



**2.5V/3.3V/5V 1:2 DIFFERENTIAL  
PECL/LVPECL/ECL  
FANOUT BUFFER**

**ECL Pro™  
SY10EP11U  
SY100EP11U**

**FEATURES**

- 2.5V, 3.3V and 5V power supply options
- Guaranteed AC parameters over temperature:
  - $f_{MAX} > 3.0\text{GHz}$
  - $< 20\text{ps}$  output-to-output skew
  - $< 200\text{ps}$   $t_r / t_f$
  - $< 300\text{ps}$  propagation delay
- Wide temperature range:  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$
- Available in 8-pin (3mm) MSOP and SOIC packages



**ECL Pro™**

**DESCRIPTION**

The SY10/100EP11U is a precision, high-speed 1:2 differential fanout buffer. Having within-device skews and output transition times significantly improved over the EL11V, the EP11U is ideally suited for those applications which require the ultimate in AC performance.

The differential inputs of the EP11U employ clamping circuitry to maintain stability under open input conditions. If the inputs are left open, the Q outputs will go LOW.

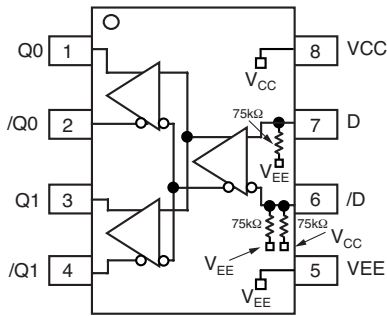
**CROSS REFERENCE TABLE**

Micrel Semiconductor	ON Semiconductor
SY10EP11UZI/KI	MC10EP11D/DT
SY10EP11UZI/KI	MC10LVEP11D/DT
SY100EP11UZI/KI	MC100EP11D/DT
SY100EP11UZI/KI	MC100LVEP11D/DT

**PIN NAMES**

Pin	Function
D	PECL, LVPECL, ECL, LVECL Clock or Data Input: Internal 75kΩ pulldown resistor. If left floating, pin defaults LOW, Q <sub>OUT</sub> goes LOW.
/D	PECL, LVPECL, ECL, LVECL complementary Clock or Data Input: Internal 75kΩ pull-up and down resistors. If left open, default is V <sub>CC</sub> /2. When the input is not used, it can be left open.
Q0, /Q0 Q1, /Q1	PECL, LVPECL, ECL, LVECL Outputs: Terminates to V <sub>CC</sub> -2V.
V <sub>CC</sub>	Positive Power Supply: Bypass with 0.1μF//0.01μF low ESR capacitors.
V <sub>EE</sub>	Negative Power Supply: For PECL operation, connect to GND.

**PACKAGE/ORDERING INFORMATION**



**8-pin MSOP and SOIC Packages**

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

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY10EP11UKC	K8-1	Commercial	HP11	Sn-Pb
SY10EP11UKCTR <sup>(2)</sup>	K8-1	Commercial	HP11	Sn-Pb
SY100EP11UKC	K8-1	Commercial	XP11	Sn-Pb
SY100EP11UKCTR <sup>(2)</sup>	K8-1	Commercial	XP11	Sn-Pb
SY10EP11UZC	Z8-1	Commercial	HEP11U	Sn-Pb
SY10EP11UZCTR <sup>(2)</sup>	Z8-1	Commercial	HEP11U	Sn-Pb
SY100EP11UZC	Z8-1	Commercial	XEP11U	Sn-Pb
SY100EP11UZCTR <sup>(2)</sup>	Z8-1	Commercial	XEP11U	Sn-Pb
SY10EP11UKI	K8-1	Industrial	HP11	Sn-Pb
SY10EP11UKITR <sup>(2)</sup>	K8-1	Industrial	HP11	Sn-Pb
SY100EP11UKI	K8-1	Industrial	XP11	Sn-Pb
SY100EP11UKITR <sup>(2)</sup>	K8-1	Industrial	XP11	Sn-Pb
SY10EP11UZI	Z8-1	Industrial	HEP11U	Sn-Pb
SY10EP11UZITR <sup>(2)</sup>	Z8-1	Industrial	HEP11U	Sn-Pb
SY100EP11UZI	Z8-1	Industrial	XEP11U	Sn-Pb
SY100EP11UZITR <sup>(2)</sup>	Z8-1	Industrial	XEP11U	Sn-Pb
SY10EP11UKG <sup>(3)</sup>	K8-1	Industrial	HP11 with Pb-Free bar-line indicator	Pb-Free NiPdAu
SY10EP11UKGTR <sup>(2, 3)</sup>	K8-1	Industrial	HP11 with Pb-Free bar-line indicator	Pb-Free NiPdAu
SY100EP11UKG <sup>(3)</sup>	K8-1	Industrial	XP11 with Pb-Free bar-line indicator	Pb-Free NiPdAu
SY100EP11UKGTR <sup>(2, 3)</sup>	K8-1	Industrial	XP11 with Pb-Free bar-line indicator	Pb-Free NiPdAu
SY10EP11UZG <sup>(3)</sup>	Z8-1	Industrial	HEP11U with Pb-Free bar-line indicator	Pb-Free NiPdAu
SY10EP11UZGTR <sup>(2, 3)</sup>	Z8-1	Industrial	HEP11U with Pb-Free bar-line indicator	Pb-Free NiPdAu
SY100EP11UZG <sup>(3)</sup>	Z8-1	Industrial	XEP11U with Pb-Free bar-line indicator	Pb-Free NiPdAu
SY100EP11UZGTR <sup>(2, 3)</sup>	Z8-1	Industrial	XEP11U with Pb-Free bar-line indicator	Pb-Free NiPdAu

**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.

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

Symbol	Rating	Value	Unit
$V_{CC} - V_{EE}$	Power Supply Voltage	6V	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 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 (SOIC) -500lfpm (SOIC) -Still-Air (MSOP) -500lfpm (MSOP)	160 109 206 155	°C/W °C/W
$\theta_{JC}$	Package Thermal Resistance (Junction-to-Case) (SOIC) (MSOP)	39 39	°C/W

- Note:**
- 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	$T_A = -40^\circ C$			$T_A = +25^\circ C$			$T_A = +85^\circ C$			Unit	Condition
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.		
$V_{CC}$	Power Supply Voltage (PECL) (LVPECL) (ECL) (LVECL)	4.5 2.37 -5.5 -3.8	5.0 — -5.0 -3.3	5.5 3.8 -4.5 -2.37	4.5 2.37 -5.5 -3.8	5.0 — -5.0 -3.3	5.5 3.8 -4.5 -2.37	4.5 2.37 -5.5 -3.8	5.0 — -5.0 -3.3	5.5 3.8 -4.5 -2.37	V	
$I_{EE}$	Power Supply Current SY10EP11U SY100EP11U	— —	— —	37 44	— —	25 30	39 44	— —	— —	40 44	mA mA	
$I_{IH}$	Input HIGH Current	—	—	150	—	—	150	—	—	150	µA	$V_{IN} = V_{IH}$
$I_{IL}$	Input LOW Current D /D	0.5 -150	— —	— —	0.5 -150	— —	— —	0.5 -150	— —	— —	µA µA	$V_{IN} = V_{IL}$ $V_{IN} = V_{IL}$
$C_{IN}$	Input Capacitance (MSOP) (SOIC)	— —	— —	— —	— —	1.0 1.35	— —	— —	— —	— —	pF pF	

- Note:**
- 10/100KEP 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.

**(10KEP) 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.		
$V_{OL}$	Output LOW Voltage	565	690	815	630	755	880	690	815	940	mV	$50\Omega$ to $V_{CC}-2V$
$V_{OH}$	Output HIGH Voltage	1365	1490	1615	1430	1555	1680	1490	1615	1740	mV	$50\Omega$ to $V_{CC}-2V$
$V_{IHCMR}$	Input HIGH Voltage <sup>(2)</sup> Common Mode Range	1.2	—	$V_{CC}$	1.2	—	$V_{CC}$	1.2	—	$V_{CC}$	V	

**(10KEP) 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)	1365	—	1690	1430	—	1755	1490	—	1815	mV	
$V_{IH}$	Input HIGH Voltage (Single-Ended)	2090	—	2415	2155	—	2480	2215	—	2540	mV	
$V_{OL}$	Output LOW Voltage	1365	1490	1615	1430	1555	1680	1490	1615	1740	mV	$50\Omega$ to $V_{CC}-2V$
$V_{OH}$	Output HIGH Voltage	2165	2290	2415	2230	2355	2480	2290	2415	2540	mV	$50\Omega$ to $V_{CC}-2V$
$V_{IHCMR}$	Input HIGH Voltage <sup>(2)</sup> Common Mode Range	1.2	—	$V_{CC}$	1.2	—	$V_{CC}$	1.2	—	$V_{CC}$	V	

**(10KEP) 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)	3065	—	3390	3130	—	3455	3190	—	3515	mV	
$V_{IH}$	Input HIGH Voltage (Single-Ended)	3790	—	4115	3855	—	4180	3915	—	4240	mV	
$V_{OL}$	Output LOW Voltage	3065	3190	3315	3130	3255	3380	3190	3315	3440	mV	$50\Omega$ to $V_{CC}-2V$
$V_{OH}$	Output HIGH Voltage	3865	3990	4115	3930	4055	4180	3990	4115	4240	mV	$50\Omega$ to $V_{CC}-2V$
$V_{IHCMR}$	Input HIGH Voltage <sup>(2)</sup> Common Mode Range	1.2	—	$V_{CC}$	1.2	—	$V_{CC}$	1.2	—	$V_{CC}$	V	

**No tes:**

- 10KEP 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 500lpm is maintained. Input and output parameters are at  $V_{CC} = 2.5V$ . They vary 1:1 with  $V_{CC}$ .
- The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal. See "Input Waveform" section. Single-ended input CLK pin operation is limited to  $V_{CC} \geq 3.0V$  in PECL mode.

### (10KEP) ECL/LVECL DC ELECTRICAL CHARACTERISTICS<sup>(3)</sup>

$V_{CC} = 0V$ ,  $V_{EE} = -5.5V$  to  $-2.375V$ .

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)	-1935	—	-1610	-1870	—	-1545	-1810	—	-1485	mV	
$V_{IH}$	Input HIGH Voltage (Single-Ended)	-1210	—	-885	-1145	—	-820	-1085	—	-760	mV	
$V_{OL}$	Output LOW Voltage	-1935	-1810	-1685	-1870	-1745	-1620	-1810	-1685	-1560	mV	$50\Omega$ to $V_{CC}-2V$
$V_{OH}$	Output HIGH Voltage	-1135	-1010	-885	-1070	-945	-820	-1010	-885	-760	mV	$50\Omega$ to $V_{CC}-2V$
$V_{IHCMR}$	Input HIGH Voltage <sup>(4)</sup> Common Mode Range	$V_{EE} + 1.2$		0.0	$V_{EE} + 1.2$		0.0	$V_{EE} + 1.2$		0.0	V	

### (100KEP) LVPECL DC ELECTRICAL CHARACTERISTICS<sup>(3)</sup>

$V_{CC} = 2.5V \pm 5\%$ .

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.		
$V_{OL}$	Output LOW Voltage	555	680	805	555	680	805	555	680	805	mV	$50\Omega$ to $V_{CC}-2V$
$V_{OH}$	Output HIGH Voltage	1355	1480	1605	1355	1480	1605	1355	1480	1605	mV	$50\Omega$ to $V_{CC}-2V$
$V_{IHCMR}$	Input HIGH Voltage <sup>(4)</sup> Common Mode Range	1.2	—	$V_{CC}$	1.2	—	$V_{CC}$	1.2	—	$V_{CC}$	V	

### (100KEP) LVPECL DC ELECTRICAL CHARACTERISTICS<sup>(3)</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	
$V_{IH}$	Input HIGH Voltage (Single-Ended)	2075	—	2420	2075	—	2420	2075	—	2420	mV	
$V_{OL}$	Output LOW Voltage	1355	1480	1605	1355	1480	1605	1355	1480	1605	mV	$50\Omega$ to $V_{CC}-2V$
$V_{OH}$	Output HIGH Voltage	2155	2280	2405	2155	2280	2405	2155	2280	2405	mV	$50\Omega$ to $V_{CC}-2V$
$V_{IHCMR}$	Input HIGH Voltage <sup>(4)</sup> Common Mode Range	1.2	—	$V_{CC}$	1.2	—	$V_{CC}$	1.2	—	$V_{CC}$	V	

**Notes:**

- 10KEP 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. See "Input Waveform" section. Single-ended input CLK pin operation is limited to  $V_{EE} \leq -3.0V$  in ECL/LVECL mode.

**(100KEP) PECL DC ELECTRICAL CHARACTERISTICS<sup>(5)</sup>** $V_{CC} = 5.0V \pm 10\%$ ,  $V_{EE} = 0V$ .

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.		
$V_{IL}$	Input LOW Voltage (Single-Ended)	3055	—	3375	3055	—	3375	3055	—	3375	mV	
$V_{IH}$	Input HIGH Voltage (Single-Ended)	3775	—	4120	3775	—	4120	3775	—	4120	mV	
$V_{OL}$	Output LOW Voltage	3055	3180	3305	3055	3180	3305	3055	3180	3305	mV	$50\Omega$ to $V_{CC}-2V$
$V_{OH}$	Output HIGH Voltage	3855	3980	4105	3855	3980	4105	3855	3980	4105	mV	$50\Omega$ to $V_{CC}-2V$
$V_{IHCMR}$	Input HIGH Voltage <sup>(6)</sup> Common Mode Range	2.0	—	$V_{CC}$	2.0	—	$V_{CC}$	2.0	—	$V_{CC}$	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 500fpm is maintained. Input and output parameters are at  $V_{CC} = 5.0V$ . They vary 1:1 with  $V_{CC}$ .
- The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal. See "Input Waveform" section. Single-ended input CLK pin operation is limited to  $V_{CC} \geq 3.0V$  in PECL mode.

**(100KEP) ECL/LVECL DC ELECTRICAL CHARACTERISTICS<sup>(7)</sup>** $V_{CC} = 0V$ ,  $V_{EE} = -5.5V$  to  $-2.375V$ .

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.		
$V_{IL}$	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 <sup>(8)</sup> Common Mode Range	$V_{EE} + 1.2$		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 500fpm is maintained.
- The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal. See "Input Waveform" section. Single-ended input CLK pin operation is limited to  $V_{EE} \leq -3.0V$  in ECL/LVECL mode.

### AC ELECTRICAL CHARACTERISTICS

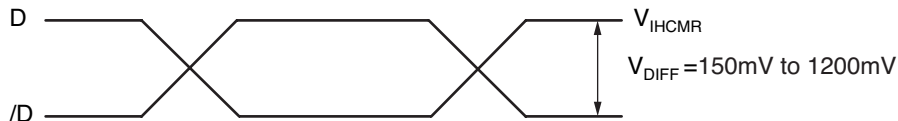
$V_{CC} = 0V$ ;  $V_{EE} = -5.5V$  to  $-2.375V$  or  $V_{CC} = 2.375V$  to  $5.5V$ ,  $V_{EE} = 0V$ .

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.		
$f_{MAX}$	Max. Toggle Frequency <sup>(9)</sup>	3	—	—	3	—	—	3	—	—	GHz	
$t_{PLH}$ $t_{PHL}$	Propagation Delay (Differential) D to Q, /Q D to Q, /Q	140 170	200 230	250 300	160 180	220 240	270 310	180 210	240 270	300 360	ps ps	$V_{CC} = 3.3/5V$ $V_{CC} = 2.5V$
$t_{SKEW}$	Within-Device Skew <sup>(10)</sup> Q, /Q	—	5	20	—	5	20	—	5	20	ps	
	Part-to-Part Skew <sup>(10)</sup>	— —	— —	130 110	— —	— —	130 110	— —	— —	150 120	ps ps	$V_{CC} = 3.3/5V$ $V_{CC} = 2.5V$
$t_{JITTER}$	Cycle-to-Cycle Jitter (RMS)	—	0.2	< 1	—	0.2	< 1	—	0.2	< 1	ps <sub>RMS</sub>	
$V_{DIFF}$	Input Swing <sup>(11)</sup>	150	800	1200	150	800	1200	150	800	1200	mV	
$t_r, t_f$	Output Rise/Fall Time (20% to 80%)	70	110	170	80	120	180	100	140	200	ps	

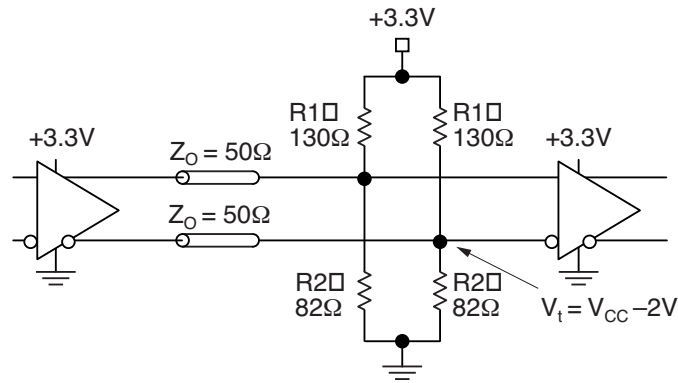
**Notes:**

- 9. Measured with 750mV input signal, 50% duty cycle. All loading with a 50Ω to  $V_{CC} - 2.0V$ .
- 10. Skew is measured between outputs under identical transitions. Duty cycle skew is defined only for differential operation when the delays are measured from the cross point of the inputs to the cross point of the outputs.
- 11. See "Input Waveform."

### INPUT WAVEFORM



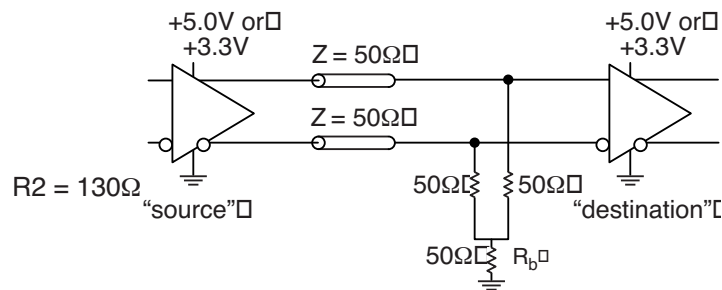
**TERMINATION RECOMMENDATIONS**



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

**Notes:**

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



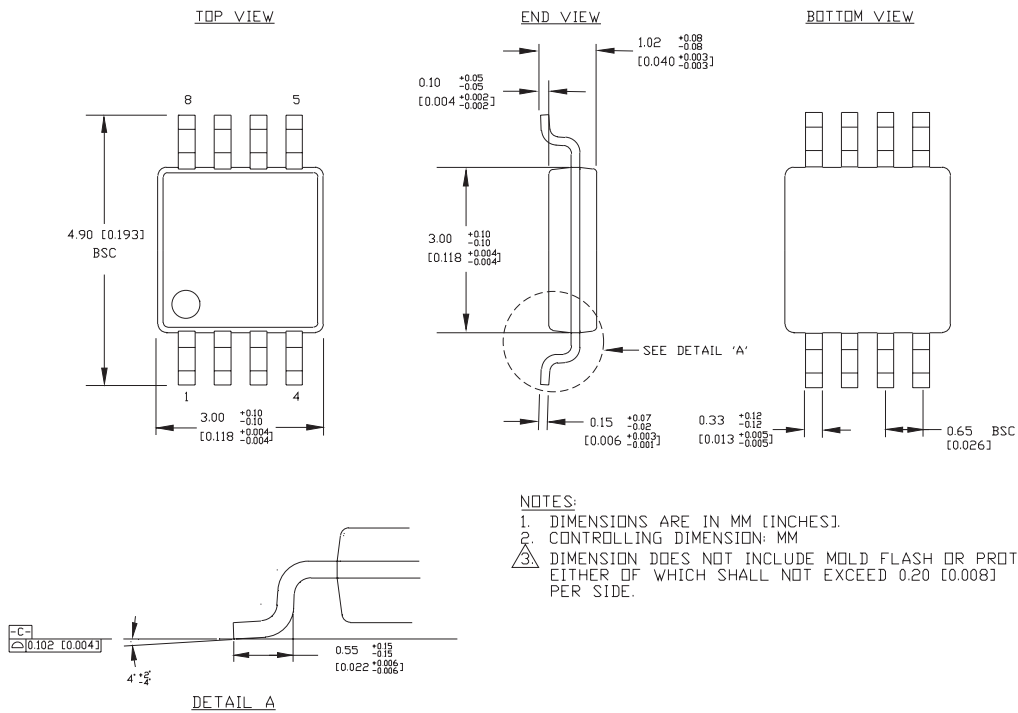
**Figure 2. Three-Resistor “Y-Termination”**

**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.

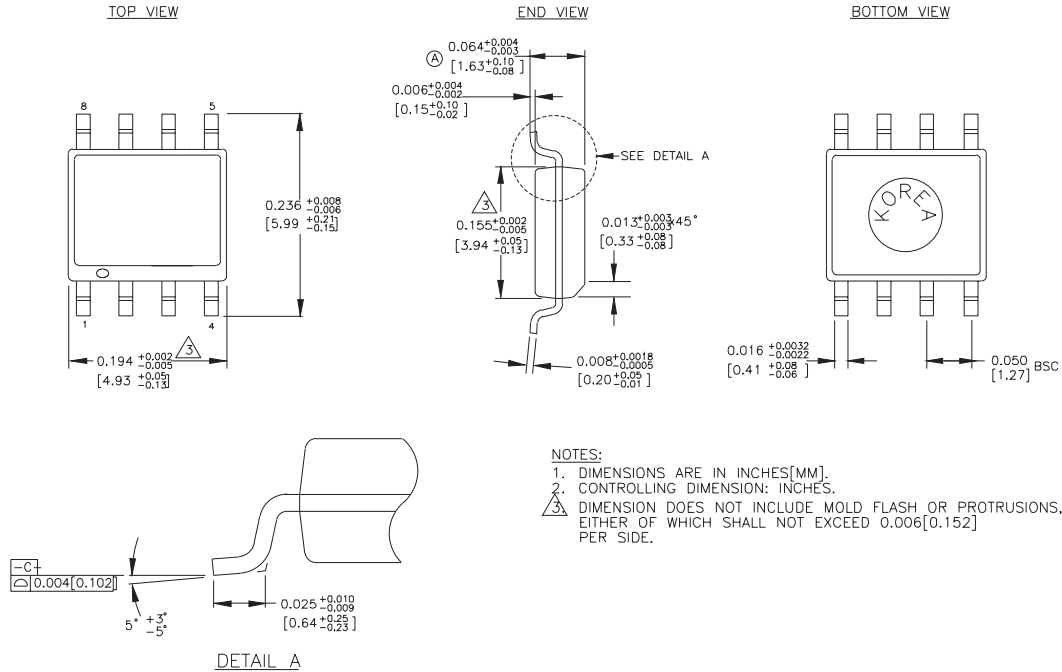


**8-PIN MSOP (K8-1)**



Rev. 01

**8-PIN SOIC (Z8-1)**



Rev. 03

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

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С конца 2013 года компания активно расширяет линейку поставок компонентов по направлению коаксиальный кабель, кварцевые генераторы и конденсаторы (керамические, пленочные, электролитические), за счёт заключения дистрибьюторских договоров

Мы предлагаем:

- Конкурентоспособные цены и скидки постоянным клиентам.
- Специальные условия для постоянных клиентов.
- Подбор аналогов.
- Поставку компонентов в любых объемах, удовлетворяющих вашим потребностям.
- Приемлемые сроки поставки, возможна ускоренная поставка.
- Доставку товара в любую точку России и стран СНГ.
- Комплексную поставку.
- Работу по проектам и поставку образцов.
- Формирование склада под заказчика.
- Сертификаты соответствия на поставляемую продукцию (по желанию клиента).
- Тестирование поставляемой продукции.
- Поставку компонентов, требующих военную и космическую приемку.
- Входной контроль качества.
- Наличие сертификата ISO.

В составе нашей компании организован Конструкторский отдел, призванный помогать разработчикам, и инженерам.

Конструкторский отдел помогает осуществить:

- Регистрацию проекта у производителя компонентов.
- Техническую поддержку проекта.
- Защиту от снятия компонента с производства.
- Оценку стоимости проекта по компонентам.
- Изготовление тестовой платы монтаж и пусконаладочные работы.



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