



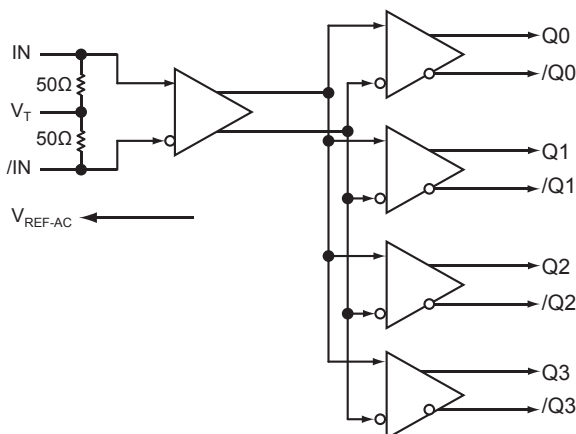
## FEATURES

- Precision 1:4, 400mV LVPECL fanout buffer
- Guaranteed AC performance over temperature and voltage:
  - >5.5GHz  $f_{MAX}$  clock
  - <80ps  $t_r/t_f$  times
  - <250ps ( $V_{IN} \geq 300mV$ )  $t_{pd}$
  - <15ps max. skew
- Low jitter performance:
  - <10ps<sub>pp</sub> total jitter (clock)
  - <1ps<sub>RMS</sub> random jitter (data)
  - <10ps<sub>pp</sub> deterministic jitter (data)
- Accepts an input signal as low as 100mV
- Unique input termination and  $V_T$  pin accepts DC- and AC-coupled differential inputs: LVPECL, LVDS and CML
- 400mV LVPECL compatible outputs
- Power supply 2.5V ±5% and 3.3V ±10%
- -40°C to +85°C temperature range
- Available in 16-pin (3mm × 3mm) MLF® package

## APPLICATIONS

- All SONET and All GigE clock distribution
- Fibre Channel clock and data distribution
- Backplane distribution
- Data distribution: OC-48, OC-48+FEC, XAUI
- High-end, low-skew, multiprocessor synchronous clock distribution

## FUNCTIONAL BLOCK DIAGRAM



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MicroLeadFrame and MLF are trademarks of Amkor Technology, Inc.



Precision Edge®

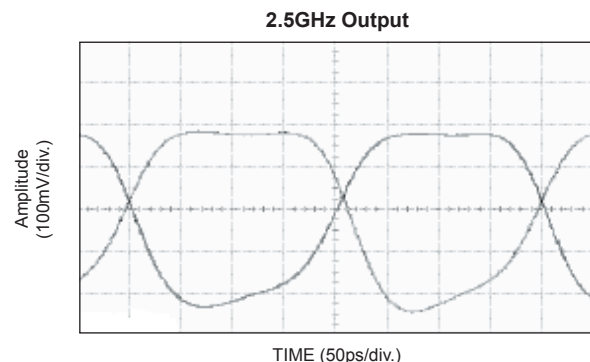
## DESCRIPTION

The SY58022U is a 2.5V/3.3V precision, high-speed, fully differential 1:4 LVPECL fanout buffer. Optimized to provide four identical output copies with less than 15ps of skew and less than 10ps<sub>pp</sub> total jitter, the SY58022U can process clock signals as fast as 5.5GHz.

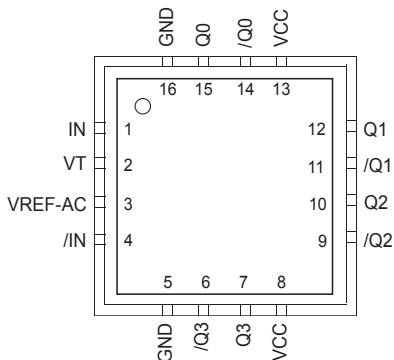
The differential input includes Micrel's unique, 3-pin input termination architecture interfaces to differential LVPECL, CML, and LVDS signals (AC- or DC-coupled) as small as 100mV without any level-shifting or termination resistor networks in the signal path. For AC-coupled input interface applications, an on-board output reference voltage ( $V_{REF-AC}$ ) is provided to bias the  $V_T$  pin. The outputs are 400mV LVPECL compatible, with extremely fast rise/fall times guaranteed to be less than 80ps.

The SY58022U operates from a 2.5V ±5% supply or 3.3V ±10% supply and is guaranteed over the full industrial temperature range (-40°C to +85°C). For applications that require greater output swing or CML compatible outputs, consider the SY58021U 1:4 fanout buffer with LVPECL outputs, or the SY58020U 1:4 fanout buffer with 400mV CML outputs. The SY58022U is part of Micrel's high-speed, Precision Edge® product line. All data sheets and support documentation can be found on Micrel's web site at: [www.micrel.com](http://www.micrel.com).

## TYPICAL PERFORMANCE



**PACKAGE/ORDERING INFORMATION**



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

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY58022UMI	MLF-16	Industrial	022U	Sn-Pb
SY58022UMITR <sup>(2)</sup>	MLF-16	Industrial	022U	Sn-Pb
SY58022UMI	MLF-16	Industrial	022U with Pb-Free bar-line indicator	Pb-Free NiPdAu
SY58022UMITR <sup>(2)</sup>	MLF-16	Industrial	022U with Pb-Free bar-line indicator	Pb-Free NiPdAu

**Notes:**

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

**16-Pin MLF® (MLF-16)**

**PIN DESCRIPTION**

Pin Number	Pin Name	Pin Function
1, 4	IN, /IN	Differential Input: This input pair receives the signal to be buffered. Each pin is internally terminated with 50Ω to the V <sub>T</sub> pin. Note that this input will default to an indeterminate state if left open. See “Input Interface Applications” section.
2	VT	Input Termination Center-Tap: Each input terminates to this pin. The V <sub>T</sub> pin provides a center-tap for each input (IN, /IN) to the termination network for maximum interface flexibility. See “Input Interface Applications” section.
3	VREF-AC	Reference Output Voltage: This output biases to V <sub>CC</sub> -1.2V. It is used when AC-coupling to differential inputs. Connect V <sub>REF-AC</sub> directly to the V <sub>T</sub> pin. Bypass with 0.01μF low ESR capacitor to V <sub>CC</sub> . See “Input Interface Applications” section.
8, 13	VCC	Positive Power Supply: Bypass with 0.1μF//0.01μF low ESR capacitors as close to the pins as possible. A 0.01μF capacitor should be as close to the V <sub>CC</sub> pin as possible.
5, 16	GND, Exposed Pad	Ground. Exposed pad must be connected to a ground plane that is the same potential as the ground pin.
14, 15 11, 12 9, 10 6, 7	/Q0, Q0, /Q1, Q1, /Q2, Q2, /Q3, Q3,	LVPECL Differential Output Pairs: Differential buffered output copy of the input signal. The output swing is typically 400mV. Proper termination is 50Ω to V <sub>CC</sub> -2V at the receiving end. Unused output pairs may be left floating with no impact on jitter or skew. See “LVPECL Output Termination” section.

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

Power Supply Voltage ( $V_{CC}$ )	.....	-0.5V to +4.0V
Input Voltage ( $V_{IN}$ )	.....	-0.5V to $V_{CC}$
Output Current ( $I_{OUT}$ )		
Continuous	.....	50mA
Surge	.....	100mA
$V_T$ Current		
Source or sink current on $V_T$ pin	.....	$\pm 100$ mA
Input Current		
Source or sink current on (IN, /IN)	.....	$\pm 50$ mA
$V_{REF}$ Current		
Source or sink current on $V_{REF-AC}$	Note 4.....	$\pm 1.5$ mA
Soldering, (20 sec.)	.....	260°C
Storage Temperature Range ( $T_{STORE}$ )	.....	-65 to +150°C

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

Power Supply Voltage ( $V_{CC}$ )	.....	+2.375V to +3.60V
Operating Temperature Range ( $T_A$ )	.....	-40°C to +85°C
Package Thermal Resistance		
MLF® ( $\theta_{JA}$ )		
Still-Air	.....	60°C/W
500lpm	.....	54°C/W
MLF® ( $\psi_{JB}$ )		
(Junction-to-Board Resistance), Note 3	.....	33°C/W

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

$T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$

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	3.60	V
$I_{CC}$	Power Supply Current	No load, $V_{CC} = \text{max}$		125	160	mA
$V_{IH}$	Input HIGH Voltage	IN, /IN, Note 6	$V_{CC}-1.6$		$V_{CC}$	V
$V_{IL}$	Input LOW Voltage	IN, /IN	0		$V_{IH}-0.1$	V
$V_{IN}$	Input Voltage Swing	IN, /IN; See Figure 1a	0.1		3.6	V
$V_{DIFF\_IN}$	Differential Input Voltage	IN, /IN; See Figure 1b	0.2		3.4	V
$R_{IN}$	IN-to- $V_T$ Resistance		40	50	60	$\Omega$
$V_{REF-AC}$	Output Reference Voltage		$V_{CC}-1.3$	$V_{CC}-1.2$	$V_{CC}-1.1$	V
$V_{TIN}$	IN-to- $V_T$ Voltage				1.28	V

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

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

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{OH}$	Output HIGH Voltage		$V_{CC}-1.145$	$V_{CC}-1.020$	$V_{CC}-0.895$	V
$V_{OL}$	Output LOW Voltage		$V_{CC}-1.545$	$V_{CC}-1.420$	$V_{CC}-1.295$	V
$V_{OUT}$	Output Differential Swing	see Figure 1a	150	400	650	mV
$V_{DIFF\_OUT}$	Differential Output Swing	see Figure 1b	300	800	1300	mV

**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. Thermal performance assumes exposed pad is soldered (or equivalent) to the device's most negative potential on the PCB.
4. Due to the limited drive capability, use for input of the same package only.
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.

## AC ELECTRICAL CHARACTERISTICS

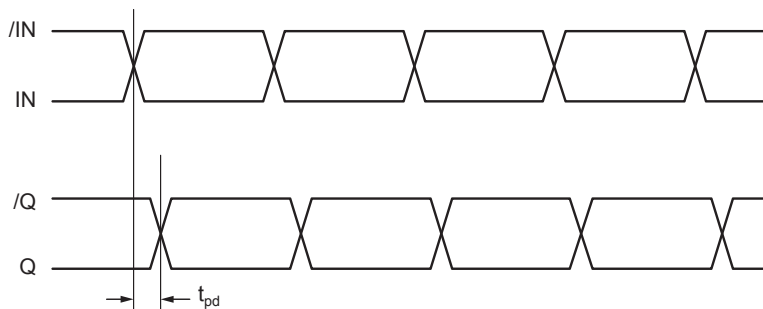
$V_{CC} = 2.5V \pm 5\%$  or  $3.3V \pm 10\%$ ;  $R_L = 50\Omega$  to  $V_{CC} - 2V$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ , unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units	
$f_{MAX}$	Maximum Operating Frequency	$V_{OUT} \geq 200mV$ Clock	5.5			GHz	
		NRZ Data		10		Gbps	
$t_{pd}$	Propagation Delay		130	200	280	ps	
$t_{CHAN}$	Channel-to-Channel Skew	<b>Note 7</b>		4	15	ps	
$t_{SKEW}$	Part-to-Part Skew	<b>Note 8</b>			50	ps	
$t_{JITTER}$	Clock Cycle-to-Cycle Jitter	<b>Note 9</b>			1	$ps_{RMS}$	
		<b>Note 10</b>			10	$ps_{PP}$	
	Data Random Jitter	<b>Note 11</b>	2.5Gbps – 3.2Gbps			1	$ps_{RMS}$
		<b>Note 12</b>	2.5Gbps – 3.2Gbps			10	$ps_{PP}$
$t_r, t_f$	Output Rise/Fall Time 20% to 80%	At full swing	20	50	80	ps	

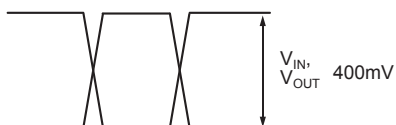
**Notes:**

7. Skew is measured between outputs of the same bank under identical transitions.
8. 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.
9. 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.
10. Total jitter definition: with an ideal clock input of frequency  $\leq f_{MAX}$ , no more than one output edge in  $10^{12}$  output edges will deviate by more than the specified peak-to-peak jitter value.
11. Random jitter is measured with a K28.7 comma detect character pattern, measured at 2.5Gbps/3.2Gbps.
12. Deterministic jitter is measured at 2.5Gbps/3.2Gbps with both K28.5 and  $2^{23}-1$  PRBS pattern.

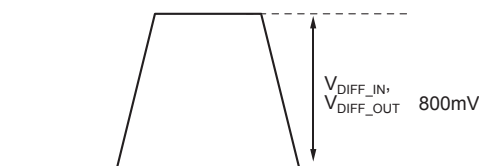
## TIMING DIAGRAM



## SINGLE-ENDED AND DIFFERENTIAL SWINGS



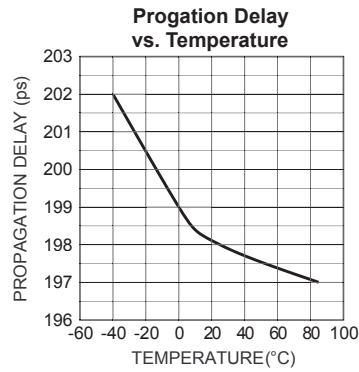
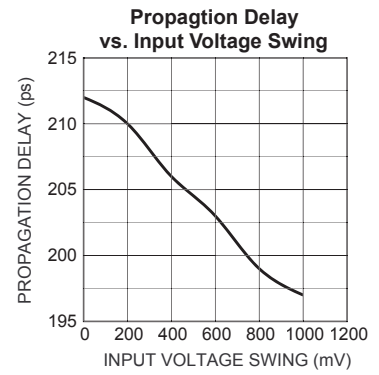
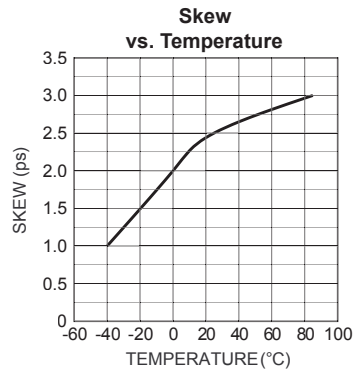
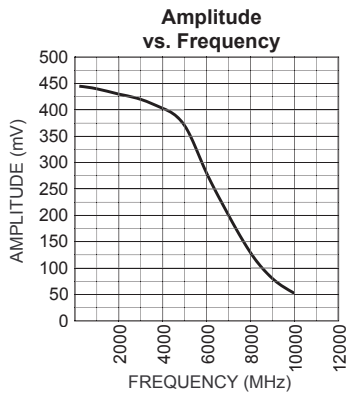
**Figure 1a. Single-Ended Swing**



**Figure 1b. Differential Swing**

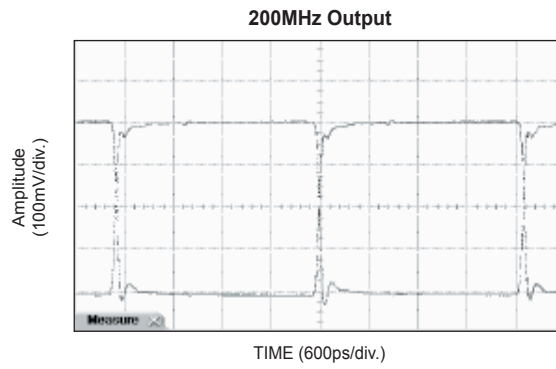
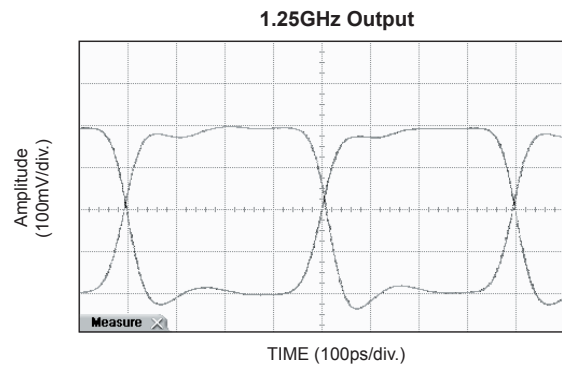
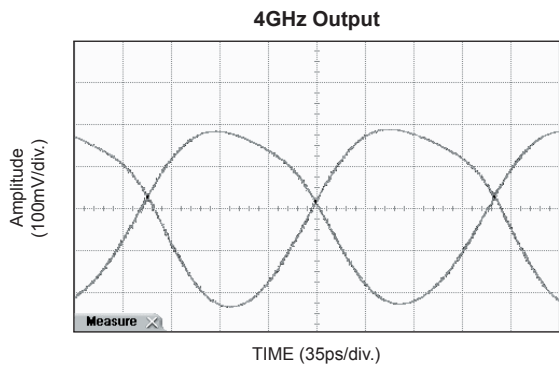
**TYPICAL OPERATING CHARACTERISTICS**

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

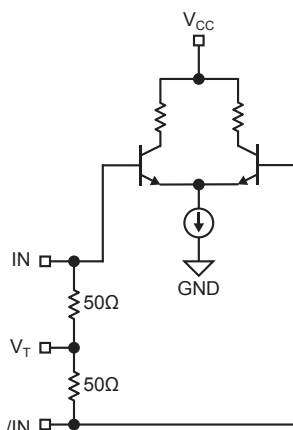


# FUNCTIONAL CHARACTERISTICS

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

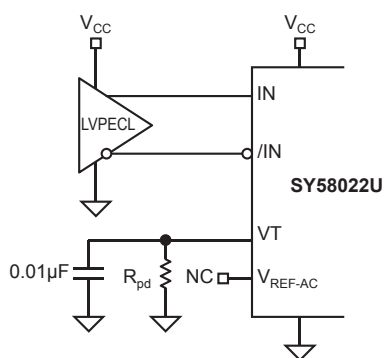


**INPUT STAGE**



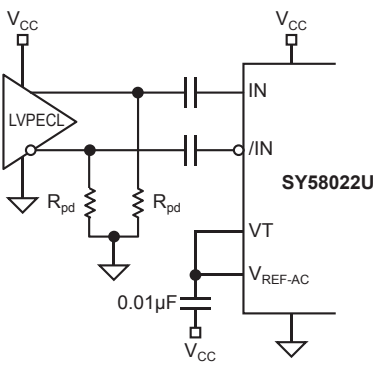
**Figure 2. Simplified Differential Input Buffer**

**INPUT INTERFACE APPLICATIONS**



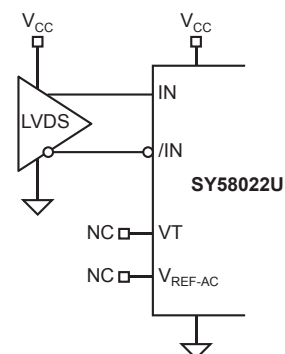
For  $V_{CC} = 2.5V$ ,  $R_{pd} = 19\Omega$ .  
For  $V_{CC} = 3.3V$ ,  $R_{pd} = 50\Omega$ .

**Figure 3a. DC-Coupled LVPECL Input Interface**

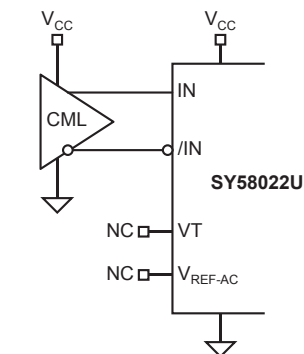


$R_{pd} = 100\Omega$  for a 3.3V system.  
 $R_{pd} = 50\Omega$  for a 2.5V system.

**Figure 3b. AC-Coupled LVPECL Input Interface**

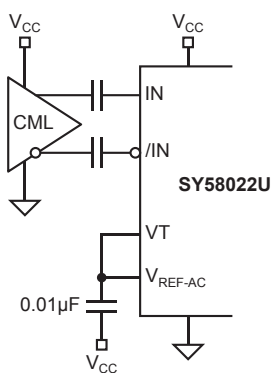


**Figure 3c. LVDS Input Interface**



(Option: May connect  $V_T$  to  $V_{CC}$ )

**Figure 3d. AC-Coupled**

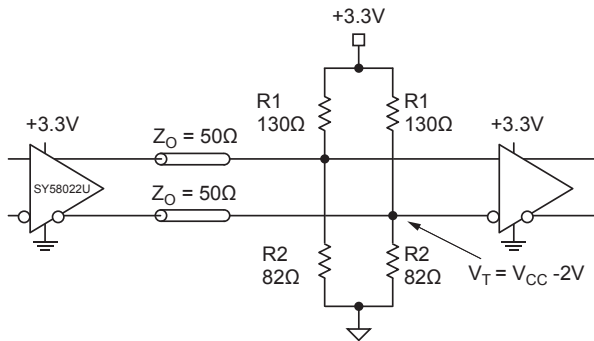


**Figure 3e. CML**

## OUTPUT TERMINATION RECOMMENDATIONS

LVPECL outputs have very low output impedance (open emitter), and small signal swing which results in low EMI (electro-magnetic interference). The LVPECL is ideal for driving 50Ω- and 100Ω-controlled impedance transmission lines. In addition, LVPECL is compatible for driving standard

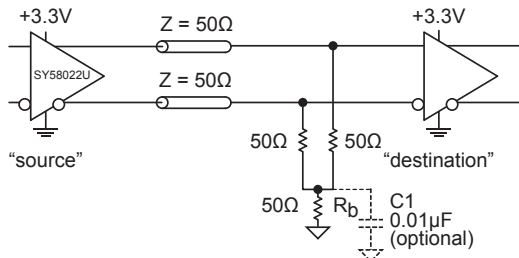
PECL inputs since PECL inputs require only 100mV input swing. Further, there are several techniques in terminating the LVPECL outputs, as shown in Figure 4 through 6.



**Figure 4. Parallel Termination–Thevenin Equivalent**

**Notes:**

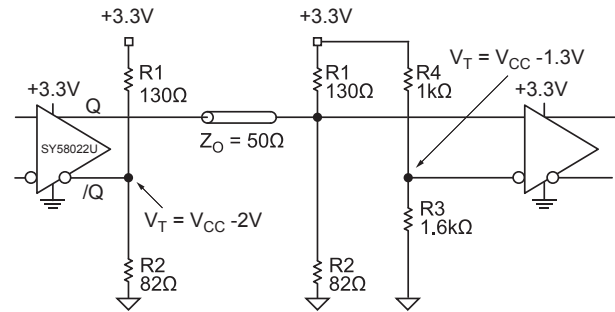
1. For +2.5V systems: R1 = 250Ω, R2 = 62.5Ω.
2. For +3.3V systems: R1 = 130Ω, R2 = 83Ω.



**Figure 5. Three-Resistor “Y-Termination”**

**Notes:**

1. Power-saving alternative to Thevenin termination.
2. Place termination resistors as close to destination inputs as possible.
3. R<sub>b</sub> resistor sets the DC bias voltage, equal to V<sub>T</sub>.  
For +2.5V systems R<sub>b</sub> = 19Ω.  
For +3.3V systems R<sub>b</sub> = 46Ω to 50Ω.
4. C1 is an optional bypass capacitor intended to compensate for any t<sub>r</sub>/t<sub>f</sub> mismatches.



**Figure 6. Terminating Unused I/O**

**Notes:**

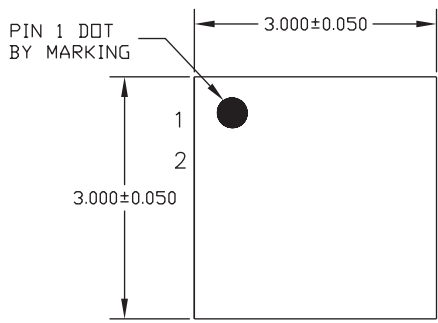
1. Unused output (/Q) must be terminated to balance the output.
2. For +2.5V systems: R1 = 250Ω, R2 = 62.5Ω, R3 = 1.25kΩ, R4 = 1.2kΩ.  
For +3.3V systems: R1 = 130Ω, R2 = 82Ω, R3 = 1kΩ, R4 = 1.6kΩ.
3. Unused output pairs (Q and /Q) may be left floating.

## RELATED MICREL PRODUCTS AND SUPPORT DOCUMENTATION

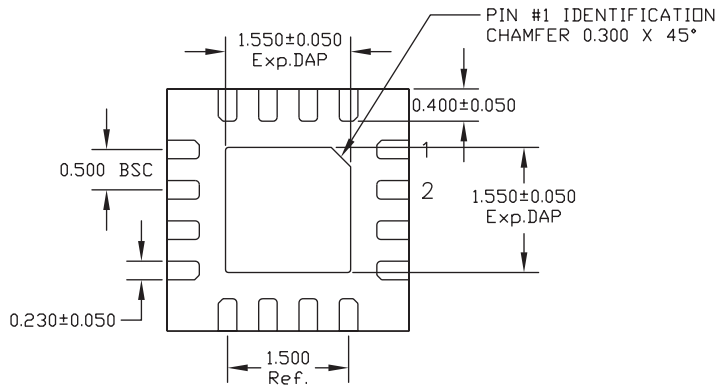
Part Number	Function	Data Sheet Link
SY58020U	6GHz, 1:4 CML Fanout Buffer/Translator Internal I/O Termination	<a href="http://www.micrel.com/product-info/prod/ucts/sy58020u.shtml">http://www.micrel.com/product-info/prod/ucts/sy58020u.shtml</a>
SY58021U	4GHz, 1:4 LVPECL Fanout Buffer/Translator with Internal Termination	<a href="http://www.micrel.com/product-info/products/sy58021u.shtml">http://www.micrel.com/product-info/products/sy58021u.shtml</a>
SY58022U	5.5GHz, 1:4 Fanout Buffer/Translator w/400mV LVPECL Outputs and Internal Input Termination	<a href="http://www.micrel.com/product-info/products/sy58022u.shtml">http://www.micrel.com/product-info/products/sy58022u.shtml</a>
	16-MLF® Manufacturing Guidelines Exposed Pad 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>
M-0317	HBW Solutions	<a href="http://www.micrel.com/product-info/as/solutions.shtml">http://www.micrel.com/product-info/as/solutions.shtml</a>



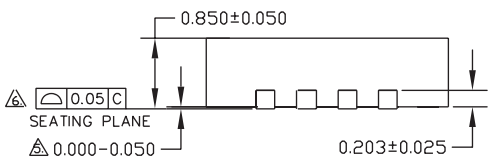
**16-PIN MicroLeadFrame® (MLF-16)**



TOP VIEW

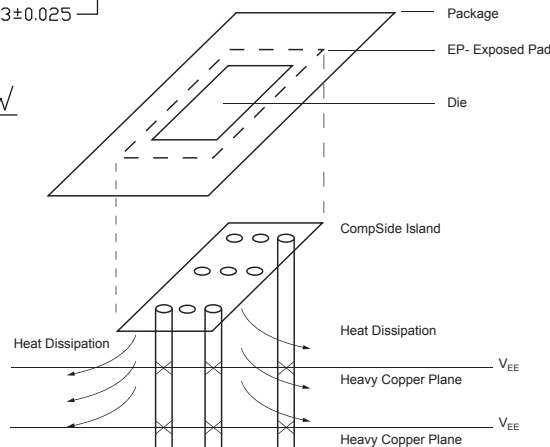


BOTTOM VIEW



SIDE VIEW

- NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
  2. MAX. PACKAGE WARPAGE IS 0.05 mm.
  3. MAXIMUM ALLOWABLE BURRS IS 0.076 mm IN ALL DIRECTIONS.
  4. PIN #1 ID ON TOP WILL BE LASER/INK MARKED.
- △ APPLIED ONLY FOR TERMINALS.  
△ APPLIED FOR EXPOSED PAD AND TERMINALS.



**PCB Thermal Consideration for 16-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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