

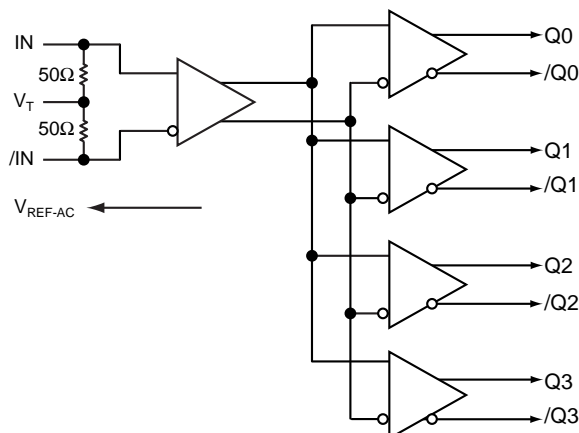
FEATURES

- 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:
 - < 10ps_{PP} total jitter (clock)
 - < 1ps_{RMS} random jitter (data)
 - < 10ps_{PP} deterministic jitter (data)
- 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
- 50 Ω source terminated CML outputs
- Power supply 2.5V \pm 5% and 3.3V \pm 10%
- Industrial temperature range: -40°C to +85°C
- Available in 16-pin (3mm \times 3mm) MLF® 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



Precision Edge®

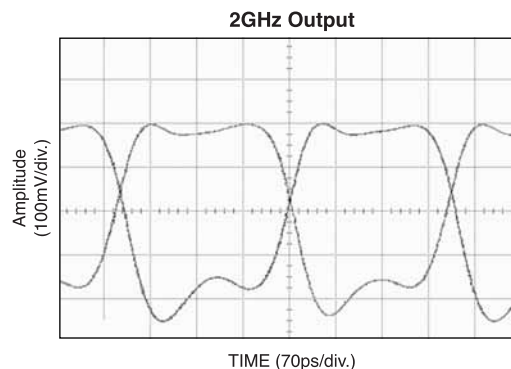
DESCRIPTION

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 less than 10ps_{PP} total jitter, the SY58020U can process clock signals as fast as 6GHz.

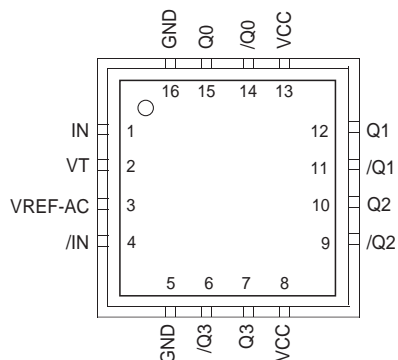
The differential input includes Micrel's unique, 3-pin input termination architecture interfaces to differential LVPECL, LVDS, and CML signals (AC- or DC-coupled) as small as 100mV without any level-shifting or termination resistor networks in the signal path. For AC-coupled input interface applications, 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 50 Ω 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°C to +85°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® product line. Datasheets and support documentation can be found on Micrel's web site at www.micrel.com.

TYPICAL PERFORMANCE



PACKAGE/ORDERING INFORMATION



16-Pin MLF® (MLF-16)

Ordering Information⁽¹⁾

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY58020UMI	MLF-16	Industrial	020U	Sn-Pb
SY58020UMITR ⁽²⁾	MLF-16	Industrial	020U	Sn-Pb
SY58020UMG ⁽³⁾	MLF-16	Industrial	020U with Pb-Free bar-line indicator	Pb-Free NiPdAu
SY58020UMGTR ^(2, 3)	MLF-16	Industrial	020U 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
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_T pin. Note that this input will default to an indeterminate state if left open. See “Input Interface Applications” section.
2	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.
3	VREF-AC	Reference Output Voltage: This output biases to $V_{CC} - 1.2\text{V}$. It is used when AC-coupling to differential inputs. Connect V_{REF-AC} directly to the V_T pin. Bypass with $0.01\mu\text{F}$ low ESR capacitor to V_{CC} . See “Input Interface Applications” section.
8, 13	VCC	Positive Power Supply: Bypass with $0.1\mu\text{F}/0.01\mu\text{F}$ 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 “CML Output Termination” section.

Absolute Maximum Ratings^(Note 1)

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} , Note 4	$\pm 1.5mA$
Lead Temperature Soldering, (20 seconds)	260°C
Storage Temperature Range (T_{STORE})	-65°C to +150°C

Operating Ratings^(Note 2)

Supply Voltage (V_{CC})	+2.375V to +3.60V
Operating Temperature Range (T_A)	-40°C to +85°C
Package Thermal Resistance	
MLF® (θ_{JA})	
Still-Air	60°C/W
500lfpm	54°C/W
MLF® (ψ_{JB})	
(Junction-to-Board Resistance), Note 3	33°C/W

DC ELECTRICAL CHARACTERISTICS^(Notes 5)

$T_A = -40^\circ C$ to $+85^\circ C$

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{CC}	Power Supply Voltage	$V_{CC} = 2.5V$	2.375	2.5	2.625	V
		$V_{CC} = 3.3V$	3.0	3.3	3.60	V
I_{CC}	Power Supply Current	No load, $V_{CC} = \text{max.}$ (includes internal 50 Ω pull-up)		150	180	mA
V_{IH}	Input HIGH Voltage	Note 6	$V_{CC}-1.6$		V_{CC}	V
V_{IL}	Input LOW Voltage		0		$V_{IH}-0.1$	V
V_{IN}	Input Voltage Swing	See Figure 1a	0.1		1.7	V
V_{DIFF_IN}	Differential Input Voltage Swing	See Figure 1b	0.2			V
R_{IN}	IN-to- V_T Resistance		40	50	60	Ω
V_{REF-AC}	Output Reference Voltage		$V_{CC} - 1.3$	$V_{CC} - 1.2$	$V_{CC} - 1.1$	V
V_{T_IN}	IN-to- V_T Voltage				1.28	V

CML DC ELECTRICAL CHARACTERISTICS^(Notes5)

$V_{CC} = 3.3V \pm 10\%$ or $2.5V \pm 5\%$; $R_L = 100\Omega$ across each output pair or equivalent; $T_A = -40^\circ C$ to $+85^\circ C$, 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 1a	325	400	500	mV
V_{DIFF_OUT}	Differential Output Voltage Swing	see Figure 1b	650	800	1000	mV
R_{OUT}	Output Source Impedance		40	50	60	Ω

Note 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.

Note 2. The data sheet limits are not guaranteed if the device is operated beyond the operating ratings.

Note 3. Thermal performance assumes exposed pad is soldered (or equivalent) to the device's most negative potential on the PCB.

Note 4. Due to the limited drive capability, use for input of the same package only.

Note 5. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

Note 6. V_{IH} (min) not lower than 1.2V.

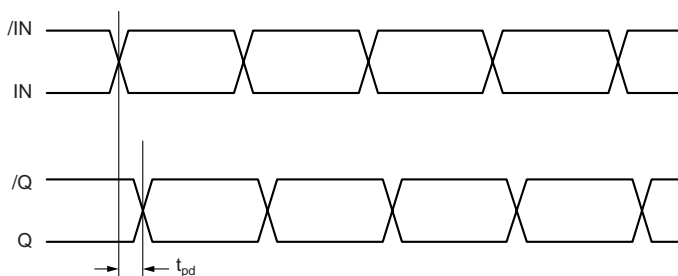
AC ELECTRICAL CHARACTERISTICS

$V_{CC} = 2.5V \pm 5\%$ 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_{CHAN}	Channel-to-Channel Skew	Note 7		4	15	ps	
t_{SKEW}	Part-to-Part Skew	Note 8			50	ps	
t_{JITTER}	Clock	Cycle-to-Cycle Jitter			1	μs_{RMS}	
		Total Jitter			10	μs_{PP}	
	Data	Random Jitter	Note 11	2.5Gbps – 3.2Gbps		1	μs_{RMS}
		Deterministic Jitter	Note 12	2.5Gbps – 3.2Gbps		10	μs_{PP}
t_r, t_f	Output Rise/Fall Time 20% to 80%	At full swing	20	40	60	ps	

- Note 7.** Skew is measured between outputs of the same bank under identical transitions.
- Note 8.** 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.
- Note 9.** 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.
- Note 10.** 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.
- Note 11.** Random jitter is measured with a K28.7 comma detect character pattern, measured at 2.5Gbps/3.2Gbps.
- Note 12.** Deterministic jitter is measured at 2.5Gbps/3.2Gbps with both K28.5 and $2^{23}-1$ PRBS pattern

TIMING DIAGRAM



SINGLE-ENDED AND DIFFERENTIAL SWINGS

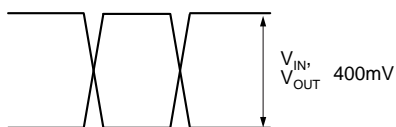


Figure 1a. Single-Ended Voltage Swing

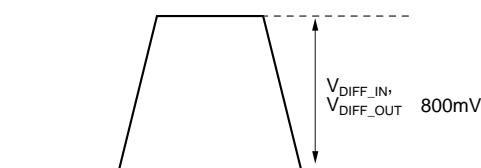
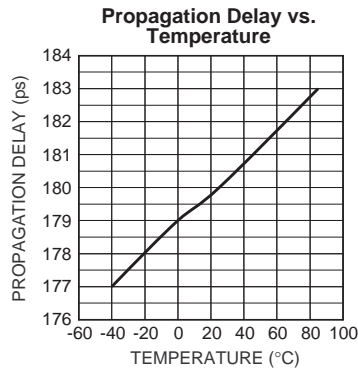
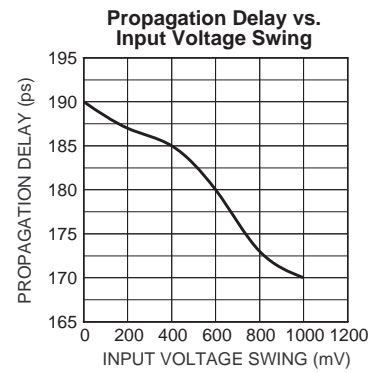
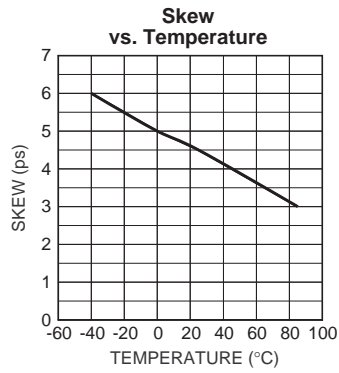
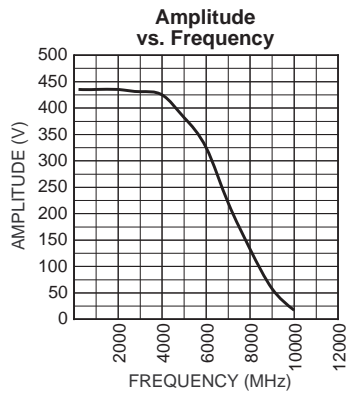


Figure 1b. Differential Voltage Swing

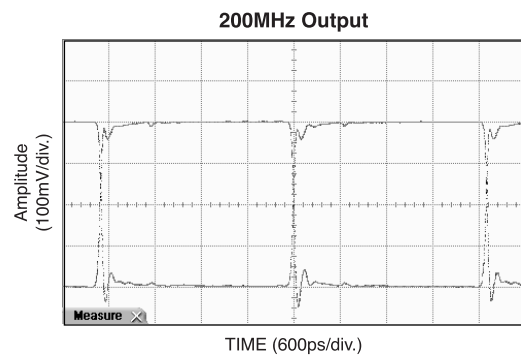
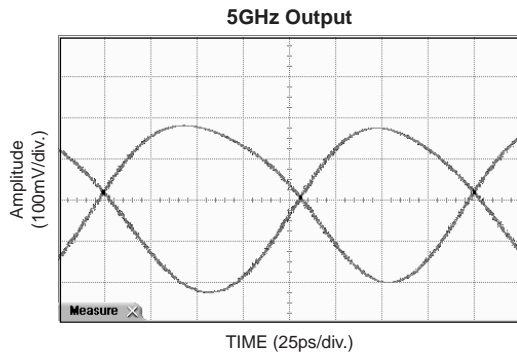
TYPICAL OPERATING CHARACTERISTICS

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



FUNCTIONAL CHARACTERISTICS

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



INPUT STAGE

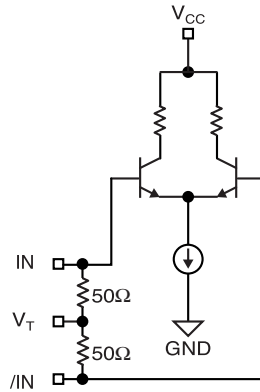
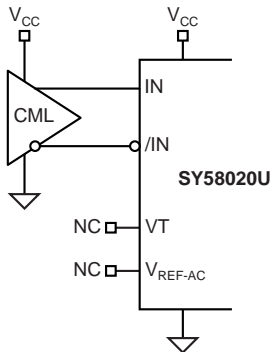


Figure 2. Simplified Differential Input Buffer

INPUT INTERFACE APPLICATIONS



(Option: May connect V_T to V_{CC})

Figure 3a. DC-Coupled CML Input Interface

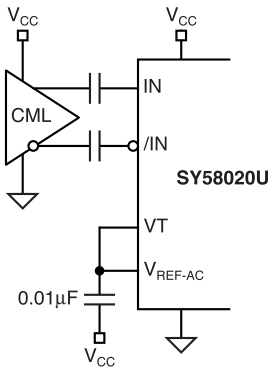


Figure 3b. AC-Coupled CML Input Interface

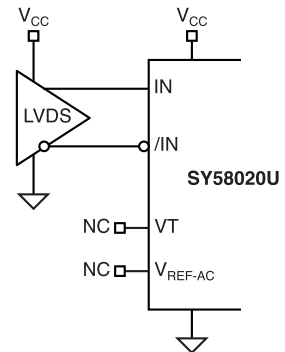
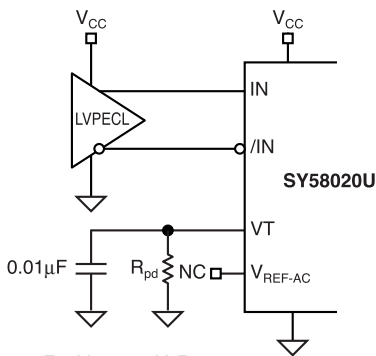
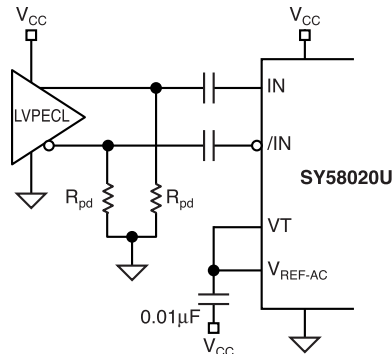


Figure 3c. LVDS Input Interface



For $V_{CC} = 2.5V$, $R_{pd} = 19\Omega$
For $V_{CC} = 3.3V$, $R_{pd} = 50\Omega$

Figure 3d. LVPECL Input Interface



$R_{pd} = 100\Omega$ for a 3.3V system
 $R_{pd} = 50\Omega$ for a 2.5V system

Figure 3e. AC-Coupled LVPECL Input Interface

CML OUTPUT TERMINATION

Figures 4 and 5 illustrate how to terminate a CML output using both the AC-coupled and DC-coupled configuration. All outputs of the SY58020U are 50Ω with a 16mA current source.

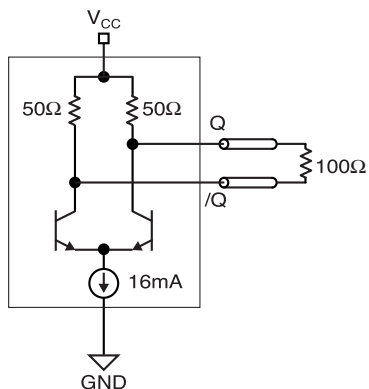


Figure 4. CML DC-Coupled

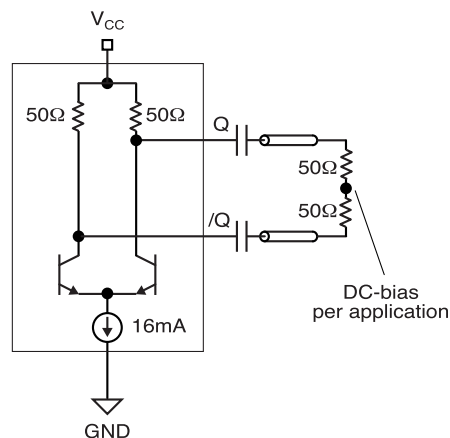
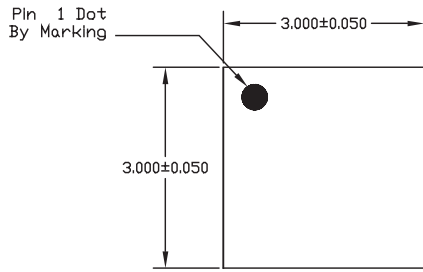


Figure 5. CML AC-Coupled Termination

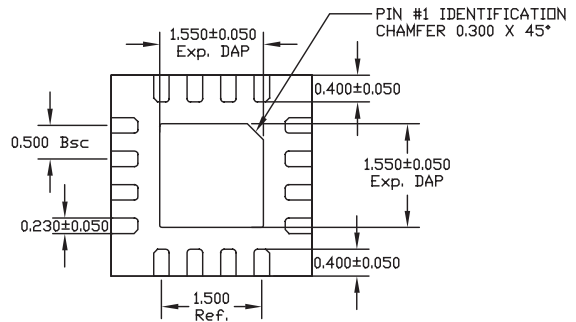
RELATED MICREL PRODUCTS AND SUPPORT DOCUMENTATION

Part Number	Function	Data Sheet Link
SY58020U	6GHz, 1:4 CML Fanout Buffer/Translator with Internal I/O Termination	http://www.micrel.com/product-info/products/sy58020u.shtml
SY58021U	4GHz, 1:4 LVPECL Fanout Buffer/Translator with Internal Termination	http://www.micrel.com/product-info/products/sy58021u.shtml
SY58022U	5.5GHz, 1:4 Fanout Buffer/Translator w/400mV LVPECL Outputs and Internal Input Termination	http://www.micrel.com/product-info/products/sy58022u.shtml
	16-MLF™ Manufacturing Guidelines Exposed Pad Application Note	www.amkor.com/products/notes_papers/MLF_AppNote_0902.pdf
M-0317	HBW Solutions	http://www.micrel.com/product-info/as/solutions.shtml

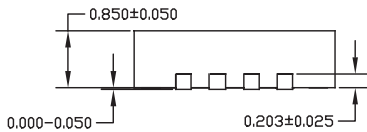
16-PIN *MicroLeadFrame*® (MLF-16)



TOP VIEW

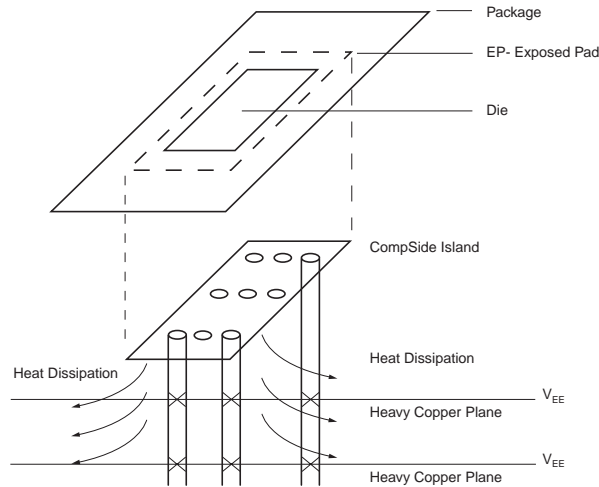


BOTTOM VIEW



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.

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 datasheet 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.