



# ULTRA-PRECISION 1:8 FANOUT BUFFER WITH 400mV LVPECL OUTPUTS AND INTERNAL TERMININATION

Precision Edge®  
SY58033U

## FEATURES

- Precision 1:8, 400mV LVPECL fanout buffer
- Guaranteed AC performance over temperature and voltage:
  - Clock frequency range: DC to 5.5GHz
  - $<80\text{ps}$   $t_r/t_f$  times
  - $<280\text{ps}$   $t_{pd}$
  - $<20\text{ps}$  skew
- Low-jitter performance:
  - $<10\text{ps}_{pp}$  total jitter (clock)
  - $<1\text{ps}_{RMS}$  random jitter (data)
- 100k LVPECL compatible outputs
- Fully differential inputs/outputs
- Accepts an input signal as low as 100mV
- Unique input termination and  $V_T$  pin accepts DC-coupled and AC-coupled differential inputs: (LVPECL, LVDS, and CML)
- Power supply  $2.5\text{V} \pm 5\%$  or  $3.3\text{V} \pm 10\%$
- Industrial temperature range:  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$
- Available in 32-pin (5mm x 5mm) MLF® Package



Precision Edge®

## DESCRIPTION

The SY58033U is a 2.5V/3.3V precision, high-speed, fully differential 400mV LVPECL 1:8 fanout buffer. The SY58033U is optimized to provide eight identical output copies with less than 20ps of skew and less than 10ps<sub>pp</sub> total jitter. It can process clock signals as fast as 5.5GHz.

The differential input includes Micrel's unique, 3-pin input termination architecture that allows the SY58033U to directly interface to LVPECL, CML, and LVDS differential signal (AC- or DC-coupled) without any level-shifting or termination resistor networks in the signal path. The result is a clean, stub-free, low-jitter solution. The LVPECL (100k temperature compensated) outputs feature a 400mV typical swing into 50Ω loads, and provide an extremely fast rise/fall time guaranteed to be less than 80ps.

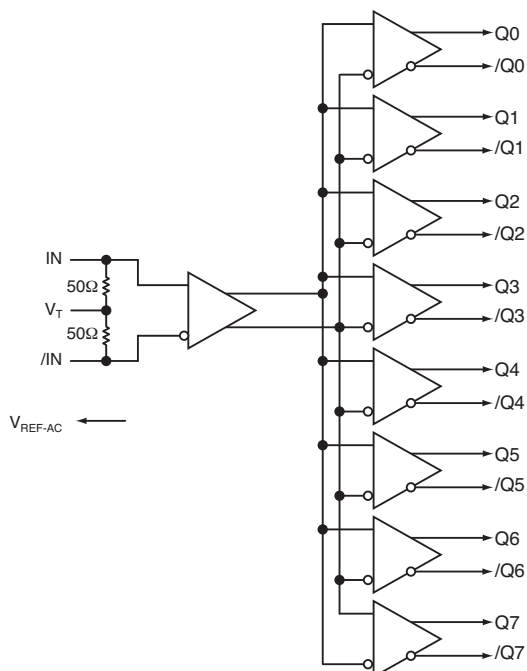
The SY58033U operates from a  $2.5\text{V} \pm 5\%$  supply or  $3.3\text{V} \pm 10\%$  supply and is guaranteed over the full industrial temperature range ( $-40^\circ\text{C}$  to  $+85^\circ\text{C}$ ). Other high-speed 1:8 fanout buffers include the CML SY58031U and the 800mV LVPECL SY58032U. The SY58033U is part of Micrel's high-speed, Precision Edge® product line.

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

## APPLICATIONS

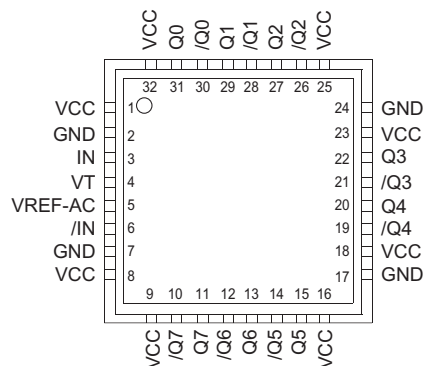
- All SONET and all GigE clock distribution
- All Fibre Channel clock and data distribution
- Network routing engine timing distribution
- High-end, low-skew multiprocessor synchronous clock distribution

## FUNCTIONAL BLOCK DIAGRAM



Precision Edge is a registered trademark of Micrel, Inc.  
MicroLeadFrame and MLF are registered trademarks of Amkor Technology, Inc.

## PACKAGE/ORDERING INFORMATION



32-Pin MLF® (MLF-32)

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

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY58033UMI	MLF-32	Industrial	SY58033U	Sn-Pb
SY58033UMITR <sup>(2)</sup>	MLF-32	Industrial	SY58033U	Sn-Pb
SY58033UMG <sup>(3)</sup>	MLF-32	Industrial	SY58033U with Pb-Free bar-line indicator	Pb-Free NiPdAu
SY58033UMGTR <sup>(2, 3)</sup>	MLF-32	Industrial	SY58033U with Pb-Free bar-line indicator	Pb-Free NiPdAu

## 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 recommended for new designs.

## PIN DESCRIPTION

Pin Number	Pin Name	Pin Function
3, 6	IN, /IN	Differential Signal Input: Each pin of this pair internally terminates with $50\Omega$ to the $V_T$ pin. Note that this input will default to an indeterminate state if left open. See "Input Interface Applications" section.
4	VT	Input Termination Center-Tap: Each input terminates to this pin. The $V_T$ pin provides a center-tap for each input (IN, /IN) to the termination network for maximum interface flexibility. See "Input Interface Applications" section.
2, 7, 17, 24	GND, Exposed Pad	Ground. Exposed pad must be connected to a ground plane that is the same potential as the ground pin.
1, 8, 9, 16, 18, 23, 25, 32	VCC	Positive Power Supply: Bypass with $0.1\mu\text{F} \parallel 0.01\mu\text{F}$ low ESR capacitors as close to the pins as possible.
31, 30, 29, 28, 27, 26, 22, 21, 20, 19, 15, 14, 13, 12, 11, 10	Q0, /Q0, Q1, /Q1, Q2, /Q2, Q3, /Q3, Q4, /Q4, Q5, /Q5, Q6, /Q6, Q7, /Q7	400mV LVPECL Differential Output Pairs: Differential buffered output copy of the input signal. The LVPECL output swing is typically 400mV into $50\Omega$ . Unused output pairs may be left floating with no impact on jitter. See "LVPECL Output" section.
5	VREF-AC	Bias Reference Voltage: Equal to $V_{CC}-1.2\text{V}$ (approx.), and used for AC-coupled applications. See "Input Interface Applications" section. When using $V_{REF-AC}$ , bypass with $0.01\mu\text{F}$ capacitor to $V_{CC}$ . Maximum sink/source current is 0.5mA.

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

Power Supply Voltage ( $V_{CC}$ )	..... -0.5V to +4.0V
Input Voltage ( $V_{IN}$ )	..... -0.5V to $V_{CC}$
Current ( $V_T$ )	
Source or sink current on $V_T$ pin	..... $\pm 100$ mA
Input Current ( $V_T$ )	
Source or sink current on IN, /IN	..... $\pm 50$ mA
Current ( $V_{REF}$ )	
Source or sink current on $V_{REF-AC}$ <sup>(3)</sup>	..... $\pm 1.5$ mA
Lead Temperature Soldering (20 sec.)	..... 260°C
Storage Temperature Range ( $T_S$ )	..... -65°C to +150°C

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

Power Supply Voltage ( $V_{CC}$ )	..... +2.375V to +3.60V
Ambient Temperature Range ( $T_A$ )	..... -40°C to +85°C
Package Thermal Resistance <sup>(4)</sup>	
MLF® ( $\theta_{JA}$ )	
Still-Air	..... 35°C/W
MLF® ( $\psi_{JB}$ )	
Junction-to-Board	..... 20°C/W

**DC ELECTRICAL CHARACTERISTICS<sup>(5)</sup>** $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ .

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{CC}$	Power Supply Voltage	2.5V nominal 3.3V nominal	2.375 3.0	2.5 3.3	2.625 3.6	V
$I_{CC}$	Power Supply Current	$V_{CC} = \text{max.}$ No. load includes current through 50 $\Omega$ pull-ups.		180	250	mA
$V_{IH}$	Input HIGH Voltage	IN, /IN	$V_{CC}-1.2$		$V_{CC}$	V
$V_{IL}$	Input LOW Voltage	IN, /IN	0		$V_{IH}-0.1$	V
$V_{IN}$	Input Voltage Swing	IN, /IN, see Figure 1a.	0.1		1.7	V
$V_{DIFF\_IN}$	Differential Input Voltage Swing IIN0, /IN0I, IIN1, /IN1I	IN, /IN, see Figure 1b.	0.2			V
$R_{IN}$	In-to- $V_T$ Resistance		40	50	60	$\Omega$
$V_{T\ IN}$	Max. In-to- $V_T$ (IN, /IN)				1.28	V
$V_{REF-AC}$			$V_{CC}-1.3$	$V_{CC}-1.2$	$V_{CC}-1.1$	V

**LVPECL DC ELECTRICAL CHARACTERISTICS<sup>(5)</sup>** $V_{CC} = 2.5\text{V} \pm 5\%$  or  $3.3\text{V} \pm 10\%$ ;  $R_L = 50\Omega$  to  $V_{CC}-2\text{V}$ ;  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$  unless otherwise stated

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{OH}$	Output HIGH Voltage		$V_{CC}-1.145$		$V_{CC}-0.895$	V
$V_{OL}$	Output LOW Voltage		$V_{CC}-1.545$		$V_{CC}-1.295$	V
$V_{OUT}$	Output Voltage Swing	see Figure 1a.	150	400		mV
$V_{DIFF\_OUT}$	Differential Voltage Swing	see Figure 1b.	300	800		mV

**Notes:**

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 Ratings" conditions for extended periods may affect device reliability.
2. The data sheet limits are not guaranteed if the device is operated beyond the operating ratings.
3. Due to the limited drive capability, use for input of the same package only.
4. Thermal performance assumes exposed pad is soldered (or equivalent) to the device's most negative potential (GND) on the PCB.  $\psi_{JB}$  uses 4-layer  $\theta_{JA}$  in still-air number unless otherwise stated.
5. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

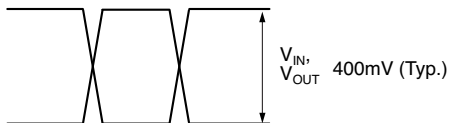
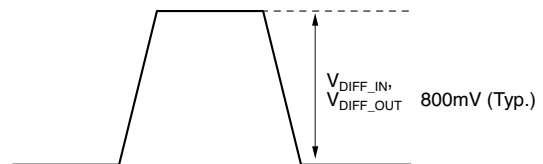
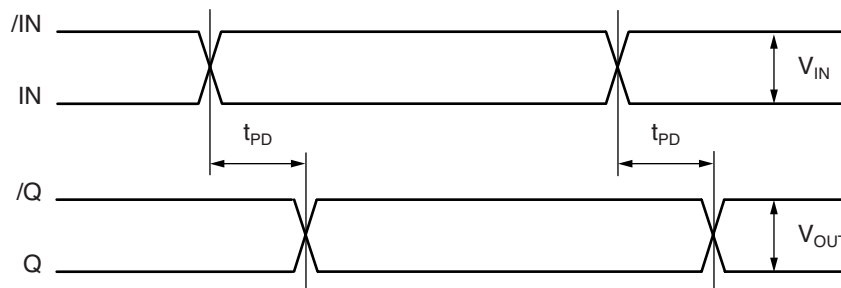
**AC ELECTRICAL CHARACTERISTICS<sup>(7)</sup>**

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

Symbol	Parameter	Condition	Min	Typ	Max	Units
$f_{MAX}$	Maximum Operating Frequency	$V_{OUT} \geq 200mV$ Clock	5.5			GHz
$t_{pd}$	Propagation Delay (IN-to-Q)		130	200	280	ps
$t_{pd} \text{ tempco}$	Differential Propagation Delay Temperature Coefficient			35		fs/°C
$t_{SKEW}$	Output-to-Output Skew (within device)	<b>Note 8</b>		7	20	ps
	Part-to-Part Skew	<b>Note 9</b>			100	ps
$t_{JITTER}$	Clock Cycle-to-Cycle	<b>Note 10</b>			1	ps <sub>RMS</sub>
	Total Jitter (Clock)	<b>Note 11</b>			10	ps <sub>PP</sub>
	Random Jitter (RJ)	<b>Note 12</b>			1	ps <sub>RMS</sub>
$t_r, t_f$	Output Rise/Fall Time	20% to 80%, at full output swing.	20	50	80	ps

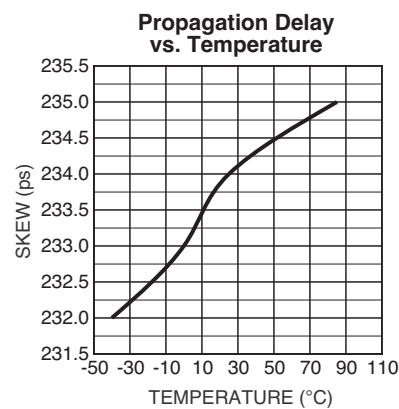
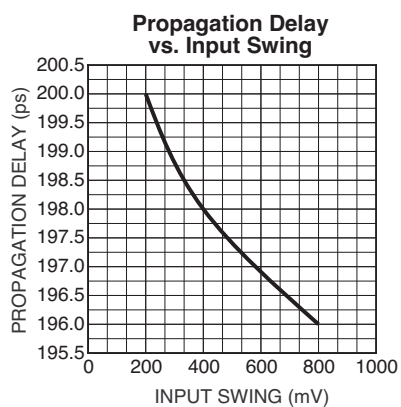
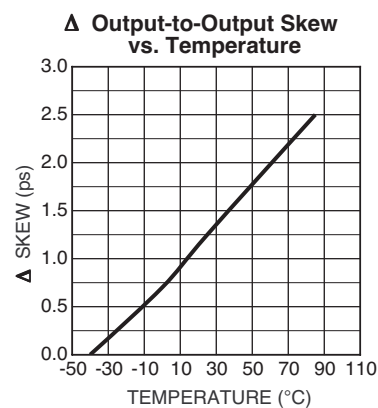
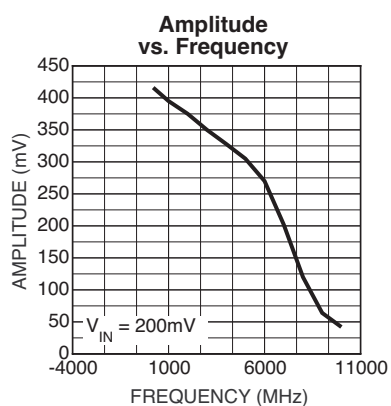
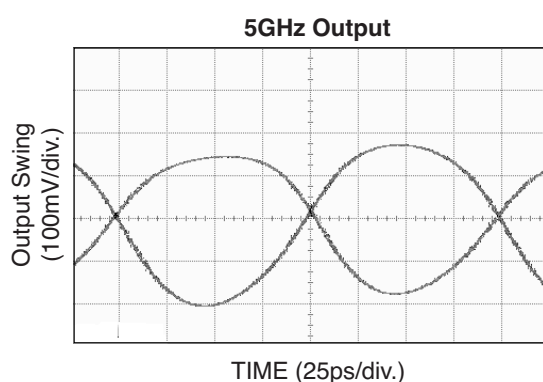
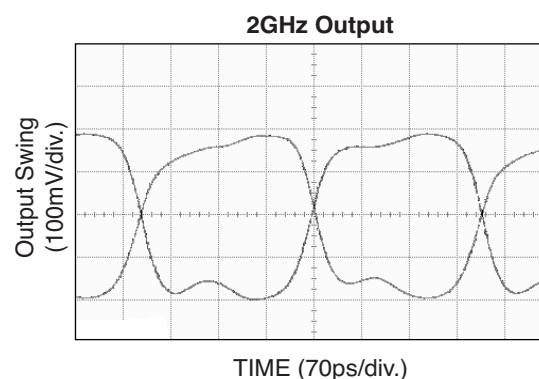
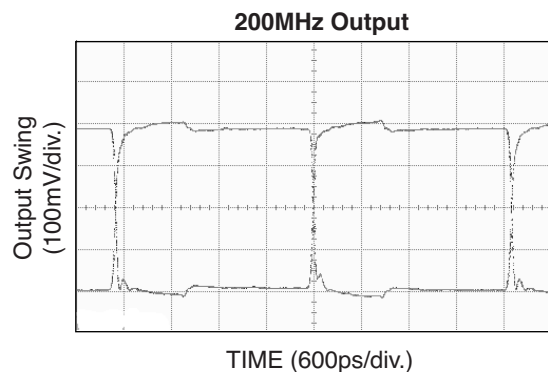
**Notes:**

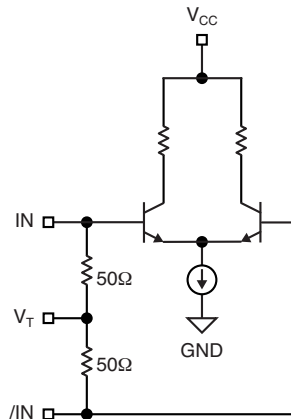
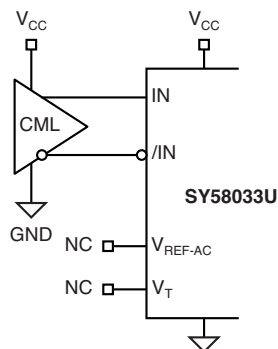
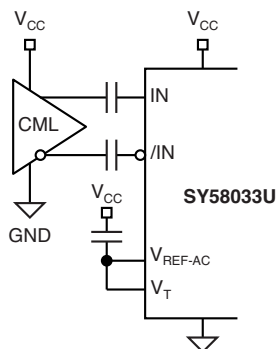
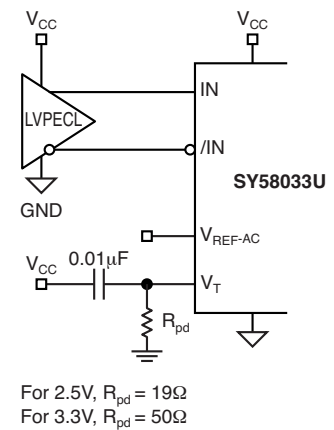
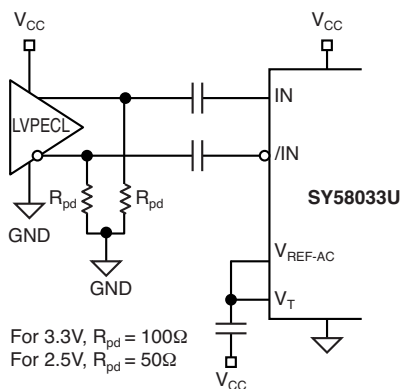
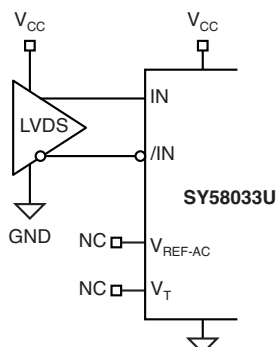
- High frequency AC electricals are guaranteed by design and characterization. All outputs loaded with  $50\Omega$  to  $V_{CC}-2V$ ,  $V_{IN} \geq 100mV$ .
- Output-to-output skew is measured between outputs under identical conditions.
- Part-to-part skew is defined for two parts with identical power supply voltages at the same temperature and with no skew of the edges at the respective inputs. Part-to-part skew includes variation in  $t_{pd}$ .
- Cycle-to-cycle jitter definition: The variation of periods between adjacent cycles,  $T_n - T_{n-1}$  where  $T$  is the time between rising edges of the output signal.
- Total jitter definition: With an ideal clock input of frequency  $\leq f_{MAX}$ , no more than one output edge in  $10^{12}$  output edges will deviate by more than the specified peak-to-peak jitter value.
- Random jitter is measured with a K28.7 comma detect character pattern, measured at 1.25Gbps and 2.5Gbps.

**SINGLE-ENDED AND DIFFERENTIAL SWINGS****Figure 1a. Single-Ended Voltage Swing****Figure 1b. Differential Voltage Swing****TIMING DIAGRAM**

**TYPICAL OPERATING CHARACTERISTICS**

$V_{CC} = 2.5V$ ,  $GND = 0$ ,  $V_{IN} = 100mV$ ,  $T_A = 25^\circ C$ , unless otherwise stated.



**INPUT BUFFER****Figure 2. Simplified Differential Input Buffer****INPUT INTERFACE APPLICATIONS****Figure 3a. DC-Coupled CML Input Interface***Option: May connect  $V_T$  to  $V_{CC}$ .***Figure 3b. AC-Coupled CML Input Interface****Figure 3c. LVPECL Input Interface****Figure 3d. AC-Coupled LVPECL Input Interface****Figure 3e. LVDS Input Interface**

LVPECL OUTPUT

LVPECL has high input impedance, and very low output impedance (open emitter), and small signal swing which results in low electromagnetic interference (EMI). LVPECL is ideal for driving 50Ω and 100Ω controlled impedance transmission lines. There are several techniques in

terminating the LVPECL output, which are the Parallel Termination-Thevenin Equivalent, the Parallel Termination (3-Resistor), and the AC-Coupled Termination. Unused output pairs may be left floating. However, single-ended outputs must be terminated, or balanced.

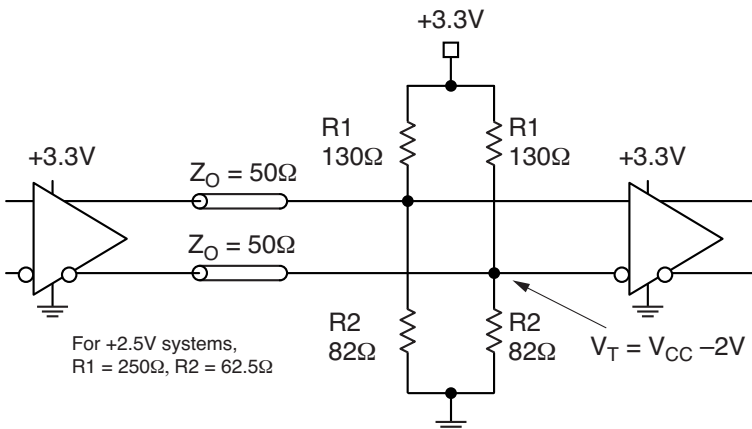
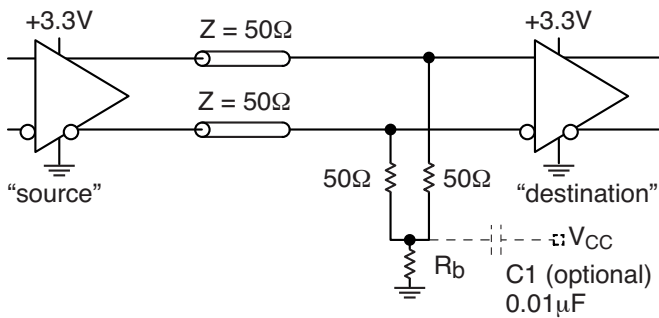


Figure 4. Parallel Termination-Thevenin Equivalent

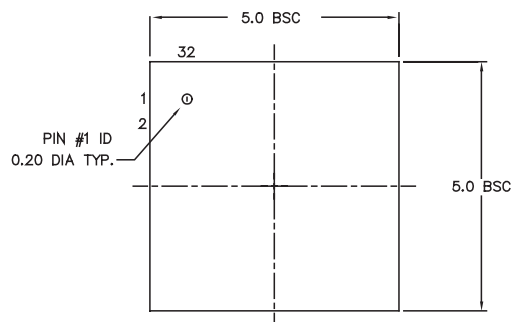


- Notes:
- 1. Power saving alternative to Thevenin termination.
  - 2. Place termination resistors as close to destination inputs as possible.
  - 3. R<sub>b</sub> resistor sets the DC bias voltage, equal to V<sub>T</sub>.
  - 4. For 2.5V systems, R<sub>b</sub> = 19Ω, For 3.3V systems, R<sub>b</sub> = 50Ω

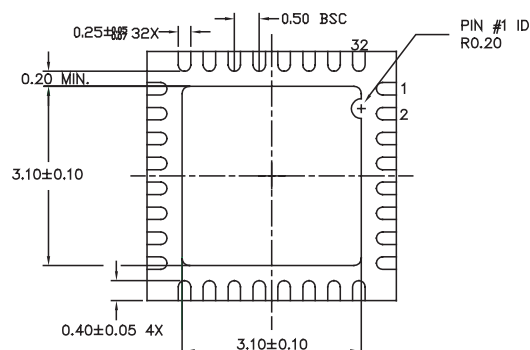
Figure 5. Parallel Termination (3-Resistor)

RELATED MICREL PRODUCTS AND SUPPORT DOCUMENTATION

Part Number	Function	Data Sheet Link
SY58031U	Ultra-Precision 1:8 Fanout Buffer with 400mV CML Outputs and Internal I/O Termination	<a href="http://www.micrel.com/product-info/products/sy58031u.shtml">http://www.micrel.com/product-info/products/sy58031u.shtml</a>
SY58032U	Ultra-Precision 1:8 Fanout Buffer with LVPECL Outputs and Internal Termination	<a href="http://www.micrel.com/product-info/products/sy58032u.shtml">http://www.micrel.com/product-info/products/sy58032u.shtml</a>
SY58033U	Ultra-Precision 1:8 Fanout Buffer with 400mV LVPECL Outputs and Internal Termination	<a href="http://www.micrel.com/product-info/products/sy58033u.shtml">http://www.micrel.com/product-info/products/sy58033u.shtml</a>
	32-MLF <sup>®</sup> Manufacturing Guidelines Exposed Pad Application Note	<a href="http://www.amkor.com/products/notes_papers/MLF_AppNote_0902.pdf">www.amkor.com/products/notes_papers/MLF_AppNote_0902.pdf</a>
	HBW Solutions	<a href="http://www.micrel.com/product-info/as/solutions.shtml">http://www.micrel.com/product-info/as/solutions.shtml</a>

**32-PIN MicroLeadFrame® (MLF-32)**

TOP VIEW



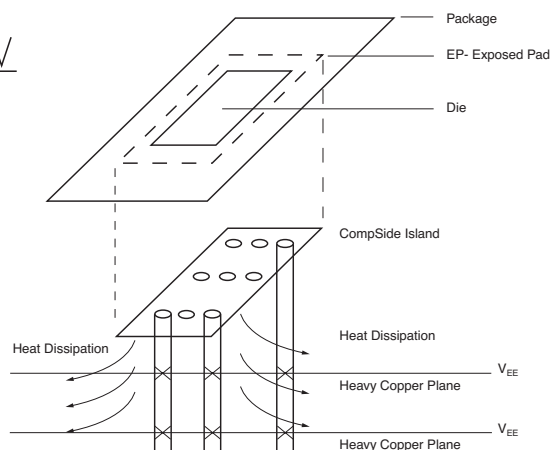
BOTTOM VIEW



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 32-Pin MLF® Package**  
**(Always solder, or equivalent, the exposed pad to the PCB)**

**Package Notes:**

1. Package meets Level 2 qualification.
2. All parts are dry-packaged before shipment.
3. Exposed pads must be soldered to a ground for proper thermal management.

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

TEL + 1 (408) 944-0800 FAX + 1 (408) 474-1000 WEB <http://www.micrel.com>

The information furnished by Micrel in this data sheet is believed to be accurate and reliable. However, no responsibility is assumed by Micrel for its use. Micrel reserves the right to change circuitry and specifications at any time without notification to the customer.

Micrel Products are not designed or authorized for use as components in life support appliances, devices or systems where malfunction of a product can reasonably be expected to result in personal injury. Life support devices or systems are devices or systems that (a) are intended for surgical implant into the body or (b) support or sustain life, and whose failure to perform can be reasonably expected to result in a significant injury to the user. A Purchaser's use or sale of Micrel Products for use in life support appliances, devices or systems is at Purchaser's own risk and Purchaser agrees to fully indemnify Micrel for any damages resulting from such use or sale.

© 2005 Micrel, Incorporated.