



# 155Mbps Low-Noise Transimpedance Amplifier

MAX3657

## General Description

The MAX3657 is a transimpedance preamplifier for receivers operating up to 155Mbps. The low noise, high gain, and low-power dissipation make it ideal for Class-B and Class-C passive optical networks (PONs).

The circuit features 14nA input-referred noise, 130MHz bandwidth, and 2mA input overload. Low jitter is achieved without external compensation capacitors. Operating from a +3.3V supply, the MAX3657 consumes only 76mW power. An integrated filter resistor provides positive bias for the photodiode. These features, combined with a small die size, allow easy assembly into a TO-46 header with a photodiode. The MAX3657 includes an average photocurrent monitor.

The MAX3657 has a typical optical sensitivity of -38dBm (0.9A/W), which exceeds the Class-C PON requirements. Typical overload is 0dBm. The MAX3657 is available in die form with both output polarities (MAX3657E/D and MAX3657BE/D.) The MAX3657 is also available in a 12-pin, 3mm x 3mm thin QFN package.

## Applications

Optical Receivers (Up to 155Mbps Operation)  
 Passive Optical Networks (PONs)  
 SFP/SFF Transceivers  
 BiDi Transceivers

## Features

- ◆ 14nA<sub>RMS</sub> Input-Referred Noise
- ◆ 54kΩ Transimpedance Gain
- ◆ 130MHz (typ) Bandwidth
- ◆ 2mA<sub>p-p</sub> Input Current—0dBm Overload Capability
- ◆ 76mW (typ) Power Dissipation
- ◆ 3.3V Single-Supply Operation
- ◆ Average Photocurrent Monitor

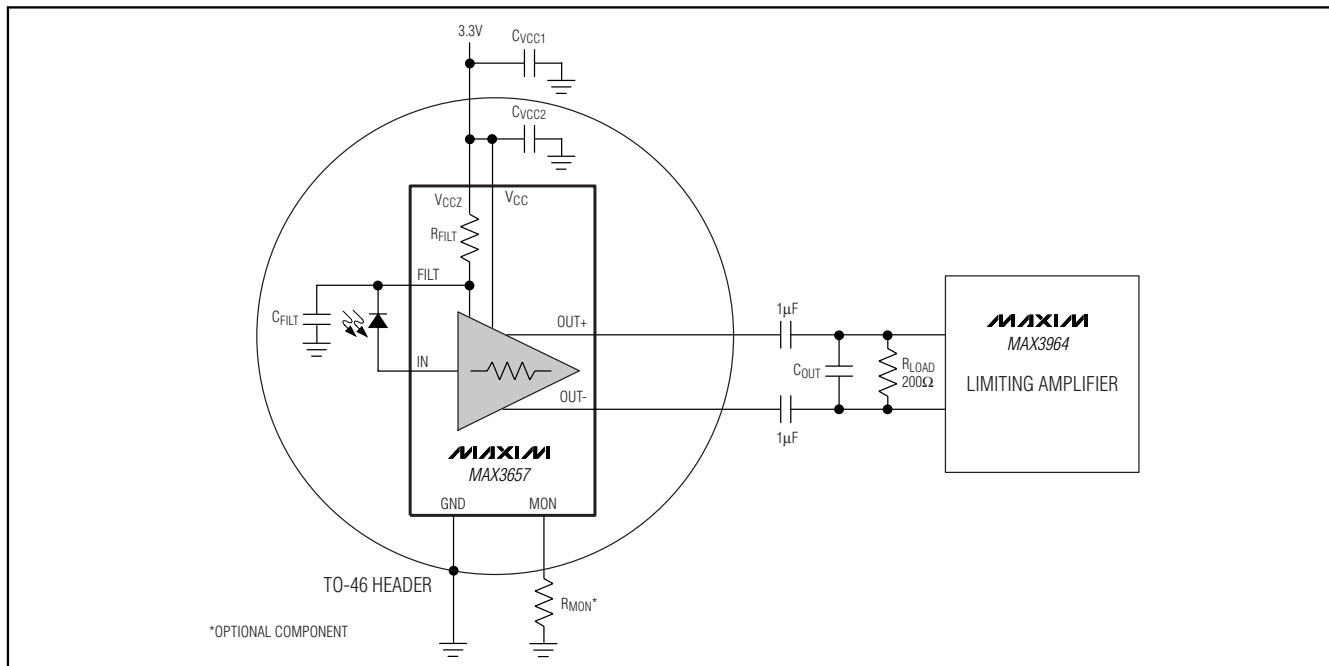
## Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX3657ETC	-40°C to +85°C	12 Thin QFN
MAX3657E/D	-40°C to +85°C	Die*
MAX3657BE/D	-40°C to +85°C	Die*

\*Dice are designed to operate over a -40°C to +110°C junction temperature ( $T_J$ ) range, but are tested and guaranteed at  $T_A = +25^\circ\text{C}$ .

Pin Configuration appears at end of data sheet.

## Typical Application Circuit



# 155Mbps Low-Noise Transimpedance Amplifier

## ABSOLUTE MAXIMUM RATINGS

Power-Supply Voltage	-0.5V to +6.0V	Operating Temperature Range	
Input Continuous Current	±3.5mA	12-Pin TQFN	-40°C to +85°C
Voltage at OUT+, OUT-	(V <sub>CC</sub> - 1.5V) to (V <sub>CC</sub> + 0.5V)	Operating Junction Temperature Range	
Voltage at FILT, MON	-0.5V to (V <sub>CC</sub> + 0.5V)	Die	-40°C to +150°C
Continuous Power Dissipation		Storage Temperature Range	-55°C to +150°C
12-Pin TQFN (derate 14.7mW/°C above +70°C)	1176mW	Lead Temperature (soldering, 10s)	+300°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.

## DC ELECTRICAL CHARACTERISTICS

(V<sub>CC1</sub> = +2.97V to +3.63V, 200Ω load between OUT+ and OUT-, T<sub>A</sub> = -40°C to +85°C. Typical values are at V<sub>CC</sub> = +3.3V, T<sub>A</sub> = +25°C, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Current	I <sub>CC</sub>			23	34	mA
Input Bias Voltage	V <sub>IN</sub>	I <sub>IN</sub> ≤ 1mA		1	1.3	V
Transimpedance Linear Range		0.95 < linearity < 1.05, referred to gain at 1μA <sub>P-P</sub> input	2			μA <sub>P-P</sub>
Small-Signal Transimpedance	Z <sub>21</sub>	Differential output, I <sub>IN</sub> < 200nA <sub>P-P</sub>	44	54	65	kΩ
Output Common-Mode Voltage		AC-coupled outputs		V <sub>CC</sub> - 0.225		V
Output Resistance (Per Side)	R <sub>OUT</sub>	Single-ended output resistance	82	100	118	Ω
Maximum Differential Output Voltage	V <sub>OUT(max)</sub>	I <sub>IN</sub> = 2mA <sub>P-P</sub> , V <sub>OUT</sub> = (V <sub>OUT+</sub> ) - (V <sub>OUT-</sub> )	170	250	450	mV <sub>P-P</sub>
Filter Resistor	R <sub>FILT</sub>		640	800	960	Ω
DC Input Overload			1	1.5		mA
Monitor Nominal Gain	G <sub>NOM</sub>	V <sub>CC</sub> = +3.3V, +25°C (Note 2)	0.8	1	1.2	A/A
Monitor Gain Stability (Note 3)	ΔG	I <sub>IN</sub> = 100μA to 1mA	-1.5		+1.5	dB
		I <sub>IN</sub> = 5μA	Die	-1.5	+2.2	
			TQFN package	-3.0	+2.7	
		I <sub>IN</sub> = 2μA	Die only	-4.0	+3.4	
I <sub>IN</sub> = 1μA	Die only		±2.0			

## AC ELECTRICAL CHARACTERISTICS

(V<sub>CC</sub> = +2.97V to +3.63V, 200Ω load between OUT+ and OUT-, C<sub>IN</sub> = 0.5pF, C<sub>FILT</sub> = 400pF, C<sub>VCC2</sub> = 680pF, T<sub>A</sub> = -40°C to +85°C. Typical values are at V<sub>CC</sub> = +3.3V, T<sub>A</sub> = +25°C, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small-Signal Bandwidth	BW <sub>-3dB</sub>	Relative to gain at 1MHz	110			MHz
Low-Frequency Cutoff		-3dB, I <sub>IN</sub> = 1μA		5	25	kHz
AC Overload			2			mA <sub>P-P</sub>
Pulse-Width Distortion	PWD	300nA <sub>P-P</sub> ≤ I <sub>IN</sub> ≤ 2mA <sub>P-P</sub>		22		psp <sub>P-P</sub>
Input-Referred Noise Current	I <sub>n</sub>	f = 100MHz (Note 4)			15	nA <sub>RMS</sub>
		f = 117MHz		14		
RMS Noise Density		f = 100MHz		1.3		pA/√Hz
Monitor Bandwidth		I <sub>IN</sub> = 1μA		5		kHz

# 155Mbps Low-Noise Transimpedance Amplifier

MAX3657

## AC ELECTRICAL CHARACTERISTICS (12-PIN TQFN)

( $V_{CC} = +2.97V$  to  $+3.63V$ ,  $R_{LOAD} = 200\Omega$ ,  $C_{IN} = 1.0pF$ ,  $C_{FILT} = 1000pF$ ,  $C_{VCC2} = 0.01\mu F$ ,  $T_A = -40^\circ C$  to  $+85^\circ C$ . Typical values are at  $V_{CC} = +3.3V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small-Signal Bandwidth	BW-3dB	Relative to gain at 1MHz		95		MHz
Low-Frequency Cutoff		-3dB, $I_{IN} = 1\mu A$		5	25	kHz
AC Overload		$\epsilon_r \geq 10$	1.6			mA
Pulse-Width Distortion	PWD	$1\mu A_{P-P} \leq I_{IN} \leq 2m A_{P-P}$		22		psp-p
Input-Referred Noise Current	$I_n$	f = 50MHz (Note 4)		5		nARMS
		f = 100MHz		13		
RMS Noise Density		f = 100MHz		1.3		pA/ $\sqrt{Hz}$

**Note 1:** Die parameters are production tested at room temperature only, but are guaranteed by design from  $T_A = -40^\circ C$  to  $+85^\circ C$ . AC characteristics guaranteed by design and characterization.

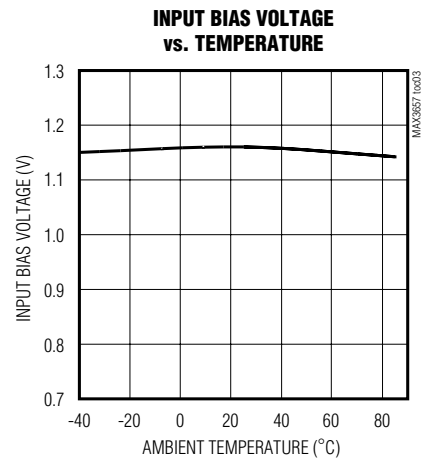
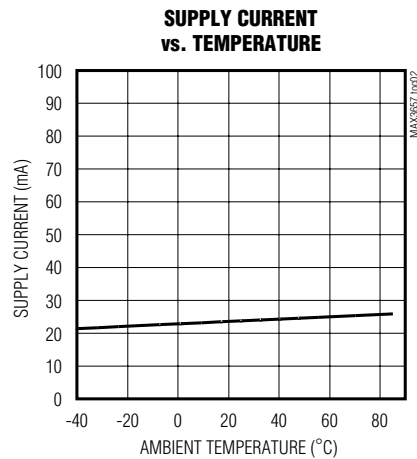
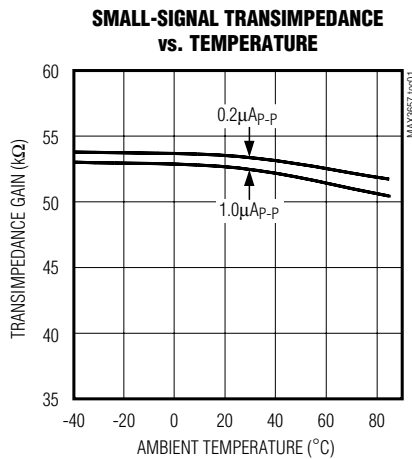
**Note 2:**  $G_{NOM} = I_{MON} (1mA) / 1mA$ .

**Note 3:** Stability is relative to the nominal gain at  $V_{CC} = +3.3V$ ,  $T_A = +25^\circ C$ .  $\Delta G(I_{IN}) \text{ dB} = 10 \log_{10} [ I_{MON}(I_{IN}) ] / [ I_{MON}(1mA) - G_{NOM} \times (1mA - I_{IN}) ]$ ,  $V_{MON} \leq 2.1V$ , Input  $t_r, t_f > 550ps$  (20% to 80%).

**Note 4:** Total noise integrated from 0 to f.

## Typical Operating Characteristics

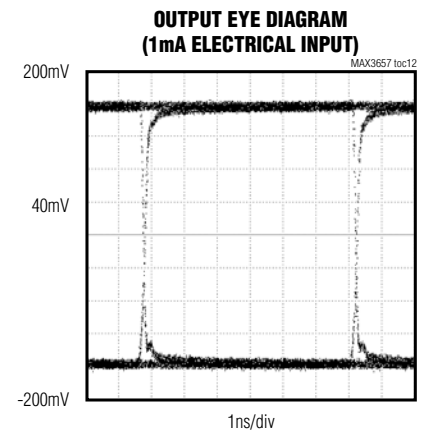
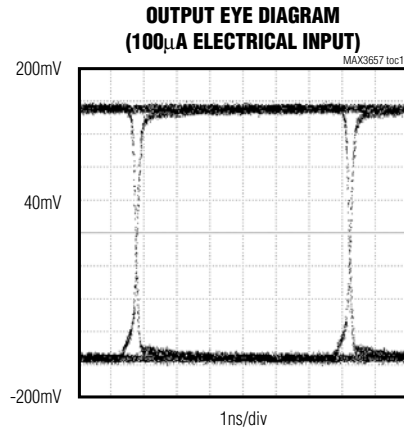
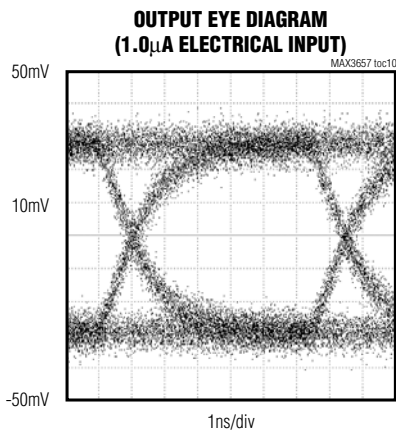
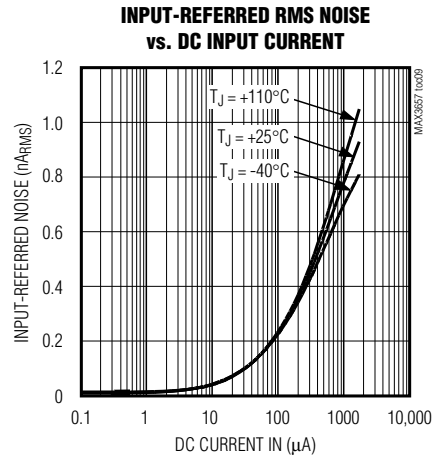
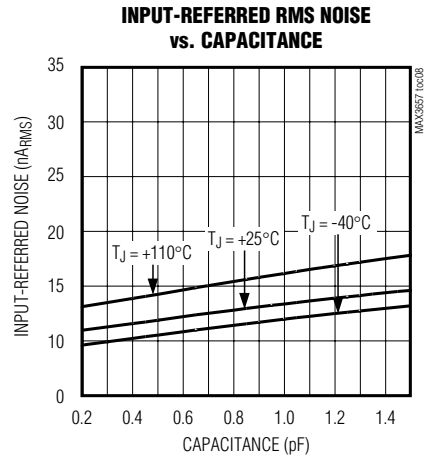
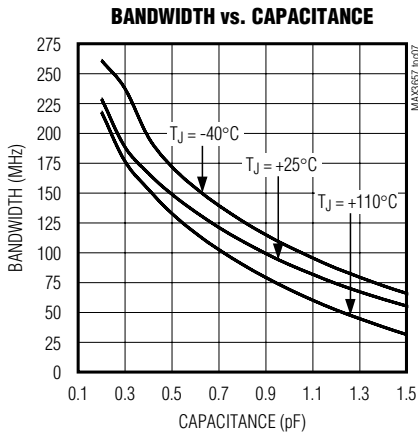
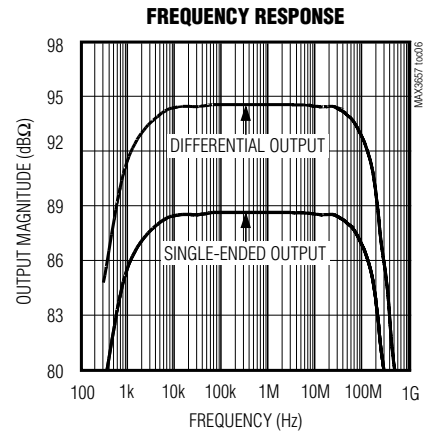
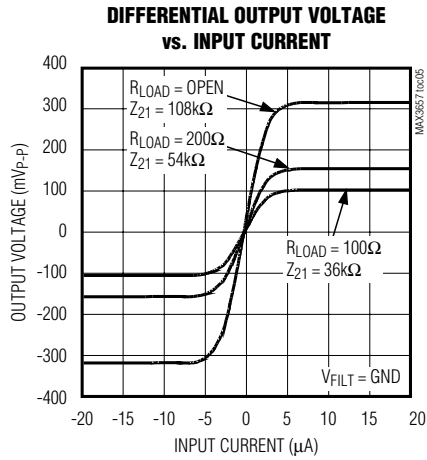
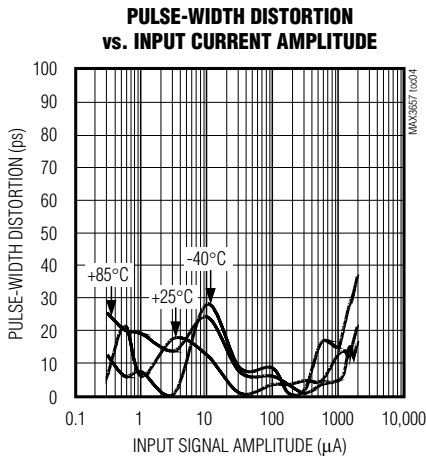
(MAX3657E/D.  $V_{CC} = 3.3V$ ,  $C_{IN} = 0.5pF$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



# 155Mbps Low-Noise Transimpedance Amplifier

## Typical Operating Characteristics (continued)

(MAX3657E/D.  $V_{CC} = 3.3V$ ,  $C_{IN} = 0.5pF$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

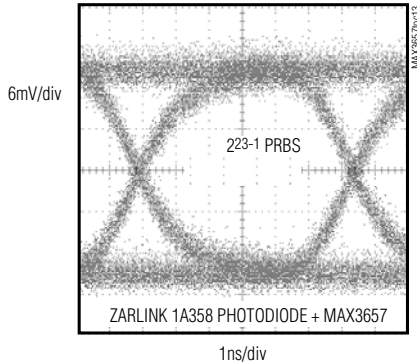


# 155Mbps Low-Noise Transimpedance Amplifier

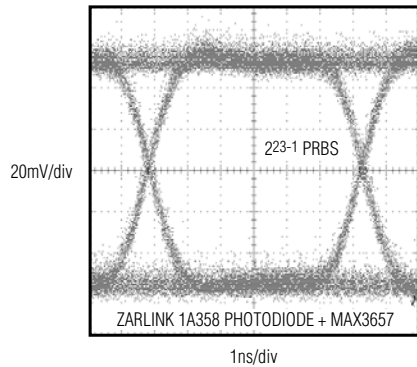
## Typical Operating Characteristics (continued)

(MAX3657E/D.  $V_{CC} = 3.3V$ ,  $C_{IN} = 0.5pF$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

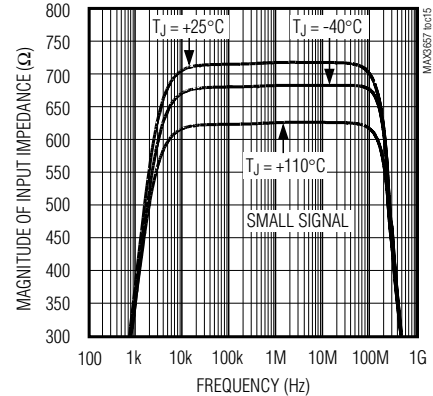
**OUTPUT EYE DIAGRAM  
(-30dBm OPTICAL INPUT)**



**OUTPUT EYE DIAGRAM  
(-1dBm OPTICAL INPUT)**



**INPUT IMPEDANCE vs. FREQUENCY**



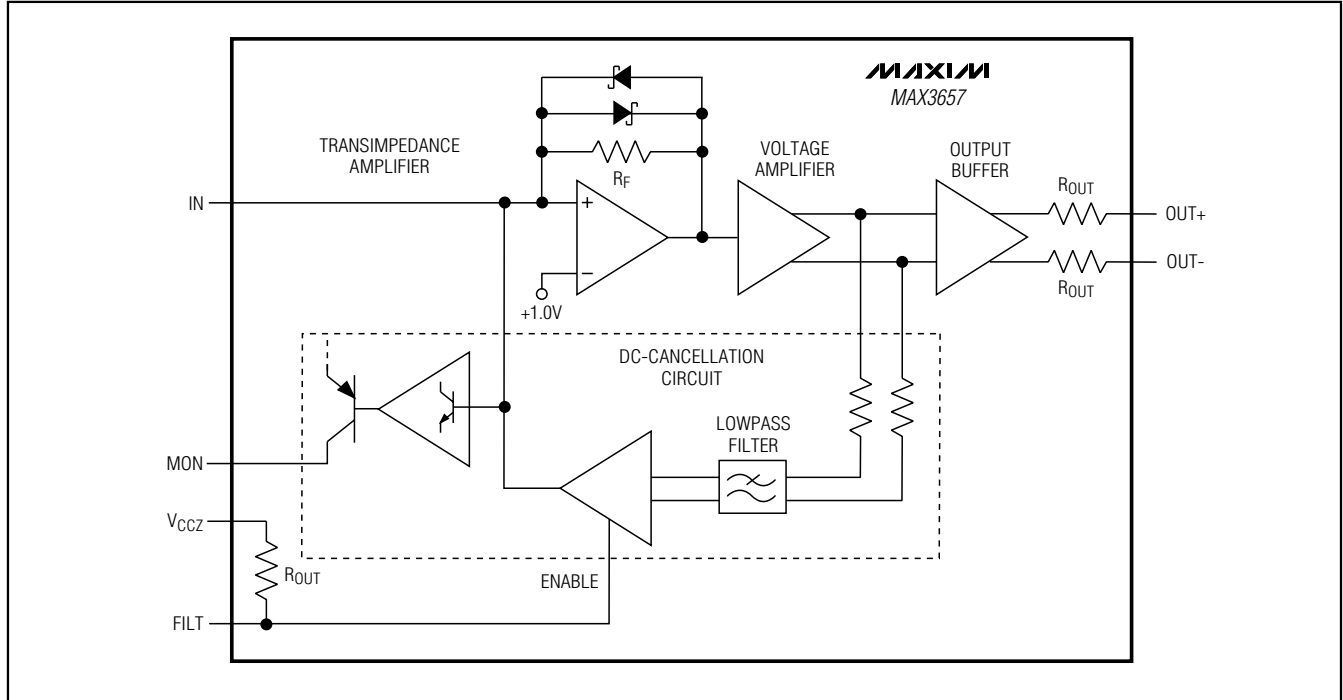
## Pin Description

PIN	NAME	FUNCTION
1, 9, 11	N.C.	No Connection. Do not connect.
2	GND	Negative Supply Voltage. Both GND and GNDZ must be connected to ground.
3	GNDZ	Negative Supply Voltage. Both GND and GNDZ must be connected to ground.
4	MON	Photocurrent Monitor. This is a current output. Connect a resistor between MON and ground to monitor the average photocurrent.
5	IN	Signal Input. Connect to photodiode anode.
6	FILT	Filter Connection (Optional). Use to bias the photodiode cathode. An internal $800\Omega$ on-chip resistor is connected between this pin and $V_{CCZ}$ ; an external decoupling capacitor connected to this pin forms a filter (see the <i>Design Procedure</i> section).
7	$V_{CCZ}$	Power-Supply Voltage. Both $V_{CC}$ and $V_{CCZ}$ must be connected to the supply.
8	$V_{CC}$	Power-Supply Voltage. Both $V_{CC}$ and $V_{CCZ}$ must be connected to the supply.
10	OUT+	Positive Data Output. This output has $100\Omega$ back termination, increasing input current causes OUT+ to increase.
12	OUT-	Negative Data Output. This output has $100\Omega$ back termination, increasing input current causes OUT- to decrease.

MAX3657

# 155Mbps Low-Noise Transimpedance Amplifier

## Functional Diagram



### Detailed Description

The MAX3657 transimpedance amplifier is designed for 155Mbps fiber-optic applications. The functional diagram of the MAX3657 comprises a transimpedance amplifier, a voltage amplifier, a DC-cancellation circuit, and a CML output buffer.

#### Transimpedance Amplifier

The signal current at the input flows into the summing node of a high-gain amplifier. Shunt feedback through resistor  $R_F$  converts this current into a voltage. Schottky diodes clamp the output signal for large input currents (Figure 1).

#### Voltage Amplifier

The voltage amplifier provides additional gain and converts the transimpedance amplifier single-ended output signal into a differential signal.

#### Output Buffer

The output buffer provides a reverse-terminated voltage output and is designed to drive a 200 $\Omega$  differential load between OUT+ and OUT-. For optimum supply-noise rejection, the MAX3657 should be terminated with a differential load. The MAX3657 single-ended outputs

do not drive a DC-coupled grounded load. The outputs should be AC-coupled or terminated to  $V_{CC}$ . If a single-ended output is required, both the used and the unused outputs should be terminated in a similar manner.

#### DC-Cancellation Circuit

The DC-cancellation circuit uses low-frequency feedback to remove the DC component of the input signal (Figure 2). This feature centers the input signal within the transimpedance amplifier's linear range, thereby reducing pulse-width distortion.

The DC-cancellation circuit is internally compensated and does not require external capacitors. This circuit minimizes pulse-width distortion for data sequences that exhibit a 50% mark density. A mark density significantly different from 50% causes the MAX3657 to generate pulse-width distortion. Grounding the FILT pin disables the DC-cancellation circuit. For normal operation, the DC-cancellation circuit must be enabled.

The DC-cancellation current is drawn from the input and creates noise. For low-level signals with little or no DC component, the added noise is insignificant. However, amplifier noise increases for signals with significant DC component (see the *Typical Operating Characteristics*).

# 155Mbps Low-Noise Transimpedance Amplifier

MAX3657

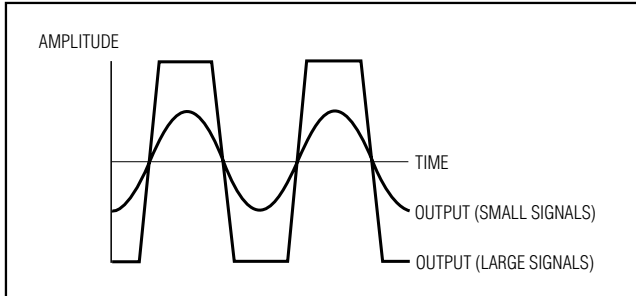


Figure 1. MAX3657 Limited Outputs

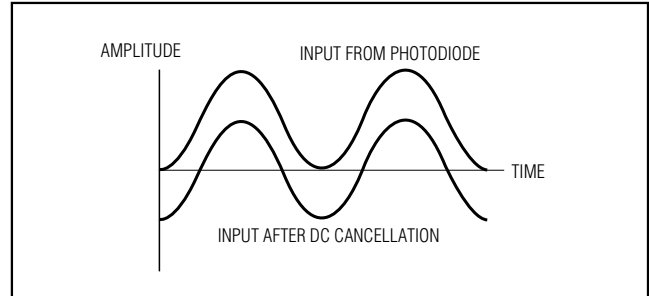


Figure 2. Effects of DC Cancellation on Input

## Photocurrent Monitor

The MAX3657 includes an average photocurrent monitor. The current at MON is approximately equal to the DC current at IN. Best monitor accuracy is obtained when data input edge time is longer than 500ps.

## Design Procedure

### Select Photodiode

Noise performance and bandwidth are adversely affected by stray capacitance on the TIA input node. Select a low-capacitance photodiode to minimize the total input capacitance on this pin. The MAX3657 is optimized for 0.5pF of capacitance on the input. Assembling the MAX3657 in die form using chip and wire technology provides the lowest capacitance input and the best possible performance.

### Select CFILT

Supply voltage noise at the cathode of the photodiode produces a current  $I = C_{PD} \Delta V/\Delta t$ , which reduces the receiver sensitivity ( $C_{PD}$  is the photodiode capacitance). The filter resistor of the MAX3657, combined with an external capacitor, can be used to reduce the noise (see the *Typical Application Circuit*). Current generated by supply-noise voltage is divided between  $C_{FILT}$  and  $C_{PD}$ . To obtain a good optical sensitivity, select  $C_{FILT} > 400pF$ .

### Select Supply Filter

The MAX3657 requires wideband power-supply decoupling. Power-supply bypassing should provide low impedance between  $V_{CC}$  and ground for frequencies between 10kHz and 200MHz. Use LC filtering at the main supply terminal and decoupling capacitors as close to the die as possible.

## Select R<sub>MON</sub>

Connect a resistor between MON and ground to monitor the average photocurrent. Select  $R_{MON}$  as large as possible:

$$R_{MON} = \frac{2.1V}{I_{MONMAX}}$$

where  $I_{MONMAX}$  is the largest average input current observed.

## Select Coupling Capacitors

A receiver built with the MAX3657 has a bandpass frequency response. The low-frequency cutoff due to the coupling capacitors and load resistors is:

$$LFC_{TERM} = \frac{1}{2\pi \times R_{LOAD} \times C_{COUPLE}}$$

Select  $C_{COUPLE}$  so the low-frequency cutoff due to the load resistors and coupling capacitors is much lower than the low-frequency cutoff of the MAX3657. The coupling capacitor should be 0.1 $\mu F$  or larger, but 1.0 $\mu F$  is recommended for lowest jitter. Refer to Maxim Application Note HFAN-01.1: *Choosing AC-Coupling Capacitors* for more information.

## Layout Considerations

Figure 3 shows a suggested layout for a TO header for the MAX3657.

## Wire Bonding

For high-current density and reliable operation, the MAX3657 uses gold metalization. For best results, use gold-wire ball-bonding techniques. Use caution if attempting wedge bonding. Die size is 41 mils x 48 mils, (1040 $\mu m$  x 1220 $\mu m$ ) and die thickness is 15 mils (380 $\mu m$ ). The bond pad is 94.4 $\mu m$  x 94.4 $\mu m$  and its metal thickness is 1.2 $\mu m$ . Refer to Maxim Application Note HFAN- 08.0.1:

# 155Mbps Low-Noise Transimpedance Amplifier

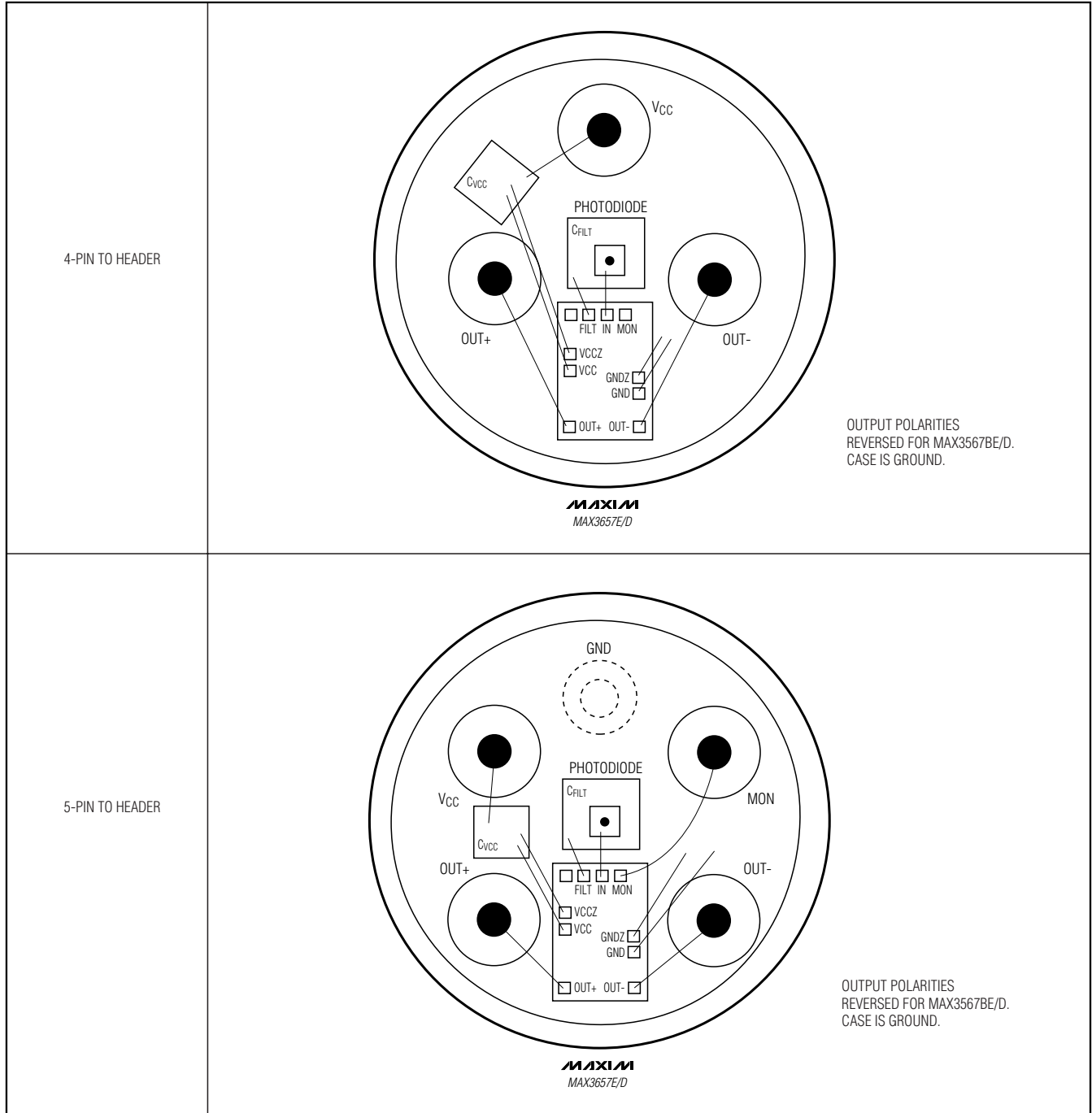


Figure 3. Suggested TO Header Layout



# 155Mbps Low-Noise Transimpedance Amplifier

MAX3657

Understanding Bonding Coordinates and Physical Die Size for more information on bond-pad coordinates.

## Applications Information

### Optical Power Relations

Many of the MAX3657 specifications relate to the input-signal amplitude. When working with optical receivers, the input is sometimes expressed in terms of average optical power and extinction ratio. Figure 4 and Table 1 show relations that are helpful for converting optical power to input signal when designing with the MAX3657.

### Optical Sensitivity Calculation

The input-referred RMS noise current ( $i_n$ ) of the MAX3657 generally determines the receiver sensitivity. To obtain a system bit-error rate (BER) of 1E-10, the signal-to-noise ratio must always exceed 12.7. The input sensitivity, expressed in average power, can be estimated as:

$$\text{Sensitivity} = 10\log\left(\frac{12.7 \times i_n \times (r_e + 1)}{2 \times \rho \times (r_e - 1)} \times 1000\right) \text{ dBm}$$

where  $\rho$  is the photodiode responsivity in A/W and  $i_n$  is the RMS noise current in amps. For example, with photodiode responsivity of 0.9A/W, an extinction ratio of 10 and 15nA input-referred noise, the sensitivity of the MAX3657 is:

$$\text{Sensitivity} = 10\log\left(\frac{12.7 \times 15\text{nA} \times 11}{2 \times 0.9\text{A/W} \times 9} \times 1000\right) \text{ dBm} = -38\text{dBm}$$

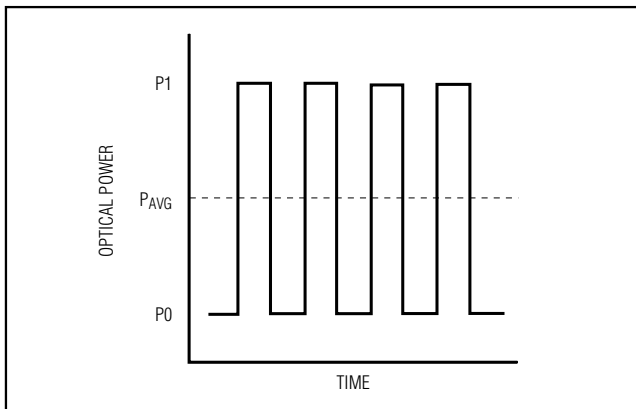


Figure 4. Optical Power Relations

Table 1. Optical Power Relations\*

PARAMETER	SYMBOL	RELATION
Average power	$P_{AVG}$	$P_{AVG} = (P_0 + P_1)/2$
Extinction ratio	$r_e$	$r_e = P_1/P_0$
Optical power of a 1	$P_1$	$P_1 = 2P_{AVG} \frac{r_e}{r_e + 1}$
Optical power of a 0	$P_0$	$P_0 = 2P_{AVG}/(r_e + 1)$
Optical modulation amplitude	$P_{IN}$	$P_{IN} = P_1 - P_0 = 2P_{AVG} \frac{r_e}{r_e + 1}$

\*Assuming a 50% average mark density.

Actual results may vary depending on supply noise, output filter, limiting amplifier sensitivity, and other factors (refer to Maxim Application Note HFAN-03.0.0: *Accurately Estimating Optical Receiver Sensitivity*).

### Input Optical Overload

Overload is the largest input the MAX3657 accepts while meeting the pulse-width distortion specification. Optical overload can be estimated in terms of average power with the following equation:

$$\text{Overload} = 10\log\left(\frac{2\text{mA}}{2 \times \rho} \times 1000\right) \text{ dBm}$$

For example, if photodiode responsivity is 1.0A/W, the input overload is 0dBm.

### Optical Linear Range

The MAX3657 has high gain, which limits the output for large input signals. The MAX3657 operates in a linear range for inputs not exceeding:

$$\text{Linear Range} = 10\log\left(\frac{2\mu\text{A} (r_e + 1)}{2 \times \rho (r_e - 1)} \times 1000\right) \text{ dBm}$$

For example, with photodiode responsivity of 0.9A/W and an extinction ratio of 10 the linear range is:

$$\text{Linear Range} = 10\log\left(\frac{2\mu\text{A} \times 11}{2 \times 0.9 \times 9} \times 1000\right) \text{ dBm} = -28\text{dBm}$$

# 155Mbps Low-Noise Transimpedance Amplifier

## Interface Schematics

### Equivalent Output Interface

The MAX3657 has a differential CML output structure with  $100\Omega$  back termination ( $200\Omega$  differentially). Figure 5 is a simplified diagram of the output interface. The output current is divided between the internal  $100\Omega$  resistor and the external load resistance. Because of the CML structure, the maximum output-signal amplitude is affected by load impedance. Note that the internal back termination is  $100\Omega$  single ended and external termination is recommended to interface the device to  $50\Omega$  test equipment. For example, if single-ended operation in a  $50\Omega$  system is required, first match the output

of the MAX3657 to the  $50\Omega$  controlled impedance by placing a  $100\Omega$  pullup resistor in parallel with the output. Then establish similar loading conditions on the unused output. Note that the loading conditions affect the overall gain of the MAX3657. Figures 6a, 6b, and 6c show alternate interface schemes for the MAX3657.

### Pad Coordinates

Table 2 lists center-pad coordinates for the MAX3657 bond pads. Refer to Maxim Application Note HFAN-08.0.1: *Understanding Bonding Coordinates and Physical Die Size* for more information on bond-pad coordinates.

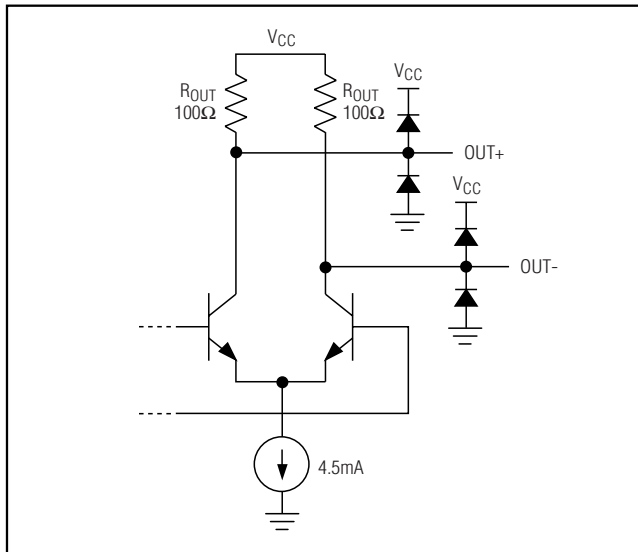


Figure 5. Equivalent Output Interface

Table 2. Bond-Pad Information

PAD	NAME		COORDINATES ( $\mu\text{m}$ )	
	MAX3657	MAX3657B	X	Y
BP1	OUT-	OUT+	47.2	994.8
BP2	GND	GND	52.2	484.6
BP3	GNDZ	GNDZ	52.2	357.7
BP4	MON	MON	395.5	47.2
BP5	IN	IN	522.3	47.2
BP6	FILT	FILT	648.5	47.2
BP7	N.C.	N.C.	808.5	49.9
BP8	VCCZ	VCCZ	808.5	176.8
BP9	VCC	VCC	808.5	303.7
BP10	OUT+	OUT-	808.5	994.8
BP11	N.C.	N.C.	741.1	859.9

# 155Mbps Low-Noise Transimpedance Amplifier

MAX3657

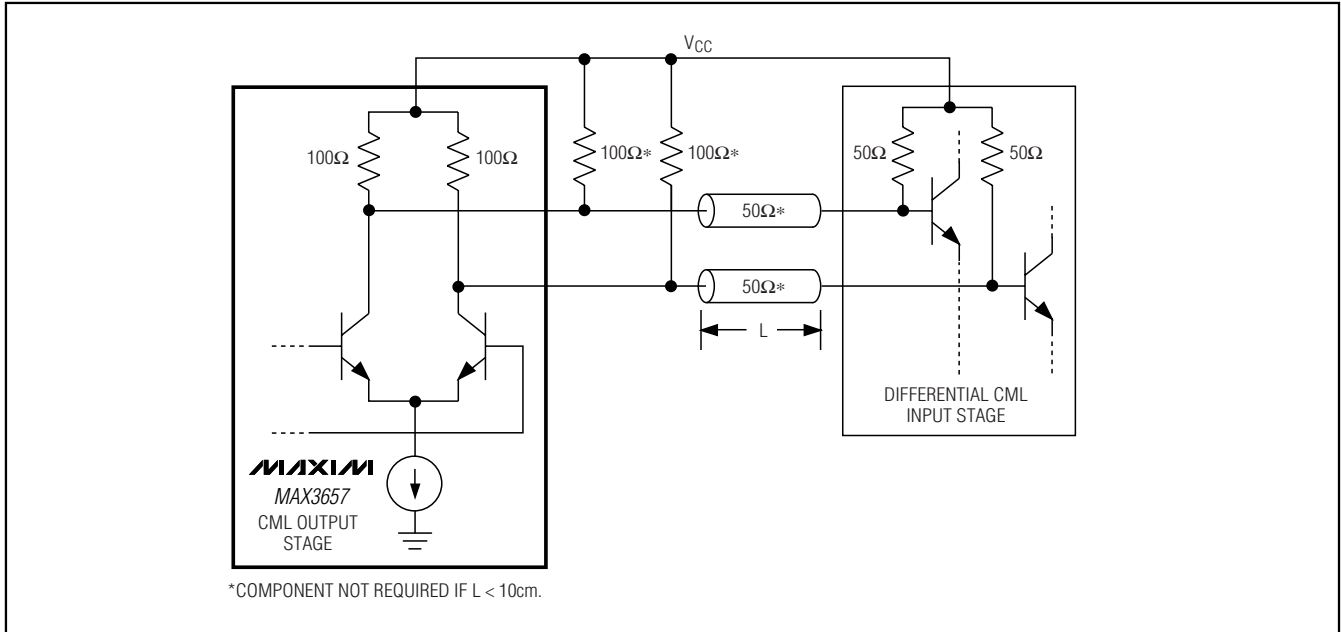


Figure 6a. 50Ω DC-Coupled Interface

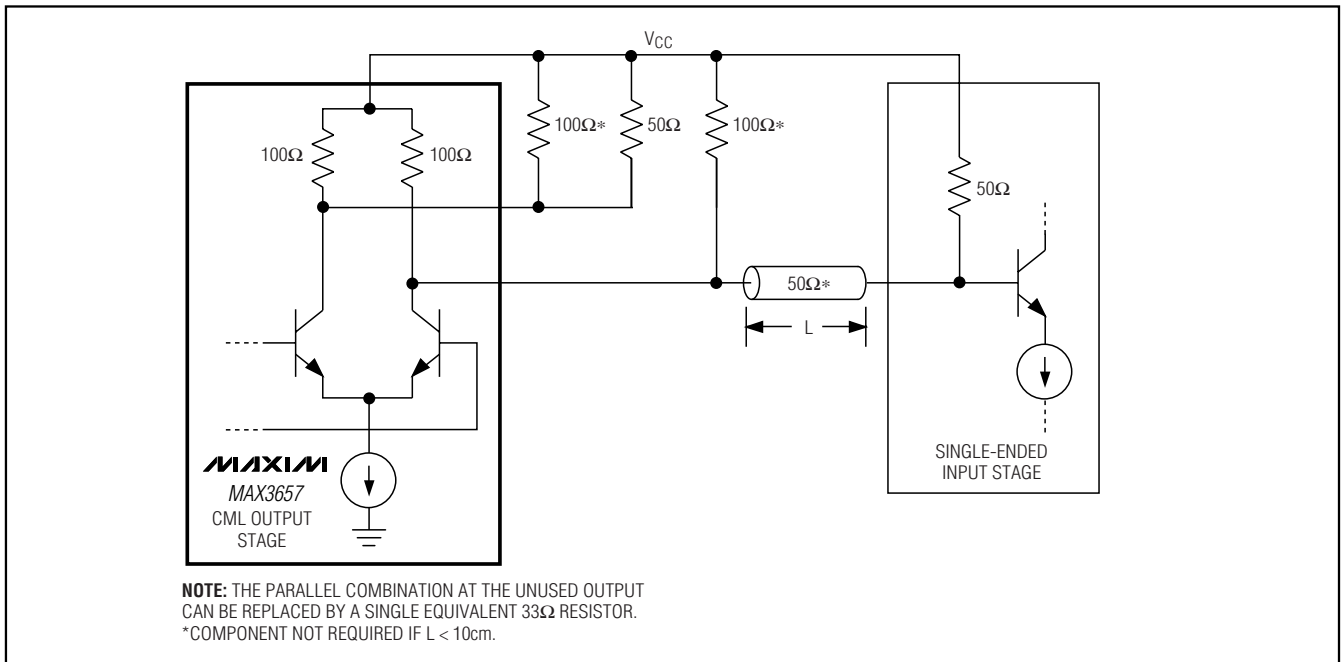


Figure 6b. 50Ω DC-Coupled Single-Ended Output Interface

# 155Mbps Low-Noise Transimpedance Amplifier

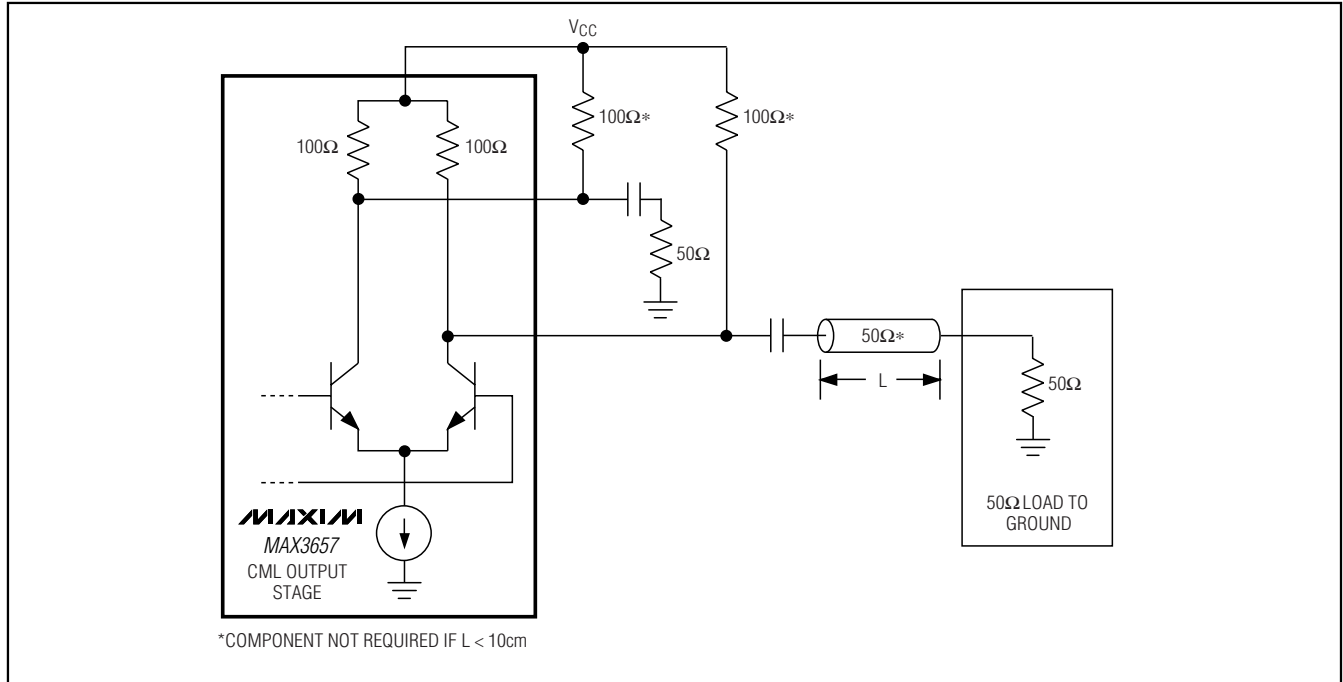


Figure 6c. 50Ω AC-Coupled Single-Ended Output Interface

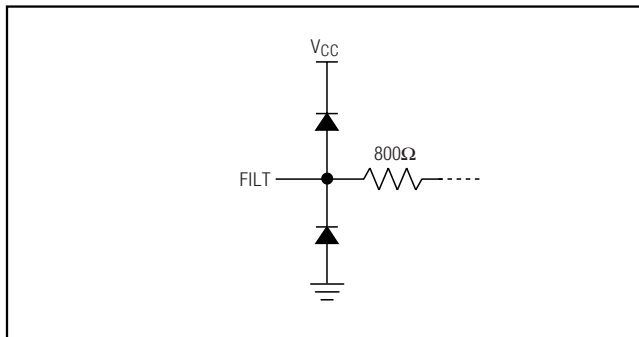


Figure 7. FILT Interface

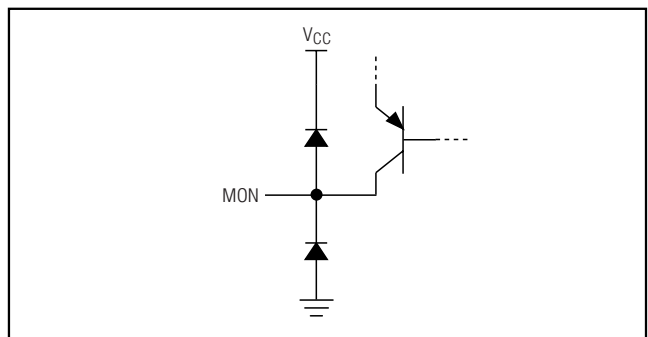


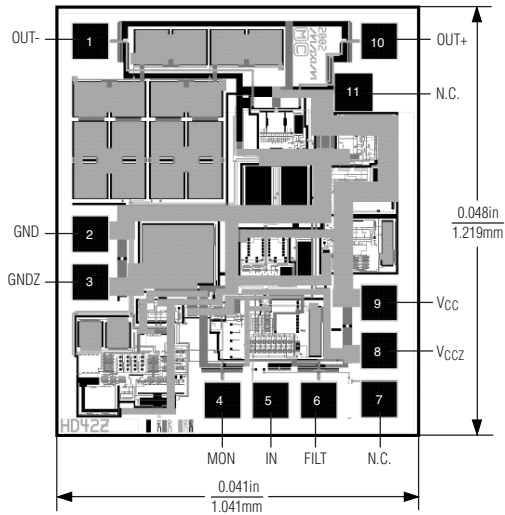
Figure 8. MON Interface

# 155Mbps Low-Noise Transimpedance Amplifier

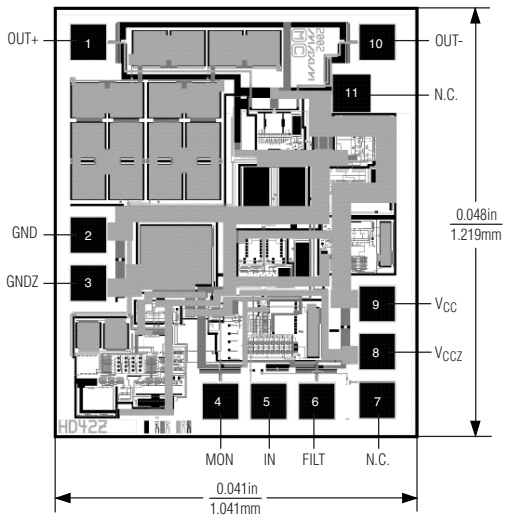
**MAX3657**

## Chip Topographies

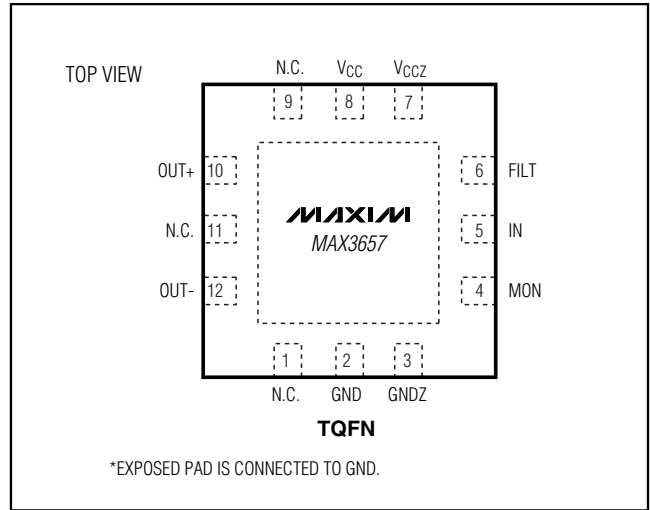
**Topography for MAX3657**



**Topography for MAX3657B**



## Pin Configuration



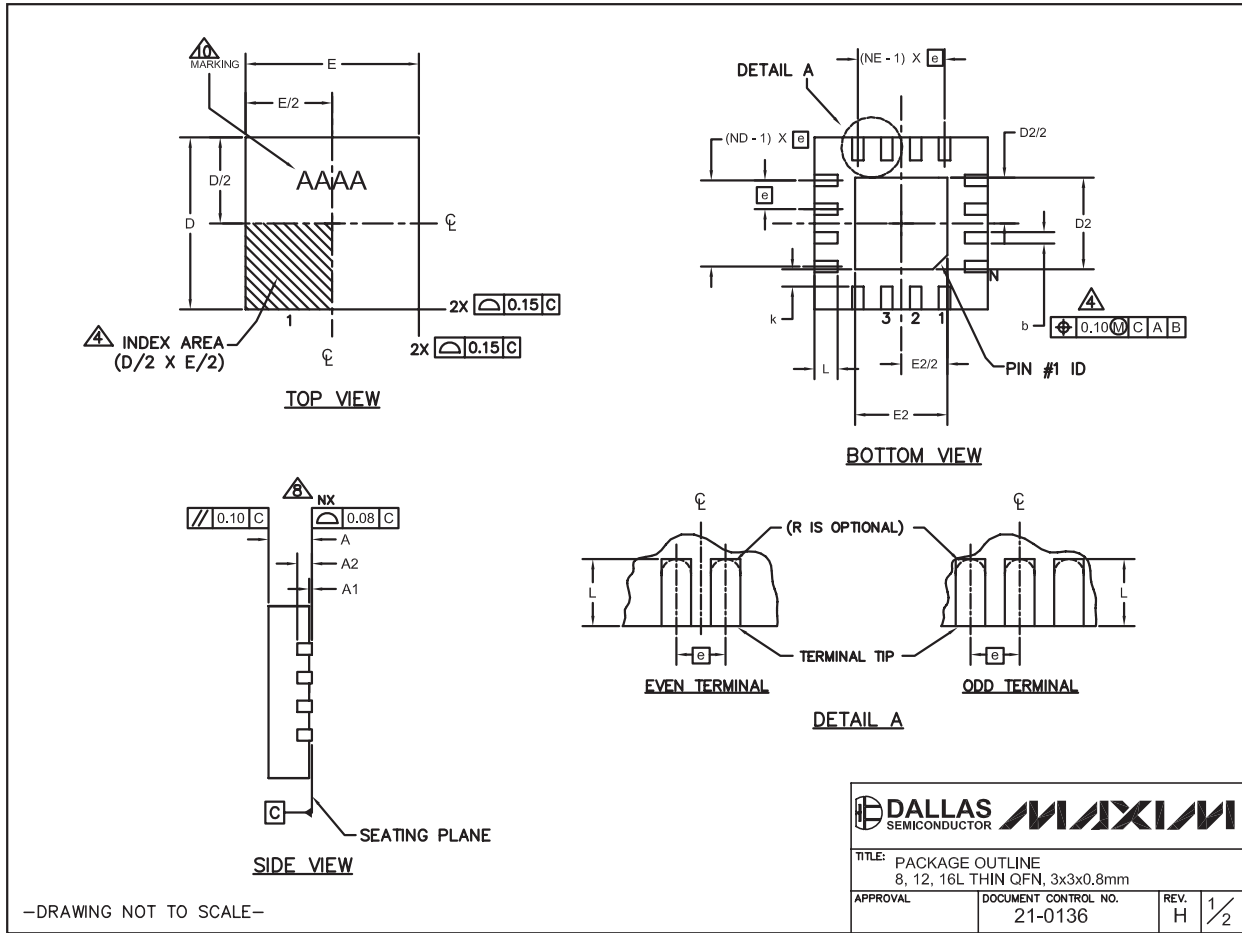
## Chip Information

TRANSISTOR COUNT: 417  
 PROCESS: Silicon bipolar  
 SUBSTRATE: Connected to GND  
 DIE SIZE: 1.04mm x 1.22mm

# 155Mbps Low-Noise Transimpedance Amplifier

## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).



-DRAWING NOT TO SCALE-

# 155Mbps Low-Noise Transimpedance Amplifier

## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).

MAX3657

PKG	8L 3x3			12L 3x3			16L 3x3		
REF.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.75	0.80	0.70	0.75	0.80	0.70	0.75	0.80
b	0.25	0.30	0.35	0.20	0.25	0.30	0.20	0.25	0.30
D	2.90	3.00	3.10	2.90	3.00	3.10	2.90	3.00	3.10
E	2.90	3.00	3.10	2.90	3.00	3.10	2.90	3.00	3.10
e	0.65 BSC.			0.50 BSC.			0.50 BSC.		
L	0.35	0.55	0.75	0.45	0.55	0.65	0.30	0.40	0.50
N	8			12			16		
ND	2			3			4		
NE	2			3			4		
A1	0	0.02	0.05	0	0.02	0.05	0	0.02	0.05
A2	0.20 REF			0.20 REF			0.20 REF		
k	0.25	-	-	0.25	-	-	0.25	-	-

EXPOSED PAD VARIATIONS								
PKG. CODES	D2			E2			PIN ID	JEDEC
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.		
TQ833-1	0.25	0.70	1.25	0.25	0.70	1.25	0.35 x 45°	WEEC
T1233-1	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-1
T1233-3	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-1
T1233-4	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-1
T1633-1	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-2
T1633-2	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-2
T1633F-3	0.65	0.80	0.95	0.65	0.80	0.95	0.225 x 45°	WEED-2
T1633FH-3	0.65	0.80	0.95	0.65	0.80	0.95	0.225 x 45°	WEED-2
T1633-4	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-2

### NOTES:

- DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.5M-1994.
- ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.
- N IS THE TOTAL NUMBER OF TERMINALS.
- THE TERMINAL #1 IDENTIFIER AND TERMINAL NUMBERING CONVENTION SHALL CONFORM TO JESD 95-1 SPP-012. DETAILS OF TERMINAL #1 IDENTIFIER ARE OPTIONAL, BUT MUST BE LOCATED WITHIN THE ZONE INDICATED. THE TERMINAL #1 IDENTIFIER MAY BE EITHER A MOLD OR MARKED FEATURE.
- DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.20 mm AND 0.25 mm FROM TERMINAL TIP.
- ND AND NE REFER TO THE NUMBER OF TERMINALS ON EACH D AND E SIDE RESPECTIVELY.
- DEPOPULATION IS POSSIBLE IN A SYMMETRICAL FASHION.
- COPLANARITY APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.
- DRAWING CONFORMS TO JEDEC MO220 REVISION C.
- MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
- NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.

-DRAWING NOT TO SCALE-

	
TITLE: PACKAGE OUTLINE 8, 12, 16L THIN QFN, 3x3x0.8mm	
APPROVAL	DOCUMENT CONTROL NO. 21-0136
REV.	H 2/2

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600 15