

## 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  $T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$**
- **Replacement for the DS90CR285**

### DESCRIPTION

The SN65LVDS93 LVDS serdes (serializer/deserializer) transmitter contains four 7-bit parallel-load serial-out shift registers, a 7-clock synthesizer, and five low-voltage differential signaling (LVDS) drivers in a single integrated circuit. These functions allow 28 bits of single-ended LVTTTL 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)**

V <sub>CC</sub>	1	56	D4
D5	2	55	D3
D6	3	54	D2
D7	4	53	GND
GND	5	52	D1
D8	6	51	D0
D9	7	50	D27
D10	8	49	LVDSGND
V <sub>CC</sub>	9	48	Y1M
D11	10	47	Y1P
D12	11	46	Y2M
D13	12	45	Y2P
GND	13	44	LVDSV <sub>CC</sub>
D14	14	43	LVDSGND
D15	15	42	Y3M
D16	16	41	Y3P
CLKSEL	17	40	CLKOUTM
D17	18	39	CLKOUTP
D18	19	38	Y4M
D19	20	37	Y4P
GND	21	36	LVDSGND
D20	22	35	PLL <sub>GND</sub>
D21	23	34	PLL <sub>V<sub>CC</sub></sub>
D22	24	33	PLL <sub>GND</sub>
D23	25	32	SHTDN
V <sub>CC</sub>	26	31	CLKIN
D24	27	30	D26
D25	28	29	GND



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# SN65LVDS93

SLLS302G–MAY 1998–REVISED MAY 2009

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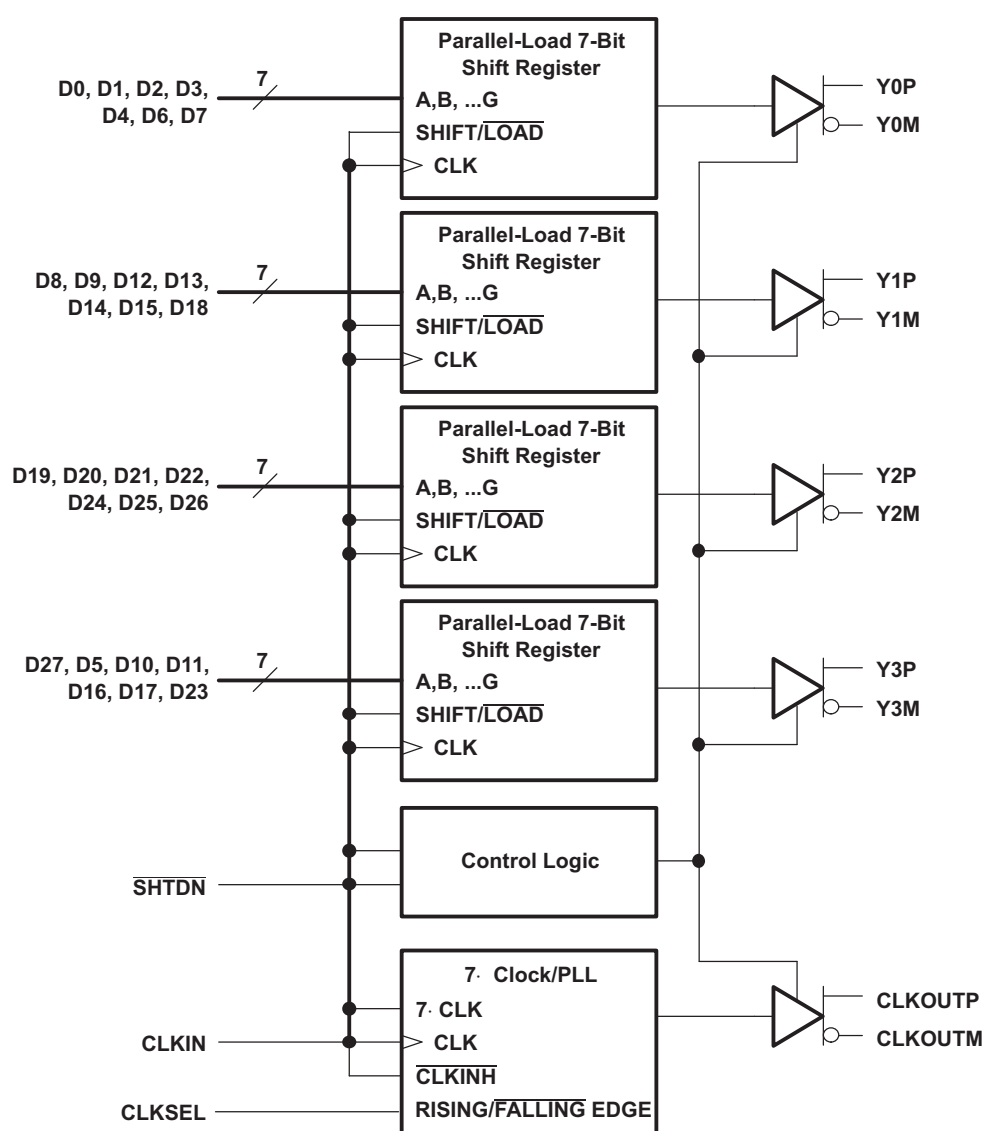
These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## 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 DIAGRAM



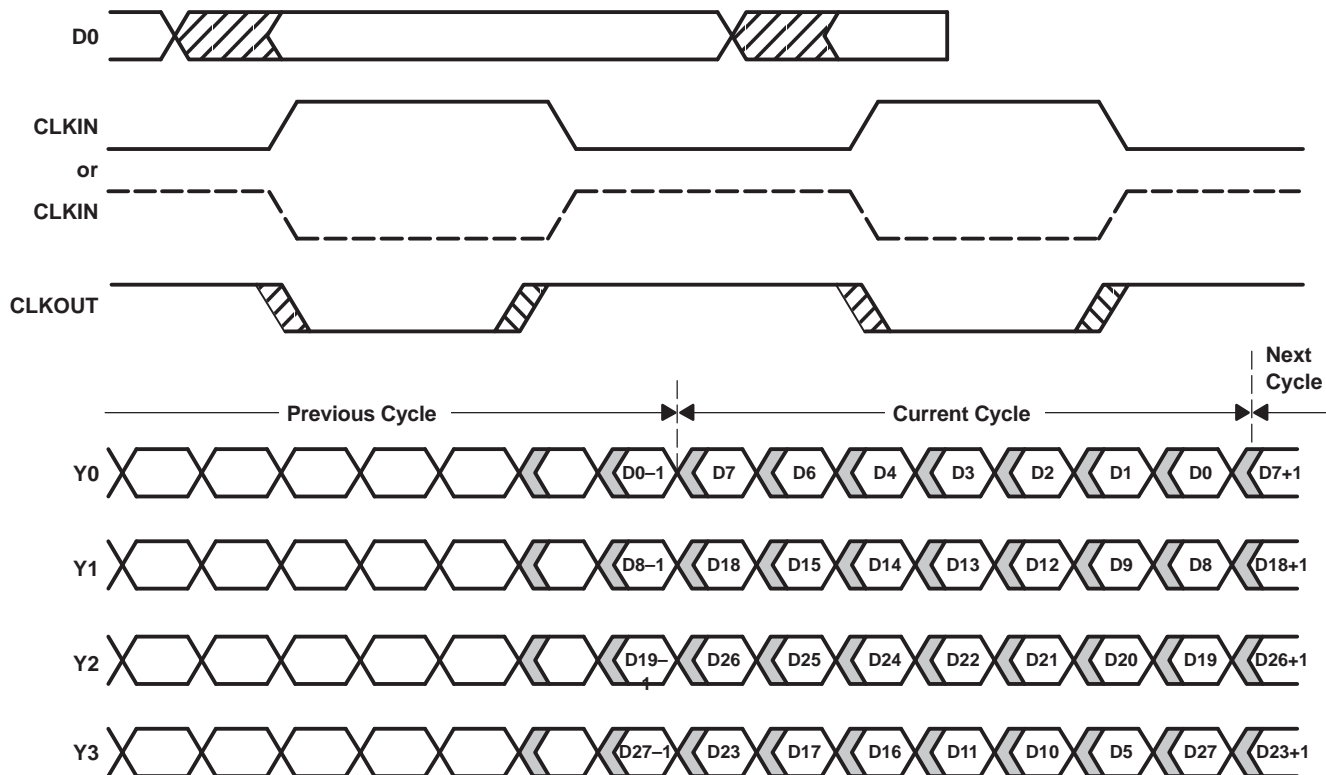
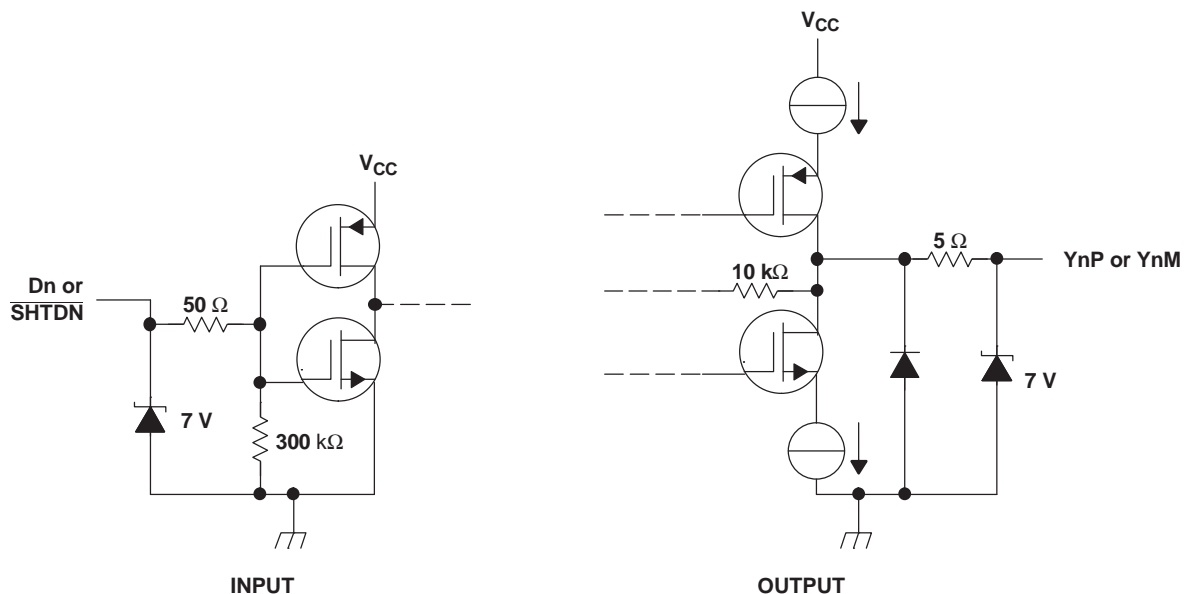


Figure 1. Typical LVDS93 Load and Shift Sequences

## EQUIVALENT INPUT AND OUTPUT SCHEMATIC DIAGRAMS



# SN65LVDS93

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## ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

		UNIT
V <sub>CC</sub>	Supply voltage range <sup>(2)</sup>	–0.5 V to 4 V
V <sub>O</sub>	Voltage range at any output terminal	–0.5 V to V <sub>CC</sub> + 0.5 V
V <sub>I</sub>	Voltage range at any input terminal	–0.5 V to 5.5 V
Electrostatic discharge <sup>(3)</sup>	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 <sub>A</sub>	Operating free-air temperature range	–40°C to 85°C
T <sub>stg</sub>	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 <sub>A</sub> ≤ 25°C POWER RATING	DERATING FACTOR <sup>(1)</sup> ABOVE T <sub>A</sub> = 25°C	T <sub>A</sub> = 70°C POWER RATING	T <sub>A</sub> = 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 <sub>CC</sub> Supply voltage	3	3.3	3.6	V
V <sub>IH</sub> High-level input voltage	2			V
V <sub>IL</sub> Low-level input voltage			0.8	V
Z <sub>L</sub> Differential load impedance	90		132	Ω
T <sub>A</sub> Operating free-air temperature	–40		85	°C

## ELECTRICAL CHARACTERISTICS

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

PARAMETER	TEST CONDITIONS	MIN	TYP <sup>(1)</sup>	MAX	UNIT
$V_T$ Input voltage threshold			1.4		V
$ V_{OD} $ Differential steady-state output voltage magnitude	$R_L = 100\ \Omega$ , See <a href="#">Figure 3</a>	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 <a href="#">Figure 3</a>	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	$\mu A$
$I_{IL}$ Low-level input current	$V_{IL} = 0\ V$			$\pm 10$	$\mu A$
$I_{OS}$ Short-circuit output current	$V_{OY} = 0\ V$			$\pm 24$	mA
	$V_{OD} = 0\ V$			$\pm 12$	mA
$I_{OZ}$ High-impedance state output current	$V_O = 0\ V$ to $V_{CC}$			$\pm 20$	$\mu A$
$I_{CC(AVG)}$ Quiescent current (average)	Disabled, All inputs at GND			350	$\mu A$
	Enabled, $R_L = 100\ \Omega$ (5 places), Worst-case pattern (see <a href="#">Figure 4</a> ), $t_c = 15.38\ ns$		95	120	mA
$C_i$ Input capacitance			3		pF

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

## 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 $CLKIN\uparrow$ or $CLKIN\downarrow$ (see <a href="#">Figure 2</a> )	3			ns
$t_h$ Data hold time, D0 through D27 after $CLKIN\downarrow$ or $CLKIN\uparrow$ (see <a href="#">Figure 2</a> )	1.5			ns

# SN65LVDS93

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## SWITCHING CHARACTERISTICS

over recommended operating conditions (unless otherwise noted)

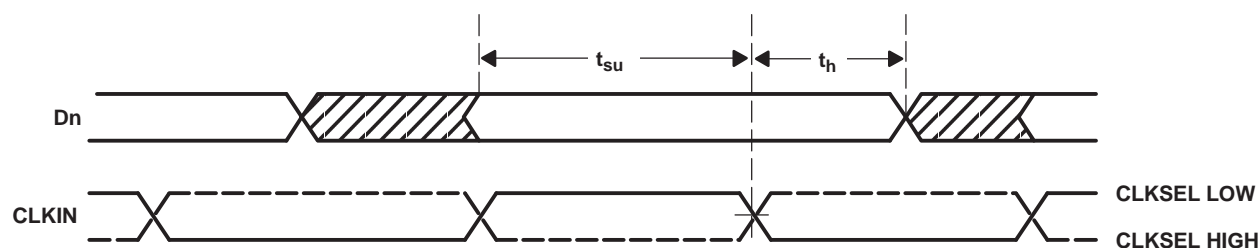
PARAMETER	TEST CONDITIONS	MIN	TYP <sup>(1)</sup>	MAX	UNIT
$t_0$ Delay time, CLKOUT↑ to serial bit position 0	$t_c = 15.38 \text{ ns } (\pm 0.2\%)$ ,  Input clock jitter  < 50 ps <sup>(2)</sup> , See Figure 5	–0.20	0	0.20	ns
$t_1$ Delay time, CLKOUT↑ to serial bit position 1		$\frac{1}{7}t_c - 0.20$	$\frac{1}{7}t_c + 0.20$		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↑	$t_c = 15.38 \text{ ns } (\pm 0.2\%)$ ,  Input clock jitter  < 50 ps <sup>(2)</sup> , 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 <sup>(3)</sup>	$t_c = 15.38 \text{ ns} + 0.75\sin(2\pi 500\text{E}3t) \pm 0.05 \text{ ns}$ , See Figure 6		±80		ps
	$t_c = 15.38 \text{ ns} + 0.75\sin(2\pi 3\text{E}6t) \pm 0.05 \text{ ns}$ , 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, SHTDN↑ to phase lock (Yn valid)	See Figure 7		1		ms
$t_{dis}$ Disable time, SHTDN↓ to off-state (CLKOUT low)	See Figure 8		250		ns

(1) All typical values are at  $V_{CC} = 3.3 \text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

(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.

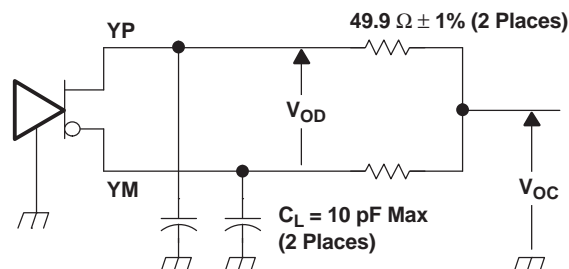
## PARAMETER MEASUREMENT INFORMATION



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.

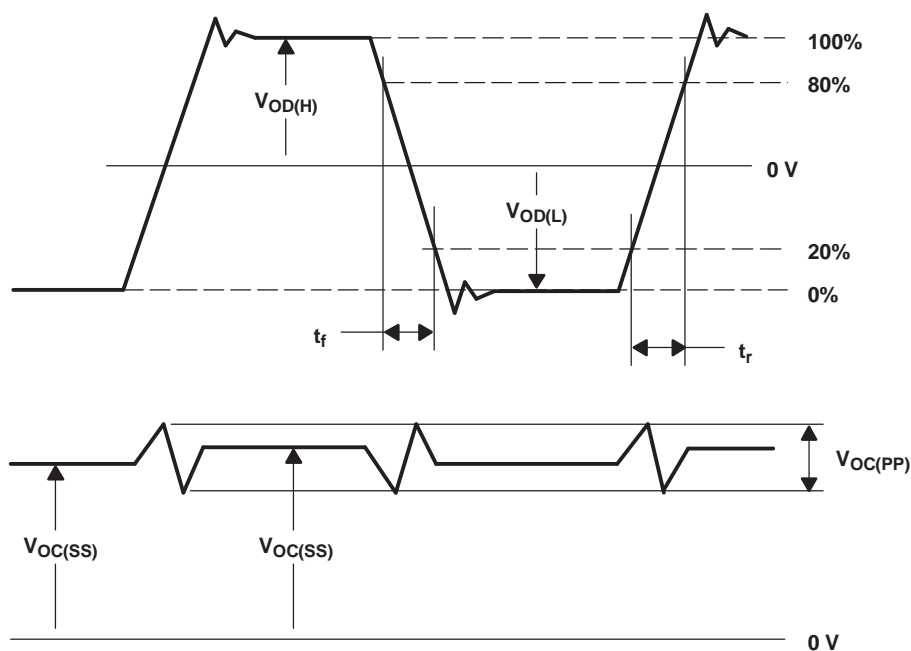
**Figure 2. Setup and Hold Time Definition**

# PARAMETER MEASUREMENT INFORMATION (continued)



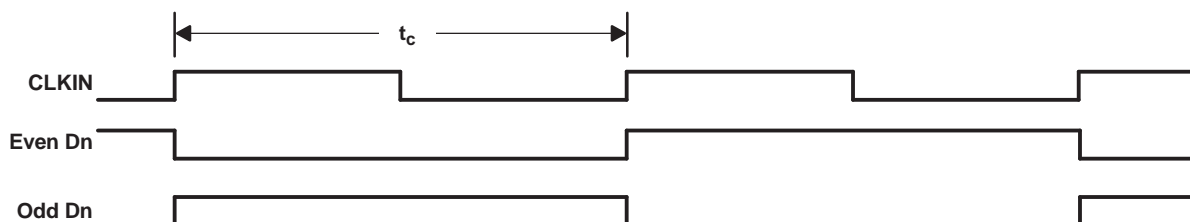
NOTE A: The lumped instrumentation capacitance for any single-ended voltage measurement is less than or equal to 10 pF. When making measurements at YP or YM, the complementary output is similarly loaded.

(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)

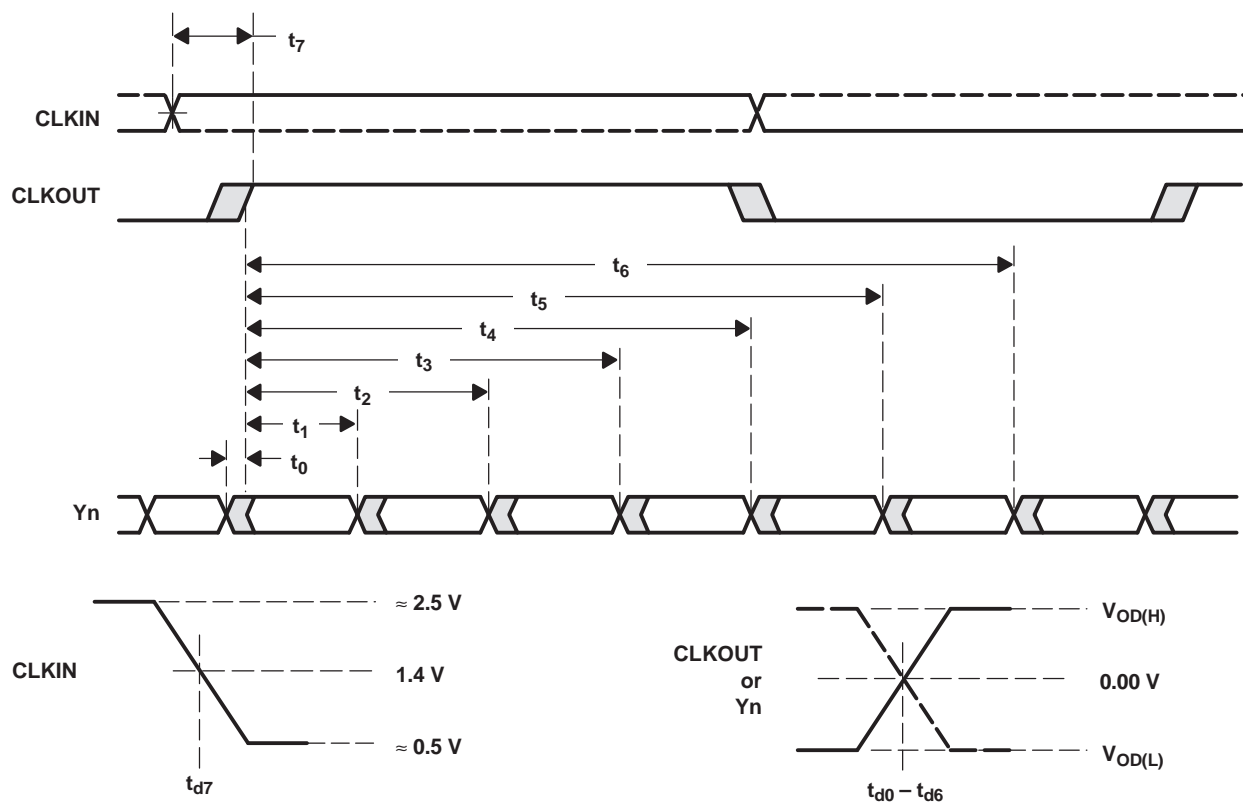


Figure 5. Timing Definitions

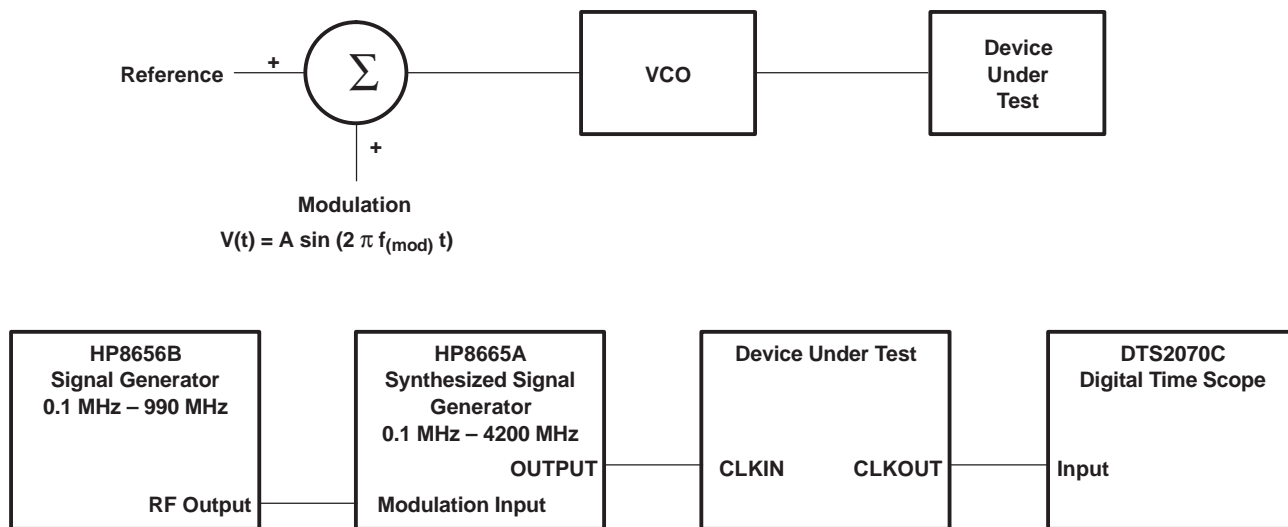
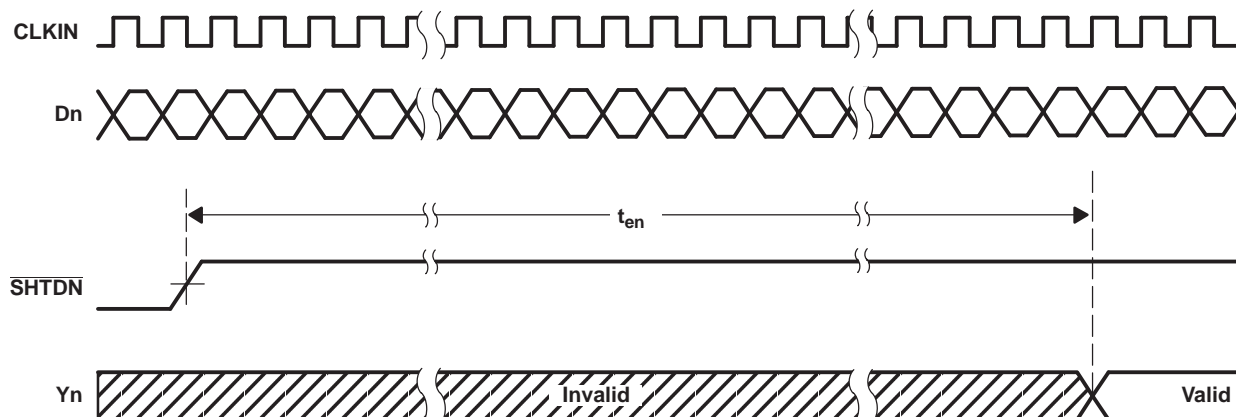


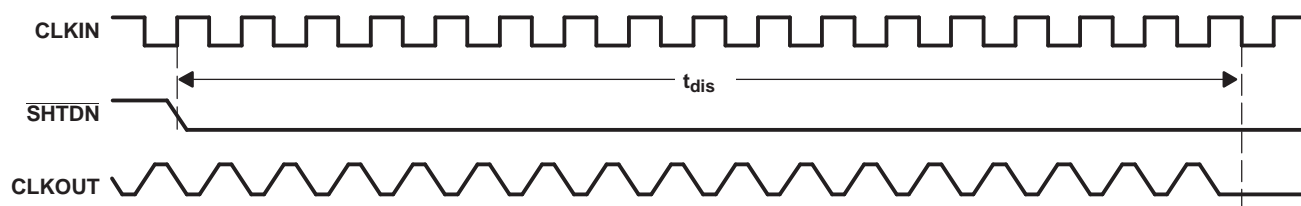
Figure 6. Output Clock Jitter Test Setup



## PARAMETER MEASUREMENT INFORMATION (continued)



**Figure 7. Enable Time Waveforms (CLKSEL low shown)**

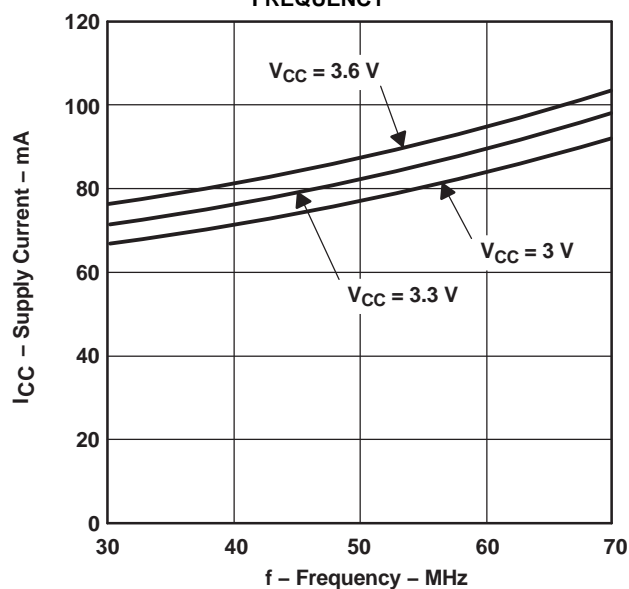


**Figure 8. Disable Time Waveforms (CLKSEL low shown)**

## TYPICAL CHARACTERISTICS

### WORST-CASE SUPPLY CURRENT

### vs FREQUENCY

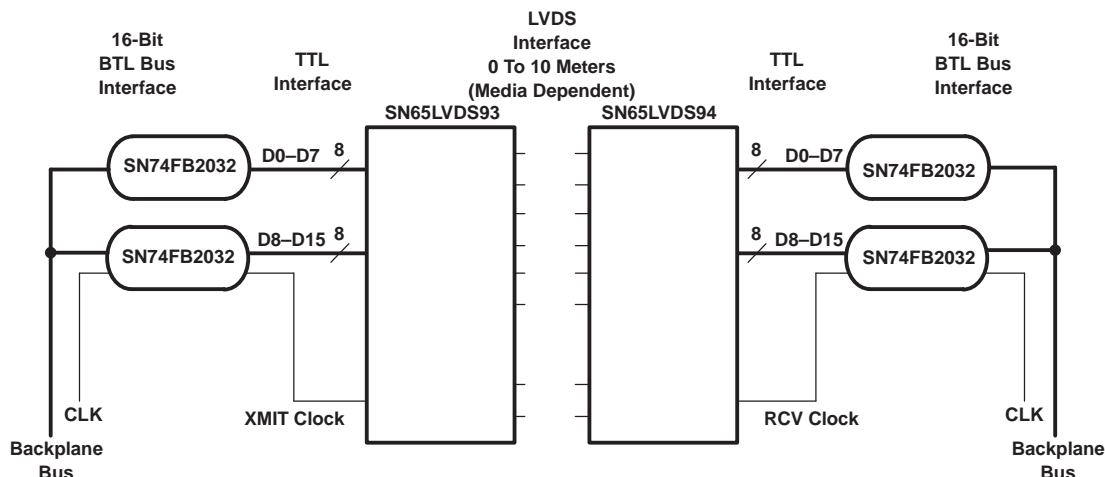


**Figure 9.**

## 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 LVTTTL 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 LVTTTL 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.

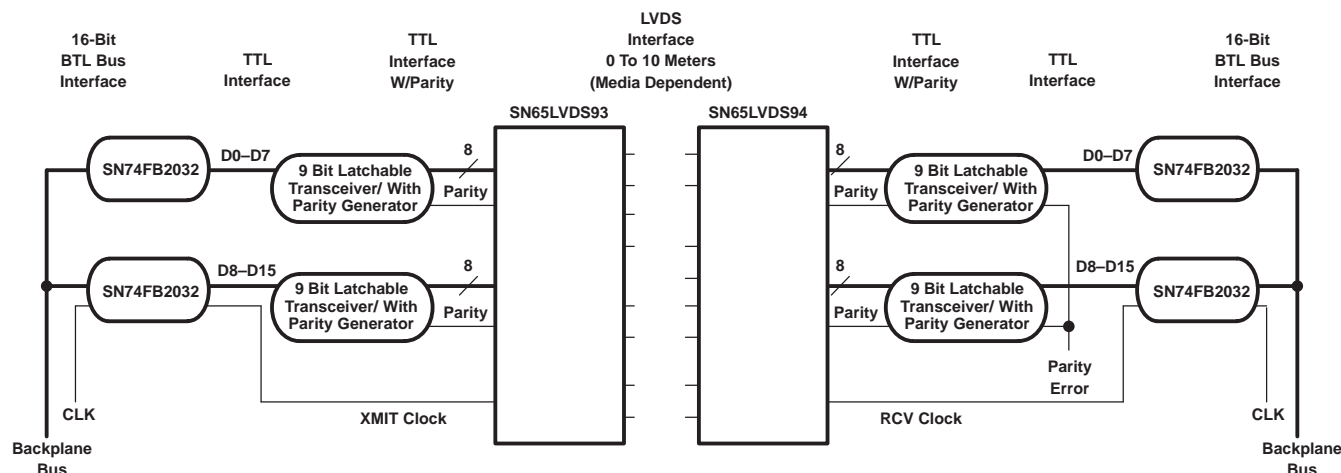


Figure 11. 16-Bit Bus Extension With Parity

### 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.

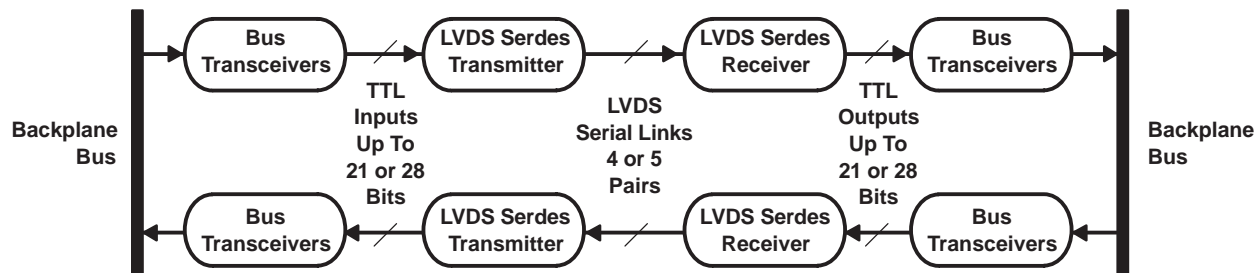


Figure 12. Virtual Backplane Transceiver

## 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)
<a href="#">SN65LVDS93DGG</a>	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
<a href="#">SN65LVDS93DGGR</a>	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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## TAPE AND REEL INFORMATION



\*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

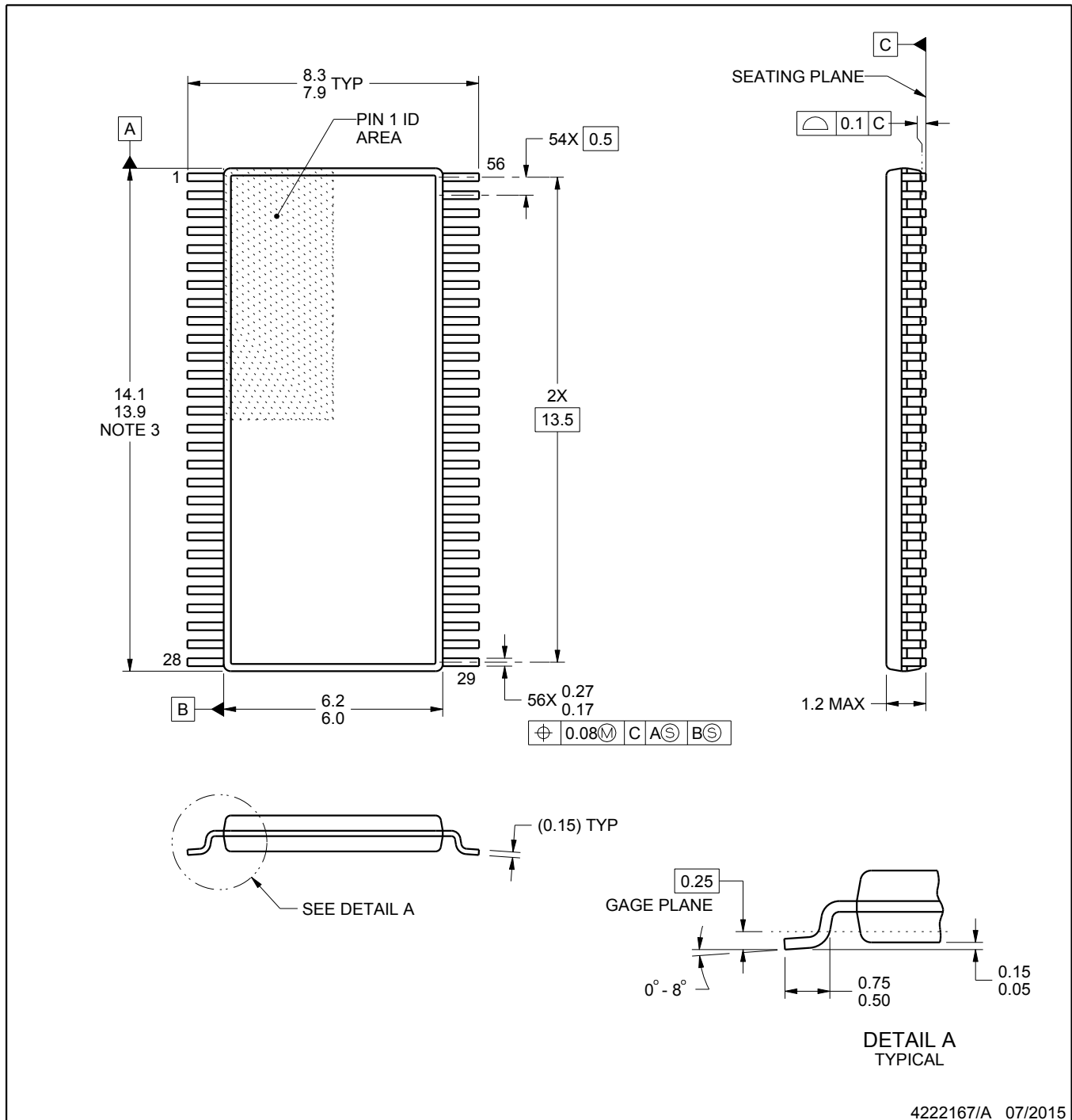
## TUBE



\*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





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## NOTES:

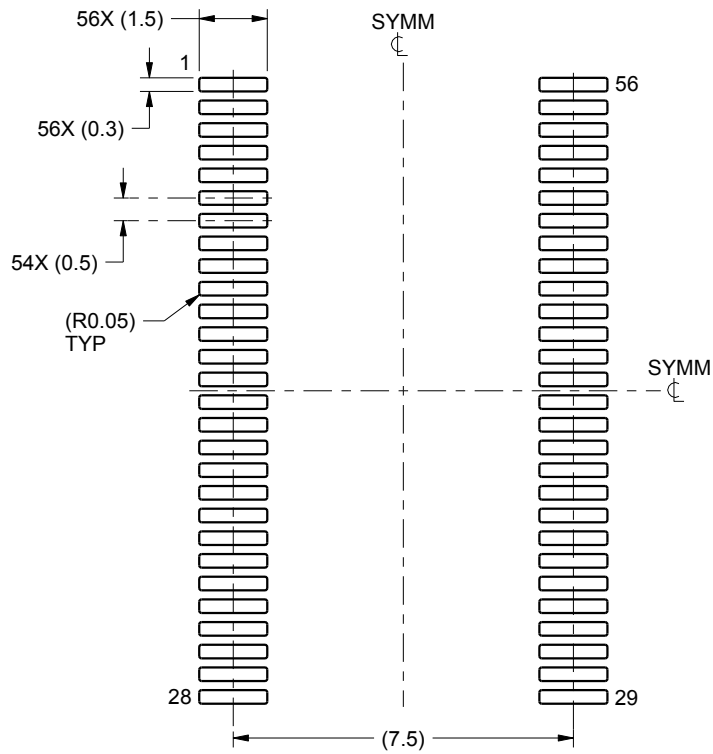
- All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
- This drawing is subject to change without notice.
- This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate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

# EXAMPLE BOARD LAYOUT

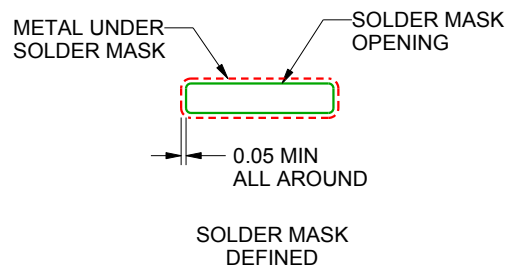
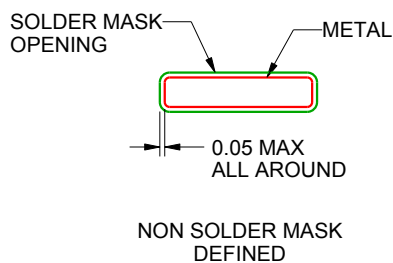
DGG0056A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
SCALE:6X



SOLDER MASK DETAILS

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NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.

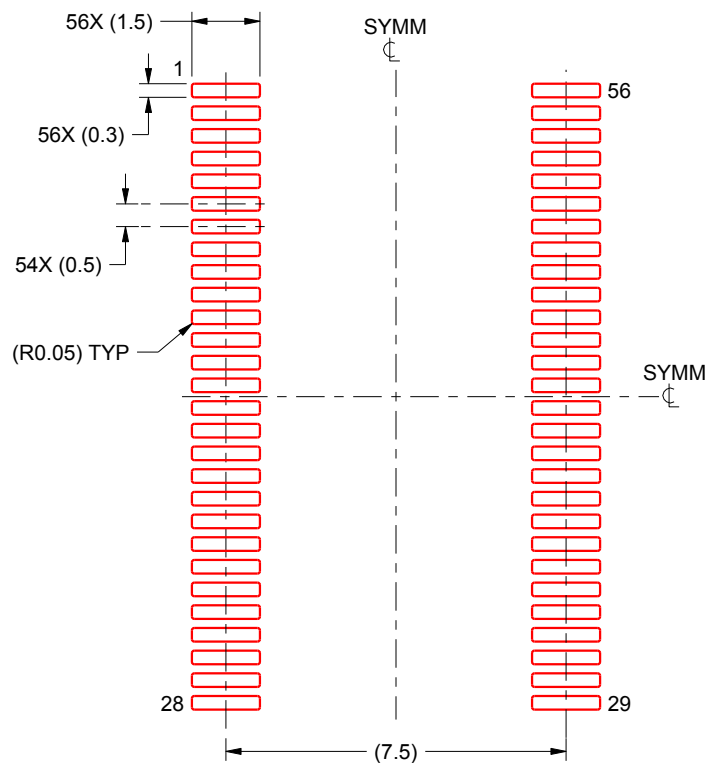
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## EXAMPLE STENCIL DESIGN

DGG0056A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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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