PD1XX5 SERIES

FOR OPTICAL COMMUNICATION AND RADAR SYSTEMS

TYPE NAME **PD1005**

DESCRIPTION

PD1XX5 is a silicon avalanche photodiode (Si-APD) having a light receiving area of 500 μm in diameter. Mitsubishi Si-APD realizes the P-side incidence method having a deep junction of planar mesa structure, increasing the gain band width area and decreasing the noise generated by the multiplication mechanism.

FEATURES

- High speed response (pulse rise time 750ps)
- Very low multiplication noise ($< M^{0.3}$)
- Flat frequency characteristic (cutoff frequency 400MHz)
- Very high gain-bandwidth product (400GHz)
- Active diameter 500 μm

APPLICATION

Light receiving element for optical fiber communication systems and optical telemetry systems

ABSOLUTE MAXIMUM RATINGS

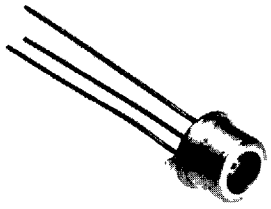
Symbol	Parameter	Conditions	Ratings	Unit
I_R	Reverse current	$T_{opr} \leqq 80$℃	200	μA
I_F	Forward current		10	mA
T_C	Case temperature	–	−40～+110	℃
T_{stg}	Storage temperature	–	−55～+150	℃

ELECTRICAL/OPTICAL CHARACTERISTICS (T_C = 25℃)

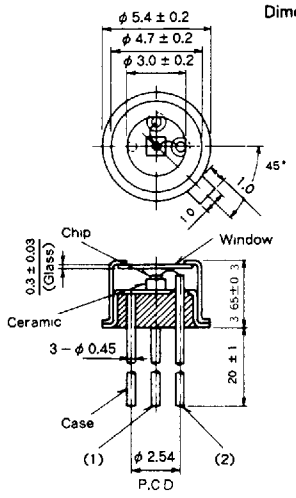
Symbol	Parameter	Test conditions	Limits			Unit
			Min.	Typ.	Max.	
$V_{(BR)R}$	Breakdown voltage	I_R = 100 μA	100	150	200	V
β	Temp. coeff. of $V_{(BR)R}$		–	0.12	–	%/℃
C_t	Total capacitance	$V_R = 0.9V_{(BR)R}$	–	5	7	pF
I_D	Dark current	V_R = 50V	–	0.3	1	nA
R	Responsivity	V_R = 50V, λ = 800nm	0.4	0.45	–	A/W
Mmax	Maximum multiplication rate	I_{PO} = 10nA, R_L = 1kΩ	–	1000	–	–
fc	Cutoff frequency	M = 100, R_L = 50Ω, −3dB	–	0.4	–	GHz
NEP	Noise equivalent power	λ = 800nm	–	1×10^{-14}	–	W/Hz
F	Excess noise factor	M = 100	–	$M^{0.25}$	–	–

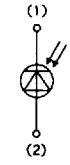
OUTLINE DRAWINGS

PD1005



Dimensions in mm



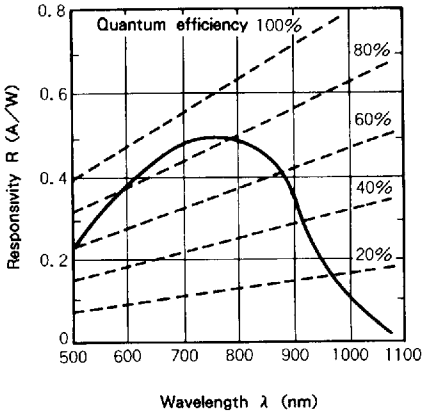


SAMPLE CHARACTERISTIC

1 Responsivity under no multiplication condition

Figure 1 shows PD1XX5's typical response characteristic against wavelength at a 50V bias. PD1XX5 is a PIN structure APD suitable for receiving the lights having a wavelength band of 600 to 900nm like He-Ne laser (633nm) and AlGaAs laser (750 to 900nm). At a wavelength of 750nm, the response becomes about 0.5A/W at peak. The dashed lines indicate quantum efficiency levels.

Fig. 1 Spectral response



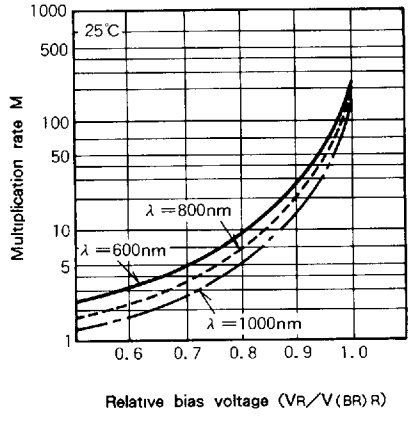
2 Multiplication characteristics

Typical voltage dependence of the multiplication rate at various wavelengths is shown in Fig. 2. Multiplication rate as high as 1000 is obtainable when the output voltage (product of multiplied photocurrent and load resistance) is smaller than 100mV.

Practically available responsivity is a product of the value in Fig. 1 and the multiplication rate M. A value as high as 300A/W can be easily obtained.

Because of the PIN structure, the PD1XX5 have much smaller scattering of the multiplication rate from device to device, more uniform multiplication rate throughout the detecting area as compared with reach through devices.

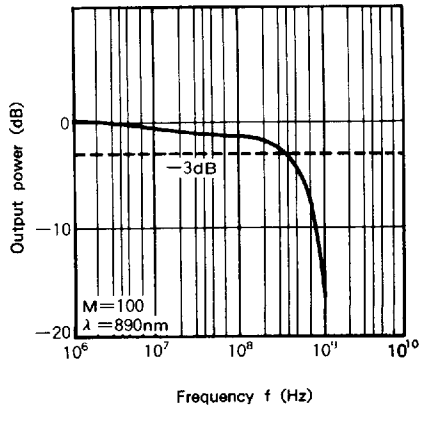
Fig. 2 Multiplication characteristics



3 Frequency response

Figure 3 shows PD1XX5's typical frequency response characteristic. The cutoff frequency (the frequency at output being −3dB) at a 50-ohm load is 400MHz or higher.

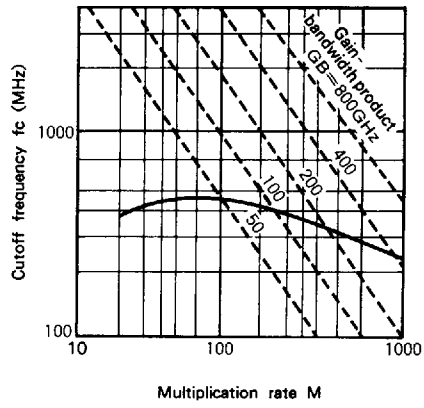
Fig. 3 Frequency response



4 Gain-bandwidth product

The gain-bandwidth product of an APD is a product of the multiplication rate and the cutoff frequency, GB. It increases with M and approaches an asymptote which is determined by the GB of multiplication process. Fig. 4. shows the GB of the PD1XX5. The multiplication limited GB of the devices is approximately 400GHz. Such a large GB is required particularly in detection of very weak and very wideband signals.

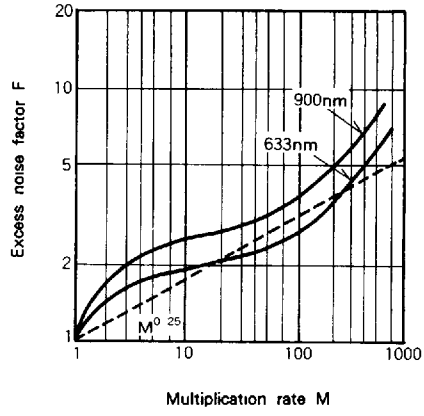
Fig. 4 Multiplication rate dependence of cutoff frequency



5 Noise characteristics

Excess noise factor of the multiplication process depends on the multiplication rate, M. It is generally approximated by an expression M^x. Fig. 5 shows the noise characteristics of the PD1XX5. They depend slightly on wavelength of incident light signals. The constant, x, of the PD1XX5 is approximately 0.25. The PD1XX5 can be low noise detectors even in the high multiplication region since their noise increment is so small.

Fig. 5 Excess noise factor of multiplication process



6 Bias circuit

Fig. 6 shows an example of APD receiver circuit. Because the multiplication rate obtained when a constant reverse bias is added changes with temperature, a stable operation for long time requires the compensation of the temperature dependence of the multiplication rate. Figure 7 shows an example of the bias circuit for temperature compensation which uses an avalanche diode (AD1000) for temperature compensation.

Fig. 6 Receiver circuit with APD

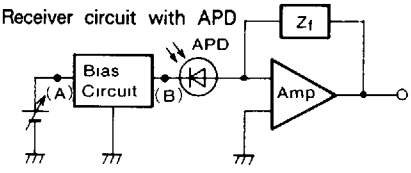


Fig. 7 APD bias circuit with temperature compensation