

Mullard



Night Vision

XX1500TV

Features:

- Designed as a pre-amplifier of CCTV camera tubes
- Long life
- Bright source protection (point highlight saturation)
- Flash protection
- Low distortion
- Small size
- Rugged construction

Image Intensifiers

18mm Microchannel Plate Inverters

The XX1500 family is the latest addition to our long line of image intensifiers. It incorporates 15 years of experience in the manufacture of microchannel plate devices, and is suitable for a wide range of observation and aiming roles.

The XX1500 series are small, very rugged, high gain image intensifiers featuring electrostatic image inversion, low noise, and facilities for the gain to be adjusted by the user. Both input and output windows are 18mm diameter fibre-optics on which are laid respectively a high sensitivity enhanced red response S25 photocathode and a high definition screen with a centrifuged P20 phosphor.

A specially designed integral power supply is incorporated which can be powered by a wide range of batteries, thus enabling the intensifiers to be used throughout the world.

The XX1500 family consists of:

XX1500TV—a high gain version intended for use in low-light-level television systems.

XX1500 —the basic version

XX1501 —a version incorporating a concave output window whose radius of curvature is the same as that of the 18mm wafer intensifier (type XX1410).

The XX1500 and XX1501 are the subject of a separate data sheet.

CHARACTERISTICS OF XX1500TV

Photocathode

Surface	S25 (enhanced red S20)		
Window	Plane, fibre-optic		
Useful area	The Useful area of the photocathode is defined by a thin plastic mask. The dimensions of this mask are given in Fig 3. This mask must not be removed.		
Sensitivity	min	typ	
T _c = 2856 K	280	350	μA/lm
λ = 800 nm	28	35	mA/W
λ = 850 nm	15	25	mA/W

Screen

Phosphor	P20 (aluminised)		
Window	Plane, fibre-optic		
Useful diameter	min 17.5 mm		

Electrical and Mechanical Characteristics

	min	typ	max	
Input voltage	2.0V	2.6V	3.4V	

The intensifier is designed to work within the specification limits over the range 2.0V to 3.4V. A wide range of batteries may be used including mercury/cadmium, nickel/cadmium rechargeable, zinc/carbon, alkaline/manganese, lithium.

	min	typ	max	
Input current	—	—	25	mA
Mass	—	—	190	g
Axial force between Bearing surfaces	—	—	100	N
Mounting position	Any The recommended orientation of the intensifier about its axis on embodiment is with the image foreground adjacent to the Keyway.			

Performance measured at 22 ± 3 °C with an input voltage of 2.6V

	min	typ	max	
Gain	65000	85000	—	
measured with the whole cathode illuminated with approximately 50 μlx and an aperture of 10 mm diameter on the screen. (with pins 1 and 3 shorted, see fig. 5)				

Mean screen luminance	min	typ	max	
with whole of photocathode illuminated with approx. 20 mlx	9	—	20	cd/m ²
Resolution centre	32	36		lp/mm
edge; at 14 mm diameter	32	36		lp/mm
Modulation transfer factors				
2.5 cycles/mm	0.85	0.92	—	
7.5 cycles/mm	0.65	0.67	—	
16.0 cycles/mm	0.30	0.33	—	

The figures quoted apply to the mean values for MTF, measured in two perpendicular directions and normalised to zero spatial frequency. Other manufacturers may normalise to different spatial frequencies which may lead to higher values being quoted. Care should be taken when comparing these MTF figures.

See fig. 2 for a typical MTF curve measured on a complete image intensifier encapsulated with its integral power supply.

	min	typ	max	
Signal to noise ratio	3.0	3.8	—	

Other manufacturers may use different measuring techniques which lead to more favourable values being quoted.

	min	typ	max	
Equivalent background illumination	—	0.07	0.20	μlx
Centre magnification	0.95	—	1.03	
Distortion	—	—	4	%
Image alignment	—	—	0.8	mm
Recovery time	—	0.2	0.4	s
Switch-on time	—	1.9	3	s

Environmental tests

Samples are subjected to the following tests at regular intervals.

Shock

6 shocks, half sine-wave, in two directions, parallel to and perpendicular to the intensifier axis, with peak acceleration 1400 m/s^2 , duration 9.0 ms.

Vibration

Sine-wave, in two directions, parallel to and perpendicular to the intensifier axis, with peak acceleration 25 m/s^2 over frequency range 10 to 3500 Hz.

Photocathode Illuminance

Recommended level Max 10 mlx

Room lighting No damage.

Point highlight sources such as car headlights, flares, tracers, etc.

No damage for short periods.

The intensifier may be used at illumination levels up to 1.0 lx but for continuous operation the recommended maximum illumination is 10 mlx. Prolonged operation with photocathode illuminances 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 camera.

Life

In sight with a scene illumination 10 mlx	min. 2000 h
Direct illumination 10 μlx on cathode	life estimate; in excess of 20000 hours

Ratings Limiting values in accordance with absolute maximum system IEC 134.

	min	max	
Supply voltage	—	3.4	V
Reverse supply voltage	—	- 3.4	V
Tamb (for storage 100 h cumulative)	—	70	°C
Tamb (for operation and long term storage)	-20	52	°C
Tamb (for operation 2 h max)	-40	52	°C
Axial force between bearing surfaces	—	100	N

Accessories

Every intensifier in the XX1500 family is supplied with a connector.

Fibre-optic insulation and extender plates are available for coupling the XX1500TV to the fibre-optic faceplate TV camera tubes.

All the XX1500 family can be supplied with a PTFE annulus around the edge of the cathode window.

Important

This data must be read in conjunction with "Using Image Intensifiers" a technical note which describes how these devices should be embodied. This note includes instructions relating to the Health and Safety at Work Act 1974 and precautions to be taken to avoid irreparable damage to the intensifier.

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.

Fig. 1 Typical Automatic Brightness Control Characterisation XX1500TV

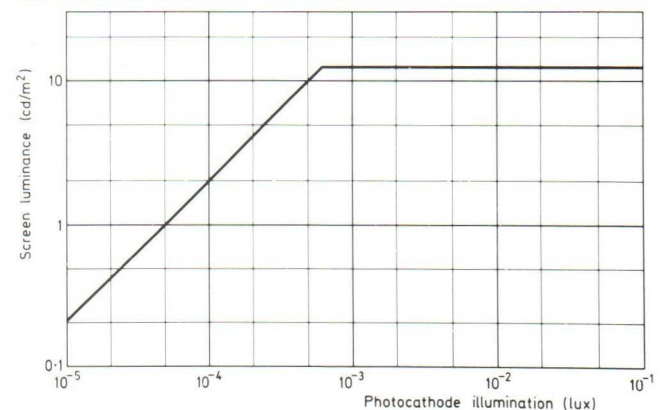
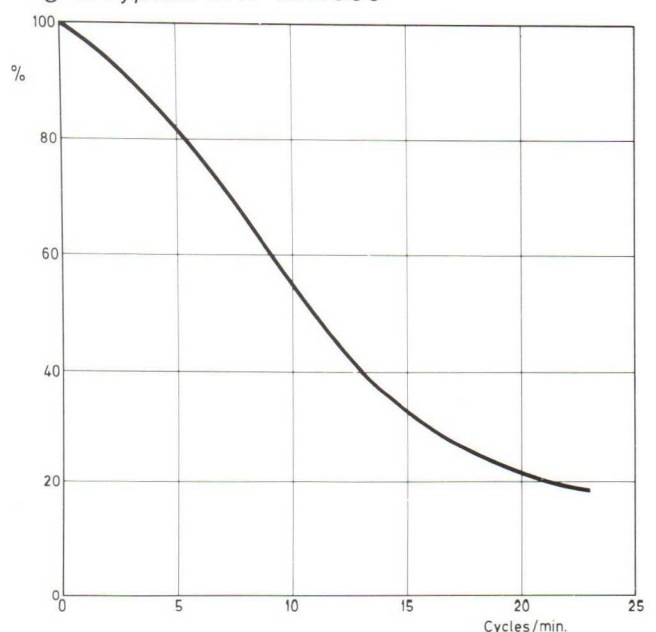
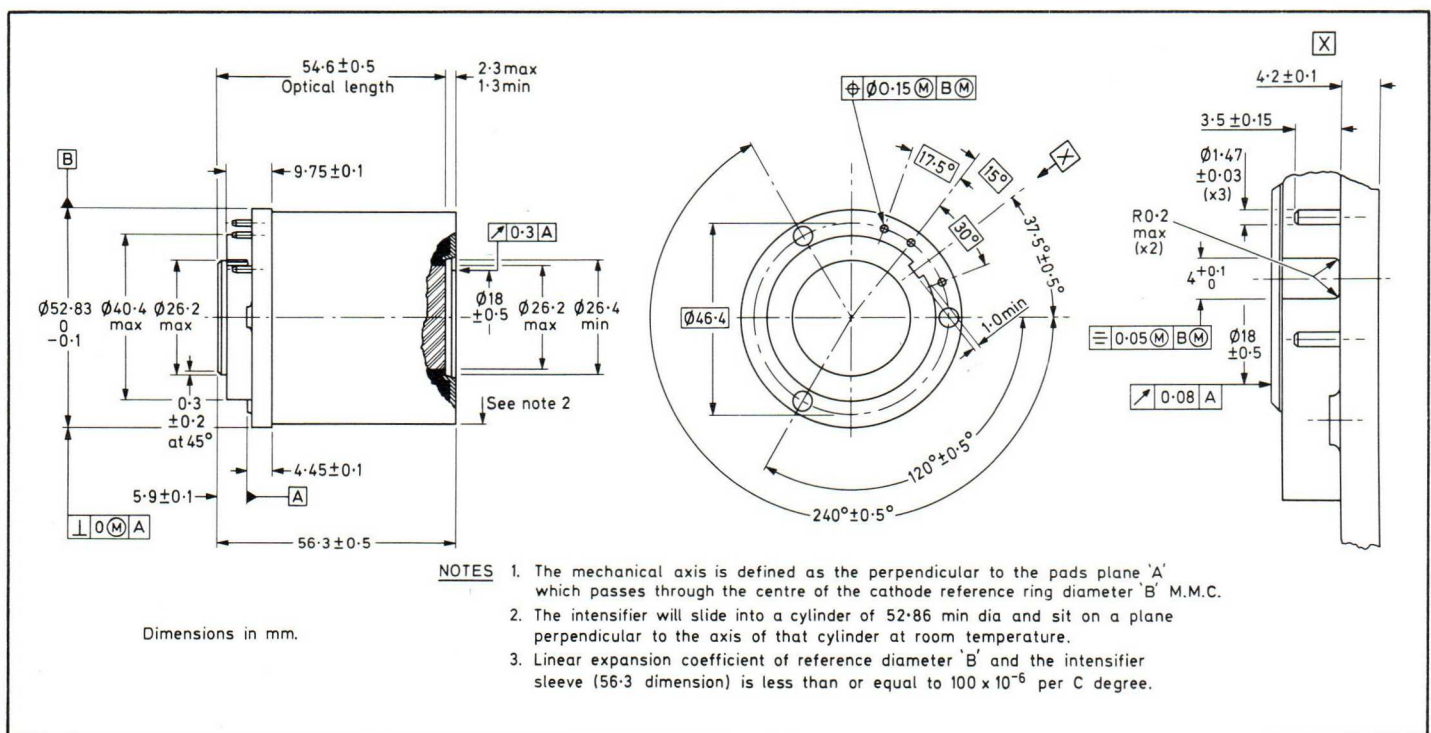
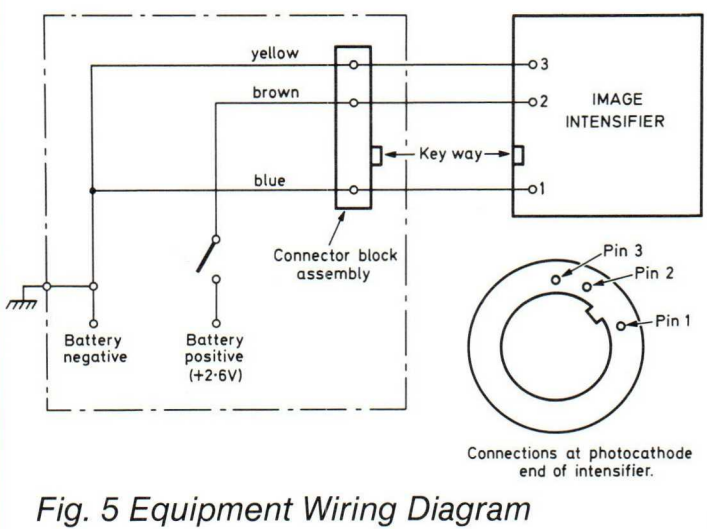
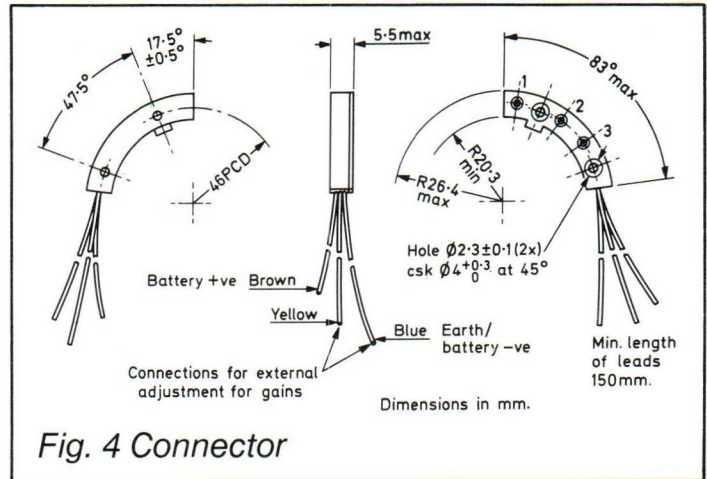
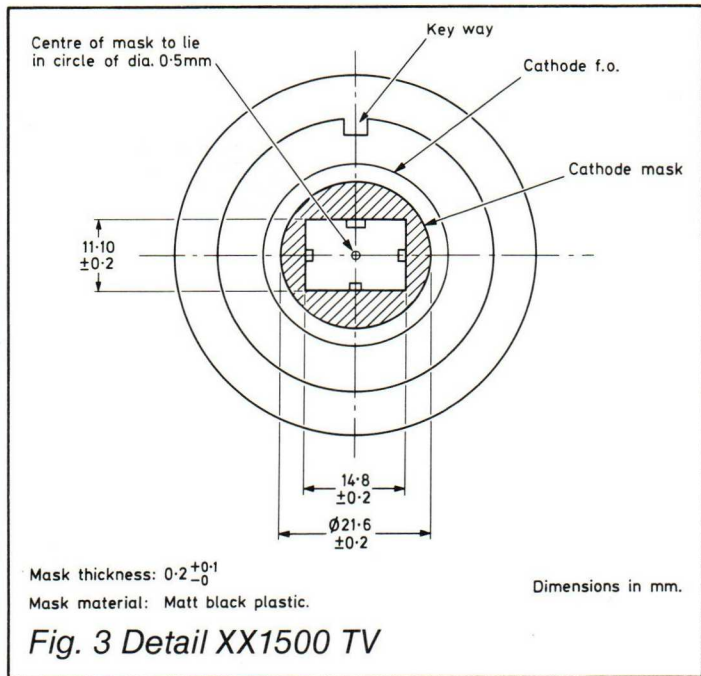


Fig. 2 Typical MTF XX1500





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Torrington Place, London WC1E 7HD.
Tel: 01-580 6633. Telex: 264341.



Mullard manufacture and market electronic components under their own name, and those of associated companies.

THE MULLARD RANGE OF IMAGE INTENSIFIERS

All tubes electrostatically focused and image inverting

Image size (mm)	Description and type no.	Photocathode			Screen		Resolution (Line/pairs/mm) typical	Gain Limits	Operating voltage	Overall Dimensions		Weight (g) Approx	Comments	Availability
		Type	Diam (mm)	Typical Sensitivity ($\mu\text{A}/\text{lm}$)	Type	Diam. (mm)				Diam. (mm)	Length (mm)			
14	Infrared image converters CV6099	S1	19 glass	25	P20	14.5 glass	50	0.4*	12kV	35	60	42	6929 Selection	Obsolete
25	Cascade image intensifiers XX1060/01	S25	25 F.O.	250	P20	25 F.O.	30	> 50000	2.7kV @ 1.6kHz	70	195	880	ABC characteristic dependent on external power/supply	Obsolete
	XX1063	S25	25 F.O.	250	P20	25 F.O.	30	> 50000	6.75V d.c.	70	195	880	Integral power supply and ABC circuit	Maintenance
18	MCP image intensifiers XX1306	S25	18 F.O.	240	P20	18 F.O.	27	23000–46000	2.6V d.c.	53	47	200	Integral power supply and AGC circuit	Current
40	XX1332	S25	50 F.O.	260	P20	40 F.O.	20	30000 to 60000	6.5V d.c.	Rectangular package 92 x 66 x 101	Rectangular package 92 x 66 x 101	850	Integral power supply with AGC	Design type
30	XX1380 series	S25	20 F.O.	280	P20 Mixed	30 F.O.	50	15000 to 25000	2.2V to 3.4V d.c.	62	80	350	Integral power supply with AGC	Design type
18	XX1500	S25	18	280	P20 Mixed	18 F.O.	32	5000–50000	2.2V to 3.2V d.c.	53	58	200	Integral power supply with AGC & manual gain control facility	Design type
18	Proximity image intensifiers XX1410	S25	18	280	P20	18 F.O. inverter	28	7500 to 15000	2.5V d.c.	43	30	100	Integral power supply with AGC	Design type

conversion coefficient in cd/lm i.r.f.

F.O. Fibre-optic windows

ABC Automatic Brightness control

AGC Automatic Gain control

M.C.P. Micro Channel plate

Full data sheets on all these devices are available on request from the Image Device Technical Commercial Department

NIGHT VISION TV CAMERA TUBES

S58XQ Pyroelectric vidicon TV camera tubes

This tube exhibits good resolution, typically 0.2°C at 150 TV lines in the 8 to 14 μm band.

S70XQ Intensified silicon vidicon camera tubes

Discontinued. Type no longer available.

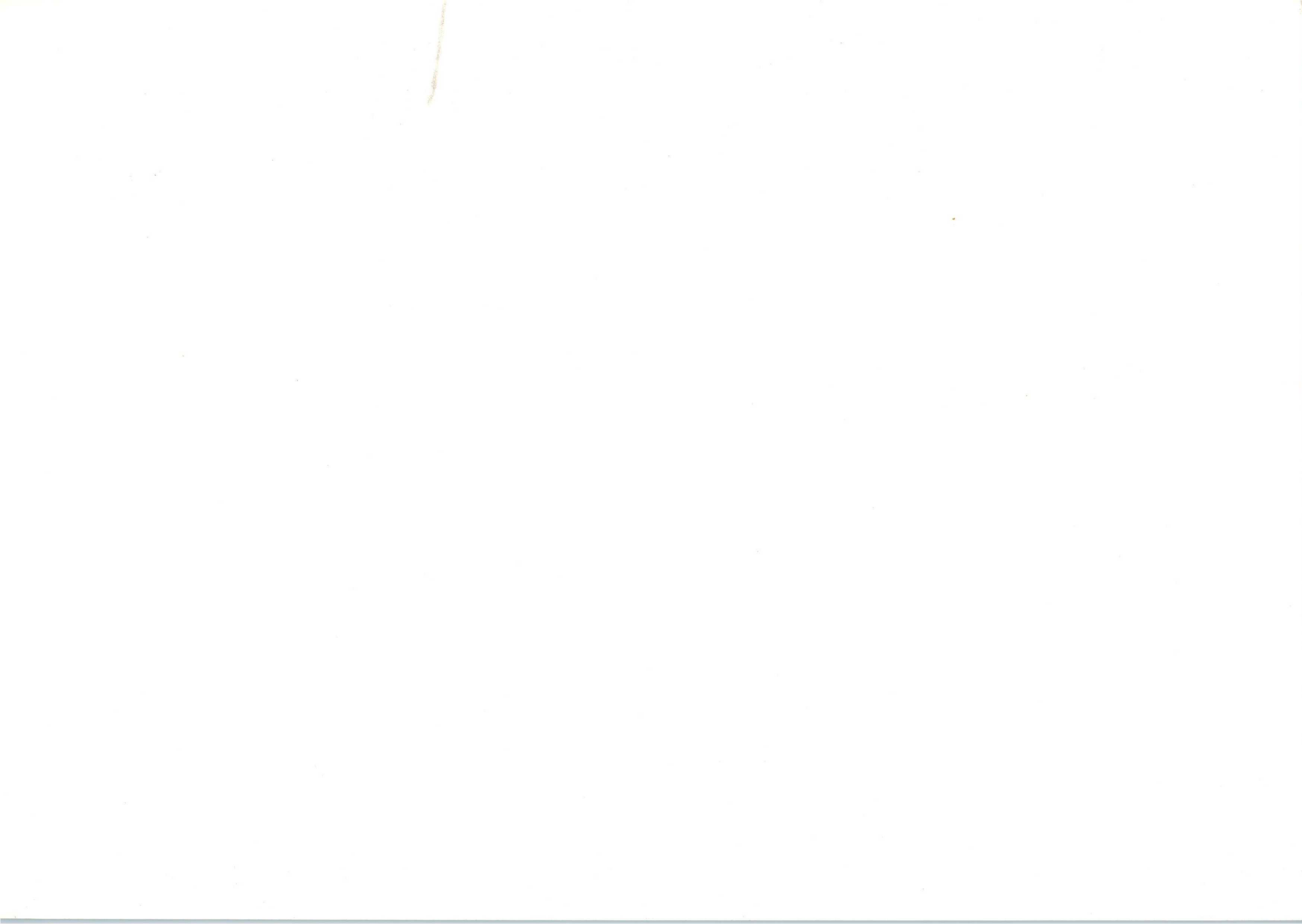
Design type recommended for new projects

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XX1500
Small Channel Plate
Image Intensifier
for Light Weight
Sights



18mm Second Generation Image Intensifier



DEVELOPMENT SAMPLE DATA

This information is derived from development samples made available for evaluation. It does not necessarily imply that the device will go into regular production.

XX1500
(Dev. No. M27XX)

IMAGE INTENSIFIER

The XX1500 is a miniature, electrostatically self-focused, inverting microchannel plate image intensifier. It has 18 mm fibre-optic input and output windows, an integral power supply and automatic gain control (AGC).

Particular features of this intensifier include an S25 photocathode, external adjustment of gain, point highlight saturation, bright source protection and low distortion. It is intended for use in hand held, direct viewing night vision systems.

This data must be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS – IMAGE INTENSIFIERS.

RECOMMENDED SUPPLY VOLTAGE

2.5 to 3.0 V

CHARACTERISTICS (Measured at 22 ± 3 °C with recommended supply voltage)

Photocathode

Surface		S25
Useful diameter	min.	17.5 mm
Sensitivity		
white light	min.	240 $\mu\text{A}/\text{lm}$
$\lambda = 800$ nm	min.	15 mA/W
$\lambda = 850$ nm	min.	10 mA/W

Screen

Phosphor		P20 type
Useful diameter	min.	17.5 mm



Mullard

March 1980

1

CHARACTERISTICS (continued)

Gain, $\phi_G = 10 \text{ mm}$, $E_i \approx 50 \mu\text{lx}$

Gain control at maximum

30 000 to 70 000

Gain control at minimum

2000 to 10 000

Mean screen luminance, $E_i \approx 20 \text{ mlx}$

min.	1.0	cd/m ²
max.	3.1	cd/m ²

Magnification, $\phi_D = 14 \text{ mm}$

min.	0.96
max.	1.04

Centre resolution

min.	30	line pairs/mm
------	----	---------------

Edge resolution, $\phi_E = 14 \text{ mm}$

min.	25	line pairs/mm
------	----	---------------

Distortion

max.	6	%
------	---	---

Modulation transfer factors (note 1)

2.5 cycles/mm

min.	0.9
------	-----

7.5 cycles/mm

min.	0.6
------	-----

16 cycles/mm

min.	0.3
------	-----

Equivalent background illumination (EBI)

max.	0.2	μlx
------	-----	----------------

Image alignment

max.	0.8	mm
------	-----	----

Signal to noise ratio (note 2)

typ.	3.0
------	-----

Recovery time

max.	0.5	s
------	-----	---

Power consumption

max.	65	mW
------	----	----

Mass

max.	200	g
------	-----	---

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

Supply voltage (note 3)

max.	3.2	V
------	-----	---

Photocathode illuminance (note 4)

max.	1.0	lx
------	-----	----

T_{amb} (for storage, 100 h cumulative)

max.	70	°C
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T_{amb} (for operation and long term storage)

max.	52	°C
min.	-10	°C

T_{amb} (for operation, 2 h max.)

max.	70	°C
min.	-40	°C

Axial force between bearing surfaces

max.	100	N
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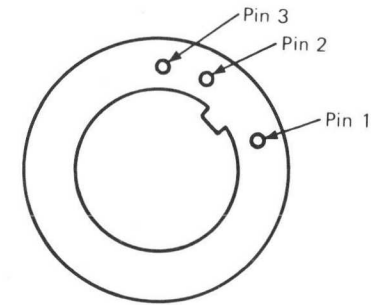
IMPORTANT

The General Operational Recommendations for Image Intensifiers contain instructions relating to the Health and Safety at Work Act, 1974 and precautions to be taken to avoid irreparable damage to the intensifier.

WARNING

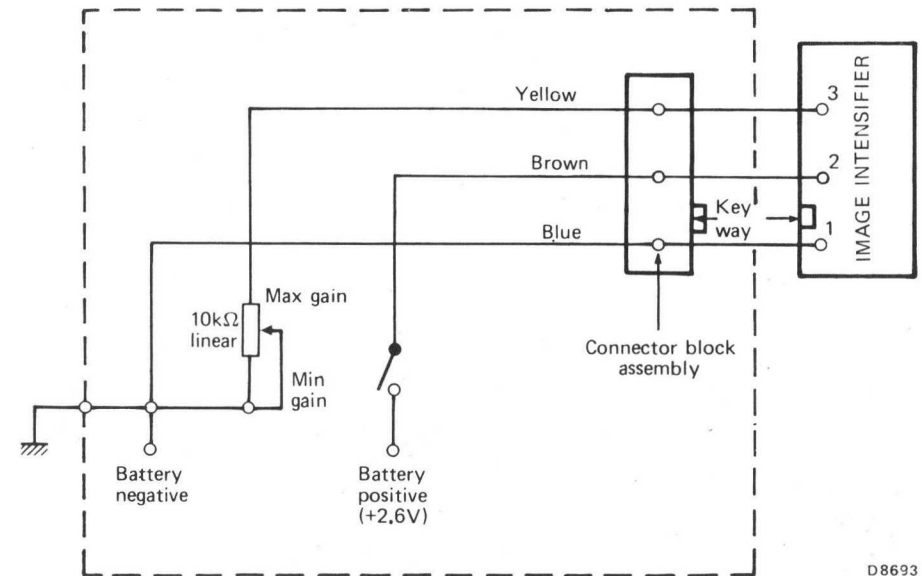
Immediately after operation, the screen will remain electrostatically charged for approximately 1 hour, during which time the intensifier should not be handled. Any attempt to discharge the intensifier by any means may result in irreparable damage.

EQUIPMENT WIRING DIAGRAM



Connections at photocathode end of intensifier

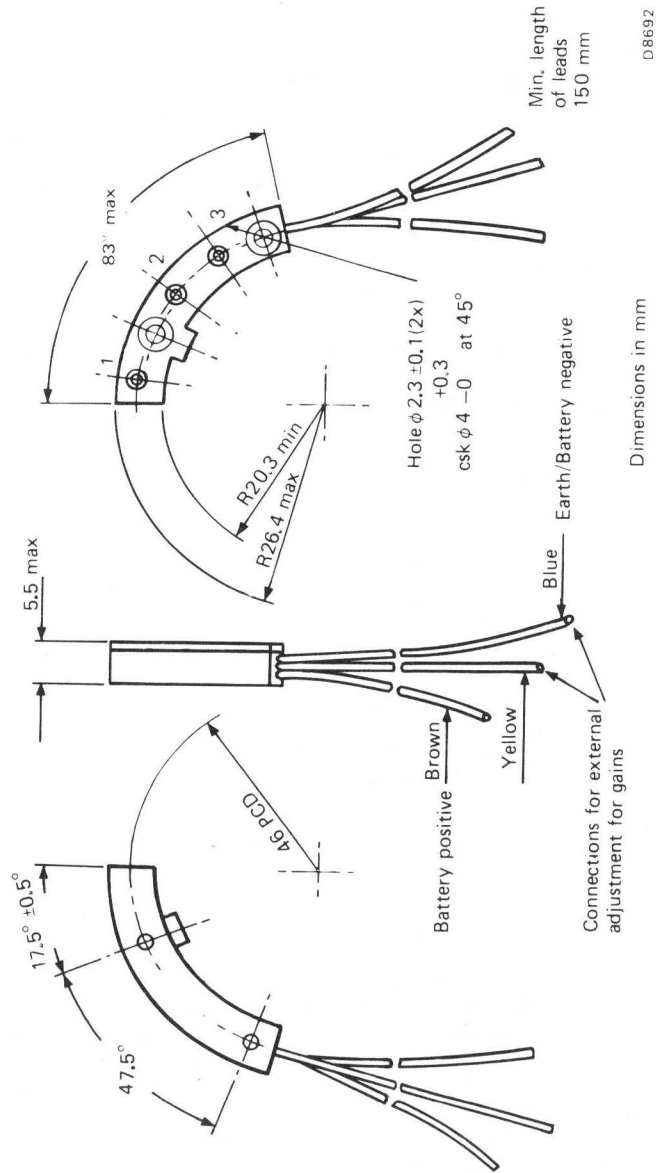
DEVELOPMENT SAMPLE DATA



D8693



CONNECTOR BLOCK DETAILS



Notes

1. These values are normalized at zero spatial frequency and are referred to the screen.
2. 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 d.c. and r.m.s. meter. Signal-to-noise ratio is defined as:

$$\frac{S}{N} = K \frac{S_o - S_b}{\sqrt{(N_o^2 - N_b^2)}} \sqrt{\left(\frac{1.24 \times 10^{-5}}{E_i} \times \frac{\pi \times 10^{-8}}{A} \right)}$$

- K = correction factor for filter to obtain equivalent bandwidth of 10 Hz.
 - N_o = r.m.s. signal output.
 - S_o = d.c. signal output
 - N_b = r.m.s. signal output
 - S_b = d.c. signal output
 - E_i = photocathode illuminance
 - A = area of circular spot.
- } with no illuminance at the photocathode

DEVELOPMENT SAMPLE DATA

3. If the supply voltage falls below 2.0 V, the intensifier will not be damaged, but may not function.
4. Prolonged operation 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 1000 hours can be expected with a photocathode illuminance of 1.0 lx.



The XX1500 is an electrostatically self focussed inverting micro channel plate image intensifier.

The intensifier has 18mm fibre optic photocathode and screen windows with a magnification of 1.0. Low distortion and high gain together with a full military environmental specification make this intensifier ideally suitable for light weight aiming and surveillance sights.

An integral power supply gives automatic gain control and particular features include facility for external adjustment of gain, point high light saturation and bright source protection.

A distinguishing feature of this tube is that the electron optical design does not require a metallic aluminium film on the input of the channel plate. A potential barrier protects the photocathode from positive ions produced in the channel plate and so contributes to long life, even at high levels of photocathode illumination. In fact under normal operating conditions tube life is likely to be many thousands of hours.

The production centre has over half a century of experience in directly related glass technology and vacuum physics. The facilities for R and D and manufacture of image intensifiers are unparalleled. There is no other organisation in the world which goes as far as to make its own special glass for this kind of device. And for the production of glass fibre-optic components a special plant has been set up as an integral part of the manufacturing facility.

High Gain

Up to 50,000 with automatic gain control.

Low Distortion

Edge distortion of less than 6% gives a virtually distortion free image.

Bright Source Protection

Able to deal with very intense small sources of light without excessive blooming.

Good Contrast

The modulation transfer factor is very good for a micro channel plate intensifier of this size.

Low Noise

The noise power factor is very favourable due to the use of an open input channel plate and special electron lens design.

System Design Advantages

Small size and rugged — suitable for light weight aiming sights.

Facility for external gain control to set optimum viewing conditions.

Low distortion to ease optical interface design. High sensitivity, S25 photocathode.

Main Applications

Aiming sights.
Hand held viewers.

XX1500 Quick Reference Data

Gain adjustable in the range	5000 to 50,000
Photocathode	S25
Photocathode sensitivity (at 2856K) Min	240 μ A/1m
Radiant sensitivity at 800mm	15 mA/W
Radiant sensitivity at 850mm	10 mA/W
Useful Cathode Diameter (nom)	18mm
Intensifier Supply Voltage	2.6 VDC
Overall dimensions	\varnothing 53 \times 58mm
Mass	200 gr
Magnification	1.0
Centre resolution (min)	30 line pairs/mm
Distortion (max)	6%
Modulation Transfer Factors	
2.5 cycles/mm	90%
7.5 cycles/mm	60%
16 cycles/mm	30%
Equivalent Background Illumination (max)	0.2 μ lx
Veiling Glare (max)	5%

Mullard

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Mullard manufacture and market electronic components
under the Mullard, Philips and Signetics brands.



Image Intensifiers for rifle sights



**FIRST IN NIGHT-
VISION COMPONENTS**

Mullard



The Optimum for your 1

The one company in the world that is actively engaged on all night vision fronts. In research and development of third generation image intensifiers and infra-red CCD's. In production of first and second generation image intensifiers and of CdHgTe (CMT) infra-red devices. The one company qualified to give unbiased advice on any application. And the one that will keep you in the forefront of advancing technology.

The rifle-sight image intensifiers in this brochure offer a choice of design advantages depending on whether cost-effectiveness, performance, or lightness and compactness are your primary requirements. Each of them has been designed and constructed to offer a set of options that satisfy both system designer and end-user. Quality, of course, goes without saying. They are intended for military applications and satisfy military quality requirements.

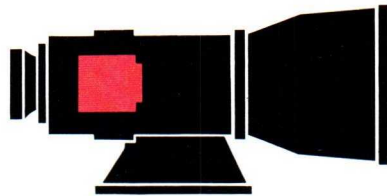


18mm Intensifier rifle sight

Microchannel plate (MCP) 2nd generation

XX1500

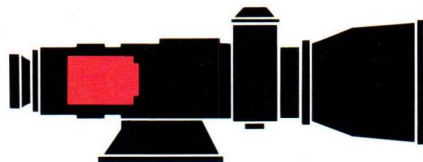
Most cost effective second generation tube



- high performance 18mm inverter tube
- light weight
- all the second generation advantages at first generation cost
- new design – incorporates latest technological advances
- just shorten the body of your current 18mm cascade sight.

XX1380

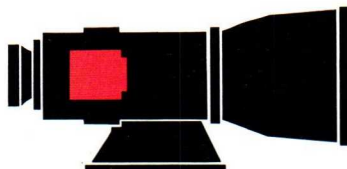
A high performance 20/30mm tube



- rugged – withstands 500g recoil
- 1,5 × magnification for lighter optics & clean, noise-free image
- highest performance second generation tube in the world.

XX1410

Smallest, lightest tube in production



- fibre-optic image inversion
- automatic brightness control
- 18mm proximity tube
- first choice where weight is deciding factor

	18 mm PROXIMITY MCP "WAFER" TUBE	25 mm INVERTER MCP	20/30 mm INVERTER MCP	18 mm MCP INVERTER	18 mm CASCADE TUBE "3 STAGE"
Mullard type	XX1410		XX1380	XX1500	
Lightweight	very	✓	✓	✓	no
Field proven	✓	✓	✓	new	✓
Microchannel plate (MCP)	✓	✓	✓	✓	no
Bright source protection (BSP)	✓	✓	✓	✓	no
Auto gain control (AGC)	✓	✓	✓	✓	no
Auto brightness control (ABC)	✓	✓	✓	✓	✓
Adjustable gain	no	✓	no	✓	no
Designed for lightweight IWS	no	no	✓✓✓	✓✓✓	no

✓ Denotes yes

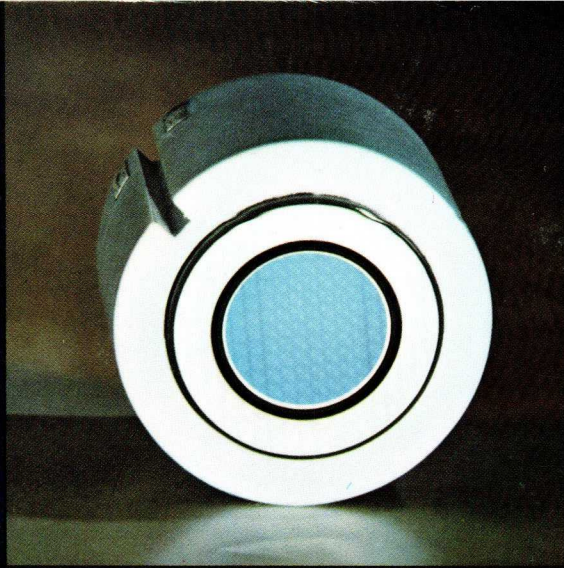
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Mullard manufacture and market electronic components
under the **Mullard**, **Philips** and **Signetics** brands.





PROXIMITY FOCUSED LIGHTWEIGHT IMAGE INTENSIFIERS



Mullard



XX1410 PROXIMITY FOCUSED MICRO CHANNEL PLATE IMAGE INTENSIFIER

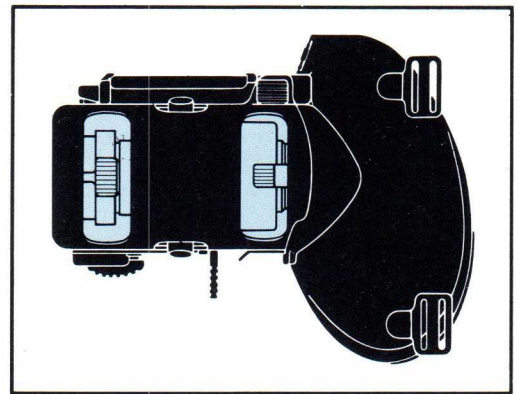
**Smallest lightest image intensifier
in production**

Specially developed for goggle applications. Ideal for lightweight weapon sights and pocket viewers.

Compatible with tubes supplied to U.S. Army. Direct replacement for tubes used in U.S. AN/PVS5 goggles.

Features of XX1410

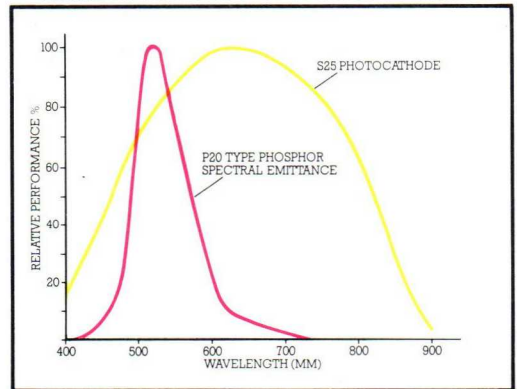
- Distortion-free image
- Image inversion with fibre-optic twister
- Low-noise—S25 photocathode
- Built-in power supply with automatic brightness control
- Designed for more than 2,000 hours operation
- Gain (factory set) 5,000 to 20,000
- Negligible recovery time to high light level exposure
- Ruggedised
- 18mm image format



OTHER PARAMETERS

Gain (present).....	5,000 to 20,000
Photocathode.....	S25
Screen phosphor.....	P20
Useful cathode diameter.....	18mm
Useful screen diameter.....	18mm
Supply voltage.....	2.2 to 3V
Sensitivity.....	280 μ A/lm
Centre resolution.....	28 lp/ μ m
Mass.....	100g

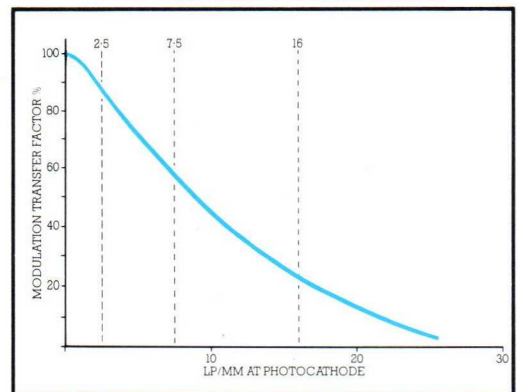
TYPICAL SPECTRAL EMITTANCE OF P20 TYPE PHOSPHOR AND TYPICAL SPECTRAL RESPONSE OF S25 PHOTOCATHODE.



50 YEARS EXPERIENCE

We are the only manufacturer in Europe who commands all the technologies needed to make image intensifiers beginning from the raw materials. We have also contributed much to the image intensifier art, starting as far back as 50 years ago—our first Patent in this field was granted in 1928.

TYPICAL MODULATION TRANSFER FUNCTION



Photocathode

Computer control of all our photocathode processing facilities assures consistently high quality. S25 photocathode chosen for low noise, high sensitivity, and a spectral response suited to night sky illumination.

Fibre optic input

Fibre optics contribute to distortion-free image transfer between optical system and photocathode. Every stage in processing, from glass manufacture to finished product is entirely in our own hands which greatly contributes to the high quality of our tubes.

P20 phosphor screen

The P20 phosphor is recognised as being the best suited to the dark adapted human eye.

Microchannel plate

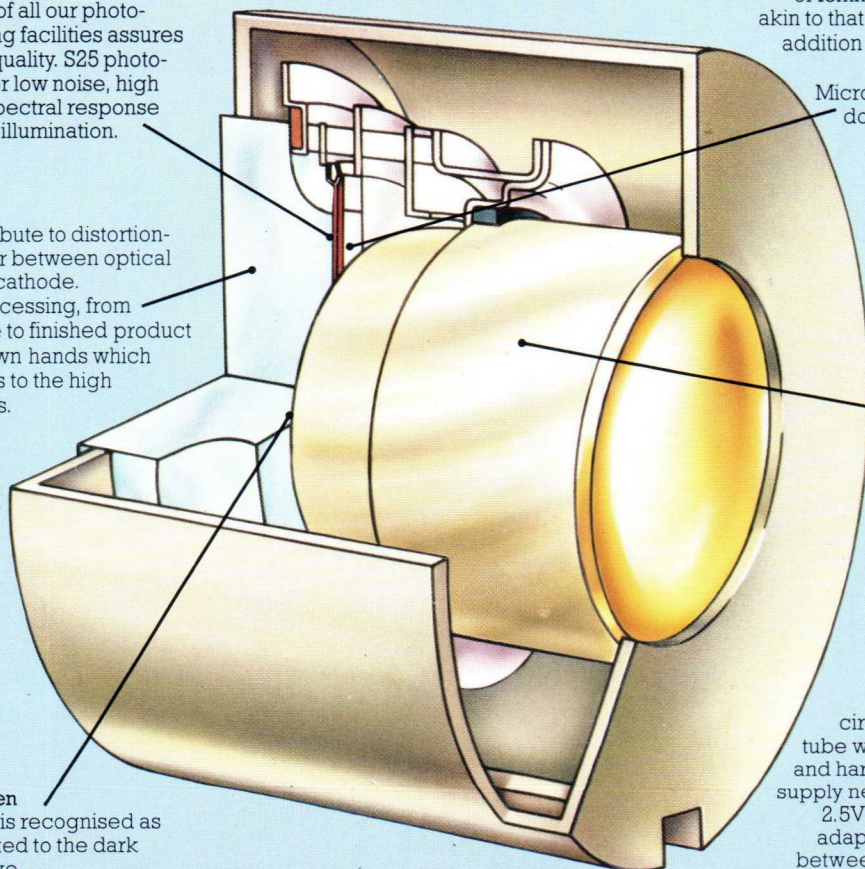
Over 6 million amplifiers in a circle of 18mm diameter. Manufacture is akin to that of fibre optics but with the addition of several technologically advanced processes. Microchannel plate intensifiers do not bloom when exposed to small intense sources of light.

Fibre optic twister

Over a length of 20mm the glass fibres are rotated through 180° resulting in a shorter, lighter optical system.

Power supply

High voltage multiplier, SMPS and gain control circuitry are built around the tube with a rubber encapsulation and hard plastic sleeve. The only supply needed is typically 15mA at 2.5V d.c. Gain is automatically adapted to scene illuminations between 10^{-5} lux and 10^{-1} lux. The tube self protects against intense flashes.



APPLICATION	XX1060/01, XX1063 CASCADE	XX1306 18mm MCP INVERTER	XX1332 50/40 MCP INVERTER	XX1380 (18XX) 20/30 MCP INV.	XX1410 (F23XX) 18mm MCP PROXIMITY	THERMAL IMAGING DETECTORS
Individual Weapon Sight	X	X		X	X	
Gunners Sight	X		X	X		X
Commanders Sight	X		X	X		X
Driving Sight			X			X
Observation Sight			X	X		X
Pocket Viewers		X			X	
Goggles					X	
Missile Tracking						X
Thermal Pointers						X
I.R. "Radar"						X
Anti Tank Weapon Sights						X
For special application in development and research the 25XX Triode Image Intensifier For TV systems—the S58XQ pyroelectric vidicon and the S70XQ intensified silicon vidicon.						



Mullard



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Mullard manufacture and market electronic components
under the **Mullard, Philips** and **Signetics** brands.

XX 1500

Low cost conversion to
2nd generation



Mullard

**FIRST IN NIGHT-
VISION COMPONENTS**



XX1500

Low cost conversion to 2nd generation

For many years large quantities of 1st generation 18mm cascade night vision sights have been in service. Now we are able to offer a cost-effective 2nd generation replacement — the XX1500 electrostatically self-focussed inverting micro-channel plate image intensifier — giving lightweight, compact performance.

Second generation can be achieved at a relatively low cost by retaining the original optics and converting the 1st generation sight body to accept the new XX1500. This will result in a shorter, lighter sight, in addition to the advantages of low distortion, bright source protection, low veiling glare and external gain control.

Low Distortion

Edge distortion of less than 6% gives a virtually distortion free image.

Bright Source Protection

Able to deal with very intense small sources of light without excessive blooming.

Low Veiling Glare

Suppression of glare from bright lights in the field of view.

External Gain Control

Facility for external gain control to set optimum viewing conditions.

Lighter Weight

Total weight reduction of 400 grams.

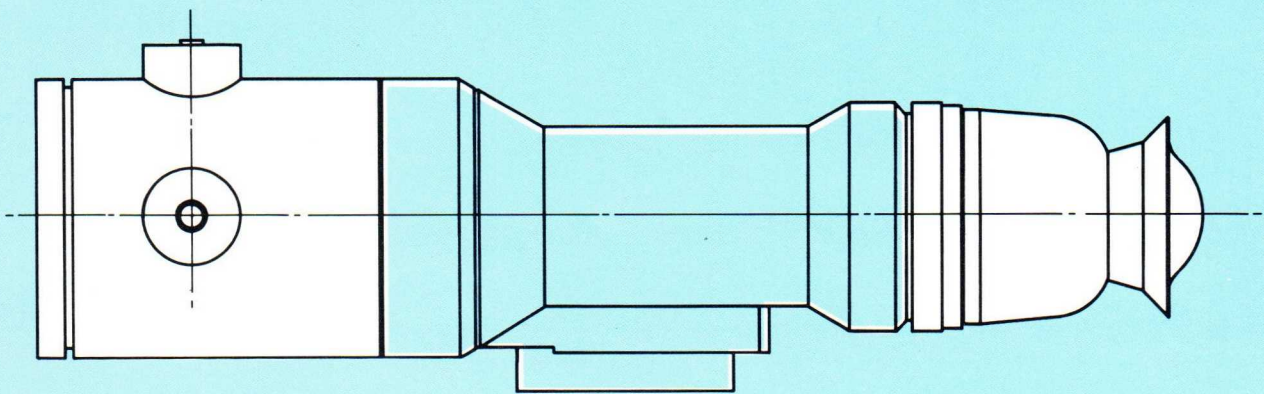
Shorter Length

Total reduction in length of 110mm.



XX1500
18mm second generation
image intensifier

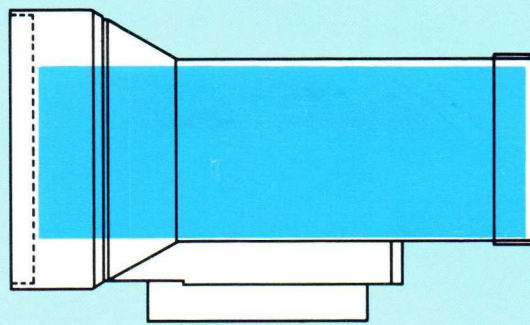
TYPICAL CONVERSION



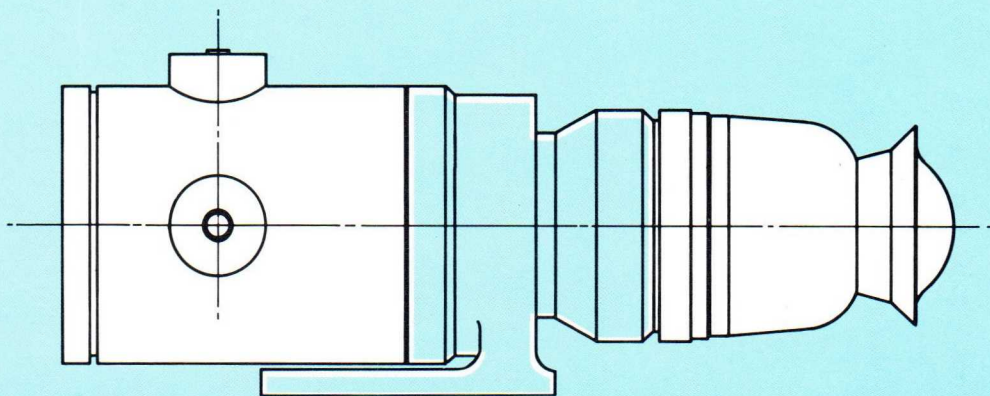
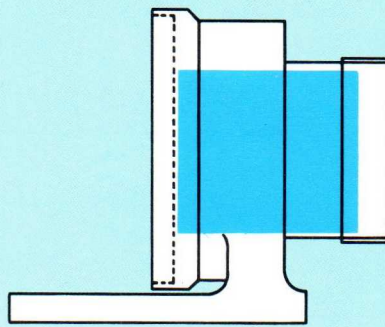
objective

body

eyepiece



first generation cascade intensifier

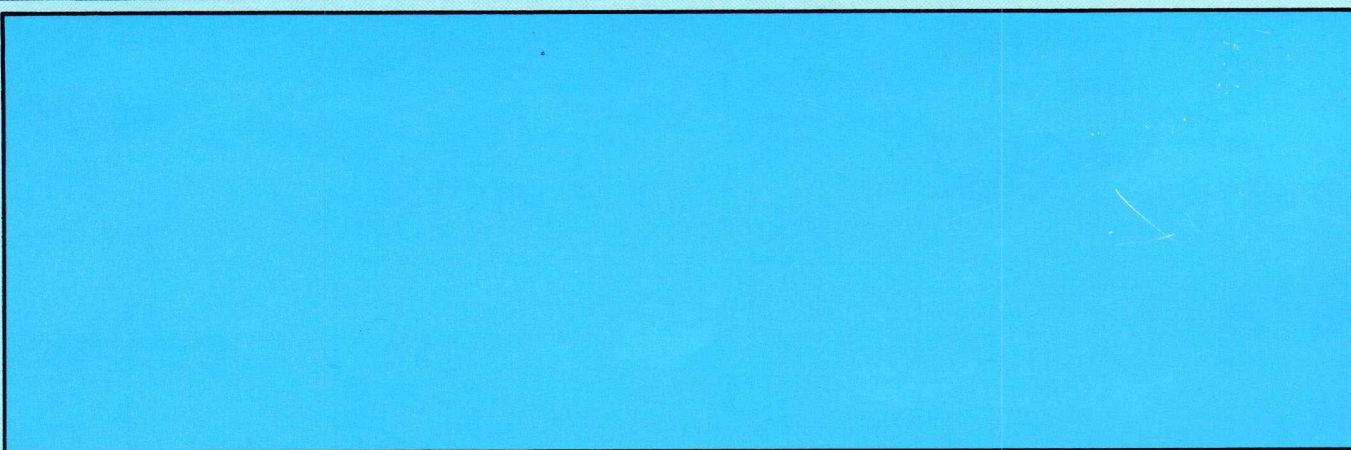


objective

body

eyepiece

second generation XX 1500



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**THE MOST
IMPORTANT
ADVANCE IN
VERY LOW
LIGHT-LEVEL
CCTV SYSTEMS
THIS DECADE...**

Mullard



- 24 HOUR SURVEILLANCE WITHOUT THE NEED FOR LIGHTS
- THE ULTIMATE IN STARLIGHT-LEVEL TELEVISION SYSTEMS FOR THE LOWEST COST



THE IMPROVED TV ADD-ON UNIT

- FOR USERS AND MANUFACTURERS OF CLOS

XX 1500 TV Image Intensifier for CCTV.

Mullard introduced the concept of the "Add-on Unit" to extend the capability of CCTV, in 1981. This simple device quickly converted any 2/3" CCTV camera to a low light level camera. In the last 12 months Mullard has refined this concept to the point where it is very simple to take a CCTV surveillance camera and turn it into a camera capable of working 24 hours/day, 365 days per year, without the aid of the usual supplementary lighting. Of course, like all systems that work using light, the performance deteriorates in the presence of mist and fog.

The Add-on Unit described in this booklet consists of a Mullard XX1500 TV image intensifier, a relay lens, and some electronic circuitry.

The Mullard XX1500 TV image intensifier is already a field proven device. We have extensive experience in 24 hour/day operation, with many tubes operating continuously far in excess of 6000 hours. Since these trials were only started in mid 1981 we have not yet been able to identify any failure mechanisms, and current indications are that each image intensifier will provide at least 10000 hours continuous operation.

The XX1500 TV is part of a family of small microchannel plate image intensifiers which Mullard have developed. This XX1500 family

incorporates over 20 years experience of manufacturing and developing image intensifiers into a compact reliable, high performance device.

This improved Add-on Unit includes some electronic circuitry. One part is designed to keep the performance of the image intensifier to an optimum, the other controls the auto iris which is included in the objective lens.

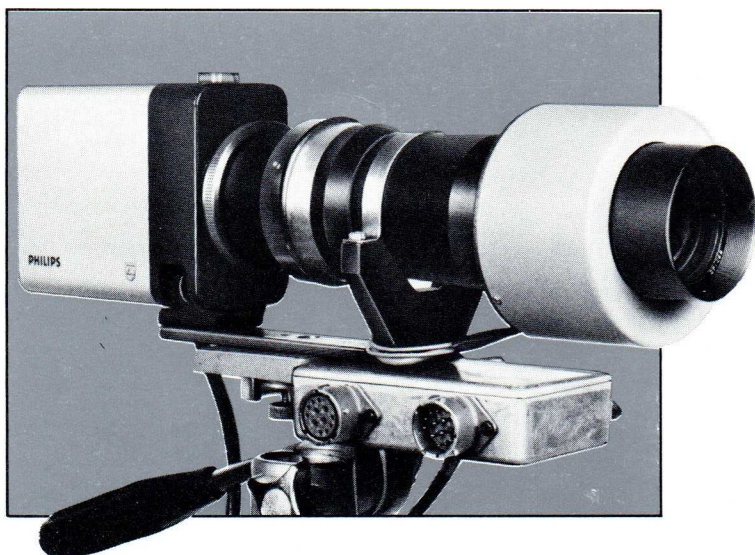
To achieve the best performance of the intensifier it is important to keep the gain optimal. This means that whilst the auto iris is in any position other than nearly fully open, the circuit maintains the gain of the intensifier at a preset low level. As the iris approaches the nearly fully open position, i.e. as the scene brightness drops below dusk, then the control circuit gradually increases the gain until the maximum intensifier gain is reached.

During the time when the intensifier is in the low gain mode, the auto iris is controlled by monitoring the brightness of the screen of the intensifier. The aperture of the auto iris is then adjusted to try to keep the screen brightness constant.

A third electronic circuit is included to prevent unnecessary overloading of the image intensifier. This circuit monitors the operation of the intensifier and when a step increase in scene illuminance occurs the auto iris is closed, thus preventing the possibility of the other two circuits becoming locked in opposition. It should be noted here that the image intensifier is fully protected against bright lights, and no damage will occur when flashes and flares are imaged onto it.

XX 1500 IT

SED-CIRCUIT TV CAMERAS



The final element of the Add-on Unit is a relay lens. In this example it is designed to relay the image from the intensifier onto a 2/3" vidicon. However with different optics it is possible to relay the image to a 1" camera tube, or even a 35mm SLR film format.

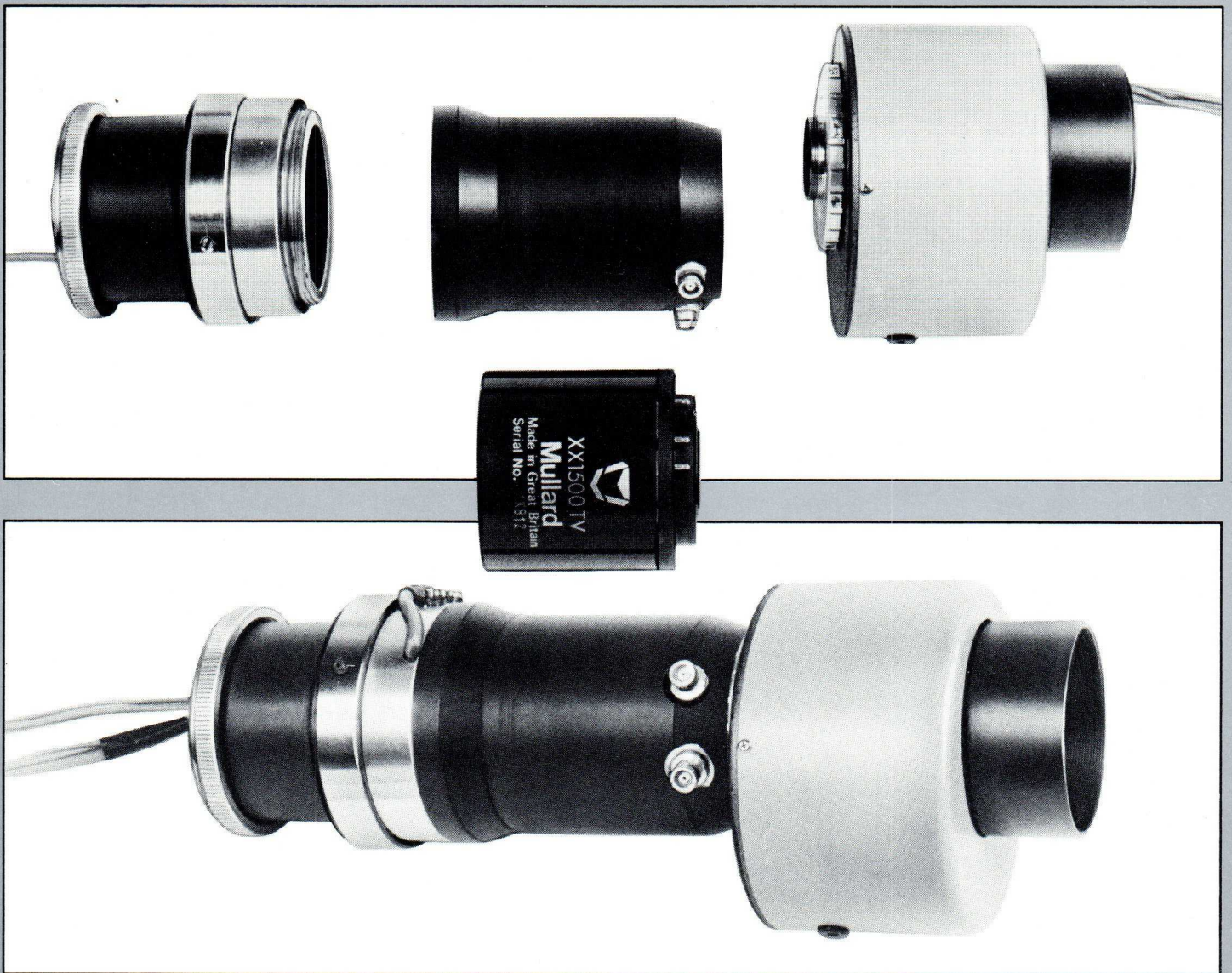
A technical note describing the Add-on Unit and a data sheet for the XX1500 TV are available on request.

If you are thinking of manufacture please

contact the NIGHT VISION DEPARTMENT at Mullard House and we will be pleased to discuss the possibilities with you. If however you are a user rather than a manufacturer, then we will be pleased to discuss how you can best use this very low light level Add-on Unit, and where possible give a demonstration.

In many cases existing installations can quickly be updated with the aid of these XX1500 TV Add-on Units.

THE IMPROVED XX1500 TV ADD-ON UNIT



Mullard



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CCTV camera add-on unit for 24 hour capability



Mullard



CCTV camera add-on unit for 24 hour capability



Mullard Limited, Mullard House, Torrington Place, London WC1E 7HD

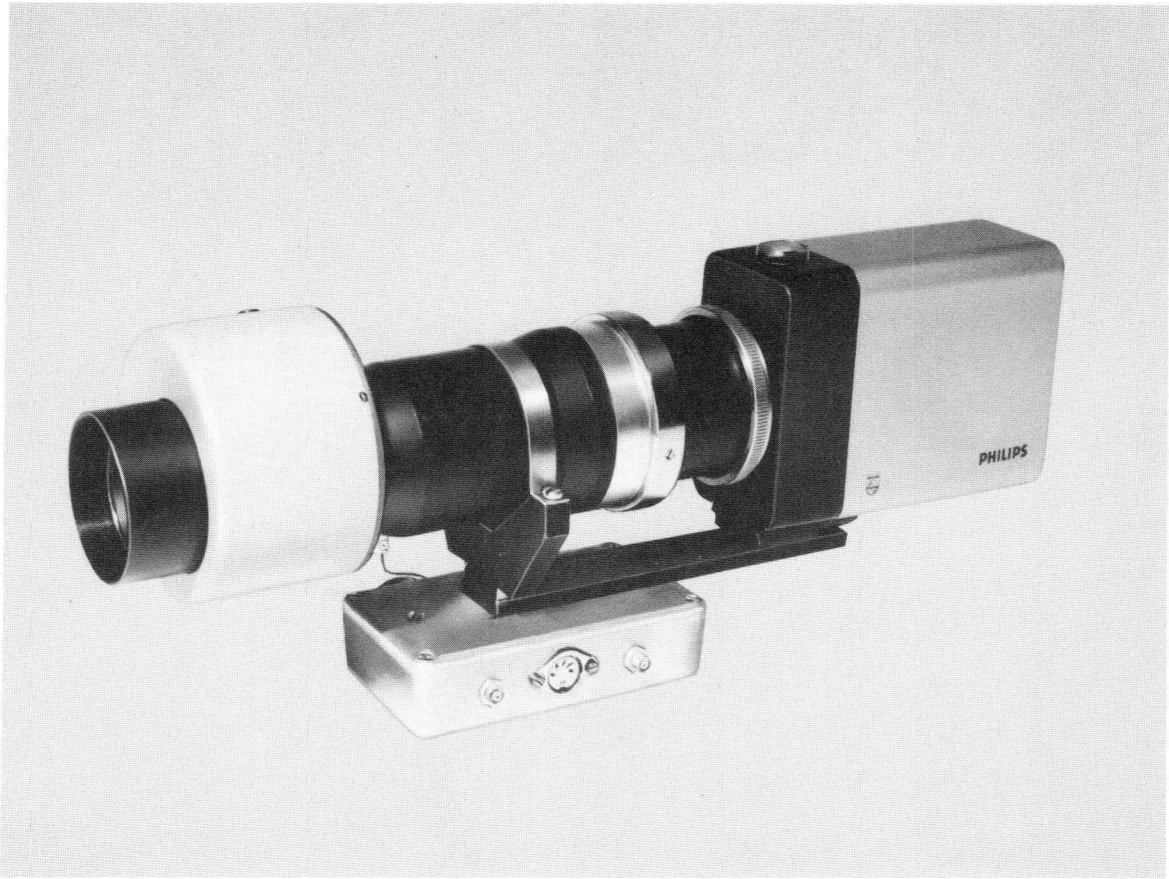


Fig.1 Add-on unit mounted on $\frac{2}{3}$ -in Newvicon CCTV camera. Housing for the control circuit is located directly under the unit.

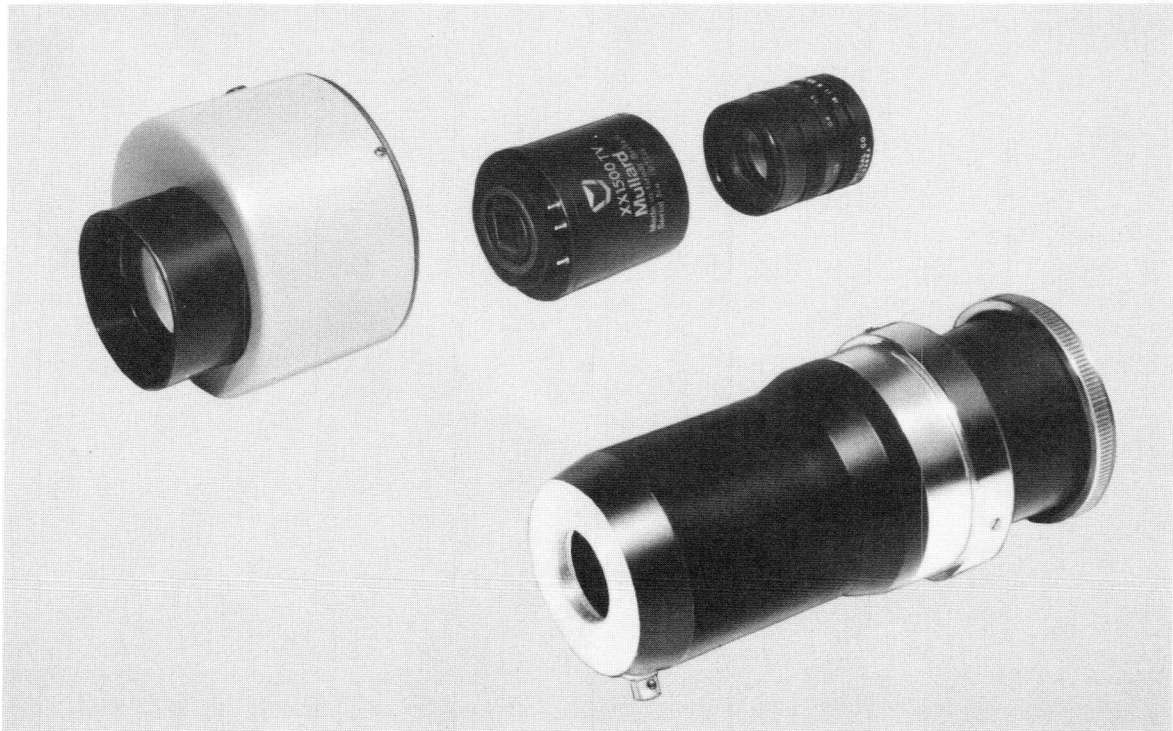


Fig.2 Optical components of add-on unit.

A CCTV camera used for 24 h surveillance without supplementary lighting must be able to operate in a scene illuminance that can change by some 8 orders of magnitude: from 10^5 lux in bright sunlight down to 10^{-3} lux in starlight. This publication describes a simple add-on unit which readily enables any 2/3-in Newvicon* CCTV camera to meet these exacting requirements. The unit is based on the XX1500TV image intensifier, a compact high-performance device with a reliability that ensures at least 10 000 h of continuous operation. In addition to the intensifier, the unit incorporates an auto-iris lens (75 mm, $f/1.8\sim T/1500$),

At high scene illuminance the iris aperture is at minimum and the gain of the intensifier is held at a constant low level. As the scene illuminance falls, the corresponding fall in the output of the image intensifier is sensed by an integrated circuit incorporating a photodiode and an op-amp. This IC is part of the screen brightness control loop which seeks to maintain the output of the image intensifier at half its saturation level. Under the action of the loop, a fall in the output of the intensifier is corrected by an increase in the iris aperture. As the scene illuminance approaches moonlight conditions (the iris almost fully

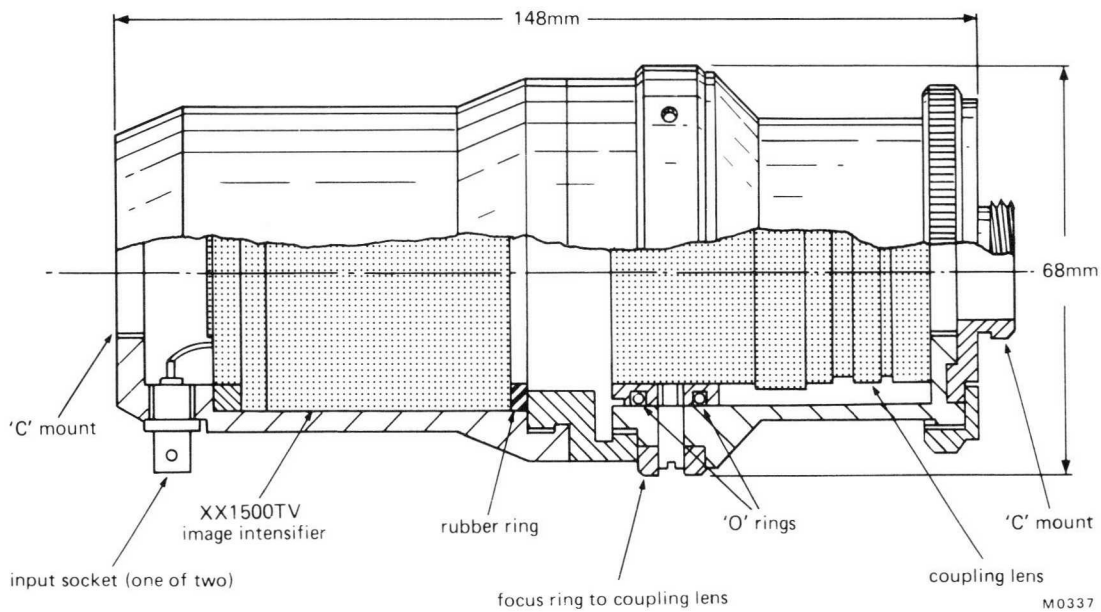


Fig.3 Housing for image intensifier and coupling lens
(For optimum performance the intensifier keyway should be located at the top of the housing).

a coupling lens (25 mm, $f/1.4$, with 60 mm, $f/2.4$ corrector lens), and associated control circuitry.

A prototype of the unit mounted on a 2/3-in Newvicon camera is shown in Fig.1, and the optical components of the unit together with the housing for the intensifier and coupling lens are shown in Fig.2. A detailed drawing of the housing is shown in Fig.3.

PRINCIPLE OF OPERATION

The auto-iris lens projects an image of the scene onto the input window of the image intensifier, and the coupling lens focuses the intensifier output onto the faceplate of the CCTV camera tube (Fig.4).

*Registered Trade Mark for television camera tubes

open), the gain of the image intensifier is gradually increased. This increase in gain is effected via the auto-iris position sensor circuit and the gain control input of the image intensifier. Thus, over the lower portion of the operating range, moonlight down to starlight, the intensifier output is maintained at a constant level by a combination of increasing iris aperture and rising gain.

When the iris is fully opened and the intensifier gain is at maximum, any further reduction in scene illuminance will result in a corresponding reduction in the output brightness of the intensifier. The illuminance on the faceplate of the camera tube will then fall, and eventually the signal from the camera tube will become too low to give an adequate picture. The change in the system variables as the scene illuminance decreases from sunlight to starlight is shown in Fig.5.

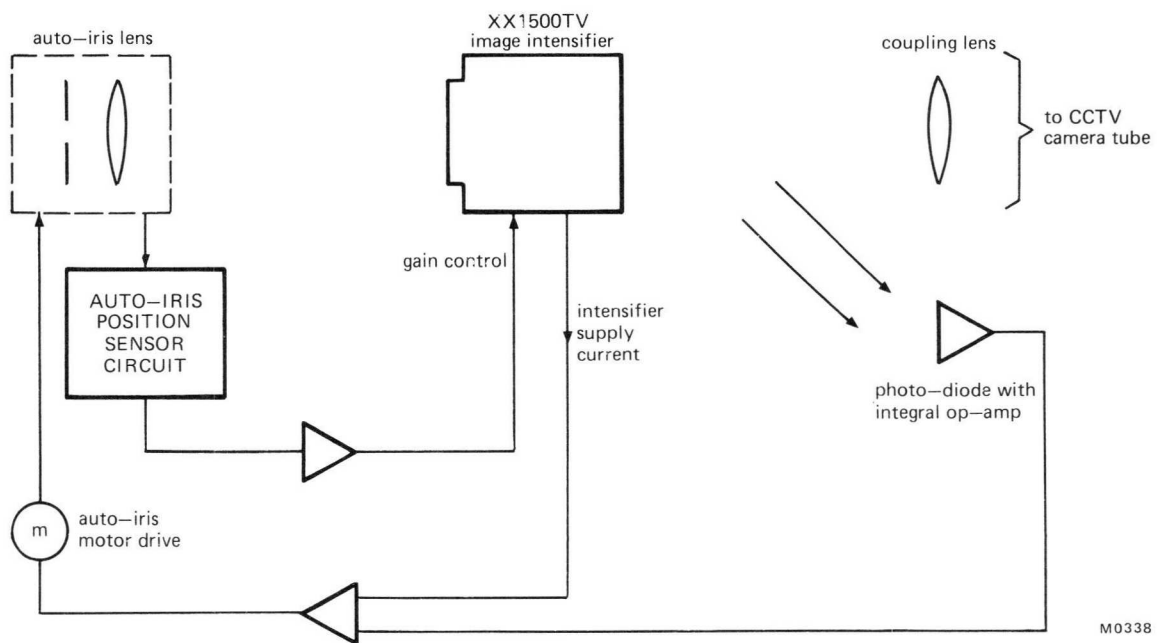


Fig.4 Schematic diagram of auto-iris add-on unit.

If there is a sudden large increase in scene illuminance, causing the illuminance on the input window of the intensifier to rise above 1 lux, then the intensifier will become overloaded and, unless protected by closure of the iris, its life expectancy may be reduced. However, under such overload conditions the intensifier is designed to give zero output brightness, so that the screen brightness control loop will seek to open the iris, the reverse of the action required for the protection of the intensifier. By monitoring the supply current drawn by the intensifier, the unit detects intensifier overload, and then overrides the screen brightness control loop and closes the iris.

CONTROL CIRCUIT

The control circuit performs three functions.

- 1) It maintains the intensifier output at a constant level by varying the iris aperture, or by simultaneously varying the iris aperture and the intensifier gain.
- 2) It protects the image intensifier against sudden large increases in scene illuminance.
- 3) It provides a d.c. supply for the image intensifier.

The intensifier gain control circuit is shown in Fig.6, and the remaining functions of the control circuit are provided by the circuit shown in Fig.7.

Intensifier gain control circuit

There are many ways in which the intensifier gain can be made dependent on the position of the iris. In the proto-

type add-on unit this is done electronically via the circuit shown in Fig.6, where the level of infrared radiation on the base of phototransistor TR1 determines the intensifier gain. This radiation is emitted by D1 (encapsulated with TR1), and reflected by a metallic strip before falling on the base of TR1. The metallic strip is attached to the auto-iris ring, and the length of strip exposed increases as the iris is opened. This increases the radiation on TR1, thereby raising the gain of the intensifier. As an alternative to sensing the position of the auto-iris electronically, the auto-iris ring could be connected mechanically to the slider of a potentiometer placed across the gain control input and the negative rail.

Auto-iris motor drive amplifier

The photodiode with integral op-amp IC1 (Fig.7), and op-amps IC2 and IC3, form a high-gain amplifier to drive the auto-iris lens motor. A rising electrical signal (luminance of image intensifier output screen increasing) at the inverting input of IC1 causes the iris to close, while a falling electrical signal causes it to open. The level of screen luminance which the circuit seeks to maintain is set by VR4, and the gain of the amplifier is set by VR5.

Intensifier protection circuit

The supply current drawn by the intensifier flows through VR2 (Fig.7). If this supply current becomes excessive, then the voltage drop across VR2 will cause TR2 and TR3 to conduct. This will pull the inverting input of IC2 to ground, and the auto-iris will then close.

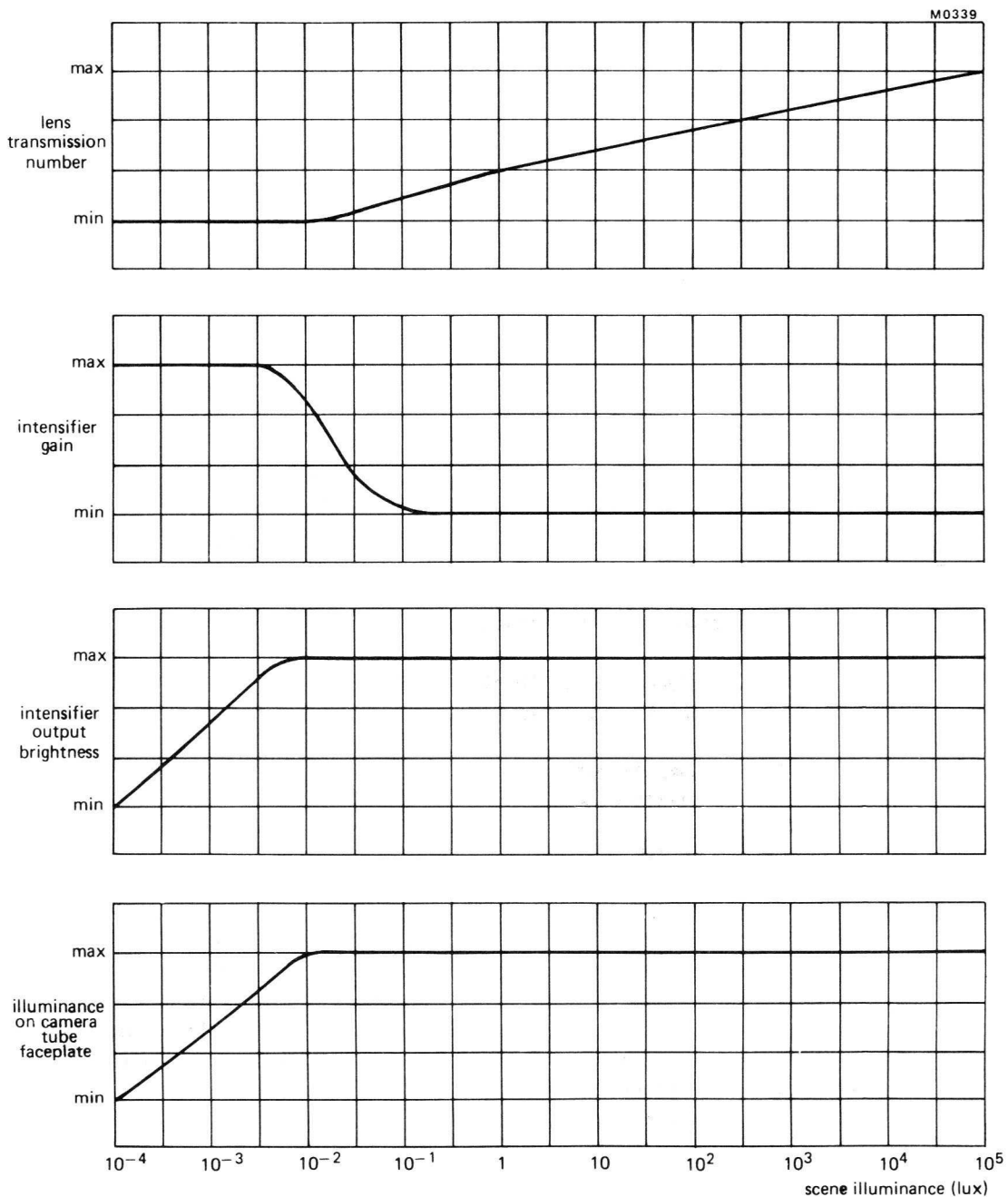


Fig.5 System variables against scene illuminance

Intensifier supply circuit

The intensifier supply (V_s in Fig.7) is taken from the stabilised supply rail via the potential divider VR1 and the emitter-follower TR1.

SETTING-UP PROCEDURE

The setting-up procedure requires a low-level light source to simulate starlight conditions; a suitable light source is shown in Fig.8. The transmission filters should have a

flat transmission characteristic out to a wavelength of $1 \mu\text{m}$. The setting-up procedure is as follows.

- 1) Set VR2 (Fig.7) to minimum resistance.
- 2) Set VR1 (Fig.7) to give an intensifier supply voltage V_s of 3 V.
- 3) Set VR3 (Fig.7) to give a slider voltage of half the supply voltage.
- 4) Under daylight conditions, adjust VR4 (Fig.7) to give a luminance for the image intensifier output screen of half the saturation value.

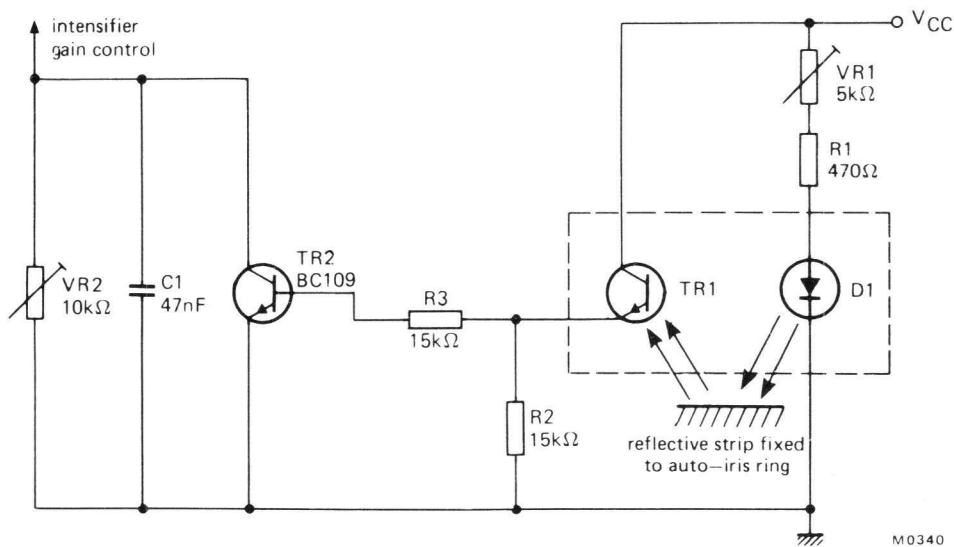


Fig.6 Intensifier gain control circuit.

- 5) Adjust VR5 (Fig.7) for maximum resistance, subject to the amplifier remaining stable.
- 6) Under starlight conditions (auto-iris fully open), adjust VR1 (Fig.6) from maximum resistance until the intensifier gain is at a maximum.
- 7) Under daylight conditions, adjust VR2 (Fig.6) to give an intensifier input illuminance of no more than 5 mlux.
- 8) Under blackout conditions, place a 390 Ω resistor across the intensifier supply and adjust VR2 (Fig.7) until the auto-iris starts to close, then remove the 390 Ω resistor.

PERFORMANCE

The variation of camera resolution (tv lines per picture) with scene illuminance for the add-on unit coupled to a Philips LDH26 camera incorporating a $2/3$ -in Newvicon

tube type XQ1274 is shown in Fig.9. Below starlight conditions, performance can be improved by using a more sensitive tv camera amplifier and integrating techniques.

ADDITIONAL APPLICATIONS

The add-on unit can be used with CCTV cameras which do not incorporate Newvicon tubes, but this may result in some loss of performance. In addition, by changing the coupling lens and modifying the intensifier and coupling lens housing (Fig.3), the unit can be used with a 1-in CCTV camera, or even a 35 mm or 110 SLR camera.

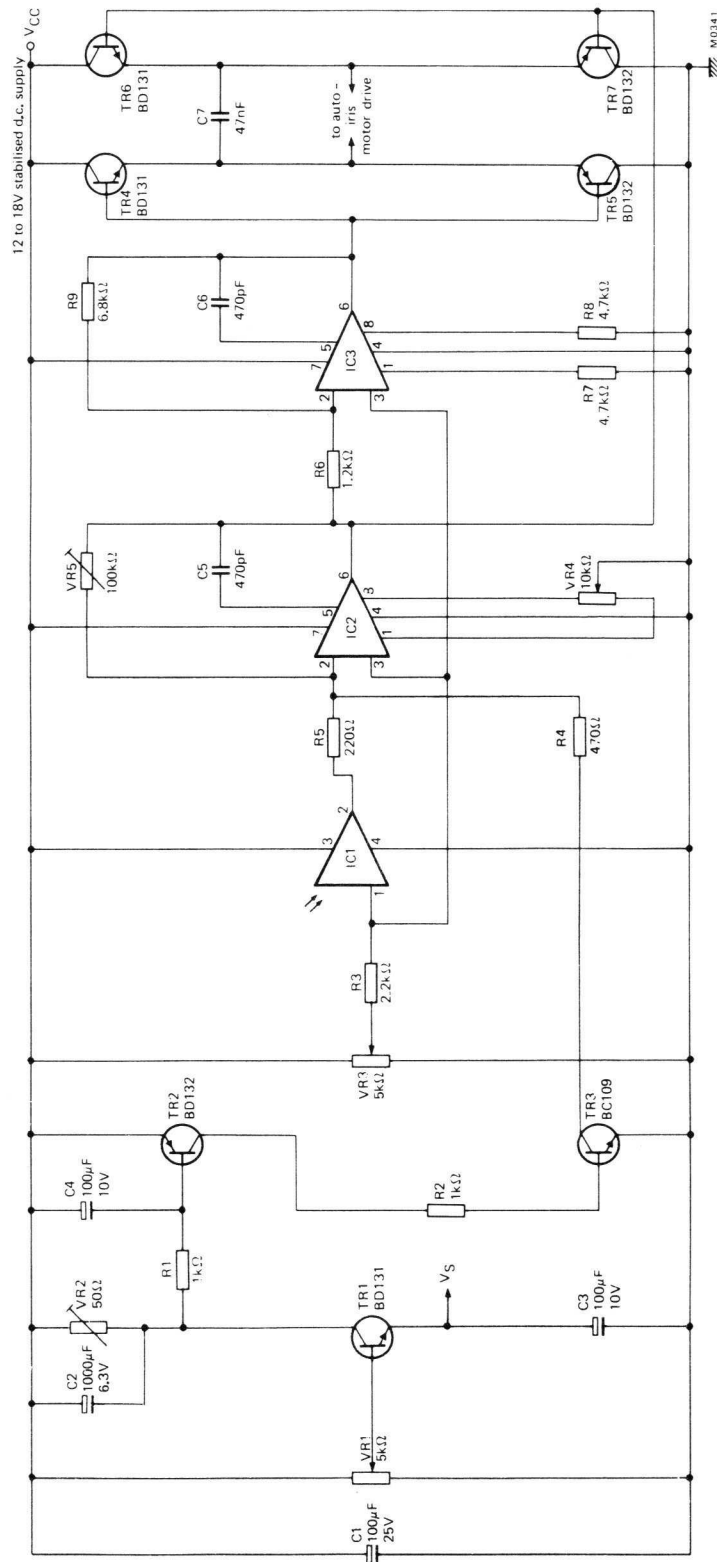


Fig.7 Intensifier supply and auto-iris motor drive circuit.

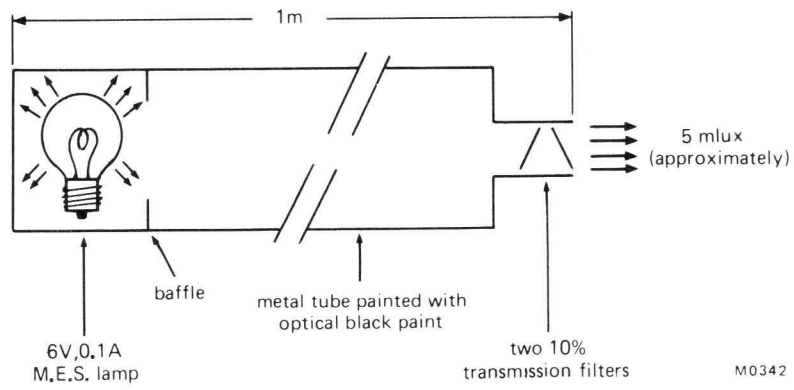


Fig.8 Low-level light source

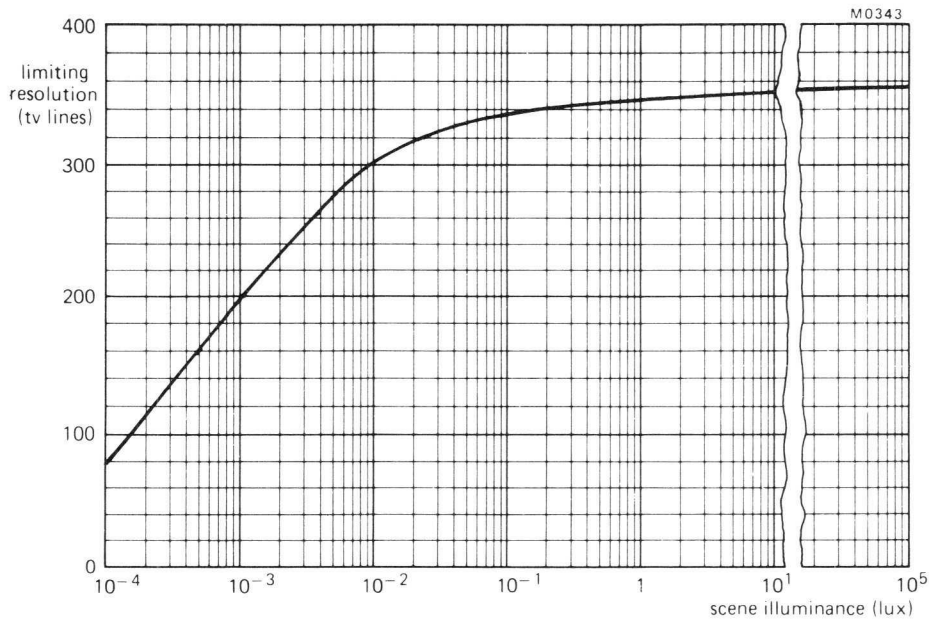


Fig.9 Resolution of LDH26 Newvicon CCTV camera with auto-iris add-on unit.
Target contrast 100% scene reflectance 100%

COMPONENT LIST

Optical components

Auto-iris lens 75 mm, f/1.8~T/1500
 Image intensifier XX1500TV
 Coupling lens 25 mm, f/1.4, with 60 mm, f/2.4 corrector lens.

R7	4.7 k Ω	2322 181 13472
R8	4.7 k Ω	2322 181 13472
R9	6.8 k Ω	2322 181 13682
VR1	5 k Ω	
VR2	50 Ω	
VR3	5 k Ω	
VR4	10 k Ω	
VR5	100 k Ω	

Intensifier gain control circuit (Fig.6)

Resistors

All fixed resistors are SFR25 \pm 5%

R1	470 Ω	2322 181 13471
R2	15 k Ω	2322 181 13153
R3	15 k Ω	2322 181 13153
VR1	5 k Ω	
VR2	10 k Ω	

Capacitors

C1	100 μ F	25 V	016	2222 016 36101
C2	1000 μ F	6.3 V	032	2222 032 13152
C3	100 μ F	10 V	016	2222 016 34101
C4	100 μ F	10 V	016	2222 016 34101
C5	470 pF		630	2222 630 02471
C6	470 pF		630	2222 630 02471
C7	47 nF		347	2222 347 41473

Capacitor

C1	47 nF	347	2222 347 41473
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Phototransistor and diode

TR1 and D1 RS components 307-913

Transistor

TR2 BC109

Transistors

TR1	BD131
TR2	BD132
TR3	BC109
TR4	BD131
TR5	BD132
TR6	BD131
TR7	BD132

Intensifier supply and auto-iris motor drive circuit (Fig.7)

Resistors

All fixed resistors are SFR25 \pm 5%

R1	1 k Ω	2322 181 13102
R2	1 k Ω	2322 181 13102
R3	2.2 k Ω	2322 181 13222
R4	470 Ω	2322 181 13471
R5	220 Ω	2322 181 13221
R6	1.2 k Ω	2322 181 13122

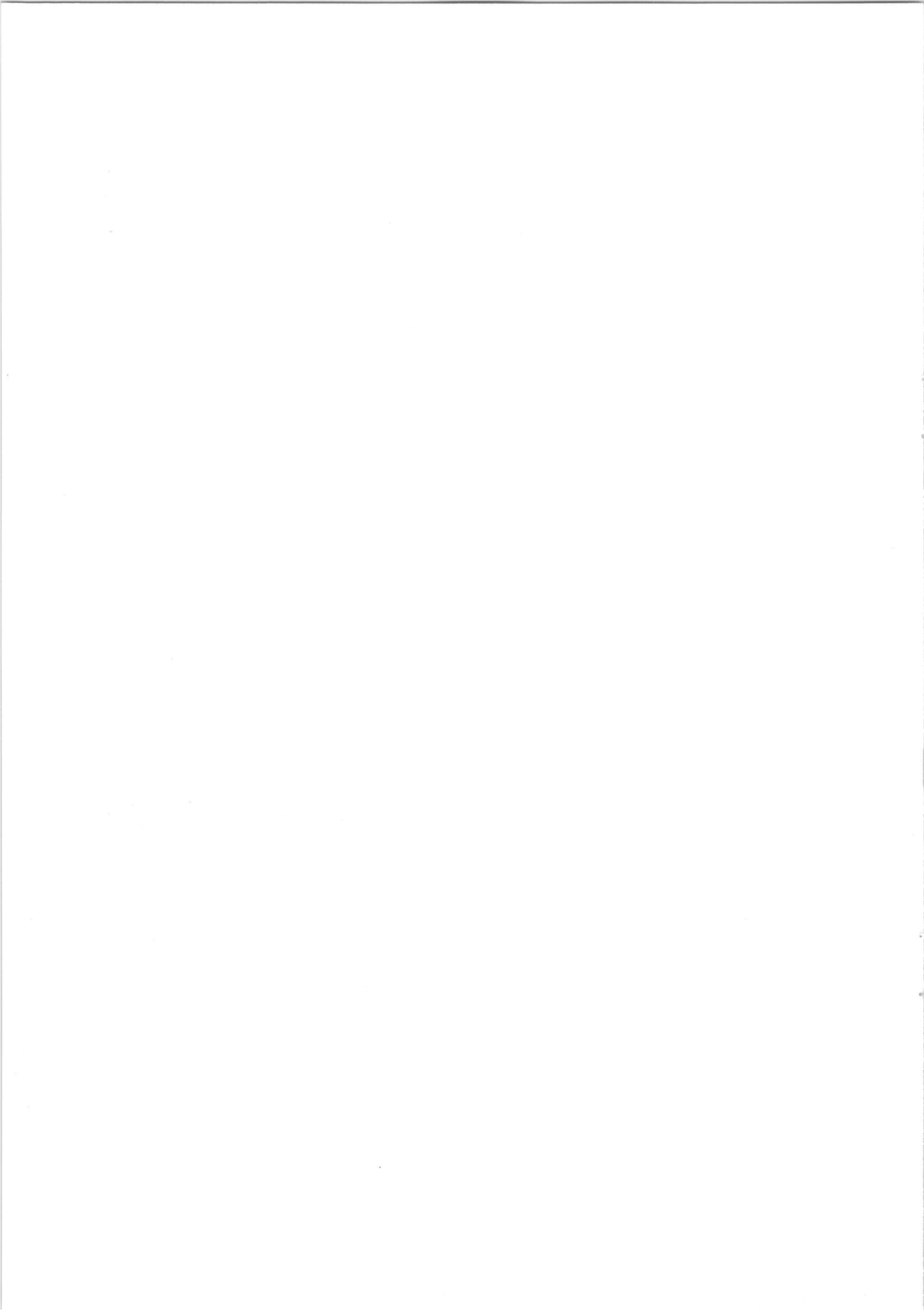
Integrated circuits

IC1	RS components 308-067
IC2	TCA520B
IC3	TCA520B

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