



# SY58020U

## 6GHz, 1:4 CML Fanout Buffer/Translator with Internal I/O Termination

### General Description

The SY58020U is a 2.5V/3.3V precision, high-speed, fully differential 1:4 CML fanout buffer. Optimized to provide four identical output copies with less than 15ps of skew and 27fs<sub>RMS</sub> of typical additive phase jitter, the SY58020U can process clock signals as fast as 6GHz.

The differential input includes Micrel's unique, 3-pin input termination architecture that interfaces to differential LVPECL, LVDS, and CML signals (AC- or DC-coupled) as small as 100mV without any level-shifting or termination resistor networks in the signal path. For AC-coupled input interface applications, an on-board output reference voltage ( $V_{REF-AC}$ ) is provided to bias the  $V_T$  pin. The outputs are optimized to drive 400mV typical swing into 50Ω loads, with extremely fast rise/fall times guaranteed to be less than 60ps.

The SY58020U operates from a 2.5V  $\pm 5\%$  supply or 3.3V  $\pm 10\%$  supply and is guaranteed over the full industrial temperature range ( $-40^\circ\text{C}$  to  $+85^\circ\text{C}$ ). For applications that require LVPECL outputs, consider the SY58021U or SY58022U 1:4 fanout buffer with 800mV and 400mV output swing, respectively. The SY58020U is part of Micrel's high-speed, Precision Edge<sup>®</sup> product line. Datasheets and support documentation are available on Micrel's web site at: [www.micrel.com](http://www.micrel.com).

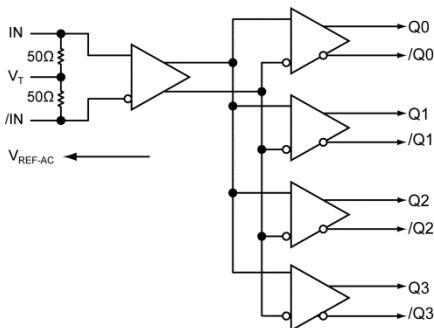
### Features

- Precision 1:4, 400mV CML fanout buffer
- Guaranteed AC performance over temperature/voltage:
  - > 6GHz  $f_{MAX}$  clock
  - < 60ps  $t_r / t_f$  times
  - < 250ps  $t_{pd}$
  - < 15ps max. skew
- Low-jitter performance:
  - 27fs<sub>RMS</sub> typical additive phase jitter
- Accepts an input signal as low as 100mV
- Unique patented input termination and  $V_T$  pin accepts DC-coupled and AC-coupled differential inputs: LVPECL, LVDS, and CML
- 50Ω source terminated CML outputs
- Power supply 2.5V  $\pm 5\%$  and 3.3V  $\pm 10\%$
- Industrial temperature range:  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$
- Available in 16-pin (3mm x 3mm) QFN package

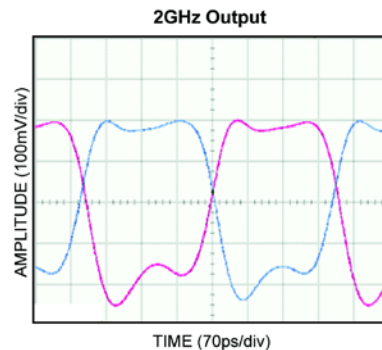
### Applications

- All SONET and All GigE clock distribution
- Fibre Channel clock and data distribution
- Backplane distribution
- Data distribution: OC-48, OC-48+FEC, XAUI
- High-end, low skew, multiprocessor synchronous clock distribution

### Functional Block Diagram



### Typical Performance



United States Patent No. RE44,134

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Micrel Inc. • 2180 Fortune Drive • San Jose, CA 95131 • USA • tel +1 (408) 944-0800 • fax + 1 (408) 474-1000 • <http://www.micrel.com>

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Revision 5.0

[tcghelp@micrel.com](mailto:tcghelp@micrel.com) or (408) 955-1690

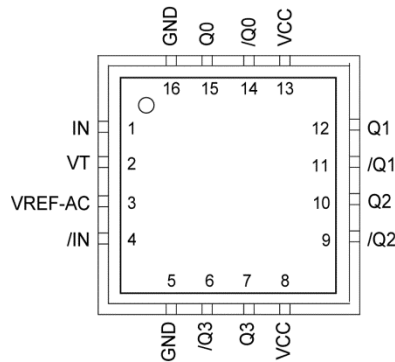
## Ordering Information<sup>(1)</sup>

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY58020UMG	QFN-16	Industrial	020U with Pb-Free bar-line indicator	Pb-Free NiPdAu
SY58020UMG TR <sup>(2)</sup>	QFN-16	Industrial	020U with Pb-Free bar-line indicator	Pb-Free NiPdAu

### Note:

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

## Pin Configuration



16-Pin QFN (QFN-16)

## Pin Description

Pin Number	Pin Name	Pin Function
1, 4	IN, /IN	Differential Input: This input pair receives the signal to be buffered. Each pin of this pair internally terminates with 50Ω to the V <sub>T</sub> pin. Note that this input will default to an indeterminate state if left open. See “ <i>Input Interface Applications</i> ” section.
2	VT	Input Termination Center-Tap: Each input terminates to this pin. The V <sub>T</sub> pin provides a center-tap for each input (IN, /IN) to the termination network for maximum interface flexibility. See “ <i>Input Interface Applications</i> ” section.
3	VREF-AC	Reference Output Voltage: This output biases to V <sub>CC</sub> -1.2V. It is used when AC-coupling to differential inputs. Connect V <sub>REF-AC</sub> directly to the V <sub>T</sub> pin. Bypass with 0.01μF low ESR capacitor to V <sub>CC</sub> . See “ <i>Input Interface Applications</i> ” section.
8, 13	VCC	Positive Power Supply: Bypass with 0.1μF//0.01μF low ESR capacitors as close to the pins as possible.
5, 16	GND, Exposed Pad	Ground. Exposed pad must be connected to a ground plane that is the same potential as the ground pin.
14, 15 11, 12 9, 10 6, 7	/Q0, Q0, /Q1, Q1, /Q2, Q2, /Q3, Q3	CML Differential Output Pairs: Differential buffered output copy of the input signal. The output swing is typically 400mV into 50Ω load. Normally terminate CML output pairs with 100Ω across Q and /Q outputs at the receiving end. Unused output pairs may be left floating with no impact on jitter or skew. See “ <i>CML Output Termination</i> ” section.

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

Power 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 $V_{CC}+0.5V$
Current ( $V_T$ )	
Source or sink current on $V_T$ pin.....	$\pm 100mA$
Input Current	
Source or sink current on IN, /IN.....	$\pm 50mA$
Current ( $V_{REF}$ )	
Source or sink current on $V_{REF-AC}$ <sup>(6)</sup> , .....	$\pm 1.5mA$
Lead Temperature Soldering, (20 sec.).....	260°C
Storage Temperature Range ( $T_S$ ).....	-65°C to +150°C

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

Supply Voltage ( $V_{CC}$ ).....	+2.375V to +3.60V
Ambient Temperature ( $T_A$ ).....	-40°C to +85°C
Junction Thermal Resistance	
QFN ( $\theta_{JA}$ )	
Still-Air .....	60°C/W
500lfpm.....	54°C/W
QFN ( $\Psi_{JB}$ )	
(Junction-to-Board Resistance) <sup>(5)</sup> .....	33°C/W

**DC Electrical Characteristics<sup>(7)</sup>**

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

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
$V_{CC}$	Power Supply Voltage	$V_{CC} = 2.5V$	2.375	2.500	2.625	V
		$V_{CC} = 3.3V$	3.000	3.300	3.600	V
$I_{CC}$	Power Supply Current	No Load, $V_{CC} = \text{max.}$ (include internal 50Ω pull-up)		150	180	mA
$V_{IH}$	Input HIGH Voltage	Note 8	$V_{CC}-1.600$		$V_{CC}$	V
$V_{IL}$	Input LOW Voltage		0		$V_{IH}-0.100$	V
$V_{IN}$	Input Voltage Swing	See Figure 1.	0.100		1.700	V
$V_{DIFF\_IN}$	Differential Input Voltage Swing	See Figure 2.	0.200		3.400	V
$R_{IN}$	IN-to- $V_T$ Resistance		40	50	60	Ω
$V_{REF-AC}$	Output Reference Voltage		$V_{CC}-1.300$	$V_{CC}-1.200$	$V_{CC}-1.100$	V
$V_{T\_IN}$	IN-to- $V_T$ Voltage				1.280	V

**CML DC Electrical Characteristics<sup>(7)</sup>**

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

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
$V_{OH}$	Output HIGH Voltage		$V_{CC}-0.020$	$V_{CC}-0.010$	$V_{CC}$	V
$V_{OUT}$	Output Voltage Swing	See Figure 1.	325	400	500	mV
$V_{DIFF\_OUT}$	Differential Output Voltage Swing	See Figure 2.	650	800	1000	mV
$R_{OUT}$	Output Source Impedance		40	50	60	Ω

**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.
- Thermal performance assumes exposed pad is soldered (or equivalent) to the device's most negative potential on the PCB.
- 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.
- $V_{IH}$  (min) not lower than 1.2V.

## AC Electrical Characteristics

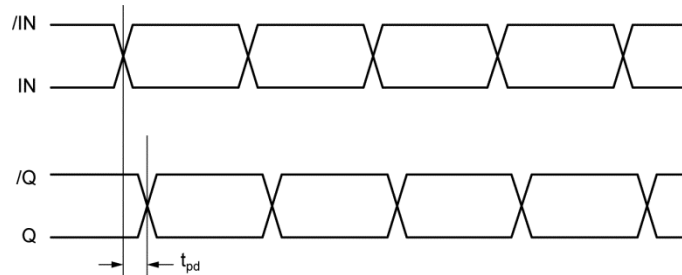
$V_{CC} = 2.5V \pm 5\%$  or  $3.3V \pm 10\%$ ;  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ ;  $R_L = 100\Omega$  across each output pair or equivalent, unless otherwise stated.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
$f_{MAX}$	Maximum Operating Frequency	$V_{OUT} \geq 200mV$ Clock	6			GHz
		NRZ Data		10		Gbps
$t_{pd}$	Propagation Delay		110	180	260	ps
$t_{SKEW}$	Output-to-Output Skew	Note 9		4	15	ps
	Part-to-Part Skew	Note 10			50	ps
$t_r, t_f$	Output Rise/Fall Time 20% to 80%	At full swing	20	40	60	ps
$t_{JITTER}$	Additive Phase Jitter	Carrier = 622MHz Integration Range: 12kHz – 20MHz		27		$f_{SRMS}$
		Carrier = 156.25MHz Integration Range: 12kHz – 20MHz		128		

**Notes:**

- 9. Skew is measured between outputs under identical transitions.
- 10. 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.

## Timing Diagram



## Single-Ended and Differential Swings

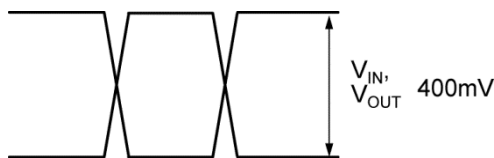


Figure 1. Single-Ended Voltage Swing

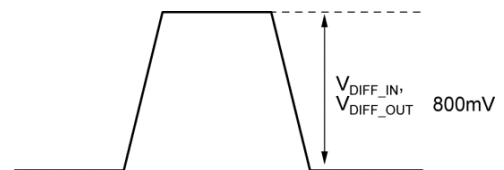
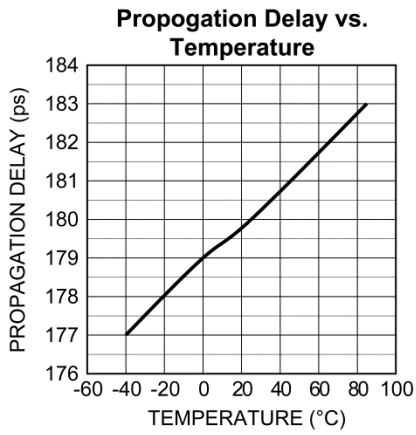
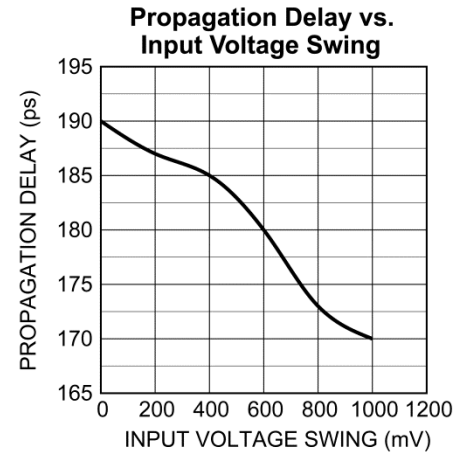
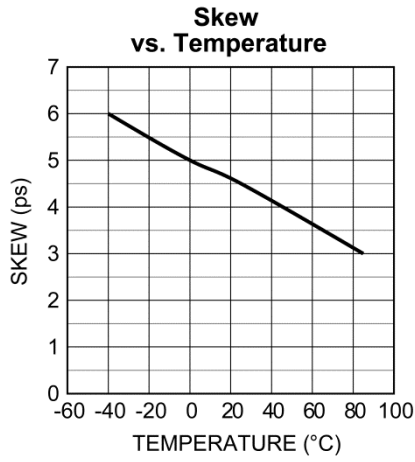
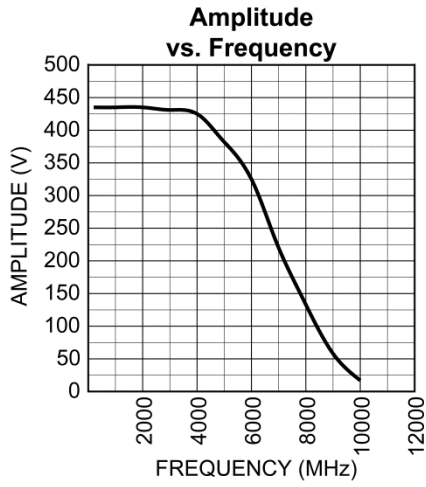


Figure 2. Differential Voltage Swing

## Typical Operating Characteristics

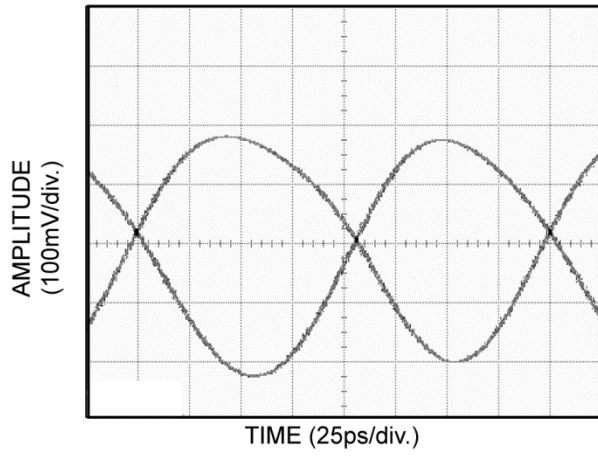
$V_{CC} = 2.5V$ ,  $GND = 0$ ,  $V_{IN} = 100mV$ ,  $T_A = 25^\circ C$ , unless otherwise stated.



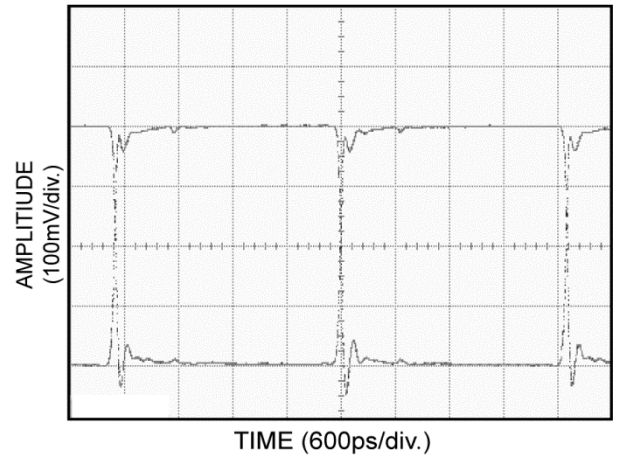
### Functional Characteristics

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

#### 5GHz Output

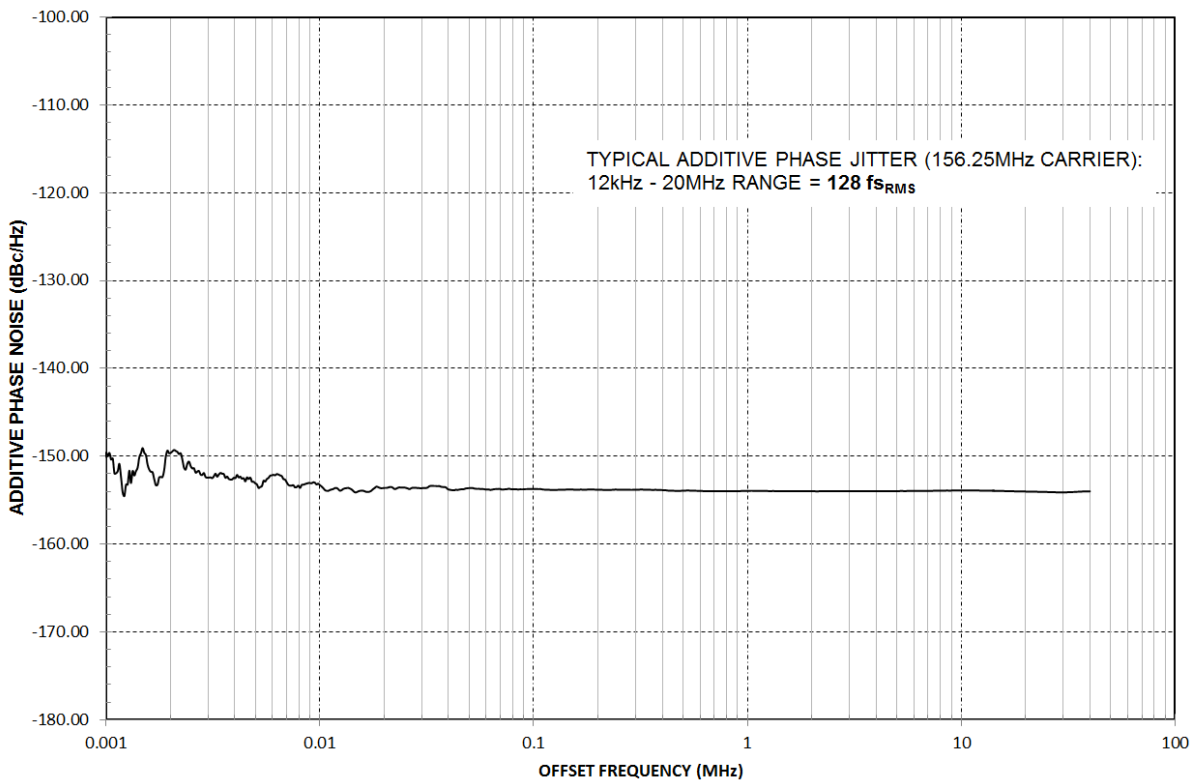
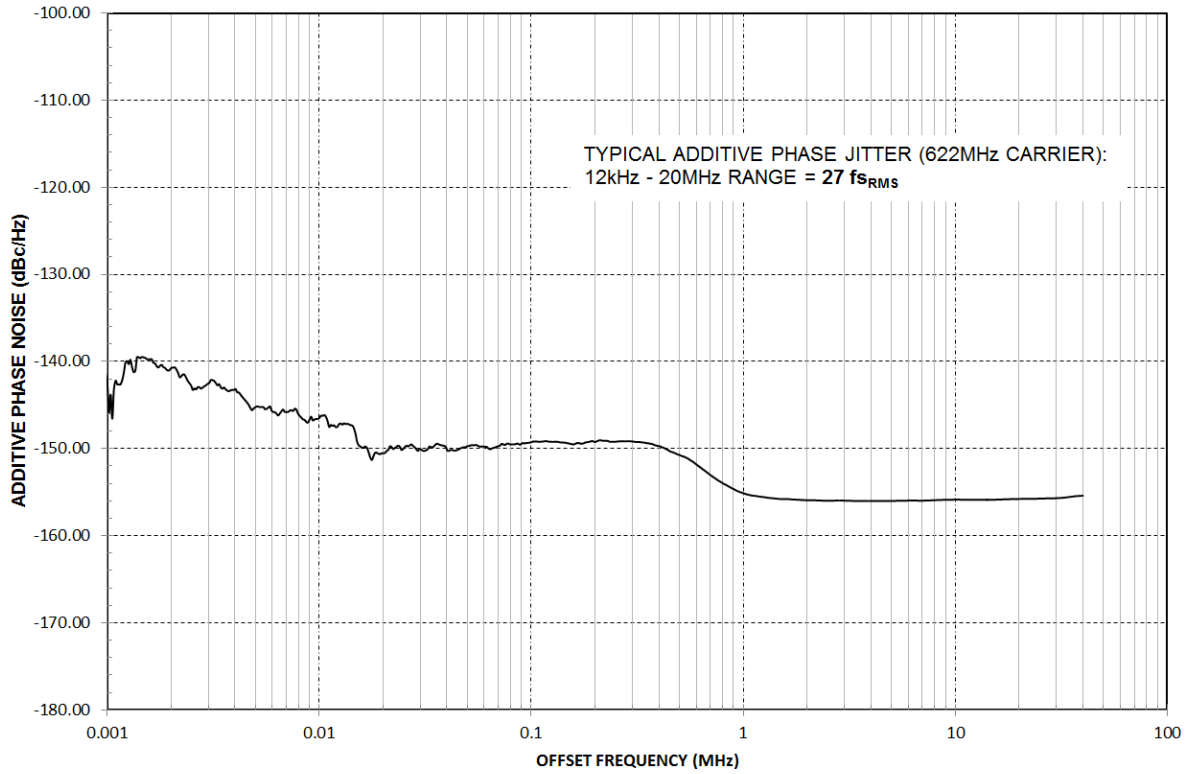


#### 200MHz Output



### Additive Phase Noise Plots

V<sub>CC</sub> = 3.3V, GND = 0, T<sub>A</sub> = 25°C.



# Input Stage

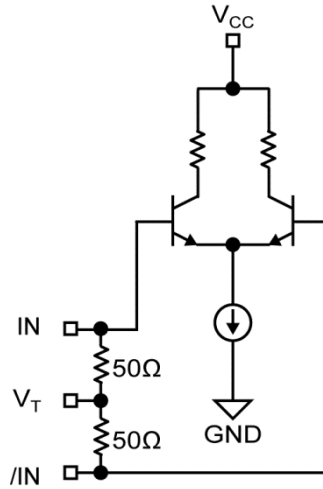


Figure 3. Simplified Differential Input Buffer

## Input Interface Applications

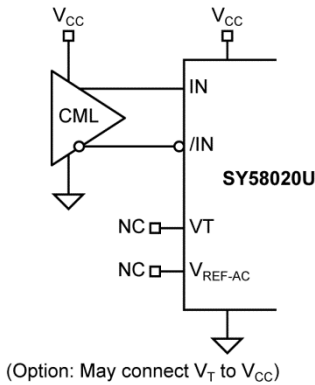


Figure 4. DC-Coupled CML Input Interface

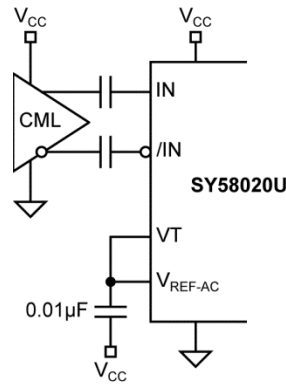


Figure 5. AC-Coupled CML Input Interface

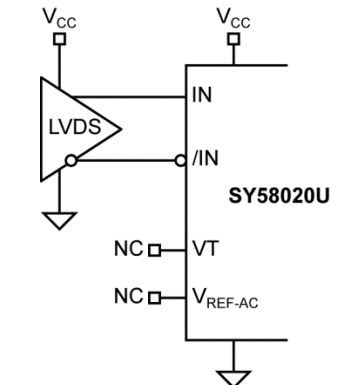


Figure 6. LVDS Input Interface

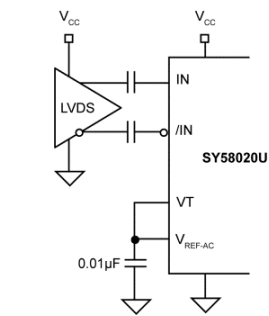


Figure 7. AC-Coupled LVDS Input Interface.

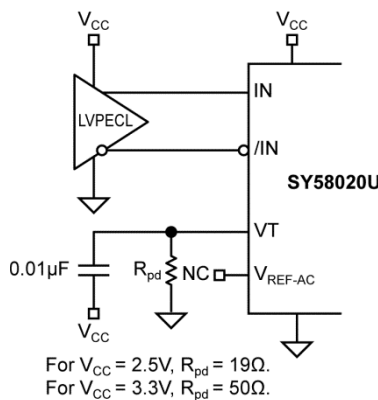


Figure 8. LVPECL Input Interface

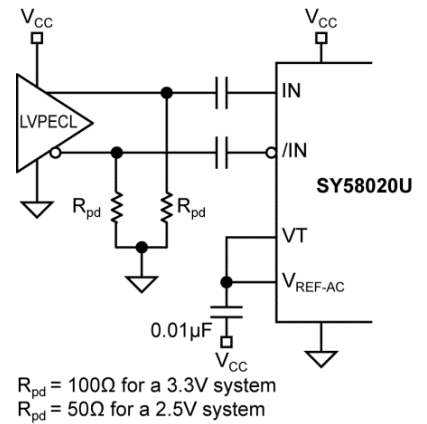


Figure 9. AC-Coupled LVPECL Input Interface

Note: Be certain that the LVDS driver can be AC-coupled.



## CML Output Termination

Figures 10 and 11 illustrate a CML output using both the AC-coupled and DC-coupled configuration. All outputs of the SY58020U are 50Ω with a 16mA current source.

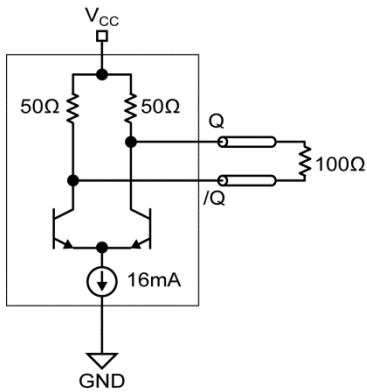


Figure 10. CML DC-Coupled

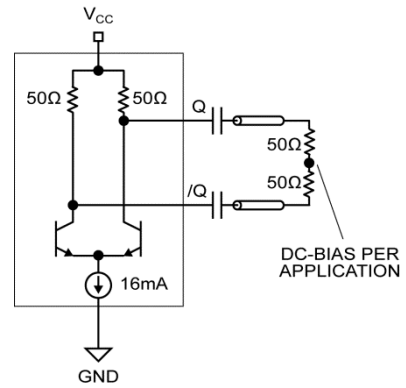
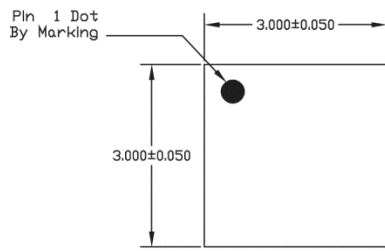
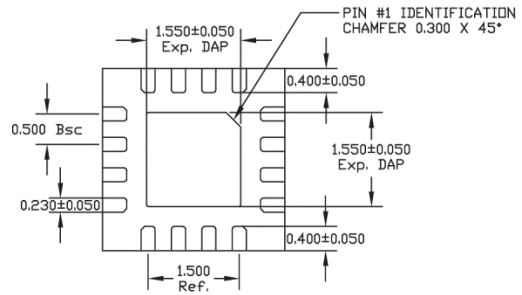


Figure 11. CML AC-Coupled Termination

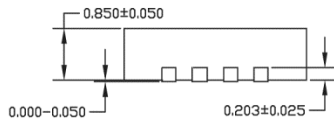
## Package Information<sup>(16)</sup>



TOP VIEW



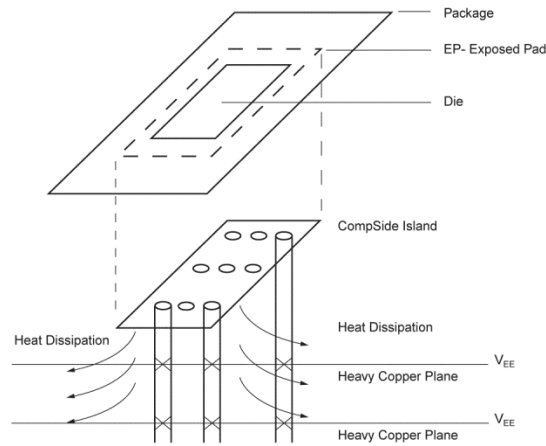
BOTTOM VIEW



SIDE VIEW

NOTE:

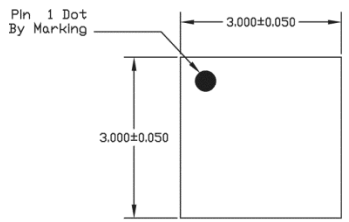
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. MAX. PACKAGE WARPAGE IS 0.05 mm.
3. MAXIMUM ALLOWABLE BURRS IS 0.076 mm IN ALL DIRECTIONS.
4. PIN #1 ID ON TOP WILL BE LASER/INK MARKED.



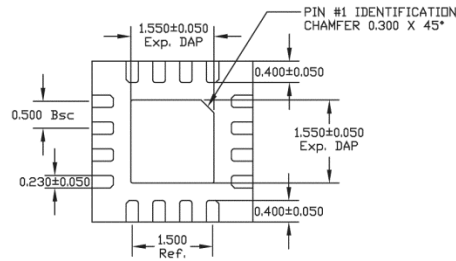
**PCB Thermal Consideration for 16-Pin MLF® Package  
(Always solder, or equivalent, the exposed pad to the PCB)**

**Package Notes:**

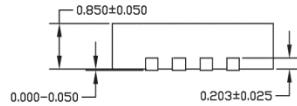
- Note 1.** Package meets Level 2 qualification.
- Note 2.** All parts are dry-packaged before shipment.
- Note 3.** Exposed pads must be soldered to a ground for proper thermal management.



TOP VIEW

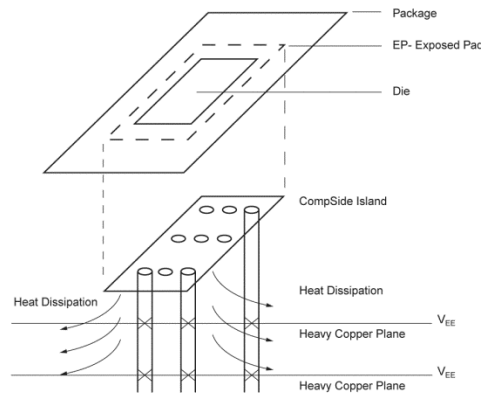


BOTTOM VIEW



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 16-Pin QFN Package  
(Always solder, or equivalent, the exposed pad to the PCB)

**Package Notes:**

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- Note 2.** All parts are dry-packaged before shipment.
- Note 3.** Exposed pads must be soldered to a ground for proper thermal management.

**16-Pin Package Type (QFN-16)**

**Note:**

11. Package information is correct as of the publication date. For updates and most current information, go to [www.micrel.com](http://www.micrel.com).

**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>

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## Revision History

Date	Change Description/Edits by:	Rev.
8/4/10	Added new paragraph to disclaimer in boiler plate. Per Colin Sturt. M.Galvan	14
1/16/13	Complete rework	15
5/8/14	Updated Contact Email	16