



5GHz, 1:2 LVPECL FANOUT BUFFER/TRANSLATOR WITH INTERNAL INPUT TERMINATION

Precision Edge®
SY58012U

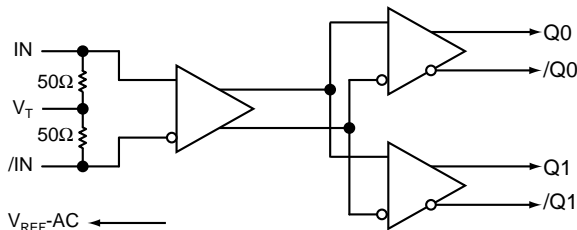
FEATURES

- Precision 1:2, 800mV LVPECL fanout buffer
- Guaranteed AC performance over temperature/voltage:
 - > 5GHz f_{MAX} (clock)
 - < 110ps t_r / t_f times
 - < 260ps 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- and AC-coupled differential inputs: LVPECL, LVDS, and CML
- Outputs are 100k LVPECL compatible, 800mV swing
- Power supply 2.5V $\pm 5\%$ and 3.3V $\pm 10\%$
- -40°C to $+85^\circ\text{C}$ temperature range
- Available in 16-pin (3mm x 3mm) MLF® package

APPLICATIONS

- All SONET and GigE clock distribution
- Fibre Channel clock and data distribution
- Backplane distribution
- High-end, low skew, multiprocessor synchronous clock distribution

FUNCTIONAL BLOCK DIAGRAM



Precision Edge®

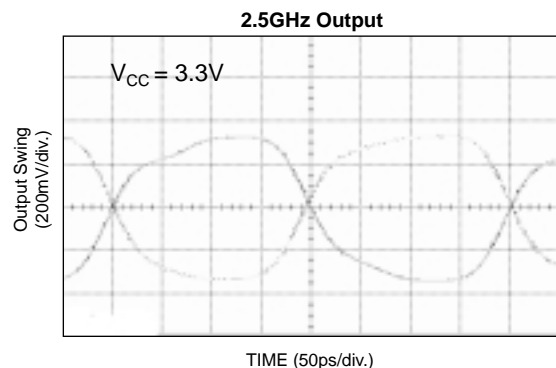
DESCRIPTION

The SY58012U is a 2.5V/3.3V precision, high-speed, fully differential 1:2 LVPECL fanout buffer. Optimized to provide two identical output copies with less than 15ps of skew and less than 10ps_(pk-pk) total jitter, the SY58012U can process clock signals as fast as 5GHz or 5Gbps data.

The differential input includes Micrel's unique, 3-pin input termination architecture that interfaces to LVPECL, LVDS or CML differential signals, (AC-coupled 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 100k LVPECL compatible, with extremely fast rise/fall times guaranteed to be less than 110ps.

The SY58012U 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 $+85^\circ\text{C}$). For applications that require faster rise/fall times, or greater bandwidth, consider the SY58013U 1:2 fanout buffer with 400mV output swing, or the SY58011 1:2 CML (400mV) fanout buffer. The SY58012U is part of Micrel's high-speed, Precision Edge® product line. Data sheets and support documentation can be found on Micrel's web site at www.micrel.com.

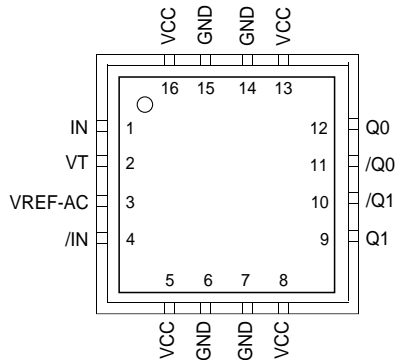
TYPICAL PERFORMANCE



2GHz with 100mV Input

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MicroLeadFrame and MLF are registered trademarks of Amkor Technology, Inc.

PACKAGE/ORDERING INFORMATION



16-Pin MLF® (MLF-16)

Ordering Information⁽¹⁾

| Part Number | Package Type | Operating Range | Package Marking | Lead Finish |
|--------------------------------|--------------|-----------------|--------------------------------------|----------------|
| SY58012UMI | MLF-16 | Industrial | 012U | Sn-Pb |
| SY58012UMITR ⁽²⁾ | MLF-16 | Industrial | 012U | Sn-Pb |
| SY58012UMG ⁽³⁾ | MLF-16 | Industrial | 012U with Pb-Free bar-line indicator | Pb-Free NiPdAu |
| SY58012UMGTR ^(2, 3) | MLF-16 | Industrial | 012U 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 is 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 a 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 the inputs (IN, /IN). Connect V_{REF-AC} directly to the V_T pin. Bypass with $0.01\mu\text{F}$ low ESR capacitor to V_{CC} . Maximum current source or sink is 0.5mA . See "Input Interface Applications" section. |
| 5, 8, 13, 16 | VCC | Positive Power Supply: Bypass with $0.1\mu\text{F}/0.01\mu\text{F}$ low ESR capacitors as close to the V_{CC} pins as possible. |
| 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 pin. |
| 12, 11 9, 10 | Q0, /Q0, Q1, /Q1 | LVPECL Differential Output Pairs: Differential buffered output copy of the input signal. The output swing is typically 800mV . Unused output pairs may be left floating with no impact on jitter. See "LVPECL 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} |
| LVPECL Output Current (I_{OUT}) | |
| Continuous | 50mA |
| Surge | 100mA |
| Source or sink current on V_T pin | |
| V_T Current | ±100mA |
| Source or sink current on IN, /IN | |
| Input Current | ±50mA |
| Source or sink current on V_{REF-AC} , Note 4 | |
| V_{REF} Current | ±1.5mA |
| Soldering, (20 seconds) | 260°C |
| Storage Temperature Range (T_{STORE}) | –65°C to +150°C |

Operating Ratings^(Note 2)

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

INPUT DC ELECTRICAL CHARACTERISTICS^(Note 5)

| Symbol | Parameter | Condition | Min | Typ | Max | Units |
|----------------|----------------------------------|-------------------------|--------------|--------------|--------------|----------|
| V_{CC} | Power Supply Voltage | | 2.375 | | 3.60 | V |
| I_{CC} | Power Supply Current | Max. V_{CC} , no load | | 55 | 80 | mA |
| 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 |
| R_{IN} | In to V_T Resistance | | 40 | 50 | 60 | Ω |
| IN to V_T | | | | | 1.28 | V |
| V_{REF-AC} | Output Reference Voltage | | $V_{CC}-1.3$ | $V_{CC}-1.2$ | $V_{CC}-1.1$ | V |

LVPECL OUTPUT DC ELECTRICAL CHARACTERISTICS^(Note 5)

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

| Symbol | Parameter | Condition | Min | Typ | Max | Units |
|-----------------|-----------------------------------|---------------------------------|----------------|------|----------------|-------|
| V_{OH} | Output HIGH Voltage | Q0, /Q0, Q1, /Q1 | $V_{CC}-1.145$ | | $V_{CC}-0.895$ | V |
| V_{OL} | Output LOW Voltage | Q0, /Q0, Q1, /Q1 | $V_{CC}-1.945$ | | $V_{CC}-1.695$ | V |
| V_{OUT} | Output Voltage Swing | Q0, /Q0, Q1, /Q1; see Figure 1a | 550 | 800 | | mV |
| V_{DIFF_OUT} | Differential Output Voltage Swing | Q0, /Q0, Q1, /Q1; see Figure 1b | 1100 | 1600 | | mV |

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.

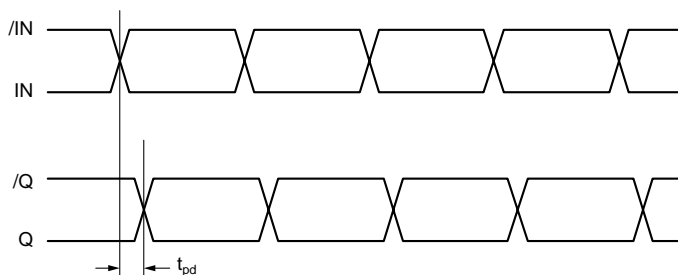
AC ELECTRICAL CHARACTERISTICS(Note 7)

$V_{CC} = 2.5V \pm 5\%$ 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 | NRZ Data | | 5 | | Gbps |
| | | $V_{OUT} \geq 400mV$ Clock | 5 | | | GHz |
| t_{pd} | Propagation Delay | $V_{IN} \geq 100mV$ | 110 | 170 | 260 | ps |
| t_{CHAN} | Channel-to-Channel Skew | Note 8 | | 3 | 15 | ps |
| t_{SKEW} | Part-to-Part Skew | Note 9 | | | 100 | ps |
| t_{JITTER} | Data Random Jitter (RJ) Deterministic Jitter (DJ) | Note 10 Note 11 | | | 1 10 | μs_{RMS} μs_{PP} |
| | Clock Cycle-to-Cycle Jitter Total Jitter (TJ) | Note 12 Note 13 | | | 1 10 | μs_{RMS} μs_{PP} |
| t_r, t_f | Output Rise/Fall Time | 20% to 80% at full output swing | 35 | 80 | 110 | ps |

- Note 7.** High frequency AC Electricals are guaranteed by design and characterization.
- Note 8.** Skew is measured between outputs of the same bank under identical transitions.
- Note 9.** 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 10.** RJ is measured with a K28.7 comma detect character pattern, measured at 10.7Gbps and 2.5Gbps/3.2Gbps.
- Note 11.** DJ is measured at 10.7Gbps and 2.5Gbps/3.2Gbps with both K28.5 and $2^{23}-1$ PRBS pattern
- Note 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.
- Note 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



SINGLE-ENDED AND DIFFERENTIAL SWINGS

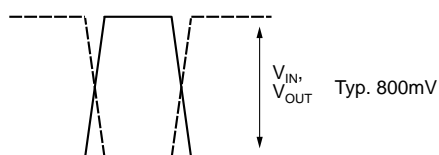


Figure 1a. Single-Ended Voltage Swing

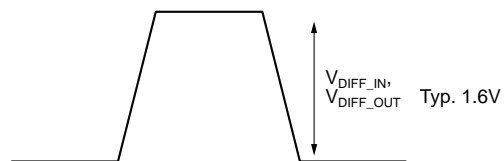
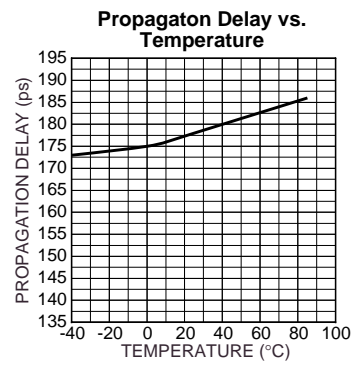
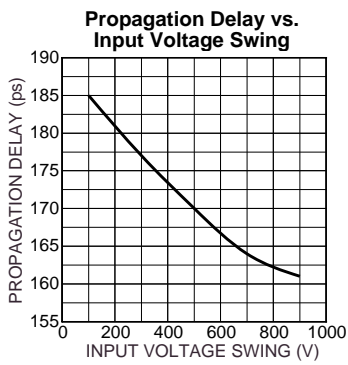
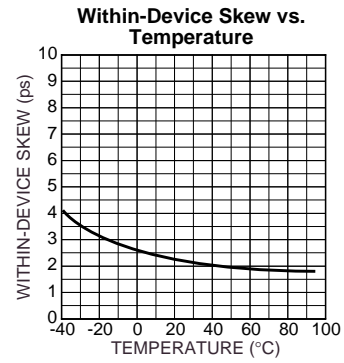
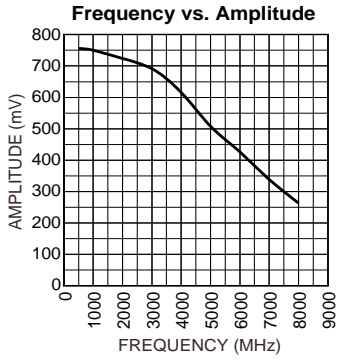


Figure 1b. Differential Voltage Swing

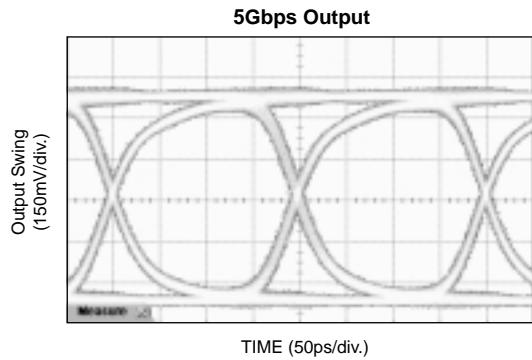
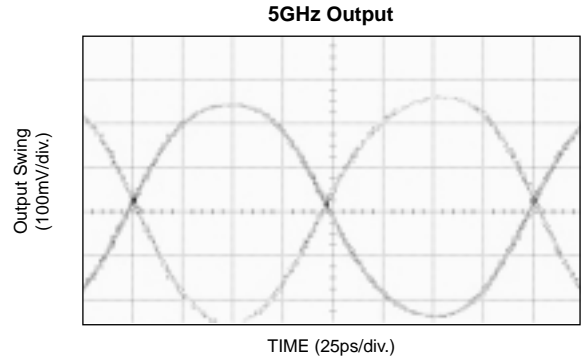
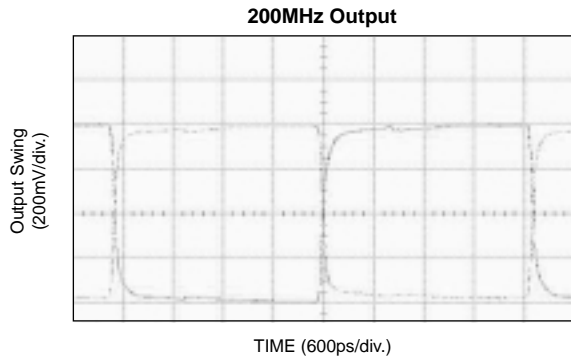
TYPICAL OPERATING CHARACTERISTICS

$V_{CC} = 3.3V$, $GND = 0$, $V_{IN} = 100mV$, $T_A = 25^{\circ}C$, unless otherwise stated.



FUNCTIONAL CHARACTERISTICS

$V_{CC} = 3.3V$, $GND = 0$, $V_{IN} = 100mV$, $T_A = 25^\circ C$, unless otherwise stated.



($2^{23}-1$ PRBS Pattern)

INPUT STAGE

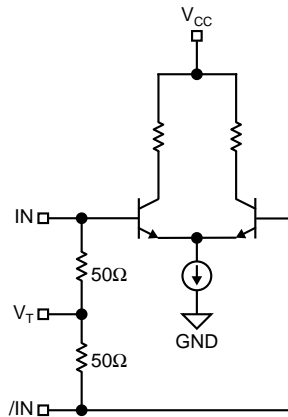
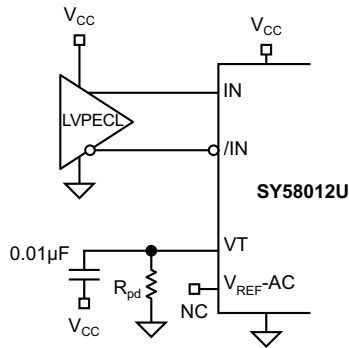


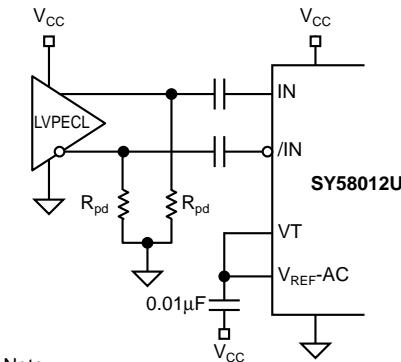
Figure 2. Simplified Differential Input Buffer

INPUT INTERFACE APPLICATIONS



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

Figure 3a. LVPECL Input Interface



Note:
For $V_{CC} = 3.3V$ system, $R_{pd} = 100\Omega$
For $V_{CC} = 2.5V$ system, $R_{pd} = 50\Omega$

Figure 3b. AC-Coupled LVPECL Input Interface

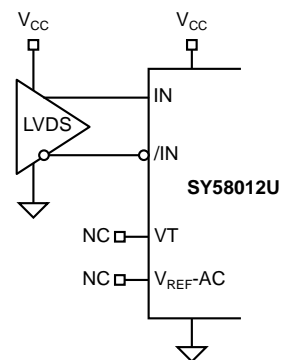


Figure 3c. LVDS Input Interface

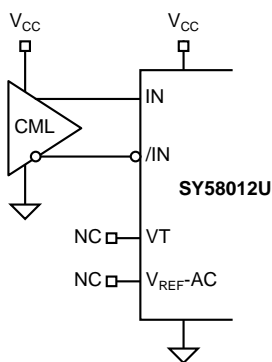


Figure 3d. DC-Coupled CML Input Interface
(option: may connect V_T to V_{CC})

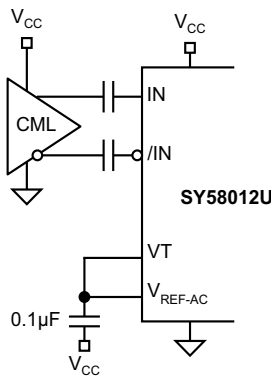


Figure 3e. AC-Coupled CML Input Interface

LVPECL OUTPUT

LVPECL output have 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 in terminating the LVPECL output, as shown in Figures 5 through 7.

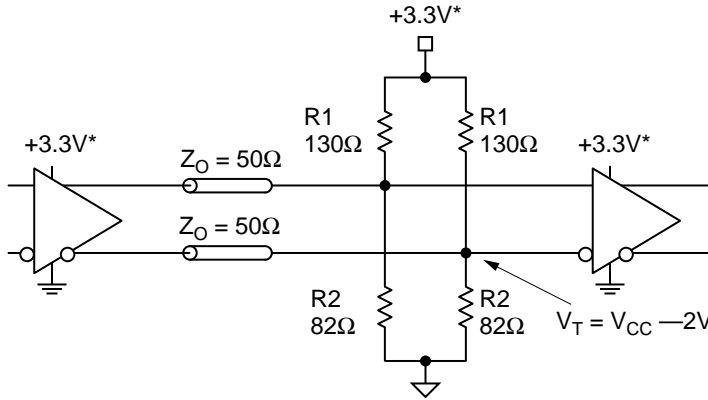


Figure 5. Parallel Termination-Thevenin Equivalent

Note 1. For +2.5V systems: R1 = 250Ω, R2 = 62.5Ω

Note 2. For +3.3V systems: R1 = 130Ω, R2 = 82Ω

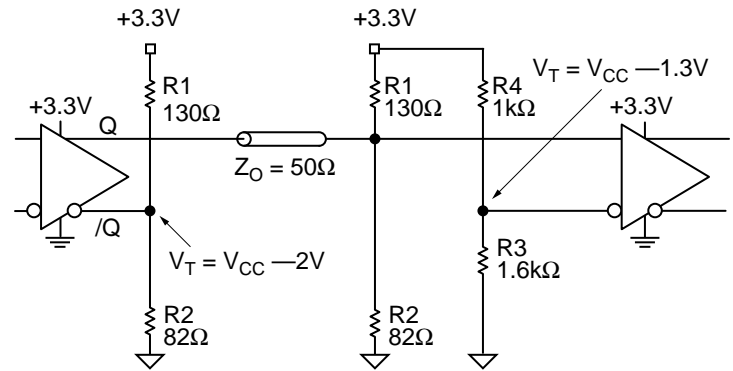


Figure 7. Terminating Unused I/O

Note 1. Unused output (/Q) must be terminated to balance the output.

Note 2. For +2.5V systems: R1 = 250Ω, R2 = 62.5Ω, R3 = 1.25kΩ, R4 = 1.2kΩ.

For +3.3V systems: R1 = 130Ω, R2 = 82Ω, R3 = 1kΩ, R4 = 1.6kΩ.

Note 3. Unused output pairs (Q and /Q) may be left floating.

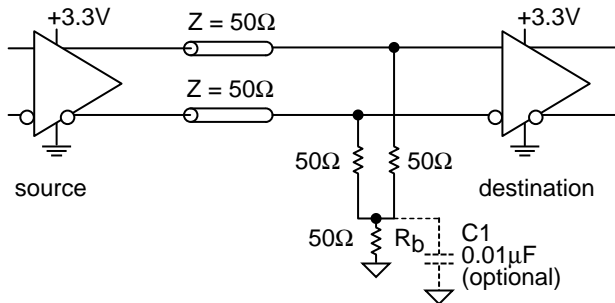


Figure 6. Three-Resistor "Y-Termination"

Note 1. Power-saving alternative to Thevenin termination.

Note 2. Place termination resistors as close to destination inputs as possible.

Note 3. R_b resistor sets the DC bias voltage, equal to V_T.

For +2.5V systems R_b = 19Ω.

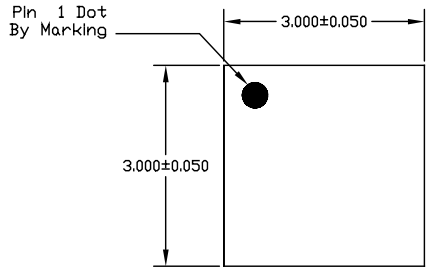
For +3.3V systems R_b = 46Ω to 50Ω.

Note 4. C1 is an optional bypass capacitor intended to compensate for any t_r/t_f mismatches.

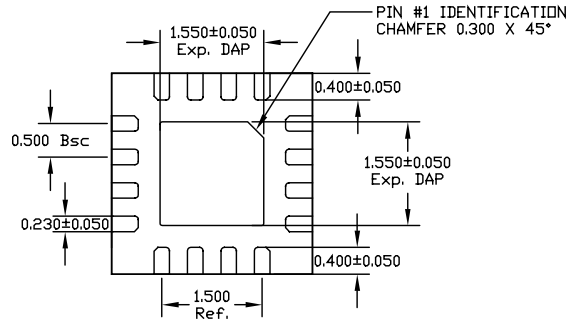
RELATED MICREL PRODUCTS AND SUPPORT DOCUMENTATION

| Part Number | Function | Data Sheet Link |
|-------------|---|--|
| SY58011U | 7GHz, 1:2 CML Fanout Buffer/Translator With Internal Input Terminations | http://www.micrel.com/product-info/products/sy58011u.shtml |
| SY58012U | 5GHz, 1:2 LVPECL Fanout Buffer/Translator With Internal Input Termination | http://www.micrel.com/product-info/products/sy58012u.shtml |
| SY58013U | 6GHz, 1:2 Fanout Buffer/Translator w/400mV LVPECL Outputs and Internal Terminations | http://www.micrel.com/product-info/products/sy58013u.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 |

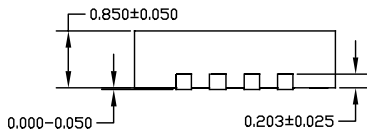
16-PIN MicroLeadFrame® (MLF-16)



TOP VIEW



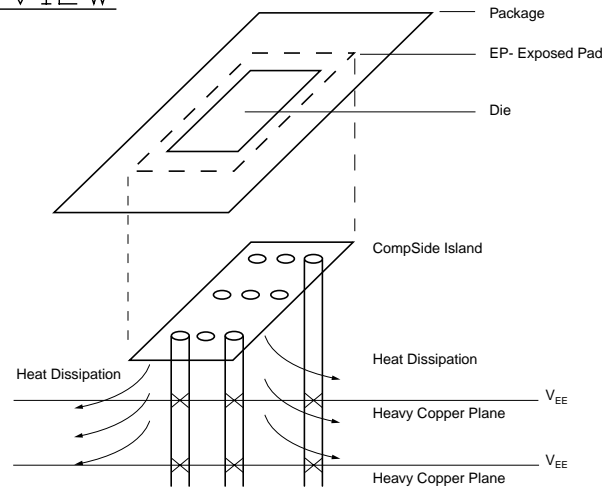
BOTTOM VIEW



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>

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