MAX3797

10.3Gbps, Low-Power Transimpedance Amplifier for 10GBASE-SR Applications

General Description

The MAX3797 is a low-power transimpedance amplifier designed for optical transmission systems at data rates up to 10.3125Gbps and for use with PIN diodes.

The MAX3797 incorporates an automatic gain control (AGC) architecture providing nominal small-signal transimpedance of 5.5kΩ. The input-referred noise is typically 1.25μA_{RMS}, which reflects a theoretical sensitivity of –14.8dBm OMA at a bit error rate (BER) of 10^{-12} for a PIN (þ = 0.55, r_e = 3) photo detector.

The small die size of 1mm x 0.76mm enables an optical subassembly using a TO-46 or TO-56 package. The MAX3797 supports low-cost ROSAs by offering stable operation with no capacitors required in the ROSA. The MAX3797's sensitivity is stable over temperature and supply.

Benefits and Features

- **Stable Sensitivity Over Supply and Temperature**
- **Up to 10.3125Gbps (NRZ) Operation**
- **Supports No-Capacitor ROSA**
- **AGC Gain of 5.5kΩ**
- **Single 3.3V Power Supply**
- **105mW Power Consumption**
- **Wide Bandwidth Current Monitor Enables RSSI-Based LOS Implementation**
- **Die Size 1mm x 0.76mm**

Applications

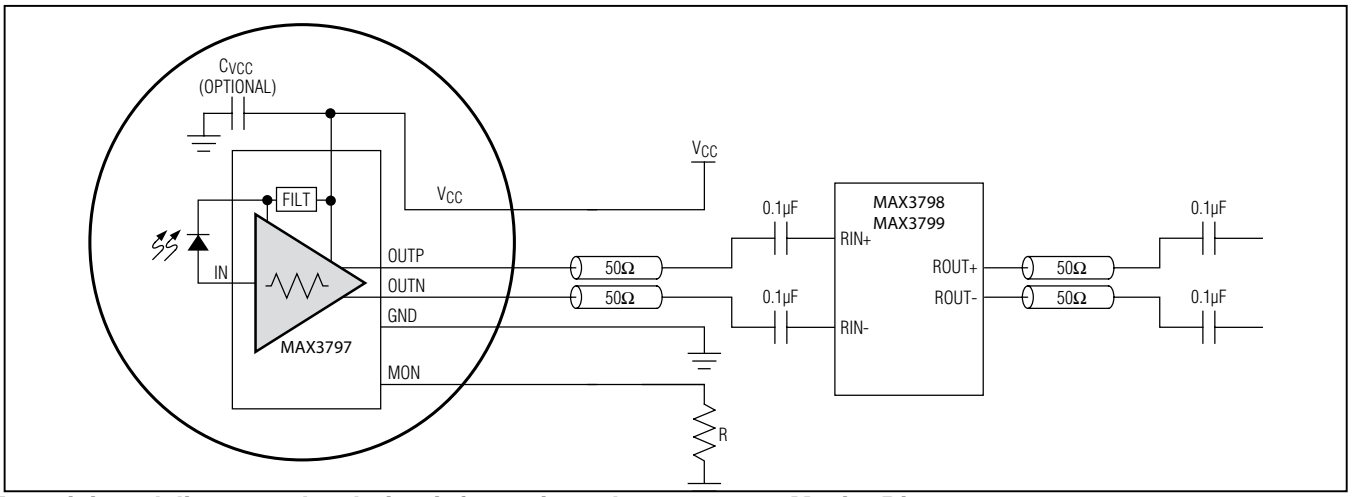
10.3125Gbps Ethernet Optical Receivers (10GBASE-SR)

8.25Gbps Fibre Channel Optical Receivers (8xFC)

***Ordering Information* appears at end of data sheet.**

For related parts and recommended products to use with this part, refer to www.maximintegrated.com/MAX3797.related.

Typical Application Circuit



For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim Integrated's website at www.maximintegrated.com.

19-6613; Rev 0; 2/13

ABSOLUTE MAXIMUM RATINGS

Power-Supply Voltage (V_{CC}).....-0.3V to +4.0V
Continuous Current into IN..... -5mA to +5mA
Continuous Current Out of FILT ..... -8mA to +8mA
Continuous Current in MON..... -5mA to +5mA
Continuous CML Output Current
into OUTP, OUTN..... -25mA to +25mA
Voltage at FILT, OUTP, OUTN, MON..... -0.3V to (V_{CC} + 0.3V)
Operating Junction Temperature Range (T_J).... -55°C to +150°C
Storage Temperature Range (T_{STG})..... -55°C to +150°C
Die Attach Temperature.....+400°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

OPERATING CONDITIONS

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage		2.97	3.3	3.63	V
Backside Die Temperature		-40	+25	+100	°C
Data Rate			10.3125		Gbps
Wire Bond Inductance at Pad IN			0.3	0.5	nH
Photo Diode Junction Capacitance			0.2		pF
Compliance Voltage at MON		1.8			V

ELECTRICAL CHARACTERISTICS

(V_{CC} = 2.97V to 3.63V. T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = 3.3V, 100Ω differential output load between OUTP and OUTN, and T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
POWER SUPPLY						
Power-Supply Current	I_{CC}	(Note 1)		32	45	mA
Power-Supply Noise Rejection	PSNR	$f \le 10MHz$, $20log(\Delta V_{OUT}/\Delta V_{CC})$		-19		dB
INPUT SPECIFICATION						
Input Bias Voltage	V_{IN}	(Note 1)		1.0	1.1	V
Resistor at FILT pad	R_{FILT}	(Note 1)	160	200	240	Ω
Input-Referred Noise	I_n	Unfiltered output (Notes 1, 2)		1.25	1.85	μA_{RMS}
TRANSFER SPECIFICATION						
Differential Transimpedance		$I_{IN} \le 20\mu A_{P-P}$ (Note 1)	4.3	5.5	6.7	kΩ
Optical Small-Signal Bandwidth	f_{3dB}	Using Cosemi 10G pin diode LPD3010		7.7		GHz
Low-Frequency Cutoff	f_{c3dB}	$I_{IN} \le 40\mu A_{P-P}$		12.5		kHz

ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = 2.97V to 3.63V. T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = 3.3V, 100Ω differential output load between OUTP and OUTN, and T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
OUTPUT SPECIFICATION						
Deterministic Jitter	DJ	10.3125Gbps with PRBS31-1, $I_{IN} \le 1.0mA_{P-P}$ (Note 3)		6.0		ps_{P-P}
Maximum Differential Output Voltage	$V_{OUT(MAX)P-P}$	$I_{IN} > 100\mu A_{P-P}$		300		mV_{P-P}
PHOTOCURRENT MONITOR (RSSI)						
Maximum Photocurrent Output Offset	$I_{MONoffset}$	No input current (Note 1)		7.5	13.5	µA
Photocurrent Monitor Gain	I_{MON}/I_{AVG}	$10\mu A \le I_{AVG} \le 1.4mA$ $0V \le V_{RSSI} \le 1.8V$ (Note 1)	0.486	0.5	0.513	A/A
Photocurrent Monitor Gain Stability	$\lvert\Delta I_{MON}/I_{AVG}\rvert$	$10\mu A \le I_{AVG} \le 1.4mA$ $0V \le V_{RSSI} \le 1.8V$ (Notes 1, 4)		0.42	0.73	%

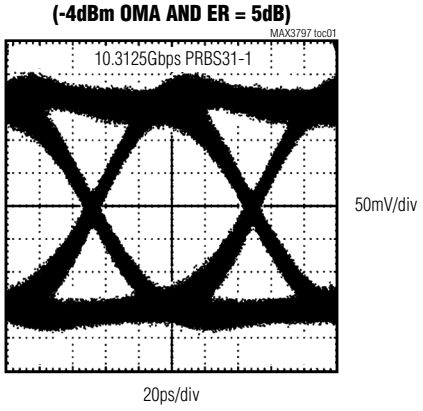
Note 1: Guaranteed by design and characterization.
Note 2: Measured using an RF-power meter with no optical signal applied to the ROSA.
Note 3: The deterministic jitter caused by the optical source is not included in the DJ specification.
Note 4: Gain stability is defined [(Gain_measured) - (Gain_reference)]/(Gain_reference) over the listed current range, temperature, and supply variation. Reference gain is an average of gain values over specified temperature and supply variation.

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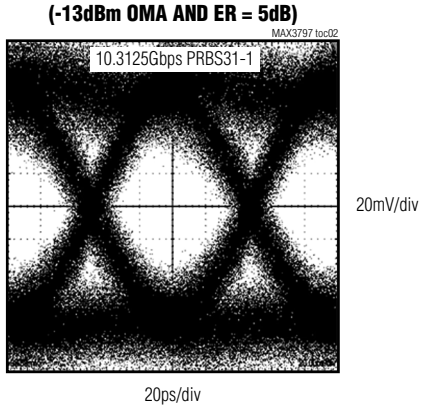
Typical Operating Characteristics

(V_{CC} = 3.3V, T_A = +25°C, 850nm ROSA with SPD3010 with responsivity of 0.5A/W, unless otherwise noted.)

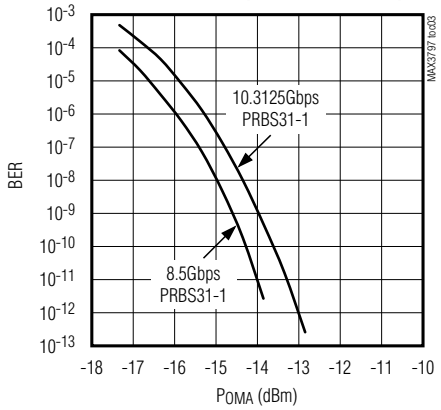
OPTICAL EYE DIAGRAM (-4dBm OMA AND ER = 5dB)



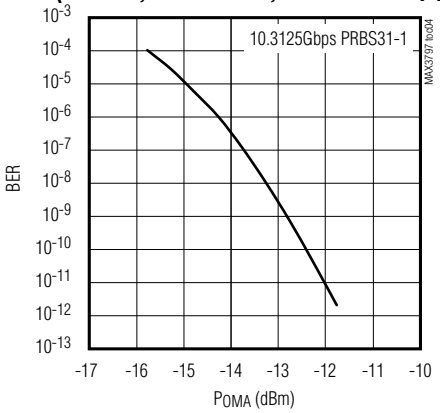
OPTICAL EYE DIAGRAM (-13dBm OMA AND ER = 5dB)



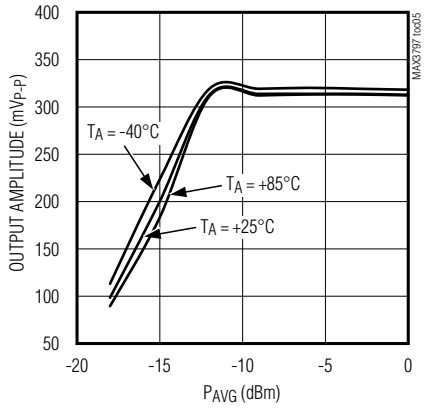
UNSTRESSED OPTICAL BER CURVES vs. DATA RATE (850nm; ER = 5dB)



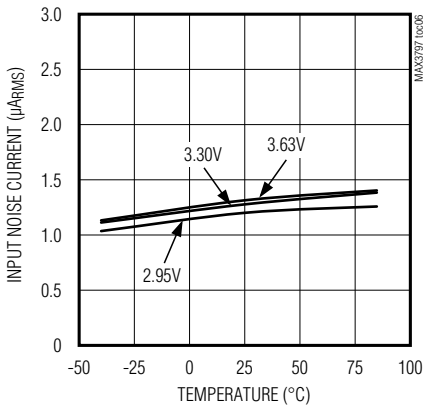
850nm STRESSED OPTICAL BER CURVE (ER = 3dB; VECP = 3.4dB; JITTER = 0.32UIP-P)



DIFFERENTIAL OUTPUT AMPLITUDE vs. INPUT OPTICAL POWER (ER = 11dB)



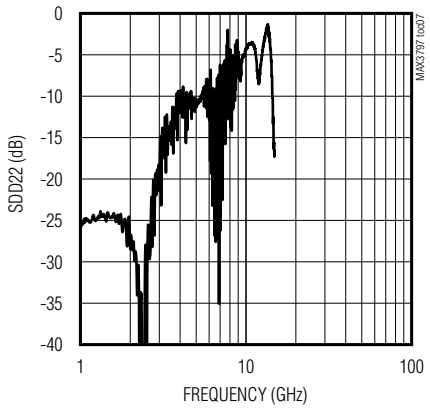
INPUT-REFERRED NOISE CURRENT vs. TEMPERATURE



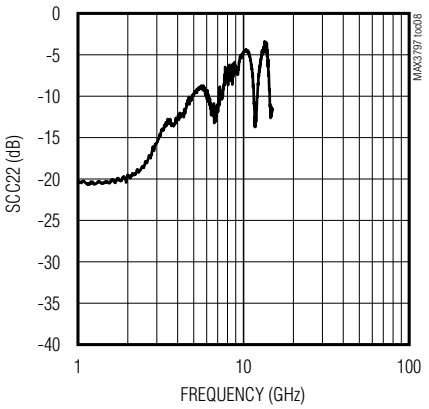
Typical Operating Characteristics (continued)

(V_{CC} = 3.3V, T_A = +25°C, 850nm ROSA with SPD3010 with responsivity of 0.5A/W, unless otherwise noted.)

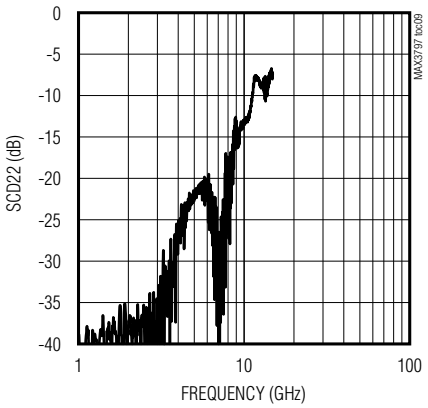
OUTPUT RETURN GAIN (SDD22) (INCLUDES ROSA WITH FLEX PCB)



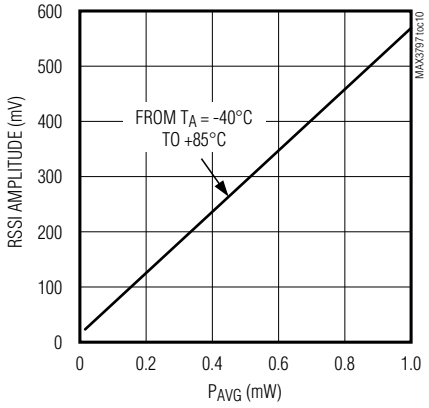
OUTPUT COMMON-MODE RETURN GAIN (SCC22) (INCLUDES ROSA WITH FLEX PCB)



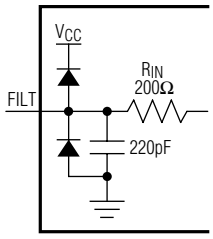
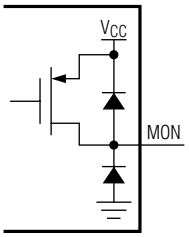
OUTPUT COMMON-MODE TO DIFFERENTIAL-MODE CONVERSION (SCD22) (INCLUDES ROSA WITH FLEX PCB)



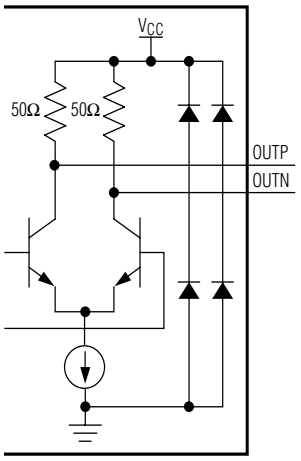
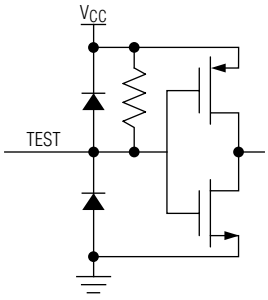
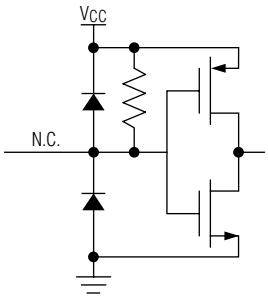
RSSI VOLTAGE vs. INPUT OPTICAL POWER (ER = 11dB)



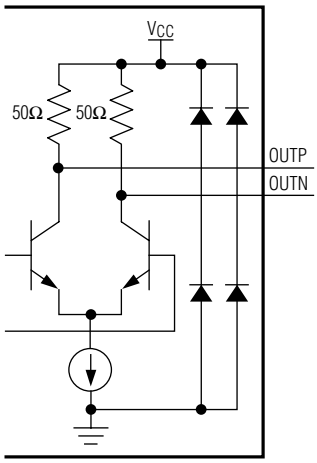
Pad Description

PAD	NAME	FUNCTION	EQUIVALENT CIRCUIT
1, 3	FILT	Provides filtered PIN bias voltage.	
2	IN	TIA Input. Signal current from the photo diode flows into this pad.	—
4	MON	Monitor Output. Analog current output proportional to the average photo diode current. Connect resistor between MON and GND to develop a GND referenced monitor voltage. **IMPORTANT**: For proper operation of the TIA signal path, it is imperative to choose the value of the external resistor according to the maximum MON compliance voltage of 1.8V. If the RSSI function is not required then MON must be tied to GND.	
5, 7, 11, 13	GND	Ground. TIA ground connection.	—

Pad Description (continued)

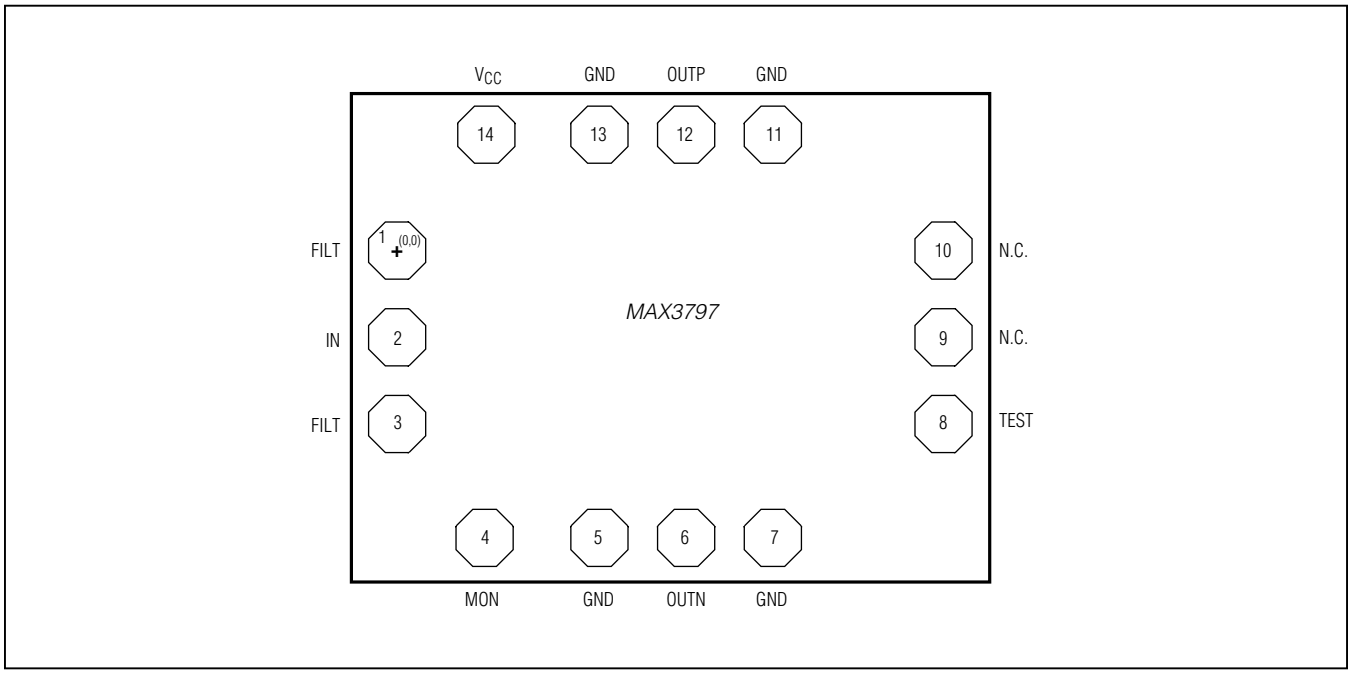
PAD	NAME	FUNCTION	EQUIVALENT CIRCUIT
6	OUTN	Negative CML Output. Current flowing into IN causes OUTN to decrease.	
8	TEST	TEST mode input. Connect through bond wire to GND for proper operation.	
9, 10	N.C.	No Connection. Leave open for proper operation	

Pad Description (continued)

PAD	NAME	FUNCTION	EQUIVALENT CIRCUIT
12	OUTP	Positive CML Output. Current flowing into IN causes OUTP to increase.	
14	V_{CC}	Supply Voltage	—

10.3Gbps, Low-Power Transimpedance Amplifier for 10GBASE-SR Applications

Chip Topography



Detailed Description

The MAX3797 is a low-power transimpedance amplifier designed for optical transmission systems at data rates up to 10.3Gbps.

The functional diagram of the MAX3797 is shown in Figure 1. The MAX3797 comprises of a transimpedance amplifier stage with automatic gain control (AGC), a DC offset correction loop, photo diode filtering with current monitor and an output buffer. The MAX3797 is designed to work with PIN photo diodes and does not require a bypass capacitor.

Transimpedance Amplifier Stage with Automatic Gain Control (AGC)

The signal current from the photodiode flows into the input node of a linear gain amplifier stage in the MAX3797 design. A low input impedance circuit converts the single-ended input current to a differential output voltage. At input currents above $100\mu A_{P-P}$ the gain of this linear amplifier is controlled by an AGC that adjusts the gain through a feedback loop.

Table 1. Pad Coordinates

PAD NUMBER	PAD NAME	X [um]	Y[um]
1	FILT	0	0
2	IN	0	-125.0
3	FILT	0	-250.0
4	MON	125.2	-390.5
5	GND	300.2	-390.5
6	OUTN	425.2	-390.5
7	GND	550.2	-390.5
8	TEST	778.0	-250.0
9	N.C.	778.0	-125.0
10	N.C.	778.0	0
11	GND	550.2	147.5
12	OUTP	425.2	147.5
13	GND	300.2	147.5
14	VCC	125.2	147.5

10.3Gbps, Low-Power Transimpedance Amplifier for 10GBASE-SR Applications

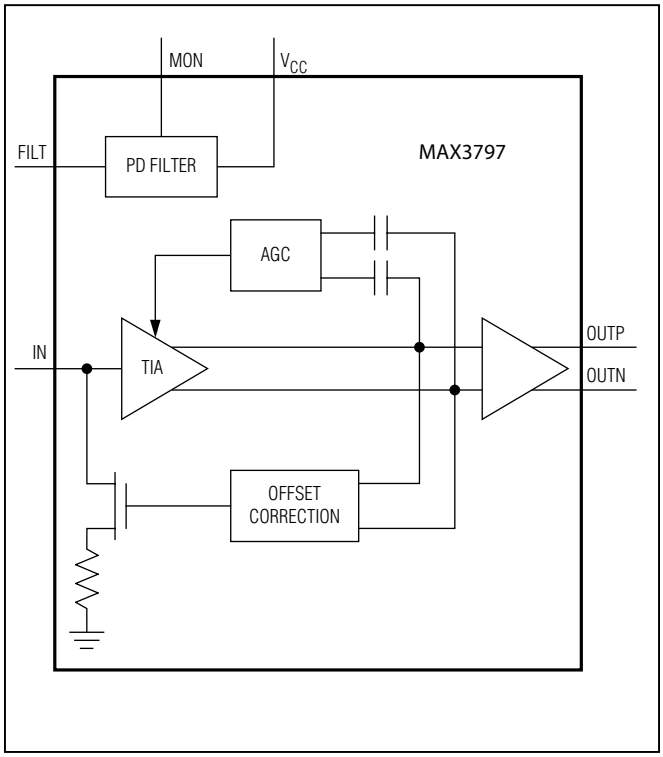


Figure 1. MAX3797 Functional Diagram

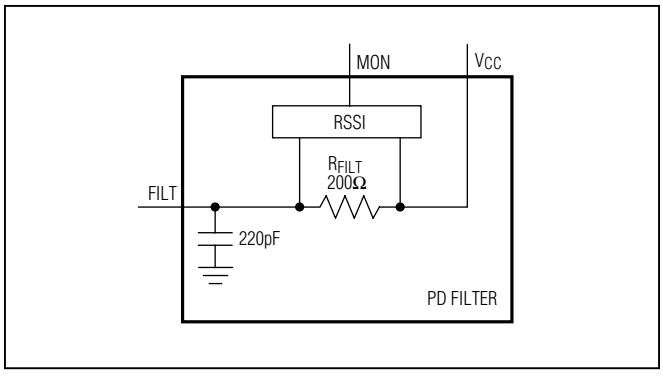


Figure 2. Photodiode BIAS Filtering with Current Monitor

DC Offset Correction Loop

The DC offset correction loop uses a low-frequency feedback circuit to remove the DC component of the input signal. This feature centers the input signal within the TIA's linear range, thereby reducing pulse-width distortion caused by large input signals. The DC cancellation circuit is internally compensated and therefore does not require external capacitors.

Photodiode Filtering with Current Monitor

Photodiode bias filtering in the MAX3797 is accomplished by an RC supply filter to V_{CC}. The filter circuitry also contains a Receive Signal Strength Indicator (RSSI) that monitors the average photodiode current by sensing the voltage across the filter resistor RFILT. The filter circuitry is shown in Figure 2.

Output Buffer

The output buffer consists of a differential stage with 50Ω single-ended termination to V_{CC}. For optimum supply-noise rejection, the MAX3797 should be AC-coupled to a matched load.

Applications Information

Layout Considerations

Noise performance and bandwidth are adversely affected by the capacitance at the IN pad. Minimize capacitance on this pad and select a low-capacitance PIN. The OUTP and OUTN bond wire lengths should also be minimized to meet the bandwidth specification. Special care should be taken when bonding the input pad IN to avoid ESD events. It is recommended to follow ROSA assembly instructions as depicted in Figure 3.

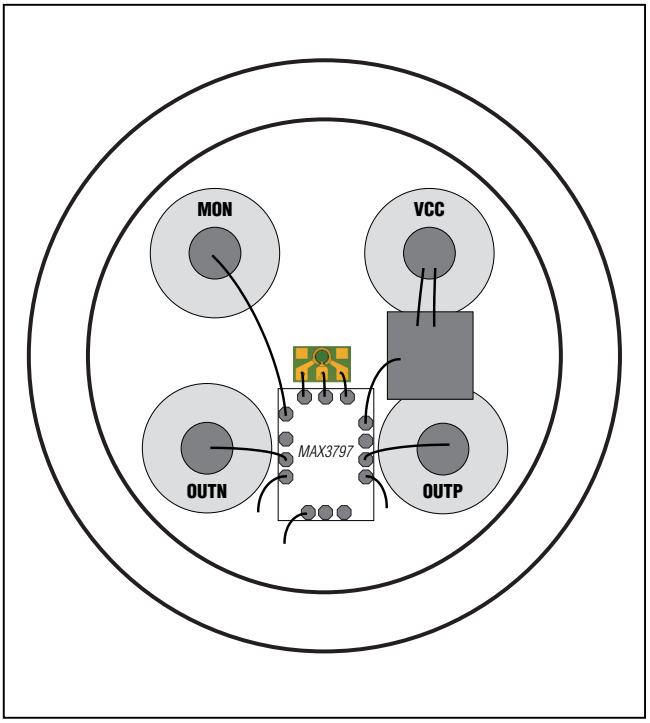


Figure 3. Typical Layout for TO-46 Header

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Chip Information

PROCESS: SiGe Bipolar

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX3797E/D+	-40°C to +100°C	Dice*

**Dice are tested and guaranteed only at +25°C, backside temperature.*

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Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	2/13	Initial release	—

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