



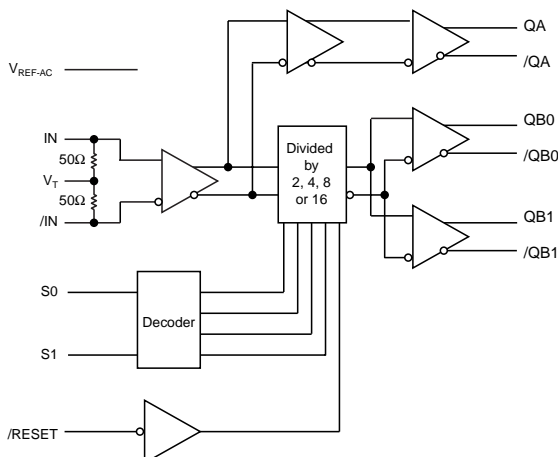
## FEATURES

- **Two matched-delay outputs:**
  - Bank A: undivided pass-through (QA)
  - Bank B: programmable divide by 2, 4, 8, 16 (QB0, QB1)
- **Matched delay: all outputs have matched delay, independent of divider setting**
- **Guaranteed AC performance:**
  - >2.5GHz  $f_{MAX}$
  - <250ps  $t_r/t_f$
  - <670ps  $t_{pd}$  (matched delay)
  - <15ps within-device skew
- **Low jitter design**
  - <1ps<sub>RMS</sub> cycle-to-cycle jitter
  - <10ps<sub>pp</sub> total jitter
- **Power supply 3.3V or 2.5V**
- **Unique patent-pending input termination and VT pin for DC- and AC-coupled inputs: any differential inputs (LVPECL, LVDS, CML, HSTL)**
- **TTL/CMOS inputs for select and reset**
- **100K EP compatible LVPECL outputs**
- **Parallel programming capability**
- **Wide operating temperature range: -40°C to +85°C**
- **Available in 16-pin (3mm x 3mm) MLF® package**

## APPLICATIONS

- OC-3 to OC-192 SONET/SDH applications
- Transponders
- Oscillators
- SONET/SDH line cards

## FUNCTIONAL BLOCK DIAGRAM



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MicroLeadFrame and MLF are registered trademarks of Amkor Technology, Inc.



Precision Edge®

## DESCRIPTION

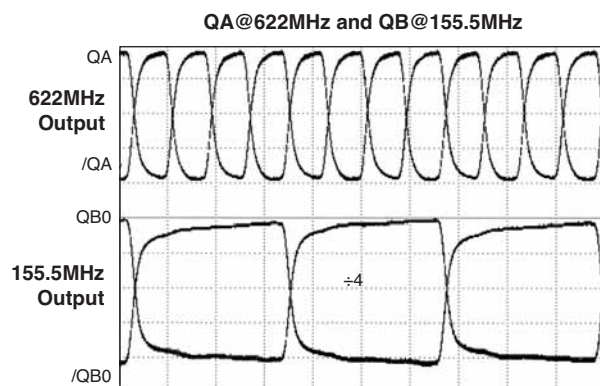
The SY89871U is a 2.5V/3.3V LVPECL output precision clock divider capable of accepting a high-speed differential clock input (AC or DC-coupled) CML, LVPECL, HSTL or LVDS clock input signal and dividing down the frequency using a programmable divider ratio to create a frequency-locked lower speed version of the input clock (Bank B). Available divider ratios are 2, 4, 8 and 16. In a typical 622MHz clock system this would provide availability of 311MHz, 155MHz, 77MHz, or 38MHz auxiliary clock components.

The differential input buffer has a unique internal termination design that allows access to the termination network through a VT pin. This feature allows the device to easily interface to different logic standards. A  $V_{REF-AC}$  reference is included for AC-coupled applications.

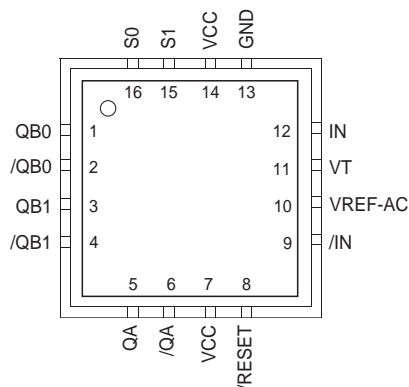
The SY89871U includes two phase-matched output banks. Bank A (QA) is a frequency-matched copy of the input. Bank B (QB0, QB1) is a divided down output of the input frequency. Bank A and Bank B maintain a matched delay independent of the divider setting.

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

## TYPICAL PERFORMANCE



**PACKAGE/ORDERING INFORMATION**



**16-Pin MLF® (MLF-16)**

**Ordering Information**

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY89871UMI	MLF-16	Industrial	871U	Sn-Pb
SY89871UMITR <sup>(1)</sup>	MLF-16	Industrial	871U	Sn-Pb
SY89871UMG <sup>(2)</sup>	MLF-16	Industrial	871U with Pb-Free bar line indicator	NiPdAu Pb-Free
SY89871UMGTR <sup>(1, 2)</sup>	MLF-16	Industrial	871U with Pb-Free bar line indicator	NiPdAu Pb-Free

**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 is recommended for new designs.

**PIN DESCRIPTION**

Pin Number	Pin Name	Pin Function
1, 2, 3, 4	QB0, /QB0 QB1, /QB1	Differential Buffered Output Clocks: This differential output is a divided-down version of the input frequency and has a matched output delay with Bank A. Divided by 2, 4, 8, or 16. See "Truth Table." Unused output pairs may be left floating.
5, 6	QA, /QA	Differential Buffered Undivided Output Clock.
7, 14	VCC	Positive Power Supply: Bypass with 0.1µF <sup>TMTM</sup> 0.01µF low ESR capacitors.
8	/RESET	Output Reset: Internal 25k $\Omega$ pull-up. Logic LOW will reset the divider select. See "Truth Table." Input threshold is V <sub>CC</sub> /2.
12, 9	IN, /IN	Differential Input: Internal 50 $\Omega$ termination resistors to VT input. See "Input Interface Applications" section.
10	VREF-AC	Reference Voltage: Equal to V <sub>CC</sub> -1.4V (approx.), and used for AC-coupled applications. For DC-coupled applications, VREF-AC is normally left floating. Maximum sink/source current is 0.5mA. See "Input Interface Applications" section.
11	VT	Input Termination Center-Tap: Each side of differential input pair terminates to this pin. The VT pin provides a center tap to a termination network for maximum interface flexibility. For CML and LVDS inputs, leave this pin floating. See "Input Interface Application" section.
13	GND	Ground.
15, 16	S1, S0	Select Pins: See "Truth Table." LVTTTL/CMOS logic levels. Internal 25k $\Omega$ pull-up resistor. Logic HIGH if left unconnected (divided by 16 mode). S0 = LSB. Input threshold is V <sub>CC</sub> /2.

**TRUTH TABLE**

/RESET	S1	S0	Bank A Output	Bank B Outputs
1	0	0	Input Clock	Input Clock $\div$ 2
1	0	1	Input Clock	Input Clock $\div$ 4
1	1	0	Input Clock	Input Clock $\div$ 8
1	1	1	Input Clock	Input Clock $\div$ 16
0	X	X	Input Clock	QB = LOW, /QB = HIGH

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

Supply Voltage ( $V_{CC}$ )	-0.5V to +4.0V
Input Voltage ( $V_{IN}$ )	-0.5V to $V_{CC} + 0.3V$
PECL Output Current ( $I_{OUT}$ )	
Continuous	50mA
Surge	100mA
$V_T$ Current ( $I_{VT}$ )	±100mA
Input Current $I_N$ , $/I_N$ ( $I_{IN}$ )	±50mA
$V_{REF-AC}$ Sink/Source Current ( $I_{VREF-AC}$ )	±2mA
Lead Temperature (soldering, 20 sec.)	260°C
Storage Temperature ( $T_S$ )	-65°C to +150°C

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

Supply Voltage ( $V_{CC}$ )	+2.375V to +3.63V
Ambient Temperature ( $T_A$ )	-40°C to +85°C
Package Thermal Resistance <sup>(3)</sup>	
MLF® ( $\theta_{JA}$ )	
Still-Air	60°C/W
500lfpm	54°C/W
MLF® ( $\psi_{JB}$ )	
Junction-to-board	38°C/W

## DC ELECTRICAL CHARACTERISTICS<sup>(4)</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		2.37		3.60	V
$I_{CC}$	Power Supply Current	No load, max $V_{CC}$ .		50	75	mA
$R_{IN}$	Differential Input Resistance, (IN-to- $/I_N$ )		90	100	110	Ω
$V_{IH}$	Input HIGH Voltage, (IN, $/I_N$ )		0.1		$V_{CC} + 0.3$	V
$V_{IL}$	Input LOW Voltage, (IN, $/I_N$ )		-0.3		$V_{IH} - 0.1$	V
$V_{IN}$	Input Voltage Swing	<b>Notes 5</b>	0.1		$V_{CC}$	V
$V_{DIFF\_IN}$	Differential Input Voltage Swing	<b>Notes 5, 6</b>	0.2			V
$ I_{IN} $	Input Current, (IN, $/I_N$ )	<b>Note 7</b>			45	mA
$V_{REF-AC}$	Reference Voltage		$V_{CC} - 1.525$	$V_{CC} - 1.425$	$V_{CC} - 1.325$	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. Junction-to-board resistance assumes exposed pad is soldered (or equivalent) to the device's most negative potential on the PCB.
4. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
5. See "Timing Diagram" for  $V_{IN}$  definition.  $V_{IN}$  (max.) is specified when  $V_T$  is floating.
6. See "Typical Operating Characteristics" section for  $V_{DIFF}$  definition.
7. Due to the internal termination (see "Input Buffer Structure" section) the input current depends on the applied voltages at IN,  $/I_N$  and  $V_T$  inputs. Do not apply a combination of voltages that causes the input current to exceed the maximum limit!

**(100KEP) LVPECL DC ELECTRICAL CHARACTERISTICS<sup>(8)</sup>**

$V_{CC} = 3.3V \pm 10\%$  or  $2.5V \pm 5\%$ ;  $T_A = -40^{\circ}C$  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		$V_{CC}-1.145$	$V_{CC}-1.020$	$V_{CC}-0.895$	V
$V_{OL}$	Output LOW Voltage		$V_{CC}-1.945$	$V_{CC}-1.820$	$V_{CC}-1.695$	V
$V_{OUT}$	Output Voltage Swing		550	800	1050	mV
$V_{DIFF\_OUT}$	Differential Output Voltage Swing		1.10	1.6	2.1	V

**LVTTTL/LVCMOS DC ELECTRICAL CHARACTERISTICS<sup>(8)</sup>**

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

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		-125		20	$\mu A$
$I_{IL}$	Input LOW Current				-300	$\mu A$

**Note:**  
8. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established. Parameters are for  $V_{CC} = 2.5V$ . They vary 1:1 with  $V_{CC}$ .

## AC ELECTRICAL CHARACTERISTICS<sup>(9)</sup>

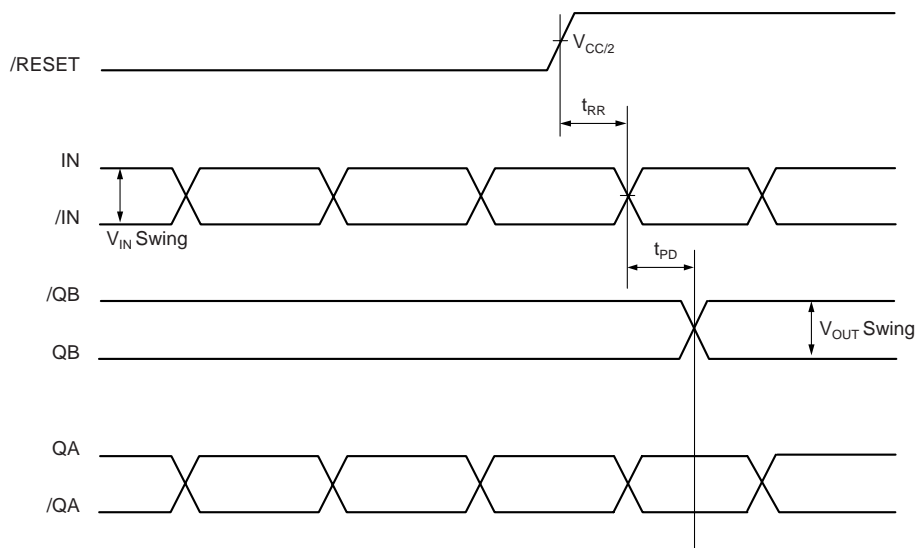
$V_{CC} = 3.3V \pm 10\%$  or  $2.5V \pm 5\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ , unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$f_{MAX}$	Maximum Output Toggle Frequency	Output Swing $\geq 400mV$	2.5			GHz
	Maximum Input Frequency	<b>Note 10</b>	3.2			GHz
$t_{PD}$	Differential Propagation Delay IN-to-QA or QB	Input Swing $< 400mV$	460	580	710	ps
		Input Swing $\geq 400mV$	420	550	670	ps
$t_{SKEW}$	Within-Device Skew (Differential) QB0-to-QB1	<b>Note 11</b>		7	15	ps
	Within-Device Skew (Differential) QA-to-QB	<b>Note 11</b>		12	30	ps
	Part-to-Part Skew (Differential)	<b>Note 11</b>			250	ps
$t_{JITTER}$	Cycle-to-Cycle Jitter	<b>Note 12</b>			1	ps <sub>RMS</sub>
	Total Jitter	<b>Note 13</b>			10	ps <sub>PP</sub>
$t_{RR}$	Reset Recovery Time		600			ps
$t_r, t_f$	Output Rise/Fall Times (20% to 80%)		70	150	250	ps

**Notes:**

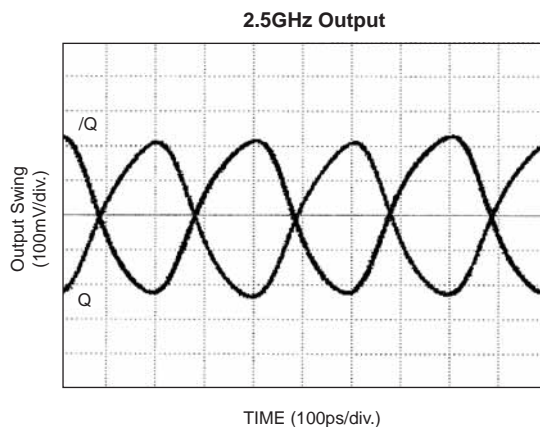
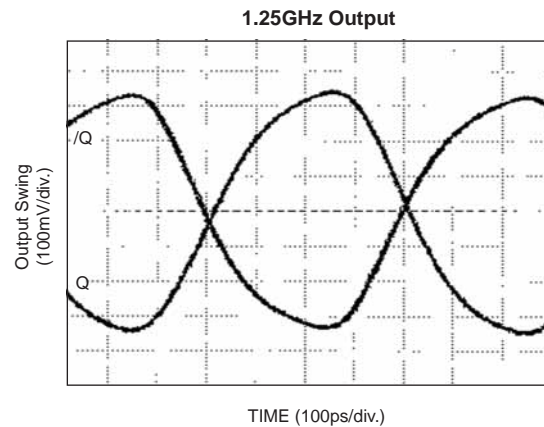
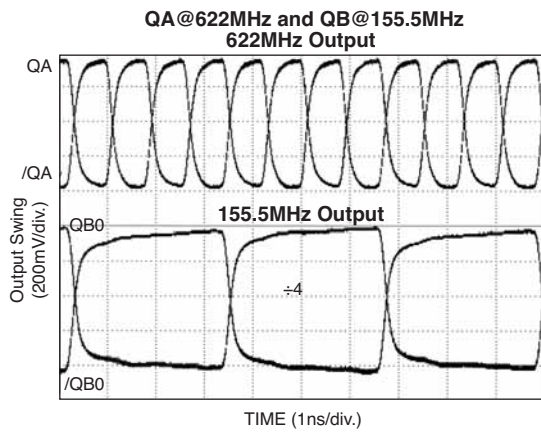
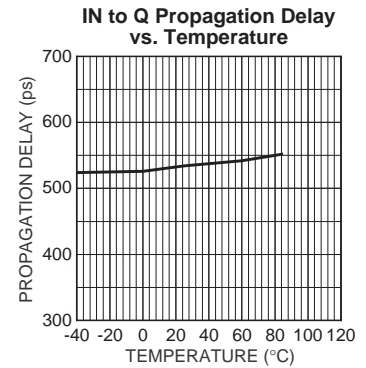
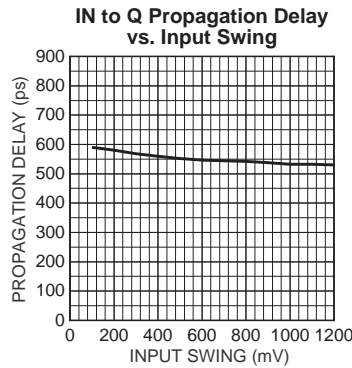
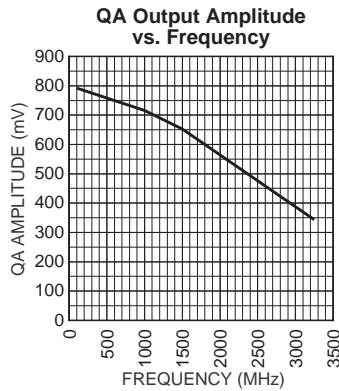
9. Measured with 400mV input signal, 50% duty cycle, all loading with 50 $\Omega$  to  $V_{CC}-2V$ , unless otherwise stated.
10. Bank A (pass-through) maximum frequency is limited by the output stage. Bank B (input-to-output  $\pm 2, \pm 4, \pm 8, \pm 16$ ) can accept an input frequency  $> 3GHz$ , while Bank A will be slew rate limited.
11. Skew is measured between outputs under identical transitions.
12. Cycle-to-cycle jitter definition: the variation in period between adjacent cycles over a random sample of adjacent cycle pairs.  $t_{JITTER\_cc} = T_n - T_{n+1}$ , where T is the time between rising edges of the output signal.
13. Total jitter definition: with an ideal clock input, of frequency -  $f_{MAX}$  (device), no more than one output edge in  $10^{12}$  output edges will deviate by more than the specified peak-to-peak jitter value.

## TIMING DIAGRAM



**TYPICAL OPERATING CHARACTERISTICS**

$V_{CC} = 3.3V$ ,  $V_{IN} = 400mV$ ,  $T_A = 25^\circ C$ ,  $R_L = 50\Omega$  to  $V_{CC} - 2V$ , unless otherwise stated.



**DEFINITION OF SINGLE-ENDED AND DIFFERENTIAL SWING**

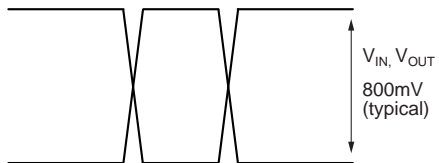


Figure 1a. Single-Ended Swing

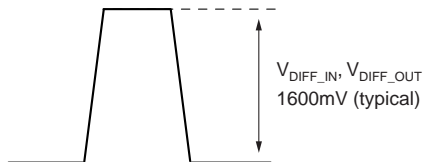


Figure 1b. Differential Swing

**INPUT BUFFER STRUCTURE**

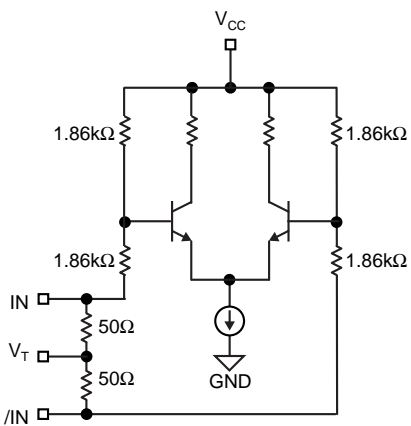


Figure 2a. Simplified Differential Input Buffer

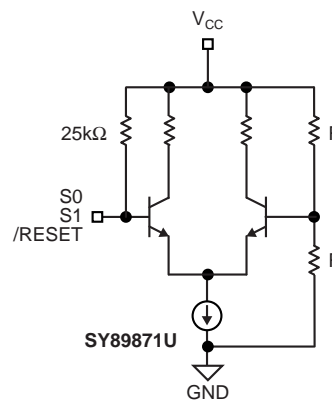
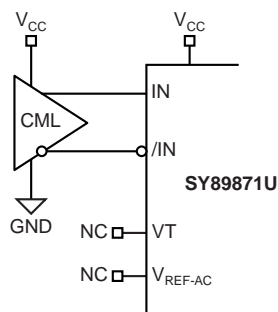
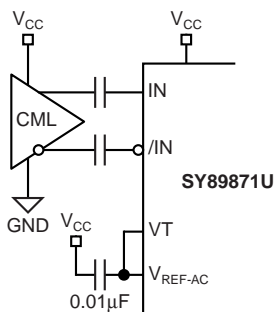


Figure 2b. Simplified TTL/CMOS Input Buffer

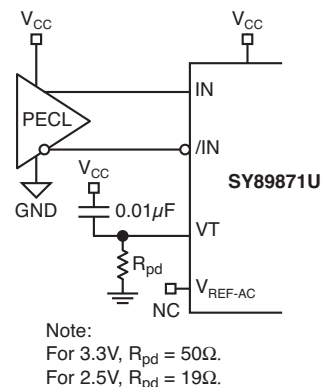
**INPUT INTERFACE APPLICATIONS**



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

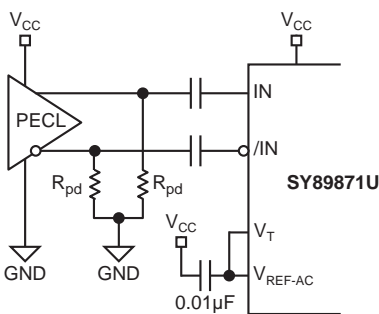


**Figure 3b. AC-Coupled CML Input Interface**



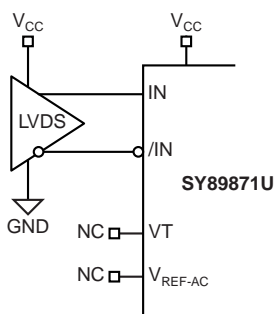
**Figure 3c. DC-Coupled PECL Input Interface**

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

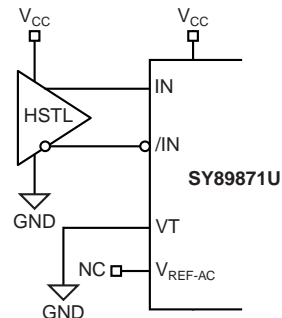


Note:  
For 3.3V, R<sub>pd</sub> = 100Ω.  
For 2.5V, R<sub>pd</sub> = 50Ω.

**Figure 3d. AC-Coupled PECL Input Interface**



**Figure 3e. LVDS Input Interface**



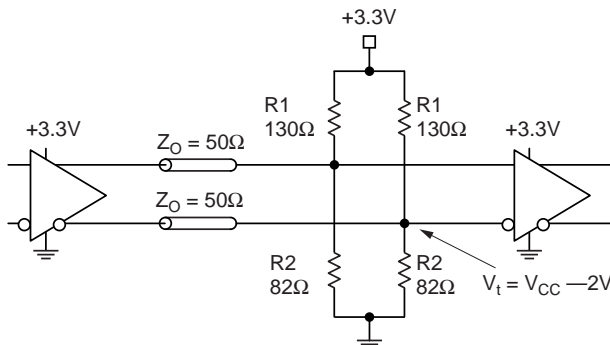
**Figure 3f. HSTL Input Interface**

**RELATED PRODUCT AND SUPPORT DOCUMENTATION**

Part Number	Function	Data Sheet Link
SY89874U	2.5GHz Any Diff. In-to-LVPECL Programmable Clock Divider and 1:2 Fanout Buffer w/Internal Termination	<a href="http://www.micrel.com/product-info/products/sy89874u.shtml">http://www.micrel.com/product-info/products/sy89874u.shtml</a>
	MLF® Application Note	<a href="http://www.amkor.com/products/notes_papers/mlf_appnote.pdf">http://www.amkor.com/products/notes_papers/mlf_appnote.pdf</a>
HBW Solutions	New Products and Applications	<a href="http://www.micrel.com/product-info/products/solutions.shtml">http://www.micrel.com/product-info/products/solutions.shtml</a>



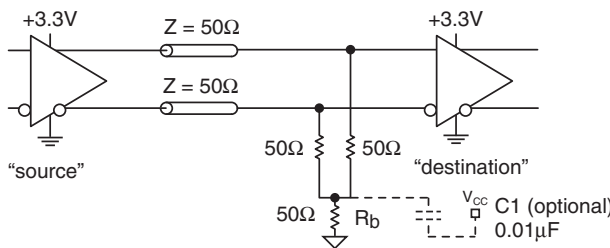
**LVPECL OUTPUT TERMINATION RECOMMENDATIONS**



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

**Note:**

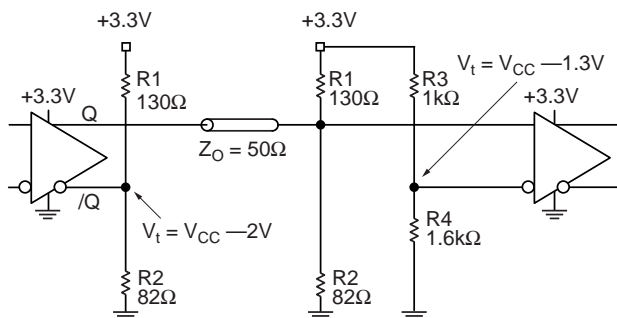
1. For +2.5V systems:  $R_1 = 250\Omega$ ,  $R_2 = 62.5\Omega$ .



**Figure 4b. Three-Resistor "Y-Termination"**

**Notes:**

1. Power-saving alternative to Thevenin termination.
2. Place termination resistors as close to destination inputs as possible.
3.  $R_b$  resistor sets the DC bias voltage, equal to  $V_T$ . For +3.3V systems  $R_b = 46\Omega$  to  $50\Omega$ . For +2.5V systems  $R_b = 19\Omega$ .
4.  $C_1$  is an optional bypass capacitor intended to compensate for any  $t_r/t_f$  mismatches.

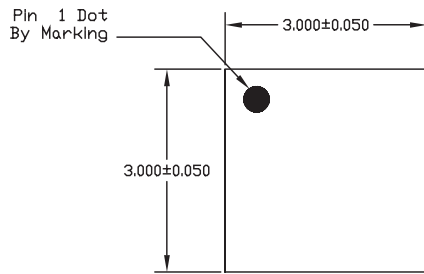


**Figure 4d. Terminating Unused I/O**

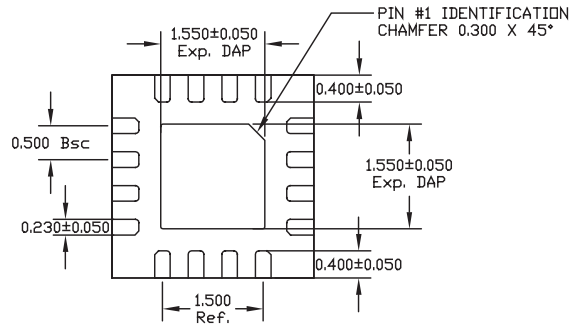
**Notes:**

1. Unused output (/Q) must be terminated to balance the output.
2. For +2.5V systems:  $R_1 = 250\Omega$ ,  $R_2 = 62.5\Omega$ ,  $R_3 = 1.25k\Omega$ ,  $R_4 = 1.2k\Omega$ .

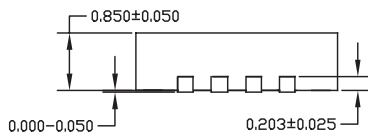
**16-PIN *MicroLeadFrame*® (MLF-16)**



TOP VIEW



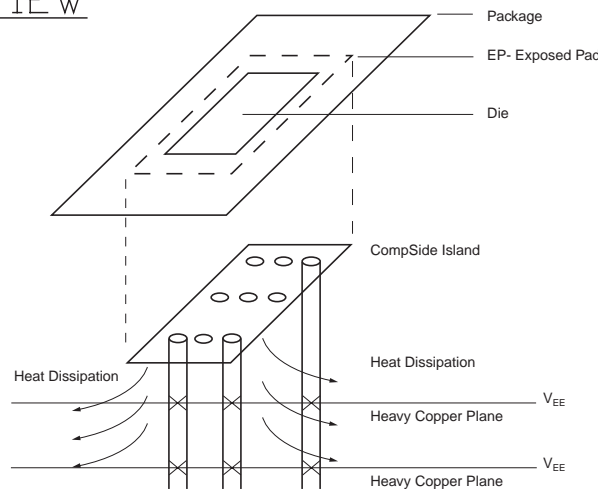
BOTTOM VIEW



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.



**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 moisture sensitivity classification, and is shipped in dry-pack form.
2. Exposed pads must be soldered to a ground for proper thermal management.

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