



# 2.5V, 2GHz ANY DIFF. IN-TO-LVDS PROGRAMMABLE CLOCK DIVIDER/FANOUT BUFFER WITH INTERNAL TERMINATION

Precision Edge®  
SY89872U

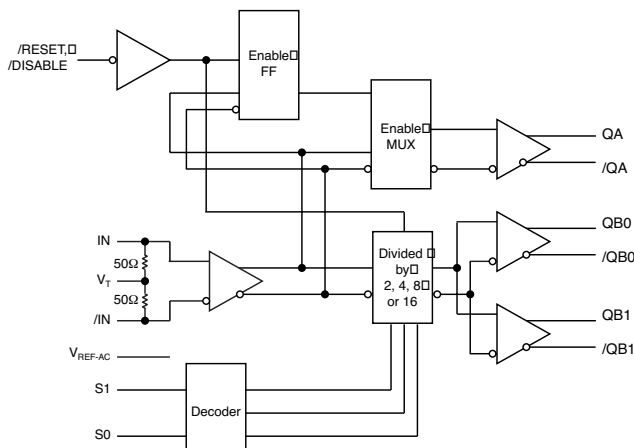
## FEATURES

- **Guaranteed AC performance over temperature and voltage:**
  - >2GHz  $f_{MAX}$
  - < 750ps  $t_{PD}$  (matched delay between banks)
  - < 15ps within-device skew
  - < 200ps rise/fall time
- **Low jitter design**
  - < 1ps<sub>RMS</sub> cycle-to-cycle jitter
  - < 10ps<sub>pp</sub> total jitter
- **Unique input termination and  $V_T$  pin for DC-coupled and AC-coupled inputs: any differential inputs (LVPECL, LVDS, CML, HSTL)**
- **Precision differential LVDS outputs**
- **Matched delay: all outputs have matched delay, independent of divider setting**
- **TTL/CMOS inputs for select and reset/disable**
- **Two output banks (matched delay)**
  - Bank A: Buffered copy of input clock (undivided)
  - Bank B: Divided output ( $\div 2$ ,  $\div 4$ ,  $\div 8$ ,  $\div 16$ ), two copies
- **2.5V power supply**
- **Wide operating temperature range:  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$**
- **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



Precision Edge®

## DESCRIPTION

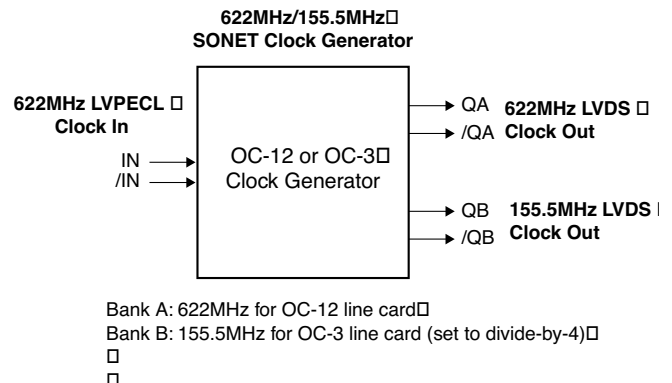
This 2.5V low-skew, low-jitter, precision LVDS output clock divider accepts any high-speed differential clock input (AC or DC-coupled) CML, LVPECL, HSTL or LVDS and divides down the frequency using a programmable divider ratio to create a frequency-locked, lower speed version of the input clock. The SY89872U includes two output banks. Bank A is an exact copy of the input clock (pass through) with matched propagation delay to Bank B, the divided output bank. 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  $V_T$  pin. This feature allows the device to easily interface to different logic standards. A  $V_{REF-AC}$  reference is included for AC-coupled applications.

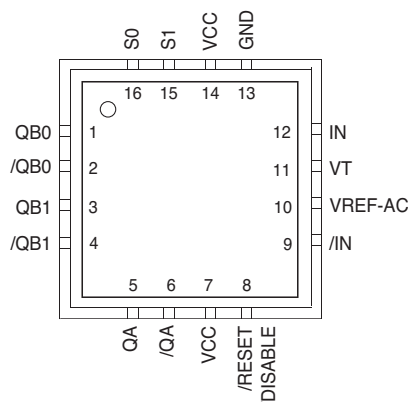
The SY89872U is part of Micrel's high-speed Precision Edge® timing and distribution family. For 3.3V applications, consider the SY89873L. For applications that require an LVPECL output, consider the SY89872U.

The /RESET input asynchronously resets the divider outputs (Bank B). In the pass-through function (Bank A) the /RESET synchronously enables or disables the outputs on the next falling edge of IN (rising edge of /IN). Refer to the "Timing Diagram."

## TYPICAL APPLICATION



## PACKAGE/ORDERING INFORMATION



16-Pin MLF® (MLF-16)

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

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY89872UMI	MLF-16	Industrial	872U	Sn-Pb
SY89872UMITR <sup>(2)</sup>	MLF-16	Industrial	872U	Sn-Pb
SY89872UMG <sup>(3)</sup>	MLF-16	Industrial	872U with Pb-Free bar line indicator	NiPdAu Pb-Free
SY89872UMGTR <sup>(2, 3)</sup>	MLF-16	Industrial	872U with Pb-Free bar line indicator	NiPdAu Pb-Free

## Notes:

1. Contact factory for die availability. Dice are guaranteed at  $T_A = 25^\circ\text{C}$ , 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 LVDS Compatible Outputs: Divide by 2, 4, 8, 16. Unused outputs must be terminated with $100\Omega$ across the pin (Q, /Q).
5, 6	QA, /QA	Differential LVDS Compatible Undivided Output Clock.
7, 14	VCC	Positive Power Supply: Bypass with $0.1\mu\text{F}/0.01\mu\text{F}$ low ESR capacitors.
8	/RESET, /DISABLE	Output Reset and Output Enable/Disable: Internal $25k\Omega$ pull-up. Input threshold is $V_{CC}/2$ . Logic LOW will reset the divider select, and align Bank A and Bank B edges. In addition, when LOW, Bank A and Bank B will be disabled.
12, 9	IN, /IN	Differential Reference Input Clock: Internal $50\Omega$ termination resistors to $V_T$ input. See "Input Interface Applications" section.
10	VREF-AC	Reference Voltage: Equal to $V_{CC}-1.4\text{V}$ (approx.), and used for AC-coupled applications. Maximum sink/source current is $0.5\text{mA}$ . See "Input Interface Applications" section.
11	VT	Termination Center-Tap: For DC-coupled CML and LVDS inputs, leave this pin floating. See "Input Interface Applications" section.
13	GND	Ground.
15, 16	S1, S0	Select Pins: LVTTL/CMOS logic levels. Internal $25k\Omega$ pull-up resistor. Logic HIGH if left unconnected (divided by 16 mode). S0 = LSB. Input threshold is $V_{CC}/2$ .

## TRUTH TABLE

/RESET /DISABLE	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	QA = Low, /QA = High <sup>(1)</sup>	QB0 = Low, /QB0 = High <sup>(2)</sup> QB1 = Low, /QB1 = High <sup>(2)</sup>

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

**Note 2.** Asynchronous reset/disable function. (See "Timing Diagram")

**Absolute Maximum Ratings**(Note 1)

Supply Voltage ( $V_{CC}$ )	–0.5V to +6.0V
Input Voltage ( $V_{IN}$ )	–0.5V to $V_{CC}$
LVDS Output Current ( $I_{OUT}$ )	±10mA
Input Current $I_N$ , $/I_N$ ( $I_{IN}$ )	±50mA
$V_{REF-AC}$ Input Sink/Source Current ( $I_{VREF-AC}$ ), <b>Note 3</b>	±2mA
Lead Temperature (soldering, 20sec.)	260°C
Storage Temperature ( $T_S$ )	–65°C to +150°C

**Operating Ratings**(Note 2)

Supply Voltage Range	2.375V to 2.625V
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**(Note 1, 2)

$T_A$  = –40°C to +85°C; Unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{CC}$	Power Supply Voltage		2.375	2.5	2.625	V
$I_{CC}$	Power Supply Current	No load, max. $V_{CC}$		75	110	mA
$R_{IN}$	Differential Input Resistance ( $I_N$ -to- $/I_N$ )		90	100	110	$\Omega$
$V_{IH}$	Input High Voltage $I_N$ , $/I_N$	Note 3	0.1		$V_{CC}+0.3$	V
$V_{IL}$	Input Low Voltage $I_N$ , $/I_N$	Note 3	–0.3		$V_{CC}+0.2$	V
$V_{IN}$	Input Voltage Swing	Notes 3, 4	0.1		3.6	V
$V_{DIFF\_IN}$	Differential Input Voltage Swing	Notes 3, 4, 5	0.2			V
$ I_{IN} $	Input Current $I_N$ , $/I_N$	Note 3			45	mA
$V_{REF-AC}$	Reference Voltage	Note 6	$V_{CC}-1.525$	$V_{CC}-1.425$	$V_{CC}-1.325$	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 Buffer Structure” section) the input current depends on the applied voltages at  $I_N$ ,  $/I_N$  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 Figures 1c and 1d 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.

**LVDS OUTPUTS DC ELECTRICAL CHARACTERISTICS**(Note 1, 2)

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

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{OUT}$	Output Voltage Swing	<b>Note 5</b>	250	350	450	mV
$V_{OH}$	Output High Voltage	<b>Note 3</b>			1.475	V
$V_{OL}$	Output Low Voltage	<b>Note 3</b>	0.925			V
$V_{OCM}$	Output Common Mode Voltage	<b>Note 4</b>	1.125		1.375	V
$\Delta V_{OCM}$	Change in Common Mode Voltage		-50		50	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 1a,  $100\Omega$  across Q and /Q outputs.

**Note 4.** Measured as per Figure 1b.

**Note 5.** See Figure 1c.

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

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

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{IH}$	Input HIGH Voltage		2.0	—	$V_{CC}$	V
$V_{IL}$	Input LOW Voltage		0	—	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**(Note 1, 2)

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

Symbol	Parameter	Condition	Min	Typ	Max	Units
$f_{MAX}$	Maximum Toggle Frequency	Output Swing: $\geq 200mV$	2			GHz
	Maximum Input Frequency	Note 3	3.2			GHz
$t_{PD}$	Differential Propagation Delay IN to Q	Input Swing: $< 400mV$	500	625	750	ps
		Input Swing: $\geq 400mV$	450	575	700	ps
$t_{SKEW}$	Within-Device Skew (differential) (QB0-to-QB1)	Note 4		7	15	ps
	Within-Device Skew (differential) (Bank A-to-Bank B)	Note 4		12	30	ps
	Part-to-Part Skew (differential)	Note 4			250	ps
$t_{rr}$	Reset Recovery Time	Note 5	600			ps
$T_{jitter}$	Cycle-to-Cycle Jitter	Note 6			1	ps <sub>RMS</sub>
	Total Jitter	Note 7			10	ps <sub>pp</sub>
$t_r, t_f$	Rise / Fall Time (20% to 80%)		70	130	200	ps

**Note 1.** Measured with 400mV input signal, 50% duty cycle. 100 $\Omega$  termination between Q and /Q, unless otherwise stated.

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

**Note 3.** 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.

**Note 4.** Skew is measured between outputs under identical transitions.

**Note 5.** See "Timing Diagram."

**Note 6.** 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 7.** 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.

## LVDS OUTPUT

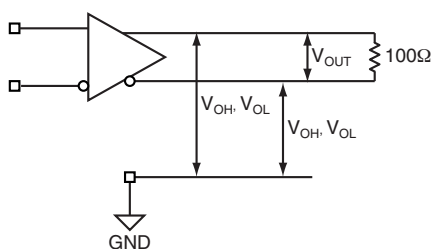


Figure 1a. LVDS Differential Measurement

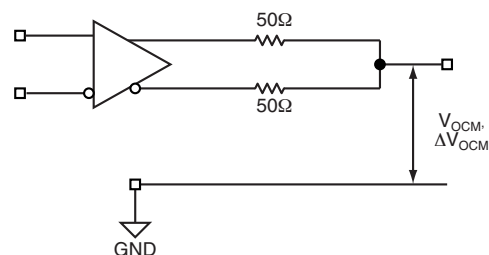


Figure 1b. LVDS Common Mode Measurement

## DEFINITION OF SINGLE-ENDED AND DIFFERENTIAL SWING

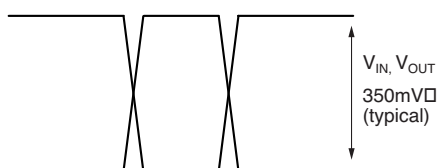


Figure 1c. Single-Ended Swing

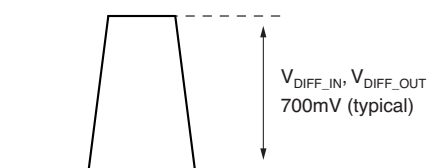
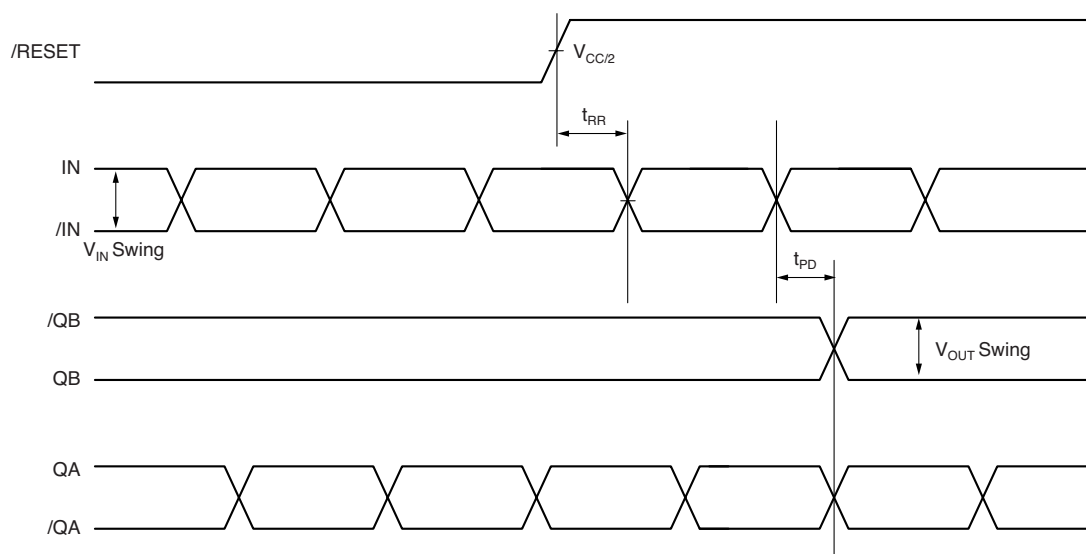


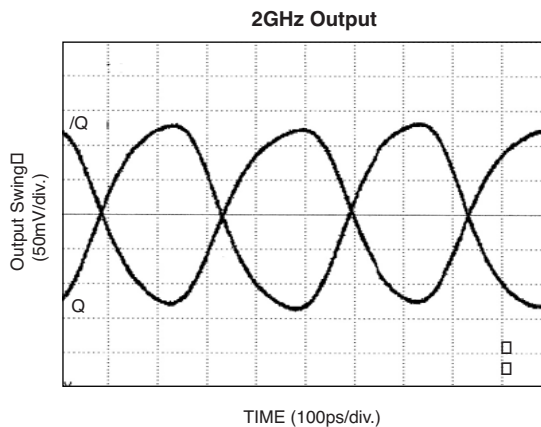
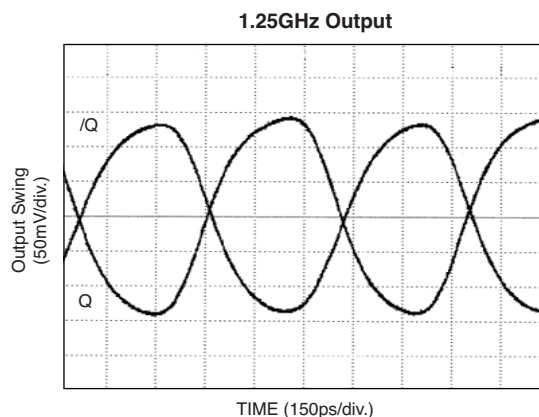
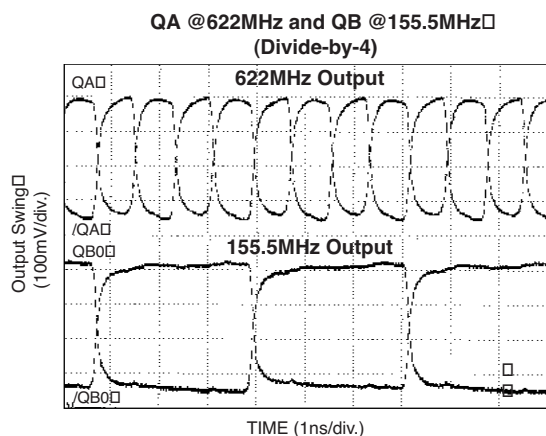
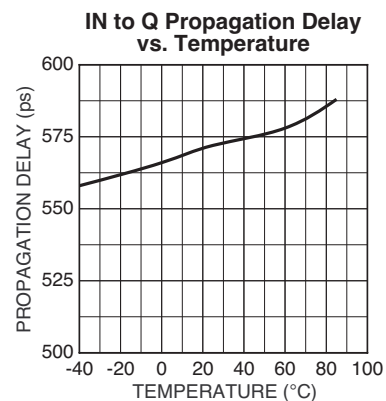
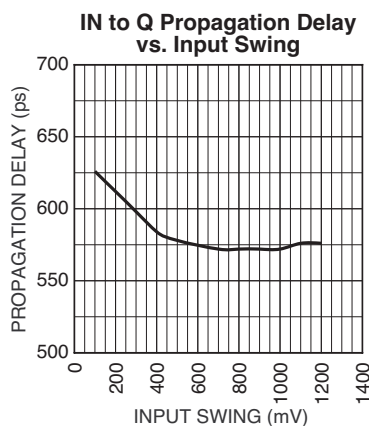
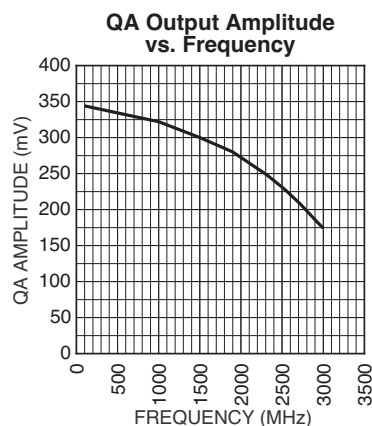
Figure 1d. Differential Swing

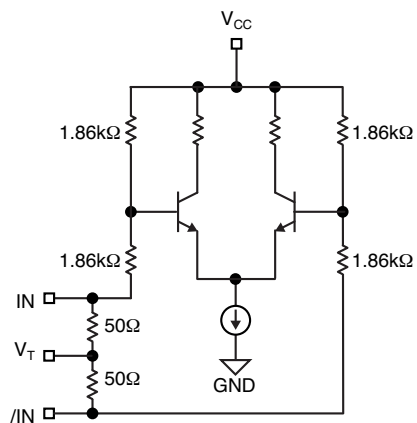
## TIMING DIAGRAM



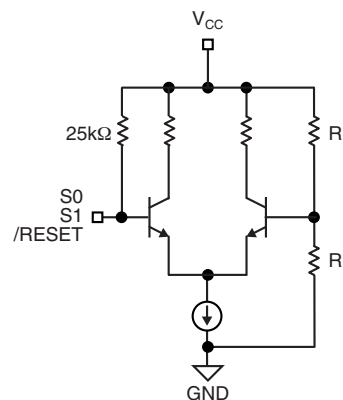
## TYPICAL OPERATING CHARACTERISTICS

$V_{CC} = 2.5V$ ,  $V_{IN} = 400mV$ ,  $T_A = 25^\circ C$ , unless otherwise stated.



**INPUT BUFFER STRUCTURE**

**Figure 2a. Simplified Differential Input Buffer**



**Figure 2b. Simplified TTL/CMOS Input Buffer**



## INPUT INTERFACE APPLICATIONS

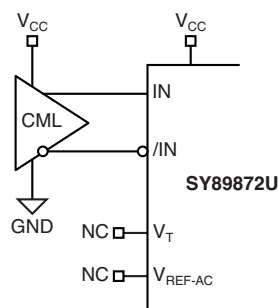


Figure 3a. DC-Coupled CML Input Interface

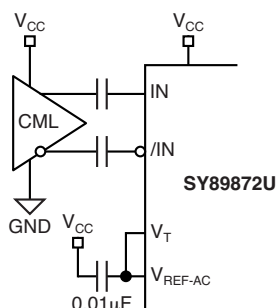


Figure 3b. AC-Coupled CML Input Interface

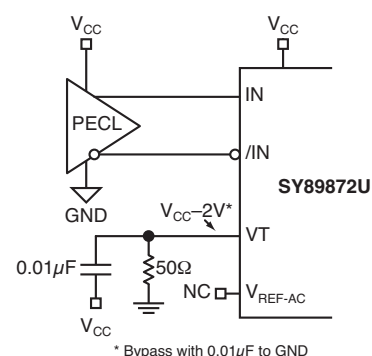


Figure 3c. DC-Coupled PECL Input Interface

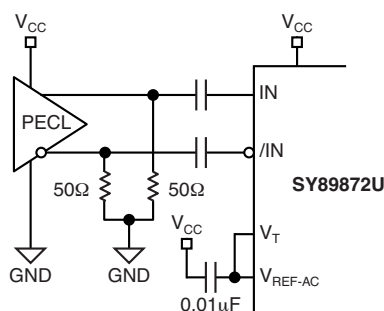


Figure 3d. AC-Coupled PECL Input Interface

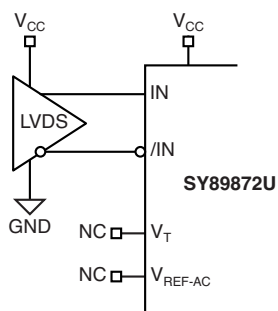


Figure 3e. LVDS Input Interface

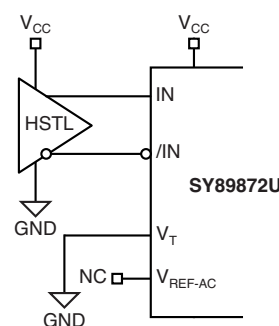
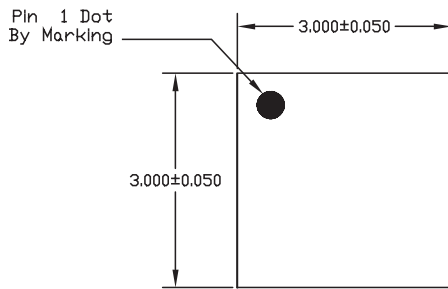


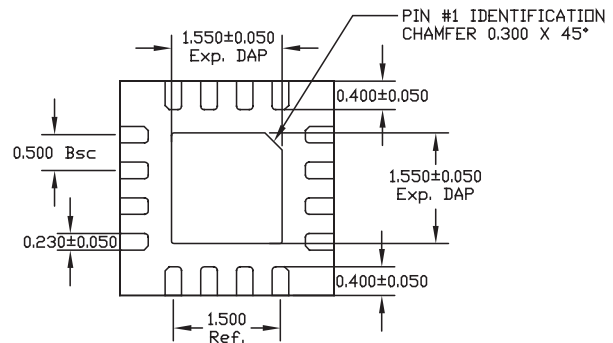
Figure 3f. HSTL Input Interface

## RELATED PRODUCT AND SUPPORT DOCUMENTATION

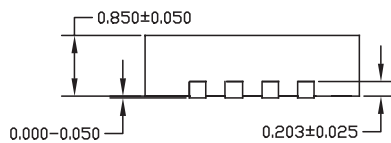
Part Number	Function	Data Sheet Link
SY89871U	2.5GHz Any Diff. In-to-LVPECL Programmable Clock Divider/Fanout Buffer w/Internal Termination	<a href="http://www.micrel.com/product-info/products/sy89871u.shtml">http://www.micrel.com/product-info/products/sy89871u.shtml</a>
SY89873L	3.3V, 2GHz Any Diff. In-to-LVDS Programmable Clock Divider/Fanout Buffer	<a href="http://www.micrel.com/product-info/products/sy89873l.shtml">http://www.micrel.com/product-info/products/sy89873l.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>

**16-PIN MicroLeadFrame® (MLF-16)**

TOP VIEW



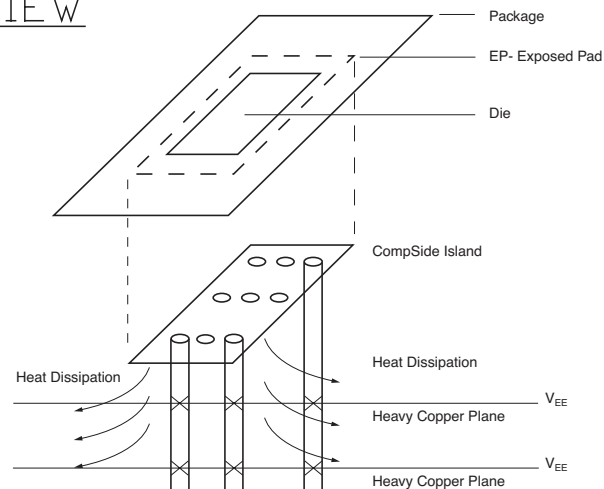
BOTTOM VIEW



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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