



## 2.5V/3.3/5V 2.5GHz 1:4 PECL/ECL CLOCK DRIVER WITH 2:1 DIFFERENTIAL INPUT MUX

Precision Edge®  
SY89830U

### FEATURES

- **Guaranteed AC parameters over temp/voltage:**
  - > 2.5GHz  $f_{MAX}$
  - < 25ps within-device skew
  - < 225ps  $t_r/t_f$  time
  - < 450ps prop delay
- **Low jitter design:**
  - < 1ps<sub>RMS</sub> cycle-to-cycle jitter
  - < 15ps<sub>PP</sub> total jitter
- **2:1 Differential MUX input**
- **Flexible supply voltage: 2.5V/3.3V/5V**
- **Wide operating temperature range: -40°C to +85°C**
- **100K ECL compatible outputs**
- **Inputs accept PECL/LVPECL/ECL/HSTL logic levels**
- **Available in a 16-pin TSSOP package**



Precision Edge®

### DESCRIPTION

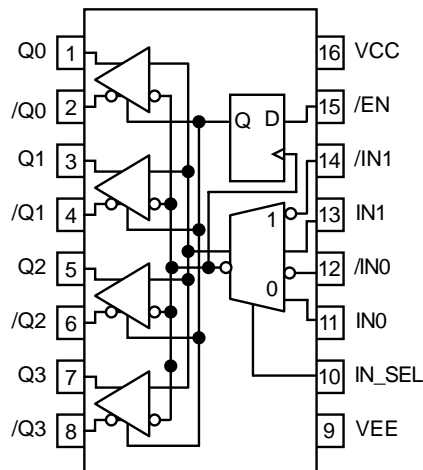
The SY89830U is a high-speed, 2.5GHz differential PECL 1:4 fanout buffer optimized for ultra-low skew applications. Within device skew is guaranteed to be less than 25ps over temperature and supply voltage. The wide supply voltage operation allows this fanout buffer to operate in 2.5V, 3.3V, and 5V systems.

The SY89830U features a 2:1 input MUX, making it an ideal solution for redundant clock switchover applications. If only one input pair is used, the other pair may be left floating. In addition, this device includes a synchronous enable pin that forces the outputs into a fixed logic state. Enable or disable state is initiated only after the outputs are in a LOW state, thus eliminating the possibility of a "runt" clock pulse.

The SY89830U I/O are fully differential and 100K ECL compatible. Differential 10K ECL logic can interface directly into the SY89830U inputs.

The SY89830U is part of Micrel's high-speed precision edge timing and distribution family. 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.

**PACKAGE/ORDERING INFORMATION**



16-Pin TSSOP (T32-1)

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

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY89830UK4I	K4-16-1	Industrial	89830U	Sn-Pb
SY89830UK4ITR <sup>(2)</sup>	K4-16-1	Industrial	89830U	Sn-Pb
SY89830UK4G <sup>(3)</sup>	K4-16-1	Industrial	89830U with Pb-Free bar line indicator	NiPdAu Pb-Free
SY89830UK4GTR <sup>(2, 3)</sup>	K4-16-1	Industrial	89830U 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
1, 2, 3, 4, 5, 6, 7, 8	Q0 to Q3 /Q0 to /Q3	(LV)PECL, (LV)ECL differential outputs: Terminate with 50Ω to V <sub>CC</sub> -2V. For single-ended applications, terminate the unused output with 50Ω to V <sub>CC</sub> -2V.
9	V <sub>EE</sub>	Negative Power Supply: For LVPECL, PECL applications, connect to GND.
10	IN_SEL	(LV)PECL, (LV)ECL compatible 2:1 mux input signal select: When IN_SEL is LOW, the IN0 input pair is selected. When IN_SEL is HIGH, the IN1 input pair is selected. Includes a 75kΩ pull-down. Default state is LOW and IN0 is selected.
11, 12, 13, 14	IN0, /IN0 IN1, /IN1	(LV)PECL, (LV)ECL, HSTL clock or data inputs. Internal 75kΩ pull-down resistors on IN0, IN1. Internal 75kΩ pull-up and 75kΩ pull-down resistors on /IN0, /IN1. /IN0, /IN1 default condition is V <sub>CC</sub> /2 when left floating. IN0, IN1 default condition is LOW when left floating.
15	/EN	(LV)PECL, (LV)ECL compatible synchronous enable: When /EN goes HIGH, Q <sub>OUT</sub> will go LOW and /Q <sub>OUT</sub> will go HIGH on the next LOW input clock transition. Includes a 75kΩ pull-down. Default state is LOW when left floating. The internal latch is clocked on the falling edge of the input (IN0, IN1)
16	V <sub>CC</sub>	Positive Power Supply: Bypass with 0.1μF//0.01μF low ESR capacitors.

**TRUTH TABLE<sup>(1)</sup>**

IN0	IN1	IN_SEL	/EN	Q
L	X	L	L	L
H	X	L	L	H
X	L	H	L	L
X	H	H	L	H
$\overline{\text{L}}$	X	L	H	L
X	$\overline{\text{L}}$	H	H	L

**Note:**

1.  $\overline{\text{L}}$  = negative edge

**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

Symbol	Rating	Value	Unit
$V_{CC} - V_{EE}$	Power Supply Voltage	6.0	V
$V_{IN}$	Input Voltage ( $V_{CC} = 0V$ , $V_{IN}$ not more negative than $V_{EE}$ ) Input Voltage ( $V_{EE} = 0V$ , $V_{IN}$ not more positive than $V_{CC}$ )	-6.0 to 0 +6.0 to 0	V
$I_{OUT}$	Output Current -Continuous -Surge	50 100	mA
$T_A$	Operating Temperature Range	-40 to +85	°C
$T_{LEAD}$	Lead Temperature (soldering, 20sec.)	260	°C
$T_{store}$	Storage Temperature Range	-65 to +150	°C
$\theta_{JA}$	Package Thermal Resistance (Junction-to-Ambient) -Still-Air (single-layer PCB) -Still-Air (multi-layer PCB) -500lfpm (multi-layer PCB)	115 75 65	°C/W
$\theta_{JC}$	Package Thermal Resistance (Junction-to-Case)	21	°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.

**DC ELECTRICAL CHARACTERISTICS<sup>(1)</sup>**

Symbol	Parameter	$T_A = -40^\circ\text{C}$			$T_A = +25^\circ\text{C}$			$T_A = +85^\circ\text{C}$			Unit	Condition	
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.			
$V_{CC}$	Power Supply Voltage										V		
	(PECL)	4.5	5.0	5.5	4.5	5.0	5.5	4.5	5.0	5.5			
	(LVPECL)	2.375	3.3	3.63	2.375	3.3	3.63	2.375	3.3	3.63			
	(ECL)	-5.5	-5.0	-4.5	-5.5	-5.0	-4.5	-5.5	-5.0	-4.5			
	(LVECL)	-3.63	-3.3	-2.375	-3.63	-3.3	-2.375	-3.63	-3.3	-2.375			
$I_{CC}$	Power Supply Current	—	—	70	—	50	72	—	—	75	mA		
$I_{IH}$	Input HIGH Current	—	—	150	—	—	150	—	—	150	μA	$V_{IN} = V_{IH}$	
$I_{IL}$	Input LOW Current	IN	0.5	—	—	0.5	—	—	0.5	—	—	μA	$V_{IN} = V_{IL}$
		/IN	-150	—	—	-150	—	—	-150	—	—	μA	$V_{IN} = V_{IL}$
$C_{IN}$	Input Capacitance (TSSOP)	—	—	—	—	1.0	—	—	—	—	pF		

**Note:**

1. 100KEP circuits are designed to meet the DC specifications shown in the above table after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and traverse airflow greater than 500lfpm is maintained.

**(100KEP) LVPECL DC ELECTRICAL CHARACTERISTICS<sup>(1)</sup>** $V_{CC} = 2.5V \pm 5\%$ ,  $V_{EE} = 0V$ 

Symbol	Parameter	$T_A = -40^\circ C$			$T_A = +25^\circ C$			$T_A = +85^\circ C$			Unit	Condition
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.		
$V_{IL}$	Input LOW Voltage (Single-ended)	555	—	875	555	—	875	555	—	875	mV	$V_{CC} = 2.5V$
$V_{IH}$	Input HIGH Voltage (Single-ended)	1275	—	1620	1275	—	1620	1275	—	1620	mV	$V_{CC} = 2.5V$
$V_{OL}$	Output LOW Voltage	555	680	805	555	680	805	555	680	805	mV	$V_{CC} = 2.5V$
$V_{OH}$	Output HIGH Voltage	1355	1480	1605	1355	1480	1605	1355	1480	1605	mV	$V_{CC} = 2.5V$
$V_{IHCMR}$	Input HIGH Voltage Common Mode Range <sup>(2)</sup>	1.2	—	$V_{CC}$	1.2	—	$V_{CC}$	1.2	—	$V_{CC}$	V	

**Notes:**

- 100KEP circuits are designed to meet the DC specifications shown in the above table after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and traverse airflow greater than 500lfpm is maintained. Input and output parameters vary 1:1 with  $V_{CC}$ . Output load is  $50\Omega$  to  $V_{CC} - 2V$ .
- The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal.

**(100KEP) LVPECL DC ELECTRICAL CHARACTERISTICS<sup>(1)</sup>** $V_{CC} = 3.3V \pm 10\%$ ,  $V_{EE} = 0V$ 

Symbol	Parameter	$T_A = -40^\circ C$			$T_A = +25^\circ C$			$T_A = +85^\circ C$			Unit	Condition
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.		
$V_{IL}$	Input LOW Voltage (Single-Ended)	1355	—	1675	1355	—	1675	1355	—	1675	mV	$V_{CC} = 3.3V$
$V_{IH}$	Input HIGH Voltage (Single-Ended)	2075	—	2420	2075	—	2420	2075	—	2420	mV	$V_{CC} = 3.3V$
$V_{OL}$	Output LOW Voltage	1355	1480	1605	1355	1480	1605	1355	1480	1605	mV	$V_{CC} = 3.3V$
$V_{OH}$	Output HIGH Voltage	2155	2280	2405	2155	2280	2405	2155	2280	2405	mV	$V_{CC} = 3.3V$
$V_{IHCMR}$	Input HIGH Voltage Common Mode Range <sup>(2)</sup>	1.2	—	$V_{CC}$	1.2	—	$V_{CC}$	1.2	—	$V_{CC}$	V	

**Notes:**

- 100KEP circuits are designed to meet the DC specifications shown in the above table after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and traverse airflow greater than 500lfpm is maintained. Input and output parameters vary 1:1 with  $V_{CC}$ . Output load is  $50\Omega$  to  $V_{CC} - 2V$ .
- The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal.

**(100KEP) PECL DC ELECTRICAL CHARACTERISTICS<sup>(1)</sup>** $V_{CC} = 5.0V \pm 10\%$ ,  $V_{EE} = 0V$ 

Symbol	Parameter	$T_A = -40^\circ C$			$T_A = +25^\circ C$			$T_A = +85^\circ C$			Unit	Condition
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.		
$V_{IL}$	Input LOW Voltage (Single-Ended)	3055	—	3375	3055	—	3375	3055	—	3375	mV	$V_{CC} = 5.0V$
$V_{IH}$	Input HIGH Voltage (Single-Ended)	3775	—	4120	3775	—	4120	3775	—	4120	mV	$V_{CC} = 5.0V$
$V_{OL}$	Output LOW Voltage	3055	3180	3305	3055	3180	3305	3055	3180	3305	mV	$V_{CC} = 5.0V$
$V_{OH}$	Output HIGH Voltage	3855	3980	4105	3855	3980	4105	3855	3980	4105	mV	$V_{CC} = 5.0V$
$V_{IHCMR}$	Input HIGH Voltage <sup>(2)</sup> Common Mode Range	1.2	—	$V_{CC}$	1.2	—	$V_{CC}$	1.2	—	$V_{CC}$	V	

**Notes:**

- 100KEP circuits are designed to meet the DC specifications shown in the above table after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and traverse airflow greater than 500lfpm is maintained. Input and output parameters vary 1:1 with  $V_{CC}$ . Output load is  $50\Omega$  to  $V_{CC} - 2V$ .
- The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal.

**(100KEP) LVECL DC ELECTRICAL CHARACTERISTICS<sup>(1)</sup>** $V_{CC} = 0V$ ,  $V_{EE} = -2.375V$  to  $-3.63V$ 

Symbol	Parameter	$T_A = -40^\circ C$			$T_A = +25^\circ C$			$T_A = +85^\circ C$			Unit	Condition
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.		
$V_{IL}$	Input LOW Voltage (Single-ended)	-1945	—	-1625	-1945	—	-1625	-1945	—	-1625	mV	
$V_{IH}$	Input HIGH Voltage (Single-ended)	-1225	—	-880	-1225	—	-880	-1225	—	-880	mV	
$V_{OL}$	Output LOW Voltage	-1945	-1820	-1695	-1945	-1820	-1695	-1945	-1820	-1695	mV	$50\Omega$ to $V_{CC}-2V$
$V_{OH}$	Output HIGH Voltage	-1145	-1020	-895	-1145	-1020	-895	-1145	-1020	-895	mV	$50\Omega$ to $V_{CC}-2V$
$V_{IHCMR}$	Input HIGH Voltage Common Mode Range <sup>(2)</sup>	$V_{EE}+1.2$	—	0.0	$V_{EE}+1.2$	—	0.0	$V_{EE}+1.2$	—	0.0	V	

**Notes:**

- 100KEP circuits are designed to meet the DC specifications shown in the above table after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and traverse airflow greater than 500lfpm is maintained.
- The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal.

**(100KEP) ECL DC ELECTRICAL CHARACTERISTICS<sup>(1)</sup>** $V_{CC} = 0V$ ,  $V_{EE} = -4.5V$  to  $-5.5V$ 

Symbol	Parameter	$T_A = -40^\circ C$			$T_A = +25^\circ C$			$T_A = +85^\circ C$			Unit	Condition
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.		
$V_{IL}$	Input LOW Voltage (Single-ended)	-1945	—	-1625	-1945	—	-1625	-1945	—	-1625	mV	
$V_{IH}$	Input HIGH Voltage (Single-ended)	-1225	—	-880	-1225	—	-880	-1225	—	-880	mV	
$V_{OL}$	Output LOW Voltage	-1945	-1820	-1695	-1945	-1820	-1695	-1945	-1820	-1695	mV	$50\Omega$ to $V_{CC}-2V$
$V_{OH}$	Output HIGH Voltage	-1145	-1020	-895	-1145	-1020	-895	-1145	-1020	-895	mV	$50\Omega$ to $V_{CC}-2V$
$V_{IHCMR}$	Input HIGH Voltage Common Mode Range <sup>(2)</sup>	$V_{EE}+1.2$	—	0.0	$V_{EE}+1.2$	—	0.0	$V_{EE}+1.2$	—	0.0	V	

**Notes:**

- 100KEP circuits are designed to meet the DC specifications shown in the above table after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and traverse airflow greater than 500lfpm is maintained.
- The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal.

**HSTL INPUT DC ELECTRICAL CHARACTERISTICS** $V_{CC} = 2.375V$  to  $3.63V$ ,  $V_{EE} = 0V$ 

Symbol	Parameter	$T_A = -40^\circ C$			$T_A = +25^\circ C$			$T_A = +85^\circ C$			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
$V_{IH}$	Input HIGH Voltage	1200	—	—	1200	—	—	1200	—	—	mV
$V_{IL}$	Input LOW Voltage	—	—	400	—	—	400	—	—	400	mV

**AC ELECTRICAL CHARACTERISTICS**LVPECL:  $V_{CC} = 2.375V$  to  $3.63V$ ,  $V_{EE} = 0V$ ; PECL:  $V_{CC} = 4.50V$  to  $5.50V$ ,  $V_{EE} = 0V$ LVECL:  $V_{CC} = 0V$ ,  $V_{EE} = -2.375V$  to  $-3.63V$ ; ECL:  $V_{CC} = 0V$ ,  $V_{EE} = -4.50V$  to  $-5.5V$ 

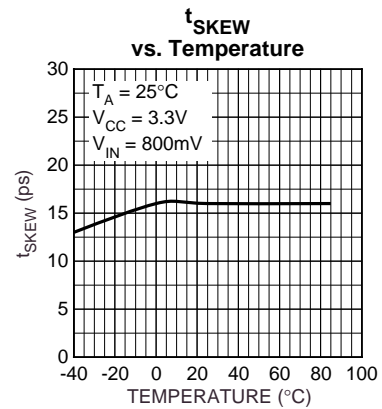
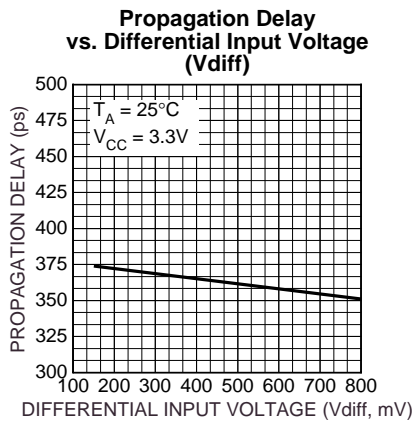
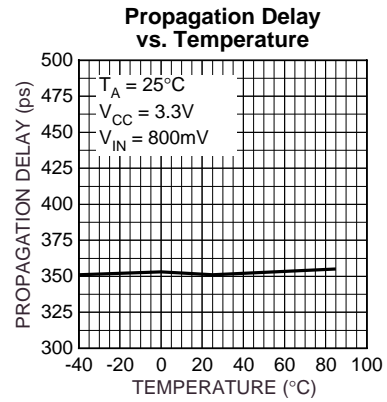
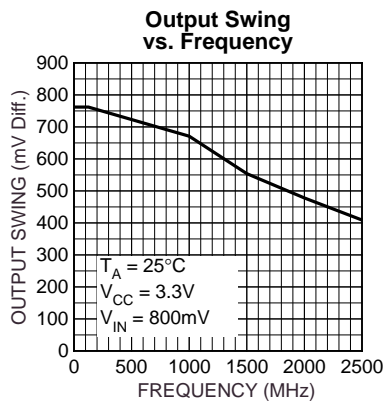
Symbol	Parameter	$T_A = -40^\circ C$			$T_A = +25^\circ C$			$T_A = +85^\circ C$			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
$f_{MAX}^{(1)}$	Maximum Frequency	2.5	—	—	2.5	—	—	2.5	—	—	GHz
$t_{PD}$	Propagation Delay to Output LVPECL/LVECL										
	Diff. IN (150mV)	—	—	—	—	375	—	—	—	—	ps
	Diff. IN (800mV)	300	350	450	300	350	450	300	350	450	ps
	Single-Ended IN	—	—	—	—	375	—	—	—	—	ps
	PECL/ECL										
	Diff. IN (150mV)	—	—	—	—	375	—	—	—	—	ps
	Diff. IN (800mV)	275	350	425	275	350	425	275	350	425	ps
Single-Ended IN	—	—	—	—	355	—	—	—	—	ps	
$t_{SKEW}^{(2)}$	HSTL	325	—	500	300	—	450	300	—	450	ps
	Within-Device Skew (Diff.) Part-to-Part Skew (Diff.)	—	15 100	25 150	—	15 100	25 150	—	15 100	25 150	ps ps
$t_{SW}$	Select to Valid Output Switchover Time	—	—	450	—	400	450	—	—	450	ps
$t_S^{(3)}$	Set-Up Time /EN to CLK	100	0	—	100	0	—	100	0	—	ps
$t_H^{(3)}$	Hold Time /EN to CLK	200	50	—	200	50	—	200	50	—	ps
$t_{JITTER}$	Cycle-to-Cycle <sup>(4)</sup>	—	0.2	1	—	0.2	1	—	0.2	1	$ps_{RMS}$
	Total Jitter (622MHz clock) <sup>(5)</sup>	—	<15	—	—	<15	—	—	<15	—	$ps_{PP}$
$V_{ID}$	Input Voltage Swing	150	800	1200	150	800	1200	150	800	1200	mV
$t_r, t_f$	Output Rise/Fall Times (20% to 80%)	75	—	225	75	130	225	85	—	225	ps

**Notes:**

- $f_{MAX}$  is defined as the maximum toggle frequency. Measured with 750mV input signal, 50% duty cycle, output swing  $\geq 400mV$  (diff), all loading with  $50\Omega$  to  $V_{CC}-2V$ .
- Skew is measured between outputs under identical transitions.
- Set-up and hold times apply to synchronous applications that intend to enable/disable before the next cycle. For asynchronous applications, set-up and hold time does not apply.
- 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 applied to one channel of the MUX, no more than one output edge in  $10^{12}$  output edges will deviate by more than the specified peak-to-peak jitter value.

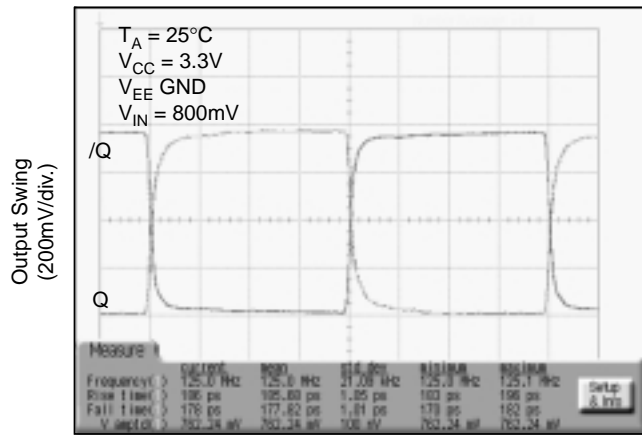
**TYPICAL OPERATING CHARACTERISTICS**

$V_{CC} = 3.3V$ ,  $V_{EE} = GND$ ,  $T_A = 25^\circ C$ , unless otherwise stated.



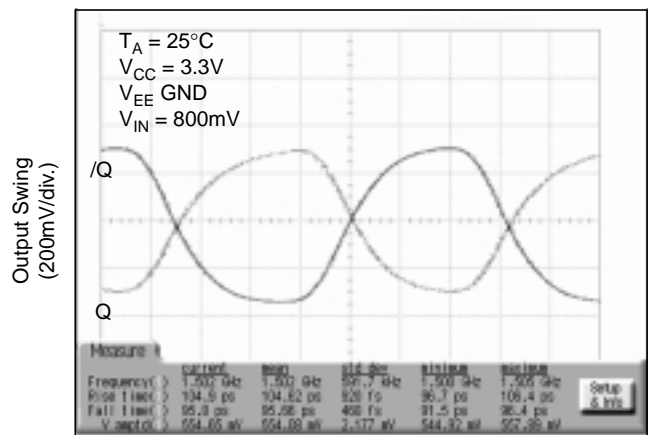
**FUNCTIONAL CHARACTERISTICS**

**125MHz Output**



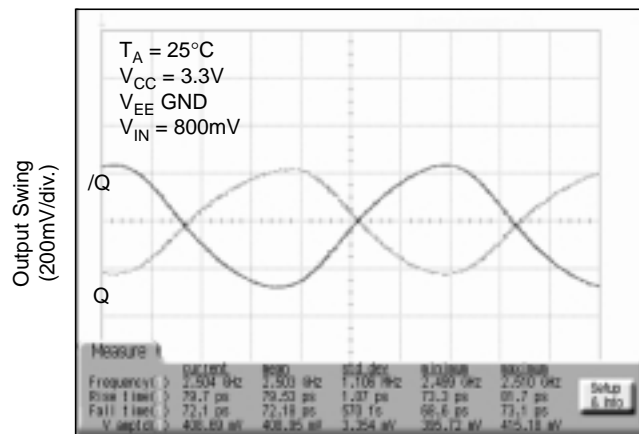
TIME (178ps/div.)

**1.5GHz Output**



TIME (96ps/div.)

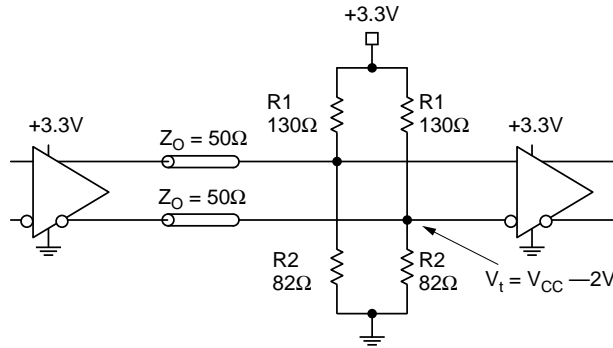
**2.5GHz Output**



TIME (72ps/div.)



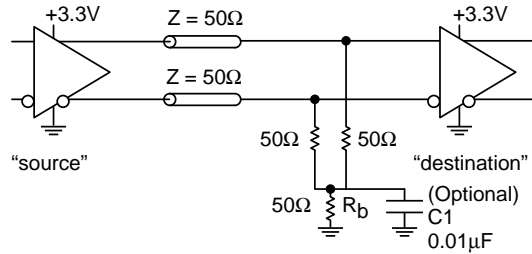
**TERMINATION RECOMMENDATIONS**



**Figure 1. Parallel Termination-Thevenin Equivalent**

**Notes:**

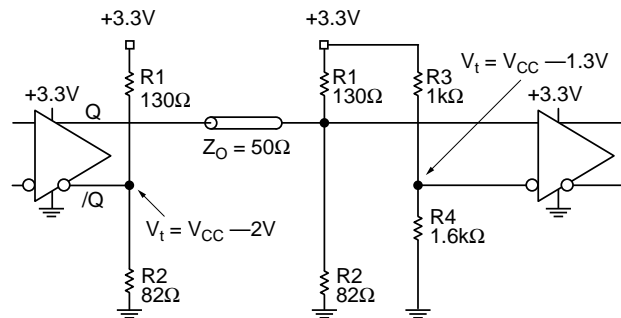
1. For +2.5V systems:  
R1 = 250Ω  
R2 = 62.5Ω
2. For +5.0V systems:  
R1 = 82Ω  
R2 = 130Ω



**Figure 2. Three-Resistor "Y-Termination"**

**Notes:**

1. Power-saving alternative to Thevenin termination.
2. Place termination resistors as close to destination inputs as possible.
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 +5V systems, R<sub>b</sub> = 110Ω.
4. C1 is an optional bypass capacitor intended to compensate for any tr/td mismatches.

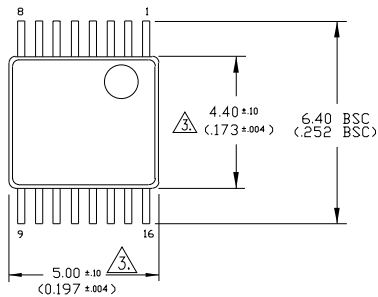


**Figure 3. Terminating Unused I/O**

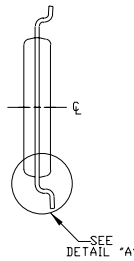
**Notes:**

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.

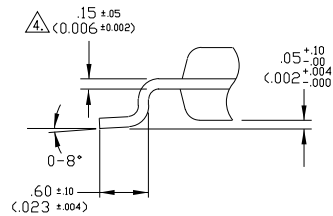
**16 LEAD TSSOP (K4-16-1)**



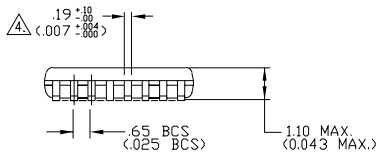
TOP VIEW



END VIEW



DETAIL 'A'  
(VIEW ROTATED 90° C.W.)



SIDE VIEW

- NOTES:  
 1. DIMENSIONS ARE IN MM[INCHES].  
 2. CONTROLLING DIMENSION: MM.  
 3. DIMENSION DOES NOT INCLUDE MOLD FLASH OF 0.254[0.010] MAX.  
 4. THIS DIMENSION INCLUDES LEAD FINISH.

Rev. 01

**MICREL, INC. 2180 FORTUNE DRIVE SAN JOSE, CA 95131 USA**

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