



**3.3V, 2.0GHz ANY DIFF. IN-TO-LVDS  
PROGRAMMABLE CLOCK DIVIDER  
FANOUT BUFFER W/ INTERNAL TERMINATION**

**Precision Edge®  
SY89873L**

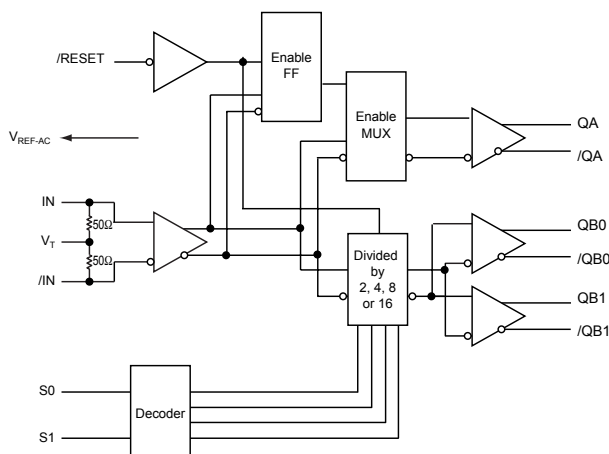
## FEATURES

- **Guaranteed AC performance**
  - > 2.0GHz  $f_{MAX}$  output toggle
  - > 3.0GHz  $f_{MAX}$  input
  - < 800ps  $t_{PD}$  (matched-delay between banks)
  - < 15ps within-device skew
  - < 190ps rise/fall time
- **Low jitter design**
  - < 1ps<sub>RMS</sub> cycle-to-cycle jitter
- **Unique input termination and  $V_T$  pin for DC-coupled and AC-coupled inputs: any differential inputs (LVPECL, LVDS, CML, HSTL)**
- **Precision differential LVDS outputs**
- **Matched delay: all outputs have matched delay, independent of divider setting**
- **TTL/CMOS inputs for select and reset/disable**
- **Two LVDS output banks (matched delay)**
  - Bank A: Buffered copy of input clock (undivided)
  - Bank B: Divided output ( $\div 2$ ,  $\div 4$ ,  $\div 8$ ,  $\div 16$ ), two copies
- **3.3V power supply**
- **Wide operating temperature range:  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$**
- **Available in 16-pin (3mm x 3mm) QFN package**

## APPLICATIONS

- SONET/SDH line cards
- Transponders
- High-end, multiprocessor servers

## FUNCTIONAL BLOCK DIAGRAM



## DESCRIPTION

This 3.3V low-skew, low-jitter, precision LVDS output clock divider accepts any high-speed differential clock input (AC- or DC-coupled) CML, LVPECL, HSTL or LVDS and divides down the frequency using a programmable divider ratio to create a frequency-locked, lower speed version of the input clock. The SY89873L includes two output banks. Bank A is an exact copy of the input clock (pass through) with matched propagation delay to Bank B, the divided output bank. Available divider ratios are 2, 4, 8 and 16. In a typical 622MHz clock system this would provide availability of 311MHz, 155MHz, 77MHz or 38MHz auxiliary clock components.

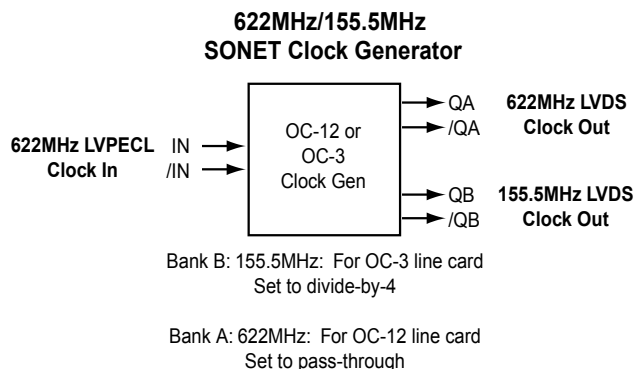
The differential input buffer has a unique internal termination design that allows access to the termination network through a VT pin. This feature allows the device to easily interface to all AC- or DC-coupled differential logic standards. A  $V_{REF-AC}$  reference is included for AC-coupled applications.

The SY89873L is part of Micrel's high-speed Precision Edge® timing and distribution family. For 2.5V applications, consider the SY89872U. For applications that require an LVPECL output, consider the SY89871U.

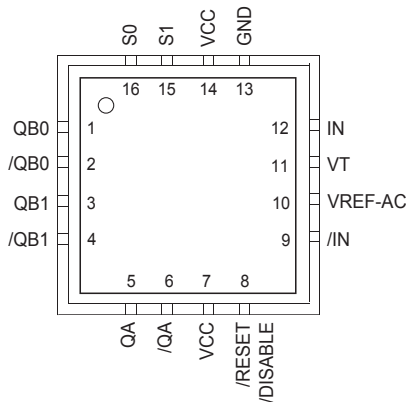
The /RESET input asynchronously resets the divider outputs (Bank B). In the pass-through function (Bank A) the /RESET synchronously enables or disables the outputs on the next falling edge of IN (rising edge of /N). Refer to the Timing Diagram.

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

## TYPICAL APPLICATION



## PACKAGE/ORDERING INFORMATION



16-Pin QFN

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

| Part Number                 | Package Type | Operating Range | Package Marking                      | Lead Finish    |
|-----------------------------|--------------|-----------------|--------------------------------------|----------------|
| SY89873LMG                  | QFN-16       | Industrial      | 873L with Pb-Free bar line indicator | NiPdAu Pb-Free |
| SY89873LMGTR <sup>(2)</sup> | QFN-16       | Industrial      | 873L 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.

## PIN DESCRIPTION

| Pin Number | Pin Name               | Pin Function                                                                                                                                                                                                                                    |
|------------|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1, 2, 3, 4 | QB0, /QB0<br>QB1, /QB1 | Differential Buffered Output Clocks: Divide by 2, 4, 8, 16. LVDS compatible.                                                                                                                                                                    |
| 5, 6       | QA, /QA                | Differential Buffered Undivided Output Clock: LVDS compatible.                                                                                                                                                                                  |
| 7, 14      | VCC                    | Positive Power Supply: Bypass with 0.1 $\mu\text{F}$ /0.01 $\mu\text{F}$ low ESR capacitors.                                                                                                                                                    |
| 8          | /RESET,<br>/DISABLE    | TTL/CMOS Compatible Output Reset and Disable: Internal 25k $\Omega$ pull-up. Input threshold is $V_{CC}/2$ . Logic LOW will reset the divider select, and align Bank A and Bank B edges. In addition, when LOW, Banks A and B will be disabled. |
| 12, 9      | IN, /IN                | Differential Input: Internal 50 $\Omega$ termination resistors to $V_T$ input. See "Input Interface Applications" section.                                                                                                                      |
| 10         | VREF-AC                | Reference Voltage: Equal to $V_{CC}-1.4\text{V}$ (approx.), and used for AC-coupled applications. Maximum sink/source current is 0.5mA. See "Input Interface Applications" section.                                                             |
| 11         | VT                     | Termination Center-Tap: For CML and LVDS inputs, leave this pin floating. Otherwise, see "Input Interface Applications" section.                                                                                                                |
| 13         | GND                    | Ground: Exposed pad is internally connected to GND and must be connected to a ground plane for proper thermal operation.                                                                                                                        |
| 16, 15     | S0, S1                 | Select Pins: LVTTL/CMOS logic levels. Internal 25k $\Omega$ pull-up resistor. Logic HIGH if left unconnected (divided by 16 mode). S0 = LSB. Input threshold is $V_{CC}/2$ .                                                                    |

## TRUTH TABLE

| /RESET<br>/DISABLE | S1 | S0 | Bank A Output                       | Bank B Outputs                                                                 |
|--------------------|----|----|-------------------------------------|--------------------------------------------------------------------------------|
| 1                  | 0  | 0  | Input Clock                         | Input Clock $\div 2$                                                           |
| 1                  | 0  | 1  | Input Clock                         | Input Clock $\div 4$                                                           |
| 1                  | 1  | 0  | Input Clock                         | Input Clock $\div 8$                                                           |
| 1                  | 1  | 1  | Input Clock                         | Input Clock $\div 16$                                                          |
| 0                  | X  | X  | QA = LOW, /QA = HIGH <sup>(1)</sup> | QB0 = LOW, /QB0 = HIGH <sup>(2)</sup><br>QB1 = LOW, /QB1 = HIGH <sup>(2)</sup> |

## Notes:

1. On the next negative transition of the input signal.
2. Asynchronous Reset/Disable function. See "Timing Diagram."

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

|                                                                         |                       |
|-------------------------------------------------------------------------|-----------------------|
| Supply Voltage ( $V_{CC}$ )                                             | –0.5V to +4.0V        |
| Input Voltage ( $V_{IN}$ )                                              | –0.5V to $V_{CC}+0.3$ |
| LVDS Output Current ( $I_{OUT}$ )                                       | ±10mA                 |
| Input Current $I_N$ , $I_{IN}$ ( $I_{IN}$ )                             | ±50mA                 |
| $V_{REF-AC}$ Input Sink/Source Current ( $I_{VREF-AC}$ ) <sup>(3)</sup> | ±2mA                  |
| Lead Temperature (soldering, 20 sec.)                                   | 260°C                 |
| Storage Temperature ( $T_S$ )                                           | –65°C to +150°C       |

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

|                                   |                |
|-----------------------------------|----------------|
| Supply Voltage ( $V_{CC}$ )       | +3.3V ±10%     |
| Ambient Temperature ( $T_A$ )     | –40°C to +85°C |
| Package Thermal Resistance        |                |
| QFN( $\theta_{JA}$ )              |                |
| Still-Air                         | 60°C/W         |
| 500 lfpm                          | 54°C/W         |
| QFN( $\Psi_{JB}$ ) <sup>(4)</sup> |                |
| Junction-to-Board                 | 38°C/W         |

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

$T_A$  = –40°C to +85°C; Unless otherwise stated.

| Symbol         | Parameter                                                | Condition             | Min            | Typ            | Max            | Units    |
|----------------|----------------------------------------------------------|-----------------------|----------------|----------------|----------------|----------|
| $V_{CC}$       | Power Supply                                             |                       | 3.0            | 3.3            | 3.6            | V        |
| $I_{CC}$       | Power Supply Current                                     | No load, Max $V_{CC}$ |                | 85             | 115            | mA       |
| $R_{IN}$       | Differential Input Resistance<br>( $I_N$ -to- $I_{IN}$ ) |                       | 90             | 100            | 110            | $\Omega$ |
| $V_{IH}$       | Input High Voltage<br>$I_N$ , $I_{IN}$                   | Note 6                | 0.1            |                | $V_{CC}+0.3$   | V        |
| $V_{IL}$       | Input Low Voltage<br>$I_N$ , $I_{IN}$                    | Note 6                | –0.3           |                | $V_{CC}$       | V        |
| $V_{IN}$       | Input Voltage Swing                                      | Notes 6, 7            | 0.1            |                | 3.6            | V        |
| $V_{DIFF\_IN}$ | Differential Input Voltage Swing                         | Notes 6, 7, 8         | 0.2            |                |                | V        |
| $ I_{IN} $     | Input Current<br>$I_N$ , $I_{IN}$                        | Note 6                |                |                | 45             | mA       |
| $V_{REF-AC}$   | Reference Voltage                                        | Note 9                | $V_{CC}-1.525$ | $V_{CC}-1.425$ | $V_{CC}-1.325$ | 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 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. Junction-to-board resistance assumes exposed pad is soldered (or equivalent) to the device's most negative potential on the PCB.
5. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
6. Due to the internal termination (see “*Input Buffer Structure*”) the input current depends on the applied voltages at  $I_N$ ,  $I_{IN}$  and  $V_T$  inputs. Do not apply a combination of voltages that causes the input current to exceed the maximum limit!
7. See “*Timing Diagram*” for  $V_{IN}$  definition.  $V_{IN}(\max)$  is specified when  $V_T$  is floating.
8. See Figures 1c and 1d for  $V_{DIFF}$  definition.
9. Operating using  $V_{IN}$  is limited to AC-coupled PECL or CML applications only. Connect directly to  $V_T$  pin.

**LVDS OUTPUT DC ELECTRICAL CHARACTERISTICS<sup>(10)</sup>**

$V_{CC} = 3.3V \pm 10\%$ ;  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ ; Unless otherwise stated.

| Symbol           | Parameter                     | Condition    | Min   | Typ | Max   | Units |
|------------------|-------------------------------|--------------|-------|-----|-------|-------|
| $V_{OUT}$        | Output Voltage Swing          | Notes 11, 12 | 250   | 350 | 450   | mV    |
| $V_{OH}$         | Output High Voltage           | Note 11      |       |     | 1.475 | V     |
| $V_{OL}$         | Output Low Voltage            | Note 11      | 0.925 |     |       | V     |
| $V_{OCM}$        | Output Common Mode Voltage    | Note 11      | 1.125 |     | 1.275 | V     |
| $\Delta V_{OCM}$ | Change in Common Mode Voltage |              | -50   |     | 50    | mV    |

**LVTTTL/CMOS DC ELECTRICAL CHARACTERISTICS<sup>(10)</sup>**

$V_{CC} = 3.3V \pm 10\%$ ;  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ ; Unless otherwise stated.

| Symbol   | Parameter          | Condition | Min  | Typ | Max  | Units         |
|----------|--------------------|-----------|------|-----|------|---------------|
| $V_{IH}$ | Input HIGH Voltage |           | 2.0  |     |      | V             |
| $V_{IL}$ | Input LOW Voltage  |           |      |     | 0.8  | V             |
| $I_{IH}$ | Input HIGH Current |           | -125 |     | 20   | $\mu\text{A}$ |
| $I_{IL}$ | Input LOW Current  |           |      |     | -300 | $\mu\text{A}$ |

**Notes:**

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

11. Measured as per Figure 1a,  $100\Omega$  across Q and /Q outputs.

12. See Figure 1c.

**AC ELECTRICAL CHARACTERISTICS<sup>(13)</sup>**

$V_{CC} = 3.3V \pm 10\%$ ;  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ ; Unless otherwise stated.

| Symbol       | Parameter                                           | Condition                         | Min | Typ | Max | Units             |
|--------------|-----------------------------------------------------|-----------------------------------|-----|-----|-----|-------------------|
| $f_{MAX}$    | Maximum Output Toggle Frequency (Bank A and Bank B) | Output Swing: $\geq 200\text{mV}$ | 2.0 |     |     | GHz               |
|              | Maximum Input Frequency                             | Note 14                           | 3.2 |     |     | GHz               |
| $t_{PD}$     | Differential Propagation Delay (IN-to-Q)            | Input Swing $< 400\text{mV}$      | 550 | 660 | 800 | ps                |
|              |                                                     | Input Swing $\geq 400\text{mV}$   | 500 | 610 | 750 | ps                |
| $t_{SKEW}$   | Within-Device Skew (diff.) (QB0-to-QB1)             | Note 15                           |     | 7   | 15  | ps                |
|              | Within-Device Skew (diff.) (Bank A-to-Bank B)       | Note 15                           |     | 12  | 30  | ps                |
|              | Part-to-Part Skew (diff.)                           | Note 15                           |     |     | 250 | ps                |
| $t_{rr}$     | Reset Recovery Time                                 | Note 16                           | 600 |     |     | ps                |
| $T_{jitter}$ | Cycle-to-Cycle Jitter                               | Note 17                           |     |     | 1   | ps <sub>RMS</sub> |
| $t_r, t_f$   | Rise / Fall Time (20% to 80%)                       |                                   | 60  | 110 | 190 | ps                |

**Notes:**

13. Measured with 400mV input signal, 50% duty cycle. All outputs terminated with  $100\Omega$  between Q and /Q, unless otherwise stated.

14. Bank A (pass-through) maximum frequency is limited by the output stage. Bank B (input-to-output  $\div 2, \div 4, \div 8, \div 16$ ) can accept an input frequency  $> 3\text{GHz}$ , while Bank A will be slew-rate limited.

15. Skew is measured between outputs under identical transitions.

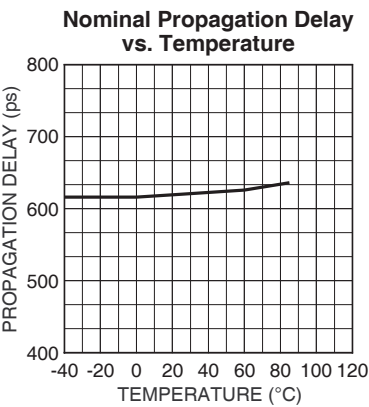
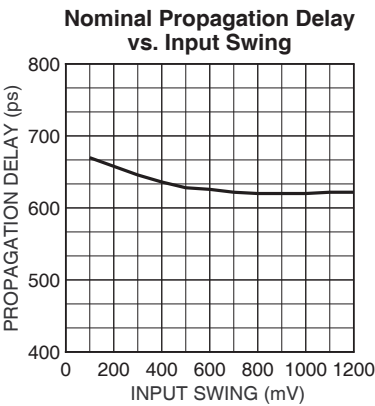
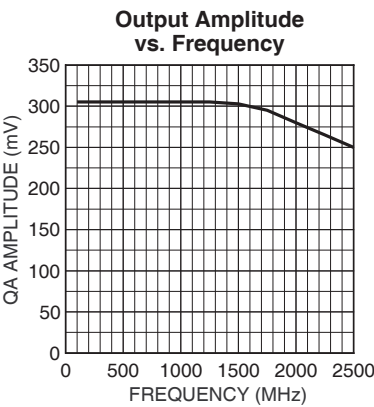
16. See "Timing Diagram."

17. Cycle-to-cycle jitter definition: the variation in 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.



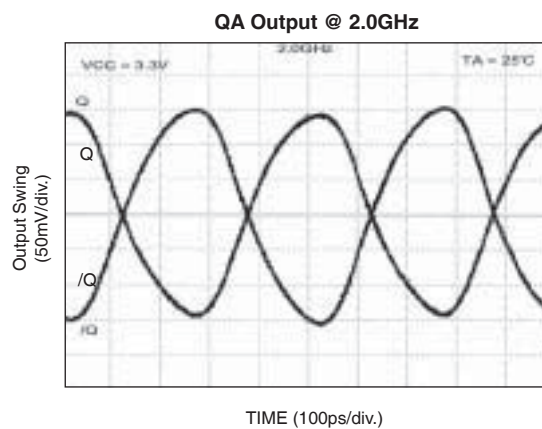
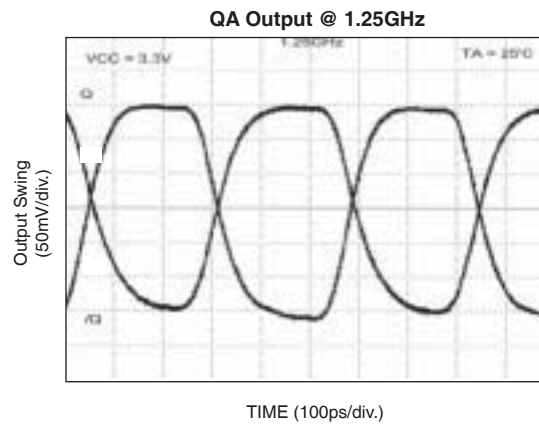
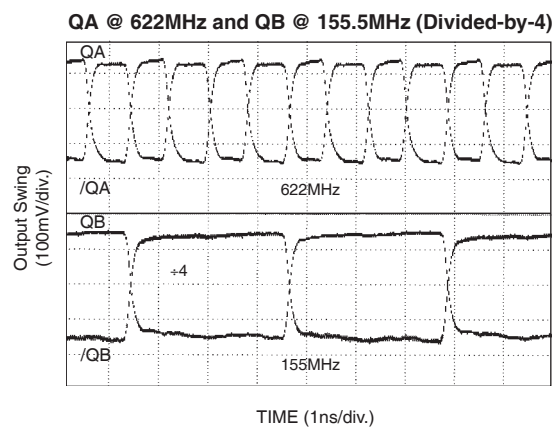
TYPICAL OPERATING CHARACTERISTICS

V<sub>CC</sub> = 3.3V, V<sub>IN</sub> = 400mV, T<sub>A</sub> = 25°C, unless otherwise stated.



**FUNCTIONAL CHARACTERISTICS**

Conditions:  $V_{CC} = 3.3V$ ,  $T_A = 25^\circ C$ , unless otherwise stated.



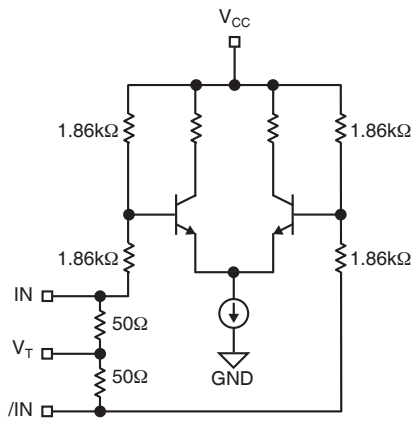
**INPUT BUFFER STRUCTURE**

Figure 2a. Simplified Differential Input Stage

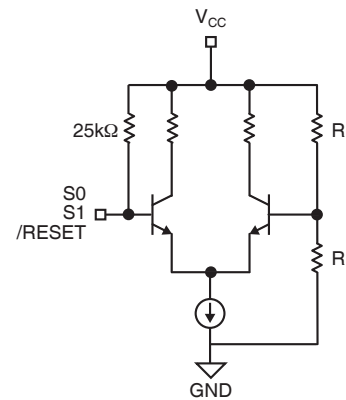
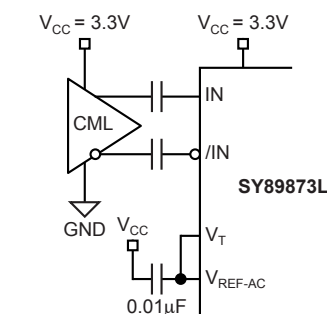
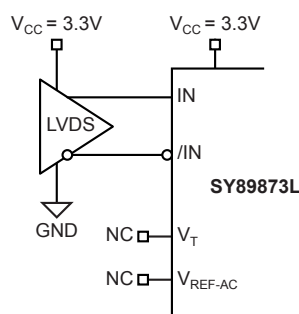


Figure 2b. Simplified TTL/CMOS Input

## INPUT INTERFACE APPLICATIONS



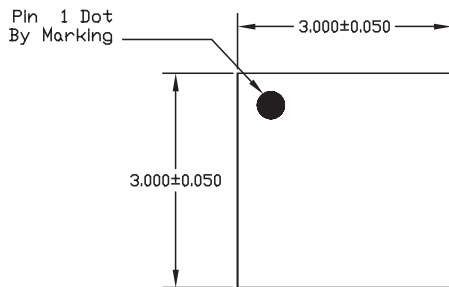
### Figure 3b. AC-Coupled CML Input Interface



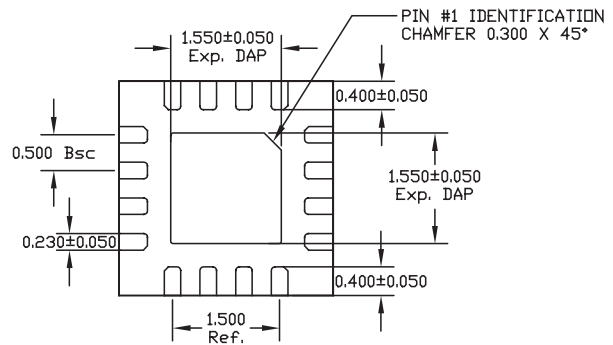
### Figure 3e. LVDS Input Interface

## RELATED MICREL PRODUCTS AND SUPPORT DOCUMENTATION

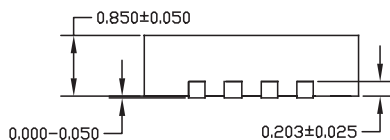
| Part Number   | Function                                                                                       | Data Sheet Link                                                                                                                |
|---------------|------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| SY89871U      | 2.5GHz Any Diff. In-to-LVPECL Programmable Clock Divider/Fanout Buffer w/Internal Termination  | <a href="http://www.micrel.com/product-info/products/sy89871u.shtml">www.micrel.com/product-info/products/sy89871u.shtml</a>   |
| SY89872U      | 2.5V 2GHz Any Diff. In-to-LVDS Programmable Clock Divider/Fanout Buffer w/Internal Termination | <a href="http://www.micrel.com/product-info/products/sy89872u.shtml">www.micrel.com/product-info/products/sy89872u.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> |

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

TOP VIEW



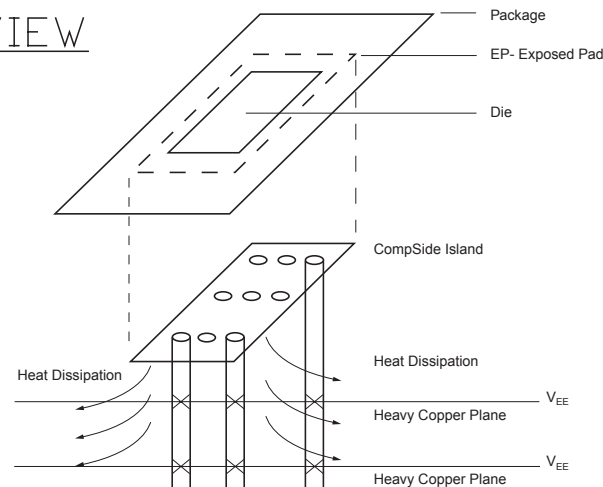
BOTTOM VIEW



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 moisture sensitivity classification, and is shipped in dry-pack form.
2. Exposed pads must be soldered to a ground for proper thermal management.

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