



## **+3.0V to +5.5V, 1.25Gbps/2.5Gbps Limiting Amplifiers**

### General Description

The 1.25Gbps MAX3264/MAX3268/MAX3768 and the 2.5Gbps MAX3265/MAX3269/MAX3765 limiting amplifiers are designed for Gigabit Ethernet and Fibre Channel optical receiver systems. The amplifiers accept a wide range of input voltages and provide constant-level output voltages with controlled edge speeds. Additional features include RMS power detectors with programmable loss-of-signal (LOS) indication, an optional squelch function that mutes the data output signal when the input voltage falls below a programmable threshold, and excellent jitter performance.

The MAX3264/MAX3265/MAX3765 feature current-mode logic (CML) data outputs that are tolerant of inductive connectors and a 16-pin TSSOP package, making these circuits ideal for GBIC receivers. The MAX3268/MAX3269/MAX3768 feature standards-compliant positive-referenced emitter-coupled logic (PECL) data outputs and are available in a tiny 10-pin  $\mu$ MAX package that is ideal for small-form-factor (SFF) receivers.

## Applications

- Gigabit Ethernet Optical Receivers
- Fibre Channel Optical Receivers
- System Interconnect
- ATM Optical Receivers

***Selector Guide appears at end of data sheet.***  
***Pin Configurations appear at end of data sheet.***

## Features

- ◆ **+3.0V to +5.5V Supply Voltage**
- ◆ **Low Deterministic Jitter**
  - 14ps (MAX3264)
  - 11ps (MAX3265/MAX3765)
- ◆ **150ps (max) Edge Speed (MAX3265/MAX3765)**  
**300ps (max) Edge Speed (MAX3264)**
- ◆ **Programmable Signal-Detect Function**
- ◆ **Choice of CML or PECL Output Interface**
- ◆ **10-Pin  $\mu$ MAX or 16-Pin TSSOP Package**

## Ordering Information

| PART               | TEMP RANGE     | PIN-PACKAGE  |
|--------------------|----------------|--------------|
| <b>MAX3264</b> CUE | 0°C to +70°C   | 16 TSSOP-EP* |
| MAX3264CUE+        | 0°C to +70°C   | 16 TSSOP-EP* |
| MAX3264C/D         | 0°C to +70°C   | Dice**       |
| <b>MAX3265</b> CUE | 0°C to +70°C   | 16 TSSOP-EP* |
| MAX3265CUE+        | 0°C to +70°C   | 16 TSSOP-EP* |
| MAX3265CUB         | 0°C to +70°C   | 10 μMAX-EP*  |
| MAX3265CUB+        | 0°C to +70°C   | 10 μMAX-EP*  |
| MAX3265EUE         | -40°C to +85°C | 16 TSSOP-EP* |
| MAX3265EUE+        | -40°C to +85°C | 16 TSSOP-EP* |
| MAX3265C/D         | 0°C to +70°C   | Dice**       |

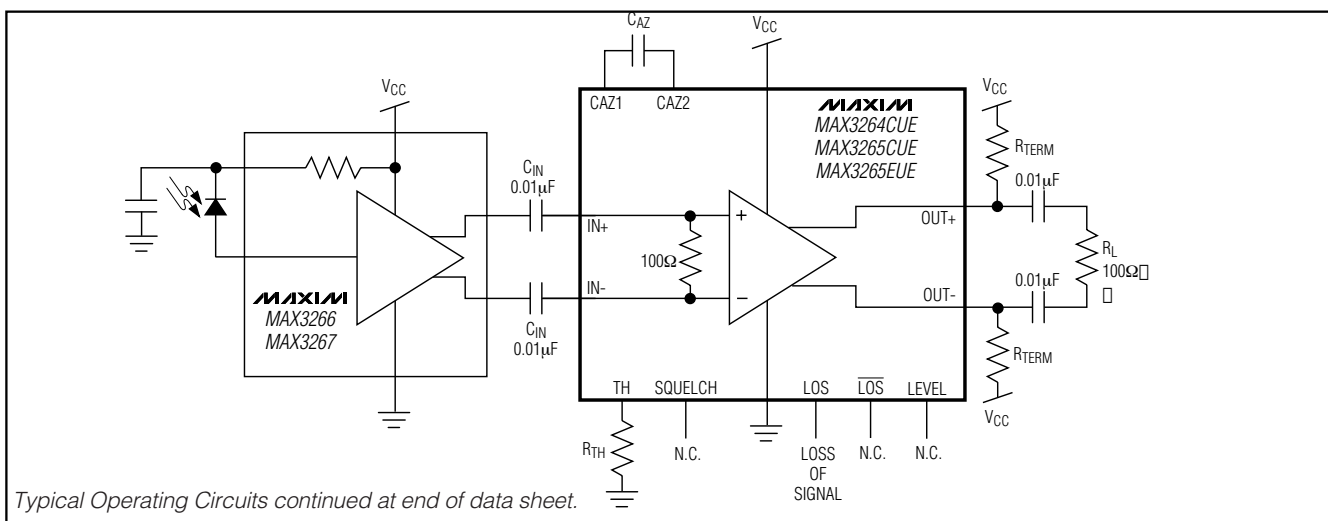
+Denotes lead-free package.

\*EP = Exposed paddle.

**\*\*Dice are designed to operate from 0°C to +70°C, but are tested and guaranteed only at  $T_A = +25^\circ\text{C}$ .**

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

## Typical Operating Circuits



Typical Operating Circuits continued at end of data sheet.

# +3.0V to +5.5V, 1.25Gbps/2.5Gbps Limiting Amplifiers

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V<sub>CC</sub>) .....-0.5V to +6.0V  
 Voltage at IN+, IN- .....(V<sub>CC</sub> - 2.4V) to (V<sub>CC</sub> + 0.5V)  
 Voltage at SQUELCH, CAZ1, CAZ2, LOS,  $\overline{\text{LOS}}$ , TH.....-0.5V to (V<sub>CC</sub> + 0.5V)  
 Voltage at LEVEL.....-0.5V to +2.0V  
 Current into LOS,  $\overline{\text{LOS}}$  .....-1mA to +9mA  
 Differential Input Voltage (IN+ - IN-) .....2.5V  
 Continuous Current at CML Outputs (OUT+, OUT-).....-25mA to +25mA

Continuous Current at PECL Outputs (OUT+, OUT-) .....50mA  
 Continuous Power Dissipation (T<sub>A</sub> = +70°C)  
   16-Pin TSSOP (derate 27mW/°C above +70°C) .....2162mW  
   10-Pin  $\mu$ MAX (derate 20mW/°C above +70°C) .....1600mW  
 Operating Ambient Temperature Range .....-40°C to +85°C  
 Storage Temperature Range .....-55°C to +150°C  
 Processing Temperature (dice) .....+400°C  
 Lead Temperature (soldering, 10s) .....+300°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.

## ELECTRICAL CHARACTERISTICS

(Data outputs terminated per Figure 1, V<sub>CC</sub> = +3.0V to +5.5V, T<sub>A</sub> = 0°C to +70°C. Typical values are at V<sub>CC</sub> = +3.3V, T<sub>A</sub> = +25°C, unless otherwise noted.) (Note 1)

| PARAMETER                | CONDITIONS                           |                         | MIN  | TYP  | MAX  | UNITS   |
|--------------------------|--------------------------------------|-------------------------|------|------|------|---------|
| Data Rate                | MAX3264/MAX3268/MAX3768              |                         |      | 1.25 |      | Gbps    |
|                          | MAX3265/MAX3269/MAX3765              |                         |      | 2.5  |      |         |
| Input Voltage Range      | MAX3264/MAX3268/MAX3768              |                         | 5    |      | 1200 | mV      |
|                          | MAX3265/MAX3269/MAX3765              |                         | 10   |      | 1200 |         |
| Deterministic Jitter     | MAX3264/MAX3268/MAX3768 (Notes 2, 3) |                         |      | 14   | 30   | psp-p   |
|                          | MAX3265/MAX3269/MAX3765 (Notes 2, 3) |                         |      | 11   | 25   |         |
| Random Jitter            | MAX3264/MAX3268/MAX3768 (Notes 2, 4) |                         |      | 15   |      | psRMS   |
|                          | MAX3265/MAX3269/MAX3765 (Notes 2, 4) |                         |      | 8    |      |         |
| Data Output Edge Speed   | MAX3264 (Note 5)                     |                         | 80   | 175  | 300  | ps      |
|                          | MAX3265/MAX3765 (Note 6)             |                         |      | 100  | 150  |         |
|                          | MAX3268/MAX3768 (Note 5)             |                         | 80   | 150  | 300  |         |
|                          | MAX3269 (Note 6)                     |                         |      | 100  | 150  |         |
| LOS Hysteresis           | (Notes 2, 7)                         |                         | 2.5  | 4.4  |      | dB      |
| LOS Assert/Deassert Time | (Notes 7, 8)                         |                         |      | 1    |      | $\mu$ s |
| Low LOS Assert Level     | R <sub>TH</sub> = 2.5k $\Omega$      | MAX3264/MAX3268/MAX3768 | 1.20 | 2.6  |      | mV      |
|                          |                                      | MAX3265/MAX3269/MAX3765 | 2.20 | 4.8  |      |         |
| Low LOS Deassert Level   | R <sub>TH</sub> = 2.5k $\Omega$      | MAX3264/MAX3268/MAX3768 |      | 4.5  |      | mV      |
|                          |                                      | MAX3265/MAX3269/MAX3765 |      | 8.5  |      |         |

# **+3.0V to +5.5V, 1.25Gbps/2.5Gbps Limiting Amplifiers**

## **ELECTRICAL CHARACTERISTICS (continued)**

(Data outputs terminated per Figure 1,  $V_{CC} = +3.0V$  to  $+5.5V$ ,  $T_A = 0^{\circ}C$  to  $+70^{\circ}C$ . Typical values are at  $V_{CC} = +3.3V$ ,  $T_A = +25^{\circ}C$ , unless otherwise noted.) (Note 1)

| PARAMETER                        | CONDITIONS                          |                         | MIN     | TYP  | MAX    | UNITS         |
|----------------------------------|-------------------------------------|-------------------------|---------|------|--------|---------------|
| Medium LOS Assert Level          | $R_{TH} = 7k\Omega$                 | MAX3264/MAX3268/MAX3768 | 5.6     | 9    |        | mV            |
|                                  |                                     | MAX3265/MAX3269/MAX3765 | 9.9     | 16   |        |               |
| Medium LOS Deassert Level        | $R_{TH} = 7k\Omega$                 | MAX3264/MAX3268/MAX3768 |         | 15   | 19.8   | mV            |
|                                  |                                     | MAX3265/MAX3269/MAX3765 |         | 27   | 40.5   |               |
| High LOS Assert Level            | $R_{TH} = 20k\Omega$                | MAX3264/MAX3268/MAX3768 | 9.4     | 21.6 |        | mV            |
|                                  |                                     | MAX3265/MAX3269/MAX3765 | 18.0    | 41.5 |        |               |
| High LOS Deassert Level          | $R_{TH} = 20k\Omega$                | MAX3264/MAX3268/MAX3768 |         | 35   |        | mV            |
|                                  |                                     | MAX3265/MAX3269/MAX3765 |         | 67   |        |               |
| Squelch Input Current            |                                     |                         | 0       | 80   | 400    | $\mu A$       |
| Differential Input Resistance    | $IN+$ to $IN-$                      |                         | 97      | 100  | 103    | $\Omega$      |
| Input-Referred Noise             | MAX3264/MAX3268/MAX3768             |                         |         | 150  |        | $\mu V_{RMS}$ |
|                                  | MAX3265/MAX3269/MAX3765             |                         |         | 230  |        |               |
| CML Output Voltage               | LEVEL = open, $R_{LOAD} = 50\Omega$ |                         | 550     |      | 1200   | mV            |
|                                  | LEVEL = GND, $R_{LOAD} = 75\Omega$  |                         | 1100    | 1270 | 1800   |               |
| PECL Output High Voltage         | Referenced to $V_{CC}$              |                         | -1.025  |      | -0.880 | V             |
| PECL Output Low Voltage          | Referenced to $V_{CC}$              |                         | -1.810  |      | -1.620 | V             |
| LOS Output High Voltage          | $I_{LOS} = -30\mu A$                |                         | 2.4     |      |        | V             |
| LOS Output Low Voltage           | $I_{LOS} = +1.2mA$                  |                         |         |      | 0.4    | V             |
| Output Signal When Squelched     | Outputs AC-coupled                  |                         |         | 20   |        | mV            |
| Power-Supply Rejection Ratio     | $f < 2MHz$                          |                         |         | 20   |        | dB            |
| Low-Frequency Cutoff             | $C_{AZ} = \text{open}$              |                         |         | 2    |        | MHz           |
|                                  | $C_{AZ} = 0.1\mu F$                 |                         |         | 2    |        | kHz           |
| Output Resistance (Single Ended) | MAX3264/MAX3265/MAX3765             |                         | 85      | 100  | 115    | $\Omega$      |
|                                  | MAX3268/MAX3269/MAX3768             |                         |         | 4    |        |               |
| Power-Supply Current             | Figure 2                            |                         | MAX3268 | 39   | 62     | mA            |
|                                  |                                     |                         | MAX3269 | 48   | 78     |               |
|                                  |                                     | Output not squelched    | MAX3264 | 38   | 62     |               |
|                                  |                                     |                         | MAX3265 | 50   | 76     |               |
|                                  |                                     |                         | MAX3765 | 50   | 76     |               |
|                                  |                                     |                         | MAX3768 | 39   | 62     |               |
|                                  |                                     | Output squelched        | MAX3765 | 64   | 90     |               |

**MAX3264/MAX3265/MAX3268/MAX3269/MAX3765/MAX3768**

**MAX3264/MAX3265/MAX3268/MAX3269/MAX3765/MAX3768**

(Data outputs terminated per Figure 1,  $V_{CC} = +3.0V$  to  $+5.5V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ . Typical values are at  $V_{CC} = +3.3V$ ,  $T_A = +25^{\circ}C$ , unless otherwise noted.) (Note 1)

**Note 1:** Specifications for Input Voltage Range, LOS Assert/Deassert Levels, and CML Output Voltage refer to the total differential peak-to-peak signal applied or measured. PECL output voltages are absolute (single-ended) voltages measured at a single output.

**Note 2:** Input edge speed is controlled using four-pole, lowpass Bessel filters with bandwidth approximately 75% of the maximum data rate.

**Note 3:** Deterministic jitter is measured with a K28.5 pattern (0011 1110 1011 0000 0101). Deterministic jitter is the peak-to-peak deviation from ideal time crossings, measured at the zero-level crossings of the differential output per ANSI X3.230, Annex A.

**Note 4:** Random jitter is measured with the minimum input signal applied after filtering with a four-pole, lowpass, Bessel filter (frequency bandwidth at 75% of the maximum data rate). For Fibre Channel and Gigabit Ethernet applications, the peak-to-peak random jitter is 14.1-times the RMS random jitter.

**Note 5:** Input signal applied after a 933MHz Bessel filter.

**Note 6:** Input signal applied after a 1.8GHz Bessel filter.

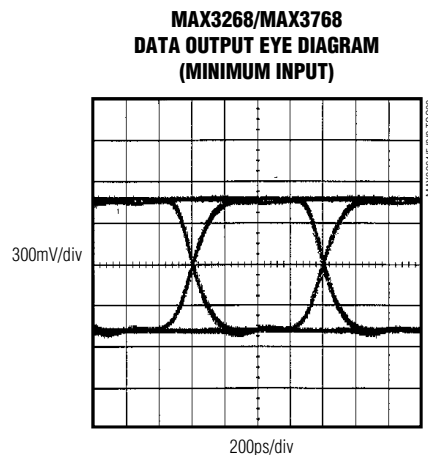
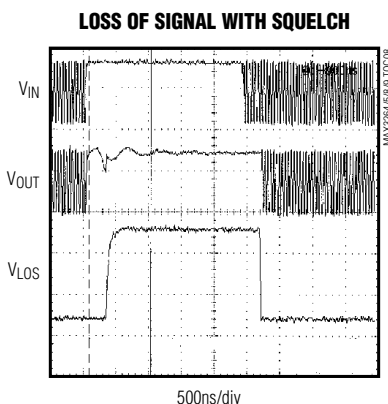
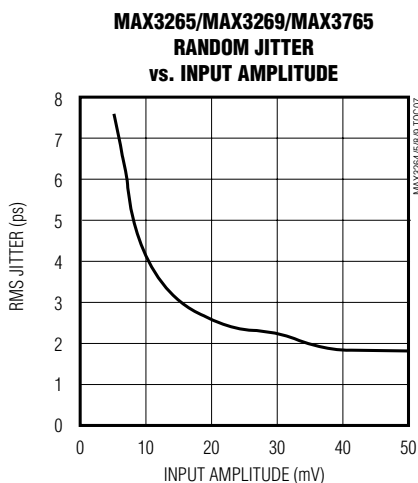
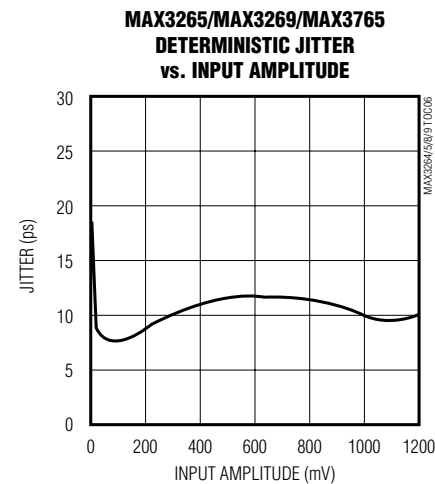
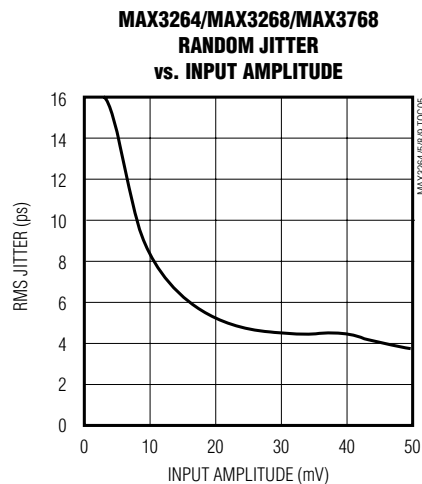
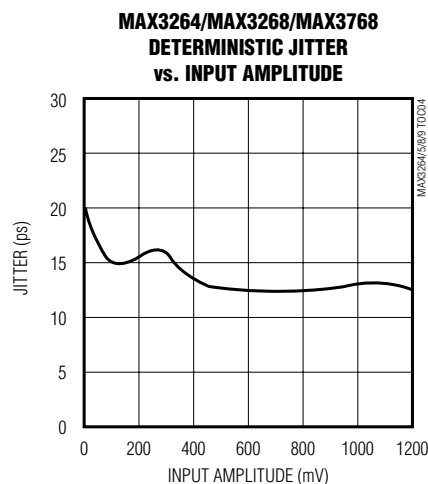
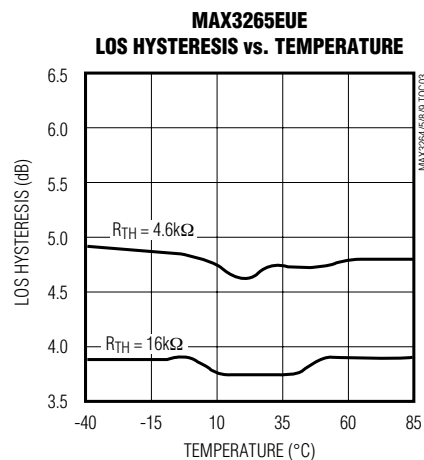
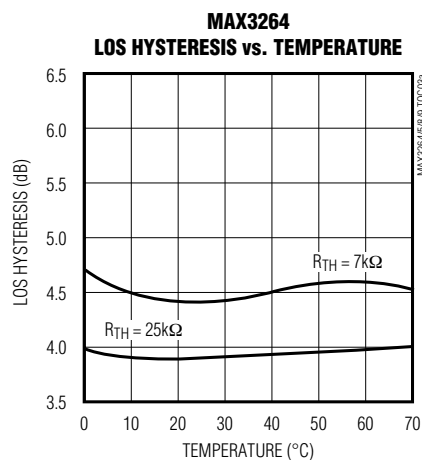
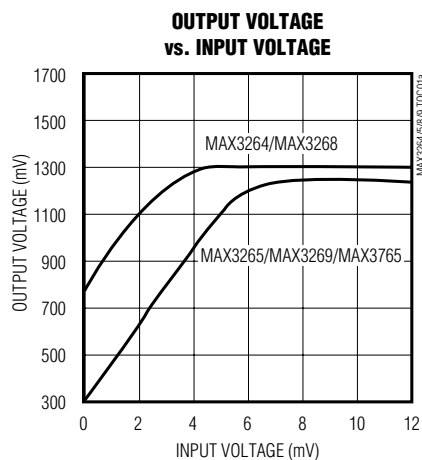
**Note 7:** Input for LOS assert/deassert and hysteresis tests is a repeating K28.5 pattern. Hysteresis is defined as:  
 $20\log(V_{\text{LOS-DEASSERT}} / V_{\text{LOS-ASSERT}})$ .

**Note 8:** Response time to a 10dB change in input power.

# +3.0V to +5.5V, 1.25Gbps/2.5Gbps Limiting Amplifiers

## Typical Operating Characteristics

( $T_A = +25^\circ\text{C}$ , unless otherwise noted.)

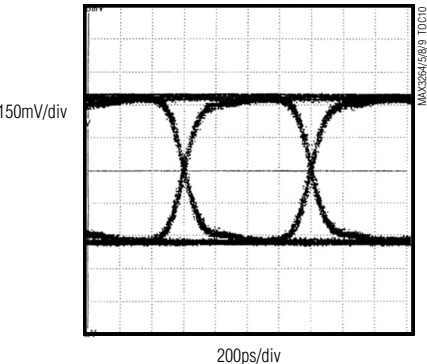


# **+3.0V to +5.5V, 1.25Gbps/2.5Gbps Limiting Amplifiers**

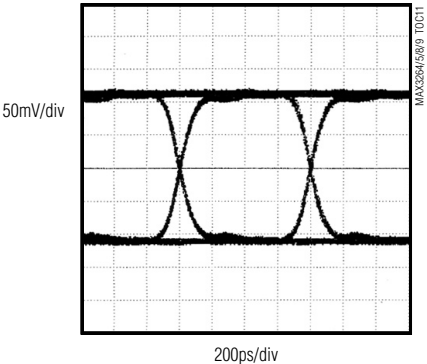
## **Typical Operating Characteristics (continued)**

(T<sub>A</sub> = +25°C, unless otherwise noted.)

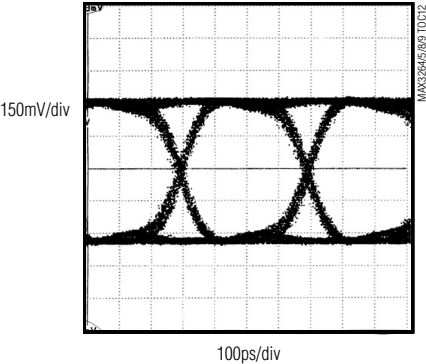
**MAX3264  
DATA OUTPUT EYE DIAGRAM AT  
1.25Gbps (MINIMUM INPUT)**



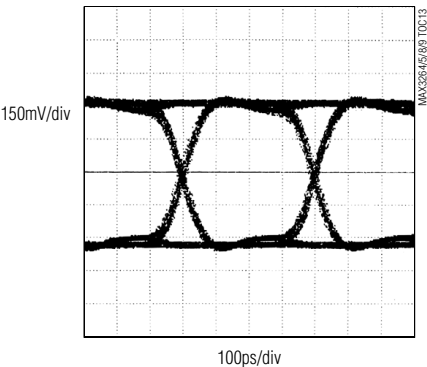
**MAX3264  
DATA OUTPUT EYE DIAGRAM AT  
1.25Gbps (MAXIMUM INPUT)**



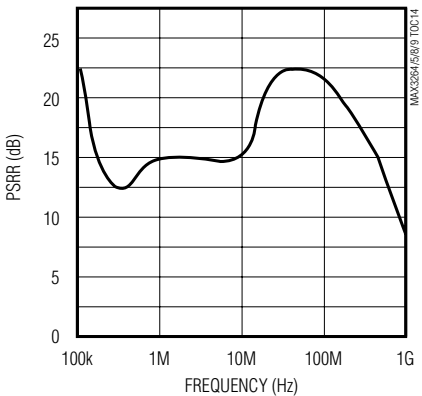
**MAX3265/MAX3765  
DATA OUTPUT EYE DIAGRAM  
2.5Gbps (MINIMUM INPUT)**



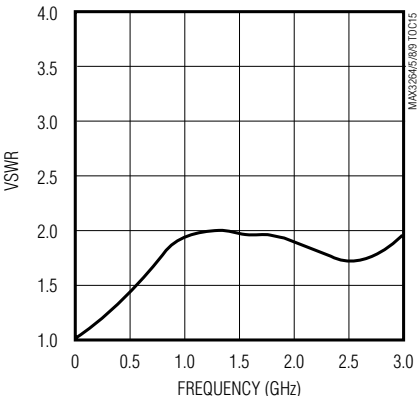
**MAX3265/MAX3765  
DATA OUTPUT EYE DIAGRAM  
2.5Gbps (MAXIMUM INPUT)**



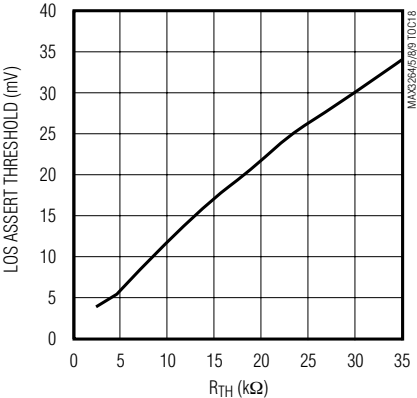
**POWER-SUPPLY REJECTION RATIO  
vs. FREQUENCY**



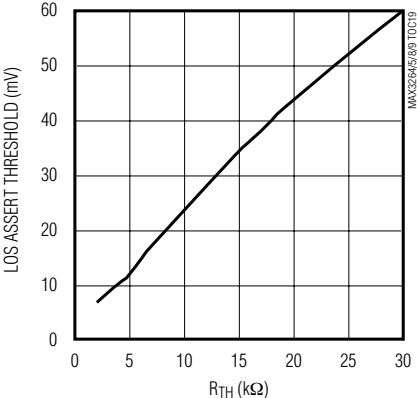
**OUTPUT VSWR vs. FREQUENCY**



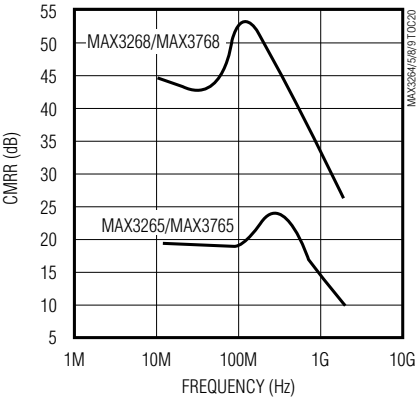
**MAX3264  
LOSS-OF-SIGNAL THRESHOLD vs. R<sub>TH</sub>**



**MAX3265/MAX3765  
LOSS-OF-SIGNAL THRESHOLD vs. R<sub>TH</sub>**



**COMMON-MODE REJECTION RATIO  
vs. FREQUENCY**



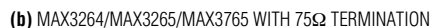
# +3.0V to +5.5V, 1.25Gbps/2.5Gbps Limiting Amplifiers

## Pin Description

| PIN   |        | NAME                    | FUNCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------|--------|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| μMAX  | TSSOP  |                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 1, 4  | 3, 6   | GND                     | Supply Ground                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 2     | 4      | IN+                     | Noninverted Input Signal                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 3     | 5      | IN-                     | Inverted Input Signal                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 5     | 8      | TH                      | Loss-of-Signal Threshold. A resistor connected from this pin to ground sets the input signal level at which the loss-of-signal (LOS) output(s) is asserted. Refer to <i>Typical Operating Characteristics</i> and <i>Design Procedure</i> .                                                                                                                                                                                                                                            |
| 6     | 9      | $\overline{\text{LOS}}$ | Inverted Loss-of-Signal Output. $\overline{\text{LOS}}$ is high when the level of the input signal is above the preset threshold set by the TH input. $\overline{\text{LOS}}$ is asserted low when the signal level drops below the threshold.                                                                                                                                                                                                                                         |
| 7, 10 | 11, 14 | V <sub>CC</sub>         | Supply Voltage                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 8     | 12     | OUT-                    | Inverted Data Output                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 9     | 13     | OUT+                    | Noninverted Data Output                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| —     | 1      | CAZ1                    | Offset-Correction-Loop Capacitor. A capacitor connected between this pin and CAZ2 extends the time constant of the offset correction loop.                                                                                                                                                                                                                                                                                                                                             |
| —     | 2      | CAZ2                    | Offset-Correction-Loop Capacitor. A capacitor connected between this pin and CAZ1 extends the time constant of the offset correction loop. Refer to <i>Design Procedure</i> .                                                                                                                                                                                                                                                                                                          |
| —     | 7      | LEVEL                   | Output Current Level. When this pin is not connected, the CML output current is approximately 16mA. When this pin is connected to ground, the output current increases to approximately 20mA. (In the MAX3265CUB/MAX3765CUB, LEVEL is internally connected to ground.)                                                                                                                                                                                                                 |
| —     | 10     | LOS                     | Noninverted Loss-of-Signal Output. LOS is low when the level of the input signal is above the preset threshold set by the TH input. LOS asserts high when the signal level drops below the threshold.                                                                                                                                                                                                                                                                                  |
| —     | 15     | SQUELCH                 | Squelch Input. The squelch function is disabled when SQUELCH is not connected or is set to a TTL low level. When SQUELCH is set to a TTL high level and LOS is asserted, the data outputs, OUT+, and OUT-, are forced to static levels. See sections <i>PECL Output Buffer</i> and <i>CML Output Buffer</i> for more information. (In the MAX3265/MAX3268/MAX3269 10-pin μMAX, SQUELCH is not connected. In the MAX3765/MAX3768, SQUELCH is internally connected to V <sub>CC</sub> .) |
| —     | 16     | N.C.                    | No Connection                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| EP    | EP     | Exposed Paddle          | Ground. The exposed paddle must be soldered to the circuit-board ground for proper thermal performance.                                                                                                                                                                                                                                                                                                                                                                                |

MAX3264/MAX3265/MAX3268/MAX3269/MAX3765/MAX3768

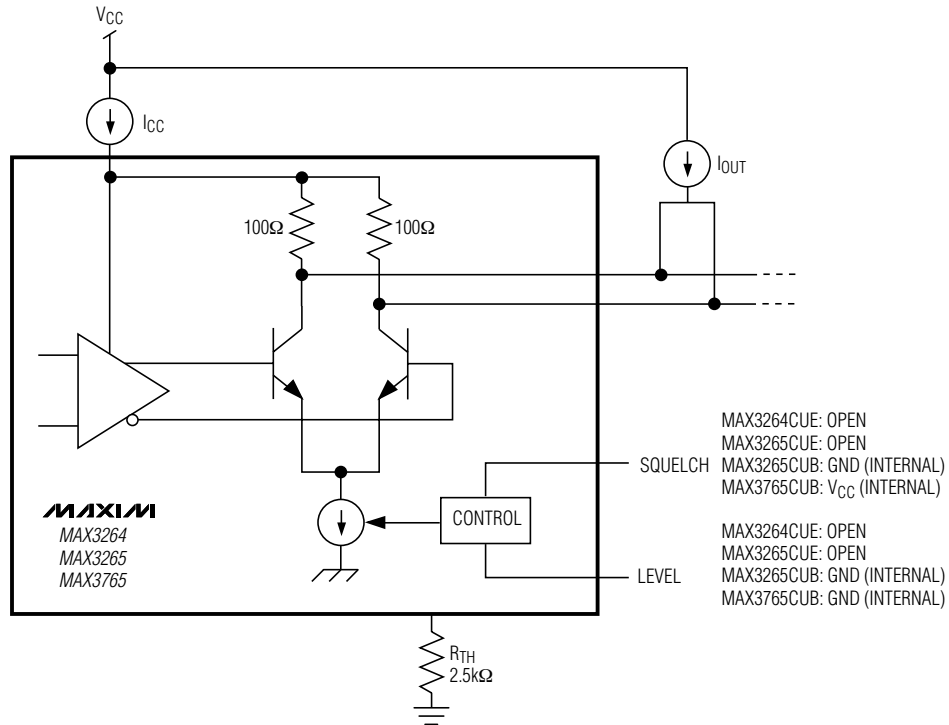
**MAX3264/MAX3265/MAX3268/MAX3269/MAX3765/MAX3768**



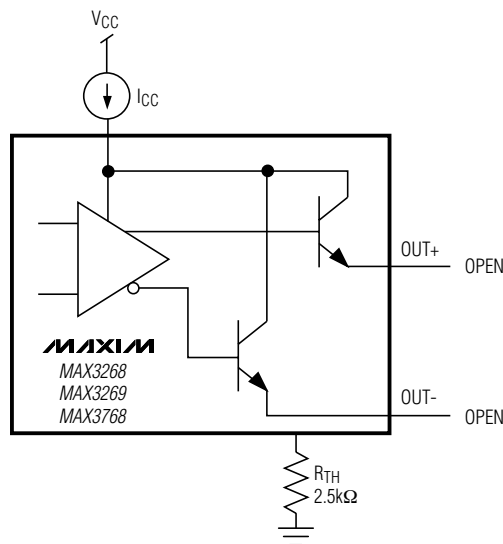
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# **+3.0V to +5.5V, 1.25Gbps/2.5Gbps Limiting Amplifiers**

**MAX3264/MAX3265/MAX3268/MAX3269/MAX3765/MAX3768**



(a) CML SUPPLY CURRENT ( $I_{CC}$ )



(b) PECL SUPPLY CURRENT ( $I_{CC}$ )

Figure 2. Power-Supply Current Measurement

# +3.0V to +5.5V, 1.25Gbps/2.5Gbps Limiting Amplifiers

## Detailed Description

Figure 3 is a functional diagram of the MAX3264/MAX3265/MAX3268/MAX3269/MAX3765/MAX3768 limiting amplifiers. A linear input buffer drives a multistage limiting amplifier and an RMS power-detection circuit. Offset correction with lowpass filtering ensures low deterministic jitter. The output buffer produces a limited output signal. The MAX3264/MAX3265/MAX3765 produce a CML output, while the MAX3268/MAX3269/MAX3768 produce a PECL-compatible output signal. Schematics of these input/output circuits are shown in Figures 4 through 7.

## RMS Power Detect with Loss-of-Signal Indicator

An RMS power detector looks at the signal from the input buffer and compares it to a threshold set by the TH resistor (see *Typical Operating Characteristics* for appropriate resistor values). The signal-detect information is provided to the LOS outputs, which are internally terminated with 8k $\Omega$  (MAX3265/MAX3269/MAX3765) or 16k $\Omega$  (MAX3264/MAX3268/MAX3768) pullup resistors. The LOS outputs meet TTL voltage specifications when loaded with a resistor  $\geq 4.7k\Omega$ .

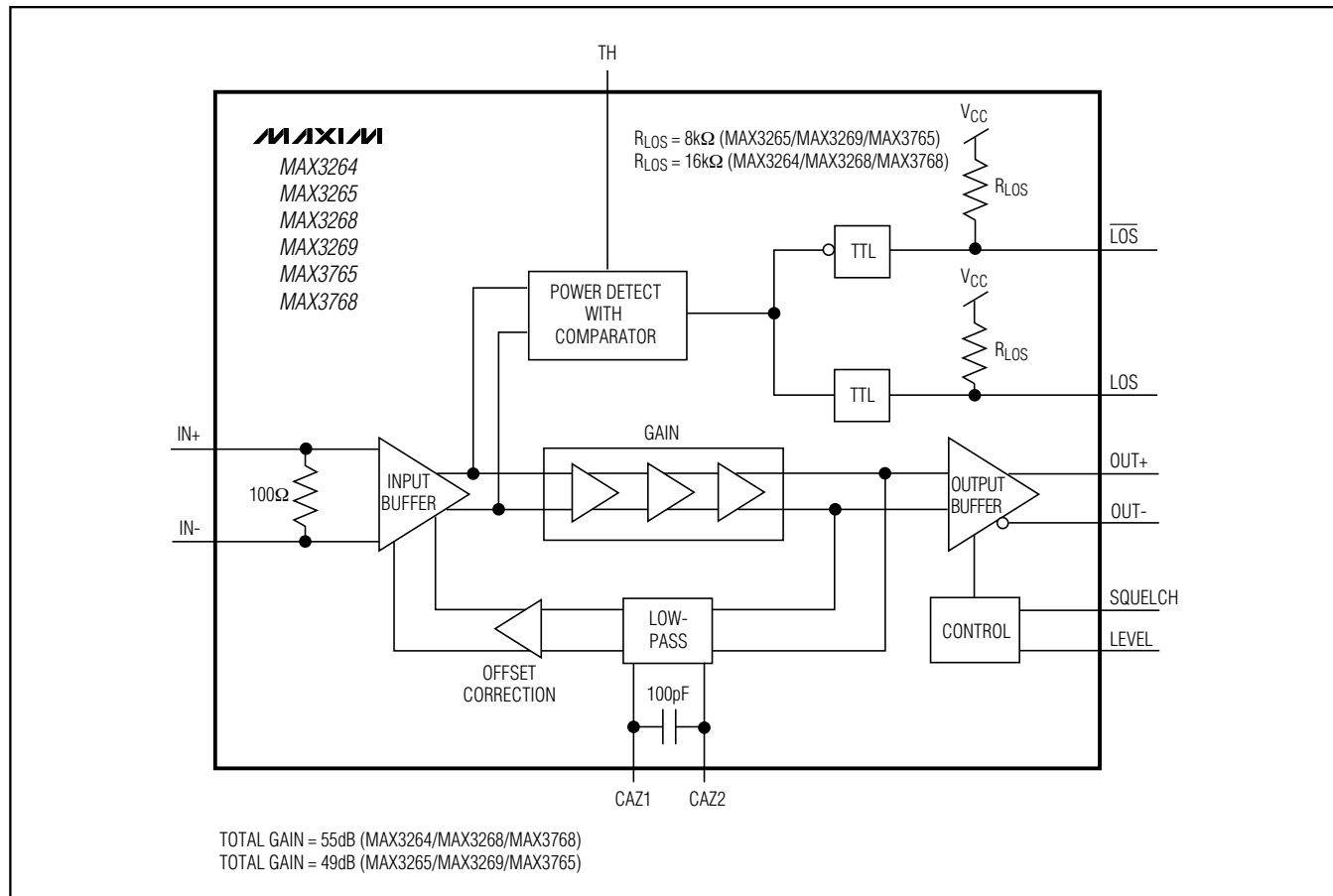


Figure 3. Functional Diagram

# **+3.0V to +5.5V, 1.25Gbps/2.5Gbps Limiting Amplifiers**

## **Input Buffer**

The input buffer is designed to accept input signals from the MAX3266/MAX3267 transimpedance amplifiers. The input buffer provides a 100Ω input impedance between IN+ and IN-. Input VSWR is typically less than 2.0 for frequencies less than 2GHz. DC-coupling the inputs is not recommended; this prevents the DC offset-correction circuitry from functioning properly.

## **Gain Stage and Offset Correction**

The limiting amplifier provides approximately 55dB (MAX3264/MAX3268/MAX3768) or 49dB (MAX3265/MAX3269/MAX3765) of gain. This large gain makes the amplifier susceptible to small DC offsets in the input signal. DC offsets as low as 1mV reduce the accuracy of the power-detection circuit and may cause deterministic jitter. A low-frequency feedback loop is integrated into the limiting amplifier to reduce input offset, typically to less than 100μV.

An external capacitor connected between CAZ1 and CAZ2, in parallel with internal capacitance, determines the time constant of the offset-correction circuit. The offset-correction circuit requires an average data-input mark density of 50% to prevent an increase in duty-cycle distortion and to ensure low deterministic jitter.

## **CML Output Buffer**

The MAX3264/MAX3265/MAX3765 CML output circuits (Figure 7) provide high tolerance to impedance mismatches and inductive connectors. The output current can be set to two levels. When the LEVEL pin is left unconnected, output current is approximately 16mA. Connecting LEVEL to ground sets the output current to approximately 20mA.

The squelch function is enabled when the SQUELCH pin is set to a TTL-high level or connected to VCC. The squelch function holds OUT+ and OUT- at a static voltage whenever the input signal power drops below the loss-of-signal threshold. In the 10-pin μMAX package of the MAX3265/MAX3268/MAX3269, the SQUELCH function is left internally unconnected. In the MAX3765/MAX3768, the SQUELCH function is always enabled by internally connecting it to VCC. SQUELCH operation for the MAX3264/MAX3265 is described in Table 1.

**Table 1.**

| LEVEL PIN | VOLTAGE WHEN SQUELCHED  |                         |
|-----------|-------------------------|-------------------------|
|           | OUT-                    | OUT+                    |
| Open      | V <sub>CC</sub> - 100mV | V <sub>CC</sub>         |
| GND       | V <sub>CC</sub> - 100mV | V <sub>CC</sub> - 100mV |

## **Internal Input/Output Schematics**

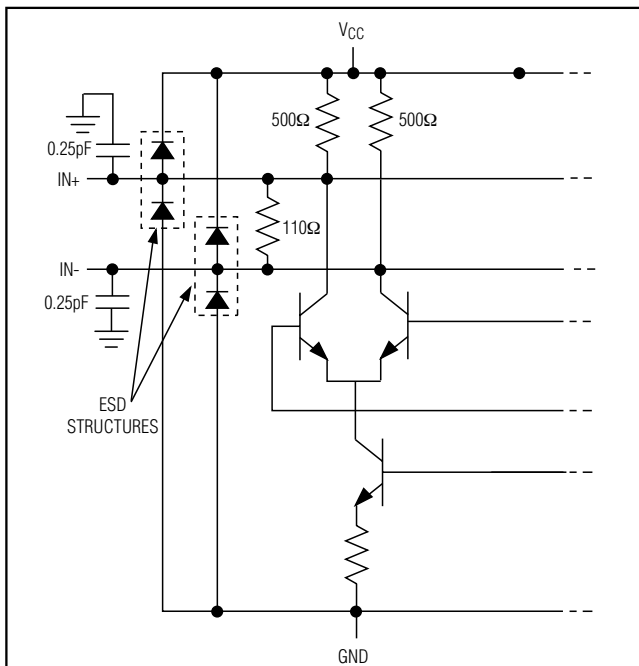


Figure 4. Input Circuit

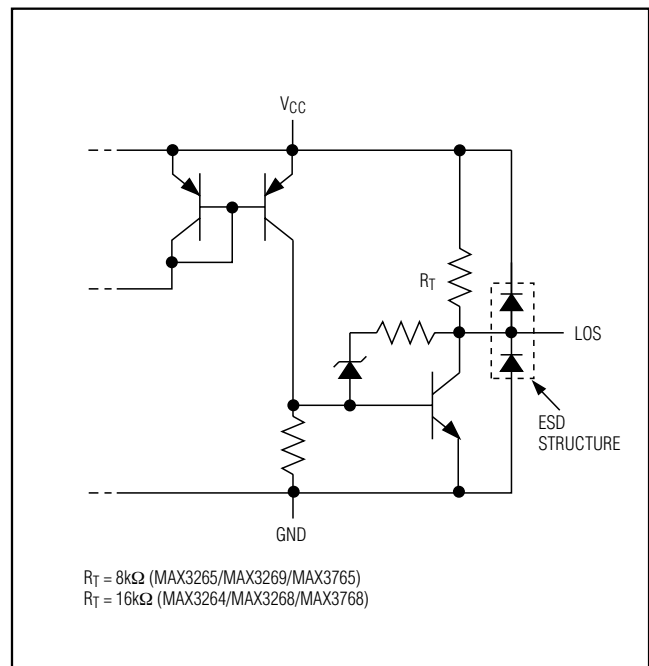


Figure 5. LOS Output Circuit

## +3.0V to +5.5V, 1.25Gbps/2.5Gbps Limiting Amplifiers

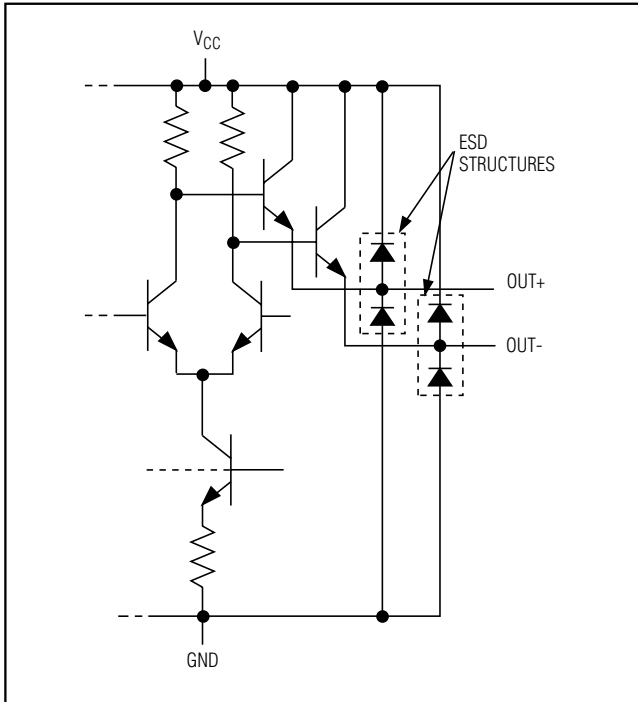


Figure 6. PECL Output Circuit

The buffer's output impedance is determined by the parallel combination of internal and external pullup resistors, which are chosen to match the impedance of the transmission line (Figure 1). The output buffer can be AC- or DC-coupled to the load.

### PECL Output Buffer

The MAX3268/MAX3269/MAX3768 offer an industry-standard PECL output. The PECL outputs should be terminated to  $V_{CC} - 2V$ . Figure 6 shows the PECL output circuit. The squelch function forces OUT+ to a high level and OUT- to a low level when the input is below the programmed LOS threshold. In the 10-pin  $\mu$ MAX, SQUELCH is left unconnected.

### Design Procedure

#### Program the LOS Assert Threshold

The loss-of-signal threshold is programmed by external resistor  $R_{TH}$ . See the LOS Threshold vs.  $R_{TH}$  graph in the *Typical Operating Characteristics*.

#### Select the Coupling Capacitors

The coupling capacitors ( $C_{IN}$ ,  $C_{OUT}$ ) should be selected to minimize the receiver's deterministic jitter. Jitter is

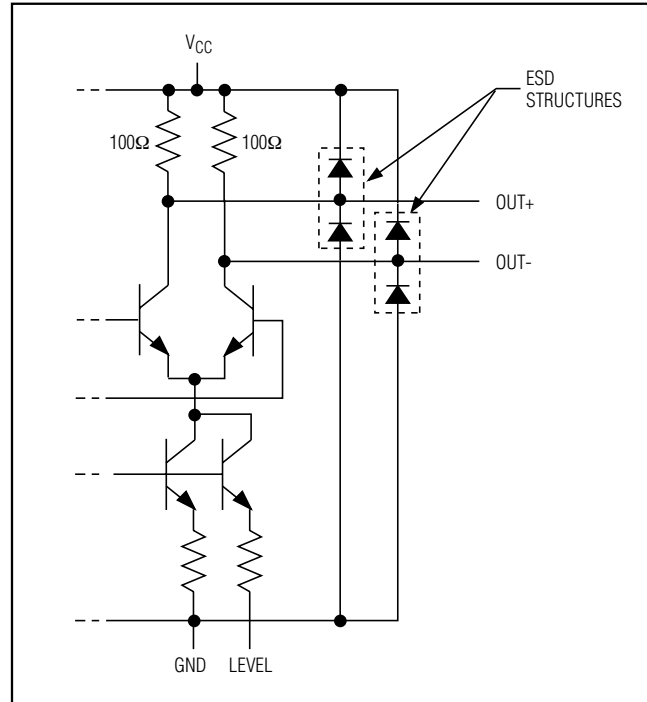


Figure 7. CML Output Circuit

minimized when the input low-frequency cutoff ( $f_{IN}$ ) is placed at a low frequency:

$$f_{IN} = 1 / [2\pi(50)(C)]$$

For Fibre Channel, Gigabit Ethernet, or other applications using 8B/10B data coding, select ( $C_{IN}$ ,  $C_{OUT}$ )  $\geq 0.01\mu F$ , which provides  $f_{IN} < 320kHz$ . For ATM/SONET or other applications using scrambled NRZ data, select ( $C_{IN}$ ,  $C_{OUT}$ )  $\geq 0.1\mu F$ , which provides  $f_{IN} < 32kHz$ .

### Select the Offset-Correction Capacitor (MAX3264/MAX3265 TSSOP Only)

To maintain stability, it is important to keep a one-decade separation between  $f_{IN}$  and the low-frequency cutoff ( $f_{OC}$ ) associated with the DC-offset-correction circuit.

$$f_{OC} = 75 / [2\pi 60k (CAZ + 100pF)] \\ = 200 \times 10^{-6} / (CAZ + 100pF)$$

For Fibre Channel, Gigabit Ethernet, or other applications using 8B/10B data coding, leave pins CAZ1, and CAZ2 open ( $f_{OC} = 2MHz$ ). For ATM/SONET or other applications using scrambled NRZ data, select CAZ  $\geq 0.1\mu F$ , which typically provides  $f_{OC} = 2kHz$ .

# +3.0V to +5.5V, 1.25Gbps/2.5Gbps Limiting Amplifiers

## Applications Information

### Optical Hysteresis

In an optical receiver, the electrical power change at the limiting amplifier is 2x the optical power change.

As an example, if a receiver's optical input power (x) increases by a factor of two, and the preamplifier is linear, then the voltage input to the limiting amplifier also increases by a factor of two.

The optical power change is  $10\log(2x/x) = 10\log(2) = +3\text{dB}$ .

At the limiting amplifier, the electrical power change is:

$$10\log \frac{(2V_{IN})^2 / R_{IN}}{V_{IN}^2 / R_{IN}} = 10\log(2^2) = 20\log(2) = +6\text{dB}$$

The MAX3264/MAX3265/MAX3268/MAX3269/MAX3765's typical voltage hysteresis is 4.4dB. This provides an optical hysteresis of 2.2dB.

### GBIC Loss of Signal

In a GBIC application, the GBIC's LOS output must be high impedance when  $V_{CC\_MODULE} = \text{GND}$ . Figure 8 shows the recommended circuit to maintain high impedance. ESD protection diodes on the MAX3264/MAX3265/MAX3268/MAX3269/MAX3765/MAX3768 LOS outputs can be turned on when  $V_{CC\_HOST} > V_{CC\_MODULE}$ .

### PECL Terminations

The standard PECL termination ( $50\Omega$  to  $V_{CC} - 2\text{V}$ ) is recommended for best performance and output characteristics (see Figure 1). The data outputs operate at high speed and should always drive transmission lines with matched, balanced terminations.

Figure 9 shows an alternate method for terminating the data outputs. The technique provides approximately 8mA DC bias current, with a  $45\Omega$  AC load, for the output termination. This technique is useful for viewing the output on an oscilloscope or changing the PECL reference voltage.

### Wire Bonding Dice

For high current density and reliable operation, the MAX3264/MAX3265/MAX3268/MAX3269 use gold metallization. Make connections to the dice with gold wire only, and use ballbonding techniques (wedge bonding is not recommended). Die-pad size is 4-mils square, with a 6-mil pitch. Die thickness is 15 mils (0.375mm).

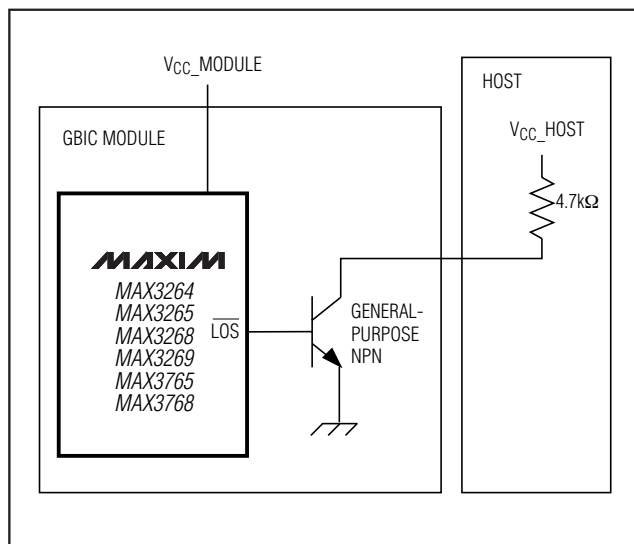


Figure 8. Recommended GBIC LOS Circuit

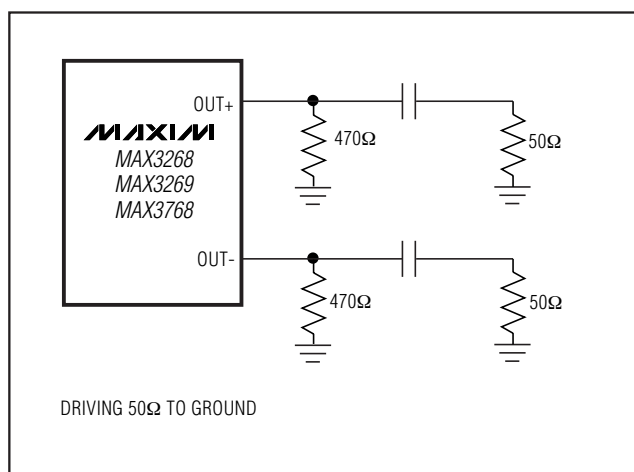
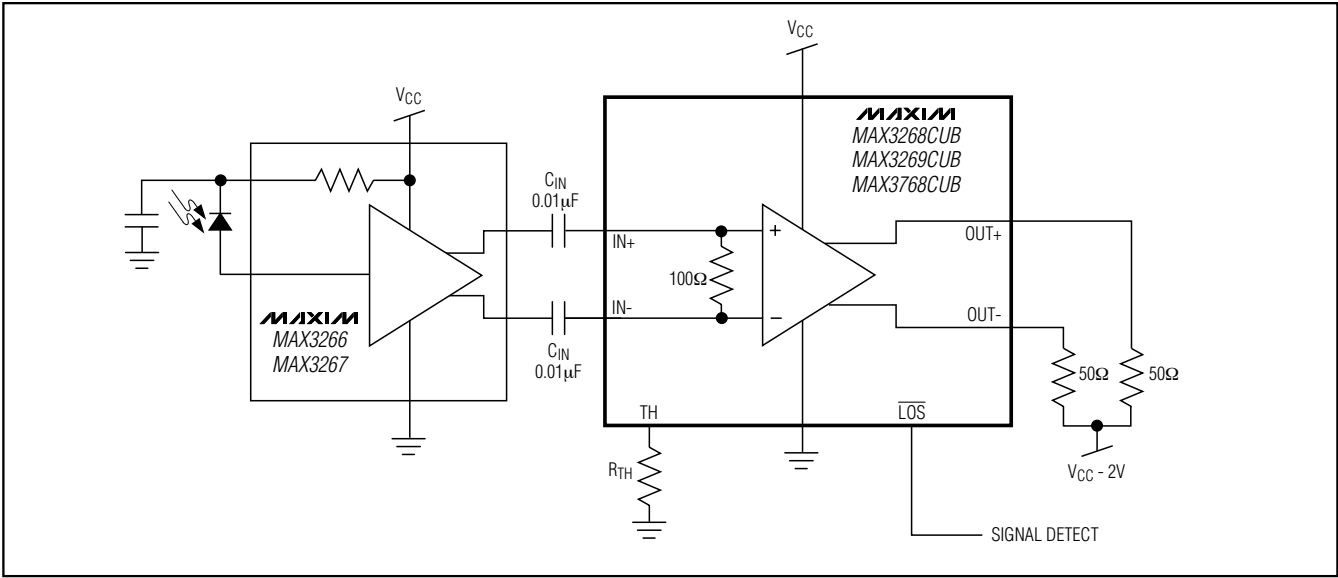


Figure 9. Alternative PECL Termination

MAX3264/MAX3265/MAX3268/MAX3269/MAX3765/MAX3768

# **+3.0V to +5.5V, 1.25Gbps/2.5Gbps Limiting Amplifiers**

## **Typical Operating Circuits (continued)**



## **Ordering Information (continued)**

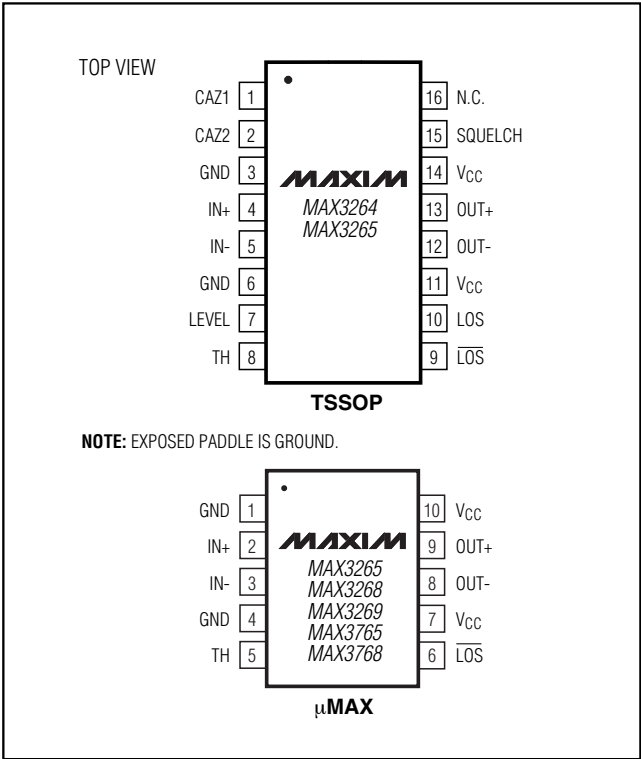
| PART              | TEMP RANGE   | PIN-PACKAGE |
|-------------------|--------------|-------------|
| <b>MAX3268CUB</b> | 0°C to +70°C | 10 µMAX-EP* |
| MAX3268CUB+       | 0°C to +70°C | 10 µMAX-EP* |
| MAX3268C/D        | 0°C to +70°C | Dice**      |
| <b>MAX3269CUB</b> | 0°C to +70°C | 10 µMAX-EP* |
| MAX3269CUB+       | 0°C to +70°C | 10 µMAX-EP* |
| MAX3269C/D        | 0°C to +70°C | Dice**      |
| <b>MAX3765CUB</b> | 0°C to +70°C | 10 µMAX-EP* |
| MAX3765CUB+       | 0°C to +70°C | 10 µMAX-EP* |
| <b>MAX3768CUB</b> | 0°C to +70°C | 10 µMAX-EP* |
| MAX3768CUB+       | 0°C to +70°C | 10 µMAX-EP* |

+Denotes lead-free package.

\*EP = Exposed paddle.

\*\*Dice are designed to operate from 0°C to +70°C, but are tested and guaranteed only at  $T_A = +25^{\circ}\text{C}$ .

## **Pin Configurations**



# +3.0V to +5.5V, 1.25Gbps/2.5Gbps Limiting Amplifiers

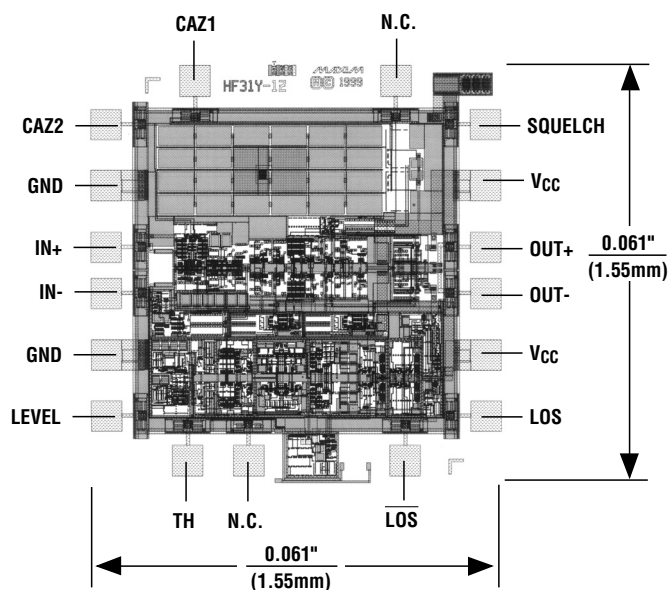
## Selector Guide

| PART    | OUTPUT | DATA RATE (Gbps) | PIN-PACKAGE     | SQUELCH FUNCTION | CML OUTPUT LEVEL |
|---------|--------|------------------|-----------------|------------------|------------------|
| MAX3264 | CML    | 1.25             | 16 TSSOP-EP     | Selectable       | Selectable       |
| MAX3265 | CML    | 2.5              | 16 TSSOP-EP     | Selectable       | Selectable       |
|         |        |                  | 10 $\mu$ MAX-EP | Disabled         | Maximum*         |
| MAX3268 | PECL   | 1.25             | 10 $\mu$ MAX-EP | Disabled         | N/A              |
| MAX3269 | PECL   | 2.5              | 10 $\mu$ MAX-EP | Disabled         | N/A              |
| MAX3765 | CML    | 2.5              | 10 $\mu$ MAX-EP | Enabled          | Maximum*         |
| MAX3768 | PECL   | 1.25             | 10 $\mu$ MAX-EP | Enabled          | N/A              |

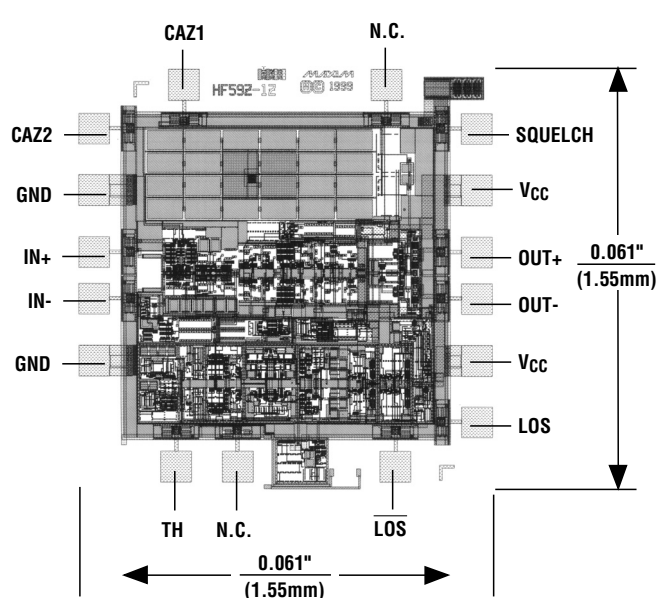
\*LEVEL pin grounded

## Chip Topographies

MAX3264/MAX3265/MAX3765



MAX3268/MAX3269/MAX3768



MAX3264/MAX3265/MAX3765  
TRANSISTOR COUNT: 726

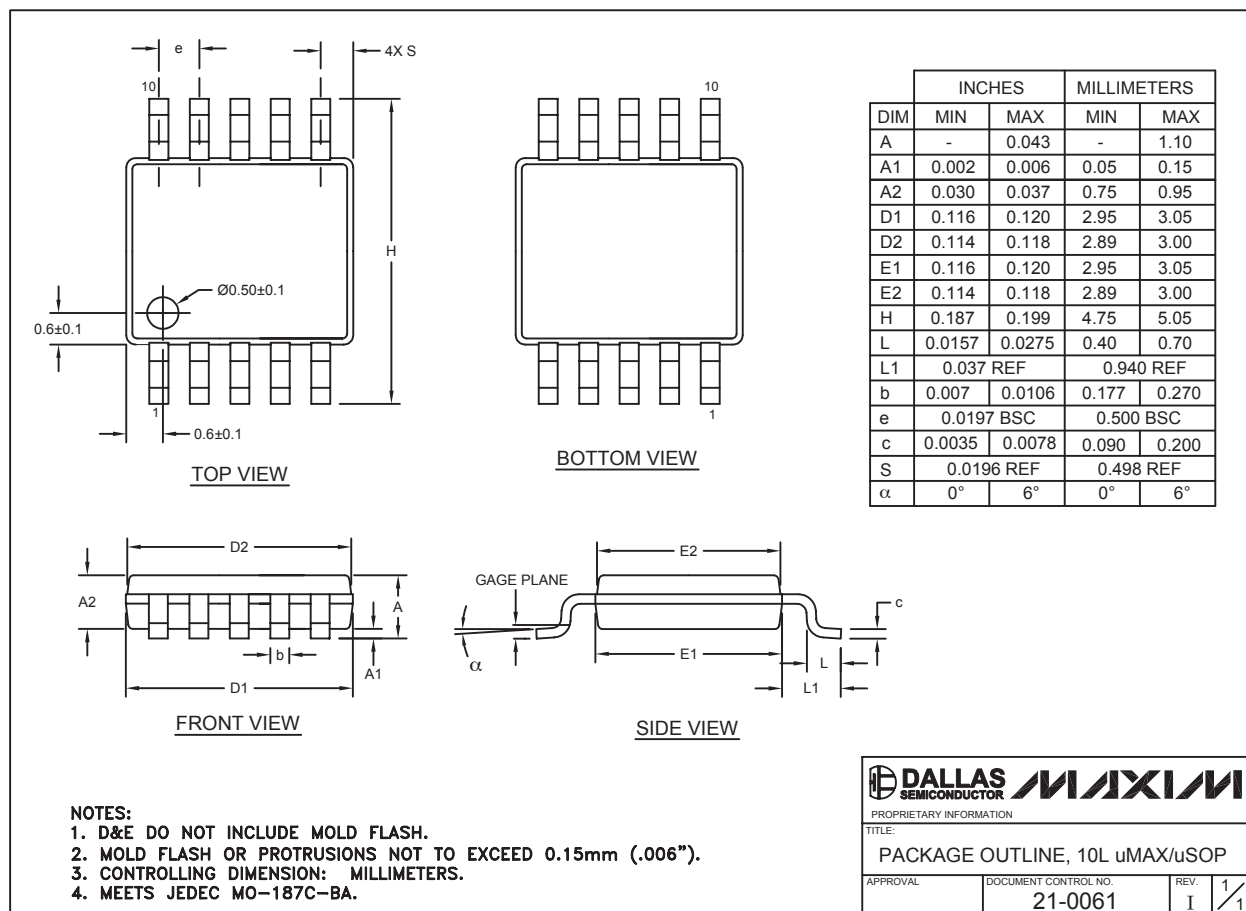
MAX3268/MAX3269/MAX3768  
TRANSISTOR COUNT: 728

SUBSTRATE CONNECTED TO GND

# +3.0V to +5.5V, 1.25Gbps/2.5Gbps Limiting Amplifiers

## 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).)

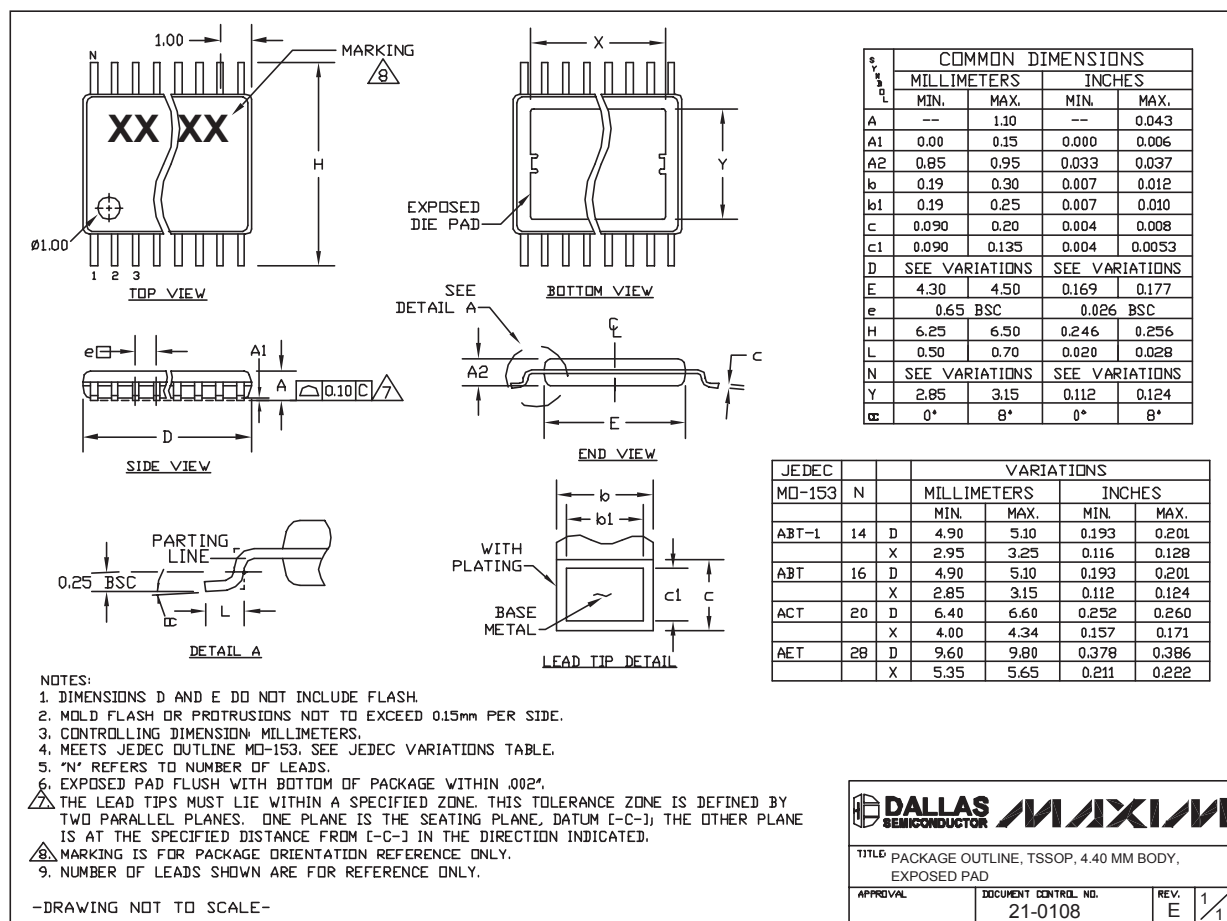


10L uMAX/EPs

# +3.0V to +5.5V, 1.25Gbps/2.5Gbps Limiting Amplifiers

## 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-integrated.com/packages](http://www.maxim-integrated.com/packages).)



TSSOP 4.4mm BODY:EPS

MAX3264/MAX3265/MAX3268/MAX3269/MAX3765/MAX3768

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