

**FEATURES**

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

**DESCRIPTION**

The AD500-1.3G-TO5 is an Avalanche Photodiode Amplifier Hybrid containing a 0.196 mm<sup>2</sup> active area APD chip integrated with an internal 1.3 GHz amplifier. Hermetically packaged in a TO-5 with a borosilicate glass window cap.

**APPLICATIONS**

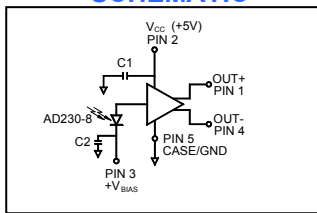
- Precision photometry
- Analytical instruments
- Medical equipment
- Low light sensor



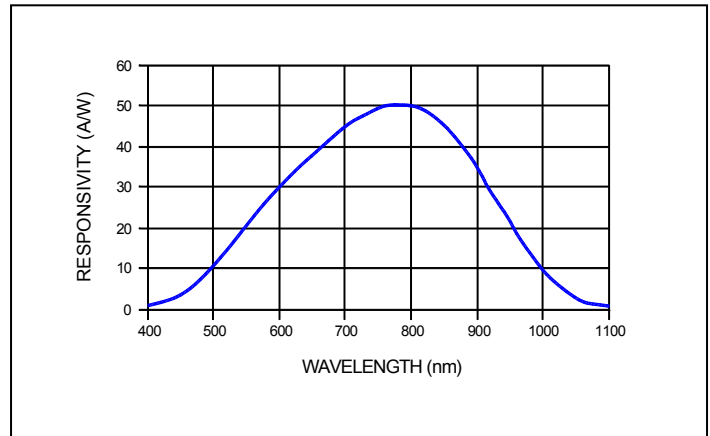
**ABSOLUTE MAXIMUM RATING**

| SYMBOL                 | PARAMETER             | MIN  | MAX  | UNITS |
|------------------------|-----------------------|------|------|-------|
| T <sub>STG</sub>       | Storage Temp          | -55  | +125 | °C    |
| T <sub>OP</sub>        | Operating Temp        | 0    | +60  | °C    |
| T <sub>SOLDERING</sub> | Soldering Temp        | -    | +240 | °C    |
| P                      | Power Dissipation     | -    | 360  | mW    |
| V <sub>CC</sub>        | Single Supply Voltage | +3.0 | +5.5 | V     |
| I <sub>CC</sub>        | Supply Current        | -    | 63   | mA    |

**SCHEMATIC**



**SPECTRAL RESPONSE at M = 100**



**ELECTRO-OPTICAL CHARACTERISTICS @ 22° C** (V<sub>CC</sub> = single supply +3.3V, R<sub>L</sub> = 100Ω unless otherwise specified)

| SYMBOL            | CHARACTERISTIC     | TEST CONDITIONS     | MIN | TYP | MAX | UNITS |
|-------------------|--------------------|---------------------|-----|-----|-----|-------|
| f <sub>-3dB</sub> | Frequency Response | -3dB @ 800 nm       | --- | 1.3 | --- | GHz   |
| S                 | Sensitivity*       | λ = 800 nm; M = 100 | --- | 100 | --- | KV/W  |
| I <sub>CC</sub>   | Supply Current     | Dark state          | --- | 34  | 63  | mA    |

\* Sensitivity = APD responsivity (0.45 A/W X 100 gain) x TIA gain (2.5K)

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

Disclaimer: Due to our policy of continued development, specifications are subject to change without notice.

## AVALANCHE PHOTODIODE DATA @ 22 °C

| SYMBOL           | CHARACTERISTIC                      | TEST CONDITIONS                     | MIN  | TYP                   | MAX  | UNITS                |
|------------------|-------------------------------------|-------------------------------------|------|-----------------------|------|----------------------|
| $I_D$            | Dark Current                        | M = 100 (see note 2)                | ---  | 0.5                   | 2.0  | nA                   |
| C                | Capacitance                         | M = 100 (see note 2)                | ---  | 2.2                   | ---  | pF                   |
| $V_{BR}$         | Breakdown Voltage (see note 1)      | $I_D = 2 \mu A$                     | 80   | 200                   | ---  | V                    |
|                  | Temperature Coefficient of $V_{BR}$ |                                     | 0.35 | 0.45                  | 0.55 | V/K                  |
|                  | Responsivity                        | M = 100; $\lambda = 800 \text{ nm}$ | 45   | 50                    | ---  | A/W                  |
| $\Delta f_{3dB}$ | Bandwidth                           | -3dB                                | ---  | 1.0                   | ---  | GHz                  |
| $t_r$            | Rise Time                           |                                     | ---  | 350                   | ---  | ps                   |
|                  | Optimum Gain                        |                                     | 50   | 60                    | ---  |                      |
|                  | "Excess Noise" factor               | M = 100                             | ---  | 2.2                   | ---  |                      |
|                  | "Excess Noise" index                | M = 100                             | ---  | 0.2                   | ---  |                      |
|                  | Noise Current                       | M = 100                             | ---  | 1.0                   | ---  | pA/Hz <sup>1/2</sup> |
|                  | Max Gain                            |                                     | 200  | ---                   | ---  |                      |
| NEP              | Noise Equivalent Power              | M = 100; $\lambda = 800 \text{ nm}$ | ---  | $2.0 \times 10^{-14}$ | ---  | W/Hz <sup>1/2</sup>  |

Note 1: The following different breakdown voltage ranges are available: (120 – 160 V), (160 – 200 V).

Note 2: Measurement conditions: Setup of photo current 1.0 nA at M = 1 and irradiated by a 680 nm, 60 nm bandwidth LED. Increase the photo current up to 1  $\mu A$ , (M = 100) by internal multiplication due to an increasing bias voltage.

## TRANSIMPEDANCE AMPLIFIER DATA @ 25 °C

( $V_{CC} = +3.0 \text{ V}$  to  $+5.5 \text{ V}$ ,  $T_A = 0^\circ \text{C}$  to  $70^\circ \text{C}$ , 100 $\Omega$  load between OUT+ and OUT-. Typical values are at  $T_A = 25^\circ \text{C}$ ,  $V_{CC} = +3.3 \text{ V}$ )

| PARAMETER                           | TEST CONDITIONS  | MIN   | TYP  | MAX  | UNITS                |
|-------------------------------------|--|-------|------|------|----------------------|
| Supply Voltage                      |  | 3     | 5    | 6    | V                    |
| Supply Current                      |  | ---   | 34   | 63   | mA                   |
| Transimpedance                      | Differential, measured with 40 $\mu A$ p-p signal  | 2.10  | 2.75 | 3.40 | K $\Omega$           |
| Output impedance                    | Single ended per side  | 48    | 50   | 52   | $\Omega$             |
| Maximum Differential Output Voltage | Input = 1 mA p-p   | 220   | 380  | 575  | mV p-p               |
| AC Input Overload                   |  | 2     | ---  | ---  | mA p-p               |
| DC Input Overload                   |  | 1     | ---  | ---  | mA                   |
| Input Referred RMS Noise            | TO-5 package, see note 4   | ---   | 490  | 668  | nA                   |
| Input Referred Noise Density        | See note 4   | ---   | 11   | ---  | pA/Hz <sup>1/2</sup> |
| Small signal bandwidth              | Source capacitance = 0.85 pF, see note 3   | 1.525 | 2.00 | ---  | GHz                  |
| Low Frequency Cutoff                | -3 dB, input < 20 $\mu A$ DC   | ---   | 30   | ---  | KHz                  |
| Transimpedance Linear Range         | Gain at 40 $\mu A$ p-p is within 5% of the small signal gain                                     | 40    | ---  | ---  | $\mu A$ p-p          |
| Power Supply Rejection Ratio (PSRR) | Output referred, $f < 2 \text{ MHz}$ , $PSSR = -20 \text{ Log} (\Delta V_{out} / \Delta V_{cc})$ | ---   | 50   | ---  | dB                   |

Note 3: Source capacitance for AD500-1.3G-TO5 is the capacitance of APD.

Note 4: Input referred noise is calculated as RMS output noise/ (gain at  $f = 10 \text{ MHz}$ ). Noise density is (input referred noise)/ $\sqrt{\text{bandwidth}}$ .

## 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<sup>2</sup>/Watts/mm<sup>2</sup>, 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  $\mu W$ , then the current from the APD = (0.4 A/W) x (1 x 10<sup>-6</sup>W) = 0.4  $\mu A$ . We can then factor in the typical gain of the APD of 100, making the input current to the amplifier 40  $\mu A$ . From Fig. 5 we can see the amplifier output will be approximately 40 mV p-p.

## APPLICATION NOTES

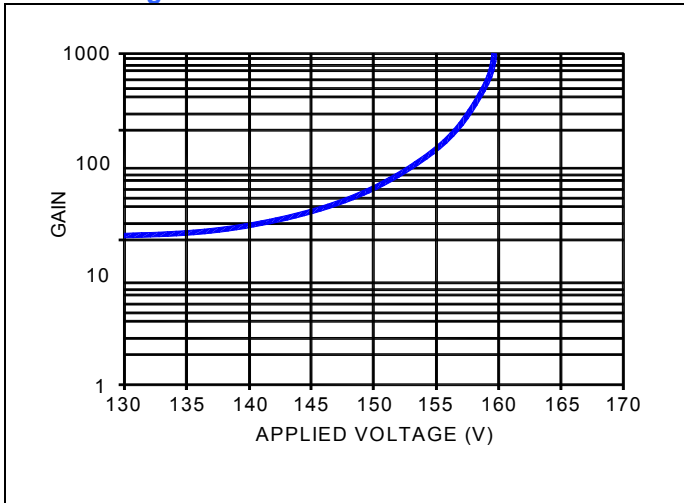
The AD500-1.3G-TO5 is a high speed optical data receiver. It incorporates an internal transimpedance amplifier with an avalanche photodiode.

This detector requires +3.5 V to +5.0 V voltage supply for the amplifier and a high voltage supply (100-200 V) for the APD. The internal APD follows the gain curve published for the AD500-8-TO52-S1 avalanche photodiode. The transimpedance amplifier provides differential output signals in the range of 200 millivolts differential.

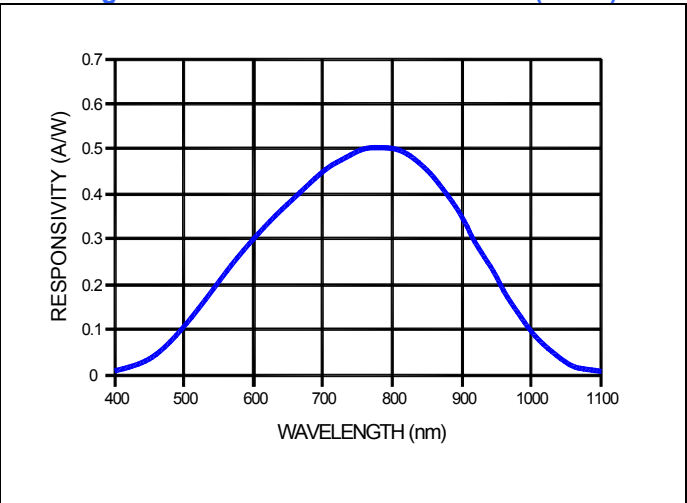
In order to achieve highest gain, the avalanche photodiode needs a positive bias voltage (Fig. 1). However, a current limiting resistor must be placed in series with the photodiode bias voltage to limit the current into the transimpedance amplifier. **Failure to limit this current may result in permanent 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.

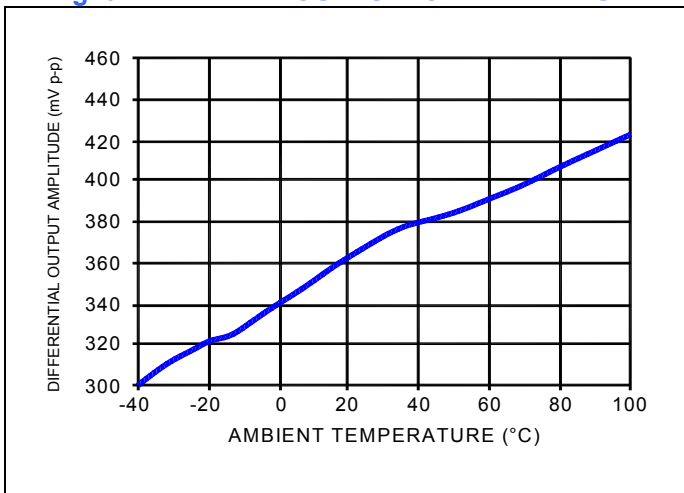
**Fig. 1: APD GAIN vs BIAS VOLTAGE**



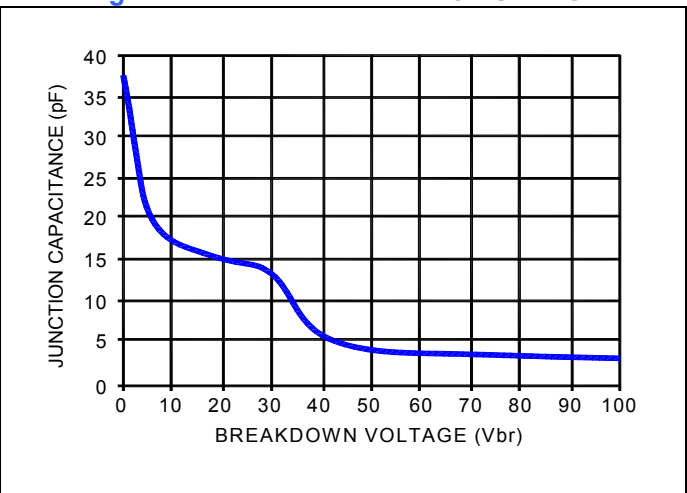
**Fig. 2: APD SPECTRAL RESPONSE (M = 1)**



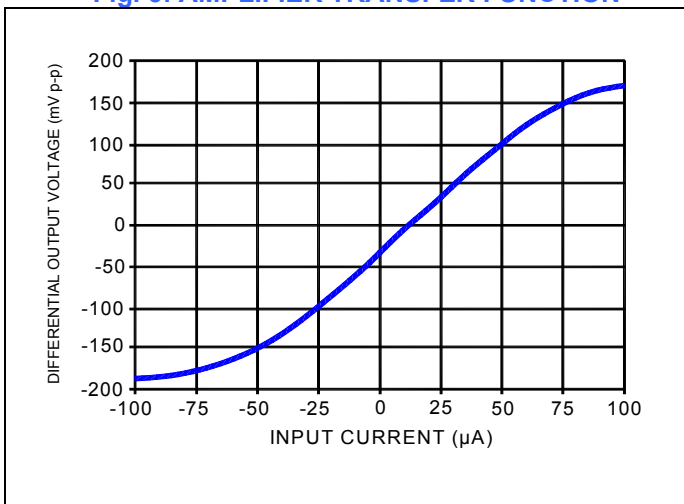
**Fig. 3 : AMPLIFIER OUTPUT vs TEMPERATURE**



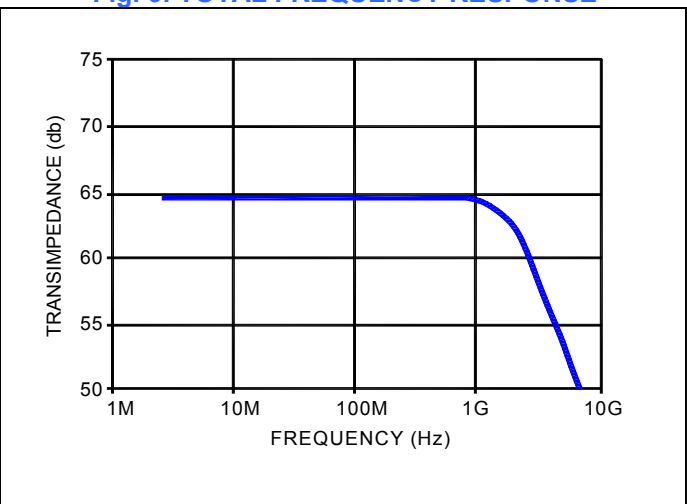
**Fig.4 : APD CAPACITANCE vs VOLTAGE**



**Fig. 5: AMPLIFIER TRANSFER FUNCTION**



**Fig. 6: TOTAL FREQUENCY RESPONSE**



**USA:**  
 Pacific Silicon Sensor, Inc.  
 5700 Corsa Avenue, #105  
 Westlake Village, CA 91362 USA  
 Phone (818) 706-3400  
 Fax (818) 889-7053  
 Email: [sales@pacific-sensor.com](mailto:sales@pacific-sensor.com)  
[www.pacific-sensor.com](http://www.pacific-sensor.com)



**International sales:**  
 First Sensor AG  
 Peter-Behrens-Str. 15  
 12459 Berlin, Germany  
 Phone +49 (0) 30 / 63 99 23 99  
 Fax +49 (0) 30 / 63 99 23 752  
 Email: [sales.opto@first-sensor.de](mailto:sales.opto@first-sensor.de)  
<http://www.first-sensor.de>



Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



#### Как с нами связаться

**Телефон:** 8 (812) 309 58 32 (многоканальный)

**Факс:** 8 (812) 320-02-42

**Электронная почта:** [org@eplast1.ru](mailto:org@eplast1.ru)

**Адрес:** 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.