Data Sheet

Photodiodes

Basics of photometry

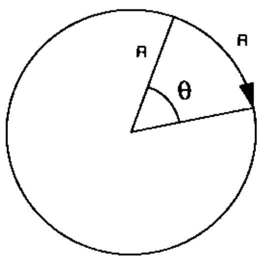
This is a brief introduction to the basics of photometry. To be able to understand this subject better a brief review of geometric principles utilised is required.

Geometric principles

Radian

In plane geometry the angle whose arc is equal to the radius generating it is called a radian. Therefore, if C = 2πR (Circumference of a circle) 2πR = 360°. Radian = 180°/π = 57.27° (approx.).

Figure 1



Two dimensional figure

Other abbreviations used.

Ae = Area of emitting (or reflecting) surface

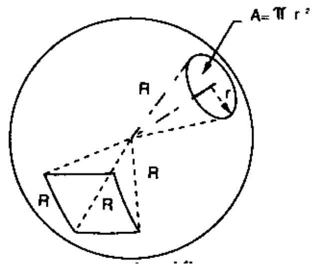
Ap = Apparent area of an emitting source whose image is projected in space and viewed at some angle, θ.

Ad = Detection area. Whether a physical target or merely a defined spatial area, it is the area of interest.

Steradian

In solid geometry one steradian is the solid angle subtended at the centre of a sphere by a portion of the surface area equal to the square of the radius of the sphere. Therefore, if AREA/R^2 = 1 = 1 steradian and the area on the surface of a sphere equals $4\pi R^2$, then $4\pi R^2/R^2$ or 4π steradians of solid angle ω about the centre of a sphere. The steradian is usually abbreviated as STER.

Figure 2



Three dimensional figure

Photometric Terminology

Flux (Symbol F)

Any radiation, whether visible or otherwise, can be expressed by a number of FLUX LINES about the source, the number being proportional to the intensity of that source. This LUMINOUS flux is expressed in LUMENS for visible radiation.

Luminous emittance (Symbol L)

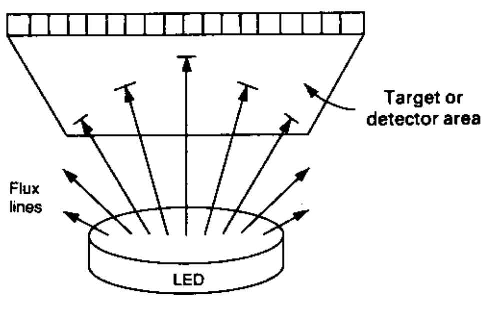
A source measurement parameter. It is defined as the ratio of the luminous flex emitted from a source to the area of that source, or L = F/Ae. Typically expressed in units of:

lumens/cm^2 or one PHOT,
lumens/m^2 or one LUX (or one METRE CANDLE),
lumens/ft^2 or one FOOT CANDLE.

Illuminance (Symbol E)

This is a target or detector area measurement paragraph meter. It is the ratio of flux lines incident on a surface to the area of that surface or E = L/Ad. Typical measurement units are the same for LUMINOUS EMITTANCE ie. lumen/cm^2 = one phot, lumen/m^2 = one lux, and lumen/ft^2 = one ft candle.

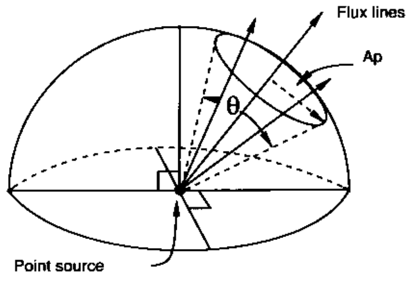
Figure 3



Luminous intensity (Symbol I)

A spatial flux density concept. It is the ratio of luminous flux of a source to the solid angle subtended by the detected area and that source. The LUMINOUS INTENSITY of a source assumes that source to be point rather than an area dimension. The LUMINOUS INTENSITY (or CANDLE POWER) of a source is measured in LUMENS/STERADIAN which is equal to one CANDELE (or loosely, one CANDLA).

Figure 4



Luminance (Symbol B)

Sometimes called photometric brightness (although the term brightness should not be used alone as it encompasses other physiological factors such as colour, sparkle, texture, etc.) it is applied to sources of appreci-able area size. Mathematically, if the area of an emitter (circular for example) has a diameter or diagonal dimension greater than 0.1 the distance to the detector, it can be considered as an area source. If less than this 10% figure, the source can be treated as point in nature. This one to ten ratio of source diameter to distance is offered as it MATHEMATICALLY very closely approximates results obtained when comparing an area source to its point equivalent. LUMINANCE presents itself as an extremely useful parameter as it applies a figure of merit to:

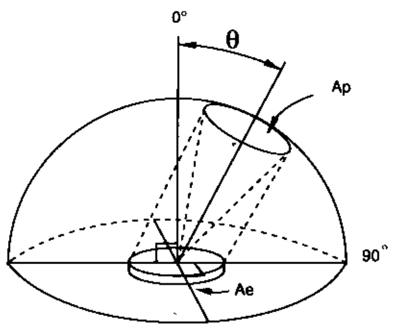
1. Apparent or protected area of the source (Ap).
2. Amount of luminous flux contained within the projected area of the source (Ap).
3. Solid angle the projected area generates with respect to the centre of the source.

Note: The projected area Ap varies directly as the cosine of θ ie. max. at 0° or normal to the surface and minimum at 90°

$$Ap = Ae \cos \theta$$

LUMINANCE is defined as the ratio of LUMINOUS INTENSITY to the projected area of the source Ap.

Figure 5



$$\frac{\text{LUMINOUS INTENSITY}}{Ap} = \frac{\frac{\text{LUMENS}}{\text{STERADIAN}}}{Ae \cos \theta} = \frac{\text{CANDELAS}}{\text{(Sq. Unit)}}$$

And depending on the units used for area:

1 CANDELA/cm^2 = 1 STILB
1 CANDELA/m^2 = 1 NIT
1 CANDELA/in^2 = } no designator available.
1 CANDELA/ft^2 = }

Also:

$1/\pi$ candela/cm^2 = LAMBERT
$1/\pi$ candela/m^2 = APOSTILB (or BLONDEL)
$1/\pi$ candela/in^2 = no designator available
$1/\pi$ candela/ft^2 = FOOT LAMBERT

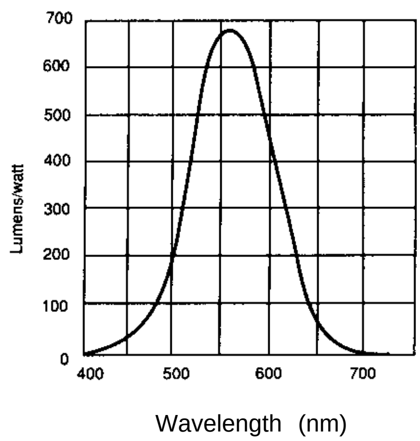
CIE curve

Photometric quantities are related to the corresponding radiometric quantities by the CIE Standard Luminosity Function which is often called the 'standard eyeball'.

The eye responds to the rate at which radiant energy falls on the retina, ie., on the radiant flux density expressed as Watts/m^2. The corresponding photometric quantity is Lumens/m^2. The standard luminosity function is then, a plot of Lumens/Watt as a function of wavelength.

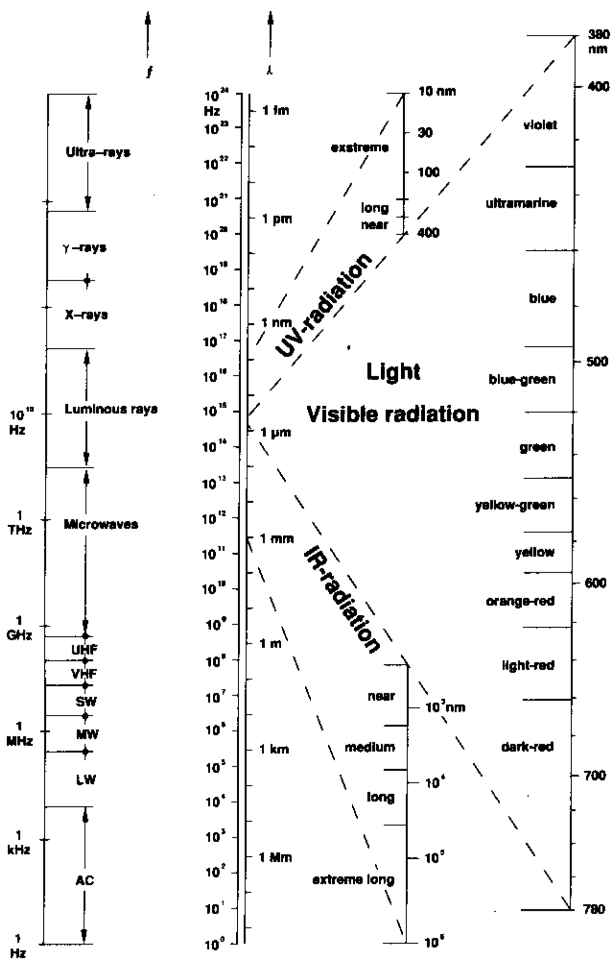
The function has a maximum value of 680 Lumens/Watt at 555nm and the $^1/_2$ power points occur at 510 nm and 610 nm (Figure 6).

Figure 6 **CIE stand photopic luminosity function**



Electromagnetic radiation spectrum

Figure 7 **Electromagnetic spectrum**



The following range of discrete opto devices is described, each of which may be used in a variety of sensing applications.

Product	RS stock no.
General purpose photodiode	305-462
BPX 65 high speed photodiode	304-346
BPW21 photodiode	303-719
Quadrant silicon photodiode	652-027
15mm² silicon photodiode	194-076
Medium area photodiode	651-995
Large area photodiode	303-674
Integral amplifier 5mm²	308-067
Integral amplifier 100mm²	590-963
5.8mm² UV photodiode	564-021
33.6mm² UV photodiode	564-037
16 element linear array	194-060

General purpose photodiode

(RS stock no. 305-462)

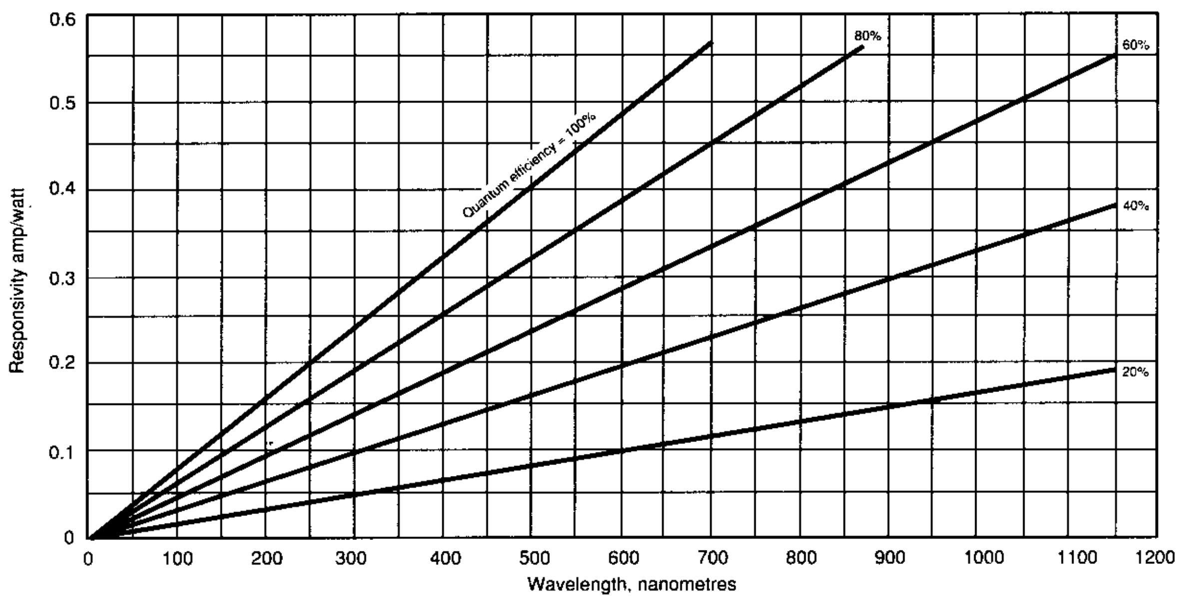
A planar diffused photodiode in a 2-lead TO-18 can with glass window. A very linear output of current versus light level can be obtained over a wide range of inputs. Light falling on the diode induces current in the diode, thus when the device is reversed biased thereby conducting very low leakage currents, it behaves as a current source controlled by the incident illumination.

Absolute maximum ratings

at +25°C (unless stated)

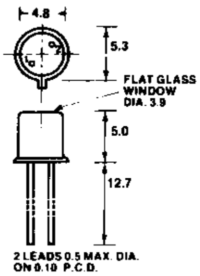
Reverse voltage V_R ____ +80V
Forward current I_F ____ 100mA
Operating temperature range ____ 0°C to +70°C
Storage temperature range ____ -55°C to +125°C
Power dissipation Pd ____ 200mW

Figure 8 **Typical quantum efficiency curves**



Pin connections and case dimensions

Case is connected to Pin 2.
Chip placement accuracy ±0.25mm of can centre.
Nominal photosensitive area 850 mils (near square)*.



***Note:** 850 mils ≙ 0.7mm × 0.7mm

Electrical characteristics (at +22°C ±2°C unless otherwise stated)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test conditions
$V_{(BR)}$	Breakdown voltage	80			V	Dark; rev. current 10μA
I_D	Dark current		1.4	14	nA	Dark; rev. bias 20V
R_e	Responsivity	0.35	0.7	1.4	μA/mW/cm^2	Zero bias; 400μW/cm^2
C	Capacitance		12		pF	Dark; rev. bias 10V
t_R	Response time		4		ns	10-90% levels
-	Temp. coeff. of responsivity		0.35		% per °C	0°C to +70°C
-	Temp. coeff. of dark current		×2		per 10°C rise	0°C to +70°C

Typical performance curves

Figure 9 **Photo current vs. irradiation**

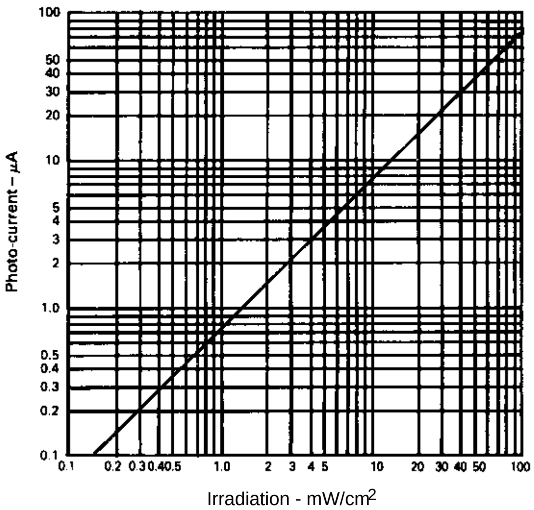


Figure 10 **Open circuit voltage vs. irradiation**

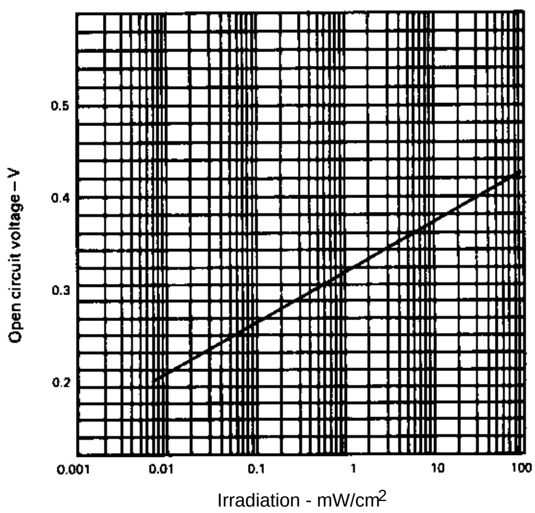


Figure 11 **Normalised capacitance vs. bias voltage**

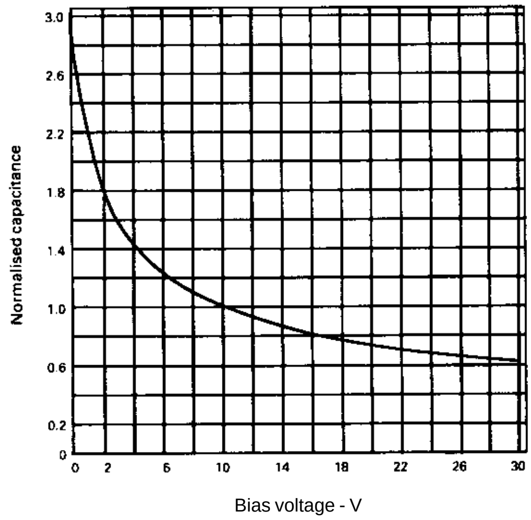


Figure 12 **Photo current vs. bias voltage**

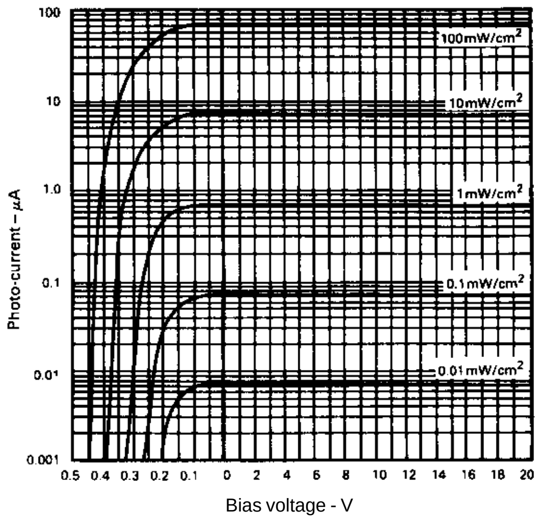
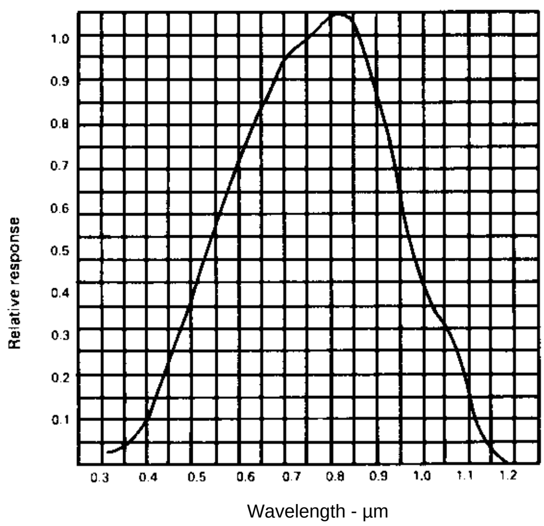


Figure 13 **Normalised spectral response**



Typical applications

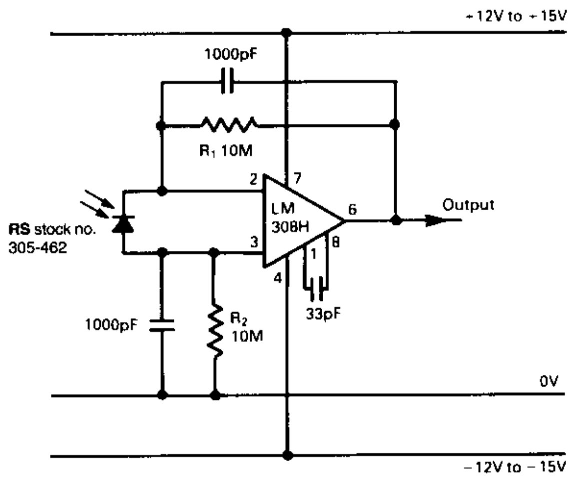
Analogue light level sensor - direct reading

Low input bias current op amps such as LM 308 or FET input types can be used to give steady dc indication of light levels as is necessary for photometric applications, photocell measurements, transmission and reflection coefficients, etc.

The values shown give approximately 14V/mW/cm² of irradiation. The value of R1 and R2 may be reduced for less sensitivity but should be kept equal. For values less than 100kΩ, a less sophisticated amplifier may be used, eg. μA741.

The 1000pF capacitors may be increased to reduce ripple from ac lighting or control response time accordingly.

Figure 14 **Analogue light level sensor - direct reading**



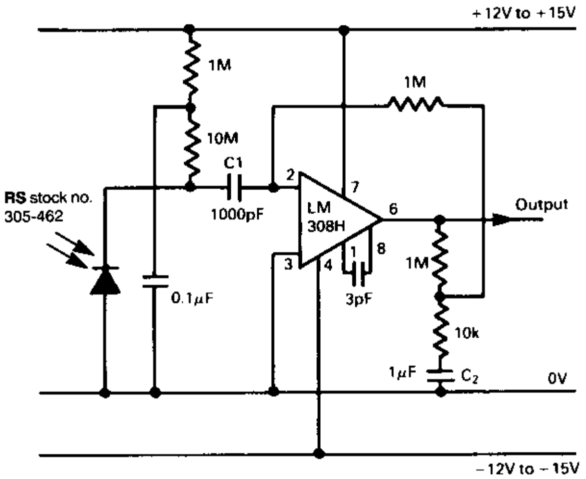
ac coupled analogue sensor for optical communications links

A stage of amplification giving the substantial gain necessary for optical communication links is implemented as shown. An op amp with low input bias currents such as LM308 or an FET input type is necessary.

The input ac coupling C1 gives a dc isolation of steady ambient conditions, and C2 minimises effects of offset voltages, both such lower break frequencies are below 10Hz.

Upper frequency response is approximately 3kHz and ac sensitivity is 70V/mW/cm². A further amplifier/buffer stage is necessary to drive a headset or loudspeaker.

Figure 15 **ac coupled analogue sensor for optical communications links**



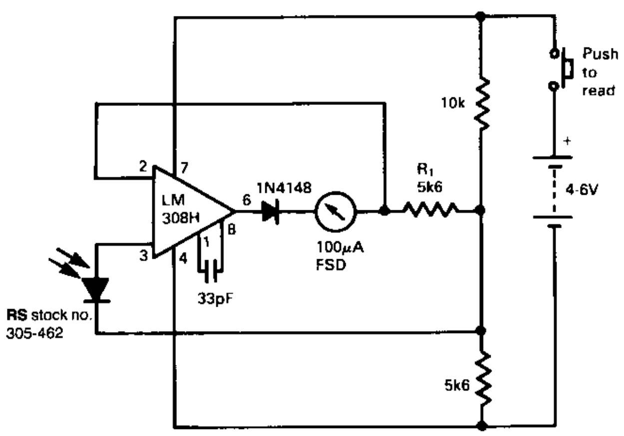
Logarithmic detector for exposure meter

Feeding the **RS** stock no. 305-462 into a high impedance gives a logarithmic voltage/illumination response.

The circuit shown is the basis for a simple battery-operated exposure meter. At very low light levels where the amplifier bias current may cause the output to go negative, a diode avoids the spurious state of negative indication.

The movement may be calibrated in photographic scales, one stop being approximately 7μA. Sensitivity can be trimmed by adjusting R1.

Figure 16 **Logarithmic detector for exposure meter**



BPX 65 high speed photodiode

(RS stock no. 304-346)

The BPX 65 is a planar silicon PIN photodiode housed in a modified TO-18 case incorporating a plain glass flat window which has no influence on the beam path of optical lens systems. The cathode is electrically connected to the case. Because the BPX 65 is capable of detecting wide bandwidth signals due to its excellent high frequency response, this coupled with its high sensitivity makes the device ideal for signal detection applications. This photodiode is outstanding for low junction capacitance and short switching times.

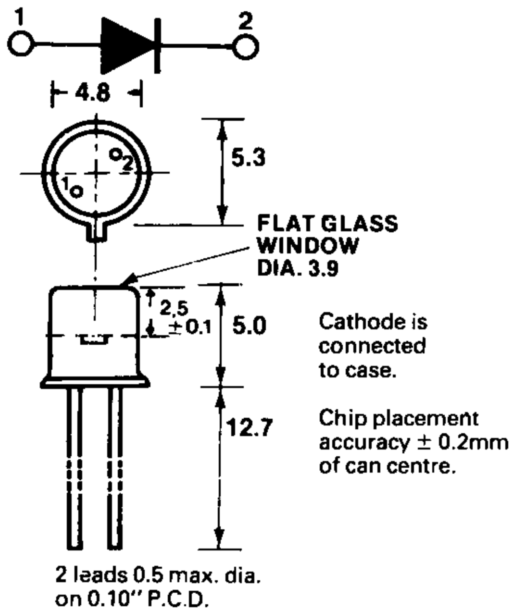
Absolute maximum ratings

at +25°C (unless stated)

Reverse voltage V_R	50V
Forward current I_F	10mA (200mA pulsed 1μs 1% duty cycle)
Operating temperature range	-25°C to +70°C
Storage temperature range	-55°C to +125°C
Junction temp. T_J	+125°C
Power dissipation Pd	250mW

(derate linearly 2.5mW/°C above +25°C)

Shape and dimensions



Electrical characteristics at +25°C (unless stated)

	Parameter	Test conditions	min.	typ.	max.	units
A	Radiant sensitive area			1		mm^2
λs max.	Wavelength of max. sensitivity			850		nm
R_e	Responsivity	λ =450nm		0.2		A/W
		λ =900nm		0.55		A/W
		λ =1064nm		0.15		A/W
t_r	Response time (10-90% levels)	R_L=50Ω; V_R=20V; λ =900nm		0.5	1	ns
C_0	Capacitance V_R=0V			15		pF
C_1	V_R=1V			12		pF
C_{20}	V_R=20V			3.5		pF
f_g	Cut-off frequency			500		MHz
1_p	Dark current	V_R=20V, Dark (E=0)		1	5	nA
S	Spectral sensitivity	V_R=20V; see Note 1	7	10		nA/Lx
NEP	Noise equivalent power	V_R=20V		3.6×10^{-14}		W/√Hz

Note1. The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

Typical performance curves

Figure 17 **Normalised spectral responses (λ) and quantum yield η (λ)**

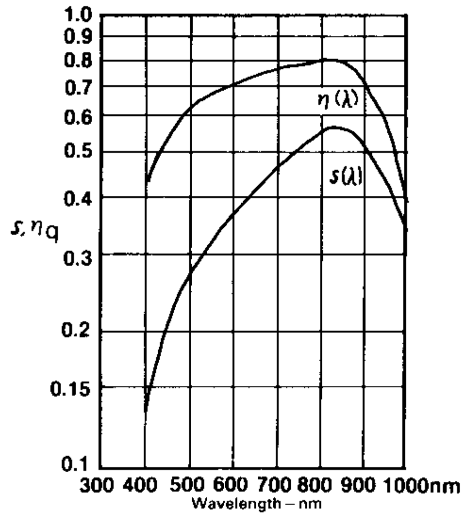


Figure 19 **Polar sensitivity curve**

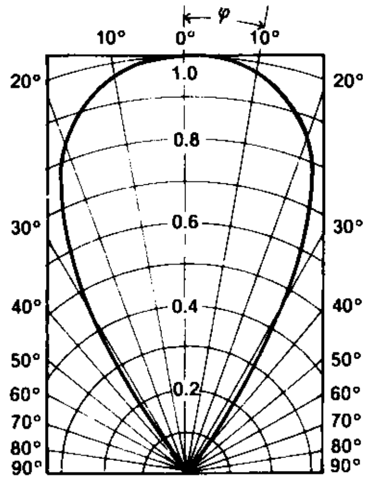


Figure 18 **Variation of output current with illumination**

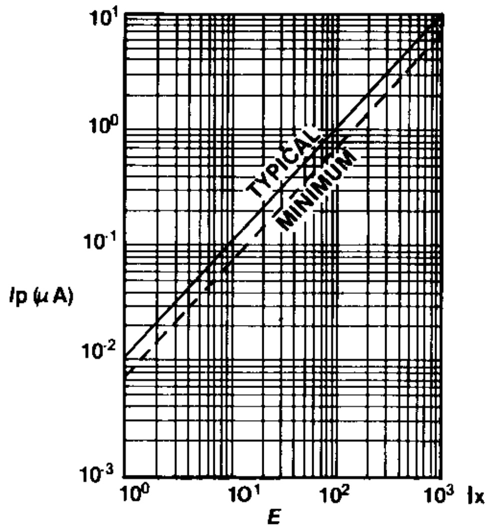


Figure 20 **Variation of diode dark current with reverse voltage**

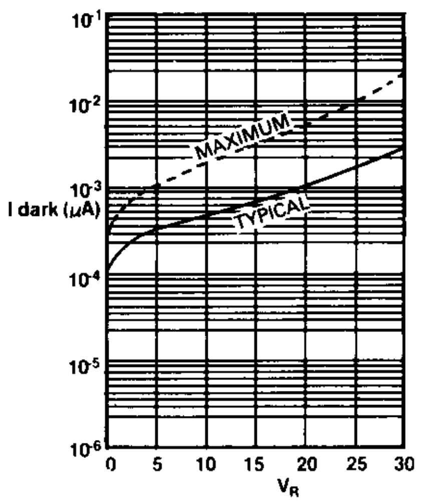


Figure 21 **Variation of output current with temperature**

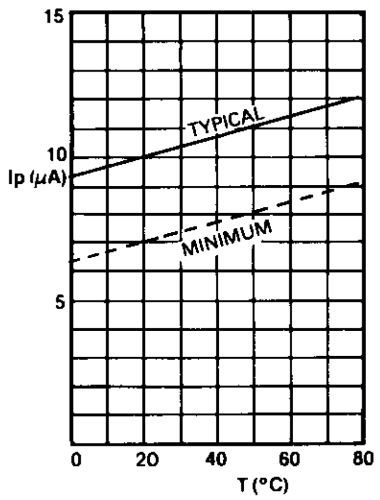


Figure 23 **Permissible power dissipation**

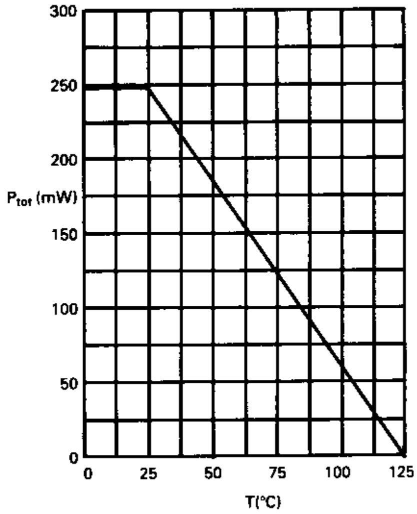


Figure 22 **Variation of diode capacitance with reverse voltage**

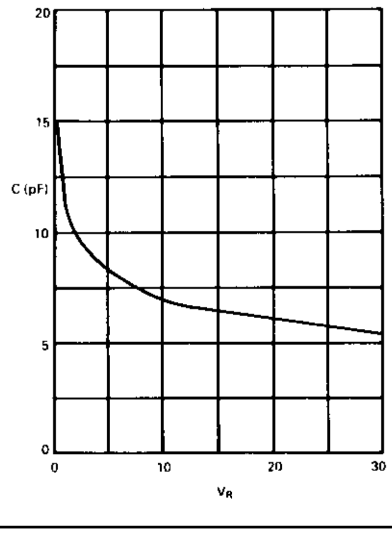
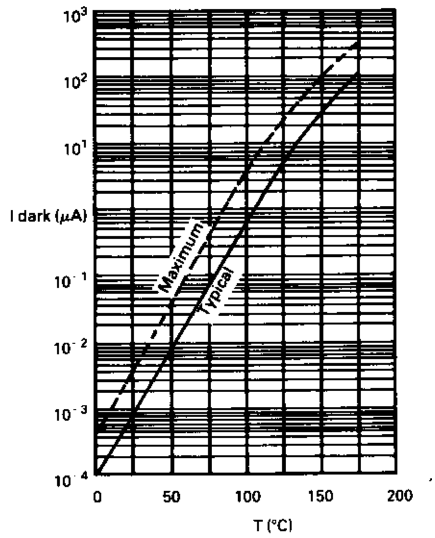


Figure 24 **Variation of dark current with diode temperature**



BPW21 photodiode

(RS stock no. 303-719)

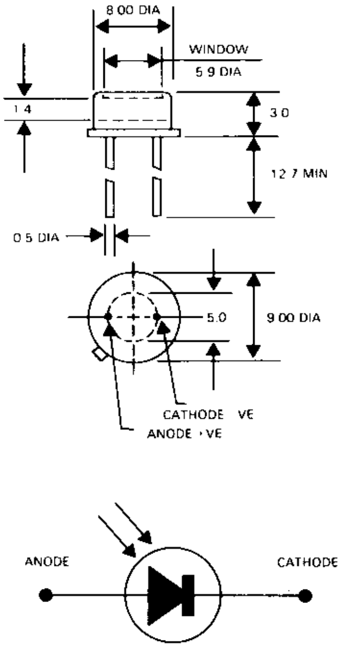
A silicon photodiode housed in an hermetically sealed case with a flat window incorporating built-in colour correction. Sensitivity approximating the human eye response. Linear current (short circuit) versus illumination. Log. voltage versus illumination. This photodiode is designed for use in the photoamperic mode and is ideally suited for use in light monitoring and control, optical instrumentation and camera control.

Absolute maximum ratings

Ambient temperature range	-25°C to +100°C
Reverse voltage, V_R	10V
Open circuit voltage	650mV
Power dissipation (at 25°C), Pd	250mW
Illuminance, E	10^5 lux

Features

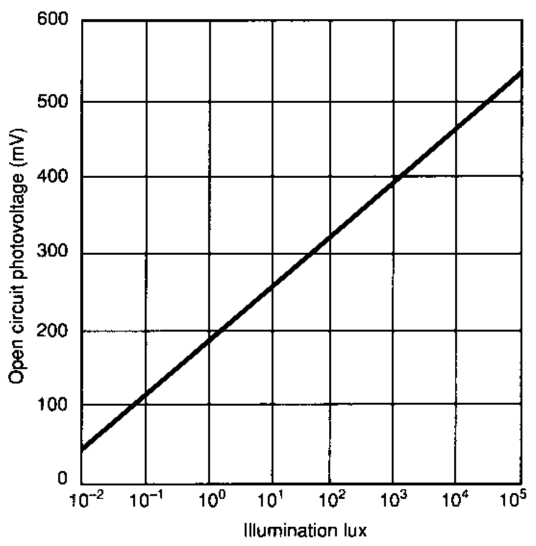
- Response approximating to the human eye
- Photovoltaic cell operation
- Linear output current versus illumination
- Hermetically sealed TO5 case.



ACTIVE AREA 7.5mm²

FIELD OF VIEW 124° MAX

Figure 25 **Photovoltage vs illumination**



(For standard illuminant A, 1000 Lux = 4.75mW/cm²)

Electrical characteristics at 25°C

	Parameter	Conditions	Min.	Typ.	Max.	Unit
S_k	Sensitivity (short circuit)	R_L = 100Ω. E_A = 10^{-2} to 10^5 lux*	4.5	7		nA/Lux
V_{ph}	Photovoltage (open circuit)	E_A = 1 Lux*		250	350	mV
T_kI_{SC}	Temp. Coeff. of short circuit current	E_A = 1K Lux*		-0.05		%/°C
T_kV_{ph}	Temp. Coeff. of open circuit voltage	R_L = 100Ω. E_A = 1K Lux*		-2		mV/°C
λp	Peak wavelength sensitivity			560		nm
	Spectral bandwidth	50% sensitivity upper limit		680		nm
		50% sensitivity lower limit		440		nm
	Junction capacitance	V_R = 0V		490		pF
t_r	Rise time	R_L = 1KΩ. V_R = 5V		1.0		μs
I_D	Dark current	R_L = 1KΩ. V_R = 5V		2	30	nA
NEP	Noise equivalent power	V_R = 5V		1.4×10^{-5}		Lux/√Hz

*The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856°K (standard Light A in accordance with DIN 5033 and IEC publ. 306-1).

Figure 26 **BPW21 and human eye spectral sensitivity**

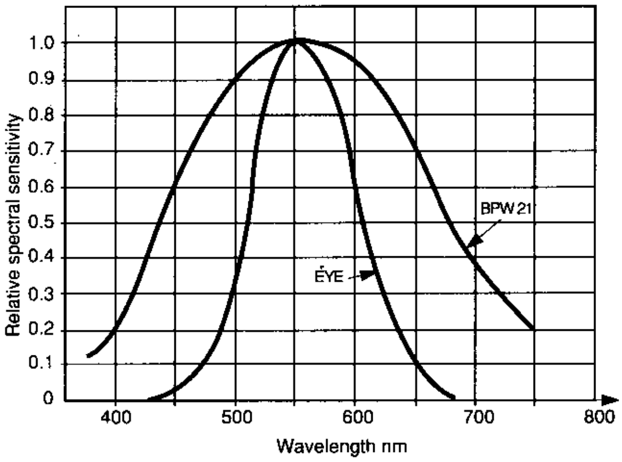
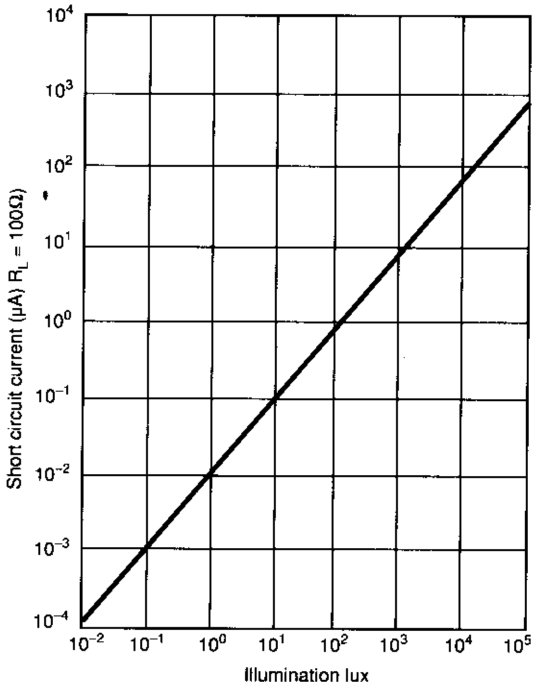
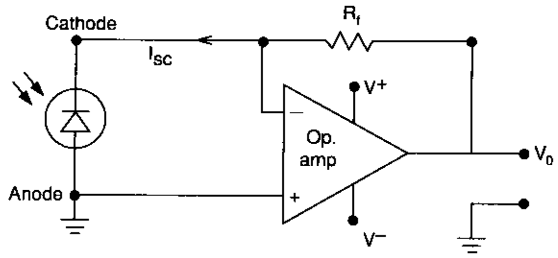


Figure 27 **Photocurrent vs illumination**



Typical photovoltaic connection

Figure 28



$V_0 = R_f, I_{SC}$
$I_{SC} = E_V, S_k$
$V_0 = R_f, E_V, S_k$

where
V_0 = Signal output voltage, V
R_f = Feedback resistance, Ω
I_{SC} = Photodiode short circuit current, A
E_V = Incident illumination, Lux
S_k = Photodiode sensitivity, A/Lux

Quadrant silicon photodiode

(RS stock no. 652-027)

A silicon photodiode containing four separate sensing elements (with commoned cathodes) arranged one per quadrant. The output voltage of each quadrant is available separately enabling null conditions to be detected with equal degrees of shading. The device is hermetically sealed in a TO5 package which incorporates the pcb pin connections.

Absolute maximum ratings

dc reverse voltage ____ 15V
Peak pulse current (1 µs, 1% duty cycle) ____ 200mA
Peak dc current ____ 10mA
Storage temperature range ____ -45°C to +100°C
Operating temperature range ____ -25°C to +75°C
Lead temperature soldering (5s) ____ +200°C

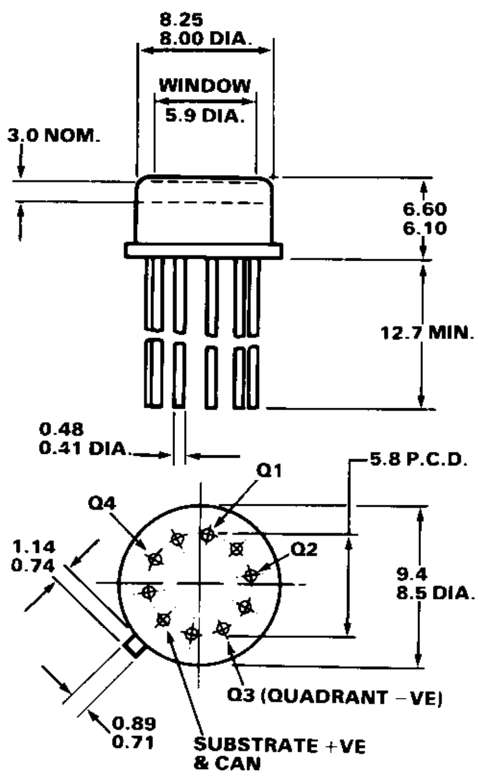
Features

- High blue sensitivity and shunt resistance
- Suitable for low light level applications
- T05 package incorporating pcb pin connections.

Applications

- High accuracy position sensing
- Alignment
- Optical surveying.

Pin connections and dimensions

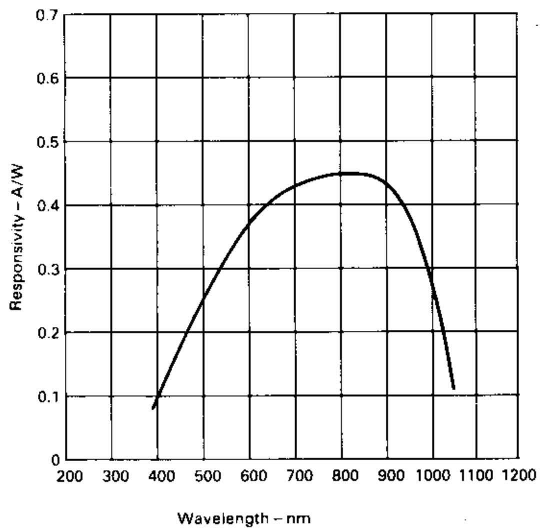


NOTE:
DIMENSION* REFERS TO DISTANCE BETWEEN WINDOW AND ACTIVE AREA. NO CONNECTION SHOULD BE MADE TO UNSPECIFIED PINS.

Specification

Parameter	Conditions	Min.	Typ.	Max.	Unit
Operating voltage				12	V
Dark current	$V_R = 1V$		0.03	3	nA
Capacitance	$V_R = 0V$		80	100	pF
Responsivity	900nm, $V_R = 1V$	0.42	0.45		A/W
Rise time	0-70%, 864nm, $V_R = 10V$, 100Ω load			<15	ns
Peak wavelength			820		nm
Spectral response range		430		900	nm
Noise equivalent power	900nm		1×10^{-13}		$WH^{-1/2}$
Active diameter			3		mm
Total active area			7		mm^2
Metallurgical separation			200		μm

Figure 29 **Typical spectral response**



Electrical/Optical specifications

Characteristics measured at 22°C (±2) ambient, and a reverse bias of 12 volts, unless otherwise stated. Shunt resistance measured at ± 10mV.

Absolute maximum ratings

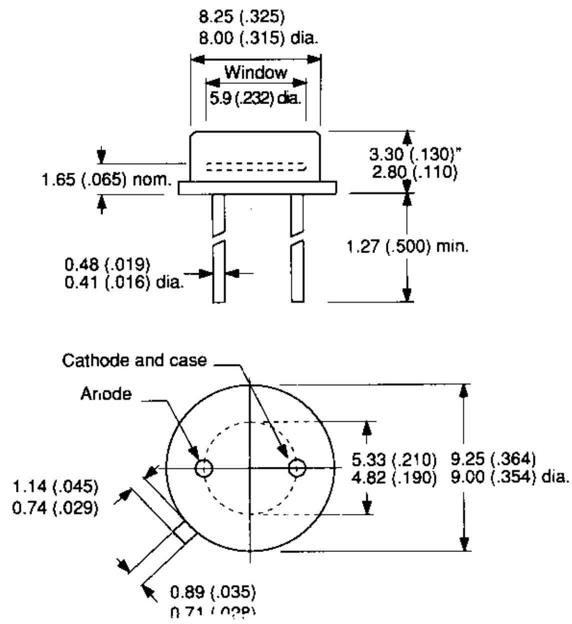
	Max. rating
dc reverse voltage	15V
Peak pulse current (1μs, 1% duty cycle)	200mA
Peak dc current	10mA
Storage temperature range	-45°C to +100°C
Operating temperature range	-25°C to +75°C
Soldering temperature for 5 seconds max.	200°C

15mm² silicon photodiode

(RS stock no. 194-076)

A 15mm² silicon photodiode housed in an hermetically sealed TO5 package. This device is ideal for low light level applications where a very high signal to noise ratio is important such as light monitoring and control applications.

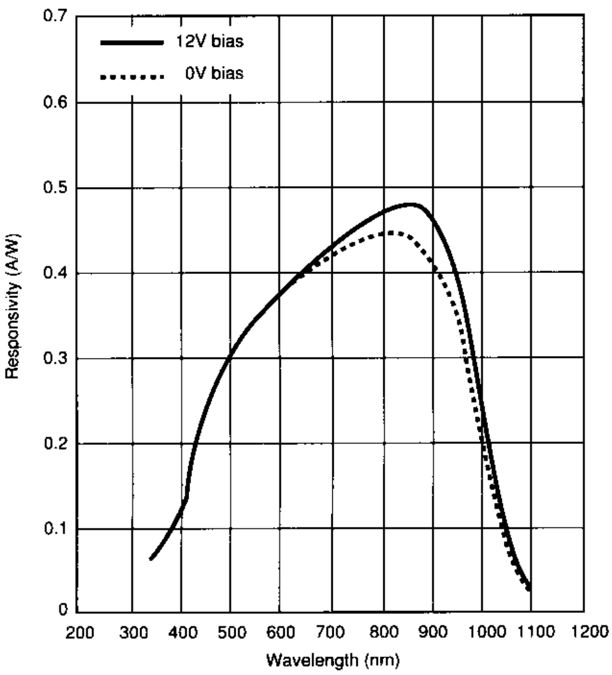
It may be operated photovoltaically or with a reverse bias of up to 12V where lower capacitance is needed.



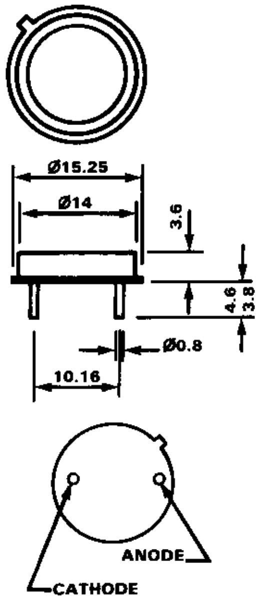
Single elements

Active area		15mm²	3.8 × 3.8mm
	Min.	Typ.	Max.
Responsivity A/W λ = 436nm	0.18	0.21	
Dark current		3nA	10nA
NEP WHz λ = 436nm Vr = 0V		8.8×10^{-14}	
Capacitance pF Vr = 0V Capacitance pF Vr = 12V			390 80
Shunt resistance megaohm	25	200	
Risetime ns λ = 820nm R_L = 50Ω		12	

Figure 30 **Typical spectral response**



Pin connections and dimensions



Medium area photodiode

(RS stock no. 651-995)

The **RS** stock no. 651-995 is a high speed, medium area, silicon photodiode mounted in an hermetically sealed TO5 package. The device is ideal for reduced light applications including brightness control, edge detectors, colour grading etc.

Absolute maximum ratings

Reverse voltage ________ 60V
Operating temperature range ________ -40°C to +70°C
Storage temperature range ________ -55°C to +125°C
Lead temperature soldering (5s) ________ +200°C

Electrical characteristics at +22°C ±2°C unless otherwise stated

Parameter	Conditions	Min.	Typ.	Max.	Unit
Radiant sensitive area			41.3		mm²
Wavelength of maximum sensitivity		760	800	880	nm
Peak responsivity	800 nm	0.4	0.5		A/W
Dark current	V_R = 1V		4.0	20	nA
	V_R = 20V		40	200	nA
Capacitance	V_R = 0V		325	400	pF
	V_R = 10V		91.5	113	pF
	V_R = 20V		71	87.5	pF
Response time	V_R = 10V, R_L = 100R		25	40	ns
Temperature coefficient of responsivity	(0°C to +70°C)		0.35		%/°C
Temperature coefficient of dark current	(0°C to +70°C)		×2		per +10°C

Typical performance curves

Figure 31 **Normalised capacitance vs bias voltage**

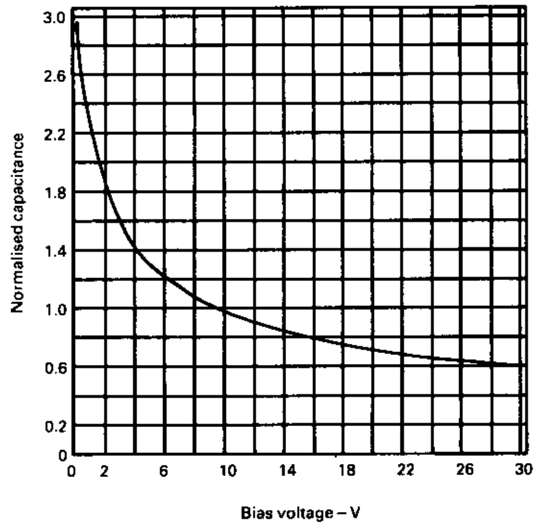


Figure 32 **Open circuit voltage vs irradiation**

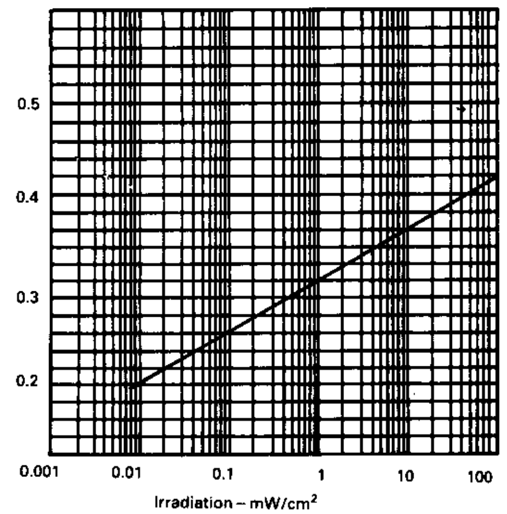
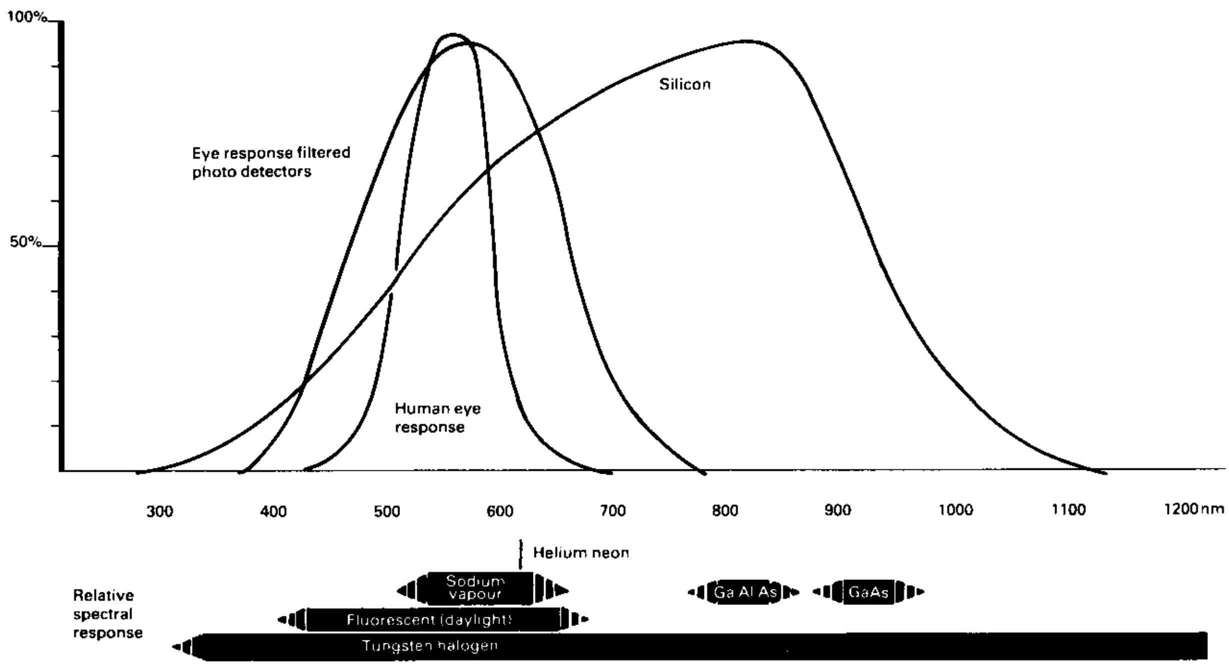


Figure 33 **Relative spectral response**



Large area photodiode

(RS stock no. 303-674)

A high speed, large area, silicon photovoltaic detector housed in a 26.2mm diameter case. Its large active area, 1cm^2, and peak spectral response at 900nm make the device suitable for use as a calibration device in optical instrumentation, and for other optical measurements. Spectral response range (5% points): 350 to 1150nm.

Absolute maximum ratings

at +25°C (unless stated)

Reverse voltage V_R ____ 50V
Operating temperature range ____ -55°C to +70°C
Forward current I_F ____ Limited by Pd and bias voltage
Power dissipation Pd ____ 100mW

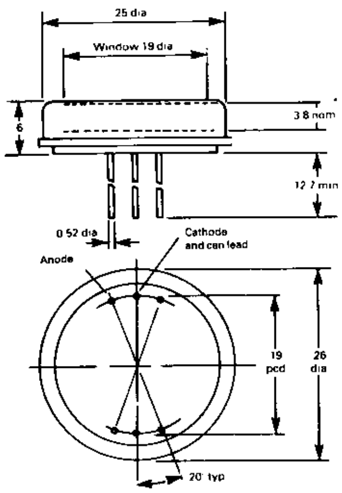
Features

- Photovoltaic operation or low-bias photoconductive operation
- High sensitivity over wide spectral range
- Circular active area (1cm^2)
- Low noise
- Fast response
- Long term stability
- Low capacitance for a photovoltaic detector.

Applications

- ▲ Optical instrumentation
- ▲ Laser detection
- ▲ Optical communication.

Pin connections and dimensions



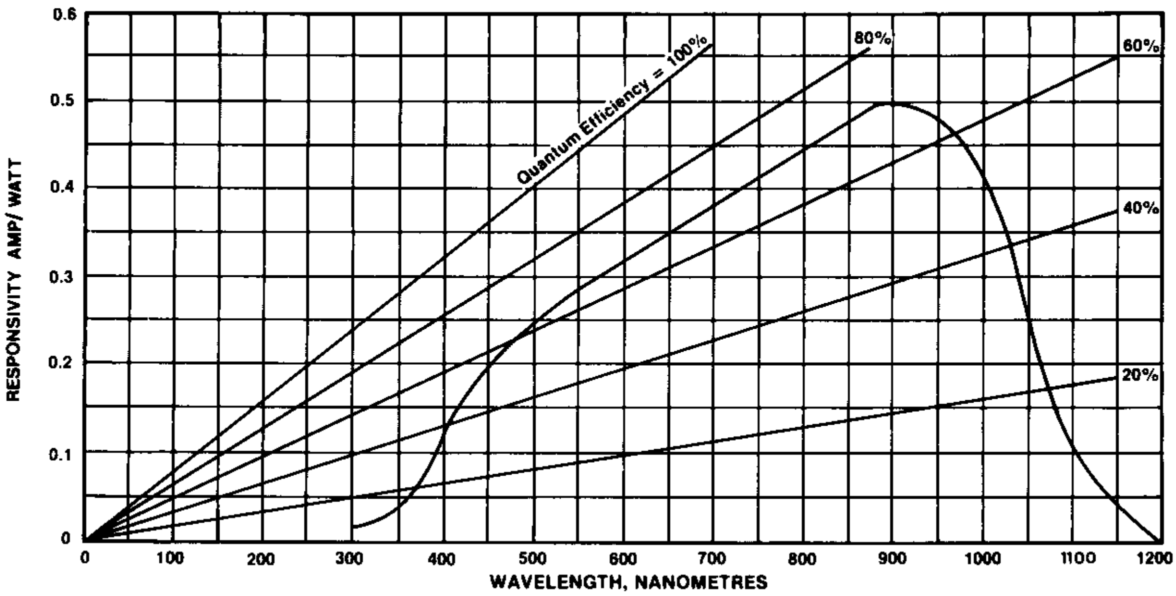
*Refers to distance between window and active area

Electrical characteristics at +25°C (unless stated)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)}$	Breakdown voltage	I_D = 100μA	50			V
I_D	Dark current	Dark, rev. bias 10V		0.5	1.5	μA
R_e	Responsivity @ 450nm			0.2	0.22	A/W
	633nm			0.35	0.4	
	900nm			0.5	0.55	
	1064nm			0.15	0.16	
C	Capacitance	at 0V		1500		pF
		at 10V rev. bias.		350		
t_r	Response time (10% to 90%)	at 0V R_L 50Ω		0.5		μs
		at 10V R_L 50Ω, λ<910nm		50		ns
R_S	Shunt resistance	at 0V ±0.1V		5		MΩ
I_n	Noise current	at 0V f = 1kHz		0.1		pA (rms)
		at 10V rev. bias f = 1kHz		0.4		√Hz
NEP	Noise equiv. power (at f = 1kHz) 450nm	at 0V		0.5		pW
		at 10V rev. bias		2		√Hz
	900nm	at 0V		0.2		pW
		at 10V rev. bias		0.8		√Hz

Typical performance curves

Figure 34 **Typical spectral response.**
Responsivity: 0.2A/W at 450nm, 0.35A/W at 633nm, 0.5A/W at 900nm, 0.15A/W at 1064nm, 7.9mA/Im (2850K source)



5mm² photodiode with amplifier

(RS stock no. 308-067)

The **RS** stock no. 308-067 consists of a high performance silicon photodiode combined with a high gain low noise amplifier in a TO5 package. It is designed particularly for use where accurate measurements are needed of low light levels, and medium speed variation in such light levels. Its small size and excellent temperature coefficients make it ideally suited for use under adverse conditions.

Any supply voltage between ±2.5V and ±18V may be used. A single output line gives a voltage with respect to earth (Pin 1) proportional to the input light level, up to a maximum only slightly less than the power rail. Correction for dark level output is not normally required due to its extremely low value. The output may be short circuit to ground or either power rail without risk of damage. Changes in ambient temperature also cause only minimal variation in signal level, typically 150µV/°C.

Absolute maximum ratings

Supply voltage	±18V
Output short circuit duration	Indefinite
Storage temperature	-65°C to +100°C
Operating temperature	0°C to +70°C

Connecting details

1. **Earth**
2. **Output**
3. **V+**
4. **V- (Connected to can)**

TO5 can with 4 leads
Gold-plated leads: 12.7mm length
Active light sensitive area: 5mm²

Features

- Very high responsivity
- Linear response
- Low output impedance
- Low noise
- Rugged construction
- Excellent temperature characteristics
- Short circuit proof
- Excellent power supply noise rejection
- TTL compatible
- Simple to use

Applications include

- Light intensity measurements
- Light fluctuation detection
- Optical spectroscopy
- Pollution monitoring
- Alarm systems
- Optical shaft encoders
- Automated inspection and control
- Flow monitoring.

CONNECTION DETAILS

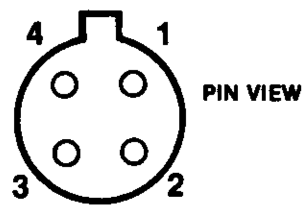
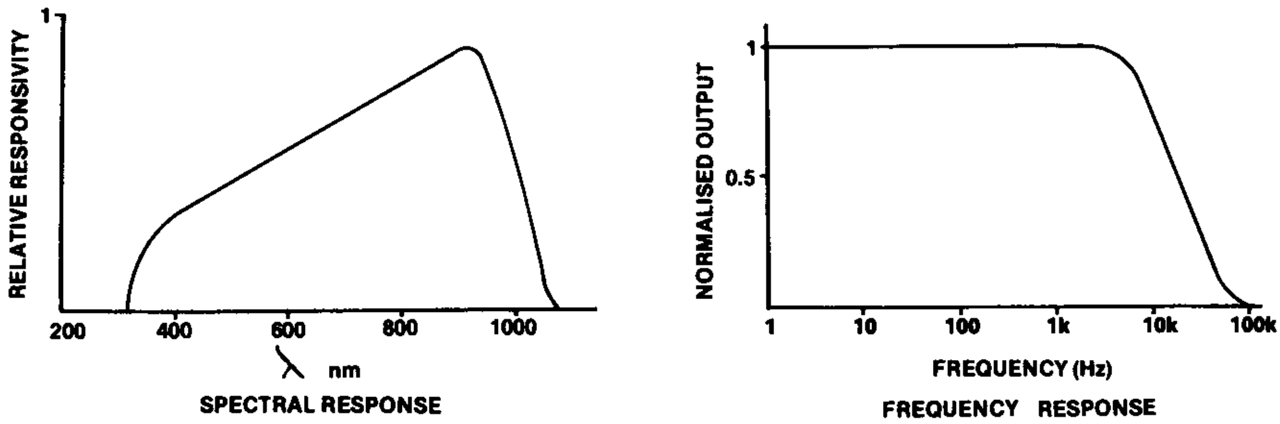


Figure 35 **Spectral and frequency response**



Electrical specification All at VS ± 15V and 25°C unless otherwise stated

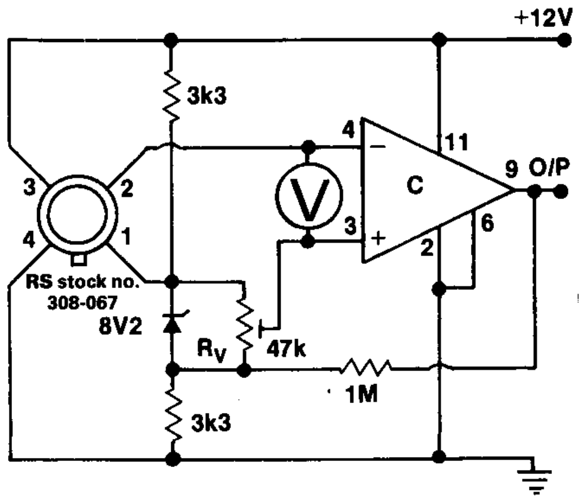
Parameter	Conditions	Min.	Typ.	Max.	Units
O/P dark level			+20	+60	mV
O/P saturation level	R_L ≥2kΩ	-9	-12		V
O/P resistance[1]			75		Ω
O/P short circuit current			6		mA
O/P noise voltage	V_O = ≤1V		1	3	mV/rms
Responsivity	430nm	30			mV/μW^{-1}cm^2
	630nm	160			
	900nm	250			
Supply voltage (V+)		2.5	15	18	V
Supply voltage (V-)		-2.5	-15	-18	V
Supply current	R_L = ∞		0.5	1.3	mA
Supply voltage rejection ratio		150	50		μV/V
Bandwidth	Upper 3dB point	3	5		kHz
Rise time[2]	C_L = 0		30	50	μs
Fall time[2]	C_L = 0		30	50	μs
Dark level temperature coefficient	20°C ≤T_A ≤50°C		150	500	μV/°C

Notes:

1. At 5kHz. Drops to 0.01 at dc.
2. Time for output signal to reach 90% of true reading after application of a step change in light intensity.

Application examples

Figure 36 **Light activated switch with 'error' monitor**

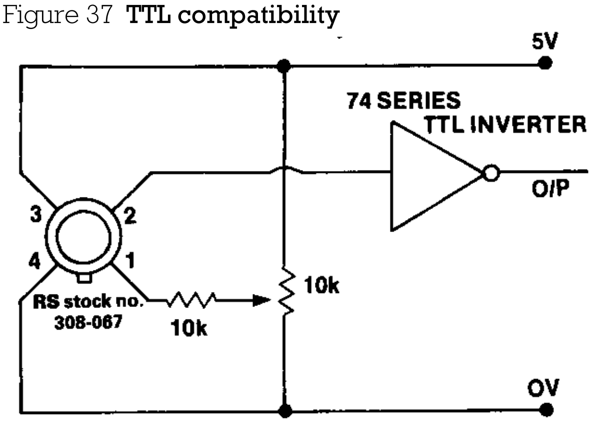


Linear interfacing

In Figure 36, the comparator (eg. **RS** stock no. 308-843) will switch its output state when the light intensity increases above a pre-set level, determined by R_V. The centre zero voltmeter registers the difference between the switching threshold intensity and the actual intensity received by the **RS** stock no. 308-067. Since the threshold is determined with respect to pin 1 of the **RS** stock no. 308-067 supply voltage variations have no effect on the operation of the circuit.

Note: Centre zero voltmeter (**RS** stock no. 196-8418) requires a series resistor (**RS** stock no. 167-967).

Figure 37 **TTL compatibility**

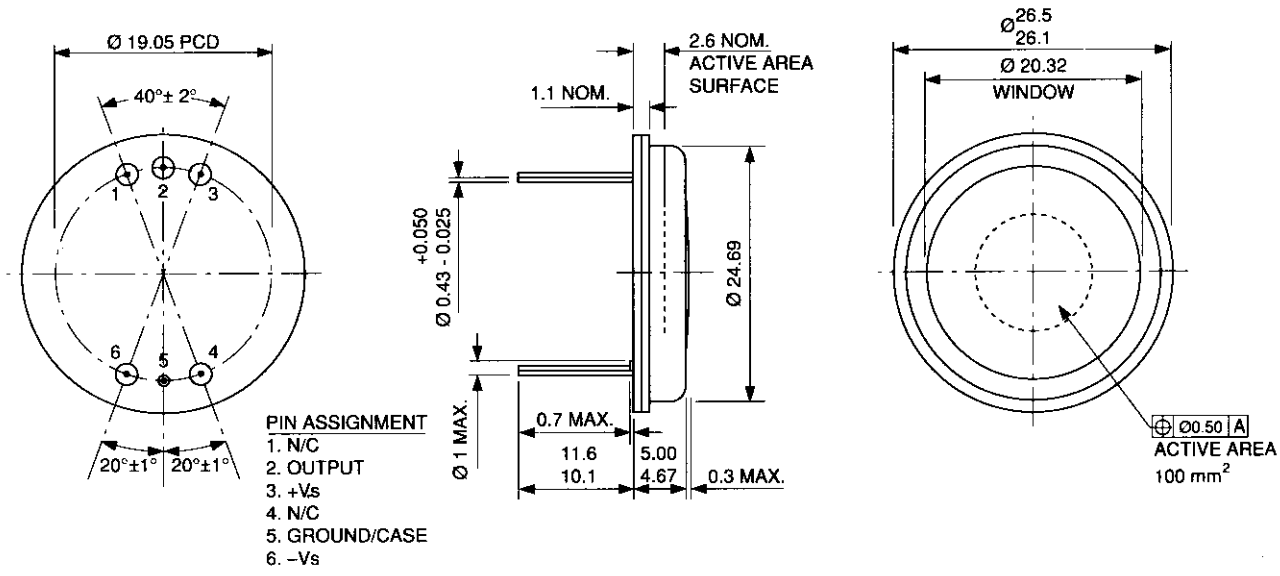


Large area photodiode + amp

(RS stock no. 590-963)

This silicon photodiode has an active area of 100mm² and an integral transimpedance amplifier. This device is ideal for use in electrically noisy environments because the length of the highly sensitive input line to the amplifier is very short and is also screened by the metal can package.

Pin connection and case dimensions



ATTENTION

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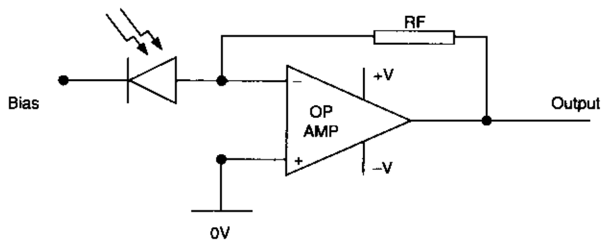
FOR HANDLING

ELECTROSTATIC
SENSITIVE
DEVICE

The transimpedance configuration provides high noise immunity and high amplifier signal saturation levels.

Figure 38 **Transimpedance amplifier circuit**



In this circuit the op amp is used with negative feedback so that the current generated by the photo-diode is converted via the resistor into an output voltage.

Gain is defined only in terms of the feedback resistor.

UV enhanced photodiodes

(RS stock nos. 564-021 and 564-037)

Ultra-violet sensitive silicon photodiodes with enhanced responsivity in the 190 to 400nm range. The devices high shunt resistance and enhanced responsivity make them ideal for light measurement photometry and fluorescence applications.

The 5.8mm² is housed in a metal can package while the 33.6mm² device is housed in ceramic packages. All packages incorporate a quartz window for enhanced spectral response.

Electrical characteristics

(Ta = 25°C, ±15V supply)

Parameter	Min.	Typ.	Max.	Units
Operating wavelength	400	-	950	nm
Peak wavelength	-	800	-	nm
Responsivity @ 530nm	1.3×10^5	-	-	V/W
Supply voltage	±5	-	±18	V
Supply current	-	-	250	μA
Transimpedance gain	-	500k	-	-
Output resistance	-	1	-	Ω
Dark output offset voltage	-	-	±5	mV
Rise time	77	-	-	μs
Bandwidth	-	5	-	kHz
Dark output noise level	-	-	400	μVrms
Temperature range	0°	-	+70	°C

Solder temperature 300°C for 15 seconds.

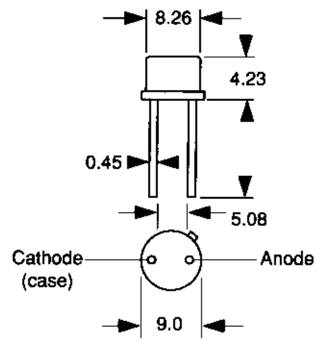
To eliminate unwanted oscillation it is recommended that a 10nF or 100nF disc ceramic capacitor in parallel with a 1μF tantalum decoupling capacitor be used between supply and 0V close to the device.

Absolute maximum ratings (Ta = 25°C)

Reverse voltage ____ 5V
Peak current (1μs, 1% duty cycle) ____ 200mA
Peak dc current ____ 10mA
Storage temperature range ____ -55°C to +125°C
Operating temperature range ____ -55°C to +70°C
Soldering temperature ____ 260°C

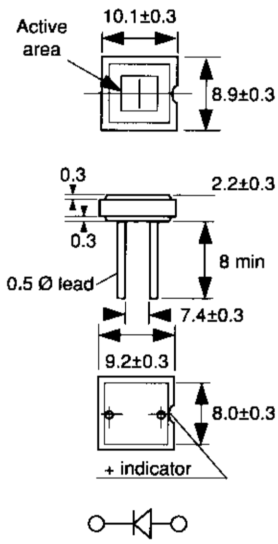
Pin connections and case dimensions

RS stock no. 564-021



Active area
5.8mm²
Metal can package

RS stock no. 564-037

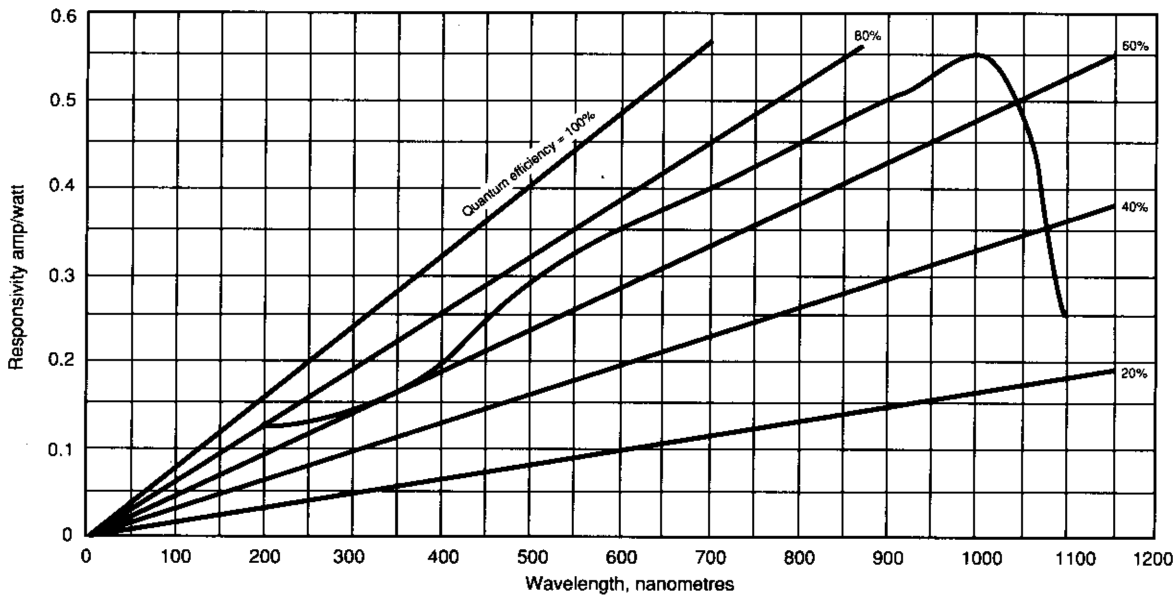


Active area
33.6mm²
Ceramic package

Electrical characteristics (Ta = 25°C)

Active area		Responsivity a/w (typical)			Peak Responsivity	Dark current @Vr = 10mV	Noise equivalent power (typ.)	Capacitance	Rise time $V_L = 0\Omega$ $R_L = 1k\Omega$	Shunt resistance @Vr = ± 10mV	
mm^2	mm	@ 190nm	@ 245nm	@ 340nm	(typical)	(typical)	@900nm	typical	typical	min.	typical
5.8	2.4 × 2.4	0.12	0.14	0.19	950nm	3pA	6×10^{-15} w/Hz$^{1/2}$	170pF	0.4μs	0.5GΩ	3GΩ
33.6	5.8 × 5.8	0.12	0.14	0.19	950nm	20pA	1.5×10^{-14} w/Hz$^{1/2}$	1000pF	2.0μs	0.5GΩ	0.5GΩ

Figure 39 **Typical spectral response and typical quantum efficiency curves**



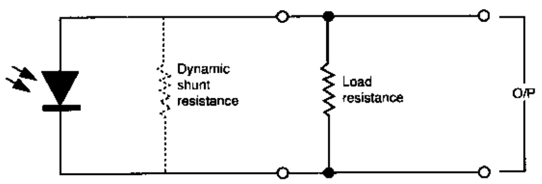
Typical applications

Photovoltaic mode

In the photovoltaic mode, as the light level increases, photocurrent induced in the device develops a voltage across the dynamic shunt resistance. However, this resistance then decreases exponentially, therefore the photogenerated voltage is a logarithmic function of the incident light intensity.

Typically this mode of operation is most useful in simple comparator applications, Figure 40 shows the basic photovoltaic circuit.

Figure 40 **Basic photovoltaic circuit**

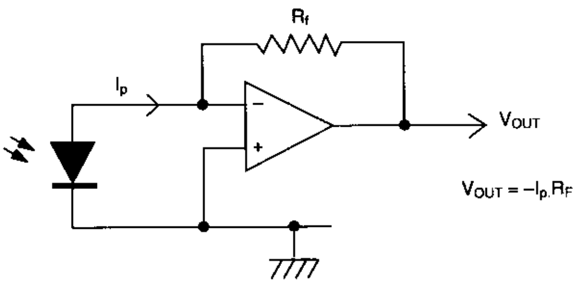


Photoamperic mode

If the photodiode is connected to a low value of load resistance the effect on the dynamic resistance is negligible and the output current is linearly related to light level.

The usual method of providing a low load resistance with subsequent amplification is to connect the diode to the virtual earth of an operational amplifier. This circuit as shown in Figure 41 is a current to voltage converter.

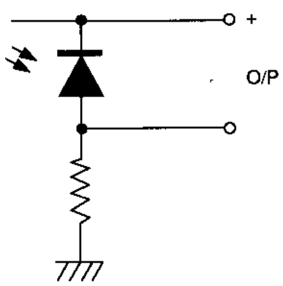
Figure 41 **Photoamperic mode**



Photoconductive mode

The dynamic resistance of a reverse biased photodiode is constant, and a high value of load resistance can be used to give a voltage output that is linearly related to the light level incident on the device. Because the diode junction capacitance decreases with increasing reverse bias voltage, diodes operated in this mode will have the fastest response times. However, noise levels will also increase in this mode as leakage current increases with bias voltage. Figure 42 shows the basic circuit.

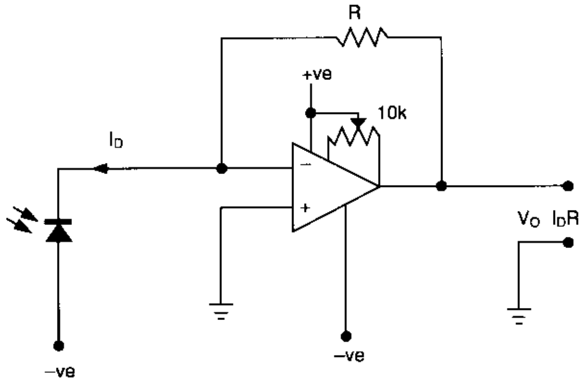
Figure 42 **Photoconductive mode**



Linear photometer

Figure 43 illustrates a photometer circuit using an FET operational amplifier. Diode current I_D varies with light level from 1nA to 1mA type. Resistor R is chosen to give required output-typ. value 1MΩ.

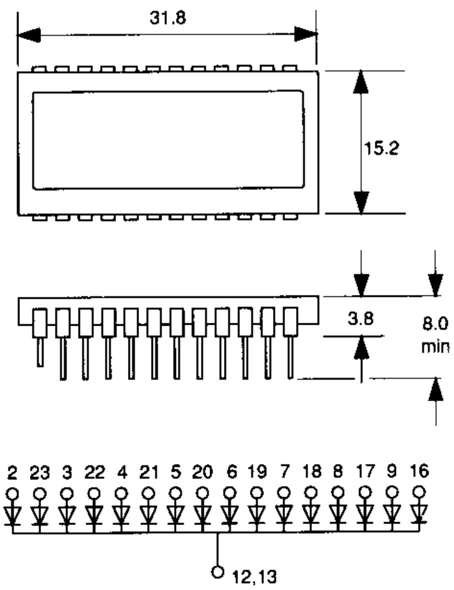
Figure 43 **Linear photometer**



16 element linear array

(RS stock no. 194-060)

A 16-element linear silicon PIN photodiode array housed in an hermetically sealed 24 pin ceramic d.i.l. package. This high speed device consists of 16 individual elements arranged on a 1mm pitch in common cathode configuration. This array is ideal for linear position sensing, wide aperture detection and edge and hole detection in strip materials.



Package type	Peak responsivity per diode A/W at λ nm	Number of diodes	Pitch of diodes mm	Active area of each diode mm^2	Dark current per diode nA (VR = 1V)	Capacitance per diode pF (VR = 0V)	Response time per diode nS (VR = 10V RL = 100R)
24 pin	0.6 900	16	1.0	0.66	0.1	9	4

Figure 44 **Spectral response**

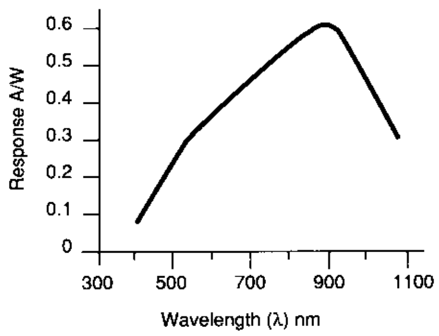


Figure 46 **Open circuit voltage vs irradiation**

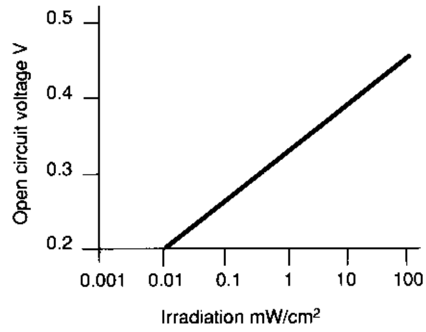


Figure 45 **Normalised capacitance vs reverse bias**