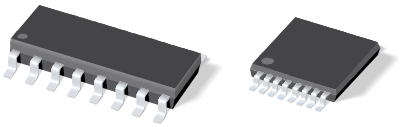


2x2 LVDS CROSSPOINT SWITCH

FEATURES

- **High Speed (>1000 Mbps) Upgrade for DS90CP22 2x2 LVDS Crosspoint Switch**
- **LVPECL Crosspoint Switch Available in SN65LVCP23**
- **Low-Jitter Fully Differential Data Path**
- **50 ps (Typ), of Peak-to-Peak Jitter With PRBS = 2^{23}–1 Pattern**
- **Less Than 200 mW (Typ), 300 mW (Max) Total Power Dissipation**
- **Output (Channel-to-Channel) Skew Is 10 ps (Typ), 50 ps (Max)**
- **Configurable as 2:1 Mux, 1:2 Demux, Repeater or 1:2 Signal Splitter**
- **Inputs Accept LVDS, LVPECL, and CML Signals**
- **Fast Switch Time of 1.7 ns (Typ)**
- **Fast Propagation Delay of 0.65 ns (Typ)**
- **16 Lead SOIC and TSSOP Packages**
- **Inter-Operates With TIA/EIA–644–A LVDS Standard**
- **Operating Temperature: –40°C to 85°C**

APPLICATIONS

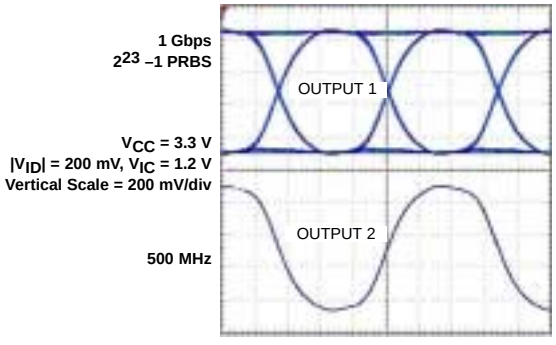
- **Base Stations**
- **Add/Drop Muxes**
- **Protection Switching for Serial Backplanes**
- **Network Switches/Routers**
- **Optical Networking Line Cards/Switches**
- **Clock Distribution**

DESCRIPTION

The SN65LVCP22 is a 2x2 crosspoint switch providing greater than 1000 Mbps operation for each path. The dual channels incorporate wide common-mode (0 V to 4 V) receivers, allowing for the receipt of LVDS, LVPECL, and CML signals. The dual outputs are LVDS drivers to provide low-power, low-EMI, high-speed operation. The SN65LVCP22 provides a single device supporting 2:2 buffering (repeating), 1:2 splitting, 2:1 multiplexing, 2x2 switching, and LVPECL/CML to LVDS level translation on each channel. The flexible operation of the SN65LVCP22 provides a single device to support the redundant serial bus transmission needs (working and protection switching cards) of fault–tolerant switch systems found in optical networking, wireless infrastructure, and data communications systems. TI offers additional gigibit repeater/translator and crosspoint products in the SN65LVDS100 and SN65LVDS122.

The SN65LVCP22 uses a fully differential data path to ensure low-noise generation, fast switching times, low pulse width distortion, and low jitter. Output channel-to-channel skew is less than 10 ps (typ) and 50 ps (max) to ensure accurate alignment of outputs in all applications. Both SOIC and TSSOP package options are available to allow easy upgrade for existing solutions, and board area savings where space is critical.

OUTPUTS OPERATING SIMULTANEOUSLY



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

ORDERING INFORMATION

PACKAGE DESIGNATOR	PART NUMBER(1)	SYMBOLIZATION
SOIC	SN65LVCP22D	LVCP22
TSSOP	SN65LVCP22PW	LVCP22

(1) Add the suffix R for taped and reeled carrier

PACKAGE DISSIPATION RATINGS

PACKAGE	CIRCUIT BOARD MODEL	$T_A \leq 25°C$ POWER RATING	DERATING FACTOR(1) ABOVE $T_A = 25°C$	$T_A = 85°C$ POWER RATING
SOIC (D)	High-K(2)	1361 mW	13.9 mW/°C	544 mW
TSSOP (PW)	High-K(2)	1074 mW	10.7 mW/°C	430 mW

(1) This is the inverse of the junction-to-ambient thermal resistance when board-mounted and with no air flow.
(2) In accordance with the High-K thermal metric definitions of EIA/JESD51-7.

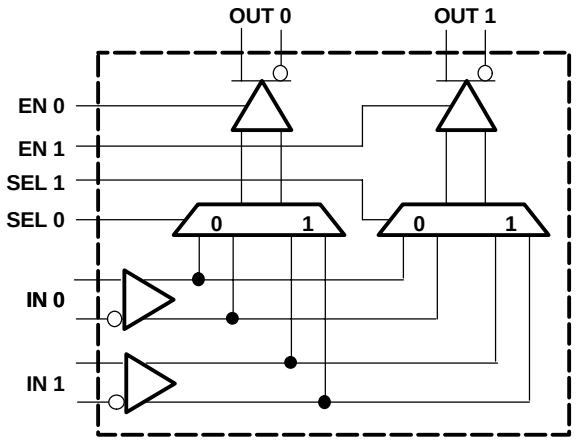
THERMAL CHARACTERISTICS

PARAMETER			TEST CONDITIONS	VALUE	UNITS
θ_{JB}	Junction-to-board thermal resistance	D		11.2	°C/W
		PW		18.4	°C/W
θ_{JC}	Junction-to-case thermal resistance	D		23.7	°C/W
		PW		16.0	°C/W
P_D	Device power dissipation	Typical	V_{CC} = 3.3–V, T_A =25°C, 1 Gbps	198	mW
		Maximum	V_{CC} = 3.6–V, T_A = 85°C, 1 Gbps	313	mW

FUNCTION TABLE

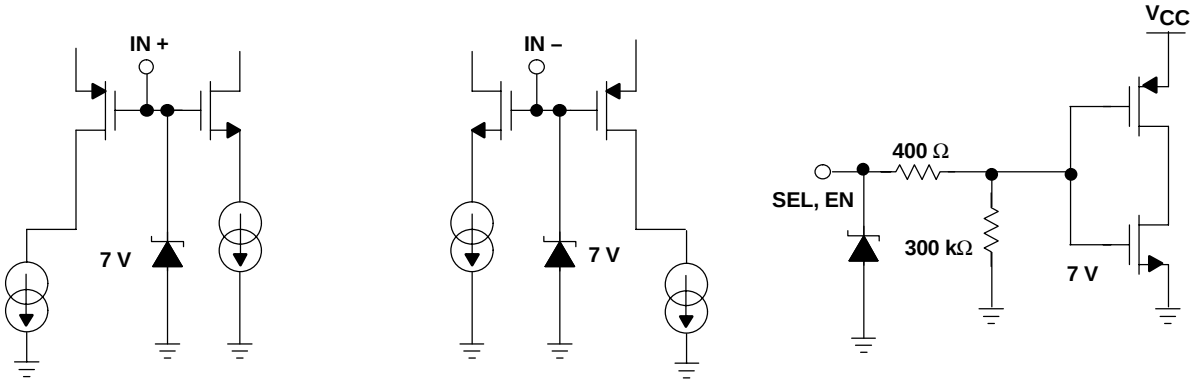
SEL0	SEL1	OUT0	OUT1	FUNCTION
0	0	IN0	IN0	1:2 Splitter
0	1	IN0	IN1	Repeater
1	0	IN1	IN0	Switch
1	1	IN1	IN1	1:2 Splitter

FUNCTIONAL BLOCK DIAGRAM

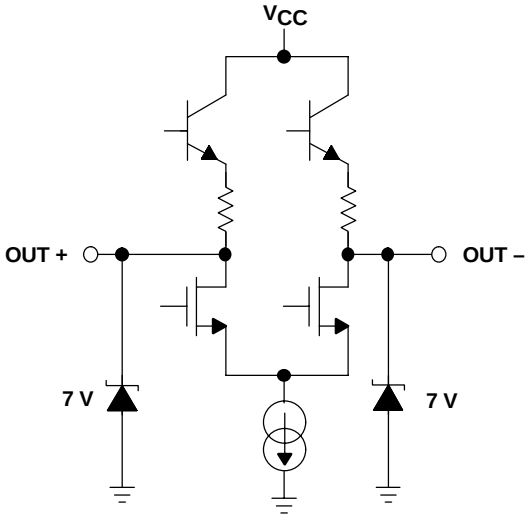


EQUIVALENT INPUT AND OUTPUT SCHEMATIC DIAGRAMS

INPUTS



OUTPUTS



ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range unless otherwise noted(1)

			UNITS
Supply voltage(2) range, V_{CC}			–0.5 V to 4 V
CMOS/TTL input voltage (ENO, EN1, SEL0, SEL1)			–0.5 V to 4 V
LVDS receiver input voltage (IN+, IN–)			–0.7 V to 4.3 V
LVDS driver output voltage (OUT+, OUT–)			–0.5 V to 4 V
LVDS output short circuit current			Continuous
Storage temperature range			–65°C to 125°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds			235°C
Continuous power dissipation			See Dissipation Rating Table
Electrostatic discharge	Human body model(3)	All pins	±5 kV
	Charged-device mode(4)	All pins	±500 V

(1) Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltage values, except differential I/O bus voltages, are with respect to network ground terminals.
(3) Tested in accordance with JEDEC Standard 22, Test Method A114-A.
(4) Tested in accordance with JEDEC Standard 22, Test Method C101.

RECOMMENDED OPERATING CONDITIONS

	MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}	3	3.3	3.6	V
Receiver input voltage	0		4	V
Junction temperature			125	°C
Operating free-air temperature, T_A(1)	–40		85	°C
Magnitude of differential input voltage $\|V_{ID}\|$	0.1		3	V

(1) Maximum free-air temperature operation is allowed as long as the device maximum junction temperature is not exceeded.

INPUT ELECTRICAL CHARACTERISTICS

over recommended operatingconditions unless otherwise noted

PARAMETER		TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
CMOS/TTL DC SPECIFICATIONS (EN0, EN1, SEL0, SEL1)						
V_{IH}	High-level input voltage		2		V_{CC}	V
V_{IL}	Low-level input voltage		GND		0.8	V
I_{IH}	High-level input current	V_{IN} = 3.6 V or 2.0 V, Vcc= 3.6 V		±3	±20	µA
I_{IL}	Low-level input current	V_{IN} = 0.0 V or 0.8 V, Vcc= 3.6 V		±1	±10	µA
V_{CL}	Input clamp voltage	I_{CL} = –18 mA		–0.8	–1.5	V
LVDS OUTPUT SPECIFICATIONS (OUT0, OUT1)						
$\|V_{OD}\|$	Differential output voltage	R_L =75 Ω, See Figure 2	270	365	475	mV
		R_L =75 Ω, V_{CC} = 3.3V, T_A = 25°C, See Figure 2	285	365	440	
$\Delta\|V_{OD}\|$	Change in differential output voltage magnitude between logic states	V_{ID}= ±100 mV, See Figure 2	–25		25	mV
V_{OS}	Steady-state offset voltage	Figure 3	1	1.2	1.45	V
ΔV_{OS}	Change in steady-state offset voltage between logic states	Figure 3	–25		25	mV
$V_{OC(PP)}$	Peak-to-peak common-mode output voltage	Figure 3		50	150	mV
I_{OZ}	High-impedance output current	V_{OUT} = GND or V_{CC}			±10	µA
I_{OFF}	Power-off leakage current	V_{CC} = 0 V, 1.5 V; V_{OUT} = 3.6 V or GND			±10	µA
I_{OS}	Output short-circuit current	V_{OUT+} or $V_{OUT–}$ = 0 V			–24	mA
I_{OSB}	Both outputs short-circuit current	V_{OUT+} and $V_{OUT–}$ = 0 V	–12		12	mA
C_O	Differential output capacitance	V_I = 0.4 sin(4E6πt) + 0.5 V		3		pF
LVDS RECEIVER DC SPECIFICATIONS (IN0, IN1)						
V_{TH}	Positive-going differential input voltage threshold	See Figure 1 and Table 1			100	mV
V_{TL}	Negative-going differential input voltage threshold	See Figure 1 and Table 1	–100			mV
$V_{ID(HYS)}$	Differential input voltage hysteresis			25		mV
V_{CMR}	Common-mode voltage range	V_{ID} = 100 mV, V_{CC} = 3.0 V to 3.6 V	0.05		3.95	V
I_{IN}	Input current	V_{IN} = 4 V, V_{CC} = 3.6 V or 0.0		±1	±10	µA
		V_{IN} = 0V, V_{CC} = 3.6V or 0.0		±1	±10	
C_{IN}	Differential input capacitance	V_I = 0.4 sin (4E6πt) + 0.5 V		3		pF
SUPPLY CURRENT						
I_{CCD}	Total supply current	R_L= 75 Ω, C_L = 5 pF, 500 MHz (1000 Mbps), EN0=EN1=High		60	87	mA
I_{CCZ}	3-state supply current	EN0 = EN1 = Low		25	35	mA

(1) All typical values are at 25°C and with a 3.3-V supply.

SWITCHING CHARACTERISTICS

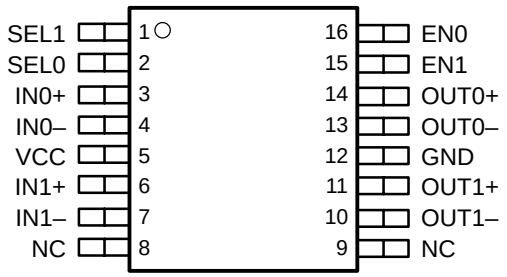
over recommended operatingconditions unless otherwise noted

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{SET}	Input to SEL setup time	Figure 6	1	0.5		ns
t_{HOLD}	Input to SEL hold time	Figure 6	1.1	0.5		ns
t_{SWITCH}	SEL to switched output	Figure 6		1.7	2.5	ns
t_{PHZ}	Disable time, high-level-to-high-impedance	Figure 5		2	4	ns
t_{PLZ}	Disable time, low-level-to-high-impedance	Figure 5		2	4	ns
t_{PZH}	Enable time, high-impedance -to-high-level output	Figure 5		2	4	ns
t_{PZL}	Enable time, high-impedance-to-low-level output	Figure 5		2	4	ns
t_{LHT}	Differential output signal rise time (20%–80%)(1)	C_L = 5 pF, Figure 4	150	280	450	ps
t_{HLT}	Differential output signal fall time (20%–80%)(1)	C_L = 5 pF, Figure 4	150	280	450	ps
t_{JIT}	Added peak–to-peak jitter	V_{ID} = 200 mV, 50% duty cycle, V_{CM} = 1.2 V, 500 MHz, C_L = 5 pF		20	40	ps
		V_{ID} = 200 mV, PRBS = 2^{23}–1 data pattern, V_{CM} = 1.2 V at 1000 Mbps, C_L = 5 pF		50	105	ps
t_{Jrms}	Added random jitter (rms)	V_{ID} = 200 mV, 50% duty cycle, V_{CM} = 1.2 V at 500 MHz, C_L = 5 pF		1.1	1.8	ps_{RMS}
t_{PLHD}	Propagation delay time, low-to-high-level output(1)		400	650	1000	ps
t_{PHLD}	Propagation delay time, high-to-low-level output(1)		400	650	1000	ps
t_{skew}	Pulse skew ($\lvert t_{PLHD} - t_{PHLD} \rvert$)(2)	C_L = 5 pF, Figure 4		20	100	ps
t_{CCS}	Output channel-to-channel skew, splitter mode	C_L = 5 pF, Figure 4		10	50	ps
f_{MAX}	Maximum operating frequency(3)		1			GHz

(1) Input: V_{IC} = 1.2 V, V_{ID} = 200 mV, 50% duty cycle, 1 MHz, t_r/t_f = 500 ps
(2) t_{skew} is the magnitude of the time difference between the t_{PLHD} and t_{PHLD} of any output of a single device.
(3) Signal generator conditions: 50% duty cycle, t_r or $t_f \leq$ 100 ps (10% to 90%), transmitter output criteria: duty cycle = 45% to 55% $V_{OD} \geq$ 300 mV.

PIN ASSIGNMENTS

D or PW PACKAGE
(TOP VIEW)



NC – No internal connection

PARAMETER MEASUREMENT INFORMATION

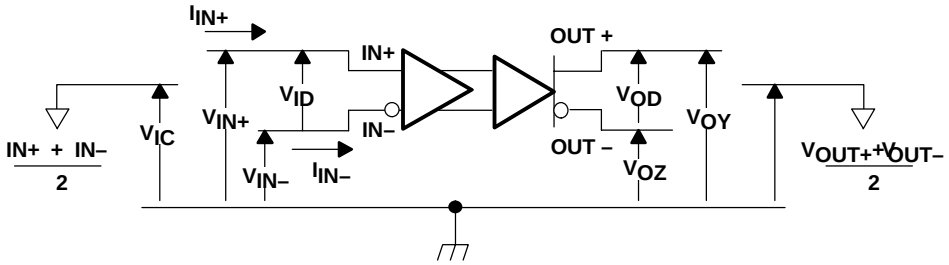


Figure 1. Voltage and Current Definitions

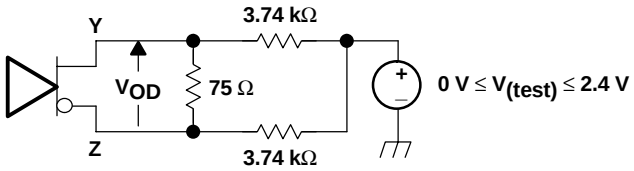
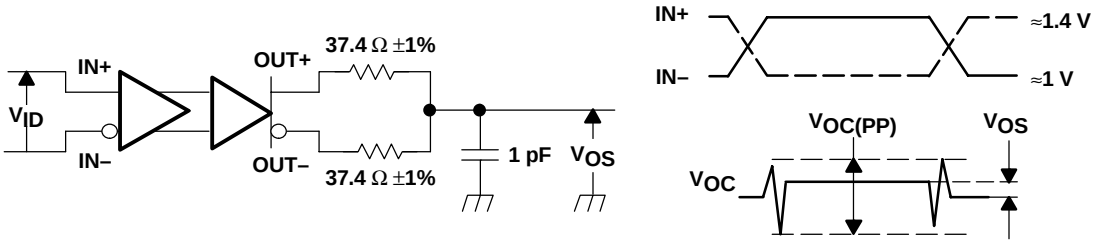
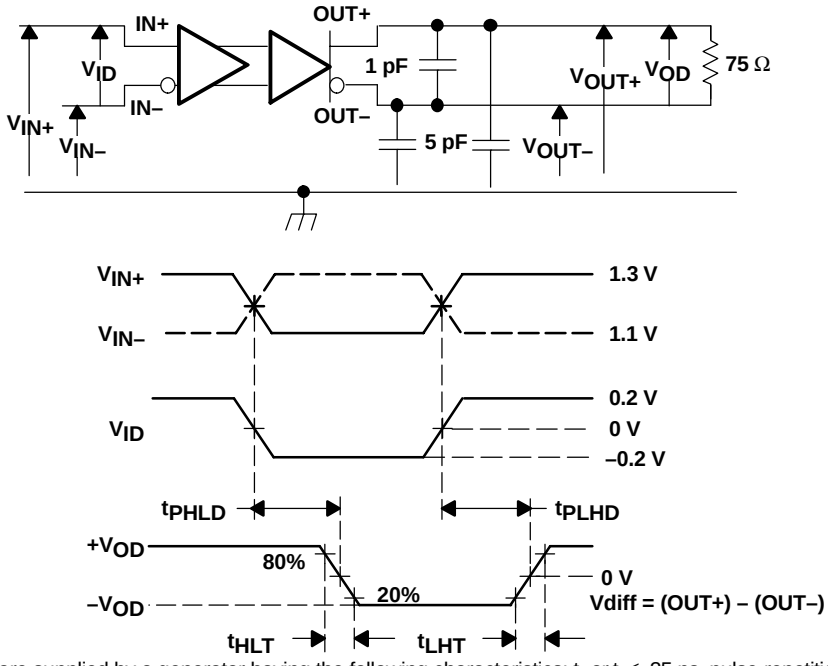


Figure 2. Differential Output Voltage (V_{OD}) Test Circuit



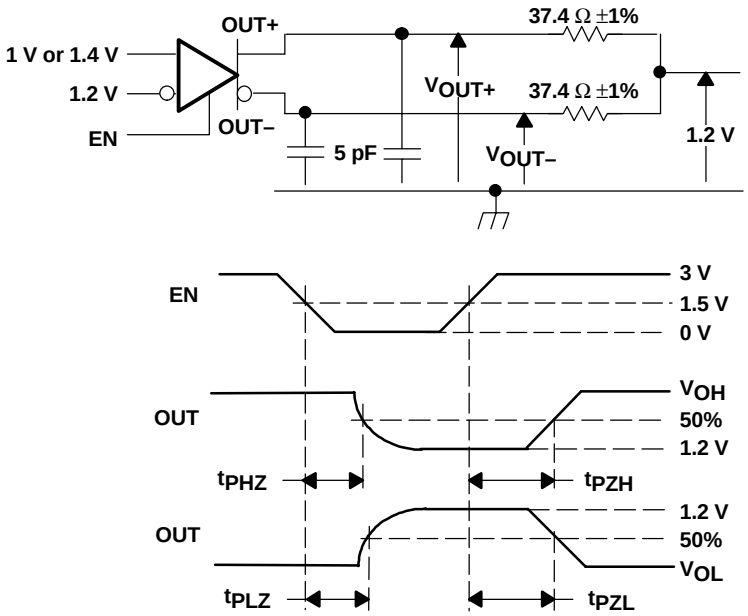
NOTE: All input pulses are supplied by a generator having the following characteristics: t_r or $t_f \leq 1$ ns, pulse-repetition rate (PRR) = 0.5 Mpps, pulse width = 500 ±10 ns; R_L = 100 Ω; C_L includes instrumentation and fixture capacitance within 0,06 mm of the D.U.T.; the measurement of $V_{OC(PP)}$ is made on test equipment with a –3 dB bandwidth of at least 300 MHz.

Figure 3. Test Circuit and Definitions for the Driver Common-Mode Output Voltage



NOTE: All input pulses are supplied by a generator having the following characteristics: t_r or $t_f \leq .25$ ns, pulse-repetition rate (PRR) = 0.5 Mpps, pulse width = 500 ± 10 ns . C_L includes instrumentation and fixture capacitance within 0,06 mm of the D.U.T.

Figure 4. Timing Test Circuit and Waveforms



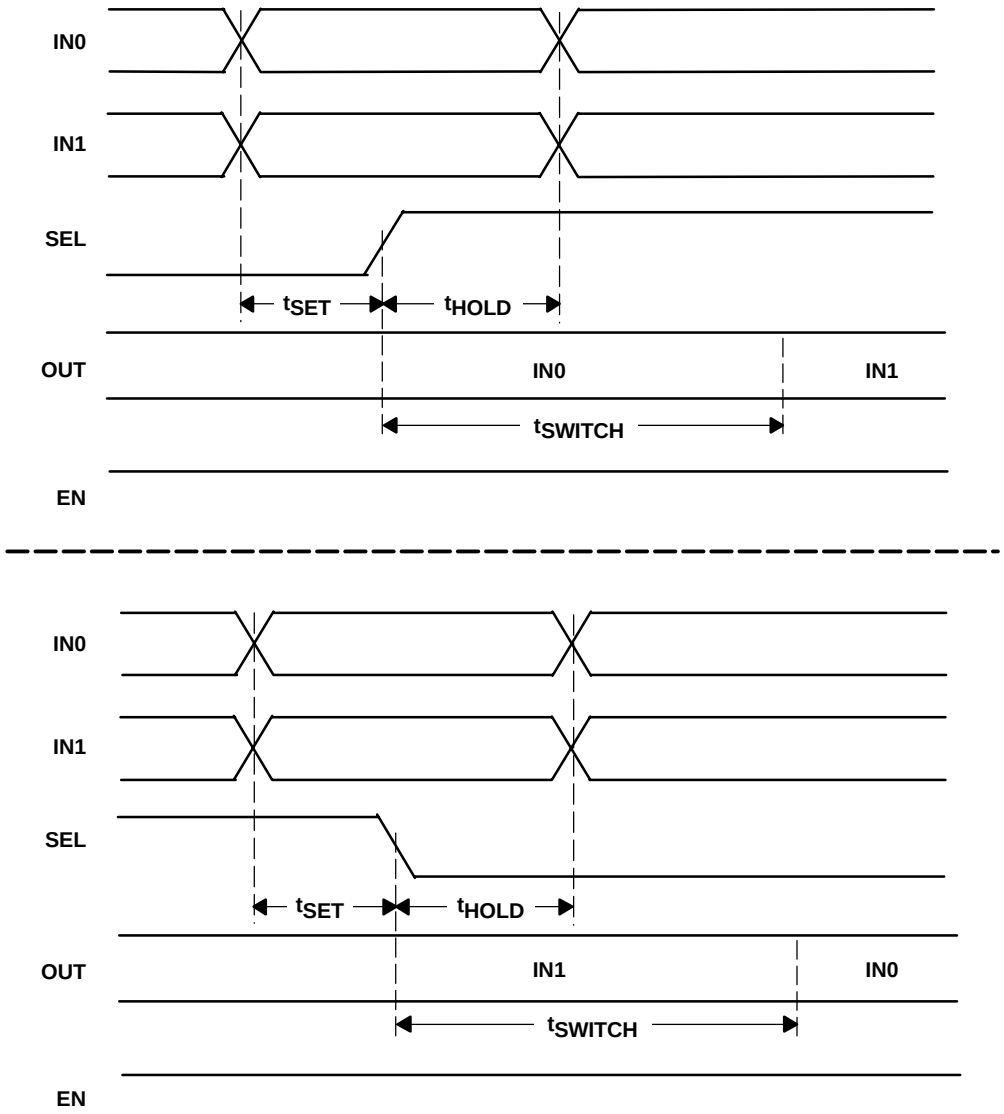
NOTE: All input pulses are supplied by a generator having the following characteristics: t_r or $t_f \leq 1$ ns, pulse-repetition rate (PRR) = 0.5 Mpps, pulse width = 500 ± 10 ns . C_L includes instrumentation and fixture capacitance within 0,06 mm of the D.U.T.

Figure 5. Enable and Disable Time Circuit and Definitions

Table 1. Receiver Input Voltage Threshold Test

APPLIED VOLTAGES		RESULTING DIFFERENTIAL INPUT VOLTAGE	RESULTING COMMON-MODE INPUT VOLTAGE	OUTPUT
V_{IA}	V_{IB}	V_{ID}	V_{IC}	
1.25 V	1.15 V	100 mV	1.2 V	H
1.15 V	1.25 V	–100 mV	1.2 V	L
4.0 V	3.9 V	100 mV	3.95 V	H
3.9 V	4. 0 V	–100 mV	3.95 V	L
0.1 V	0.0 V	100 mV	0.05 V	H
0.0 V	0.1 V	–100 mV	0.05 V	L
1.7 V	0.7 V	1000 mV	1.2 V	H
0.7 V	1.7 V	–1000 mV	1.2 V	L
4.0 V	3.0 V	1000 mV	3.5 V	H
3.0 V	4.0 V	–1000 mV	3.5 V	L
1.0 V	0.0 V	1000 mV	0.5 V	H
0.0 V	1.0 V	–1000 mV	0.5 V	L

H = high level, L = low level



NOTE: t_{SET} and t_{HOLD} times specify that data must be in a stable state before and after mux control switches.

Figure 6. Input to Select for Both Rising and Falling Edge Setup and Hold Times

TYPICAL CHARACTERISTICS

DIFFERENTIAL OUTPUT VOLTAGE vs RESISTIVE LOAD

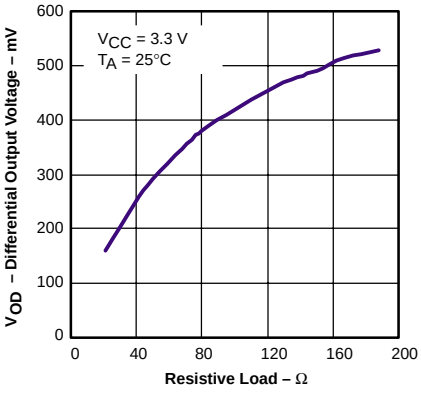


Figure 7

SUPPLY CURRENT vs FREQUENCY

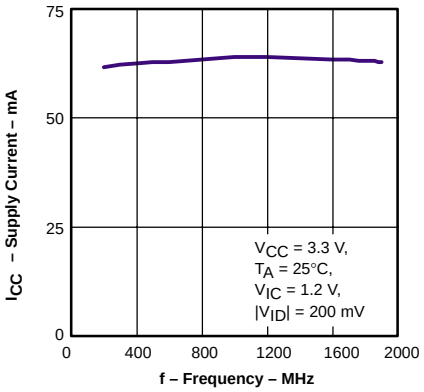


Figure 8

PROPAGATION DELAY TIME vs FREE-AIR TEMPERATURE

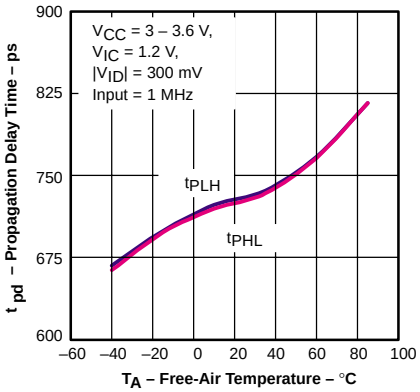


Figure 9

PEAK-TO-PEAK JITTER vs FREQUENCY

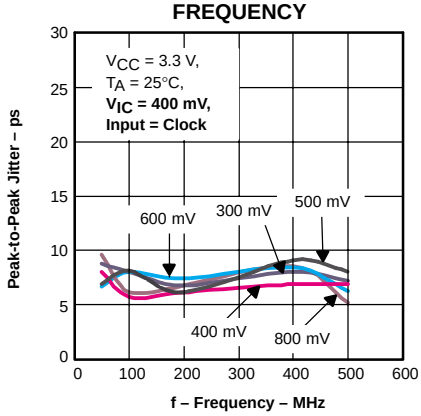


Figure 10

PEAK-TO-PEAK JITTER vs DATA RATE

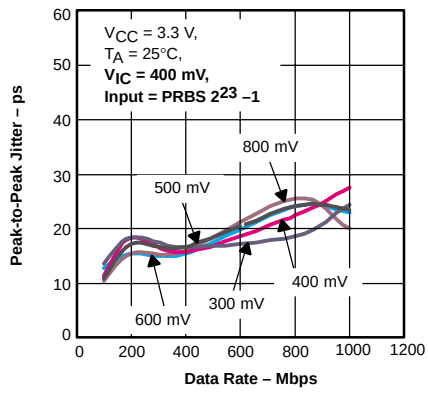


Figure 11

PEAK-TO-PEAK JITTER vs FREQUENCY

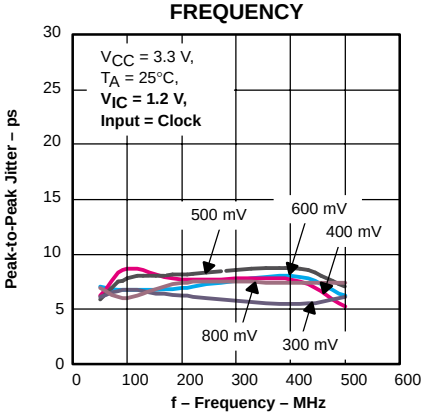


Figure 12

PEAK-TO-PEAK JITTER vs DATA RATE

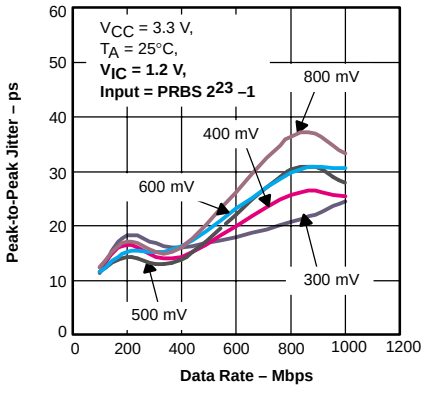


Figure 13

PEAK-TO-PEAK JITTER vs FREQUENCY

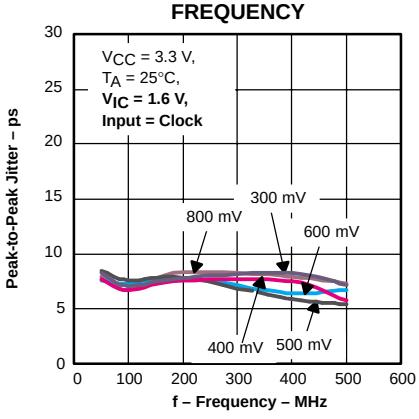


Figure 14

PEAK-TO-PEAK JITTER vs DATA RATE

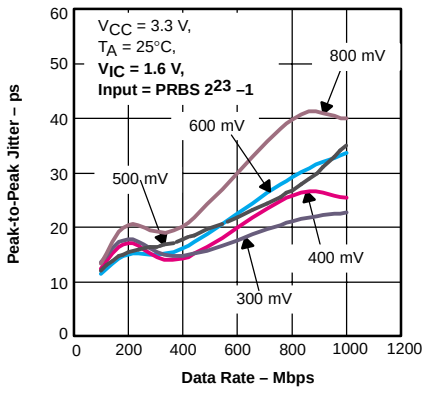


Figure 15

TYPICAL CHARACTERISTICS

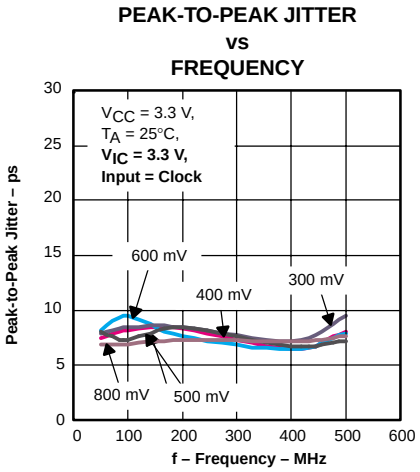


Figure 16

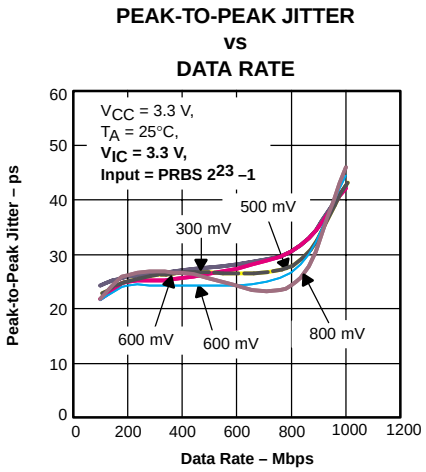


Figure 17

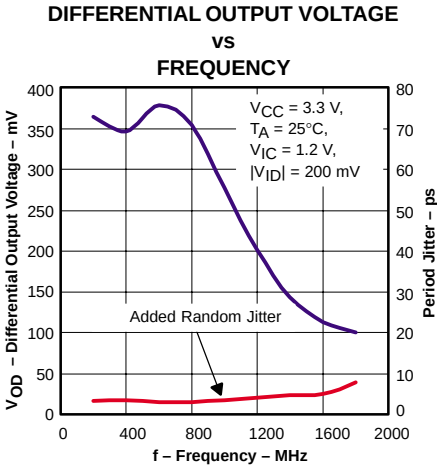


Figure 18

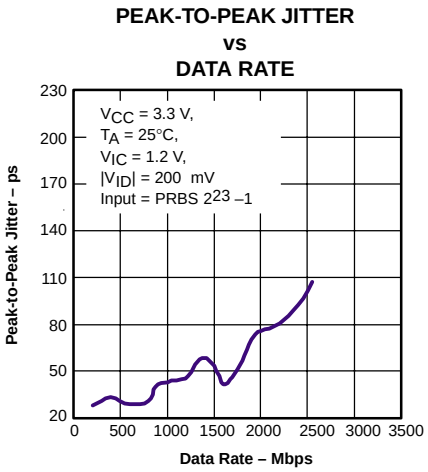


Figure 19

APPLICATION INFORMATION

TYPICAL APPLICATION CIRCUITS (ECL, PECL, LVDS, ETC.)

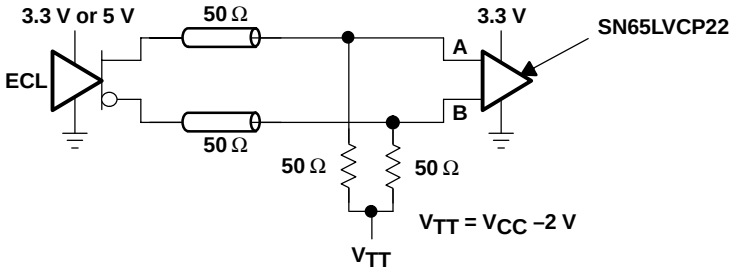


Figure 20. Low-Voltage Positive Emitter-Coupled Logic (LVPECL)

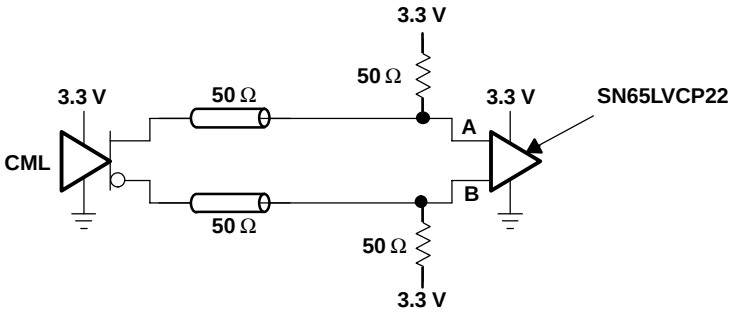


Figure 21. Current-Mode Logic (CML)

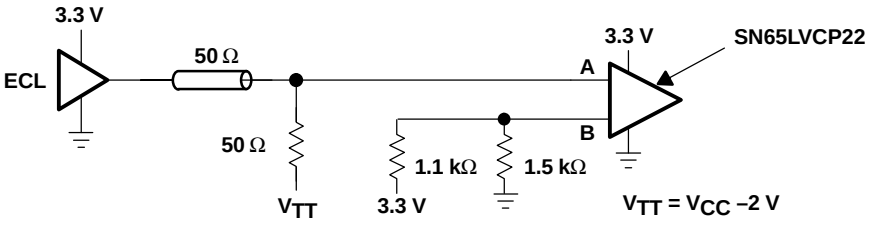


Figure 22. Single-Ended (LVPECL)

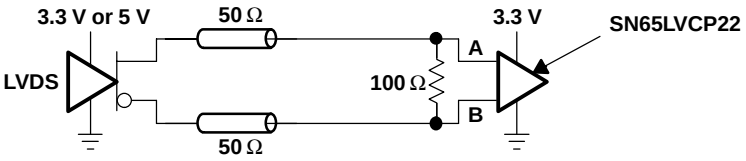


Figure 23. Low-Voltage Differential Signaling (LVDS)

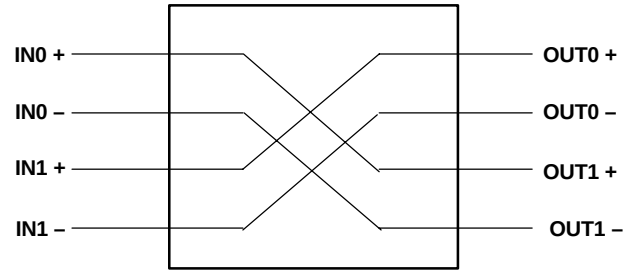


Figure 24. 2 x 2 Crosspoint

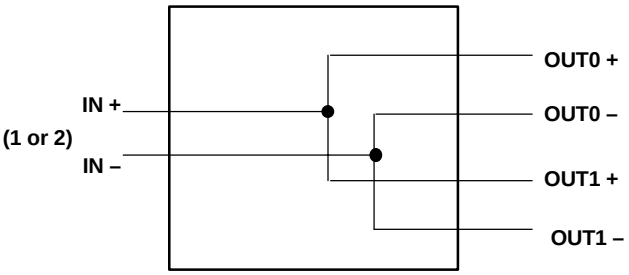


Figure 25. 1:2 Spitter

Figure 26. Dual Repeater

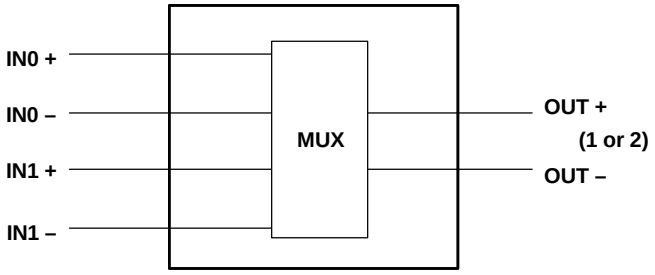


Figure 27. 2:1 MUX

PACKAGING INFORMATION

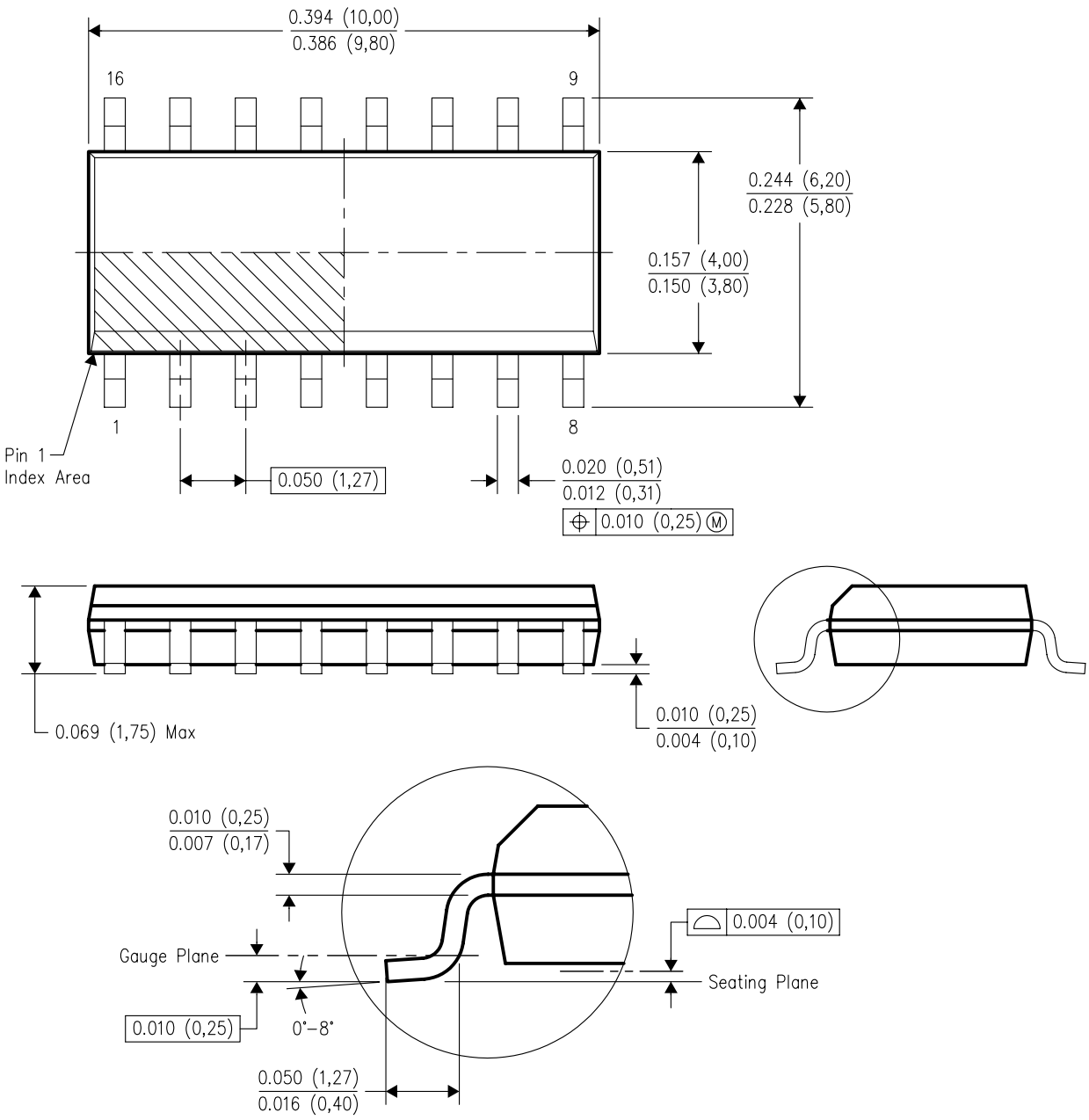
Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
SN65LVCP22D	ACTIVE	SOIC	D	16	40	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM
SN65LVCP22DR	ACTIVE	SOIC	D	16	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM
SN65LVCP22PW	ACTIVE	TSSOP	PW	16	90	None	CU NIPDAU	Level-1-220C-UNLIM
SN65LVCP22PWR	ACTIVE	TSSOP	PW	16	2000	None	CU NIPDAU	Level-1-220C-UNLIM

[1] The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

[2] Eco Plan - May not be currently available - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
None: Not yet available Lead (Pb-Free).
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Green (RoHS & no Sb/Br): TI defines "Green" to mean "Pb-Free" and in addition, uses package materials that do not contain halogens, including bromine (Br) or antimony (Sb) above 0.1% of total product weight.

[3] MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDECindustry standard classifications, and peak solder temperature.

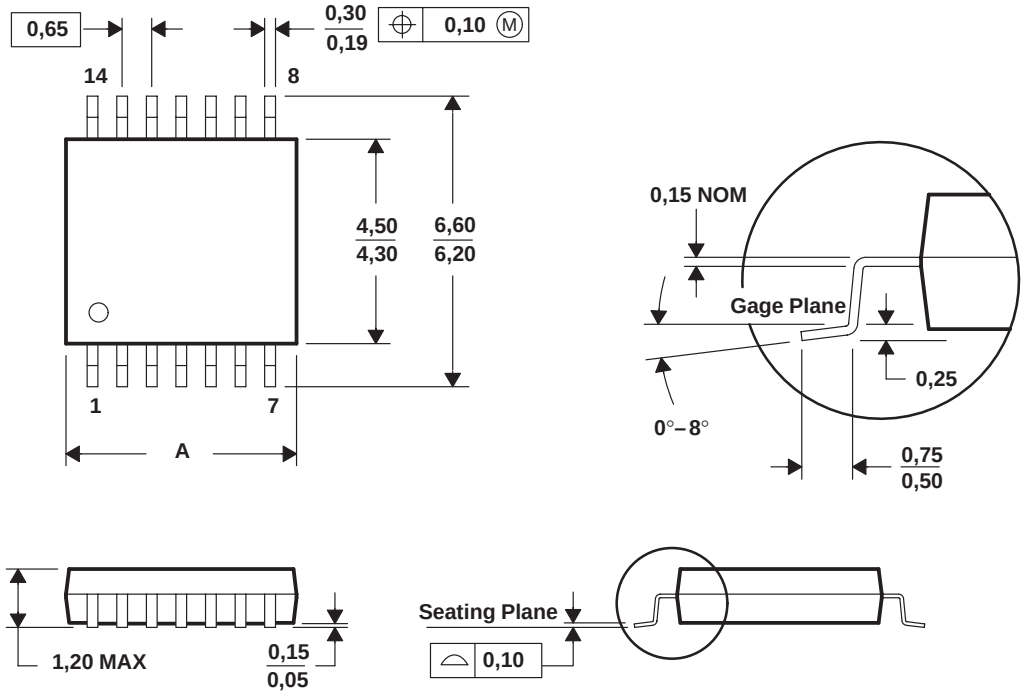
D (R–PDSO–G16) PLASTIC SMALL–OUTLINE PACKAGE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS–012 variation AC.

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN



DIM \ PINS **	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

4040064/F 01/97

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

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