

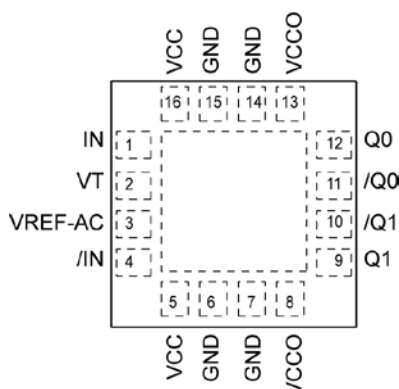
## Ordering Information<sup>(1)</sup>

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY54011RMG	MLF-16	Industrial	011R with Pb-Free bar-line indicator	NiPdAu Pb-Free
SY54011RMGTR <sup>(2)</sup>	MLF-16	Industrial	011R with Pb-Free bar-line indicator	NiPdAu Pb-Free

### Notes:

1. Contact factory for die availability. Dice are guaranteed at TA = 25°C, DC Electricals only.
2. Tape and Reel.

## Pin Configuration



16-Pin MLF<sup>®</sup> (MLF-16)

## Pin Description

Pin Number	Pin Name	Pin Function
1, 4	IN, /IN	Differential Input: This input pair is the differential signal input to the device. Input accepts differential signals as small as 100mV (200mV <sub>PP</sub> ). Each input pin internally terminates with 50Ω to the VT pin.
2	VT	Input Termination Center-Tap: Each side of the differential input pair terminates to VT pin. This pin provides a center-tap to a termination network for maximum interface flexibility. See "Interface Applications" section.
3	VREF-AC	Reference Voltage: This output biases to V <sub>CC</sub> -1.15V. It is used for AC-coupling inputs IN and /IN. Connect VREF-AC directly to the VT pin. Bypass with 0.1μF low ESR capacitor to VCC. Maximum sink/source current is ±0.5mA. See "Input Interface Applications" section.
5, 16	VCC	Positive Power Supply: Bypass with 0.1μF//0.01μF low ESR capacitors as close to the VCC pins as possible. Supplies input and core circuitry.
8, 13	VCCO	Output Supply: Bypass with 0.1μF//0.01μF low ESR capacitors as close to the VCCO pins as possible. Supplies the output buffers.
6, 7, 14, 15	GND, Exposed pad	Ground: Exposed pad must be connected to a ground plane that is the same potential as the ground pins.
10, 9 11, 12	/Q1, Q1 /Q0, Q0	CML Differential Output Pairs: Differential buffered copies of the input signal. The output swing is typically 390mV. See "Interface Applications" section for termination information.

**Absolute Maximum Ratings<sup>(3)</sup>**

Supply Voltage ( $V_{CC}$ )	.....	-0.5V to +3.0V
Supply Voltage ( $V_{CCO}$ )	.....	-0.5V to +2.7V
$V_{CC} - V_{CCO}$	.....	<1.8V
$V_{CCO} - V_{CC}$	.....	<0.5V
Input Voltage ( $V_{IN}$ )	.....	-0.5V to $V_{CC}$
CML Output Voltage ( $V_{OUT}$ )	.....	0.6V to $V_{CCO}+0.5V$
Current ( $I_T$ )		
Source or sink current on $V_T$ pin	.....	$\pm 100mA$
Input Current		
Source or sink current on (IN, /IN)	.....	$\pm 50mA$
Current ( $V_{REF-AC}$ )		
Source or sink current on $V_{REF-AC}$ <sup>(6)</sup>	.....	$\pm 0.5mA$
Maximum operating Junction Temperature	.....	125°C
Lead Temperature (soldering, 20sec.)	.....	260°C
Storage Temperature ( $T_s$ )	.....	-65°C to +150°C

**Operating Ratings<sup>(4)</sup>**

Supply Voltage ( $V_{CC}$ )	.....	2.375V to 2.625V
( $V_{CCO}$ )	.....	1.14V to 1.9V
Ambient Temperature ( $T_A$ )	.....	-40°C to +85°C
Package Thermal Resistance <sup>(5)</sup>		
MLF <sup>®</sup>		
Still-air ( $\theta_{JA}$ )	.....	75°C/W
Junction-to-board ( $\Psi_{JB}$ )	.....	33°C/W

**DC Electrical Characteristics<sup>(7)</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 Voltage Range	$V_{CC}$	2.375	2.5	2.625	V
		$V_{CCO}$	1.14	1.2	1.26	V
		$V_{CCO}$	1.7	1.8	1.9	V
$I_{CC}$	Power Supply Current	Max. $V_{CC}$		15	22	mA
$I_{CCO}$	Power Supply Current	No Load. $V_{CCO}$		32	42	mA
$R_{IN}$	Input Resistance (IN-to-VT, /IN-to-VT)		45	50	55	$\Omega$
$R_{DIFF\_IN}$	Differential Input Resistance (IN-to-/IN)		90	100	110	$\Omega$
$V_{IH}$	Input HIGH Voltage (IN, /IN)	IN, /IN	1.2		$V_{CC}$	V
$V_{IL}$	Input LOW Voltage (IN, /IN)	$V_{IL}$ with $V_{IH}$ of 1.2V	0.2		$V_{IH}-0.1$	V
$V_{IH}$	Input HIGH Voltage (IN, /IN)	IN, /IN	1.14		$V_{CC}$	V
$V_{IL}$	Input LOW Voltage (IN, /IN)	$V_{IL}$ with $V_{IH}$ of 1.14V, (1.2V-5%)	0.66		$V_{IH}-0.1$	V
$V_{IN}$	Input Voltage Swing (IN, /IN)	see Figure 4	0.1		1.0	V
$V_{DIFF\_IN}$	Differential Input Voltage Swing ( IN - /IN )	see Figure 5	0.2		2.0	V
$V_{REF-AC}$	Output Reference Voltage		$V_{CC}-1.3$	$V_{CC}-1.15$	$V_{CC}-1.0$	V
$V_{T\_IN}$	Voltage from Input to VT				1.28	V

**Notes:**

- 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.
- The data sheet limits are not guaranteed if the device is operated beyond the operating ratings.
- Package thermal resistance assumes exposed pad is soldered (or equivalent) to the device's most negative potential on the PCB.  $\theta_{JB}$  and  $\Psi_{JA}$  values are determined for a 4-layer board in still-air number, unless otherwise stated.
- Due to the limited drive capability, use for input of the same package only.
- The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

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

$V_{CCO} = 1.14V$  to  $1.26V$   $R_L = 50\Omega$  to  $V_{CCO}$ ,

$V_{CCO} = 1.7V$  to  $1.9V$ ,  $R_L = 50\Omega$  to  $V_{CCO}$  or  $100\Omega$  across the outputs,

$V_{CC} = 2.375V$  to  $2.625V$ .  $T_A = -40^\circ C$  to  $+85^\circ C$ , unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{OH}$	Output HIGH Voltage	$R_L = 50\Omega$ to $V_{CCO}$	$V_{CCO}-0.020$	$V_{CCO}-0.010$	$V_{CCO}$	V
$V_{OUT}$	Output Voltage Swing	See Figure 4	300	390	475	mV
$V_{DIFF\_OUT}$	Differential Output Voltage Swing	See Figure 5	600	780	950	mV
$R_{OUT}$	Output Source Impedance		45	50	55	$\Omega$

## AC Electrical Characteristics

$V_{CCO} = 1.14V$  to  $1.26V$   $R_L = 50\Omega$  to  $V_{CCO}$ ,

$V_{CCO} = 1.7V$  to  $1.9V$ ,  $R_L = 50\Omega$  to  $V_{CCO}$  or  $100\Omega$  across the outputs,

$V_{CC} = 2.375V$  to  $2.625V$ .  $T_A = -40^\circ C$  to  $+85^\circ C$ , unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$f_{MAX}$	Maximum Frequency	NRZ Data	3.2			Gbps
		$V_{OUT} > 200mV$ Clock	3.2			GHz
$t_{PD}$	Propagation Delay IN-to-Q	Figure 1	150	205	300	ps
$t_{Skew}$	Within Device Skew	Note 8		3	15	ps
	Part-to-Part Skew	Note 9			75	ps
$t_{Jitter}$	Additive Phase Jitter	Carrier = 622MHz. Integration Range: 12kHz – 20MHz		50		fs <sub>RMS</sub>
$t_R$ $t_F$	Output Rise/Fall Times (20% to 80%)	At full output swing.	30	60	95	ps
	Duty Cycle	Differential I/O	47		53	%

### Notes:

8. Within device skew is measured between two different outputs under identical input transitions.
9. Part-to-part skew is defined for two parts with identical power supply voltages at the same temperature and no skew at the edges at the respective inputs.

## Interface Applications

For Input Interface Applications see Figures 6-11 and for CML Output Termination see Figures 12-15.

### CML Output Termination with VCCO 1.2V

For VCCO of 1.2V, Figure 12, terminate the output with 50 $\Omega$ -to-1.2V, DC-coupled, not 100 $\Omega$  differentially across the outputs.

If AC-coupling is used, Figure 15, terminate into 50 $\Omega$ -to-1.2V before the coupling capacitor and then connect to a high value resistor to a reference voltage. Do not AC couple with internally terminated receiver. For example, 50 $\Omega$  ANY-IN input. AC-coupling will offset the output voltage by 200mV and this offset voltage will be too low for proper driver operation.

Any unused output pair needs to be terminated when VCCO is 1.2V, do not leave floating.

### CML Output Termination with VCCO 1.8V

For VCCO of 1.8V, Figure 12 and Figure 13, terminate with either 50 $\Omega$ -to-VCCO or 100 $\Omega$  differentially across the outputs. AC- or DC-coupling is fine.

### Input AC Coupling

The SY54011R input can accept AC coupling from any driver. Tie VT to VREF-AC and bypass with a 0.1 $\mu$ F capacitor as shown in Figures 8 and 9.

## Timing Diagrams

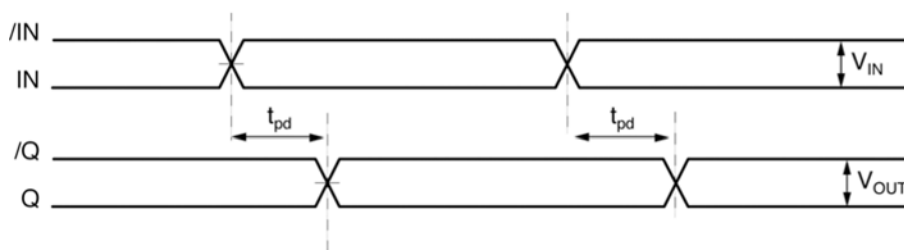
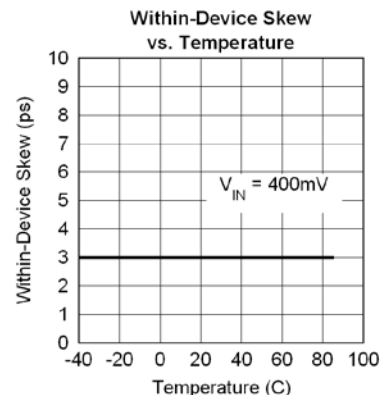
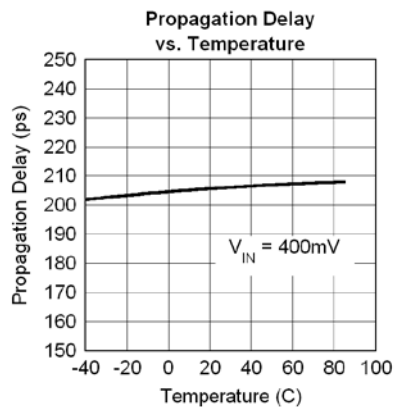
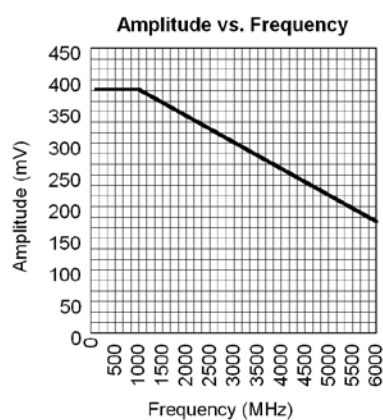


Figure 1. Propagation Delay

## Typical Characteristics

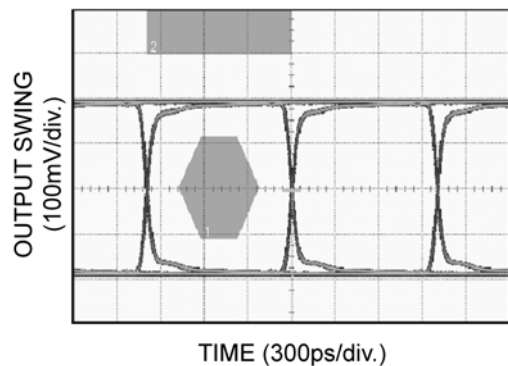
$V_{CC} = 2.5V$ ,  $V_{CCO} = 1.2V$ ,  $GND = 0V$ ,  $V_{IN} = 100mV$ ;  $R_L = 50\Omega$  to  $1.2V$ ;  $T_A = 25^\circ C$ , unless otherwise stated.



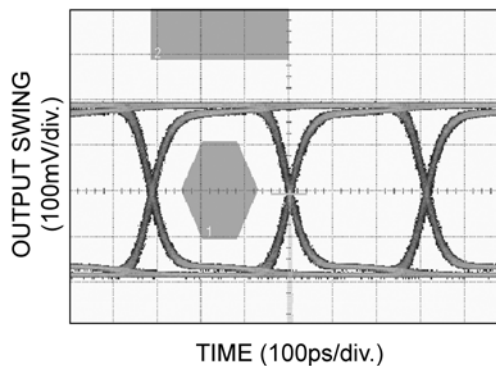
## Functional Characteristics

$V_{CC} = 2.5V$ ,  $V_{CCO} = 1.2V$ ,  $GND = 0V$ ,  $V_{IN} = 100mV$ ;  $R_L = 50\Omega$  to  $1.2V$ , Data Pattern:  $2^{23}-1$ ;  $T_A = 25^\circ C$ , unless otherwise stated.

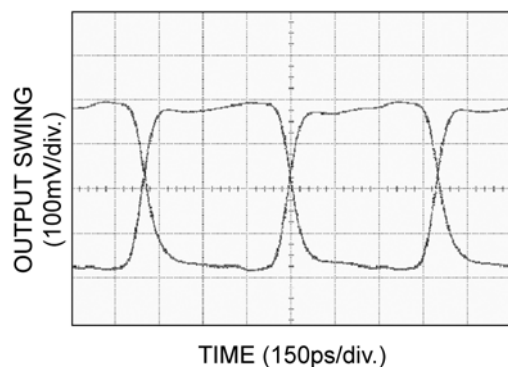
**1.0Gbps Data**



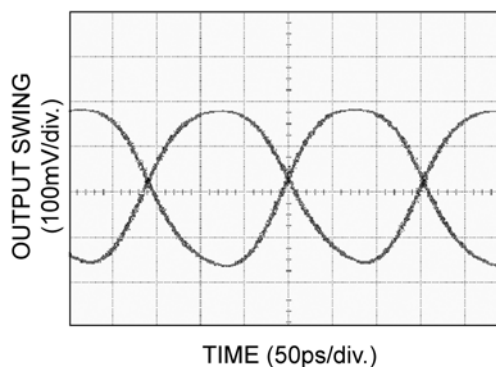
**3.2Gbps Data**



**1.0GHz Clock**

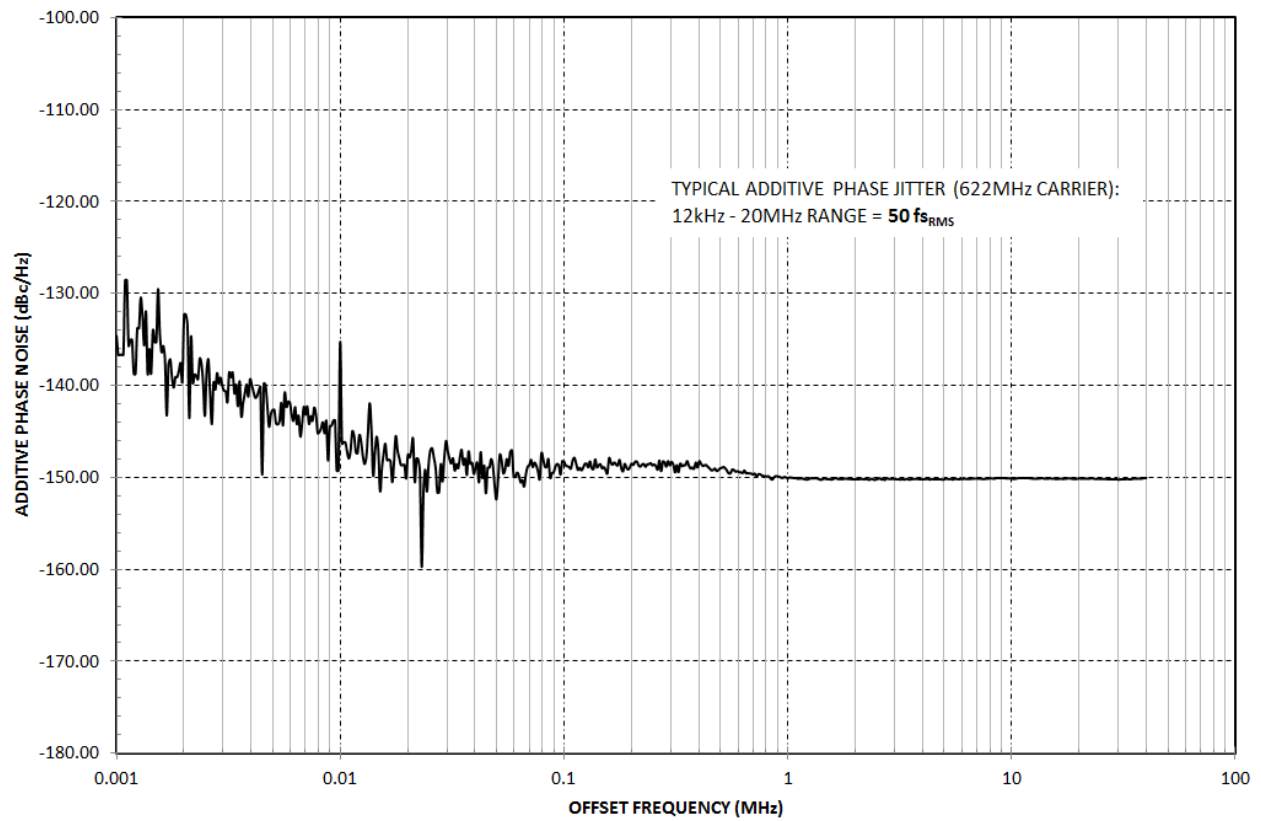


**3.2GHz Clock**



## Additive Phase Noise Plot

$V_{CC} = +2.5V$ ,  $GND = 0$ ,  $T_A = 25^\circ C$



## Input and Output Stage

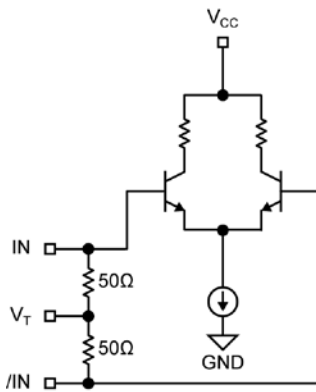


Figure 2. Simplified Differential Input Buffer

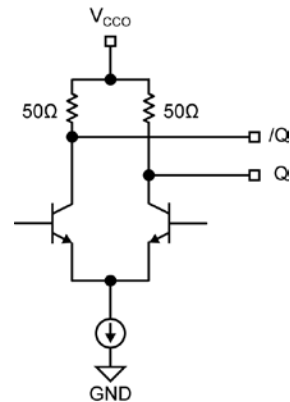


Figure 3. Simplified CML Output Buffer

## Single-Ended and Differential Swings

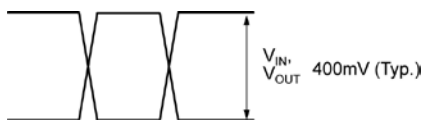


Figure 4. Single-Ended Swing

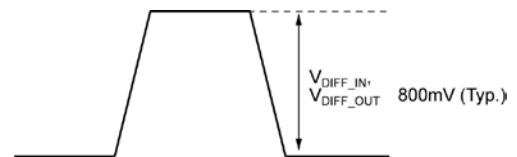


Figure 5. Differential Swing

## Input Interface Applications

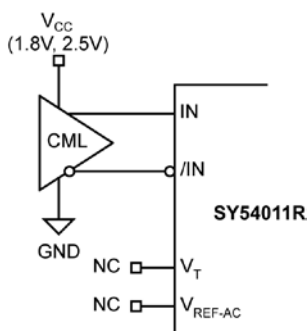


Figure 6. CML Interface  
(DC-Coupled, 1.8V, 2.5V)

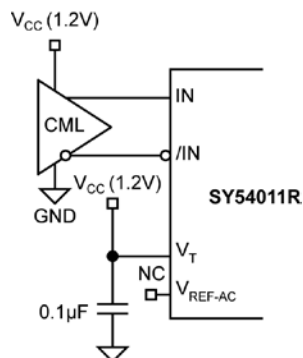


Figure 7. CML Interface  
(DC-Coupled, 1.2V)

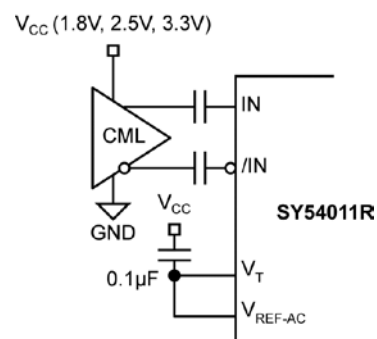


Figure 8. CML Interface  
(AC-Coupled)

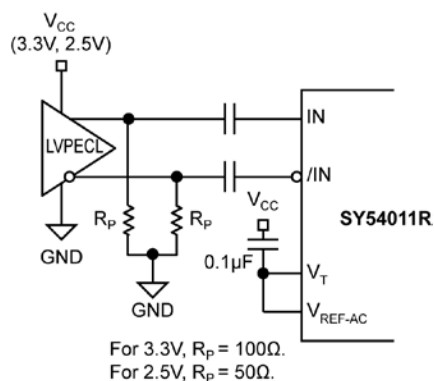


Figure 9. LVPECL Interface  
(AC-Coupled)

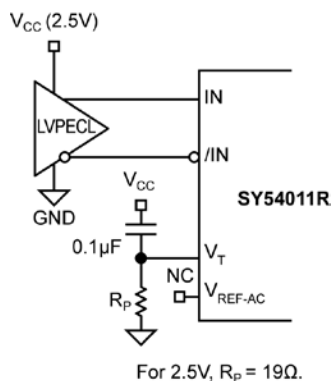


Figure 10. LVPECL Interface  
(DC-Coupled)

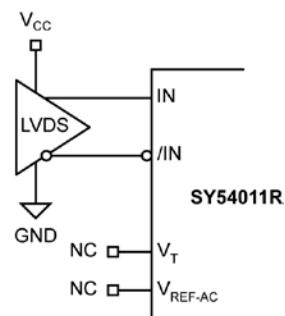


Figure 11. LVDS Interface



## CML Output Termination

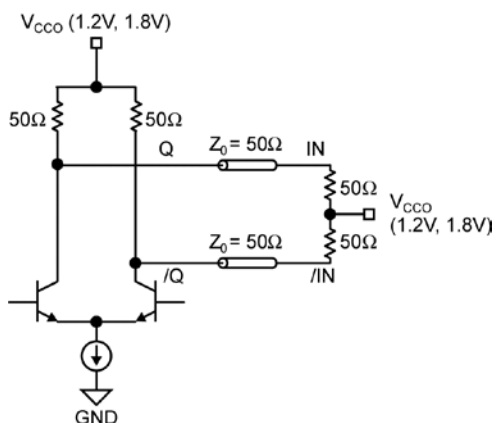


Figure 12. 1.2V or 1.8V  
CML DC-Coupled Termination

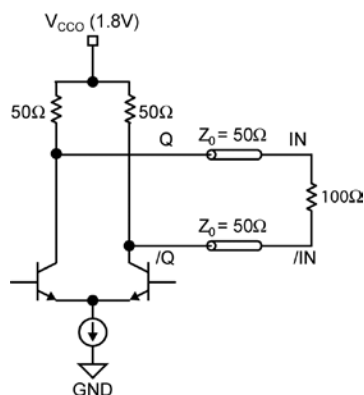


Figure 13. 1.8V  
CML DC-Coupled Termination

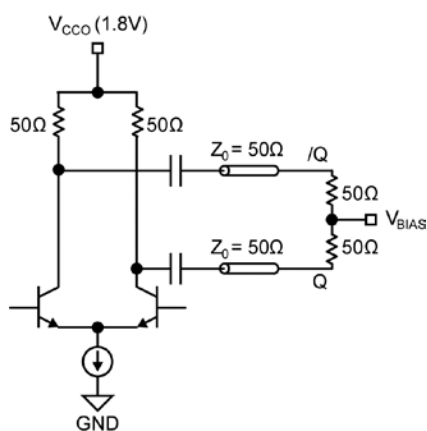


Figure 14. CML AC-Coupled Termination  
( $V_{CCO}$  1.8V only)

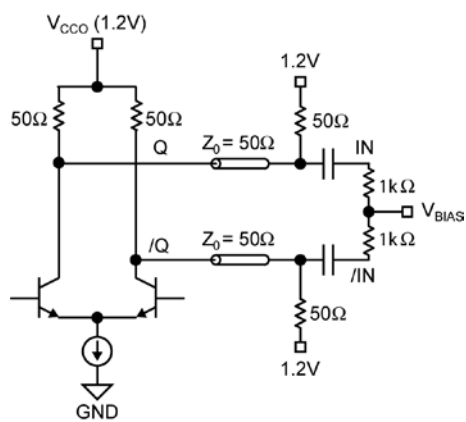
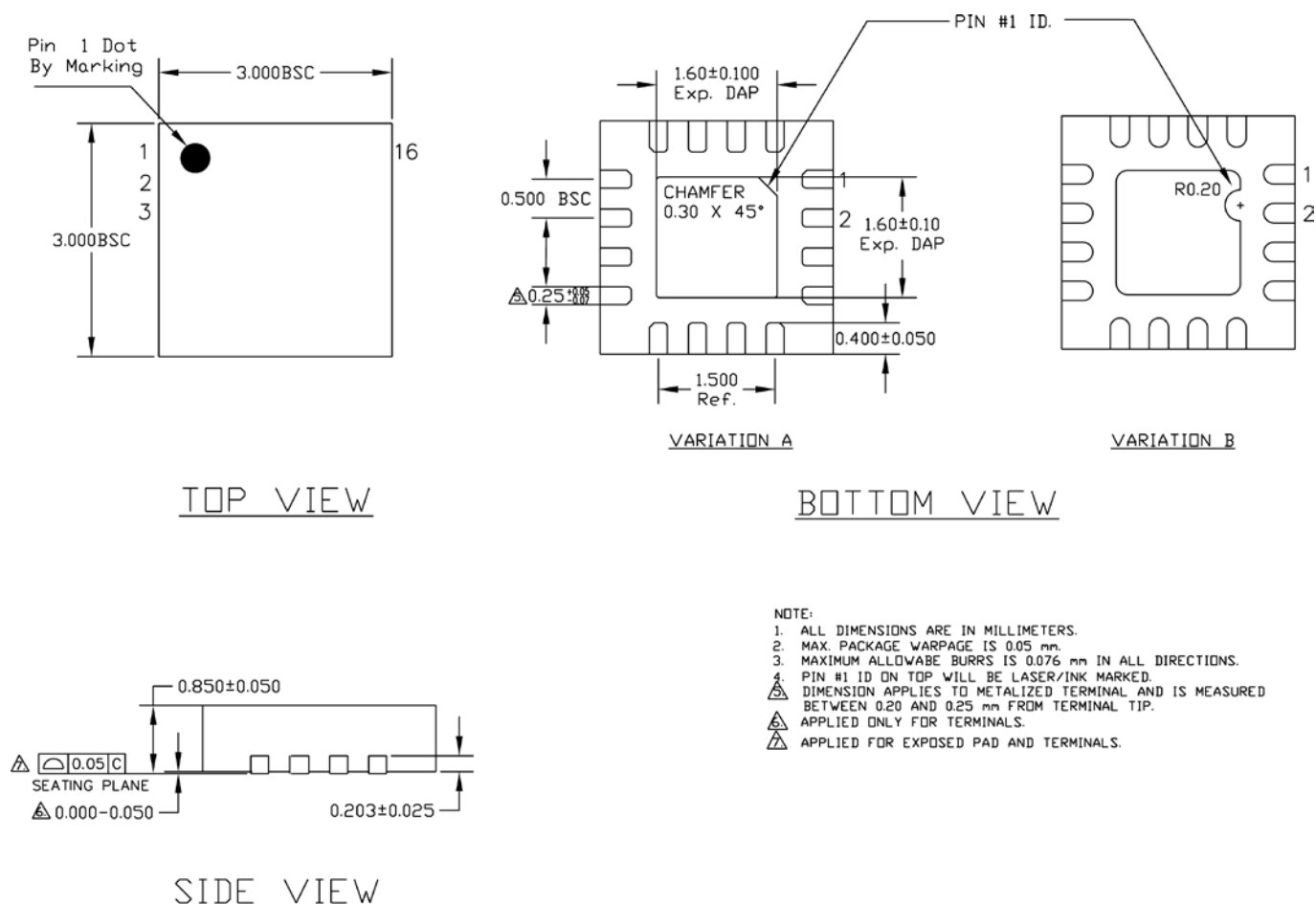


Figure 15. CML AC-Coupled Termination  
( $V_{CCO}$  1.2V only)

## Package Information



**16-Pin MLF<sup>®</sup> (3mm x3mm) (MLF-16)**

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