



# ULTRA PRECISION 8:1 MUX WITH INTERNAL TERMINATION AND 1:2 LVPECL FANOUT BUFFER

Precision Edge®  
SY58038U

## FEATURES

- Selects between 1 of 8 inputs, and provides 2 precision, low skew LVPECL output copies
- Guaranteed AC performance over temperature and voltage:
  - DC to 4.5Gbps throughput
  - <500ps propagation delay IN-to-Q ( $V_{IN} \geq 100mV$ )
  - <100ps  $t_r$  /  $t_f$  time
  - <15ps skew (output-to-output)
- Unique, patent-pending, channel-to-channel isolation design provides superior crosstalk performance
- Ultra-low jitter design:
  - <1ps<sub>RMS</sub> random jitter
  - <10ps<sub>PP</sub> deterministic jitter
  - <10ps<sub>PP</sub> total jitter (clock)
  - <1ps<sub>RMS</sub> cycle-to-cycle jitter
  - <0.7ps<sub>RMS</sub> crosstalk-induced jitter
- Unique, patent-pending, input termination and VT pin accepts DC- and AC-coupled inputs (CML, PECL, LVDS)
- 800mV LVPECL output swing
- Power supply 2.5V ±5% or 3.3V ±10%
- -40°C to +85°C temperature range
- Available in 44-pin (7mm x 7mm) MLF® package



Precision Edge®

## 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 patent-pending isolation design that significantly improves channel-to-channel crosstalk performance.

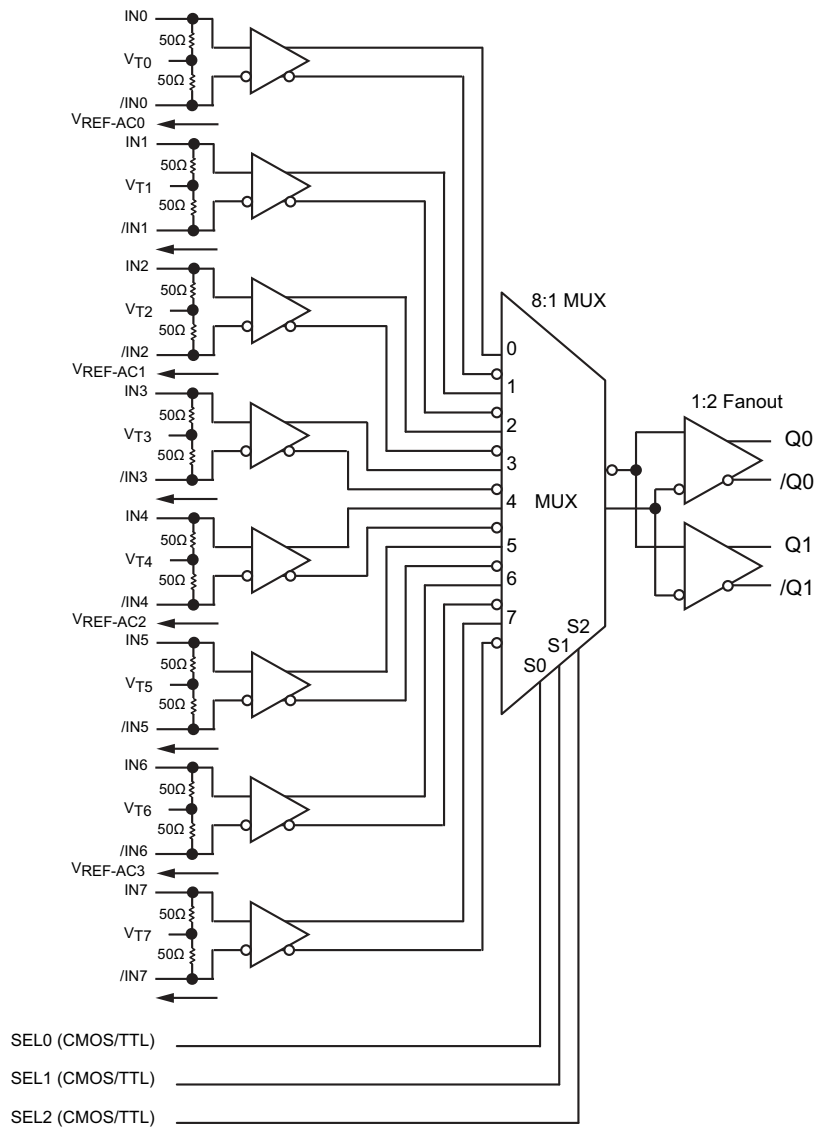
The SY58038U operates from a 2.5V ±5% or 3.3V ±10% supply and is guaranteed over the full industrial temperature range of -40°C to +85°C. The SY58038U is part of Micrel's high-speed, Precision Edge® product line.

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

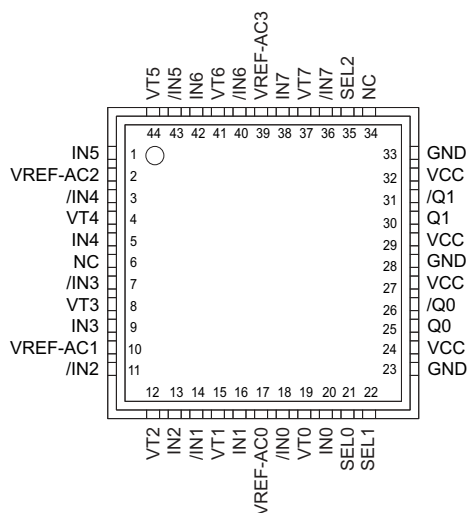
**FUNCTIONAL BLOCK DIAGRAM**



**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 MLF® (MLF-44)**

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

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY58038UMI	MLF-44	Industrial	SY58038U	Sn-Pb
SY58038UMITR <sup>(2)</sup>	MLF-44	Industrial	SY58038U	Sn-Pb
SY58038UMG <sup>(3)</sup>	MLF-44	Industrial	SY58038U with Pb-Free bar-line indicator	Pb-Free NiPdAu
SY58038UMGTR <sup>(2, 3)</sup>	MLF-44	Industrial	SY58038U with Pb-Free bar-line indicator	Pb-Free NiPdAu

**Notes:**

1. Contact factory for die availability. Dice are guaranteed at T<sub>A</sub> = 25°C, DC electricals only.
2. Tape and Reel.
3. Pb-Free package recommended for new designs.

**PIN DESCRIPTION**

Pin Number	Pin Name	Pin Function
20, 18, 16, 14, 13, 11, 9, 7, 5, 3, 1, 43, 42, 40, 38, 36	IN0, /IN0, IN1, /IN1, IN2, /IN2, IN3, /IN3, IN4, /IN4, IN5, /IN5, IN6, /IN6, 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. Please refer to the "Input Interface Applications" section for more details.
19,15, 12, 8, 4, 44, 41, 37	VT0, VT1 VT2, VT3, VT4, VT5, 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, 10, 2 39	VREF-AC0, VREF-AC1, VREF-AC2, 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, 22, 35	SEL0, SEL1, 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, 30, 31	Q0,/Q0, 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 <sub>CC</sub> -2V. (or V <sub>CC</sub> -1.2V if AC-coupled).
23, 28, 33	GND, 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, 20 sec.) ..... 260°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>  
     MLF® ( $\theta_{JA}$ )  
         Still-Air ..... 24°C/W  
     MLF® ( $\psi_{JB}$ )  
         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. $V_{CC}$ .		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)		$V_{CC}-1.2$		$V_{CC}$	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		$V_{CC}-1.3$	$V_{CC}-1.2$	$V_{CC}-1.1$	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.

**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 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 1a.	550	800		mV
$V_{DIFF\_OUT}$	Differential Output Voltage Swing Q, /Q	See Figure 1b.	1100	1600		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	4.5			Gbps
		$V_{OUT} \geq 400mV$ Clock	3.5	5		GHz
$t_{pd}$	Differential Propagation Delay (IN-to-Q) (SEL-to-Q)	$V_{IN} \geq 100mV$	280	390	500	ps
			150		600	ps
$\Delta t_{pd}$ Tempco	Differential Propagation Delay 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
$t_{JITTER}$	Data Random Jitter (RJ)	<b>Note 11</b>			1	ps <sub>RMS</sub>
	Deterministic Jitter (DJ)	<b>Note 12</b>			10	ps <sub>RMS</sub>
	Clock Cycle-to-Cycle Jitter Total Jitter (TJ)	<b>Note 13</b> <b>Note 14</b>			1 10	ps <sub>PP</sub> ps <sub>RMS</sub>
	Crosstalk-induced Jitter	<b>Note 15</b>			0.7	ps <sub>RMS</sub>
$t_r, t_f$	Output Rise/Fall Time	At full output swing, 20% to 80%.	35	65	100	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.
- 11. Random jitter is measured with a K28.7 character pattern, measured at  $<f_{MAX}$ .
- 12. Deterministic jitter is measured at 2.5Gbps/3.2Gbps, with both K28.5 and  $2^{23}-1$  PRBS pattern.
- 13. 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.
- 14. 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.
- 15. Crosstalk is measured at the output while applying two similar differential clock frequencies that are asynchronous with respect to each other at the inputs.

**SINGLE-ENDED AND DIFFERENTIAL SWINGS**

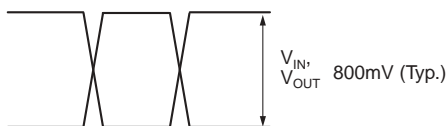


Figure 1a. Single-Ended Voltage Swing

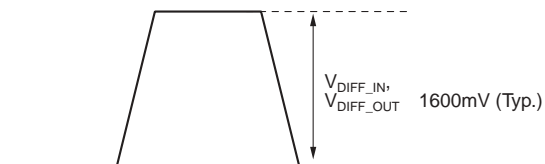
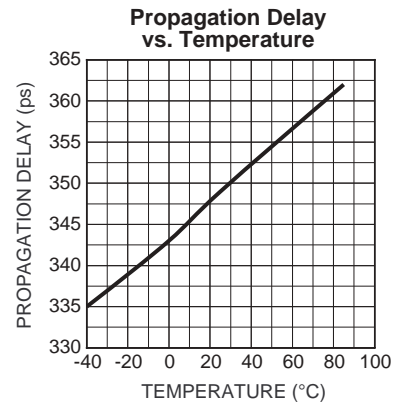
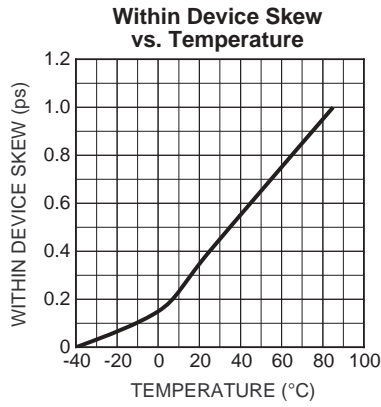
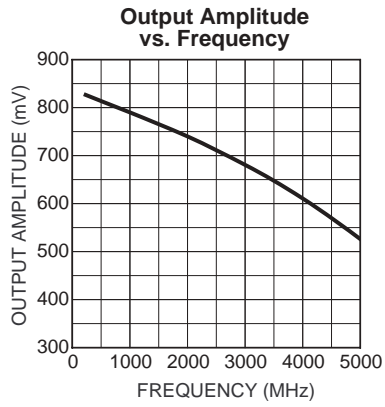


Figure 1b. Differential Voltage Swing

**TYPICAL OPERATING CHARACTERISTICS**

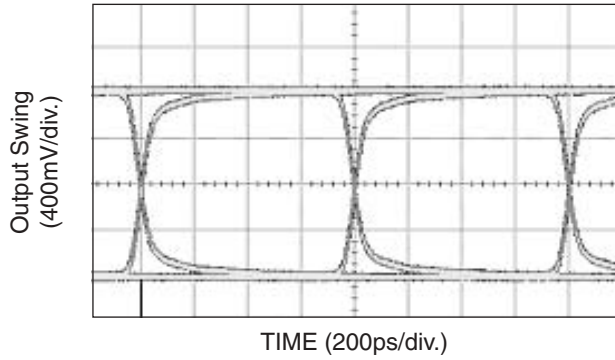
$V_{CC} = 3.3V$ ,  $GND = 0$ ,  $V_{IN} = 100mV$ ,  $T_A = 25^{\circ}C$ , unless otherwise stated.



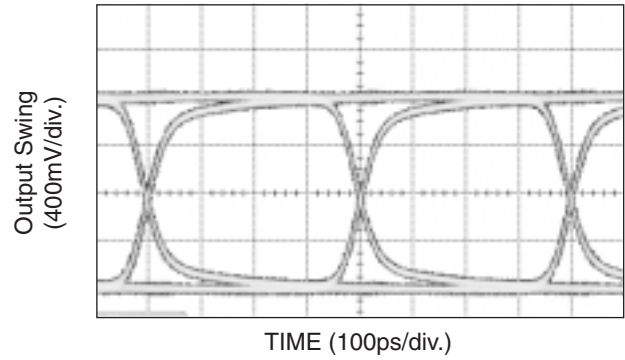
# FUNCTIONAL CHARACTERISTICS

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

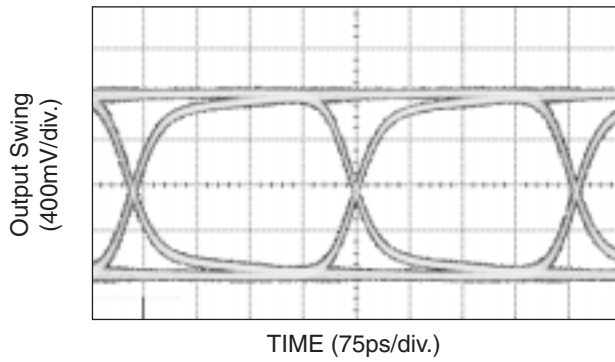
1.25Gbps Output (Q - /Q)



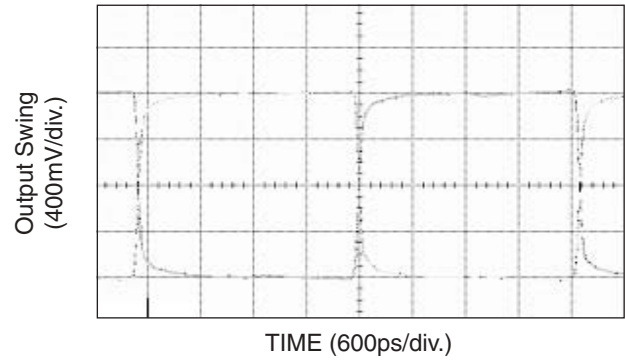
2.5Gbps Output (Q - /Q)



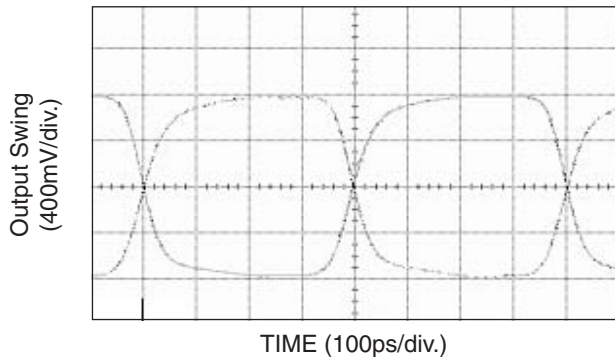
3.2Gbps Output (Q - /Q)



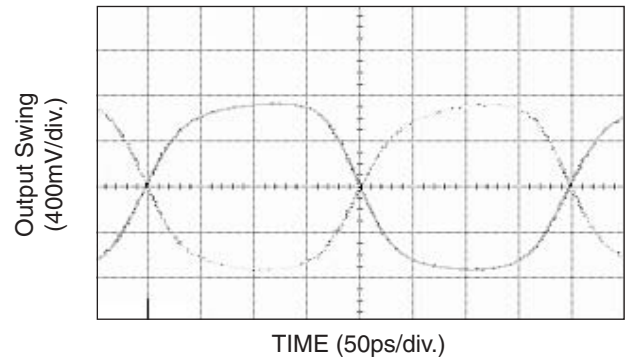
200MHz Output (Q - /Q)



1.25GHz Output (Q - /Q)

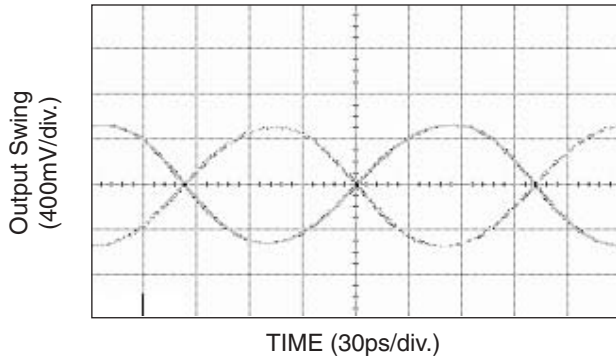


2.5GHz Output (Q - /Q)





5GHz Output (Q - /Q)



**INPUT AND OUTPUT STAGES**

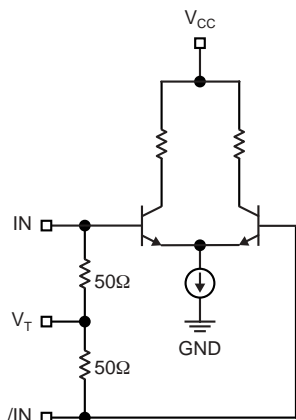


Figure 2a. Simplified Differential Input Stage

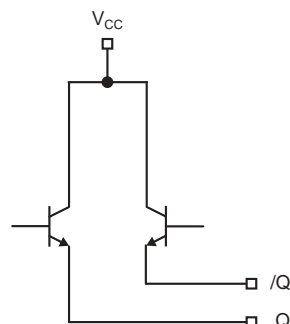
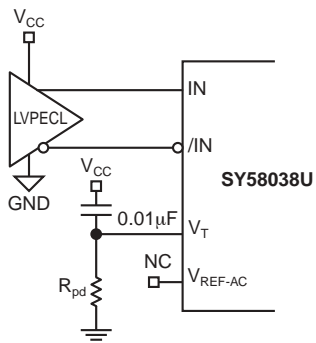


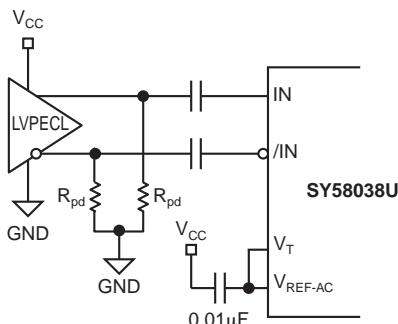
Figure 2b. Simplified LVPECL Output Stage

**INPUT INTERFACE APPLICATIONS**



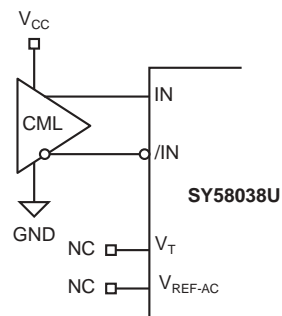
For  $V_{CC} = 3.3V$ ,  $R_{pd} = 50\Omega$ .  
For  $V_{CC} = 2.5V$ ,  $R_{pd} = 19\Omega$ .

Figure 3a. LVPECL Interface (DC-Coupled)



For  $3.3V$ ,  $R_{pd} = 100\Omega$ .  
For  $2.5V$ ,  $R_{pd} = 50\Omega$ .

Figure 3b. LVPECL Interface (AC-Coupled)



Option: May connect  $V_T$  to  $V_{CC}$ .

Figure 3c. CML Interface (DC-Coupled)

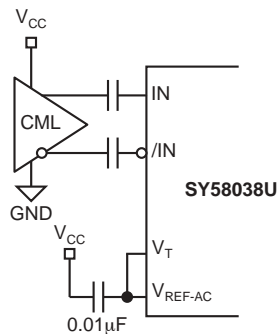


Figure 3d. CML Interface (AC-Coupled)

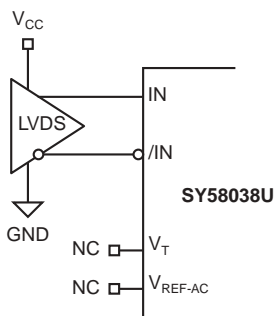
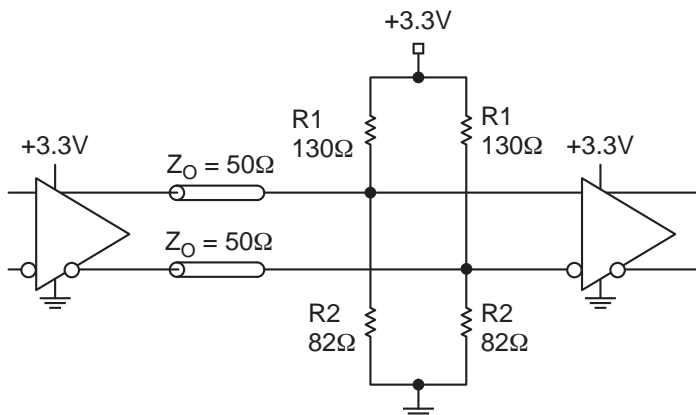


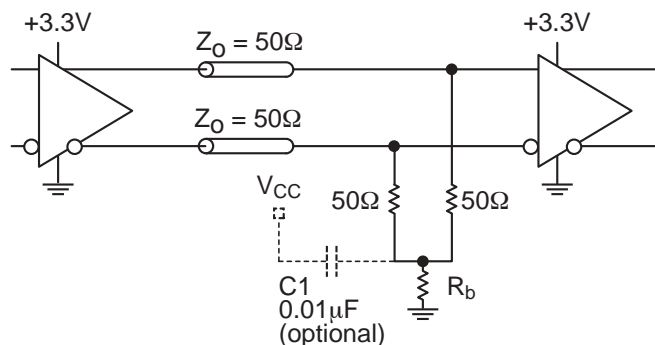
Figure 3e. LVDS Interface

**OUTPUT INTERFACE APPLICATIONS**



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

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



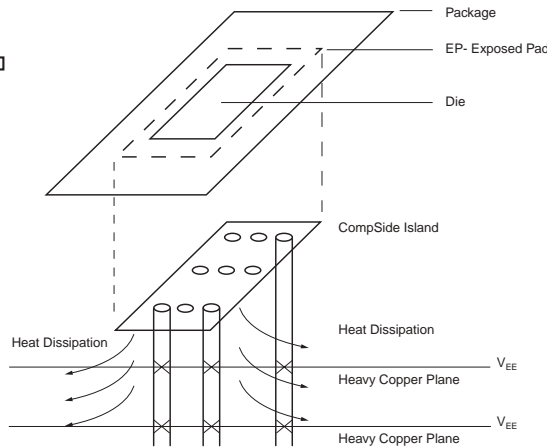
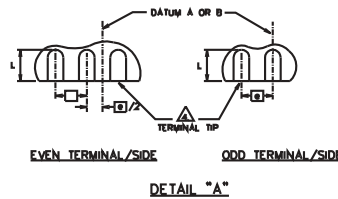
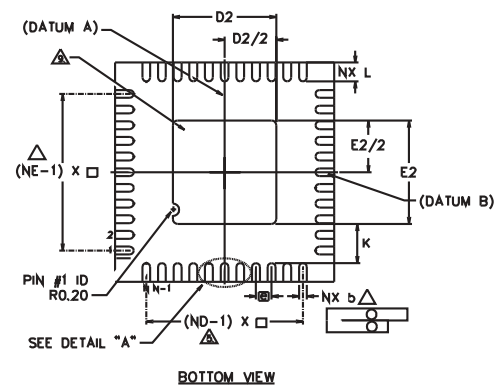
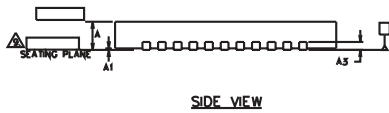
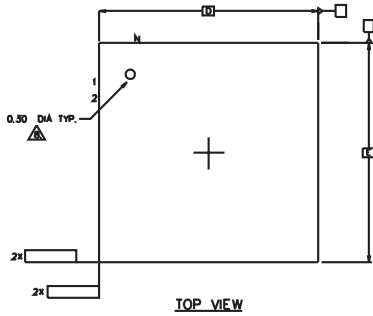
**Figure 4b. Parallel Termination (3-Resistor)**

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

**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-PIN MicroLeadFrame® (MLF-44)**



**NOTES :**

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5M. - 1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS, Ø IS IN DEGREES.
3. N IS THE TOTAL NUMBER OF TERMINALS.
- △ DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30mm FROM TERMINAL TIP. IF THE TERMINAL HAS THE OPTIONAL RADIUS ON THE OTHER END OF THE TERMINAL, THE DIMENSION b SHOULD NOT BE MEASURED IN THAT RADIUS AREA.
- △ ND AND NE REFER TO THE NUMBER OF TERMINALS ON EACH D AND E SIDE RESPECTIVELY.
6. MAX. PACKAGE WARPAGE IS 0.05 mm.
7. MAXIMUM ALLOWABLE BURRS IS 0.076 mm IN ALL DIRECTIONS.
- △ PIN #1 ID ON TOP WILL BE LASER MARKED.
- △ BILATERAL COPLANARITY ZONE APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.
10. THIS DRAWING CONFORMS TO JEDEC REGISTERED OUTLINE MO-220

SYMBOL	DIMENSIONS			NOTES
	MIN.	NOM.	MAX.	
Ø	0.50 BSC			
N	44			
ND	11			3
NE	11			3
L	0.55	0.60	0.65	
b	0.18	0.25	0.30	△
D2	3.20	3.30	3.40	
E2	3.20	3.30	3.40	
D	7.00 BSC			
E	7.00 BSC			
A	0.80	0.85	1.00	
A1	0.00	0.02	0.05	
K	0.20 MIN.			
θ	0	—	12	2

**PCB Thermal Consideration for 44-Pin MLF® 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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