



# SY58031U

## Ultra-Precision 1:8 CML Fanout Buffer with Internal I/O Termination

### General Description

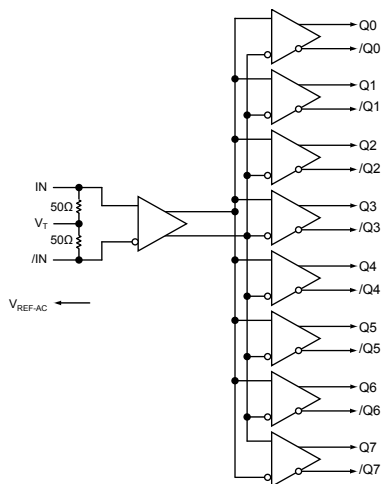
The SY58031U is a 2.5V/3.3V precision, high-speed, fully differential CML 1:8 fanout buffer. The SY58031U is optimized to provide eight identical output copies with less than 20ps of skew and only 75fs<sub>RMS</sub> phase jitter. It can process clock signals as fast as 6GHz.

The differential input includes Micrel's unique, 3-pin input termination architecture that allows the SY58031U to directly interface to CML, LVPECL, and LVDS differential signals (AC- or DC-coupled) without any level-shifting or termination resistor networks in the signal path. The result is a clean, stub-free, low-jitter interface solution. The CML outputs feature 400mV typical swing into 50Ω loads and provide an extremely fast rise/fall time guaranteed to be less than 60ps.

The SY58031U operates from a 2.5V ±5% supply or 3.3V ±10% supply and is guaranteed over the full industrial temperature range (−40°C to +85°C). For applications that require high-speed 1:8 LVPECL fanout buffers, consider the SY58032U and SY58033U. The SY58031U is part of Micrel's high-speed, Precision Edge<sup>®</sup> product line.

Datasheets and support documentation are available on Micrel's web site at: [www.micrel.com](http://www.micrel.com).

### Block Diagram



Precision Edge<sup>®</sup>

### Features

- Precision 1:8, 400mV CML fanout buffer
- Guaranteed AC performance over temperature and voltage:
  - Clock frequency range: DC to >6GHz
  - <60ps t<sub>r</sub>/t<sub>f</sub> time
  - <270ps t<sub>pd</sub>
  - <20ps output-to-output skew
- Low-jitter performance:
  - 75fs<sub>RMS</sub> phase jitter (typ.)
- 50Ω source-terminated CML outputs
- 400mV CML output swing into 50Ω load
- Fully differential I/O
- Accepts an input signal as low as 100mV
- Unique, patent-pending input termination and VT pin accepts DC-coupled and AC-couple differential inputs (LVPECL, LVDS, and CML)
- Power supply 2.5V ±5% or 3.3V ±10%
- Industrial temperature range: −40°C to +85°C
- Available in 32-pin, 5mm × 5mm QFN package

### Applications

- All SONET and GigE clock distribution
- All Fibre Channel clock and data distribution
- Network routing engine timing distribution
- High-end, low-skew multiprocessor synchronous clock distribution

Precision Edge is a registered trademark of Micrel, Inc.

Micrel Inc. • 2180 Fortune Drive • San Jose, CA 95131 • USA • tel +1 (408) 944-0800 • fax + 1 (408) 474-1000 • <http://www.micrel.com>

October 1, 2013

Revision 5.0  
[hbwhelp@micrel.com](mailto:hbwhelp@micrel.com) or (408) 955-1690

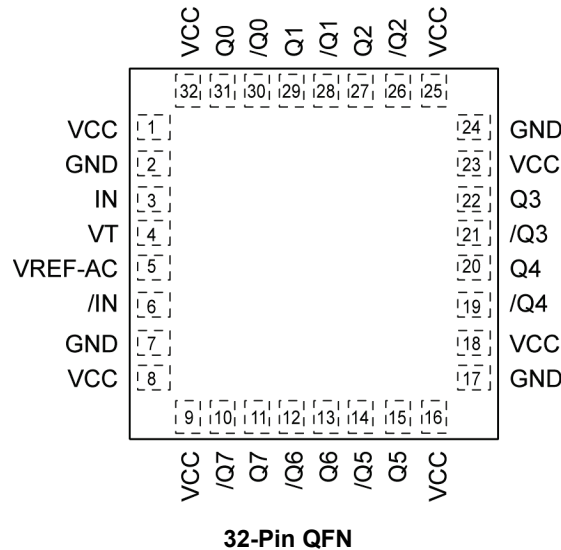
## Ordering Information

| Part Number <sup>(1)</sup>  | Package Type | Operating Range | Package Marking                          | Lead Finish    |
|-----------------------------|--------------|-----------------|--|----------------|
| SY58031UMG                  | QFN-32       | Industrial      | SY58031U with Pb-free bar-line indicator | Pb-Free NiPdAu |
| SY58031UMGTR <sup>(2)</sup> | QFN-32       | Industrial      | SY58031U with Pb-free bar-line indicator | Pb-Free NiPdAu |

**Note:**

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

## Pin Configuration



## Pin Description

| Pin Number  | Pin Name   | Pin Function   |
|---|--|--|
| 3, 6  | IN, /IN  | Differential signal input: Each pin of this pair internally terminates with 50Ω to the VT pin. Note that this input will default to an indeterminate state if left open. See Input Interface Applications section.                                   |
| 4   | VT   | Input termination center-tap: Each input terminates to this pin. The VT pin provides a center-tap for each input (IN, /IN) to the termination network for maximum interface flexibility. See Input Interface Applications section.                   |
| 2, 7, 17, 24  | GND,<br>Exposed Pad  | Ground. Exposed pad must be connected to a ground plane that is the same potential as the ground pin.  |
| 1, 8, 9, 16<br>18, 23, 25, 32   | VCC  | Positive power supply: Bypass with 0.1μF/0.01μF low ESR capacitors as close to the pins as possible  |
| 31, 30, 29, 28,<br>27, 26, 22, 21<br>20, 19, 15, 14<br>13, 12, 11, 10 | Q0, /Q0, Q1, /Q1<br>Q2, /Q2, Q3, /Q3<br>Q4, /Q4, Q5, /Q5<br>Q6, /Q6, Q7, /Q7 | CML differential output pairs: Differential buffered output copy of the input signal. The CML output swing is typically 400mV into 50Ω. Unused output pairs may be left floating with no impact on jitter. See CML Output Termination section        |
| 5   | VREF-AC  | Bias Reference Voltage: Equal to $V_{CC}-1.2V$ (typical), and used for AC-coupled applications. See Input Interface Applications section. When using $V_{REF-AC}$ , bypass with 0.01μF capacitor to $V_{CC}$ . Maximum sink/source current is 0.5mA. |

### Absolute Maximum Ratings<sup>(3)</sup>

Power Supply Voltage (VCC)..... -0.5V to +4.0V  
 Input Voltage (VIN)..... -0.5V to VCC  
 Current (VT)  
     Source or sink current on VT pin..... ±100mA  
 Input Current (VT)  
     Source or sink current on IN, /IN..... ±50mA  
 Current (VREF)  
     Source or sink current on VREF-AC<sup>(5)</sup> ..... ±1.5mA  
 Lead Temperature (soldering, 20s)..... 260°C  
 Storage Temperature (Ts)..... -65°C to +150°C

### Operating Ratings<sup>(4)</sup>

Power Supply Voltage (VCC) ..... +2.375V to +3.6V  
 Ambient Temperature (TA)..... -40°C to +85°C  
 Junction Thermal Resistance<sup>(6)</sup>  
     QFN (θJA), Still-Air..... 35°C/W  
     QFN (ψJB), Junction-to-Board..... 20°C/W

### DC Electrical Characteristics<sup>(7)</sup>

TA = -40°C to +85°C.

| Symbol   | Parameter   | Condition   | Min.         | Typ.       | Max.         | Units |
|----------|---|---|--------------|------------|--------------|-------|
| VCC      | Power supply voltage                                      | 2.5V nominal<br>3.3V nominal                                | 2.375<br>3.0 | 2.5<br>3.3 | 2.625<br>3.6 | V     |
| ICC      | Power supply current                                      | VCC = max., no load. Includes current through 50Ω pull-ups. |              | 265        | 330          | mA    |
| VIH      | Input HIGH voltage  | IN1, /IN1, <a href="#">Note 8</a>                           | VCC-1.6      |            | VCC          | V     |
| VIL      | Input LOW voltage   | IN1, /IN1   | 0            |            | VIH-0.1      | V     |
| VIN      | Input voltage swing                                       | IN1, /IN1, see <a href="#">Figure 1</a> .                   | 0.1          |            | 1.7          | V     |
| VDIFF_IN | Differential input voltage swing [IN0, /IN0], [IN1, /IN1] | IN1, /IN1, see <a href="#">Figure 2</a> .                   | 0.2          |            |              | V     |
| RIN      | In-to-VT resistance                                       |   | 40           | 50         | 60           | Ω     |
| VT IN    | Max. In-to-VT (IN, /IN)                                   |   |              |            | 1.28         | V     |
| VREF-AC  |   |   | VCC-1.3      | VCC-1.2    | VCC-1.1      | V     |

## CML DC Electrical Characteristics<sup>(7)</sup>

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

| Symbol          | Parameter                  | Condition     | Min.            | Typ. | Max.     | Units    |
|-----------------|----------------------------|---------------|-----------------|------|----------|----------|
| $V_{OH}$        | Output HIGH voltage        |               | $V_{CC} - 0.02$ |      | $V_{CC}$ | V        |
| $V_{OUT}$       | Output LOW voltage         | See Figure 1. | 325             | 400  |          | mV       |
| $V_{DIFF\_OUT}$ | Differential voltage swing | See Figure 2. | 650             | 800  |          | mV       |
| $R_{OUT}$       | Output source impedance    |               | 40              | 50   | 60       | $\Omega$ |

### Notes:

- Exceeding the absolute maximum ratings may damage the device.
- The datasheet ratings are not guaranteed if the device is operated beyond the operating ratings.
- Due to the limited drive capability, use for input of the same package only.
- Thermal performance assumes exposed pad is soldered (or equivalent) to the device's most negative potential (GND) on the PCB.  $\psi_{JB}$  uses 4-layer  $\theta_{JA}$  in still-air number unless otherwise stated.
- The device is not guaranteed to function outside its operating ratings.
- $V_{IH}$  (min.) not lower than 1.2V.

## AC Electrical Characteristics<sup>(9)</sup>

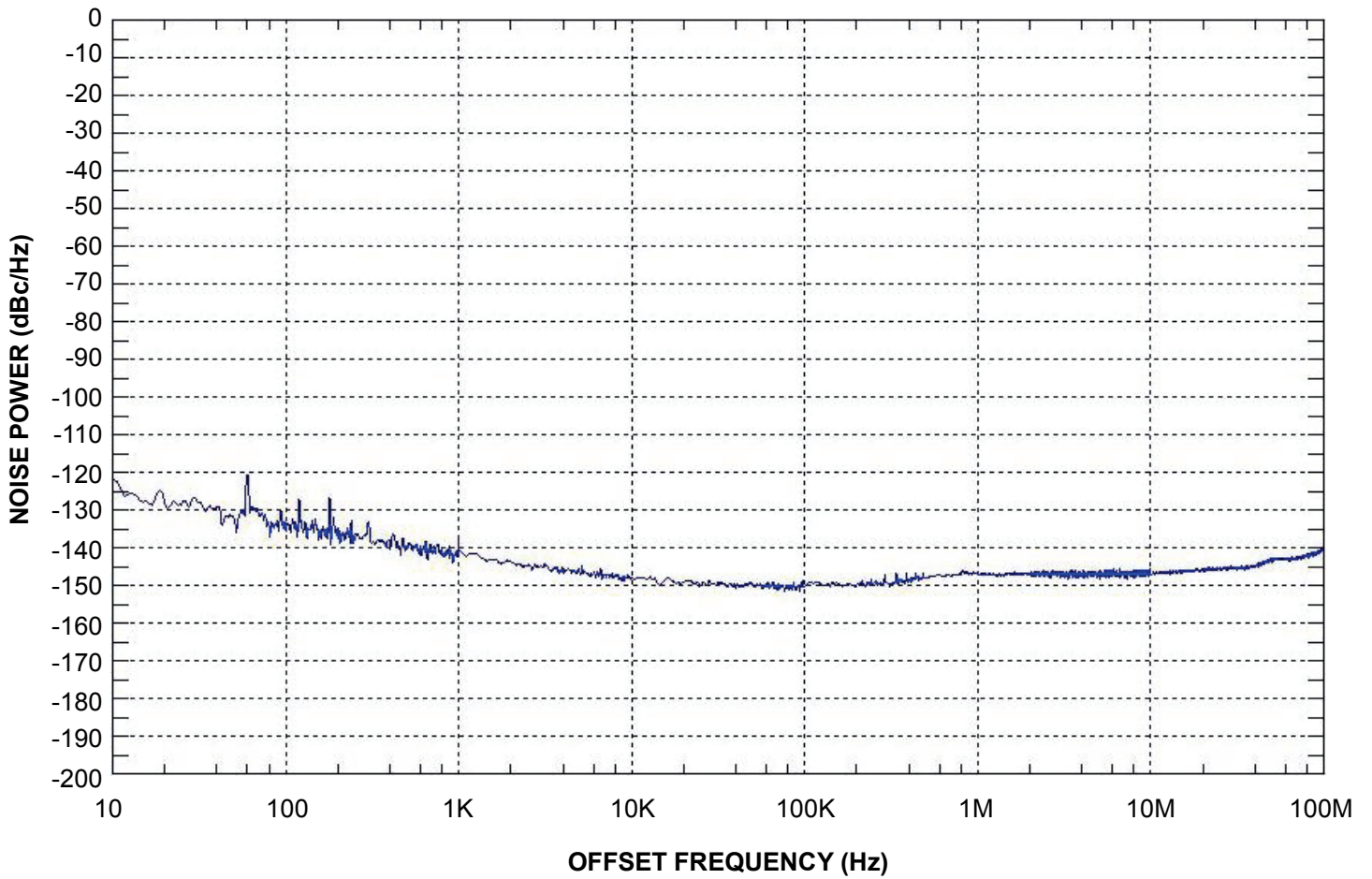
$V_{CC} = 2.5V \pm 5\%$  or  $3.3V \pm 10\%$ ;  $R_L = 100\Omega$  across each output pair or equivalent;  $T_A = -40^\circ C$  to  $+85^\circ C$ , unless otherwise stated.

| Symbol           | Parameter  | Condition   | Min. | Typ. | Max. | Units          |
|------------------|--|---|------|------|------|----------------|
| $f_{MAX}$        | Maximum operating frequency                            | $V_{OUT} \geq 200mV$ clock                        | 6    |      |      | GHz            |
| $t_{pd}$         | Propagation delay (IN-to-Q)                            |   | 120  | 230  | 270  | ps             |
| $t_{pd\ tempco}$ | Differential propagation delay temperature coefficient |   |      | 35   |      | fs/ $^\circ C$ |
| $t_{SKEW}$       | Output-to-output (within device)                       | Note 10   |      | 7    | 20   | ps             |
|                  | Part-to-part   | Note 11   |      |      | 100  | ps             |
| $t_{JITTER}$     | RMS phase jitter                                       | Output: 622MHz<br>Integration range 12kHz – 20MHz |      | 75   |      | ps             |
| $t_r/t_f$        | Output rise/fall time                                  | 20% to 80% at full output swing.                  | 20   | 45   | 60   | ps             |

### Notes:

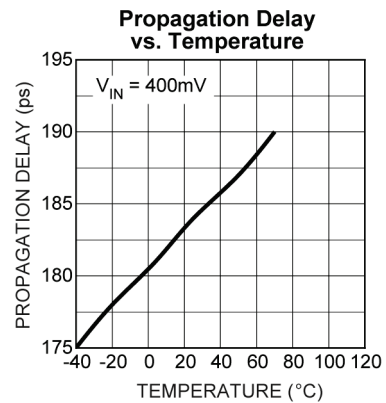
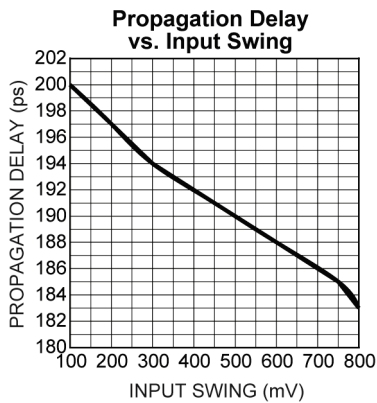
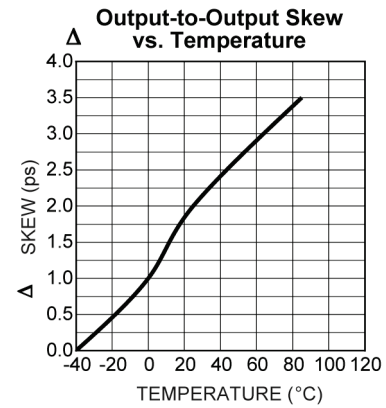
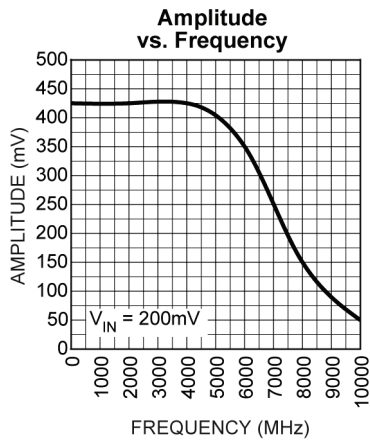
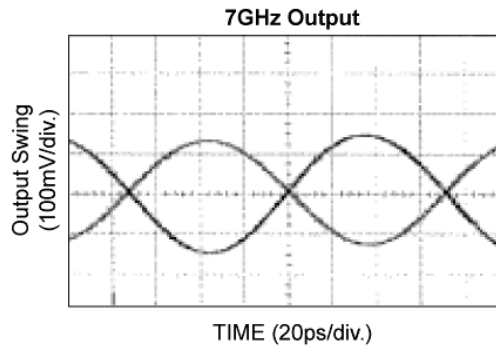
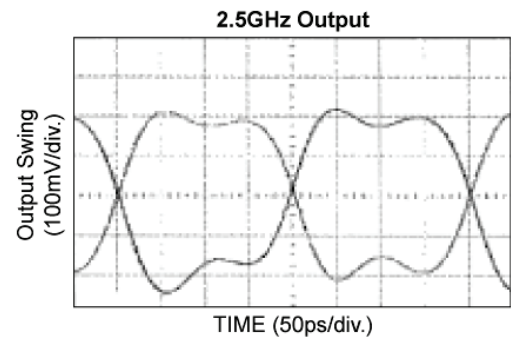
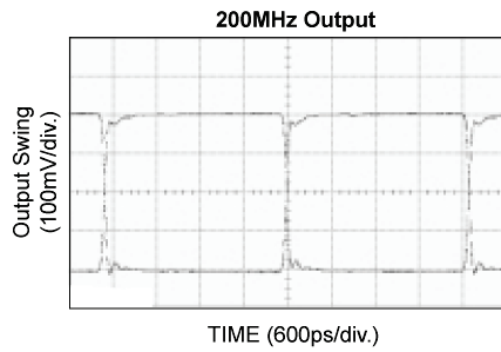
- High frequency AC electricals are guaranteed by design and characterization. All outputs loaded,  $V_{IN} \geq 100mV$ .
- Output-to-output skew is measured between outputs under identical transitions.
- Part-to-part skew is defined for two parts with identical power supply voltages at the same temperature with no skew of the edges at the respective inputs. Part-to-part skew includes variation in  $t_{pd}$ .

### Phase Noise Plot



Phase Noise Plot: 622MHz @ 3.3V

# Typical Operating Characteristics



### Single-Ended and Differential Swings

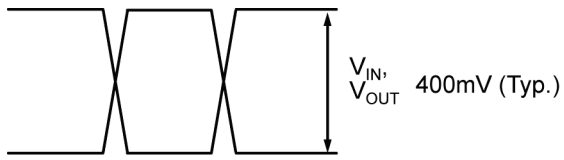


Figure 1. Single-Ended Voltage Swing

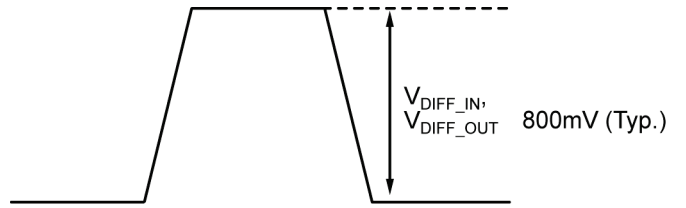
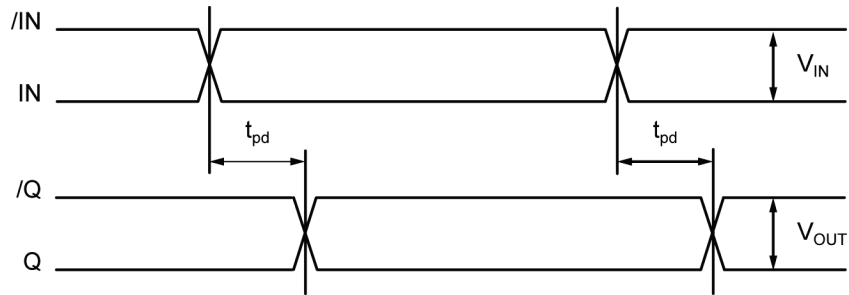


Figure 2. Differential Voltage Swing

### Timing Diagram





# Input Buffer

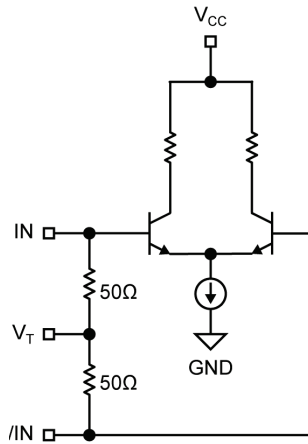


Figure 3. Simplified Differential Input Buffer

## Input Interface Applications

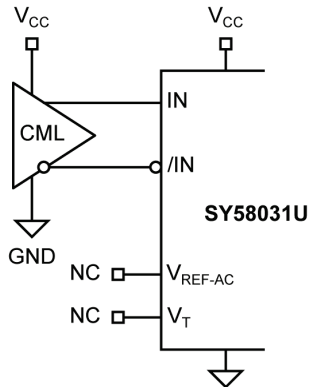


Figure 4. DC-Coupled CML Input Interface  
Optional: May connect  $V_T$  to  $V_{CC}$

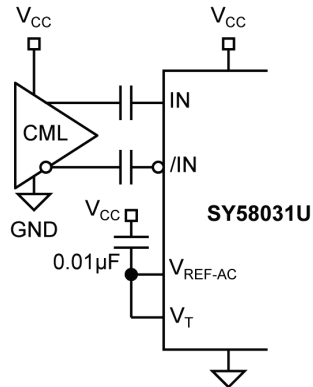
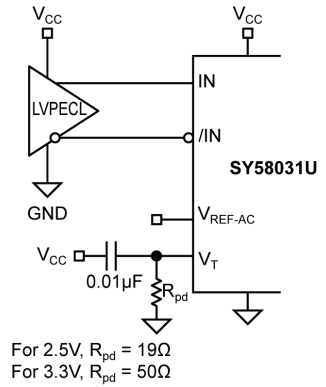
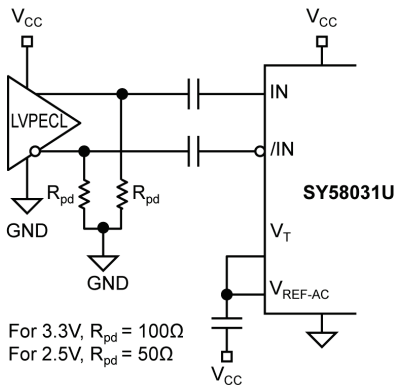


Figure 5. AC-Coupled CML Input Interface



For 2.5V,  $R_{pd} = 19\Omega$   
For 3.3V,  $R_{pd} = 50\Omega$

Figure 6. LVPECL Input Interface



For 3.3V,  $R_{pd} = 100\Omega$   
For 2.5V,  $R_{pd} = 50\Omega$

Figure 7. AC-Coupled LVPECL Input Interface

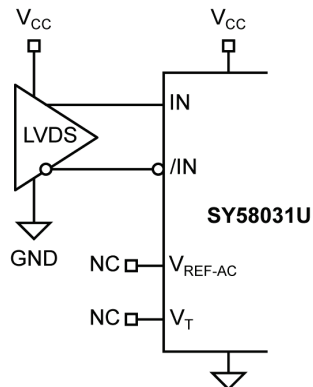


Figure 8. LVDS Input Interface

### CML Output Termination

Figure 9 and Figure 10 illustrate how to terminate a CML output using both the AC- and DC-coupled configuration. All outputs of the SY58031U are 50Ω with a 16mA current source.

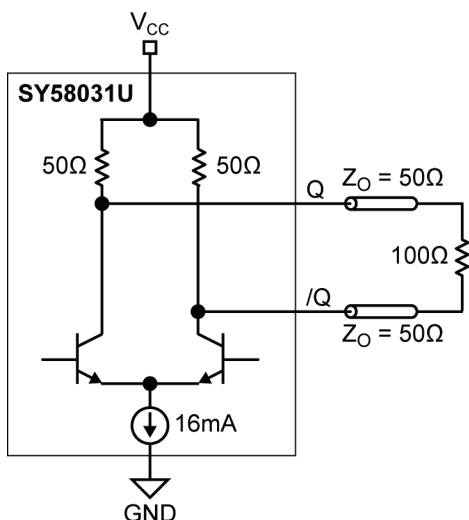


Figure 9. CML DC-Coupled Termination

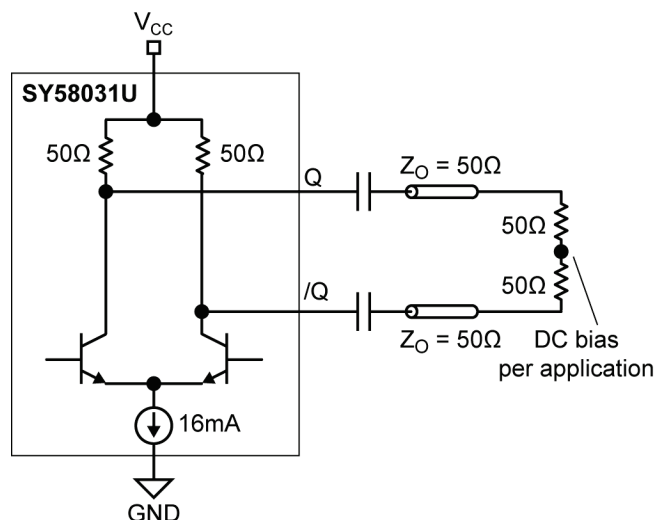
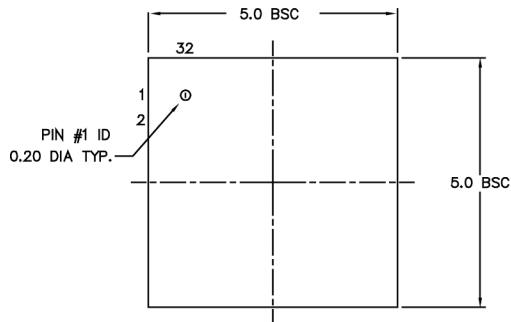


Figure 10. CML AC-Coupled Termination

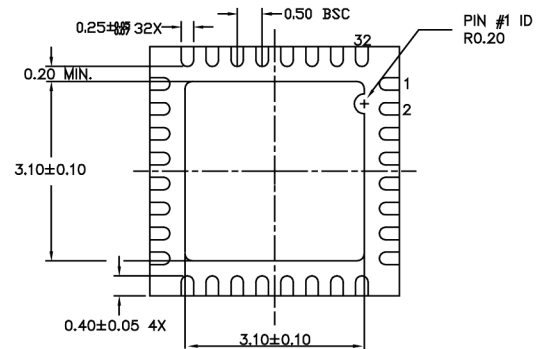
### Related Micrel Products and Support Documentation

| Part Number | Function  | Website Link  |
|-------------|---|---|
| SY58031U    | Ultra-Precision 1:8 CML Fanout Buffer with Internal I/O Termination | <a href="http://www.micrel.com/PDF/HBW/sy58031u.pdf">http://www.micrel.com/PDF/HBW/sy58031u.pdf</a>                                       |
| SY58032U    | Ultra-Precision 1:8 LVPECL Fanout Buffer with Internal Termination  | <a href="http://www.micrel.com/PDF/HBW/sy58032u.pdf">http://www.micrel.com/PDF/HBW/sy58032u.pdf</a>                                       |
| SY58033U    | Ultra-Precision 1:8 400mV Fanout Buffer with Internal Termination   | <a href="http://www.micrel.com/PDF/HBW/sy58033u.pdf">http://www.micrel.com/PDF/HBW/sy58033u.pdf</a>                                       |
|             | HBW Solutions   | <a href="http://www.micrel.com/index.php/en/products/clock-timing.html">http://www.micrel.com/index.php/en/products/clock-timing.html</a> |

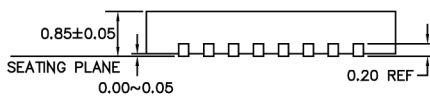
Package Information<sup>(12, 13)</sup>



TOP VIEW



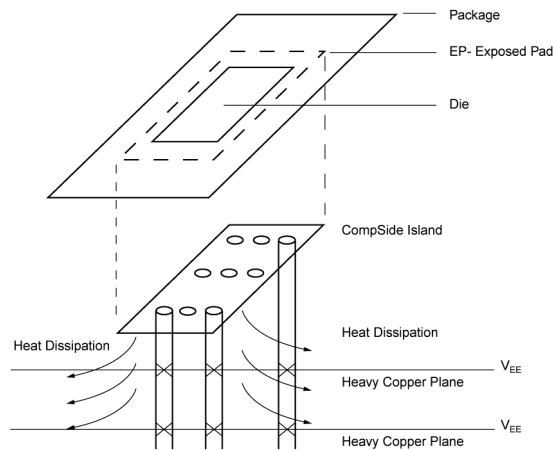
BOTTOM VIEW



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.



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

Note:

12. Package information is correct as of the publication date. For updates and most current information, go to [www.micrel.com](http://www.micrel.com).
13. Package meets Level 2 qualification. All parts are dry-packaged before shipment. Exposed pads must be soldered to a ground for proper thermal management.

---

**MICREL, INC. 2180 FORTUNE DRIVE SAN JOSE, CA 95131 USA**TEL +1 (408) 944-0800 FAX +1 (408) 474-1000 WEB <http://www.micrel.com>

Micrel makes no representations or warranties with respect to the accuracy or completeness of the information furnished in this data sheet. This information is not intended as a warranty and Micrel does not assume responsibility for its use. Micrel reserves the right to change circuitry, specifications and descriptions at any time without notice. No license, whether express, implied, arising by estoppel or otherwise, to any intellectual property rights is granted by this document. Except as provided in Micrel's terms and conditions of sale for such products, Micrel assumes no liability whatsoever, and Micrel disclaims any express or implied warranty relating to the sale and/or use of Micrel products including liability or warranties relating to fitness for a particular purpose, merchantability, or infringement of any patent, copyright or other intellectual property right.

Micrel Products are not designed or authorized for use as components in life support appliances, devices or systems where malfunction of a product can reasonably be expected to result in personal injury. Life support devices or systems are devices or systems that (a) are intended for surgical implant into the body or (b) support or sustain life, and whose failure to perform can be reasonably expected to result in a significant injury to the user. A Purchaser's use or sale of Micrel Products for use in life support appliances, devices or systems is a Purchaser's own risk and Purchaser agrees to fully indemnify Micrel for any damages resulting from such use or sale.

© 2013 Micrel, Incorporated.