



# ULTRA-PRECISION DIFFERENTIAL 400mV LVPECL LINE DRIVER/RECEIVER WITH INTERNAL TERMINATION

Precision Edge®  
SY58602U

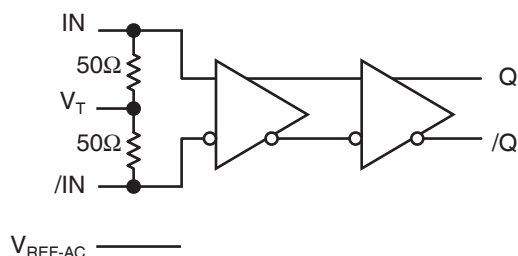
## FEATURES

- **Guaranteed AC performance over temperature and voltage:**
  - DC-to >10.7Gbps data rate throughput
  - DC-to >7GHz clock  $f_{MAX}$
  - <250ps In-to-Out  $t_{pd}$
  - $t_r / t_f < 70ps$
- **Ultra low-jitter design:**
  - 75fs RMS phase jitter
- **Minimum input swing 200mV ( $|IN-|IN|$ )**
- **Unique, patent-pending input termination and VT pin accepts DC- and AC-coupled inputs (CML, PECL, LVDS)**
- **Typical 400mV LVPECL output swing**
- **Power supply 2.5V  $\pm 5\%$  or 3.3V  $\pm 10\%$**
- **-40°C to 85°C industrial temperature range**
- **Available in an ultra-small (2mm  $\times$  2mm) 8-pin QFN package**

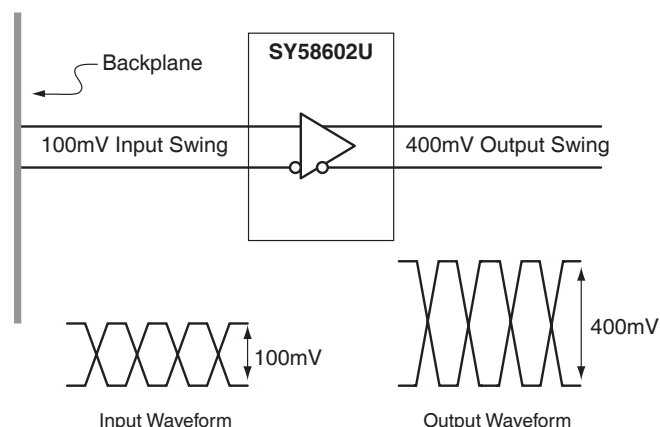
## APPLICATIONS

- Backplane buffering
- OC-12 to OC-192 SONET/SDN clock/data distribution
- All Gigabit Ethernet distribution
- Fibre Channel distribution

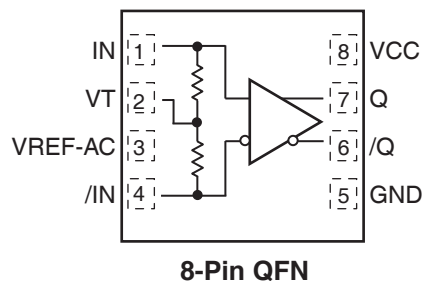
## FUNCTIONAL BLOCK DIAGRAM



## TYPICAL APPLICATION



## PACKAGE/ORDERING INFORMATION

Ordering Information<sup>(1)</sup>

| Part Number                 | Package Type | Operating Range | Package Marking                        | Lead Finish       |
|-----------------------------|--------------|-----------------|----------------------------------------|-------------------|
| SY58602UMGTR <sup>(2)</sup> | MLF-8        | Industrial      | 602 with<br>Pb-Free bar-line indicator | Pb-Free<br>NiPdAu |

## Notes:

1. Contact factory for die availability. Dice are guaranteed at  $T_A = 25^\circ\text{C}$ , DC electricals only.
2. Tape and Reel.

## PIN DESCRIPTION

| Pin Number | Pin Name     | Pin Function                                                                                                                                                                                                                                                                                                                                                  |
|------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1, 4       | IN, /IN      | Differential Input: This input pair is the signal to be buffered. These inputs accept AC or DC-coupled signals as small as 100mV. Each pin of this pair internally terminates to a VT pin through 50Ω. Note that this input will default to an indeterminate state if left open. Please refer to the “Input Interface Applications” section for more details. |
| 2          | VT           | Input Termination Center-Tap: Each side of the differential input pair terminates to this pin. The VT pin provides a center-tap to a termination network for maximum interface flexibility. See “Input Interface Applications” section for more details.                                                                                                      |
| 3          | VREF-AC      | Reference Output Voltage: This output biases to $V_{CC} - 1.2\text{V}$ . Connect to VT pin when AC-coupling the input. Bypass with 0.01μF low ESR capacitor to $V_{CC}$ . Maximum current source or sink is 0.5mA. See “Input Interface Applications” section.                                                                                                |
| 8          | VCC          | Positive Power Supply. Bypass with 0.1μF  0.01μF low ESR capacitors as close to the VCC pin as possible.                                                                                                                                                                                                                                                      |
| 7, 6       | Q, /Q        | Differential 100K LVPECL Output: This LVPECL output is the output of the device. Terminate through 50Ω to $V_{CC} - 2.0\text{V}$ . See “Output Interface Applications” section.                                                                                                                                                                               |
| 5          | GND, Exposed | Ground. Ground pin and exposed pad must be connected to the same ground plane.                                                                                                                                                                                                                                                                                |

**Absolute Maximum Ratings<sup>(1)</sup>**

|                                        |                   |
|----------------------------------------|-------------------|
| Supply Voltage ( $V_{CC}$ )            | –0.5V to +4.0V    |
| Input Voltage ( $V_{IN}$ )             | –0.5V to $V_{CC}$ |
| LVPECL Output Current ( $I_{OUT}$ )    |                   |
| Continuous                             | 50mA              |
| Surge                                  | 100mA             |
| Termination Current                    |                   |
| Source or Sink Current on $V_T$        | $\pm 100$ mA      |
| Input Current                          |                   |
| Source or Sink Current on IN, /IN      | $\pm 50$ mA       |
| Current ( $V_{REF}$ ) <sup>(3)</sup>   |                   |
| Source or Sink Current on $V_{REF-AC}$ | $\pm 1.5$ mA      |
| Lead Temperature (soldering, 20 sec.)  | +260°C            |
| Storage Temperature ( $T_S$ )          | –65°C to +150°C   |

**Operating Ratings<sup>(2)</sup>**

|                                           |                                         |
|-------------------------------------------|-----------------------------------------|
| Supply Voltage ( $V_{CC}$ )               | +2.375V to +2.625V or<br>+3.0V to +3.6V |
| Ambient Temperature ( $T_A$ )             | –40°C to +85°C                          |
| Package Thermal Resistance <sup>(4)</sup> |                                         |
| QFN ( $\theta_{JA}$ )                     |                                         |
| Still-Air                                 | 93°C/W                                  |
| QFN ( $\psi_{JB}$ )                       |                                         |
| Junction-to-Board                         | 32°C/W                                  |

**DC ELECTRICAL CHARACTERISTICS<sup>(5)</sup>**

$T_A$  = –40°C to +85°C, unless otherwise noted.

| Symbol         | Parameter                                           | Condition                              | Min            | Typ            | Max            | Units    |
|----------------|-----------------------------------------------------|----------------------------------------|----------------|----------------|----------------|----------|
| $V_{CC}$       | Power Supply                                        | $V_{CC} = 2.5$ V.<br>$V_{CC} = 3.3$ V. | 2.375<br>3.0   | 2.5<br>3.3     | 2.625<br>3.6   | V        |
| $I_{CC}$       | Power Supply Current                                | No Load, max. $V_{CC}$ , <b>Note 6</b> |                | 48             | 65             | mA       |
| $R_{DIFF\_IN}$ | Differential Input Resistance<br>(IN-to-/IN)        |                                        | 80             | 100            | 120            | $\Omega$ |
| $R_{IN}$       | Input Resistance<br>(IN-to- $V_T$ , /IN-to- $V_T$ ) |                                        | 40             | 50             | 60             | $\Omega$ |
| $V_{IH}$       | Input HIGH Voltage<br>(IN, /IN)                     | <b>Note 7</b>                          | $V_{CC} - 1.6$ |                | $V_{CC}$       | V        |
| $V_{IL}$       | Input LOW Voltage<br>(IN, /IN)                      |                                        | 0              |                | $V_{IH} - 0.1$ | V        |
| $V_{IN}$       | Input Voltage Swing<br>(IN, /IN)                    | See Figure 1a.                         | 0.1            |                | 1.7            | V        |
| $V_{DIFF\_IN}$ | Differential Input Voltage Swing<br> IN–, /IN       | See Figure 1b.                         | 0.2            |                |                | V        |
| $V_{T\_IN}$    | In-to- $V_T$<br>(IN, /IN)                           |                                        |                |                | 1.28           | V        |
| $V_{REF-AC}$   | Output Reference Voltage                            |                                        | $V_{CC} - 1.3$ | $V_{CC} - 1.2$ | $V_{CC} - 1.1$ | V        |

**Notes:**

1. Permanent device damage may occur if the ratings in “Absolute Maximum Ratings” section are exceeded. This is a stress rating only and functional operation is not implied for conditions other than those detailed in the operational sections of this data sheet. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.
2. The data sheet limits are not guaranteed if the device is operated beyond the operating ratings.
3. Due to the limited drive capability use for input of the same package only.
4. Package thermal resistance assumes exposed pad is soldered (or equivalent) to the devices most negative potential on the PCB.  $\psi_{JB}$  uses 4-layer  $\theta_{JA}$  in still-air, unless otherwise stated.
5. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
6. Includes current through internal 50 $\Omega$  pull-ups.
7.  $V_{IH}$  (min) not lower than 1.2V.

**LVPECL OUTPUTS DC ELECTRICAL CHARACTERISTICS<sup>(8)</sup>**

$V_{CC} = 2.5V \pm 5\%$  or  $3.3V \pm 10\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ ;  $R_L = 50\Omega$  to  $V_{CC}-2V$ , unless otherwise noted.

| Symbol          | Parameter                                  | Condition      | Min            | Typ | Max            | Units |
|-----------------|--------------------------------------------|----------------|----------------|-----|----------------|-------|
| $V_{OH}$        | Output HIGH Voltage<br>Q, /Q               |                | $V_{CC}-1.145$ |     | $V_{CC}-0.895$ | V     |
| $V_{OL}$        | Output LOW Voltage<br>Q, /Q                |                | $V_{CC}-1.545$ |     | $V_{CC}-1.295$ | mV    |
| $V_{OUT}$       | Output Voltage Swing<br>Q, /Q              | See Figure 1a. | 200            | 400 |                | mV    |
| $V_{DIFF\_OUT}$ | Differential Output Voltage Swing<br>Q, /Q | See Figure 1b. | 400            | 800 |                | mV    |

**AC ELECTRICAL CHARACTERISTICS<sup>(9)</sup>**

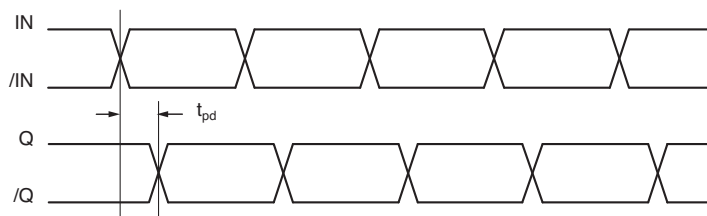
$V_{CC} = 2.5V \pm 5\%$  or  $3.3V \pm 10\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ ;  $R_L = 50\Omega$  to  $V_{CC}-2V$ , unless otherwise noted.

| Symbol          | Parameter                                                 | Condition                                           | Min  | Typ | Max | Units |
|-----------------|-----------------------------------------------------------|-----------------------------------------------------|------|-----|-----|-------|
| $f_{MAX}$       | Maximum Operating Frequency                               | $V_{OUT} \geq 400mV$ NRZ Data                       | 10.7 |     |     | Gbps  |
|                 |                                                           | Clock                                               | 7    |     |     | GHz   |
| $t_{pd}$        | Propagation Delay IN-to-Q                                 | $V_{IN} \geq 100mV$                                 | 70   | 125 | 220 | ps    |
| $t_{pd} Tempco$ | Differential Propagation Delay<br>Temperature Coefficient |                                                     |      | 115 |     | fs/°C |
| $t_{JITTER}$    | RMS Phase Jitter                                          | Output = 622MHz<br>Integration range: 12kHz - 20MHz |      | 75  |     | fs    |
| $t_r, t_f$      | Output Rise/Fall Times Q, /Q                              | (20% to 80%) At full output swing.                  | 20   | 40  | 70  | ps    |

**Notes:**

8. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
9. High-frequency AC electricals are guaranteed by design and characterization.

## TIMING DIAGRAM



## DEFINITION OF SINGLE-ENDED AND DIFFERENTIAL SWINGS



Figure 1a. Single-Ended Swing

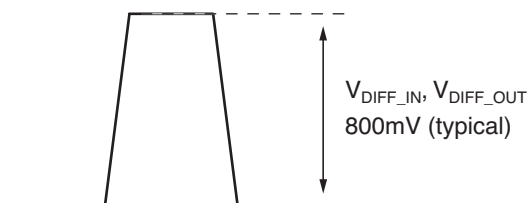


Figure 1b. Differential Swing

## INPUT AND OUTPUT STAGE INTERNAL TERMINATION

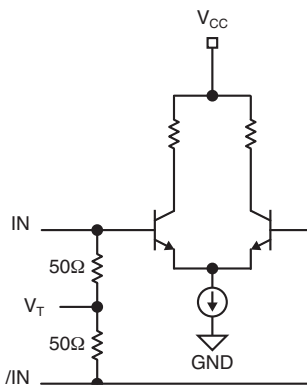


Figure 2a. Simplified Differential Input Stage

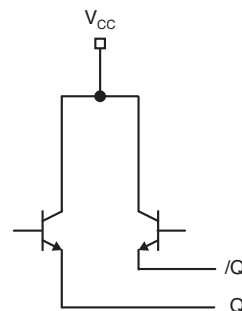
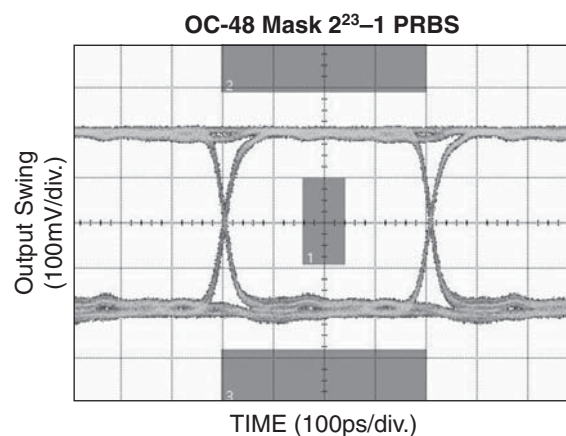
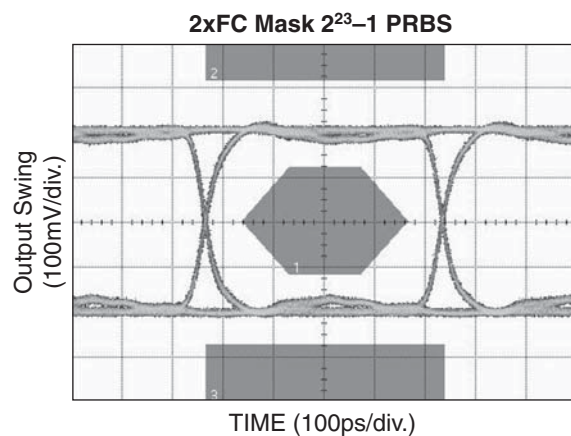
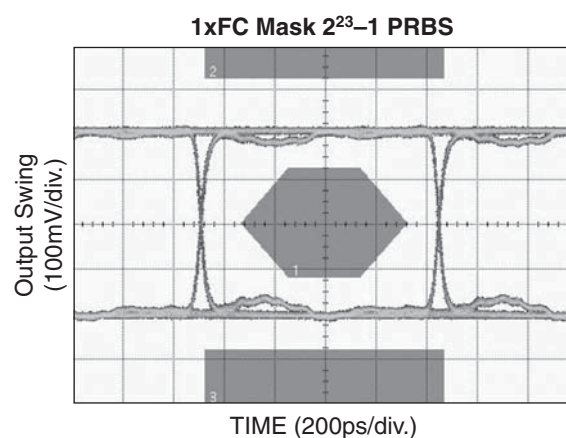
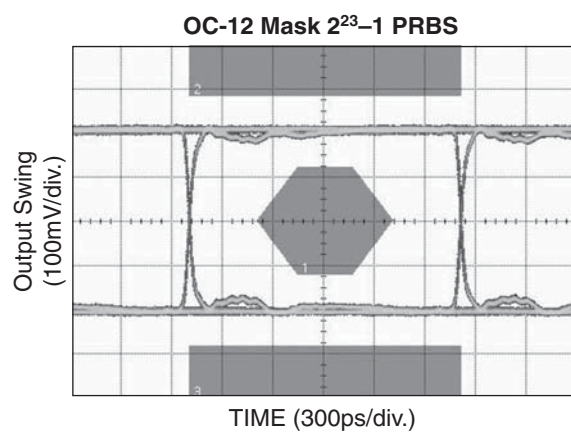
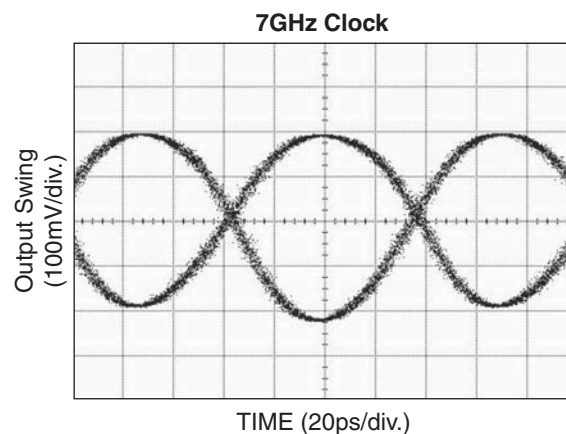
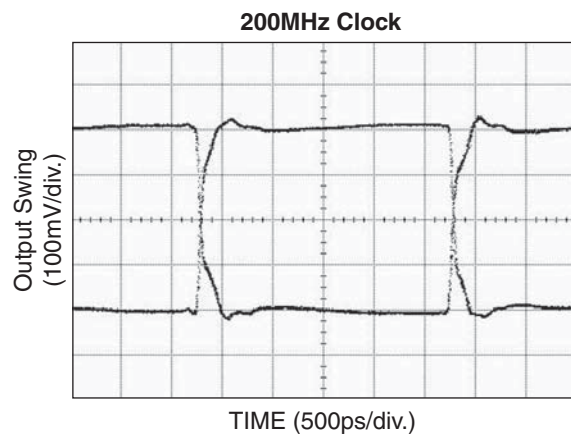
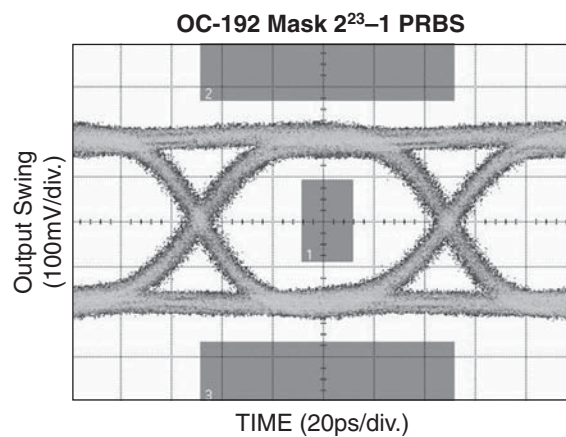
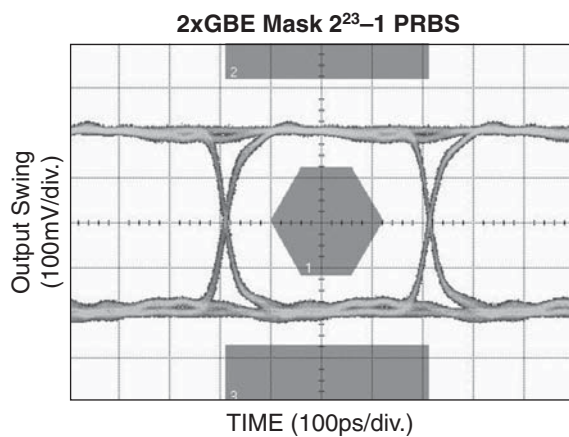


Figure 2b. Simplified Differential Output Stage

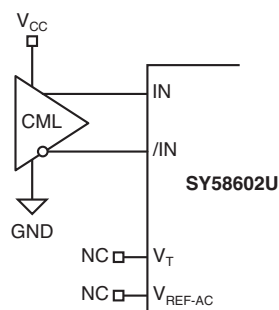
**TYPICAL OPERATING CHARACTERISTICS**

$V_{CC} = 3.3V$ ,  $GND = 0$ ,  $V_{IN} = 800mV$ .



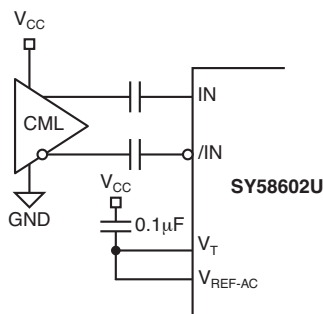
**TYPICAL OPERATING CHARACTERISTICS CONT'D** $V_{CC} = 3.3V$ ,  $GND = 0$ ,  $V_{IN} = 800mV$ .

## INPUT INTERFACE APPLICATIONS

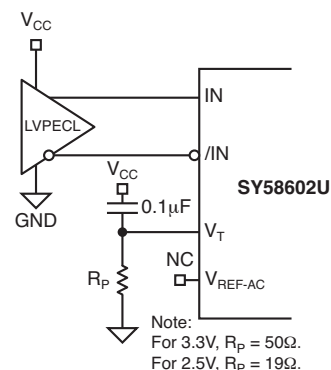


**Figure 3a. CML Interface  
(DC-Coupled)**

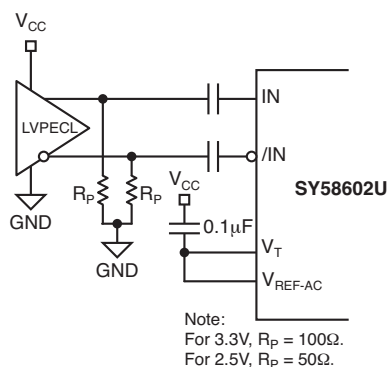
Option:  $V_T$  may be connected to  $V_{CC}$ .



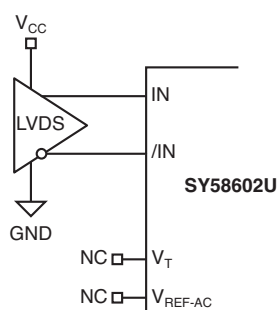
**Figure 3b. CML Interface  
(AC-Coupled)**



**Figure 3c. LVPECL Interface  
(DC-Coupled)**



**Figure 3d. LVPECL Interface  
(AC-Coupled)**



**Figure 3e. LVDS Interface**

OUTPUT INTERFACE APPLICATIONS

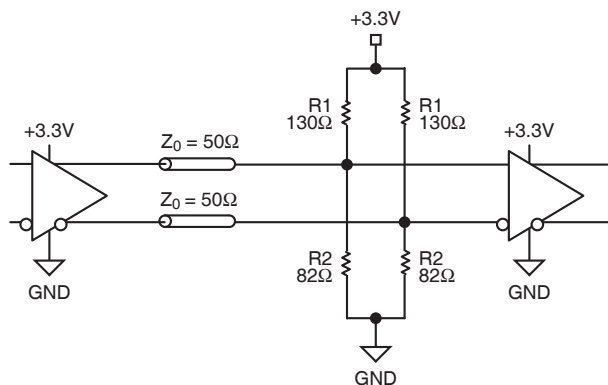


Figure 4a. Parallel Thevenin-Equivalent Termination

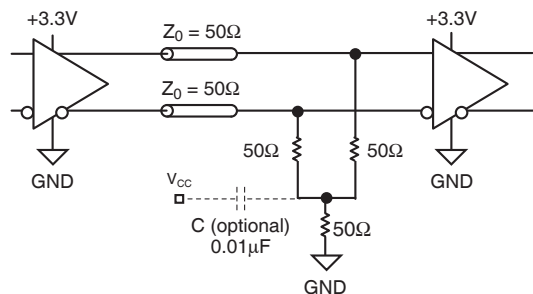
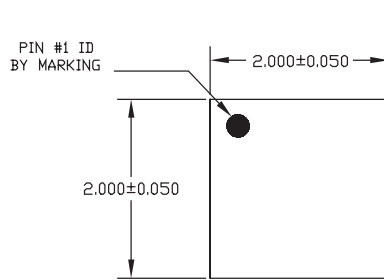


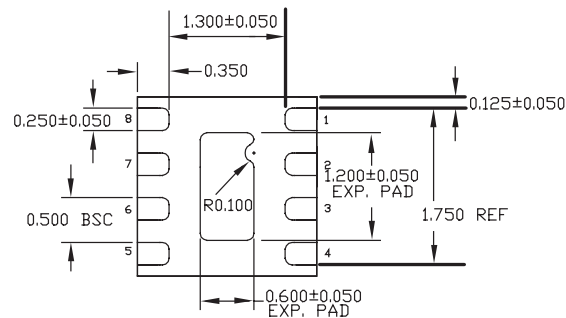
Figure 4b. Parallel Termination (3-Resistor)

RELATED PRODUCT AND SUPPORT DOCUMENTATION

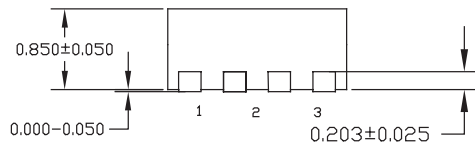
| Part Number   | Function                                                                                 | Data Sheet Link                                                                                                                |
|---------------|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| SY58600U      | Ultra-Precision Differential 400mV CML Line Driver/Receiver with Internal Termination    | <a href="http://www.micrel.com/product-info/products/sy58600u.shtml">www.micrel.com/product-info/products/sy58600u.shtml</a>   |
| SY58601U      | Ultra-Precision Differential 800mV LVPECL Line Driver/Receiver with Internal Termination | <a href="http://www.micrel.com/product-info/products/sy58601u.shtml">www.micrel.com/product-info/products/sy58601u.shtml</a>   |
| HBW Solutions | New Products and Applications                                                            | <a href="http://www.micrel.com/product-info/products/solutions.shtml">www.micrel.com/product-info/products/solutions.shtml</a> |

**8-PIN ULTRA-SMALL EPAD QFN (QFN-8)**

TOP VIEW

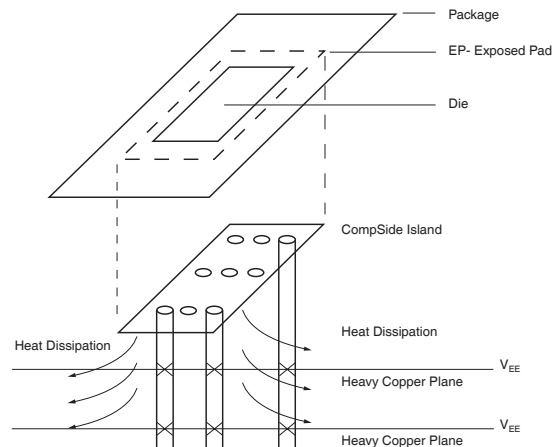


BOTTOM VIEW



SIDE VIEW

- NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
  2. MAX. PACKAGE WARPAGE IS 0.05 mm.
  3. MAXIMUM ALLOWABLE BURRS IS 0.076 mm IN ALL DIRECTIONS.
  4. PIN #1 ID ON TOP WILL BE LASER/INK MARKED.



**PCB Thermal Consideration for 8-Pin QFN Package**  
**(Always solder, or equivalent, the exposed pad to the PCB)**

**Package Notes:**

1. Package meets Level 2 qualification.
2. All parts dry-packaged before shipment.
3. Exposed pads must be soldered to a ground for proper thermal management.

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