HIGH-SPEED DIFFERENTIAL LINE DRIVER

Check for Samples: SN65LVDS31-EP

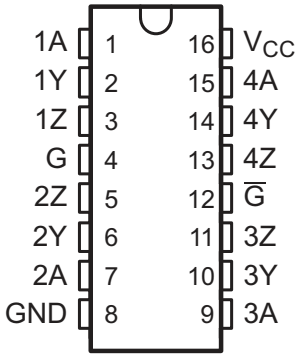
FEATURES

- Meet or Exceed the Requirements of ANSI TIA/EIA-644 Standard
- Low-Voltage Differential Signaling With Typical Output Voltage of 350 mV and 100-Ω Load
- Typical Output Voltage Rise and Fall Times of 500 ps (400 Mbps)
- Typical Propagation Delay Times of 1.7 ns
- Operate From a Single 3.3-V Supply
- Power Dissipation 25 mW Typical Per Driver at 200 MHz
- Driver at High Impedance When Disabled or With V_{CC} = 0
- Bus-Terminal ESD Protection Exceeds 8 kV
- Low-Voltage TTL (LVTTL) Logic Input Levels
- Pin Compatible With AM26LS31, MC3487, and μA9638
- Cold Sparing for Space and High Reliability Applications Requiring Redundancy

SUPPORTS DEFENSE, AEROSPACE, AND MEDICAL APPLICATIONS

- Controlled Baseline
- One Assembly/Test Site
- One Fabrication Site
- Available in Military (–55°C/125°C) Temperature Range
- Extended Product Life Cycle
- Extended Product-Change Notification
- Product Traceability

D PACKAGE
(TOP VIEW)



DESCRIPTION

The SN65LVDS31 is a differential line driver that implements the electrical characteristics of low-voltage differential signaling (LVDS). This signaling technique lowers the output voltage levels of 5-V differential standard levels (such as TIA/EIA-422B) to reduce the power, increase the switching speeds, and allow operation with a 3.3-V supply rail. This driver will deliver a minimum differential output voltage magnitude of 247 mV into a 100-Ω load when enabled.

The intended application of this device and signaling technique is both point-to-point and multidrop (one driver and multiple receivers) data transmission over controlled impedance media of approximately 100 Ω. The transmission media may be printed-circuit board traces, backplanes, or cables. The ultimate rate and distance of data transfer is dependent upon the attenuation characteristics of the media and the noise coupling to the environment.

The SN65LVDS31 is characterized for operation from –55°C to 125°C.

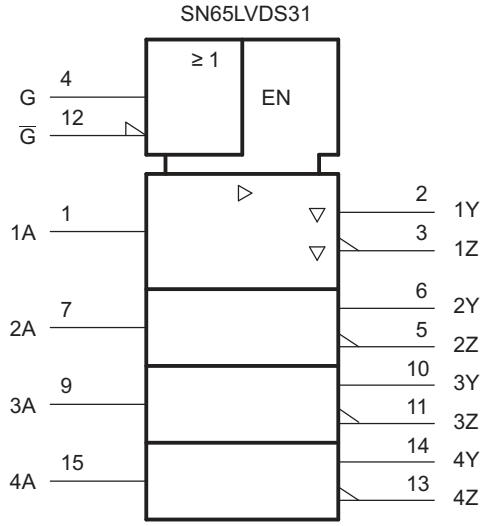
These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

ORDERING INFORMATION(1)

T_A	PACKAGE(2)	ORDERABLE PART NUMBER	TOP-SIDE MARKING	VID NUMBER
–55°C to 125°C	SOIC-D	SN65LVDS31MDREP	LVDS31EP	V62/07627-01XE

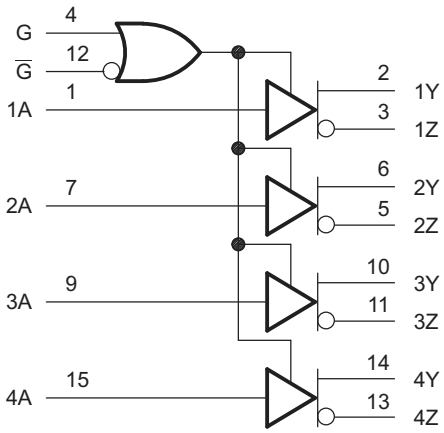
(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.
(2) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

Logic Symbol



This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

SN65LVDS31 Logic Diagram (Positive Logic)



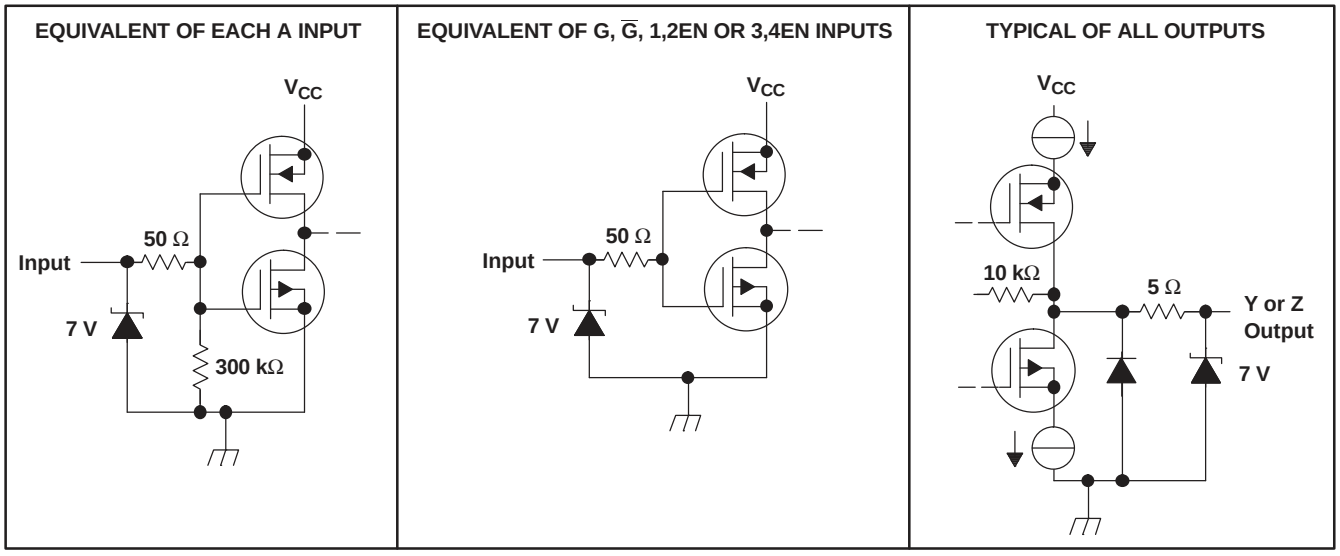
FUNCTION TABLE

Table 1. SN65LVDS31 (1)

INPUT A	ENABLES		OUTPUTS	
	G	G	Y	Z
H	H	X	H	L
L	H	X	L	H
H	X	L	H	L
L	X	L	L	H
X	L	H	Z	Z
Open	H	X	L	H
Open	X	L	L	H

(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off)

EQUIVALENT INPUT AND OUTPUT SCHEMATIC DIAGRAMS



ABSOLUTE MAXIMUM RATINGS(1)

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

		UNIT
V_{CC}	Supply voltage range(2)	–0.5 V to 4 V
V_I	Input voltage range	–0.5 V to V_{CC} + 0.5 V
	Continuous total power dissipation	See Dissipation Rating Table
	Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°C
θ_{JA}	Thermal resistance, junction-to-ambient	73°C/W
θ_{JC}	Thermal resistance, junction-to-case	36.9°C/W
T_{stg}	Storage temperature range	–65°C to 150°C

(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 voltages, except differential I/O bus voltages, are with respect to the network ground terminal.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR(1) ABOVE $T_A = 25°C$	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ POWER RATING	$T_A = 125°C$ POWER RATING
D (16)	950 mW	7.6 mW/°C	608 mW	494 mW	190 mW

(1) This is the inverse of the junction-to-ambient thermal resistance when board-mounted and with no air flow.

RECOMMENDED OPERATING CONDITIONS

		MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage	3	3.3	3.6	V
V_{IH}	High-level input voltage	2			V
V_{IL}	Low-level input voltage			0.8	V
T_A	Operating free-air temperature	–55		125	°C

ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS		MIN	TYP(1)	MAX	UNIT
V_{OD}	Differential output voltage magnitude	R_L = 100 Ω,	See Figure 2	247	340	454	mV
ΔV_{OD}	Change in differential output voltage magnitude between logic states	R_L = 100 Ω,	See Figure 2	–50		50	mV
$V_{OC(SS)}$	Steady-state common-mode output voltage	See Figure 3		1.125	1.2	1.375	V
$\Delta V_{OC(SS)}$	Change in steady-state common-mode output voltage between logic states	See Figure 3		–50		50	mV
$V_{OC(PP)}$	Peak-to-peak common-mode output voltage	See Figure 3			50		mV
I_{CC}	Supply current	V_I = 0.8 V or 2 V,	Enabled, No load		9	20	mA
		V_I = 0.8 or 2 V,	R_L = 100 Ω, Enabled		25	35	
		V_I = 0 or V_{CC},	Disabled		0.25	1	
I_{IH}	High-level input current	V_{IH} = 2			4	20	µA
I_{IL}	Low-level input current	V_{IL} = 0.8 V			0.1	10	µA
I_{OS}	Short-circuit output current	$V_{O(Y)}$ or $V_{O(Z)}$ = 0			–4	–24	mA
		V_{OD} = 0				±12	
I_{OZ}	High-impedance output current	V_O = 0 or 2.4 V				±1	µA
$I_{O(OFF)}$	Power-off output current	V_{CC} = 0,	V_O = 2.4 V			±4	µA
C_i	Input capacitance				3		pF

(1) All typical values are at T_A = 25°C and with V_{CC} = 3.3 V.

SWITCHING CHARACTERISTICS

over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
t_{PLH}	Propagation delay time, low-to-high-level output	R_L = 100 Ω, C_L = 10 pF, See Figure 2	0.5	1.4	4	ns
t_{PHL}	Propagation delay time, high-to-low-level output		1	1.7	4.5	ns
t_r	Differential output signal rise time (20% to 80%)			0.5		ns
t_f	Differential output signal fall time (80% to 20%)			0.5		ns
$t_{sk(p)}$	Pulse skew ($\|t_{PHL} - t_{PLH}\|$)			0.3	0.6	ns
$t_{sk(o)}$	Channel-to-channel output skew(2)			0.3	0.8	ns
t_{PZH}	Propagation delay time, high-impedance-to-high-level output	See Figure 4		5.4	17	ns
t_{PZL}	Propagation delay time, high-impedance-to-low-level output			2.5	17	ns
t_{PHZ}	Propagation delay time, high-level-to-high-impedance output			8.1	18	ns
t_{PLZ}	Propagation delay time, low-level-to-high-impedance output			7.3	17	ns

(1) All typical values are at T_A = 25°C and with V_{CC} = 3.3 V.
(2) $t_{sk(o)}$ is the maximum delay time difference between drivers on the same device.

PARAMETER MEASUREMENT INFORMATION

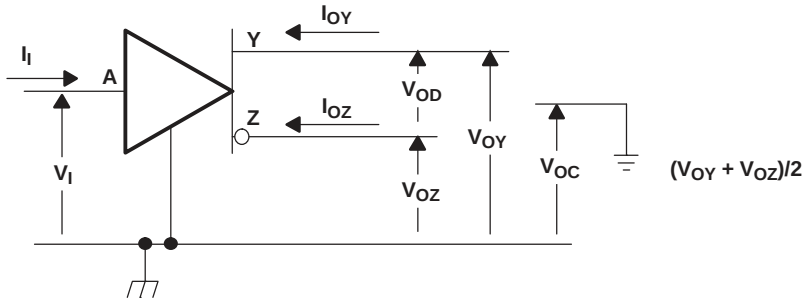
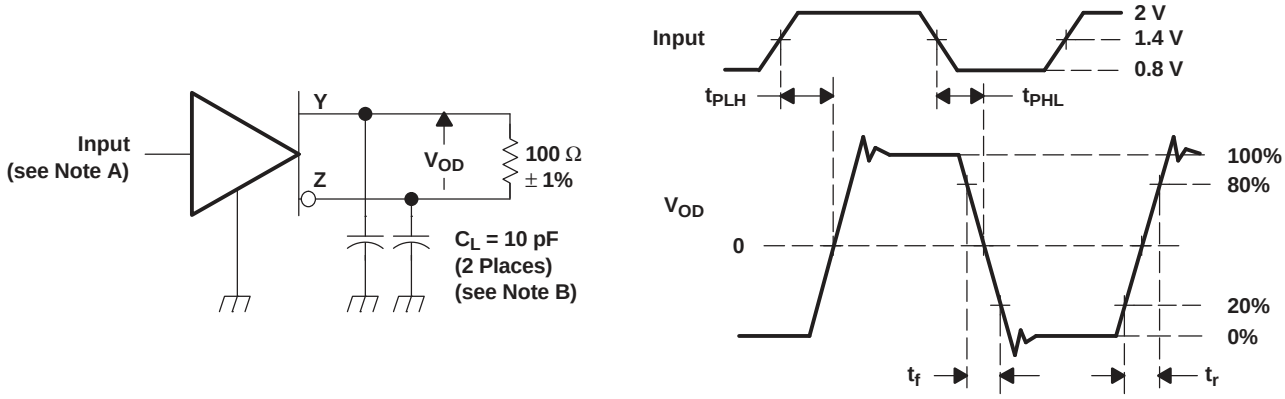


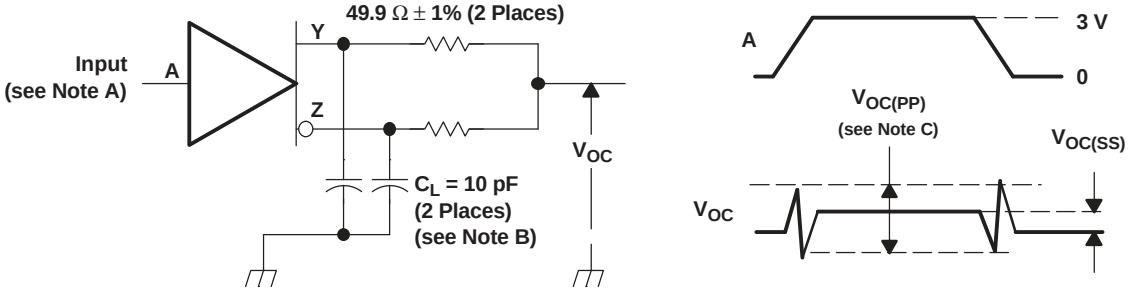
Figure 1. Voltage and Current Definitions



NOTES: A. All input pulses are supplied by a generator having the following characteristics: t_r or $t_f \leq$ 1 ns, pulse repetition rate (PRR) = 50 Mpps, pulse width = 10 ± 0.2 ns.
B. C_L includes instrumentation and fixture capacitance within 6 mm of the D.U.T.

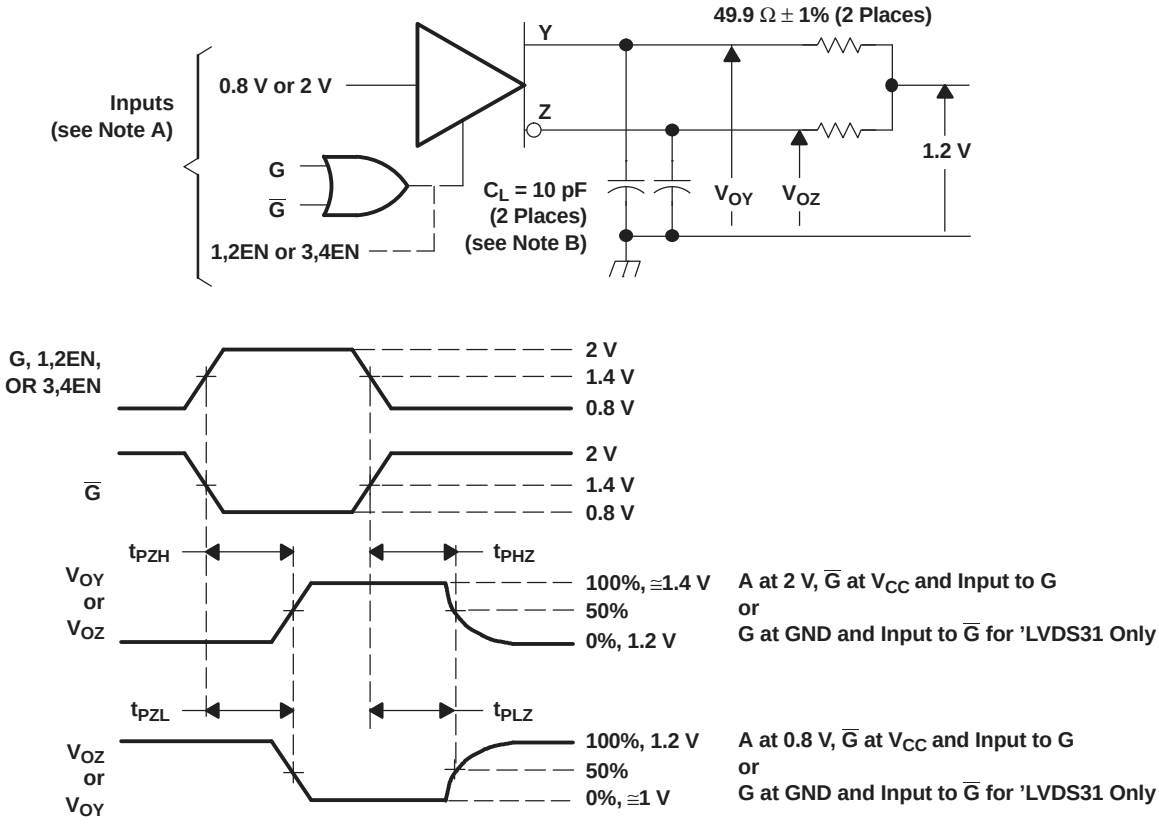
Figure 2. Test Circuit, Timing, and Voltage Definitions for the Differential Output Signal

PARAMETER MEASUREMENT INFORMATION (continued)



NOTES: A. All input pulses are supplied by a generator having the following characteristics: t_r or $t_f \leq 1$ ns, pulse repetition rate (PRR) = 50 Mpps, pulse width = 10 ± 0.2 ns.
B. C_L includes instrumentation and fixture capacitance within 6 mm of the D.U.T.
C. 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



NOTES: A. All input pulses are supplied by a generator having the following characteristics: t_r or $t_f < 1$ ns, pulse repetition rate (PRR) = 0.5 Mpps, pulse width = 500 ± 10 ns.
B. C_L includes instrumentation and fixture capacitance within 6 mm of the D.U.T.

Figure 4. Enable-/Disable-Time Circuit and Definitions

TYPICAL CHARACTERISTICS

SUPPLY CURRENT
vs
FREQUENCY

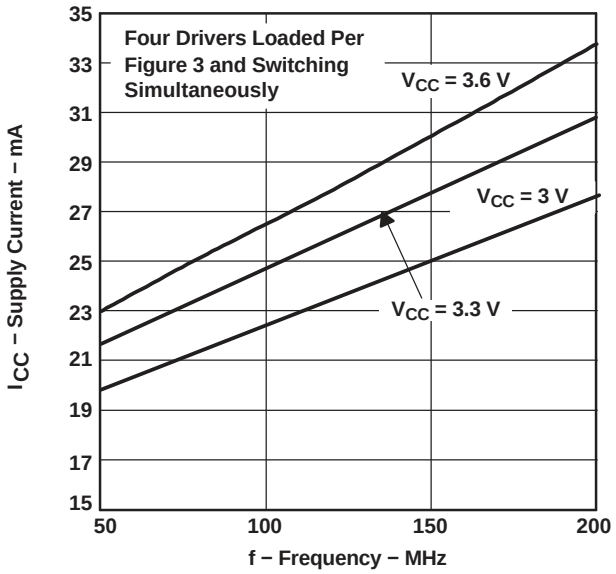


Figure 5.

LOW-TO-HIGH PROPAGATION DELAY TIME
vs
FREE-AIR TEMPERATURE

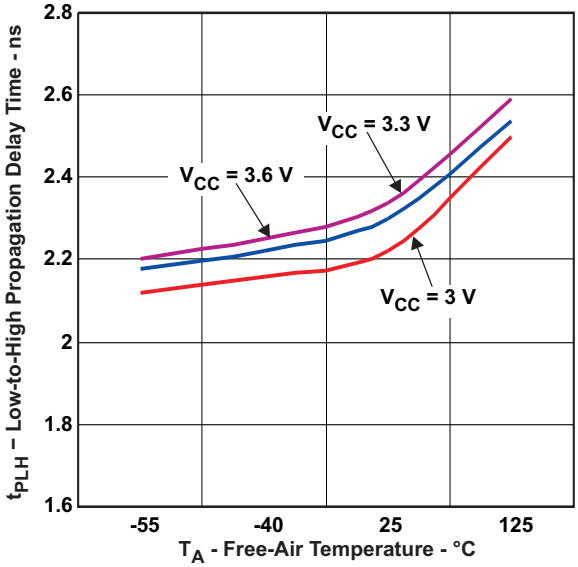


Figure 6.

HIGH-TO-LOW PROPAGATION DELAY TIME
vs
FREE-AIR TEMPERATURE

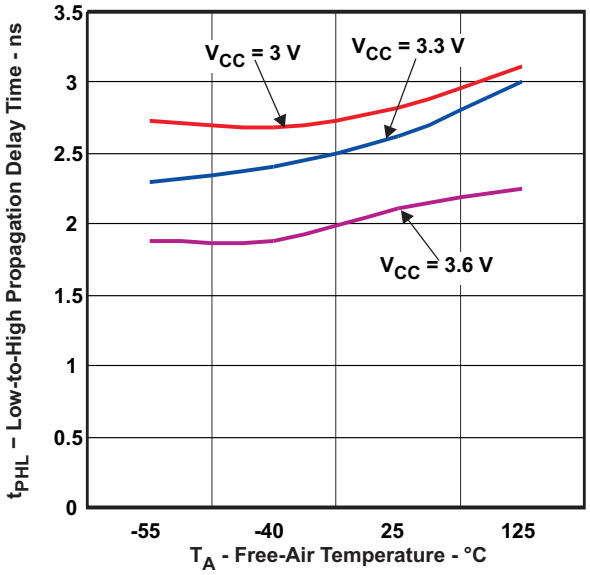
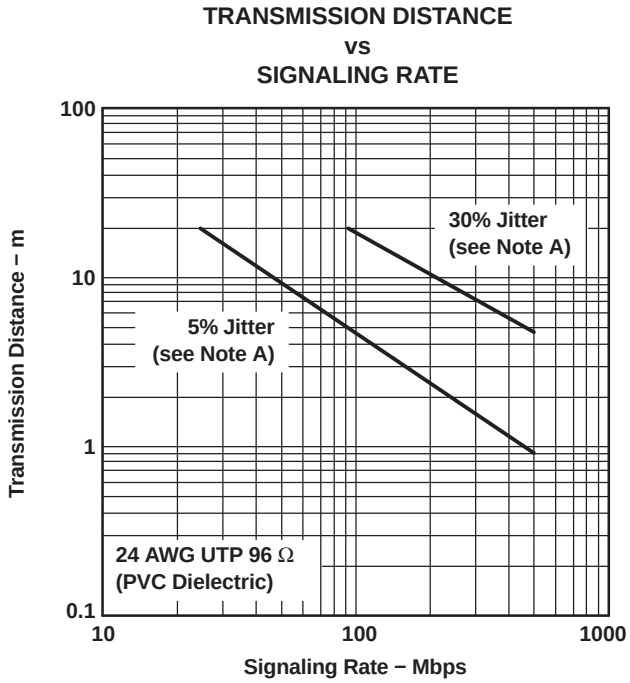


Figure 7.

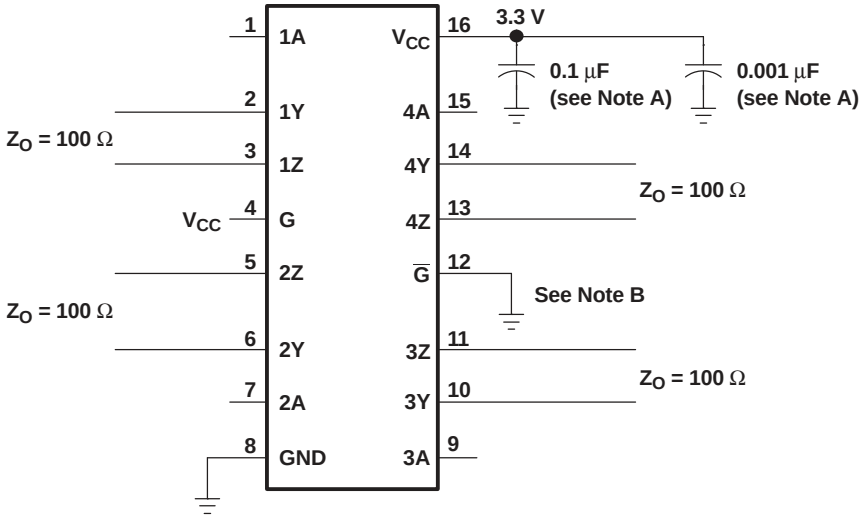
APPLICATION INFORMATION

The SN65LVDS31 is generally used as a building block for high-speed point-to-point data transmission where ground differences are less than 1 V. The SN65LVDS31 can interoperate with RS-422, PECL, and IEEE-P1596. Drivers/receivers approach ECL speeds without the power and dual supply requirements.



A. This parameter is the percentage of distortion of the unit interval (UI) with a pseudorandom data pattern.

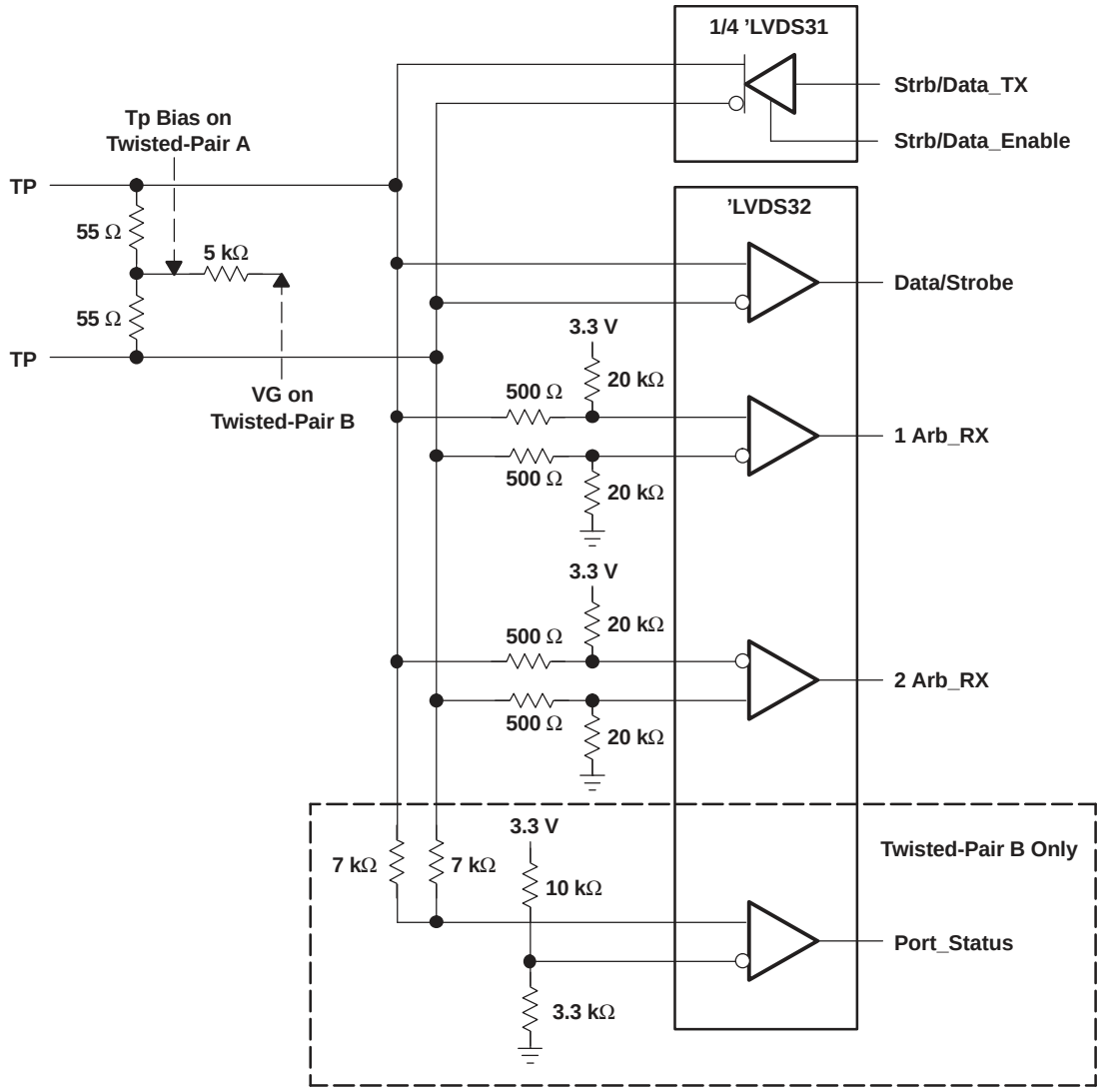
Figure 8. Typical Transmission Distance Versus Signaling Rate



NOTES: A. Place a 0.1-μF and a 0.001-μF Z5U ceramic, mica, or polystyrene dielectric, 0805 size, chip capacitor between V_{CC} and the ground plane. The capacitors should be located as close as possible to the device terminals.

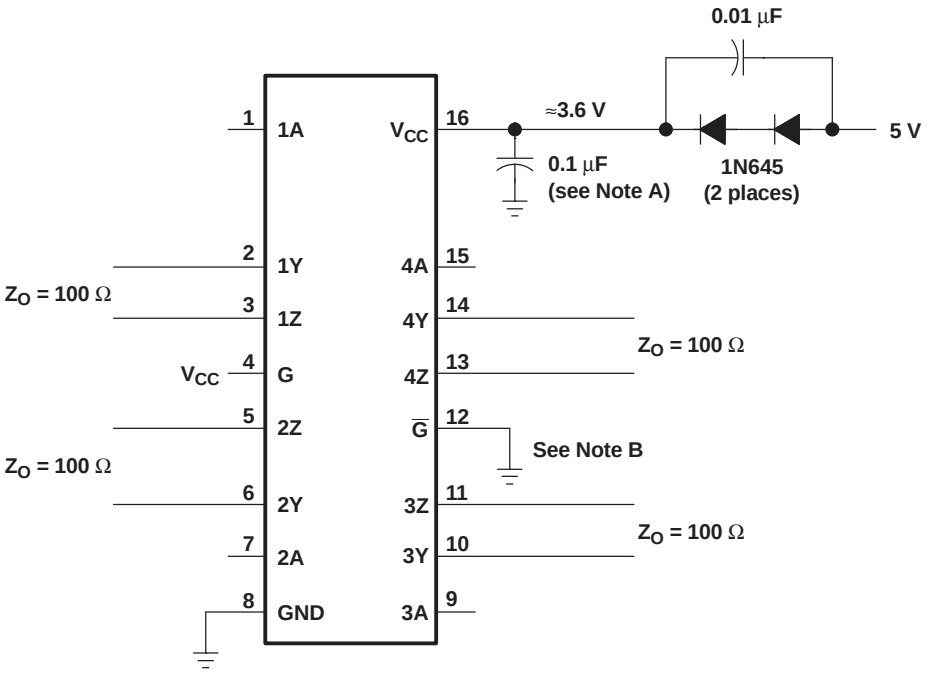
B. Unused enable inputs should be tied to V_{CC} or GND, as appropriate.

Figure 9. Typical Application Circuit Schematic



NOTES: A. Resistors are leadless, thick film (0603), 5% tolerance.
B. Decoupling capacitance is not shown, but recommended.
C. V_{CC} is 3 V to 3.6 V.
D. The differential output voltage of the 'LVDS31 can exceed that specified by IEEE1394.

Figure 10. 100-Mbps IEEE 1394 Transceiver



A. Place a 0.1-µF Z5U ceramic, mica, or polystyrene dielectric, 0805 size, chip capacitor between V_{CC} and the ground plane. The capacitor should be located as close as possible to the device terminals.

B. Unused enable inputs should be tied to V_{CC} or GND, as appropriate.

Figure 11. Operation With 5-V Supply

COLD SPARING

Systems using cold sparing have a redundant device electrically connected without power supplied. To support this configuration, the spare must present a high-input impedance to the system so that it does not draw appreciable power. In cold sparing, voltage may be applied to an I/O before and during power up of a device. When the device is powered off, V_{CC} must be clamped to ground and the I/O voltages applied must be within the specified recommended operating conditions.

RELATED INFORMATION

IBIS modeling is available for this device. Contact the local TI sales office or the TI Web site at www.ti.com for more information.

For more application guidelines, see the following documents:

- *Low-Voltage Differential Signaling Design Notes* (SLLA014)
- *Interface Circuits for TIA/EIA-644* (LVDS) (SLLA038)
- *Reducing EMI With LVDS* (SLLA030)
- *Slew Rate Control of LVDS Circuits* (SLLA034)
- *Using an LVDS Receiver With RS-422 Data* (SLLA031)
- *Evaluating the LVDS EVM* (SLLA033)

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN65LVDS31MDREP	ACTIVE	SOIC	D	16	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-55 to 125	LVDS31EP	Samples
V62/07627-01XE	ACTIVE	SOIC	D	16	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-55 to 125	LVDS31EP	Samples

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

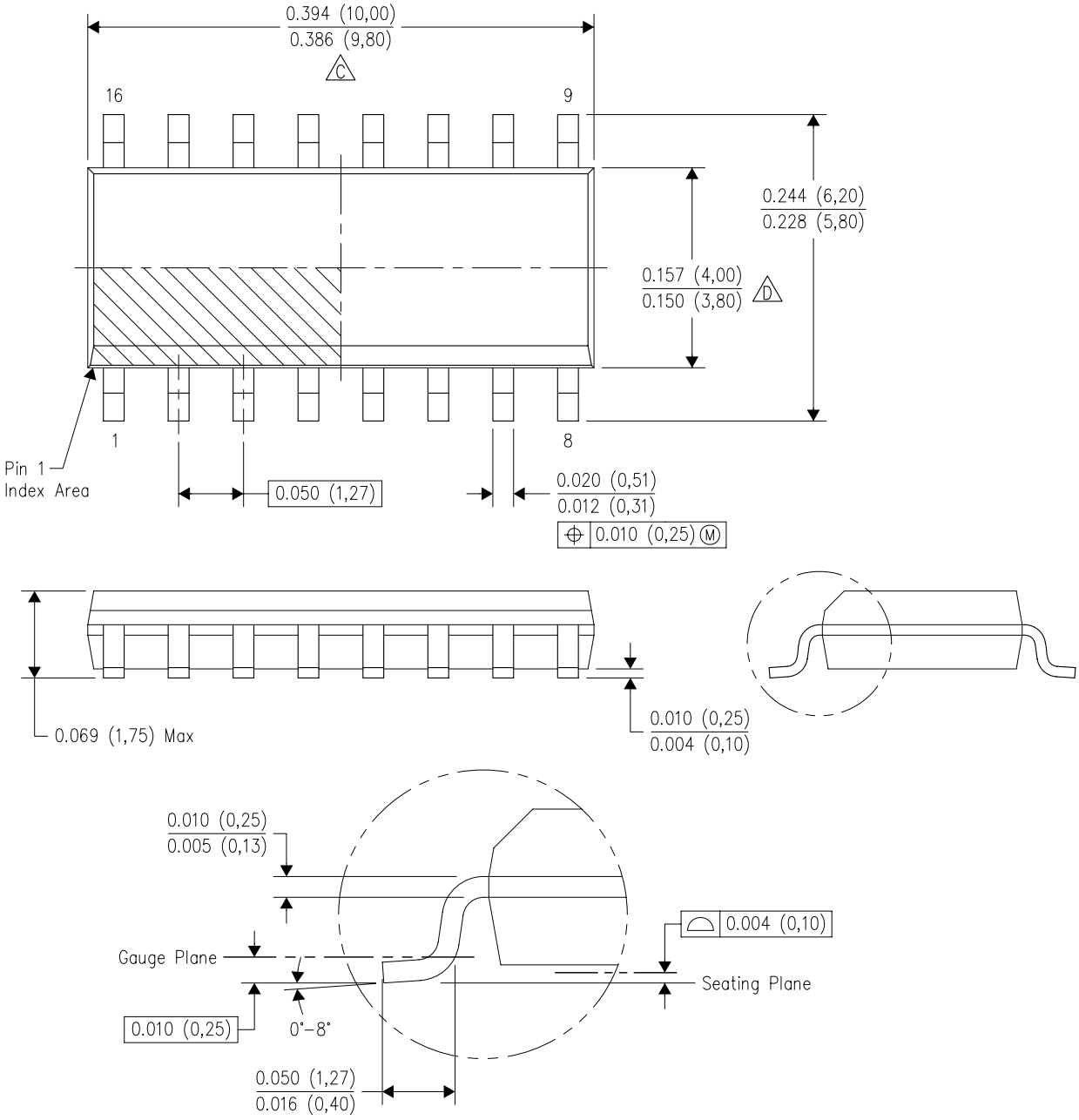
OTHER QUALIFIED VERSIONS OF SN65LVDS31-EP :

- Catalog: SN65LVDS31

NOTE: Qualified Version Definitions:

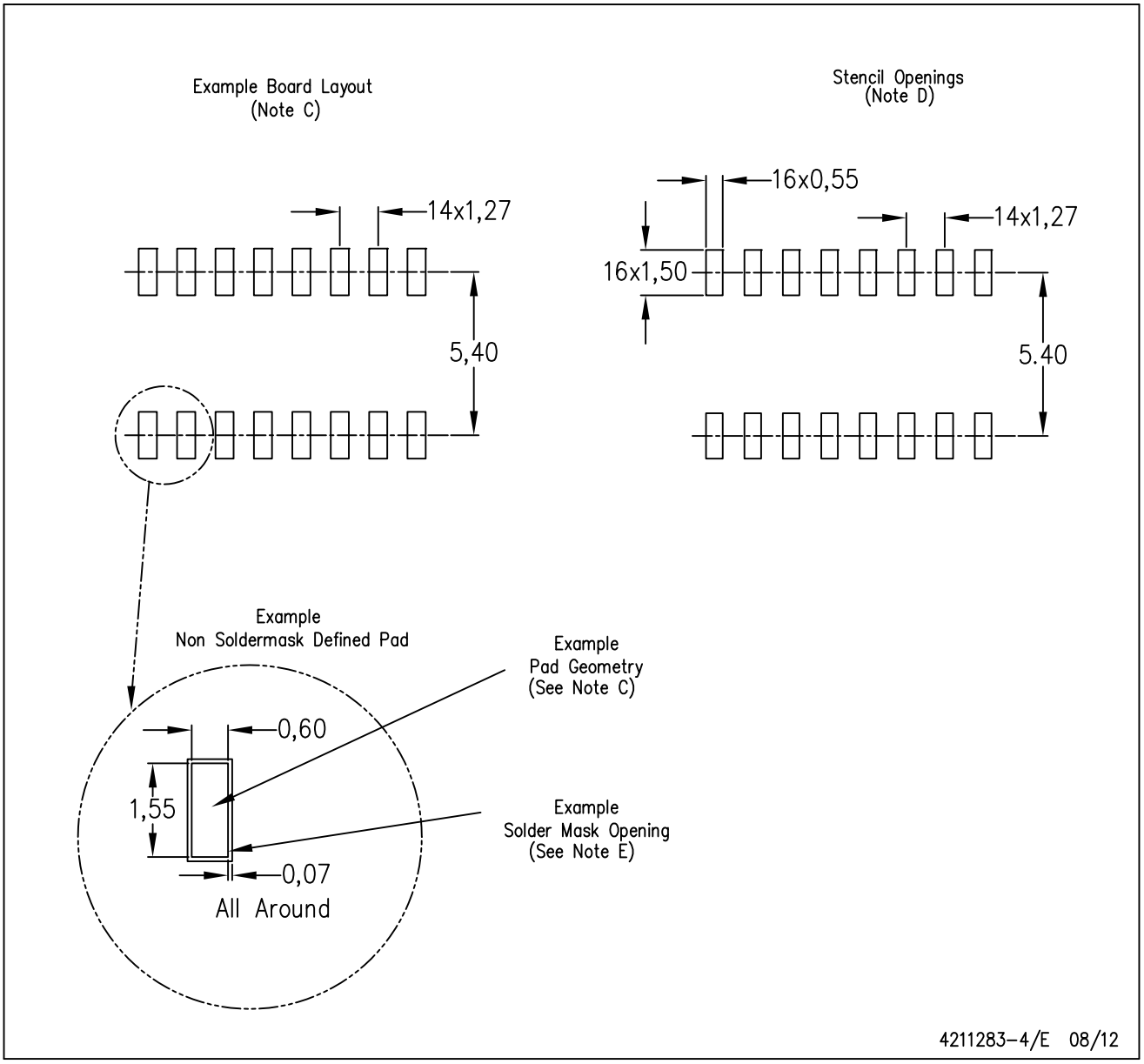
- Catalog - TI's standard catalog product

D (R–PDSO–G16) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
E. Reference JEDEC MS–012 variation AC.

D (R–PDSO–G16) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC–7525 for other stencil recommendations.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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