



## SY58021U

4GHz, 1:4 LVPECL Fanout  
Buffer/Translator with Internal Termination  
Precision Edge®

### General Description

The SY58021U is a 2.5V/3.3V precision, high-speed, fully differential 1:4 LVPECL fanout buffer. Optimized to provide four identical output copies with less than 15ps output skew and only 70 fs<sub>RMS</sub> phase jitter, the SY58021U can process clock signals as fast as 4GHz.

The differential input includes Micrel's unique, 3-pin input termination architecture interfaces to differential LVPECL, CML, and LVDS signals (AC- 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 ( $V_{REFAC}$ ) is provided to bias the VT pin. The outputs are 100k LVPECL compatible, with extremely fast rise/fall times guaranteed to be less than 100ps.

The SY58021U operates from a 2.5V  $\pm 5\%$  supply or 3.3V  $\pm 10\%$  supply and is guaranteed over the full industrial temperature range ( $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ). For applications that require faster rise/fall times, or greater bandwidth, consider the SY58022U 1:4 fanout buffer with 400mV LVPECL output swing, or the SY58020U 1:4 CML fanout buffer. The SY58021U is part of Micrel's high-speed, Precision Edge® product line.

Data sheets and support documentation can be found on Micrel's web site at [www.micrel.com](http://www.micrel.com).



Precision Edge®

### Features

- Precision 1:4 LVPECL fanout buffer
- Guaranteed AC performance-over-temperature/voltage:
  - $>4\text{GHz } f_{\text{MAX}}$  (clock)
  - $<100\text{ps } t_r/t_f$  times
  - $<300\text{ps } t_{\text{PD}}$
  - $<15\text{ps}$  maximum skew
- Low jitter performance:
  - 70fs<sub>RMS</sub> phase jitter (typical)
- Accepts an input signal as low as 100mV
- Unique input termination and VT pin accepts DC-coupled and AC-coupled differential inputs: LVPECL, LVDS, and CML
- 100k LVPECL-compatible 800mV swing output
- Power supply 2.5V  $\pm 5\%$  and 3.3V  $\pm 10\%$
- $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  temperature range
- Available in 16-pin (3mm  $\times$  3mm) QFN package

### Applications

- All SONET and GigE clock distribution
- Fibre Channel clock and data distribution
- Backplane distribution
- High-end, low-skew, multiprocessor, synchronous clock distribution

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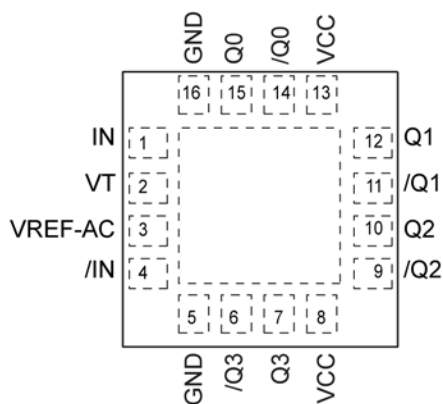
## Ordering Information<sup>(1)</sup>

| Part Number                   | Package Type | Operating Range | Package Marking                      | Lead Finish    |
|-------------------------------|--------------|-----------------|--------------------------------------|----------------|
| SY58021UMI                    | QFN-16       | Industrial      | 021U                                 | Sn-Pb          |
| SY58021UMITR <sup>(2)</sup>   | QFN-16       | Industrial      | 021U                                 | Sn-Pb          |
| SY58021UMG <sup>(3)</sup>     | QFN-16       | Industrial      | 021U with Pb-Free bar-line indicator | Pb-Free NiPdAu |
| SY58021UMGTR <sup>(2,3)</sup> | QFN-16       | Industrial      | 021U with Pb-Free bar-line indicator | Pb-Free NiPdAu |

**Notes:**

1. Contact factory for die availability. Dice are guaranteed at T<sub>A</sub> = 25°C, DC electrical only.
2. Tape and Reel.
3. Pb-Free package recommended for new designs.

## Pin Configuration



16-Pin QFN

## Pin Description

| Pin Number                     | Pin Name                                 | Pin Function  |
|--------------------------------|--|---|
| 1, 4                           | IN, /IN                                  | Differential Input: This input pair receives the signal to be buffered. 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.   |
| 2                              | 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.  |
| 3                              | VREF-AC                                  | Reference Output Voltage: This output biases to VCC -1.2V. It is used when AC-coupling to differential inputs. Connect VREF-AC directly to the VT pin. Bypass with 0.01μF low ESR capacitor to VCC. See "Input Interface Applications" section.   |
| 8, 13                          | VCC                                      | Positive Power Supply: Bypass with 0.1μF//0.01μF low ESR capacitors as close to the VCC pins as possible.   |
| 5, 16                          | GND,<br>Exposed Pad                      | Ground. Exposed pad must be connected to a ground plane that is the same potential as the ground pin.   |
| 14, 15, 11, 12,<br>9, 10, 6, 7 | /Q0, Q0, /Q1,<br>Q1, /Q2, Q2,<br>/Q3, Q3 | LVPECL Differential Output Pairs: Differential buffered output copy of the input signal. The output swing is typically 800mV. Proper termination is 50Ω to VCC-2V at the receiving end. Unused output pairs may be left floating with no impact on jitter or skew. See "LVPECL Output Termination" section. |

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

Power 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  
 Source or Sink Current on VT Pin  
      $V_T$  Current .....  $\pm 100$ mA  
 Source or Sink Current on IN, /IN  
     Input Current.....  $\pm 50$ mA  
 Source or Sink Current on  $V_{REF-AC}$ <sup>(4)</sup>  
      $V_{REF}$  Current.....  $\pm 1.5$ mA  
 Soldering (20s)..... 260°C  
 Storage Temperature ( $T_s$ ) ..... -65°C to +150°C

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

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

### Input DC Electrical Characteristics<sup>(5)</sup>

$T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ .

| Symbol         | Parameter                        | Condition                          | Min.            | Typ.           | Max.           | Units    |
|----------------|----------------------------------|------------------------------------|-----------------|----------------|----------------|----------|
| $V_{CC}$       | Power Supply Voltage             | $V_{CC} = 2.5\text{V}$             | 2.375           | 2.5            | 2.625          | V        |
|                |                                  | $V_{CC} = 3.3\text{V}$             | 3.0             | 3.3            | 3.60           |          |
| $I_{CC}$       | Power Supply Current             | No load, $V_{CC} = \text{maximum}$ |                 | 125            | 160            | 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              | IN, /IN (see Figure 1a)            | 0.1             |                | 1.7            | V        |
| $V_{DIFF\_IN}$ | Differential Input Voltage Swing | IN, /IN (see Figure 1b)            | 0.2             |                |                | V        |
| $R_{IN}$       | IN-to- $V_T$ Resistance          |                                    | 40              | 50             | 60             | $\Omega$ |
| $V_{T\_IN}$    | IN-to- $V_T$ Voltage             |                                    |                 |                | 1.28           | V        |
| $V_{REF-AC}$   | Output Reference Voltage         |                                    | $V_{CC} - 1.30$ | $V_{CC} - 1.2$ | $V_{CC} - 1.1$ | V        |

**Notes:**

1. Permanent device damage may occur if ratings in the “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. Thermal performance assumes exposed pad is soldered (or equivalent) to the device’s most negative potential 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.  $V_{IH}$  (minimum) not lower than 1.2V.

## LVPECL Output DC Electrical Characteristics<sup>(5)</sup>

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

| Symbol          | Parameter                         | Condition       | Min.             | Typ. | Max.             | Units |
|-----------------|-----------------------------------|-----------------|------------------|------|------------------|-------|
| $V_{OH}$        | Output HIGH Voltage               |                 | $V_{CC} - 1.145$ |      | $V_{CC} - 0.895$ | V     |
| $V_{OL}$        | Output LOW Voltage                |                 | $V_{CC} - 1.945$ |      | $V_{CC} - 1.695$ | V     |
| $V_{OUT}$       | Output Voltage Differential Swing | (see Figure 1a) | 550              | 780  | 1050             | mV    |
| $V_{DIFF\_OUT}$ | Differential Output Voltage Swing | (see Figure 1b) | 1100             | 1560 | 2100             | mV    |

## AC Electrical Characteristics

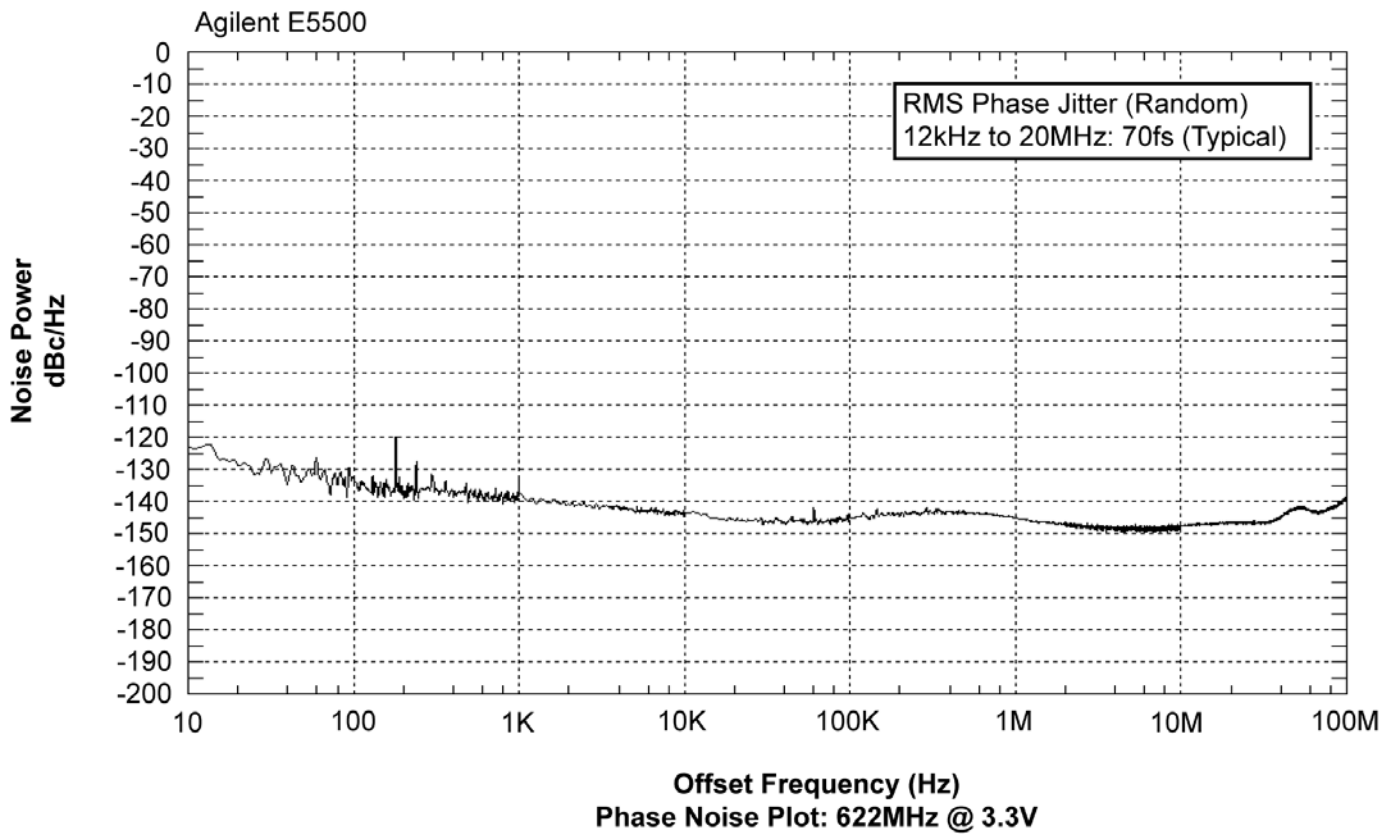
$V_{CC} = 2.5V \pm 5\%$  or  $3.3 \pm 10\%$ ;  $R_L = 50\Omega$  to  $V_{CC} - 2V$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ , unless otherwise stated.

| Symbol       | Parameter                          | Condition   | Min. | Typ. | Max. | Units |
|--------------|------------------------------------|---|------|------|------|-------|
| $f_{MAX}$    | Maximum Operating Frequency        | $V_{OUT} \geq 400mV$ Clock<br>NRZ Data                | 4    |      |      | GHz   |
|              |                                    |   |      | 5    |      | Gbps  |
| $t_{PD}$     | Propagation Delay                  |   | 150  | 220  | 300  | ps    |
| $t_{CHAN}$   | Channel-to-Channel Skew            | Note 7  |      | 4    | 15   | ps    |
| $t_{SKEW}$   | Part-to-Part Skew                  | Note 8  |      |      | 50   | ps    |
| $t_{JITTER}$ | RMS Phase Jitter                   | Output: 622MHz<br>Integration Range:<br>12kHz – 20MHz |      | 70   |      | fs    |
| $t_r, t_f$   | Output Rise/Fall Time (20% to 80%) | At full swing   | 35   | 75   | 110  | ps    |

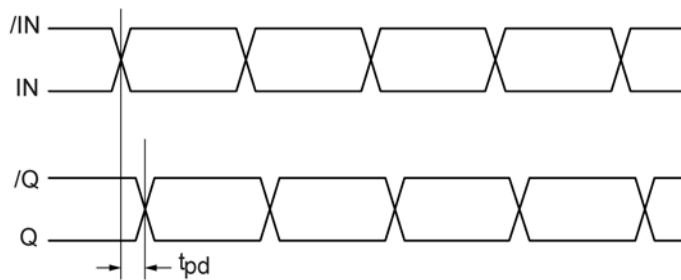
### Notes:

- Skew is measured between outputs of the same bank under identical transitions.
- 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 Graph



## Timing Diagram



## Single-Ended and Differential Swings

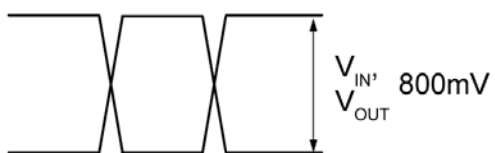


Figure 1a. Single-Ended Voltage Swing

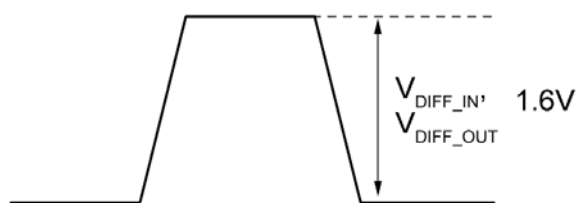
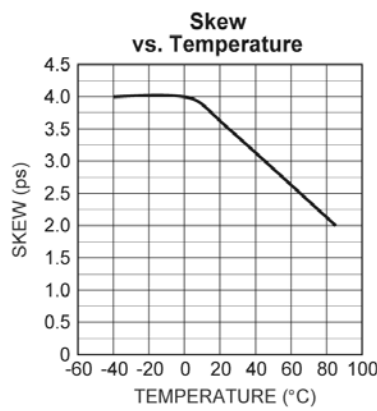
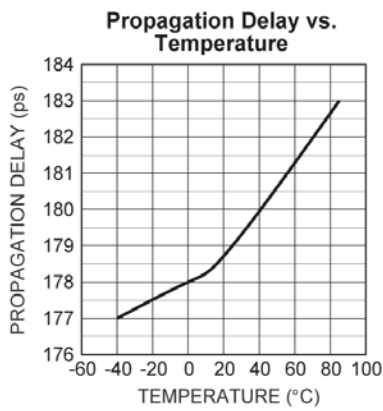
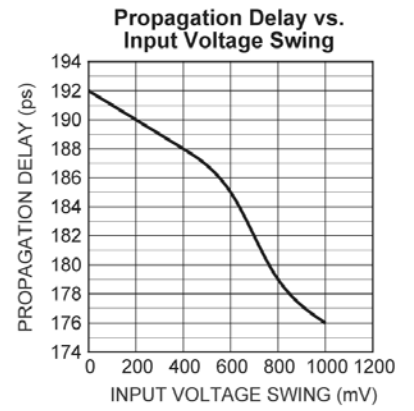
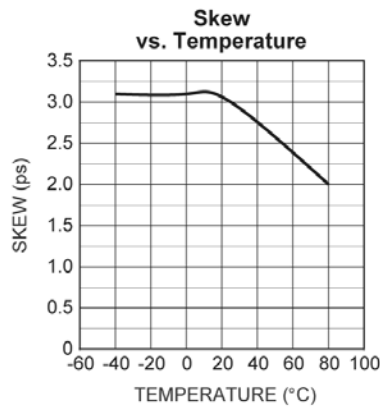
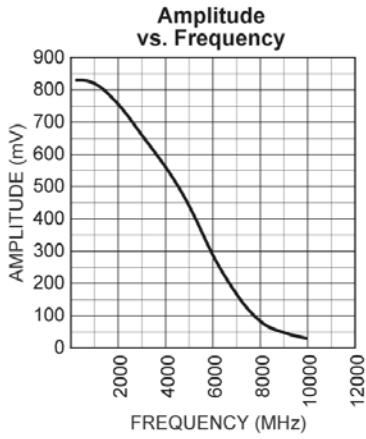


Figure 1b. Differential Voltage Swing

## Typical Characteristics

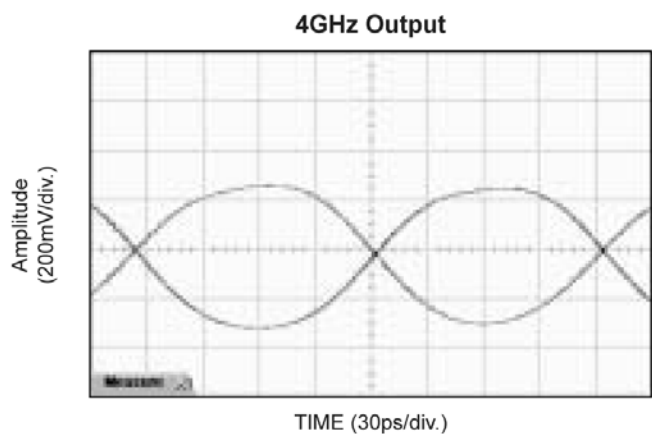
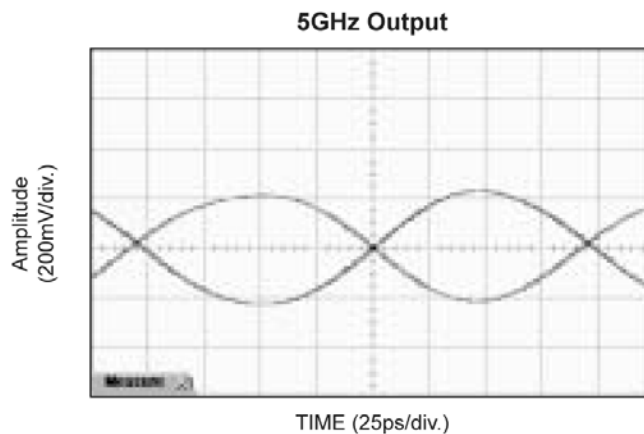
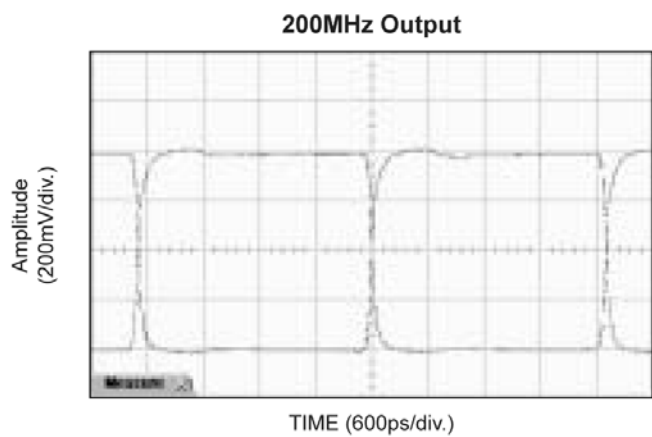
$V_{CC} = 2.5V$ ,  $GND = 0$ ,  $V_{IN} = 100mV$ ,  $T_A = 25^{\circ}C$ , unless otherwise stated.





## Functional Characteristics

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



## Input Stage

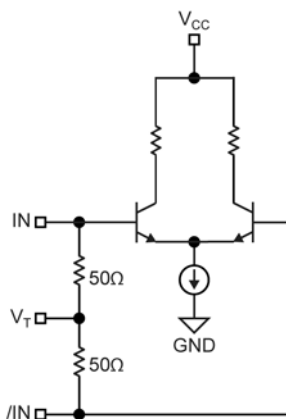
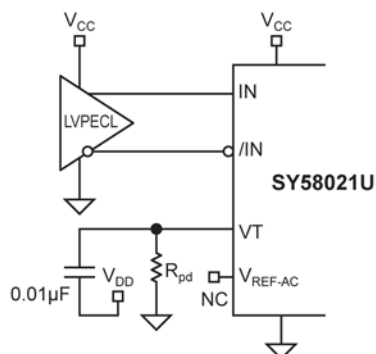


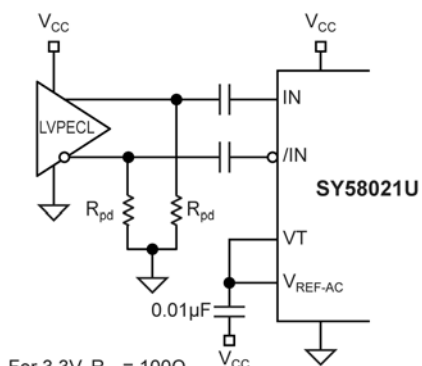
Figure 2. Simplified Differential Input Buffer

## Input Interface Applications



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

Figure 3a. LVPECL Input Interface



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

Figure 3b. AC-Coupled LVPECL Input Interface

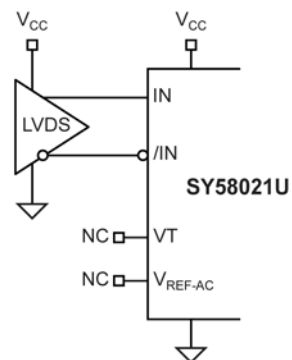
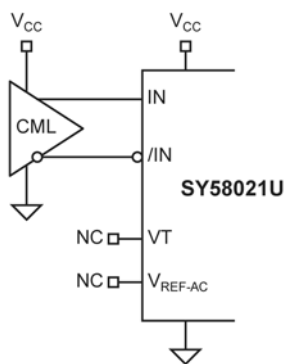


Figure 3c. LVDS Input Interface



Option: May connect  $V_T$  to  $V_{CC}$

Figure 3d. DC-Coupled CML Input Interface

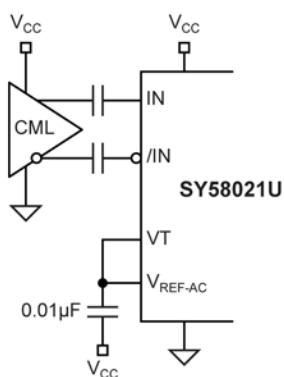
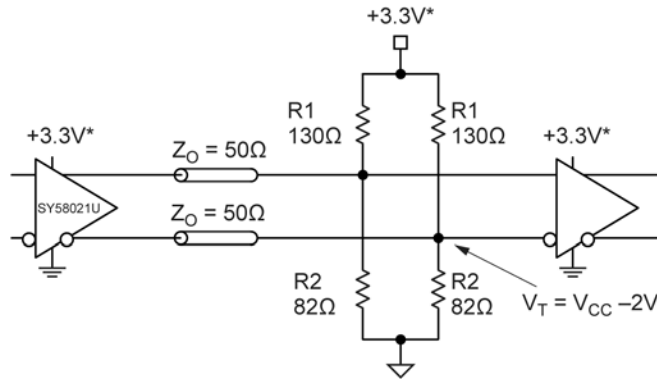


Figure 3e. AC-Coupled CML Input Interface

## LVPECL Output

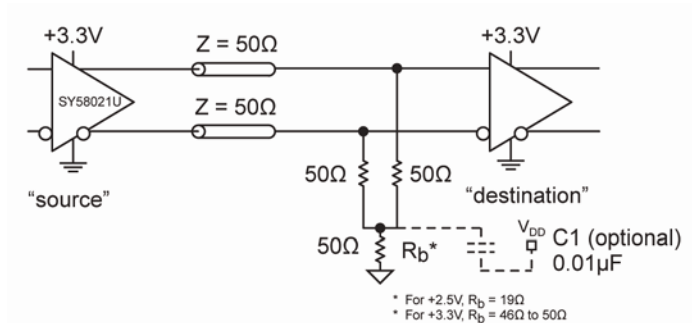
LVPECL outputs have very-low output impedance (open emitter), and small signal swing which results in low EMI. LVPECL is ideal for driving 50Ω- and 100Ω-controlled impedance transmission lines. There are several techniques in terminating the LVPECL output (Figures 4 through 6).



**Note:**

1. For +2.5V systems, R1 = 250Ω, R2 = 62.5Ω.

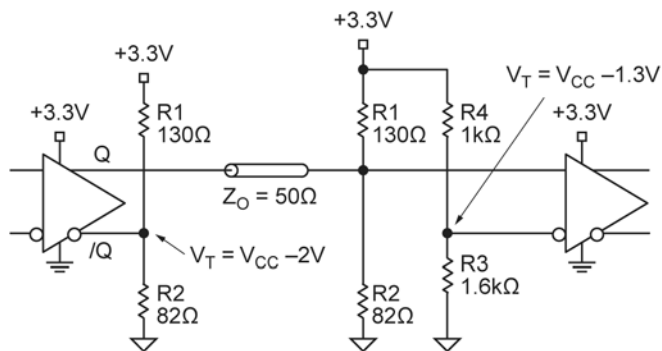
**Figure 4. Parallel Termination-Thevenin Equivalent**



**Notes:**

1. Power-saving alternative to Thevenin termination.
2. Place termination resistors as close to destination inputs as possible.
3. R<sub>b</sub> resistor sets the DC bias voltage, equal to V<sub>T</sub>.

**Figure 5. Parallel Termination (3-Resistor)**



**Notes:**

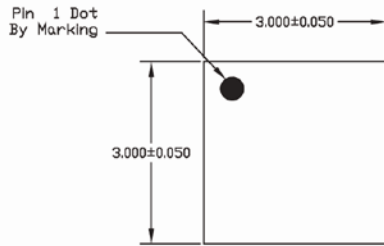
1. Unused output (/Q) must be terminated to balance the output.
2. For +2.5V systems: R1 = 250, R2 = 62.5, R3 = 1.25k, R4 = 1.2k  
For +3.3V systems: R1 = 130, R2 = 82, R3 = 1k, R4 = 1.6k
3. Unused output pairs (Q and /Q) may be left floating.

**Figure 6. Terminating Unused I/O**

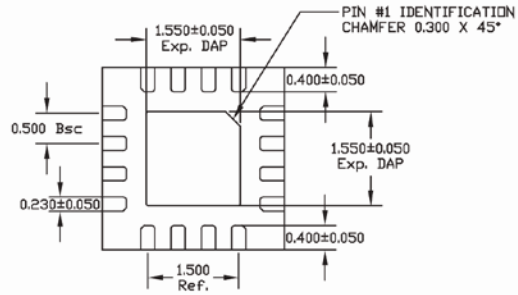
**Related Micrel Products and Support Documentation**

| Part Number | Function   | Data Sheet Link  |
|-------------|--|--|
| SY58020U    | 6GHz, 1:4 CML Fanout Buffer/Translator with Internal I/O Terminations                    | <a href="http://www.micrel.com/product-info/products/sy58020u.shtml">www.micrel.com/product-info/products/sy58020u.shtml</a> |
| SY58021U    | 4GHz, 1:4 LVPECL Fanout Buffer/Translator with Internal Termination                      | <a href="http://www.micrel.com/product-info/products/sy58021u.shtml">www.micrel.com/product-info/products/sy58021u.shtml</a> |
| SY58022U    | 5.5GHz, 1:4 Fanout Buffer/Translator with 400mV LVPECL Outputs and Internal Terminations | <a href="http://www.micrel.com/product-info/products/sy58022u.shtml">www.micrel.com/product-info/products/sy58022u.shtml</a> |
| M-0317      | HBW Solutions  | <a href="http://www.micrel.com/product-info/as/solutions.shtml">www.micrel.com/product-info/as/solutions.shtml</a>           |

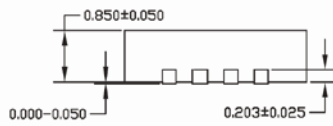
**Package Information**



TOP VIEW

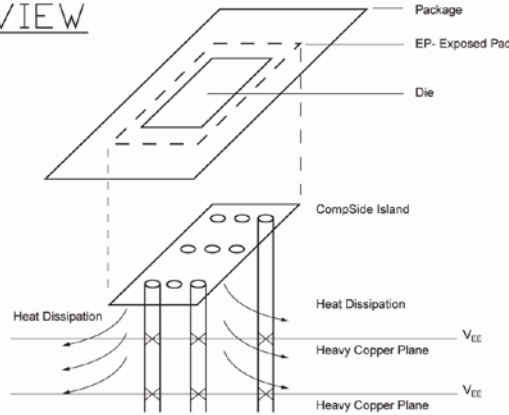


BOTTOM VIEW



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 MLF™ 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.

**16-Pin QFN**

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