SY58611U

3.2Gbps Precision, LVDS 2:1 MUX with Internal Termination and Fail Safe Input

General Description

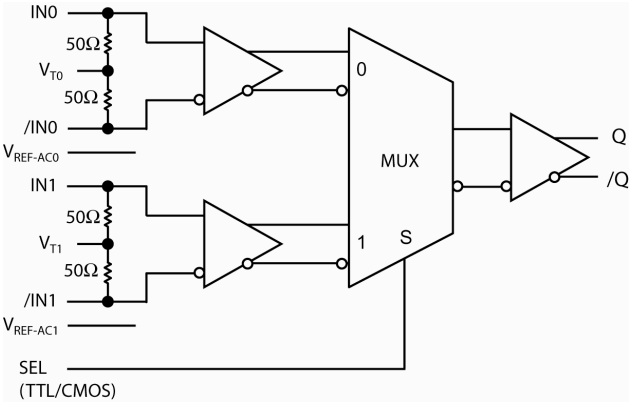
The SY58611U is a 2.5V, high-speed, fully differential LVDS 2:1 MUX capable of processing clocks up to 2.5GHz and data up to 3.2Gbps. SY58611U is optimized to provide a buffered output of the selected input with less than 20ps of skew and less than $10ps_{pp}$ total jitter. Patented MUX Isolation design reduces crosstalk and provides superior signal integrity.

The differential inputs include Micrel's unique, 3-pin input termination architecture that interfaces to LVPECL, LVDS or CML differential signals, (AC- or DC-coupled) as small as $100mV_{PK}$ ($200mV_{pp}$) without any level-shifting or termination resistor networks in the signal path. For AC-coupled input interface applications, an integrated reference voltage (V_{REF-AC}) is provided to bias the V_T pin. The output is LVDS compatible, with rise/fall times guaranteed to be less than 120ps.

The SY58611U operates from a 2.5V ±5% supply and is guaranteed over the full industrial temperature range (–40°C to +85°C). For applications that require CML or LVPECL output, consider the SY58609U and SY58610U, 2:1 MUX with 400mV and 800mV output swings respectively. The SY58611U 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.

Functional Block Diagram



Precision Edge®

Features

- Selects between two sources and provides buffered copy of the selected input signal
- Fail Safe Input
  - Prevents output from oscillating when input is invalid or removed
- Guaranteed AC performance over temperature and voltage:
  - DC-to > 3.2Gbps throughput
  - <420ps typical propagation delay (IN-to-Q)
  - <120ps rise/fall times
- Unique, patented internal termination and VT pin accepts DC- and AC-coupled inputs (CML, PECL, LVDS)
- Unique, patented MUX input isolation design minimizes adjacent channel crosstalk
- Ultra-low jitter design
  - $<1ps_{RMS}$ cycle-to-cycle jitter
  - $<10ps_{PP}$ total jitter
  - $<1ps_{RMS}$ random jitter
  - $<10ps_{PP}$ deterministic jitter
- 2.5V ±5% power supply operation
- Industrial temperature range: –40°C to +85°C
- Available in 16-pin (3mm x 3mm) QFN package

Applications

- All SONET clock distribution
- Fibre Channel clock and data distribution
- Gigabit Ethernet clock or data distribution
- Backplane distribution

Markets

- DataCom and Telecom
- Storage
- ATE
- Test and Measurement

Precision Edge is a registered trademark of Micrel, Inc.

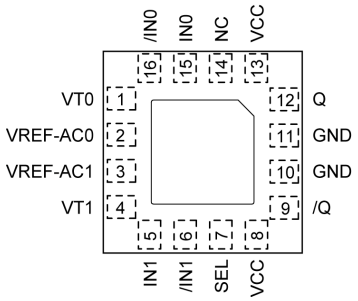
Ordering Information[1]

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY58611UMG	QFN-16	Industrial	611U with Pb-Free bar-line indicator	NiPdAu Pb-Free
SY58611UMGTR[2]	QFN-16	Industrial	611U with Pb-Free bar-line indicator	NiPdAu Pb-Free

Notes:

1. Contact factory for die availability. Dice are guaranteed at T_A = 25°C, DC Electricals only.
2. Tape and Reel.

Pin Configuration



16-Pin QFN

Truth Table

SEL	Output
0	IN0 Selected
1	IN1 Selected

Pin Description

Pin Number	Pin Name	Pin Function
1, 4	VT0, VT1	Input Termination Center-Tap: Each side of the differential input pair terminates to the VT pin. This pin provides a center-tap to a termination network for maximum interface flexibility. See "Input Interface Applications" subsection.
2, 3	VREF-AC0, VREF-AC1	Reference Voltage: These outputs bias to V_{CC}–1.2V. They are used for AC-coupling inputs IN and /IN. Connect VREF-AC directly to the corresponding VT pin. Bypass with 0.01µF low ESR capacitor to VCC. Due to limited drive capability, the VREF-AC pin is only intended to drive its respective VT pin. Maximum sink/source current is ±0.5mA. See "Input Interface Applications" subsection.
5, 6 15, 16	IN1, /IN1 IN0, /IN0	Differential Inputs: These input pairs are the differential signal inputs to the device. Inputs accept AC- or DC-Coupled differential signals as small as 100mV (200mV_{PP}). Each pin of the pairs internally terminates with 50Ω to the V_T pin. If the input swing falls below a certain threshold (typical 30mV), the Fail Safe Input (FSI) feature will guarantee a stable output by latching the output to its last valid state. See "Input Interface Applications" subsection.
7	SEL	Single-Ended Input: This single-ended TTL/CMOS-compatible input selects the inputs to the multiplexer. Note that this input is internally connected to a 25kΩ pull-up resistor and will default to logic HIGH state if left open. The input-switching threshold is V_{CC}/2.
8, 13	VCC	Positive Power Supply: Bypass with 0.1µF//0.01µF low ESR capacitors as close to the V_{CC} pins as possible.
9, 12	/Q, Q	LVDS Differential Output Pair: Differential buffered output copy of the selected input signal. The output swing is typically 325mV. Normally terminated 100_ across the output (Q and /Q). See "LVDS Output Interface Applications" subsection.
10, 11	GND, Exposed pad	Ground. Exposed pad must be connected to a ground plane that is the same potential as the ground pin.
14	NC	No connect.

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Absolute Maximum Ratings[1]

Supply Voltage (V_{CC}) ..... –0.5V to +4.0V
Input Voltage (V_{IN}) ..... –0.5V to V_{CC}
LVDS Output Current (I_{OUT}) ..... ±10mA
Input Current
  Source or Sink Current on (IN, /IN)..... ±50mA
Current (V_{REF})
  Source or sink current on V_{REF-AC}[4] ..... ±0.5mA
Maximum operating Junction Temperature ..... 125°C
Lead Temperature (soldering, 20sec.) ..... 260°C
Storage Temperature (T_s) ..... –65°C to +150°C

Operating Ratings[2]

Supply Voltage (V_{CC}) ..... +2.375V to +2.635V
Ambient Temperature (T_A) ..... –40°C to +85°C
Package Thermal Resistance[3]
  QFN
    Still-air (θ_{JA}) ..... 60°C/W
    Junction-to-Board (ψ_{JB})..... 33°C/W

DC Electrical Characteristics[5]

T_A = –40°C to +85°C unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{CC}	Power Supply Voltage Range		2.375	2.5	2.625	V
I_{CC}	Power Supply Current	No load, max. V_{CC}		40	60	mA
R_{IN}	Input Resistance (IN-to-V_T, /IN-to-V_T)		45	50	55	Ω
R_{DIFF_IN}	Differential Input Resistance (IN-to-/IN)		90	100	110	Ω
V_{IH}	Input HIGH Voltage (IN, /IN)		1.2		V_{CC}	V
V_{IL}	Input LOW Voltage (IN, /IN)		0.2		V_{IH}–0.1	V
V_{IN}	Input Voltage Swing (IN, /IN)	see Figure 3a, Note 6	0.1		1.0	V
V_{DIFF_IN}	Differential Input Voltage Swing (|IN - /IN|)	see Figure 3b	0.2			V
V_{IN_FSI}	Input Voltage Threshold that Triggers FSI			30	100	mV
V_{REF-AC}	AC Reference Voltage	$I_{VREF-AC}$ = ± 0.5mA	V_{CC}-1.3		V_{CC}-1.0	V
V_{T_IN}	Voltage from Input to V_T				1.28	V

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 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. Package thermal resistance assumes exposed pad is soldered (or equivalent) to the device's most negative potential on the PCB. ψ_{JB} and θ_{JA} values are determined for a 4-layer board in still-air number, unless otherwise stated.
4. Due to the limited drive capability, use for input of the same package only.
5. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
6. V_{IN} (max) is specified when V_T is floating.

LVDS Output DC Electrical Characteristics[7]

V_{CC} = +2.5V ±5%, R_L = 100Ω across the output pair; T_A = –40°C to +85°C, unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{OUT}	Output Voltage Swing (Q, /Q)	See Figure 3a	250	325		mV
V_{DIFF_OUT}	Differential Output Voltage Swing |Q-/Q|	See Figure 3b	500	650		mV
V_{OCM}	Output Common Mode Voltage (Q, /Q)	See Figure 5b	1.125	1.20	1.275	V
ΔV_{OCM}	Change in Common Mode Voltage (Q, /Q)	See Figure 5b	–50		50	mV

LVTTL/CMOS DC Electrical Characteristics[7]

V_{CC} = 2.5V ±5%; T_A = –40°C to + 85°C, unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{IH}	Input HIGH Voltage		2.0			V
V_{IL}	Input LOW Voltage				0.8	V
I_{IH}	Input HIGH Current		-125		30	µA
I_{IL}	Input LOW Current		-300			µA

Notes:

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

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AC Electrical Characteristics[8]

V_{CC} = +2.5V ±5%, R_L = 100Ω across the output pair; Input $t_r/t_f \leq$ 300ps, T_A = –40°C to +85°C, unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
f_{MAX}	Maximum Frequency	NRZ Data	3.2			Gbps
		V_{OUT} > 200mV Clock	2.5	3		GHz
t_{PD}	Propagation Delay IN-to-Q	V_{IN}: 100mV-200mV	190	330	470	ps
		V_{IN}: > 200mV	150	280	420	ps
	SEL-to-Q		150		450	ps
t_{Skew}	Input-to-Input Skew	Note 9, 10		5	20	ps
	Part-to-Part Skew	Note 11			150	ps
t_{Jitter}	Data Random Jitter	Note 12			1	ps_{RMS}
	Deterministic Jitter	Note 13			10	ps_{PP}
	Clock Cycle-to-Cycle Jitter	Note 14			1	ps_{RMS}
	Total Jitter	Note 15			10	ps_{PP}
t_r, t_f	Output Rise/Fall Times (20% to 80%)	At full output swing.	40	80	120	ps
	Duty Cycle	Differential I/O	47		53	%

Notes:

8. High-frequency AC-parameters are guaranteed by design and characterization.
9. Input-to-Input skew is the time difference between the two inputs and one output, under identical input transitions.
10. Input-to-Input Skew is included in IN-to-Q propagation delay.
11. Part-to-part skew is defined for two parts with identical power supply voltages at the same temperature, same transition edge, and no skew at the edges at the respective inputs.
12. Random jitter is measured with a K28.7 pattern, measured at ≤ f_{MAX}.
13. Deterministic jitter is measured at 2.5Gbps with both K28.5 and 2^{23}–1 PRBS pattern.
14. Cycle-to-cycle jitter definition: the variation period between adjacent cycles over a random sample of adjacent cycle pairs. $t_{JITTER_CC} = T_n - T_{n+1}$, where T is the time between rising edges of the output signal.
15. Total jitter definition: with an ideal clock input frequency of ≤ f_{MAX} (device), no more than one output edge in 10^{12} output edges will deviate by more than the specified peak-to-peak jitter value.

Functional Description

Fail-Safe Input (FSI)

The input includes a special fail-safe circuit to sense the amplitude of the input signal and to latch the output when there is no input signal present, or when the amplitude of the input signal drops sufficiently below $100mV_{PK}$ ($200mV_{PP}$), typically $30mV_{PK}$. Refer to Figure 1b.

Input Clock Failure Case

If the input clock fails to a floating, static, or extremely low signal swing such that the voltage swing across the input pair is significantly less than 100mV, FSI function will eliminate a metastable condition and latch the output to the last valid state. No ringing and no undetermined state will occur at the output under these conditions. The output recovers to normal operation once the input signal returns to a valid state with a typical swing greater than 30mV.

Note that the FSI function will not prevent duty cycle distortion in case of a slowly deteriorating (but still toggling) input signal. Due to the FSI function, the propagation delay will depend on rise and fall time of the input signal and on its amplitude. Refer to "Typical Operating Characteristics" for detailed information.

Timing Diagrams

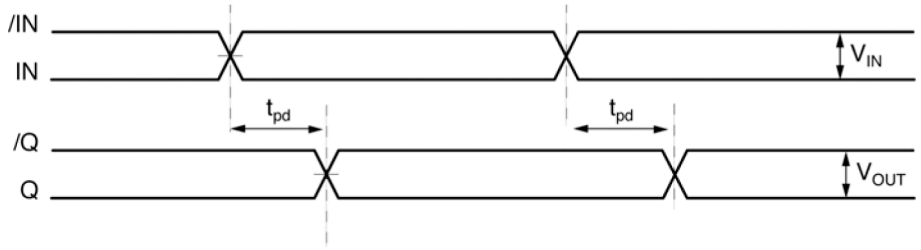

Figure 1a. Propagation Delay

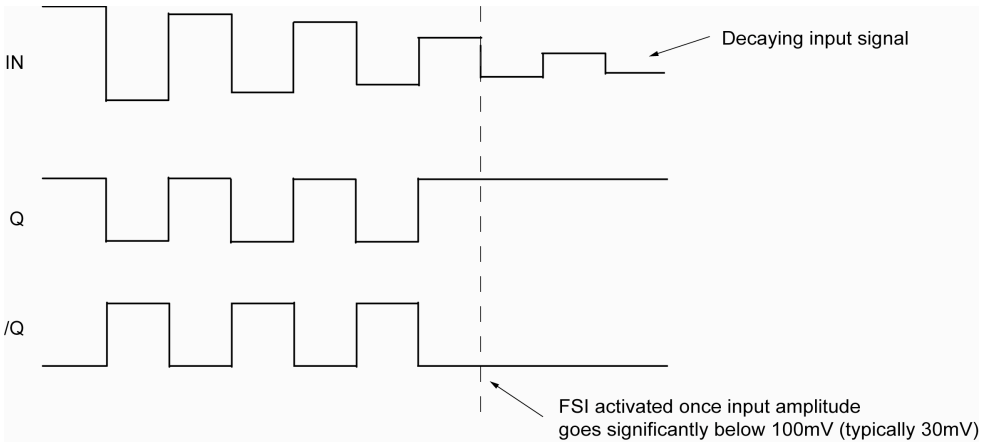

Figure 1b. Fail-Safe Feature

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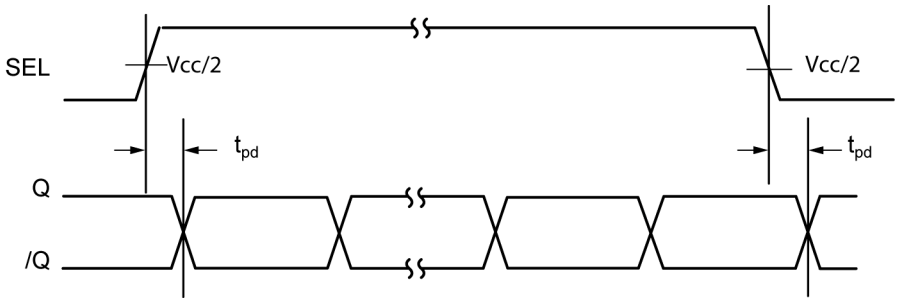


Figure 1c. SEL-to-Q Delay

Input Stage

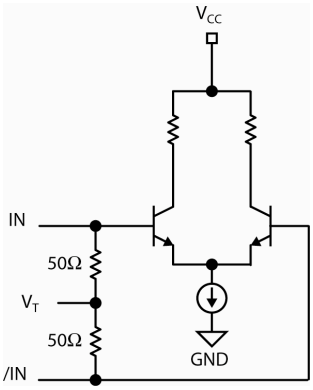


Figure 2. Simplified Differential Input Buffer

Single-Ended and Differential Swings

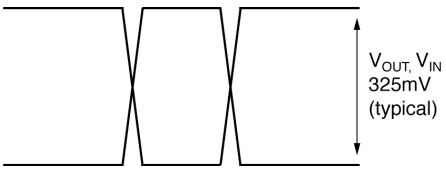


Figure 3a. Single-Ended Swing

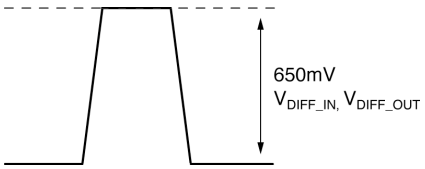
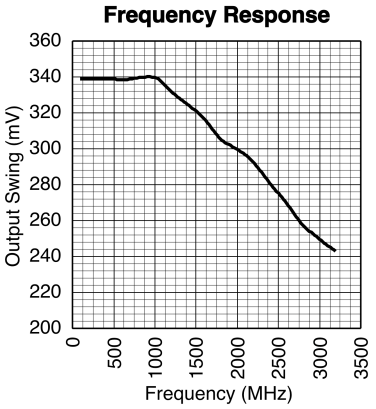
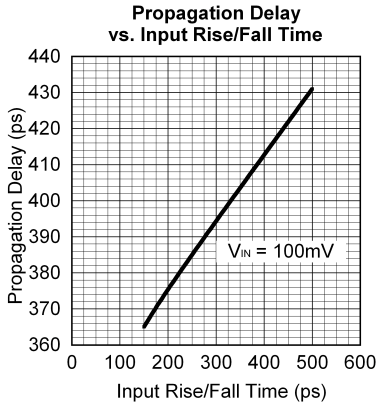


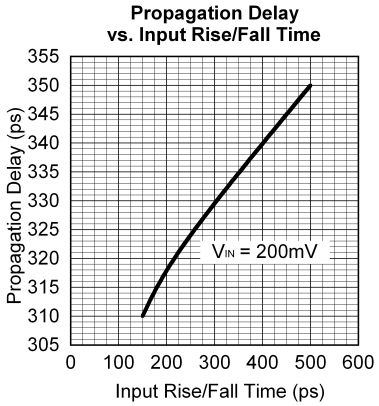
Figure 3b. Differential Swing

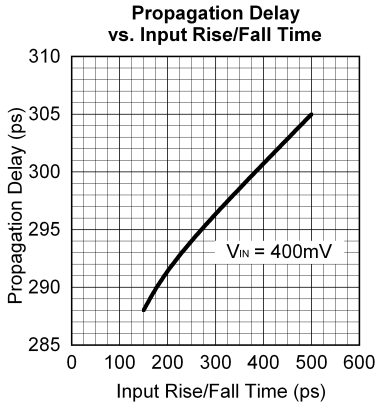
Typical Characteristics

V_{CC} = 2.5V, GND = 0V, V_{IN} = 100mV, R_L = 100Ω across the output pair, T_A = 25°C, unless otherwise stated.









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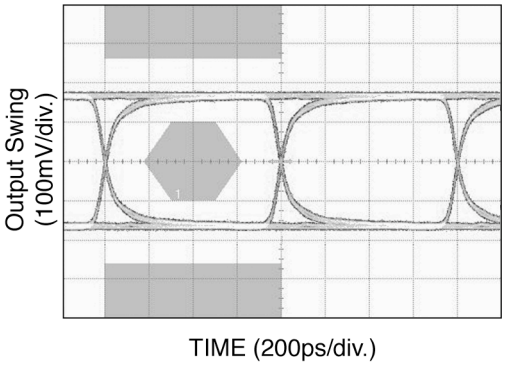
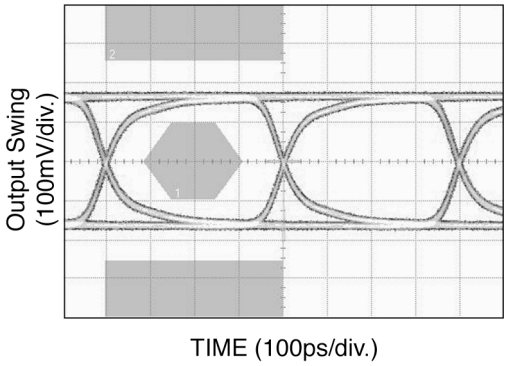
Functional Characteristics

V_{CC} = 2.5V, GND = 0V, V_{IN} = 325mV, R_L = 100Ω across the output pair, T_A = 25°C, unless otherwise stated.

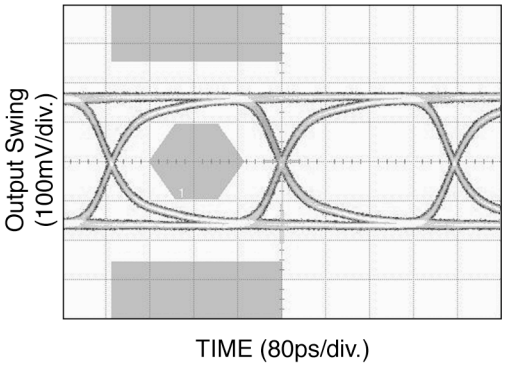
1.25Gbps Data



2.5Gbps Data



3.2Gbps Data



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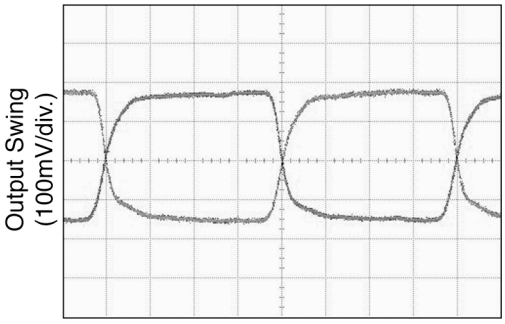
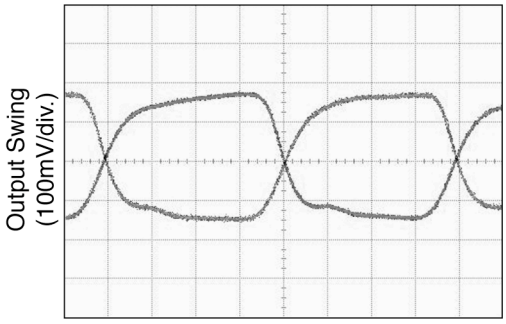
Functional Characteristics (continued)

V_{CC} = 2.5V, GND = 0V, V_{IN} = 325mV, R_L = 100Ω across the output pair, T_A = 25°C, unless otherwise stated.

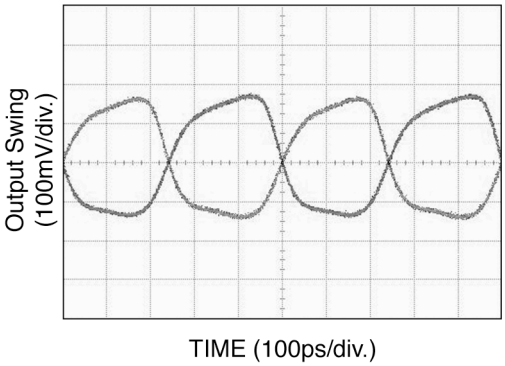
625MHz Clock



1.25GHz Clock



2GHz Clock



Input Interface Applications

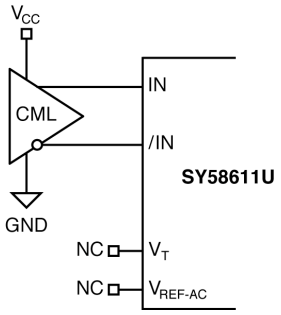


Figure 4a. CML Interface (DC-Coupled)
Option: May connect V_T to VCC

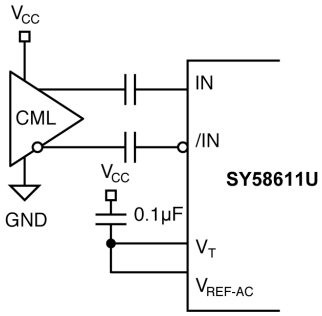


Figure 4b. CML Interface (AC-Coupled)

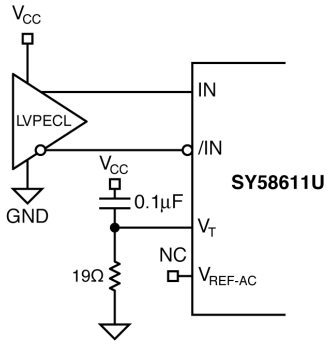


Figure 4c. LVPECL Interface (DC-Coupled)

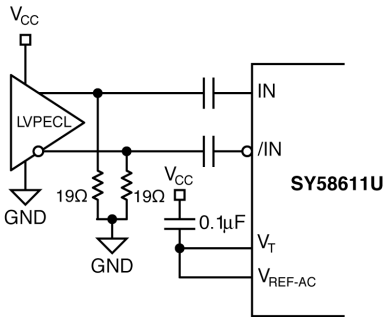


Figure 4d. LVPECL Interface (AC-Coupled)

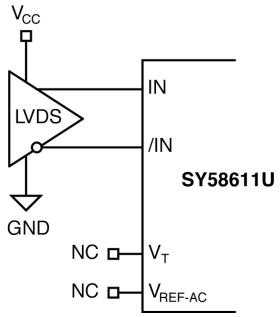


Figure 4e. LVDS Interface

LVDS Output Interface Applications

LVDS specifies a small swing of 325mV typical, on a nominal 1.2V common mode above ground. The common mode voltage has tight limits to permit large variations in the ground between and LVDS driver and receiver. Also, change in common mode voltage, as a function of data input, is kept to a minimum, to keep EMI low.

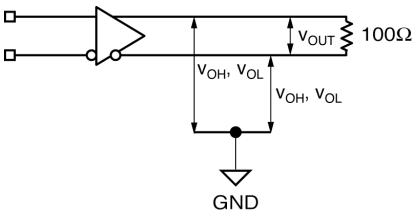


Figure 5a. LVDS Differential Measurement

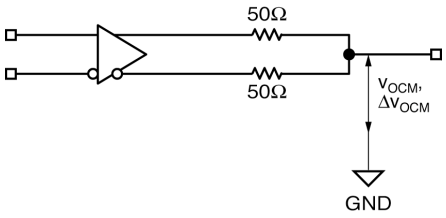
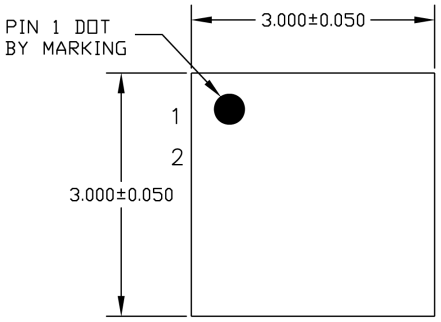


Figure 5b. LVDS Common Mode Measurement

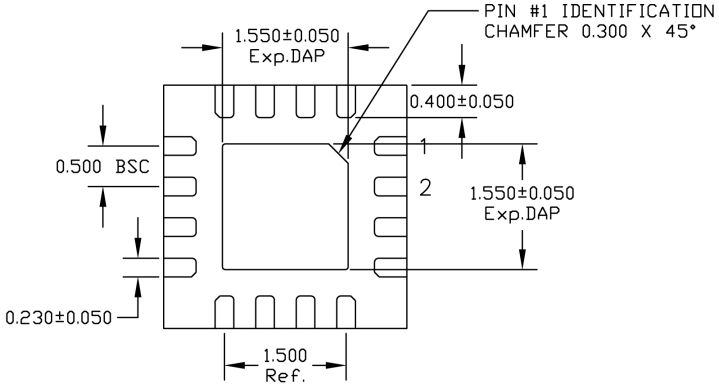
Related Products and Support Documentation

Part Number	Function	Data Sheet Link
SY58609U	4.25Gbps Precision, CML 2:1 MUX with Internal Termination and Fail Safe Input	http://www.micrel.com/_PDF/HBW/sy58609u.pdf
SY58610U	3.2Gbps Precision, LVPECL 2:1 MUX with Internal Termination and Fail Safe Input	http://www.micrel.com/_PDF/HBW/sy58610u.pdf
HBW Solutions	New Products and Termination Application Notes	http://www.micrel.com/page.do?page=/product-info/as/HBWsolutions.shtml

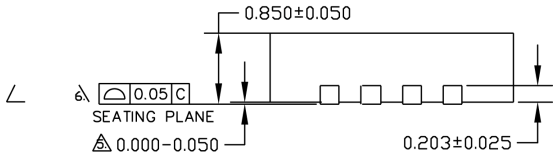
Package Information



TOP VIEW



BOTTOM VIEW



SIDE VIEW

NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. MAX. PACKAGE WARPAGE IS 0.05 mm.
3. MAXIMUM ALLOWABE BURRS IS 0.076 mm IN ALL DIRECTIONS.
4. PIN #1 ID ON TOP WILL BE LASER/INK MARKED.
5. APPLIED ONLY FOR TERMINALS.
6. APPLIED FOR EXPOSED PAD AND TERMINALS.

16-Pin (3mm x 3mm) QFN

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