



## SY89853U

### Precision Low-Power Dual 2:1 LVPECL MUX with Internal Termination

## General Description

The SY89853U features two, low jitter 2:1 differential multiplexers with 100K LVPECL (800mV) compatible outputs, capable of handling clocks up to 2.5GHz and data streams up to 2.5Gbps.

The SY89853U differential inputs include Micrel's unique, 3-input termination architecture that allows users to interface to any differential signal (AC- or DC-Coupled) as small as 100mV without any level shifting or termination resistors networks in the signal path. The result is a clean, stub-free, low jitter interface solution. The differential 800mV LVPECL outputs have fast rise/fall times guaranteed to be less than 180ps.

The SY89853U operates from a 2.5V  $\pm 5\%$  or a 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 higher performance, consider the SY58026U. The SY89853U is part of Micrel's Precision Edge<sup>®</sup> product family.

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



Precision Edge<sup>®</sup>

## Features

- Dual 2:1 MUX, each channel selects from inputs
- Unique, patent-pending input isolation design minimizes crosstalk
- Low power 210mW ( $V_{CC} = 2.5\text{V}$ )
- Guaranteed AC performance over temperature and voltage:
  - DC-to->2.5Gbps data rate throughput
  - $<360\text{ps}$  IN-to-Q  $t_{pd}$
  - $<180\text{ps}$   $t_r/t_f$  times
- Ultra-low jitter design:
  - $<1\text{ps}_{RMS}$  random jitter
  - $<10\text{ps}_{PP}$  deterministic jitter
  - $<10\text{ps}_{PP}$  total jitter (clock)
  - $<0.7\text{ps}_{RMS}$  crosstalk-induced jitter
- Unique, patent-pending 50 $\Omega$  input termination and VT pin accepts DC- and AC-coupled inputs (CML, LVDS, PECL)
- 800mV LVPECL output swing
- Power supply 2.5V  $\pm 5\%$  or 3.3V  $\pm 10\%$
- $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  temperature range
- Available in 32-pin (5mm x 5mm) MLF<sup>®</sup> package

## Applications

- Data communication systems
- All SONET OC-3 to OC-48 applications
- All Fibre Channel applications
- All GigE applications

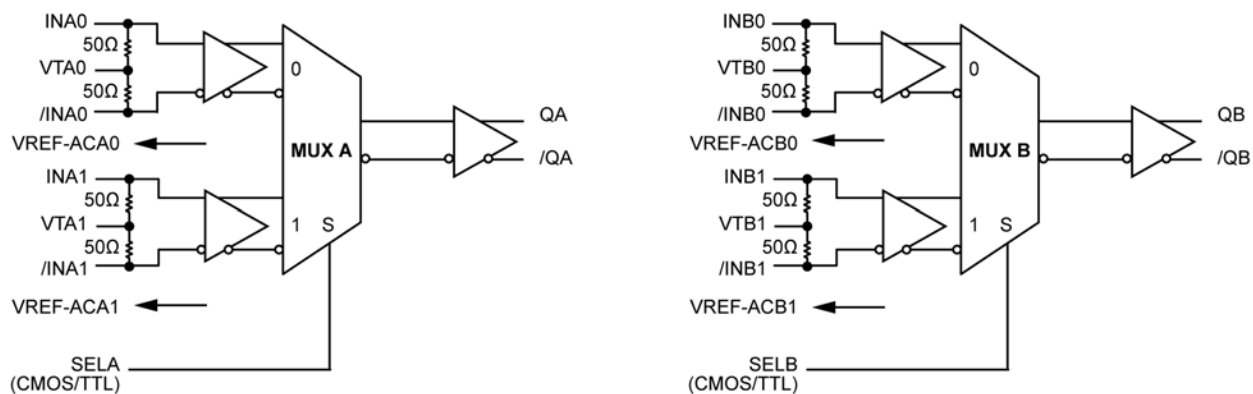
## Markets

- LAN/WAN communication
- Enterprise servers
- ATE
- Test and measurement

Precision Edge is a registered trademark of Micrel, Inc.  
MLF and MicroLeadFrame are registered trademarks of Amkor Technology.

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

## Functional Block Diagram



## Truth Table

| SEL | Q                |
|-----|------------------|
| 0   | IN0 Input Select |
| 1   | IN1 Input Select |

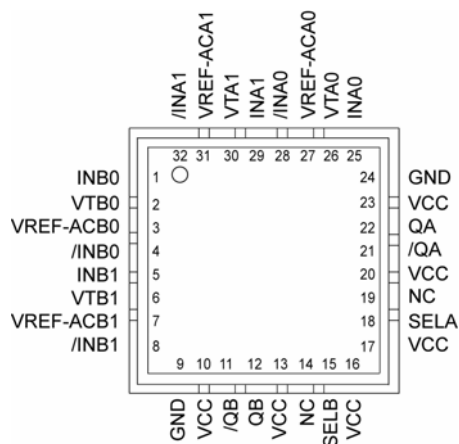
## Ordering Information<sup>(1)</sup>

| Part Number                 | Package Type | Operating Range | Package Marking                          | Lead Finish    |
|-----------------------------|--------------|-----------------|------------------------------------------|----------------|
| SY89853UMG                  | MLF-32       | Industrial      | SY89853U with Pb-Free bar-line indicator | NiPdAu Pb-Free |
| SY89853UMGTR <sup>(2)</sup> | MLF-32       | Industrial      | SY89853U 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 Configuration



32-Pin MLF<sup>®</sup> (MLF-32)

## Pin Description

| Pin Number                        | Pin Name                                                    | Pin Function                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 25, 28,<br>29, 32<br>1, 4<br>5, 8 | INA0, /INA0,<br>INA1, /INA1,<br>INB0, /INB0,<br>INB1, /INB1 | Differential Inputs: These input pairs are the differential signal inputs to the device. Inputs accept AC- or DC-coupled signals as small as 100mV. Each pin of a pair internally terminates to a VT pin through 50Ω. Note that these inputs will default to an indeterminate state if left open. Connecting one input to VCC and the complementary input-to-GND through 1kΩ resistor can terminate unused differential input pairs. The VT pin is to be left open in this configuration. Please refer to the "Input Interface Applications" section for more details. |
| 10, 13, 16, 17,<br>20, 23         | VCC                                                         | Positive power supply. Bypass with 0.1μF//0.01μF low ESR capacitors. The 0.01μF capacitor should be as close to VCC pin as possible.                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 14, 19                            | NC                                                          | Not connected.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 18<br>15                          | SELA,<br>SELB                                               | Bank A and Bank B Input Channel Select (TTL/CMOS): These TTL/CMOS-compatible inputs select the inputs to the multiplexers. These inputs are internally connected to a 25kΩ pull-up resistor and will default to logic HIGH state if left open.                                                                                                                                                                                                                                                                                                                         |
| 22, 21<br>12, 11                  | QA, /QA,<br>QB, /QB                                         | Differential Outputs: These LVPECL output pairs are the outputs of the device. They are a logic function of the INA0, INA1, INB0, INB1 and SELA and SELB inputs. Please refer to the "Truth Table" below for details.                                                                                                                                                                                                                                                                                                                                                  |
| 26, 30<br>2, 6                    | VTA0, VTA1<br>VTB0, VTB1                                    | Input Termination Center-Tap: Each side of the differential input pair terminates to a VT pin. The VTA0, VTA1, VTB0, VTB1 pins provide a center-tap to a termination network for maximum interface flexibility. See "Input Interface Applications" section for details.                                                                                                                                                                                                                                                                                                |
| 27<br>31<br>3<br>7                | VREF-ACA0,<br>VREF-ACA1,<br>VREF-ACB0,<br>VREF-ACB1         | Reference Voltages: These reference voltage outputs are equivalent to $V_{CC}-1.2V$ . They are used for AC-coupled inputs. Connect VREF-AC directly to the VT pin and bypass with 0.01μF low ESR capacitor to $V_{CC}$ . See "Input Interface Applications" section. Maximum sink/source current is $\pm 1.5mA$ .                                                                                                                                                                                                                                                      |
| 9, 24                             | GND,<br>Exposed Pad                                         | Ground: Ground pins and exposed pad must be connected to the same ground plane.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

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

|                                          |                        |
|------------------------------------------|------------------------|
| Supply Voltage ( $V_{CC}$ )              | .....-0.5V to +4.0V    |
| Input Voltage ( $V_{IN}$ )               | .....-0.5V to $V_{CC}$ |
| LVPECL Output Current ( $I_{OUT}$ )      |                        |
| Continuous                               | ..... $\pm 50$ mA      |
| Surge                                    | ..... $\pm 100$ mA     |
| Termination Current                      |                        |
| Source or Sink Current on $V_T$          | ..... $\pm 50$ mA      |
| Input Current                            |                        |
| Source or Sink Current on $I_N$ , $/I_N$ | ..... $\pm 50$ mA      |
| Current ( $V_{REF-AC}$ )                 |                        |
| Source or Sink Current on $V_{REF-AC}$   | ..... $\pm 2$ mA       |
| Lead Temperature (soldering, 20sec.)     | .....260°C             |
| Storage Temperature ( $T_s$ )            | ..... -65°C to +150°C  |

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

|                                           |                         |
|-------------------------------------------|-------------------------|
| Supply Voltage ( $V_{CC}$ )               | .....+2.375V to +2.625V |
|                                           | .....+3.0V to +3.6V     |
| Ambient Temperature ( $T_A$ )             | .....-40°C to +85°C     |
| Package Thermal Resistance <sup>(3)</sup> |                         |
| MLF <sup>®</sup> ( $\theta_{JA}$ )        |                         |
| Still-Air                                 | .....35°C/W             |
| 500lfpm                                   | .....28°C/W             |
| MLF <sup>®</sup> ( $\psi_{JB}$ )          |                         |
| Junction-to-Board                         | .....16°C/W             |

**DC Electrical Characteristics<sup>(4)</sup>**

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

| Symbol         | Parameter                                          | Condition                                        | Min            | Typ            | Max            | Units    |
|----------------|----------------------------------------------------|--------------------------------------------------|----------------|----------------|----------------|----------|
| $V_{CC}$       | Power Supply                                       | $V_{CC} = 2.5\text{V}$<br>$V_{CC} = 3.3\text{V}$ | 2.375<br>3.0   | 2.5<br>3.3     | 2.625<br>3.6   | V        |
| $I_{CC}$       | Power Supply Current                               | No load, max. $V_{CC}$ .                         |                | 65             | 85             | mA       |
| $R_{IN}$       | Input Resistance<br>(IN-to- $V_T$ )                |                                                  | 45             | 50             | 55             | $\Omega$ |
| $R_{DIFF\_IN}$ | Differential Input Resistance<br>(IN-to- $/I_N$ )  |                                                  | 90             | 100            | 110            | $\Omega$ |
| $V_{IH}$       | Input High Voltage<br>(IN, $/I_N$ )                |                                                  | $V_{CC} - 1.2$ |                | $V_{CC}$       | V        |
| $V_{IL}$       | Input Low Voltage<br>(IN, $/I_N$ )                 |                                                  | 0              |                | $V_{IH} - 0.1$ | V        |
| $V_{IN}$       | Input Voltage Swing<br>(IN-to- $/I_N$ )            | See Figure 1a.                                   | 100            |                | 1700           | mV       |
| $V_{DIFF\_IN}$ | Differential Input Voltage Swing<br>$ I_N - /I_N $ | See Figure 1b.                                   | 200            |                |                | mV       |
| $V_{T\_IN}$    | Maximum Input Voltage<br>(IN-to- $V_T$ )           |                                                  |                |                | 1.28           | V        |
| $V_{REF-AC}$   | Output Reference Voltage                           |                                                  | $V_{CC} - 1.3$ | $V_{CC} - 1.2$ | $V_{CC} - 1.1$ | 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. Package thermal resistance assumes exposed pad is soldered (or equivalent) to the devices most negative potential on the PCB.  $\theta_{JA}$  and  $\psi_{JB}$  values are determined for a 4-layer board in still-air, unless otherwise stated.
4. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

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

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

| Symbol         | Parameter                                    | Condition      | Min            | Typ  | Max            | Units |
|----------------|----------------------------------------------|----------------|----------------|------|----------------|-------|
| $V_{OH}$       | Output High Voltage<br>(Q, /Q)               |                | $V_{CC}-1.145$ |      | $V_{CC}-0.895$ | V     |
| $V_{OL}$       | Output Low Voltage<br>(Q, /Q)                |                | $V_{CC}-1.945$ |      | $V_{CC}-1.695$ | V     |
| $V_{OUT}$      | Output Voltage Swing<br>(Q, /Q)              | See Figure 1a. | 400            | 800  |                | mV    |
| $V_{DIFF-OUT}$ | Differential Output Voltage Swing<br>(Q, /Q) | See Figure 1b. | 800            | 1600 |                | mV    |

## LVTTTL/CMOS DC Electrical Characteristics<sup>(5)</sup>

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

| 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 | $V_{IN} = V_{CC}$ |      |     | 75  | $\mu A$ |
| $I_{IL}$ | Input Low Current  | $V_{IN} = 0.5V$   | -300 |     |     | $\mu A$ |

### Notes:

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

## AC Electrical Characteristics<sup>(6)</sup>

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

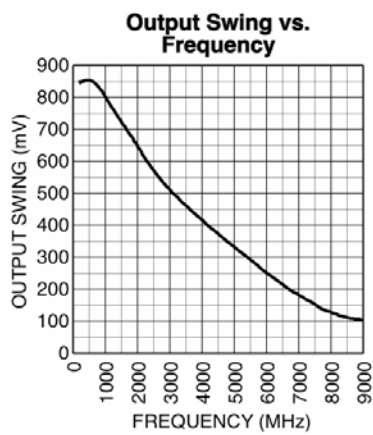
| Symbol             | Parameter                                                 | Condition                | Min | Typ | Max | Units             |
|--------------------|-----------------------------------------------------------|--------------------------|-----|-----|-----|-------------------|
| $f_{MAX}$          | Maximum Operating Frequency                               | NRZ Data                 | 2.5 |     |     | Gbps              |
|                    |                                                           | Clock, $V_{OUT} > 400mV$ | 2.5 |     |     | GHz               |
| $t_{pd}$           | Propagation Delay                                         |                          |     |     |     |                   |
|                    | IN-to-Q                                                   |                          | 160 | 250 | 360 | ps                |
|                    | SEL-to-Q                                                  |                          | 100 | 260 | 400 | ps                |
| $t_{pd}$<br>Tempco | Differential Propagation Delay<br>Temperature Coefficient |                          |     | 143 |     | fs/ °C            |
| $t_{SKEW}$         | Input-to-Input Skew (Within-bank)                         | Note 7                   |     | 10  | 20  | ps                |
|                    | Bank-to-Bank Skew                                         | Note 8                   |     | 12  | 25  | ps                |
| $t_{JITTER}$       | Data                                                      |                          |     |     |     |                   |
|                    | Random Jitter (RJ)                                        | Note 9                   |     |     | 1   | ps <sub>RMS</sub> |
|                    | Deterministic Jitter (DJ)                                 | Note 10                  |     |     | 10  | ps <sub>PP</sub>  |
|                    | Clock                                                     |                          |     |     |     |                   |
|                    | Cycle-to-Cycle Jitter                                     | Note 11                  |     |     | 1   | ps <sub>RMS</sub> |
|                    | Total Jitter (TJ)                                         | Note 12                  |     |     | 10  | ps <sub>PP</sub>  |
| $t_r, t_f$         | Crosstalk-Induced Jitter                                  |                          |     |     |     |                   |
|                    | Channel-to-Channel (Within-bank)                          | Note 13, within-bank     |     |     | 0.7 | ps <sub>RMS</sub> |
| $t_r, t_f$         | Output Rise/Fall Time (20% to 80%)                        | At full output swing.    | 50  | 100 | 180 | ps                |

### Notes:

6. High-speed AC parameters are guaranteed by design and characterization.  $V_{IN}$  swing  $\geq 100mV$ , unless otherwise stated.
7. Input-to-input skew is the difference in time between two inputs to the output within a bank.
8. Bank-to-bank skew is the difference in time from input to the output between banks.
9. Random jitter is measured with a K28.7 character pattern, measured at  $<f_{MAX}$ .
10. Deterministic jitter is measured at 2.5Gbps with both K28.5 and  $2^{23}-1$  PRBS pattern.
11. Cycle-to-cycle jitter definition: the variation of periods between adjacent cycles,  $T_n - T_{n-1}$  where T is the time between rising edges of the output signal.
12. Total jitter definition: with an ideal clock input of frequency  $<f_{MAX}$ , no more than one output edge in  $10^{12}$  output edges will deviate by more than the specified peak-to-peak jitter value.
13. Crosstalk is measured at the output while applying two similar differential clock frequencies that are asynchronous with respect to each other at the inputs.

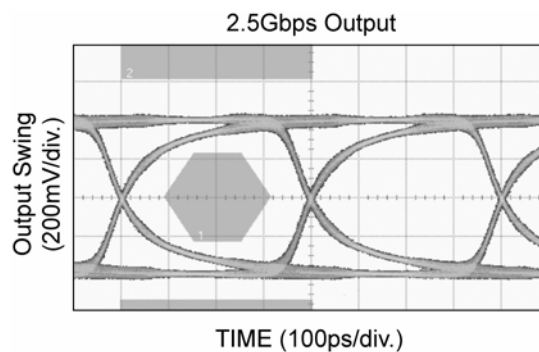
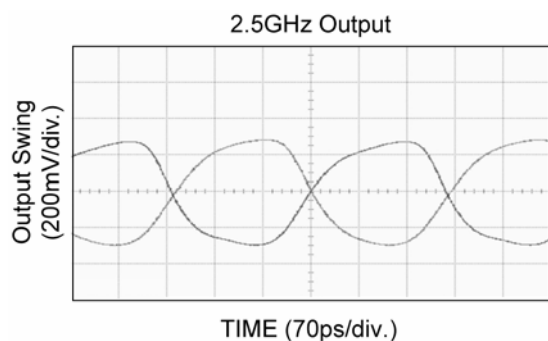
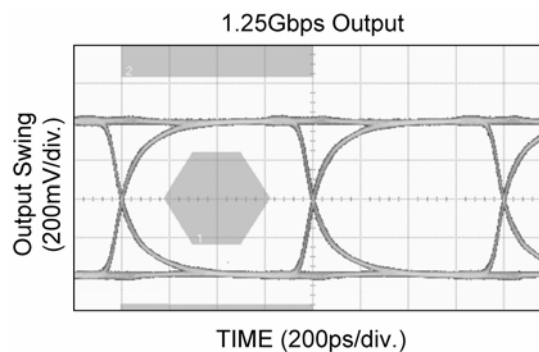
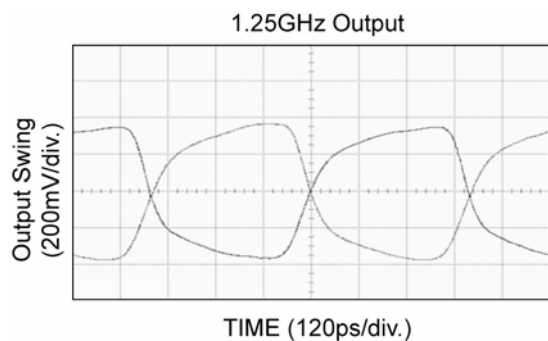
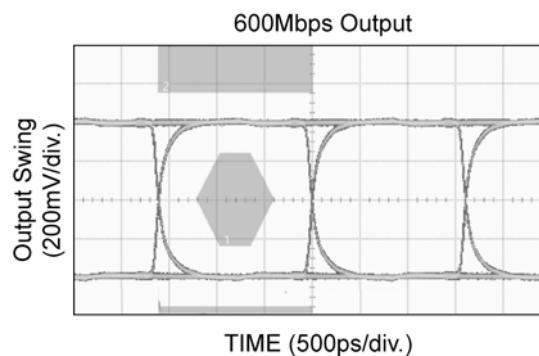
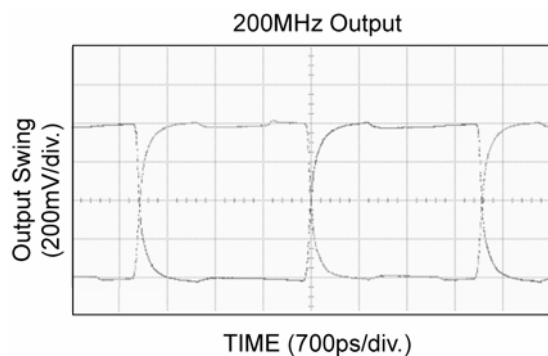
## Typical Operating Characteristics

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



## Functional Characteristics

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





## Single-Ended and Differential Swings

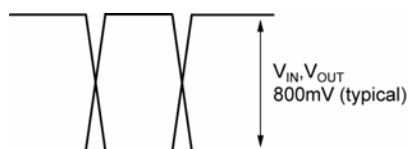


Figure 1a. Single-Ended Voltage Swing

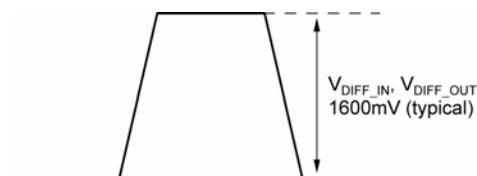
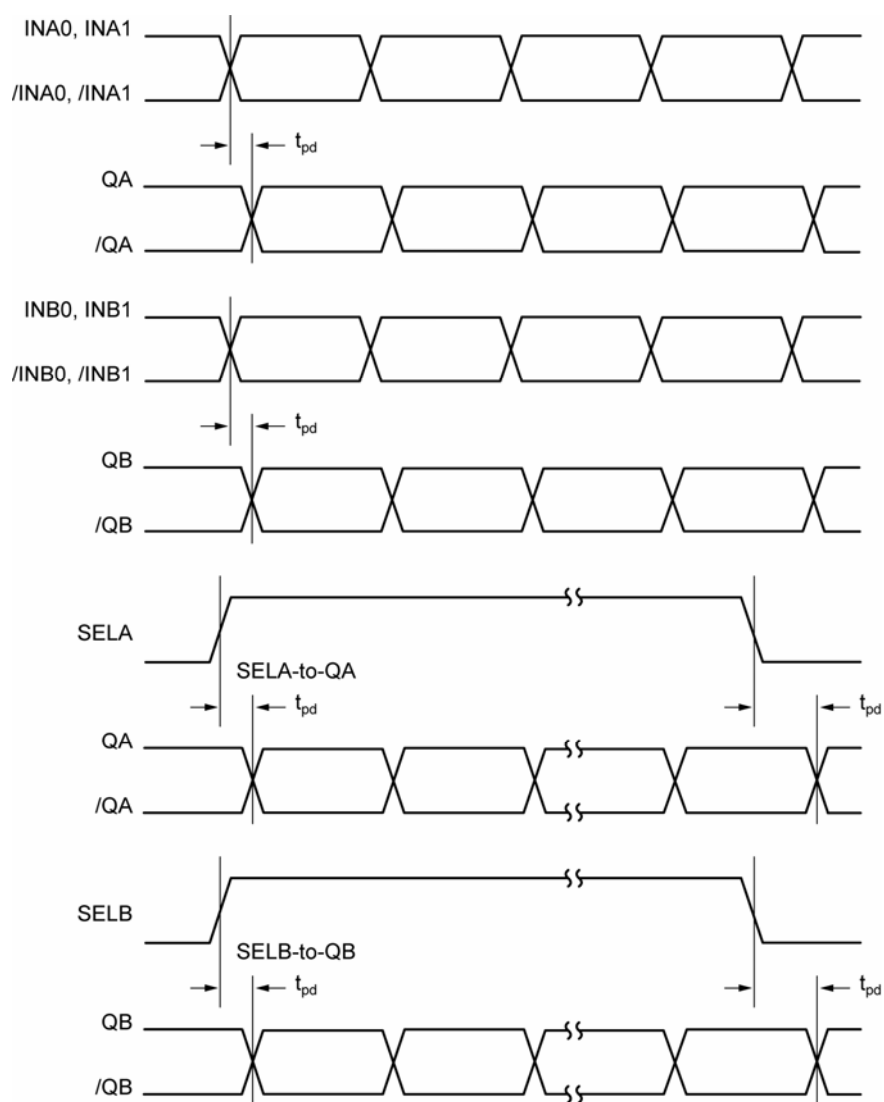
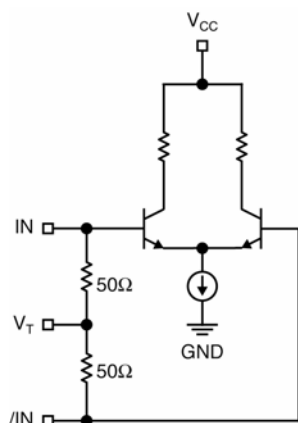


Figure 1b. Differential Voltage Swing

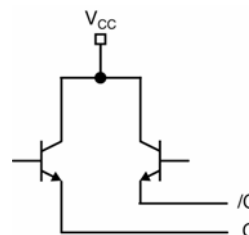
## Timing Diagram



## Input and Output Stages

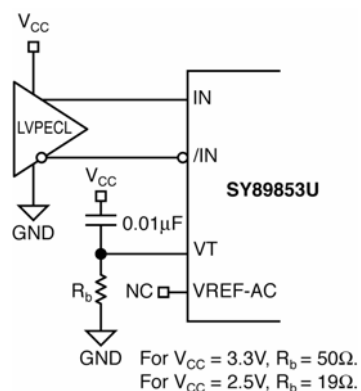


**Figure 2a. Simplified Differential Input Stage**

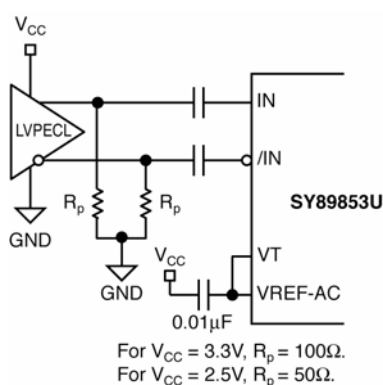


### Figure 2b. Simplified LVPECL Output Stage

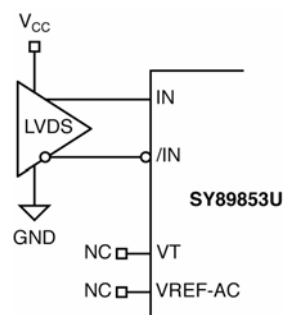
## Input Interface Applications



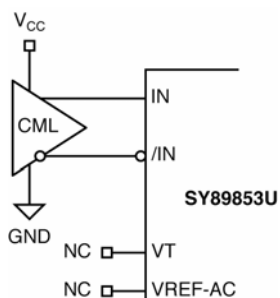
**Figure 3a. LVPECL Interface  
(DC-Coupled)**



**Figure 3b. LVPECL Interface (AC-Coupled)**

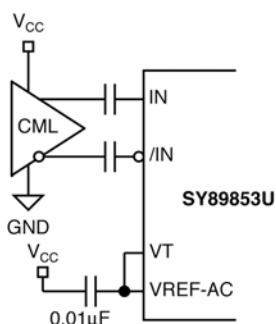


### Figure 3c. LVDS Interface



option: may connect  $V_T$  to  $V_{CC}$ .

**Figure 3d. CML Interface  
(DC-Coupled)**

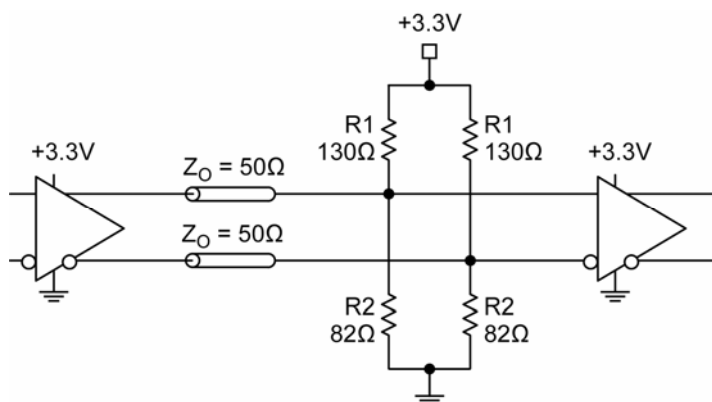


**Figure 3e. CML Interface  
(AC-Coupled)**

## Output Interface Applications

LVPECL has high input impedance, very low output impedance (open emitter) impedance, and small signal swing, which result in low EMI. LVPECL is ideal for driving 50Ω and 100Ω controlled impedance transmission lines. There are different techniques for terminating

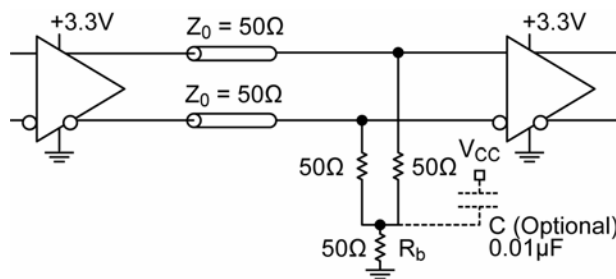
LVPECL outputs: Parallel Termination Thevenin-Equivalent, Parallel Termination (3-resistor), and AC-coupled termination. Unused output pairs may be left floating; however, single-ended outputs must be terminated or balanced.



**Note:**

1. For a 2.5V system,  $R1 = 250\Omega$ ,  $R2 = 62.5\Omega$ .
2. For a 3.3V system,  $R1 = 130\Omega$ ,  $R2 = 82\Omega$ .

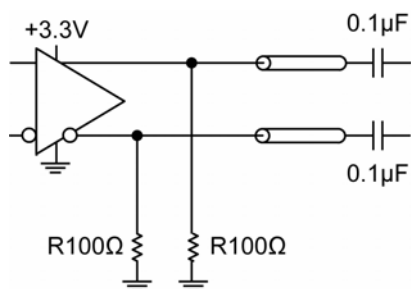
**Figure 4a. Parallel Thevenin-Equivalent Termination**



**Note:**

1. For a 2.5V system,  $R_b = 19\Omega$ .
2. For a 3.3V system,  $R_b = 50\Omega$ .

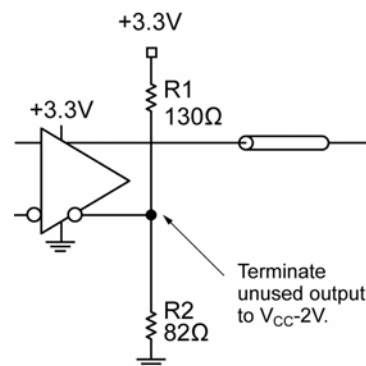
**Figure 4b. Parallel Termination (3-Resistor)**



**Note:**

For a 2.5V system,  $R = 50\Omega$ .

**Figure 4c. AC-Coupled Termination**



**Note:**

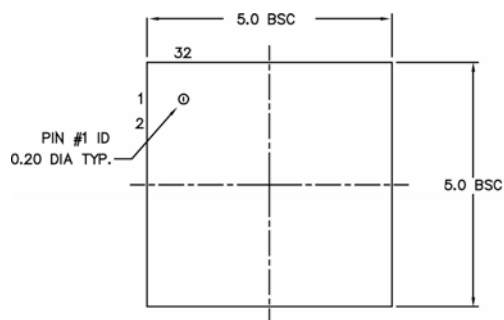
For a 2.5V system,  $R1 = 250\Omega$ ,  $R2 = 62.5\Omega$ .

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

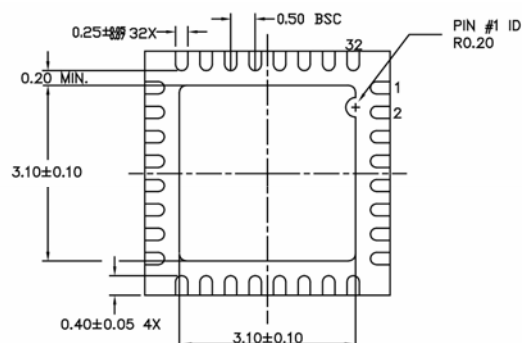
## Related Product and Support Documentation

| Part Number   | Function                                                   | Data Sheet Link                                                                                                                |
|---------------|------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| SY58026U      | 5Gbps Dual 2 :1 400mV LVPECL MUX with Internal Termination | <a href="http://www.micrel.com/product-info/products/sy58026u.shtml">www.micrel.com/product-info/products/sy58026u.shtml</a>   |
|               | MLF® Application Note                                      | <a href="http://www.amkor.com/products/notes_papers/MLFAppNote.pdf">www.amkor.com/products/notes_papers/MLFAppNote.pdf</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> |

## Package Information



TOP VIEW



BOTTOM VIEW

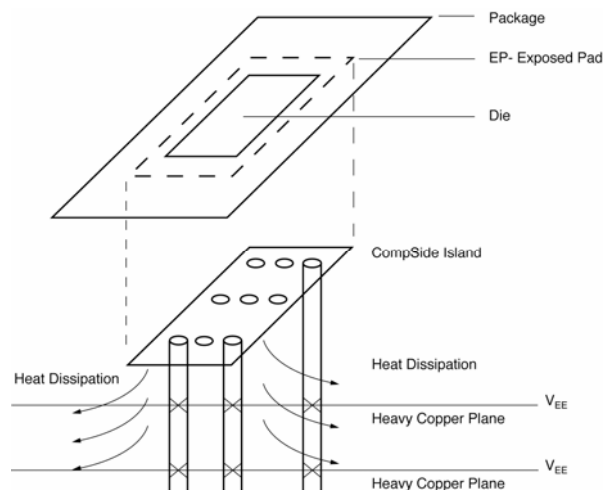


SIDE VIEW

### 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.

### 32-Pin MLF® (MLF-32)



### PCB Thermal Consideration for 32-Pin MLF® Package (Always solder, or equivalent, the exposed pad to the PCB)

#### Packages Notes:

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

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