



# ULTRA-PRECISION DIFFERENTIAL CML LINE DRIVER/RECEIVER WITH INTERNAL TERMINATION

Precision Edge™  
SY58600U

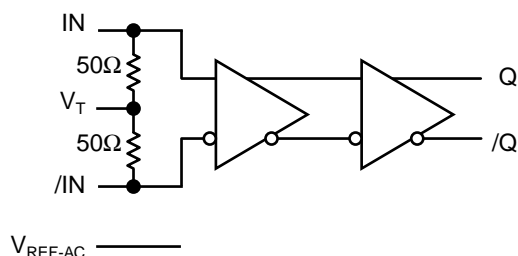
## FEATURES

- Guaranteed AC performance over temperature and voltage:
  - DC-to >10.7Gbps data rate throughput
  - DC-to >7GHz clock  $f_{MAX}$
  - <220ps in-to-out  $t_{pd}$
  - $t_r / t_f < 60ps$
- Ultra low-jitter design:
  - <1ps<sub>rms</sub> random jitter
  - <10ps<sub>pp</sub> deterministic jitter
  - <10ps<sub>pp</sub> total jitter (clock)
- Minimum input swing 200mV ( $|IN-|IN|$ )
- Unique, patent-pending input termination and VT pin accepts DC-coupled and AC-coupled inputs (CML, PECL, LVDS)
- Internal 50Ω output source termination
- Typical 400mV CML output swing
- Power supply 2.5V ±5% or 3.3V ±10%
- -40°C to 85°C industrial temperature range
- Available in an ultra-small (2mm × 2mm) 8-pin MLF™ package

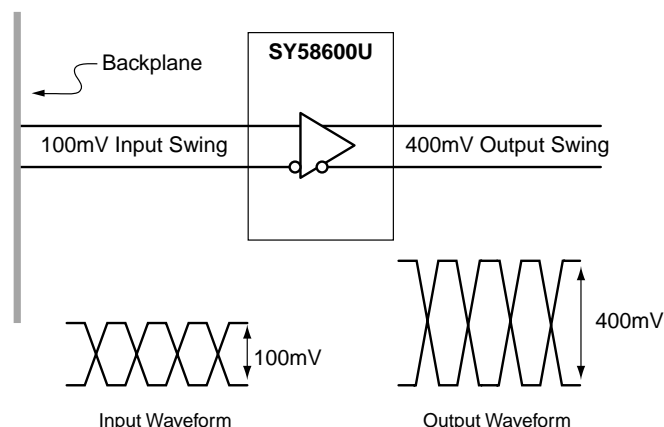
## APPLICATIONS

- Backplane buffering
- OC-12 to OC-192 SONET/SDN clock/data distribution
- All Gigabit Ethernet distribution
- Fibre Channel distribution

## FUNCTIONAL BLOCK DIAGRAM

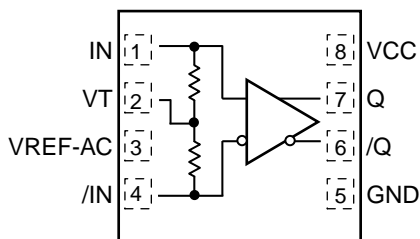


## TYPICAL APPLICATION



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

## PACKAGE/ORDERING INFORMATION



8-Pin MLF™ (MLF-8)

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

Part Number	Package Type	Operating Range	Package Marking
SY58600UMITR <sup>(2)</sup>	MLF-8	Industrial	600

## Notes:

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

## PIN DESCRIPTION

Pin Number	Pin Name	Pin Function
1, 4	IN, /IN	Differential Input: This input pair is the signal to be buffered. These inputs accept AC or DC-coupled signals as small as 100mV. Each pin of this pair internally terminates to a VT pin through 50Ω. Note that this input will default to an indeterminate state if left open. Please refer to the "Input Interface Applications" section for more details.
2	VT	Input Termination Center-Tap: Each side of the differential input pair terminates to this pin. The VT pin provides a center-tap to a termination network for maximum interface flexibility. See "Input Interface Applications" section for more details.
3	VREF-AC	Reference Output Voltage: This output biases to $V_{CC} - 1.2\text{V}$ . Connect to VT pin when AC-coupling the input. Bypass with 0.01μF low ESR capacitor to $V_{CC}$ . Maximum current source or sink is 0.5mA. See "Input Interface Applications" section.
8	VCC	Positive Power Supply. Bypass with 0.1μF  0.01μF low ESR capacitors as close to the VCC pin as possible.
7, 6	Q, /Q	Differential CML Output: Differential buffered output copy of the input signal. The differential output swing is typically 800mV into a 50Ω load, or 100Ω across the pair. See "Output Interface Applications" section.
5	GND, Exposed	Ground. Ground pin 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 $V_{CC}$
CML Output Voltage ( $V_{OUT}$ )	..... $V_{CC} - 1.0V$ to $V_{CC} + 0.5V$
Termination Current <sup>(3)</sup>	
Source or Sink Current on $V_T$	..... $\pm 100mA$
Input Current	
Source or Sink Current on IN, /IN	..... $\pm 50mA$
Current ( $V_{REF}$ )	
Source or Sink Current on $V_{REF-AC}$	..... $\pm 1.5mA$
Lead Temperature (soldering, 10 sec.)	..... +265°C
Storage Temperature ( $T_S$ )	..... -65°C to +150°C

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

Supply Voltage ( $V_{CC}$ )	..... +2.375V to +2.625V or ..... +3.0V to +3.6V
Ambient Temperature ( $T_A$ )	..... -40°C to +85°C
Package Thermal Resistance <sup>(4)</sup>	
MLF™ ( $\theta_{JA}$ )	
Still-Air	..... 93°C/W
MLF™ ( $\psi_{JB}$ )	
Junction-to-Board	..... 32°C/W

**DC ELECTRICAL CHARACTERISTICS<sup>(5)</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	$V_{CC} = 2.5V$ $V_{CC} = 3.3V$	2.375 3.0	2.5 3.3	2.625 3.6	V
$I_{CC}$	Power Supply Current	No Load, max. $V_{CC}$ , <b>Note 6</b>		45	65	mA
$R_{DIFF\_IN}$	Differential Input Resistance (IN-to-/IN)		80	100	120	$\Omega$
$R_{IN}$	Input Resistance (IN-to- $V_T$ , /IN-to- $V_T$ )		40	50	60	$\Omega$
$V_{IH}$	Input HIGH Voltage (IN, /IN)	<b>Note 7</b>	$V_{CC} - 1.6$		$V_{CC}$	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		3.4	V
$V_{T\_IN}$	In-to- $V_T$ (IN, /IN)				1.28	V
$V_{REF-AC}$	Output Reference Voltage		$V_{CC} - 1.3$	$V_{CC} - 1.2$	$V_{CC} - 1.1$	V

**Notes:**

1. Permanent device damage may occur if the ratings in "Absolute Maximum Ratings" section are exceeded. This is a stress rating only and functional operation is not implied for 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 device's most negative potential on the PCB.  $\psi_{JB}$  uses 4-layer  $\theta_{JA}$  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. Includes current through internal 50 $\Omega$  pull-ups.
7.  $V_{IH}$  (min) not lower than 1.2V.

**CML OUTPUTS DC ELECTRICAL CHARACTERISTICS<sup>(8)</sup>**

$V_{CC} = 2.5V \pm 5\%$  or  $3.3V \pm 10\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ ;  $R_L = 100\Omega$  across output pair or equivalent, unless otherwise noted.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{OH}$	Output HIGH Voltage Q, /Q		$V_{CC}-0.020$	$V_{CC}-0.010$	$V_{CC}$	V
$V_{OUT}$	Output Voltage Swing Q, /Q	See Figure 1a.	325	400		mV
$V_{DIFF\_OUT}$	Differential Output Voltage Swing Q, /Q	See Figure 1b.	650	800		mV
$R_{OUT}$	Output Source Impedance Q, /Q		40	50	60	$\Omega$

**AC ELECTRICAL CHARACTERISTICS<sup>(9)</sup>**

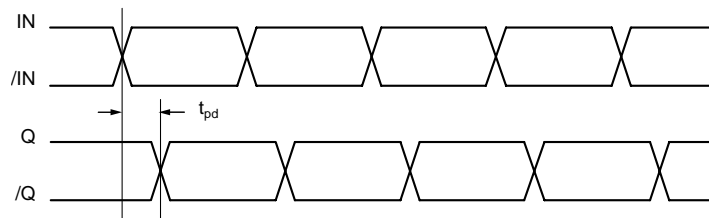
$V_{CC} = 2.5V \pm 5\%$  or  $3.3V \pm 10\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ ;  $R_L = 100\Omega$  across output pair or equivalent, unless otherwise noted.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$f_{MAX}$	Maximum Operating Frequency	NRZ Data	10.7			Gbps
		$V_{OUT} \geq 200mV$ Clock	7			GHz
$t_{pd}$	Propagation Delay	IN-to-Q	70	125	220	ps
$t_{pd} \text{ Tempco}$	Differential Propagation Delay Temperature Coefficient			115		fs/ $^\circ C$
$t_{JITTER}$	Data Random Jitter (RJ)	<b>Note 10</b>			1	ps <sub>rms</sub>
	Deterministic Jitter (DJ)	<b>Note 11</b>			10	ps <sub>pp</sub>
	Clock Cycle-to-Cycle Jitter	<b>Note 12</b>			1	ps <sub>rms</sub>
	Total Jitter (TJ)	<b>Note 13</b>			10	ps <sub>pp</sub>
$t_r, t_f$	Output Rise/Fall Times Q, /Q	(20% to 80%) At full output swing.	20	40	60	ps

**Notes:**

8. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
9. High frequency AC electricals are guaranteed by design and characterization.
10. Random jitter is measured with a K28.7 comma detect character pattern, measured at 2.5Gbps/3.2Gbps.
11. Deterministic jitter is measured at 2.5Gbps/3.2Gbps with both K28.5 and  $2^{23}-1$  PRBS pattern.
12. 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.
13. 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.

## TIMING DIAGRAM



## DEFINITION OF SINGLE-ENDED AND DIFFERENTIAL SWINGS

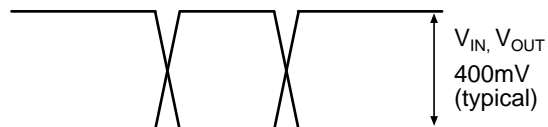


Figure 1a. Single-Ended Swing

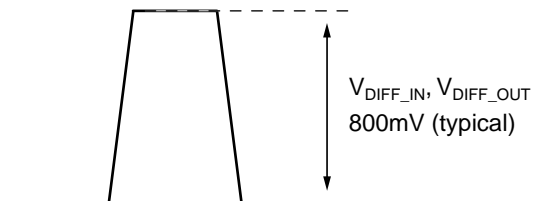


Figure 1b. Differential Swing

## INPUT AND OUTPUT STAGE INTERNAL TERMINATION

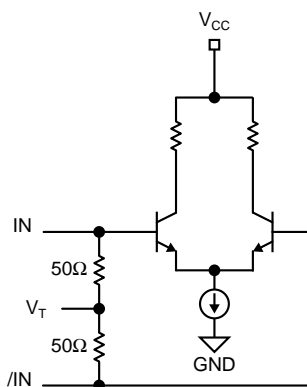


Figure 2a. Simplified Differential Input Stage

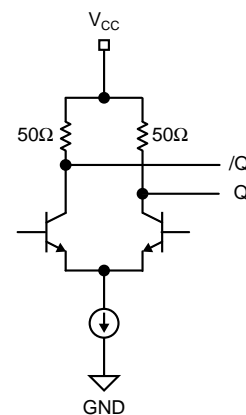
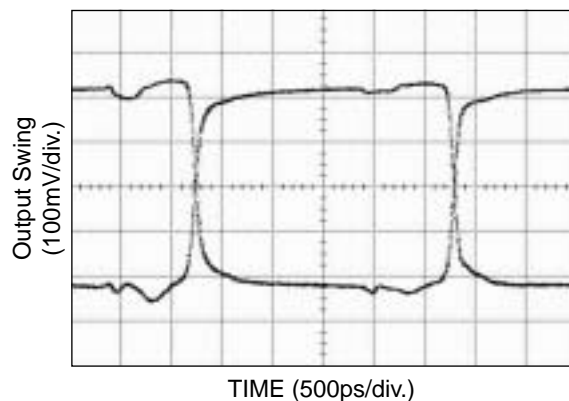
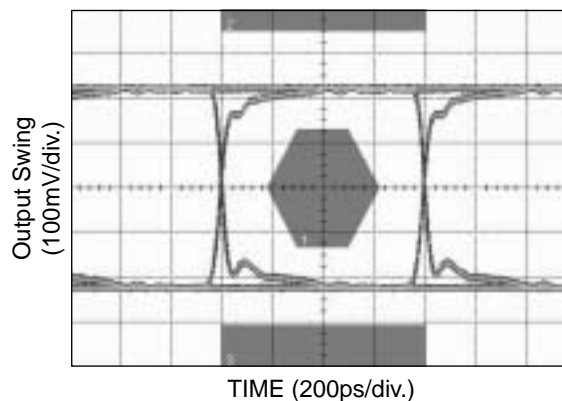
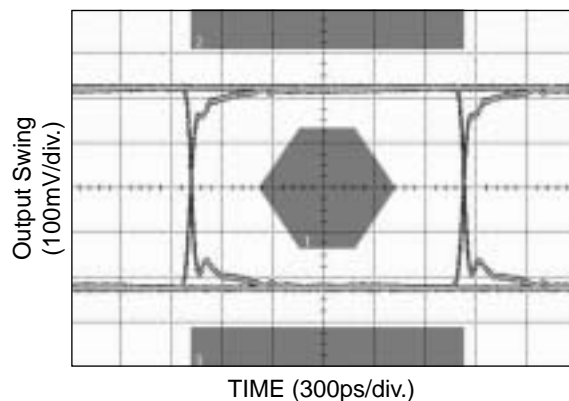
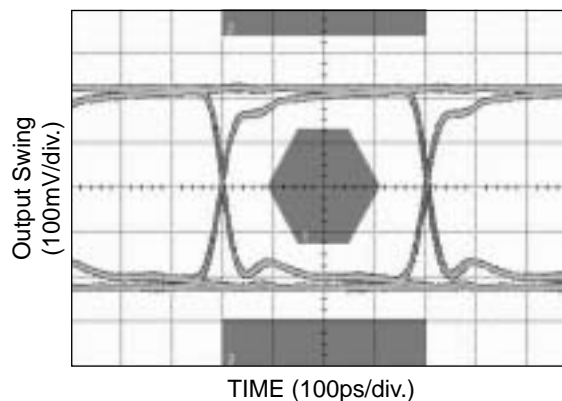
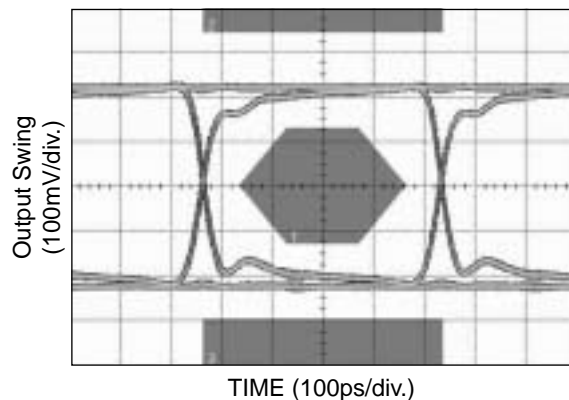
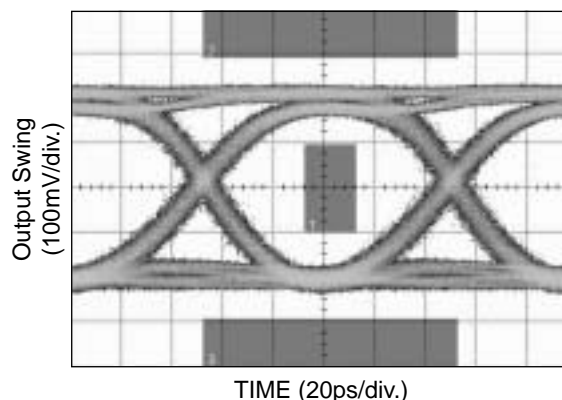


Figure 2b. Simplified Differential Output Stage

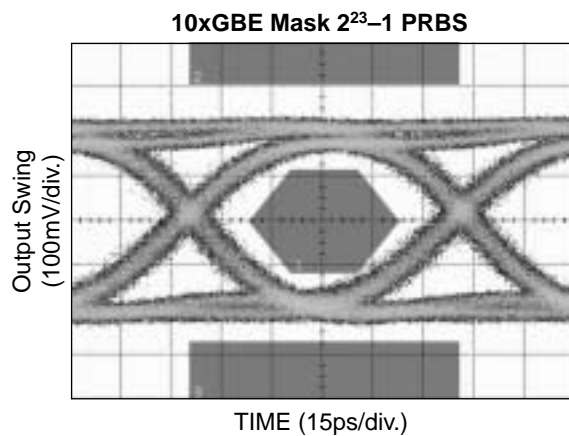
**TYPICAL OPERATING CHARACTERISTICS**

$V_{CC} = 3.3V$ ,  $GND = 0$ ,  $V_{IN} = 800mV$ .

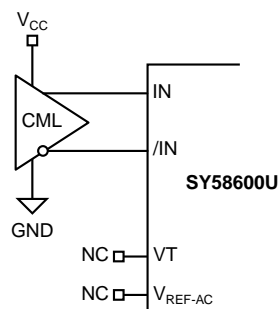
**200MHz Clock****1xGBE Mask 2<sup>23</sup>-1****OC-12 Mask 2<sup>23</sup>-1 PRBS****2xGBE Mask 2<sup>23</sup>-1 PRBS****2xFC Mask 2<sup>23</sup>-1 PRBS****OC-192 Mask 2<sup>23</sup>-1 PRBS**

**TYPICAL OPERATING CHARACTERISTICS CONT'D**

$V_{CC} = 3.3V$ ,  $GND = 0$ ,  $V_{IN} = 800mV$ .

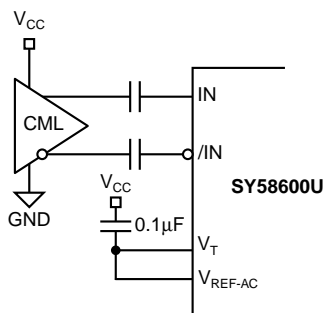


## INPUT INTERFACE APPLICATIONS

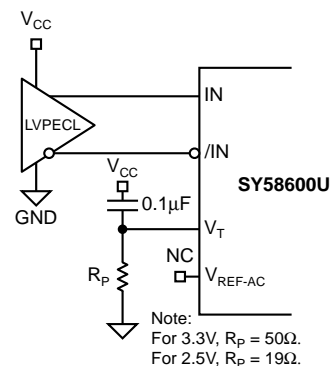


**Figure 3a. CML Interface  
(DC-Coupled)**

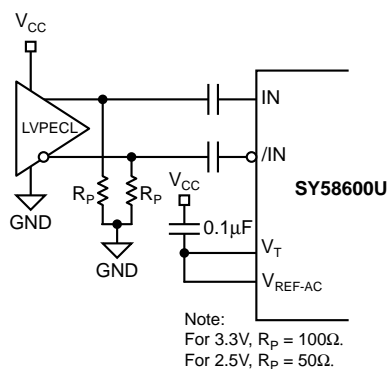
*Option:  $V_T$  may be connected to  $V_{CC}$*



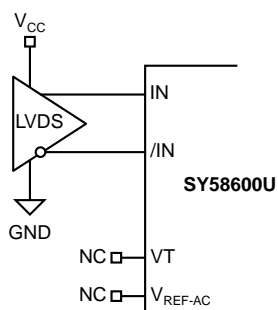
**Figure 3b. CML Interface  
(AC-Coupled)**



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



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



**Figure 3e. LVDS Interface**



## OUTPUT INTERFACE APPLICATIONS

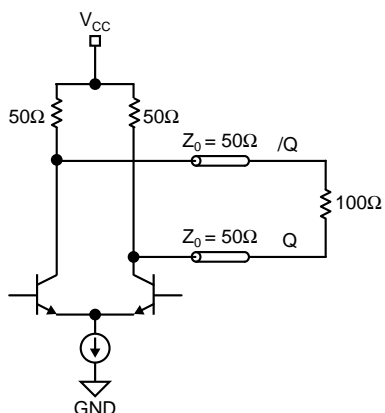


Figure 4a. CML DC-Coupled Termination

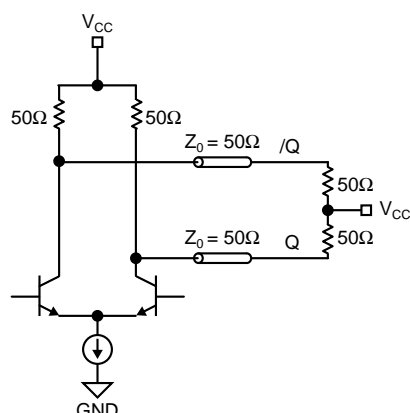


Figure 4b. CML DC-Coupled Termination

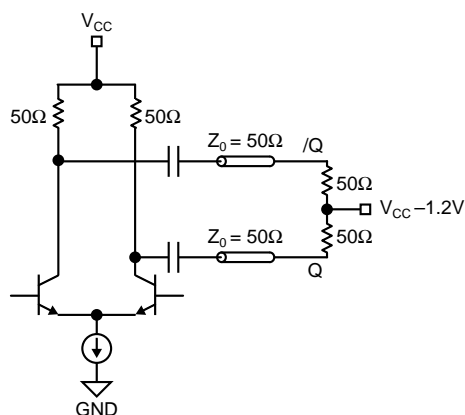
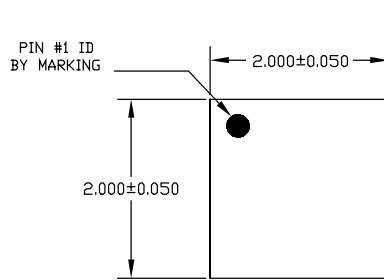


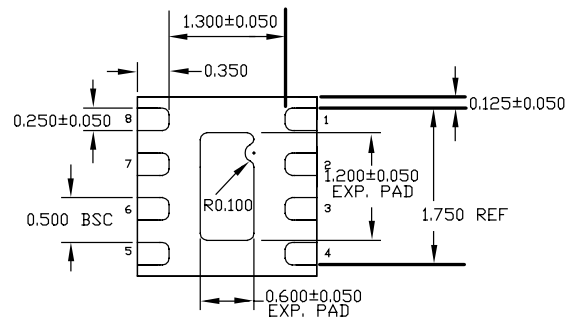
Figure 4c. CML AC-Coupled Termination

## RELATED PRODUCT AND SUPPORT DOCUMENTATION

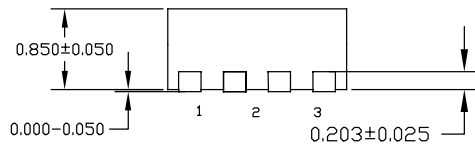
Part Number	Function	Data Sheet Link
SY58601U	2.5V/3.3V 5Gbps Differential 800mV LVPECL Line Driver/Receiver with Internal Termination	<a href="http://www.micrel.com/product-info/products/sy58601u.shtml">www.micrel.com/product-info/products/sy58601u.shtml</a>
SY58602U	2.5V/3.3V 10.7Gbps Differential 400mV LVPECL Line Driver/Receiver with Internal Termination	<a href="http://www.micrel.com/product-info/products/sy58602u.shtml">www.micrel.com/product-info/products/sy58602u.shtml</a>
	MLF™ 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	New Products and Applications	<a href="http://www.micrel.com/product-info/products/solutions.shtml">www.micrel.com/product-info/products/solutions.shtml</a>

**8 LEAD ULTRA-SMALL EPAD MicroLeadFrame™ (MLF-8)**

TOP VIEW



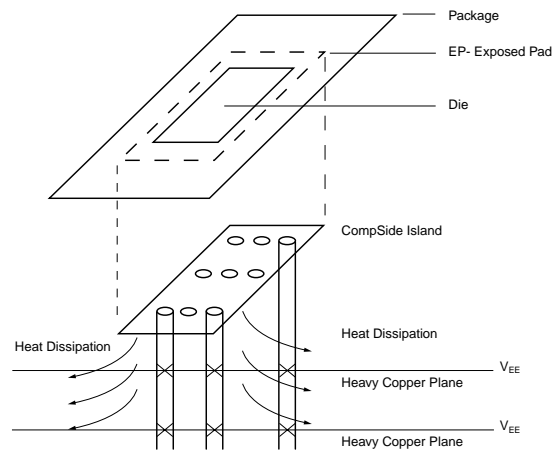
BOTTOM VIEW



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

**Package Notes:**

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

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