



# 7GHz, 1:2 CML FANOUT BUFFER/TRANSLATOR WITH INTERNAL I/O TERMINATION

Precision Edge®  
SY58011U

## FEATURES

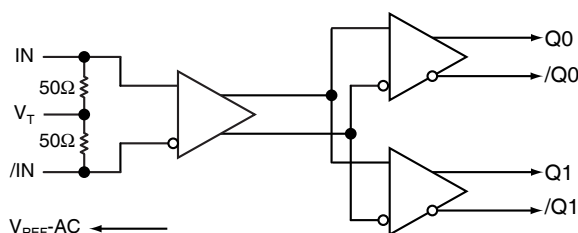
- Precision 1:2, 400mV CML fanout buffer
- Low jitter performance:
  - 49fs<sub>RMS</sub> phase jitter (typ)
- Guaranteed AC performance over temperature/ voltage:
  - > 7GHz  $f_{MAX}$  clock
  - < 60ps  $t_r$  /  $t_f$  times
  - < 250ps  $t_{pd}$
  - < 15ps max. skew
- Accepts an input signal as low as 100mV
- Unique input termination and  $V_T$  pin accepts DC-coupled and AC-coupled differential inputs: LVPECL, LVDS, and CML
- 50ohms source terminated CML outputs
- Power supply 2.5V  $\pm 5\%$  and 3.3V  $\pm 10\%$
- Industrial temperature range: -40°C to +85°C
- Available in 16-pin (3mm \* 3mm) QFN package

United States Patent No. RE44,134

## APPLICATIONS

- All SONET and GigE clock distribution
- Fibre Channel clock and data distribution
- Backplanes
- Data distribution: OC-48, OC-48+FEC, XAUI
- High-end, low skew, multiprocessor synchronous clock distribution

## FUNCTIONAL BLOCK DIAGRAM



Precision Edge®

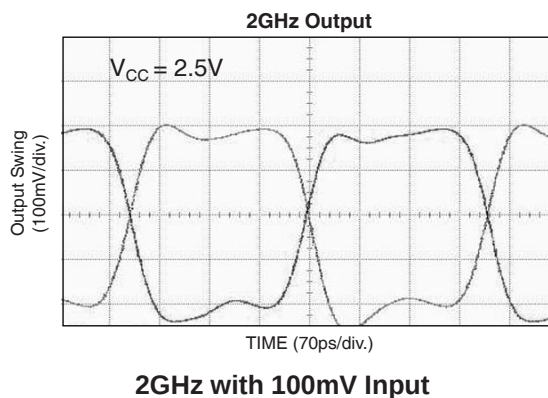
## DESCRIPTION

The SY58011U is a 2.5V/3.3V precision, high-speed, fully differential 1:2 CML fanout buffer. Optimized to provide two identical output copies with less than 15ps of skew and only 49fs<sub>RMS</sub> phase jitter, the SY58011U can process clock signals as fast as 7GHz or data patterns up to 10.7Gbps.

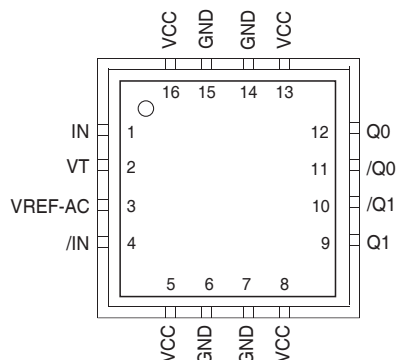
The differential input includes Micrel's unique, 3-pin input termination architecture that interfaces to LVPECL, LVDS, or CML differential signals, (AC-coupled or DC-coupled) as small as 100mV without any level-shifting or termination resistor networks in the signal path. For AC-coupled input interface applications, an on-board output reference voltage ( $V_{REF-AC}$ ) is provided to bias the  $V_T$  pin. The outputs are compatible with 400mV typical swing into 50ohms loads, with extremely fast rise/fall times guaranteed to be less than 60ps.

The SY58011U operates from a 2.5V  $\pm 5\%$  supply or 3.3V  $\pm 10\%$  supply and is guaranteed over the full industrial temperature range (-40°C to +85°C). For applications that require LVPECL outputs, consider the SY58012U or SY58013U 1:2 fanout buffer with 800mV and 400mV output swing, respectively. The SY58011U is part of Micrel's high-speed, Precision Edge® product line. Datasheets and support documentation can be found on Micrel's web site at [www.micrel.com](http://www.micrel.com).

## TYPICAL PERFORMANCE



## PACKAGE/ORDERING INFORMATION



**16-Pin QFN (QFN-16)**

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

| Part Number                    | Package Type      | Operating Range | Package Marking                         |
|--------------------------------|-------------------|-----------------|-----------------------------------------|
| SY58011UMG <sup>(3)</sup>      | QFN-16<br>Pb-Free | Industrial      | 011U with<br>Pb-Free bar-line indicator |
| SY58011UMGTR <sup>(2, 3)</sup> | QFN-16<br>Pb-Free | Industrial      | 011U with<br>Pb-Free bar-line indicator |

**Notes:**

1. Contact factory for die availability. Dice are guaranteed at  $T_A = 25^\circ\text{C}$ , DC electricals only. All devices are Pb-Free.
2. Tape and Reel.
3. Pb-Free package recommended for new designs.

## PIN DESCRIPTION

| Pin Number      | Pin Name              | Pin Function                                                                                                                                                                                                                                                                                                                          |
|-----------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1, 4            | IN, /IN               | Differential Input: This input pair is the signal to be buffered. Each pin of this pair internally terminates with 50ohms to the $V_T$ pin. Note that this input will default to an indeterminate state if left open. See <i>"Input Interface Applications"</i> section.                                                              |
| 2               | VT                    | Input Termination Center-Tap: Each input terminates to this pin. The $V_T$ pin provides a center-tap for each input (IN, /IN) to a termination network for maximum interface flexibility. See <i>"Input Interface Applications"</i> section.                                                                                          |
| 3               | VREF-AC               | Reference Output Voltage: This output biases to $V_{CC} - 1.2\text{V}$ . It is used when AC-coupling the inputs (IN, /IN). Connect $V_{REF-AC}$ directly to the $V_T$ pin. Bypass with 0.01 $\mu\text{F}$ low ESR capacitor to $V_{CC}$ . Maximum current source or sink is 0.5mA. See <i>"Input Interface Applications"</i> section. |
| 5, 8, 13, 16    | VCC                   | Positive Power Supply: Bypass with 0.1 $\mu\text{F}$ //0.01 $\mu\text{F}$ low ESR capacitors as close to the $V_{CC}$ pins as possible.                                                                                                                                                                                               |
| 6, 7, 14, 15    | GND,<br>(Exposed Pad) | Ground. Exposed pad must be connected to a ground plane that is the same potential as the ground pin.                                                                                                                                                                                                                                 |
| 12, 11<br>9, 10 | Q0, /Q0,<br>Q1, /Q1   | CML Differential Output Pairs: Differential buffered output copy of the input signal. The output swing is typically 400mV. Unused output pairs may be left floating with no impact on jitter. See <i>"CML Output Termination"</i> section.                                                                                            |

**Absolute Maximum Ratings**(Note 1)

|                                                        |                                      |
|--------------------------------------------------------|--------------------------------------|
| Power Supply Voltage ( $V_{CC}$ )                      | ..... -0.5V to +4.0V                 |
| Input Voltage ( $V_{IN}$ )                             | ..... -0.5V to $V_{CC}$              |
| CML Output Voltage ( $V_{OUT}$ )                       | ..... $V_{CC}-1.0V$ to $V_{CC}+0.5V$ |
| Current ( $V_T$ )                                      |                                      |
| Source or sink current on $V_T$ pin                    | ..... $\pm 100mA$                    |
| Input Current                                          |                                      |
| Source or sink current on IN, /IN                      | ..... $\pm 50mA$                     |
| Current ( $V_{REF}$ )                                  |                                      |
| Source or sink current on $V_{REF-AC}$ , <b>Note 4</b> | ..... $\pm 1.5mA$                    |
| Lead Temperature Soldering, (20 seconds)               | ..... 260°C                          |
| Storage Temperature Range ( $T_{STORE}$ )              | ... -65°C to +150°C                  |

**Operating Ratings**(Note 2)

|                                           |                         |
|-------------------------------------------|-------------------------|
| Supply Voltage ( $V_{CC}$ )               | ..... +2.375V to +3.60V |
| Operating Temperature Range ( $T_A$ )     | ..... -40°C to +85°C    |
| Package Thermal Resistance, <b>Note 3</b> |                         |
| QFN ( $\theta_{JA}$ )                     |                         |
| Still-Air                                 | ..... 60°C/W            |
| 500lfpm                                   | ..... 54°C/W            |
| QFN ( $\psi_{JB}$ )                       | ..... 33°C/W            |

**DC ELECTRICAL CHARACTERISTICS**(Note 5) $T_A = -40^\circ C$  to  $+85^\circ C$ 

| Symbol         | Parameter                        | Condition               | Min          | Typ          | Max          | Units    |
|----------------|----------------------------------|-------------------------|--------------|--------------|--------------|----------|
| $V_{CC}$       | Power Supply Voltage             |                         | 2.375        |              | 3.60         | V        |
| $I_{CC}$       | Power Supply Current             | Max. $V_{CC}$ , no load |              | 75           | 95           | mA       |
| $V_{IH}$       | Input HIGH Voltage               | IN, /IN, Note 6         | $V_{CC}-1.6$ |              | $V_{CC}$     | V        |
| $V_{IL}$       | Input LOW Voltage                | IN, /IN                 | 0            |              | $V_{IH}-0.1$ | V        |
| $V_{IN}$       | Input Voltage Swing              | see Figure 1a.          | 0.1          |              | 1.7          | V        |
| $V_{DIFF\_IN}$ | Differential Input Voltage Swing | see Figure 1b.          | 0.2          |              |              | V        |
| $R_{IN}$       | Into $V_T$ Resistance            |                         | 40           | 50           | 60           | $\Omega$ |
| $V_{REF-AC}$   | Output Reference Voltage         |                         | $V_{CC}-1.3$ | $V_{CC}-1.2$ | $V_{CC}-1.1$ | V        |
| IN to $V_T$    |                                  |                         |              |              | 1.28         | V        |

**CML DC ELECTRICAL CHARACTERISTICS**(Note 5) $V_{CC} = 3.3V \pm 10\%$  or  $2.5V \pm 5\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ ;  $R_L = 100\Omega$  across each output pair, or equivalent, unless otherwise stated.

| Symbol          | Parameter                         | Condition                        | Min            | Typ            | Max      | Units |
|-----------------|-----------------------------------|----------------------------------|----------------|----------------|----------|-------|
| $V_{OH}$        | Output HIGH Voltage               | Q0, /Q0, Q1, /Q1                 | $V_{CC}-0.020$ | $V_{CC}-0.010$ | $V_{CC}$ | V     |
| $V_{OUT}$       | Output Voltage Swing              | Q0, /Q0, Q1, /Q1; see Figure 1a. | 325            | 400            |          | mV    |
| $V_{DIFF\_OUT}$ | Differential Output Voltage Swing | Q0, /Q0, Q1, /Q1; see Figure 1b. | 650            | 800            |          | mV    |
| $R_{OUT}$       | Output Source Impedance           | Q0, /Q0, Q1, /Q1                 | 40             | 50             | 60       | ohms  |

**Notes:**

1. Permanent device damage may occur if absolute maximum ratings are exceeded. This is a stress rating only and functional operation is not implied at 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. Thermal performance assumes exposed pad is soldered (or equivalent) to the device's most negative potential (gnd) on the pcb.
4. Due to the limited drive capability, use for input of the same package only.
5. The circuit is designed to meet the dc specifications shown in the above table after thermal equilibrium has been established.
6.  $V_{IH}$  (min) not lower than 1.2V.

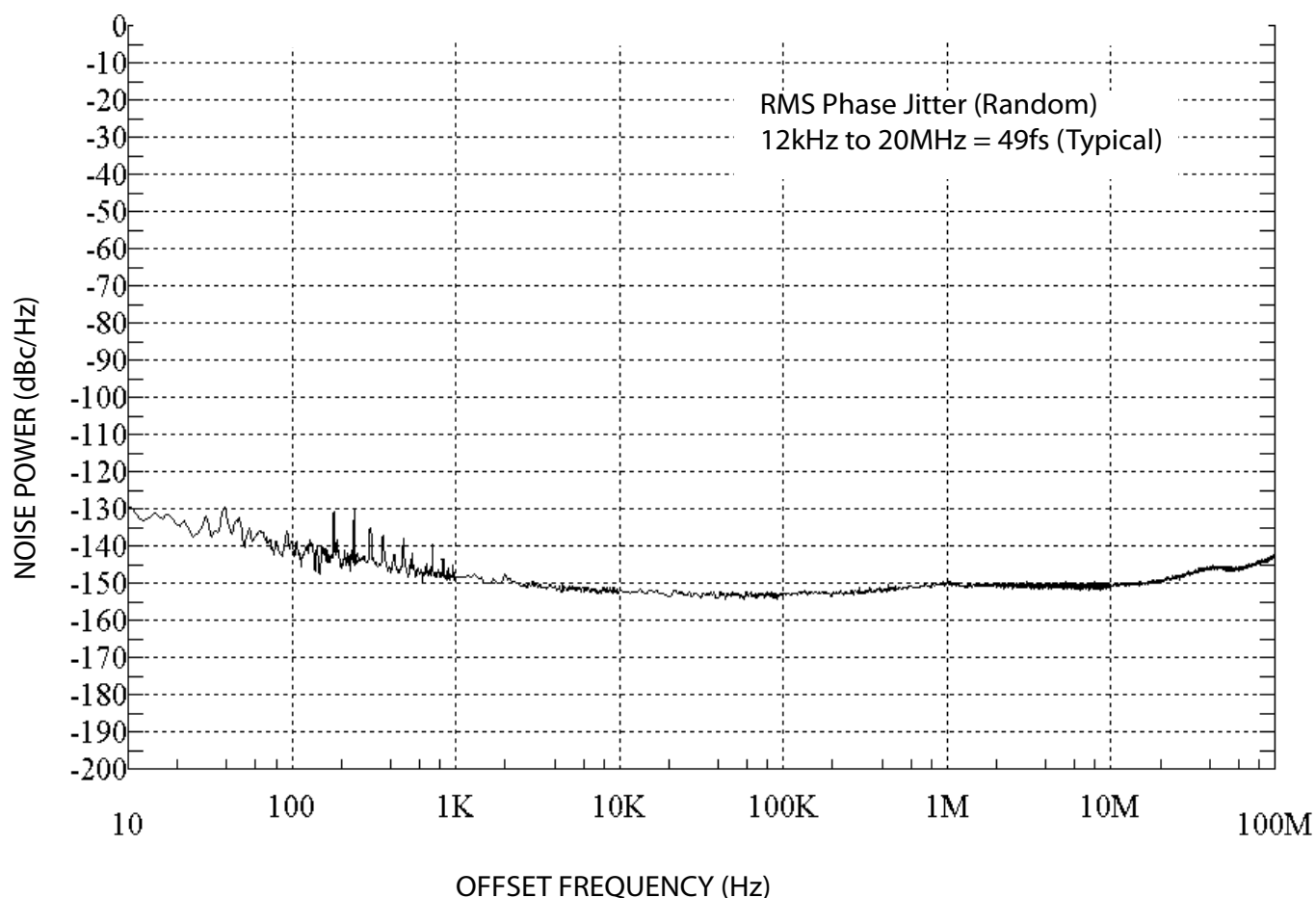
**AC ELECTRICAL CHARACTERISTICS (Note 7)**

$V_{CC} = 2.5V \pm 5\%$  or  $3.3V \pm 10\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ ;  $R_L = 100\Omega$  across each output pair, or equivalent, unless otherwise stated.

| Symbol       | Parameter                   | Condition                                           | Min | Typ  | Max | Units             |
|--------------|-----------------------------|-----------------------------------------------------|-----|------|-----|-------------------|
| $f_{MAX}$    | Maximum Operating Frequency | NRZ Data                                            |     | 10.7 |     | Gbps              |
|              |                             | $V_{OUT} > 200mV$ Clock                             | 7   | 8    |     | GHz               |
| $t_{pd}$     | Propagation Delay           | $V_{IN} > 100mV$                                    | 100 | 170  | 250 | ps                |
| $t_{CHAN}$   | Channel-to-Channel Skew     | <b>Note 8</b>                                       |     | 3    | 15  | ps                |
| $t_{SKEW}$   | Part-to-Part Skew           | <b>Note 9</b>                                       |     |      | 100 | ps                |
| $t_{JITTER}$ | RMS Phase Jitter            | Output = 622MHz<br>Integration Range: 12kHz - 20MHz |     | 49   |     | fs <sub>RMS</sub> |
| $t_r, t_f$   | Output Rise/Fall Time       | 20% to 80% at full output swing                     | 20  | 40   | 60  | ps                |

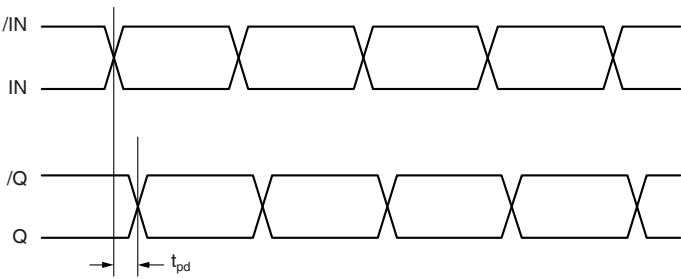
**Notes:**

7. High frequency AC electricals are guaranteed by design and characterization.
8. Skew is measured between outputs of the same bank under identical transitions.
9. Skew is defined for two parts with identical power supply voltages at the same temperature and with no skew of the edges at the respective inputs.

**PHASE NOISE**

Phase Noise Plot: 622MHz @ 3.3V

**TIMING DIAGRAM**



**SINGLE-ENDED AND DIFFERENTIAL SWINGS**

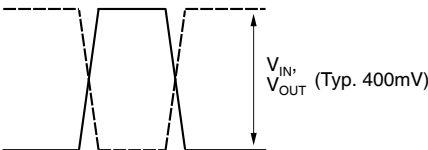


Figure 1a. Single-Ended Voltage Swing

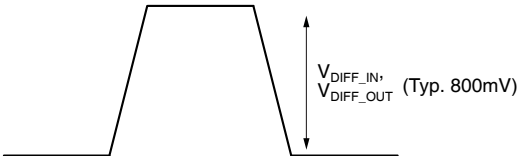
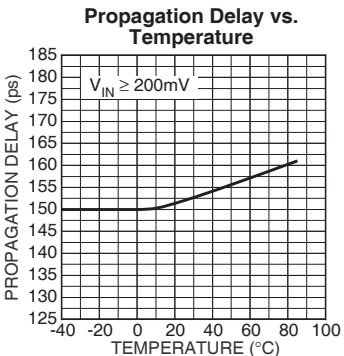
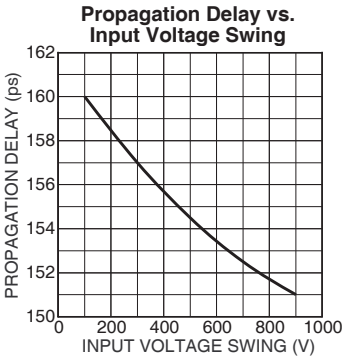
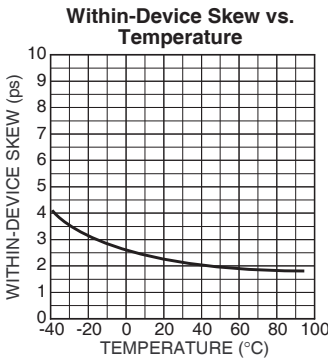
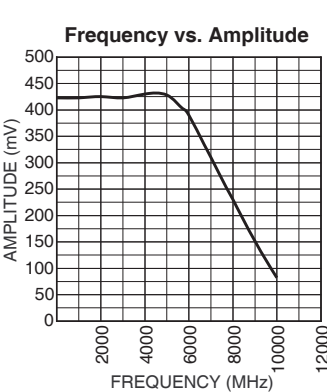


Figure 1b. Differential Voltage Swing

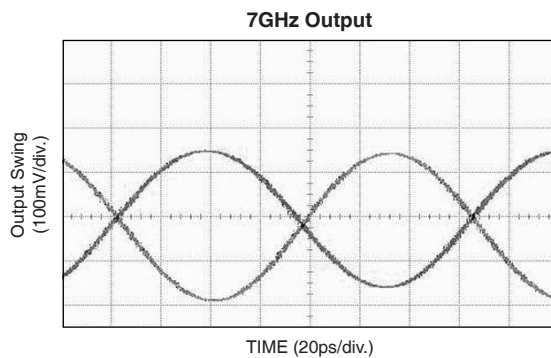
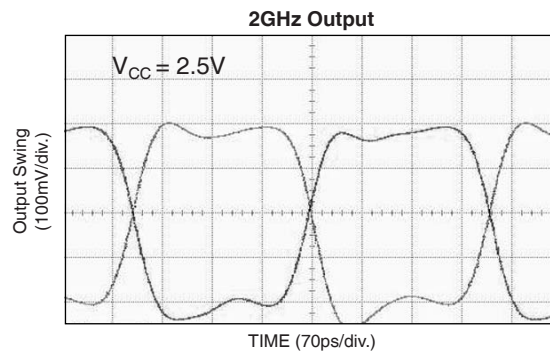
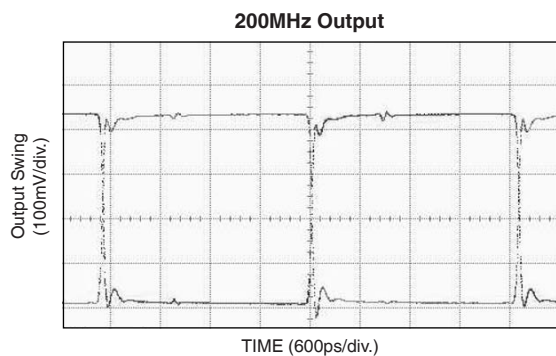
TYPICAL OPERATING CHARACTERISTICS

$V_{CC} = 3.3V$ ,  $GND = 0$ ,  $V_{IN} = 100mV$ ,  $T_A = 25^{\circ}C$ , unless otherwise stated.

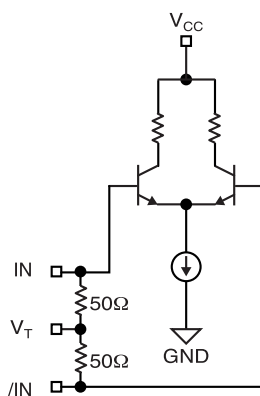


**FUNCTIONAL CHARACTERISTICS**

$V_{CC} = 2.5V$ ,  $GND = 0$ ,  $V_{IN} = 100mV$ ,  $T_A = 25^\circ C$ , unless otherwise stated.

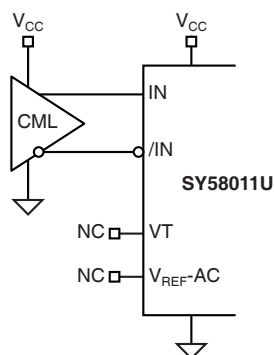


## INPUT STAGE

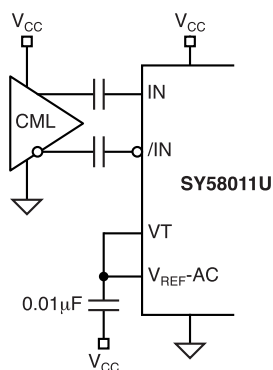


**Figure 2. Simplified Differential Input Buffer**

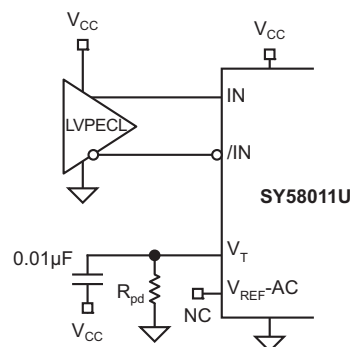
## INPUT INTERFACE APPLICATIONS



**Figure 3a. DC-Coupled CML Input Interface**  
(option: may connect  $V_T$  to  $V_{CC}$ )

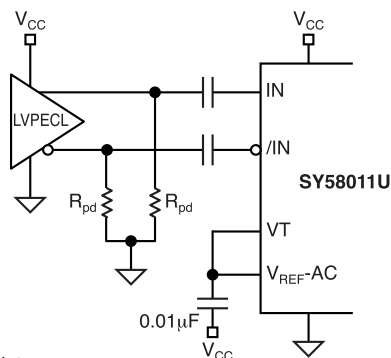


**Figure 3b. AC-Coupled CML Input Interface**



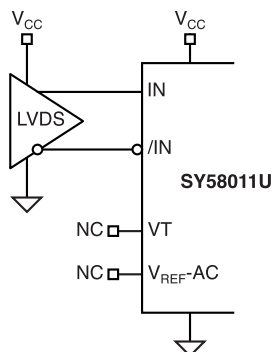
Note:  
For  $V_{CC} = 2.5V$  systems,  $R_{pd} = 19\Omega$ .  
For  $V_{CC} = 3.3V$  systems,  $R_{pd} = 50\Omega$ .

**Figure 3c. LVPECL Input Interface**



Note:  
 $R_{pd} = 100\Omega$  for a 3.3V system  
 $R_{pd} = 50\Omega$  for a 2.5V system

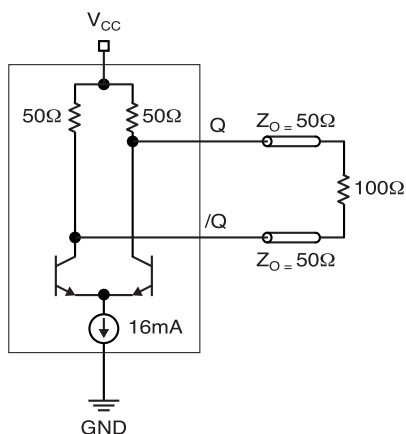
**Figure 3d. AC-Coupled LVPECL Input Interface**



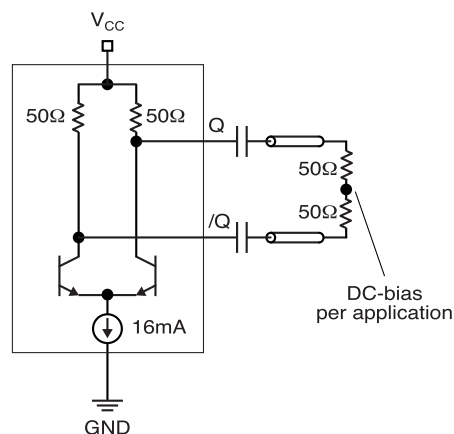
**Figure 3e. LVDS Input Interface**

## CML OUTPUT TERMINATION

Figure 4 and Figure 5 illustrates how to terminate a CML output using both the AC-coupled and DC-coupled configuration. All outputs of the SY58011 are 50ohms with a 16mA current source.



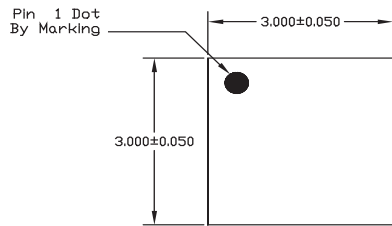
**Figure 4. CML DC-Coupled Termination**



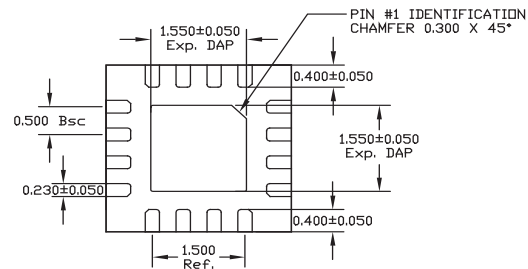
**Figure 5. CML AC-Coupled Termination**

## RELATED MICREL PRODUCTS AND SUPPORT DOCUMENTATION

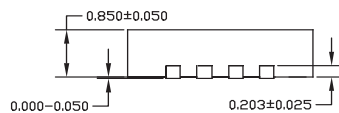
| Part Number | Function                                                                                    | Data Sheet Link                                                                                                                        |
|-------------|---------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| SY58011U    | 7GHz, 1:2 CML Fanout Buffer/Translator with Internal I/O Termination                        | <a href="http://www.micrel.com/product-info/products/sy58011u.shtml">http://www.micrel.com/product-info/products/sy58011u.shtml</a>    |
| SY58012U    | 5GHz, 1:2 LVPECL Fanout Buffer/Translator with Internal Input Termination                   | <a href="http://www.micrel.com/product-info/products/sy58012u.shtml">http://www.micrel.com/product-info/products/sy58012u.shtml</a>    |
| SY58013U    | 6GHz, 1:2 Fanout Buffer/Translator with 400mV LVPECL Outputs and Internal Input Termination | <a href="http://www.micrel.com/product-info/products/sy58013u.shtml">http://www.micrel.com/product-info/products/sy58013u.shtml</a>    |
|             | 16-MLF <sup>®</sup> Manufacturing Guidelines Exposed Pad Application Note                   | <a href="http://www.amkor.com/products/notes_papers/MLF_AppNote_0902.pdf">www.amkor.com/products/notes_papers/MLF_AppNote_0902.pdf</a> |
|             | HBW Solutions                                                                               | <a href="http://www.micrel.com/product-info/as/solutions.shtml">http://www.micrel.com/product-info/as/solutions.shtml</a>              |

**16-PIN QFN (QFN-16)**

TOP VIEW



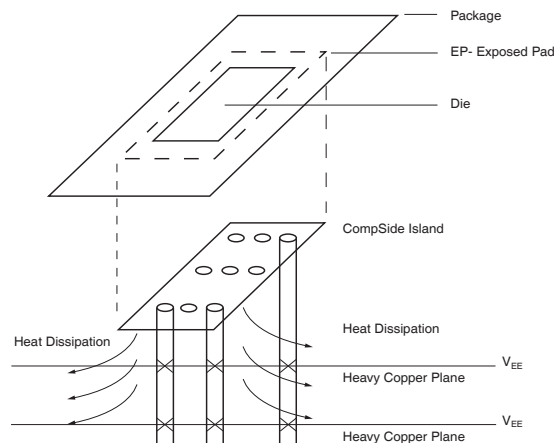
BOTTOM VIEW



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 16-Pin QFN Package**  
**(Always solder, or equivalent, the exposed pad to the PCB)**

**Package Notes:**

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

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