



## SY89858U

### Precision Low Power 1:8 LVPECL Fanout Buffer with Internal Termination

#### General Description

The SY89858U is a 2.5V/3.3V precision, high-speed, fully differential LVPECL 1:8 fanout buffer optimized to provide eight identical output copies with less than 30ps of skew and less than 10ps<sub>pp</sub> total jitter. It can process clock signals as fast as 2.0GHz.

The differential input includes Micrel's unique, 3-pin input termination architecture that allows the SY89858U to directly interface to LVPECL, CML, and LVDS differential signals (AC- or DC-coupled) as small as 100mV without any level shifting or termination resistor networks in the signal path. The result is a clean, stub-free, low-jitter interface solution. The LVPECL (100k temperature compensated) outputs feature 800mV typical swing into 50Ω loads, and provide fast rise/fall times guaranteed to be less than 200ps.

The SY89858U operates from a 2.5V ±5% supply or 3.3V ±10% supply and is guaranteed over the full industrial temperature range of -40°C to +85°C. For applications that require a higher speed fanout buffer, consider the SY58032U. The SY89858U 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).



Precision Edge®

#### Features

- Precision 1:8, LVPECL fanout buffer
- Low power: 238mW (2.5V)
- Guaranteed AC performance over temperature and supply voltage:
  - Wide operating frequency: DC to 2.0GHz
  - <380ps In-to-Out t<sub>pd</sub>
  - <200ps t<sub>r</sub>/t<sub>f</sub>
  - <30ps skew
- Ultra-low jitter design:
  - <1ps<sub>RMS</sub> random jitter
  - <1ps<sub>RMS</sub> cycle-to-cycle jitter
  - <10ps<sub>pp</sub>total jitter
- 100k LVPECL compatible outputs
- Fully differential inputs/outputs
- Accepts an input signal as low as 100mV (200mV<sub>pp</sub>)
- Unique patent pending input termination and VT pin accepts DC-coupled and AC-coupled differential inputs (LVPECL, LVDS, and CML)
- Power supply 2.5V ±5% or 3.3V ±10%
- -40°C to +85°C industrial temperature range
- Available in 32-pin (5mm x 5mm) MLF® package

#### Applications

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

#### Markets

- LAN/WAN
- Enterprise servers
- ATE
- Test and measurement

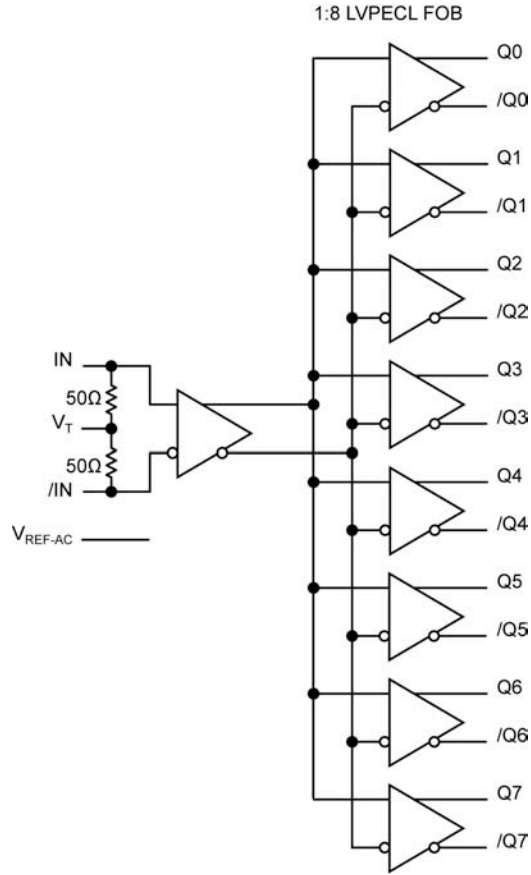
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# Typical Application



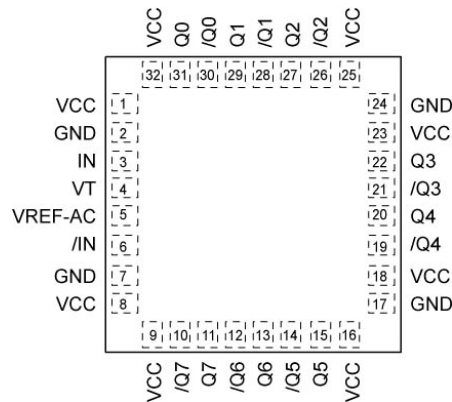
## Ordering Information<sup>(1)</sup>

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY89858UMG	MLF-32	Industrial	SY89858 with Pb-Free bar-line indicator	NiPdAu Pb-Free
SY89858UMGTR <sup>(2)</sup>	MLF-32	Industrial	SY89858 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.

## Pin Configuration



**32-Pin MLF<sup>®</sup> (MLF-32)**

## Pin Description

Pin Number	Pin Name	Pin Function
3, 6	IN, /IN	Differential Input: This differential input accepts AC- or DC-coupled signals as small as 100mV (200mV <sub>PP</sub> ). Each pin of this pair internally terminates to a VT pin through 50W. Note that these inputs will default to an indeterminate state if left open. Please refer to the “Input Interface Applications” section for more details.
4	VT	Input Termination Center-Tap: Each side of the differential input pair terminates to this VT pin. The VT pin provides a center-tap to a termination network for maximum interface flexibility. See the “Input Interface Applications” section for more details.
5	VREF-AC	Reference Voltage: This output biases to V <sub>CC</sub> -1.2V (typical). It is used for AC-coupling inputs IN and /IN. Connect VREF-AC directly to the corresponding VT pin. Bypass with 0.01uF low ESR capacitor to V <sub>CC</sub> . Maximum sink/source capability is 1.5mA.
1, 8, 9, 16, 18, 23, 25, 32	VCC	Positive Power Supply: Bypass with 0.1mF//0.01mF low ESR capacitors as close to the VCC 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	100k LVPECL Differential Outputs: Differential buffered output copy of the input signal. The LVPECL output swing is typically 800mV into 50Ω to V <sub>CC</sub> -2V. Unused output pairs may be left floating with no impact on jitter. See “LVPECL Output” section.
2, 7, 17, 24	GND Exposed Pad	Ground: Ground pins and exposed pad must be connected to the same ground plane.

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

Supply Voltage ( $V_{CC}$ )	-0.5V to +4.0V
Input Voltage ( $V_{IN}$ )	-0.5V to $V_{CC}$
Termination Current	
Source or sink current on $V_T$	$\pm 100$ mA
Reference Current <sup>(3)</sup>	
Source or sink current on $V_{REF-AC}$	$\pm 1.5$ mA
LVPECL Output Current ( $I_{OUT}$ )	
Continuous	50mA
Surge	100mA
Lead Temperature (soldering, 20 sec.)	+260°C
Storage Temperature ( $T_S$ )	-65°C to 150°C

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

Supply Voltage ( $V_{CC}$ )	+2.375V to +2.625V
	+3.0V to +3.6V
Ambient Temperature ( $T_A$ )	-40°C to +85°C
Package Thermal Resistance <sup>(4)</sup>	
MLF <sup>®</sup> ( $\theta_{JA}$ )	
Still-Air	35°C/W
MLF <sup>®</sup> ( $\psi_{JB}$ )	
Junction-to-Board	20°C/W

**DC Electrical Characteristics<sup>(5)</sup>**

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

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{CC}$	Power Supply		2.375	2.5	2.625	V
			3.0	3.3	3.6	V
$I_{CC}$	Power Supply Current	No load, max. $V_{CC}$		95	150	mA
$R_{IN}$	Input Resistance (IN-to- $V_T$ )		45	50	55	$\Omega$
$R_{DIFF\_IN}$	Differential Input Resistance (IN-to-/IN)		90	100	110	$\Omega$
$V_{IH}$	Input High Voltage (IN, /IN)	Note 6	$V_{CC} - 1.6$		$V_{CC}$	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  IN-/IN	See Figure 1b.	0.2			V
$V_{T\_IN}$	IN-to- $V_T$ (IN, /IN)				1.28	V
$V_{REF-AC}$	Output Reference Voltage		$V_{CC} - 1.3$ V	$V_{CC} - 1.2$ V	$V_{CC} - 1.1$ V	V

**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. Package Thermal Resistance assumes exposed pad is soldered (or equivalent) to the devices most negative potential on the PCB.  $\theta_{JA}$  and  $\psi_{JB}$  values are determined for a 4-layer board in still air, unless otherwise stated.
5. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
6.  $V_{IH}$  (min) not lower than 1.2V.

## LVPECL Outputs DC Electrical Characteristics<sup>(7)</sup>

$V_{CC} = 2.5V \pm 5\%$  or  $3.3V \pm 10\%$ ;  $T_A = -40^\circ C$  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 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 1a.	500	800		mV
$V_{DIFF-OUT}$	Differential Output Voltage Swing Q, /Q	See Figure 1b.	1000	1600		mV

### Note:

7. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

## AC Electrical Characteristics<sup>(8)</sup>

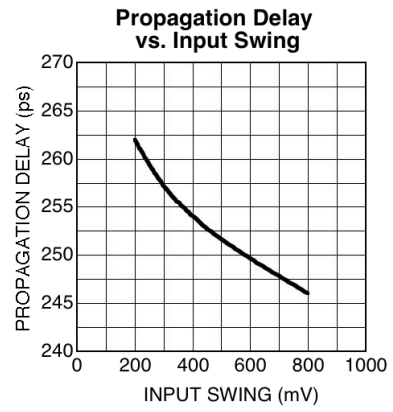
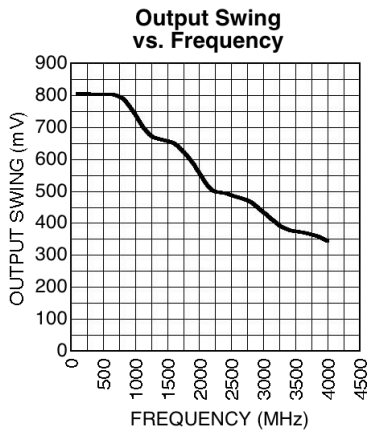
$V_{CC} = 2.5V \pm 5\%$  or  $3.3V \pm 10\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ ,  $R_L = 50\Omega$  to  $V_{CC} - 2V$ , unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$f_{MAX}$	Maximum Operating Frequency	$V_{OUT} \geq 400mV$	2.0	3.0		GHz
$t_{PD}$	Propagation Delay (IN-to-Q)		180	260	380	ps
$T_{pd}$ Tempco	Differential Propagation Delay Temperature Coefficient			115		fs/ $^\circ C$
$T_{skew}$	Output-to-Output Skew	Note 9			30	ps
	Part-to-Part Skew	Note 10			150	
$t_{jitter}$	Random Jitter (RJ)	Note 11			1	pSRMS
	Deterministic Jitter (DJ)	Note 12			10	pSPP
	Cycle-to-Cycle Jitter	Note 13			1	pSPP
	Total Jitter	Note 14			10	pSPP
$t_R, t_F$	Output Rise/Fall Time (20% to 80%)	At full output swing.	75	130	200	ps

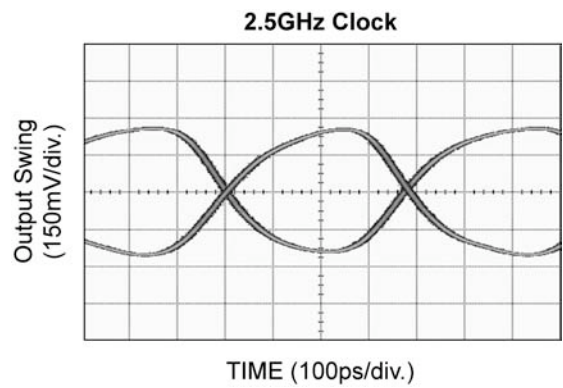
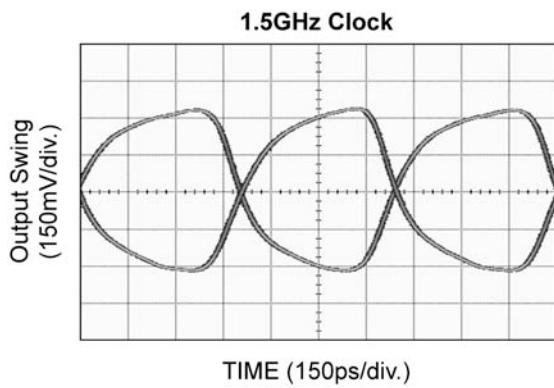
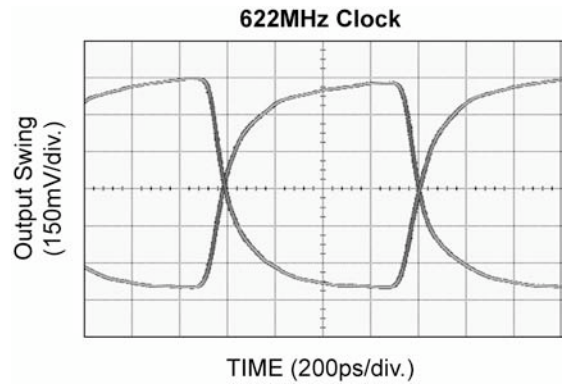
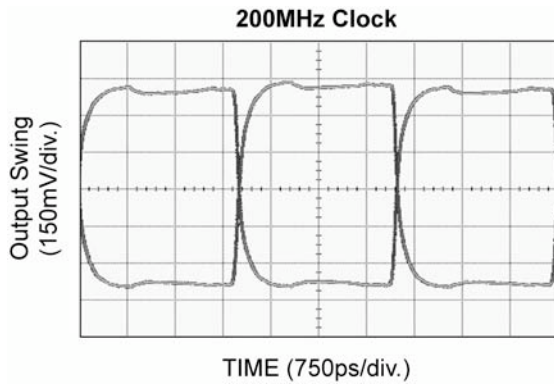
### Notes:

- High-frequency AC-parameters are guaranteed by design and characterization.
- 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  $t_{pd}$ .
- Random jitter is measured with a K28.7 character pattern, measured at 2.5Gbps.
- Deterministic Jitter is measured at 2.5Gbps, with both K28.5 and  $2^{23} - 1$  PRBS pattern.
- 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  $< f_{MAX}$ , no more than one output edge in  $10^{12}$  output edges will deviate by more than the specified peak-to-peak jitter value.

### Typical Operating Characteristics



### Functional Characteristics



### Singled-Ended and Differential Swings



Figure 1a. Singled-Ended Voltage Swing

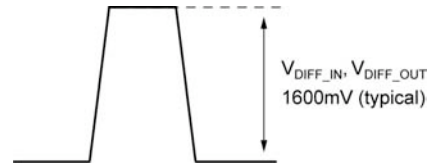
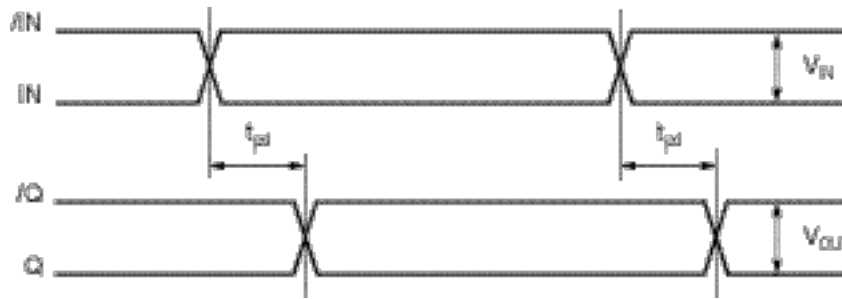


Figure 1b. Differential Voltage Swing

### Timing Diagram



### Input and Output Stages

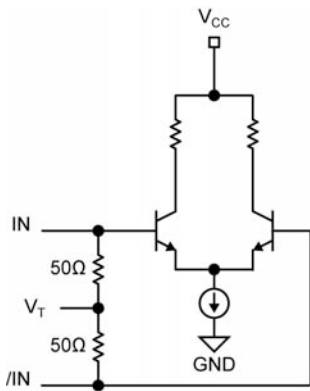


Figure 2a. Simplified Differential Input Stage

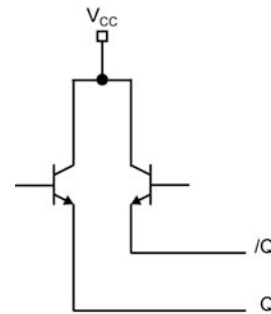
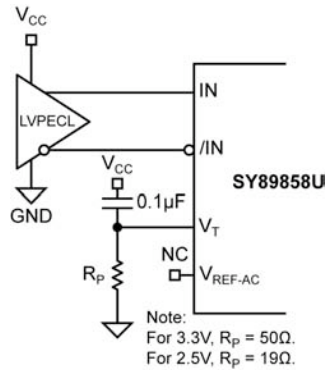
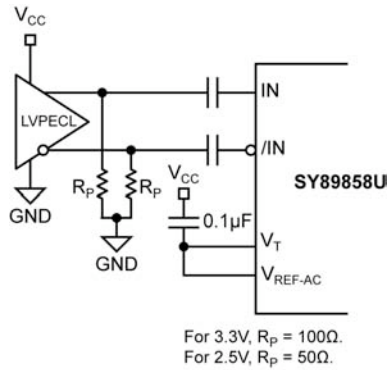


Figure 2b. Simplified LVPECL Output Stage

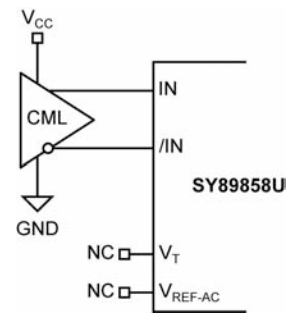
## Input Interface Applications



**Figure 3a. LVPECL Interface (DC-Coupled)**

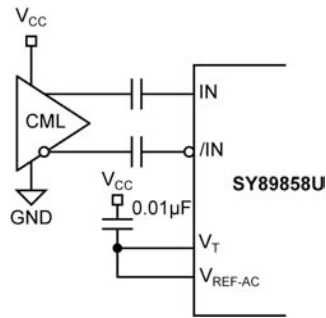


**Figure 3b. LVPECL Interface (AC-Coupled)**

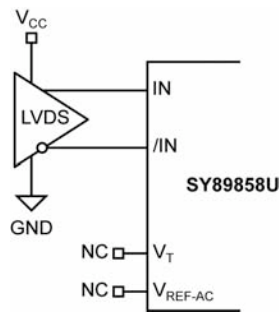


Option: may connect  $V_T$  to  $V_{CC}$

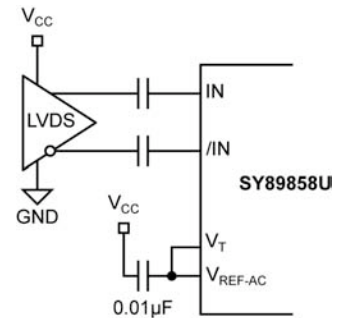
**Figure 3c. CML Interface (DC-Coupled)**



**Figure 3d. CML Interface (AC-Coupled)**



**Figure 3e. LVDS Interface (DC-Coupled)**



**Figure 3f. LVDS Interface (AC-Coupled)**



### LVPECL Output Interface Applications

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

Termination-Thevenin Equivalent, Parallel Termination (3-resistor), and AC-coupled Termination. Unused output pairs may be left floating. However, single-ended outputs must be terminated, or balanced.

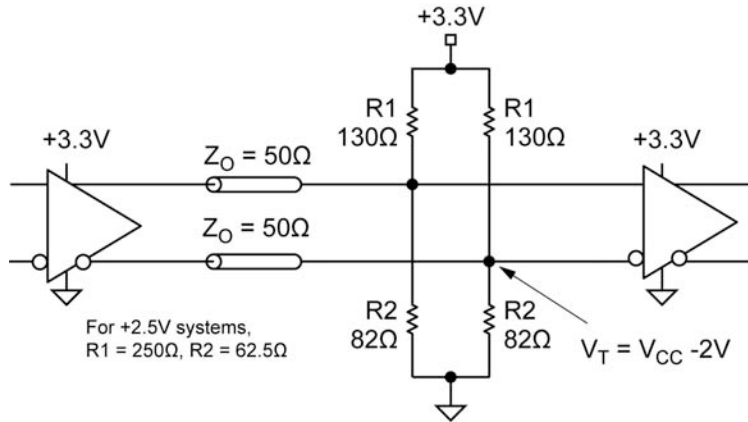
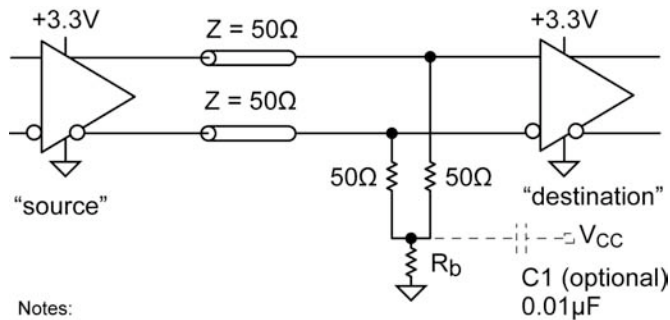


Figure 4a. Parallel Termination-Thevenin Equivalent



Notes:

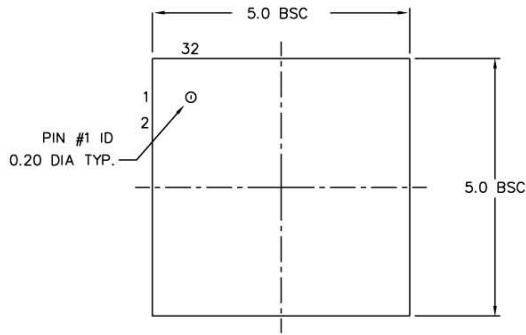
1. Power-saving alternative to Thevenin termination.
2. Place termination resistors as close to destination inputs as possible.
3.  $R_b$  resistor sets the DC bias voltage, equal to  $V_T$ .
4. For 2.5V systems,  $R_b = 19\Omega$ , For 3.3V systems,  $R_b = 50\Omega$

Figure 4b. Parallel Termination (3-Resistor)

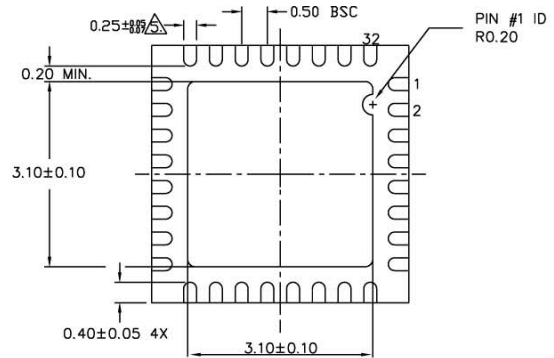
### Related Product and Support Documentation

Part Number	Function	Datasheet Link
SY58032U	Ultra-Precision 1:8 LVPECL Fanout Buffer w/Internal Termination	<a href="http://www.micrel.com/product-info/products/sy58032u.shtml">www.micrel.com/product-info/products/sy58032u.shtml</a>
	MLF <sup>®</sup> Application Note	<a href="http://www.amkor.com/products/notes_papers/MLFAppNote.pdf">www.amkor.com/products/notes_papers/MLFAppNote.pdf</a>
HBW Solutions	New Products and Applications	<a href="http://www.micrel.com/product-info/products/solutions.shtml">www.micrel.com/product-info/products/solutions.shtml</a>

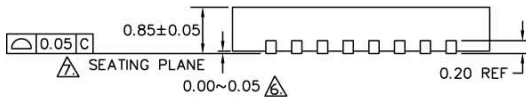
**Package Information**



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.
- ⚠ DIMENSION APPLIES TO METALIZED TERMINAL AND IS MEASURED BETWEEN 0.20 AND 0.25 mm FROM TERMINAL TIP.
  - ⚠ APPLIED ONLY FOR TERMINALS.
  - ⚠ APPLIED FOR EXPOSED PAD AND TERMINALS.

**32-Pin (5mm x 5mm) MicroLeadFrame®**

**Package Notes:**

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

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