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## SY89831U

### Ultra-Precision 1:4 LVPECL Fanout Buffer/Translator with Internal Termination

Precision Edge®

## General Description

The SY89831U is a high-speed, 2GHz differential LVPECL 1:4 fanout buffer optimized for ultra-low skew applications. Within-device skew is guaranteed to be less than 20ps (5ps typ.) over supply voltage and temperature. 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 VREF-AC reference output is included for AC-coupled applications.

The SY89831U is a part of Micrel's high-speed clock synchronization family. For applications that require a different I/O combination, consult Micrel's 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.

Datasheets and support documentation are available on Micrel's web site at: [www.micrel.com](http://www.micrel.com).



Precision Edge®

## Features

- Guaranteed AC performance over temperature and voltage
  - DC-to 2.5GHz throughput (typical)
  - 350ps propagation delay (IN-to-Q) (typical)
  - 5ps within-device skew (typical)
  - 150ps rise/fall time (typical)
- Ultra-low jitter design
  - 62fs RMS phase jitter (typical)
- Unique patent-pending input termination and VT pin accepts DC- and AC-coupled differential inputs
- 800mV, 100K LVPECL typical output swing
- Power supply 2.5V ±5% or 3.3V ±10%
- Industrial temperature range: -40°C to +85°C
- Available in 16-pin (3mm x 3mm) MLF® package

## Applications

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

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January 17, 2014

Revision 7.0

[hbwhelp@micrel.com](mailto:hbwhelp@micrel.com) or (408) 955-1690

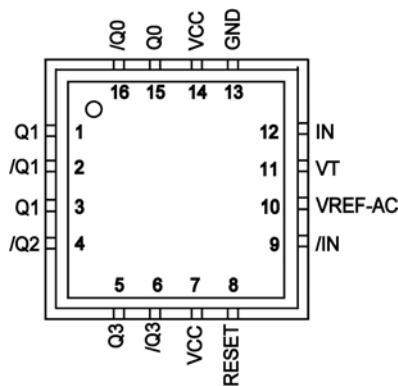
## Ordering Information<sup>(1)</sup>

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY89831UMG <sup>(2)</sup>	MLF-16	Industrial	831U with Pb-Free bar-line indicator	NiPdAu Pb-Free
SY89831UMGTR <sup>(2, 3)</sup>	MLF-16	Industrial	831U with Pb-Free bar-line indicator	NiPdAu Pb-Free

### Notes:

- Contact factory for die availability. Dice are guaranteed at  $T_A = 25^\circ\text{C}$ , DC electricals only.
- Pb-Free package is recommended for new designs.
- Tape and Reel.

## Pin Configuration



16-MLF (MLF-16)

## Pin Description

Pin #	Pin Name	Functional Description
15, 16 1, 2 3, 4 5, 6	Q0, /Q0 Q1, /Q1 Q2, /Q2 Q3, /Q3	Differential 100K LVPECL Outputs: These LVPECL outputs are the precision, low-skew copies of the inputs. Please refer to the <a href="#">"Truth Table"</a> section for details. Unused output pairs may be left open. Terminate with $50\Omega$ to $V_{CC} - 2V$ . See the <a href="#">"Output Termination Recommendations"</a> section for more details.
8	EN	This single-ended TTL/CMOS-compatible input functions as a synchronous output enable. The synchronous enable ensures that enable/disable only occurs when the outputs are in a logic low state. Note that this input is internally connected to a $25k\Omega$ pull-up resistor and will default to logic high state (enabled) if left open.
9, 12	/IN, IN	Differential Inputs: These input pairs are the differential signal inputs to the device. Inputs accept AC- or DC-coupled differential signs as small as $100\text{mV}$ . Each pin of a pair internally terminates to a VT pin through $50\Omega$ . Note that these inputs default to an intermediate state if left open. Please refer to the <a href="#">"Input Interface Applications"</a> section for more details.
10	VREF-AC	Reference Voltage: These outputs bias to $V_{CC} - 1.4V$ . They are used when AC coupling the inputs (IN, /IN). For AC-coupled applications, connect VREF-AC to the VT pin and bypass with a $0.01\mu\text{F}$ low-ESR capacitor to $V_{CC}$ . See the <a href="#">"Input Interface Applications"</a> section for more details. Maximum sink/source current is $\pm 1.5\text{mA}$ . Due to the limited drive capability, each VREF-AC pin should only drive its respective VT pin. If VREF-AC is used with a $2.5V$ supply, make sure the input swing is large enough to comply with the $V_{IH}$ min. spec.

Pin #	Pin Name	Functional Description
11	VT	Input Termination Center-Tap: Each side of the differential input pair terminates to a VT pin. The VT pins provide a center-tap to a termination network for maximum interface flexibility. See the “ <a href="#">Input Interface Applications</a> ” section for more details.
13	GND	Ground. GND pins and exposed pad must be connected to the most negative potential of the device ground.
7, 14	VCC	Positive Power Supply: Bypass with 0.1μF/0.01μF low-ESR capacitors placed as close as possible to each VCC pin.

## Truth Table

IN	/IN	EN	Q	/Q
0	1	1	0	1
1	0	1	1	0
X	X	0	0 <sup>(4)</sup>	1 <sup>(4)</sup>

**Note:**

4. On the next negative transition of the input signal (IN).



**Absolute Maximum Ratings<sup>(5)</sup>**

Supply Voltage ( $V_{CC}$ )	–0.5V to +4.0V
Input Voltage ( $V_{IN}$ )	–0.5V to $V_{CC} + 0.5V$
LVPECL Output Current ( $I_{OUT}$ )	
Continuous	50mA
Surge	100mA
Input Current	
Source or Sink Current on (IN, /IN)	±50mA
VREF-AC Current	
Source or Sink Current on ( $I_{VT}$ )	±2mA
Lead Temperature (soldering, 20s)	260°C
Storage Temperature ( $T_s$ )	–65°C to +150°C

**Operating Ratings<sup>(6)</sup>**

Supply Voltage Range	+2.375V to +2.625V
	+3.0V to +3.6V
Ambient Temperature ( $T_A$ )	–40°C to +85°C
Package Thermal Resistance <sup>(7)</sup>	
( $\theta_{JA}$ ) Still Air	60°C/W
( $\theta_{JA}$ ) Junction to Board	32°C/W

**DC Electrical Characteristics<sup>(8)</sup>**

$T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ , unless otherwise noted.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
$V_{CC}$	Power Supply		2.375 3.0		2.625 3.6	V
$I_{CC}$	Power Supply Current	No load, max. $V_{CC}$		47	70	mA
$R_{IN}$	Input Resistance (IN-to-VT)		45	50	55	$\Omega$
$R_{DIFF-IN}$	Differential Input Resistance (IN-to-/IN)		90	100	110	$\Omega$
$V_{IH}$	Input HIGH Voltage (IN, /IN)		1.2		$V_{CC}$	V
$V_{IL}$	Input LOW Voltage (IN, /IN)		0		$V_{IH} - 0.1$	V
$V_{IN}$	Input Voltage Swing (IN, /IN)	See Figure 1.	0.1		1.7	V
$V_{DIFF\_IN}$	Differential Input Voltage Swing $ IN - /IN $	See Figure 2.	0.2			V
$V_{REF-AC}$	Output Reference Voltage		$V_{CC} - 1.525$	$V_{CC} - 1.425$	$V_{CC} - 1.325$	V

**LVTTTL/LVCMOS Input DC Electrical Characteristics**

$V_{CC} = 2.375V$  to  $3.60V$ ;  $V_{EE} = 0V$ ;  $T_A = -40^\circ\text{C}$  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			$\mu\text{A}$

**Notes:**

- 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 datasheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
- The datasheet limits are not guaranteed if the device is operated beyond the operating ratings.
- Package thermal resistance assumes the exposed pad is soldered (or equivalent) to the device's most negative potential on the PCB.  $\Psi_{JB}$  and  $\theta_{JA}$  values are determined for a 4-layer board at the still-air package thermal resistance, unless otherwise stated.
- The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

## LVPECL Output DC Electrical Characteristics<sup>(8)</sup>

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

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
$V_{OH}$	Output HIGH Voltage (Q, /Q)		$V_{CC} - 1.145$		$V_{CC} - 0.895$	V
$V_{OL}$	Output LOW Voltage (Q, /Q)		$V_{CC} - 1.945$		$V_{CC} - 1.695$	V
$V_{OUT}$	Output Voltage Swing (Q, /Q)	See Figure 1.	550	800		mV
$V_{DIFF\_OUT}$	Differential Output Voltage Swing (Q, /Q)	See Figure 2.	1100	1600		mV

## LVTTL/LVCMOS DC Electrical Characteristics<sup>(8)</sup>

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

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		30	$\mu A$
$I_{IL}$	Input LOW Current		-300			$\mu A$

## AC Electrical Characteristics<sup>(9)</sup>

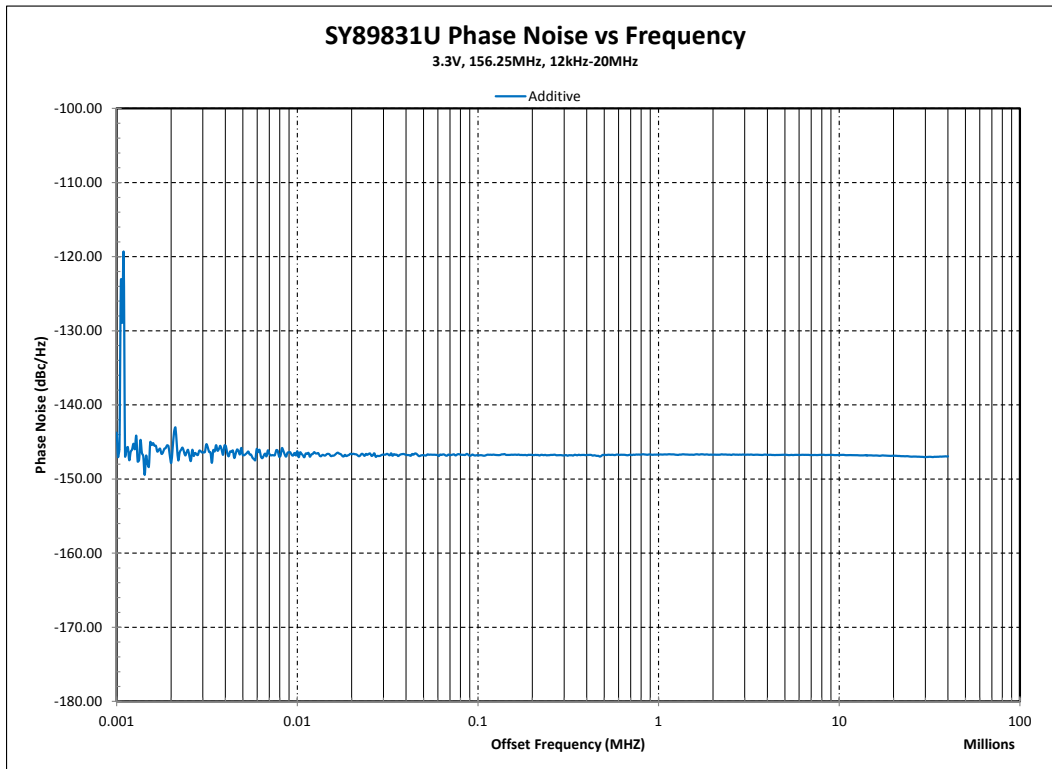
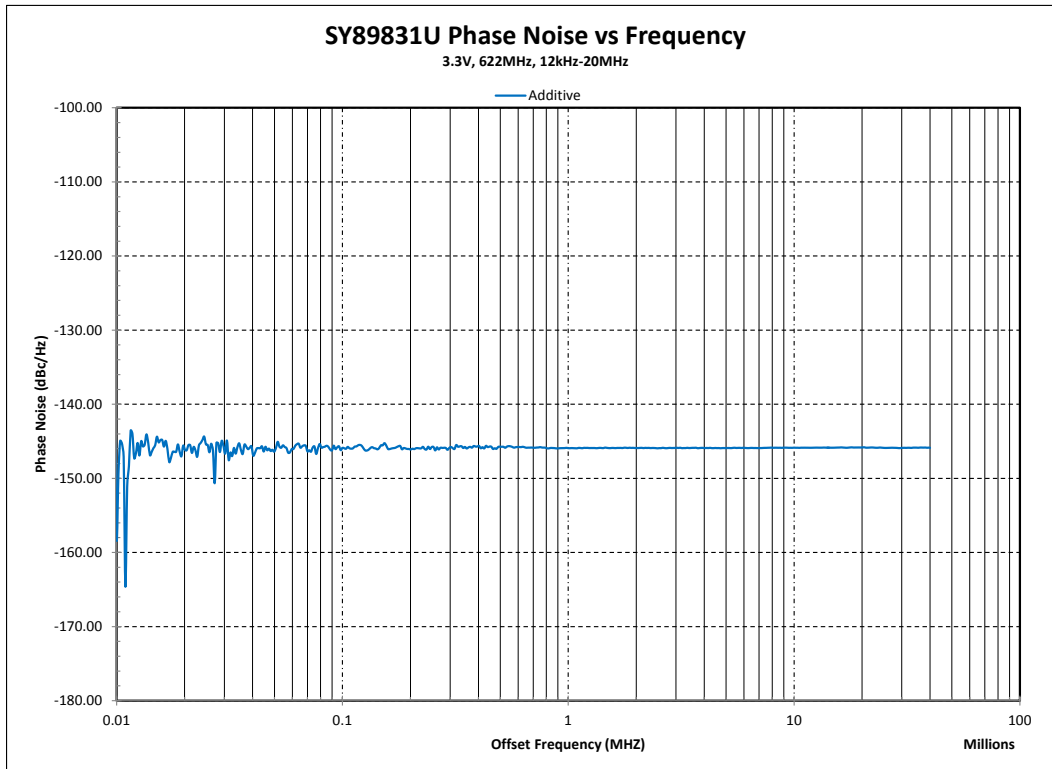
$V_{CC} = 2.5V \pm 5\%$  or  $3.3V \pm 10\%$ ;  $R_L = 50\Omega$  to  $V_{CC} - 2V$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ , unless otherwise noted.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
$f_{MAX}$	Maximum Frequency	$V_{OUT} \geq 450mV$	2.0	2.5		GHz
$t_{pd}$	Propagation Delay	IN-to-Q		390		ps
		IN-to-Q	$V_{IN} \geq 800mV$	250	350	450
$t_{SKEW}$	Within-Device Skew	Note 10		5	20	ps
	Part-to-Part Skew	Note 11			150	ps
$t_S$	Set-Up Time	EN to IN, /IN	Note 12	300		ps
$t_H$	Hold Time	EN to IN, /IN	Note 12	300		ps
$t_{JITTER}$	RMS Phase Jitter	Output = 622MHz Integration Range 12kHz–20MHz		62		fs
$t_r, t_f$	Output Rise/Fall Times (20% to 80%)	At full output swing	70	150	225	ps
	Duty Cycle	Freq. < 630MHz	48	50	52	%

### Notes:

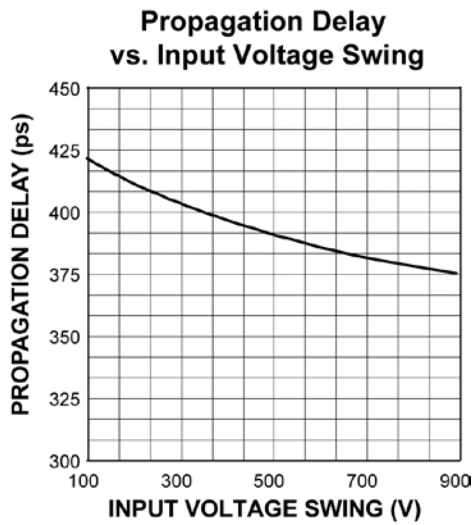
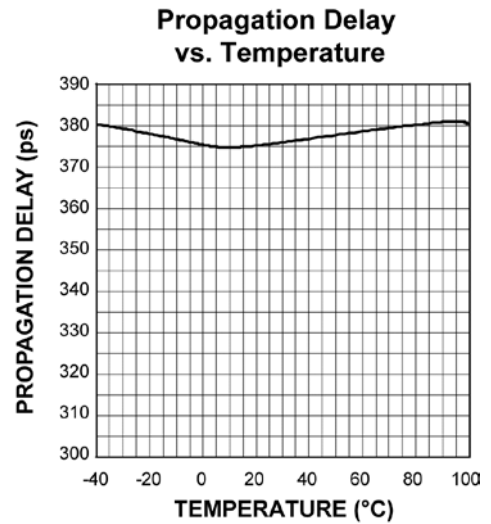
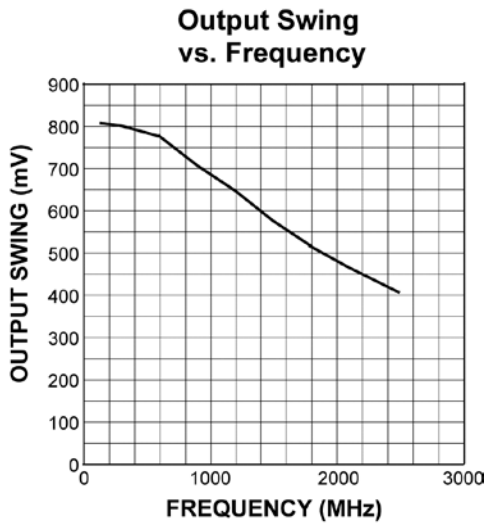
9. High-frequency AC parameters are guaranteed by design and characterization.
10. Within-device skew is measured between two different outputs under identical input transitions.
11. Part-to-part skew is defined for two parts with identical power supply voltages at the same temperature and no skew at the edges at the respective inputs.
12. Set-up and hold times apply to synchronous applications that will enable/disable before the next clock cycle. For asynchronous applications, set-up and hold times do not apply.

# Typical Phase Noise



## Typical Characteristics

$V_{CC} = 3.3V$ ;  $GND = 0V$ ;  $R_L = 50\Omega$  to  $V_{CC} - 2V$ ;  $T_A = 25^\circ C$ , unless otherwise noted.

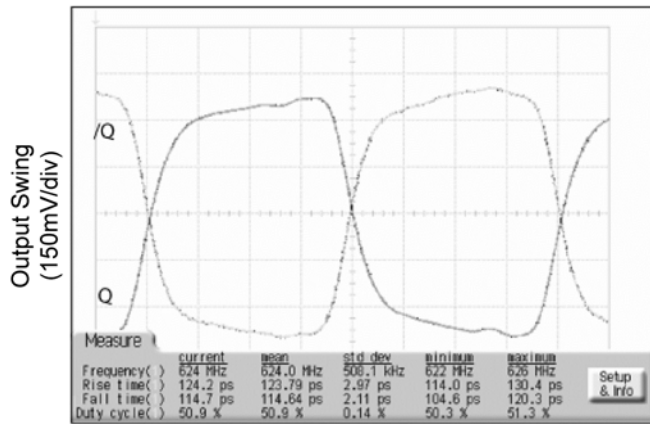




## Typical Output Waveforms

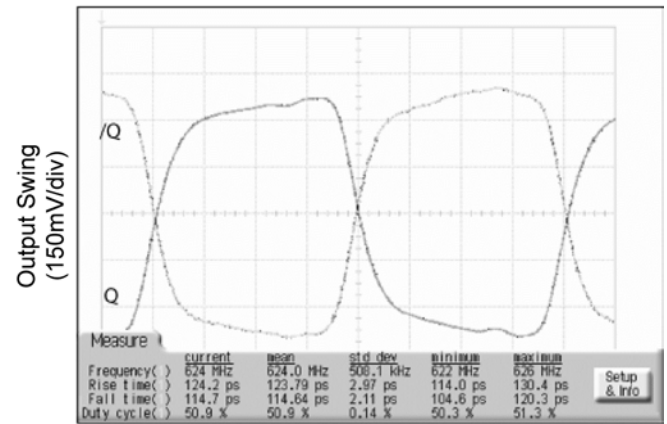
$V_{CC} = 3.3V$ ;  $GND = 0V$ ;  $V_{IN} = 800mV$ ;  $R_L = 50\Omega$  to  $V_{CC} - 2V$ ;  $T_A = 25^\circ C$ , unless otherwise noted.

155MHz Output



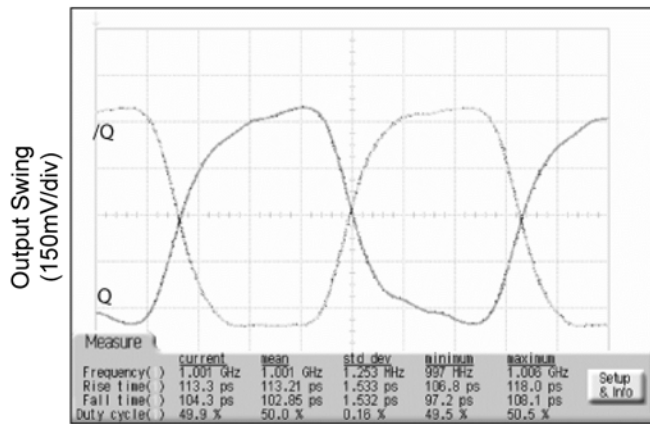
Time (1ns/div)

622MHz Output



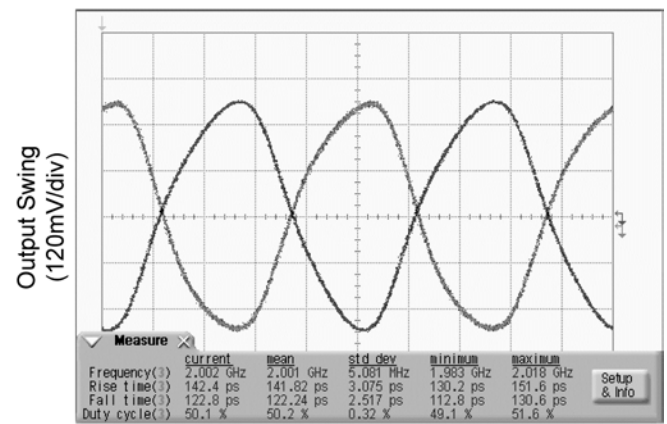
Time (200ps/div)

1GHz Output



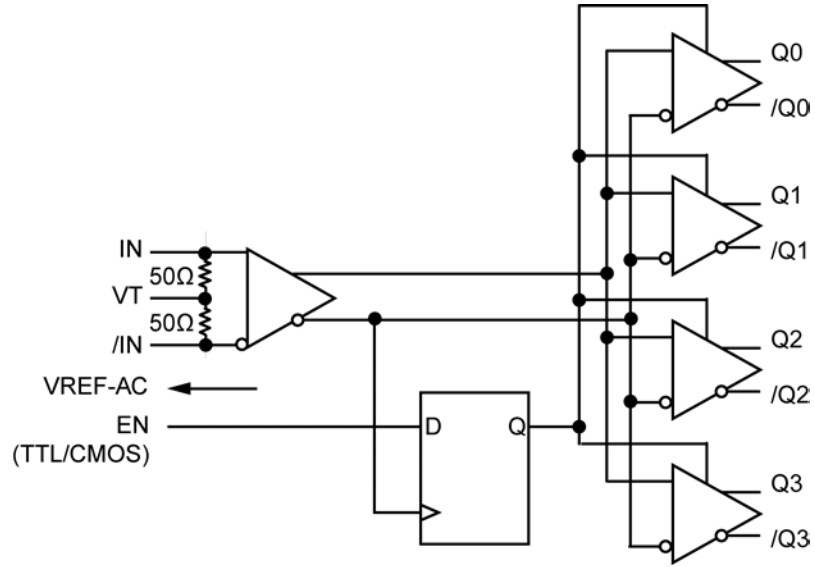
Time (150ps/div)

2GHz Output



Time (100ps/div)

### Functional Block Diagram



### Single-Ended and Differential Swings

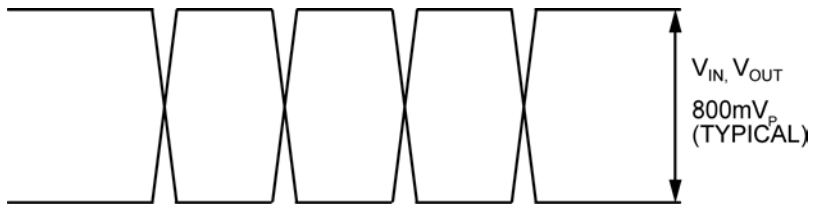


Figure 1. Single-Ended Swing

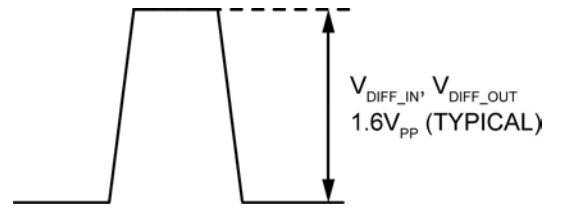


Figure 2. Differential Swing

### Input and Output Stages

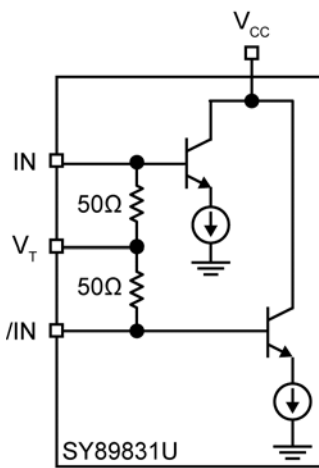


Figure 3. Simplified Differential

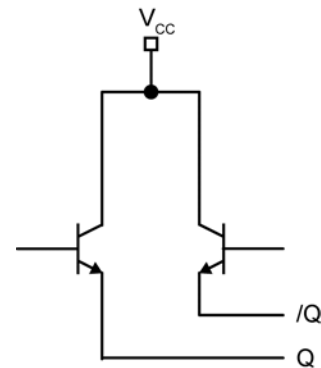
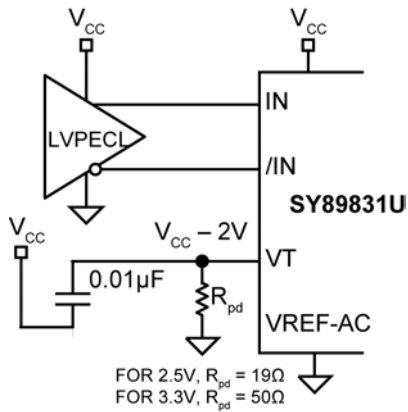
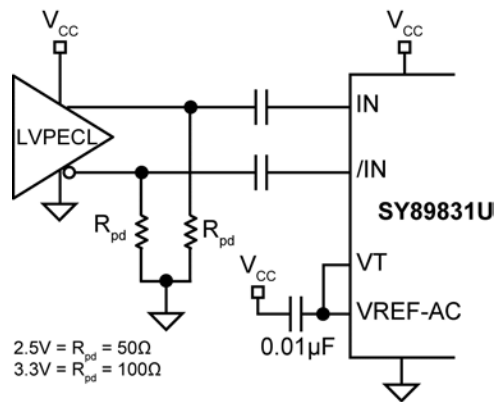


Figure 4. Simplified LVPECL Output Stage

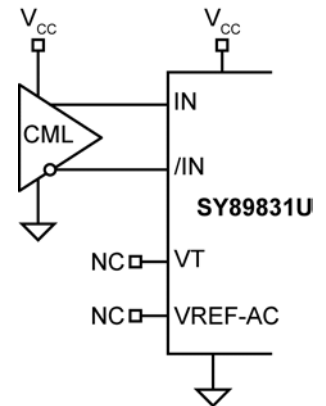
## Input Interface Applications



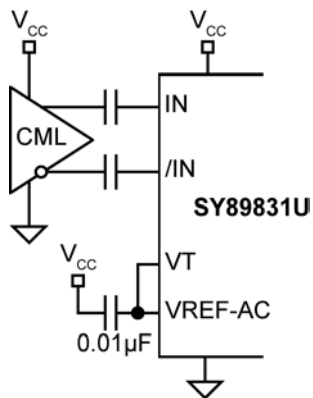
**Figure 5. DC-Coupled LVPECL Input Interface**



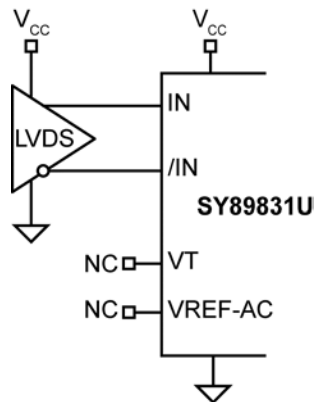
**Figure 6. AC-Coupled LVPECL Input Interface**



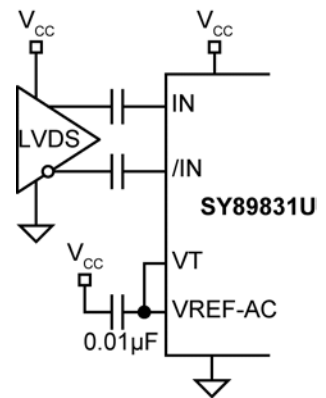
**Figure 7. DC-Coupled CML Input Interface**



**Figure 8. AC-Coupled CML Input Interface**



**Figure 9. DC-Coupled LVDS Input Interface**



**Figure 10. AC-Coupled LVDS Input Interface**

## Output Termination Recommendations

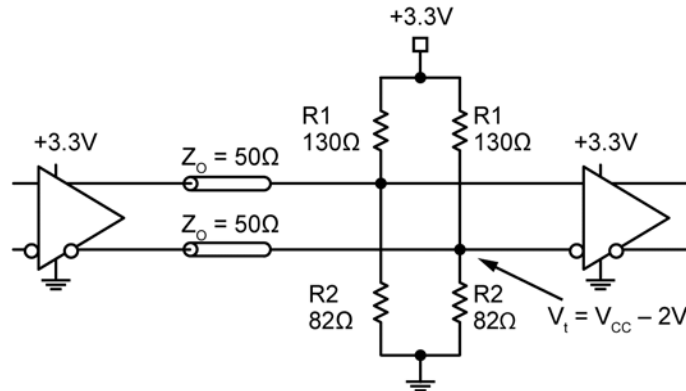


Figure 11. Parallel Termination – Thevenin Equivalent

**Note:**

13. For +2.5V Systems: R1 = 250Ω, R2 = 62.5Ω.

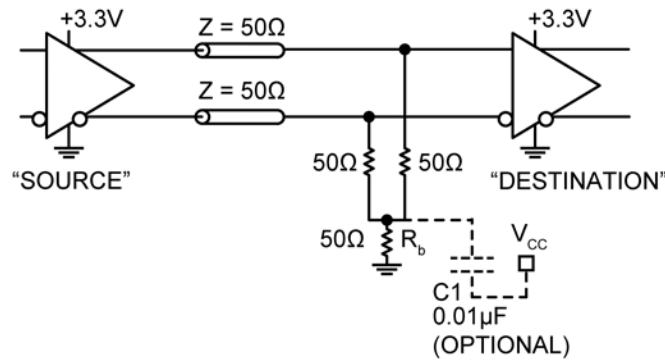


Figure 12. Three-Resistor ‘Y-Termination’

**Notes:**

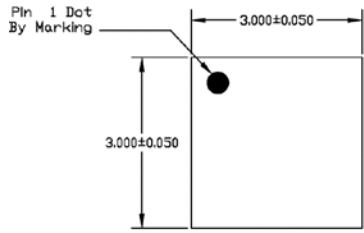
- 14. Power-saving alternative to Thevenin termination.
- 15. Place termination resistors as close to destination inputs as possible.
- 16. The R<sub>b</sub> resistor sets the DC bias voltage equal to V<sub>t</sub>. For +2.5V systems, R<sub>b</sub> = 19Ω.
- 17. C1 is an optional bypass capacitor that compensates for any t<sub>r</sub>/t<sub>f</sub> mismatches.



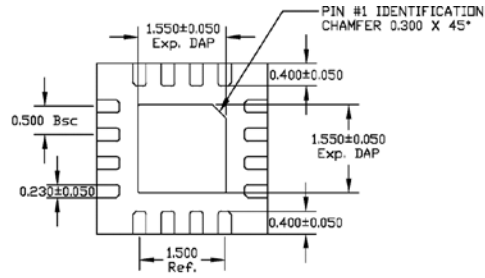
## Related Product and Support Documentation

Part Number	Function	Data Sheet Link
SY89830U	1:4 LVPECL Fanout Buffer w/2:1 MUX Input	<a href="http://www.micrel.com/index.php/en/products/clock-timing/clock-data-distribution/fanout-buffers/article/51-sy89830u.html">http://www.micrel.com/index.php/en/products/clock-timing/clock-data-distribution/fanout-buffers/article/51-sy89830u.html</a>
SY89832U	2.5V Ultra-Precision 1:4 LVDS Fanout Buffer/ Translator with Internal Termination	<a href="http://www.micrel.com/index.php/en/products/clock-timing/clock-data-distribution/fanout-buffers/article/38-sy89832u.html">http://www.micrel.com/index.php/en/products/clock-timing/clock-data-distribution/fanout-buffers/article/38-sy89832u.html</a>
SY89833AL	3.3V Ultra-Precision 1:4 LVDS Fanout Buffer/Translator with Internal Termination	<a href="http://www.micrel.com/index.php/en/products/clock-timing/clock-data-distribution/fanout-buffers/article/39-sy89833al.html">http://www.micrel.com/index.php/en/products/clock-timing/clock-data-distribution/fanout-buffers/article/39-sy89833al.html</a>
SY89834U	2.5/3.3V Two Input, 1GHz LVTTTL/CMOS-to-LVPECL 1:4 Fanout Buffer/Translator	<a href="http://www.micrel.com/index.php/en/products/clock-timing/clock-data-distribution/fanout-buffers/article/50-sy89834u.html">http://www.micrel.com/index.php/en/products/clock-timing/clock-data-distribution/fanout-buffers/article/50-sy89834u.html</a>
	16-MLF <sup>®</sup> Manufacturing Guidelines Exposed Pad Application Note	<a href="http://www.amkor.com/products/notes_papers/MLF_AppNote_0301.pdf">www.amkor.com/products/notes_papers/MLF_AppNote_0301.pdf</a>

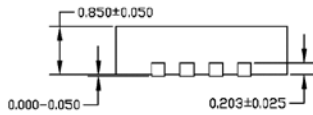
**Package Information** <sup>(18)</sup>



TOP VIEW

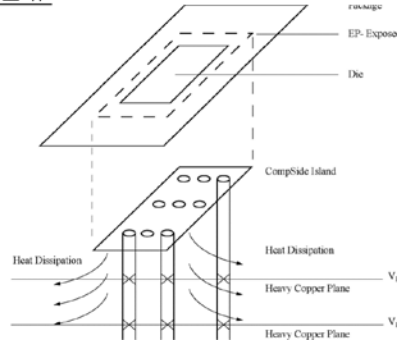


BOTTOM VIEW



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)**

**16-Pin EPAD MicroLeadFrame® (MLF-16)**

**Notes:**

- 18. Package information is correct as of the publication date. For updates and most current information, go to [www.micrel.com](http://www.micrel.com).
- 19. Package meets Level 2 moisture sensitivity classification, and is shipped in dry-pack.
- 20. Exposed pads must be soldered to a ground for proper thermal management.

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