



## SY89874AU

### 2.5GHz, Any-In to LVPECL, Programmable Clock Divider/Fanout Buffer with Internal Termination

## General Description

This low-skew, low-jitter device can accept a high-speed (622MHz or higher) LVTTTL, LVCMOS, CML, LVPECL, LVDS or HSTL clock input signal and divide 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 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 /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).

Use the SY89874U version, which has a wider input range, to DC-couple low offset differential signals.

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



Precision Edge®

## 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 VT pin for DC-coupled and AC-coupled Inputs; LVCMOS, LVTTTL, 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) QFN package

## Applications

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

United States Patent No. RE44,134

Precision Edge is a registered trademark of Micrel, Inc

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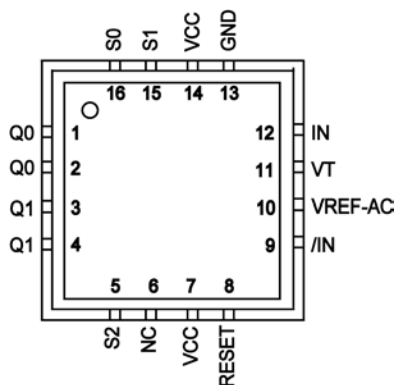
## Ordering Information<sup>(1)</sup>

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY89874AUMG	QFN-16	Industrial	874U	Pb-Free
SY89874AUMGTR <sup>(2)</sup>	QFN-16	Industrial	874U	Pb-Free

### Notes:

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

## Pin Configuration

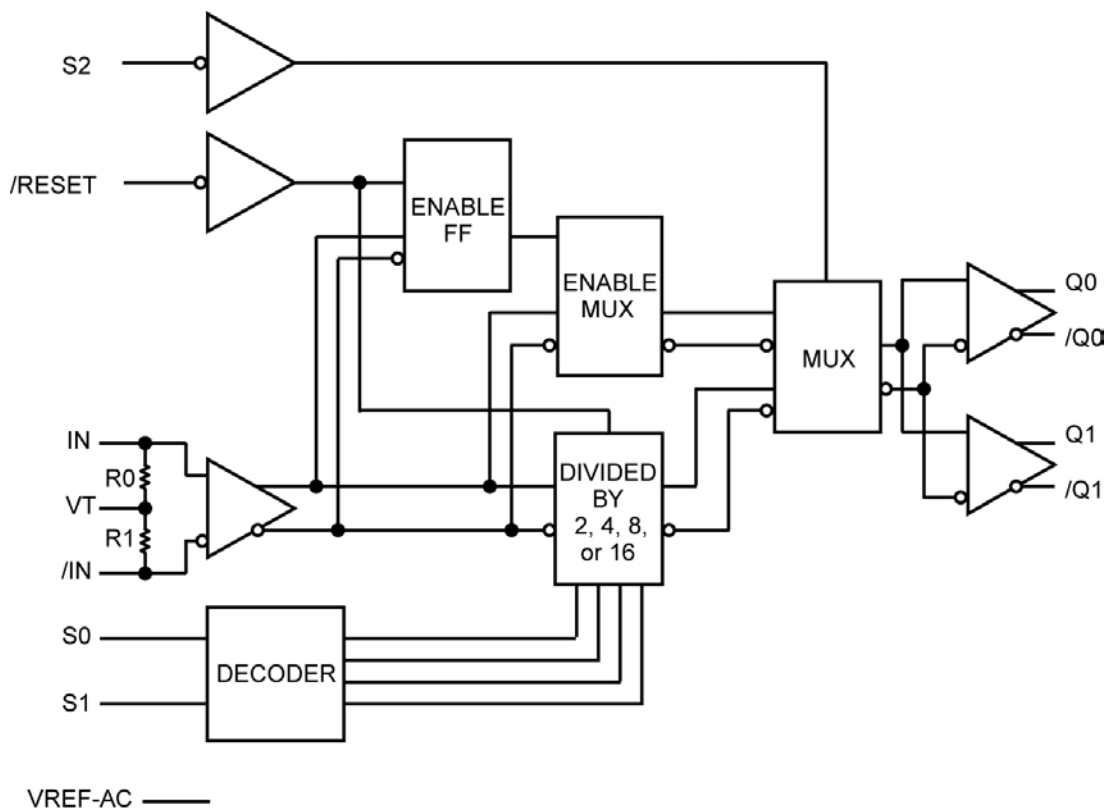


16-Pin QFN

## Pin Description

Pin Number	Pin Name	Pin Function
12, 9	IN, /IN	Input. Internal 50 $\Omega$ termination resistors to VT input. Flexible input accepts any input. See the "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 the "Truth Table." Unused PECL outputs may be left floating with no impact on jitter performance.
16, 15, 5	S0, S1, S2	Select Pins. See the "Truth Table." LVTTTL/CMOS logic levels. Internal 25k $\Omega$ pull-up resistor. Logic high if left unconnected (divided by 16 mode). Input threshold is $V_{CC}/2$ .
6	NC	No Connect.
8	/RESET /DISABLE	LVTTTL/CMOS Logic Levels. Internal 25k $\Omega$ 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 $V_{CC}/2$ .
10	VREF-AC	Reference Voltage. Equal to $V_{CC} - 1.4\text{V}$ (approximately). Used for AC-coupled applications only. Decouple the VREF-AC pin with a 0.01 $\mu\text{F}$ capacitor. See the "Input Interface Applications" section.
11	VT	Termination Center Tap. For CML or LVDS inputs, leave this floating. Otherwise, see Figures 3a to 3f in the "Input Interface Applications" section.
7, 14	VCC	Positive Power Supply. Bypass with .01 $\mu\text{F}$ /0.01 $\mu\text{F}$ low-ESR capacitor.
13	GND	Ground.

### Functional Block Diagram



### Truth Table

/RESET	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	1	X	X	Q = Low, /Q = High Clock Disable

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

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

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

Supply Voltage ( $V_{CC}$ )	+3.3V ±10% or +2.5V ±5%
Ambient Temperature ( $T_A$ )	–40°C to +85°C
Package Thermal Resistance	
QFN ( $\theta_{JA}$ )	
Still-Air	60°C/W
500lfpm	54°C/W
QFN ( $\Psi_{JB}$ ) <sup>(4)</sup>	
Junction-to-Board	32°C/W

**DC Electrical Characteristics<sup>(5, 6)</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		3.63	V
$I_{CC}$	Power Supply Current	No load, maximum $V_{CC}$		50	75	mA
$R_{IN}$	Differential Input Resistance (IN-to-/IN)		90	100	110	$\Omega$
$V_{IH}$	Input High Voltage (IN, /IN)	Note 5	0.8	–	$V_{CC} + 0.3$	V
$V_{IL}$	Input Low Voltage (IN, /IN)	Note 5	–0.3	–	$V_{IH} - 0.1$	V
$V_{IN}$	Input Voltage Swing	Notes 5, 6, 10	0.1	–	$V_{CC}$	V
$V_{DIFF\_IN}$	Differential Input Voltage Swing	Notes 5, 6, 7, 9, 10	0.2	–		V
$ I_{IN} $	Input Current (IN, /IN)	Note 5, 7	–	–	45	mA
$V_{REF-AC}$	Reference Voltage	Note 8	$V_{CC} - 1.525$	$V_{CC} - 1.425$	$V_{CC} - 1.325$	V

**Notes:**

- Permanent device damage can 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 data sheet limits are not guaranteed if the device is operated beyond the operating ratings.
- Due to the limited drive capability, use for input of the same package only.
- Junction-to-board resistance assumes that the exposed pad is soldered (or equivalent) to the device's most negative potential on the PCB.
- The circuit is designed to meet the DC specifications shown in the "DC Electrical Characteristics" table after thermal equilibrium has been established. For a wider differential input range, use the SY89874U device.
- Specification for packaged product only.
- Due to the internal termination (see "Input Buffer Structure"), the input current depends on the applied voltages at the IN, /IN, and VT inputs. Do not apply a combination of voltages that causes the input current to exceed the maximum limit.
- See the Timing Diagram for VT definition.  $V_{IN}$  (maximum) is specified when VT is floating.
- See the "Typical Characteristics" section for  $V_{DIFF}$  definition.
- Operation using  $V_{IN}$  is limited to AC-coupled PECL or CML applications only. Connect directly to the VT pin.

## LVPECL (100KEP) DC Electrical Characteristics<sup>(1, 2)</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	1.60	2.10	V

## LVTTTL/CMOS DC Electrical Characteristics<sup>(2, 3)</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
$V_{IH}$	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	$\mu A$

## AC Electrical Characteristics<sup>(2, 4)</sup>

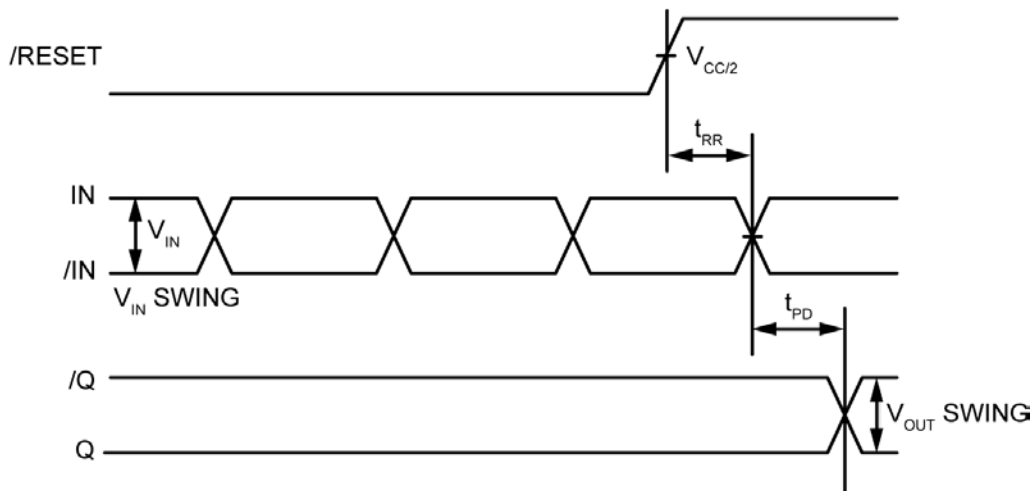
$V_{CC} = 3.3V \pm 10\%$  or  $2.5V \pm 5\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ , unless otherwise stated.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
$f_{MAX}$	Maximum Output Toggle Frequency	Output Swing $\geq 400mV$	2.5			GHz
	Maximum Input Frequency	Divide by 2, 4, 8, 16	3.2			GHz
$t_{PD}$	Differential Propagation Delay	Input Swing $< 400mV$	510	620	760	ps
	IN to Q	Input Swing $\geq 400mV$	450	570	700	
$t_{SKEW}$	Within-Device Skew (differential)	Note 5		7	15	ps
	Q0 – Q1					
	Part-to-Part Skew (differential)	Note 5			250	
$t_{RR}$	Reset Recovery Time	Note 6	600			ps
$t_{JITTER}$	Cycle-to-Cycle Jitter	Note 7			1	ps <sub>RMS</sub>
	Total Jitter	Note 8			10	ps <sub>PP</sub>
$t_r, t_f$	Rise/Fall Time (20% to 80%)		70	150	250	ps

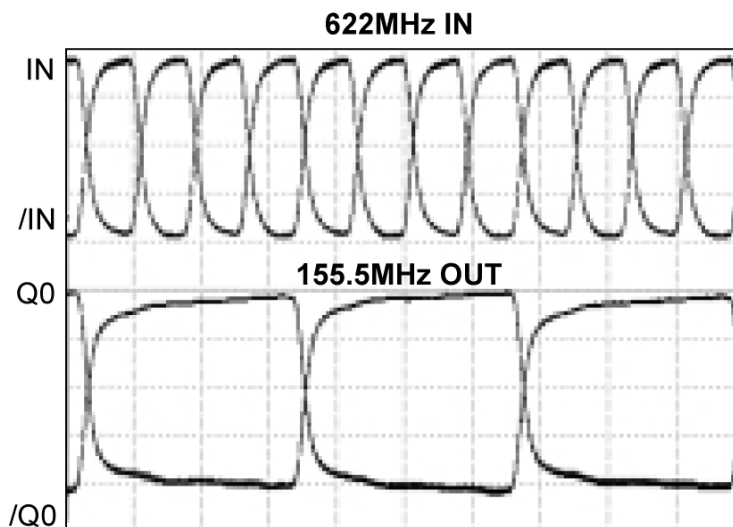
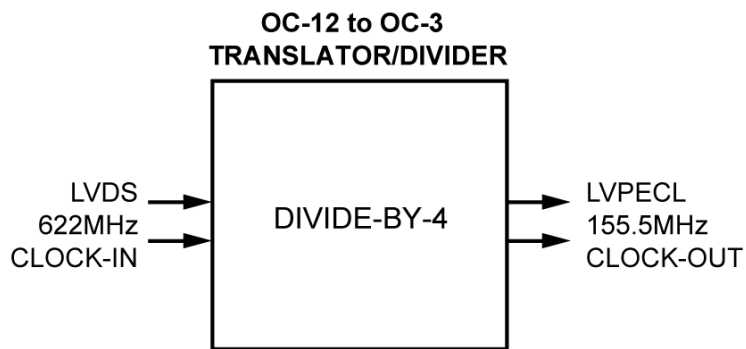
### Notes:

- The circuit is designed to meet the DC specifications shown in the "LVPECL (100KEP) Electrical Characteristics" table after thermal equilibrium has been established.
- Specification for packaged product only.
- The circuit is designed to meet the DC specifications shown in the "LVTTTL/CMOS Electrical Characteristics" table after thermal equilibrium has been established.
- Measured with 400mV signal, 50% duty cycle, all outputs loaded with  $50\Omega$  to  $V_{CC} - 2V$ , unless otherwise stated.
- Skew is measured between outputs under identical transitions.
- See the "Timing Diagram" section.
- 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.
- Total Jitter Definition: With an ideal clock input, of frequency  $\leq f_{MAX}$  (device), no more than one output edge in 1012 output edges will deviate by more than the specified peak-to-peak jitter value.

### Timing Diagram



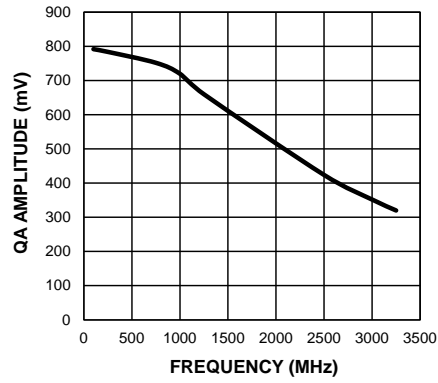
### Typical Performance



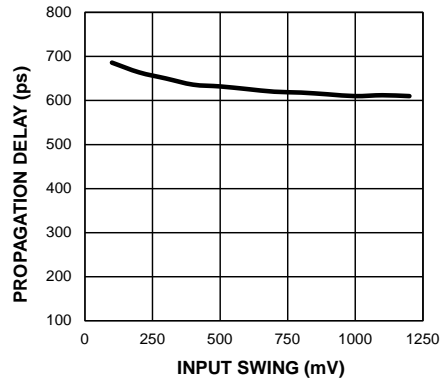
## Typical Characteristics

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

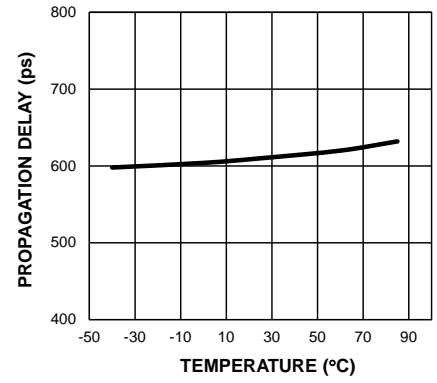
QA Output Amplitude vs. Frequency



IN to Q Propagation Delay vs. Input Swing

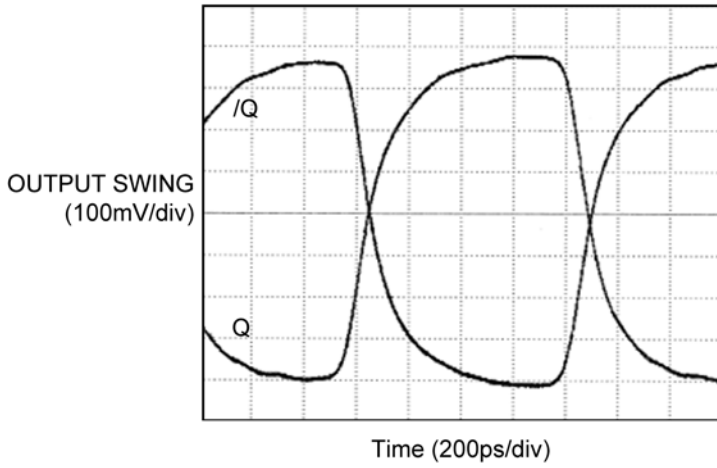


IN to Q Propagation Delay vs. Temperature

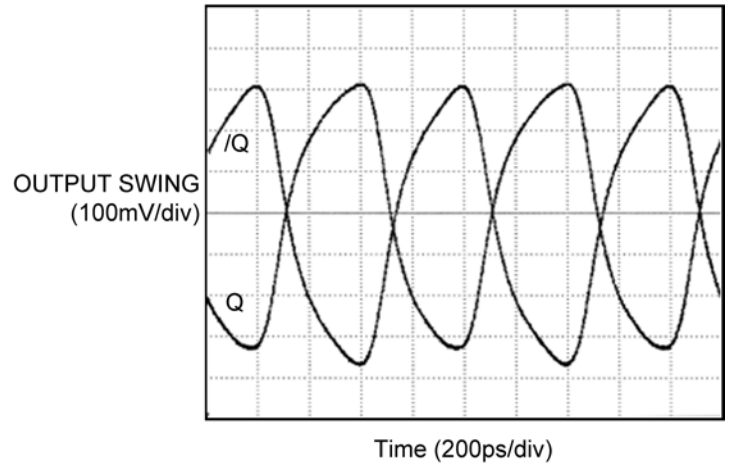


## Functional Characteristics

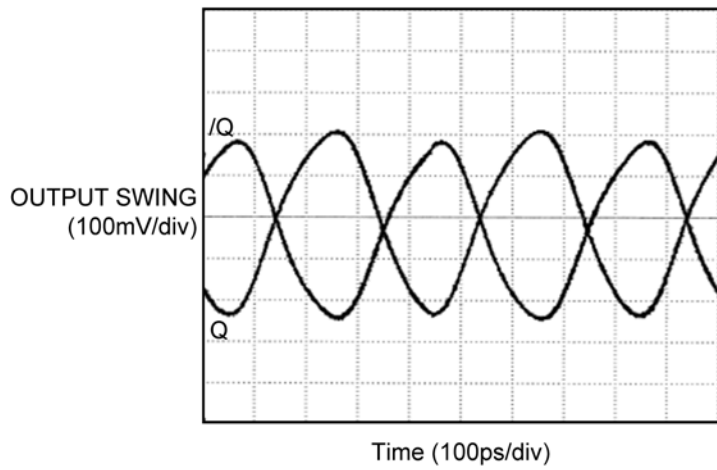
**622MHz Output**



**1.25GHz Output**



**2.5MHz Output**





## Definition of Single-Ended and Differential Swing

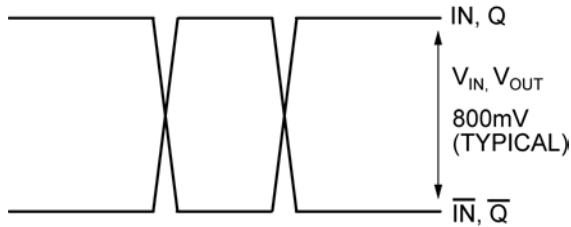


Figure 1a. Single-Ended Swing<sup>(1)</sup>

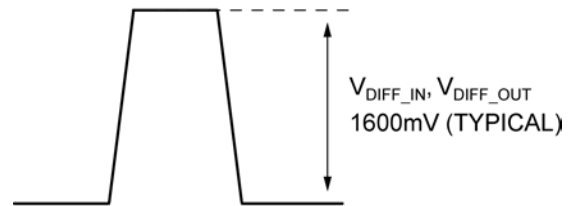


Figure 1b. Differential Swing<sup>(2)</sup>

## Input Buffer Structure

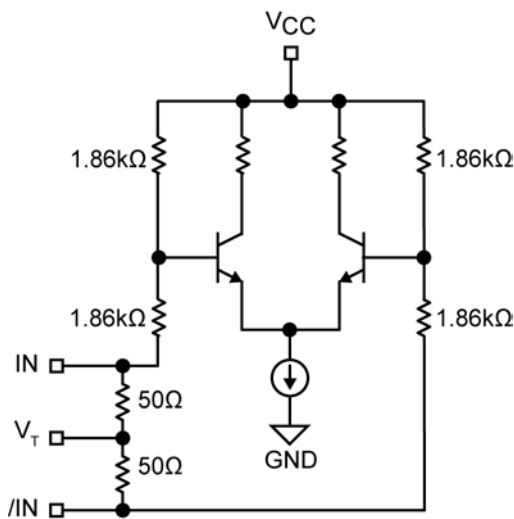


Figure 2a. Differential Input Structure<sup>(2)</sup>

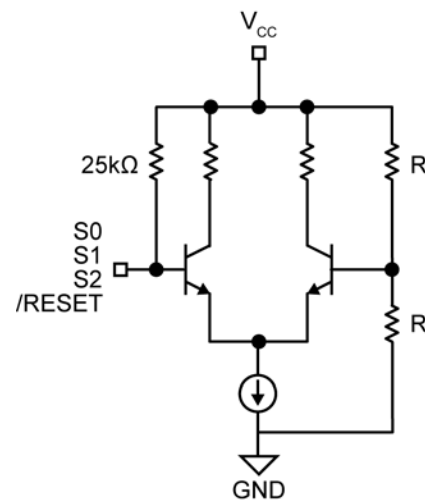


Figure 2b. Single-Ended Input Structure<sup>(1)</sup>

**Notes:**

1. Single-ended swing is the amplitude of the signal when driven differentially.
2. Differential swing is defined as  $IN - /IN$  (or  $Q - /Q$ ).

## Differential Input Interface Applications

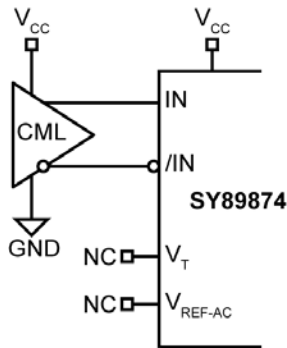


Figure 3a. DC-Coupled CML Input Interface

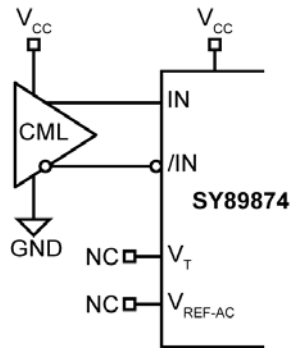


Figure 3b. AC-Coupled CML Input Interface

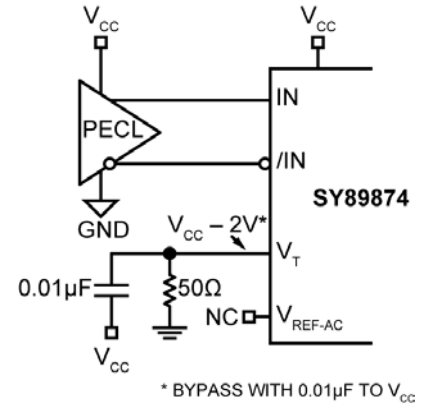


Figure 3c. DC-Coupled PECL Input Interface

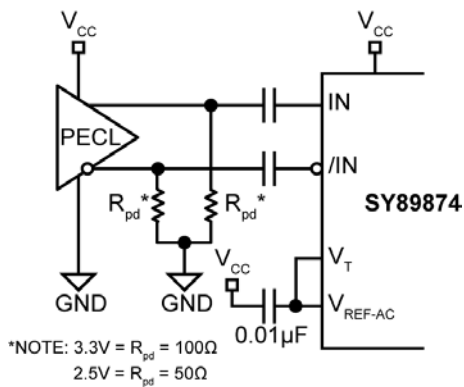


Figure 3d. AC-Coupled PECL Input Interface

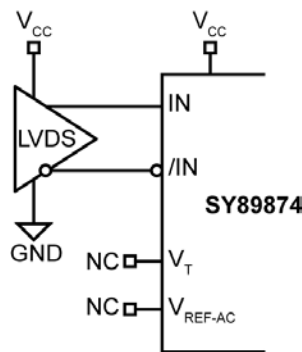


Figure 3e. LVDS Input Interface

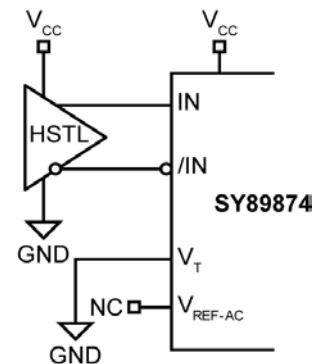


Figure 3f. HSTL Input Interface

## Single-Ended Input Interface Applications

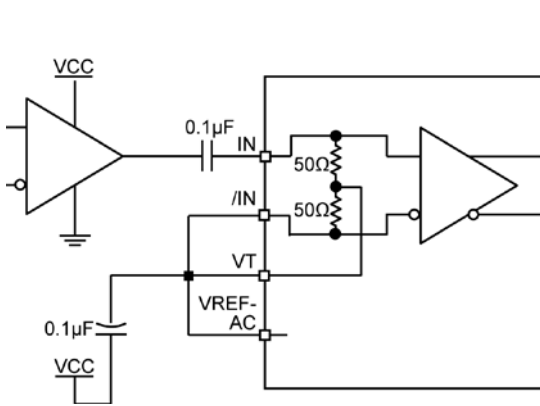


Figure 4a. AC-Coupled LVTTTL CLK Termination

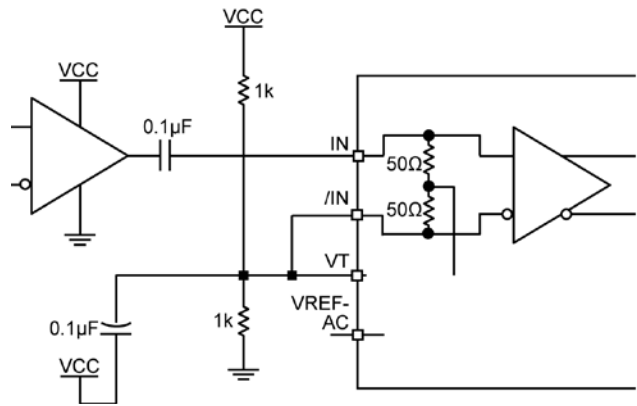


Figure 4b. AC-Coupled CMOS CLK Termination

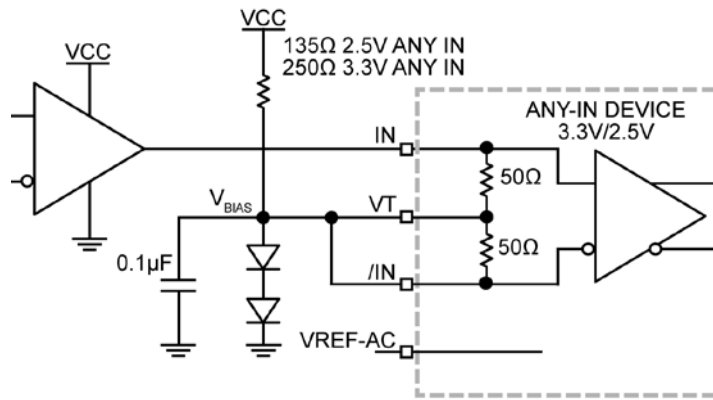
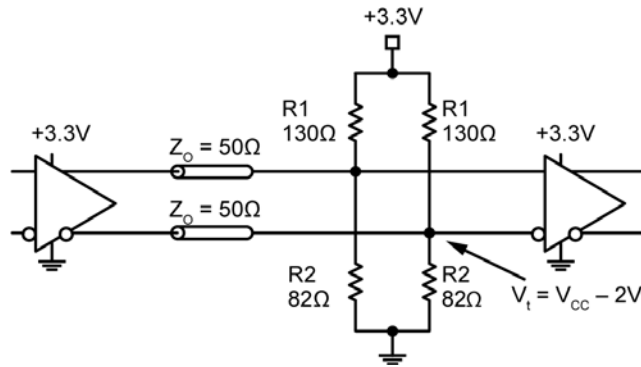


Figure 4c. DC-Coupled Data Termination

## Related Product and Support Documentation

Part Number	Function	Data Sheet Link
Clock Dividers	Divide down clocking signals to make lower frequencies available on board	<a href="http://www.micrel.com/index.php/products/timing-and-communications/clock-data-distribution/clock-dividers.html?orderby=Part_Num&amp;ordering=DESC">http://www.micrel.com/index.php/products/timing-and-communications/clock-data-distribution/clock-dividers.html?orderby=Part_Num&amp;ordering=DESC</a>
SY89871U	2.5GHz Any Differential In-to-LVPECL Programmable Clock Divider/Fanout Buffer with Internal Termination	<a href="http://www.micrel.com/index.php/en/products/timing-and-communications/clock-data-distribution/clock-dividers/article/11-sy89871u.html">http://www.micrel.com/index.php/en/products/timing-and-communications/clock-data-distribution/clock-dividers/article/11-sy89871u.html</a>

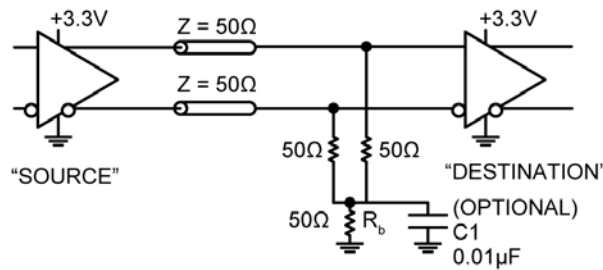
## LVPECL Output Termination Recommendations



**Figure 5a. Parallel Termination-Thevenin Equivalent**

**Note:**

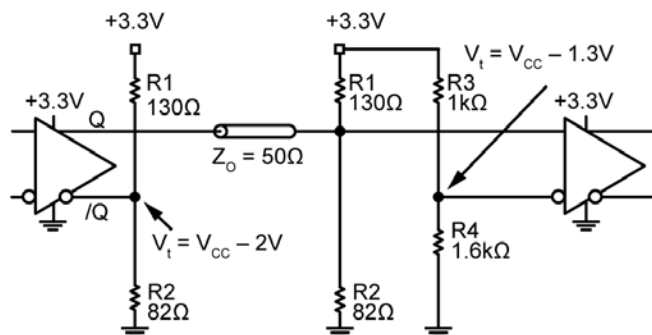
1. For +2.5V Systems: R1 = 250Ω, R2 = 62.5Ω.



**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. The 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.
4. C1 is an optional bypass capacitor that compensates for any t<sub>r</sub>/t<sub>f</sub> mismatches.

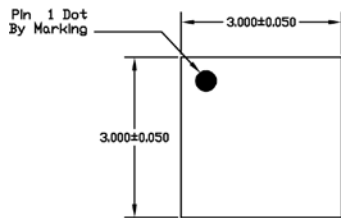


**Figure 4c. Terminating Unused I/O**

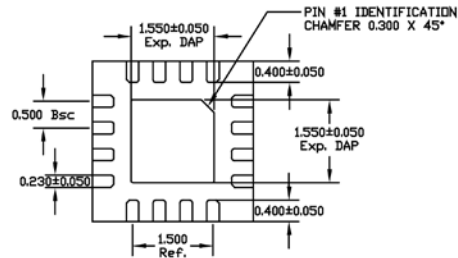
**Notes:**

1. Unused output (/Q) must be terminated to balance the output.
2. For +2.5V Systems: R1 = 250Ω, R2 = 62.5Ω, R3 = 1.25kΩ, R4 = 1.2kΩ.

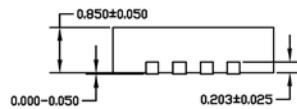
# Package Information<sup>(1)</sup>



TOP VIEW

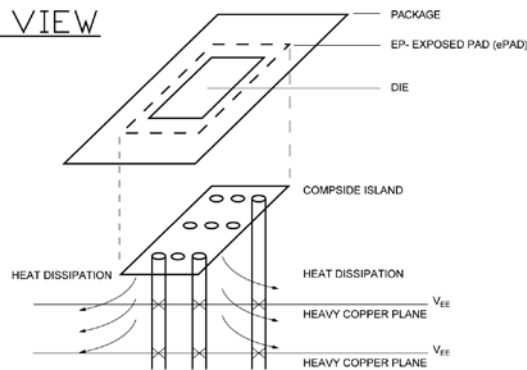


BOTTOM VIEW



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 QFN Package (Always solder, or equivalent, the exposed pad to the PCB)

**Notes:**

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

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