



**ULTRA-LOW JITTER DUAL 2 × 2  
CROSSPOINT SWITCH w/ CML OUTPUTS  
AND INTERNAL I/O TERMINATION**

**Precision Edge™  
SY58024U**

## FEATURES

- **Guaranteed AC performance over temperature and voltage:**
  - >10.7Gbps data throughput
  - <60ps  $t_r/t_f$  times
  - <350ps  $t_{pd}$  (IN-to-Q)
  - <20ps skew
- **Low jitter:**
  - <10ps<sub>pp</sub> total jitter (clock)
  - <1ps<sub>rms</sub> random jitter (data)
  - <10ps<sub>pp</sub> deterministic jitter (data)
- **Crosstalk induced jitter: <0.7ps<sub>rms</sub>**
- **Unique, patent-pending input isolation minimizes adjacent channel crosstalk**
- **Accepts an input signal as low as 100mV**
- **Unique, patent-pending input termination and VT pin accepts DC-coupled and AC-coupled differential inputs: LVPECL, LVDS, and CML**
- **Fully differential inputs/outputs**
- **50Ω source terminated CML outputs**
- **Power supply 2.5V ±5% and 3.3V ±10%**
- **Industrial –40°C to +85°C temperature range**
- **Available in 32-pin (5mm × 5mm) MLF™ package**

## APPLICATIONS

- Gigabit Ethernet data/clock routing
- SONET data/clocking routing
- Switch fabric clock routing
- Redundant switchover
- Backplane redundancy



Precision Edge™

## DESCRIPTION

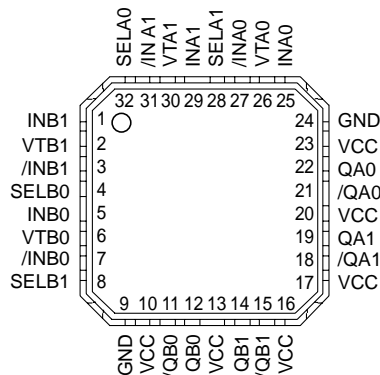
The SY58024U is a 2.5V/3.3V precision, high-speed, fully differential dual CML crosspoint switch. The SY58024U is optimized to provide two identical output copies with less than 20ps of skew and ultra-low jitter. The SY58024U can process clock signals as fast as 6GHz or data patterns up to 10.7Gbps.

The differential input includes Micrel's unique, 3-pin input termination architecture that allows the SY58024U to directly interface to LVPECL, LVDS, and CML differential signal (AC- or DC-coupled) without any level-shifting or termination resistor networks in the signal path. The CML outputs features a 400mV typical swing into 50Ω loads, and provides an extremely fast rise/fall time guaranteed to be less than 60ps.

The SY58024U operates from a 2.5V ±5% supply or 3.3V ±10% supply and is guaranteed over the full industrial temperature range (–40°C to +85°C). For applications that require high-speed single channel CML switches, consider the SY58023U. The SY58024U is part of Micrel's high-speed, Precision Edge™ product line.

Data sheets and support documentation can be found on Micrel's website at [www.micrel.com](http://www.micrel.com).

## PACKAGE/ORDERING INFORMATION



32-Pin MLF™ (MLF-32)

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

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY58024UMI	MLF-32	Industrial	SY58024U	Sn-Pb
SY58024UMITR <sup>(2)</sup>	MLF-32	Industrial	SY58024U	Sn-Pb
SY58024UMY	MLF-32	Industrial	SY58024U with "Y" designator	Pb-Free
SY58024UMYTR <sup>(2)</sup>	MLF-32	Industrial	SY58024U with "Y" designator	Pb-Free

## Notes:

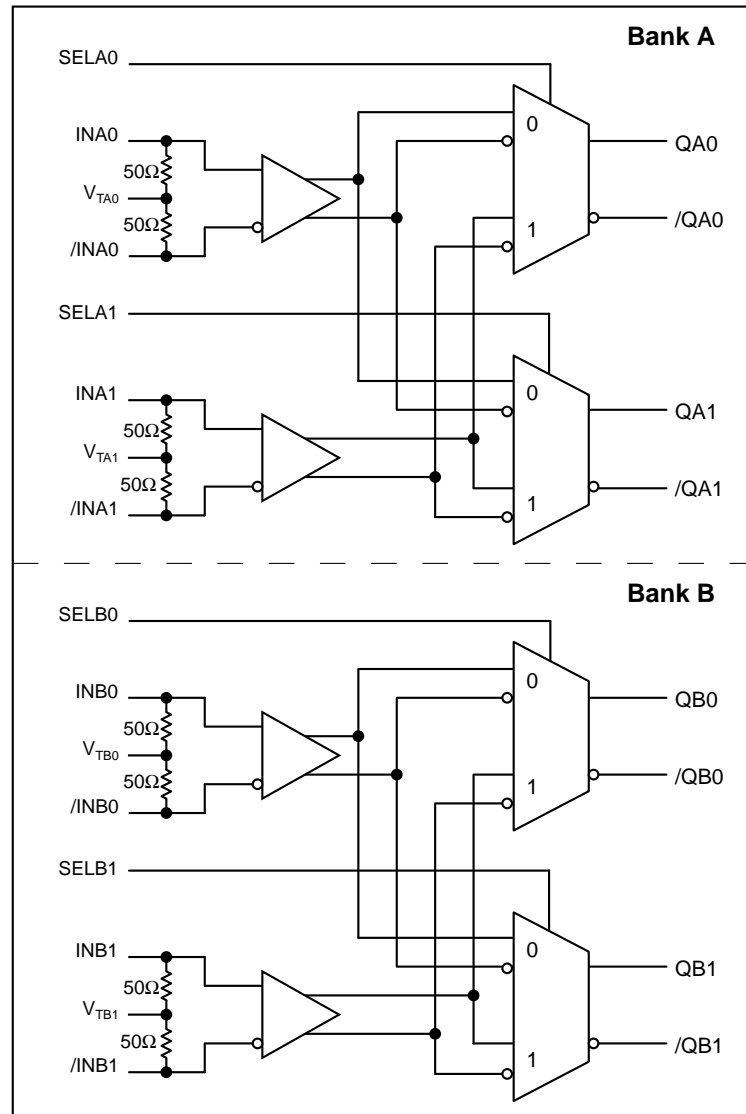
1. Contact factory for die availability. Dice are guaranteed at  $T_A = 25^\circ\text{C}$ , DC electricals only.
2. Tape and Reel.

## PIN DESCRIPTION

Pin Number	Pin Name	Pin Function
25, 27 29, 31, 1, 3, 5, 7	INA0, /INA0, INA1, /INA1, INB1, /INB1 INB0, /INB0	Differential Signal: Each pin of this pair internally terminates with 50Ω to the VT pin. The input will default to an indeterminate state if left open. See "Input Interface Application" section.
26, 30 2, 6	VTA0, VTA1, VTB1, VTB0	Input Termination Center-Tap: Each input terminates to this pin. The VT pin provides a center-tap for each input (IN, /IN) to a termination network for maximum interface flexibility. See "Input Interface Application" section.
32, 28, 8, 4	SELA0, SELA1, SELB1, SELB0	Select Input: TTL/CMOS select input controls that selects inputs IN0, or IN1, for their respective banks A and B. Each input is internally connected to a 25kΩ pull-up resistor and will default to a logic high state if left open.
9, 24	GND, Exposed Pad	Ground. Exposed pad must be connected to a ground plane that is the same potential as the device ground pins.
10, 13, 16, 17, 20, 23	VCC	Positive Power Supply: Bypass with 0.1μF   0.01μF low ESR capacitors as close to the V <sub>CC</sub> pins as possible.
11, 12, 14, 15 18, 19, 21, 22	/QB0, QB0, QB1, /QB1, /QA1, QA1, /QA0, QA0	CML Differential Output Pairs: Differential buffered output copy of the selected input signal. The CML single-ended output swing is typically 400mV into 50Ω or 100Ω across the pair. Unused output pairs may be left floating with no impact on jitter. See "CML Output Termination" section.

## TRUTH TABLE

SELA0	SELA1	QA0	QA1	SELB0	SELB1	QB0	QB1
0	0	INA0	INA0	0	0	INB0	INB0
0	1	INA0	INA1	0	1	INB1	INB1
1	0	INA1	INA0	1	0	INB1	INB0
1	1	INA1	INA1	1	1	INB1	INB1

**FUNCTIONAL BLOCK DIAGRAM****SY58024U Dual 2 × 2 Crosspoint Switch**

**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 $V_{CC} + 0.5V$
Current ( $V_T$ )	
Source or Sink Current on VT pin	±100mA
Input Current ( $V_T$ )	
Source or Sink Current on IN, /IN	±50mA
Lead Temperature (soldering, 20 sec.)	260°C
Storage Temperature ( $T_S$ )	–65°C to +150°C

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

Supply Voltage ( $V_{CC}$ )	+2.375V to +3.60V
Ambient Temperature ( $T_A$ )	–40°C to +85°C
Package Thermal Resistance <sup>(3)</sup>	
MLF™ ( $\theta_{JA}$ )	
Still-Air	35°C/W
500lfpm	28°C/W
MLF™ ( $\psi_{JB}$ )	
Junction-to-board resistance	20°C/W

**DC ELECTRICAL CHARACTERISTICS<sup>(4)</sup>** $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ .

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{CC}$	Power Supply Voltage	2.5V nominal 3.3V nominal	2.375 3.0	2.5 3.3	2.625 3.60	V
$I_{CC}$	Power Supply Current	$V_{CC} = \text{max.}$ , current through internal 50Ω source termination resistor included.		200	250	mA
$V_{IH}$	Input HIGH Voltage	IN, /IN; <b>Note 5</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 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

**CML OUTPUT DC ELECTRICAL CHARACTERISTICS<sup>(4)</sup>** $V_{CC} = +3.3V \pm 10\%$  or  $+2.5V \pm 5\%$ ;  $R_L = 100\Omega$  across each pair;  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ , unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{OH}$	Output HIGH Voltage	Q0, /Q0; Q1, /Q1	$V_{CC} - 0.020$		$V_{CC}$	V
$V_{OUT}$	Output Voltage Swing	Q0, /Q0; Q1, /Q1; see Figure 1a.	325	400	500	mV
$V_{DIFF\_OUT}$	Differential Voltage Swing	Q0, /Q0; Q1, /Q1; see Figure 1b.	650	800	1000	mV
$R_{OUT}$	Output Source Impedance	Q0, /Q0; Q1, /Q1	40	50	60	Ω

**Notes:**

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 Rating" 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. Thermal performance assumes exposed pad is soldered (or equivalent) to the device's most negative potential (GND) on the PCB.  $\theta_{JA}$  and  $\psi_{JB}$  are characterized for 4-layer boards in still air, unless otherwise stated.
4. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
5.  $V_{IH}$  (min.) not lower than 1.2V.

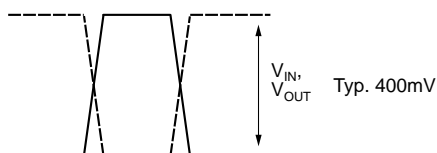
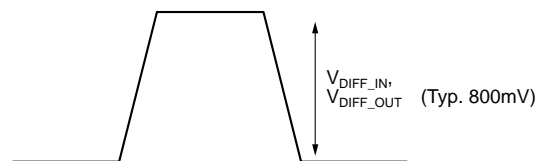
**AC ELECTRICAL CHARACTERISTICS<sup>(6)</sup>**

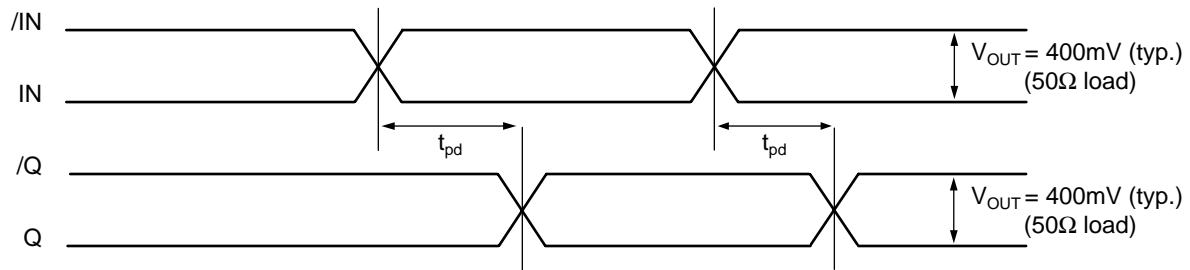
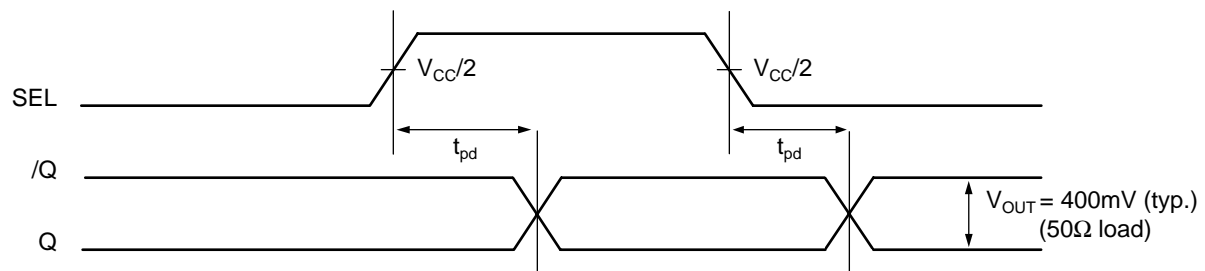
$V_{CC} = +2.5V \pm 5\%$  or  $+3.3V \pm 10\%$ ;  $R_L = 100\Omega$  across each output pair;  $T_A = -40^\circ C$  to  $+85^\circ C$ , unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$f_{MAX}$	Maximum Operating Frequency	$V_{IN} \geq 100mV$ ; $V_{OUT} \geq 200mV$ Clock	6			GHz
		NRZ Data	10.7			Gbps
$t_{pd}$	Propagation Delay	IN-to-Q	200		350	ps
		SEL-to-Q	100		400	ps
$t_{SKEW}$	Channel-to-Channel Skew (Within Bank)	<b>Note 7</b>			20	ps
	Part-to-Part Skew	<b>Note 8</b>			75	ps
$t_{JITTER}$	Clock Cycle-to-Cycle Jitter	<b>Note 9</b>			1	pS <sub>rms</sub>
	Total Jitter	<b>Note 10</b>			10	pS <sub>pp</sub>
	Data Random Jitter	<b>Note 11</b>			1	pS <sub>rms</sub>
	Deterministic Jitter	<b>Note 12</b>			10	pS <sub>pp</sub>
	Crosstalk Induced Jitter Adjacent Channel	<b>Note 13</b>			0.7	pS <sub>rms</sub>
$t_r, t_f$	Output Rise/Fall Time	20% to 80% at full swing.	25		60	ps

**Notes:**

6. High frequency AC-parameters are guaranteed by design and characterization.
7. Skew is measured between outputs of the same bank under identical transitions.
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.
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.
10. 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.
11. 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.
13. Crosstalk induced jitter is defined as the added jitter that results from signals applied to two adjacent channels. It is measured at the output while applying similar, differential clock frequencies that are asynchronous with respect to each other at inputs.

**SINGLE-ENDED AND DIFFERENTIAL SWINGS****Figure 1a. Single-Ended Voltage Swing****Figure 1b. Differential Voltage Swing**

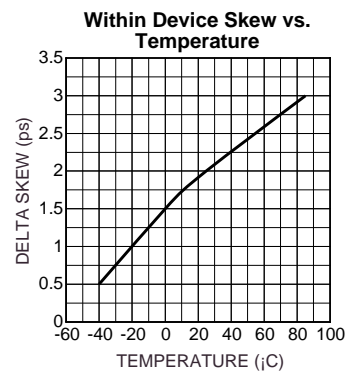
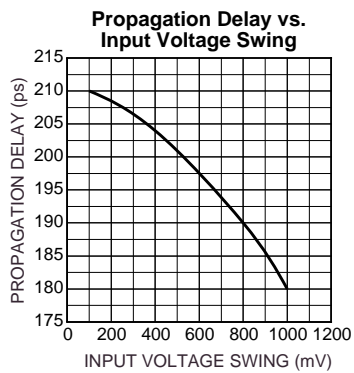
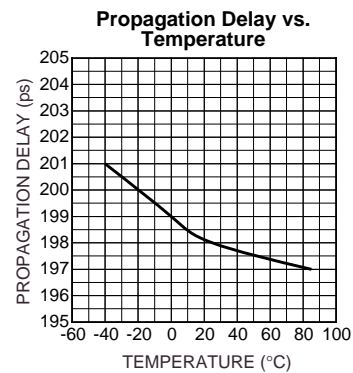
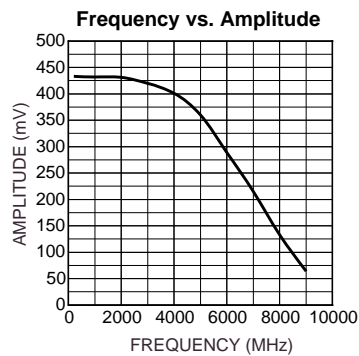
**TIMING DIAGRAM****Figure 2a. AC Timing Diagram IN-to-Q**

$\text{IN0}, \overline{\text{IN1}} = \text{LOW}, \overline{\text{IN0}}, \text{IN1} = \text{HIGH}$

**Figure 2b. AC Timing Diagram SEL-to-Q**

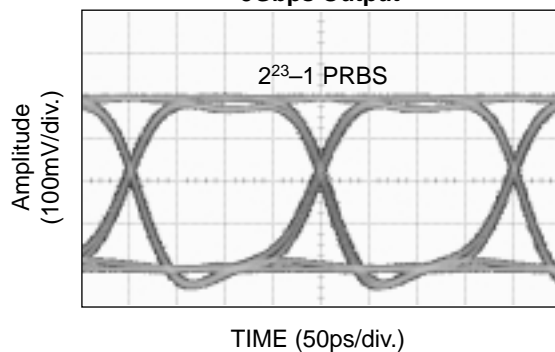
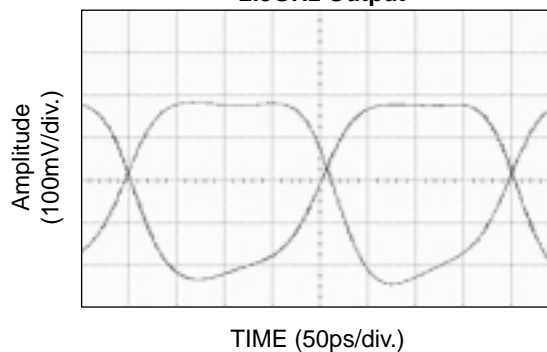
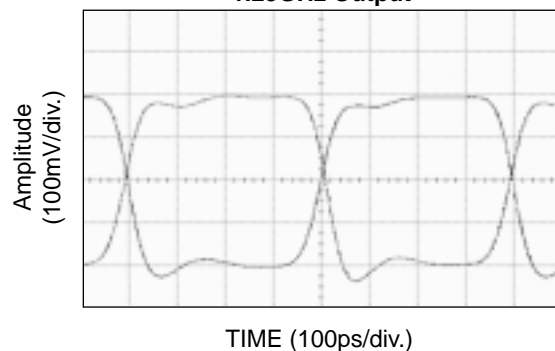
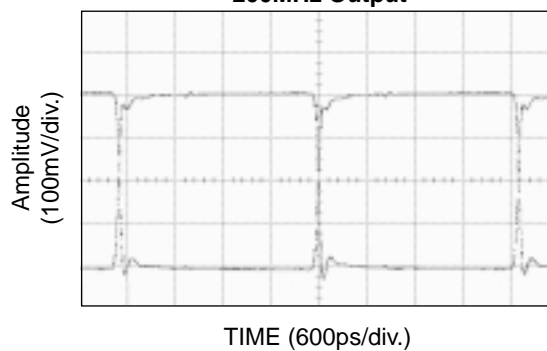
**TYPICAL OPERATING CHARACTERISTICS**

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



**FUNCTIONAL CHARACTERISTICS**

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

**5Gbps Output****2.5GHz Output****1.25GHz Output****200MHz Output**



## INPUT STAGE

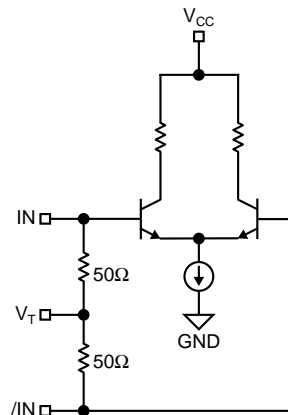
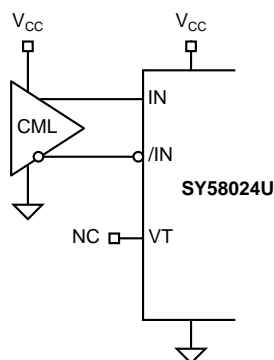
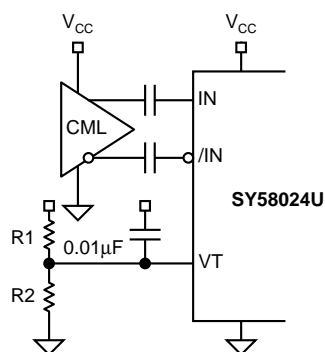
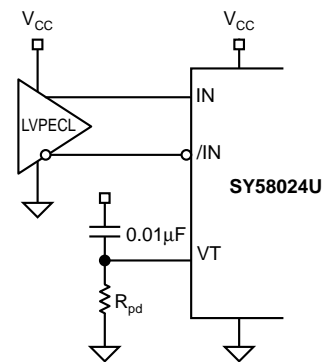
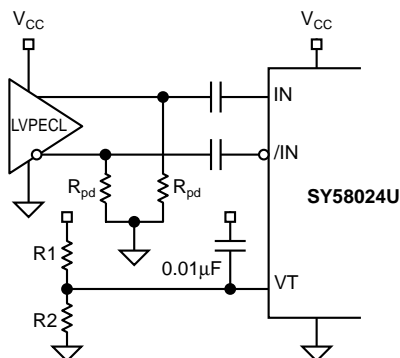
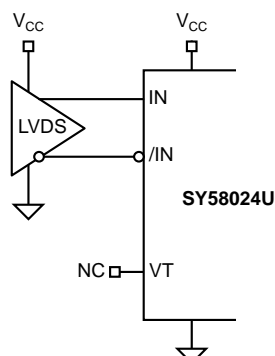


Figure 3. Simplified Differential Input Buffer

## INPUT INTERFACE APPLICATIONS

Figure 4a. DC-Coupled CML  
Input InterfaceOption: may connect  $V_T$  to  $V_{CC}$ For 2.5V,  $R_1 = 1\text{k}\Omega$ ,  $R_2 = 1.1\text{k}\Omega$ .  
For 3.3V,  $R_1 = 649\Omega$ ,  $R_2 = 1\text{k}\Omega$ .Figure 4b. AC-Coupled CML  
Input InterfaceFor 2.5V,  $R_{pd} = 19\Omega$ .  
For 3.3V,  $R_{pd} = 50\Omega$ .Figure 4c. DC-Coupled LVPECL  
Input InterfaceFor 2.5V,  $R_{pd} = 50\Omega$ ,  $R_1 = 1\text{k}\Omega$ ,  $R_2 = 1.1\text{k}\Omega$ .  
For 3.3V,  $R_{pd} = 100\Omega$ ,  $R_1 = 649\Omega$ ,  $R_2 = 1\text{k}\Omega$ .Figure 4d. AC-Coupled LVPECL  
Input InterfaceFigure 4e. LVDS  
Input Interface

CML OUTPUT TERMINATION

Figures 5 and Figure 6 illustrates how to terminate a CML output using both the AC-coupled and DC-coupled configuration. All outputs of the SY58024U are 50Ω with a 16mA current source.

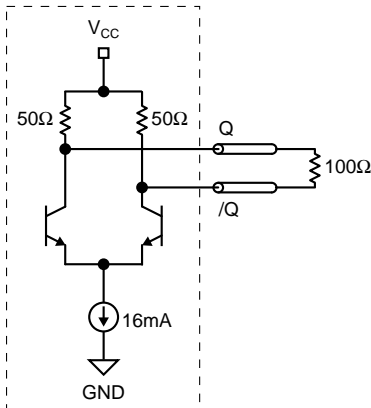


Figure 5. CML  
DC-Coupled Termination

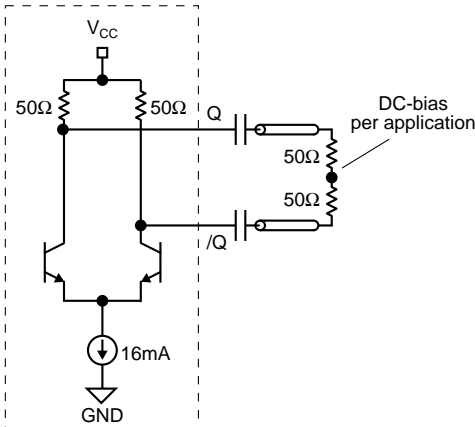
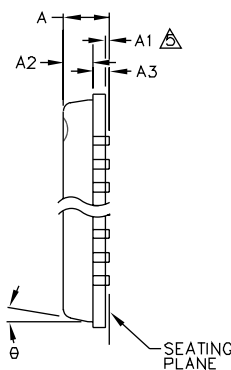
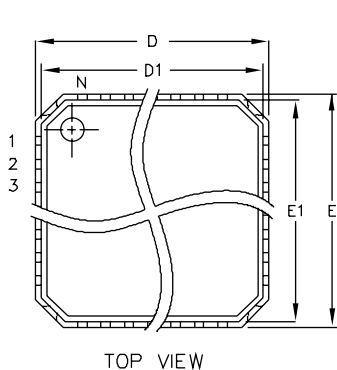


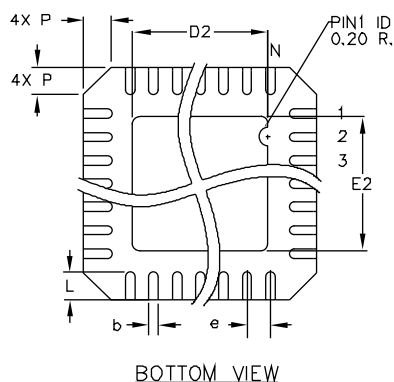
Figure 6. CML  
AC-Coupled Termination

RELATED PRODUCT AND SUPPORT DOCUMENTATION

Part Number	Function	Data Sheet Link
SY58023U	Ultra-low Jitter 2x2 Crosspoint Switch w/CML Outputs and Internal I/O Termination	<a href="http://www.micrel.com/product-info/products/SY58023U.shtml">http://www.micrel.com/product-info/products/SY58023U.shtml</a>
SY58024U	Ultra-low Jitter Dual 2x2 Crosspoint Switch w/CML Outputs and Internal I/O Termination	<a href="http://www.micrel.com/product-info/products/sy58024u.shtml">http://www.micrel.com/product-info/products/sy58024u.shtml</a>
	32-MLF Manufacturing Guidelines Exposed Pad Application Note	<a href="http://www.amkor.com/products/notes_papers/MLF_AppNote.pdf">www.amkor.com/products/notes_papers/MLF_AppNote.pdf</a>
	HBW Solutions	<a href="http://www.micrel.com/product-info/as/solutions.shtml">http://www.micrel.com/product-info/as/solutions.shtml</a>

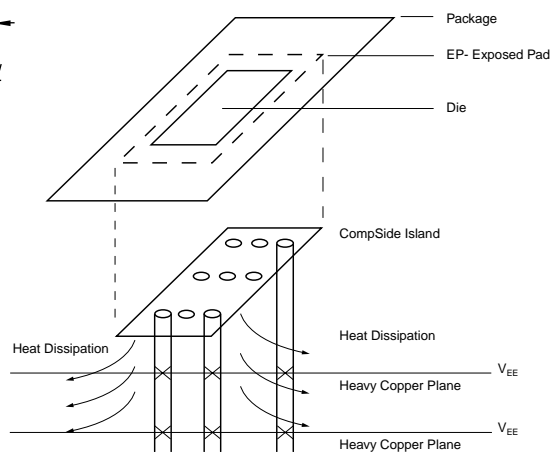
**32 LEAD MicroLeadFrame™ (MLF-32)**

	DIMENSION (mm)	
	MIN.	MAX.
A		0.90
A1	0.00	0.05
A2		0.70
A3	0.20 REF.	
D	5.00 BSC	
D1	4.75 BSC	
D2	2.95	3.45
E	5.00 BSC	
E1	4.75 BSC	
E2	2.95	3.45
q		12°
P	0.24	0.60
e	0.50 BSC	
N	32	
L	0.30	0.50
b	0.18	0.30



## NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. N IS THE NUMBER OF TERMINALS.  
THE NUMBER OF TERMINALS PER SIDE IS N/4.
3. THE PIN#1 IDENTIFIER MUST BE EXISTED ON THE TOP SURFACE OF PACKAGE BY USING IDENTIFICATION MARK OR OTHER FEATURE OF PACKAGE BODY.  
PACKAGE WARPAGE MAX 0.05mm.
4. APPLIED FOR EXPOSED PAD AND TERMINALS.



Rev. 01

**PCB Thermal Consideration for 32-Pin MLF™ Package**  
**(Always solder, or equivalent, the exposed pad to the PCB)**

**Package Notes:**

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

**MICREL, INC. 1849 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 data sheet 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.

© 2004 Micrel, Incorporated.