



## SY58038U

Ultra-Precision, 8:1 MUX with Internal Termination and 1:2 LVPECL Fanout Buffer

Precision Edge®

### General Description

The SY58038U 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 SY58038U distributes clock frequencies from DC to 3.5GHz, and data rates to 4.5Gbps guaranteed over temperature and voltage.

The SY58038U 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 800mV, 100K compatible LVPECL with extremely fast rise/fall times guaranteed to be less than 100ps.

The SY58038U features a patented isolation design that significantly improves channel-to-channel crosstalk performance.

The SY58038U operates from a 2.5V  $\pm 5\%$  or 3.3V  $\pm 10\%$  supply and is guaranteed over the full industrial temperature range of  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ . The SY58038U is part of Micrel's high-speed, Precision Edge® product line.

Datasheets and support documentation are available on Micrel's web site at: [www.micrel.com](http://www.micrel.com).



Precision Edge®

### Features

- Selects between 1 of 8 inputs, and provides two precise, low-skew LVPECL output copies
- Ultra-low jitter design:
  - 72fs<sub>rms</sub> phase jitter (typical)
- Guaranteed AC performance over temperature and voltage:
  - DC to 4.5Gbps throughput
  - <500ps propagation delay IN-to-Q ( $V_{IN} > 100\text{mV}$ )
  - <100ps  $t_r$  /  $t_f$  time
  - <15ps skew (output-to-output)
- Unique, patented, channel-to-channel isolation design provides superior crosstalk performance
- Unique, patented, input termination and  $V_T$  pin accepts DC- and AC-coupled inputs (CML, PECL, LVDS)
- 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 44-pin (7mm  $\times$  7mm) QFN package

### Applications

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

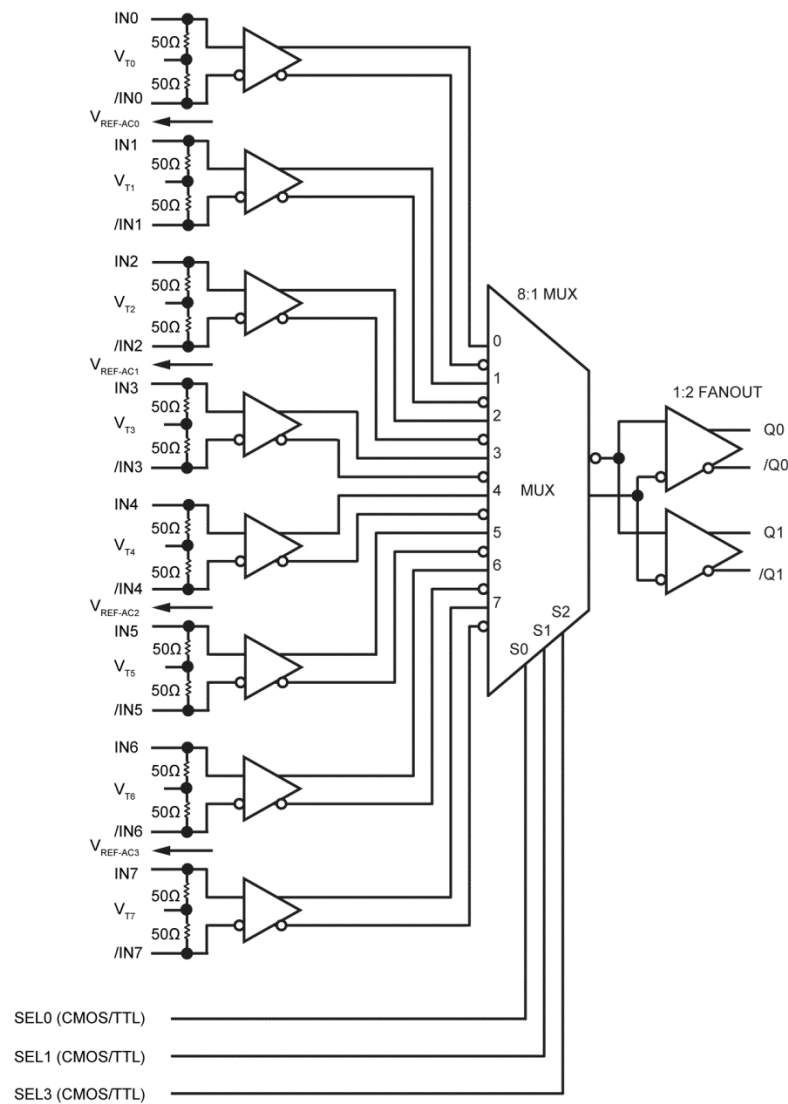
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March 26, 2015

Revision 3.0  
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## Functional Block Diagram



## Truth Table

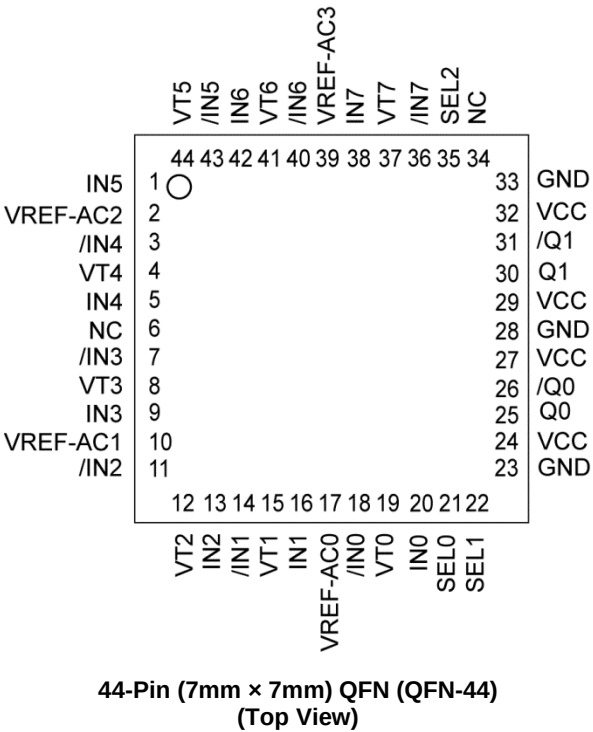
| SEL2 | SEL1 | SEL0 | Q   | /Q   |
|------|------|------|-----|------|
| L    | L    | L    | IN0 | /IN0 |
| L    | L    | H    | IN1 | /IN1 |
| L    | H    | L    | IN2 | /IN2 |
| L    | H    | H    | IN3 | /IN3 |
| H    | L    | L    | IN4 | /IN4 |
| H    | L    | H    | IN5 | /IN5 |
| H    | H  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

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

| Part Number                  | Marking  | Operating Range | Package                |
|------------------------------|----------|-----------------|------------------------|
| SY58038UMY                   | SY58038U | −40°C to +85°C  | 44-pin (7mm × 7mm) QFN |
| SY58038UMY TR <sup>(2)</sup> | SY58038U | −40°C to +85°C  | 44-pin (7mm × 7mm) QFN |

- Notes:
- 1. Contact factory for die availability. Die are guaranteed at T<sub>A</sub> = +25°C, DC electricals only.
  - 2. Tape and reel.

Pin Configuration



## 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 50Ω. Note that these inputs will default to an indeterminate state if left open. Refer to the <a href="#">Input Interface Applications</a> 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. Refer to the <a href="#">Input Interface Applications</a> section for more details.                                                                                                      |
| 17<br>10<br>2<br>39                                                     | VREF-AC0<br>VREF-AC1<br>VREF-AC2<br>VREF-AC3                                                         | Reference Voltage: This output biases to $V_{CC} - 1.2V$ . 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 $V_{CC}$ or GND, depending on input type. Refer to the <a href="#">Input Interface Applications</a> 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 25kΩ 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 LVPECL output pairs are the outputs of the device. Unused output pairs may be left open. Each output is designed to drive 800mV into 50Ω terminated to $V_{CC} - 2V$ (or $V_{CC} - 1.2V$ , if AC-coupled).                                                                                                                                               |
| 23, 28, 33                                                              | GND, ePad                                                                                            | Ground. GND and exposed pad (ePad) must both be connected to the most negative potential of chip ground.                                                                                                                                                                                                                                                                             |

## Absolute Maximum Ratings<sup>(3)</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>(6)</sup>  |                   |
| Source or Sink Current (on VT pin)  | ±100mA            |
| Lead Temperature (soldering, 10s)   | +260°C            |
| Storage Temperature Range ( $T_S$ ) | –65°C to +150°C   |

## Operating Ratings<sup>(4)</sup>

|                                           |                                     |
|-------------------------------------------|-------------------------------------|
| Power Supply                              |                                     |
| Voltage ( $V_{CC}$ )                      | +2.375V to +2.625V or +3.0V to 3.6V |
| Ambient Temperature ( $T_A$ )             | –40°C to +85°C                      |
| Package Thermal Resistance <sup>(5)</sup> |                                     |
| QFN ( $\theta_{JA}$ )                     |                                     |
| Still Air                                 | 24°C/W                              |
| QFN ( $\psi_{JB}$ )                       |                                     |
| Junction-to-Board                         | 12°C/W                              |

## DC Electrical Characteristics<sup>(7)</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 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            |          |
| $I_{CC}$       | Power Supply Current                         | No load, maximum $V_{CC}$ |                | 120            | 170            | mA       |
| $R_{IN}$       | Input Resistance (IN-to- $V_T$ )             |                           | 40             | 50             | 60             | $\Omega$ |
| $R_{DIFF\_IN}$ | Differential Input Resistance (IN-to-/IN)    |                           | 80             | 100            | 120            | $\Omega$ |
| $V_{IH}$       | Input HIGH Voltage (IN-to-/IN)               | Note 8                    | $V_{CC} - 1.6$ |                | $V_{CC}$       | V        |
| $V_{IL}$       | Input LOW Voltage (IN-to-/IN)                |                           | 0              |                | $V_{IN} - 0.1$ | V        |
| $V_{IN}$       | Input Voltage Swing (IN-to-/IN)              | See Figure 1              | 0.1            |                | 1.7            | V        |
| $V_{DIFF\_IN}$ | Differential Input Voltage Swing (IN-to-/IN) | See Figure 2              | 0.2            |                |                | V        |
| $V_{T\_IN}$    | IN-to- $V_T$ (IN-to-/IN)                     |                           |                |                | 1.28           | V        |
| $V_{REF\_AC}$  | Output Reference Voltage                     |                           | $V_{CC} - 1.3$ | $V_{CC} - 1.2$ | $V_{CC} - 1.1$ | V        |

### Notes:

- 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.
- The datasheet limits are not guaranteed if the device is operated beyond the operating ratings.
- 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.
- Due to the limited drive capability, use for input of the same package only.
- The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
- $V_{IH}$  (minimum), not lower than 1.2V.

## LVPECL Output DC Electrical Characteristics<sup>(9)</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 noted.

| Symbol          | Parameter                                 | Condition    | Min.             | Typ. | Max.             | Units |
|-----------------|-------------------------------------------|--------------|------------------|------|------------------|-------|
| $V_{OH}$        | Output HIGH Voltage (Q, /Q)               |              | $V_{CC} - 1.145$ |      | $V_{CC} - 0.895$ | V     |
| $V_{OL}$        | Output LOW Voltage (Q, /Q)                |              | $V_{CC} - 1.945$ |      | $V_{CC} - 1.695$ | V     |
| $V_{OUT}$       | Output Differential Swing (Q, /Q)         | See Figure 1 | 550              | 800  |                  | mV    |
| $V_{DIFF\_OUT}$ | Differential Output Voltage Swing (Q, /Q) | See Figure 2 | 1100             | 1600 |                  | mV    |

## LVTTL/CMOS DC Electrical Characteristics<sup>(9)</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  |      | $V_{CC}$ | V       |
| $V_{IL}$ | Input LOW Voltage  |           |      |      | 0.8      | V       |
| $I_{IH}$ | Input HIGH Current |           | -125 |      | 30       | $\mu A$ |
| $I_{IL}$ | Input LOW Current  |           | -300 |      |          | $\mu A$ |

## AC Electrical Characteristics<sup>(10)</sup>

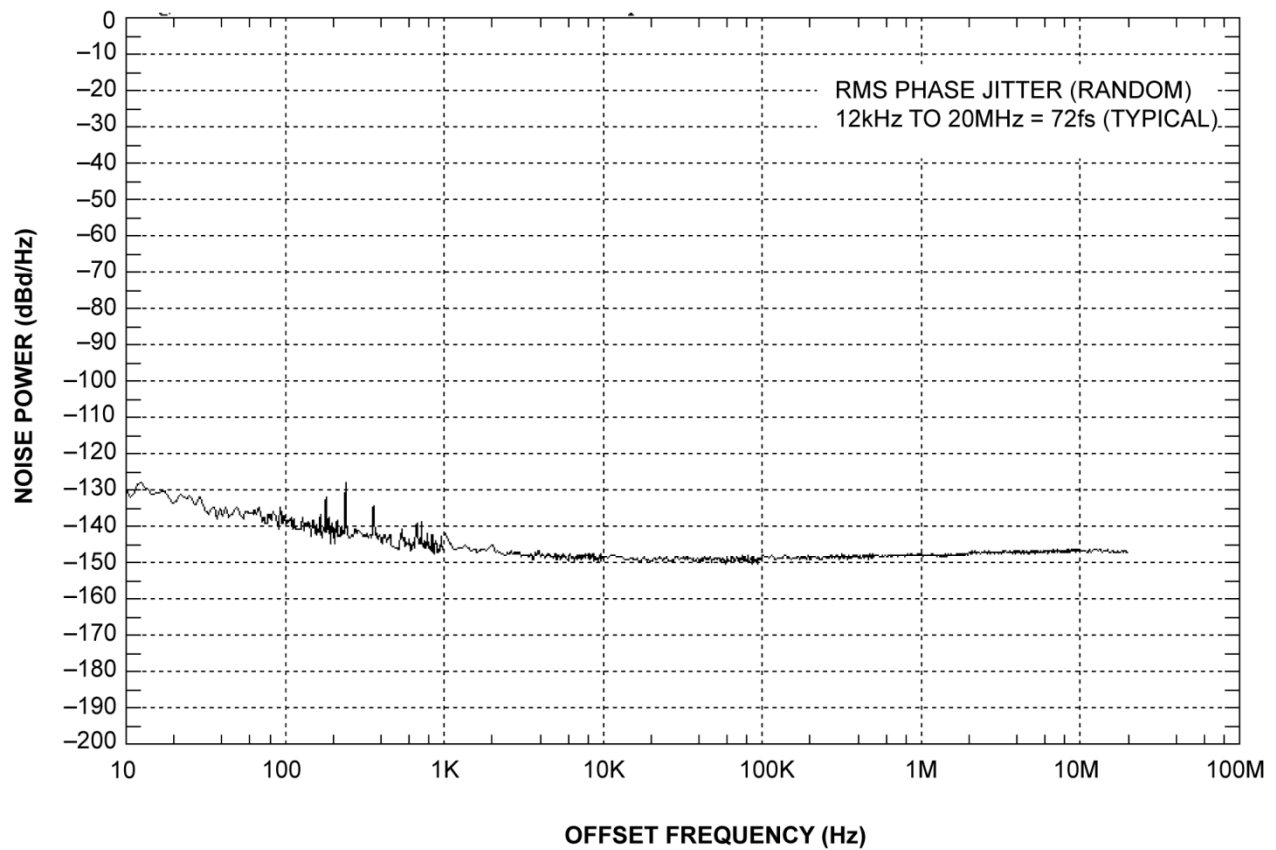
$V_{CC} = 2.5V \pm 5\%$  or  $3.3V \pm 10\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ ,  $R_L = 50\Omega$  to  $V_{CC} - 2V$ , unless otherwise noted.

| Symbol                           | Parameter                                              | Condition                                               | Min. | Typ. | Max. | Units             |
|----------------------------------|--------------------------------------------------------|---------------------------------------------------------|------|------|------|-------------------|
| $f_{MAX}$                        | Maximum Operating Frequency                            | NRZ Data                                                | 4.5  |      |      | Gbps              |
|                                  |                                                        | $V_{OUT} \geq 400mV$ Clock                              | 3.5  | 5    |      | GHz               |
| $t_{pd}$                         | Differential Propagation Delay                         | IN-to-Q $V_{IN} \geq 100mV$                             | 280  | 390  | 500  | ps                |
|                                  |                                                        | SEL-to-Q                                                | 150  |      | 600  | ps                |
| $\Delta t_{pd}$ Temp Coefficient | Differential Propagation Delay Temperature Coefficient |                                                         |      | 220  |      | fs/ $^\circ C$    |
| $t_{SKEW}$                       | Output-to-Output Skew                                  | Note 11                                                 |      |      | 15   | ps                |
|                                  | Part-to-Part Skew                                      | Note 12                                                 |      |      | 150  | ps                |
| $t_{JITTER}$                     | RMS Phase Jitter                                       | Carrier = 622MHz<br>Integration Range:<br>12kHz – 20MHz |      | 72   |      | fs <sub>rms</sub> |
| $t_r, t_f$                       | Output Rise/Fall Time                                  | At full output swing, 20% to 80%                        | 35   | 65   | 100  | ps                |

### Note:

9. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
10. High-frequency AC-parameters are guaranteed by design and characterization.
11. Output-to-output skew is measured between two different outputs under identical input transitions.
12. 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 Plot



## Single-Ended and Differential Swings

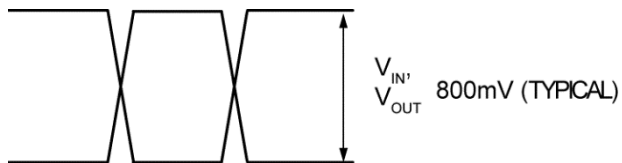


Figure 1. Single-Ended Voltage Swing

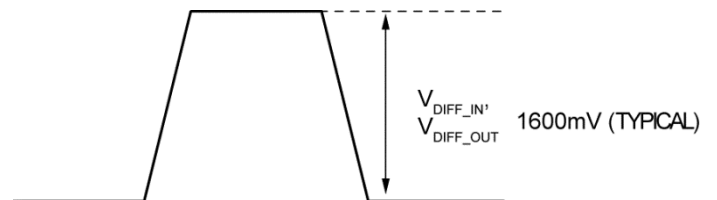
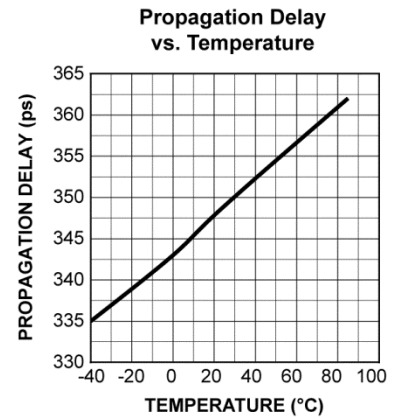
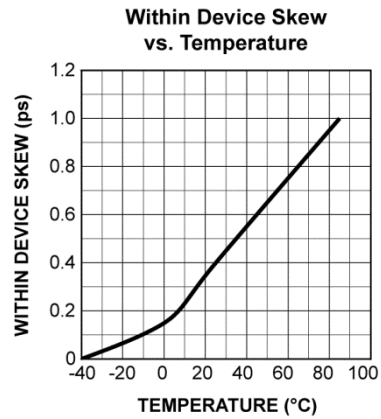
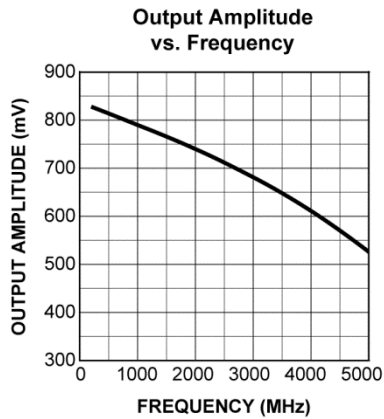


Figure 2. Differential Voltage Swing

## Typical Operating Characteristics

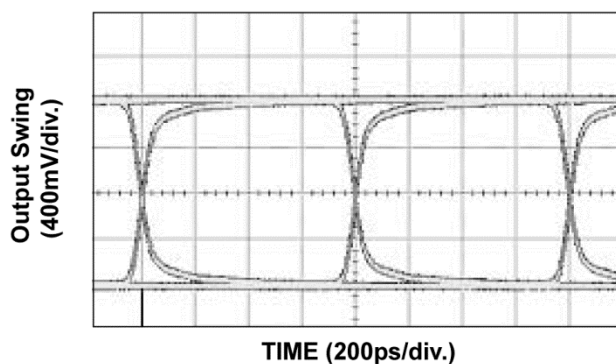
$V_{CC} = 3.3V$ ,  $GND = 0$ ,  $V_{IN} = 100mV$ ,  $T_A = +25^\circ C$ , unless otherwise stated



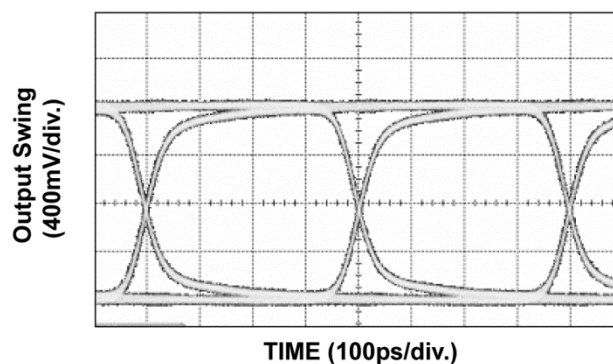
## Functional Characteristics

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

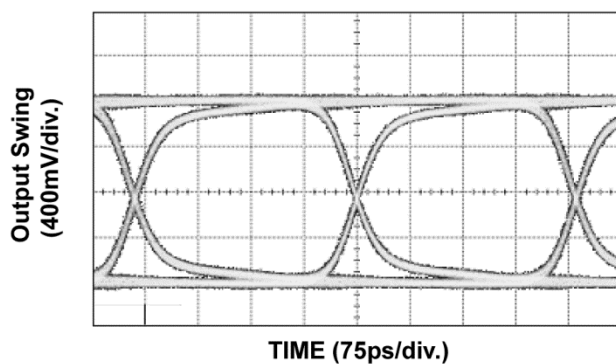
**1.25Gbps Output (Q – /Q)**



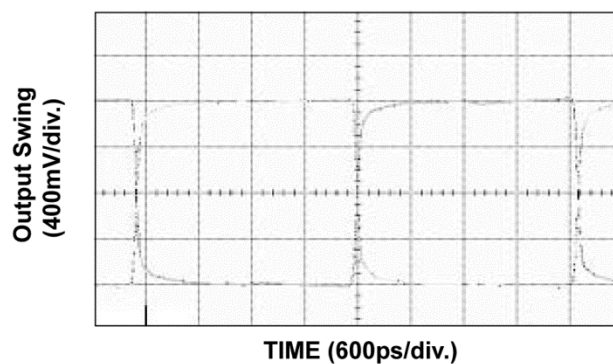
**2.5Gbps Output (Q – /Q)**



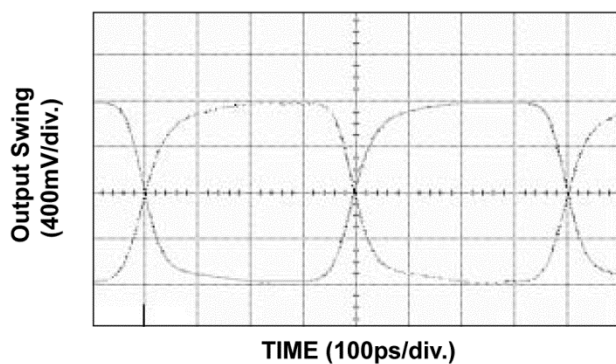
**3.2Gbps Output (Q – /Q)**



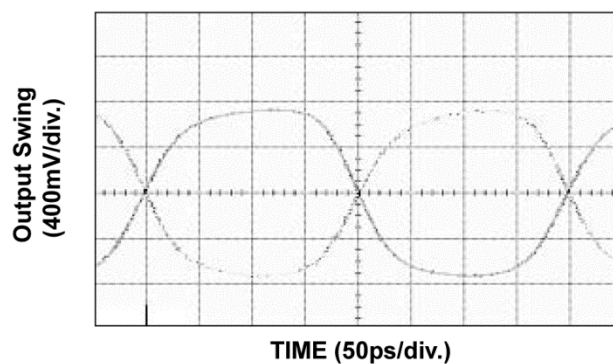
**200MHz Output (Q – /Q)**



**1.25GHz Output (Q – /Q)**

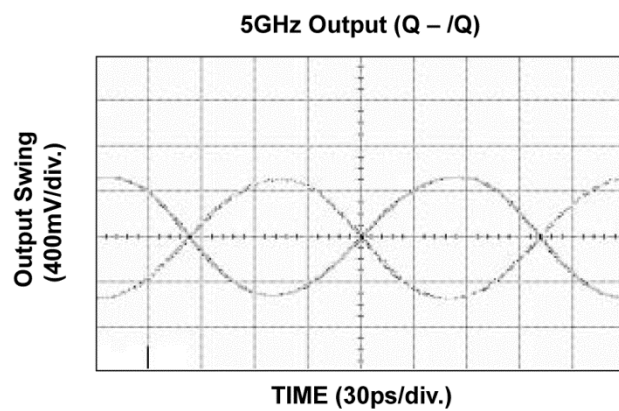


**2.5GHz Output (Q – /Q)**



## Functional Characteristics (Continued)

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



## Input and Output Stages

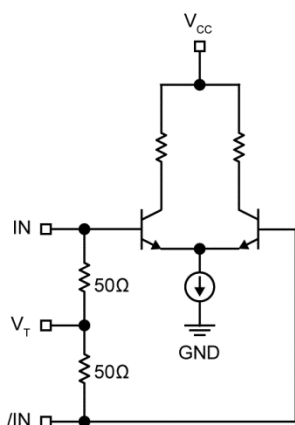


Figure 3. Simplified Differential Input Stage

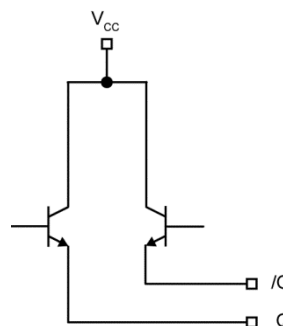


Figure 4. Simplified LVPECL Output Stage

## Input Interface Applications

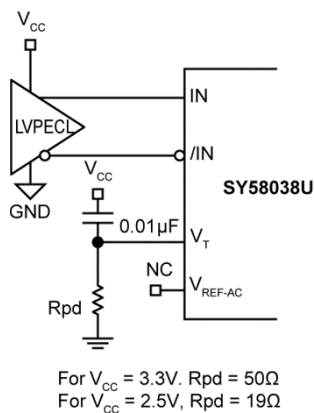


Figure 5. LVPECL Interface (DC-Coupled)

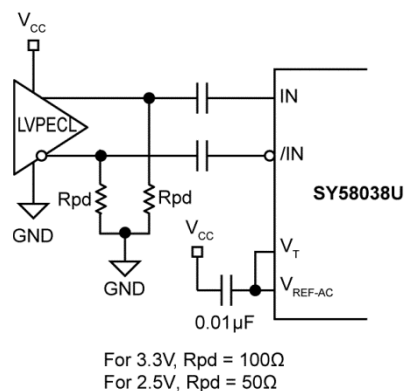


Figure 6. LVPECL Interface (AC-Coupled)

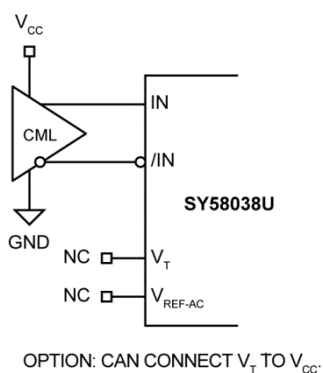


Figure 7. CML Interface (DC-Coupled)

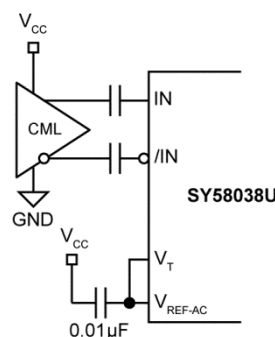
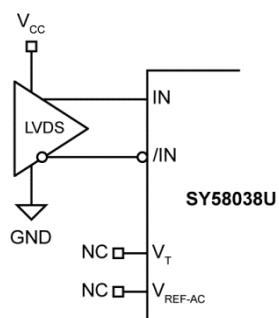
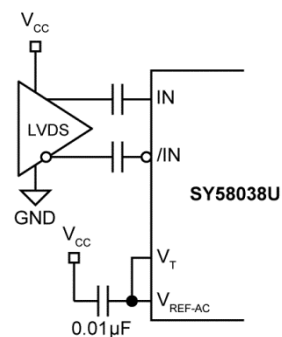


Figure 8. CML Interface (AC-Coupled)

## Input Interface Applications (Continued)

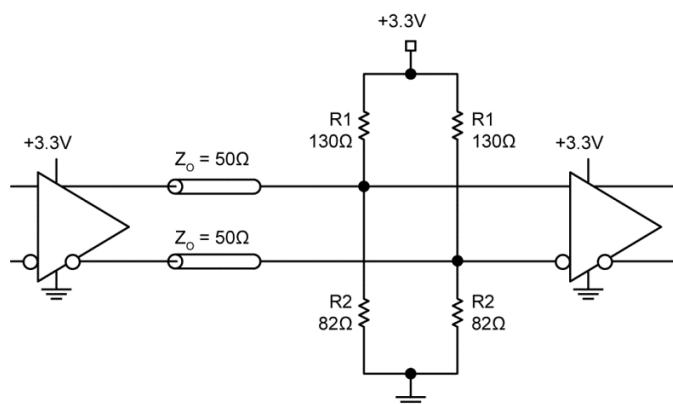


**Figure 9. LVDS Interface (DC Coupled)**



**Figure 10. LVDS Interface (AC Coupled)**

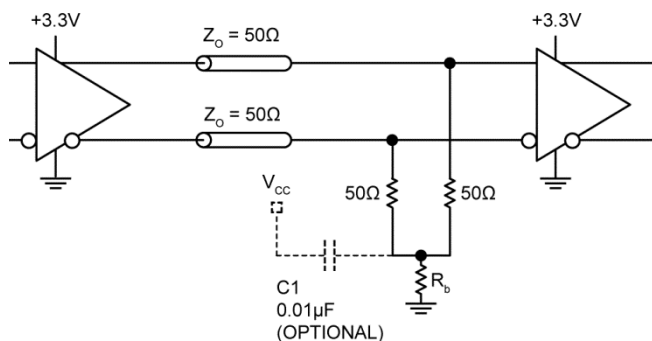
## Output Interface Applications



**Note:**

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

### Figure 11. Parallel Thevenin-Equivalent Termination



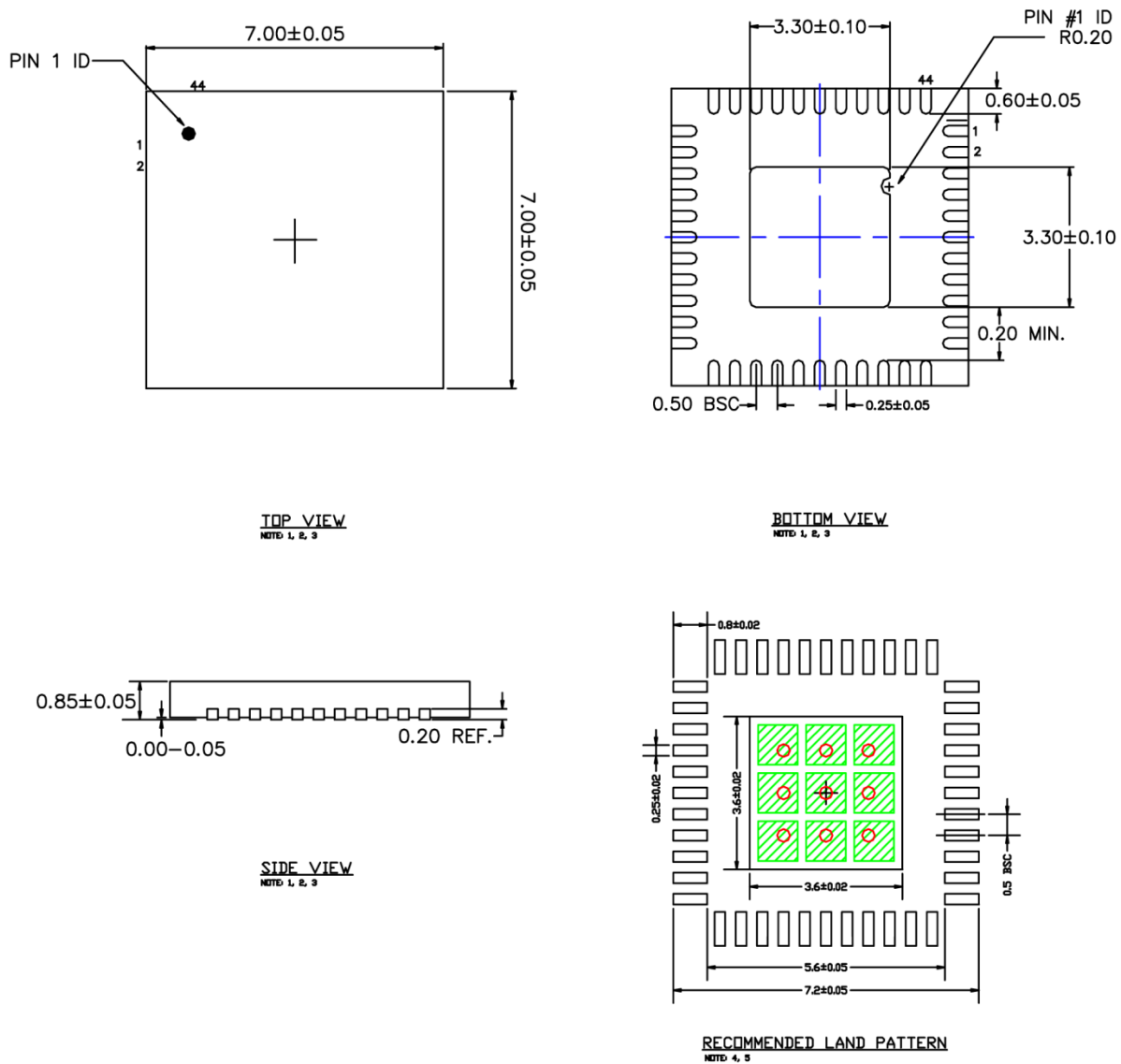
**Note:**

For +2.5V system,  $R_b = 19\Omega$

For +3.3V system,  $R_b = 50\Omega$

### Figure 12. Parallel Termination (3-Resistor)

## Package Information and Recommended Landing Pattern<sup>(13)</sup>



NOTE:  
 1. MAX PACKAGE WARPAGE IS 0.05 MM  
 2. MAX ALLOWABLE BURR IS 0.076MM IN ALL DIRECTIONS  
 3. PIN #1 IS ON TOP WILL BE LASER MARKED  
 4. RED CIRCLE IN LAND PATTERN INDICATE THERMAL VIA. SIZE SHOULD BE 0.30-0.35MM IN DIAMETER AND SHOULD BE CONNECTED TO GND FOR MAX THERMAL PERFORMANCE. 1.0MM PITCH  
 5. GREEN RECTANGLES (SHADED AREA) REPRESENT SOLDER STENCIL OPENING ON EXPOSED PAD AREA. RECOMMENDED SIZE IS 0.93x0.93MM, SPACING IS 0.2MM

### 44-Pin 7mm × 7mm QFN (MM)

#### Note:

13. Package meets Level 2 qualification. All parts are dry-packaged before shipment. Exposed pads must be soldered to a ground for proper thermal management. Package information is correct as of the publication date. For updates and most current information, go to [www.micrel.com](http://www.micrel.com).

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