PROFESSIONAL COMPONENTS

DATA HANDBOOK

Image Intensifiers

BOOK PC08 1989

Philips Components

PHILIPS

IMAGE INTENSIFIERS

IMAGE INTENSIFIERS

RATING SYSTEM

(in accordance with IEC Publication 134)

ABSOLUTE MAXIMUM RATING SYSTEM

Absolute maximum ratings are limiting values of operating and environmental conditions applicable to any electronic device of a specified type as defined by its published data, which should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the device under consideration and of all other electronic devices in the equipment.

The equipment manufacturer should design so that, initially and throughout life, no absolute maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply variation, equipment component variation, equipment control adjustment, load variations, signal variation, environmental conditions, and variations in characteristics of the device under consideration and of all other electronic devices in the equipment.

Dimensional drawings are in mm unless otherwise indicated.

GENERAL

1. INTRODUCTION

Image intensifiers are electron-optical devices in which the image of a scene focused onto a photocathode is intensified and displayed on a luminescent screen.

The image intensifiers described in this book are the "second generation" type comprising a multi-alkali photocathode, an electrostatic focusing system, a micro channel plate "MCP" (the amplifying element) and a luminescent screen positioned immediately behind the MCP. A battery powered DC to DC up converter is usually included in the encapsulation.

Second generation image intensifiers can be conveniently classified according to the focusing method and/or inversion of the output image. In some intensifiers the electrons emitted from the photocathode are focused on the MCP by an electron lens which inverts the image, whilst in others, where the MCP is close to the photocathode, "proximity" focusing is used. The latter is called "double proximity" or "wafer" configuration. However, a "wafer" device output image may be inverted by a special fibre-optic output window ("twister").

1.1 The photocathode

The most important properties of photocathodes are spectral response and sensivity. Sensivity is expressed in luminous sensivity (μA/lm - white light) and radiant sensivity (mA/W - at a given wavelength). Both are measured using a tungsten lamp with a colour temperature of 2856 ± 50 K as the light source. Filters are used to determine the radiant sensivity at wavelengths of 800 nm and 850 nm. The image intensifiers described in the data section of this handbook use S25 multi-alkali photocathodes (with extended red response) placed against the inner surface of the (usually fibre-optic) input window. This construction makes them particularly suitable for passive night vision applications which require photocathodes that are highly sensitive in both luminous and radiant qualities (especially near infrared).

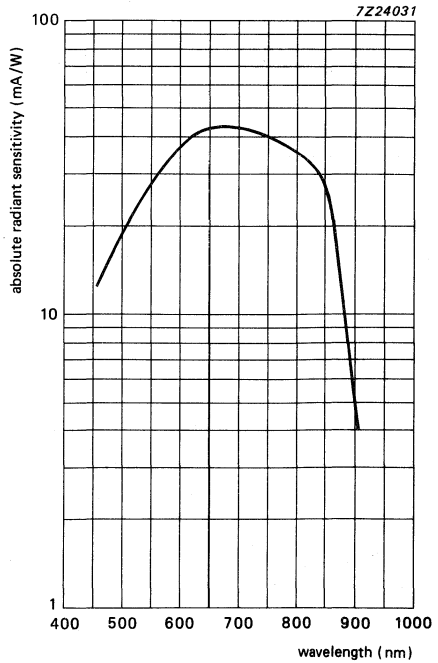


Fig.1 Typical S25 spectral response curve.

1.2 Electrostatic focusing

The image intensifiers in this data book are electrostatically focused, either by an electron lens or by the proximity method. The design of the electron optics determine such parameters as magnification, distortion, resolution, image alignment and, in the case of inverter devices with built-in ion trap, operational life.

1.3 The microchannel plate

With all the image intensifiers described in this publication, the image is intensified by a microchannel plate which considerably reduces size and weight compared with first generation types having similar gain (image intensification). Other advantages using MCP intensifiers are point highlight saturation, automatic gain control (AGC), flash protection and automatic brightness control (ABC).

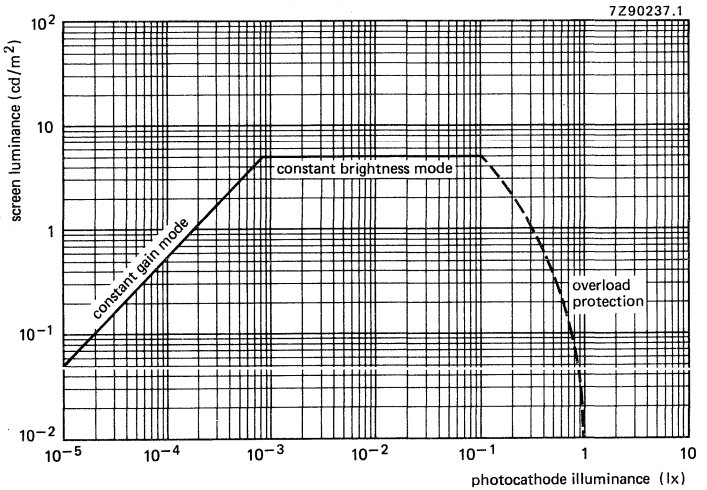


Fig.2 Example of screen luminance as a function of photocathode illuminance.

The luminescent screen

The screen of an image intensifier is normally viewed directly, therefore, the standard phosphor used in this series of devices is the green P20 type to which the eye is particularly sensitive.

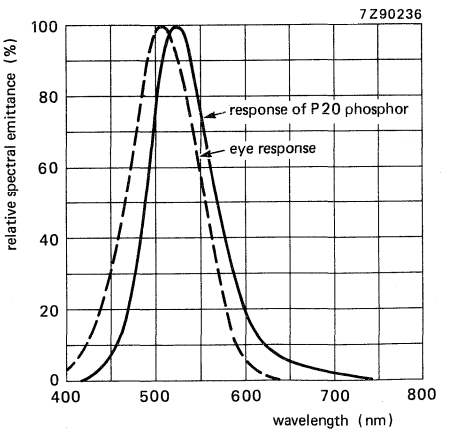


Fig.3 Typical spectral emittance of P20 phosphor and spectral response of dark-adapted eye.

The decay time of the output phosphor of an image intensifier is the time taken (after the excitation due to the incident electron beam is removed) for the screen luminance to fall to 37% (e^{-1}) of the initial peak value. For special applications, alternative phosphors with decay times between 0.2 mS and 1 mS may be available.

2 CHARACTERISTICS

2.1 Gain (or luminance gain)

The gain of an image intensifier is related to the screen luminance L_o (cd/m^2) and the illuminance E_i (lx) of the photocathode by:

$$\text{gain} = \frac{\pi L_o}{E_i}.$$

The screen luminance is measured over a diameter of ϕ_G in a direction normal to the screen, using an eye-corrected photometer having an acceptance angle of less than 10°. The photocathode is uniformly illuminated over a stated area by a tungsten lamp operating at a colour temperature of 2856 ± 50 K. The data for each particular image intensifier type states the applicable values of E_i and ϕ_G. Gain is dimensionless.

2.2 Mean screen luminance

This is the mean luminous intensity (cd) of the screen over a stated area (m^2). This characteristic is given only for intensifiers with an integral power supply because it depends on the properties of the power supply. Automatic brightness control (ABC) is a means of limiting the screen brightness at high levels of photocathode illuminance. Where appropriate, the ABC characteristics are given in the data.

2.3 Magnification and distortion

The magnification of an image intensifier is normally measured at two diameters. Centre magnification is determined by measuring the diameter ϕ_s of the image on the screen of a small circle of diameter ϕ_d projected on the centre of the photocathode. The centre magnification M_d is then defined as ϕ_s/ϕ_d. Great care must be exercised when determining M_d because of the difficulty of accurately measuring the small diameter ϕ_s.

Similarly, the edge magnification is obtained by measuring the greater diameter ϕ_S of the image on the screen of a larger circle of diameter ϕ_D projected onto the centre of the photocathode. The edge magnification M_D is defined as ϕ_S/ϕ_D.

The magnification of intensifiers focused by an electron lens can vary with the distance from the centre of the screen causing a small amount of distortion to the image. This kind of distortion cannot normally occur in proximity focused intensifiers. A very small amount of optical distortion may, however, be introduced when a fibre optic output window (twister) is used to invert the image. The distortion figures given in the data sheets for individual types refer to percentage of distortion which is calculated as follows:

$$\left\{ \frac{M_D}{M_d} - 1 \right\} \times 100.$$

2.4 Limiting resolution and modulation transfer factors

Limiting resolution and modulation transfer factors indicate the degradation of contrast modulation introduced by an imaging device. This is measured using a standard resolution chart. For the figures given in the data, a bar pattern with a mark-space ratio of 1:1 and contrast approaching 100% is used. The spatial frequency is relative to the input plane (photocathode). The resolution pattern projected onto the photocathode and screen is microscopically examined by a magnification factor of at least 5x. Two figures are normally given in line-pairs per mm (lp/mm); the centre resolution and the resolution at a distance from the centre ($\phi_E/2$). The latter is known as the edge resolution.

The practice of specifying image quality in terms of limiting resolution is borrowed from photography. A better characteristic for optical systems (intensifiers may be considered as optical systems) is the modulation transfer function (MTF). When a bar pattern with sinusoidally varying intensity is projected onto the input of an optical system which satisfies the transfer conditions (light output linearly related to light input and where the imaging properties do not vary from point to point), the image at the output will also be a sinusoidal bar pattern but with lower contrast (modulation). Then a Fourier analysis of slit image will yield the MTF as the ratio between the contrast of the input and output images over a range of spatial frequencies. This relationship at any one frequency (line-pairs/mm or cycles/mm) is the modulation transfer factor. Spatial frequency may be referred to either the input (photocathode) or the output (screen) plane and is returned to a normal 100% when line pairs/mm or cycles/mm are zero. An example of an MTF curve is given in Fig.4.

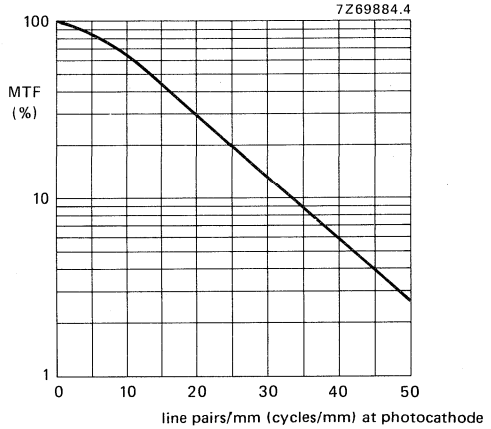


Fig.4 An example of a transfer function curve.

2.5 Veiling glare

With a partially illuminated input, veiling glare is expressed as the ratio (%) between the luminance of the dark and light parts of the screen.

2.6 Signal-to-noise ratio

The signal-to-noise ratio of the image projected onto the input window deteriorates as it passes through an intensifier. This deterioration occurs at the photocathode (which is relative to the photocathode quantum efficiency) and at the microchannel plate (relative to the effective open area of the MCP and it's associated variance in electron multiplication). This ratio is determined by measuring the signal-to-noise ratio of the screen image at a small area of the photocathode which is illuminated at a specified level.

2.7 Equivalent background illumination (EBI)

With the supply voltage applied and no incident illumination on the photocathode, the screen will have a finite background brightness. The EBI is the input illumination required to give an increase in screen brightness equivalent to this background brightness.

2.8 Brightness uniformity (or screen luminance ratio).

The luminance at the output window may vary somewhat over the screen, but this will not impair the image quality providing there is no sharp demarcation between light and dark areas. For some types, a brightness uniformity value is given. This is the ratio of maximum to minimum luminance values of small areas over the useful screen when the photocathode is uniformally illuminated by a white light source.

2.9 Picture quality

In all image intensifiers some minor blemishes may occur that do not affect normal usage. A blemish is defined as a dark or bright area differing in contrast by more than 30% with respect to the immediate surrounding area. The picture quality of an intensifier is assessed by viewing the screen through a magnifier of between 5x and 10x magnification. This method is used because of the difference in the appearance of an intensified image viewed directly through a magnifier to that viewed on a TV screen.

2.10 Image alignment

Image alignment is a measure of the geometric and optical axes of an intensifier which may not exactly coincide. It is the displacement of an image from the geometric centre of the screen when a test pattern is geometrically centred on the photocathode.

2.11 Recovery time

The recovery time is the time taken for a useful image to be restored on the screen after a rapid change in photocathode illuminance. The photocathode is subjected to an illumination pulse and the time between the end of the pulse and recovery to a specified steady-state output is measured.

3 RATINGS, ETC.

3.1 Supply voltage

The supply voltage required to operate an image intensifier is given in the data. Under no circumstances should the Absolute Maximum Rating be exceeded. Precautions should be taken to protect the device against switching transients, e.g. by a 10 μF capacitor across the supply terminals. An intensifier with an encapsulated power supply will not function but will not be damaged if the supply voltage is reversed for up to one minute. The length of the connecting leads to the intensifier should be kept to a minimum.

3.2 Maximum photocathode illuminance

The figures given in the data refer to a uniform continious illumination. All intensifiers will tolerate intermittent bursts of cathode illuminance that are much higher than the rated maximum value. However, prolonged exposure to any source of bright light can damage an intensifier. Some devices incorporate automatic control of brightness (ABC) or gain (AGC). These reduce the screen luminance but will not necessarily reduce the photocathode current. Whenever possible, the photocathode illuminance should comply with the recommended operating conditions where given in the data.

3.3 Storage and handling

Intensifiers should be stored in desiccated airtight containers and in temperatures maintained within the specified limits. The devices must be handled with care. Particularly, the intensifier case must not be compressed, the fibre optic windows should be protected from damage by dust, grit, etc. and the protective plastic end-caps should not be removed until the intensifier is about to be mounted in equipment. (see also the Warning in section 8).

3.4 Mounting

Intensifiers may normally be mounted in any orientation but, where a particular mounting for optimum operation is recommended, the details are included in the data. The intensifier should be mounted in such a way that any axial forces are absorbed on the bearing surfaces and not on input or output windows. To avoid flash-over, care should be exercised to ensure that no conductive equipment or component is mounted too close to the input or output windows (i.e. within a few millimeters).
See also sections 5 and 8.

4. OUTLINE DRAWING

The mechanical drawings included in the data show only the major dimensions of the device. The supplier should be consulted when more detailed information is required for equipment design etc.

5 EHT PRECAUTIONS

Image intensifiers operate with high voltages, therefore, care must be taken to ensure that when the supply voltage is connected or residual high potentials exist on connectors or faceplates, the ambient atmosphere is dry throughout the temperature range for the device. Care should also be exercised with some microchannel plate image intensifiers which can retain potentials of several kV for up to one hour after switching off (the screen and cathode windows are at opposite potentials of approximately 6 kV with respect to the input terminals). Irrepairable damage may occur if the input or output windows of an intensifier are shorted to the supply terminals. It is recommended that suitable measures are taken for the prevention of corona discharge to which image intensifiers are particularly sensitive.

6 SAFETY

Image intensifiers with integral power supplies offer no risk during normal operation. The ultrasonic noise produced by power supplies (operating at frequencies between 1 and 40 kHz) of encapsulated intensifiers is unlikely to be detrimental to health.
After operation, intensifiers may retain charges of several kV for a number of hours. Fibre-optics, glass plates or metal components of an intensifier must not be touched by the operator or allowed to come into contact with conductive material. Failure to observe these precautions will be hazardous to the operator and may cause irrepairable damage to the intensifier. If the device is damaged or broken, precautions should be taken against the following hazards:

- Broken glass. Protective clothing, such as rubber gloves, should be worn.
- Contamination by photocathode and fluorescent screen materials. Particularly, skin contact and inhalation of these materials should be avoided.
- Disposal. Incineration is not recommended because toxic fumes may be generated by the burning materials. When using other methods of disposal the above warnings must be observed and care should be taken to avoid environmental pollution.

7 WARNING

Image intensifiers are very high vacuum devices and any deterioration in the vacuum will lead to a shortening of their useful life. Intensifier elements are permeable to helium, so it is imperative that they are not subjected to excessive concentrations of this gas. It is particularly important that when equipment incorporating an intensifier is purged, helium-free gas must be used.

Image intensifiers, typical values

Category and types	input/output window mm	gain x 1000	photocathode sensivity white μA/W	800 nm mA/W	850 nm mA/W	MTF at l_p/mm % 2.5	7.5	15	optical length mm	mass gms	page	remarks
A. Electro-optic inverter types												
XX1332	50/40	45	320	28	17	94	73	45	99	850	15	P20 screen phosphor
XX1380	20/30	22	350	35	30	96	79	50	80	350	21	P20/P39 mixed phosphor
XX1380FL	20/30	22 adj.	350	35	30	96	79	50	80	350	28	P20/P39 mixed phosphor
XX1381	20/30	22	350	35	30	96	81	53	80	350	29	
XX1381FL	20/30	22 adj.	350	35	30	96	81	53	80	350	29	
XX1387*	20/30	22	350	35	30	96	81	53	80	330	30	
XX1500	18/18	45 adj.	350	35	25	92	67	33	54.6	180	53	
XX1500HG	18/18	85 adj.	350	35	25	92	67	33	54.6	180	59	
XX1500TV	15 x 11/18	85 adj.	350	35	25	92	67	33	54.6	180	61	
XX1500TVMC	15 x 11/18	85 adj.	350	35	25	92	67	33	54.6	180	63	
XX1501	18/18, concave	45 adj.	350	35	25	92	67	33	54.6	180	66	
XX1502*	18/18	17 adj.	350	35	25	92	67	33	54.6	300	67	
B. Proximity focused types												
XX1390	18/18	15 adj.	400	35	30	29 lp/mm			4	40	32	glass windows
XX1410	18/18, concave, inv.	10	420	40	30	89	60	30	26.6	100 max.	35	
XX1410/SP10005-201	18/18, concave, inv.	15	450	40	30	90	62	30	20	75 max.	39	glass input window
XX1410/SP20103-260	18/18, concave, inv.	10	420	40	30	89	60	30	26.6	100 max.	43	
XX1410/SP20103-265	18/18										43	
XX1410/SP20121-210*	18/18, flat	15 adj.	420	40	30	89	60	30	21	80 max.	44	
XX1410/SP20121-211	18/18										46	
XX1410/SP20122-210	18/18, flat	10	420	40	30	89	60	30	21	100 max.	48	
XX1410/SP31021-162	18/18										49	
XX1410/SP41021-160	18/18										51	
XX1610	18/18	22	600	50	35	80	60	30	26,6	100 max.	71	
C. Intensified image sensors												
XX1410/SP20123-AA0	18/**		400			21 lp/mm				115		CCIR
XX1410/SP20123-AB0	18/**		400							115		EIA

* Power supply not included.

** 24 pin DIL (for further information please consult the manufacturer).

SUPERSEDES DATA OF SEPTEMBER 1983

IMAGE INTENSIFIER

The XX1332 is an electrostatically self-focused, inverting microchannel plate image intensifier which incorporates an integral power supply. With a 50 mm optic input window and a 40 mm fibre optic output window it gives a large format high resolution image, enabling a single bi-ocular output eyepiece to be used. This makes the intensifier suitable for surveillance or vehicle-borne night vision applications. Other features of this intensifier include automatic gain control, bright source protection (due to point highlight saturation), automatic brightness control and very fast recovery from exposure to high light levels.

This data must be read in conjunction with General Introduction Image Intensifiers.

QUICK REFERENCE DATA

Input			
Photocathode		S25	
Useful diameter	min.	48,8	mm
Material		plane fibre optic	
Output			
Screen phosphor		P20, aluminized	
Useful diameter	min.	38,8	mm
Material	-	plane fibre optic	
Optical length	nom.	98,7	mm
Recommended supply voltage		6,5	V
Input current	typ.	32	mA
	max.	50	mA
Mass	max.	850	g

CHARACTERISTICS

Measured at 22 ± 3 °C with recommended supply voltage

	min.	typ.	max.	
Sensitivity				
white light	250	320		μA/lm
λ = 800 nm	20	28		mA/W
λ = 850 nm	10	17		mA/W
Luminance gain, ϕ_G = 25 mm, $E_i \approx 50$ μlx	30 000	45 000*	60 000	
Mean screen luminance, ϕ_G = 22,5 mm, $E_i \approx 20$ mlx	4,0	6,5	8,0	cd/m²
Equivalent background illumination (EBI)		0,08	0,20	μlx
Resolution				
centre	18	23		lp/mm
edge, ϕ_E = 28 mm	18	20		lp/mm
Magnification				
centre, ϕ_d = 4,0 mm	0,62	0,66	0,71	
edge, ϕ_D = 40 mm	0,71	0,74	0,77	

* Preset by manufacturer.

CHARACTERISTICS (continued)

	min.	typ.	max.	
Modulation transfer factors*				
5 cycles/mm	80	86		%
10 cycles/mm	55	63		%
20 cycles/mm	20	30		%
Veiling glare		0,8	1,0	%
Distortion, ϕ_D = 40 mm		10		%
Image alignment			2,0	mm
Recovery time		0,2	0,5	s
Brightness uniformity			3:1	
Mounting position		any**		

RATINGS

Limiting values in accordance with the Absolute Maximum System IEC 134

	max.	min.	
Supply voltage			
continuous	6,75		V
instantaneous	7,0		V
Photocathode illuminance	1,0		lx
Ambient temperature			
for storage, 100 hrs. cumulative	70	−20	°C
for operation and long term storage	35	−20	°C
for operation, 2 hrs. max.	52	−40	°C
Axial forces between bearing surfaces	150		N

Note: If the supply voltage falls below 6,0 V, the intensifier may not function, but will not be damaged. If the supply voltage is reversed up to 60 s, the intensifier will not function, but will not be damaged.

QUALIFICATION APPROVAL

Qualification approval to DEF STAN 59-60/90/089, Issue 2, September 1980 has been obtained. Testing of the various characteristics is normally carried out as required by that specification. Intensifiers can be supplied with certificates of conformity to the DEF STAN specification.

WARNING

Immediately after operation, the screen will remain electrostatically charged for approximately 1 minute, during which time the intensifier should not be handled. Any attempt to discharge the intensifier by any means may result in irreparable damage.

ENVIRONMENTAL TESTS

Shock	6 shocks, half-sinewave, pulses of peak acceleration 981 m/s^2, duration 6 ms, in 3 mutually perpendicular directions.
Vibration	Sinewave, displacement 0,15 mm over frequency range 10 to 58 Hz, peak acceleration 19,6 m/s^2 over frequency range 58 to 150 Hz, in 3 mutually perpendicular directions.
Temperature cycle	8½ hour cycle including 1½ hours storage at −40 °C, 2 hours storage at + 70 °C, operation at 52 °C and 22 °C.

* These values are normalized at zero spatial frequency and are referred to the screen.
** Force on supply contacts must not exceed 10 N.

PHOTOCATHODE ILLUMINANCE

Recommended level	max. 10 mlx. The intensifier may be used at illumination levels up to 1,0 lx but for continuous operation the recommended maximum illumination is 10 mlx.
Room lighting	no damage, with no applied voltage.
Point light sources such as car lights tracers, flashers, etc.	no damage.

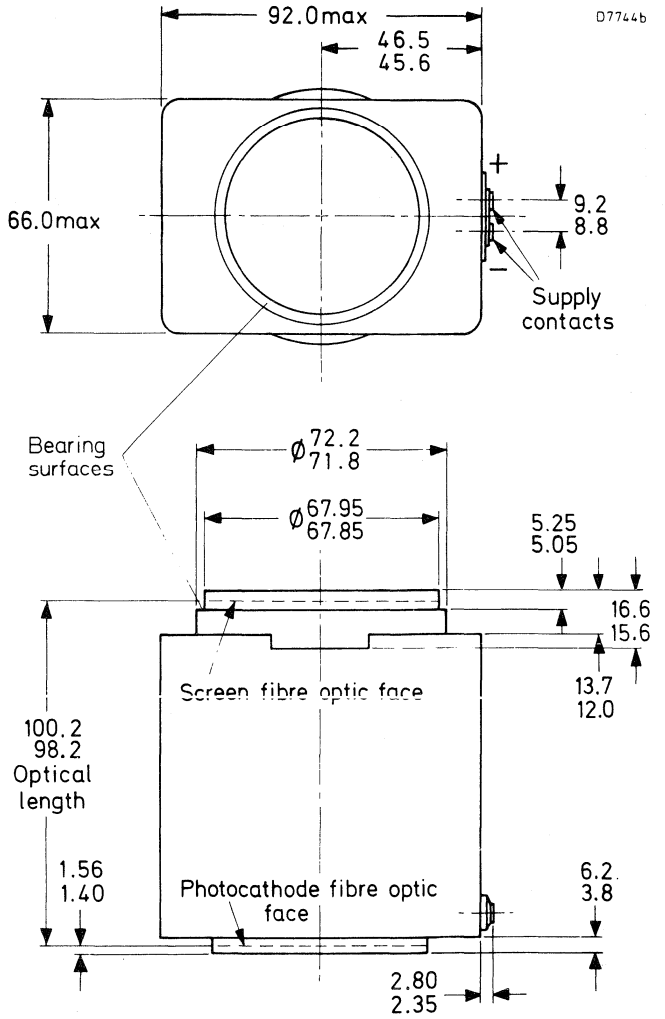
Prolonged operation with illuminance exceeding 10 mlx can reduce the life of the intensifier. This corresponds to the scene illuminance of deep twilight when the intensifier is incorporated in a typical sight.

LIFE EXPECTANCY

Cathode illumination	
1 mlx	min. 2000 hrs.
100 μlx	min. 5000 hrs.

MECHANICAL DATA

Dimensions in mm



Force on supply contacts must not exceed 10 N

Fig. 1 Outline drawing.

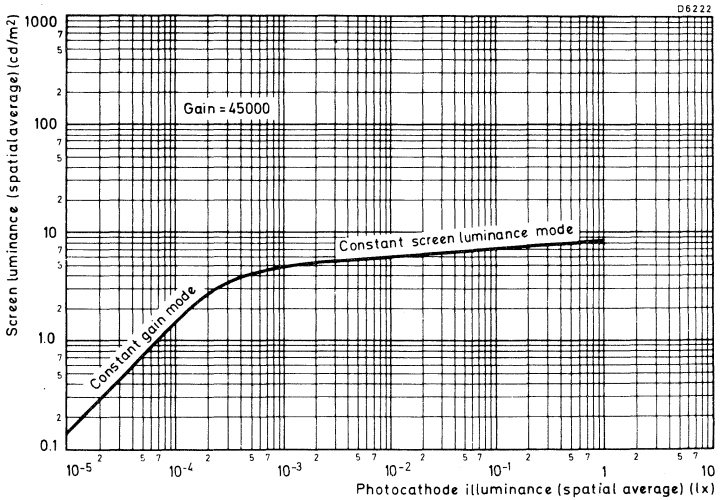


Fig. 2 Typical automatic brightness control characteristic.

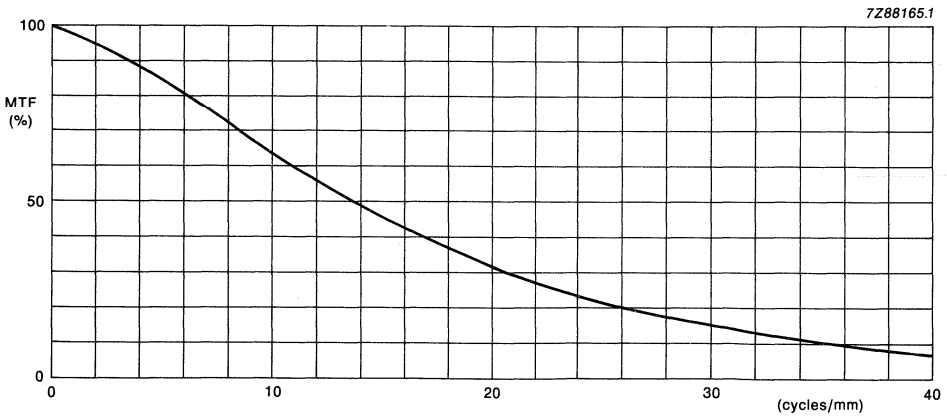


Fig. 3 Typical modulation transfer factor.

SUPERSEDES DATA OF AUGUST 1985

IMAGE INTENSIFIERS

The XX1380 series image intensifiers are self-focusing magnifying compact microchannel plate image intensifiers with integral power supply, incorporating automatic gain control, intended for use in light-weight night vision systems for visible light and near-infrared radiation. Particular features of these intensifiers include point highlight saturation, high resolution and precision engineered surfaces. The intensifiers have plane fibre-optic input and output windows and a medium-long persistence phosphor screen.

This data must be read in conjunction with General Introduction Image Intensifiers.

The XX1380 family consists of:

XX1380	the basic version, P20/P39 mixed screen phosphor, aluminized
XX1380FL	as XX1380, but with flying leads and adjustable luminance gain (note 1)
XX1381	as XX1380, but with P20 screen phosphor
XX1381FL	as XX1381, but with flying leads and adjustable luminance gain (note 1)
XX1387	as XX1381, but without integral power supply

Other special versions of the XX1380 series are available on request

QUICK REFERENCE DATA

Input			
Photocathode		S25	
Useful diameter	min.	19,5	mm
Material		fibre-optic	
Output			
Screen phosphor XX1380, XX1380FL		P20/P39 mixed, aluminized	
XX1381, XX1381FL, XX1387		P20, aluminized	
Useful diameter	min.	30	mm
Material		fibre-optic	
Optical length	nom.	80,1	mm
Recommended supply voltage (note 2)		2,6	V
Input current (note 2)	max.	25	mA
Mass	max.	350	g

CHARACTERISTICS

Measured at 25 ± 5 °C with recommended supply voltage	min.	typ.	
Sensitivity, measured before P.S.U. is fitted,			
white-light, colour temperature 2856K	240	350	μA/lm
λ = 800 nm	20	35	mA/W
λ = 850 nm	15	30	mA/W
Useful diameter	19,5		mm
Material	fibre-optic		

CHARACTERISTICS (continued)

	min.	typ.	max.	
Luminance gain (note 3)				
→ ϕ_G = 7,5 mm, $E_i \approx 50$ μlx		22 000	80 000	
Mean screen luminance, $E_i \approx 10$ mlx, see Fig. 3	4		6	cd/m²
Equivalent background illumination (EBI)			0.20	μlx
Signal-to-noise ratio (note 4)				
→ XX1380, XX1380FL	4.5	5.5		
→ XX1381, XX1381FL	2.8	3.5		
Resolution				
centre	44	51		lp/mm
edge, ϕ_E = 16 mm	40	45		lp/mm
Magnification				
centre, ϕ_d = 2,5 mm		1.5		
Modulation transfer factor, reduced area (note 5)				
2,5 lp/mm	92	96		%
7,5 lp/mm	75	81		%
15 lp/mm	45	53		%
Veiling glare		1.5	5.0	%
→ Distortion, ϕ_D = 16 mm (note 6)		0.3	2	%
Image alignment			1.0	mm
Recovery time			0.5	s
Image shift		0.02	0.15	mm
Mounting position		any		
Output brightness uniformity (white light)			2.5: 1	

RATINGS

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

	max.	min.	
→ Supply voltage (note 7)	3.4	2.2	V
Photocathode illuminance, max. 1 hour (note 8; no voltage applied)	5000		lx
Ambient temperature			
for operation and long term storage	52	−40	°C
for storage	68	−55	°C
Axial forces between bearing surfaces (note 9)	250		N

SHOCK AND VIBRATION RESISTANCE

The following test conditions are supplied on a sampling basis to access the mechanical quality of the intensifiers.

Shock 1

The device with the operating voltage applied is subjected 6 times to a peak acceleration of 500 g in each of the following directions:
a. parallel to the mechanical axis,
b. perpendicular to mechanical axis.

Pulse shape: half-sinusoidal, pulse duration: 0,30 ± 0,05 ms measured between the 10% of the peak amplitude values.

Shock 2

The device with the operational voltage applied is subjected 6 times to a peak acceleration of 140 g in each of the following directions:
a. parallel to the mechanical axis,
b. perpendicular to the mechanical axis.

Pulse shape: half-sinusoidal, pulse duration 9,0 ± 0,05 ms measured between the 10% of the peak amplitude values.

Shock 3 (bump test)

The device with no voltage applied is subjected 2000 times to a peak acceleration of 40 g in each of the following directions:
a. parallel to the mechanical axis,
b. perpendicular to the mechanical axis.

Pulse shape: half-sinusoidal, pulse duration 6 ± 2 ms and 2 to 4 shocks per second.

Vibration

The device is subjected to a vibration frequency of 10 Hz to 3500 Hz with an acceleration of 2,5 g in the following directions:
a. parallel to the mechanical axis,
b. perpendicular to the mechanical axis.

Duration of vibration: 30 minutes. Sweep rate: 10 Hz to 3500 Hz in a logarthmic sweep rate of 30 minutes. (2 sweeps (a and b), total test duration 2 hours).

PACKAGING

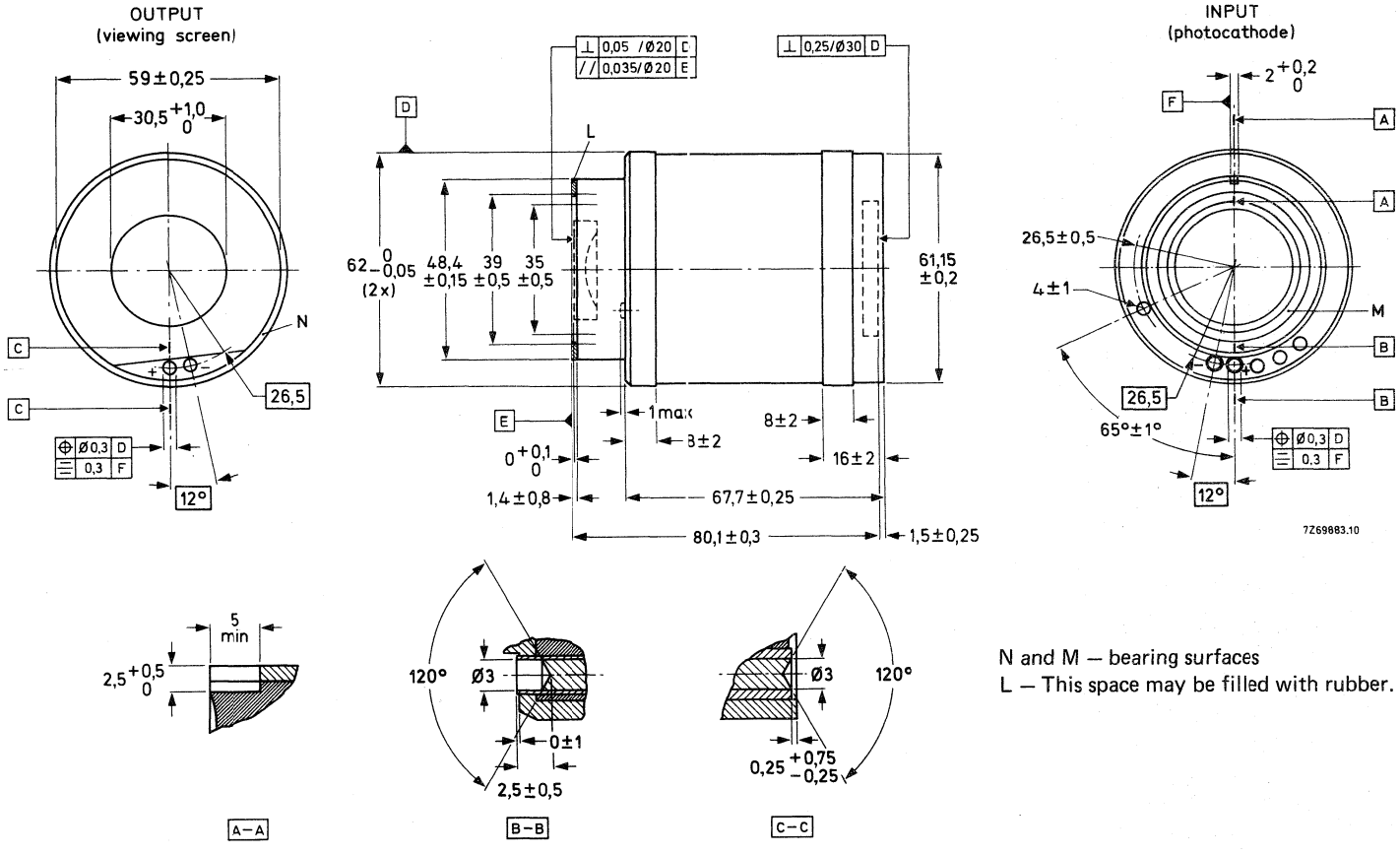
The tubes are individually packed in an hermetically sealed tin, filled with nitrogen. This tin should not be opened before use.

LIFE EXPECTANCY

	min.	typ.
Cathode illumination 100 μlx	2000	5000 hrs.

MECHANICAL DATA

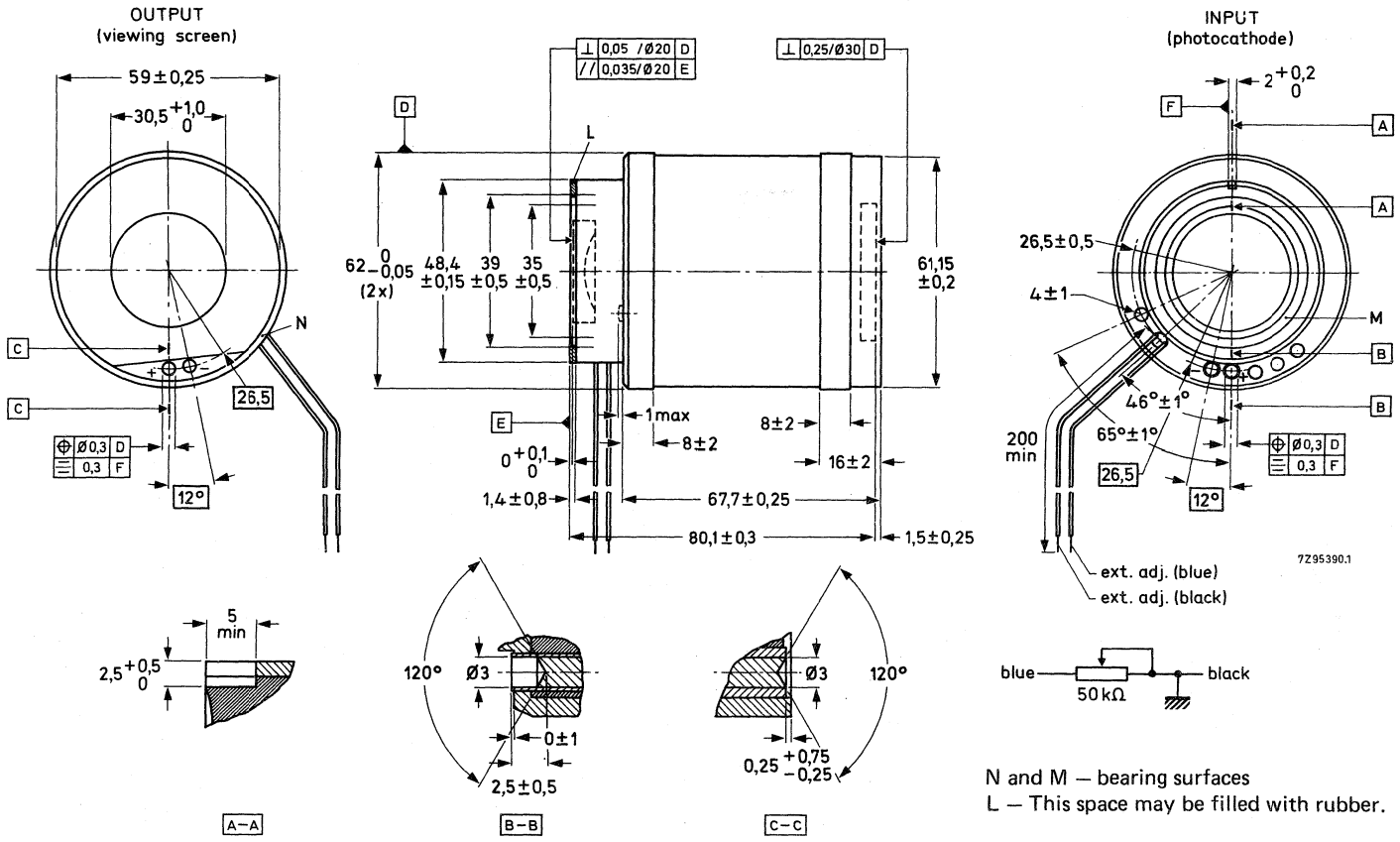
Dimensions in mm



N and M — bearing surfaces
L — This space may be filled with rubber.

Fig. 1 Outline drawing XX1380/XX1381.

Dimensions in mm



N and M — bearing surfaces
L — This space may be filled with rubber.

Fig. 2 Outline drawing XX1380FL/XX1381FL.

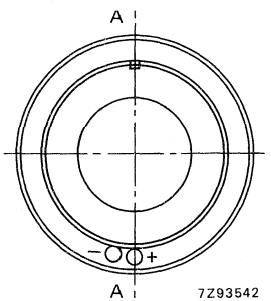
Notes

1. The user can vary the luminance gain up to the preset value by means of a 50 kΩ variable resistor.
2. Recommended supply voltage and input current except for XX1387 delivered without integral power supply.
3. Upon request the luminance gain can be set at other values.
4. The signal-to-noise ratio is measured by uniformly illuminating, with illuminance E_i, a circular spot of known area on the photocathode. The resultant output photocurrent from the screen is filtered with a four-pole Butterworth low-pass filter set for a 3 dB point at 20 Hz. The output from the filter is measured with a DC and r.m.s. meter. The combination of the filter and the P20 phosphor has a bandwidth of 17,5 Hz. Signal-to-noise ratio is defined as:

$$\frac{S}{N} = K \frac{S_o - S_b}{\sqrt{(N_o^2 - N_b^2)}} \cdot \sqrt{\left(\frac{1{,}24 \times 10^{-5}}{E_i} \times \frac{3{,}14 \times 10^{-8}}{A} \right)}$$

   K = correction factor for filter (1,32), to obtain equivalent bandwidth of 10 Hz.
   N_o = r.m.s. signal output.
   S_o = DC signal output.
   N_b = r.m.s. signal output } when the intensifier's photocathode is capped.
   S_b = DC signal output }
   E_i = photocathode illuminance.
   A = area of circular spot.

5. Measuring the modulation transfer factor in a reduced area gives a negligible low-frequency drop. The measurement is referred to the centre of the photocathode in A-A direction.



6. The same limits also apply at ϕ_D = 19 mm.
7. The tube will operate at any supply voltage from 2,2 V to 3,4 V. If the supply voltage falls below 2,2 V, the intensifier may not function, but will not be damaged. If the supply voltage is reversed for up to 60 s, the intensifier will not function, but will not be damaged.
8. Exposure to focused intense light or infrared radiation should be avoided.
9. The intensifier should be mounted only between bearing surfaces M and N. Surface M is defined by the diameters 39 mm and 35 mm at the photocathode end. Surface N is defined by the diameters 59 mm and 61 mm at the screen end.

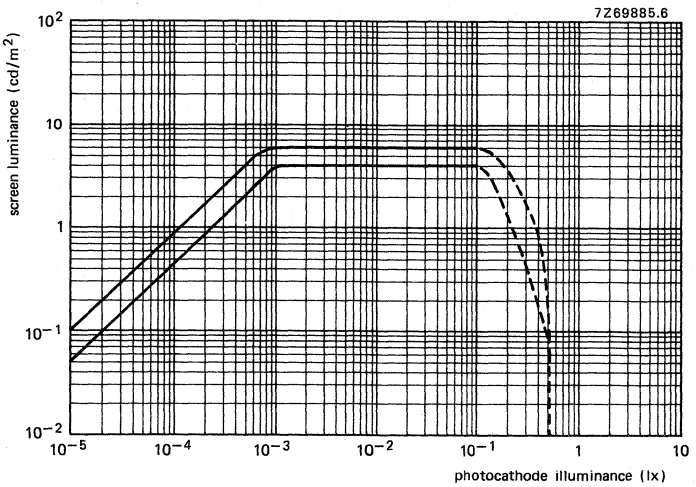


Fig. 3 Maximum and minimum screen luminance as a function of photocathode illuminance.

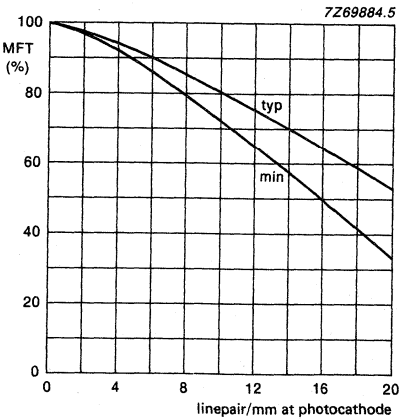


Fig. 4 Reduced area modulation transfer characteristic.

SUPERSEDES DATA OF AUGUST 1985

IMAGE INTENSIFIERS

This intensifier conforms to the specification of the XX1380-series. For this reason only changes and/or additions, relevant to XX1380 (XX1380FL) are given in this data sheet.

QUICK REFERENCE DATA

Overall phosphor persistence (mixed phosphor)	medium to long		
→ Input current	max.	25	mA

CHARACTERISTICS

Measured at 25 ± 5 °C with recommended supply voltage

Mean screen luminance, ϕ_G = 7.5 mm, $E_i \approx$ 10 mlx		4 to 6	cd/m²
Signal-to-noise ratio	min.	4,5	
Ambient temperature (storage, 100 hours cumulative)	max.	68	°C
Recovery time		0.5	S
→ Decay time (10% level)		10 to 20	mS

Note: The image intensifier XX1380FL is identical to XX1380 but has flying leads. With the help of a variable resistor of 50 kΩ the user can vary the luminance gain up to the preset value.

SUPERSEDES DATA OF AUGUST 1985

IMAGE INTENSIFIERS

This intensifier conforms to the specification of the XX1380-series. For this reason only changes and/or additions, relevant to XX1381 (XX1381FL) are given in this data sheet.

QUICK REFERENCE DATA

Overall phosphor persistance (P20)	medium		
Input current	max.	25 mA	←

CHARACTERISTICS

Measured at 25 ± 5 °C with recommended supply voltage

Mean screen luminance, ϕ_G = 7.5 mm, $E_i \approx$ 10 mlx		4 to 6	cd/m²
Signal-to-noise ratio	min.	2.8	
Decay time (10% level)	max.	3 mS	←

Note: The image intensifier XX1381FL is identical to XX1381 but has so called flying leads. With the help of a variable resistor of 50 kΩ the user can vary the luminance gain up to the preset value.

IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1380-series but does not incorporate a power supply. For this reason only changes and/or additions, relevant to XX1387 are given in this data sheet.

QUICK REFERENCE DATA

Overall phosphor persistence (P20)	medium

WORKING CONDITIONS*

Anode to MCP output	2800 ± 100 V
Screen to MCP output (note 2)	3800 ± 100 V
MCP input to MCP output	−600 to −1000 V
Photocathode to MCP *input* (note 3)	−900 ± 50 V
MCP output	0 V

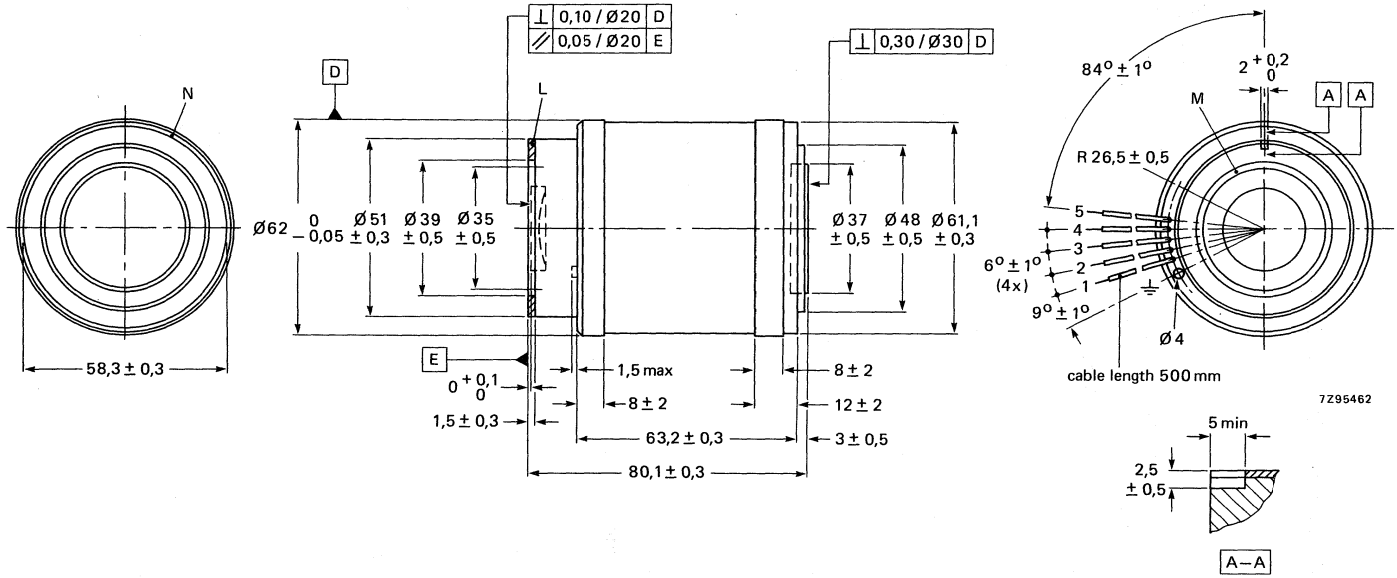
Notes

1. If required for particular application the screen section may be put at earth potential. All other voltages should be changed accordingly.
2. The ripple (peak to peak) and rapid fluctuations should be kept within 2%.

* **CAUTION**

The screen surround is not isolated from the high voltages present during operation. If the device is not configured with the screen at earth potential (see note 1), the intensifier should not be handled, thus avoiding the hazards associated with high voltages.

Dimensions in mm



N and M bearing surfaces

L This space may be filled with rubber

cable connections

1 = cathode
2 = anode (cone)
3 = MCP input
4 = MCP output
5 = screen
↓ = earth (container only)

Fig.1 Mechanical outline

IMAGE INTENSIFIER

The XX1390 image intensifier is a miniature, distortionless, electrostatic proximity focused microchannel plate image intensifier. No power supply is included in the encapsulation. It has 18 mm diameter plane glass input and output window. It is primarily intended for use in lightweight night vision goggles, but is suitable for many very low light level applications.

This data must be read in conjunction with General Introduction Image Intensifiers.

QUICK REFERENCE DATA

Input			
Photocathode		S25	
Useful diameter	min.	18	mm
Material glass; refractive index 1,49 mm, thickness		1,5	mm
Output			
Screen phosphor		P20, aluminized	
Useful diameter	min.	18	mm
Material glass; refractive index 1,49, thickness		2	mm
Optical length		2	mm
Mass		40	g

CHARACTERISTICS

Measured at 20 ± 5 °C with recommended supply voltage

	min.	typ.	max.	
Sensitivity				
white light	220	400		μA/lm
λ = 800 nm	12	35		mA/W
λ = 850 nm	4	30		mA/W
Luminance gain, ϕ_G = 140 mm, $E_i \approx 100$ μlx measured with PSU fitted (note 2)	7500		15 000	
Mean screen luminance			10	cd/m²
Equivalent background illumination (EBI)			0,5	μlx
Signal-to-noise ratio (note 3)	2,5			
Resolution				
centre	25	29		lp/mm
edge, ϕ_E = 14 mm	25	29		lp/mm
Magnification		1,000		
Mounting position		any		
Output brightness uniformity (white light)			3 : 1	

RATINGS

Limiting values in accordance with the Absolute Maximum System IEC 134

	max.	min.	
Supply voltage			
MCP input to photocathode	150		V
MCP output to input	900		V
Screen to MCP output	6		kV
Photo cathode illuminance			
Continuous	10		mlx
Short periods	20		mlx
Ambient temperature			
for storage, 2 hours max.	65	−55	°C
for long term storage	27	−55	°C

Notes

1. Recommended operating conditions:

Voltages			
MCP input to photocathode		50 ± 100	V
MCP output to input		700 ± 200	V
Screen to MCP output		5700 ± 300	V
MCP resistance at + 20 °C	min.	150	MΩ
Photocathode illuminance, continuous		10	mlx
Relative humidity		35 to 50	%

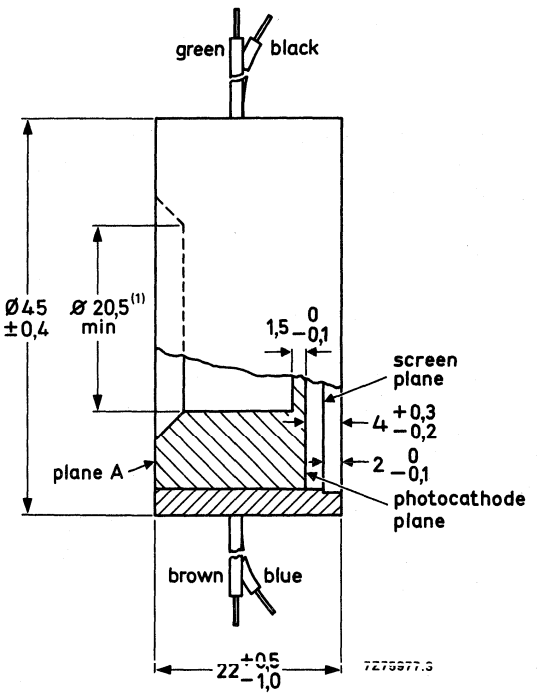
   Each tube is accompanied by a test result sheet giving the recommended operating conditions. Particular attention should be paid to the maximum MCP voltage.

2. The gain is adjusted by varying the value of the microchannel plate voltage, see Fig. 2.
3. Input illumination 12,5 μlx, ϕ 0,2 mm, bandwidth 20 Hz.
4. The intensifier is encapsulated in a soft plastic housing. Four electrical leads exit from this housing. Their functions are:
   black: microchannel plate output
   blue: photocathode
   brown: screen
   green: microchannel plate input

LIFE EXPECTANCY

Cathode illumination 100 μlux	min.	1000	hours

MECHANICAL DATA Dimensions in mm



(1) This dimension is guaranteed not to exceed a depth of 11.5 mm from plane A.

Fig.1 Outline drawing.

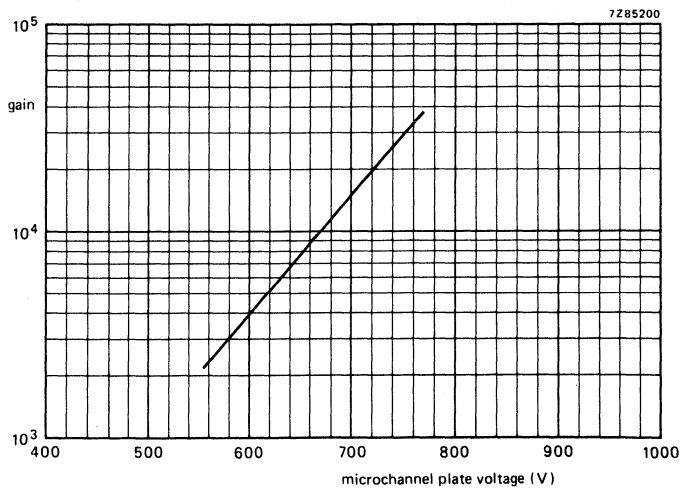


Fig.2 Typical luminous gain characteristic.

SUPERSEDES DATA OF AUGUST 1985

IMAGE INTENSIFIERS

The XX1410-series image intensifiers are miniature, distortionless, double electrostatic proximity focused microchannel plate image intensifiers with 18 mm input window and 18 mm fibre optic output window, either straight or inverting (twisted), plane or concave.

The integral power supply incorporates automatic gain control. Point highlight saturation and bright source protection are features of this intensifier. It is primarily intended for use in lightweight night vision goggles, but is also suitable for many very low light level applications.

This data must be read in conjunction with General Introduction Image Intensifiers.

The XX1410 family consists of:

- XX1410, the basic version with fibre optic input window, mixed screen phosphor on twisted and concave output window, electrical contacts.
- XX1410/SP10005-201, improved version of XX1410 but with glass input window and very small 'ANVIS' lightweigth power supply.
- XX1410/SP20103-260, as XX1410 but with flying leads.
- XX1410/SP20103-265, rugged version of XX1410/SP20103-260.
- XX1410/SP20121-210, as XX1410 but with straight and flat fibre-optic output window and without integral power supply.
- XX1410/SP20121-211, as XX1410 but with S20 photocathode and metalised screen connected to separate lead.
- XX1410/SP20122-210, as XX1410 but with straight and flat fibre-optic output window.
- XX1410/SP31021-162, as XX1410/SP20121-211 but with magnesium fluoride input window.
- XX1410/SP41021-160, as XX1410/SP20121-211 but with transparent monocrystal sapphire input window.

Other tubes with straight output fibres and/or S20 photocathodes are available on request.

QUICK REFERENCE DATA

Input			
Photocathode		S25	
Useful diameter	min.	17,5	mm
Material		fibre optic	
Output			
Screen phosphor		mixed phosphor	
Useful diameter	min.	17,5	mm
Material		fibre optic	
Recommended supply voltage (note 1)		2,7	V
Input current	typ.	10	mA
	max.	16	mA
Mass	max.	100	g

CHARACTERISTICS

Measured at 22 ± 3 °C with recommended supply voltage	min.	typ.	max.	
Sensitivity, measured before PSU is fitted				
white light	240	420		μA/lm
λ = 800 nm	20	40		mA/W
λ = 830 nm	18	35		mA/W
λ = 850 nm	12	30		mA/W
Luminance gain, ϕ_G = 17 mm, $E_i \approx 20$ μlx	7500		15 000	
Mean screen luminance, see also Fig. 1				
ϕ_G = 17,0 mm, $E_i \approx 20$ mlx	1,0		3,0	cd/m²
Equivalent background illumination (EBI)		0,15		μlx
Signal-to-noise ratio note 2	4,5	5,0		
Resolution				
centre	25	29		lp/mm
edge, ϕ_E = 14 mm	25	29		lp/mm
Magnification		1,000		
Modulation transfer factors				
2,5 lp/mm	86	89		%
7,5 lp/mm	58	60		%
15 lp/mm	20	30		%
Image alignment			0,4	mm
Rise time			5	s
Output brightness uniformity, white light			3 : 1	
Mounting position, note 3		any		
→ Operational life	1000	2000		hrs

RATINGS

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

	min.	max.	
Supply voltage		3,2	V
Photocathode illuminance			
Continuous		10	mlx
Short periods		20	lx
Ambient temperature			
for storage, 2 hr. max.	−55	65	°C
long term storage	−55	27	°C
→ for operation, continuous	−45	45	°C
Axial forces between bearing surfaces		200	N

ENVIRONMENTAL TESTS

Shock: Six shocks, half-sinewave, in two directions, parallel and perpendicular to the optical axis with peak acceleration 750 m/s^2, duration 8 mS.

Vibration: Sinewave in two directions, parallel and perpendicular to the optical axis, 10 cycles, frequency range 10 to 55 Hz, amplitude 2.54 mm.

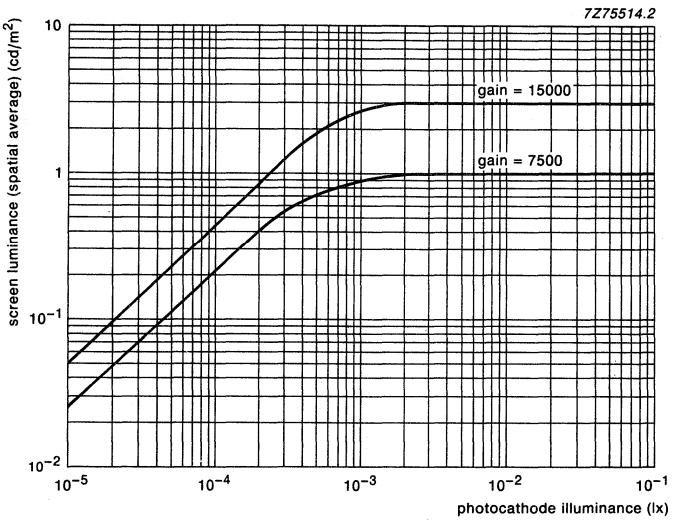


Fig.1 Typical automatic gain control characteristic.

Notes

1. If the supply voltage falls below 2,0 V, but remains greater than −2,7 V, the intensifier may not function, but will not be damaged.
2. Initial measurement E_i = 12,5 μlx, ϕ 0,2 mm, bandwidth 10 Hz.
3. Force on supply contacts must not exceed 10 N.
4. It is recommended that exposure to relative humidity greater than 40% be avoided. Humidity may affect the intensifier operation either temporarily or definitively.

IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1410-series. For this reason only changes and/or additions, relevant to XX1410 are given in this data sheet.

QUICK REFERENCE DATA

Output material	fibre optic, concave, inverting	
Optical length	typ.	26,6 mm

OUTLINES

Dimensions in mm

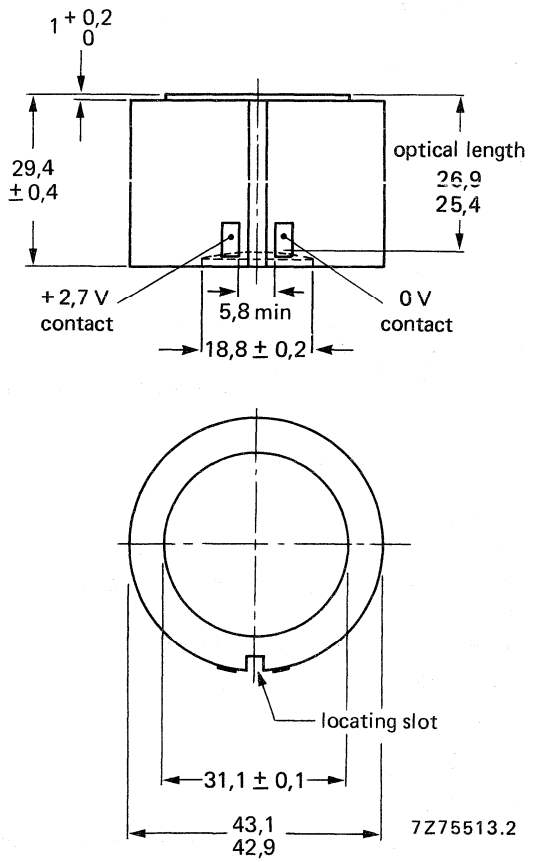


Fig. 1 Overall dimensions.

Radius of concave output window: 40,0 ± 0,1

Locating slot depth: 2,8 min.
width: 2,8 min.

Contact length: 5,6
width: 3,0
thickness: 0,2

SUPERSEDES DATA OF AUGUST 1985

IMAGE INTENSIFIER

The XX1410/SP10005-201 image intensifier conforms to the specification of the XX1410-series. For this reason only changes and/or additions relevant to the XX1410/SP10005-201 are given in this data sheet.
Type XX1410/SP10005-201 is fully compatible with 3rd generation U.S. 'ANVIS' tubes. This type incorporates a miniature power supply with automatic gain control and is primarily intended for use in very light weight high performance night vision goggles.

QUICK REFERENCE DATA

Input		
Photocathode		S25
Useful diameter	min.	17,5 mm
Material		glass
Refractive index		1,49
Output		
Screen phosphor		P20
Useful diameter	min.	17,5 mm
Material		fibre optic
Optical length	nom.	20 mm
Recommended supply voltage (see note 1)		2,7 V
Input current	max.	45 mA
Outer diameter		36,78 mm
Mass	max.	85 g

CHARACTERISTICS

Measured at 22 ± 3 °C with recommended supply voltage

	min.	typ.	max.	
Sensitivity, measured before PSU is fitted				
white light	300	450		μA/lm
λ = 830 nm	20	35		mA/W
Luminance gain, ϕ_G = 17 mm, $E_i \approx 20$ μlx	7500		15000	
Mean screen luminance, ϕ_G = 17 mm, $E_i \approx 20$ mlx, see also Fig. 2	1,7		5	cd/m²
Equivalent background illumination (EBI)		0,15	0,25	μlx
Signal-to-noise ratio*	4,5	4,8		
Resolution				
centre	32	34		lp/mm
edge, ϕ_E = 14 mm	32	34		lp/mm
Magnification		1		

* Initial measurement E_i = 12,5 μlx, ϕ 0,2 mm, bandwidth 10 Hz.

CHARACTERISTICS (continued)

	min.	typ.	max.	
Modulation transfer factors				
2,5 lp/mm	87	90		%
7,5 lp/mm	59	62		%
15 lp/mm	25	30		%
Image alignment			0,16	mm
Output brightness uniformity, white light			3 : 1	
Mounting position, note 2		any		

RATINGS

Limiting values in accordance with the Absolute Maximum System IEC 134

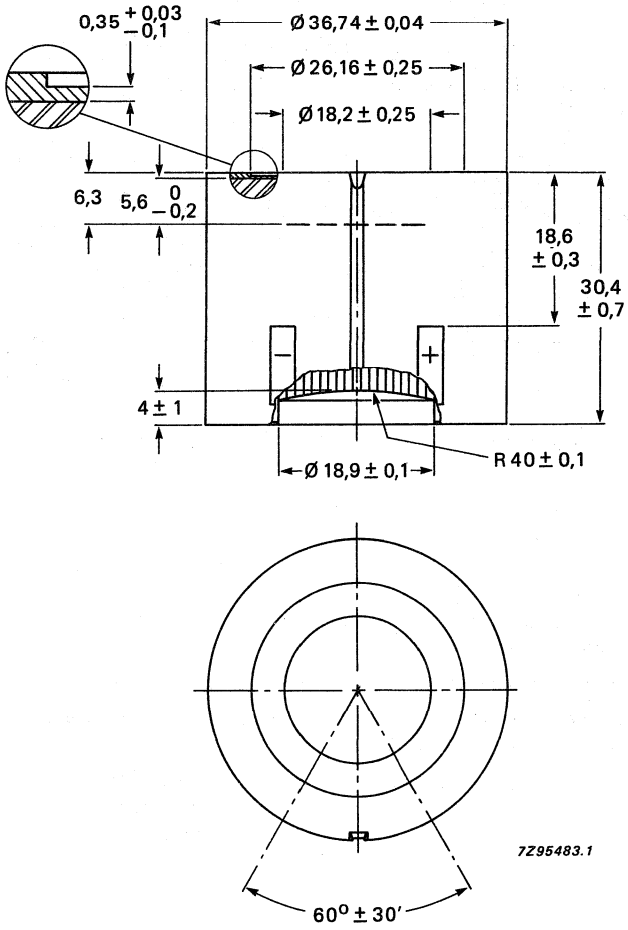
	min.	max.	
Supply voltage	2.0	3,0	V
Photocathode illuminance			
continuous		10	mlx
instantaneous		20	lx
Ambient temperature			
for storage, 2 hr. max.	–55	65	°C
for long term storage	–55	27	°C
→ for operation, continuous	–45	45	°C
Axial forces between bearing surfaces		200	N

NOTES

1. If the supply voltage falls below 2,0 V, but remains greater than –2,7 V, the intensifier may not function, but will not be damaged.
2. Force on supply contacts must not exceed 10 N.
3. It is recommended to avoid exposure to relative humidity greater than 40%. Humidity may affect the intensifier operation either temporarily or definitively.
4. Bearing surfaces are flat plastic surfaces on both ends of the intensifier. It is recommended to operate the intensifier in a metallic assembly which is electrically connected to the negative terminal of the intensifier supply. Metallic parts should be at least 1 mm of the optical surfaces.

OUTLINES

Dimensions in mm



Radius of concave output window: 40 ± 1

Contact length : 9,5 ± 0,2

Contact width : 3,2 ± 0,1

Fig.1 Overall dimensions.

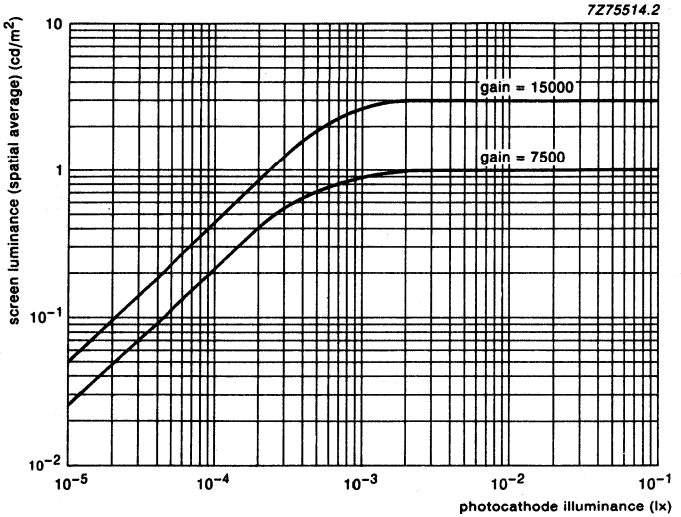


Fig.2 Typical automatic gain control characteristic.

SUPERSEDES DATA OF AUGUST 1985

IMAGE INTENSIFIER

These intensifiers conform to the specifications of the XX1410 series. For this reason only changes and/or additions relevant to SP20103-260 and SP20103-265 are given in this data sheet. Type XX1410/SP20103-260 has flying leads instead of contacts. Type XX1410/SP20103-265 is a rugged version with flying leads and enhanced shock resistance.

QUICK REFERENCE DATA

Output material	fibre optic, concave, inverting	
Optical length	typ.	26.6 mm

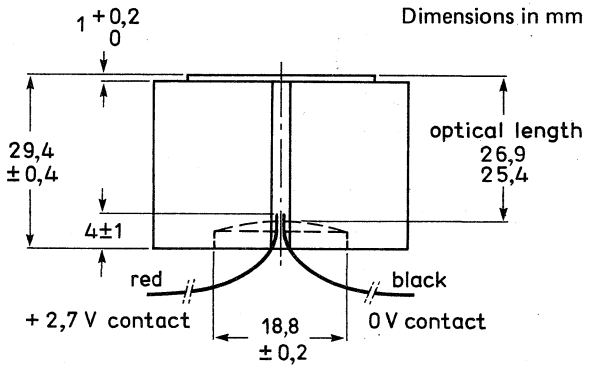
ENVIRONMENTAL TESTS

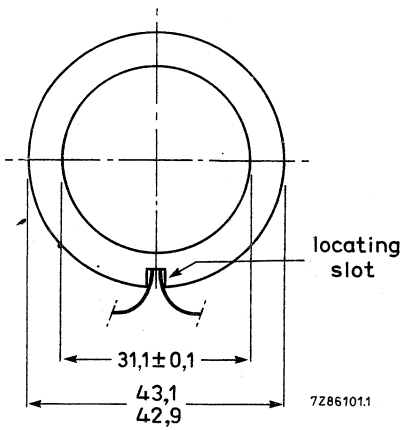
Shock: Six shocks, half-sinewave, in two directions, parallel and perpendicular to the optical axis with peak acceleration 5000 m/s^2, duration 8 mS.

Vibration: Sinewave in two directions, parallel and perpendicular to the optical axis, 10 cycles, frequency range 10 to 55 Hz, amplitude 2.54 mm.

OUTLINES

Dimensions in mm





Radius of concave output window 40.0 ± 0.1

Locating slot depth: 2.8 min.
width: 2.8 min.
Contact length : 250 min.

Fig.1 Overall dimensions.

SUPERSEDES DATA OF AUGUST 1985

IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1410-series. For this reason only changes and/or additions, relevant to XX1410/SP20121-210 are given in this data sheet. Type XX1410/SP20121-210 has a flat, straight fibre-optic output window and does not incorporate a power supply.

QUICK REFERENCE DATA

Output			
material		fibre optic, flat, straight	
Optical length	typ.	21	mm

RATINGS

Limiting values in accordance with the Absolute Maximum System IEC 134

Supply voltage	max.		
MCP input to photocathode		300	V
MCP output to input		1000	V
screen to MCP output		6000	V
Photocathode illuminance			
continuous		10	mlx
instantaneous		20	lx
Screen luminance		5	cd/m^2

RECOMMENDED WORKING CONDITIONS

Supply voltage			
MCP input to photocathode		50 to 300	V
MCP output to input		800 ± 200	V
screen to MCP output		4500 to 6000	V
MCP resistance at 20 °C	min.	150	MΩ
Mean screen luminance		2	cd/m^2

Each tube is accompanied by a test result sheet giving the recommended operating conditions and the maximum MCP voltage.

The gain is adjusted by varying the value of the microchannel plate voltage. Particular attention should be paid to the maximum MCP voltage mentioned.

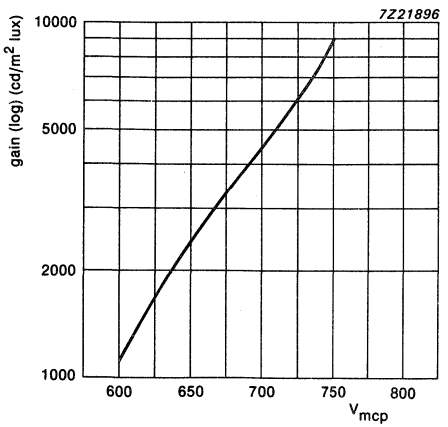
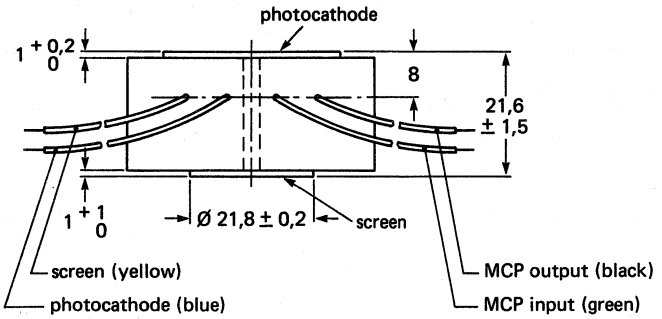


Fig.1 Gain as a function of MCP voltage.

OUTLINES

Dimensions in mm



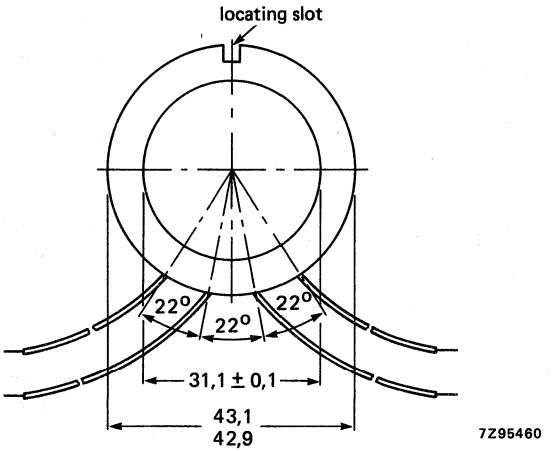


Fig.2 Overall dimensions.

Locating slot depth: 2,8 min.
width: 2,8 min.

Contact length: 250 min.

IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1410 series. For this reason only changes and/or additions relevant to XX1410/SP20121-211 are given in this data sheet.

QUICK REFERENCE DATA

Input	S20 photocathode
Input material	straight fibre optic
Screen material	mixed P20 phosphor
Screen output	straight, flat fibre optic, metallised connected to separate lead
Power supply	not incorporated

RATINGS

Limiting values in accordance with Absolute Maximum System IEC 134

Supply voltage		
MCP input to photocathode	max.	240 V
MCP output to input	max.	950 V
Screen to MCP output	max.	6000 V

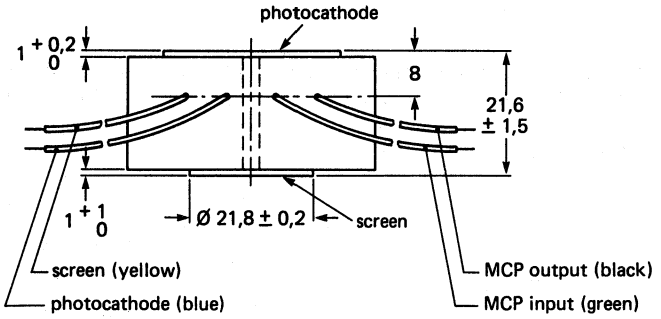
RECOMMENDED WORKING CONDITIONS

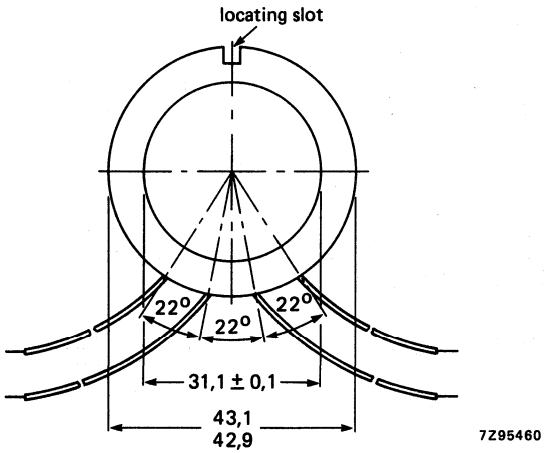
Supply voltage	
MCP input to photocathode	180 to 240 V
MCP output to input	630 to 950 V
Screen to MCP output	5400 to 6000 V

Note:
Reversed polarities if applied will invariably damage the intensifier.

OUTLINES

Dimensions in mm





Locating slot depth: 2.8 min.
width: 2.8 min.

Contact length: 250 min.

Fig.1 Overall dimensions.

IMAGE INTENSIFIER

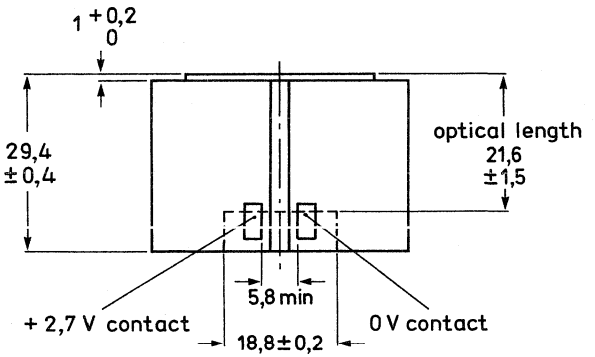
This intensifier conforms to the specification of the XX1410-series. For this reason only changes and/or additions, relevant to XX1410/SP20122-210 are given in this data sheet. Type XX1410/SP20122-210 has a flat, straight fibre-optic output window.

QUICK REFERENCE DATA

Output material	fibre optic, flat, straight	
Optical length	typ.	21 mm

OUTLINES

Dimensions in mm



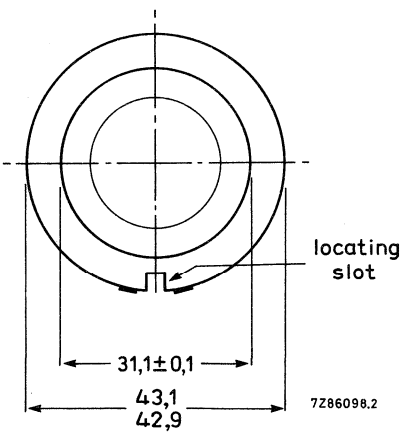


Fig. 1 Overall dimensions.

Locating slot depth: 2,8 min.
width: 2,8 min.

Contact length: 5,6
width: 3,0
thickness: 0,2

IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1410 series. For this reason only changes and/or additions relevant to XX1410/SP31021-162 are given in this data sheet.

QUICK REFERENCE DATA

Input	
Photocathode	S20
Material	magnesium fluoride
Refractive index (Nd)	1.38
Output	
Screen phosphor	mixed P20
Material	straight, flat fibre optic, metalised connected to separate lead
Power supply	not incorporated

RATINGS

Limiting values in accordance with Absolute Maximum System IEC 134

Supply voltage		
MCP input to photocathode	max.	240 V
MCP output to input	max.	950 V
Screen to MCP output	max.	6000 V

RECOMMENDED WORKING CONDITIONS

Supply voltage	
MCP input to photocathode	180 to 240 V
MCP output to input	630 to 950 V
Screen to MCP output	5400 to 6000 V

Note: Reversed polarities if applied will invariably damage the intensifier.

Dimensions in mm

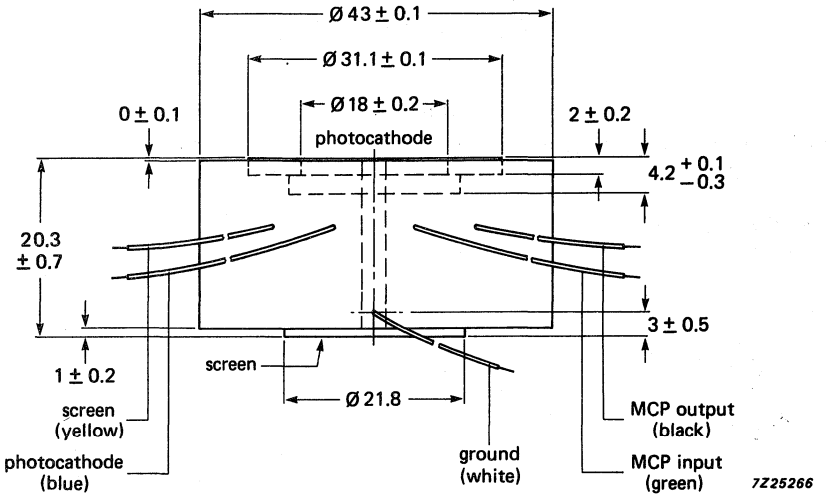


Fig.1 Mechanical outline.

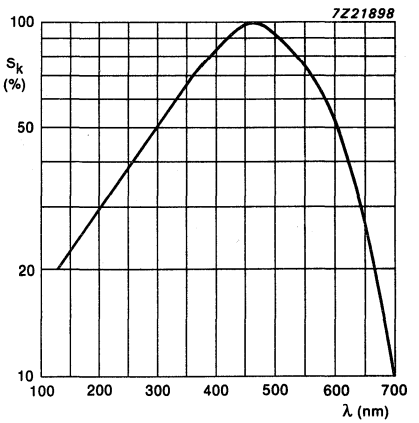


Fig.2 Typical photocathode response.

IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1410 series. For this reason only changes and/or additions relevant to XX1410/SP41021-160 are given in this data sheet.

QUICK REFERENCE DATA

Input	
Photocathode	S20
Material	transparent monocrystal sapphire
Refractive index (Nd)	1.78
Output	
Screen phosphor	mixed P20
Material	straight, flat fibre optic, metalised connected to separate lead
Power supply	not incorporated

RATINGS

Limiting values in accordance with Absolute Maximum System IEC 134

Supply voltage		
MCP input to photocathode	max.	240 V
MCP output to input	max.	950 V
Screen to MCP output	max.	6000 V

RECOMMENDED WORKING CONDITIONS

Supply voltage	
MCP input to photocathode	180 to 240 V
MCP output to input	630 to 950 V
Screen to MCP output	5400 to 6000 V

Note: Reversed polarities if applied will invariably damage the intensifier.

Dimensions in mm

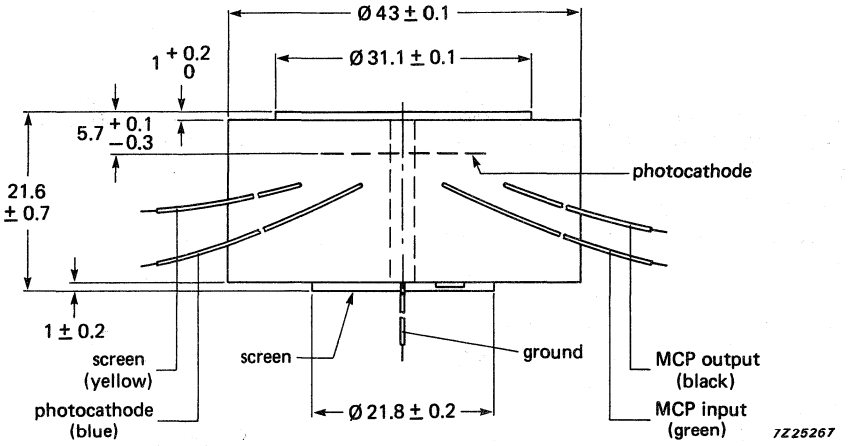


Fig.1 Mechanical outline.

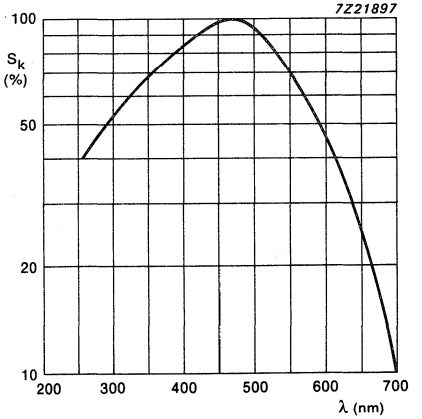


Fig.2 Typical photocathode response.

SUPERSEDES DATA OF JULY 1985

IMAGE INTENSIFIERS

The XX1500 series is a family of miniature, electrostatically self-focused, inverting microchannel plate image intensifiers. They have plane 18 mm input and output windows and an integral power supply with automatic gain control (AGC). Particular features include a S25 photocathode, external adjustment of gain, bright source protection (thanks to point highlight saturation) and low distortion.

This data must be read in conjunction with General Introduction Image Intensifiers.

The XX1500 family consists of:

XX1500	the basic version for use in direct viewing night vision systems.
XX1500HG	high gain version for photographic applications.
XX1500TV	as XX1500HG but with fitted photocathode mask and intended for use as a pre-amplifier for lens-coupled low light television camera systems.
XX1500TVMC	as XX1500TV but for fibre-optic camera tubes and solid state imaging devices.
XX1501	as XX1500 but with a concave fibre-optic screen allowing use of wafer tube eye-piece.
XX1502	fitted with a photocathode mask and a resistor network for external high voltage supply and primarily intended for fibre-optic coupled low light television applications.

QUICK REFERENCE DATA

Input			
Photocathode		S25	
Useful diameter	min.	17,5	mm
Material		plane fibre optic	
Output			
Screen phosphor		P20, aluminized	
Useful diameter	min.	17,5	mm
Material		plane fibre optic	
Optical length	nom.	54,6	mm
Recommended supply voltage		2,6	V
Input current	max.	25	mA
Mass	max.	180	g

CHARACTERISTICS

Measured at 22 ± 3 °C with recommended supply voltage

	min.	typ.	max.	
Sensitivity				
white light	280	350		μA/lm
λ = 800 nm	28	35		mA/W
λ = 850 nm	15	25		mA/W
Luminance gain, ϕ_G = 10 mm, $E_i \approx 50$ μlx				
gain control at maximum	30 000	45 000	70 000	
gain control at minimum	2 000		10 000	
Mean screen luminance, ϕ_G = 10 mm, $E_i \approx 20$ mlx	5,0		10,0	cd/m²
Equivalent background illumination (EBI)			0,20	μlx

CHARACTERISTICS (continued)	min.	typ.	max.	
Signal-to-noise ratio	3,0	3,8		
Resolution				
centre	32	36		lp/mm
edge, ϕ_E = 14 mm	32	36		lp/mm
Magnification, any position	0,94		1,02	
Distortion, ϕ_d = 1,44 mm; ϕ_D = any		4		mm
Modulation transfer factors, values normalized to zero spatial frequency and referred to the screen				
2,5 cycles/mm	85	92		%
7,5 cycles/mm	65	67		%
16 cycles/mm	30	33		%
Veiling glare			2,0	%
Image alignment		0,8		mm
Recovery time		0,5		s
Brightness uniformity			3 : 1	
Mounting position		any		

RATINGS

Limiting values in accordance with the Absolute Maximum System IEC 134

	max.	min.	
Supply voltage	3,4		
Photo cathode illuminance (see notes)	1,0		lx
Ambient temperature			
→ for storage	70	−54	°C
→ for operation, 2 hours max.	52	−54	°C
Axial forces between bearing surfaces	100		N

Notes

If the supply voltage falls below 2,0 V, the intensifier may not function, but will not be damaged. If the supply voltage is reversed up to 60 s, the intensifier will not function, but will not be damaged.

Prolonged operations with illuminance exceeding 10 mlx can reduce the life of the intensifier. This corresponds to a scene illuminance of deep twilight when the intensifier is incorporated in a typical sight. However, operation of 2000 hours can be expected with a photocathode illuminance of 1 mlx.

Connection diagram

Each intensifier in this series is supplied with a connector (see next page). XX1500 can be supplied with a PTFE annulus around the edge of the cathode window.

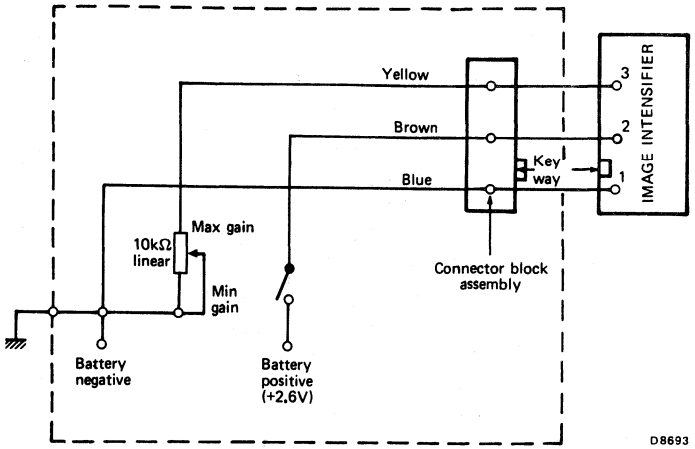


Fig. 1 Equipment wiring diagram.

Dimmensions in mm

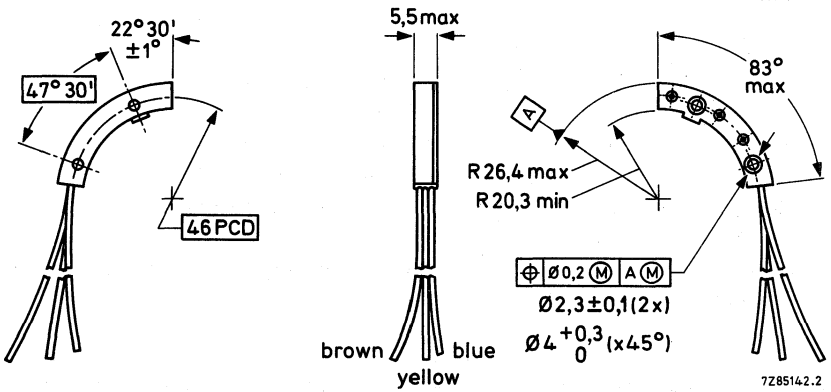


Fig. 2 Connector block assembly.
blue: earth/battery negative
brown: battery positive
yellow: customer gain control; 10 kΩ linear variable resistor to battery negative
(R_s = 10 kΩ yields min. gain, R_s = 0 yields max. gain).

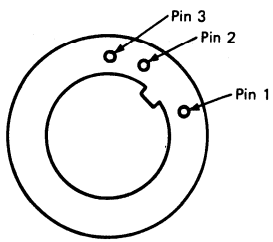


Fig. 3 Connections at photocathode end of intensifier.

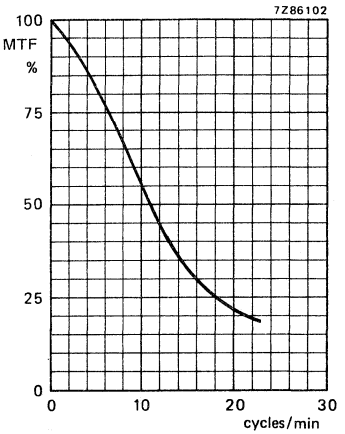


Fig. 4 Typical modulation transfer factor.

MECHANICAL DATA, see Fig. 5.

The mechanical axis is defined as the axis perpendicular to the pads plane 'A', which passes through the centre of the cathode reference ring diameter 'B' M.M.C.

The intensifier will fit into a cylinder of 53,00 diameter or greater, concentric with reference 'B' M.M.C. and sit on a plane perpendicular to the axis of that cylinder at room temperature.

Linear expansion coefficient of reference diameter 'B' and the intensifier sleeve (dimension 56 ± 1) is less than or equal to 100×10^{-6}/K.

The onus is on the customer to ensure that the maximum mounting forces are not exceeded throughout the operational temperature range.

WARNING

Immediately after operation, the screen will remain electrostatically charged for approximately 1 minute, during which time the intensifier should not be handled. Any attempt to discharge the intensifier by any means may result in irreparable damage.

ENVIRONMENTAL TESTS

Shock	6 shocks, half-sinewave, in two directions, parallel and perdendicular to the intensifier axis, with peak acceleration 1400 m/s^2, duration 9,0 ms.
Vibration	Sinewave, in two directions, parallel and perpendicular to the intensifier axis, with peak acceleration 25 m/s^2, over frequency range 10 to 3500 Hz.

Outline drawing

Dimensions in mm

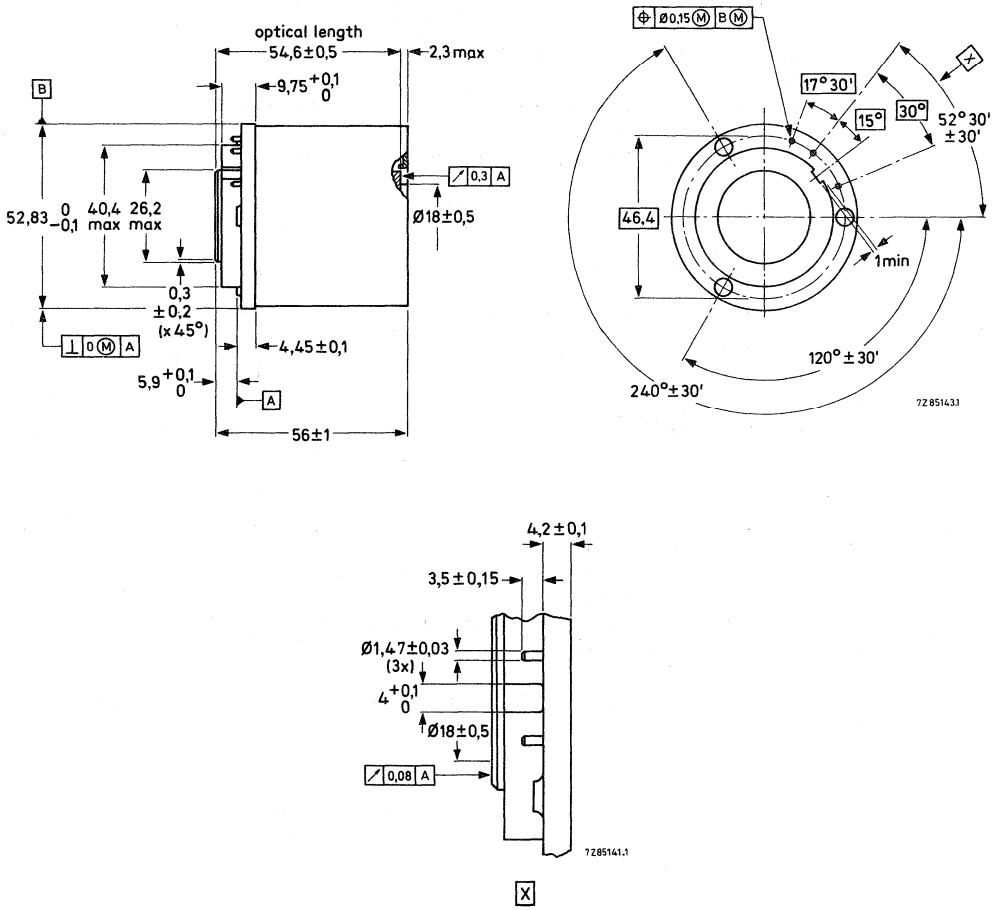


Fig. 5 Outlines of types XX1500, XX1500HG, XX1500TV, XX1500TVMC.
For XX1501 and XX1502 see also separate data sheet.

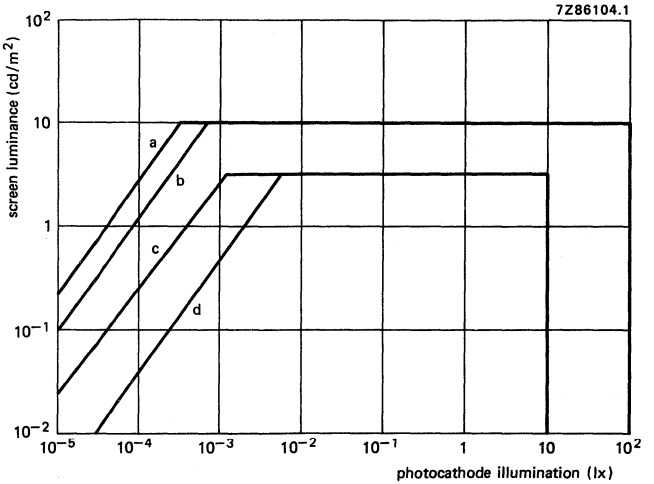


Fig. 6 Typical automatic brightness control characteristics.

a = Maximum gain at max. setting.
b = Minimum gain at max. setting.
c = Maximum gain at min. setting.
d = Minimum gain at min. setting.

IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1500-series. For this reason only changes and/or additions, relevant to XX1500HG are given in this data sheet.

The XX1500HG is a high gain version of the XX1500 and intended for photographic applications.

QUICK REFERENCE DATA

Input current	max.	30 mA
Luminous gain, ϕ = 10 mm, $E_i \approx 50$ μlx		
gain control at maximum	min.	65 000
gain control at minimum	max.	5 000

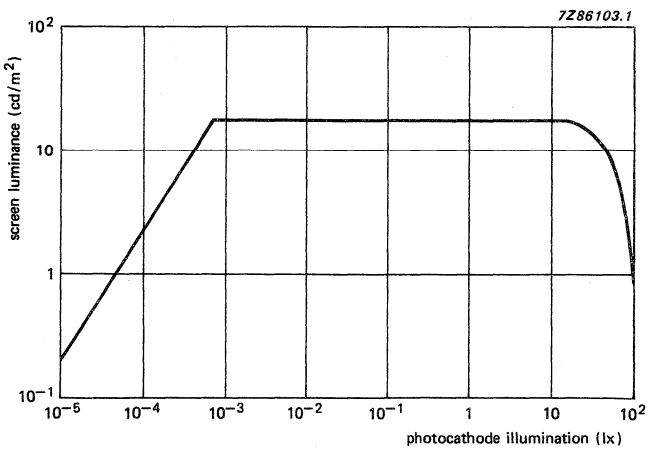


Fig.1 Typical automatic gain control characteristics.

SUPERSEDES DATA OF AUGUST 1985

IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1500-series. For this reason only changes and/or additions, relevant to XX1500TV are given in this data sheet.

The XX1500TV is a high gain version fitted with photocathode mask and intended for use as a preamplifier for lens-coupled low light television camera systems.

QUICK REFERENCE DATA

Input current	max.	30 mA
Photocathode mask	see Fig.1	

CHARACTERISTICS

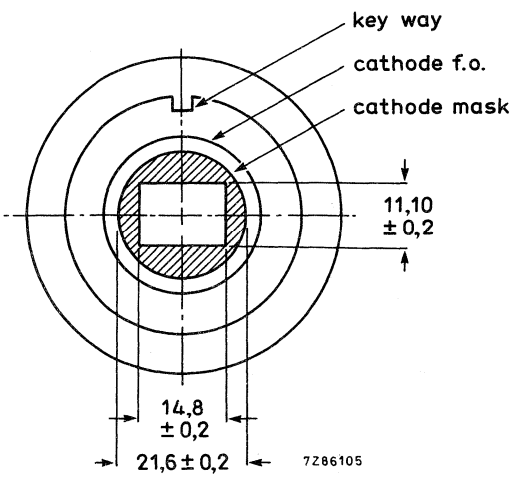
Measured at 22 ± 3 °C with recommended supply voltage

Luminous gain, ϕ = 10 mm, $E_i \approx$ 20 mlx		
gain control at maximum	min.	65 000
gain control at minimum	max.	5 000
Mean screen luminance ϕ = 10 mm, $E_i \approx$ 20 mlx	min.	12 cd/m²
	max.	20 cd/m²

ACCESSORIES

Fibre optic insulator and extender plates enabling the XX1500TV to be fibre-optically coupled to a fibre-optic faceplate TV camera tube are available.

Dimensions in mm



Mask thickness $0.2^{+0.15}_{-0}$

Fig.1 Detail of photocathode end, showing mask.

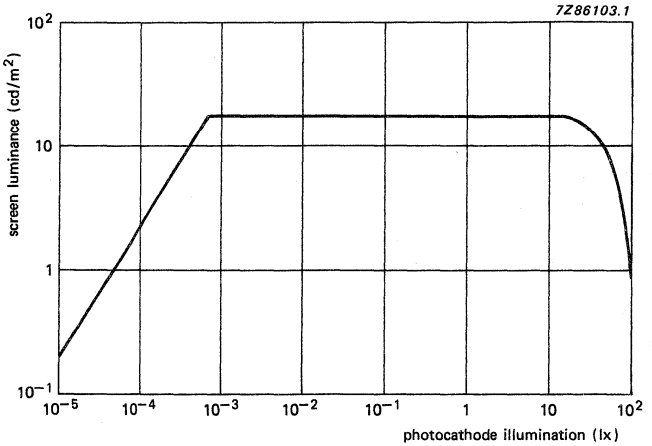


Fig.2 Typical automatic gain control characteristics.

IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1500-series. For this reason only changes and/or additions, relevant to XX1500TV are given in this data sheet.

The XX1500TVMC is a high gain version fitted with photocathode mask and featuring external voltage control of gain. It is intended for use as a preamplifier for fibre-optic camera tubes and solid state imaging devices.

QUICK REFERENCE DATA

Input current	max.	30 mA
Photocathode mask	see Fig.1	

CHARACTERISTICS

Measured at 22 ± 3 °C with recommended supply voltage

Luminous gain, ϕ = 10 mm, $E_i \approx$ 20 mlx		
gain control at maximum	min.	65 000
gain control at minimum	max.	5 000
External gain control voltage ≈ 20 mlx	min.	−3.0 V
	max.	+ 3.0 V
Mean screen luminance ϕ = 10 mm, $E_i \approx$ 20 mlx	min.	12 cd/m
	max.	20 cd/m²

ACCESSORIES

Fibre optic insulator and extender plates enabling the XX1500TV to be fibre-optically coupled to a fibre-optic faceplate TV camera tube are available.

Mask thickness $0.2^{+0.15}_{-0}$

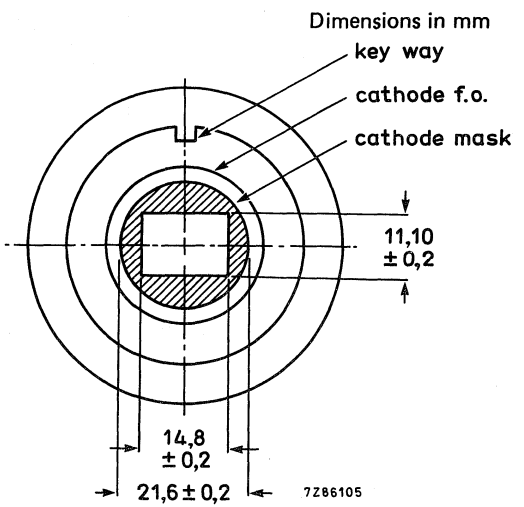


Fig.1 Detail of photocathode end, showing mask.

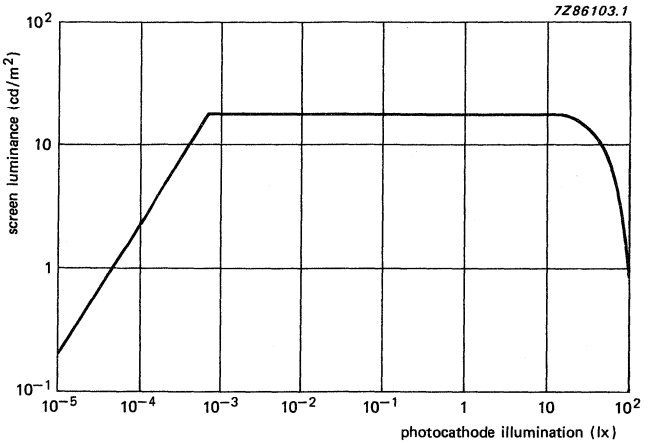


Fig.2 Typical automatic gain control characteristics.

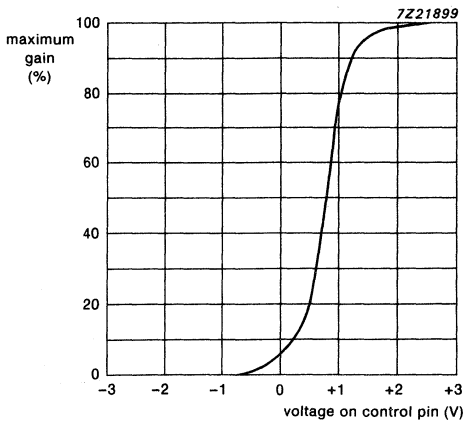


Fig.3 Typical external gain control characteristics.

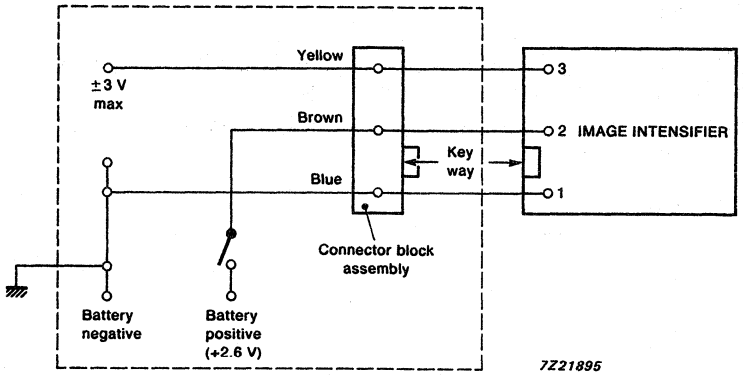


Fig.4 XX1500TVMC wiring diagram.

IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1500-series and XX1500. For this reason only changes and/or additions, relevant to XX1501 are given in this data sheet.

Featuring a concave fibre optic screen this intensifier is compatible with wafer tubes and therefore can make use of wafer tube eye-pieces.

QUICK REFERENCE DATA

Screen material	concave fibre optic
Optical length	nom. 53,4 mm

Dimensions in mm

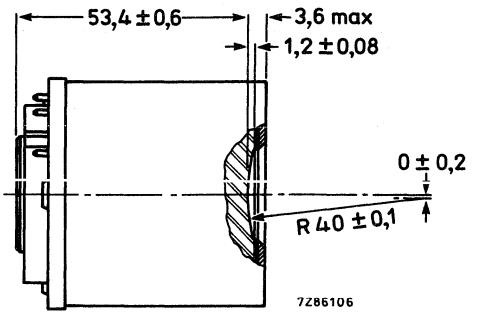


Fig. 1 Detail XX1501.

IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1500-series. The XX1502 is a version for use in low light level TV systems, fibre-optically coupled to the TV camera tube. It is fitted with a photocathode mask and has an integral resistor network to provide tube voltages from external high voltage supply. Gain is controlled by supply voltage, a screen current monitor lead is provided to facilitate automatic gain control. Particular features of this intensifier include type S25 photocathode, point highlight saturation, bright source protection and low distortion.

This data must be read in conjunction with General Introduction Image Intensifiers.

QUICK REFERENCE DATA

Input			
Photocathode		S25	
Useful area	min.	14.0 x 10.5	mm
Material		plane fibre optic	
Output			
Screen phosphor		P20, aluminized	
Useful area	min.	14.0 x 10.5	mm
Material		plane fibre optic	
Optical length	nom.	54.6	mm
Supply voltage for gain = 10 000	nom.	7.5	kV
Input current	nom.	38	μA
Mass	max.	300	g

CHARACTERISTICS

Measured at 22 ± 3 °C with recommended supply voltage

	min.	typ.	max.	
Sensitivity				
white light	280	350		μA/lm
λ = 800 nm	28	35		mA/W
λ = 850 nm	15	15		mA/W
Luminous gain, ϕ = 10 mm, $E_i \approx$ 10 mlx, supply voltage = 7.8 kV	10 000	17 000		
Input voltage for				
luminance gain = 10 000		7.5	7.8	kV
luminance gain = 1 000		6.5		kV
Input current, supply voltage 7.5 kV		38	50	μA
Screen current, for screen brightness 2.0 cd/m² (E_i = 5.0 mlx)		50	200	nA
Equivalent background illumination (EBI)			0.20	μlx
Magnification	0.94		1.02	
Distortion, ϕ_d = 1.44 mm; ϕ_D = any		4		%
Signal-to-noise ratio	3.0	3.8		

CHARACTERISTICS (continued)

	min.	typ.	max.	
Resolution				
centre	32	36		lp/mm
edge, ϕ_E = 14 mm	32	36		lp/mm
Modulation transfer factors, values normalized to zero spatial frequency and referred to the screen				
2.5 cycles/mm	85			%
7.5 cycles/mm	61			%
16 cycles/mm	27			%
Veiling glare			2.0	%
Image alignment			0.8	mm
Brightness uniformity			3 : 1	
Mounting position		any		

Recommended operating conditions

Supply voltage for gain control	6.4	to	7.8	kV
Photocathode illuminance, continuous operation	max.		5	mlx
Screen current	20	to	50	nA

RATINGS

Limiting values in accordance with the Absolute Maximum System IEC 134

	max.	min.	
Supply voltage, negative	8.2		kV
Photocathode illuminance, see note	1.0		lx
Screen current, see note	200		nA
Monitor impedance	100		MΩ
Ambient temperature			
→ for storage	70	−54	°C
→ for operation	52	−54	°C
Axial forces between bearing surfaces	100		N
between fibre optic and bearing surface	90		N

Note

Prolonged operation with illuminance exceeding 5 mlx and screen currents above 50 nA can reduce the life of the intensifier. Operation of 9000 hours can be expected when used at the recommended operating conditions.

MECHANICAL DATA

The mechanical axis is defined as the axis perpendicular to the pads plane 'A' which passes through the centre of the cathode reference ring diameter 'B' MMC. The customer must ensure that the maximum axial force ratings are not exceeded throughout the operational temperature range. The linear expansion coefficient of reference diameter 'B' and intensifier sleeve (dimension 56.3 ± 0.5 mm) is less than, or equal to 100 x 10^{-6}/K.

Connections

The white lead is the negative input. The grey coaxial lead is the positive input. The red inner lead is provided for monitoring screen current; if not required it should be connected to earth and positive input. Lead length 250 mm min. Diameter 4.0 mm max.

ENVIRONMENTAL TESTS

Shock 6 shocks, half-sinewave, pulses of peak acceleration 1400 m/s^2, duration 9 ms, in 2 directions, parallel and perpendicular to the intensifier axis.

Vibration Sinewave, peak acceleration 25 m/s^2 over frequency range 10 to 3500 Hz, in 2 directions, parallel and perpendicular to the intensifier axis.

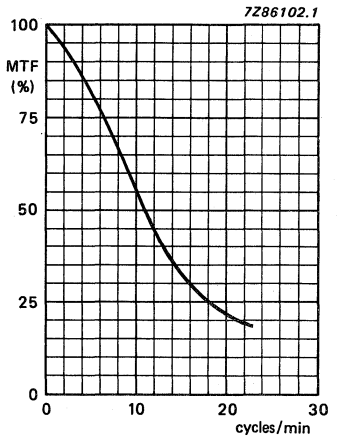


Fig. 1 Typical modulation transfer factor curve.

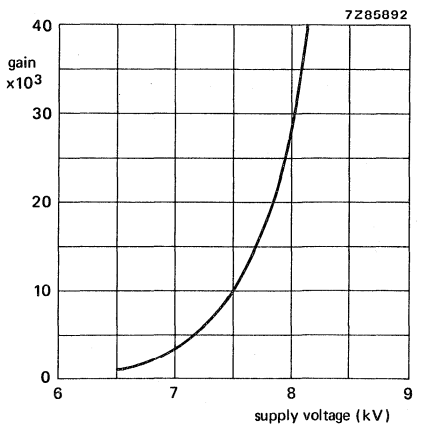


Fig. 2 Gain as a function of supply voltage, typical control characteristic.

OUTLINE DRAWING

Dimensions in mm

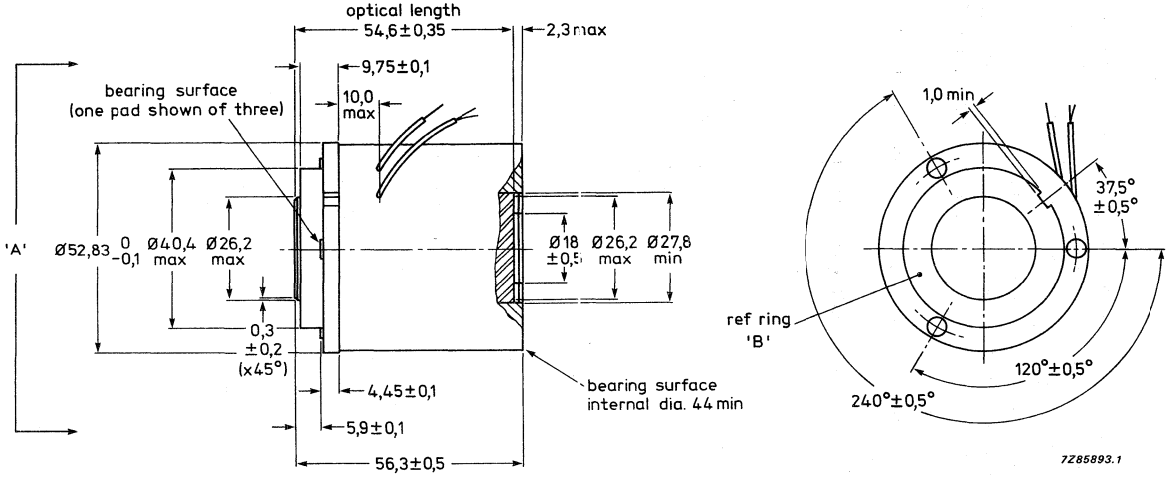


Fig. 3 Outlines of XX1502.

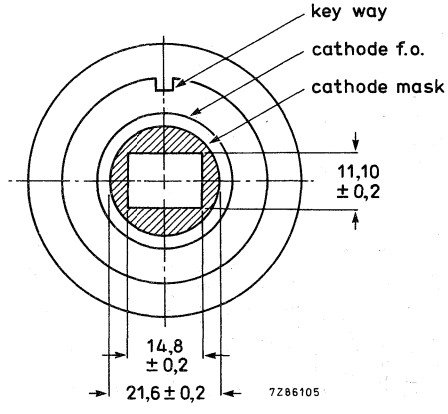


Fig. 4 Detail of photocathode end, showing mask.

Mask thickness $0.2^{+0.15}_{-0}$.

SUPERSEDES DATA OF NOVEMBER 1987

IMAGE INTENSIFIERS

The XX1610 series are miniature distortionless, double electrostatic proximity focused microchannel plate image intensifiers. They incorporate a 18 mm clear glass anti-veiling glare input window and a 18 mm fibre optic output window, either straight or inverting (twisted), plane or concave.

The intensifiers have a very high photocathode sensitivity, signal-to-noise ratio, resolution and other characteristics which bring their performance close to third generation image intensifiers. An integral power supply is incorporated with automatic gain control (AGC). In addition, the image intensifiers have point highlight saturation and bright source protection.

The intensifiers are used mainly in the manufacture of lightweight night vision goggles and rifle sights, but have many uses in low light level applications.

This data must be read in conjunction with the General Introduction, Image Intensifiers.

The XX1610 series consists of:

XX1610 – the basic version.

A second version, fully compatible with the third generation "ANVIS" tube is also available.

QUICK REFERENCE DATA

Input		
Photocathode		S25
Useful diameter	min.	17.5 mm
Material		clear glass, anti-veiling glare
Refrative index		1.49 ←
Output		
Screen phosphor type		P20 mixed
Useful diameter	min.	17.5 mm
Material		fibre optic
Recommended supply voltage (note 1)		2.7 V
Supply current	typ.	10 mA
	max.	16 mA
Mass	max.	100 grams

CHARACTERISTICS

Measured at 22 ± 3 °C, using recommended supply voltage.

	min.	typ.	max.		notes
Sensitivity					
White light	500			μA/lm	2
λ = 800 nm	50			mA/W	2
λ = 830 nm	40			mA/W	
λ = 850 nm	35			mA/W	
λ = 880 nm	10			mA/W	
Luminance gain					
→ ϕ_G = 17 mm, E_i 20 μlx			22 000		3
Mean screen luminance					
ϕ_G = 17 mm, E_i 20 mlx	1.0		4.0	cd/m²	3
Equivalent background illumination (EBI)			0.25	μlx	4
Signal-to-noise ratio	15.5				5
Resolution					
centre φ 4 mm	36	38		lp/lm	6
edge φ 14 mm	36	38		lp/lm	6
Modulator transfer function					
2.5 lp/mm	83			%	
7.5 lp/mm	58			%	
15 lp/mm	28			%	
25 lp/mm	8			%	
Output brightness uniformity, white light			3:1		
Optical to mechanical axis eccentricity			0.5		7
Rise time			5	s	
Operational life	3500			hours	

RATINGS

Limiting values in accordance with the Absolute Maximum Rating System IEC 134

	min.	typ.	max.		notes	
Supply voltage	2.0		3.0	V	8	
Ambient temperature						
storage, 2 hours max.	−56		+65	°C		
long term storage	−56		+35	°C		←
operation, continuous	−20		+35	°C		
Bright source protection	5.0×10^4 lux on 1 mm² photocathode, duration 1 minute					←
Shock	6 shocks, half-sinewave, in two directions, parallel and perpendicular to the optical axis with peak acceleration 5000 m/s², duration 8 mS					
Vibration	sinewave in two directions, parallel and perpendicular to the optical axis, 10 cycles, frequency range 10 to 55 Hz, amplitude 2.5 mm					←

Notes

1. If the supply voltage falls below 2.0 V, but remains greater than −2.7 V, the intensifier may not function, but will not be damaged.
2. Photocathode sensitivity measured before encapsulation.
3. Luminance gain to be specified by the customer up to the limits defined in this data sheet.
4. Dark stabilisation maximum 15 minutes with U_b (2.7 V) on, and no illumination on the photocathode.
5. Initial measurement E_i = 100 μlx, spot: ϕ = 0,2 mm, bandwidth = 10 Hz.
6. Measured in 2 perpendicular directions, adjusted illumination.
7. Mechanical reference, outer diameter.
8. Negative terminal connected to ground.

PICTURE QUALITY

Table 1 Maximum number of permitted spots (contrast over 30%)

spot diameter microns	zone 1 ϕ 6 mm	zone 2 6 – 15 mm	zone 3 15 – 17.5 mm
400 – 500	0	0	0
300 – 400	0	1	2
250 – 300	0	3	3
150 – 250	1	6	9
75 – 150	3	10	14
0 – 75	NA	NA	NA

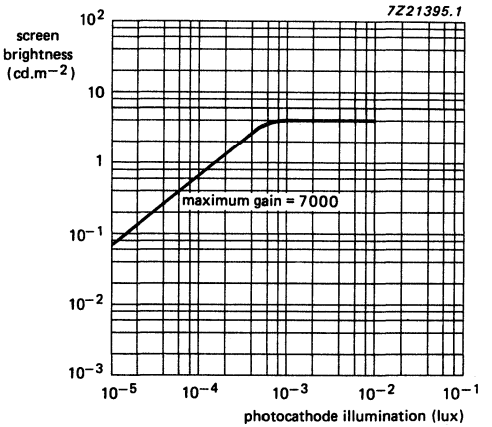


Fig. 1 Maximum gain curve.

IMAGE INTENSIFIER

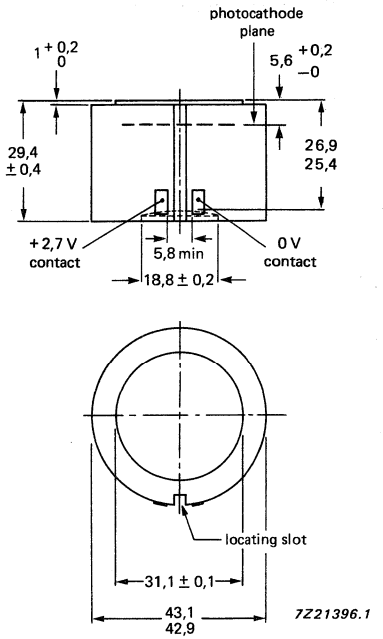
This image intensifier conforms to the specification of the XX1610 series. For this reason, changes and/or additions relevant to the XX1610 only are given in this data sheet.

QUICK REFERENCE DATA

Output material		fibre optic, concave, inverting
Optical length	typ.	26.6 mm

OUTLINES

All dimensions in mm.



Radius of concave output window: 40.0 ± 0.1

Locating slot depth: 2.8 min.
width: 2.8 min.

Contact length: 5.6
width: 3.0
thickness: 0.2

Fig.1 Overall dimensions.

INDEX OF TYPE NUMBERS

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DATA HANDBOOK SYSTEM

DATA HANDBOOK SYSTEM

Our Data Handbook System comprises more than 60 books with specifications on electronic components, subassemblies and materials. It is made up of six series of handbooks:

INTEGRATED CIRCUITS

DISCRETE SEMICONDUCTORS

DISPLAY COMPONENTS

PASSIVE COMPONENTS*

PROFESSIONAL COMPONENTS**

MATERIALS*

The contents of each series are listed on pages iii to viii.

The data handbooks contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

When ratings or specifications differ from those published in the preceding edition they are indicated with arrows in the page margin. Where application is given it is advisory and does not form part of the product specification.

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Information on current Data Handbooks and how to obtain a subscription for future issues is available from any of the Organizations listed on the back cover.
Product specialists are at your service and enquiries will be answered promptly.

* Will replace the Components and materials (green) series of handbooks.
** Will replace the Electron tubes (blue) series of handbooks.

INTEGRATED CIRCUITS

This series of handbooks comprises:

code	handbook title
IC01	**Radio, audio and associated systems** Bipolar, MOS
IC02a/b	**Video and associated systems** Bipolar, MOS
IC03	**ICs for Telecom** Bipolar, MOS Subscriber sets, Cordless Telephones
IC04	**HE4000B logic family** CMOS
IC05	**not yet issued**
IC06	**High-speed CMOS; PC74HC/HCT/HCU** Logic family
IC07	**not yet issued**
IC08	**ECL 10K and 100K logic families**
IC09N	**TTL logic series**
IC10	**Memories** MOS, TTL, ECL
IC11	**Linear Products**
Supplement to IC11	**Linear Products**
IC12	**I^2C-bus compatible ICs**
IC13	**Semi-custom** Programmable Logic Devices (PLD)
IC14	**Microcontrollers** Bipolar, MOS
IC15	**FAST TTL logic series**
IC16	**CMOS integrated circuits for clocks and watches**
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IC18	**Microprocessors and peripherals**
IC19	**Data communication products**

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current code	new code	handbook title
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S2b	SC03*	**Thyristors and triacs**
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S4a	SC05*	**Low-frequency power transistors and hybrid IC power modules**
S4b	SC06	**High-voltage and switching power transistors**
S5	SC07*	**Small-signal field-effect transistors**
S6	SC08* SC09*	**RF power transistors** **RF power modules**
S7	SC10*	**Surface mounted semiconductors**
S8a	SC11*	**Light emitting diodes**
S8b	SC12*	**Optocouplers**
S9	SC13*	**PowerMOS transistors**
S10	SC14*	**Wideband transistors and wideband hybrid IC modules**
S11	SC15	**Microwave transistors**
S15**	SC16	**Laser diodes**
S13	SC17	**Semiconductor sensors**
S14	SC18*	**Liquid crystal displays and driver ICs for LCDs**

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

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This series of data handbooks comprises:

current code	new code	handbook title
T8	**DC01**	**Colour display systems**
T16	**DC02***	**Monochrome tubes and deflection units**
C2	**DC03***	**Television tuners, coaxial aerial input assemblies**
C3	**DC04***	**Loudspeakers**
C20	**DC05***	**Wire-wound components for TVs and monitors**

* These handbooks are currently issued in another series; they are not yet issued in the Display Components series of handbooks.

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This series of data handbooks comprises:

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C14	**PA01**	**Electrolytic capacitors; solid and non-solid**
C11	**PA02***	**Varistors, thermistors and sensors**
C12	**PA03***	**Potentiometers, encoders 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
T1	*	**Power tubes for RF heating and communications**
T2a	*	**Transmitting tubes for communications, glass types**
T2b	*	**Transmitting tubes for communications, ceramic types**
T3	**PC01****	**High-power klystrons**
T4	*	**Magnetrons for microwave heating**
T5	**PC02****	**Cathode-ray tubes**
T6	**PC03****	**Geiger-Müller tubes**
T9	**PC04****	**Photo and electron multipliers**
T10	**PC05****	**Plumbicon camera tubes and accessories**
T11	**PC06****	**Microwave diodes and sub-assemblies**
T12	**PC07****	**Vidicon and Newvicon camera tubes and deflection units**
T13	**PC08****	**Image intensifiers and infrared detectors**
T15	**PC09****	**Dry reed switches**
C8	**PC10**	**Variable mains transformers; annular fixed transformers**

* These handbooks will not be reissued.
** Not yet issued with the new code in this series of handbooks.

MATERIALS

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

* Handbooks C4 and C5 will be reissued as one handbook having the new code MA01.

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

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