SY58051U

Ultra-Precision CML AnyGate® with Internal Input and Output Termination

Precision Edge®

General Description

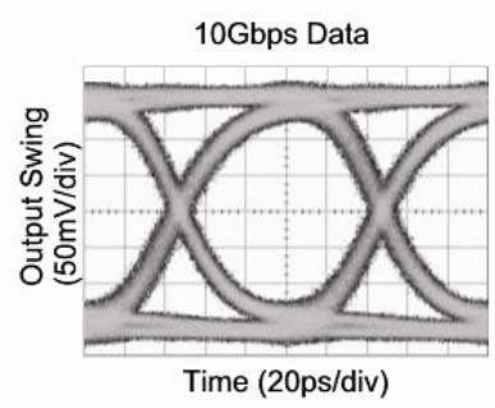
The SY58051U is an ultra-fast, low jitter universal logic gate with a guaranteed maximum data or clock throughput of 10.7Gbps or 7GHz, respectively. This AnyGate® differential logic device will produce many logic functions of two Boolean variables, such as AND, NAND, OR, NOR, DELAY, or NEGATION.

The SY58051U differential inputs include a unique internal termination design that allows access to the termination network throughout a V_T pin. This feature allows the device to easily interface to different logic standards, both AC- and DC-coupled without external resistor-bias and termination networks. The result is a clean, stub-free, low-jitter interface solution. The differential CML output is optimized for environments with internal 50Ω source termination and a 400mV output swing.

The SY58051U operates from a 2.5 or 3.3V supply, and is guaranteed over the full industrial temperature range (-40°C to +85°C). The SY58051U is part of Micrel's Precision Edge® product family.

All support documentation can be found on Micrel's web site at www.micrel.com.

Typical Application



Precision Edge®

Features

- Three matched-delay input pair provide any logic function: AND, NAND, OR, NOR
- Guaranteed AC performance over temperature and
- voltage:
  - DC to > 10.7Gbps data rate throughput
  - DC to > 7GHz clock f_{MAX}
  - <190ps Any In-to-Out t_{pd}
  - t_r / t_f < 60ps
- Ultra low-jitter design:
  - <1ps$_{RMS}$ random jitter
  - <10ps$_{PP}$ deterministic jitter
  - <10ps$_{PP}$ total jitter (clock)
- Unique input termination and V_T pin accepts DC-coupled and AC-coupled inputs (CML, PECL)
- Internal 50Ω output source termination
- Typical 400mV CML output swing (R_{IN} = 50Ω)
- Internal 50Ω input termination
- Power supply 2.5V ±5% or 3.3V ±10%
- –40°C to 85°C temperature range
- Available in a 16-pin (3mm × 3mm) QFN® package

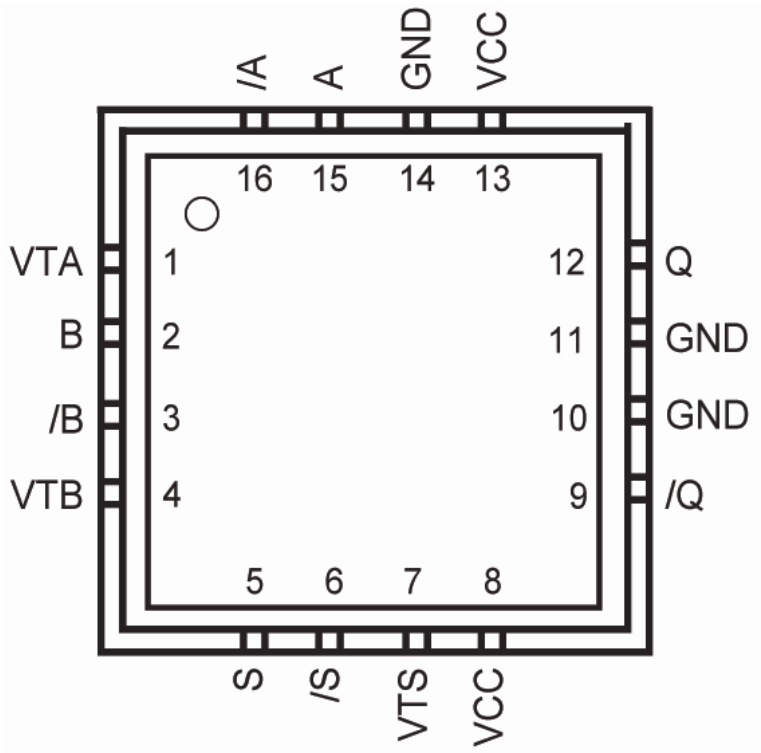
Applications

- Data communication systems
- OC-192, OC192+FEC
- All SONET OC-3—OC-768 applications
- All Fibre Channel applications
- All GigE applications

Ordering Information

Part Number	Package Type	Operational Range	Package Marking
SY58051UMG[3]	Pb-free QFN-16	Industrial	051U with Pb-Free bar-line indicator
SY58051UMGTR[2, 3]	Pb-free QFN-16	Industrial	051U with Pb-Free bar-line indicator

Pin Configuration



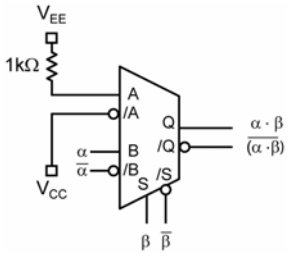
16-Pin QFN® (QFN-16)

Pin Description

Pin Number	Pin Name	Pin Function
1	VT	Input Termination Center Tap: Each of the two inputs, (A, /A) terminates to this pin through a50Ω resistor. The VTA pin provides a center-tap to a termination network for maximum interface flexibility. See “Input Interface Applications” section for more details.
15, 16 2, 3	A, /A B, /B	Differential Input: These input pairs are the two data inputs to the device. Each pin of a pair 2, 3 B, /B internally terminates to the VTA or VTB pin to 50Ω. Note that these inputs will default to an indeterminate state if left open. See “Input Interface Applications” section for more details.
4	VTB	Input Termination Center Tap: Each of the two inputs, (B, /B) terminates to this pin through a 50Ω resistor. The VTB pin provides a center-tap to a termination network for maximum interface flexibility.
5, 6	S, /S	Differential Input: This input pair is the select input to the device. Each pin of this pair internally terminates to the VTS pin to 50Ω. Note that this input will default to an indeterminate state if left open. See “Input Interface Applications” section for more details.
7	VTS	Input Termination Center Tap: Each of the two inputs, S, /S terminates to this pin. The VTS pin provides a center-tap to a termination network for maximum interface flexibility.
8, 13	VCC	Positive Power Supply. Bypass with 0.1µF 0.01µF low ESR capacitors.
12, 9	Q, /Q	Differential Output: This CML output pair is the output of the device. It is a logic function of the A, B, and S inputs. See “Truth Tables” for details.
10, 11, 14	GND	Ground. Exposed pad must be connected to the same potential as GND pin.

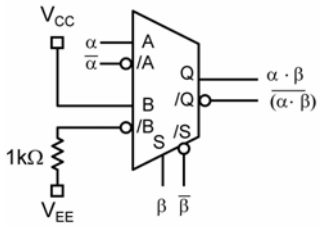
Truth Tables

A	/A	B	/B	S	/S	Q	/Q
0	1	X	X	0	1	0	1
1	0	X	X	0	1	1	0
X	X	0	1	1	0	0	1
X	X	1	0	1	0	1	0



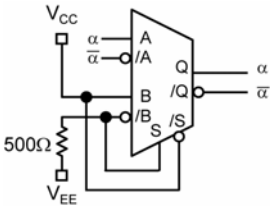
AND/NAND

A	α B	β B	α • β Q	$\overline{(\alpha \bullet \beta)}$ /Q
L	L	L	L	H
L	H	L	L	H
L	L	H	L	H
L	H	H	H	L



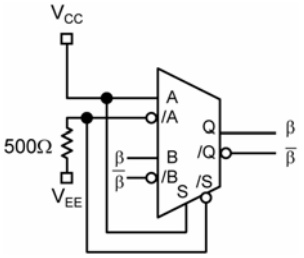
OR/NOR

α A	B	β B	α • β Q	$\overline{(\alpha + \beta)}$ /Q
L	H	L	L	H
H	H	L	H	L
L	H	H	H	L
H	H	H	H	L



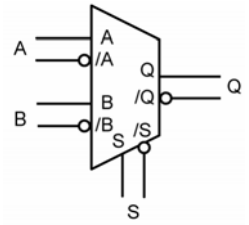
DELAY/NEGATION

α A	B	S	α Q	$\overline{\alpha}$ /Q
L		S	L	H
H		S	H	L



DELAY/NEGATION

A	β B	S	β Q	$\overline{\beta}$ /Q
	L	H	L	H
	H	H	H	L



2:1 MUX

S	Q	/Q
L	A	$\overline{A}$
H	B	$\overline{B}$

Absolute Maximum Ratings [1]

Supply Voltage (V_{CC}).....–0.5 to +4.0V
Input Voltage (V_{IN}).....-0.5V to V_{CC}
CML Output Voltage (V_{OUT})..... V_{CC} to -1.0V to V_{CC} +0.5V
Termination Current [3]
Source or Sink Current on V_{TA}, V_{TB}, V_{TS} .....±60mA
Input Current
Source or Sink Current on A, /A, B, /B, S, /S .....±30mA
Lead Temperature (soldering, 20 sec.).....+260°C
Storage Temperature (T_S.).....-65°C to +150°C

Operating Ratings [2]

Supply Voltage (V_{CC})..... +2.375V to +2.625V
or +3.0°C to +85°C
Ambient Temperature (T_A)..... –40°C to +85°C
Package Thermal Resistance [4]
PDIP (θ_{JA})
Still-Air.....61°C/W
QFN (ψ_{JB}).....38°C/W

DC Electrical Characteristics [5]

TA = —40°C to +85°C, unless otherwise noted.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
V_{cc}	Power Supply	V_{CC} = 2.5V. V_{CC} = 3.3V.	2.375 3.0	2.5 3.3	2.625 3.6	V V
I_{cc}	Power Supply Current	No Load, max. V_{CC}.		55	70	mA
R_{DIFF_IN}	Differential Input Resistance (A-to/A, B-to-/B or S-to/S)		80	100	120	Ω
R_{IN}	Input Resistance (A-to-V_{TA}, B-to-V_{TB} or S-to-V_{TS})		40	50	60	Ω
V_{IH}	Input HIGH Voltage (A, /A or B, /B or S, /S)	**Note 6**	1.2		V_{cc}	V
V_{IL}	Input LOW Voltage (A, /A or B, /B or S, /S)	**Note 6**	0		V_{IH}-0.1	mV
V_{IN}	Input Voltage Swing (A, /A or B, /B or S, /S)	**Note 6** See Figure 2a.	100			mV
V_{DIFF_IN}	Differential Input Voltage Swing IA-, /AI or IB-, /BI or S-, /SI	**Note 6** See Figure 2b.	200			mV
I_{IN}	Input Current (A, /A or B, /B or S, /S)	**Note 6**			21	mA

Notes:

1. Permanent device damage may occur if the ratings in the “Absolute Maximum Ratings” section are exceeded. This is a stress rating only and functional operation is not implied for 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.
2. The data sheet limits are not guaranteed if the device is operated beyond the operating ratings.
3. Due to the limited drive capability use for input of the same package only.
4. Package thermal resistance assumes exposed pad is soldered (or equivalent) to the devices most negative potential on the PCB. Ψ_{JB} uses 4-layer θ_{JA} n still-air, unless otherwise stated.
5. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
6. Due to the internal termination (see Figure 1a) the input current depends on the applied voltages at A, /A and V_{TA} inputs, the B, /B and V_{TB} inputs or the S, /S and V_{TS} inputs. Do not apply a combination of voltages that causes the input current to exceed the maximum limit.

CML Electrical Characteristics [5]

V_{CC} = 2.5V ±5% or 3.3V ±10%; R_L =100Ω across output pair or equivalent; T_A = -40°C to +85°C; unless otherwise noted.

Symbol	Parameter	Condition	Min.	Typ	Max	Units
V_{CH}	Output HIGH Voltage Q, /Q		V_{CC}–0.020		V_{CC} 3.6	V
V_{OUT}	Output Voltage Swing Q, /Q	See Figure 2a.	325	400	500	mV
V_{DIFF_OUT}	Differential Output Voltage Swing Q, /Q	See Figure 2b.	650	800	1000	mV
R_{OUT}	Output Source Impedance Q, /Q		40	50	60	Ω

AC Electrical Characteristics [8]

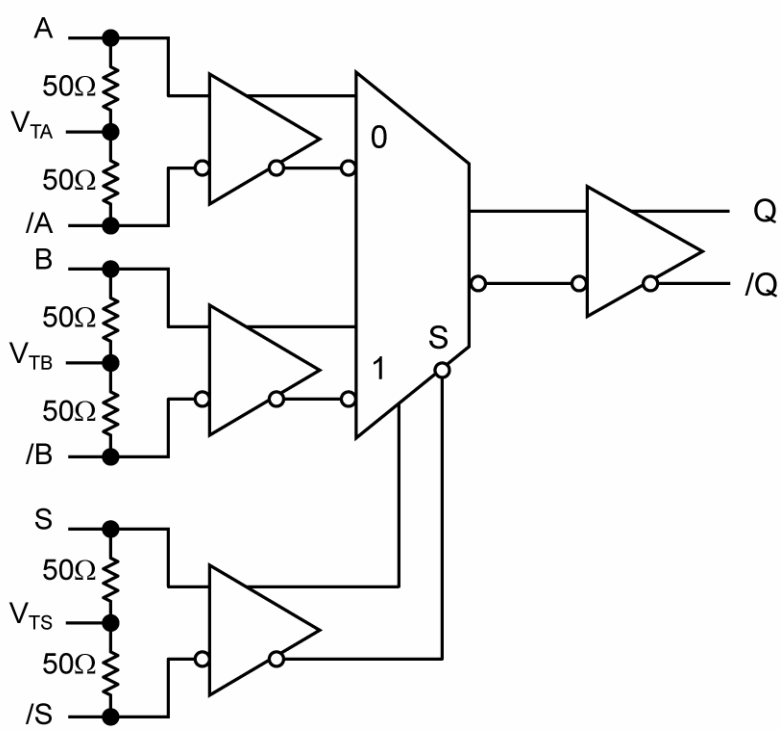
V_{CC} = 2.5V ±5% or 3.3V ±10%; R_L =100Ω across output pair or equivalent; T_A = -40°C to +85°C; unless otherwise noted.

Symbol	Parameter	Condition	Min	Typ	Max	Units
F_{MAX}	Maximum Operating Frequency	Clock NRZ Data	10.7	7		GHz Gbps
t_{pd}	Propagation Delay Any Input (A, B, S)-to-Q		70		190	ps
t_{SKEW}	Part-to-Part Skew	**Note 9**			100	ps
t_{JITTER}	Data					
	Random Jitter (RJ)	**Note 10**			1	ps_{RMS}
	Deterministic Jitter (DJ)	**Note 11**			10	ps_{PP}
	Clock					
	Cycle-to-Cycle Jitter (RJ)	**Note 12**			1	ps_{RMS}
	Total Jitter (TJ)	**Note 13**			10	ps_{PP}
T_R, t_f	Output Rise/Fall Times (20% to 80%)	At full output swing.	20		60	ps

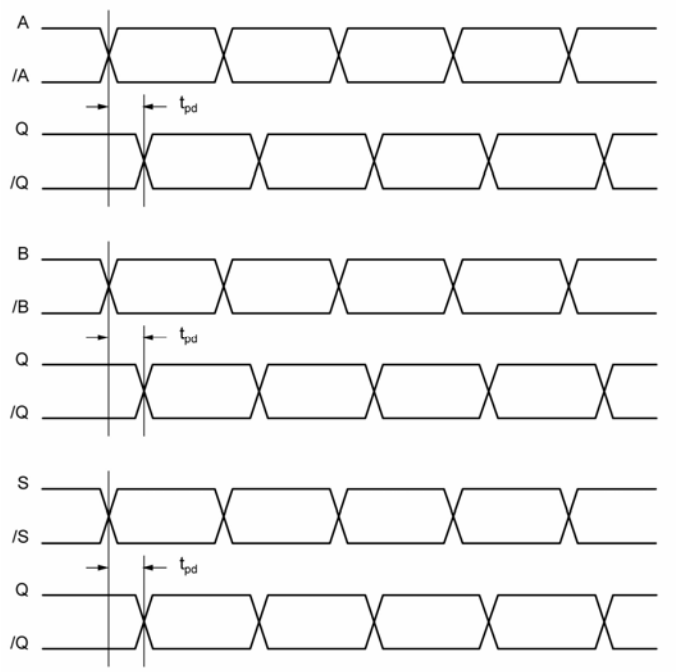
Notes:

7. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
8. Measured with 100mV input swing. See “Timing Diagrams” section for definition of parameters. High-frequency AC parameters are guaranteed by design and characterization.
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.
10. 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.
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.
13. 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.

Functional Block Diagram



Timing Diagram



Input and Output Stage Internal Termination

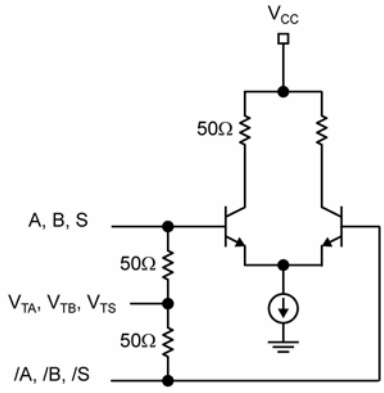


Figure 1a. Simplified Differential Input Stage

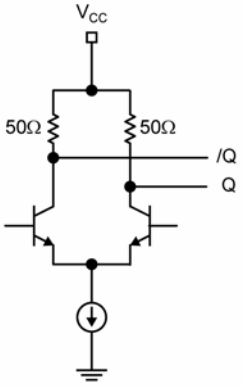


Figure 1b. Simplified Differential Output Stage

Definition of Single-Ended and Differential Swings

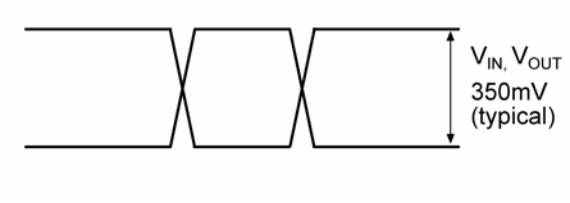


Figure 2a. Single-Ended Swing

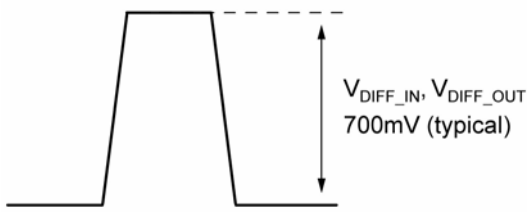
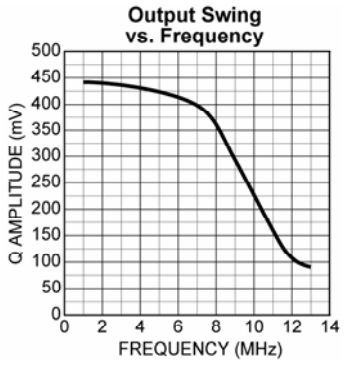
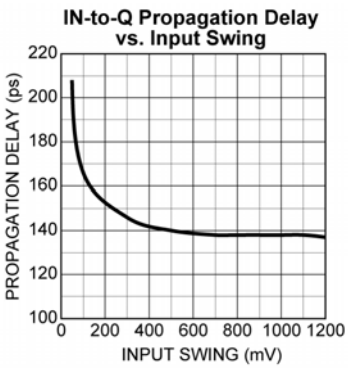
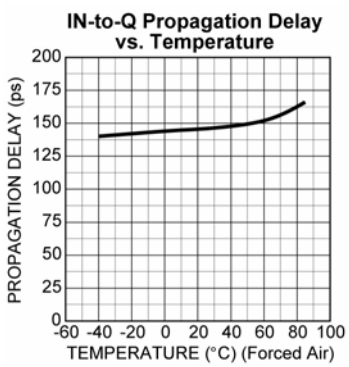


Figure 2b. Differential Swing

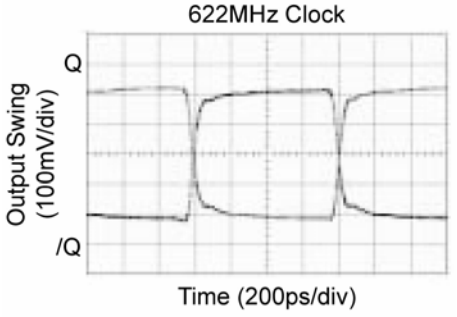
Typical Operating Characteristics



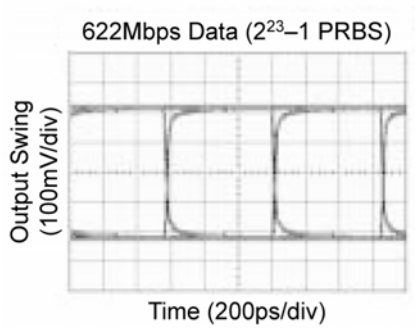




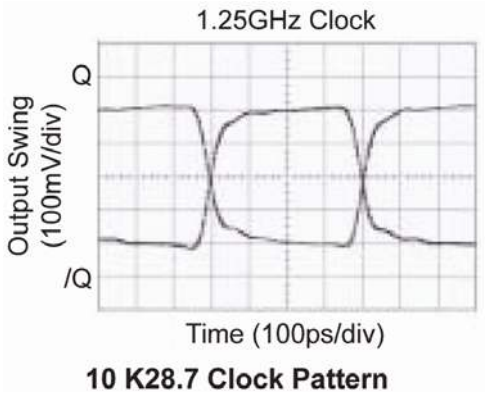
Functional Characteristics



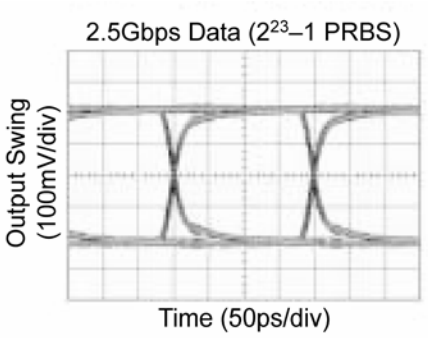
10 K28.7 Clock Pattern



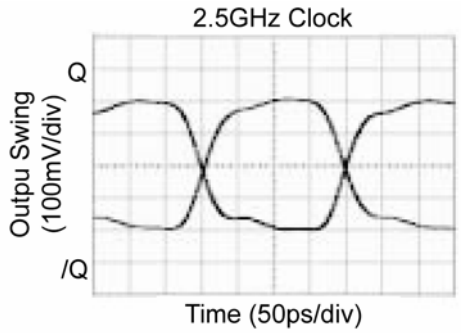
2^{23}–1 PRBS Pattern



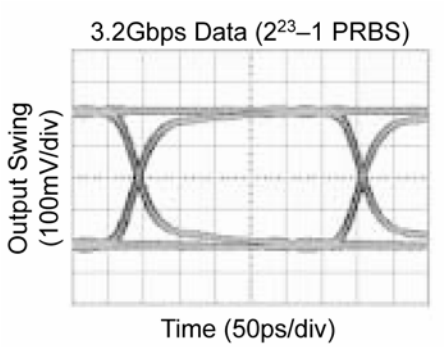
10 K28.7 Clock Pattern



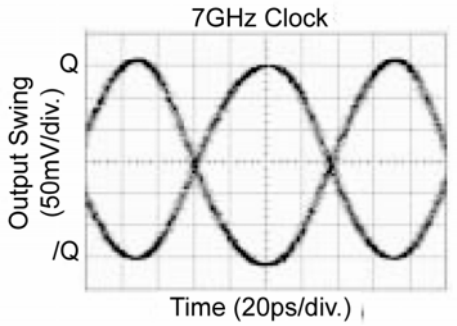
2^{23}–1 PRBS Pattern



10 K28.7 Clock Pattern



2^{23}–1 PRBS Pattern



10 K28.7 Clock Pattern

Input Interface Applications

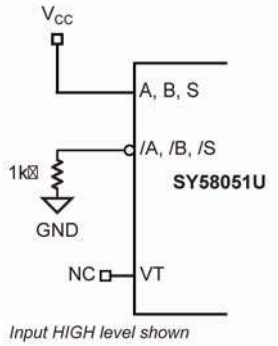


Figure 3a. Static Input Level

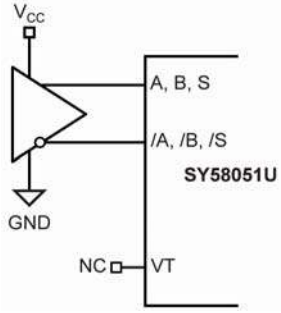


Figure 3b. LVDS Interface (DC-Coupled)

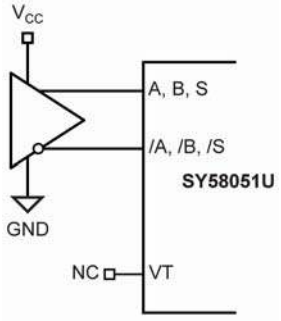


Figure 3c. CML Interface (DC-Coupled)

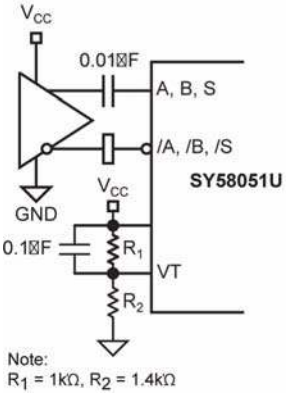


Figure 3d. CML Interface (AC-Coupled)

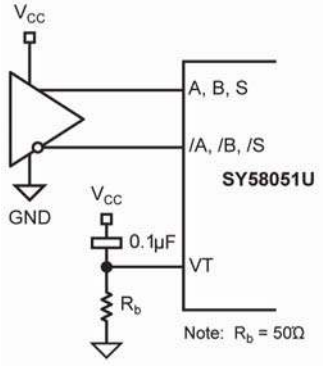


Figure 3e. PECL Interface (DC-Coupled)

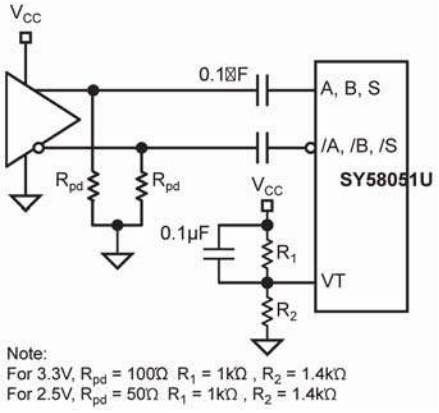
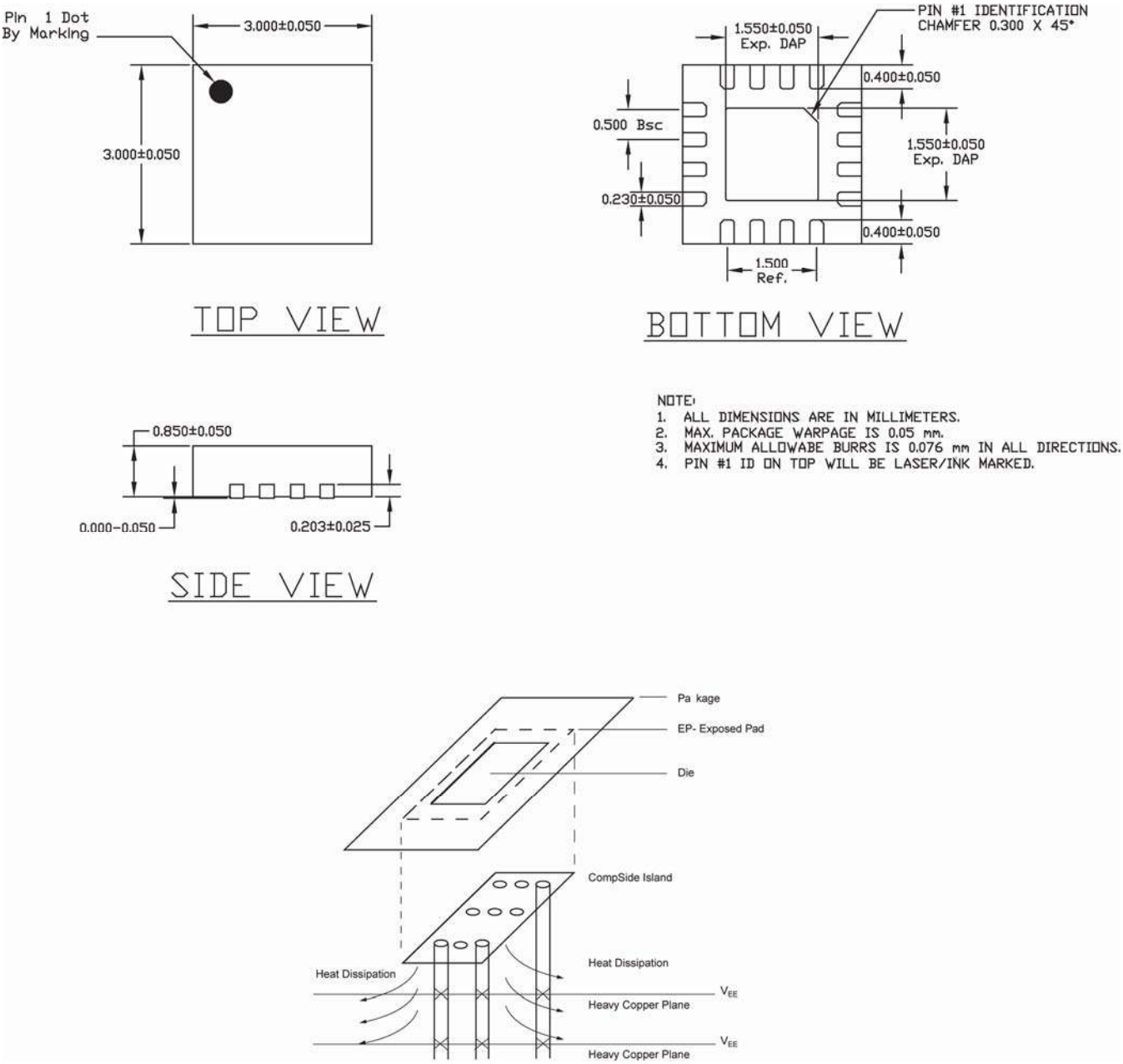


Figure 3f. PECL Interface (AC-Coupled)

Related Product and Support Documentation

Part Number	Function	Data Sheet Link
SY58016L	3.3V 10Gbps Differential CML Line Driver/Receiver with Internal Termination	http://www.micrel.com/product-info/products/sy58016l.shtml
SY58052U	10Gbps Clock/Data Retimer with 50Ω Input Termination	www.micrel.com/product-info/products/sy58052u.shtml
	QFN® Application Note	www.amkor.com/products/notes_papers/MLF_AppNote_0902.pdf
HBW Solutions	New Products and Applications	www.micrel.com/product-info/products/solutions.shtml

16-PIN *Micro*LeadFrame® (MLF-16)



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

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