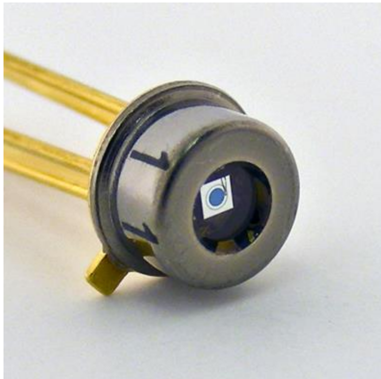
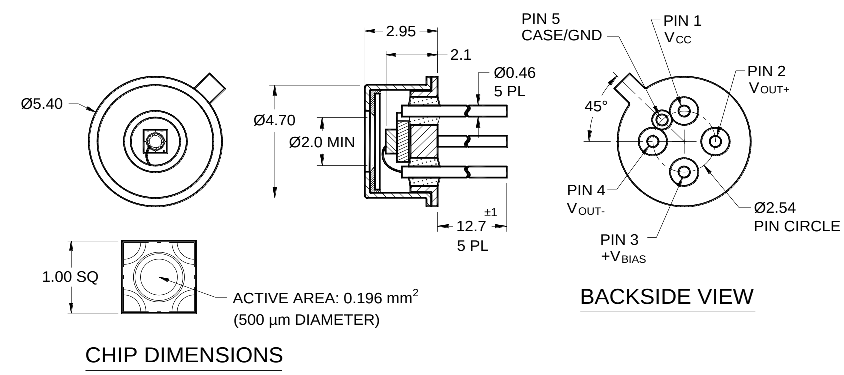
First Sensor

APD Hybrid Series Data Sheet
Part Description AD500-9-8015 TO52
US Order # 05-100
International Order # 5000041





Features

- ∅ 0.500 mm active area
- Low noise
- High gain
- Long term stability

Description

The AD500-9-8015 TO52 is an Avalanche Photodiode Amplifier Hybrid containing a 0.196 mm^2 active area APD chip integrated with an internal transimpedance amplifier. Hermetically packaged in a TO-52 with a flat borosilicate glass window cap.

Applications

- Precision photometry
- Analytical instruments
- Medical equipment
- Low light sensor

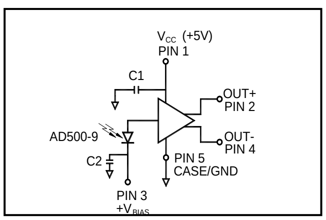
RoHS

2011/65/EU

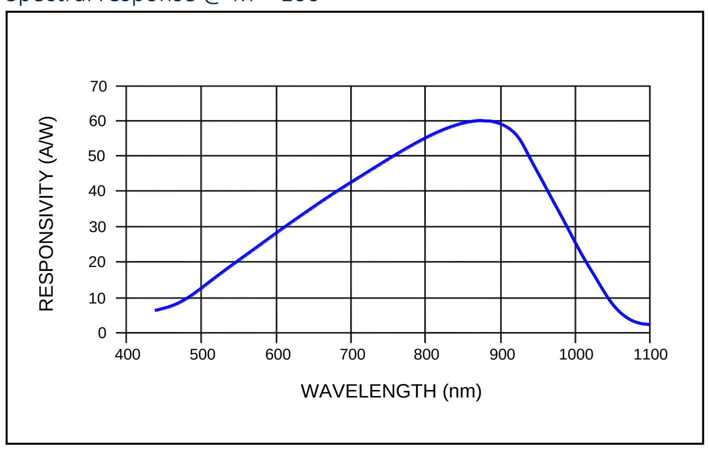
Absolute maximum ratings

Symbol	Parameter	Min	Max	Unit
T_{STG}	Storage Temp	-55	+125	°C
T_{OP}	Operating Temp	0	+60	°C
$T_{SOLDERING}$	Soldering Temp	-	+240	°C
P	Power Dissipation	-	360	mW
V_{cc}	Single Supply Voltage	+4.5	+11	V
I_{cc}	Supply Current	-	26	mA

Schematic



Spectral response @ M = 100



Electro-optical characteristics @ 23° C (V_{CC} = single supply +5V, R_L = 50W unless otherwise specified)

Symbol	Characteristic	Test-Condition	Min	Typ	Max	Unit
f_{-3dB}	Frequency Response	-3dB @ 905 nm	---	100	---	MHz
S	Sensitivity*	λ = 905 nm; M = 100	---	1160	---	KV/W
I_{cc}	Supply Current	Dark state	---	25	26	mA

* Sensitivity = APD responsivity (0.58 A/W X 100 gain) x TIA gain (20 K)

These devices are sensitive to electrostatic discharge. Please use ESD precautions when handling.

Avalanche photodiode data @ 23 °C

Symbol	Characteristic	Test-Condition	Min	Typ	Max	Unit
I_D	Dark Current	M = 100 (see note 1)	---	0.5	5.0	nA
C	Capacitance	M = 100 (see note 1)	---	1.2	---	pF
V_{BR}	Breakdown Voltage	I_D = 2 µA	160	200	---	V
	Temperature Coefficient of V_{BR}		---	1.55	---	V/K
	Responsivity	M = 100; = 0 V; λ = 905 nm	55	60	---	A/W
Δf_{3dB}	Bandwidth	-3dB	---	0.5	---	GHz
t_r	Rise Time	M = 100	---	550	---	ps
	Optimum Gain		50	60	---	
	"Excess Noise" factor	M = 100	---	2.5	---	
	"Excess Noise" index	M = 100	---	0.2	---	
	Noise Current	M = 100	---	1.0	---	$pA/Hz^{1/2}$
	Max Gain		200	---	---	
NEP	Noise Equivalent Power	M = 100; λ = 905 nm	---	2.0×10^{-14}	---	$W/Hz^{1/2}$

Note 1: Measurement conditions: Setup of photo current 1 nA at M = 1 and irradiated by a 880 nm, 80 nm bandwidth LED. Increase the photo current up to 100 nA, (M = 100) by internal multiplication due to an increasing bias voltage.

Transimpedance amplifier data @ 25 °C

(Vcc = +4.5 V to +11V, TA = 0°C to 70°C, 50Ω load between OUT+ and OUT-. Typical values are at TA = 25°C, Vcc = +5 V)

Parameter	Test-Condition	Min	Typ	Max	Unit
Supply Voltage		+4.5	+5	+11	V
Supply Current		---	25	26	mA
Transimpedance	Differential, measured with 40 µA p-p signal	16	20	24	KΩ
Output impedance	Single ended per side	40	50	60	Ω
Maximum Differential Output Voltage	Input = 2 mA p-p with 50 Ω differential termination	---	600	---	mV p-p
Input Referred RMS Noise	TO-5 package, see note 3	---	26.5	---	nA
Input Referred Noise Density	See note 3	---	3.0	---	$pA/Hz^{1/2}$
Small signal bandwidth	Source capacitance = 1.2 pF, see note 2	180	240	---	MHz
Low Frequency Cutoff	-3 dB, input < 20 µA DC	---	5	---	KHz
Transimpedance Linear Range	Peak to peak 0.95 < linearity < 1.05	±25	±30	---	µA p-p
Power Supply Rejection Ratio (PSRR)		---	40	---	dB

Note 2: Source capacitance for AD500-9-8015-TO52 is the capacitance of APD.
Note 3: Input referred noise is calculated as RMS output noise/ (gain at f = 100 Mhz). Noise density is (input referred noise)/√bandwidth.

TRANSFER CHARACTERISTICS

The circuit used is an avalanche photodiode directly coupled to a high speed data handling transimpedance amplifier. The output of the APD (light generated current) is applied to the input of the amplifier. The amplifier output is in the form of a differential voltage pulsed signal.

The APD responsivity curve is provided in Fig. 2. The term Amps/Watt involves the area of the APD and can be expressed as $Amps/mm^2/Watts/mm^2$, where the numerator applies to the current generated divided by the area of the detector, the denominator refers to the power of the radiant energy present per unit area. As an example assume a radiant input of 1 microwatt at 850 nm. The APD's corresponding responsivity is 0.4 A/W.

If energy in = 1 µW, then the current from the APD = (0.4 A/W) x (1×10^{-6}W) = 0.4 µA. We can then factor in the typical gain of the APD of 100, making the input current to the amplifier 40 µA.

APPLICATION NOTES

The AD500-9-8015-TO52 is a high speed optical data receiver. It incorporates an internal transimpedance amplifier with an avalanche photodiode.

This detector requires +4.5 V to +11 V voltage supply for the amplifier and a high voltage supply (100-240 V) for the APD. The internal APD follows the gain curve published for the AD500-9-TO52-S1 avalanche photodiode. The transimpedance amplifier provides differential output signals in the range of 200 millivolts differential.

In order to achieve highest gain, the avalanche photodiode needs a positive bias voltage (Fig. 1). However, a current limiting resistor must be placed in series with the photodiode bias voltage to limit the current into the transimpedance amplifier. **Failure to limit this current may result in permanent failure of the device.** The suggested initial value for this limiting resistor is 390 KOhm.

When using this receiver, good high frequency placement and routing techniques should be followed in order to achieve maximum frequency response. This includes the use of bypass capacitors, short leads and careful attention to impedance matching. The large gain bandwidth values of this device also demand that good shielding practices be used to avoid parasitic oscillations and reduce output noise.

Fig. 1: APD gain vs bias voltage

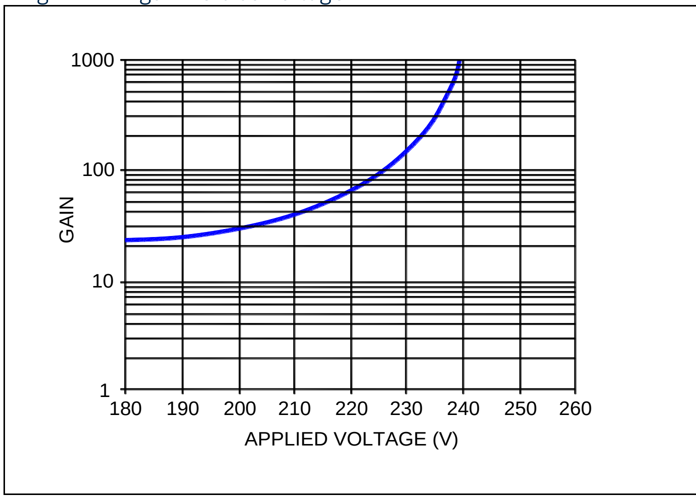


Fig. 2: APD Spectral response (M = 1)

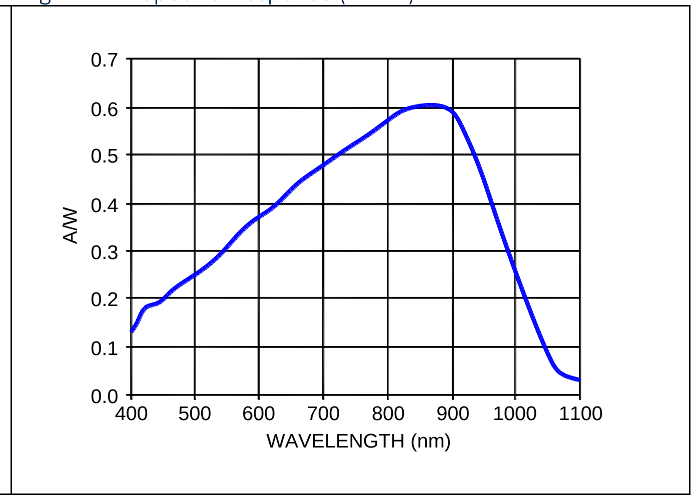


Fig. 3: Amplifier bandwith vs temperature

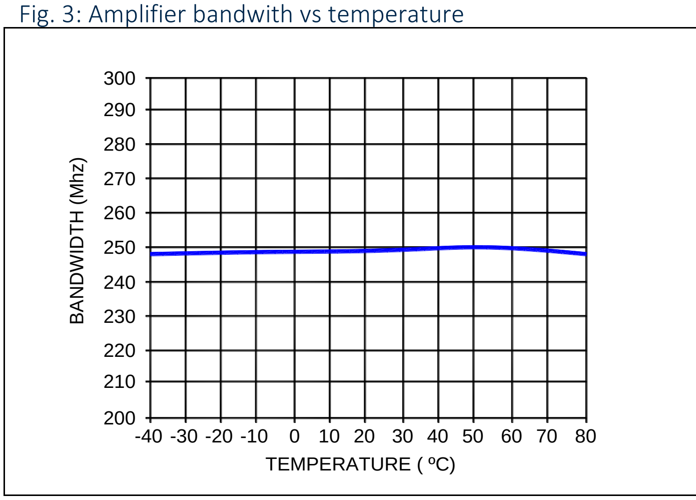


Fig.4: APD Capacitance vs voltage

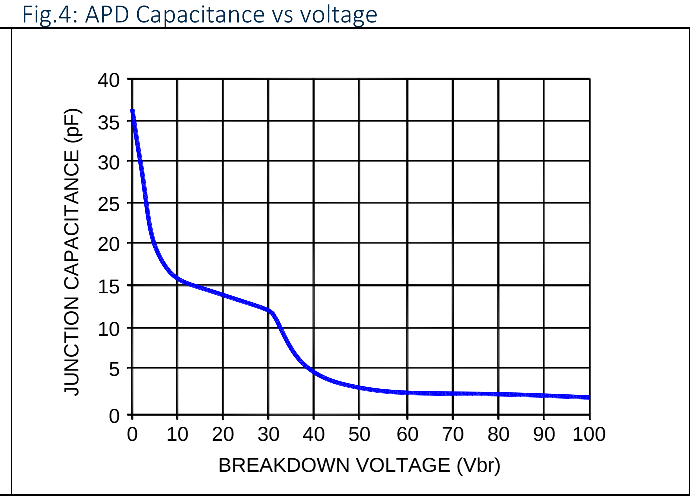


Fig. 5: Differential gain vs. supply

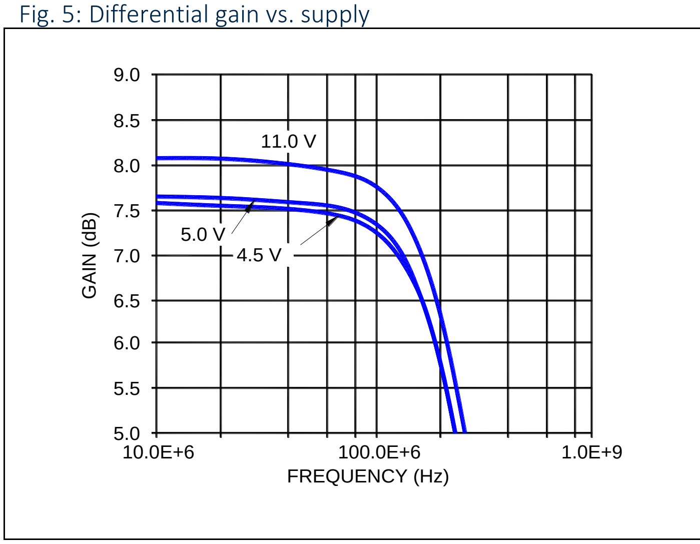


Fig. 6: Amplifier gain vs. frequency