

## FEATURES

- Accepts any differential input signal and provides four LVDS output copies
- Guaranteed AC performance over temperature and voltage:
  - > 2.0GHz  $f_{MAX}$
  - < 20ps within-device skew
  - < 190ps rise/fall times
- Low jitter design
  - < 1ps(rms) cycle-to-cycle jitter
  - < 10ps(pk-pk) total jitter
- 3.3V power supply operation
- TTL/CMOS input for enable
- Unique input termination and  $V_T$  pin accepts DC-coupled and AC-coupled inputs (CML, PECL, LVDS, and HSTL)
- High-speed LVDS outputs
- Wide operating temperature range:  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- Available in 16-pin (3mm × 3mm) MLF™ package



Precision Edge™

## DESCRIPTION

The SY89833L is a 3.3V, high-speed 2GHz differential Low Voltage Differential Swing (LVDS) 1:4 fanout buffer optimized for ultra-low skew applications. Within device skew is guaranteed to be less than 20ps over supply voltage and temperature.

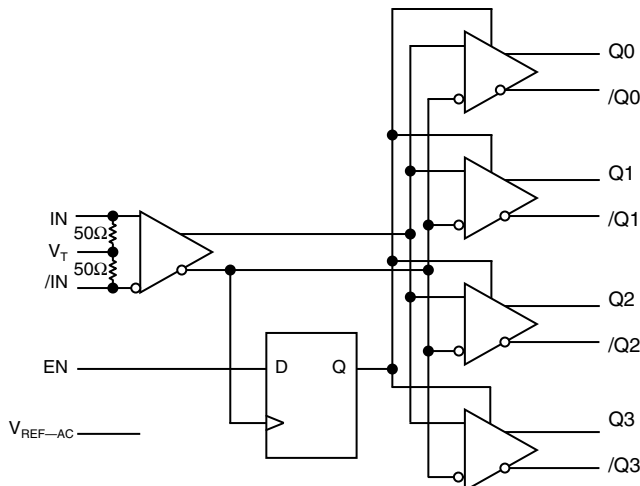
The differential input buffer has a unique internal termination design that allows access to the termination network through a  $V_T$  pin. This feature allows the device to easily interface to different logic standards. A  $V_{REF\_AC}$  reference is included for AC-coupled applications.

The SY89833L is part of Micrel's high-speed clock synchronization family. For 2.5V applications, the SY89832U provides similar functionality while operating from a 2.5V  $\pm 5\%$  supply. For applications that require a different I/O combination, consult the Micrel website at [www.micrel.com](http://www.micrel.com), and choose from a comprehensive product line of high-speed, low-skew fanout buffers, translators and clock generators.

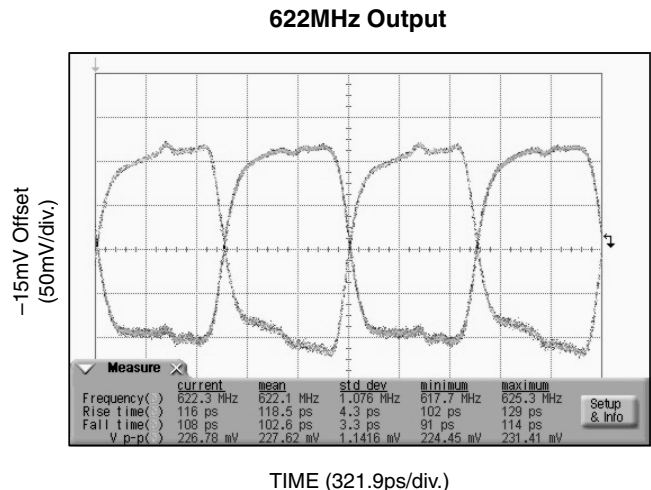
## APPLICATIONS

- Processor clock distribution
- SONET clock distribution
- Fibre Channel clock distribution
- Gigabit Ethernet clock distribution

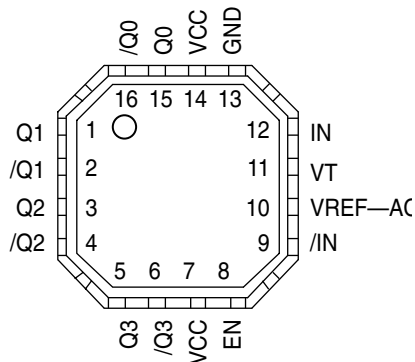
## FUNCTIONAL BLOCK DIAGRAM



## TYPICAL PERFORMANCE



**PACKAGE/ORDERING INFORMATION**



16-Pin MLF™

**Ordering Information**

Part Number	Package Type	Operating Range	Package Marking
SY89833LMI	MLF-16	Industrial	833L
SY89833LMITR*	MLF-16	Industrial	833L

\*Tape and Reel

**PIN DESCRIPTION**

Pin Number	Pin Name	Pin Function
15, 16, 1, 2, 3, 4, 5, 6	(Q0, /Q0) to (Q3, /Q3)	LVDS Differential (Outputs): Normally terminated with 100Ω across the pair (Q, /Q). See “LVDS Outputs” section, Figure 2a. Unused outputs should be terminated with a 100Ω resistor across each pair.
8	EN	TTL/CMOS Compatible Synchronous Enable: When EN goes LOW, Q outputs will go LOW and /Q outputs will go HIGH on the next LOW transition at IN inputs. Input threshold is $V_{CC}/2V$ . A 25kΩ pull-up resistor is included. The default state is HIGH when left floating. The internal latch is clocked on the falling edge of the input signal (IN, /IN).
9, 12	/IN, IN	Differential Clock (Inputs): Internal 50Ω termination resistors to the $V_T$ pin. See “Input Interface Applications” section.
10	VREF-AC	Reference Voltages: Equals to $V_{CC}-1.4V$ , and is used for AC-coupled applications. The maximum sink/source current is 0.5mA. See “Input Interface Applications.” When using $V_{REF-AC}$ , bypass with a 0.01μF capacitor to $V_{CC}$ .
11	VT	Termination Center-Tap. For CML or LVDS inputs, leave this pin floating. See Figures 3a to 3f. See “LVDS Outputs” Figures 2a and 2b for LVDS differential and common mode measurements.
13, Exposed Pad	GND	Ground. Exposed pad internally connected to GND and must be connected to a ground plane for proper thermal operation.
7, 14	VCC	Positive Power Supply: Bypass with 0.1μF//0.01μF low ESR capacitors.

**TRUTH TABLE**

IN	/IN	EN	Q	/Q
0	1	1	0	1
1	0	1	1	0
X	X	0	0 <sup>(1)</sup>	1 <sup>(1)</sup>

**Note 1.** On next negative transition of the input signal (IN).

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

Supply Voltage ( $V_{CC}$ )	-0.5V to +4.0V
Input Voltage ( $V_{IN}$ )	-0.5V to $V_{CC}+0.3V$
Output Current ( $I_{OUT}$ )	$\pm 10mA$
Input Current ( $I_N, /IN$ )	$\pm 50mA$
$V_T$ Current ( $I_{VT}$ )	$\pm 100mA$
Input Sink/Source Current ( $V_{REF-AC}$ ), <b>Note 3</b>	$\pm 2mA$
Lead Temperature (Soldering, 10 sec.)	220°C
Storage Temperature ( $T_S$ )	-65°C to +150°C

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

Supply Voltage Range	+2.97V to +3.63V
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>	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>(Note 1, 2)</sup>

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

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{CC}$	Power Supply Voltage Range		2.97	3.3	3.63	V
$I_{CC}$	Power Supply Current	No Load		75	100	mA
$R_{IN}$	Differential Input Resistance ( $I_N, /IN$ )		80	100	120	$\Omega$
$V_{IH}$	Input HIGH Voltage ( $I_N, /IN$ )	<b>Note 3</b>	0.1		$V_{CC}+0.3$	V
$V_{IL}$	Input LOW Voltage ( $I_N, /IN$ )	<b>Note 3</b>	-0.3		$V_{CC}+0.2$	V
$V_{IN}$	Input Voltage Swing	<b>Note 3</b> , see Figure 2c $V_{IN}(\text{max}), V_T = \text{floating}$ .	0.1		3.6	V
$V_{DIFF\_IN}$	Differential Input Voltage	<b>Note 3</b> , see Figure 2d	0.2			V
$ I_{IN} $	Input Current ( $I_N, /IN$ )	<b>Note 3</b>			45	mA
$V_{REF-AC}$	Reference Voltage	<b>Note 3</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 "Differential Input") the input current depends on the applied voltages at  $I_N, /IN$  and  $V_T$  inputs. Do not apply a combination of voltages that causes the input current to exceed the maximum limit.

**LVDS OUTPUTS DC ELECTRICAL CHARACTERISTICS**(Note 1, 2) $V_{CC} = 3.3V \pm 10\%$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ 

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{OH}$	Output HIGH Voltage	Note 3			1.475	V
$V_{OL}$	Output LOW Voltage	Note 3	0.925			V
$V_{OCM}$	Output Common Mode Voltage		1.125		1.275	V
$\Delta V_{OCM}$	Change in Common Mode Voltage		-50		50	mV
$V_{OUT}$	Single-Ended Output	see Figures 2c-2d	250	350	450	mV
$V_{DIFF\_OUT}$	Differential Output	see Figures 2c-2d	500	700	900	mV

**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.** Measured as per Figure 2a,  $100\Omega$  across Q and /Q outputs.**LVTTTL/CMOS INPUTS DC ELECTRICAL CHARACTERISTICS**(Note 1, 2) $V_{CC} = 3.3V \pm 10\%$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ 

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{IH}$	Input HIGH Voltage		2.0		$V_{CC}$	V
$V_{IL}$	Input LOW Voltage		0		0.8	V
$I_{IH}$	Input HIGH Current		-125		20	$\mu\text{A}$
$I_{IL}$	Input LOW Current				-300	$\mu\text{A}$

**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.

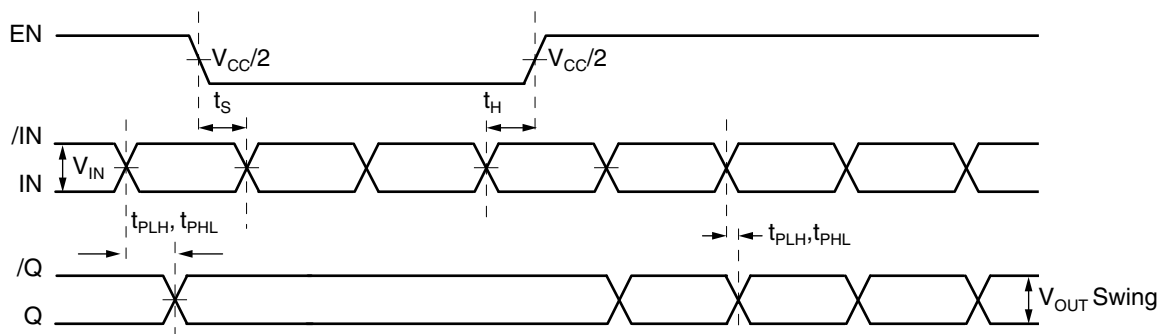
**AC ELECTRICAL CHARACTERISTICS**(Note 1, 2)

$V_{CC} = 3.3V \pm 10\%$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$

Symbol	Parameter	Condition	Min	Typ	Max	Units
$f_{MAX}$	Maximum Frequency	$\geq 200mV_{pp}$ Output Swing	2.0			GHz
$t_{PLH}$	Differential Propagation (Delay) (IN-to-Q)	Input Swing: $< 400mV$	400	500	600	ps
$t_{PHL}$		Input Swing: $\geq 400V$	330	440	530	ps
$t_{SKEW}$	Within-Device Skew (Differential)	<b>Note 3</b>		5	20	ps
	Part-to-Part Skew (Differential)				200	ps
$t_S$	Set-Up Time (EN to IN, /IN)	<b>Note 4 and Note 5</b>	300			ps
$t_H$	Hold Time (EN to IN, /IN)	<b>Note 4 and Note 5</b>	500			ps
$t_{JITTER}$	Cycle-to-Cycle Jitter (rms)	<b>Note 6</b>			1	ps(rms)
	Total Jitter	<b>Note 7</b>			10	ps(pk-pk)
$t_r, t_f$	Output Rise/Fall Times (20% to 80%)		60	110	190	ps

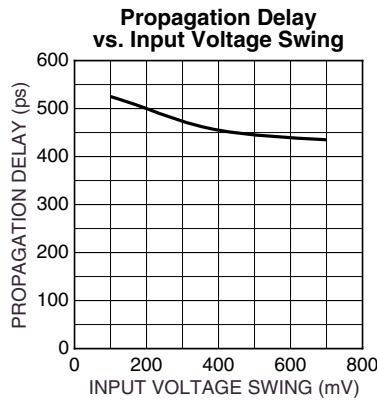
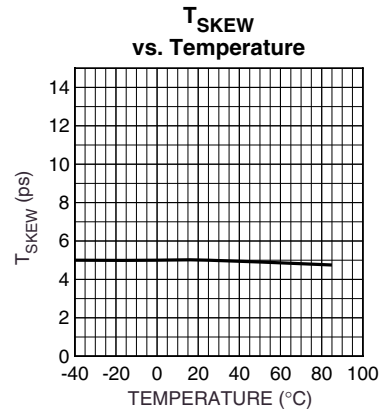
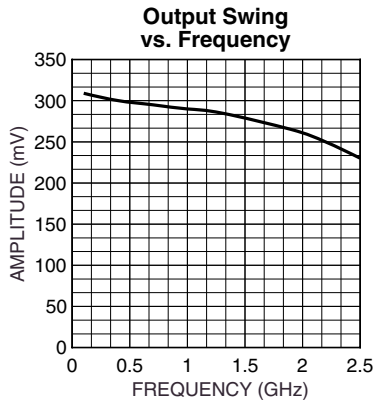
- Note 1.** Measured with 400mV input signal, 50% duty cycle, all outputs are loaded with 100Ω between Q and /Q. Output swing is  $\geq 200mV$ .
- Note 2.** Specification for packaged product only.
- Note 3.** Skew is measured between outputs under identical transitions.
- Note 4.** Set-up and hold times apply to synchronous applications that intend to enable/disable before the next clock cycle. For asynchronous applications set-up and hold times do not apply.
- Note 5.** See "Timing Diagram."
- Note 6.** Cycle-to-cycle jitter definition: The variation 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 7.** Total jitter definition: with an ideal clock input frequency of  $\leq f_{MAX}$  (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**

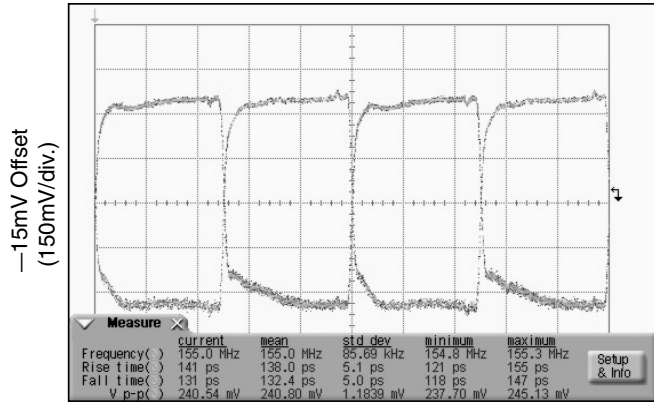
$V_{CC} = 3.3V$ ,  $V_{IN} = 400mV$ ,  $T_A = 25^\circ C$ , unless otherwise stated.



**FUNCTIONAL CHARACTERISTICS**

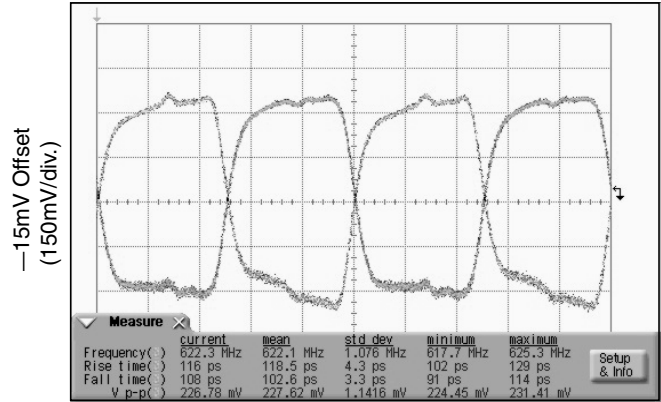
V<sub>CC</sub> = 3.3V, V<sub>IN</sub> = 400mV, T<sub>A</sub> = 25°C, unless otherwise stated.

**155MHz Output**



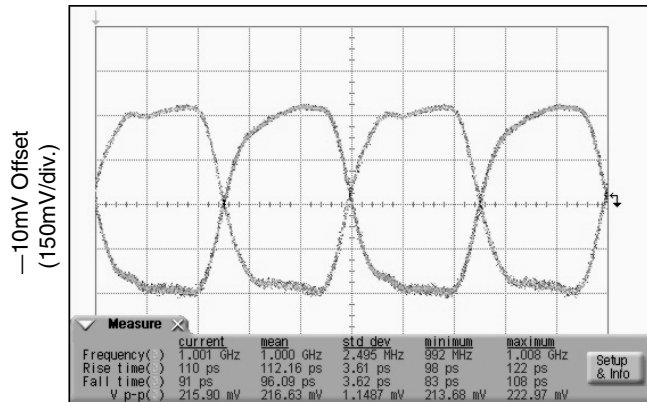
TIME (1.29ns/div.)

**622MHz Output**



TIME (321.9ps/div.)

**1GHz Output**



TIME (200ps/div.)

**INPUT STAGE**

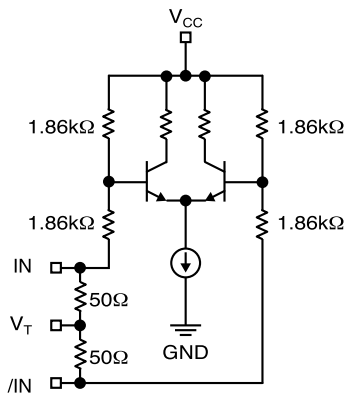


Figure 1a. Simplified Differential Input Buffer

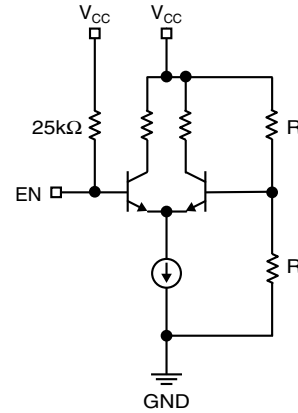


Figure 1b. Simplified TTL/CMOS Input Buffer

**LVDS OUTPUTS**

LVDS specifies a small swing of 350mV typical, on a nominal 1.25V common mode above ground. The common

mode voltage has tight limits to permit large variations in ground noise between an LVDS driver and receiver.

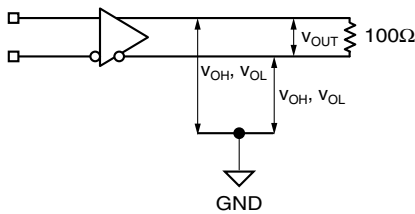


Figure 2a. LVDS Differential Measurement

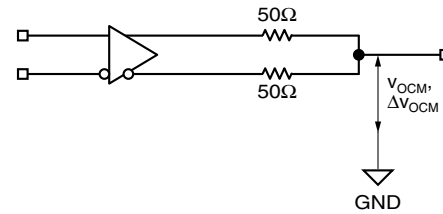


Figure 2b. LVDS Common Mode Measurement

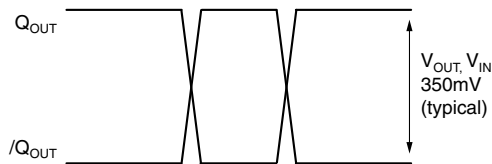


Figure 2c. Single-Ended Swing

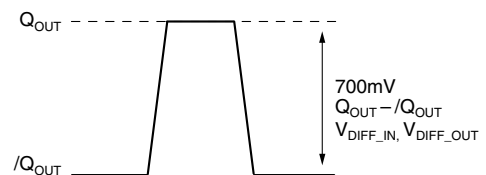
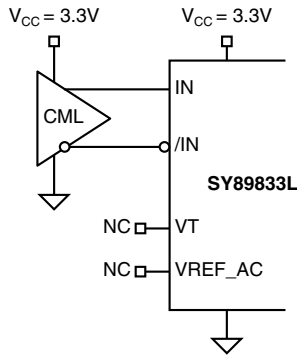
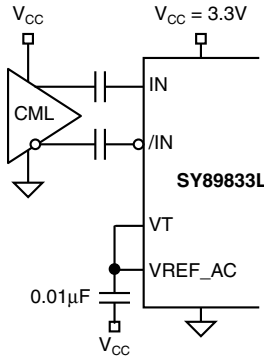


Figure 2d. Differential Swing

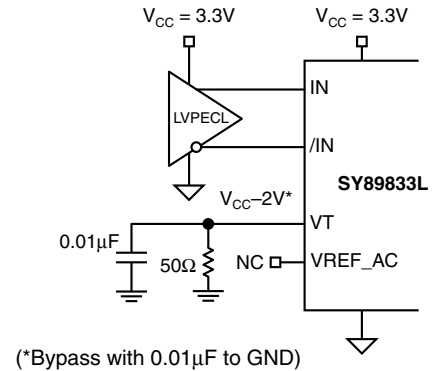
**INPUT INTERFACE APPLICATIONS**



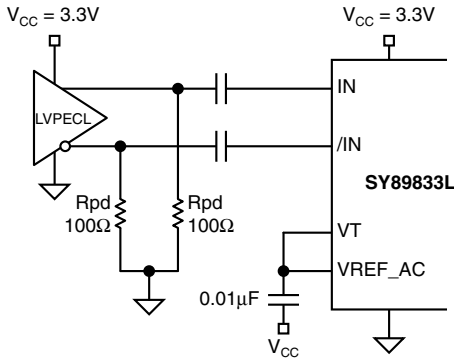
**Figure 3a. DC-Coupled CML Input Interface**



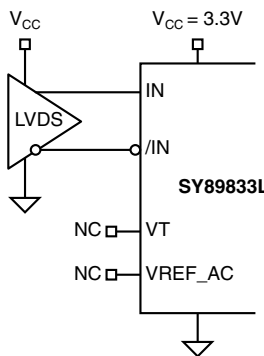
**Figure 3b. AC-Coupled CML Input Interface**



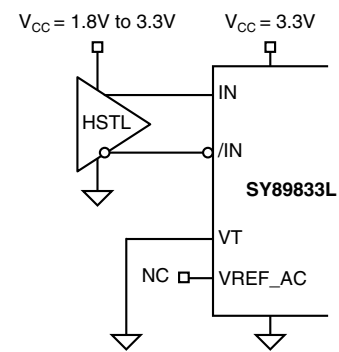
**Figure 3c. DC-Coupled PECL Input Interface**  
(\*Bypass with 0.01µF to GND)



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



**Figure 3e. LVDS Input Interface**

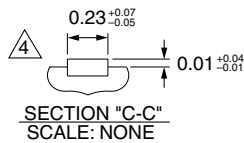
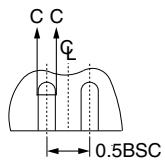
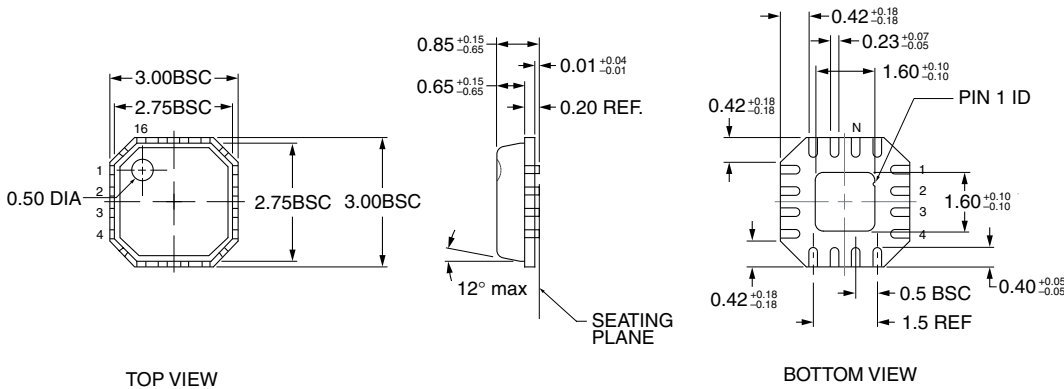


**Figure 3f. HSTL Input Interface**

**RELATED PRODUCT AND SUPPORT DOCUMENTS**

Part Number	Function	Data Sheet Link
SY89830U	2.5V/3.3V/5V 2.5GHz 1:4 PECL/ECL Clock Driver with 2:1 Differential Input Mux	<a href="http://www.micrel.com/product-info/products/sy89830u.shtml">http://www.micrel.com/product-info/products/sy89830u.shtml</a>
SY89831U	2GHz Ultra Low-Jitter and Skew 1:4 LVPECL Fanout Buffer/Translator w/ Internal Termination	<a href="http://www.micrel.com/product-info/products/sy89831u.shtml">http://www.micrel.com/product-info/products/sy89831u.shtml</a>
SY89832U	2GHz Ultra Low-Jitter and Skew 1:4 LVPECL Fanout Buffer/Translator w/ Internal Termination	<a href="http://www.micrel.com/product-info/products/sy89832u.shtml">http://www.micrel.com/product-info/products/sy89832u.shtml</a>
SY89833U	2GHz ANY DIFFERENTIAL INPUT-to-LVDS Out 1:4 Fanout Buffer Translator w/ Internal Termination	<a href="http://www.micrel.com/product-info/products/sy89833u.shtml">http://www.micrel.com/product-info/products/sy89833u.shtml</a>
	16-MLF™ Manufacturing Guidelines Exposed Pad Application Note	<a href="http://www.amkor.com/products/notes_papers/MLF_appnote_0301.pdf">http://www.amkor.com/products/notes_papers/MLF_appnote_0301.pdf</a>
HBW Solutions	New Products and Termination App. Note	<a href="http://www.micrel.com/product-info/as/solutions.shtml">http://www.micrel.com/product-info/as/solutions.shtml</a>

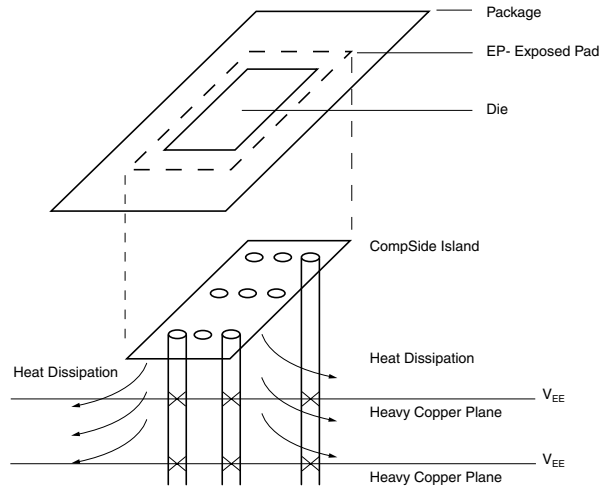
**16 LEAD EPAD MicroLeadFrame™ (MLF-16)**



1. DIMENSIONS ARE IN mm.
2. DIE THICKNESS ALLOWABLE IS 0.305mm MAX.
3. PACKAGE WARPAGE MAX 0.05mm.
4. THIS DIMENSION APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.20mm AND 0.25mm FROM TIP.
5. APPLIES ONLY FOR TERMINALS

FOR EVEN TERMINAL/SIDE

Rev. 02



**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 are shipped in dry-pack form.
- Note 2.** Exposed pads must be soldered to a ground for proper thermal management.

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