



**2.5GHz ANY DIFF. IN-TO-LVPECL  
PROGRAMMABLE CLOCK DIVIDER/  
FANOUT BUFFER WITH INTERNAL TERMININATION**

**Precision Edge®  
SY89874U**

**FEATURES**

- Integrated programmable clock divider and 1:2 fanout buffer
- Guaranteed AC performance over temperature and voltage:
  - > 2.5GHz  $f_{MAX}$
  - < 250ps  $t_r/t_f$
  - < 15ps within device skew
- Low jitter design:
  - < 10ps<sub>PP</sub> total jitter
  - < 1ps<sub>RMS</sub> cycle-to-cycle jitter
- Unique input termination and  $V_T$  pin for DC-coupled and AC-coupled Inputs; CML, PECL, LVDS and HSTL
- TTL/CMOS inputs for select and reset
- 100k EP compatible LVPECL outputs
- Parallel programming capability
- Programmable divider ratios of 1, 2, 4, 8 and 16
- Low voltage operation 2.5V or 3.3V
- Output disable function
- -40°C to 85°C temperature range
- Available in 16-pin (3mm x 3mm) MLF® package



Precision Edge®

**DESCRIPTION**

This low-skew, low-jitter device is capable of accepting a high-speed (e.g., 622MHz or higher) CML, LVPECL, LVDS or HSTL 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. Available divider ratios are 2, 4, 8 and 16, or straight pass-through. In a typical 622MHz clock system this would provide availability of 311MHz, 155MHz, 77MHz or 38MHz auxiliary clock components.

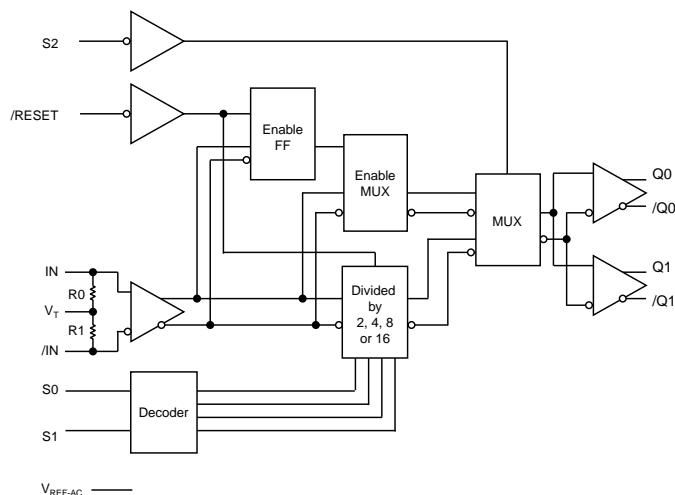
The differential input buffer has a unique internal termination design that allows access to the termination network through a  $V_T$  pin. This feature allows the device to easily interface to different logic standards. A  $V_{REF-AC}$  reference is included for AC-coupled applications.

The /RESET input asynchronously resets the divider. In the pass-through function (divide by 1) the /RESET synchronously enables or disables the outputs on the next falling edge of IN (rising edge of /N).

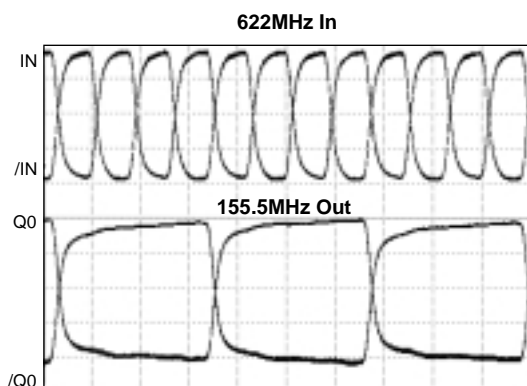
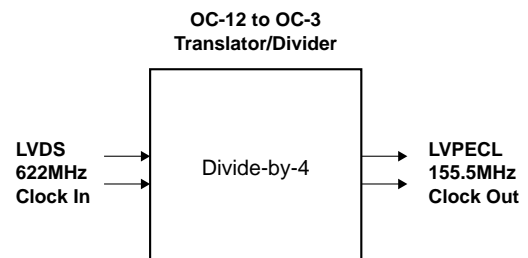
**APPLICATIONS**

- SONET/SDH line cards
- Transponders
- High-end, multiprocessor sensors

**FUNCTIONAL BLOCK DIAGRAM**

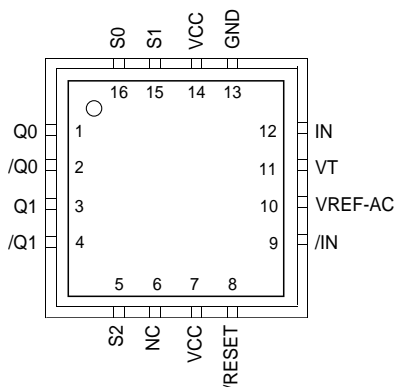


**TYPICAL PERFORMANCE**



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MicroLeadFrame and MLF are trademarks of Amkor Technology, Inc.

**PACKAGE/ORDERING INFORMATION**



**16-Pin MLF® (MLF-16)**

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

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY89874UMI	MLF-16	Industrial	874U	Sn-Pb
SY89874UMITR <sup>(2)</sup>	MLF-16	Industrial	874U	Sn-Pb
SY89874UMG <sup>(3)</sup>	MLF-16	Industrial	874U with Pb-Free bar line indicator	NiPdAu Pb-Free
SY89874UMGTR <sup>(2, 3)</sup>	MLF-16	Industrial	874U 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
12, 9	IN, /IN	Differential Input: Internal 50Ω termination resistors to V <sub>T</sub> input. Flexible input accepts any differential input. See “Input Interface Applications” section.
1, 2, 3, 4	Q0, /Q0 Q1, /Q1	Differential Buffered LVPECL Outputs: Divided by 1, 2, 4, 8 or 16. See “Truth Table.” Unused PECL outputs may be left floating with no impact on jitter performance.
16, 15, 5	S0, S1, S2	Select Pins: See “Truth Table.” LVTTTL/CMOS logic levels. Internal 25kΩ pull-up resistor. Logic HIGH if left unconnected (divided by 16 mode.) Input threshold is V <sub>CC</sub> /2.
6	NC	No Connect.
8	/RESET /DISABLE	LVTTTL/CMOS Logic Levels: Internal 25kΩ pull-up resistor. Logic HIGH if left unconnected. Apply LOW to reset the divider (divided by 2, 4, 8 or 16 mode). Also acts as a synchronous disable/enable function. The reset and disable function occurs on the next high-to-low clock input transition. Input threshold is V <sub>CC</sub> /2.
10	VREF-AC	Reference Voltage: Equal to V <sub>CC</sub> -1.4V (approx.). Used for AC-coupled applications only. Decouple the V <sub>REF-AC</sub> pin with a 0.01μF capacitor. See “Input Interface Applications” section.
11	VT	Termination Center-Tap: For CML or LVDS inputs, leave this pin floating. Otherwise, see Figures 2a to 2f “Input Interface Applications” section.
7, 14	VCC	Positive Power Supply: Bypass with 0.1μF//0.01μF low ESR capacitor.
13	GND	Ground.

**TRUTH TABLE**

/RESET <sup>(1)</sup>	S2	S1	S0	Outputs
1	0	X	X	Reference Clock (pass through)
1	1	0	0	Reference Clock ÷2
1	1	0	1	Reference Clock ÷4
1	1	1	0	Reference Clock ÷8
1	1	1	1	Reference Clock ÷16
0 <sup>(1)</sup>	1	X	X	Q = LOW, /Q = HIGH Clock Disable

**Note 1.** Reset/Disable function is asserted on the next clock input (IN, /IN) high-to-low transition.

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

Supply Voltage ( $V_{CC}$ )	.....	-0.5V to +4.0V
Input Voltage ( $V_{IN}$ )	.....	-0.5V to $V_{CC}+0.3$
ECL Output Current ( $I_{OUT}$ )		
Continuous	.....	50mA
Surge	.....	100mA
Input Current $I_N$ , $I_{IN}$ ( $I_{IN}$ )	.....	$\pm 50$ mA
$V_T$ Current ( $I_{VT}$ )	.....	$\pm 100$ mA
$V_{REF-AC}$ Sink/Source Current ( $I_{VREF-AC}$ ), <b>Note 3</b>	.....	$\pm 2$ mA
Lead Temperature (soldering 20 sec.)	.....	260°C
Storage Temperature ( $T_S$ )	.....	-65°C to +150°C

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

Supply Voltage ( $V_{CC}$ )	.....	+3.3V $\pm 10\%$ or +2.5V $\pm 5\%$
Ambient Temperature ( $T_A$ )	.....	-40°C to +85°C
Package Thermal Resistance		
MLF® ( $\theta_{JA}$ )		
Still-Air	.....	60°C/W
500lfpm	.....	54°C/W
MLF® ( $\psi_{JB}$ ), <b>Note 4</b>		
Junction-to-Board	.....	32°C/W

- Note 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 rating conditions for extended periods may affect device reliability.
- Note 2.** The data sheet limits are not guaranteed if the device is operated beyond the operating ratings.
- Note 3.** Due to the limited drive capability use for input of the same package only.
- Note 4.** Junction-to-board resistance assumes exposed pad is soldered (or equivalent) to the device's most negative potential on the pcb.

## DC ELECTRICAL CHARACTERISTICS<sup>(Notes 1, 2)</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		2.375		3.63	V
$I_{CC}$	Power Supply Current	No load, max. $V_{CC}$		50	75	mA
$R_{IN}$	Differential Input Resistance (IN-to-/IN)		90	100	110	$\Omega$
$V_{IH}$	Input High Voltage (IN, /IN)	<b>Note 3</b>	0.1	-	$V_{CC}+0.3$	V
$V_{IL}$	Input Low Voltage (IN, /IN)	<b>Note 3</b>	-0.3	-	$V_{IH}-0.1$	V
$V_{IN}$	Input Voltage Swing	<b>Notes 3, 4</b>	0.1	-	$V_{CC}$	V
$V_{DIFF\_IN}$	Differential Input Voltage Swing	<b>Notes 3, 4, 5</b>	0.2	-		V
$ I_{IN} $	Input Current (IN, /IN)	<b>Note 3</b>	-	-	45	mA
$V_{REF-AC}$	Reference Voltage	<b>Note 6</b>	$V_{CC}-1.525$	$V_{CC}-1.425$	$V_{CC}-1.325$	V

- Note 1.** The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
- Note 2.** Specification for packaged product only.
- Note 3.** Due to the internal termination (see "Input Structures") the input current depends on the applied voltages at IN, /IN and  $V_T$  inputs. Do not apply a combination of voltages that causes the input current to exceed the maximum limit!
- Note 4.** See "Timing Diagram" for  $V_{IN}$  definition.  $V_{IN}$  (Max) is specified when  $V_T$  is floating.
- Note 5.** See "Typical Operating Characteristics" section for  $V_{DIFF}$  definition.
- Note 6.** Operating using  $V_{IN}$  is limited to AC-coupled PECL or CML applications only. Connect directly to  $V_T$  pin.

## (100KEP) LVPECL DC ELECTRICAL CHARACTERISTICS<sup>(Notes 1, 2)</sup>

$V_{CC} = 3.3V \pm 10\%$  or  $2.5V \pm 5\%$ ;  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ ,  $R_L = 50\Omega$  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	1.60	2.10	V

- Note 1.** The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
- Note 2.** Specification for packaged product only.

**LVTTTL/CMOS DC ELECTRICAL CHARACTERISTICS**(Notes 1, 2)

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

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{IH}$	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 1.** The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

**Note 2.** Specification for packaged product only.

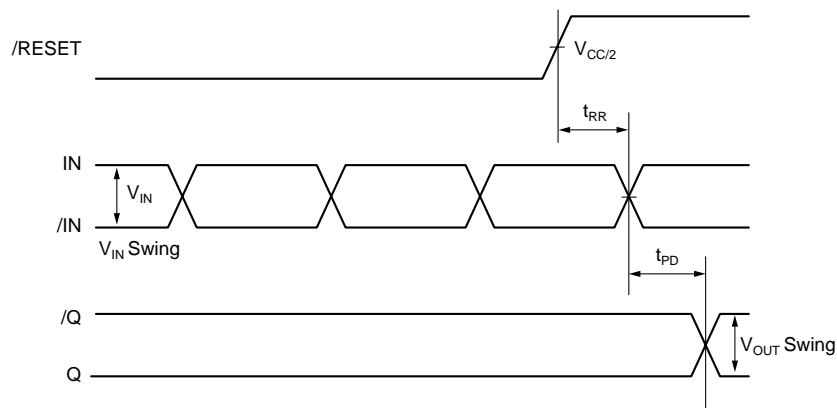
**AC ELECTRICAL CHARACTERISTICS(Notes 1, 2)**

$V_{CC} = 3.3V \pm 10\%$  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	Divide by 2, 4, 8, 16	3.2			GHz
$t_{PD}$	Differential Propagation Delay IN to Q	Input Swing $< 400mV$	540	650	790	ps
		Input Swing $\geq 400mV$	480	600	730	ps
$t_{SKEW}$	Within-Device Skew (diff.) Q0-Q1	<b>Note 3</b>		7	15	ps
	Part-to-Part Skew (diff.)	<b>Note 3</b>			250	ps
$t_{RR}$	Reset Recovery Time	<b>Note 4</b>	600			ps
$T_{jitter}$	Cycle-to-Cycle Jitter	<b>Note 5</b>			1	ps <sub>RMS</sub>
	Total Jitter	<b>Note 6</b>			10	ps <sub>PP</sub>
$t_r, t_f$	Rise/Fall Time (20% to 80%)		70	150	250	ps

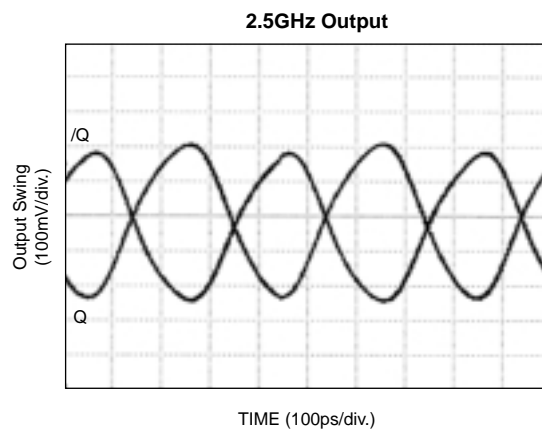
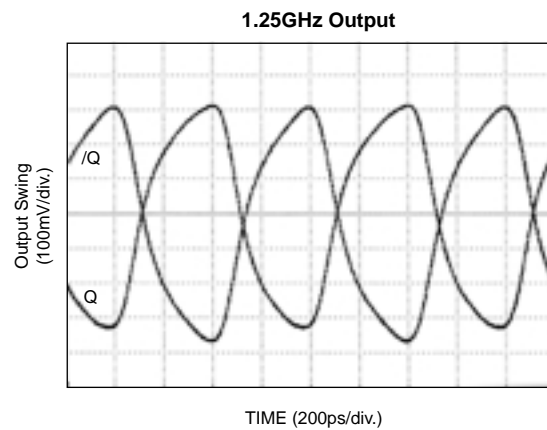
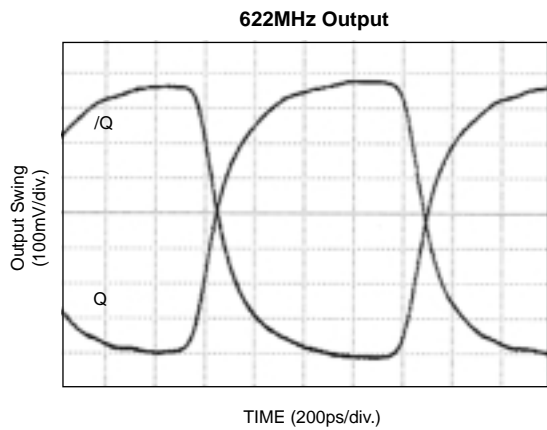
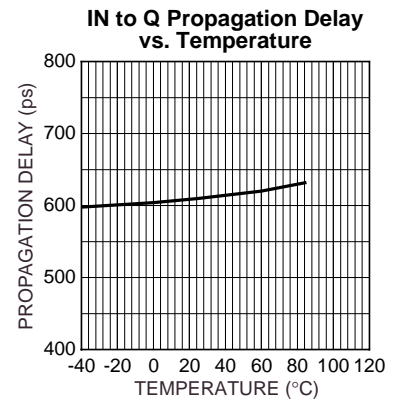
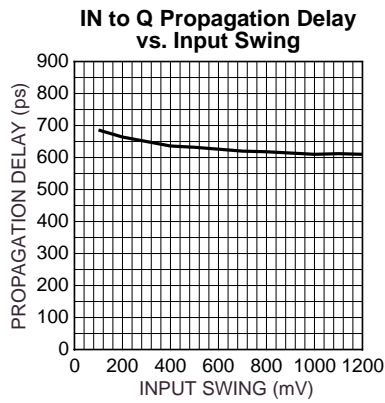
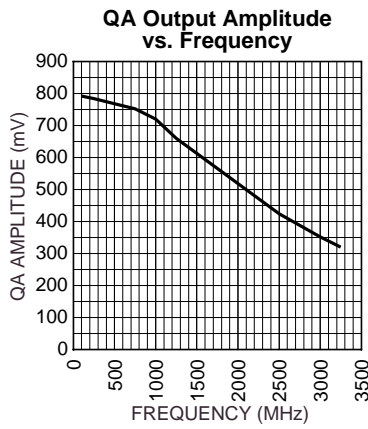
- Note 1.** Measured with 400mV input signal, 50% duty cycle, all outputs loaded with 50Ω to  $V_{CC}-2V$ , unless otherwise stated.
- Note 2.** Specification for packaged product only.
- Note 3.** Skew is measured between outputs under identical transitions.
- Note 4.** See "Timing Diagram."
- Note 5.** 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.
- Note 6.** Total jitter definition: with an ideal clock input, of frequency  $\leq f_{MAX}$  (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**

$V_{CC} = 3.3V$ ,  $V_{IN} = 400mV$ ,  $T_A = 25^{\circ}C$ , unless otherwise stated.



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

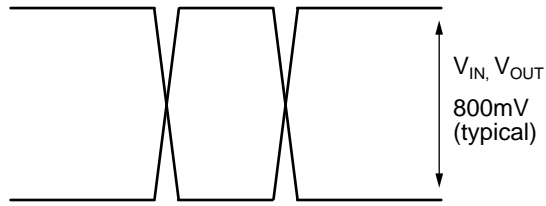


Figure 1a. Single-Ended Swing

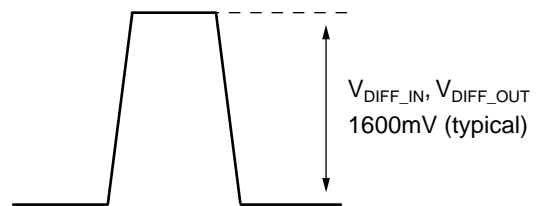


Figure 1b. Differential Swing

**INPUT BUFFER STRUCTURE**

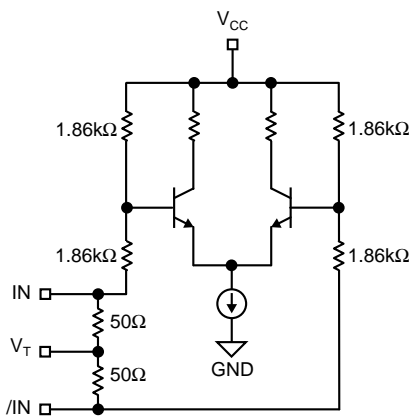


Figure 2a. Simplified Differential Input Buffer

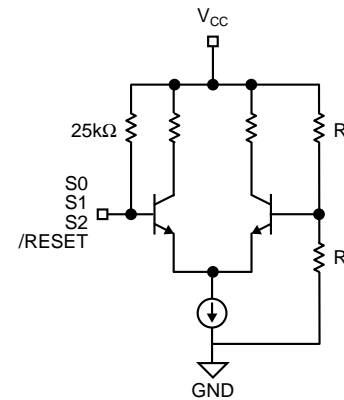
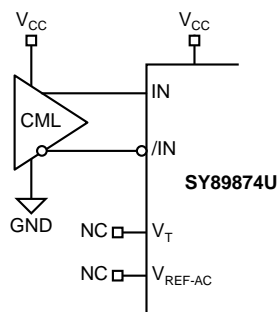
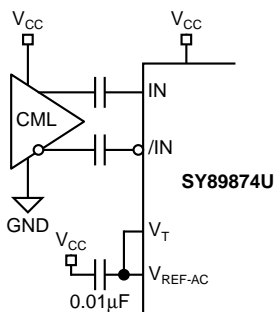


Figure 2b. Simplified TTL/CMOS Input Buffer

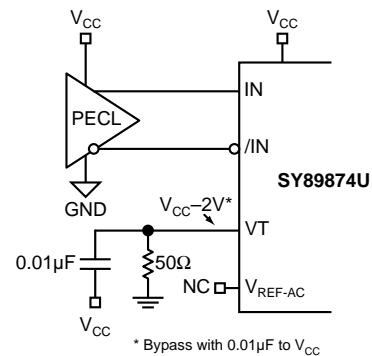
**INPUT INTERFACE APPLICATIONS**



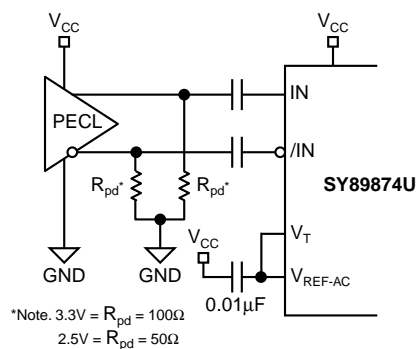
**Figure 3a. DC-Coupled CML Input Interface**



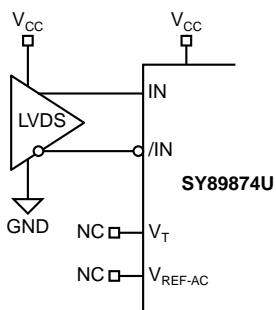
**Figure 3b. AC-Coupled CML Input Interface**



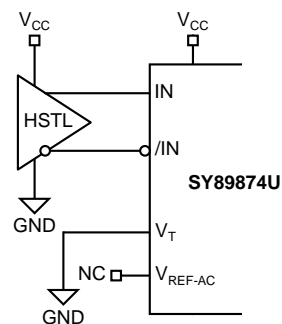
**Figure 3c. DC-Coupled PECL Input Interface**



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



**Figure 3e. LVDS Input Interface**



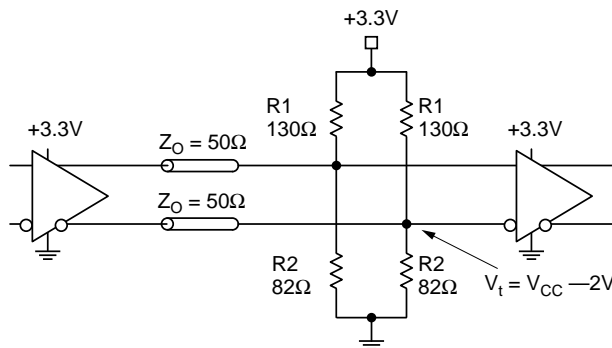
**Figure 3f. HSTL Input Interface**

**RELATED PRODUCT AND SUPPORT DOCUMENTATION**

Part Number	Function	Data Sheet Link
SY89871U	2.5GHz Any Diff. In-to-LVPECL Programmable Clock Divider/Fanout Buffer w/Internal Termination	<a href="http://www.micrel.com/product-info/products/sy89871u.shtml">http://www.micrel.com/product-info/products/sy89871u.shtml</a>
	MLF® Application Note	<a href="http://www.amkor.com/products/notes_papers/mlf_appnote_0902.pdf">http://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">http://www.micrel.com/product-info/products/solutions.shtml</a>

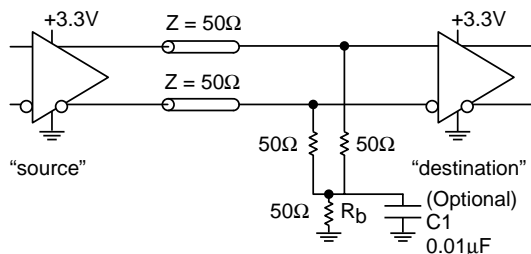


**LVPECL OUTPUT TERMINATION RECOMMENDATIONS**



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

**Note 1.** For +2.5V systems: R1 = 250Ω, R2 = 62.5Ω



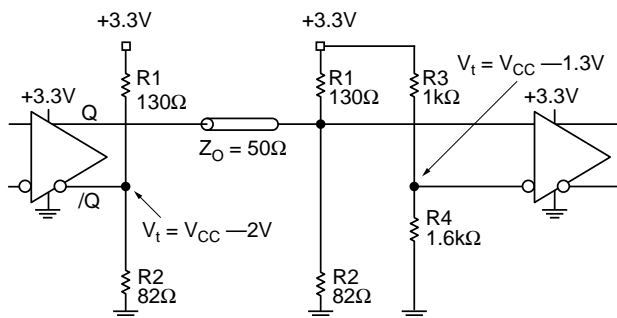
**Figure 4b. Three-Resistor ‘Y-Termination’**

**Note 1.** Power-saving alternative to Thevenin termination.

**Note 2.** Place termination resistors as close to destination inputs as possible.

**Note 3.** R<sub>b</sub> resistor sets the DC bias voltage, equal to V<sub>t</sub>. For +3.3V systems R<sub>b</sub> = 46Ω to 50Ω. For +2.5V systems R<sub>b</sub> = 39Ω

**Note 4.** C1 is an optional bypass capacitor intended to compensate for any t<sub>r</sub>/t<sub>f</sub> mismatches.

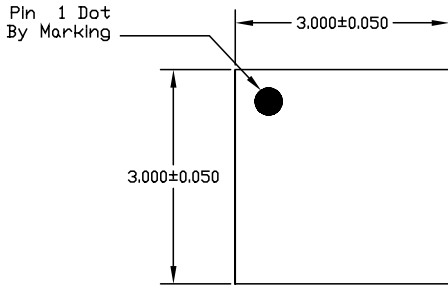


**Figure 4d. Terminating Unused I/O**

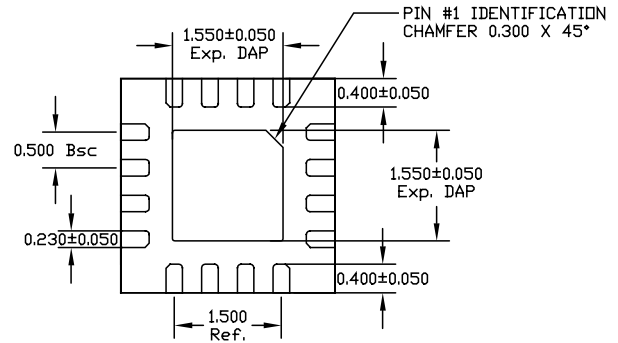
**Note 1.** Unused output (/Q) must be terminated to balance the output.

**Note 2.** For +2.5V systems: R1 = 250Ω, R2 = 62.5Ω, R3 = 1.25kΩ, R4 = 1.2kΩ.

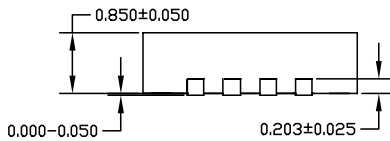
**16-PIN MicroLeadFrame® (MLF-16)**



TOP VIEW



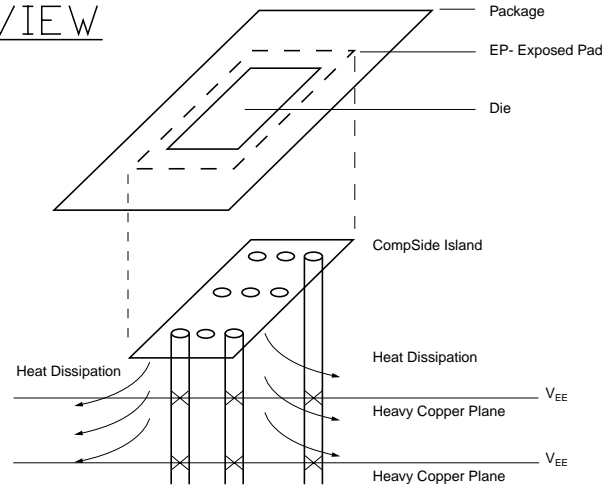
BOTTOM VIEW



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:**

- Note 1.** Package meets Level 2 moisture sensitivity classification, and is shipped in dry-pack form.
- Note 2.** Exposed pads must be soldered to a ground for proper thermal management.

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