10.7Gbps 2 × 2 DUAL CROSSPOINT SWITCH w/CML OUTPUTS AND INTERNAL 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 max. skew**
- **Low jitter:**
  - **< 10ps$_{(pk-pk)}$ total jitter (clock)**
  - **< 1ps$_{(rms)}$ random jitter (data)**
  - **< 10ps$_{(pk-pk)}$ deterministic jitter (data)**
- **Crosstalk induced jitter: <1ps$_{(rms)}$**
- **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**
- **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 5.5GHz 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-coupled 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 provide 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.

PACKAGE/ORDERING INFORMATION

32-Pin MLF™
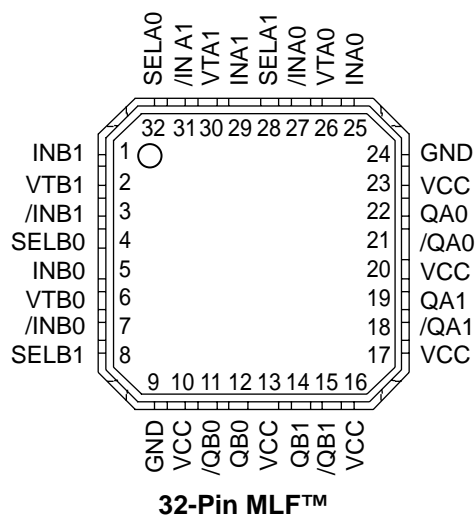
Ordering Information(Note 1)

Part Number	Package Type	Operating Range	Package Marking
SY58024UMI	MLF-32	Industrial	024U
SY58024UMITR(Note 2)	MLF-32	Industrial	024U

**Note 1.** Contact factory for die availability. Die are guaranteed at $T_A = 25°C$, DC electricals only.

Note 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 V_T pin. Note that this 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 V_T 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. Note that this 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 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. Unused output pairs may be left floating with no impact on jitter. See *"CML Output Termination"* section.

TRUTH TABLE

SELA0	SELA1	SELB0	SELB1	QA0	QA1	QB0	QB1
L	L	L	L	INA0	INA0	INB0	INB0
L	L	L	H	INA0	INA0	INB0	INB1
L	L	H	L	INA0	INA0	INB1	INB0
L	L	H	H	INA0	INA0	INB1	INB1
L	H	L	L	INA0	INA1	INB0	INB0
L	H	L	H	INA0	INA1	INB0	INB1
L	H	H	L	INA0	INA1	INB1	INB0
L	H	H	H	INA0	INA1	INB1	INB1
H	L	L	L	INA1	INA0	INB0	INB0
H	L	L	H	INA1	INA0	INB0	INB1
H	L	H	L	INA1	INA0	INA1	INB0
H	L	H	H	INA1	INA0	INA1	INB1
H	H	L	L	INA1	INA1	INA0	INB0
H	H	L	H	INA1	INA1	INA0	INB1
H	H	H	L	INA1	INA1	INA1	INB0
H	H	H	H	INA1	INA1	INA1	INB1

FUNCTIONAL BLOCK DIAGRAM

SY58024U Dual 2 × 2 Crosspoint Switch
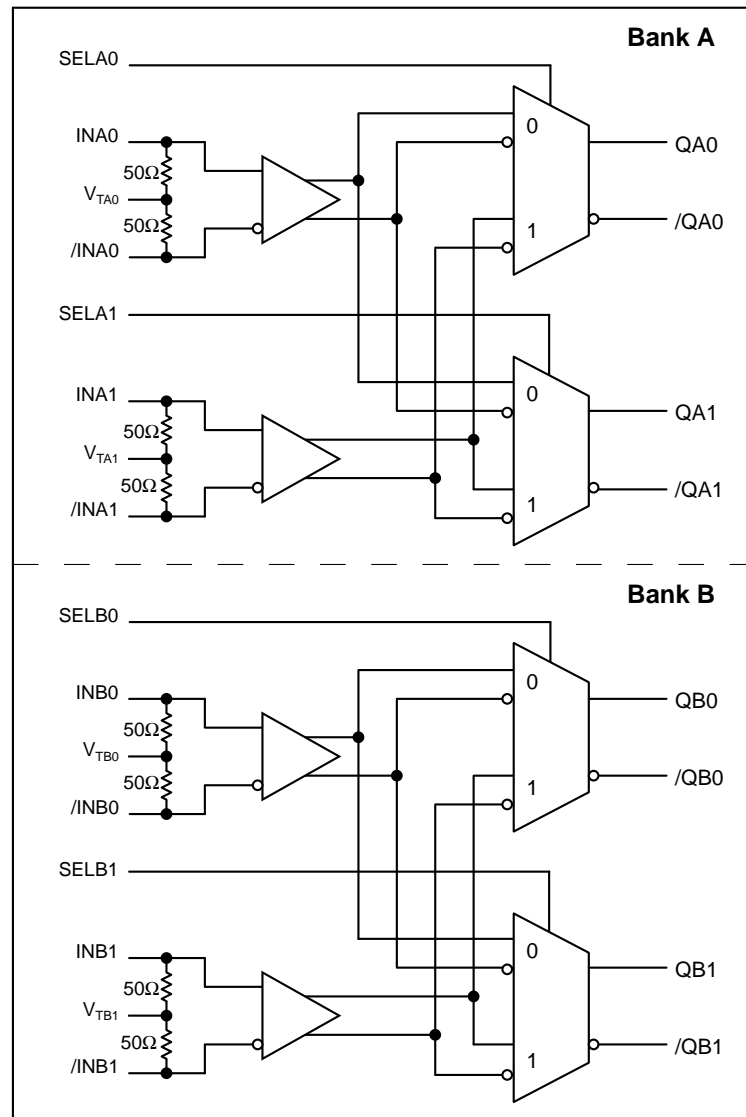
Absolute Maximum Ratings[(Note 1)]

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 ....±100mA

Input Current (V_T)

Source or Sink Current on IN, /IN ....±50mA

Lead Temperature (soldering, 10 sec.) .... 270°C

Storage Temperature (T_S) .... –65°C +150°C

Operating Ratings[(Note 2)]

Supply Voltage (V_{CC}) .... +2.375V to +3.60V

Ambient Temperature (T_A) .... –40°C to +85°C

Package Thermal Resistance (**Note 3**)

MLF™ (θ_{JA})

Still-Air .... 35°C/W

500lfpm .... 28°C/W

MLF™ (ψ_{JB}),

Junction-to-board resistance .... 16°C/W

DC ELECTRICAL CHARACTERISTICS[(Note 4)]

T_A = –40°C to +85°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 V
I_{CC}	Power Supply Current	V_{CC} = max., current through internal 50Ω source termination resistor included		200	250	mA
V_{IH}	Input HIGH Voltage	IN, /IN; **Note 5**	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		3.4	V
R_{IN}	IN-to-V_T Resistance		40	50	60	Ω
IN to V_T					1.28	V

CML DC ELECTRICAL CHARACTERISTICS[(Note 4)]

V_{CC} = 3.3V ±10% or 2.5V ±5%; R_L = 100Ω across each pair, or equivalent; T_A = –40°C to +85°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

AC ELECTRICAL CHARACTERISTICS

V_{CC} = 2.5V ±5% or 3.3V ±10%; R_L = 100Ω across each output pair, or equivalent; T_A = –40°C to +85°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_{CHAN}	Channel-to-Channel (Within Bank)	**Note 6**				20	ps
t_{SKEW}	Part-to-Part Skew	**Note 7**				75	ps
t_{JITTER}	Clock Cycle-to-Cycle Jitter	**Note 8**				1	ps(rms)
	Total Jitter	**Note 9**				10	ps(pk-pk)
	Data Random Jitter	**Note 10**				2	ps(rms)
	Deterministic Jitter	**Note 11**				10	ps(pk-pk)
	Crosstalk Induced Jitter (rms)	**Note 12**			<1		ps(rms)
t_r, t_f	Output Rise/Fall Time	20% to 80% at full swing		25		60	ps

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 RATING 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. Package Thermal Resistance assumes exposed pad is soldered (or equivalent) to the device's most negative potential (GND) on the PCB.

Note 4. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

Note 5. V_{IH} (min.) not lower than 1.2V.

Note 6. Skew is measured between outputs of the same bank under identical transitions.

Note 7. 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 8. 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 9. 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.

Note 10. Random jitter is measured with a K28.7 comma detect character pattern, measured at 2.5Gbps–3.2Gbps and 10.7Gbps.

Note 11. Deterministic jitter is measured at 2.5Gbps–3.2Gbps and 10.7Gbps with both K28.5 and 2^{23}–1 PRBS pattern.

Note 12. Crosstalk is measured at the output while applying two similar frequencies that are asynchronous with respect to each other at the inputs.
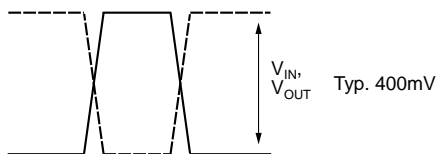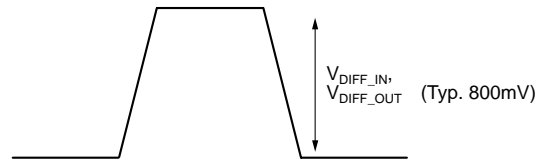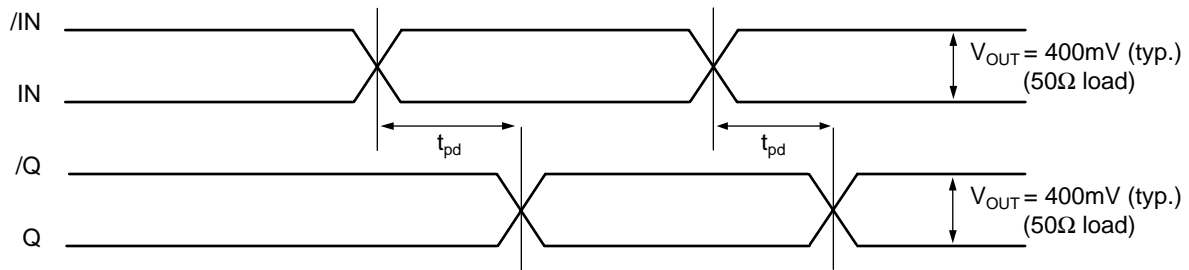
SINGLE-ENDED AND DIFFERENTIAL SWINGS

V_{IN}, V_{OUT} Typ. 400mV

Figure 1a. Single-Ended Voltage Swing

V_{DIFF_IN}, V_{DIFF_OUT} (Typ. 800mV)

Figure 1b. Differential Voltage Swing

TIMING DIAGRAM

/IN

IN

V_{OUT} = 400mV (typ.)
(50Ω load)

t_{pd}

t_{pd}

/Q

Q

V_{OUT} = 400mV (typ.)
(50Ω load)

Figure 2a. AC Timing Diagram IN-to-Q

SEL

$V_{CC}/2$

$V_{CC}/2$

t_{pd}

t_{pd}

/Q

Q

V_{OUT} = 400mV (typ.)
(50Ω load)
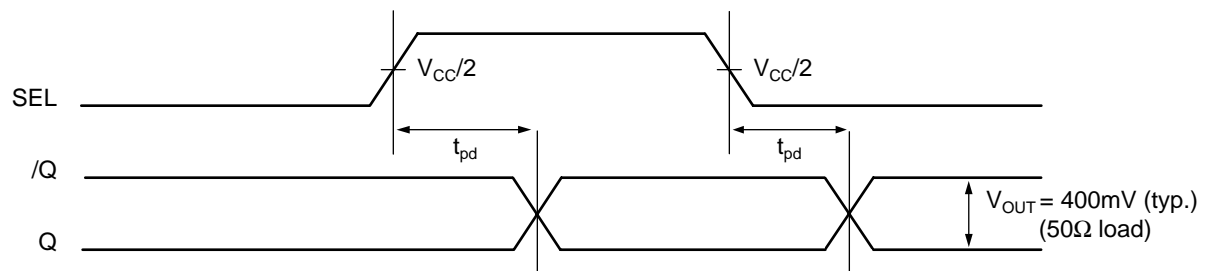
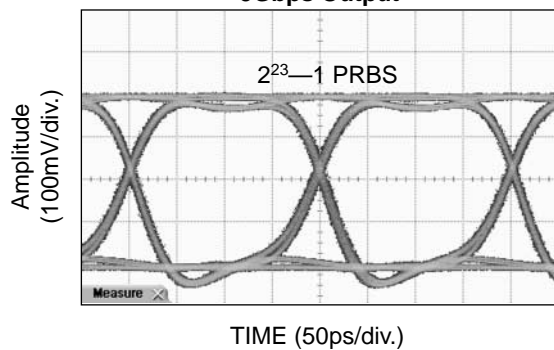IN0, /IN1 = LOW, /IN0, IN1 = HIGH

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

TYPICAL OPERATING CHARACTERISTICS

V_{CC} = 2.5V, V_{IN} = 100mV, T_A = 25°C, unless otherwise noted.

Frequency vs. Amplitude

AMPLITUDE (mV) vs. FREQUENCY (MHz)

Propagation Delay vs. Temperature

PROPAGATION DELAY (ps) vs. TEMPERATURE (°C)

Propagation Delay vs. Input Voltage Swing

PROPAGATION DELAY (ps) vs. INPUT VOLTAGE SWING (mV)

Within Device Skew vs. Temperature

AMPLITUDE (mV) vs. TEMPERATURE (°C)
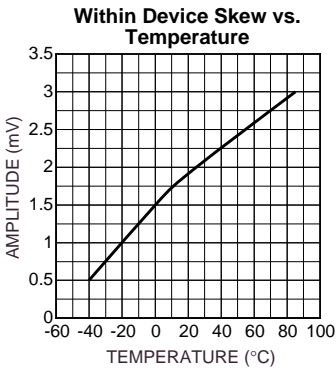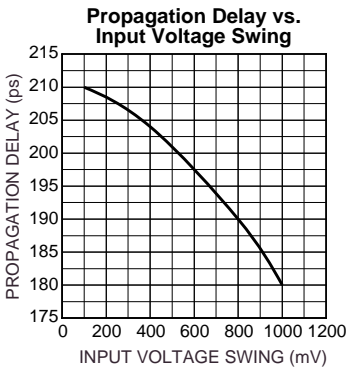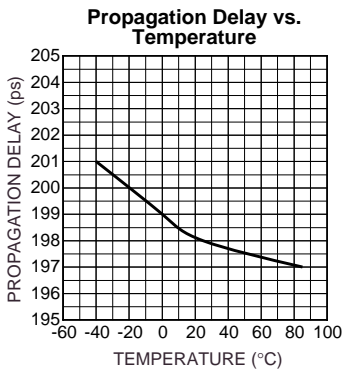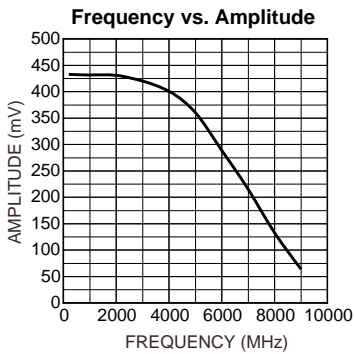
FUNCTIONAL CHARACTERISTICS

V_{CC} = 2.5V, V_{IN} = 100mV, T_A = 25°C, unless otherwise noted.

5Gbps Output

2^{23}—1 PRBS

TIME (50ps/div.)

2.5GHz Output

TIME (50ps/div.)

1.25GHz Output

TIME (100ps/div.)

200MHz Output

TIME (600ps/div.)
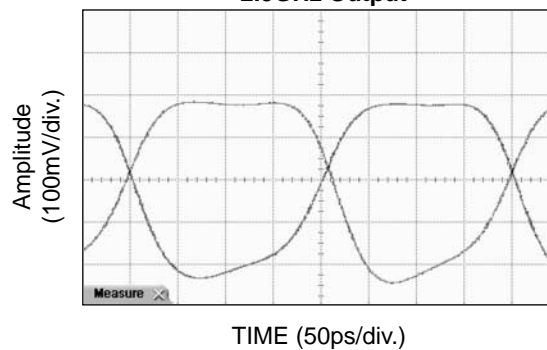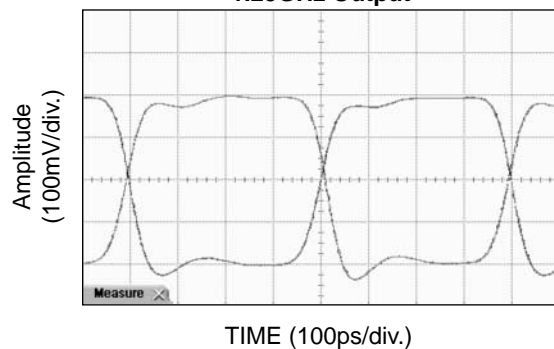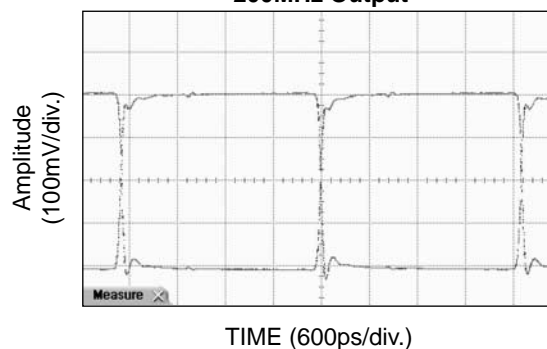
INPUT STAGE
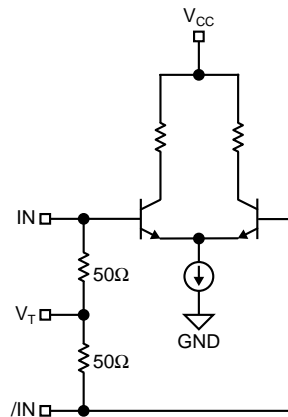
Figure 3. Simplified Differential Input Buffer

INPUT INTERFACE APPLICATIONS
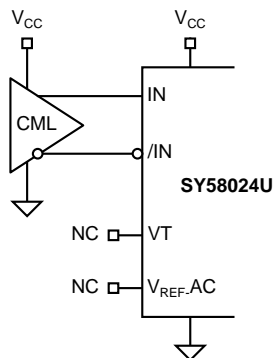
Figure 4a. DC-Coupled CML Input Interface
(Option: may connect V_T to V_{CC})
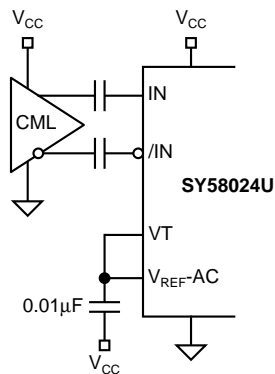
Figure 4b. AC-Coupled CML Input Interface

For V_{CC} = 2.5V, R_{pd} = 19Ω
For V_{CC} = 3.3V, R_{pd} = 50Ω
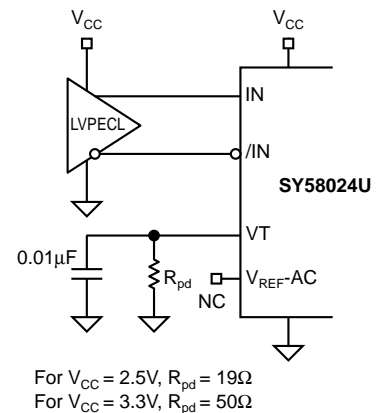
Figure 4c. DC-Coupled LVPECL Input Interface

For V_{CC} = 2.5V, R_{pd} = 50Ω
For V_{CC} = 3.3V, R_{pd} = 100Ω
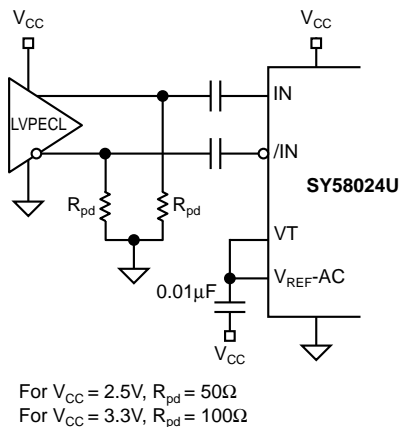
Figure 4d. AC-Coupled LVPECL Input Interface
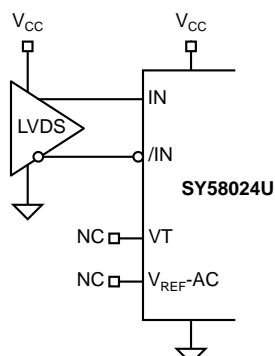
Figure 4e. LVDS Input Interface

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.
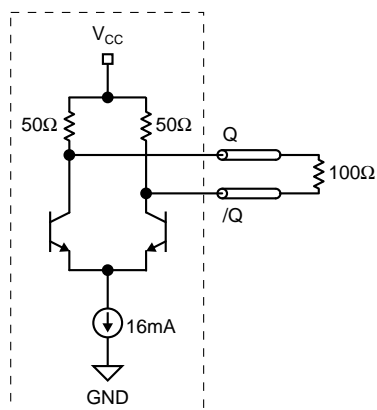

**Figure 5. CML
DC-Coupled Termination**
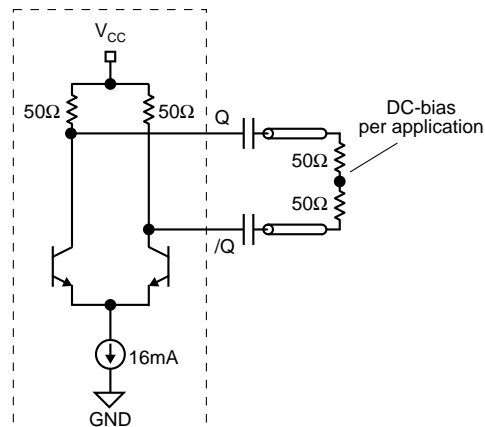
**Figure 6. CML
AC-Coupled Termination**

## RELATED PRODUCT AND SUPPORT DOCUMENTATION

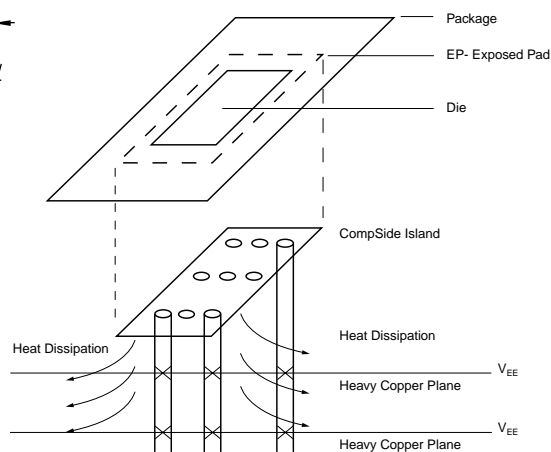| Part Number	Function	Data Sheet Link
SY58023U	6GHz (10.7Gbps) 2x2 Crosspoint Switch w/CML Outputs	http://www.micrel.com/product-info/products/SY58023U.shtml
SY58024U	5.5GHz (10.7Gbps) Dual 2x2 Crosspoint Switch w/CML Outputs	http://www.micrel.com/product-info/products/sy58024u.shtml
	32-MLF Manufactering Guidelines Exposed Pad Application Note	www.amkor.com/products/notes_papers/MLF_AppNote_0902.pdf
	HBW Solutions	http://www.micrel.com/product-info/as/solutions.shtml

32 LEAD *Micro*LeadFrame™ (MLF-32)

TOP VIEW

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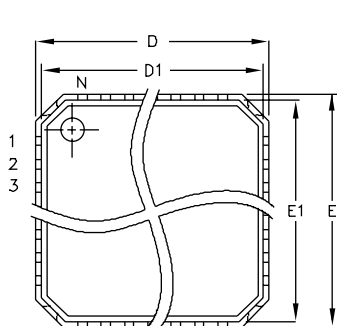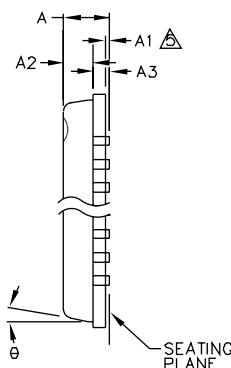
DIMENSION (mm)		
	MIN.	MAX.
A	−	0.90
A1	0.00	0.05
A2	−	0.70
A3	0.20 REF.	
D	5.00 BSC	
D1	4.75 BSC	
D2	2.95	3.45
E	5.00 BSC	
E1	4.75 BSC	
E2	2.95	3.45
θ		12°
P	0.24	0.60
e	0.50 BSC	
N	32	
L	0.30	0.50
b	0.18	0.30

BOTTOM VIEW

PIN1 ID 0.20 R.
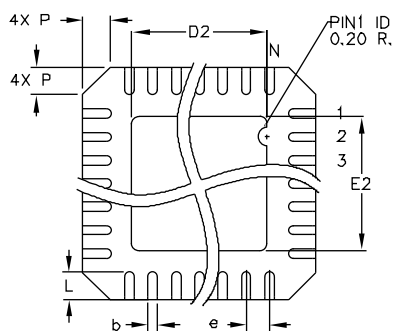
NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. N IS THE NUMBER OF TERMINALS.
   THE NUMBER OF TERMINALS PER SIDE IS N/4.
3. THE PIN#1 IDENTIFIRE MUST BE EXISTED ON THE TOP SURFACE
   OF PACKAGE BY USING IDENTIFICATION MARK OR OTHER
   FEATURE OF PACKAGE BODY.
4. PACKAGE WARPAGE MAX 0.05mm.
5. APPLIED FOR EXPOSED PAD AND TERMINALS.

Rev. 01

Package

EP- Exposed Pad

Die

CompSide Island

Heat Dissipation

Heat Dissipation

V$_{EE}$

Heavy Copper Plane

V$_{EE}$

Heavy Copper Plane

PCB Thermal Consideration for 32-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.