SY58608U

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

Features

- Precision 1:2 LVDS Fanout Buffer
- Guaranteed AC Performance Over Temperature and Voltage:
  - DC-to > 3.2 Gbps Throughput
  - <300 ps Propagation Delay (IN-to-Q)
  - <20 ps Within-Device Skew
  - <100 ps Rise/Fall Times
- Fail Safe Input
  - Prevents Outputs From Oscillating When Input Is Invalid
- Ultra-Low Jitter Design
  - 130 fs_{RMS} Typical Additive Phase Jitter
  - High-Speed LVDS Outputs
- 2.5V ±5% Power Supply Operation
- Industrial Temperature Range: –40°C to +85°C
- Available In 16-pin (3 mm x 3 mm) QFN Package

Applications

- All SONET Clock And Data Distribution
- Fibre Channel Clock And Data Distribution
- Gigabit Ethernet Clock And Data Distribution
- Backplane Distribution

Markets

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

General Description

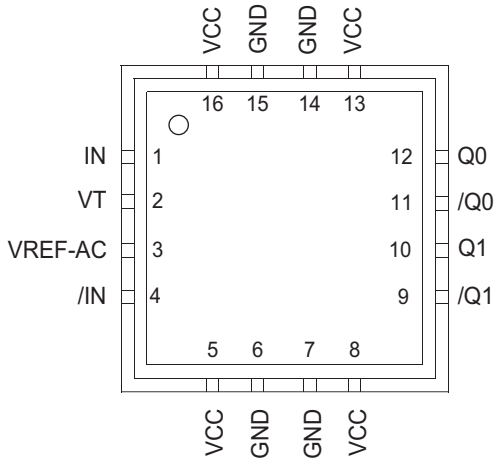
The SY58608U is a 2.5V, high-speed, fully differential 1:2 LVDS fanout buffer optimized to provide two identical output copies with less than 20 ps of skew and 130 fs_{RMS} typical additive phase jitter. The SY58608U can process clock signals as fast as 2 GHz or data patterns up to 3.2 Gbps.

The differential input includes Microchip's unique, 3-pin input termination architecture that interfaces to LVPECL, LVDS or CML differential signals, (AC- or DC-coupled) as small as 100 mV (200 mV_{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 outputs are 325 mV LVDS, with rise/fall times guaranteed to be less than 100 ps.

The SY58608U operates from a 2.5V ±5% supply and is guaranteed over the full industrial temperature range (–40°C to +85°C). The SY58608U is part of Microchip's high-speed, Precision Edge® product line.

Package Type

SY58608U
3x3 QFN-16
Top View



United States Patent No. RE44,134

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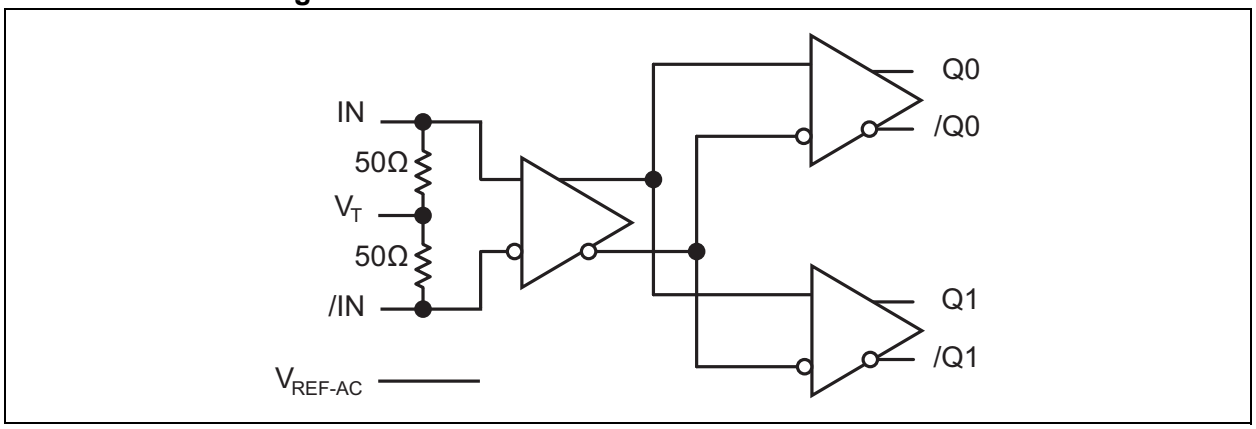
Functional Block Diagram



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1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Supply Voltage, V_{CC} ..... –0.5V to +4.0V
Input Voltage, V_{IN} ..... –0.5V to V_{CC} +0.3V
LVDS Output Current, I_{OUT} ..... ±10 mA
Input Current
    Source or Sink Current on, IN, /IN ..... ±50 mA
Current, V_{REF}
    Source or Sink Current on V_{REF-AC} (Note 1) ..... ±1.5 mA

Operating Ratings ††

Supply Voltage, V_{IN} ..... +2.375V to +2.625V

† Notice: 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.

†† Notice: The data sheet limits are not guaranteed if the device is operated beyond the operating ratings.

Note 1: Due to the limited drive capability, use for input of the same package only.

DC CHARACTERISTICS (Note 1)

Electrical Characteristics: T_A = –40°C to +85°C, Unless otherwise stated.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Power Supply Voltage Range	V_{CC}	2.375	2.5	2.625	V	—
Power Supply Current	I_{CC}	—	55	75	mA	No load, max. V_{CC}
Differential Input Resistance (IN-to-/IN)	R_{DIFF_IN}	90	100	110	Ω	—
Input HIGH Voltage (IN, /IN)	V_{IH}	1.2	—	V_{CC}	V	IN, /IN
Input LOW Voltage (IN, /IN)	V_{IL}	0	—	V_{IH}–0.1	V	IN, /IN
Input Voltage Swing (IN, /IN)	V_{IN}	0.1	—	1.7	V	See Figure 6-2, (Note 2)
Differential Input Voltage Swing (|IN - /IN|)	V_{DIFF_IN}	0.2	—	—	V	See Figure 6-4
Input Voltage Threshold that Triggers FSI	V_{IN_FSI}	—	30	100	mV	—
Output Reference Voltage	V_{REF-AC}	V_{CC} – 1.3	V_{CC} – 1.2	V_{CC} – 1.1	V	—
Voltage from Input to V_T	IN to V_T	—	—	1.28	V	—

Note 1: The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

2: V_{IN} (max) is specified when V_T is floating.

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LVDS OUTPUTS DC ELECTRICAL CHARACTERISTICS (Note 1)

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

Parameter	Symbol	Min.	Typ.	Max.	Units	Condition
Output Voltage Swing	V_{OUT}	250	325	—	mV	See Figure 6-2, 6-3.
Differential Output Voltage Swing	V_{DIFF_OUT}	500	650	—	mV	See Figure 6-4.
Output Common Mode Voltage	V_{OCM}	1.125	1.20	1.275	V	See Figure 6-5.
Change in Common Mode Voltage	ΔV_{OCM}	–50	—	50	mV	See Figure 6-5.

Note 1: The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

AC ELECTRICAL CHARACTERISTICS (Note 1)

Electrical Characteristics: V_{CC} = +2.5V ±5%, R_L = 100Ω across the output pairs; Input t_r/t_f: ≤300 ps; T_A = –40°C to +85°C, Unless otherwise stated.

Parameter	Symbol	Min.	Typ.	Max.	Units	Condition
Maximum Frequency	f_{MAX}	3.2	4.25	—	Gbps	NRZ (Data)
		2	3	—	GHz	V_{OUT} > 200 mV (Clock)
Propagation Delay IN-to-Q	t_{PD}	170	280	420	ps	V_{IN}: 100 mV - 200 mV
		130	200	300	ps	V_{IN}: 200 mV - 800 mV
Within Device Skew	t_{SKEW}	—	5	20	ps	Note 2
Part-to-Part Skew		—	—	135	ps	Note 3
Additive Phase Jitter	t_{JITTER}	—	130	—	fs_{RMS}	Carrier = 622 MHz Integration Range: 12 kHz – 20 MHz
Output Rise/Fall Time (20% to 80%)	t_r, t_f	35	60	100	ps	At full output swing
Duty Cycle	—	47	—	53	%	Differential I/O

Note 1: These high-speed parameters are guaranteed by design and characterization.

2: Within-device skew is measured between two different outputs under identical input transitions.

3: 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.

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TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Operating Ambient Temperature Range	T_A	–40	—	+85	°C	—
Maximum Junction Operating Temperature	T_J	—	—	+125	°C	—
Storage Temperature Range	T_A	–65	—	+150	°C	—
Package Thermal Resistances (Note 1)						
Thermal Resistance, 3 x 3 QFN-16Ld	θ_{JA}	—	60	—	°C/W	Still-air
	ψ_{JB}	—	33	—	°C/W	Junction-to-board

Note 1: 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.

2.0 FUNCTIONAL DESCRIPTION

2.1 Fail-Safe Input (FSI)

The input includes a special fail-safe 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 100 mV_{PK} (200 mV_{PP}), typically 30 mV_{PK}. Maximum frequency of SY58608U is limited by the FSI function.

2.2 Input Clock Failure Case

If the input clock fails to a floating, static, or extremely low signal swing such that the differential voltage across the input pair is less than 100 mV, the FSI function will eliminate a metastable condition and latch the outputs to the last valid state. No ringing and no indeterminate 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 differential voltage ≥100 mV.

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 Performance Curves" for detailed information.

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3.0 TIMING DIAGRAMS

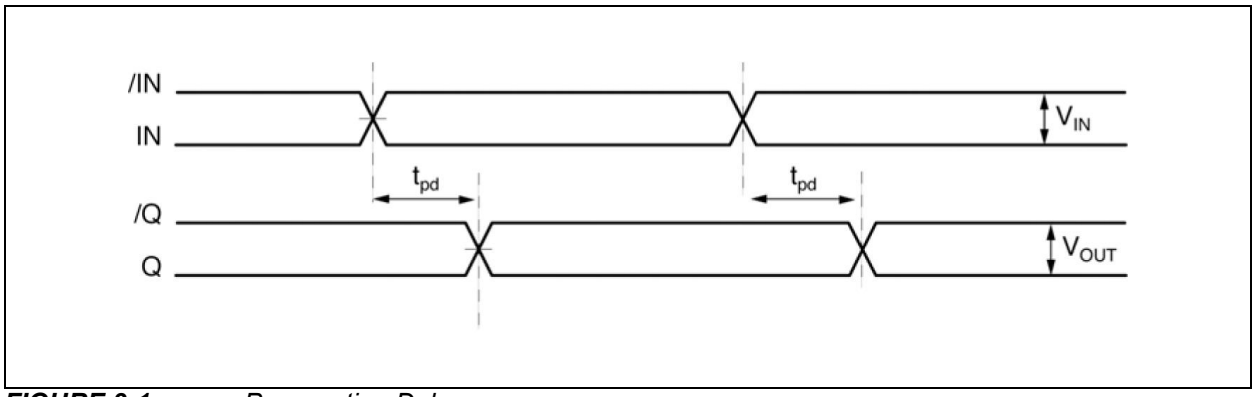

FIGURE 3-1: *Propagation Delay.*

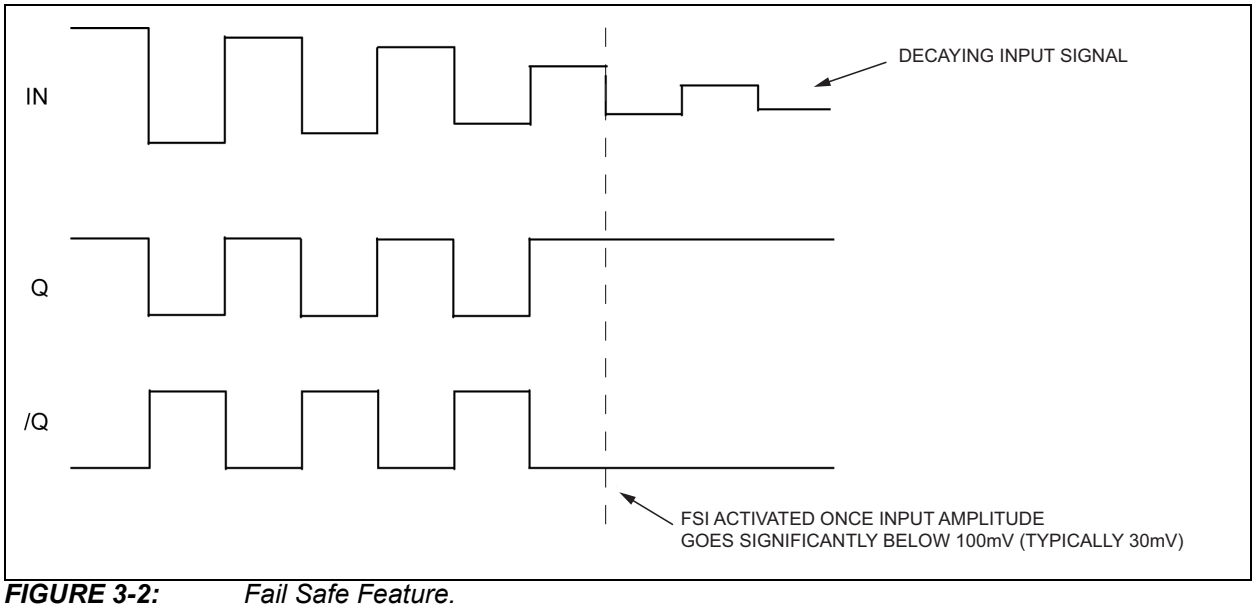

FIGURE 3-2: *Fail Safe Feature.*

4.0 TYPICAL PERFORMANCE CURVES

Note:	The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

NOTE: Unless otherwise indicated, V_{CC} = 2.5V, GND = 0V, V_{IN} = 100 mV, R_L = 100Ω across the output pairs, T_A = +25°C.

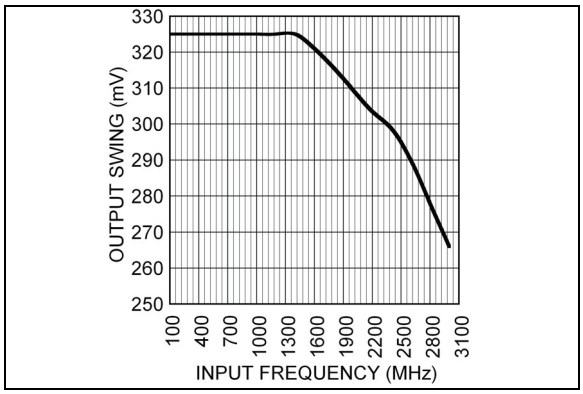

FIGURE 4-1: *Frequency Response.*

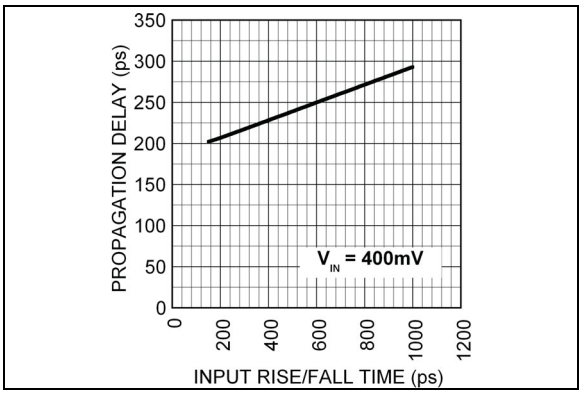

FIGURE 4-4: *Propagation Delay vs. Input Rise/Fall Time.*

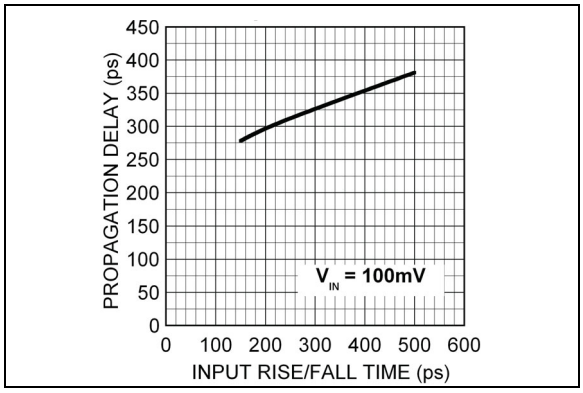

FIGURE 4-2: *Propagation Delay vs. Input Rise/Fall Time.*

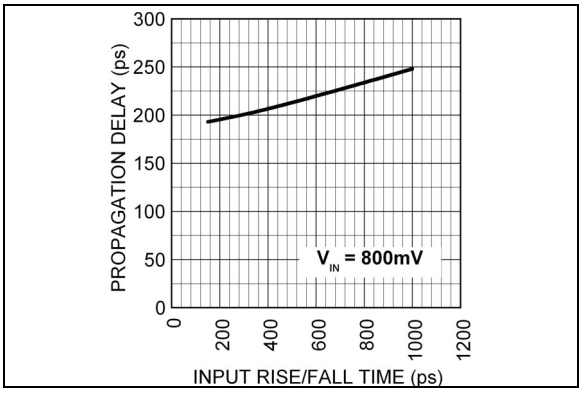

FIGURE 4-5: *Propagation Delay vs. Input Rise/Fall Time.*

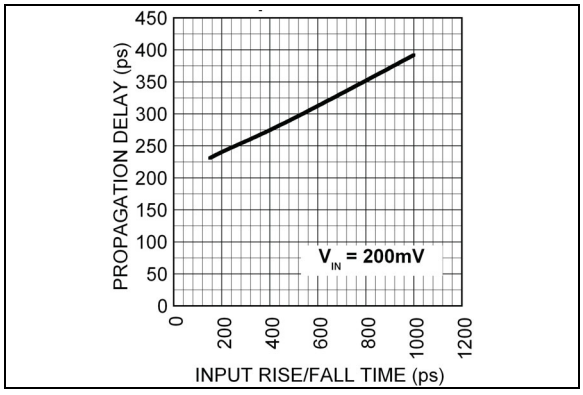

FIGURE 4-3: *Propagation Delay vs. Input Rise/Fall Time.*

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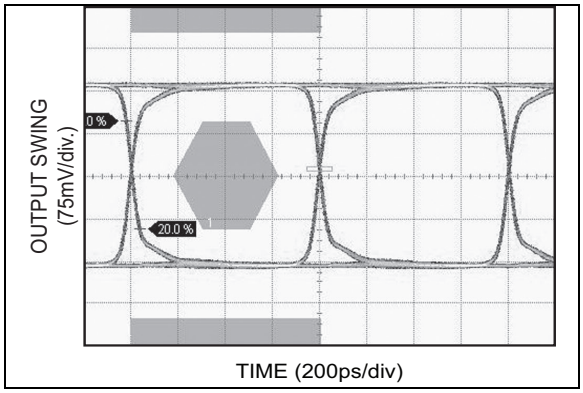

FIGURE 4-6: *1.25 Gbps Data.*

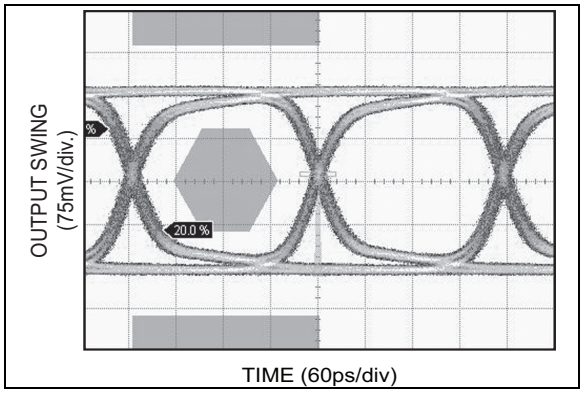

FIGURE 4-9: *4.25 Gbps Data.*

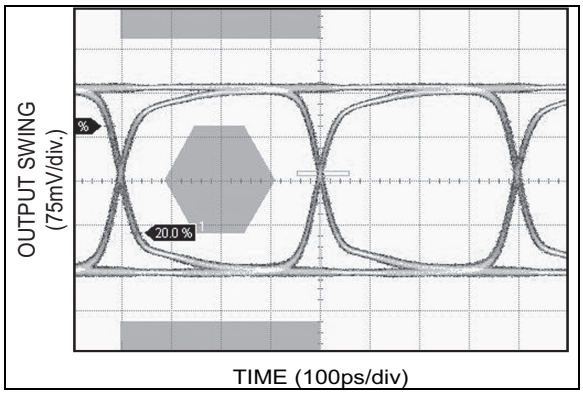

FIGURE 4-7: *2.5 Gbps Data.*

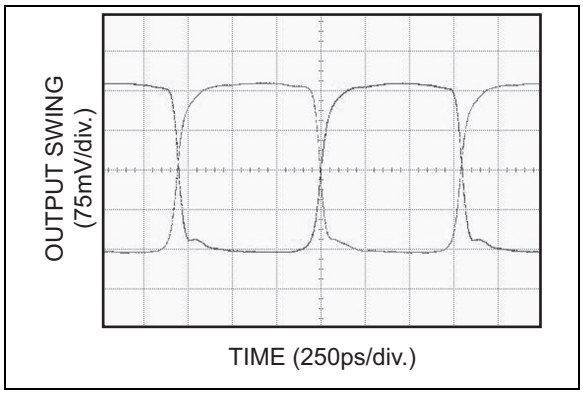

FIGURE 4-10: *625 MHz Clock.*

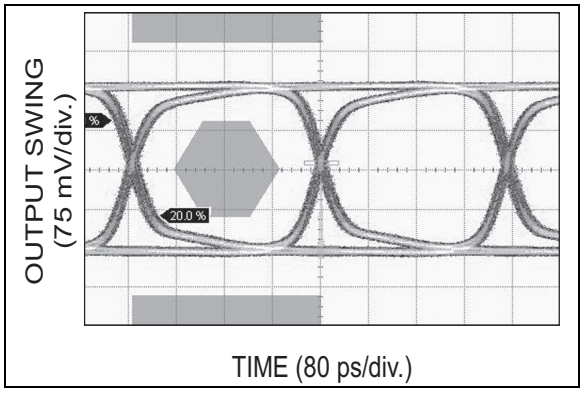

FIGURE 4-8: *3.2 Gbps Data.*

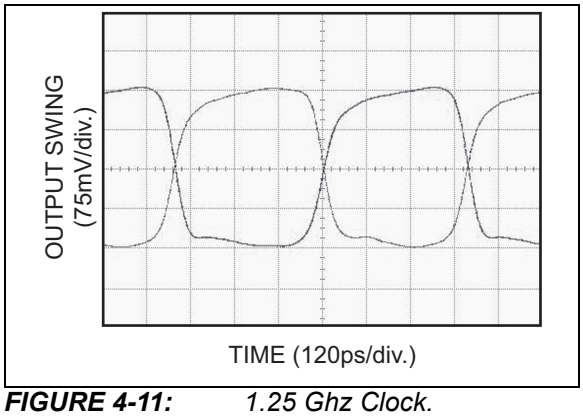

FIGURE 4-11: *1.25 Ghz Clock.*

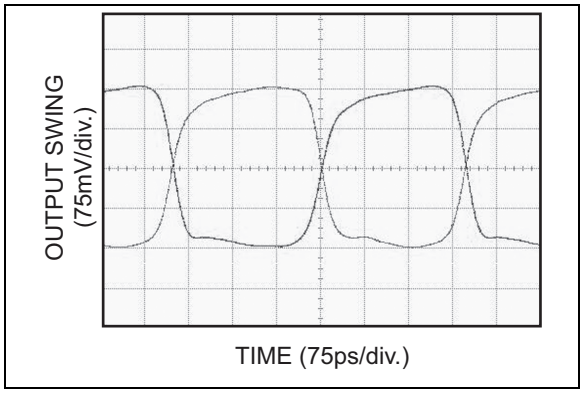

FIGURE 4-12: *2 GHz Clock.*

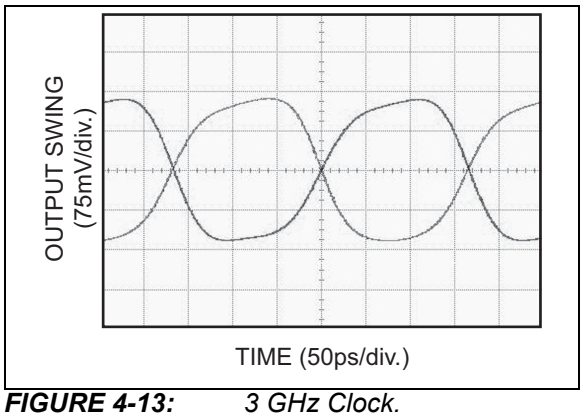

FIGURE 4-13: *3 GHz Clock.*

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5.0 ADDITIVE PHASE NOISE PLOT

V_{CC} = +2.5V, T_A = 25°C.

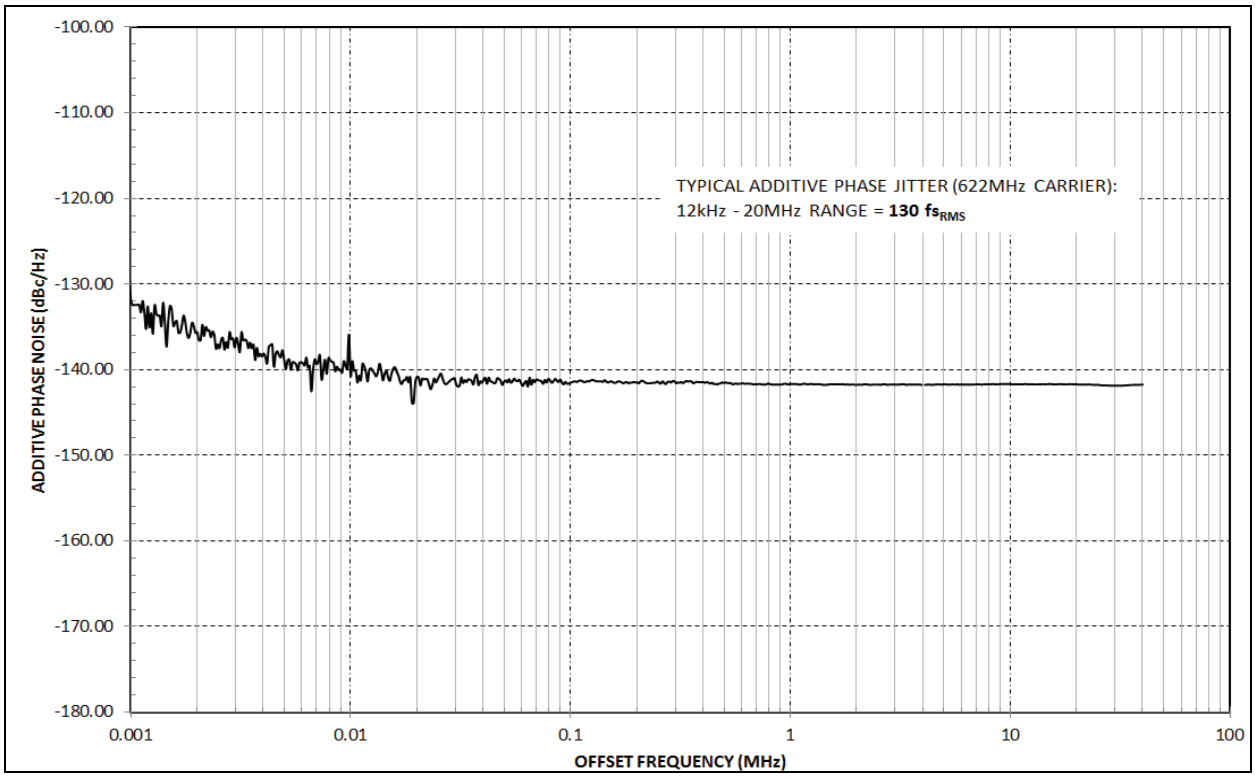

FIGURE 5-1: *Additive Noise Plot.*

6.0 INPUT STAGE

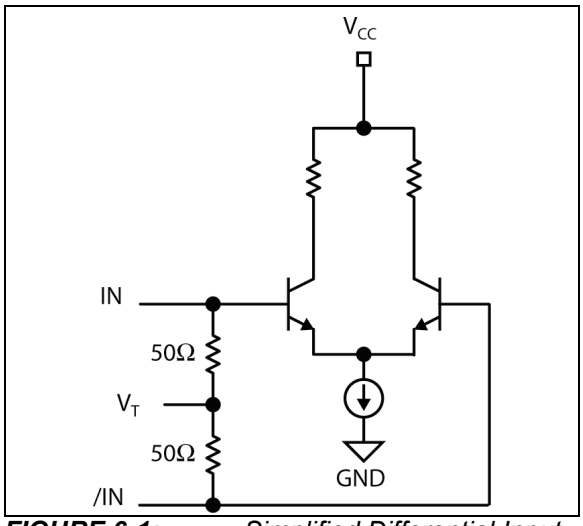

FIGURE 6-1: *Simplified Differential Input Buffer.*

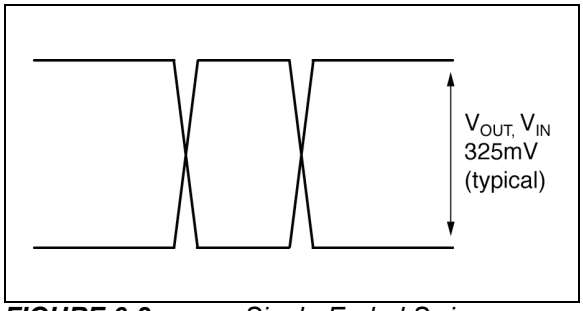

FIGURE 6-2: *Single-Ended Swing.*

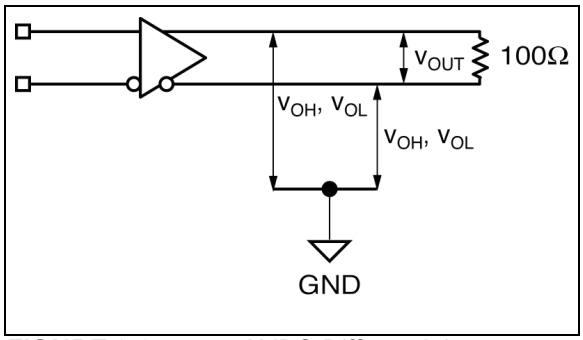

FIGURE 6-3: *LVDS Differential Measurement.*

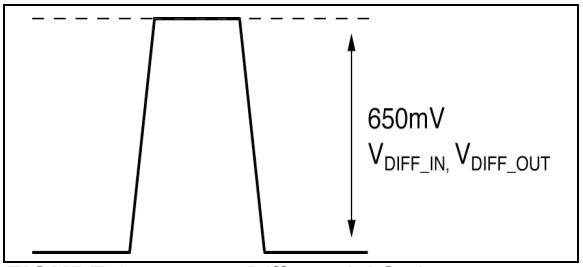

FIGURE 6-4: *Differential Swing.*

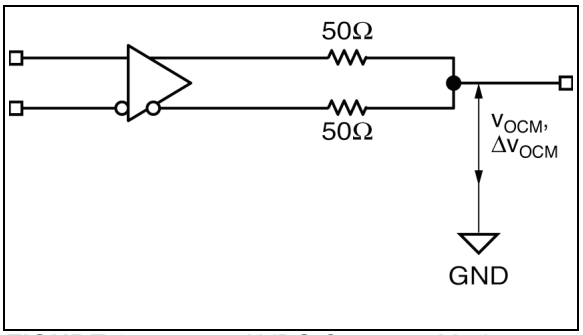

FIGURE 6-5: *LVDS Common Mode Measurement.*

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7.0 INPUT INTERFACE APPLICATIONS

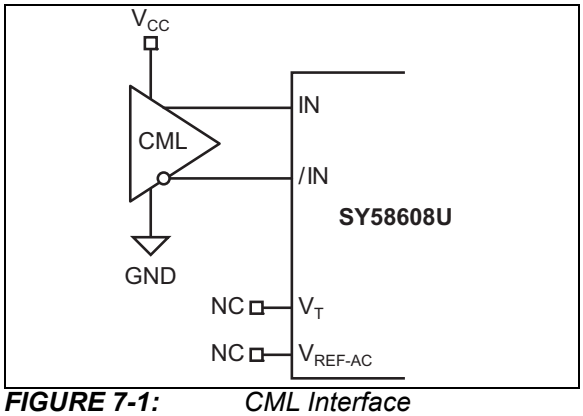

FIGURE 7-1: *CML Interface (DC-Coupled).*

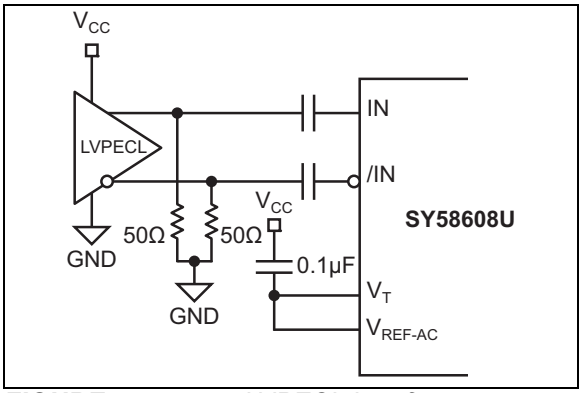

FIGURE 7-4: *LVPECL Interface (AC-Coupled).*

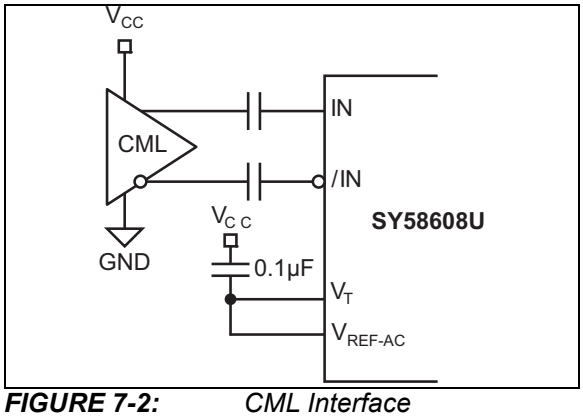

FIGURE 7-2: *CML Interface (AC-Coupled).*

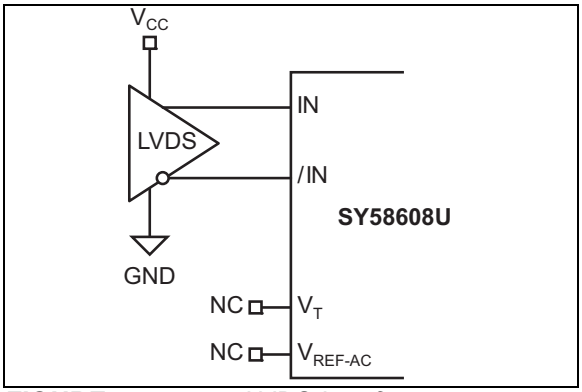

FIGURE 7-5: *LVDS Interface (DC-Coupled).*

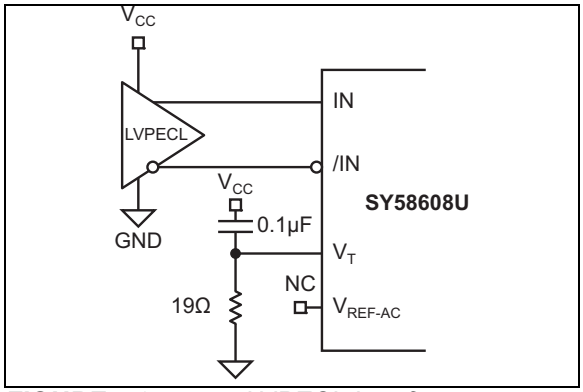

FIGURE 7-3: *LVPECL Interface (DC-Coupled).*

8.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 8-1.

TABLE 8-1: PIN FUNCTION TABLE

Pin Number	Symbol	Description
1, 4	IN, /IN	Differential Inputs: This input pair is the differential signal input to the device. Input accepts DC-coupled differential signals as small as 100 mV (200 mV_{PP}). Each pin of this pair internally terminates with 50Ω to the V_T pin. If the input swing falls below a certain threshold (typical 30 mV), the Fail Safe Input (FSI) feature will guarantee a stable output by latching the outputs to its last valid state. See "Input Interface Applications" section for more details.
2	V_T	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 Applications" section.
3	V_{REF-AC}	Reference Voltage: This output bias to V_{CC}–1.2V. It is used for AC-coupling inputs IN and /IN. Connect V_{REF-AC} directly to the V_T pin. Bypass with 0.01 µF low ESR capacitor to V_{CC}. Maximum sink/source current is ±1.5 mA. See "Input Interface Applications" section for more details.
5, 8,13, 16	V_{CC}	Positive Power Supply: Bypass with 0.1 µF//0.01 µF low ESR capacitors as close to the V_{CC} pins as possible.
6, 7, 14, 15	GND, Exposed pad	Ground. Exposed pad must be connected to a ground plane that is the same potential as the ground pins.
9, 10 11, 12	/Q1, Q1 /Q0, Q0	LVDS Differential Output Pairs: Differential buffered output copy of the input signal. The output swing is typically 325 mV. Normally terminated 100Ω across the output pairs (Q and /Q).

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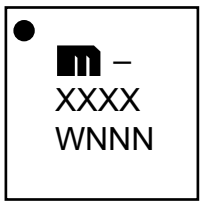
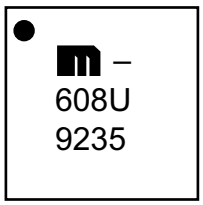
9.0 PACKAGING INFORMATION

9.1 Package Marking Information

16-Lead QFN*



Example



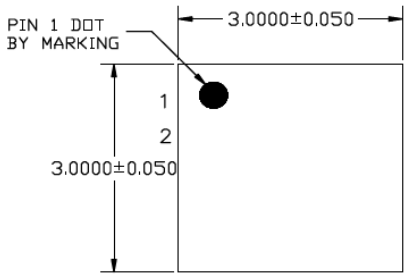
Legend:	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.
	●, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

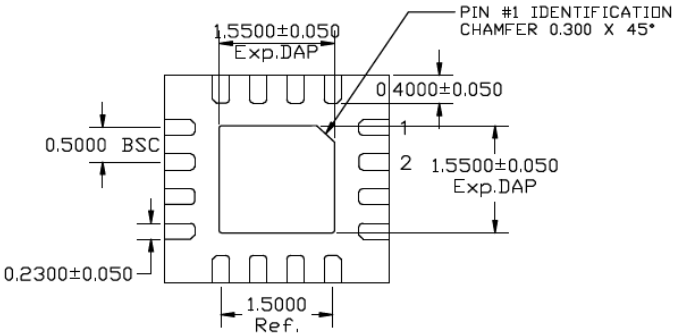
Underbar (_) and/or Overbar (¯) symbol may not be to scale.

TITLE
16 LEAD QFN 3x3mm PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

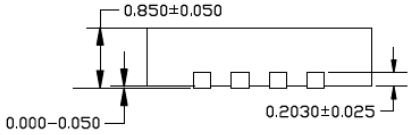
DRAWING #	QFN33-16LD-PL-1	UNIT	MM



TOP VIEW
NOTE: 1, 2, 3



BOTTOM VIEW
NOTE: 1, 2, 3



SIDE VIEW
NOTE: 1, 2, 3

NOTE:
1. MAX PACKAGE WARPAGE IS 0.05 MM
2. MAX ALLOWABLE BURR IS 0.076 MM IN ALL DIRECTIONS
3. PIN #1 IS ON TOP WILL BE LASER MARKED
4. RED CIRCLE IN LAND PATTERN INDICATE THERMAL VIA. SIZE SHOULD BE 0.30-0.35 MM IN DIAMETER AND SHOULD BE CONNECTED TO GND FOR MAX THERMAL PERFORMANCE
5. GREEN RECTANGLES (SHADED AREA) indicate SOLDER STENCIL OPENING ON EXPOSED PAD AREA. SIZE SHOULD BE 0.60x0.60 MM IN SIZE, 0.20 MM SPACING.

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

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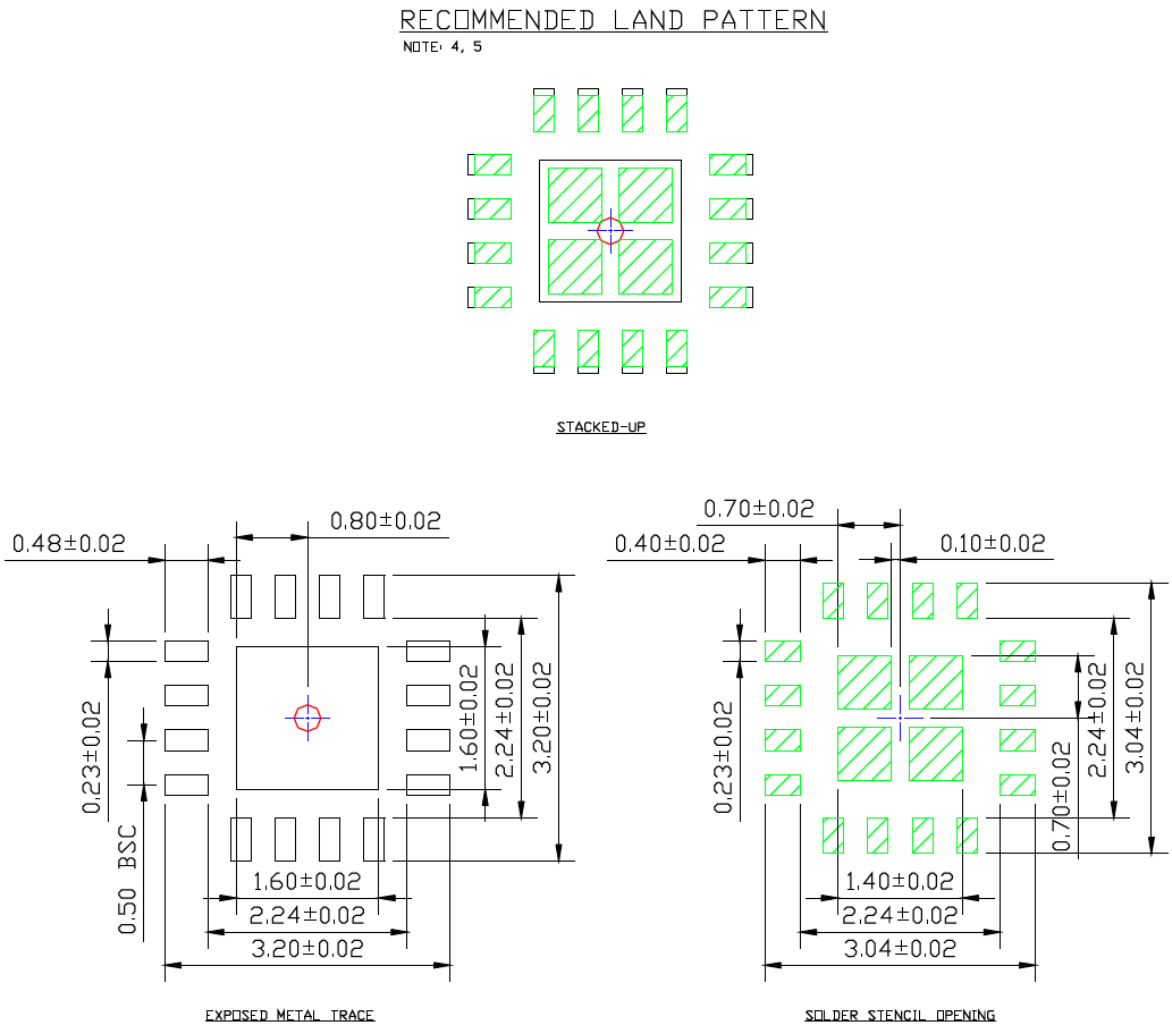
POD-Land Pattern drawing # QFN33-16LD-PL-1



Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

NOTES:

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APPENDIX A: REVISION HISTORY

Revision A (December 2018)

- Converted Micrel document SY58608U to Microchip data sheet template DS20005605A.
- Minor text changes throughout.
- Corrected parameters of Figure 4-12.
- Corrected parameters for Figure 5-1.

NOTES:

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PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

PART NO.	X	X	X	XX
Device	Output Voltage	Package	Temperature Range	Tape and Reel

Device:	SY58608:		3.2 Gbps Precision, 1:2 LVDS Fanout Buffer with Internal Termination and Fail Safe Input
Output Voltage:	U	=	2.5V
Package:	M	=	QFN-16
Temperature Range:	G	=	–40°C to 85°C (NiPdAu Lead-Free)
Special Processing:	<blank>=		100/Tube
	TR	=	1,000/Reel

Examples:

a) SY58608UMG: 3.2 Gbps Precision, 1:2 LVDS Fanout Buffer with Internal Termination and Fail Safe Input, 2.5V or 3.3 V Output Voltage, QFN–16, –40°C to 85°C (NiPdAu Lead–Free), 100/Tube

b) SY58608UMGTR: 3.2 Gbps Precision, 1:2 LVDS Fanout Buffer with Internal Termination and Fail Safe Input, 2.5V or 3.3 V Output Voltage, QFN–16, –40°C to 85°C (NiPdAu Lead–Free), 1,000/Reel

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

NOTES:

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ISBN: 978-1-5224-3967-7

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