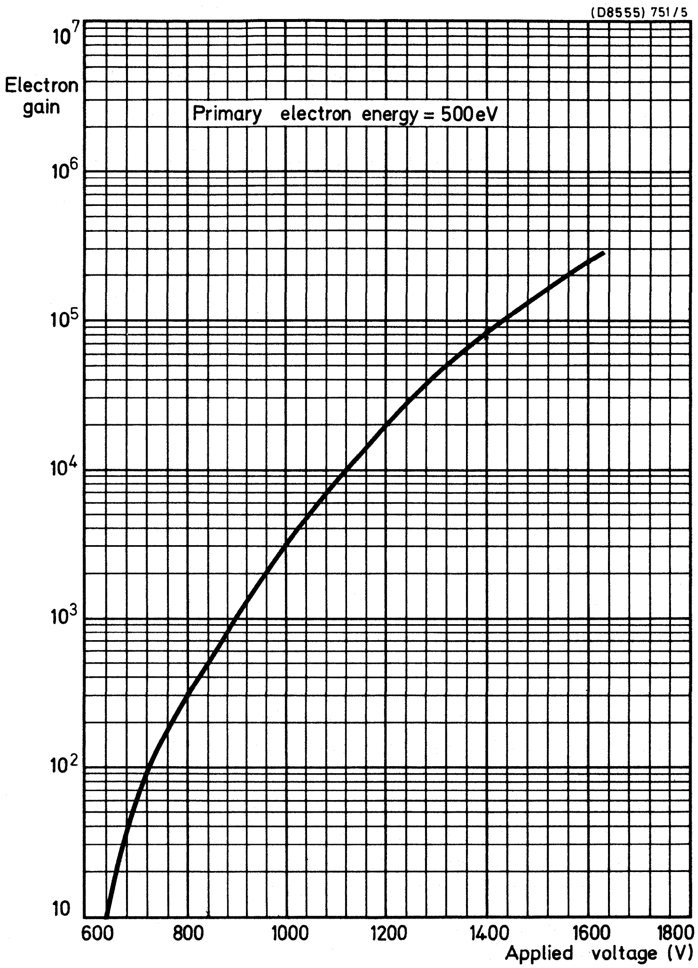


Fig. 1 Typical current gain as a function of applied voltage

MOUNTING

A channel plate is fragile and great care must be taken to ensure that it is not unduly stressed when mounted in the vacuum system. It is recommended that the plate is mounted between clean polished stainless steel rings, giving noise-free electrical contacts. The device will withstand a contact pressure of at least 10^4 $N.m^{-2}$ (corresponding to a load of ~1 g per mm^2) applied via screws pushing against small helical springs. Polished annular shims, about 1.5 mm wide and 50 μm thick, are recommended for insertion between plates operating in cascade.

OVERLOAD PROTECTION

Due to the glass characteristics, it is essential that power supplies should not be capable of delivering a current in excess of 1 mA. This can be achieved by the use of a series current limiting resistor, the value of which may be calculated as follows:

$$R_p = \text{operating voltage (max.)} \times 10^3\ \Omega.$$

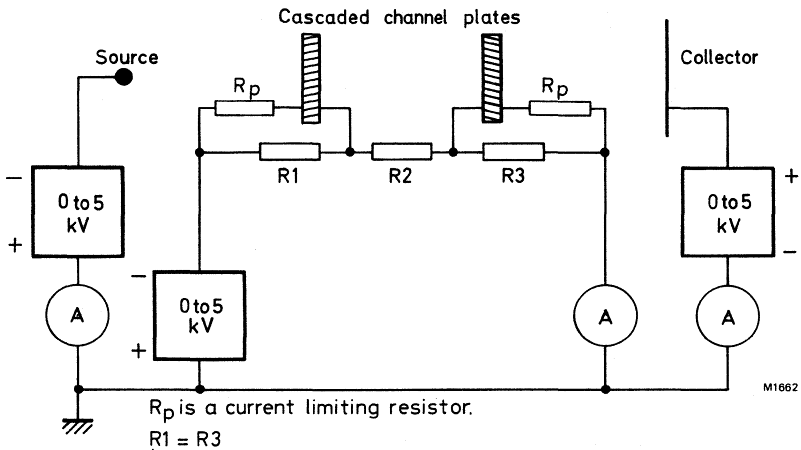


Fig.2 Circuit for cascaded channel plates

SOLID EDGE CHANNEL ELECTRON MULTIPLIER PLATE

This consists of an array of channel electron multipliers fused into the shape of a disc with a solid edge. The multipliers are electrically connected in parallel by means of nickel-chromium electrodes evaporated on to the faces of the disc.

SPECIFICATION

Disc diameter		24.80 ± 0.05	mm
Useful diameter	min.	18.8	mm
Disc thickness		0.5 ± 0.02	mm
Channel diameter	nom.	12.5	μm
Channel pitch	nom.	15.0	μm
Open area	min.	60	%
Electrode material		nickel-chromium	
Electrical resistance between electrodes		200 to 750	MΩ
Current gain at 1.0 kV (see Fig.1)	min.	1000	
Angle of channel to perpendicular axis of disc		13	degrees

For a linear relationship between input and output, the output current must not exceed 0.1 of the standing current.

APPLICATIONS

This device must operate in a vacuum and may be used to detect electrons, ions, soft X-rays and ultra-violet photons falling in the input face of the disc by producing electron pulses from the output face of the corresponding channel.

For space experiments, the environmental vacuum is adequate for its operation and it has considerable potential in the field of X-ray and ultra-violet astronomy from rockets and satellites. In laboratory use it must be incorporated in a vacuum chamber, where it will have important applications in field ion microscopy, electron microscopy and allied areas of research.

Such applications are fully discussed by P. Lecomte and V. Perez-Mendez in I.E.E.E. Transactions on Nuclear Science, Vol. NS—25, No. 2 April 1978 — 'Channel Electron Multipliers: Properties, Development and Applications' and 'X-ray detectors in Astronomy' by G. W. Fraser, Cambridge Astrophysics Series, 1989 — Cambridge University Press, ISBN 052132663X.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC134)

Operating voltage	max.	1.5	kV
Temperature** (operating)	max.	55	°C
Bake temperature	max.	300	°C
Ambient pressure with high voltage applied	max.	13.3 (1.0×10^{-4} torr)	$mN.m^{-2}$

* The suffix /A denotes a pair of plates which are resistance matched for applications requring two plates in cascade, (see Fig.2).

** The plate should be stored in a dry or vacuum environment at a temperature below 70 °C.

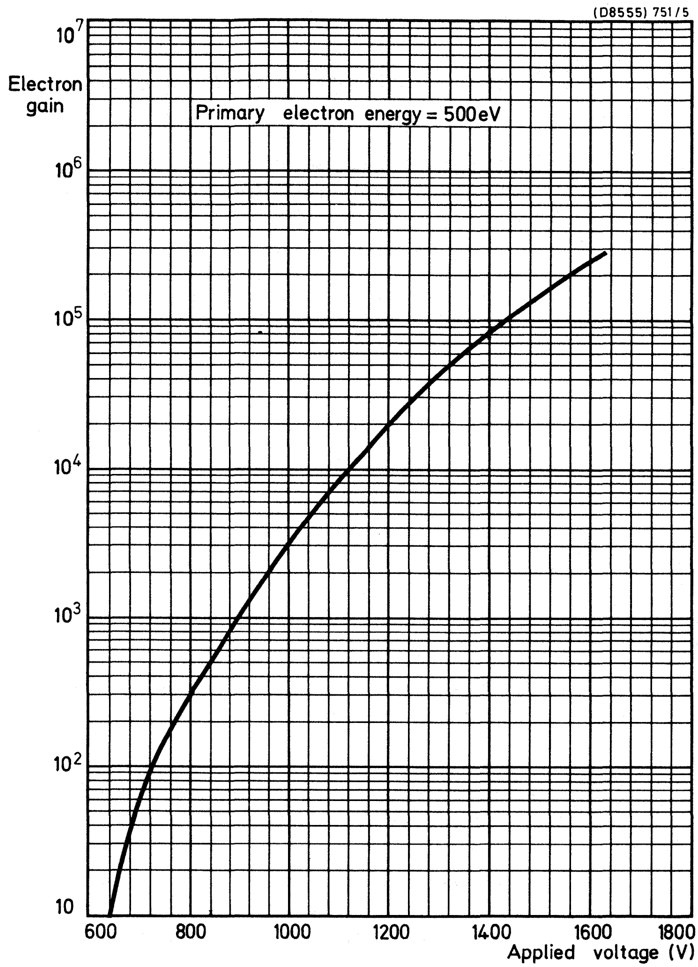


Fig.1 Typical current gain as a function of applied voltage.

MOUNTING

A channel plate is fragile and great care must be taken to ensure that it is not unduly stressed when mounted in the vacuum system. It is recommended that the plate is mounted between clean polished stainless steel rings, giving noise-free electrical contacts. The device will withstand a contact pressure of at least 10^4 $N.m^{-2}$ (corresponding to a load of ~1 g per mm^2) applied via screws pushing against small helical springs. Polished annular shims, about 1.5 mm wide and 50 μm thick, are recommended for insertion between plates operating in cascade.

OVERLOAD PROTECTION

Due to the glass characteristics, it is essential that power supplies should not be capable of delivering a current in excess of 1 mA. This can be achieved by the use of a series current limiting resistor, the value of which may be calculated as follows:

$$R_p = \text{operating voltage (max.)} \times 10^3\ \Omega.$$

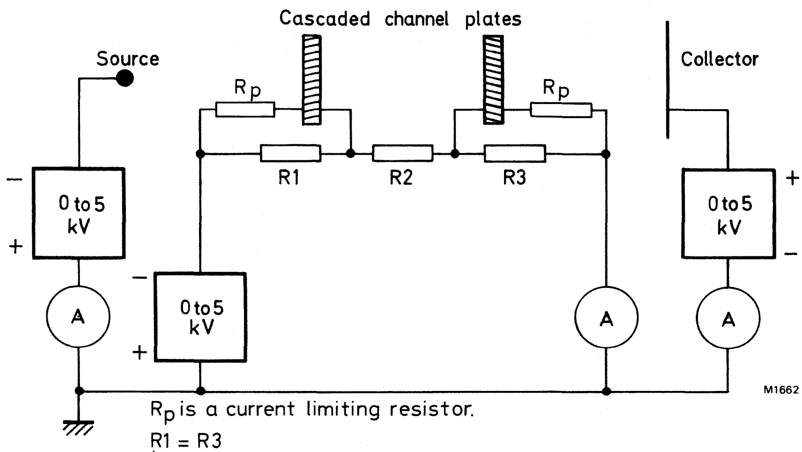


Fig.2 Circuit for cascaded channel plates

CHANNEL ELECTRON MULTIPLIER PLATE

This consists of an array of channel electron multipliers fused into the shape a disc. The multipliers are electrically connected in parallel by means of nickel-chromium electrodes evaporated on to the faces of the disc.

SPECIFICATION

Disc diameter		$36^{+0}_{-0.1}$	mm
Useful diameter	min.	32.5	mm
Disc thickness		0.5 ± 0.02	mm
Channel diameter	nom.	12.5	µm
Channel pitch	nom.	15	µm
Open area	min.	60	%
Electrode material		nickel-chromium	
Electrical resistance between electrodes		80 to 300	MΩ
Current gain at 1.0 kV (see Fig.1)	min.	1000	
Angle of channel to perpendicular axis of disc		13	degrees

For a linear relationship between input and output, the output current must not exceed 0.1 of the standing current.

APPLICATIONS

This device must operate in a vacuum and may be used to detect electrons, ions, soft X-rays and ultra-violet photons falling on the input face of the disc by producing electron pulses from the output face of the corresponding channel.

For space experiments, the environmental vacuum is adequate for its operation and it has considerable potential in the field of X-ray and ultra-violet astronomy from rockets and satellites. In laboratory use it must be incorporated in a vacuum chamber, where it will have important applications in field ion microscopy, electron microscopy and allied areas of research.

Such applications are fully discussed by P. Lecomte and V. Perez-Mendez in I.E.E.E. Transactions on Nuclear Science, Vol. NS—25, No. 2 April 1978 — 'Channel Electron Multipliers: Properties, Development and Applications' and 'X-ray detectors in Astronomy' by G. W. Fraser, Cambridge Astrophysics Series, 1989 — Cambridge University Press, ISBN 052132663X.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC134)

Operating voltage	max.	1.5	kV
Temperature ** (operating)	max.	55	°C
Bake temperature	max.	300	°C
Ambient pressure with high voltage applied	max.	13.3 (1.0×10^{-4} torr)	$mN.m^{-2}$
Plate clamping rings internal diameter	max.	33	mm

* The suffix /A denotes a pair of plates which are resistance matched for applications requiring two plates in cascade, (see Fig.2).

** The plate should be stored in a dry or vacuum environment at a temperature below 70 °C.

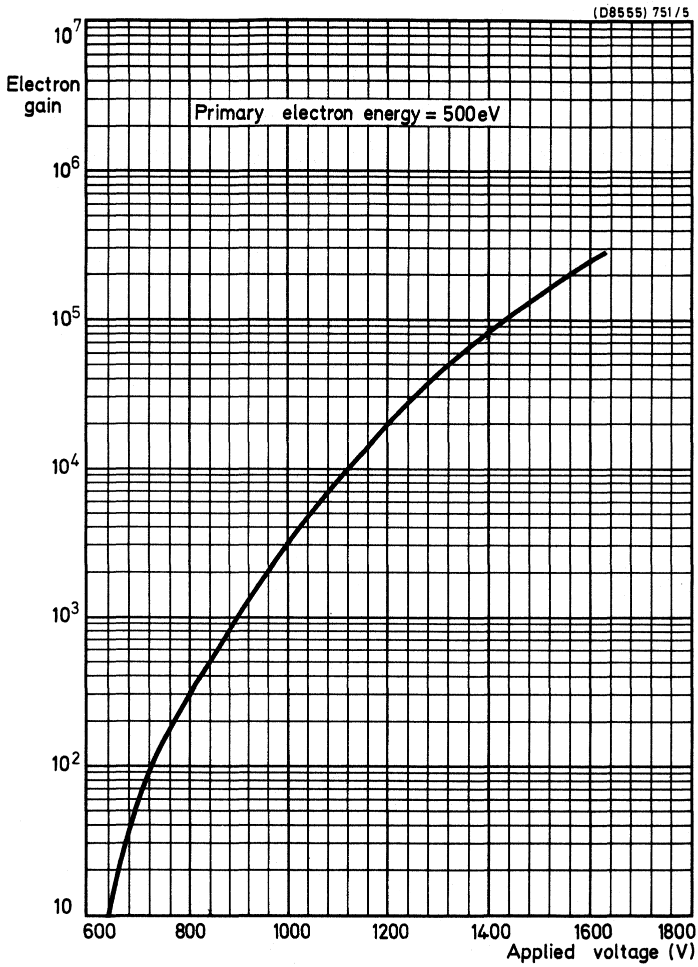


Fig. 1 Typical current gain as a function of applied voltage.

MOUNTING

A channel plate is fragile and great care must be taken to ensure that it is not unduly stressed when mounted in the vacuum system. It is recommended that the plate is mounted between clean polished stainless steel rings, giving noise-free electrical contacts. The device will withstand a contact pressure of at least 10^4 N.m^{-2} (corresponding to a load of ~1 g per mm^2) applied via screws pushing against small helical springs. Polished annular shims, about 1.5 mm wide and 50 μm thick, are recommended for insertion between plates operating in cascade.

OVERLOAD PROTECTION

Due to the glass characteristics, it is essential that power supplies should not be capable of delivering a current in excess of 1 mA. This can be achieved by the use of a series current limiting resistor, the value of which may be calculated as follows:

$$R_p = \text{operating voltage (max.)} \times 10^3\ \Omega.$$

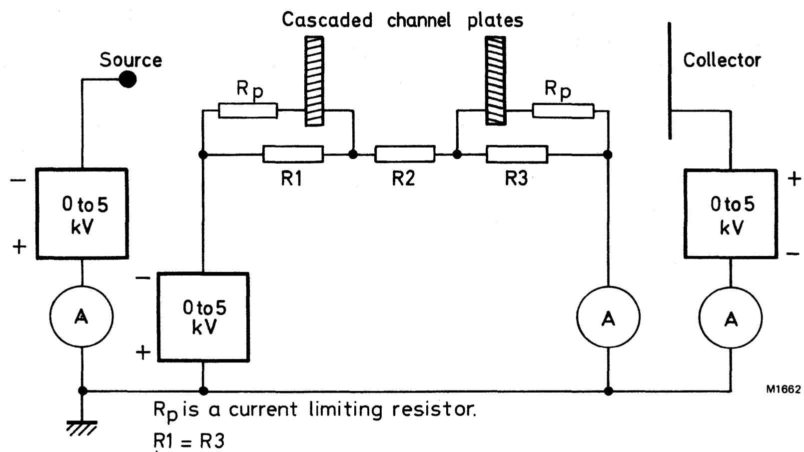


Fig.2 Circuit for cascaded channel plates

CHANNEL ELECTRON MULTIPLIER PLATES

Each plate consists of an array of channel electron multipliers fused into the shape of a disc. The multipliers are electrically connected in parallel by means of nickel-chromium electrodes evaporated on to the faces of the disc. These plates have been specially developed for use in pairs in the pulse detection mode for X-rays and other types of radiation. The suffix DT indicates double thickness. The G12-36DT/0 is cut so that the channels form an angle of 0 degrees to the perpendicular axis; in the G12-36DT/13 the channels form an angle of 13^{o} to the perpendicular axis.

SPECIFICATION

Disc diameter		$36^{+0}_{-0.1}$	mm
Useful diameter	min.	32.5	mm
Disc thickness		1.0 ± 0.02	mm
Channel diameter	nom.	12.5	μm
Channel pitch	nom.	15.0	μm
Open area	min.	60	%
Electrode material		nickel-chromium	
Electrical resistance between electrodes		200 to 600	MΩ
Length to diameter ratio		80:1	
Current gain for a pair of plates at 1.4 kV/plate	nom.	10^6	

APPLICATIONS

These devices must operate in a vacuum and may be used to detect electrons, ions, soft X-rays and ultra-violet photons falling on the input face of the disc, by producing electron pulses from the output face of the corresponding channel.

For space experiments, the environmental vacuum is adequate for their operation and they have considerable potential in the field of X-ray and ultra-violet astronomy from rockets and satellites. In laboratory use they must be incorporated in a vacuum chamber, where they will have important applications in field ion microscopy, electron microscopy and allied areas of research.

Such applications are fully discussed by P. Lecomte and V. Perez-Mendez in I.E.E.E. Transactions on Nuclear Science, Vol. NS—25, No. 2 April 1978 — 'Channel Electron Multipliers: Properties, Development and Applications' and 'X-ray detectors in Astronomy' by G. W. Fraser, Cambridge Astrophysics Series, 1989 — Cambridge University Press, ISBN 052132663X.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC134)

Operating voltage (pair of plates)	max.	4.5	kV
Operating voltage (single plate)	max.	2.3	kV
Temperature* (operating)	max.	55	^{o}C
Bake temperature	max.	300	^{o}C
Ambient pressure with high voltage applied	max.	13.3 (1.0 x 10^{-4} torr)	mN.m^{-2}
Plate clamping rings internal diameter	max.	33	mm

*The plate should be stored in a dry or vacuum environment at a temperature below 70 ^{o}C.

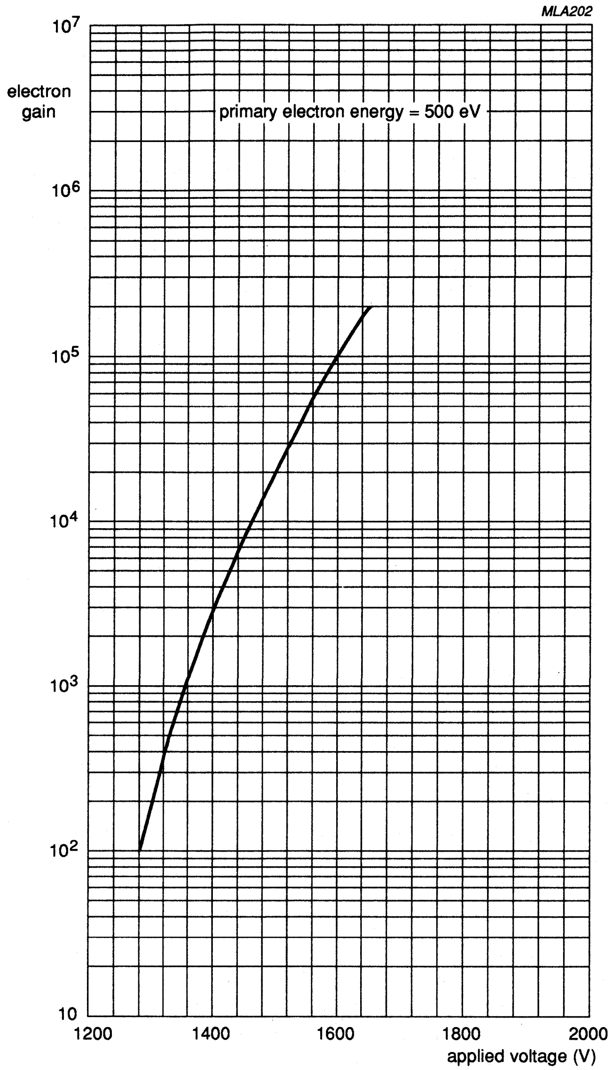


Fig.1 Typical gain curve for a single plate.

MOUNTING

Channel plates are fragile and great care must be taken to ensure that they are not unduly stressed when mounted in the vacuum system. It is recommended that the plates are mounted between clean polished stainless steel rings, giving noise-free electrical contacts. The device will withstand a contact pressure of at least 10^4 N.m^{-2} (corresponding to a load of ~1 g per mm^2) applied via screws pushing against small helical springs. Polished annular shims, about 1.5 mm wide and 50 μm thick, are recommended for insertion between plates operating in cascade.

OVERLOAD PROTECTION

Due to the glass characteristics, it is essential that power supplies should not be capable of delivering a current in excess of 1 mA. This can be achieved by the use of a series current limiting resistor, the value of which may be calculated as follows:

$$R_p = \text{operating voltage (max.)} \times 10^3\ \Omega.$$

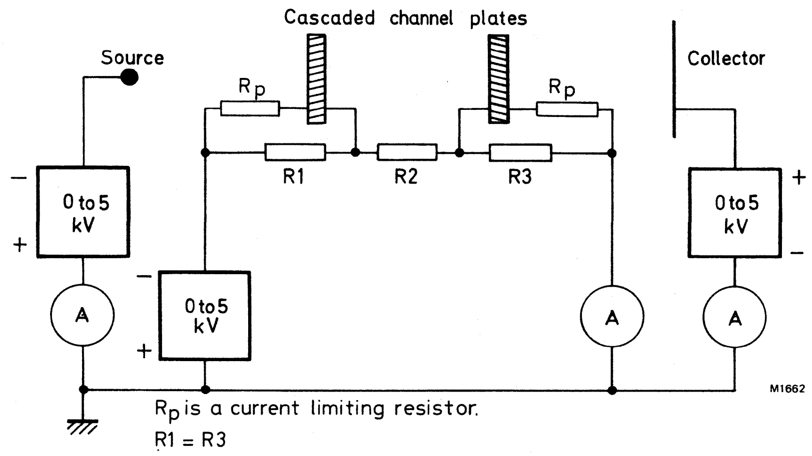


Fig.2 Circuit for cascaded channel plates

CHANNEL ELECTRON MULTIPLIER PLATE

This consists of an array of channel electron multipliers fused into the shape of a disc. The multipliers are electrically connected in parallel by means of nickel-chromium electrodes evaporated on to the faces of the disc.

SPECIFICATION

Disc diameter		$46^{+0}_{-0.1}$	mm
Useful diameter	min.	42	mm
Disc thickness		0.5 ± 0.02	mm
Channel diameter	nom.	12.5	μm
Channel pitch	nom.	15.0	μm
Open area	min.	60	%
Electrode material		nickel-chromium	
Electrical resistance between electrodes		30 to 100	MΩ
Current gain at 1.0 kV (see Fig.1)	min.	1000	
Angle of channel to perpendicular axis of disc		13	degrees

For a linear relationship between input and output, the output current must not exceed 0.1 of the standing current.

APPLICATIONS

This device must operate in a vacuum and may be used to detect electrons, ions, soft X-rays and ultra-violet photons falling on the input face of the disc, by producing electron pulses from the output face of the corresponding channel.

For space experiments, the environmental vacuum is adequate for its operation and it has considerable potential in the field of X-ray and ultra-violet astronomy from rockets and satellites. In laboratory use it must be incorporated in a vacuum chamber, where it will have important applications in field ion microscopy, electron microscopy and allied areas of research

Such applications are fully discussed by P. Lecomte and V. Perez-Mendez in I.E.E.E. Transactions on Nuclear Science, Vol. NS–25, No.2 April 1978 – 'Channel Electron Multipliers: Properties, Development and Applications' and 'X-ray detectors in Astronomy' by G. W. Fraser, Cambridge Astrophysics Series, 1989 – Cambridge University Press, ISBN 052132663X.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC134)

Operating voltage	max.	1.5	kV
Temperature** (operating)	max.	55	°C
Bake temperature	max.	300	°C
Ambient pressure with high voltage applied		13.3 (1.0×10^{-4}) torr	$mN.m^{-2}$
Plate clamping rings internal diameter	max.	42.5	mm

* The suffix/A denotes a pair of plates which are resistance matched for applications requiring two plates in cascade, (see Fig.2).

** The plate should be stored in a dry vacuum environment at a temperature below 70 °C.

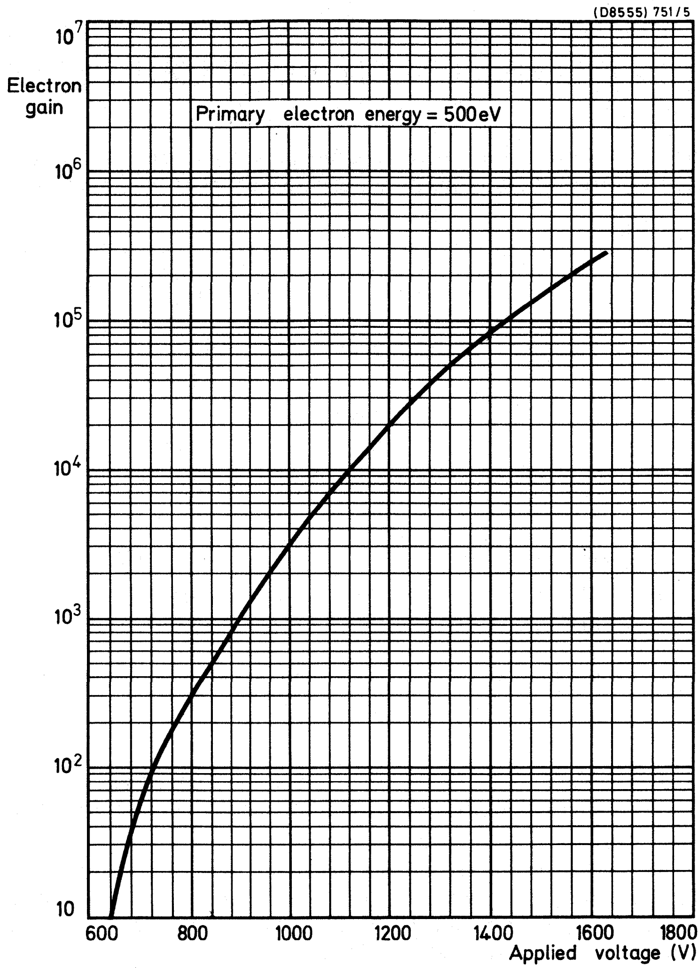


Fig.1 Typical current gain as a function of applied voltage

MOUNTING

A channel plate is fragile and great care must be taken to ensure that it is not unduly stressed when mounted in the vacuum system. It is recommended that the plate is mounted between clean polished stainless steel rings, giving noise-free electrical contacts. The device will withstand a contact pressure of at least 10^4 $N.m^{-2}$ (corresponding to a load of ~1 g per mm^2) applied via screws pushing against small helical springs. Polished annular shims, about 1.5 mm wide and 50 μm thick, are recommended for insertion between plates operating in cascade.

OVERLOAD PROTECTION

Due to the glass characteristics, it is essential that power supplies should not be capable of delivering a current in excess of 1 mA. This can be achieved by the use of a series current limiting resistor, the value of which may be calculated as follows:

$$R_p = \text{operating voltage (max.)} \times 10^3\ \Omega.$$

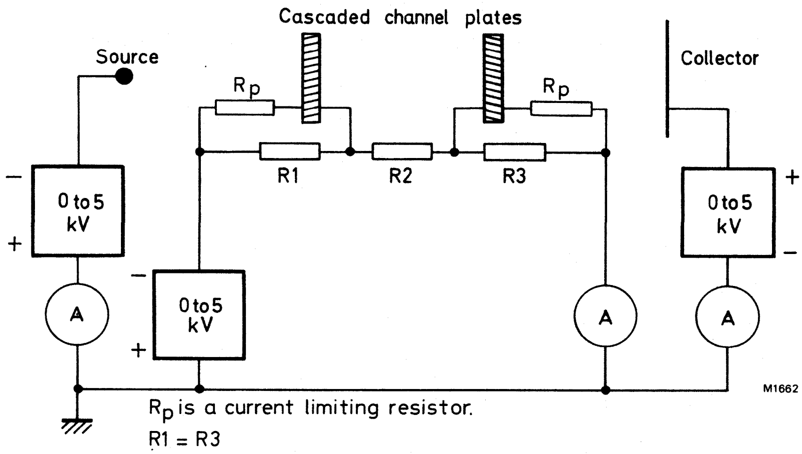


Fig.2 Circuit for cascaded channel plates

CHANNEL ELECTRON MULTIPLIER PLATES

Each plate consists of an array of channel electron multipliers fused into the shape of a disc. The multipliers are electrically connected in parallel by means of nickel-chromium electrodes evaporated on to the faces of the disc. These plates have been specially developed for use in pairs in the pulse detection mode for X-rays and other types of radiation. The suffix DT indicates double thickness. The G12-46DT/0 is cut so that the channels form an angle of 0 degrees to the perpendicular axis; in the G12-46DT/13 the channels form an angle of 13^{o} to the perpendicular axis.

SPECIFICATION

Disc diameter		$46^{+0}_{-0.1}$	mm
Useful diameter	min.	42	mm
Disc thickness		1.0 ± 0.02	mm
Channel diameter	nom.	12.5	µm
Channel pitch	nom.	15.0	µm
Open area	min.	60	%
Electrode material		nickel-chromium	
Electrical resistance between electrodes		60 to 250	MΩ
Length to diameter ratio		80:1	
Current gain for a pair of plates at 1.4 kV/plate	nom.	10^{6}	

APPLICATIONS

These devices must operate in a vacuum and may be used to detect electrons, ions, soft X-rays and ultra-violet photons falling on the input face of the disc, by producing electron pulses from the output face of the corresponding channel.

For space experiments, the environmental vacuum is adequate for their operation and they have considerable potential in the field of X-ray and ultra-violet astronomy from rockets and satellites. In laboratory use they must be incorporated in a vacuum chamber, where they will have important applications in field ion microscopy, electron microscopy and allied areas of research.

Such applications are fully discussed by P. Lecomte and V. Perez-Mendez in I.E.E.E. Transactions on Nuclear Science, Vol. NS—25, No. 2 April 1978 — 'Channel Electron Multipliers: Properties, Development and Applications' and 'X-ray detectors in Astronomy' by G. W. Fraser, Cambridge Astrophysics Series, 1989 — Cambridge University Press, ISBN 052132663X.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC134)

Operating voltage (pair of plates)	max.	4.5	kV
Operating voltage (single plate)	max.	2.3	kV
Temperature* (operating)	max.	55	^{o}C
Bake temperature	max.	300	^{o}C
Ambient pressure with high voltage applied	max.	13.3 (1.0 x 10^{-4} torr)	$mN.m^{-2}$
Plate clamping rings internal diameter	max.	42.5	mm

*This plate should be stored in a dry or vacuum environment at a temperature below 70 ^{o}C.

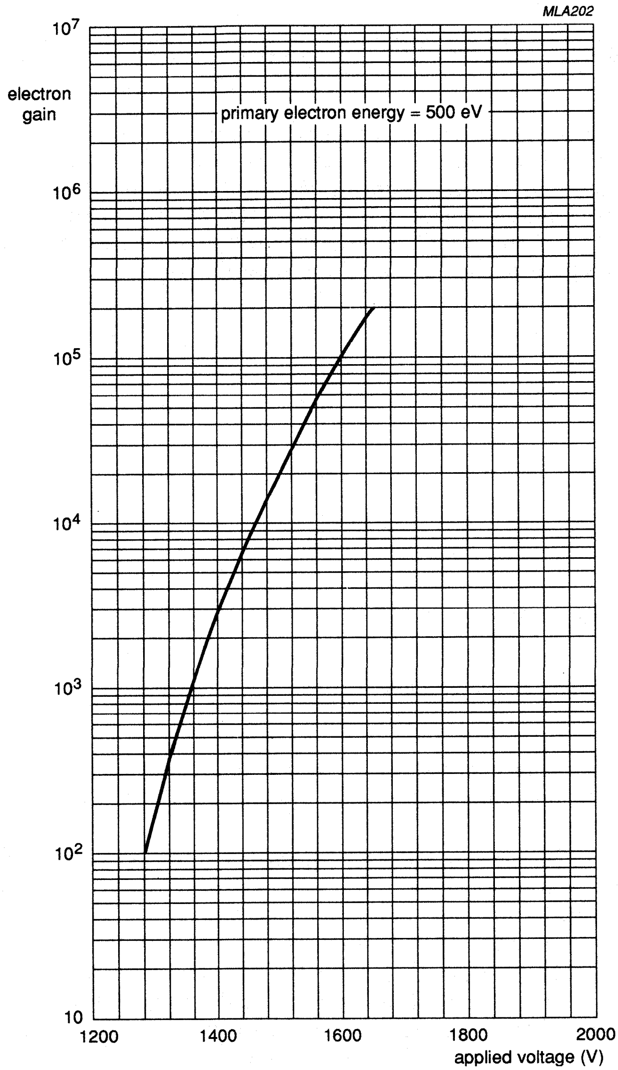


Fig.1 Typical gain curve for a single plate

MOUNTING

Channel plates are fragile and great care must be taken to ensure that they are not unduly stressed when mounted in the vacuum system. It is recommended that the plates are mounted between clean polished stainless steel rings, giving noise-free electrical contacts. The device will withstand a contact pressure of at least 10^4 $N.m^{-2}$ (corresponding to a load of ~1 g per mm^2) applied via screws pushing against small helical springs. Polished annular shims, about 1.5 mm wide and 50 μm thick, are recommended for insertion between plates operating in cascade.

OVERLOAD PROTECTION

Due to the glass characteristics, it is essential that power supplies should not be capable of delivering a current in excess of 1 mA. This can be achieved by the use of a series current limiting resistor, the value of which may be calculated as follows:

$$R_p = \text{operating voltage (max.)} \times 10^3\ \Omega.$$

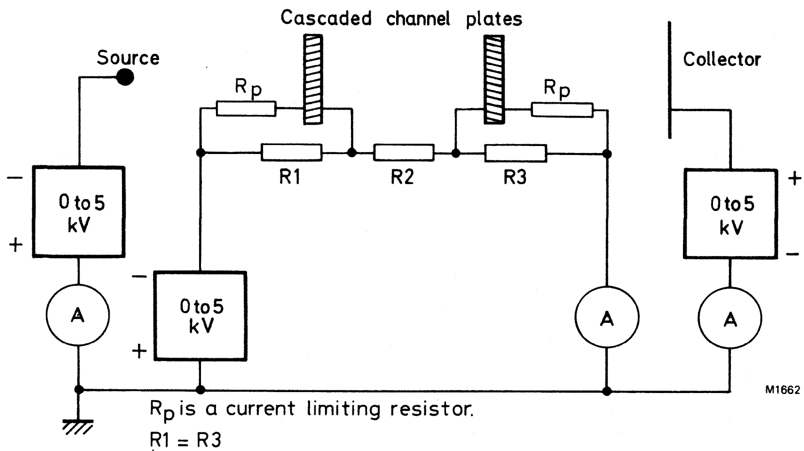


Fig.2 Circuit for cascaded channel plates

CHANNEL ELECTRON MULTIPLIER PLATE

This consists of an array of channel electron multipliers fused into the shape of a disc. The multipliers are electrically connected in parallel by means of nickel-chromium electrodes evaporated on to the faces of the disc.

SPECIFICATION

Disc diameter		$70.0^{+0}_{-0.1}$	mm
Useful diameter	min.	67	mm
Disc thickness		1.0 ± 0.05	mm
Channel diameter	nom.	12.5	μm
Channel pitch	nom.	15	μm
Open area	min.	60	%
Electrode material		nickel-chromium	
Electrical resistance between electrodes	approx.	40	MΩ
Current gain at 1.4 kV (see Fig.1)	min.	1000	
Angle of channel to perpendicular axis of plate		13	degrees

For a linear relationship between input and output, the output current must not exceed 0.1 of the standing current.

APPLICATIONS

This device must operate in a vacuum and may be used to detect electrons, ions, soft X-rays and ultra-violet photons falling in the input face of the plate, by producing electron pulses from the output face of the corresponding channel.

For space experiments, the environmental vacuum is adequate for its operation and it has considerable potential in the field of X-ray and ultra-violet astronomy from rockets and satellites. In laboratory use it must be incorporated in a vacuum chamber, where it will have important applications in field ion microscopy, electron microscopy and allied areas of research.

Such applications are fully discussed by P. Lecomte and V. Perez-Mendez in I.E.E.E. Transactions on Nuclear Science, Vol. NS—25, No. 2 April 1978 – 'Channel Electron Multipliers: Properties, Development and Applications' and 'X-ray detectors in Astronomy' by G. W. Fraser, Cambridge Astrophysics Series, 1989 – Cambridge University Press, ISBN 052132663X.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC134)

Operating voltage	max.	2.3	kV
Temperature* (operating)	max.	55	°C
Bake temperature	max.	300	°C
Ambient pressure with high voltage applied	max.	13.3 (1.0×10^{-4} torr)	$mN.m^{-2}$
Plate clamping rings internal diameter	max.	67.5	mm

*The plate should be stored in a dry or vacuum environment at a temperature below 70 °C.

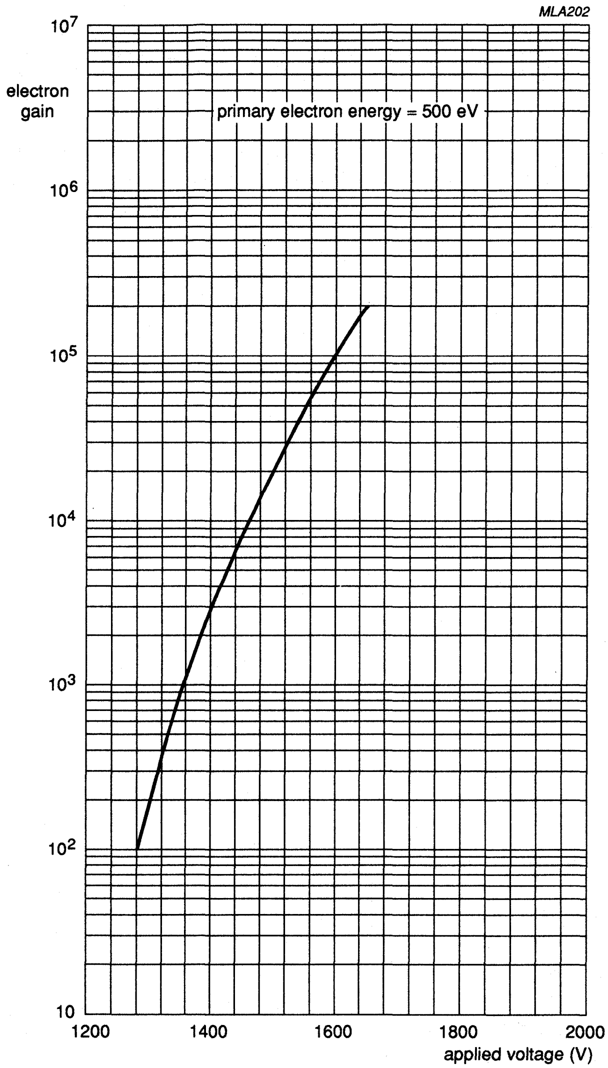


Fig.1 Typical gain curve for a single plate.

MOUNTING

A channel plate is fragile and great care must be taken to ensure that it is not unduly stressed when mounted in the vacuum system. It is recommended that the plate is mounted between clean polished stainless steel rings, giving noise-free electrical contacts. The device will withstand a contact pressure of at least 10^4 $N.m^{-2}$ (corresponding to a load of ~1 g per mm^2) applied via screws pushing against small helical springs. Polished annular shims, about 1.5 mm wide and 50 μm thick, are recommended for insertion between plates operating in cascade.

OVERLOAD PROTECTION

Due to the glass characteristics, it is essential that power supplies should not be capable of delivering a current in excess of 1 mA. This can be achieved by the use of a series current limiting resistor, the value of which may be calculated as follows:

$$R_p = \text{operating voltage (max.)} \times 10^3\ \Omega.$$

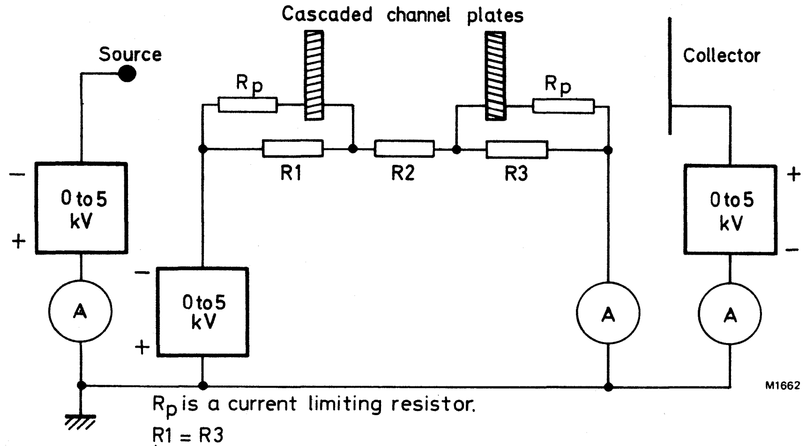


Fig.2 Circuit for cascaded channel plates

CHANNEL ELECTRON MULTIPLIER PLATE

This consists of an array of channel electron multipliers fused into the shape of a disc. The multipliers are electrically connected in parallel by means of nickel-chromium electrodes evaporated on to the faces of the disc.

SPECIFICATION

Diameter of disc		27.1 ± 0.1	mm
Useful diameter	min.	26.5	mm
Disc thickness		1.0 ± 0.1	mm
Channel diameter		25	μm
Channel pitch		31	μm
Open area	min.	60	%
Electrode material		nickel chromium	
Electrical resistance between electrodes		30 to 150	MΩ
Current gain at 1.0 kV (see Fig.1)	min.	1000	
Maximum current output at 1.0 kV for linear operation		1.0	μA
Angle of channel to perpendicular axis of plate		13	degrees

APPLICATIONS

This device must operate in a vacuum, and may be used to detect electrons, ions, soft X-rays and ultra-violet photons falling on the input face of the disc, by producing electron pulses from the output face of the corresponding channel.

For space experiments the environmental vacuum is adequate for its operation, and it has considerable potential in the field of X-ray and ultra-violet astronomy from rockets and satellites.

In laboratory use it must be incorporated in a vacuum chamber, where it will have important applications in field ion microscopy, electron microscopy and allied areas of work.

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RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC134)

Operating voltage	max.	1.5	kV
Temperature** (operating)	max.	55	°C
Bake temperature	max.	300	°C
Ambient pressure with high voltage applied	max.	13.3 (1.0×10^{-4} torr)	$mN.m^{-2}$
Plate clamping rings diameter	max.	26.6	mm

* The suffix /A denotes a pair of plates which are resistance matched for applications requiring two plates in cascade, (see Fig.2).

** The plate should be stored in a dry or vacuum environment at a temperature below 70 °C.

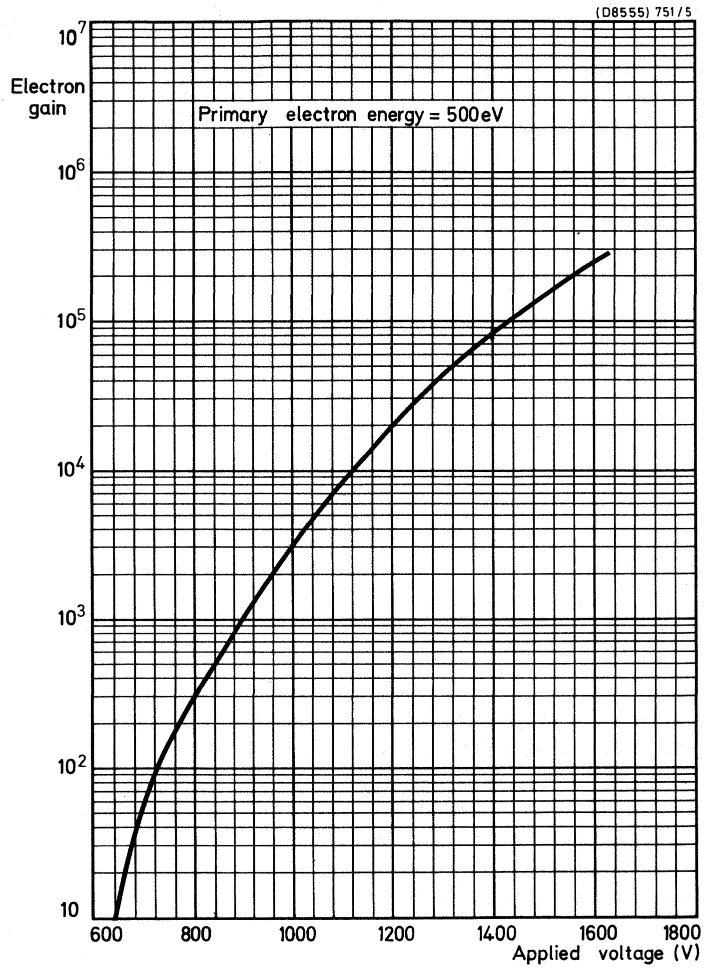

Fig. 1 Typical current gain as a function of applied voltage.

MOUNTING

A channel plate is fragile and great care must be taken to ensure that it is not unduly stressed when mounted in the vacuum system. It is recommended that the plate is mounted between clean polished stainless steel rings, giving noise-free electrical contacts. The device will withstand a contact pressure of at least 10^4 $N.m^{-2}$ (corresponding to a load of ~1 g per mm^2) applied via screws pushing against small helical springs. Polished annular shims, about 1.5 mm wide and 50 μm thick, are recommended for insertion between plates operating in cascade.

OVERLOAD PROTECTION

Due to the glass characteristics, it is essential that power supplies should not be capable of delivering a current in excess of 1 mA. This can be achieved by the use of a series current limiting resistor, the value of which may be calculated as follows:

$$R_p = \text{operating voltage (max.)} \times 10^3 \ \Omega.$$

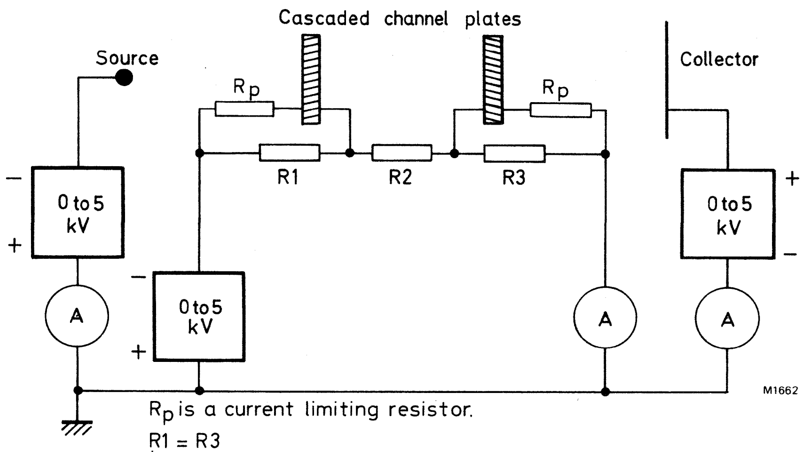

Fig.2 Circuit for cascaded channel plates

Maintenance type

CHANNEL ELECTRON MULTIPLIER PLATE

This consists of an array of channel electron multipliers fused into the shape of a disc. The multipliers are electrically connected in parallel by means of nickel-chromium electrodes evaporated on to the faces of the disc.

SPECIFICATION

Diameter of disc		$53.0^{+0}_{-0.2}$	mm
Useful diameter	min.	51.8	mm
Thickness		1.0 ± 0.1	mm
Channel diameter		25	μm
Channel pitch		31	μm
Open area	min.	60	%
Electrode material		nickel-chromium	
Electrical resistance between electrodes		7 to 40	MΩ
Current gain at 1.0 kV (see Fig.1)	min.	1000	
Angle of channel to perpendicular axis of plate		13	degrees

For linear relationship between input and output the output current must not exceed 0.1 of the standing current.

APPLICATIONS

This device must operate in a vacuum, and may be used to detect electrons, ions, soft X-rays and ultra-violet photons falling on the input face of the disc, by producing electron pulses from the output face of the corresponding channel.

For space experiments the environmental vacuum is adequate for its operation.

In laboratory use it must be incorporated in a vacuum chamber, where it will have important applications in field ion microscopy, electron microscopy and allied areas of work.

Such applications are fully discussed by P. Lecomte and V. Perez-Mendez in I.E.E.E. Transactions on Nuclear Science, Vol. NS—25, No. 2 April 1978 — 'Channel Electron Multipliers: Properties, Development and Applications' and 'X-ray detectors in Astronomy' by G. W. Fraser, Cambridge Astrophysics Series, 1989 — Cambridge University Press, ISBN 052132663X.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC134)

Operating voltage	max.	1.5	kV
Temperature* (operating)	max.	55	^{o}C
Bake temperature	max.	300	^{o}C
Ambient pressure with high voltage applied	max.	13.3 (1.0×10^{-4} torr)	$mN.m^{-2}$
Plate clamping rings diameter	max.	52.4	mm

*The plate should be stored in a dry or vacuum environment at a temperature below 70 ^{o}C.

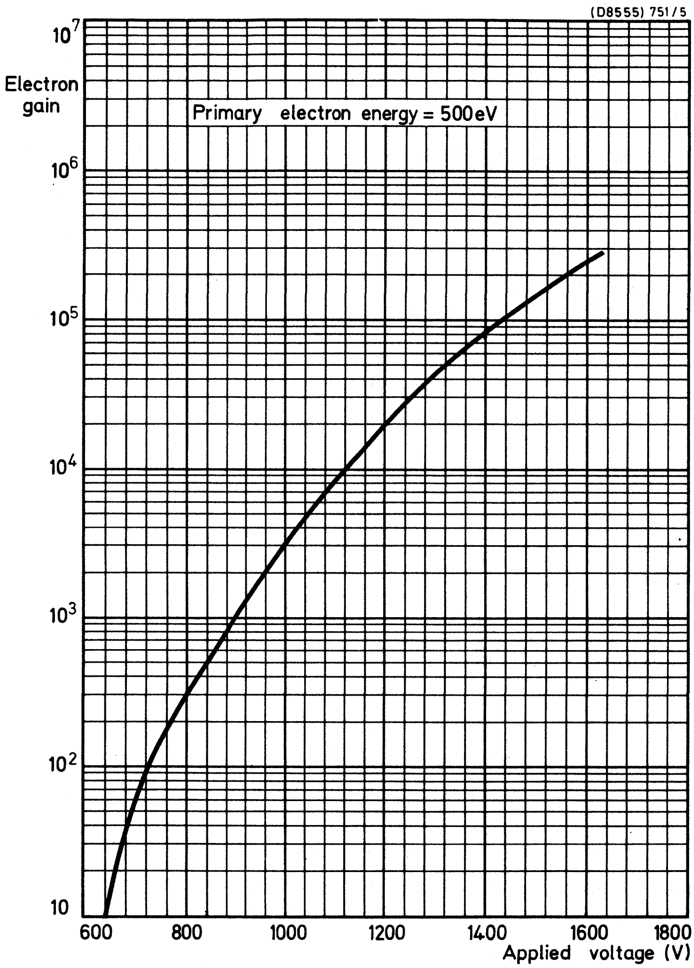

Fig. 1 Typical current gain as a function of applied voltage

MOUNTING

A channel plate is fragile and great care must be taken to ensure that it is not unduly stressed when mounted in the vacuum system. It is recommended that the plate is mounted between clean polished stainless steel rings, giving noise-free electrical contacts. The device will withstand a contact pressure of at least 10^4 N.m^{-2} (corresponding to a load of ~1 g per mm^2) applied via screws pushing against small helical springs. Polished annular shims, about 1.5 mm wide and 50 μm thick, are recommended for insertion between plates operating in cascade.

OVERLOAD PROTECTION

Due to the glass characteristics, it is essential that power supplies should not be capable of delivering a current in excess of 1 mA. This can be achieved by the use of a series current limiting resistor, the value of which may be calculated as follows:

$$R_p = \text{operating voltage (max.)} \times 10^3\ \Omega.$$

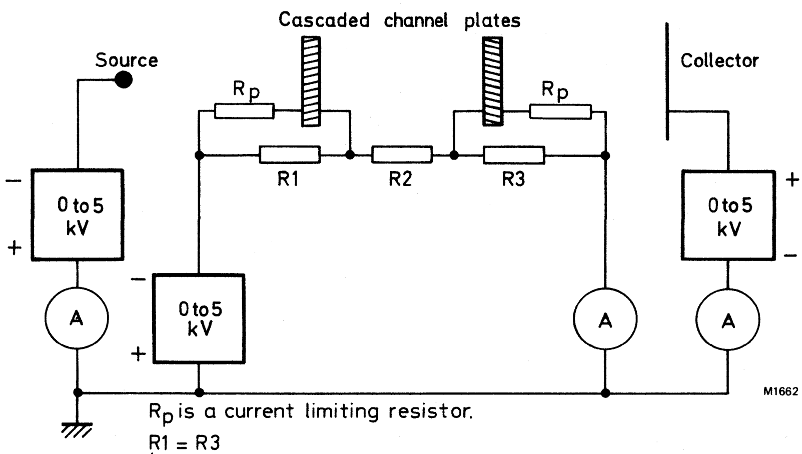

Fig.2 Circuit for cascaded channel plates

Maintenance type

CHANNEL ELECTRON MULTIPLIER PLATE

This consists of an array of channel electron multipliers fused into the shape of a disc. The multipliers are electrically connected in parallel by means of nickel-chromium electrodes evaporated on to the faces of the disc.

SPECIFICATION

Diameter of disc		$70.0^{+0}_{-0.2}$	mm
Useful diameter	min.	68.0	mm
Disc thickness		1.0 ± 0.1	mm
Channel diameter		25	µm
Channel pitch		31	µm
Open area	min.	60	%
Electrode material		nickel-chromium	
Electrical resistance between electrodes	nom.	5	MΩ
Current gain at 1.0 kV (see Fig.1)	min.	1000	
Angle of channel to perpendicular axis of plate		13	degrees

For linear relationship between input and output the output current must not exceed 0.1 of the standing current.

APPLICATIONS

This device must operate in a vacuum and may be used to detect electrons, ions, soft X-rays and ultra-violet photons falling on the input face of the disc, by producing electron pulses from the output face of the corresponding channel.

For space experiments the environmental vacuum is adequate for its operation.

In laboratory use it must be incorporated in a vacuum chamber, where it will have important applications in field ion microscopy, electron microscopy and allied areas of work.

Such applications are fully discussed by P. Lecomte and V. Perez-Mendez in I.E.E.E. Transactions on Nuclear Science, Vol. NS–25, No. 2 April 1978 – 'Channel Electron Multipliers: Properties, Development and Applications' and 'X-ray detectors in Astronomy' by G. W. Fraser, Cambridge Astrophysics Series, 1989 – Cambridge University Press, ISBN 052132663X.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC134)

Operating voltage	max.	1.5	kV
Temperature* (operating)	max.	55	°C
Bake temperature	max.	300	°C
Ambient pressure wuth high voltage applied	max.	13.3 (1.0×10^{-4} torr)	$mN.m^{-2}$
Plate clamping rings diameter	max.	68.5	mm

*The plate should be stored in a dry or vacuum environment at a temperature below 70 °C.

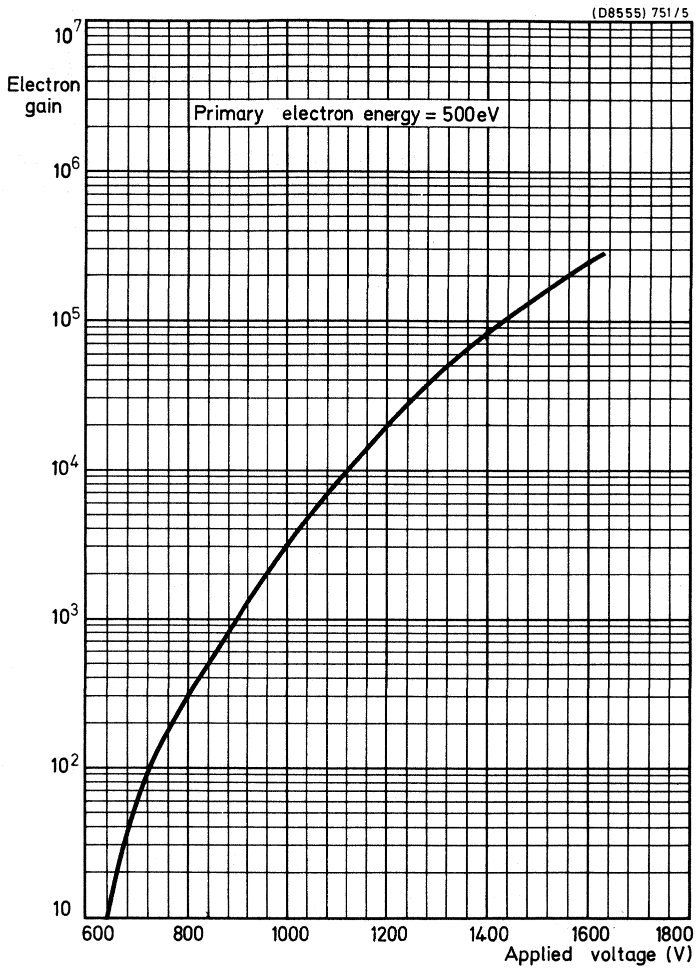

Fig. 1 Typical current gain as a function of applied voltage

MOUNTING

As channel plate is fragile and great care must be taken to ensure that it is not unduly stressed when mounted in the vacuum system. It is recommended that the plate is mounted between clean polished stainless steel rings, giving noise-free electrical contacts. The device will withstand a contact pressure of at least 10^4 $N.m^{-2}$ (corresponding to a load of ~ 1 g per mm^2) applied via screws pushing against small helical springs. Polished annular shims, about 1.5 mm wide and 50 μm thick, are recommended for insertion between plates operating in cascade.

OVERLOAD PROTECTION

Due to the glass characteristics, it is essential that power supplies should not be capable of delivering a current in excess of 1 mA. This can be achieved by the use of a series current limiting resistor, the value of which may be calculated as follows:

$$R_p = \text{operating voltage (max.)} \times 10^3\ \Omega.$$

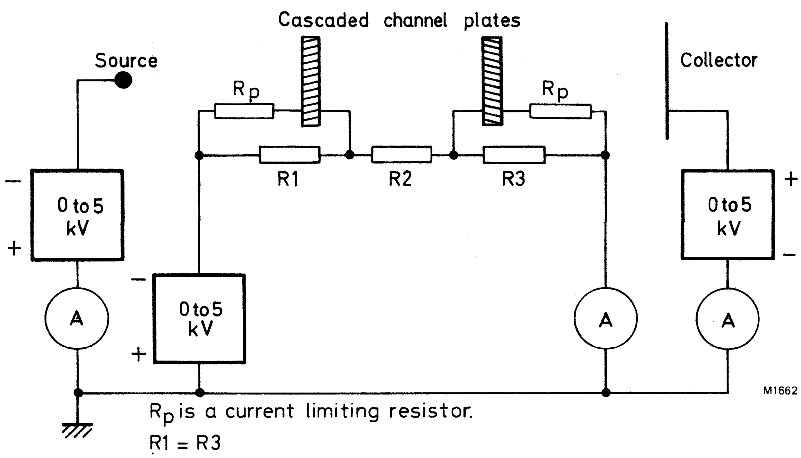

Fig.2 Circuit for cascaded channel plates

DATA HANDBOOK SYSTEM

DATA HANDBOOK SYSTEM

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S4b	**SC06**	**High-voltage and switching power transistors**
S5	**SC07**	**Small-signal field-effect transistors**
S6	**SC08a***	**RF power bipolar transistors**
	SC08b**	**RF power MOS transistors**
	SC09	**RF power modules**
S7	**SC10**	**Surface mounted semiconductors**
S8b	**SC12**	**Optocouplers**
S9	**SC13***	**Power MOS transistors**
S10	**SC14**	**Wideband transistors and wideband hybrid IC modules**
S11	**SC15**	**Microwave transistors**
S15**	**SC16**	**Laser diodes**
S13	**SC17**	**Semiconductor sensors**

* Not yet issued with the new code in this series of handbooks.
** New handbook in this series; will be issued shortly.

DISPLAY COMPONENTS

This series of data handbooks comprises:

code	handbook title
DC01	**Colour display components** Colour TV Picture Tubes and Assemblies Colour Monitor Tube Assemblies
DC02	**Monochrome monitor tubes and deflection units**
DC03	**Television tuners, coaxial aerial input assemblies**
DC04	**Loudspeakers**
DC05	**Flyback transformers, mains transformers and general-purpose FXC assemblies**

PASSIVE COMPONENTS

This series of data handbooks comprises:

current code	new code	handbook title
C14	**PA01**	**Electrolytic capacitors; solid and non-solid**
C11	**PA02**	**Varistors, thermistors and sensors**
C12	**PA03**	**Potentiometers and switches**
C7	**PA04**	**Variable capacitors**
C22	**PA05***	**Film capacitors**
C15	**PA06**	**Ceramic capacitors**
C9	**PA07***	**Piezoelectric quartz devices**
C13	**PA08**	**Fixed resistors**

* Not yet issued with the new code in this series of handbooks.

PROFESSIONAL COMPONENTS

This series of data handbooks comprises:

current code	new code	handbook title
T3	**PC01**	**High-power klystrons and accessories**
T5	**PC02***	**Cathode-ray tubes**
T6	**PC03***	**Geiger-Müller tubes**
T9	**PC04**	**Photo multipliers**
T10	**PC05**	**Plumbicon camera tubes and accessories**
T11	**PC06**	**Circulators and Isolators**
T12	**PC07**	**Vidicon and Newvicon camera tubes and deflection units**
T13	**PC08**	**Image intensifiers**
T15	**PC09**	**Dry-reed switches**
	PC11	**Solid state image sensors and peripherals integrated circuits**
T9	**PC12**	**Electron multipliers**

* Not yet issued with the new code in this series of handbooks.

MAGNETIC PRODUCTS

This series of data handbooks comprises:

current code	new code	handbook title
C4 **C5**	**MA01**	**Soft Ferrites**
C16	**MA02***	**Permanent magnet materials**
C19	**MA03***	**Piezoelectric ceramics**

* Not yet issued with the new code in this series of handbooks.

LIQUID CRYSTAL DISPLAYS

current code	new code	handbook title
S14	**LCD01**	**Liquid Crystal Displays and driver ICs for LCDs**

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