First Sensor

PIN 5 CASE/GND
PIN 1 V_{OUT+}
PIN 2 V_{CC}
45°
PIN 4 V_{OUT-}
PIN 3 $+V_{BIAS}$
Ø2.54 PIN CIRCLE

Ø5.40
Ø4.70
Ø2.0 MIN
2.95
2.1
Ø0.46 5 PL
12.7 5 PL
±1

BACKSIDE VIEW

1.00 SQ
ACTIVE AREA: 0.196 mm^2 (500 µm DIAMETER)

CHIP DIMENSIONS

Features

- Ø 0.500 mm active area
- Low noise
- High speed
- Miniaturized

Description

The AD500-8-1.3G-MINI 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 borosilicate glass window cap.

Applications

- Lidar
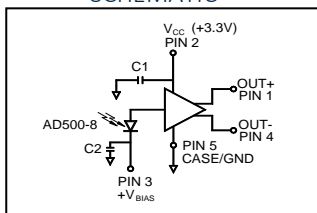- Analytical instruments
- Medical equipment

RoHS

2011/65/EU

Absolute maximum ratings

SYMBOL	PARAMETER	MIN	MAX	UNITS
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	+3.0	+5.5	V
I_{CC}	Supply Current	-	63	mA

SCHEMATIC

V_{CC} (+3.3V) PIN 2
C1
OUT+ PIN 1
AD500-8
OUT- PIN 4
C2
PIN 5 CASE/GND
PIN 3 $+V_{BIAS}$

Spectral response @ M = 100
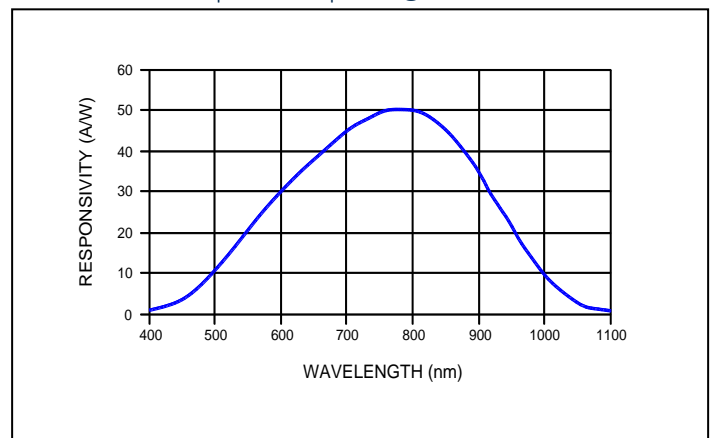
ELECTRO-OPTICAL CHARACTERISTICS @ 23° C (V_{CC} = single supply +3.3V, R_L = 100W unless otherwise specified)

Symbol	Characteristic	Test-Condition	Min	Typ	Max	Unit
f_{-3dB}	Frequency Response	-3dB @ 905 nm	---	1.3	---	GHz
S	Sensitivity*	λ = 905 nm; M = 100	---	85	---	mV/µW
I_{CC}	Supply Current	Dark state	---	34	63	mA

* Sensitivity = APD responsivity (0.3 A/W X 100 gain) x TIA gain (2.8K)

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

Avalanche Photodiode data @ 23 °C

Symbol	Characteristics	Test-Condition	Min	Typ	Max	Unit
I_D	Dark Current	M = 100 (see note 1)	---	0.5	2.0	nA
C	Capacitance	M = 100 (see note 1)	---	2.2	---	pF
V_{BR}	Breakdown Voltage	I_D = 2 µA	80	---	120	V
	Temperature Coefficient of V_{BR}		---	0.45	---	V/K
	Responsivity	M = 100; λ = 800 nm	45	50	---	A/W
Δf_{3dB}	Bandwidth	-3dB	---	1.3	---	GHz
t_r	Rise Time	M = 100; λ = 905 nm; R_L = 50 Ω	---	0.35	---	ns
	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$^{1/2}$
	Max Gain		200	---	---	
NEP	Noise Equivalent Power	M = 100; λ = 905 nm	---	2.0 X 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

(V_{CC} = +3.0 V to 5.5 V, T_A = 0°C to 70°C, 100Ω load between OUT+ and OUT-. Typical values are at T_A = 25°C, V_{CC} = +3.3 V)

Parameter	Test-Condition	Min	Typ	Max	Unit
Supply Voltage		3	5	5.5	V
Supply Current		---	34	63	mA
Transimpedance	Differential, measured with 40 µA p-p signal	2.10	2.75	3.40	kΩ
Output impedance	Single ended per side	48	50	52	Ω
Maximum Differential Output Voltage	Input = 2 mA p-p with 100 Ω differential termination	220	380	575	mV p-p
AC Input Overload		2	---	---	mA p-p
DC Input Overload		1	---	---	mA
Input Referred RMS Noise	TO-52 package, see note 3	---	490	668	nA
Input Referred Noise Density	See note 3	---	11	---	pA/Hz$^{1/2}$
Small signal bandwidth	Source capacitance = 0.85 pF, see note 2	1.525	2.00	---	GHz
Low Frequency Cutoff	-3 dB, input < 20 µA DC	---	30	---	kHz
Transimpedance Linear Range	Peak to peak 0.95 < linearity < 1.05	40	---	---	µA p-p
Power Supply Rejection Ratio (PSRR)	Output referred, f < 2 MHz, PSSR = -20 Log (ΔVout / ΔVcc)	---	50	---	dB

Note 2: Source capacitance for AD500-8-1.3G-MINI is the capacitance of APD.

Note 3: Input referred noise is calculated as RMS output noise/ (gain at f = 10 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 x 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. From Fig. 5 we can see the amplifier output will be approximately 75 mV p-p.

APPLICATION NOTES

The AD500-8-1.3G-MINI is a high speed optical data receiver. It incorporates an internal transimpedance amplifier with an avalanche photodiode. This device does not operate in DC mode or below 30 kHz.

This detector requires +3.0 V to +5.5 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 AD500-8-TO52-S1 avalanche photodiode. The transimpedance amplifier provides differential output signals in the range of 200 millivolts differential. The APD gain is voltage and temperature dependent. Some form of temperature compensation bias voltage control may be required.

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.

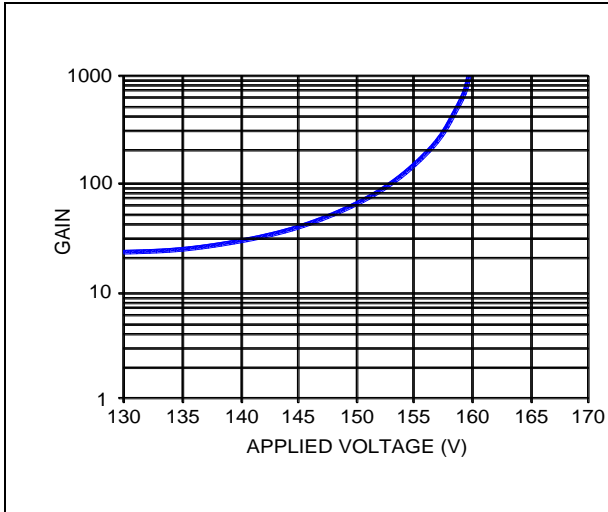Fig. 1: APD gain vs bias voltage

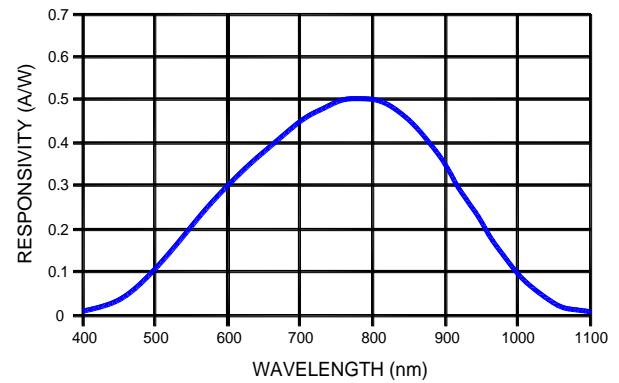
Fig. 2: APD Spectral response (M = 1)

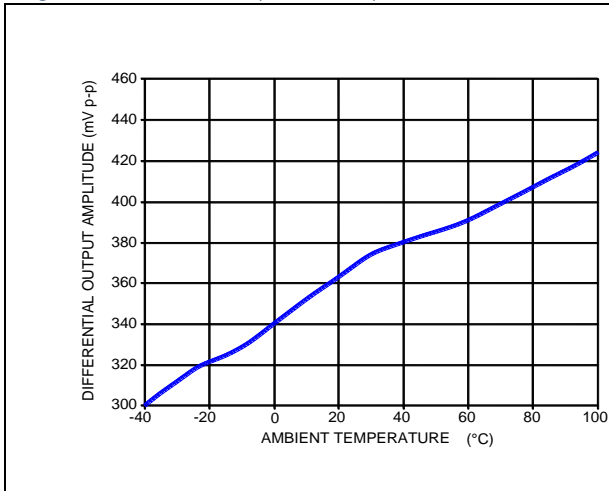Fig. 3 : Differential output vs temperature

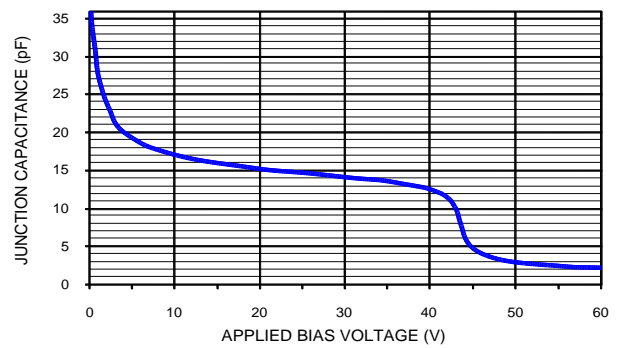Fig.4 : APD Capacitance vs voltage
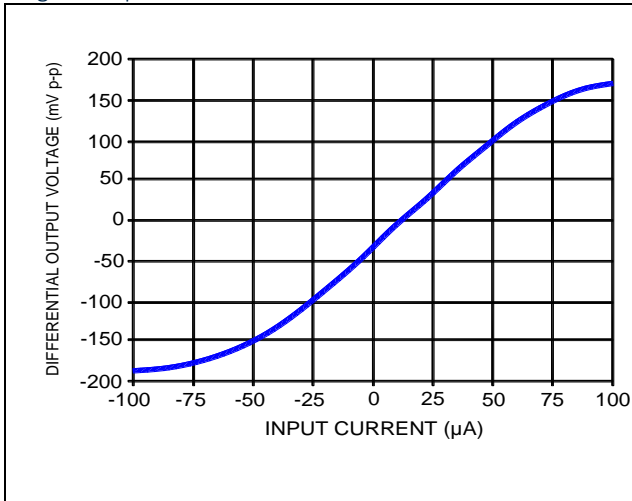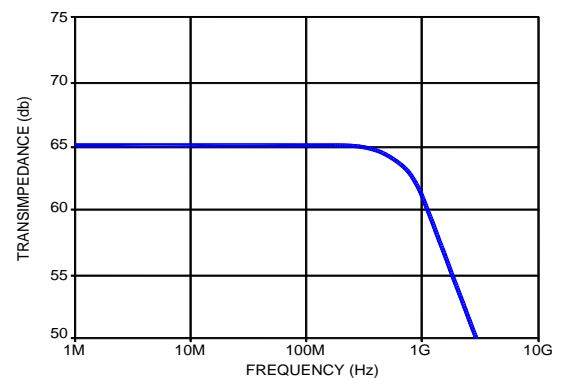

Fig. 5: Amplifier transfer function

Fig. 6: Total frequency response

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