LVDS SERDES TRANSMITTER

FEATURES

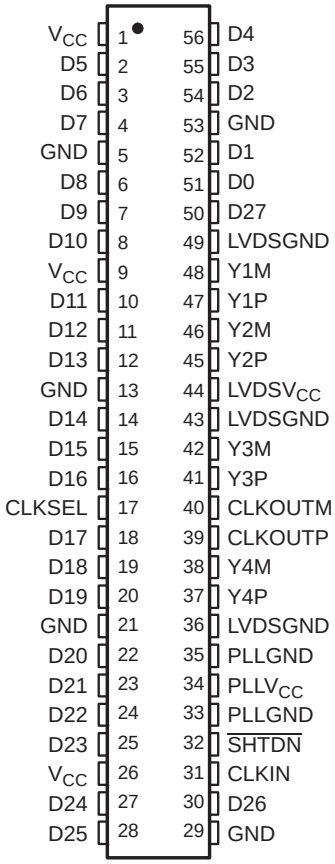
- **28:4 Data Channel Compression at up to 1.904 Gigabits per Second Throughput**
- **Suited for Point-to-Point Subsystem Communication With Very Low EMI**
- **28 Data Channels Plus Clock in Low-Voltage TTL and 4 Data Channels Plus Clock Out Low-Voltage Differential**
- **Selectable Rising or Falling 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 7ıclock 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)



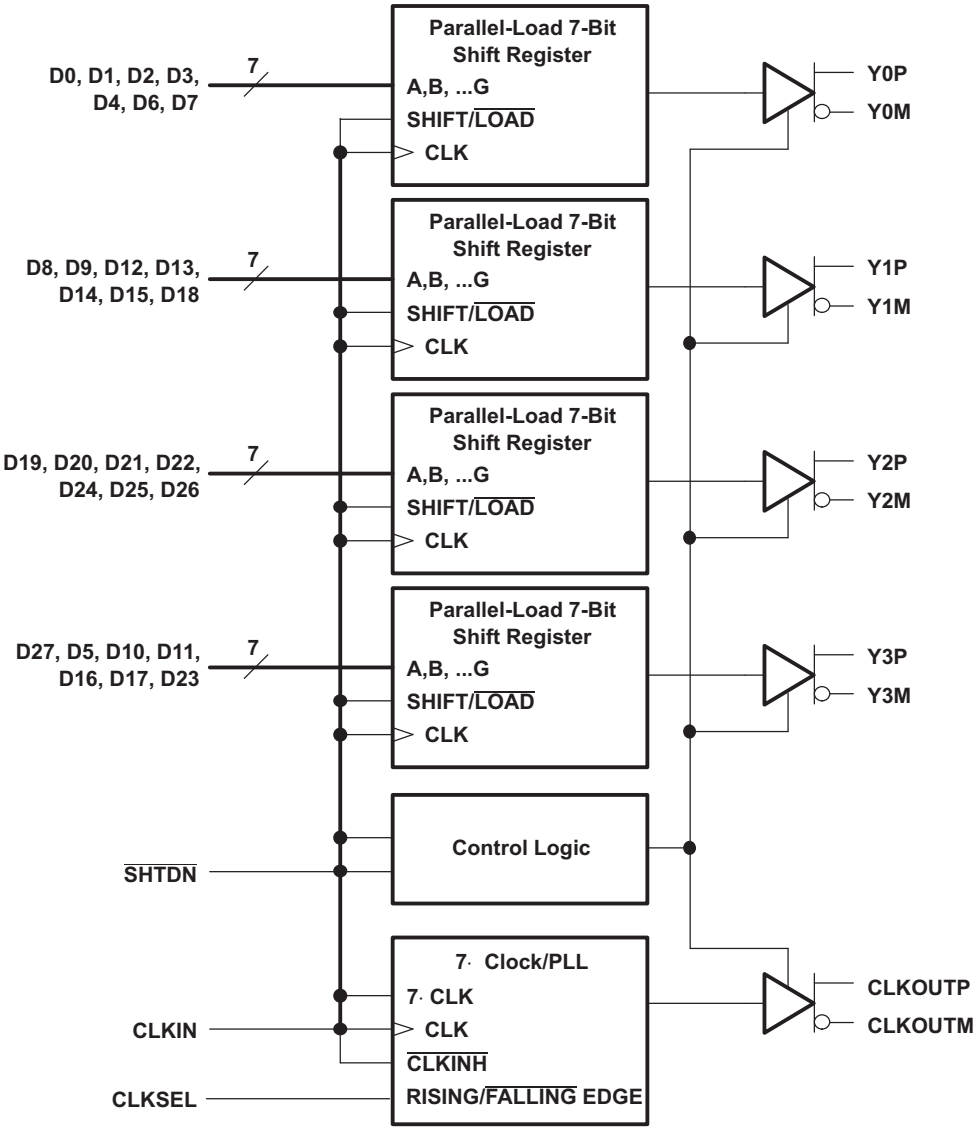
These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

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 ($\overline{SHTDN}$). $\overline{SHTDN}$ 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



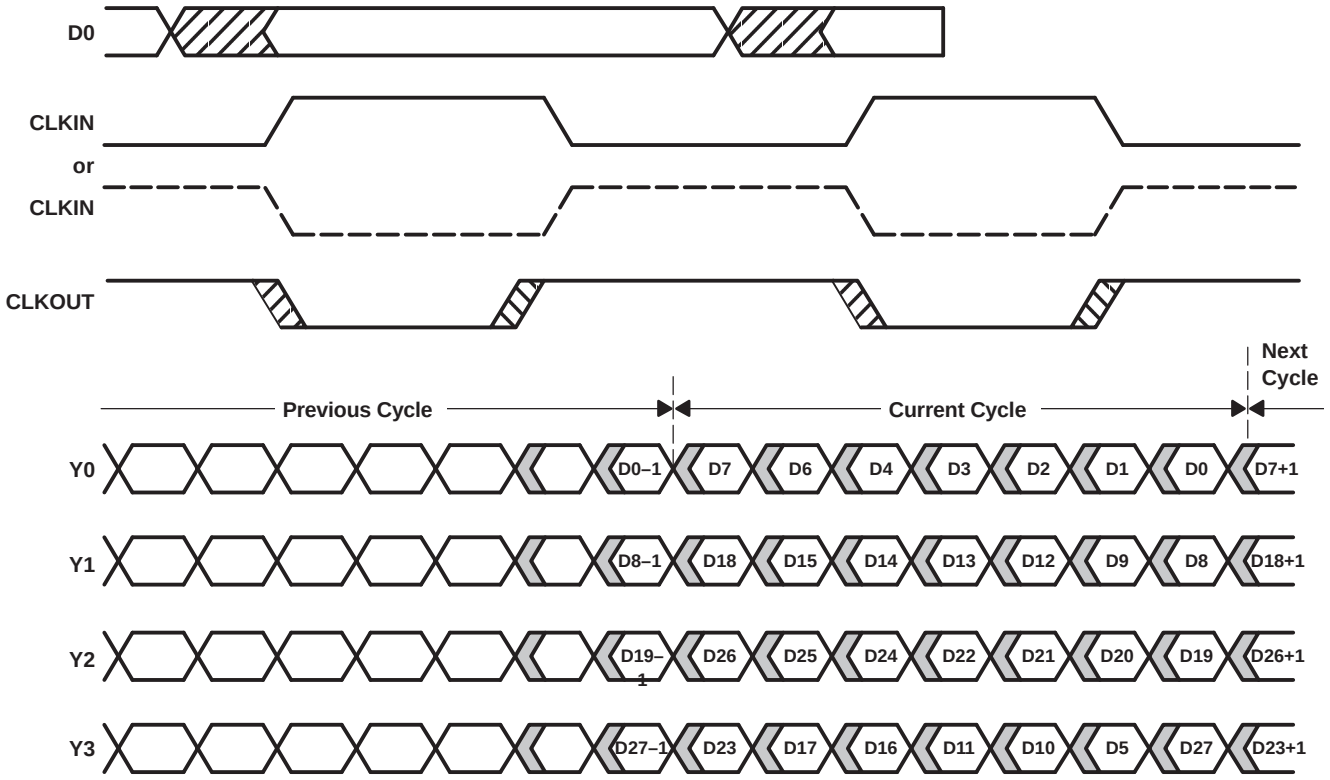
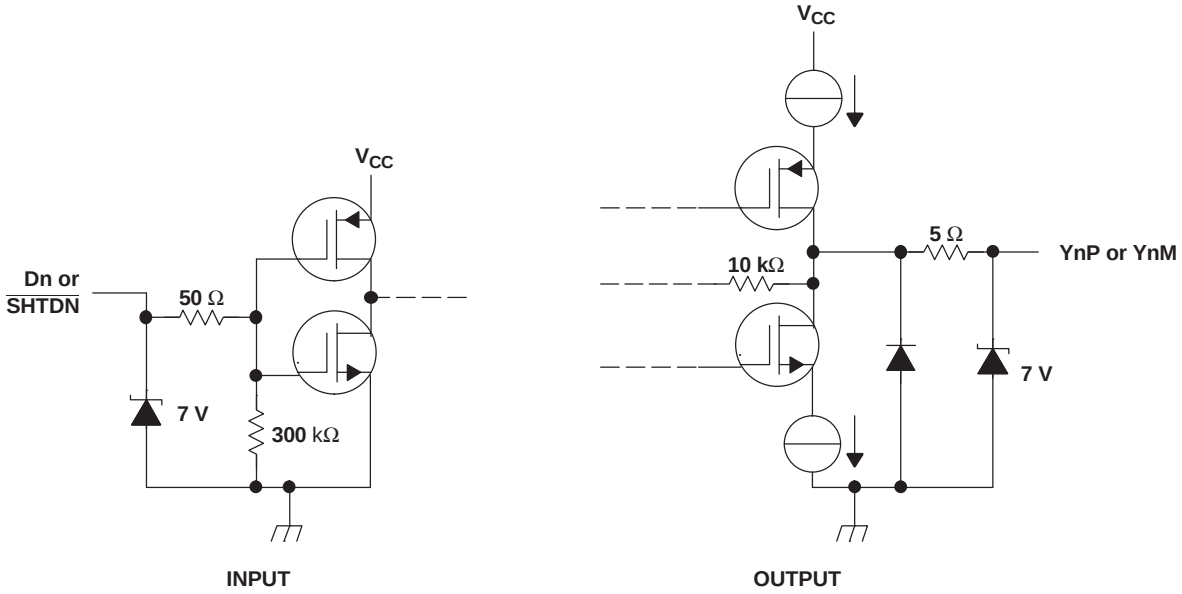


Figure 1. Typical 'LVDS93 Load and Shift Sequences

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	$T_A \le 25°C$ POWER RATING	DERATING FACTOR(1) ABOVE $T_A = 25°C$	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ POWER RATING
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

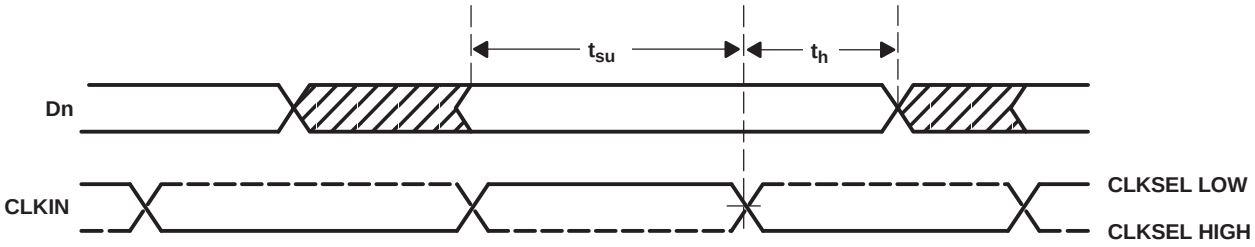
SWITCHING CHARACTERISTICS

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, $\overline{SHTDN}$↑ to phase lock (Yn valid)	See Figure 7		1		ms
t_{dis}	Disable time, $\overline{SHTDN}$↓ 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.

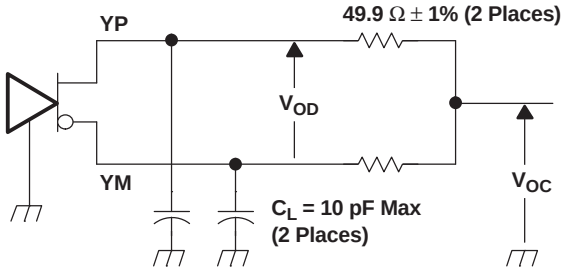
PARAMETER MEASUREMENT INFORMATION



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.

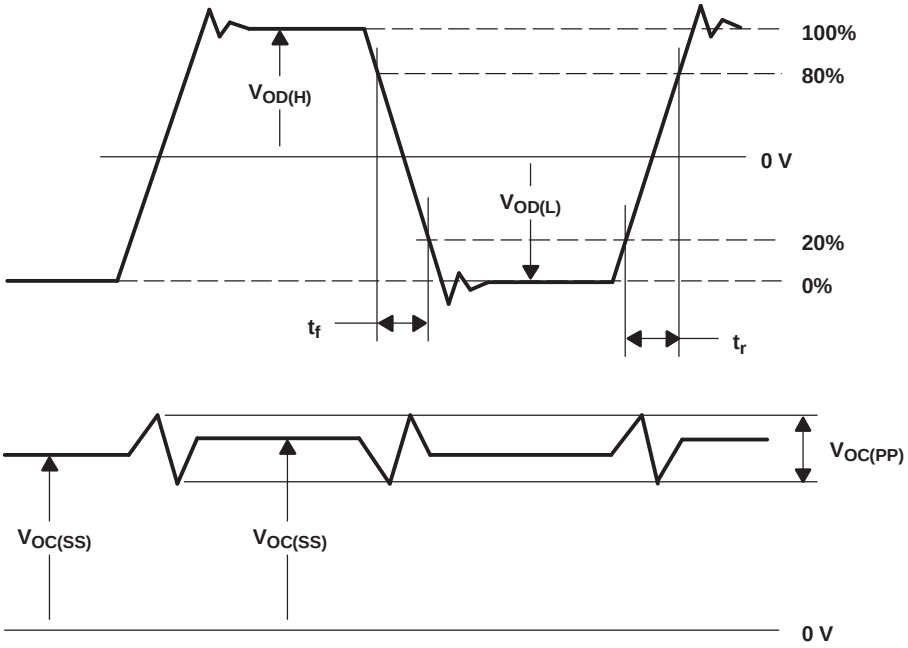
Figure 2. Setup and Hold Time Definition

PARAMETER MEASUREMENT INFORMATION (continued)



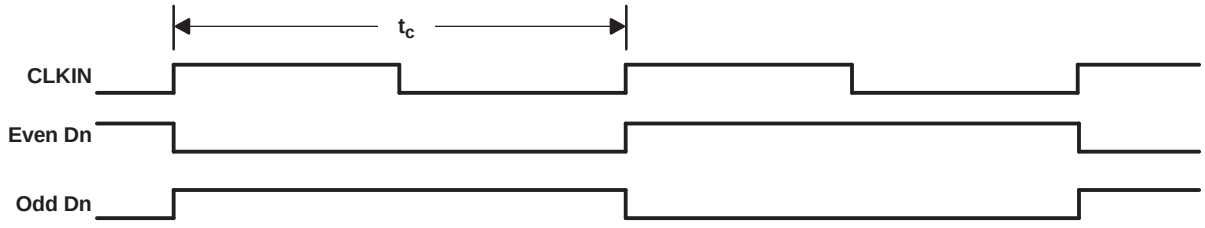
NOTE A: The lumped instrumentation capacitance for any single-ended voltage measurement is less than or equal to 10 pF. When making measurements at YP or YM, the complementary output is similarly loaded.

(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)

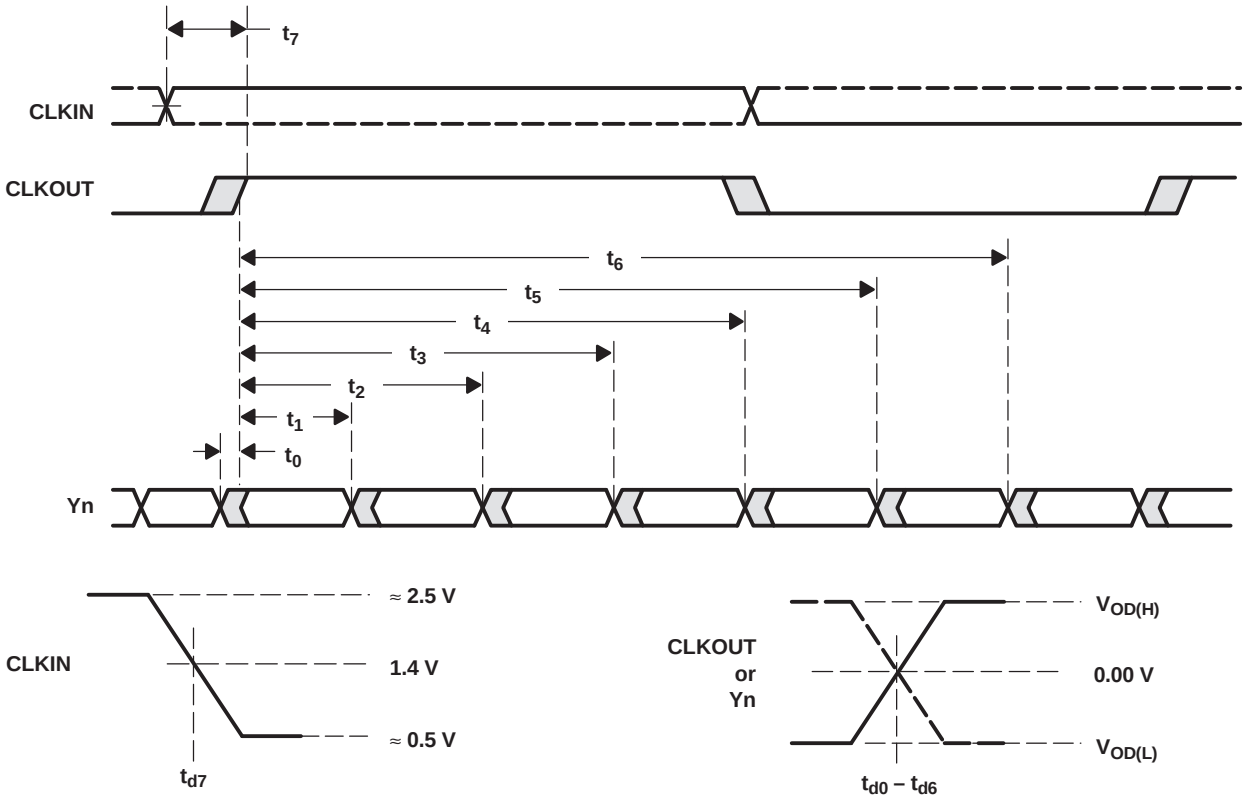


Figure 5. Timing Definitions

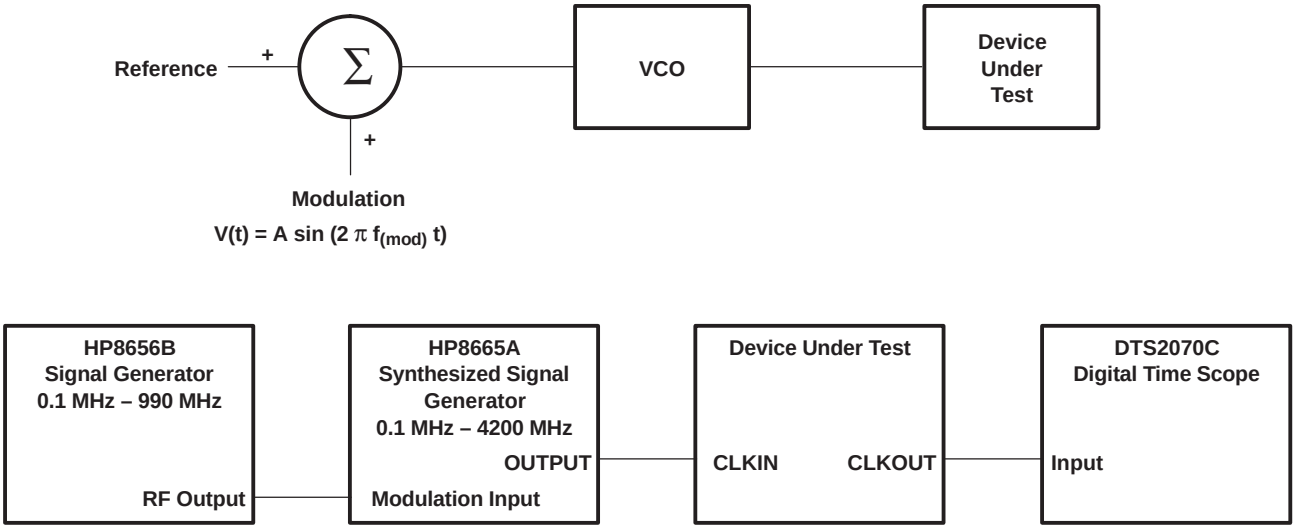


Figure 6. Output Clock Jitter Test Setup

PARAMETER MEASUREMENT INFORMATION (continued)

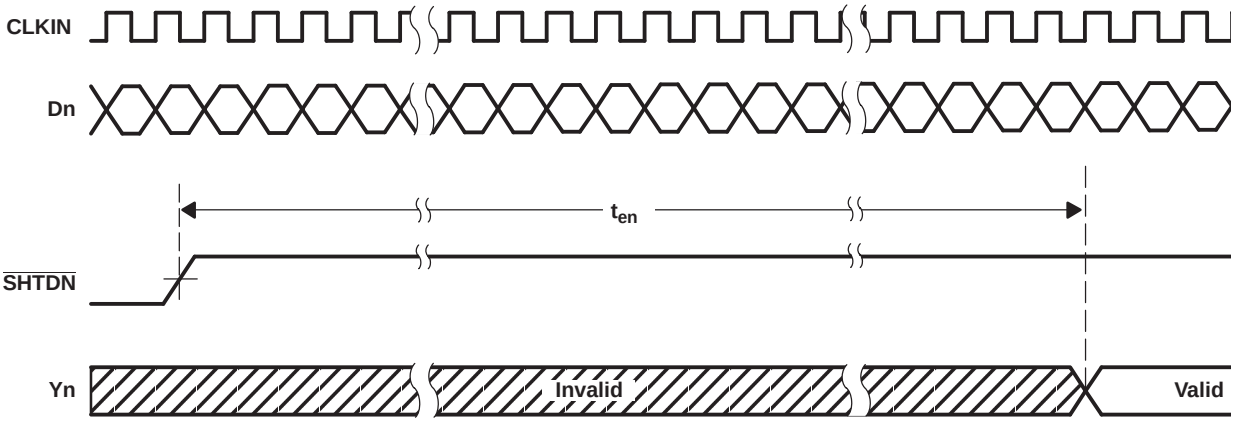


Figure 7. Enable Time Waveforms (CLKSEL low shown)

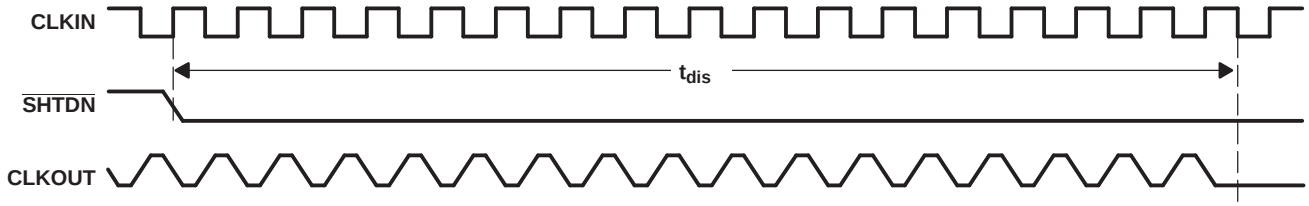


Figure 8. Disable Time Waveforms (CLKSEL low shown)

TYPICAL CHARACTERISTICS

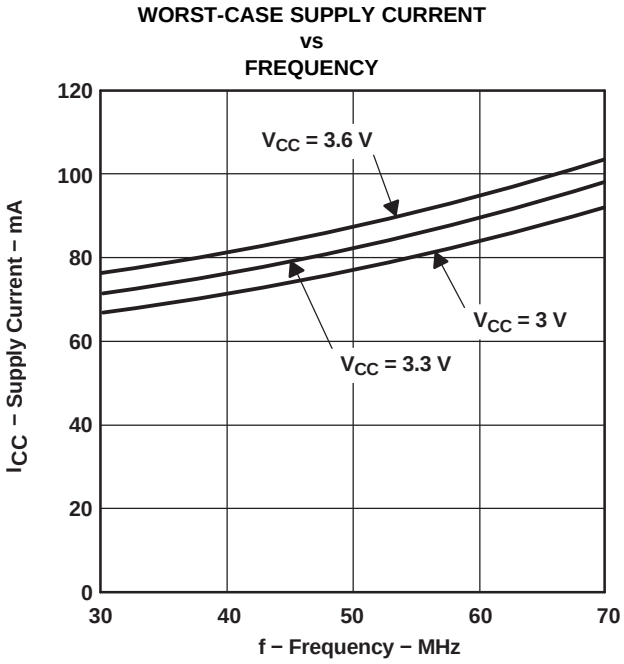


Figure 9.

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.

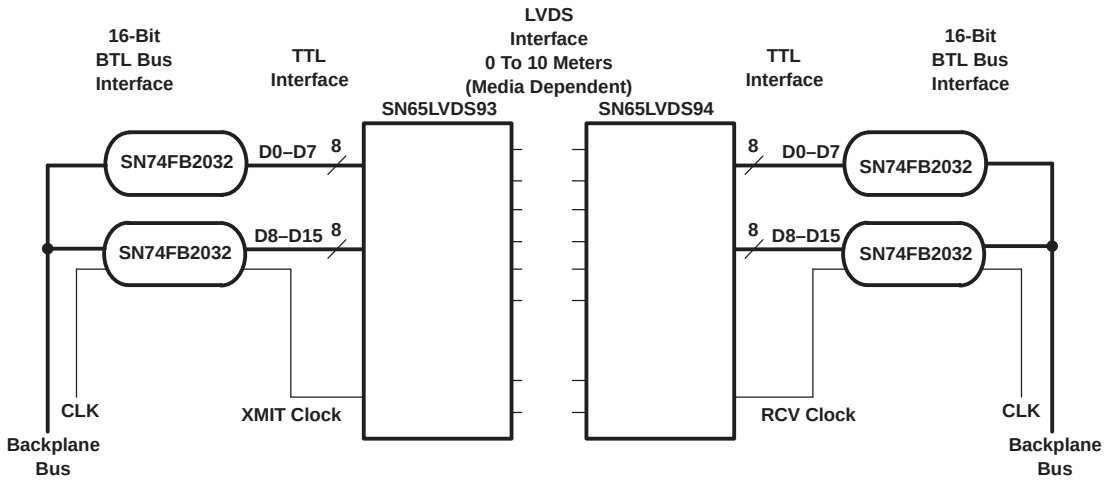


Figure 10. 16-Bit Bus Extension

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.

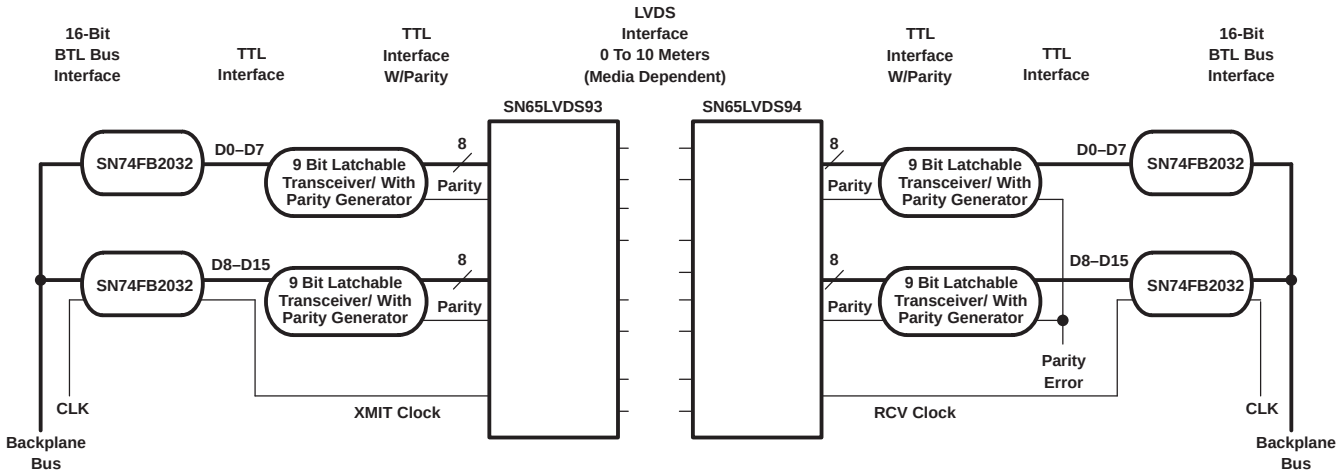


Figure 11. 16-Bit Bus Extension With Parity

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.

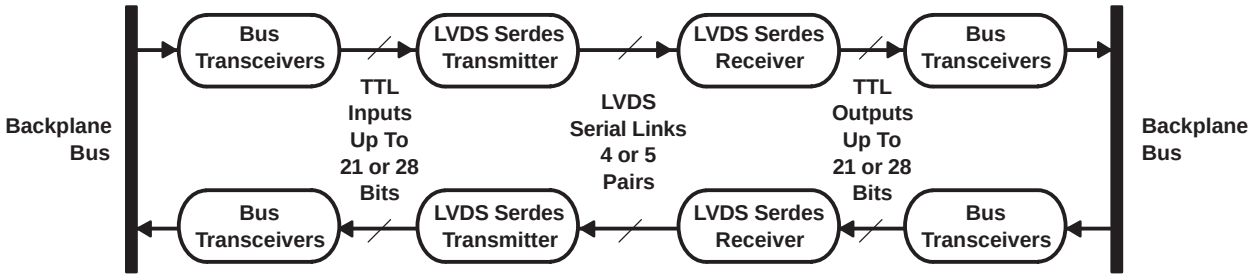


Figure 12. Virtual Backplane Transceiver

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
SN65LVDS93DGG	ACTIVE	TSSOP	DGG	56	35	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR		SN65LVDS93	Samples
SN65LVDS93DGGG4	ACTIVE	TSSOP	DGG	56	35	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR		SN65LVDS93	Samples
SN65LVDS93DGGR	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LVDS93	Samples
SN65LVDS93DGGRG4	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LVDS93	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.

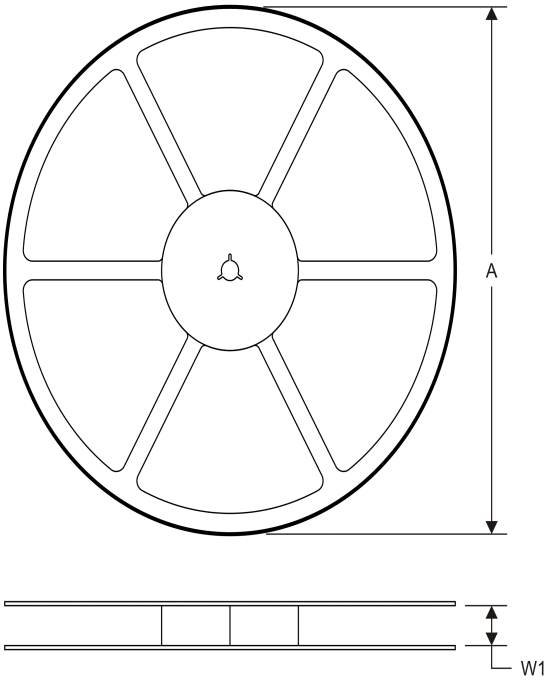
(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
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.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

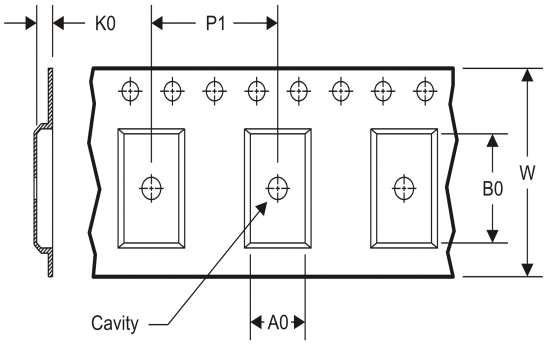
(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



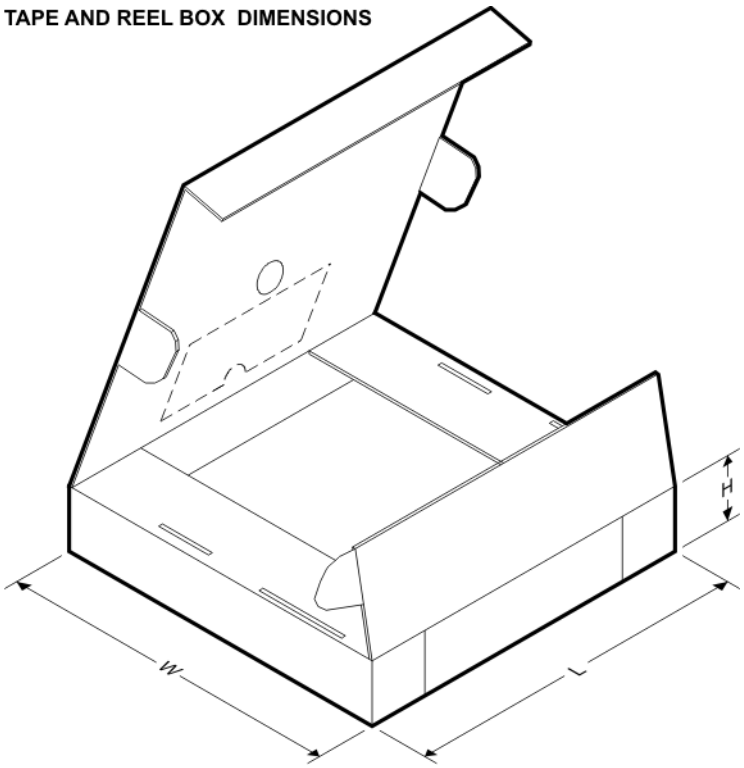
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

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

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

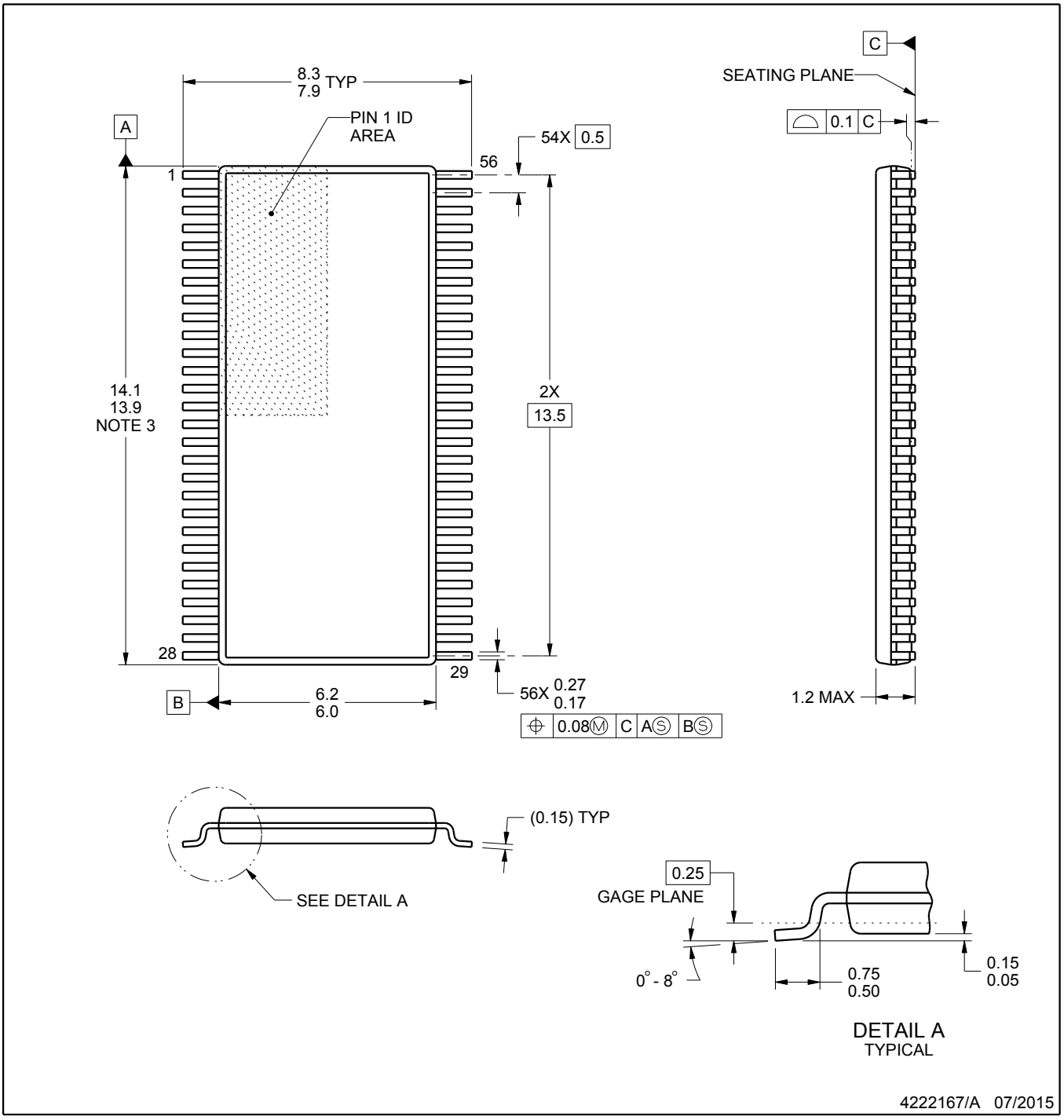
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN65LVDS93DGGR	TSSOP	DGG	56	2000	367.0	367.0	45.0

PACKAGE OUTLINE

DGG0056A

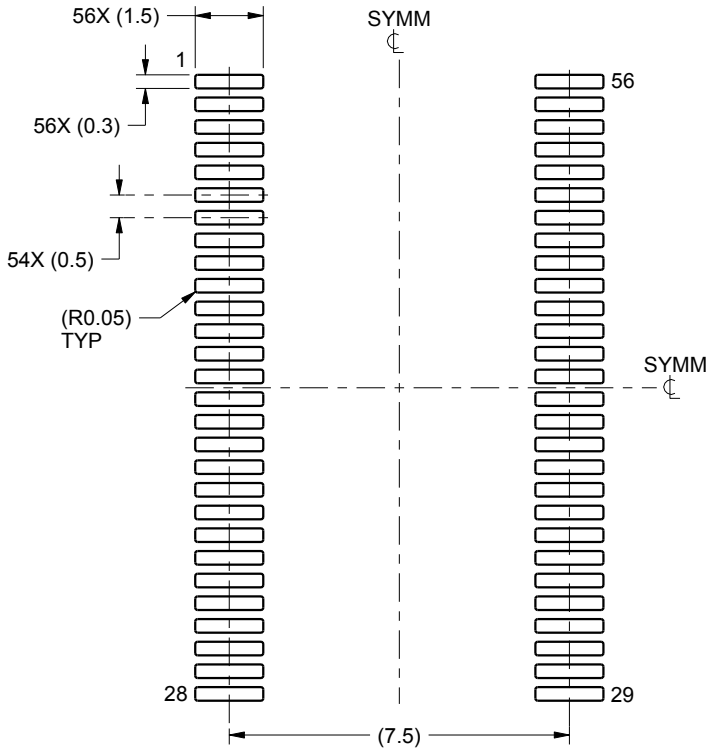
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE

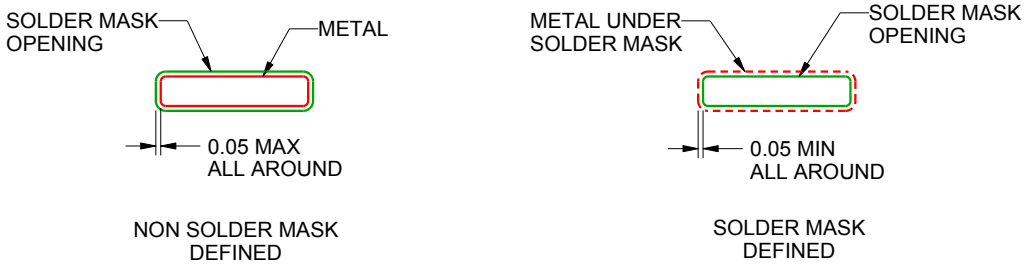


NOTES:

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

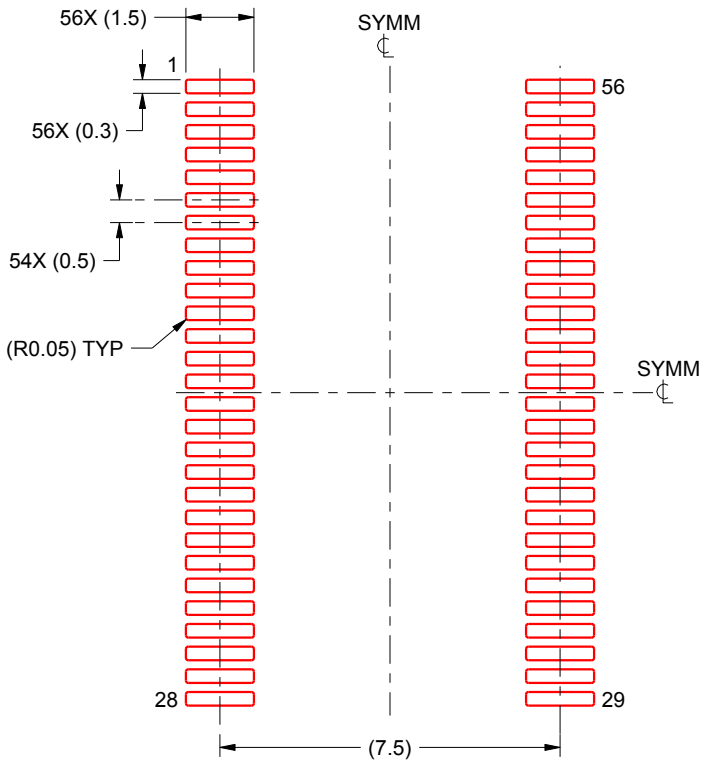


SOLDER MASK DETAILS

4222167/A 07/2015

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

4222167/A 07/2015

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.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265