

**ULTRA PRECISION 8:1 MUX WITH  
INTERNAL TERMINATION AND 1:2  
400mV LVPECL FANOUT BUFFER****Precision Edge™  
SY58039U****FEATURES**

- Selects between 1 of 8 inputs, and provides 2 precision, low skew LVPECL output copies
- Ultra-low jitter design:
  - 80fs<sub>rms</sub> phase jitter (typ)
- Guaranteed AC performance over temperature and voltage:
  - DC to 5Gbps throughput
  - <490ps propagation delay IN-to-Q ( $V_{IN} > 100mV$ )
  - <85ps  $t_r / t_f$  time
  - <15ps skew (output-to-output)
- Unique, patent-pending, channel-to-channel isolation design provides superior crosstalk performance
- Unique, patent-pending, input termination and VT pin accepts DC- and AC-coupled inputs (CML, PECL, LVDS)
- 400mV LVPECL output swing
- Power supply 2.5V ±5% or 3.3V ±10%
- -40°C to +85°C temperature range
- Available in 44-pin (7mm \* 7mm) QFN package

**Precision Edge™****DESCRIPTION**

The SY58039U is a low jitter, low skew, high-speed 8:1 multiplexer with a 1:2 differential fanout buffer optimized for precision telecom and enterprise server distribution applications. The SY58039U distributes clock frequencies from DC to 4GHz, and data rates to 5Gbps guaranteed over temperature and voltage.

The SY58039U differential input includes Micrel's unique, 3-pin input termination architecture that directly interfaces to any differential signal (AC- or DC-coupled) as small as 100mV without any level shifting or termination resistor networks in the signal path. The outputs are 400mV, 100K-compatible LVPECL with extremely fast rise/fall times guaranteed to be less than 85fs.

The SY58039U features a patent-pending isolation design that significantly improve channel-to-channel crosstalk performance.

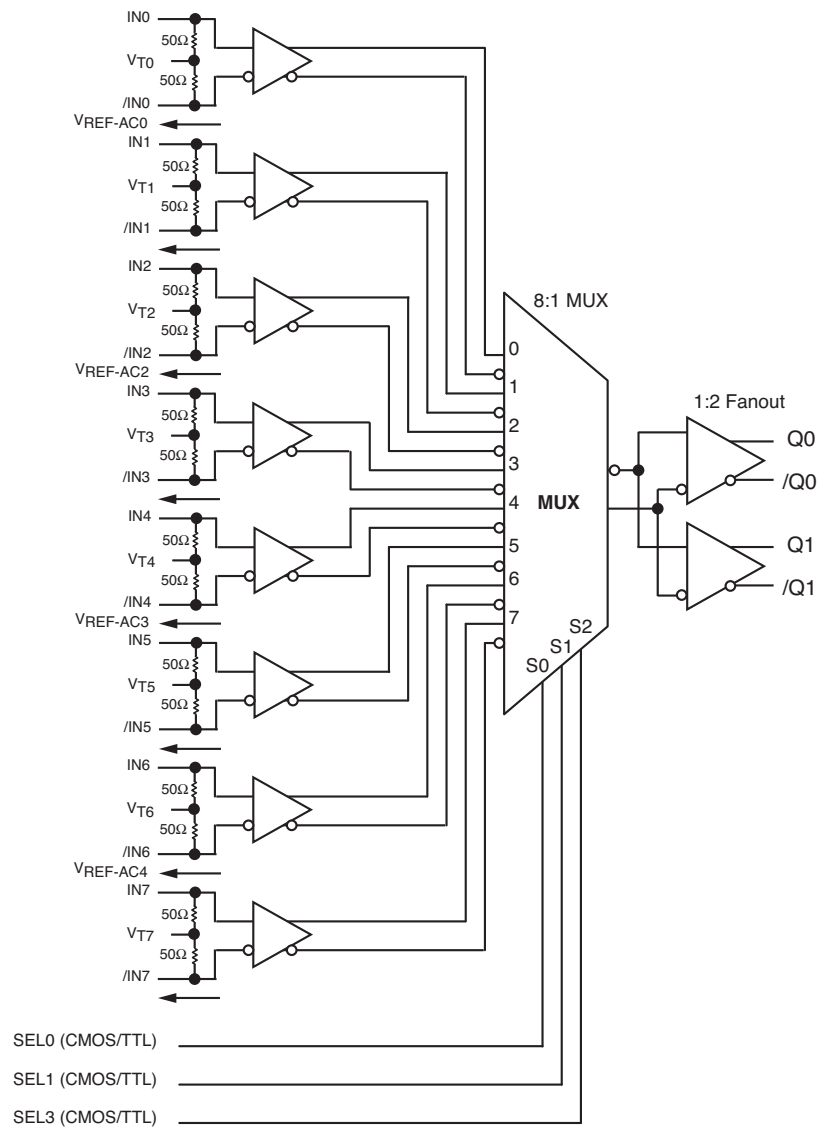
The SY58039U operates from a 2.5V ±5% or 3.3V ±10% supply and is guaranteed over the full industrial temperature range of -40°C to +85°C. The SY58039U is part of Micrel's high-speed, Precision Edge™ product line.

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

**APPLICATIONS**

- Data communication systems
- All SONET/SDH data/clock applications
- All Fibre Channel applications
- All Gigabit Ethernet applications

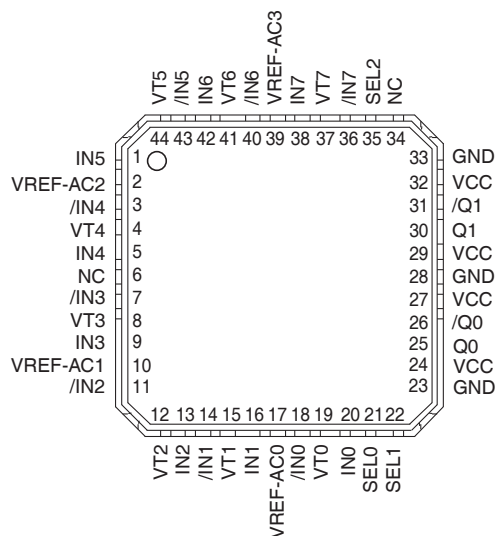
**FUNCTIONAL BLOCK DIAGRAM**



**TRUTH TABLE**

| SEL2 | SEL1 | SEL0 | Q   | /Q   |
|------|------|------|-----|------|
| L    | L    | L    | IN0 | /IN0 |
| L    | L    | H    | IN1 | /IN1 |
| L    | H    | L    | IN2 | /IN2 |
| L    | H    | H    | IN3 | /IN3 |
| H    | L    | L    | IN4 | /IN4 |
| H    | L    | H    | IN5 | /IN5 |
| H    | H    | L    | IN6 | /IN6 |
| H    | H    | H    | IN7 | /IN7 |

**PACKAGE/ORDERING INFORMATION**



**44-Pin QFN (QFN-44)**

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

| Part Number                 | Package Type | Operating Range | Package Marking |
|-----------------------------|--------------|-----------------|-----------------|
| SY58039UMI                  | QFN-44       | Industrial      | SY58039U        |
| SY58039UMITR <sup>(2)</sup> | QFN-44       | Industrial      | SY58039U        |

**Notes:**

- Contact factory for die availability. Die are guaranteed at T<sub>A</sub> = 25°C, DC electricals only.  
All devices are Pb-Free.
- Tape and Reel.

**PIN DESCRIPTION**

| Pin Number  | Pin Name  | Pin Function  |
|---|---|---|
| 20, 18<br>16, 14<br>13, 11<br>9, 7<br>5, 3<br>1, 43<br>42, 40<br>38, 36 | IN0, /IN0,<br>IN1, /IN1,<br>IN2, /IN2,<br>IN3, /IN3,<br>IN4, /IN4,<br>IN5, /IN5,<br>IN6, /IN6,<br>IN7, /IN7 | 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 50ohms. Note that these inputs will default to an indeterminate state if left open. Please refer to the “Input Interface Applications” section for more details. |
| 19, 15<br>12, 8<br>4, 44<br>41, 37                                      | VT0, VT1<br>VT2, VT3,<br>VT4, VT5,<br>VT6, VT7  | 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. For a CML or LVDS inputs, the VT pin is left floating.   |
| 17<br>10<br>2<br>39   | VREF-AC0,<br>VREFAC1,<br>VREFAC2,<br>VREF-AC3   | Reference Voltage: This output biases to V <sub>CC</sub> -1.2V. It is used when AC coupling the inputs (IN, /IN). For AC-coupled applications, connect VREF_AC to the VT pin and bypass with a 0.01µF low ESR capacitor to V <sub>CC</sub> . See “Input Interface Applications” section for more details.   |
| 21<br>22<br>35  | SEL0,<br>SEL1,<br>SEL2  | The single-ended TTL/CMOS-compatible inputs select the inputs to the multiplexer. Note that this input is internally connected to a 25kohms pull-up resistor and will default to a logic HIGH state if left open.   |
| 24, 27, 29, 32  | VCC   | Positive Power Supply. Bypass with 0.1µF//0.01µF low ESR capacitors as close to each VCC pin.   |
| 25, 26,<br>30, 31   | Q0,/Q0,<br>Q1,/Q1   | Differential Outputs: These 400mV LVPECL output pairs are the outputs of the device. Each output is designed to drive 400mV into 50Ω terminated V <sub>CC</sub> -2V (or V <sub>CC</sub> -1.2V if AC-coupled). Unused output pairs may be left open.   |
| 23, 28, 33  | GND,<br>Exposed Pad   | Ground. GND and exposed pad must both be connected to the most negative potential of chip ground.   |

### 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             |
| Termination Current <sup>(3)</sup>    |                   |
| Source or sink current on VT pin      | ±100mA            |
| Lead Temperature (soldering, 10 sec.) | 265°C             |
| Storage Temperature Range ( $T_S$ )   | -65°C to +150°C   |

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

|   |                    |
|---|--------------------|
| Power Supply Voltage ( $V_{CC}$ )         | +2.375V to +2.625V |
|   | +3.0V to +3.6V     |
| Ambient Temperature Range ( $T_A$ )       | -40°C to +85°C     |
| Package Thermal Resistance <sup>(4)</sup> |                    |
| QFN ( $\theta_{JA}$ )                     |                    |
| Still-Air                                 | 24°C/W             |
| QFN ( $\psi_{JB}$ )                       |                    |
| Junction-to-board                         | 12°C/W             |

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

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

| 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          | 3.6          | V     |
| $I_{CC}$       | Power Supply Current                         | No load, max. $V_{CC}$ . |              | 110          | 155          | mA    |
| $R_{IN}$       | Input Resistance (IN-to- $V_T$ )             |                          | 40           | 50           | 60           | ohms  |
| $R_{DIFF\_IN}$ | Differential Input Resistance (IN-to-/IN)    |                          | 80           | 100          | 120          | ohms  |
| $V_{IH}$       | Input HIGH Voltage (IN-to-/IN)               | <b>Note 6</b>            | $V_{CC}-1.6$ |              | $V_{CC}$     | V     |
| $V_{IL}$       | Input LOW Voltage (IN-to-/IN)                |                          | 0            |              | $V_{IH}-0.1$ | V     |
| $V_{IN}$       | Input Voltage Swing (IN-to-/IN)              | See Figure 1a.           | 0.1          |              | 1.7          | V     |
| $V_{DIFF\_IN}$ | Differential Input Voltage Swing (IN-to-/IN) | See Figure 1b.           | 0.2          |              |              | V     |
| $V_{T\_IN}$    | IN-to- $V_T$ (IN-to-/IN)                     |                          |              |              | 1.28         | V     |
| $V_{REF\_AC}$  | Output Reference Voltage ( $V_{REF\_AC}$ )   |                          | $V_{CC}-1.3$ | $V_{CC}-1.2$ | $V_{CC}-1.1$ | 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. Due to the limited drive capability, use for input of the same package only.
4. Package thermal resistance assumes exposed pad is soldered (or equivalent) to the device's most negative potential on the PCB.  $\psi_{JB}$  uses 4-layer  $\theta_{JA}$  in still-air number unless otherwise stated.
5. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
6.  $V_{IH}$  (min), not lower than 1.2V.

**LVPECL OUTPUT DC ELECTRICAL CHARACTERISTICS<sup>(7)</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 |
|-----------------|--|----------------|------------------|-----|------------------|-------|
| $V_{OH}$        | Output HIGH Voltage<br>Q, /Q               |                | $V_{CC} - 1.145$ |     | $V_{CC} - 0.895$ | V     |
| $V_{OL}$        | Output LOW Voltage<br>Q, /Q                |                | $V_{CC} - 1.545$ |     | $V_{CC} - 1.295$ | V     |
| $V_{OUT}$       | Output Differential Swing<br>Q, /Q         | See Figure 1a. | 150              | 400 |                  | mV    |
| $V_{DIFF\_OUT}$ | Differential Output Voltage Swing<br>Q, /Q | See Figure 1b. | 300              | 800 |                  | mV    |

**LVTTL/CMOS DC ELECTRICAL CHARACTERISTICS<sup>(7)</sup>**

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

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

**Note:**

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

## AC ELECTRICAL CHARACTERISTICS<sup>(8)</sup>

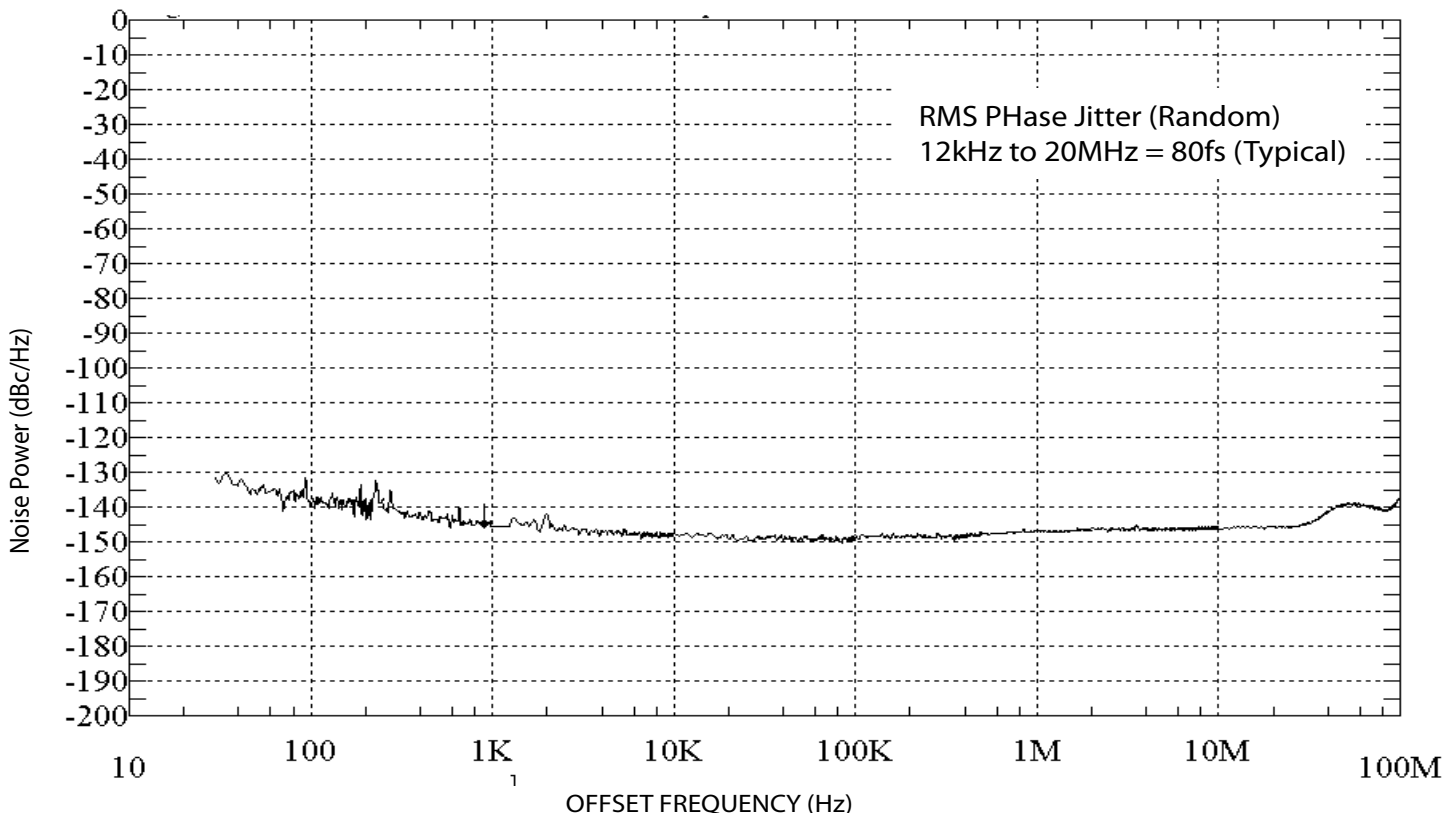
$V_{CC} = 2.5V \pm 5\%$  or  $3.3V \pm 10\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ ,  $R_L = 50\Omega$  to  $V_{CC} - 2V$ , unless otherwise stated.

| Symbol                 | Parameter   | Condition   | Min | Typ | Max | Units             |
|------------------------|---|---|-----|-----|-----|-------------------|
| $f_{MAX}$              | Maximum Operating Frequency                               | NRZ data  | 5   |     |     | Gbps              |
|                        |   | $V_{OUT} > 200mV$<br>Clock                          | 4   | 5.5 |     | GHz               |
| $t_{pd}$               | Differential Propagation Delay<br>(IN-to-Q)<br>(SEL-to-Q) | $V_{IN} > 100mV$                                    | 280 | 390 | 500 | ps                |
|                        |   |   | 150 |     | 600 | ps                |
| $\Delta t_{pd}$ Tempco | Differential Propagation Delay<br>Temperature Coefficient |   |     | 220 |     | fs/°C             |
| $t_{SKEW}$             | Output-to-Output Skew                                     | <b>Note 9</b>                                       |     |     | 15  | ps                |
|                        | Part-to-Part Skew   | <b>Note 10</b>                                      |     |     | 150 | ps                |
| $t_{JITTER}$           | RMS Phase Jitter  | Output = 622MHz<br>Integration Range: 12kHz - 20MHz |     | 80  |     | fs <sub>rms</sub> |
| $t_r, t_f$             | Output Rise/Fall Time                                     | At full output swing, 20% to 80%.                   | 25  | 60  | 85  | ps                |

**Notes:**

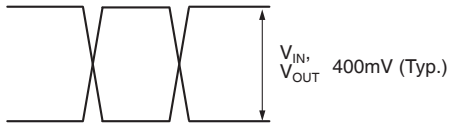
- 8. High-frequency AC-parameters are guaranteed by design and characterization.
- 9. Output-to-output skew is measured between two different outputs under identical input transitions.
- 10. Part-to-part skew is defined for two parts with identical power supply voltages at the same temperature and with no skew of the edges at the respective inputs.

## PHASE NOISE

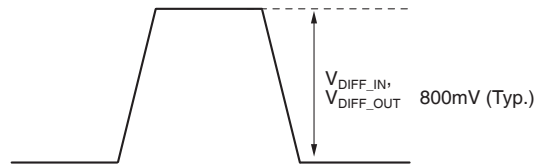


Phase Noise Plot: 622MHz @ 3.3V

**SINGLE-ENDED AND DIFFERENTIAL SWINGS**



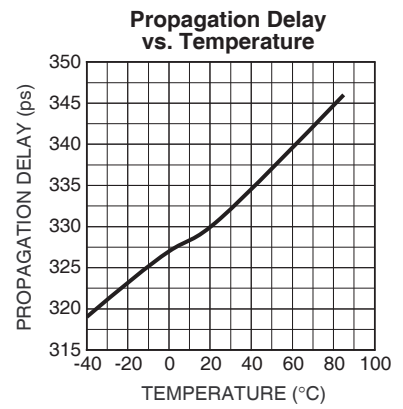
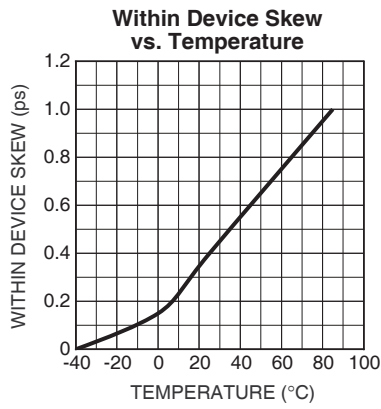
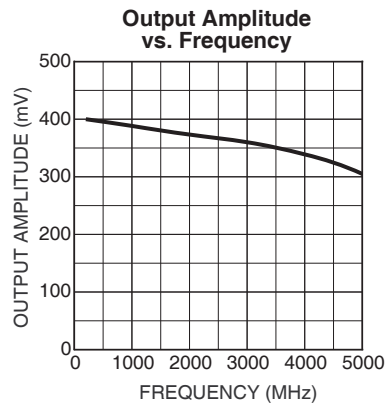
**Figure 1a. Single-Ended Voltage Swing**



**Figure 1b. Differential Voltage Swing**

**TYPICAL OPERATING CHARACTERISTICS**

$V_{CC} = 3.3V$ ,  $GND = 0$ ,  $V_{IN} = 100mV$ ,  $T_A = 25^{\circ}C$ , unless otherwise stated.

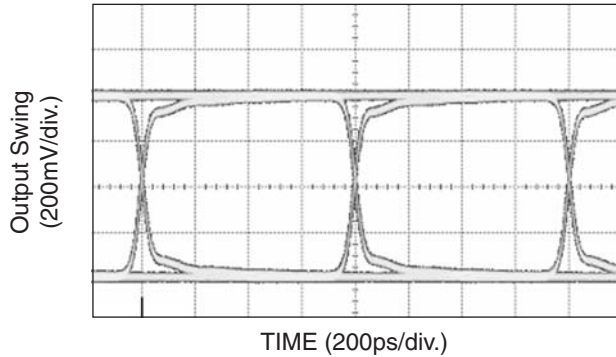




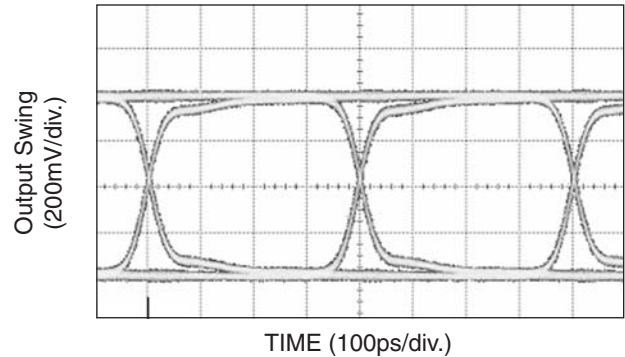
**FUNCTIONAL CHARACTERISTICS**

$V_{CC} = 3.3V$ ,  $GND = 0$ ,  $V_{IN} = 100mV$ ,  $T_A = 25^\circ C$ , unless otherwise stated.

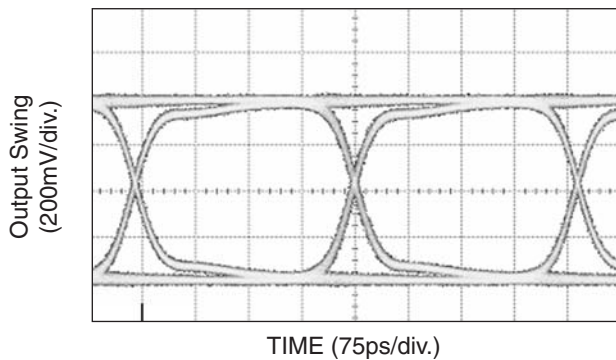
**1.25Gbps Output (Q - /Q)**



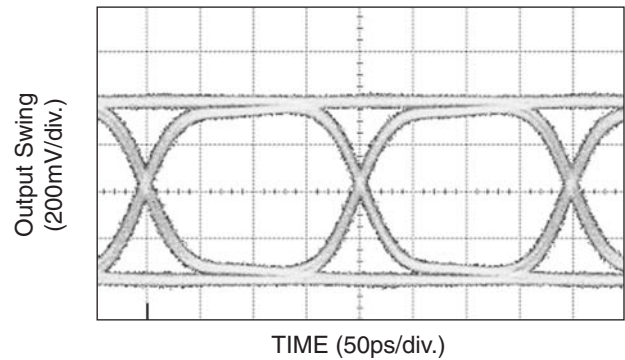
**2.5Gbps Output (Q - /Q)**



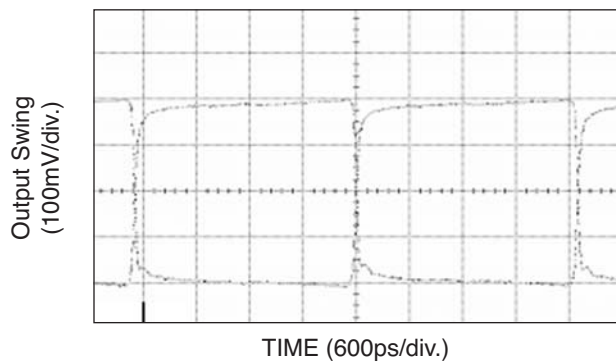
**3.2Gbps Output (Q - /Q)**



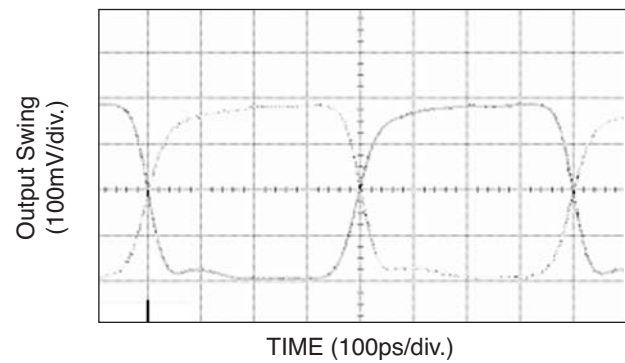
**5Gbps Output (Q - /Q)**



**200MHz Output**

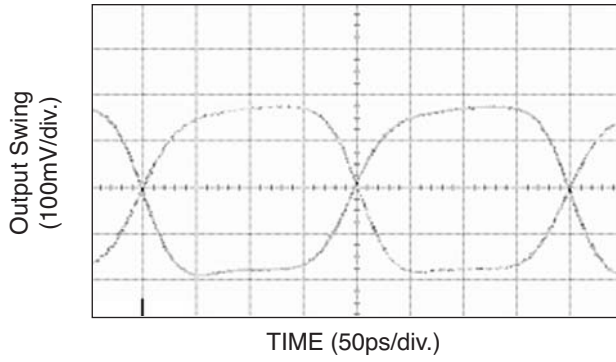


**1.25GHz Output**

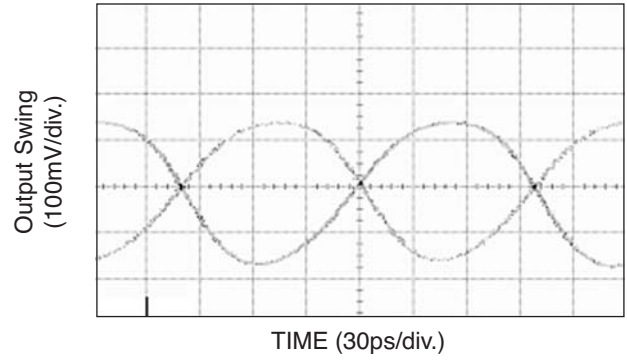


**FUNCTIONAL CHARACTERISTICS (CONTINUED)**

**2.5GHz Output**



**5GHz Output**



**INPUT AND OUTPUT STAGES**

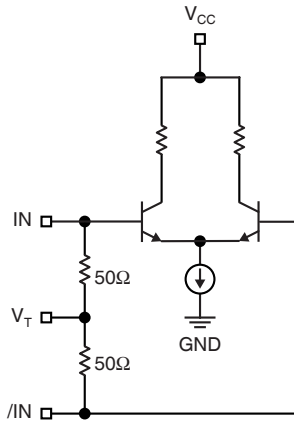


Figure 2a. Simplified Differential Input Stage

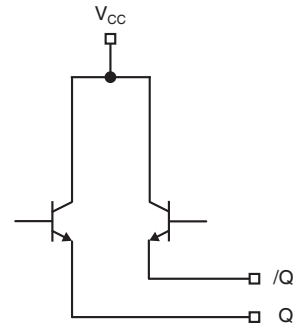


Figure 2b. Simplified LVPECL Output Stage

**INPUT INTERFACE APPLICATIONS**

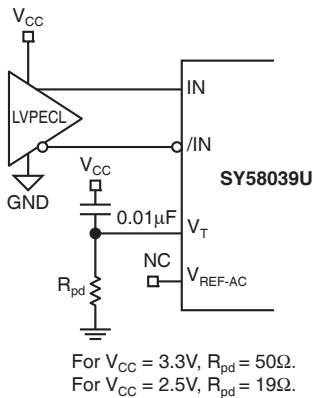


Figure 3a. LVPECL Interface (DC-Coupled)

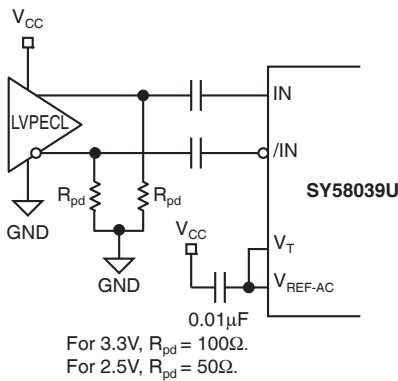


Figure 3b. LVPECL Interface (AC-Coupled)

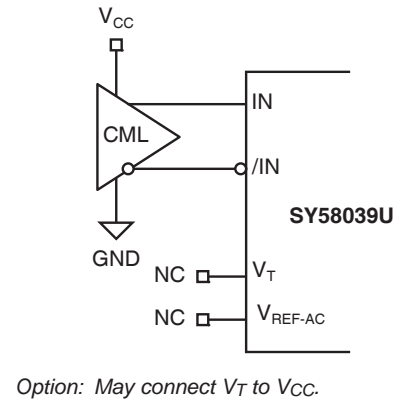


Figure 3c. CML Interface (DC-Coupled)

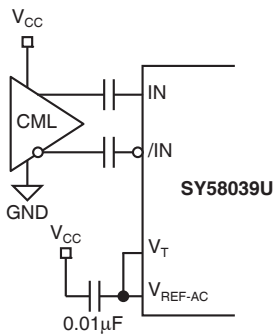


Figure 3d. CML Interface (AC-Coupled)

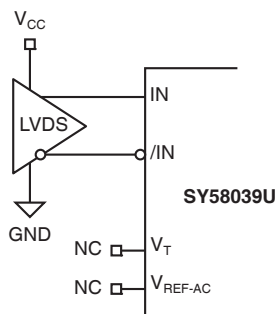
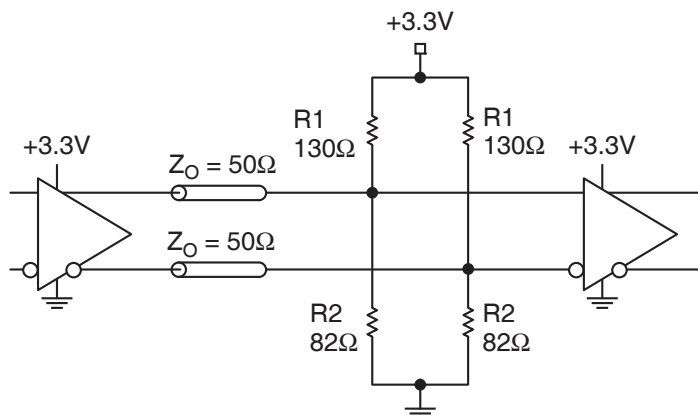


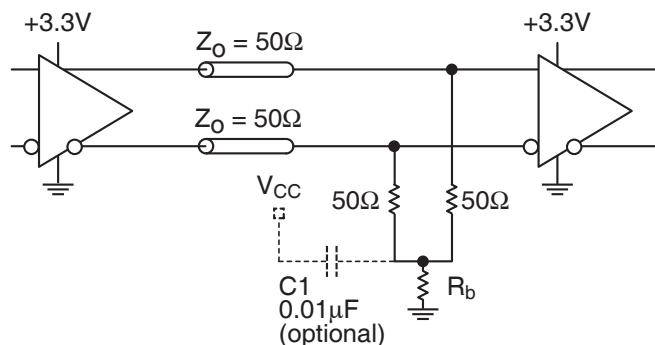
Figure 3e. LVDS Interface

**OUTPUT INTERFACE APPLICATIONS**



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

Note:  
For +2.5V system, R1 = 250ohms, R2 = 62.5ohms.



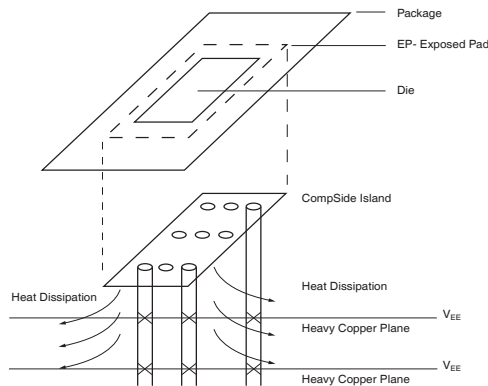
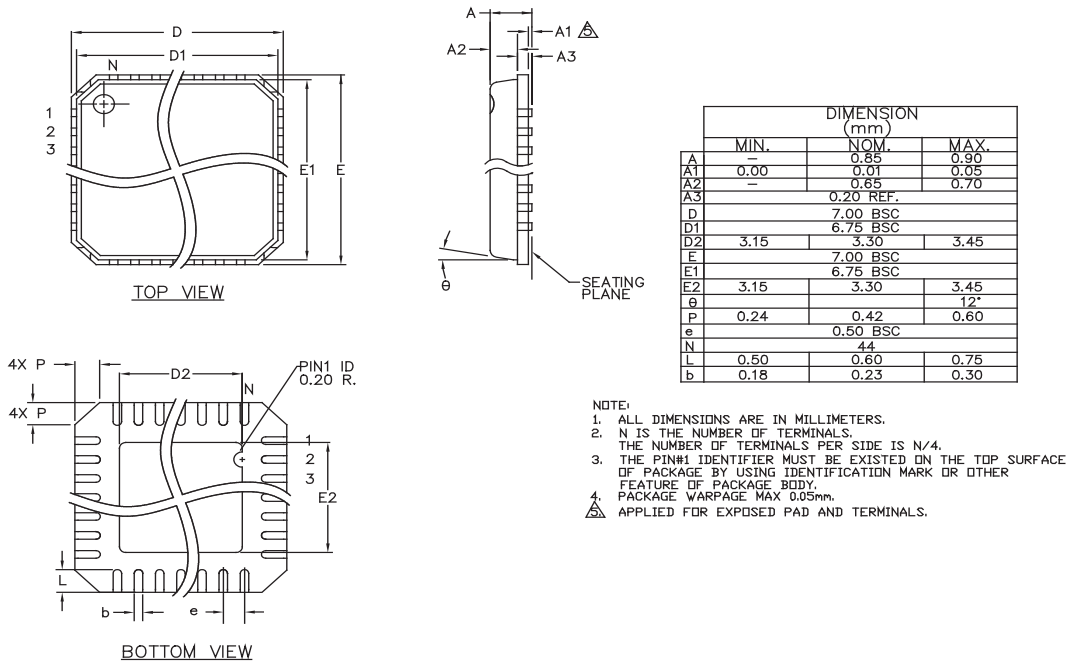
**Figure 4b. Parallel Termination (3-Resistor)**

Note:  
For +2.5V system, R<sub>b</sub> = 19ohms.  
For +3.3V system, R<sub>b</sub> = 50ohms.

**RELATED MICREL PRODUCTS AND SUPPORT DOCUMENTATION**

| Part Number   | Function   | Data Sheet Link  |
|---------------|--|--|
| SY58037U      | Ultra Precision 8:1 MUX with Internal Termination and 1:2 CML Fanout Buffer          | <a href="http://www.micrel.com/product-info/products/sy58037u.shtml">http://www.micrel.com/product-info/products/sy58037u.shtml</a>    |
| SY58038U      | Ultra Precision 8:1 MUX with Internal Termination and 1:2 LVPECL Fanout Buffer       | <a href="http://www.micrel.com/product-info/products/sy58038u.shtml">http://www.micrel.com/product-info/products/sy58038u.shtml</a>    |
| SY58039U      | Ultra Precision 8:1 MUX with Internal Termination and 1:2 400mV LVPECL Fanout Buffer | <a href="http://www.micrel.com/product-info/products/sy58039u.shtml">http://www.micrel.com/product-info/products/sy58039u.shtml</a>    |
|               | MLF™ Application Note  | <a href="http://www.amkor.com/products/notes_papers/MLF_AppNote_0902.pdf">www.amkor.com/products/notes_papers/MLF_AppNote_0902.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>         |

**44 LEAD QFN (QFN-44)**



**PCB Thermal Consideration for 44-Pin QFN 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.

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