High Sensitivity Transimpedance Amplifier with Precision Monitor for Fiber Optical Receivers up to 300Mb/s

MG2300 is a CMOS TIA with wide input dynamic range, high optical sensitivity (-35dBm with PIN) and high overload tolerance. Automatic gain control (AGC) circuit is implemented in order to achieve such wide dynamic range. In addition to automatically reducing TIA gain, this AGC circuit also helps to maintain integrity of input signal with excellent transimpedance linearity over frequency. A current sourcing monitor of average photodiode current is available at MON pad for receiver power monitoring for PIN photodiode.

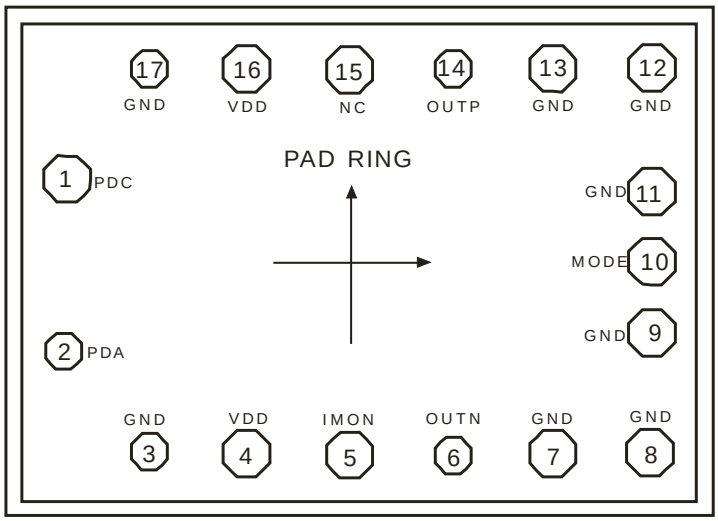
Features

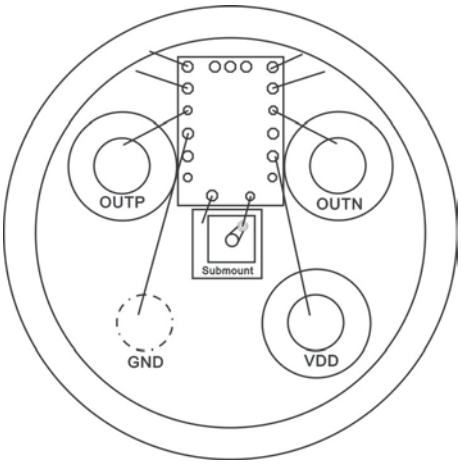
- Data rate up to 360 Mbps
- Typical optical sensitivity with PIN: -35dBm
- Typical optical overload with PIN: 0dBm
- Typical differential transimpedance 40kΩ
- Excellent gain linearity over frequency
- Precision average current monitor(sourcing)
- No ROSA decoupling capacitor required
- Internal or external bias for photodiode
- Low power: supply current 20mA with +3v

Applications

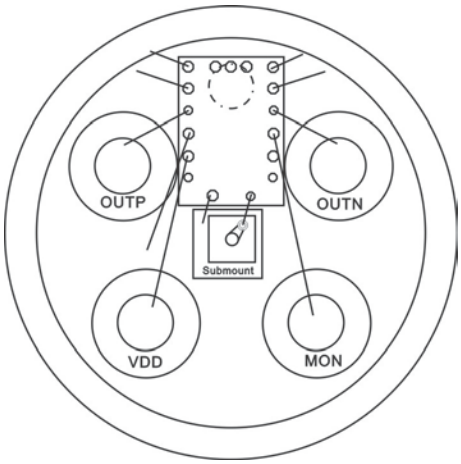
- APON
- SDH/SONET
- Fast Ethernet
- 1x9 Transceiver
- SDI-SD(360Mb/s)
- SDI-SD(270Mb/s)

Pad and Bonding Diagrams:





(a) 4 pin TO-CAN for PIN without monitor



(b) 5 pin TO-CAN for PIN with I-source monitor

1.0 Product Specification

1.1 Absolute Maximum Ratings

Absolute maximum ratings are the values of voltage, current, temperature, power dissipation etc., which should not be exceeded at any time, otherwise deterioration or destruction of the IC may take place.

Parameter	Min	Max	Units
Power supply (VCC - GND)	-0.5	4	V
Storage temperature	-55	150	°C
Input current average	0	4	mA

1.2 Recommended Operating Conditions

Parameter	Min	Max	Units
Power supply (VCC - GND)	2.97	3.63	V
PD capacitance for 155 Mbps	0.5	0.7	pF
Operating ambient temperature	-40	85	°C

1.3 DC Characteristics

Symbol	Parameter	Min	Typ	Max	Units
VB	Photodiode bias voltage (PDC - PDA)		2.2		V
VCM	Common mode output voltage		3.15		V
ICC	Supply current (no loads)		18	22	mA
RLOAD	Recommended output load (single side)	-	500	-	Ω
NOTES:					

1.4 AC Characteristics

Parameter	Conditions	Min	Typical	Max	Units
Small Signal Bandwidth	Input below AGC on		210		MHz
Small Signal Low Frequency Cut-off	Input below AGC on		30		kHz
Small Signal Transimpedance	Input below AGC on		40		kΩ
Input Referred Noise (RMS)	155 Mbps application		20		nA
Optical Input Sensitivity	SNR=14,ρ=0.9,er=11		-35		dBm
Overload Input Current			2		mA_{PP}
Differential Output Swing	Input above $5\mu A_{PP}$		300		mV_{PP}
Differential Output Resistance			100		Ω
Photo Current Monitor Offset			0		μA
Photo Current Monitor Ratio	VMON=0 to 1.5V		1		
Photo Current Monitor Ratio Accuracy	Input: 10μA to 2mA	0.95	1	1.05	
	Input: 1μA to 10μA	0.90	1	1.10	
Power Supply Rejection Ratio	DC to 4MHz		25		dB
Note: Typical conditions: T = 25 °C, VCC = 3.3V, C = 0.75 pF, L = 1.0 nH，load resistance=500Ω					

2.0Functional Description

2.1 Overview

MG2300 is a CMOS TIA with wide input dynamic range, high optical sensitivity (typical -35dBm) and high overload tolerance. Automatic gain control (AGC) circuit is implemented in order to achieve such wide dynamic range. In addition to automatically reducing TIA gain, this AGC circuit also helps to maintain integrity of input signal with excellent transimpedance linearity over frequency. A precision current sourcing monitor of average photodiode current is available at the MON pad for PIN photodiodes.

2.2 General Description

MG2300 is a continuous mode transimpedance amplifier. Its main function is to convert input light pulse streams into output voltage pulse streams over various environment conditions (supply voltages, temperature etc) and across 35dB input range. It also has an important feature: to provide an indicator of average optical signal strength in.

MG2300 is constructed with TIA front stage to convert high speed photo current signal into voltage signal, automatic gain control circuit to extend the amplifier's dynamic range, out stage to interface with outside world, and input strength monitor circuit.

2.3 TIA Front Stage

The transimpedance amplifier consists of a high gain single-ended CMOS amplifier (TIA) with a feedback resistor. Advanced CMOS design techniques are employed to maintain the stability of the amplifier across all input conditions. An on-chip low dropout linear regulator has been incorporated into the design to give excellent noise rejection up to several MHz. Higher frequency power supply noise is removed by a decoupling capacitor connected to PDC. The circuit is designed for photodiodes in common cathode configuration, with the anode connected to the input of TIA and the cathode connected to AC ground (PDC terminal). Reverse DC bias is applied to reduce the photodiode capacitance. Avalanche photodiode cathode can be connected externally to a higher voltage.

2.4 AGC

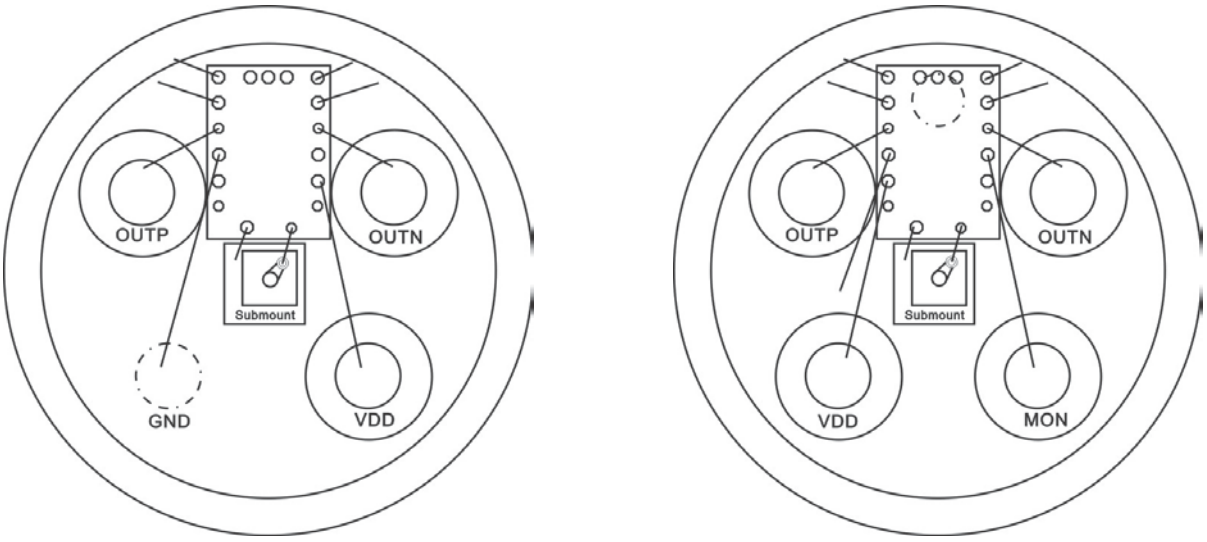
The MG2300 has been designed to operate over the input range of -38dBm to 0dBm. An advanced circuit design technique (AGC) is developed here to extend the amplifier's dynamic range by automatically limiting the transimpedance gain. Another function of AGC is that it drastically improve linearity and reduce distortion of the transimpedance amplifier when input optical signal is greater than approximately –20dBm (@ 0.9 A/W), or 20μA_{PP}.

2.5 Monitor Output Configuration

MON pin in MG2300 sources current to ground accurately representing average photodiode current.

3.0Applications Information

TO-CAN Bonding Diagrams：



(a) 4 pin TO-CAN for PIN without monitor (b) 5 pin TO-CAN for PIN with I-source monitor

Figure 3-1 Typical TO-CAN Bonding Diagram with Photodiode Mounted on PDC

Typical TO-CAN bonding configurations are shown in Figure 3-1(a) and (b) for different applications. The VCC bond wire de-coupling capacitor is optional. If provided, it will help to reduce the bond wire coupling.

TO Assembly

Typical recommended assembly of TIA in optical TO header is shown in Figure 3-2. MG2300 is designed to work with bond wire inductance of ~1nH. Metal Shim is often required to raise TIA so that bonding pads are horizontally in the same level as photo diode which is typically mounted on a ceramic sub-mount for appropriate focal length.

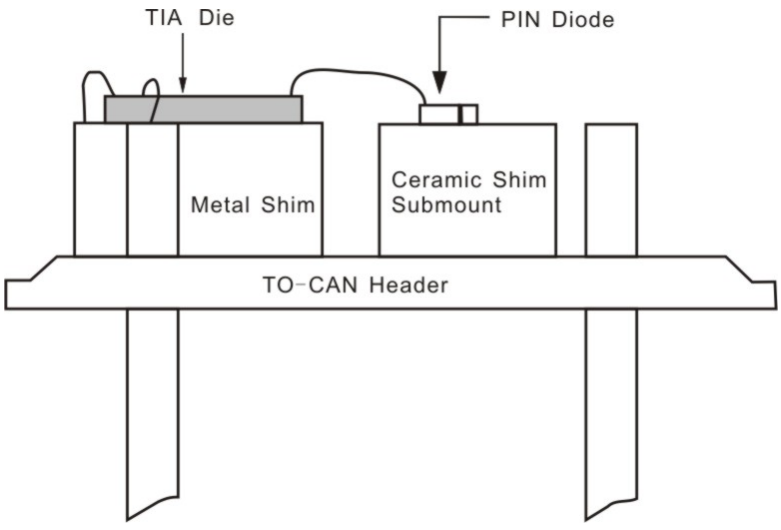


Figure 3-2 Suggested PIN Diode Connection Methods

4.0 Die Specifications

4.1 Pad Descriptions

Die Pad	Name	Function
1	PDC	PIN PD Common input. Connect to photo diode cathode (and optional cap).
2	PDA	Active PIN input. Connect to photo diode anode.
3,7-9,11-13,17	GND	Ground pin. Connect to the most negative supply (at least connect 4 GND).
4,16	VCC	Power pin. Connect to most positive supply (only one VCC pad needs to be connected).
5	MON	Analog current source output. Current matched to average photodiode current.
6	OUTN	Differential data output negative (goes low as light increases).
10	MODE	Monitor PD anode average current when this pad tied to ground; Monitor PD cathode average current when this pad not connected.
14	OUTP	Differential data output (goes high as light increases).
15	NC	Connected to ground for 300Mb/s operation.
NA	Backside	Backside. Connect to the lowest potential, usually ground.

4.2 Pad Coordinates

Pad Number	Pad	X	Y	Pad Number	Pad	X	Y
1	PDC	-430	100	10	MODE	434	0
2	PDA	-430	-100	11	GND	434	150
3	GND	-375	-334	12	GND	434	329
4	VDD	-228	-329	13	GND	228	329
5	IMON	-76	-329	14	OUTP	76	329
6	OUTN	76	-329	15	NC	-76	329
7	GND	228	-329	16	VDD	-228	329
8	GND	434	-329	17	GND	-375	334
9	GND	434	-150				

4.3 Other Notes

Die Thickness：250μm
Die Size：1060 μm x 840 μm
Pad Materials：Aluminum