SY58604U

3.2Gbps Precision, LVPECL Buffer with Internal Termination and Fail Safe Input

General Description

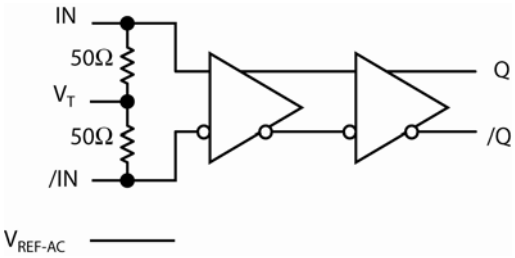
The SY58604U is a 2.5/3.3V, high-speed, fully differential LVPECL buffer optimized to provide only 108fs$_{RMS}$ phase jitter. The SY58604U can process clock signals as fast as 2.5GHz or data patterns up to 3.2Gbps.

The differential input includes 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 (200mV$_{pp}$) without any level-shifting or termination resistor networks in the signal path. For AC-coupled input interface applications, an integrated voltage reference (V_{REF-AC}) is provided to bias the V_T pin. The output is 800mV LVPECL, with extremely fast rise/fall times guaranteed to be less than 110ps.

The SY58604U 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 CML or LVDS outputs, consider the SY58603U and the SY58605U, buffers with 400mV and 325mV output swings respectively. The SY58604U 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

- Precision 800mV LVPECL buffer
- Ultra-low jitter design
  - 108fs$_{RMS}$ phase jitter
- Guaranteed AC performance over temperature and voltage:
  - DC-to > 3.2Gbps throughput
  - <350ps typical propagation delay (IN-to-Q)
  - <110ps rise/fall times
- Fail Safe Input
  - Prevents output from oscillating when input is invalid
- High-speed LVPECL output
- 2.5V ±5% or 3.3V ±10% power supply operation
- Industrial temperature range: –40°C to +85°C
- Available in 8-pin (2mm x 2mm) DFN package

Applications

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

Markets

- Storage
- ATE
- Test and measurement
- Enterprise networking equipment
- High-end servers
- Access
- Metro area network equipment

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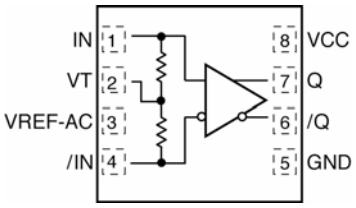
Ordering Information[1]

Part Number	Package Type	Operating Range	Package Marking
SY58604UMG	DFN-8	Industrial	604 with Pb-Free bar-line indicator
SY58604UMGTR[2]	DFN-8	Industrial	604 with Pb-Free bar-line indicator

Notes:

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

Pin Configuration



8-Pin DFN

Pin Description

Pin Number	Pin Name	Pin Function
1, 4	IN, /IN	Differential Input: This input pair is the differential signal input to the device. Input accepts DC-Coupled differential signals as small as 100mV (200mVpp). Each pin of this pair internally terminates with 50Ω to the VT 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 for more details.
2	VT	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 Applications” subsection.
3	VREF-AC	Reference Voltage: This output biases to V_{CC}–1.2V. It is used for AC-coupling inputs IN and /IN. Connect VREF-AC directly to the VT pin. Bypass with 0.01µF low ESR capacitor to VCC. Maximum sink/source current is ±1.5mA. See “Input Interface Applications” subsection for more details.
5	GND, Exposed pad	Ground: Exposed pad must be connected to a ground plane that is the same potential as the ground pin.
6, 7	/Q, Q	LVPECL Differential Output Pair: Differential buffered output copy of the input signal. The output swing is typically 800mV. See “LVPECL Output Termination” subsection.
8	VCC	Positive Power Supply: Bypass with 0.1µF//0.01µF low ESR capacitors as close to the V_{CC} pin as possible.

Absolute Maximum Ratings[1]

Supply Voltage (V_{CC}) ..... –0.5V to +4.0V
Input Voltage (V_{IN}) ..... –0.5V to V_{CC}+0.5V
LVPECL Output Current (I_{OUT})
  Continuous 50mA
  Surge 100mA
Current (V_T)
  Source or sink on VT pin ..... ±100mA
Input Current
  Source or sink Current on (IN, /IN) ..... ±50mA
Current (V_{REF})
  Source or sink current on V_{REF}-AC[4] ..... ±1.5mA
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_{IN}) ..... +2.375V to +3.60V
Ambient Temperature (T_A) ..... –40°C to +85°C
Package Thermal Resistance[3]
  DFN
    Still-air (θ_{JA}) ..... 93°C/W
    Junction-to-board (Ψ_{JB}) ..... 56°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 3.0	2.5 3.3	2.625 3.6	V
I_{CC}	Power Supply Current	No load, max. V_{CC}		30	45	mA
R_{DIFF_IN}	Differential Input Resistance (IN-to-/IN)		90	100	110	Ω
V_{IH}	Input HIGH Voltage (IN, /IN)	IN, /IN, Note 7	V_{CC}–1.6		V_{CC}	V
V_{IL}	Input LOW Voltage (IN, /IN)	IN, /IN	0		V_{IH}–0.1	V
V_{IN}	Input Voltage Swing (IN, /IN)	see Figure 3a, Note 6	0.1		1.7	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
$V_{REF\text{-}AC}$	Output Reference Voltage		V_{CC}–1.3	V_{CC}–1.2	V_{CC}–1.1	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.
7. V_{IH} (min) not lower than 1.2V.

LVPECL Outputs DC Electrical Characteristics[5]

V_{CC} = +2.5V ±5% or +3.3V ±10%, R_L = 50Ω to V_{CC}-2V; T_A = –40°C to +85°C, unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{OH}	Output HIGH Voltage		V_{CC}-1.145		V_{CC} -0.895	V
V_{OL}	Output LOW Voltage		V_{CC}-1.945		V_{CC}-1.695	V
V_{OUT}	Output Voltage Swing	See Figure 3a	550	800	950	mV
V_{DIFF_OUT}	Differential Output Voltage Swing	See Figure 3b	1100	1600		mV

AC Electrical Characteristics

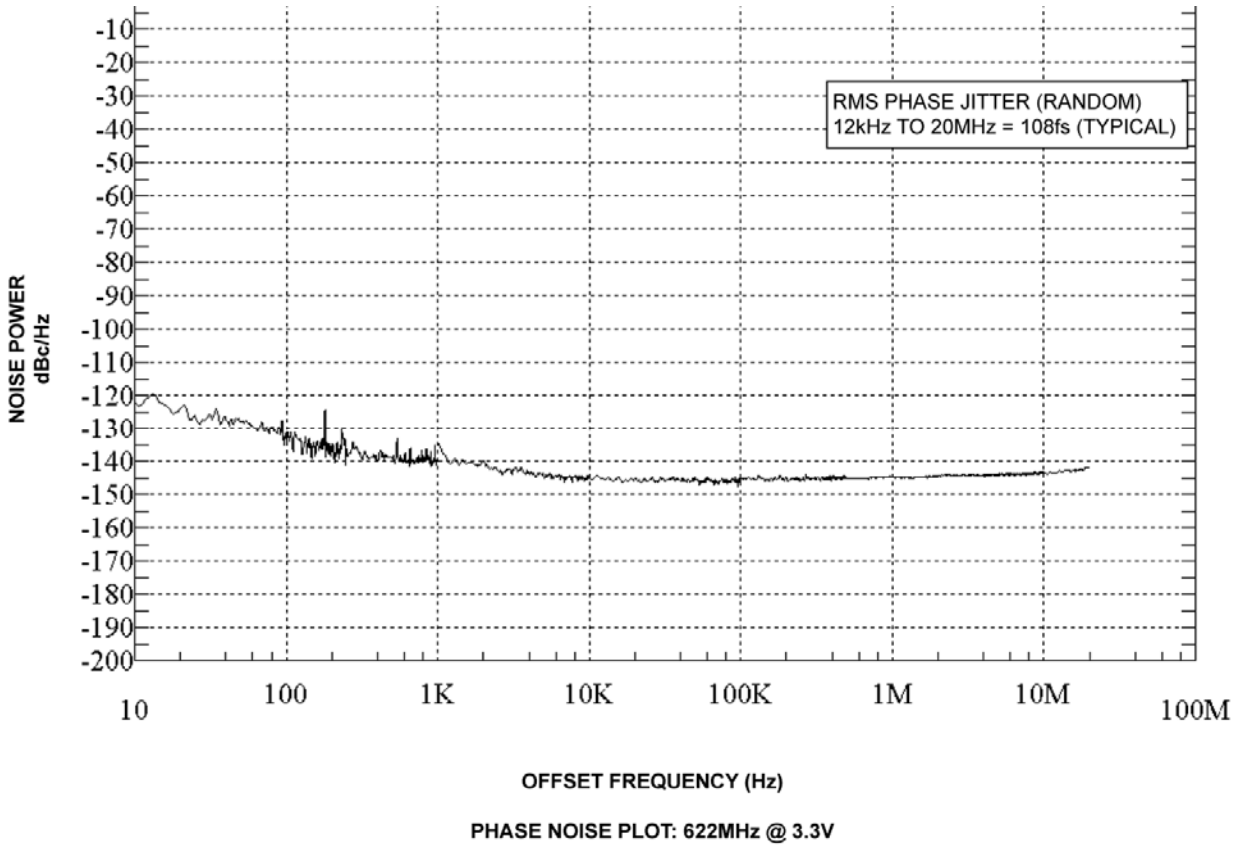
V_{CC} = +2.5V ±5% or +3.3V ±10%, R_L = 50Ω to V_{CC}-2V, Input t_r/t_f: ≤300ps; T_A = –40°C to +85°C, unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
f_{MAX}	Maximum Frequency	NRZ Data	3.2	4.25		Gbps
		V_{OUT} > 400mV Clock	2.5	3		GHz
t_{PD}	Propagation Delay IN-to-Q	V_{IN}: 100mV-200mV	180	320	450	ps
		V_{IN}: 200mV-800mV	150	230	350	ps
t_{Skew}	Part-to-Part Skew	Note 7			135	ps
t_{Jitter}	RMS Phase Jitter	Output = 622MHz Integration Range: 12kHz – 20MHz		108		fs_{RMS}
t_r, t_f	Output Rise/Fall Times (20% to 80%)	At full output swing.	40	75	110	ps
	Duty Cycle	Differential I/O	47		53	%

Notes:

7. Part-to-part skew is defined for two parts with identical power supply voltages at the same temperature and no skew at the edges at the respective inputs.

Phase Noise Plot



PHASE NOISE PLOT: 622MHz @ 3.3V

Functional Description

Fail-Safe Input (FSI)

The input includes a special failsafe circuit to sense the amplitude of the input signal and to latch the outputs when there is no input signal present, or when the amplitude of the input signal drops sufficiently below $100mV_{PK}$ ($200mV_{PP}$), typically $30mV_{PK}$. Maximum frequency of SY58604U is limited by the FSI function.

Input Clock Failure Case

If the input clock fails to a floating, static, or extremely low signal swing, then the FSI function will eliminate a metastable condition and guarantee a stable output. No ringing and no undetermined state will occur at the output under these conditions.

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 Characteristics” for detailed information.

Timing Diagrams

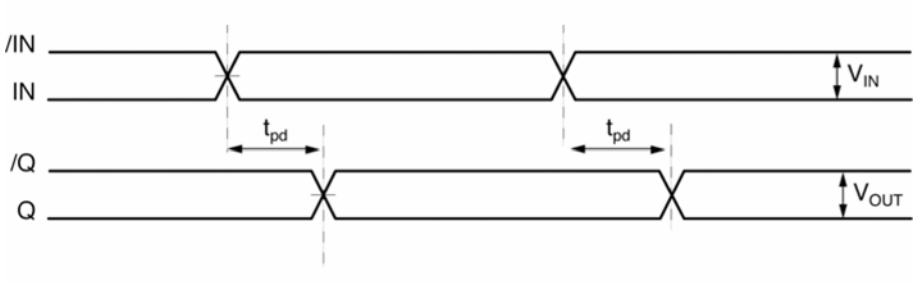


Figure 1a. Propagation Delay

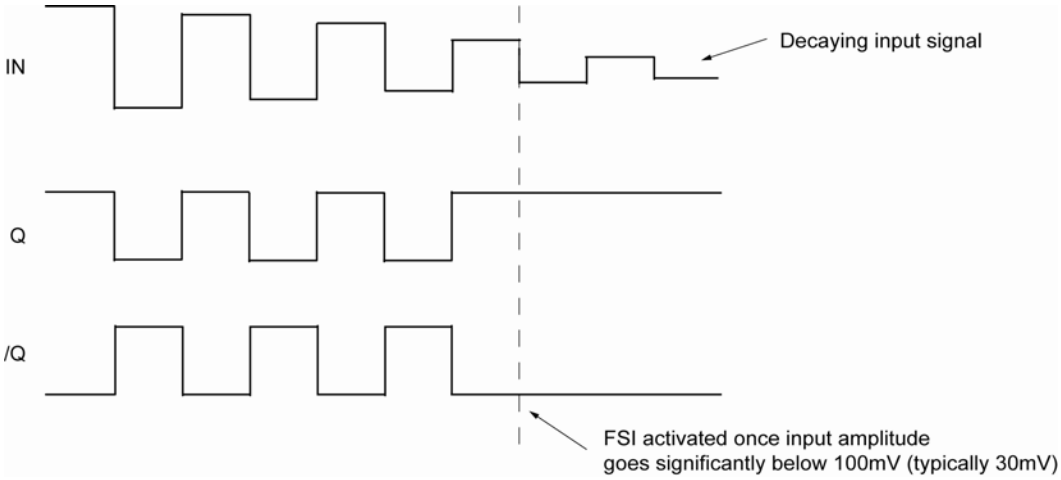
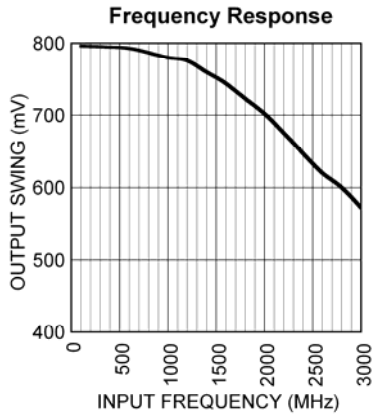
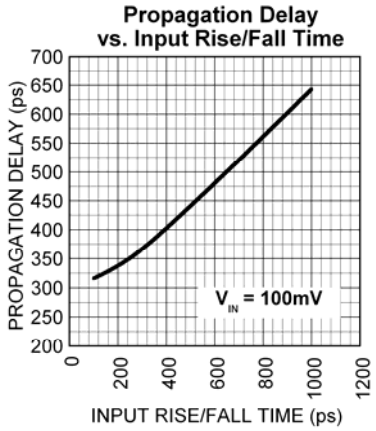


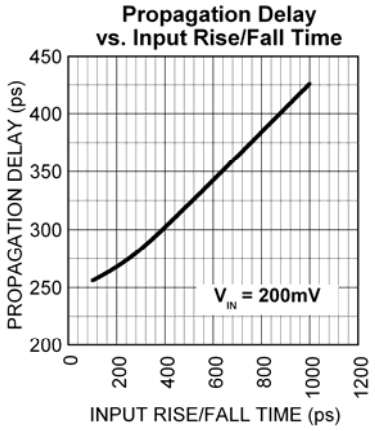
Figure 1b. Fail Safe Feature

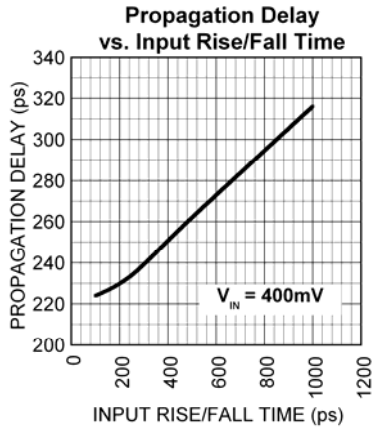
Typical Characteristics

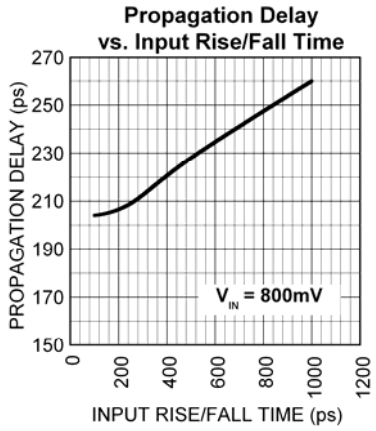
V_{CC} = 3.3V, GND = 0V, V_{IN} = 100mV, R_L = 50Ω to V_{CC}-2V, T_A = 25°C, unless otherwise stated.











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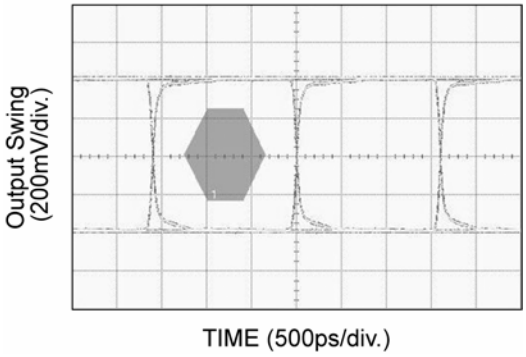
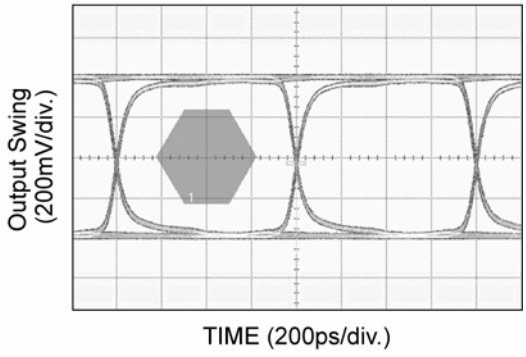
Functional Characteristics

V_{CC} = 3.3V, GND = 0V, V_{IN} = 400mV, Data Pattern: 2^{23}-1, R_L = 50Ω to V_{CC}-2V, T_A = 25°C, unless otherwise stated.

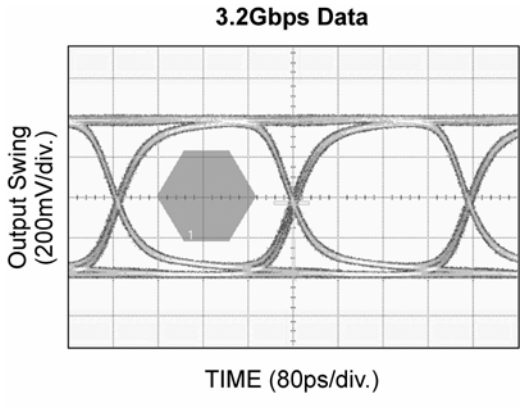
625Mbps Data



1.25Gbps Data



3.2Gbps Data

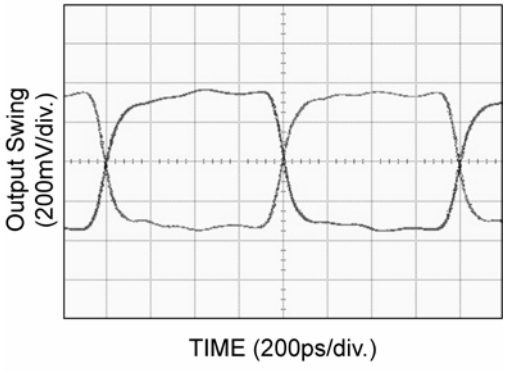


Functional Characteristics (continued)

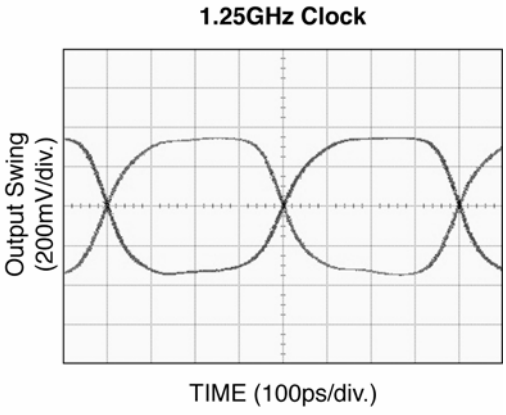
V_{CC} = 3.3V, GND = 0V, V_{IN} = 400mV, R_L = 50Ω to V_{CC}-2V, T_A = 25°C, unless otherwise stated.

200MHz Clock

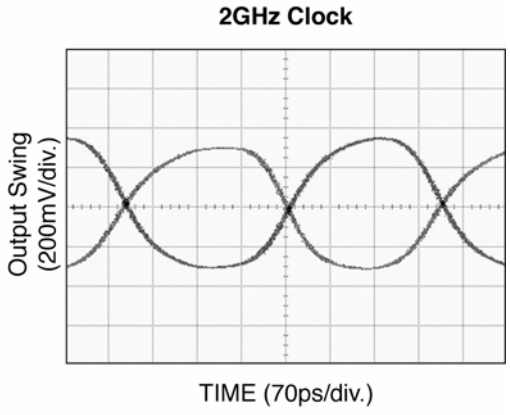
625MHz Clock



1.25GHz Clock



2GHz Clock



Input and Output Stage

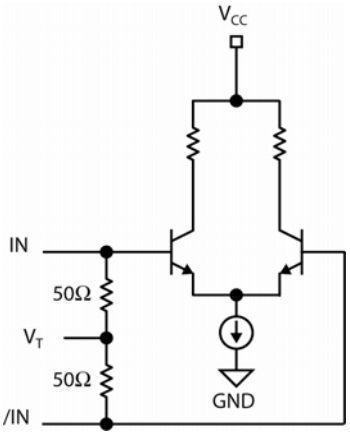


Figure 2a. Simplified Differential Input Buffer

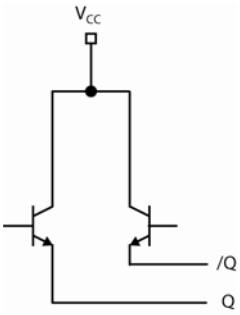


Figure 2b. Simplified LVPECL Output Buffer

Single-Ended and Differential Swings

Figure 3a. Single-Ended Voltage Swing

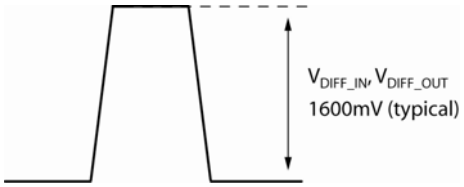


Figure 3b. Differential Voltage Swing

Input Interface Applications

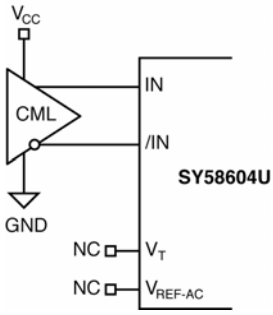


Figure 4a. CML Interface (DC-Coupled)

Option: May connect V_T to V_{CC}

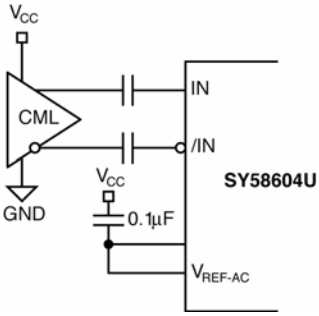


Figure 4b. CML Interface (AC-Coupled)

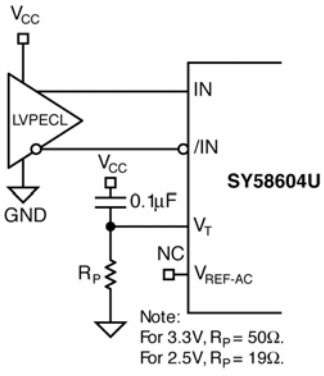


Figure 4c. LVPECL Interface (DC-Coupled)

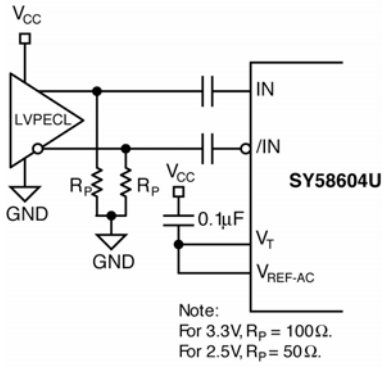


Figure 4d. LVPECL Interface (AC-Coupled)

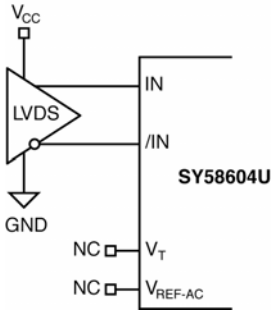


Figure 4e. LVDS Interface

LVPECL Output Termination

LVPECL outputs 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 Figure 5a and 5b.

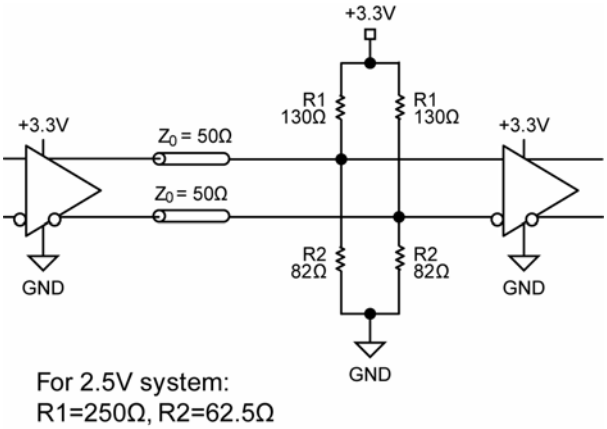


Figure 5a. Parallel Termination-Thevenin Equivalent

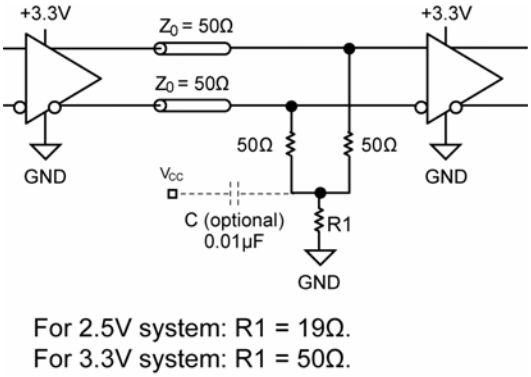
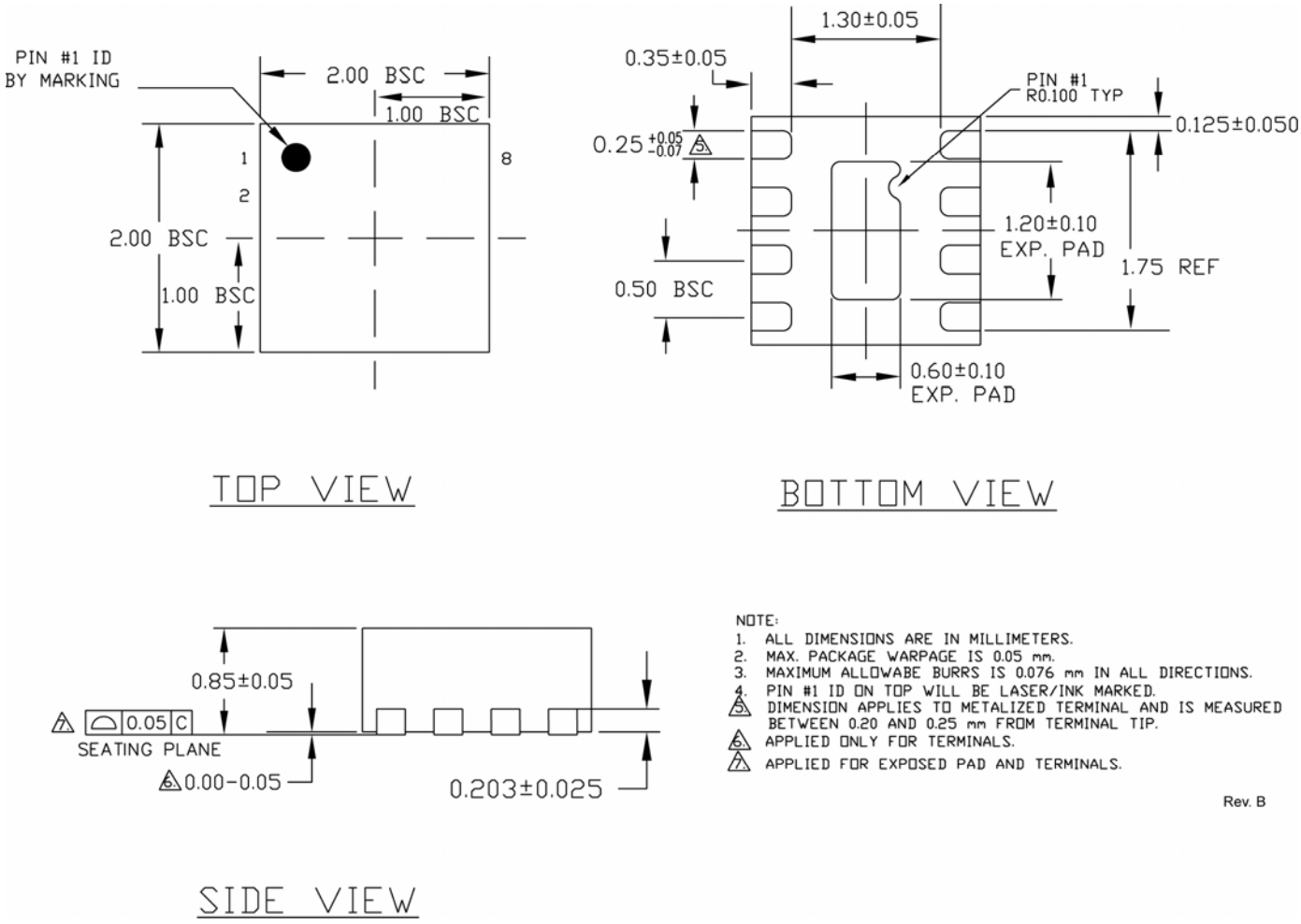


Figure 5b. Three-Resistor "Y-Termination"

Related Product and Support Documents

Part Number	Function	Data Sheet Link
SY58603U	4.25Gbps Precision CML Buffer with Internal Termination and Fail Safe Input	http://www.micrel.com/page.do?page=/product-info/products/sy58603u.shtml
SY58605U	3.2Gbps Precision LVDS Buffer with Internal Termination and Fail Safe Input	http://www.micrel.com/page.do?page=/product-info/products/sy58605u.shtml
HBW Solutions	New Products and Termination Application Notes	http://www.micrel.com/page.do?page=/product-info/as/HBWsolutions.shtml

Package Information



8-Pin (2mm x 2mm) DFN

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