

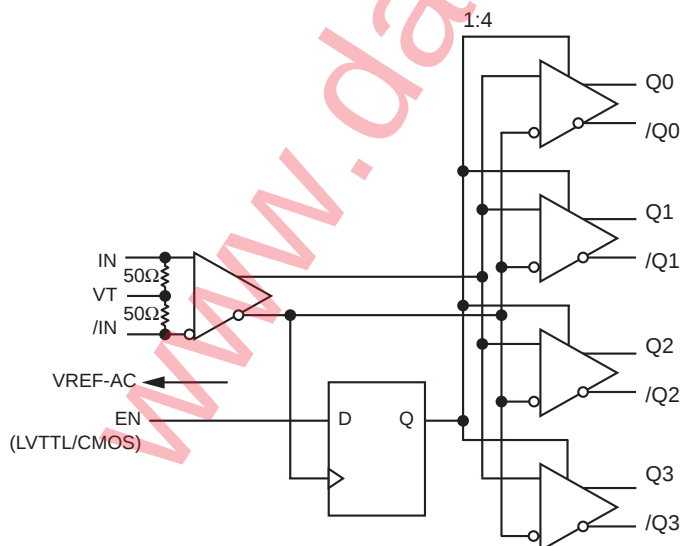
## FEATURES

- **Guaranteed AC performance over temperature and voltage:**
  - DC-to >2.0GHz throughput
  - <570ps propagation delay (IN-to-Q)
  - <20ps within-device skew
  - <200ps rise/fall time
- **Ultra-low jitter design:**
  - <1ps<sub>RMS</sub> cycle-to-cycle jitter
  - <1ps<sub>RMS</sub> random jitter
  - <10ps<sub>PP</sub> deterministic jitter
  - <10ps<sub>PP</sub> total jitter (clock)
- **Unique, patent-pending input termination and VT pin accepts DC- and AC-coupled inputs**
- **High-speed LVDS outputs**
- **2.5V voltage supply operation**
- **Industrial temperature range: -40°C to +85°C**
- **Available in 16-pin (3mm x 3mm) MLF® package**

## APPLICATIONS

- Processor clock distribution
- SONET clock distribution
- Fibre Channel clock distribution
- Gigabit Ethernet clock distribution

## FUNCTIONAL BLOCK DIAGRAM



## DESCRIPTION

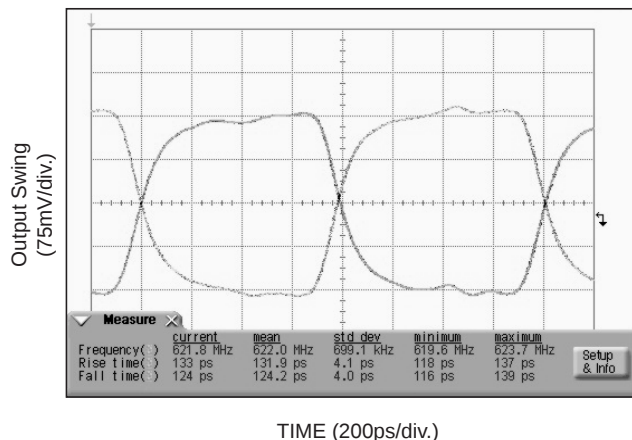
The SY89832U is a 2.5V, high-speed, 2GHz differential LVDS (Low Voltage Differential Swing) 1:4 fanout buffer optimized for ultra-low skew applications. Within device skew is guaranteed to be less than 20ps over supply voltage and temperature.

The differential input buffer has a unique internal termination design that allows access to the termination network through a VT pin. This feature allows the device to easily interface to different logic standards. A VREF-AC reference output is included for AC-coupled applications.

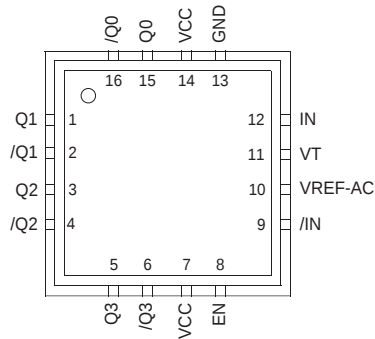
The SY89832U is a part of Micrel's high-speed clock synchronization family. For 3.3V applications, see SY89833L. For applications that require a different I/O combination, consult Micrel's website at: [www.micrel.com](http://www.micrel.com), and choose from a comprehensive product line of high-speed, low-skew fanout buffers, translators and clock generators.

## TYPICAL PERFORMANCE

**622MHz Output**



## PACKAGE/ORDERING INFORMATION



16-Pin MLF® (MLF-16)

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

| Part Number                    | Package Type | Operating Range | Package Marking                      | Lead Finish    |
|--------------------------------|--------------|-----------------|--------------------------------------|----------------|
| SY89832UMI                     | MLF-16       | Industrial      | 832U                                 | Sn-Pb          |
| SY89832UMITR <sup>(2)</sup>    | MLF-16       | Industrial      | 832U                                 | Sn-Pb          |
| SY89832UMG <sup>(3)</sup>      | MLF-16       | Industrial      | 832U with Pb-Free bar line indicator | NiPdAu Pb-Free |
| SY89832UMGTR <sup>(2, 3)</sup> | MLF-16       | Industrial      | 832U with Pb-Free bar line indicator | NiPdAu Pb-Free |

## Notes:

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

## PIN DESCRIPTION

| Pin Number                     | Pin Name                                 | Pin Function                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15, 16<br>1, 2<br>3, 4<br>5, 6 | Q0, /Q0<br>Q1, /Q1<br>Q2, /Q2<br>Q3, /Q3 | LVDS Differential (Outputs): Normally terminated with $100\Omega$ across the pair (Q, /Q). See "LVDS Outputs" section, Figure 2a. Unused outputs should be terminated with a $100\Omega$ resistor across each pair.                                                                                                                                                                                                                               |
| 8                              | EN                                       | This single-ended TTL/CMOS-compatible input functions as a synchronous output enable. The synchronous enable ensures that enable/disable will only occur when the outputs are in a logic LOW state. Note that this input is internally connected to a $25k\Omega$ pull-up resistor and will default to logic HIGH state (enabled) if left open.                                                                                                   |
| 9, 12                          | /IN, IN                                  | Differential Inputs: These input pairs are the differential signal inputs to the device. Inputs accept AC- or DC-Coupled differential signals as small as 100mV. Each pin of a pair internally terminates to a VT pin through $50\Omega$ . Note that these inputs will default to an intermediate state if left open. Please refer to the "Input Interface Applications" section for more details.                                                |
| 10                             | VREF-AC                                  | Reference Voltage: These outputs bias to $V_{CC}-1.4V$ . They are used when AC coupling the inputs (IN, /IN). For AC-Coupled applications, connect VREF-AC to VT pin and bypass with $0.01\mu F$ low ESR capacitor to $V_{CC}$ . See "Input Interface Applications" section for more details. Maximum sink/source current is $\pm 1.5mA$ . Due to the limited drive capability, each VREF-AC pin is only intended to drive its respective VT pin. |
| 11                             | VT                                       | Input Termination Center-Tap: Each side of the differential input pair terminates to a VT pin. The VT pins provide a center-tap to a termination network for maximum interface flexibility. See "Input Interface Applications" section for more details.                                                                                                                                                                                          |
| 13                             | GND                                      | Ground. GND pins and exposed pad must be connected to the most negative potential of the device ground.                                                                                                                                                                                                                                                                                                                                           |
| 7, 14                          | VCC                                      | Positive Power Supply: Bypass with $0.1\mu F/0.01\mu F$ low ESR capacitors and place as close to each VCC pin as possible.                                                                                                                                                                                                                                                                                                                        |

## TRUTH TABLE

| IN | /IN | EN | Q                | /Q               |
|----|-----|----|------------------|------------------|
| 0  | 1   | 1  | 0                | 1                |
| 1  | 0   | 1  | 1                | 0                |
| X  | X   | 0  | 0 <sup>(1)</sup> | 1 <sup>(1)</sup> |

**Note 1.** On next negative transition of the input signal (IN).

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

|                                        |                          |
|----------------------------------------|--------------------------|
| Supply Voltage ( $V_{CC}$ )            | –0.5V to +4.0V           |
| Input Voltage ( $V_{IN}$ )             | –0.5V to $V_{CC} + 0.3V$ |
| LVDS Output Current ( $I_{OUT}$ )      | ±10mA                    |
| Input Current                          |                          |
| Source or Sink Current on (IN, /IN)    | ±50mA                    |
| VREF-AC Current                        |                          |
| Source or Sink Current on ( $I_{VT}$ ) | ±2mA                     |
| Lead Temperature (soldering, 20sec.)   | 260°C                    |
| Storage Temperature ( $T_S$ )          | –65°C to +150°C          |

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

|                                           |                   |
|-------------------------------------------|-------------------|
| Supply Voltage Range                      | +2.375V to 2.625V |
| Ambient Temperature ( $T_A$ )             | –40°C to +85°C    |
| Package Thermal Resistance <sup>(3)</sup> |                   |
| MLF®                                      |                   |
| ( $\theta_{JA}$ ) Still-Air               | 60°C/W            |
| ( $\psi_{JB}$ )                           | 32°C/W            |

**DC ELECTRICAL CHARACTERISTICS<sup>(4)</sup>**

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

| Symbol         | Parameter                                  | Condition              | Min              | Typ              | Max              | Units |
|----------------|--------------------------------------------|------------------------|------------------|------------------|------------------|-------|
| $V_{CC}$       | Power Supply                               |                        | 2.375            | 2.5              | 2.625            | V     |
| $I_{CC}$       | Power Supply Current                       | No load, max. $V_{CC}$ |                  | 75               | 100              | mA    |
| $R_{IN}$       | Input Resistance (IN-to-VT)                |                        | 45               | 50               | 55               | Ω     |
| $R_{DIFF-IN}$  | Differential Input Resistance (IN-to-/IN)  |                        | 90               | 100              | 110              | Ω     |
| $V_{IH}$       | Input HIGH Voltage (IN, /IN)               |                        | 0.1              |                  | $V_{CC} + 0.3$   | V     |
| $V_{IL}$       | Input LOW Voltage (IN, /IN)                |                        | –0.3             |                  | $V_{IH} - 0.1$   | V     |
| $V_{IN}$       | Input Voltage Swing (IN, /IN)              | see Figure 2c.         | 0.1              |                  | $V_{CC}$         | V     |
| $V_{DIFF\_IN}$ | Differential Input Voltage Swing  IN – /IN | see Figure 2d.         | 0.2              |                  |                  | V     |
| $ I_{IN} $     | Input Current IN, /IN                      | Note 5                 |                  |                  | 45               | mA    |
| $V_{REF-AC}$   | Output Reference Voltage                   |                        | $V_{CC} - 1.525$ | $V_{CC} - 1.425$ | $V_{CC} - 1.325$ | V     |

**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 rating 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. Package thermal resistance assumes exposed pad is soldered (or equivalent) to the device's most negative potential on the PCB.  $\psi_{JB}$  and  $\theta_{JA}$  values are determined for a 4-layer board in still-air number, unless otherwise stated.
4. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
5. Due to the internal termination (see "Input Buffer Structure" section) the input current depends on the applied voltages at IN, /IN and VT inputs. Do not apply a combination of voltages that causes the input current to exceed the maximum limit!

**LVDS OUTPUTS DC ELECTRICAL CHARACTERISTICS<sup>(6)</sup>**

$V_{CC} = 2.5V \pm 5\%$ ,  $R_L = 100\Omega$  across the outputs;  $T_A = -40^\circ C$  to  $+85^\circ C$

| Symbol           | Parameter                         | Condition      | Min   | Typ | Max   | Units |
|------------------|-----------------------------------|----------------|-------|-----|-------|-------|
| $V_{OUT}$        | Output Voltage Swing              | See Figure 2c. | 250   | 325 |       | mV    |
| $V_{DIFF\_OUT}$  | Differential Output Voltage Swing | See Figure 2d. | 500   | 650 |       | mV    |
| $V_{OCM}$        | Output Common Mode Voltage        |                | 1.125 |     | 1.275 | V     |
| $\Delta V_{OCM}$ | Change in Common Mode Voltage     |                | -50   |     | 50    | mV    |

**LVTTTL/CMOS DC ELECTRICAL CHARACTERISTICS<sup>(6)</sup>**

$V_{CC} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $+85^\circ C$

| Symbol   | Parameter          | Condition | Min  | Typ | Max      | Units   |
|----------|--------------------|-----------|------|-----|----------|---------|
| $V_{IH}$ | Input HIGH Voltage |           | 2.0  |     | $V_{CC}$ | V       |
| $V_{IL}$ | Input LOW Voltage  |           | 0    |     | 0.8      | V       |
| $I_{IH}$ | Input HIGH Current |           | -125 |     | 30       | $\mu A$ |
| $I_{IL}$ | Input LOW Current  |           | -300 |     |          | $\mu A$ |

**Notes:**

6. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

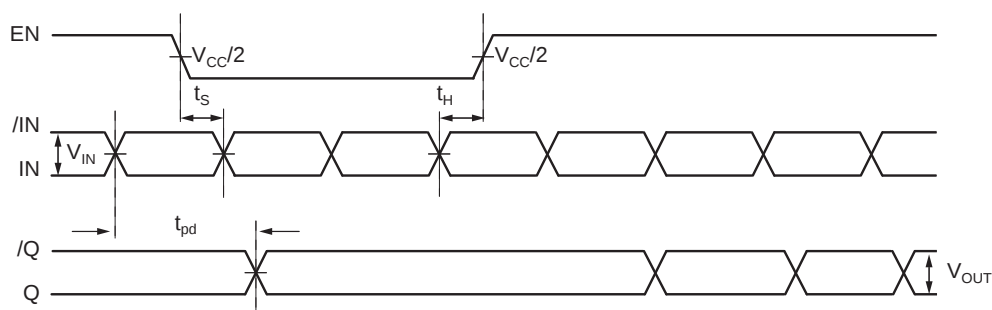
**AC ELECTRICAL CHARACTERISTICS<sup>(7)</sup>**

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

| Symbol       | Parameter                                               | Condition                        | Min | Typ | Max     | Units                   |
|--------------|---------------------------------------------------------|----------------------------------|-----|-----|---------|-------------------------|
| $f_{MAX}$    | Maximum Frequency                                       | $V_{OUT} \geq 200mV$             | 2.0 | 2.5 |         | GHz                     |
| $t_{pd}$     | Propagation Delay                                       | IN-to-Q<br>$V_{IN} < 400mV$      | 370 | 470 | 570     | ps                      |
|              |                                                         | IN-to-Q<br>$V_{IN} \geq 400mV$   | 300 | 410 | 500     | ps                      |
| $t_{SKEW}$   | Within-Device Skew                                      | <b>Note 8</b>                    |     | 5   | 20      | ps                      |
|              | Part-to-Part Skew                                       | <b>Note 9</b>                    |     |     | 200     | ps                      |
| $t_S$        | Set-Up Time                                             | EN to IN, /IN                    | 300 |     |         | ps                      |
| $t_H$        | Hold Time                                               | EN to IN, /IN                    | 500 |     |         | ps                      |
| $t_{JITTER}$ | Data<br>Random Jitter (RJ)<br>Deterministic Jitter (DJ) | <b>Note 11</b><br><b>Note 12</b> |     |     | 1<br>10 | $ps_{RMS}$<br>$ps_{PP}$ |
|              | Clock<br>Cycle-to-Cycle Jitter<br>Total Jitter (TJ)     | <b>Note 13</b><br><b>Note 14</b> |     |     | 1<br>10 | $ps_{RMS}$<br>$ps_{PP}$ |
| $t_r, t_f$   | Output Rise/Fall Times<br>(20% to 80%)                  | At full output swing.            | 70  | 150 | 200     | ps                      |

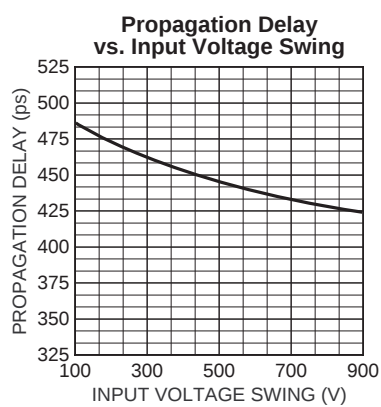
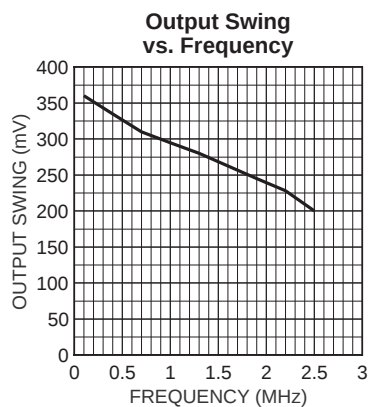
**Notes:**

- High-frequency AC parameters are guaranteed by design and characterization.
- Within device skew is measured between two different outputs under identical input transitions.
- Part-to-part skew is defined for two parts with identical power supply voltages at the same temperature and no skew at the edges at the respective inputs.
- Set-up and hold times apply to synchronous applications that intend to enable/disable before the next clock cycle. For asynchronous applications, set-up and hold times do not apply.
- Random jitter is measured with a K28.7 pattern, measured at  $f_{MAX}$ .
- Deterministic jitter is measured at 2.5Gbps with both K28.5 and  $2^{23}-1$  PRBS pattern.
- Cycle-to-cycle jitter definition: The variation period between adjacent cycles over a random sample of adjacent cycle pairs.  
 $t_{JITTER\_CC} = T_n - T_{n+1}$ , where T is the time between rising edges of the output signal.
- Total jitter definition: with an ideal clock input frequency of  $f_{MAX}$  (device), no more than one output edge in  $10^{12}$  output edges will deviate by more than the specified peak-to-peak jitter value.

**TIMING DIAGRAM**

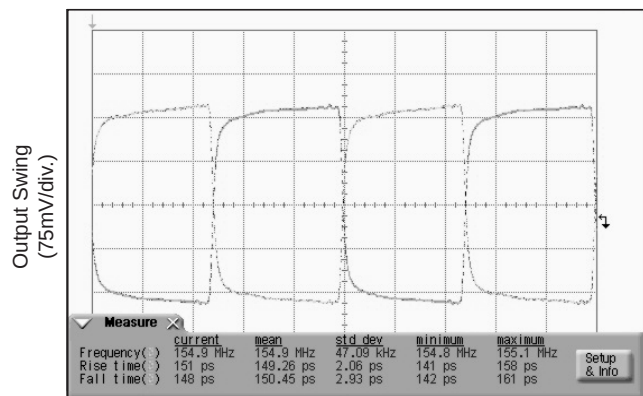
**TYPICAL OPERATING CHARACTERISTICS**

$V_{CC} = 2.5V$ ,  $GND = 0V$ ,  $R_L = 100\Omega$  across the outputs;  $T_A = 25^\circ C$ ,  $V_{IN} = 400mV$ , unless otherwise stated.

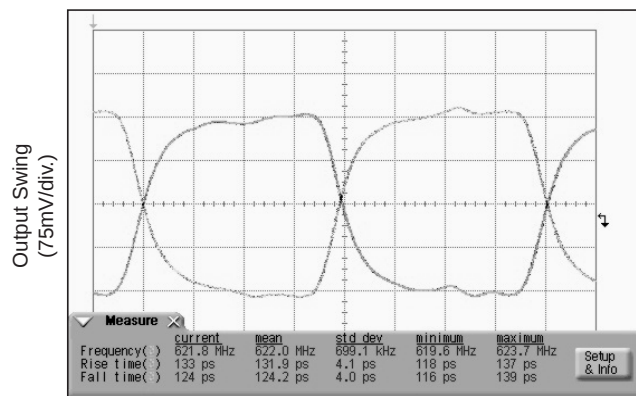


**FUNCTIONAL CHARACTERISTICS**

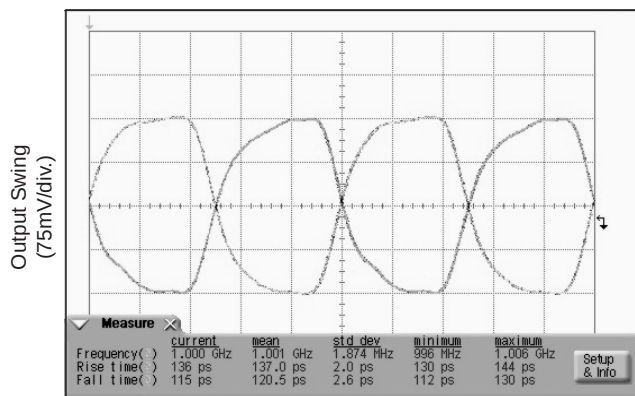
$V_{CC} = 2.5V$ ,  $GND = 0V$ ,  $V_{IN} = 400mV$ ,  $R_L = 100\Omega$  across the outputs;  $T_A = 25^\circ C$ , unless otherwise stated.

**155MHz Output**

TIME (1.291ns/div.)

**622MHz Output**

TIME (200ps/div.)

**1GHz Output**

TIME (200ps/div.)

## INPUT STAGE

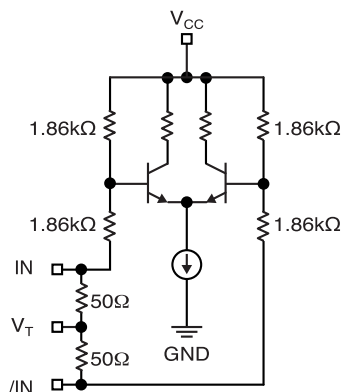


Figure 1. Simplified Differential Input Buffer

## LVDS OUTPUTS

LVDS specifies a small swing of 325mV typical, on a nominal 1.2V common mode above ground. The common

mode voltage has tight limits to permit large variations in ground noise between an LVDS driver and receive

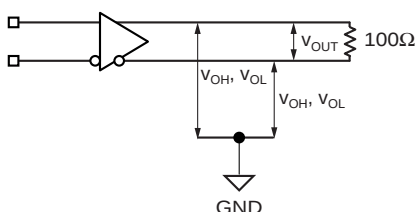


Figure 2a. LVDS Differential Measurement

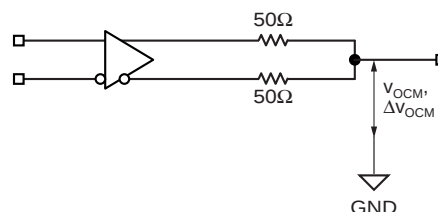


Figure 2b. LVDS Common Mode Measurement

## SINGLE-ENDED AND DIFFERENTIAL SWINGS

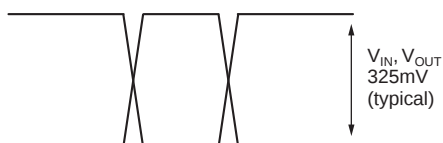


Figure 2c. Single-Ended Swing

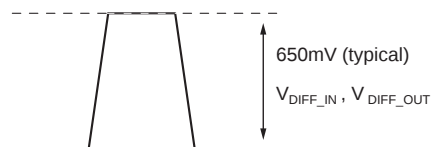


Figure 2d. Differential Swing

## INPUT INTERFACE APPLICATIONS

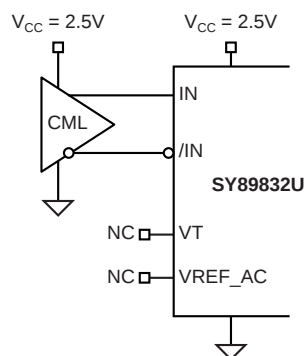


Figure 3a. DC-Coupled CML Input Interface

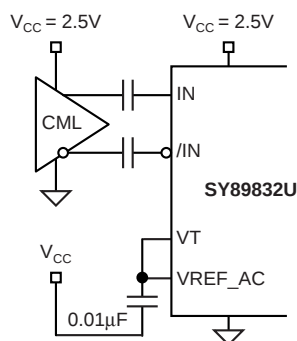


Figure 3b. AC-Coupled CML Input Interface

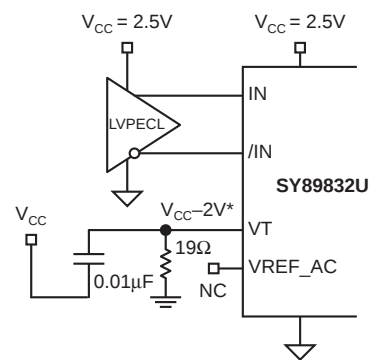


Figure 3c. DC-Coupled LVPECL Input Interface  
(\*Bypass with 0.01μF to GND)

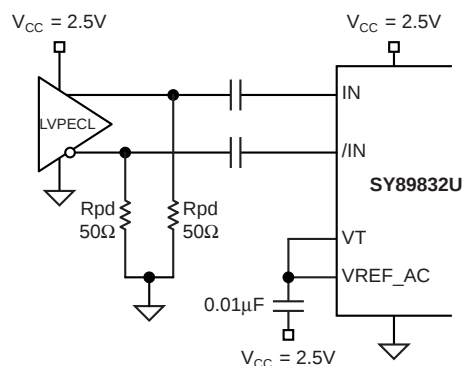


Figure 3d. AC-Coupled LVPECL Input Interface

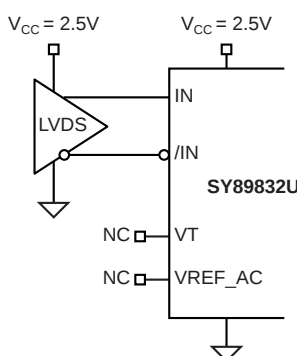
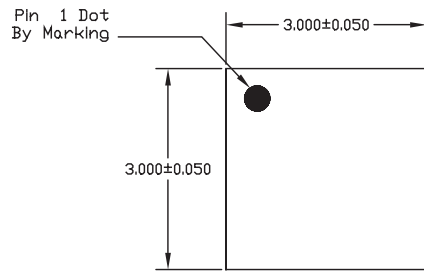
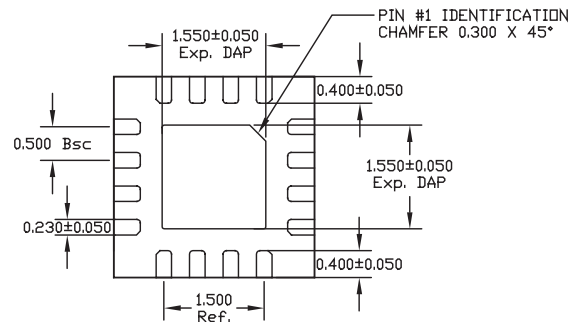
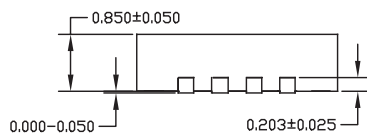


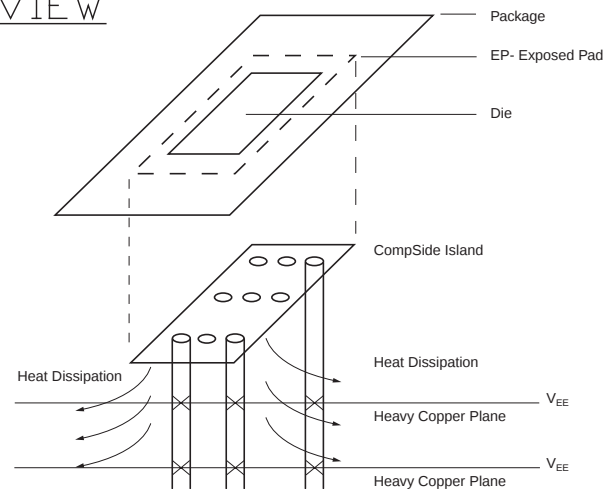
Figure 3e. LVDS Input Interface

## RELATED PRODUCT AND SUPPORT DOCUMENTATION

| Part Number   | Function                                                                      | Data Sheet Link                                                                                                                               |
|---------------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| SY89830U      | 2.5V/3.3/5V 2.5GHz 1:4 PECL/ECL Clock Driver with 2:1 Differential Input MUX  | <a href="http://www.micrel.com/product-info/products/sy89830u.shtml">http://www.micrel.com/product-info/products/sy89830u.shtml</a>           |
| SY89831U      | Ultra-Precision 1:4 LVPECL Fanout Buffer/Translator with Internal Termination | <a href="http://www.micrel.com/product-info/products/sy89831u.shtml">http://www.micrel.com/product-info/products/sy89831u.shtml</a>           |
| SY89833U      | 3.3V Ultra-Precision 1:4 LVDS Fanout Buffer with Internal Termination         | <a href="http://www.micrel.com/product-info/products/sy89833u.shtml">http://www.micrel.com/product-info/products/sy89833u.shtml</a>           |
| SY89834U      | 2.5/3.3V Two Input, 1GHz LVTTTL/CMOS-to-LVPECL 1:4 Fanout Buffer/Translator   | <a href="http://www.micrel.com/product-info/products/sy89834u.shtml">http://www.micrel.com/product-info/products/sy89834u.shtml</a>           |
|               | 16-MLF® Manufacturing Guidelines Exposed Pad Application Note                 | <a href="http://www.amkor.com/products/notes_papers/MLF_appnote_0301.pdf">http://www.amkor.com/products/notes_papers/MLF_appnote_0301.pdf</a> |
| HBW Solutions | New Products and Applications                                                 | <a href="http://www.micrel.com/product-info/as/solutions.shtml">http://www.micrel.com/product-info/as/solutions.shtml</a>                     |

**16-PIN EPAD MicroLeadFrame® (MLF-16)**TOP VIEWBOTTOM VIEWSIDE 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:**

- Note 1.** Package meets Level 2 moisture sensitivity classification, and are shipped in dry-pack form.
- Note 2.** Exposed pads must be soldered to a ground for proper thermal management.

**MICREL, INC. 2180 FORTUNE DRIVE SAN JOSE, CA 95131 USA**

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