LVDS SERDES TRANSMITTER

FEATURES

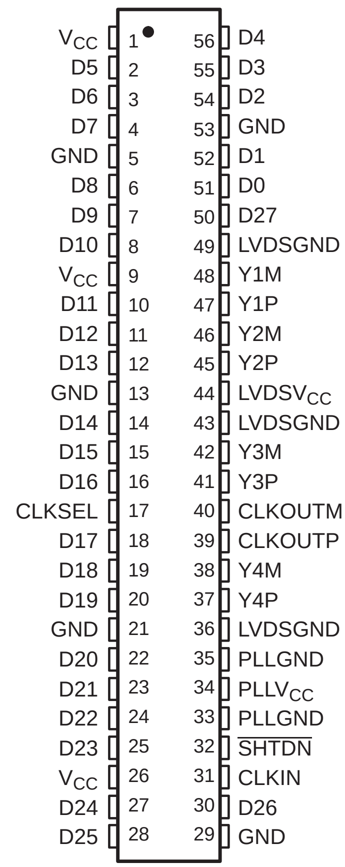
- **28:4 Data Channel Compression at up to 1.904 Gigabits per Second Throughput**
- **Suited for Point-to-Point Subsystem Communication With Very Low EMI**
- **28 Data Channels Plus Clock in Low-Voltage TTL and 4 Data Channels Plus Clock Out Low-Voltage Differential**
- **Selectable Rising or Falling Clock Edge Triggered Inputs**
- **Bus Pins Tolerate 6-kV HBM ESD**
- **Operates From a Single 3.3-V Supply and 250 mW (Typ)**
- **5-V Tolerant Data Inputs**
- **Packaged in Thin Shrink Small-Outline Package With 20 Mil Terminal Pitch**
- **Consumes <1 mW When Disabled**
- **Wide Phase-Lock Input Frequency Range 20 MHz to 68 MHz**
- **No External Components Required for PLL**
- **Outputs Meet or Exceed the Requirements of ANSI EIA/TIA-644 Standard**
- **Industrial Temperature Qualified T_A = –40°C to 85°C**
- **Replacement for the DS90CR285**

DESCRIPTION

The SN65LVDS93 LVDS serdes (serializer/deserializer) transmitter contains four 7-bit parallel-load serial-out shift registers, a 7ɔclock synthesizer, and five low-voltage differential signaling (LVDS) drivers in a single integrated circuit. These functions allow 28 bits of single-ended LVTTL data to be synchronously transmitted over five balanced-pair conductors for receipt by a compatible receiver, such as the SN65LVDS94.

When transmitting, data bits D0 through D27 are each loaded into registers upon the edge of the input clock signal (CLKIN). The rising or falling edge of the clock can be selected via the clock select (CLKSEL) pin. The frequency of CLKIN is multiplied seven times and then used to serially unload the data registers in 7-bit slices. The four serial streams and a phase-locked clock (CLKOUT) are then output to LVDS output drivers. The frequency of CLKOUT is the same as the input clock, CLKIN.

DGG PACKAGE
(TOP VIEW)



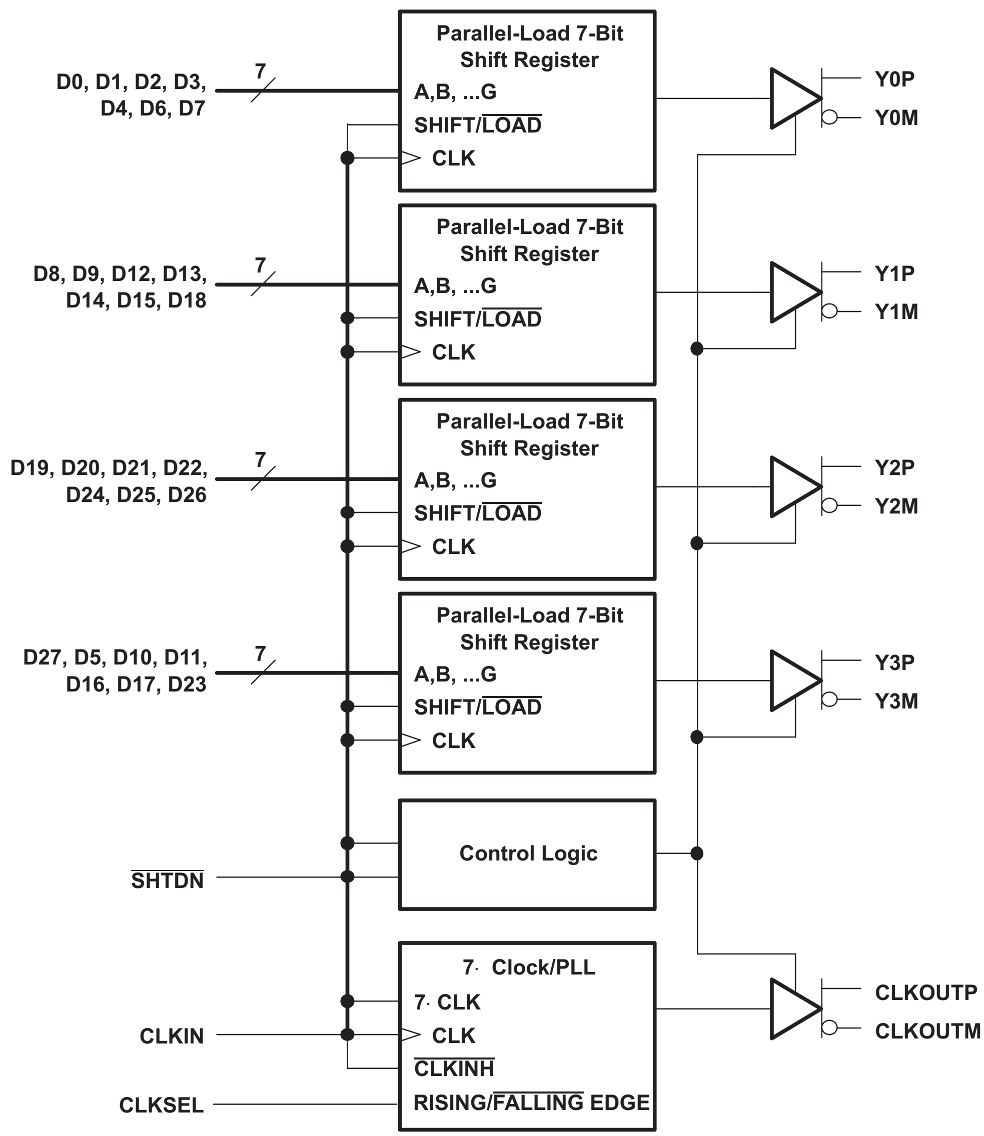
These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

DESCRIPTION (CONTINUED)

The SN65LVDS93 requires no external components and little or no control. The data bus appears the same at the input to the transmitter and output of the receiver with the data transmission transparent to the user(s). The only user intervention is selecting a clock rising edge by inputting a high level to CLKSEL or a falling edge with a low-level input and the possible use of the shutdown/clear (SHTDN). SHTDN is an active-low input to inhibit the clock and shut off the LVDS output drivers for lower power consumption. A low level on this signal clears all internal registers at a low level.

The SN65LVDS93 is characterized for operation over ambient air temperatures of –40°C to 85°C.

FUNCTIONAL BLOCK DIAGARAM



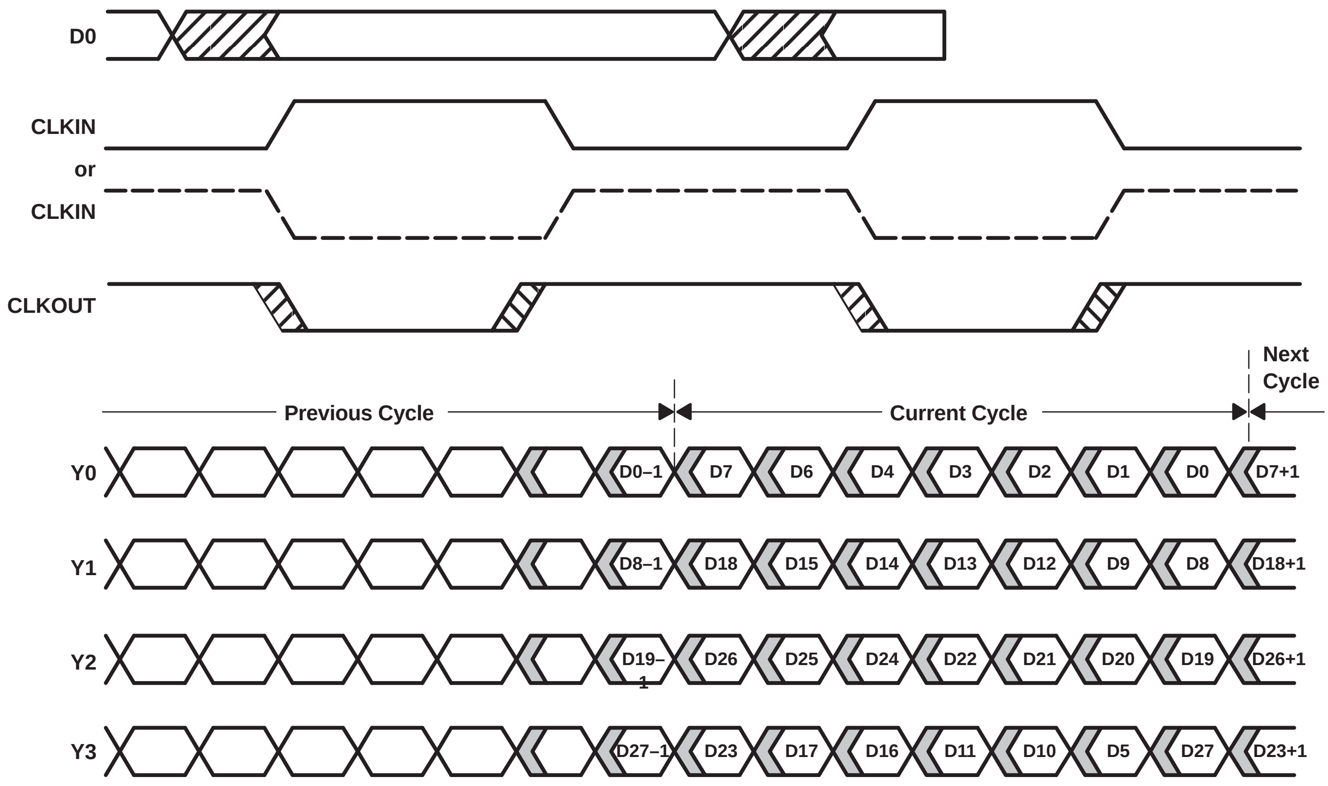
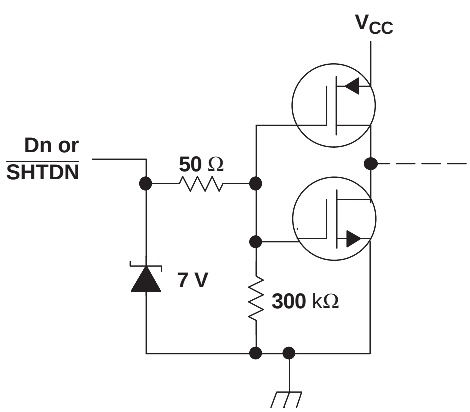
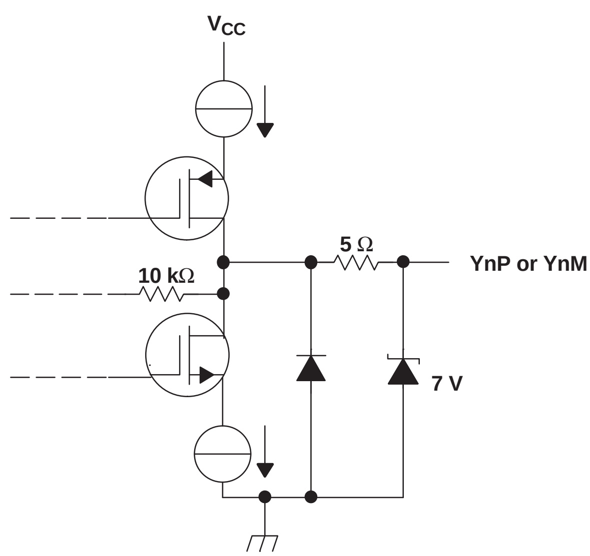


Figure 1. Typical 'LVDS93 Load and Shift Sequences

EQUIVALENT INPUT AND OUTPUT SCHEMATIC DIAGRAMS





ABSOLUTE MAXIMUM RATINGS

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

			UNIT
V_{CC}	Supply voltage range(2)		–0.5 V to 4 V
V_O	Voltage range at any output terminal		-0.5 V to V_{CC} + 0.5 V
V_I	Voltage range at any input terminal		–0.5 V to 5.5 V
	Electrostatic discharge(3)	Bus Pins (Class 3A)	6 KV
		Bus Pins (Class 2B)	400 V
		Bus Pins (Class 2A)	6 KV
		Bus Pins (Class 2B)	200 V
	Continuous total power dissipation		See Dissipation Rating Table
T_A	Operating free-air temperature range		–40°C to 85°C
T_{stg}	Storage temperature range		–65°C to 150°C
	Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds		260°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 voltage values are with respect to the GND terminals.
(3) This rating is measured using MIL-STD-883C Method, 3015.7.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25°C$ POWER RATING	DERATING FACTOR(1) ABOVE $T_A = 25°C$	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ POWER RATING
DGG	1377 mW	11 mW/°C	882 mW	717 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
Z_L	Differential load impedance	90		132	Ω
T_A	Operating free-air temperature	–40		85	°C

ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
V_T	Input voltage threshold			1.4		V
$\|V_{OD}\|$	Differential steady-state output voltage magnitude	R_L = 100 Ω, See Figure 3	247		454	mV
$\Delta\|V_{OD}\|$	Change in the steady-state differential output voltage magnitude between opposite binary states				50	mV
$V_{OC(SS)}$	Steady-state common-mode output voltage	See Figure 3	1.125		1.375	V
$V_{OC(PP)}$	Peak-to-peak common-mode output voltage				150	mV
I_{IH}	High-level input current	$V_{IH} = V_{CC}$			20	µA
I_{IL}	Low-level input current	V_{IL} = 0 V			±10	µA
I_{OS}	Short-circuit output current	V_{OY} = 0 V			±24	mA
		V_{OD} = 0 V			±12	mA
I_{OZ}	High-impedance state output current	V_O = 0 V to V_{CC}			±20	µA
$I_{CC(AVG)}$	Quiescent current (average)	Disabled, All inputs at GND			350	µA
		Enabled, R_L = 100 Ω (5 places), Worst-case pattern (see Figure 4), t_c = 15.38 ns		95	120	mA
C_i	Input capacitance			3		pF

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

TIMING REQUIREMENTS

		MIN	NOM	MAX	UNIT
t_c	Input clock period	14.7	t_c	50	ns
t_w	High-level input clock pulse width duration	$0.4t_c$		$0.6t_c$	ns
t_t	Input signal transition time			5	ns
t_{su}	Data setup time, D0 through D27 before CLKIN↑ or CLKIN↓ (see Figure 2)	3			ns
t_h	Data hold time, D0 through D27 after CLKIN↓ or CLKIN↑ (see Figure 2)	1.5			ns

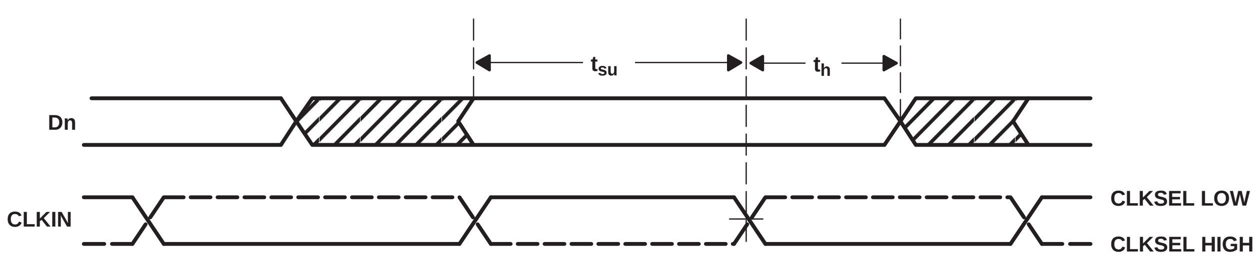
SWITCHING CHARACTERISTICS

over recommended operating conditions (unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN	TYP[1]	MAX	UNIT
t_0	Delay time, CLKOUT↑ to serial bit position 0	t_c = 15.38 ns (±0.2%), |Input clock jitter| < 50 ps[2], See Figure 5	–0.20	0	0.20	ns
t_1	Delay time, CLKOUT↑ to serial bit position 1		$\frac{1}{7}t_c - 0.20$		$\frac{1}{7}t_c + 0.20$	ns
t_2	Delay time, CLKOUT↑ serial bit position 2		$\frac{2}{7}t_c - 0.20$		$\frac{2}{7}t_c + 0.20$	ns
t_3	Delay time, CLKOUT↑ serial bit position 3		$\frac{3}{7}t_c - 0.20$		$\frac{3}{7}t_c + 0.20$	ns
t_4	Delay time, CLKOUT↑ to serial bit position 4		$\frac{4}{7}t_c - 0.20$		$\frac{4}{7}t_c + 0.20$	ns
t_5	Delay time, CLKOUT↑ to serial bit position 5		$\frac{5}{7}t_c - 0.20$		$\frac{5}{7}t_c + 0.20$	ns
t_6	Delay time, CLKOUT↑ to serial bit position 6		$\frac{6}{7}t_c - 0.20$		$\frac{6}{7}t_c + 0.20$	ns
$t_{sk(o)}$	Output skew, $t_n - \frac{n}{7}t_c$		–0.20		0.20	ns
t_7	Delay time, CLKIN↓ or CLKIN↑ to CLKOUT↑	t_c = 15.38 ns (±0.2%), |Input clock jitter| < 50 ps[2], See Figure 5		4.2		ns
$t_{c(o)}$	Output clock period			t_c		ps
$\Delta t_{c(o)}$	Output clock cycle-to-cycle jitter[3]	t_c = 15.38 ns + 0.75sin (2π500E3t) ± 0.05 ns, See Figure 6		±80		ps
		t_c = 15.38 ns + 0.75sin (2π3E6t) ± 0.05 ns, See Figure 6		±300		ns
t_w	High-level output clock pulse duration			$\frac{4}{7}t_c$		ps
t_t	Differential output voltage transition time (t_r or t_f)	See Figure 3	260	700	1500	ps
t_{en}	Enable time, $\overline{\text{SHTDN}}$↑ to phase lock (Yn valid)	See Figure 7		1		ms
t_{dis}	Disable time, $\overline{\text{SHTDN}}$↓ to off-state (CLKOUT low)	See Figure 8		250		ns

(1) All typical values are at V_{CC} = 3.3 V, T_A = 25°C.
(2) Input clock jitter is the magnitude of the charge in the input clock period
(3) The output clock jitter is the change in the output clock period from one cycle to the next cycle observed over 15,000 cycles.

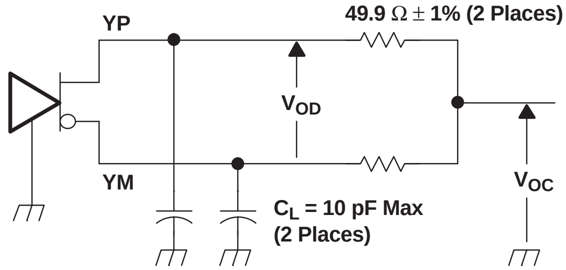
PARAMETER MEASUREMENT INFORMATION



note: All input timing is defined at 1.4 V on an input signal with a 10% to 90% rise or fall time of less than 5 ns.

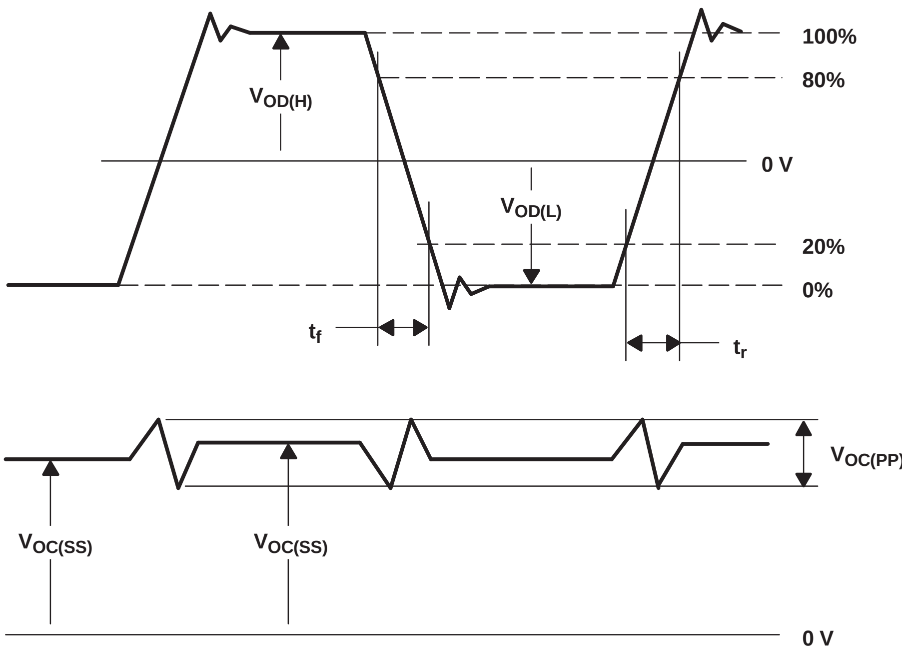
Figure 2. Setup and Hold Time Definition

PARAMETER MEASUREMENT INFORMATION (continued)



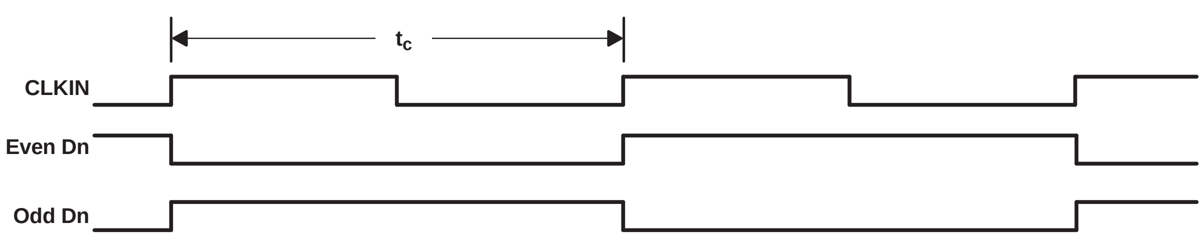
NOTE A: The lumped instrumentation capacitance for any single-ended voltage measurement is less than or equal to 10 pF. When making measurements at YP or YM, the complementary output is similarly loaded.

(a) SCHEMATIC



(b) WAVEFORMS

Figure 3. Test Load and Voltage Definitions for LVDS Outputs



NOTE A: The worst-case test pattern produces nearly the maximum switching frequency for all of the LVDS outputs. Pattern with CLKSEL low shown.

Figure 4. Worst-Case Test Pattern (CLKSEL Low Shown)

PARAMETER MEASUREMENT INFORMATION (continued)

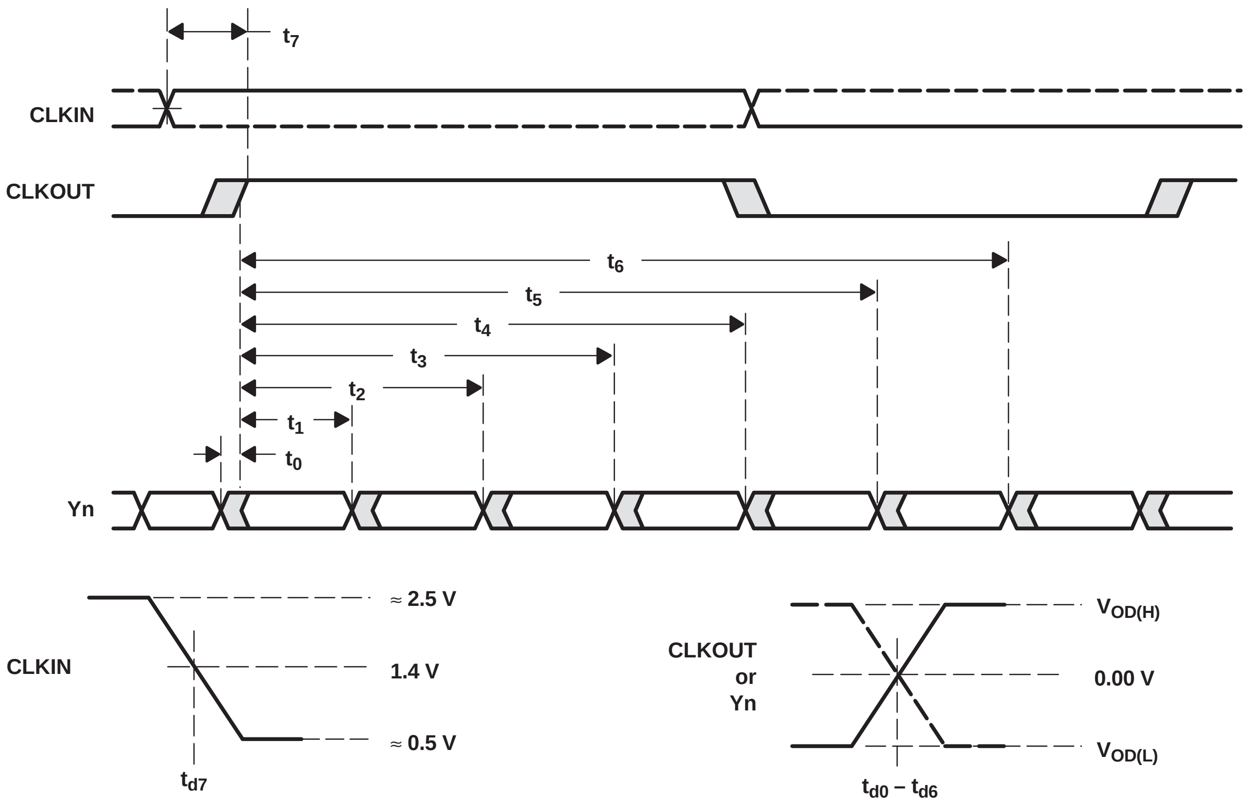
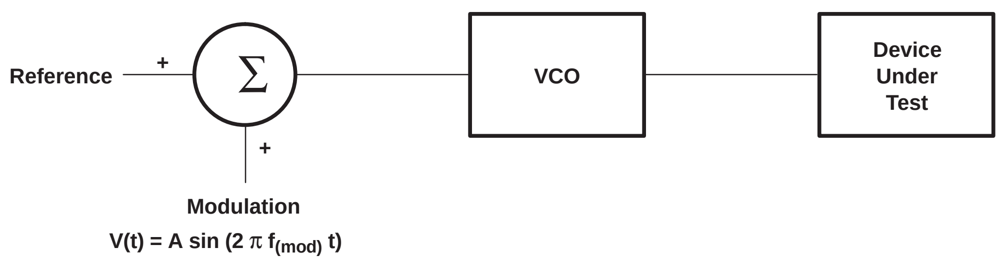


Figure 5. Timing Definitions



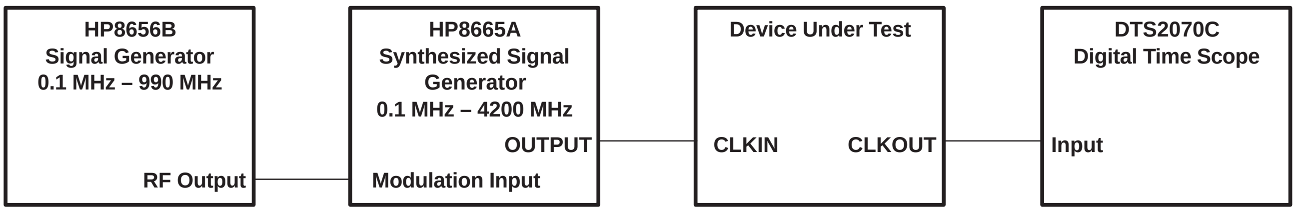


Figure 6. Output Clock Jitter Test Setup

PARAMETER MEASUREMENT INFORMATION (continued)

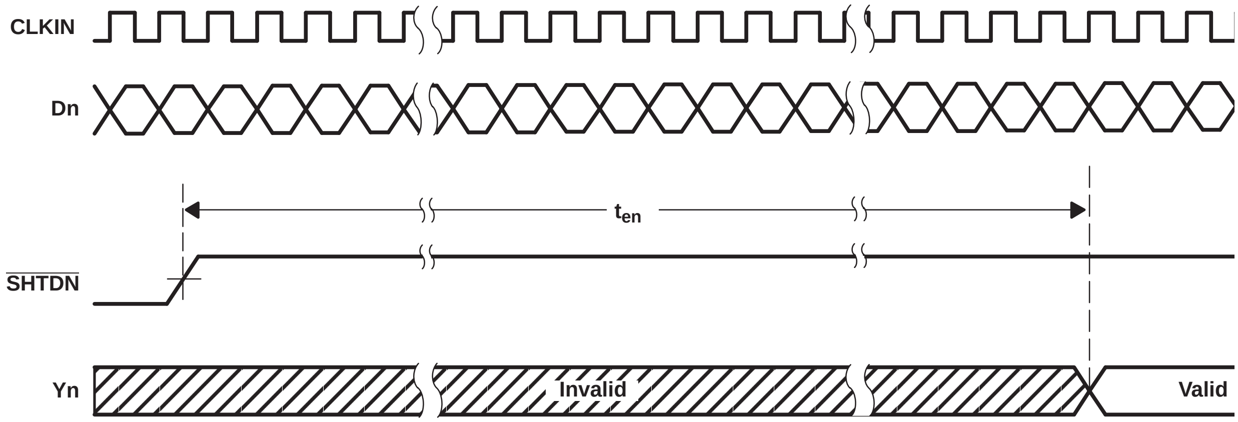


Figure 7. Enable Time Waveforms (CLKSEL low shown)

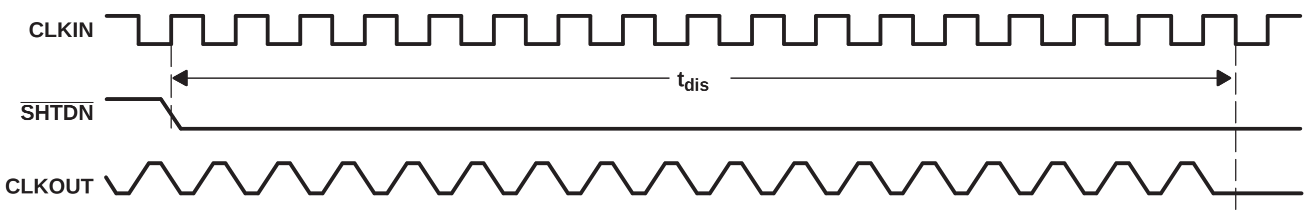


Figure 8. Disable Time Waveforms (CLKSEL low shown)

TYPICAL CHARACTERISTICS

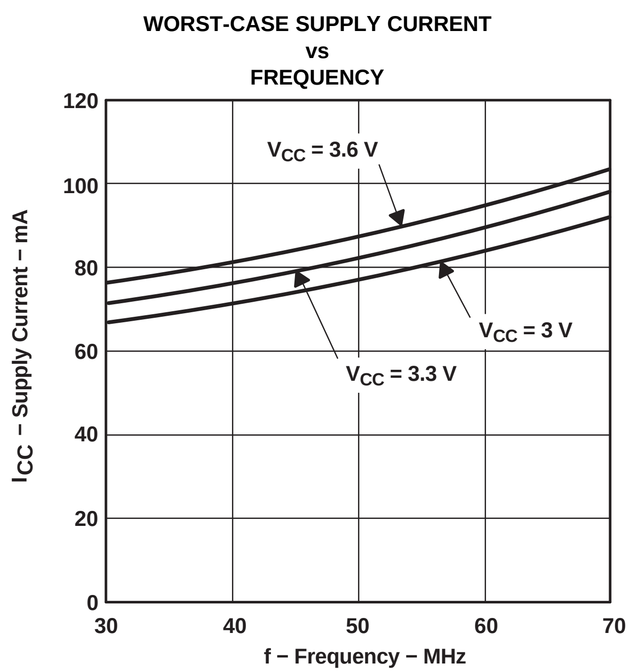


Figure 9.

APPLICATION INFORMATION

16-BIT BUS EXTENSION

In a 16-bit bus application (Figure 10), TTL data and clock coming from bus transceivers that interface the backplane bus arrive at the Tx parallel inputs of the LVDS serdes transmitter. The clock associated with the bus is also connected to the device. The on-chip PLL synchronizes this clock with the parallel data at the input. The data is then multiplexed into three different line drivers which perform the TTL to LVDS conversion. The clock is also converted to LVDS and presented to a separate driver. This synchronized LVDS data and clock at the receiver, which recovers the LVDS data and clock, performs a conversion back to TTL. Data is then demultiplexed into a parallel format. An on-chip PLL synchronizes the received clock with the parallel data, and then all are presented to the parallel output port of the receiver.

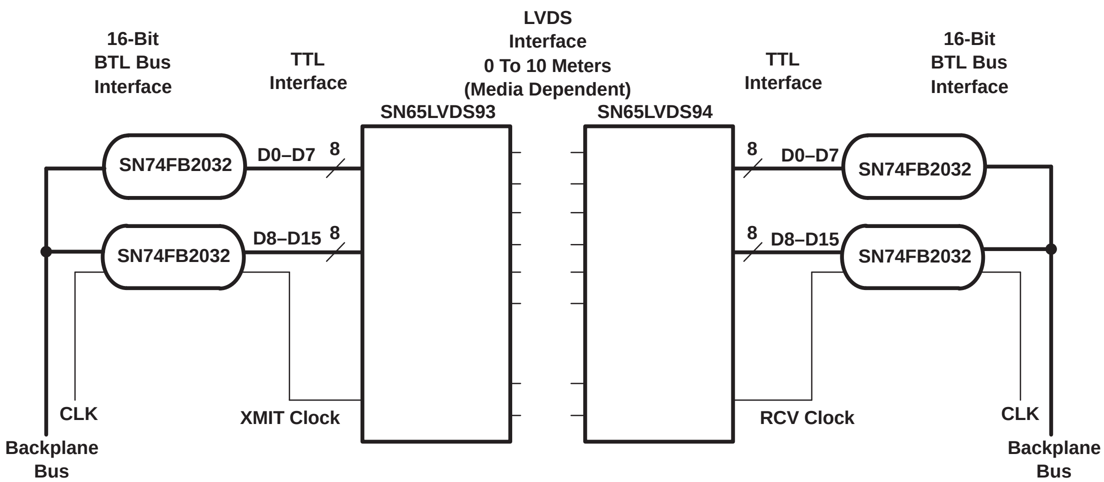


Figure 10. 16-Bit Bus Extension

16-BIT BUS EXTENSION WITH PARITY

In the previous application we did not have a checking bit that would provide assurance that the data crosses the link. If we add a parity bit to the previous example, we would have a diagram similar to the one in Figure 11. The device following the SN74FB2032 is a low-cost parity generator. Each transmit-side transceiver/parity generator takes the LVTTL data from the corresponding transceiver, performs a parity calculation over the byte, and then passes the bits with its calculated parity value on the parallel input of the LVDS serdes transmitter. Again, the on-chip PLL synchronizes this transmit clock with the eighteen parallel bits (16 data + 2 parity) at the input. The synchronized LVDS data/parity and clock arrive at the receiver.

The receiver performs the conversion from LVDS to LVTTL and the transceiver/parity generator performs the parity calculations. These devices compare their corresponding input bytes with the value received on the parity bit. The transceiver/parity generator will assert its parity error output if a mismatch is detected.

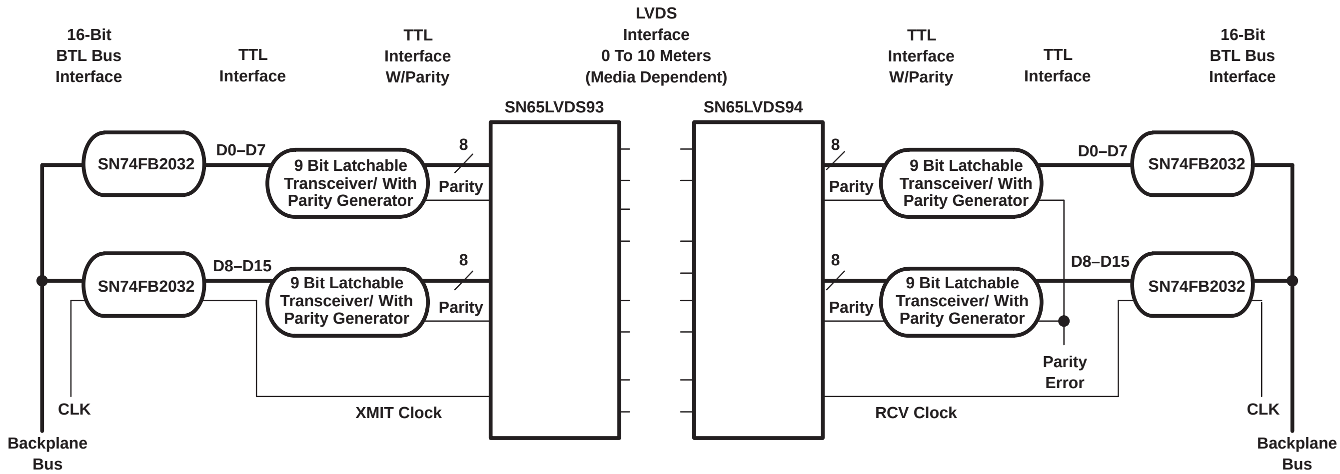


Figure 11. 16-Bit Bus Extension With Parity

low cost virtual backplane transceiver

Figure 12 represents LVDS serdes in an application as a virtual backplane transceiver (VBT). The concept of a VBT can be achieved by implementing individual LVDS serdes chipsets in both directions of subsystem serialized links.

Depending on the application, the designer will face varying choices when implementing a VBT. In addition to the devices shown in Figure 12, functions such as parity and delay lines for control signals could be included. Using additional circuitry, half-duplex or full-duplex operation can be achieved by configuring the clock and control lines properly.

The designer may choose to implement an independent clock oscillator at each end of the link and then use a PLL to synchronize LVDS serdes's parallel I/O to the backplane bus. Resynchronizing FIFOs may also be required.

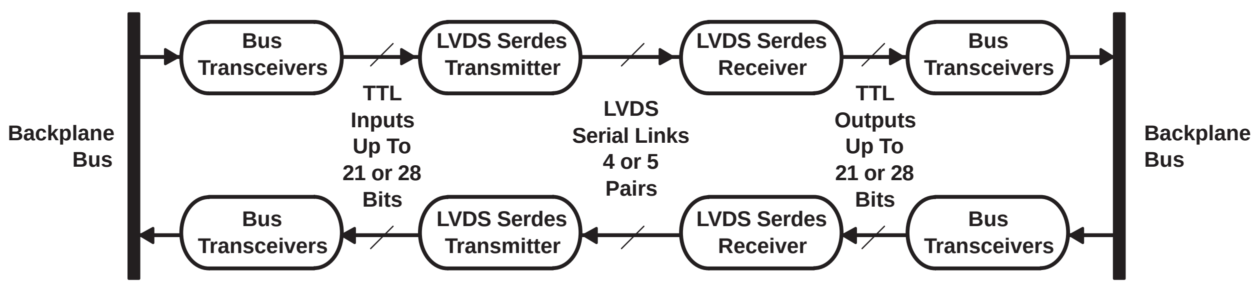


Figure 12. Virtual Backplane Transceiver

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
SN65LVDS93DGG	Active	Production	TSSOP (DGG) | 56	35 | TUBE	Yes	NIPDAU	Level-2-260C-1 YEAR	-	SN65LVDS93
SN65LVDS93DGG.B	Active	Production	TSSOP (DGG) | 56	35 | TUBE	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LVDS93
SN65LVDS93DGGG4	Active	Production	TSSOP (DGG) | 56	35 | TUBE	Yes	NIPDAU	Level-2-260C-1 YEAR	See SN65LVDS93DGG	SN65LVDS93
SN65LVDS93DGGR	Active	Production	TSSOP (DGG) | 56	2000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LVDS93
SN65LVDS93DGGR.B	Active	Production	TSSOP (DGG) | 56	2000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LVDS93
SN65LVDS93DGGR1G4	Active	Production	TSSOP (DGG) | 56	2000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LVDS93
SN65LVDS93DGGR1G4.B	Active	Production	TSSOP (DGG) | 56	2000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LVDS93

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts 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.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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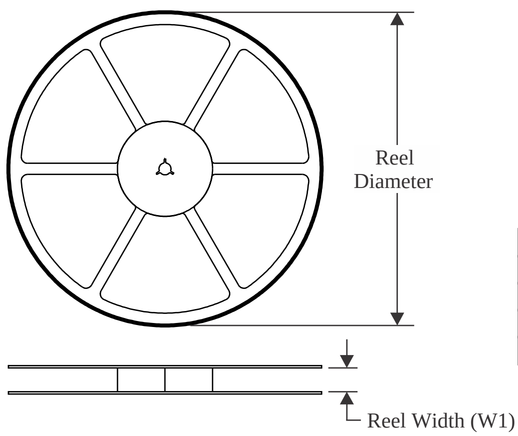
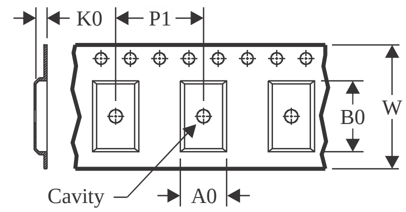
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

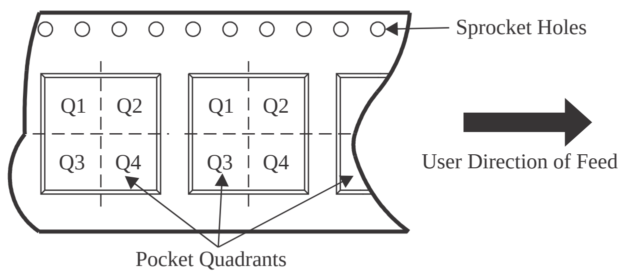


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

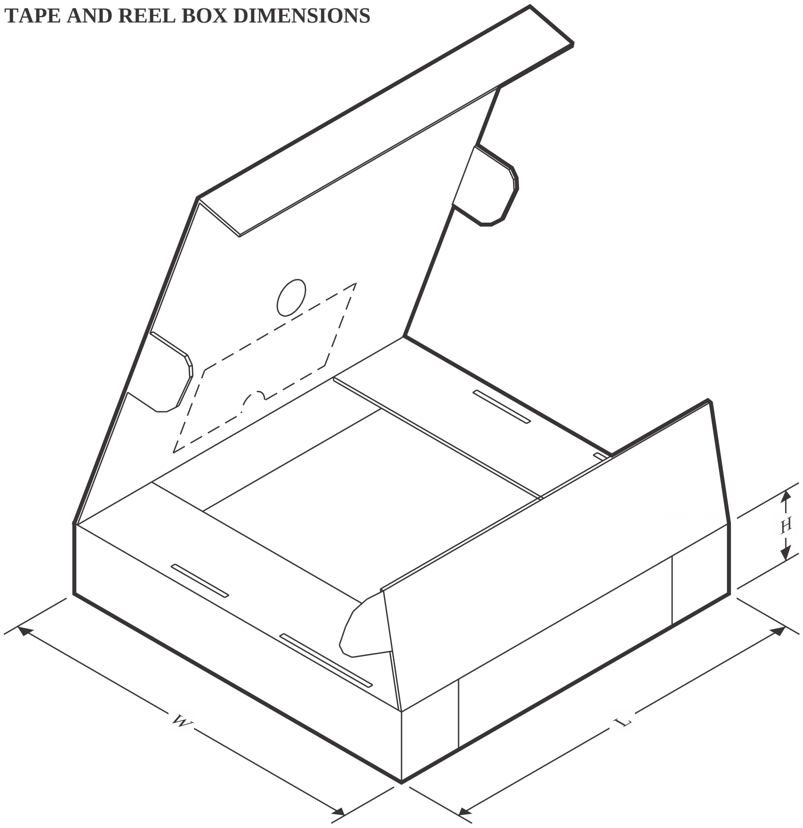
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN65LVDS93DGGR	TSSOP	DGG	56	2000	330.0	24.4	8.6	15.6	1.8	12.0	24.0	Q1
SN65LVDS93DGGR1G4	TSSOP	DGG	56	2000	330.0	24.4	8.6	15.6	1.8	12.0	24.0	Q1

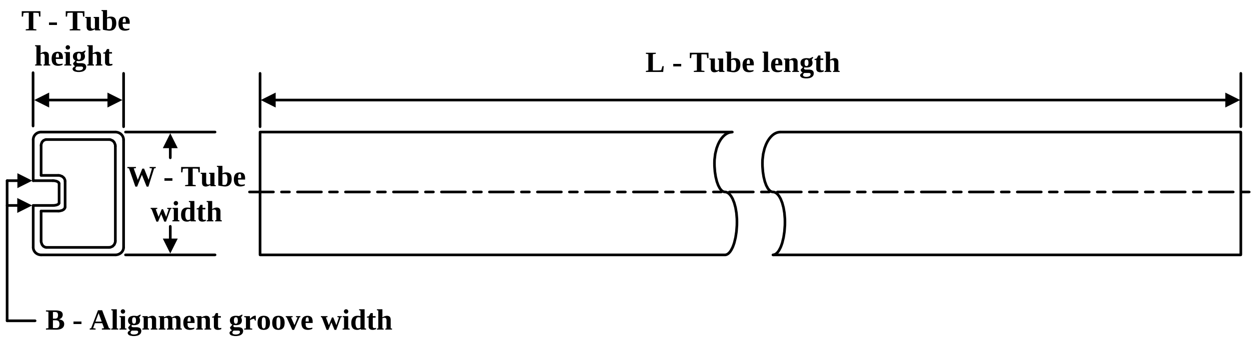
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN65LVDS93DGGR	TSSOP	DGG	56	2000	350.0	350.0	43.0
SN65LVDS93DGGR1G4	TSSOP	DGG	56	2000	350.0	350.0	43.0

TUBE



*All dimensions are nominal

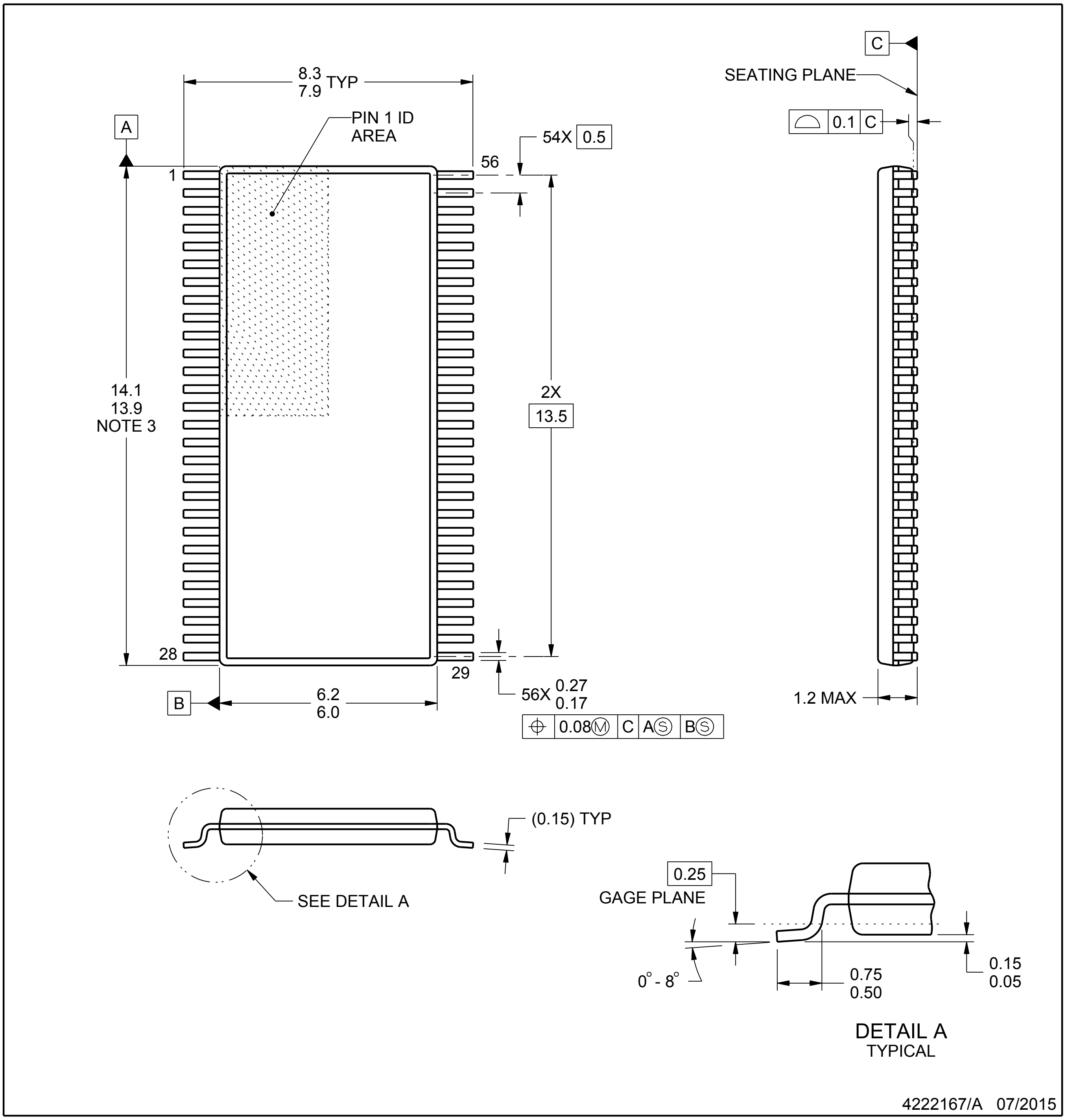
Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
SN65LVDS93DGG	DGG	TSSOP	56	35	530	11.89	3600	4.9
SN65LVDS93DGG.B	DGG	TSSOP	56	35	530	11.89	3600	4.9
SN65LVDS93DGGG4	DGG	TSSOP	56	35	530	11.89	3600	4.9

PACKAGE OUTLINE

DGG0056A

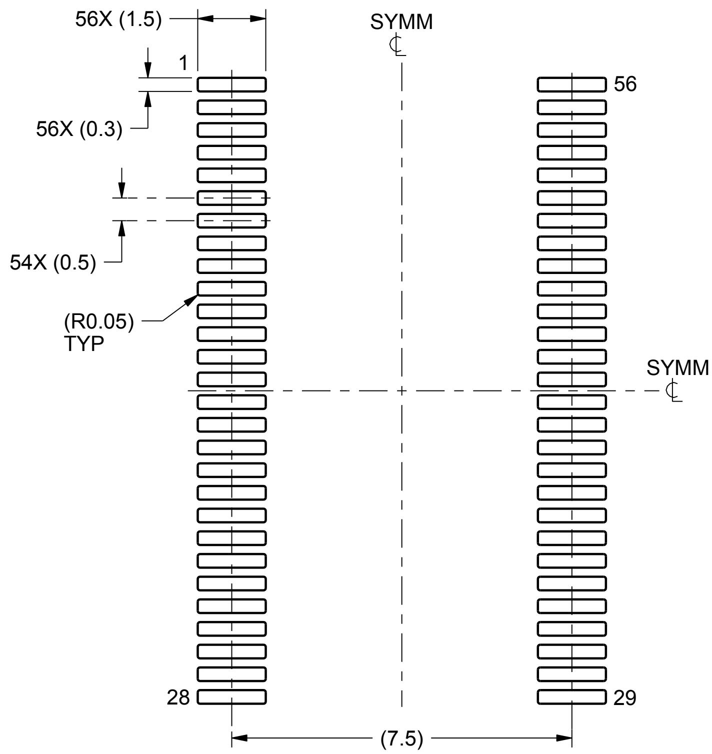
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE

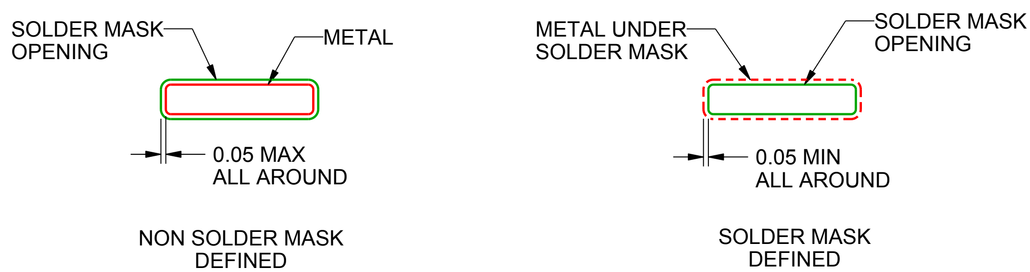


NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-153.



LAND PATTERN EXAMPLE
SCALE:6X



SOLDER MASK DETAILS

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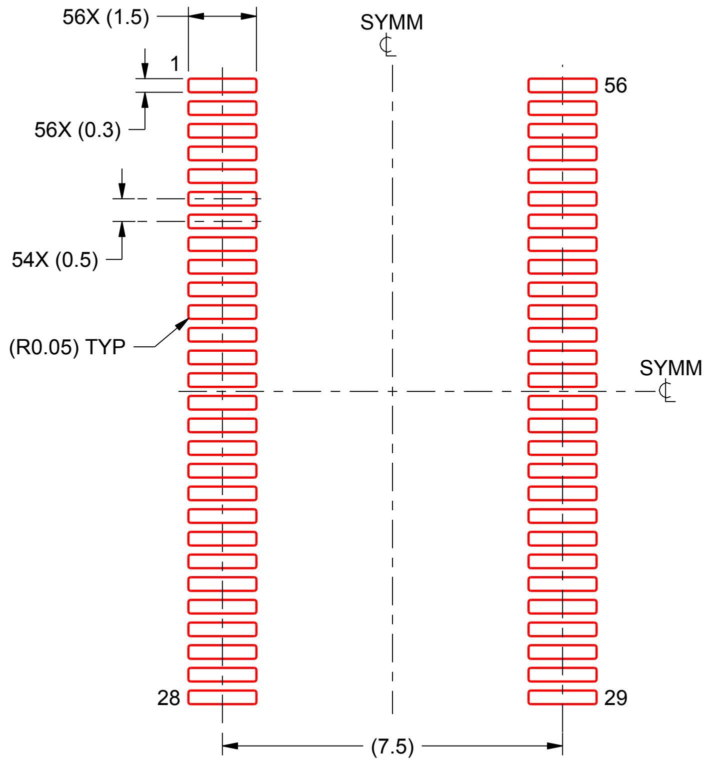
NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:6X

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NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

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