High Sensitivity Transimpedance Amplifier with Precision Monitor for Fiber Optical Receiver up to 2.5Gb/s

MG2253 is a CMOS TIA with wide input dynamic range, high optical sensitivity，high overload tolerance (0dBm) and low harmonic distortion. When used with APD photo detector, optical sensitivity can be better than -33dBm; with PIN detector, sensitivity of -28dBm can be achieved. Automatic gain control (AGC) circuit is implemented in order to achieve 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 and input range. A current sourcing monitor of average photodiode current is available at MON pad for receiver power monitoring in both PIN and APD application through bonding options.

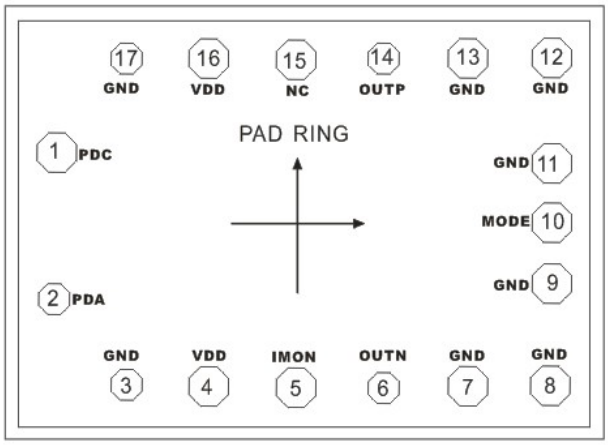
Features

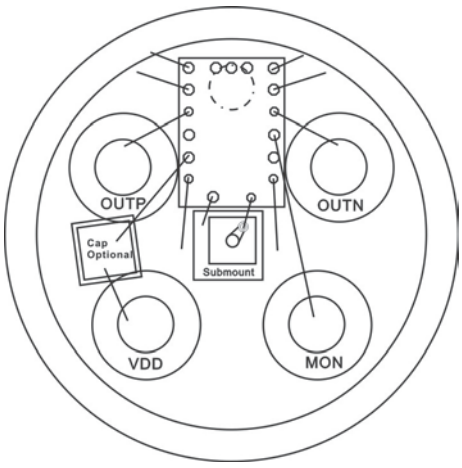
- Data rates up to 2.5Gbps
- Sensitivity typical -33dBm (APD), -28dBm (PIN)
- Input current overload greater than 2mA
- Typical differential transimpedance 10kΩ
- Excellent gain linearity over frequency
- Average input current monitor
- No TO decoupling capacitor required
- Internal or external bias for photodiode
- Low power: current 30mA with 3.3V supply

Applications

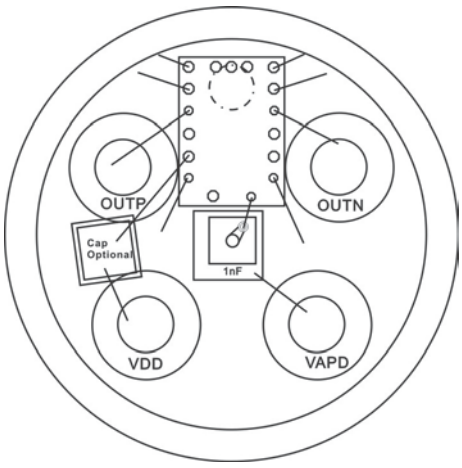
- GPON ONU ROSA/BOSA
- OC-48 Receiver
- SFF/SFP Modules
- ATM/SONET
- 2X Fiber Channel

Pad and Bonding Diagram:





5 pin TO-CAN for PIN with I-source monitor



5 pin TO-CAN for APD without IMON

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	0	4	mA

1.2 Recommended Operating Conditions

Parameter	Min	Max	Units
Power supply (VCC - GND)	2.97	3.63	V
PD capacitance for 2.5Gbps	0.5	0.6	pF
Operating ambient temperature	-40	85	°C

1.3 DC Characteristics

Symbol	Parameter	Min	Typ	Max	Units
VB	Photodiode bias voltage (PDC - PDA)		2.8		V
VCM	Common mode output voltage		2.70		V
ICC	Supply current (no loads)		30	35	mA
RLOAD	Recommended differential output load		100		Ω

1.4 AC Characteristics

Parameter	Conditions	Min	Typical	Max	Units
Small Signal Bandwidth	Input below AGC on		1800		MHz
Small Signal Low Frequency Cut-off	Input below AGC on		12		kHz
Small Signal Transimpedance	Input below AGC on		10		kΩ
Input Referred Noise (RMS)	2.5Gbps application		200		nA
Optical Input Sensitivity（PIN detector）	SNR=14,ρ=0.9,er=11		-28		dBm
Overload Input Current			2		mA
Differential Output Swing	$30\mu A_{PP}$ to $4mA_{PP}$		300		mV_{PP}
Total Harmonic Distortion (THD)	$50\mu A_{PP}$ 100MHz Sine		10		%
Single Side Output Resistance			50		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
Typical Condition: T = 25 °C, VCC = 3.3V, C = 0.5 pF, L = 1.0 nH					

2.0 Functional Description

2.1 Overview

MG2253 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 wide input range. It also has an important feature: to provide an indicator of optical signal strength in term of average optical power value.

MG2253 is a CMOS TIA with wide input dynamic range, high optical sensitivity (typical -28dBm) and high overload tolerance (greater than $2mA_{PP}$). 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 photo-alignment and 'Loss of Signal' detecting for both PIN and APD photodiodes through bonding options.

2.2 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.

2.2 AGC

The MG2253 has been designed to operate over the input range of 0dBm to -28dBm. 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 –15dBm (@ 0.9 A/W), or ~$40\mu A_{PP}$.

2.3 Output Stage

The output stage is designed to drive a differential (100Ω) load. CML type of output stage, i.e. differential pair circuit is used in MG2253 design. It is suitable for driving capacitive loads such as inter-stage filters. Since the MG2253 exhibits rapid roll-off (3 pole), simple external filtering is sufficient.

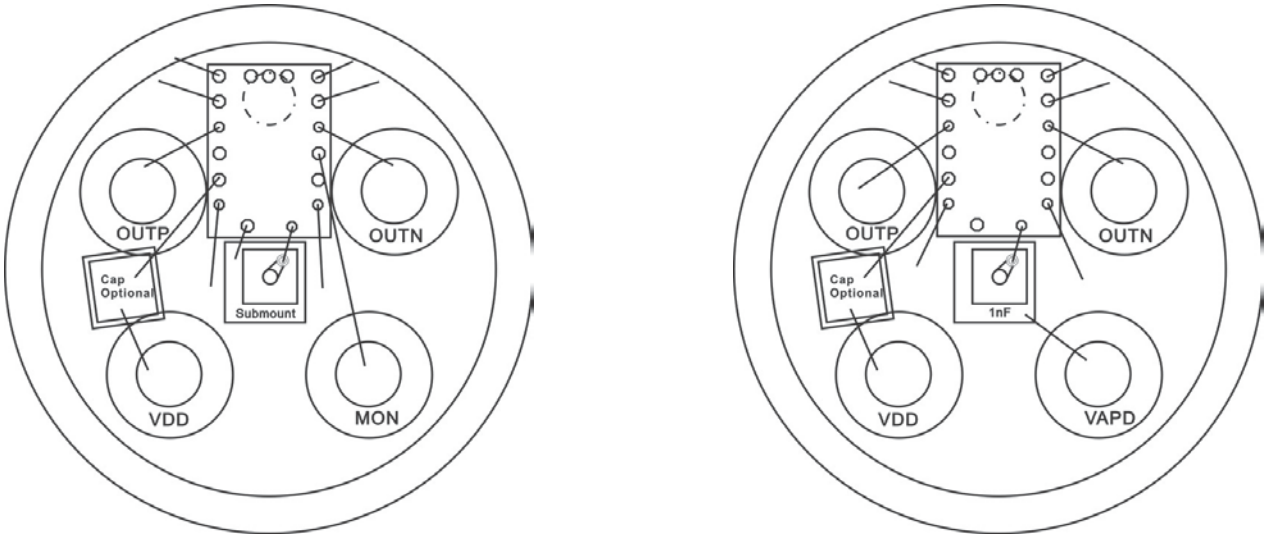
2.4 Monitor Output Configuration

Through different bonding options of pad MODE，MON pin in MG2253 can be configured to source current to ground accurately in two mode compatible with the DDMI Receive Power Specification (SFP-8472).

MODE Pad	MON Output
Floating	average dc current through pad PDC
Tied to GND	average dc current through pad PDA

3.0 Applications Information

3.1 Typical TO-CAN Bonding Diagrams:



(a) 5 pin TO for PIN with I-source monitor (b) 5 pin TO for APD w/o current monitor

Figure 3-1 Typical TO-CAN Bonding Diagram with PIN and APD

Typical TO-CAN bonding configurations are shown in Figure 3-1(a) and (b) for PIN diode and APD diode applications. The VCC bond wire de-coupling capacitor is optional (not shown). If provided, it will help to reduce the bond wire coupling.

3.2 TO Assembly

Typical recommended assembly of TIA in optical TO header is shown in Figure 3-2. The MG2253 is designed to work with bond wire inductance of ~1nH. Metal Shim is often required to raise TIA die 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.

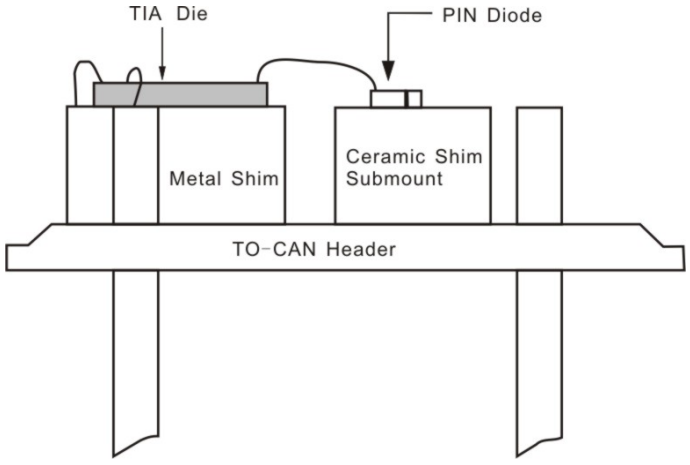


Figure 3-2 Suggested PIN Diode Connection Methods

4.0 Die Specification

4.1 Pad Descriptions

Die Pad	Name	Function
1	**PDC**	Photo diode 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**	Not used for normal 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