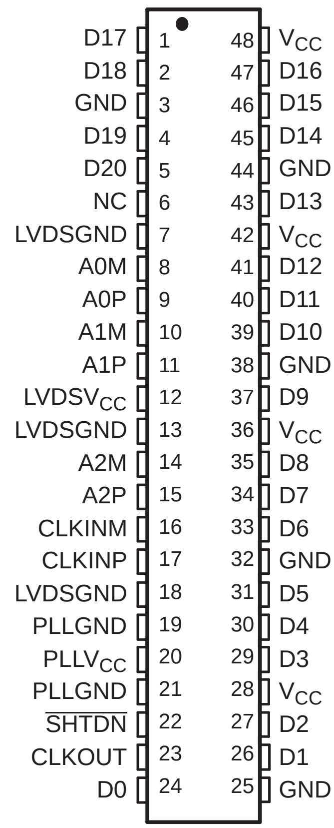
LVDS SERDES RECEIVER

FEATURES

- **3:21 Data Channel Compression at up to 1.428 Gigabits/s Throughput**
- **Suited for Point-to-Point Subsystem Communication With Very Low EMI**
- **3 Data Channels and Clock Low-Voltage Differential Channels in and 21 Data and Clock Low-Voltage TTL Channels Out**
- **Operates From a Single 3.3-V Supply and 250 mW (Typ)**
- **5-V Tolerant $\overline{\text{SHTDN}}$ Input**
- **Rising Clock Edge Triggered Outputs**
- **Bus Pins Tolerate 4-kV HBM ESD**
- **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**
- **Inputs Meet or Exceed the Requirements of ANSI EIA/TIA-644 Standard**
- **Industrial Temperature Qualified T_A = –40°C to 85°C**
- **Replacement for the DS90CR216**

DGG PACKAGE (TOP VIEW)



DESCRIPTION

The SN65LVDS96 LVDS serdes (serializer/deserializer) receiver contains three serial-in 7-bit parallel-out shift registers, a 7× clock synthesizer, and four low-voltage differential signaling (LVDS) line receivers in a single integrated circuit. These functions allow receipt of synchronous data from a compatible transmitter, such asthe SN65LVDS95, over four balanced-pair conductors and expansion to 21 bits of single-ended LVTTL synchronous data at a lower transfer rate.

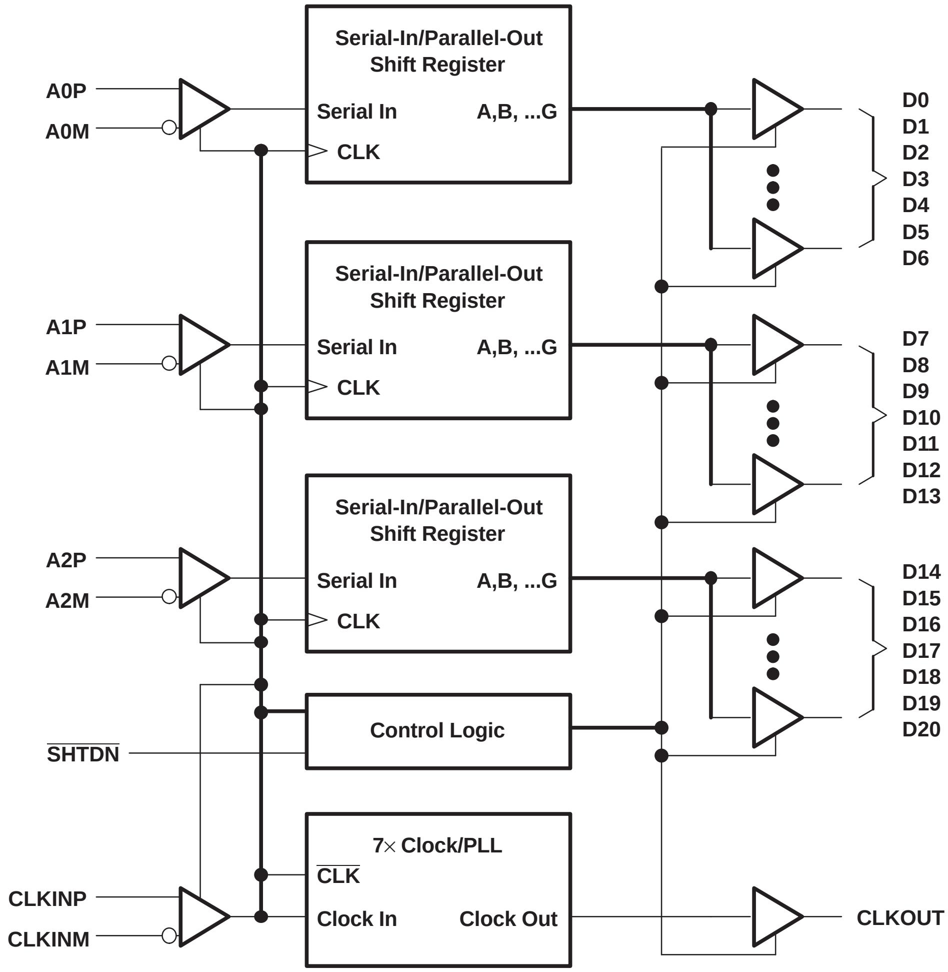
When receiving, the high-speed LVDS data is received and loaded into registers at the rate of seven times the LVDS input clock (CLKIN). The data is then unloaded to a 21-bit wide LVTTL parallel bus at the CLKIN rate. A phase-locked loop clock synthesizer circuit generates a 7× clock for internal clocking and an output clock for the expanded data. The SN65LVDS96 presents valid data on the rising edge of the output clock (CLKOUT).

The SN65LVDS96 requires only four line termination resistors for the differential inputs and little or no control. The data bus appears the same at the input to the transmitter and output of the receiver with data transmission transparent to the user(s). The only user intervention is the possible use of the shutdown/clear ($\overline{\text{SHTDN}}$) active-low input to inhibit the clock and shut off the LVDS receivers for lower power consumption. A low level on this signal clears all internal registers to a low level.

The SN65LVDS96 is characterized for operation over ambient air temperatures of –40°C to 85°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.

FUNCTIONAL BLOCK DIAGRAM



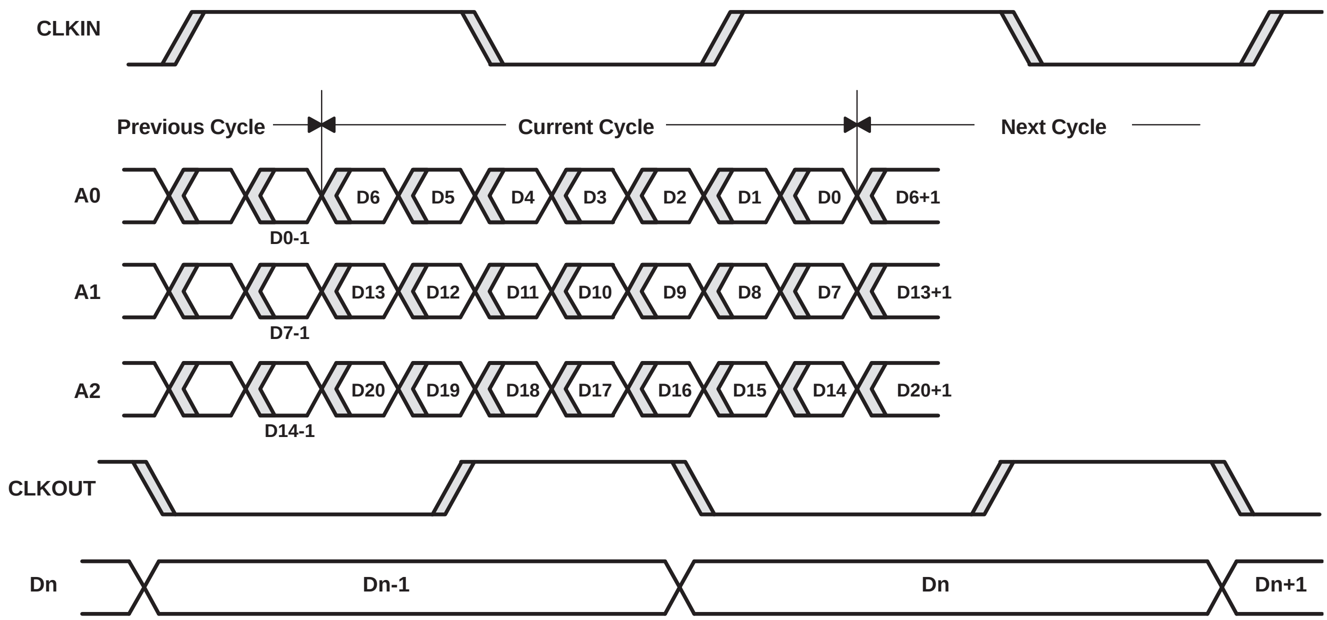
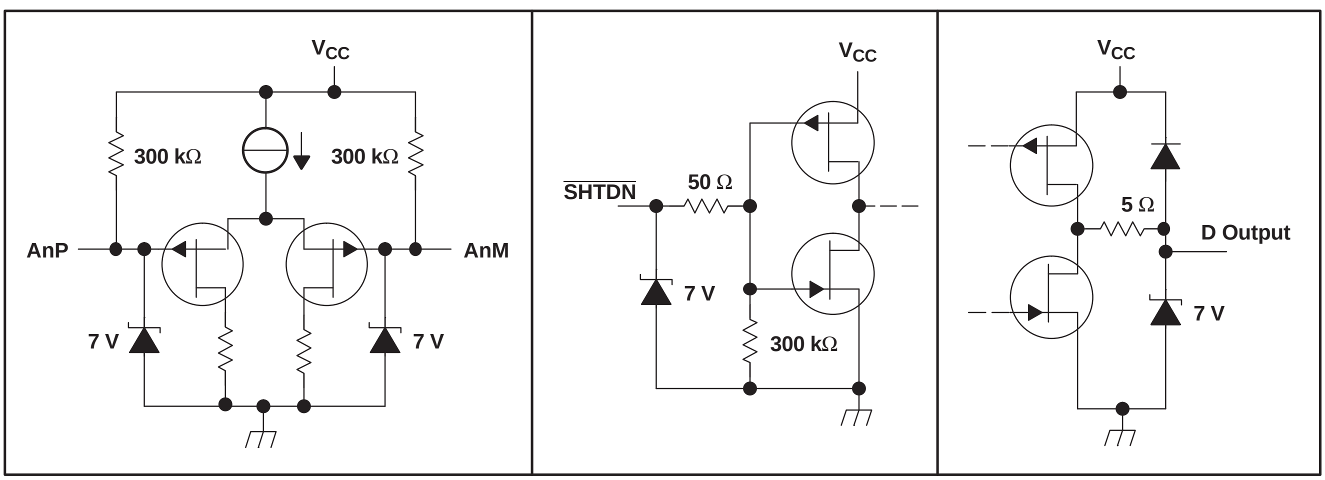


Figure 1. Typical 'LVDS96 Load and Shift Sequences

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
	Voltage range at any terminal (except $\overline{\text{SHTDN}}$)		–0.5 V to V_{CC} + 0.5 V
	Voltage range at $\overline{\text{SHTDN}}$ terminal		–0.5 V to 5.5 V
	Electrostatic discharge(3)	Bus pins (Class 3A)	4 KV
		Bus pins (Class 2B)	200 V
		All pins (Class 3A)	3 KV
		All 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 unless otherwise noted.
(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	1316 mW	13.1 mW/°C	724 mW	526 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	$\overline{\text{SHTDN}}$	2			V
V_{IL}	Low-level input voltage	$\overline{\text{SHTDN}}$			0.8	V
$\lvert V_{ID}\rvert$	Magnitude of differential input voltage		0.1		0.6	V
V_{IC}	Common-mode input voltage		$\frac{\lvert V_{ID}\rvert}{2}$		$2.4 \times \frac{\lvert V_{ID}\rvert}{2}$	V
					V_{CC}–0.8	
T_A	Operating free-air temperature		–40		85	°C

TIMING REQUIREMENTS

PARAMETERS		MIN	NOM	MAX	UNIT
t_c(1)	Input clock period	14.7	t_c	50	ns

(1) t_c is defined as the mean duration of a minimum of 32,000 clock periods.

ELECTRICAL CHARACTERISTICS

over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP[(1)]	MAX	UNIT
V_{IT+}	Positive-going differential Input voltage threshold				100	mV
V_{IT-}	Negative-going differential Input voltage threshold[(2)]		–100			mV
V_{OH}	High-level output voltage	I_{OH} = –4 mA	2.4			V
V_{OL}	Low-level output voltage	I_{OH} = 4 mA			0.4	V
I_{CC}	Quiescent current (average)	Disabled, all inputs open			280	μA
		Enabled, AnP at 1 V and AnM at 1.4 V, t_c = 15.38 ns		60	82	mA
		Enabled, C_L = 8 pF, Worst-case pattern (see Figure 4), t_c = 15.38 ns		94		mA
I_{IH}	High-level input current ($\overline{SHTDN}$)	$V_{IH} = V_{CC}$			±20	μA
I_{IL}	Low-level input current ($\overline{SHTDN}$)	V_{IL} = 0 V			±20	μA
I_{IN}	Input current (A inputs)	0 V ≤ V_I ≤ 2.4 V			±20	μA
I_{OZ}	High-impedance output current	V_O = 0 V to V_{CC}			±10	μA

(1) All typical values are V_{CC} = 3.3 V, T_A = 25°C.
(2) The algebraic convention, in which the less-positive (more-negative) limit is designated minimum, is used in this data sheet for the negative-going input voltage threshold only.

SWITCHING CHARACTERISTICS

over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_{su}	Data setup time, D0 through D20 to CLKOUT↑	C_L = 8 pF,	See Figure 5	3.4	6		ns
t_h	Data hold time, CLKOUT↑ to D0 through D20	C_L = 8 pF,	See Figure 5	4	6		ns
t_{RSKM}	Receiver input skew margin[(1)] (see Figure 7)	t_c = 15.38 ns (±0.2%), |Input clock jitter| <50 ps[(2)]	T_A = 0°C to 85°C	490	800		ps
			T_A = –40°C to 0°C	350			ps
t_d	Delay time, input clock to output clock (see Figure 7)	t_c = 15.38 ns (±0.2%)			3.7		ns
$\Delta t_{C(O)}$	Change in output clock period from cycle to cycle[(3)]	t_c = 15.38 + 0.75 sin (2π500E3t) ±0.05 ns, See Figure 7			±80		ps
		t_c = 15.38 + 0.75 sin (2π3E6t) ±0.05 ns, See Figure 7			±300		ps
t_{en}	Enable time, $\overline{SHTDN}$ to phase lock	See Figure 8			1		ms
t_{dis}	Disable time, $\overline{SHTDN}$ to Off state	See Figure 9			400		ns
t_t	Output transition time (10% to 90% t_r or t_f)	C_L = 8 pF			3		ns
t_w	Output clock pulse duration				0.43 t_c		ns

(1) t_{RSKM} is the timing margin available to allocate to the transmitter and interconnection skews and clock jitter. The value of this parameter at clock periods other than 15.38 ns can be calculated from $\frac{tc}{14}$ –600 ps.
(2) |Input clock jitter| is the magnitude of the change in the input clock period.
(3) $\Delta t_{C(O)}$ is the change in the output clock period from one cycle to the next cycle observed over 15,000 cycles.

PARAMETER MEASUREMENT INFORMATION

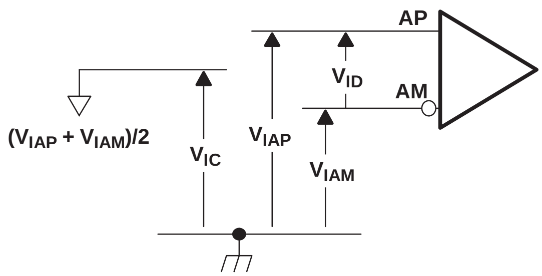


Figure 2. Voltage Definitions

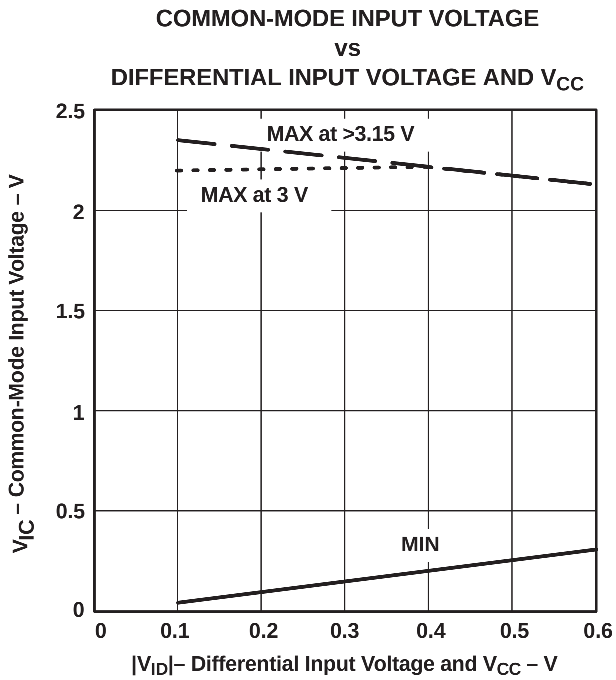
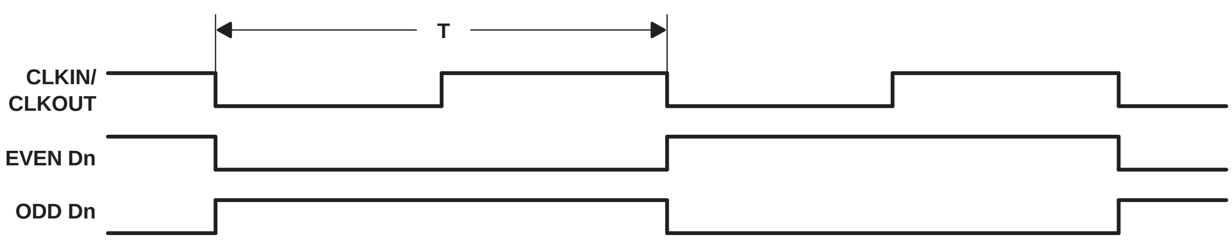


Figure 3. Maximum V_{IC} vs V_{ID} and V_{CC}



(1) The worst-case test pattern produces nearly the maximum switching frequency for all of the LV-TTL outputs.

Figure 4. Worst-Case[(1)] Test Pattern

PARAMETER MEASUREMENT INFORMATION (continued)

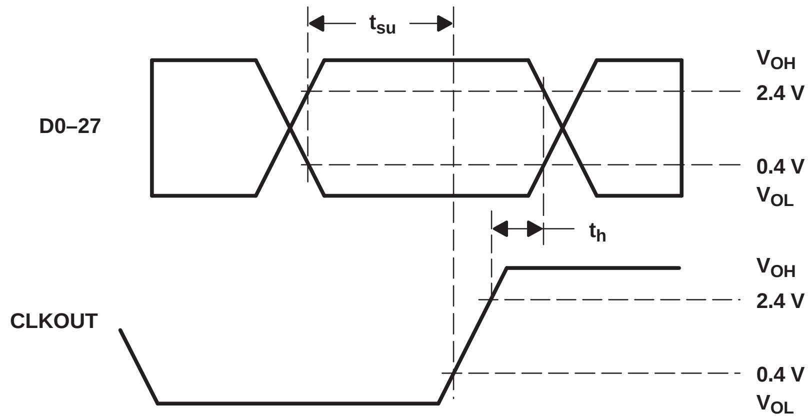
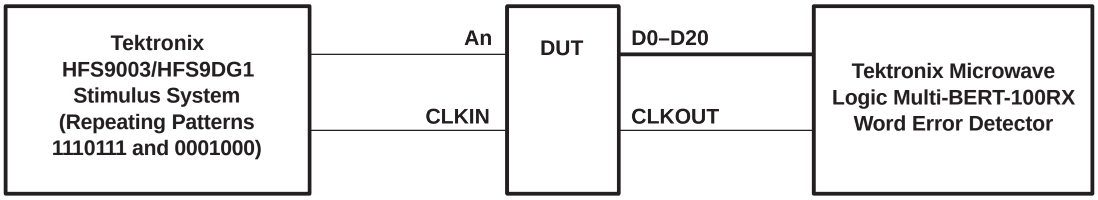


Figure 5. Setup and Hold-Time Measurements

PARAMETER MEASUREMENT INFORMATION (continued)



NOTES: A. CLKIN is advanced or delayed with respect to data until errors are observed at the receiver outputs.
B. The advance or delay is then reduced until there are no data errors observed.
C. The magnitude of the advance or delay from step 2 is t_{RSKM}.

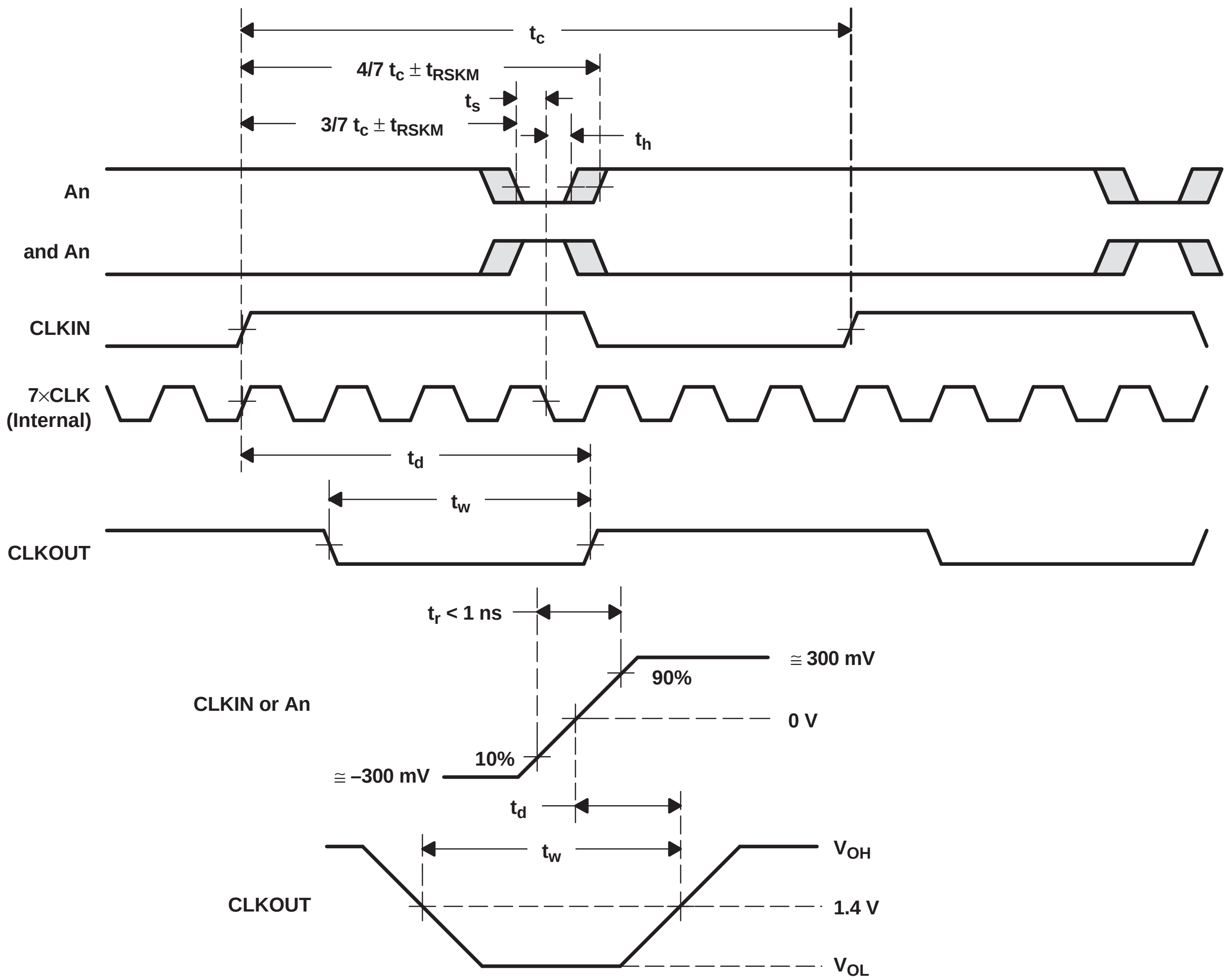


Figure 6. Receiver Input Skew Margin, Setup/Hold Time, and t_d Definitions

PARAMETER MEASUREMENT INFORMATION (continued)

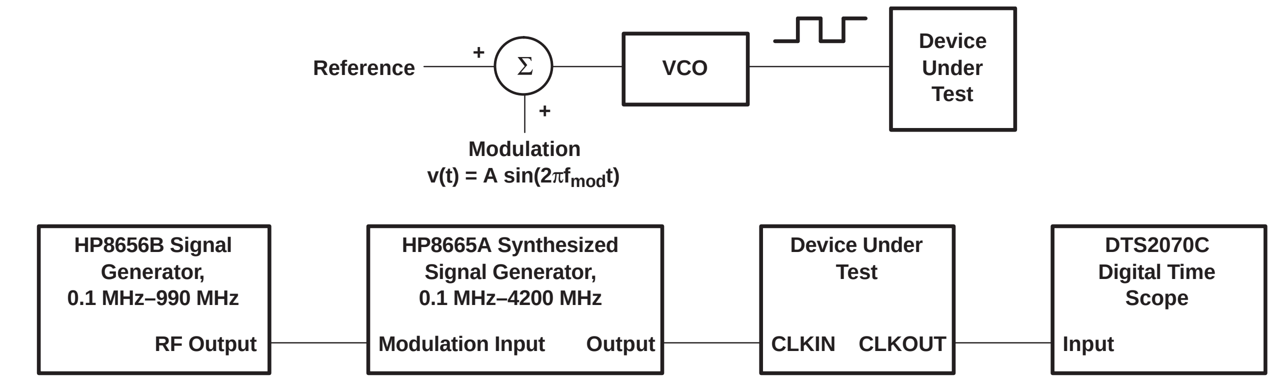


Figure 7. Output Clock Jitter Test Setup

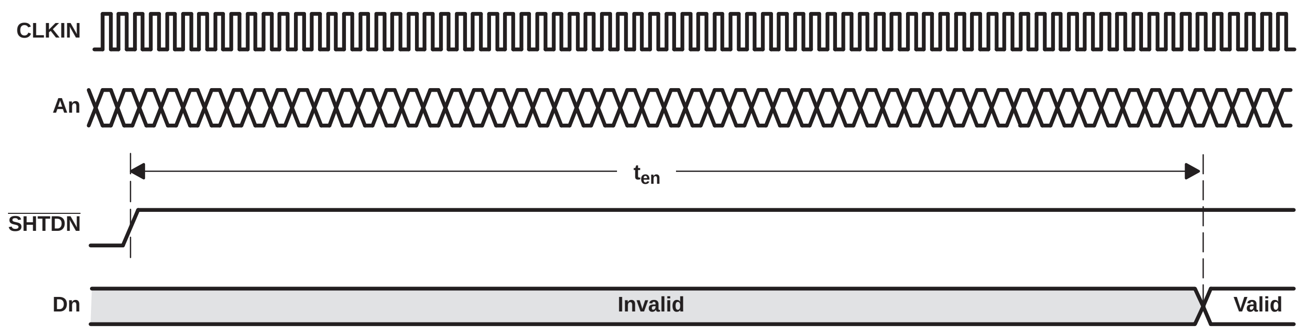


Figure 8. Enable Time Waveforms

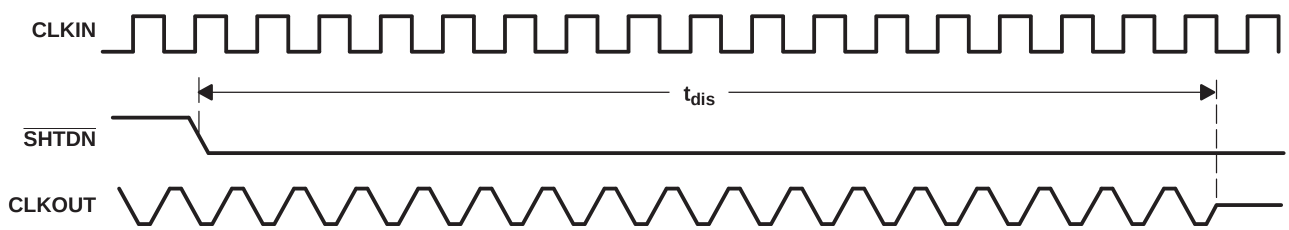


Figure 9. Disable Time Waveforms

TYPICAL CHARACTERISTICS

WORST-CASE SUPPLY CURRENT
vs
FREQUENCY

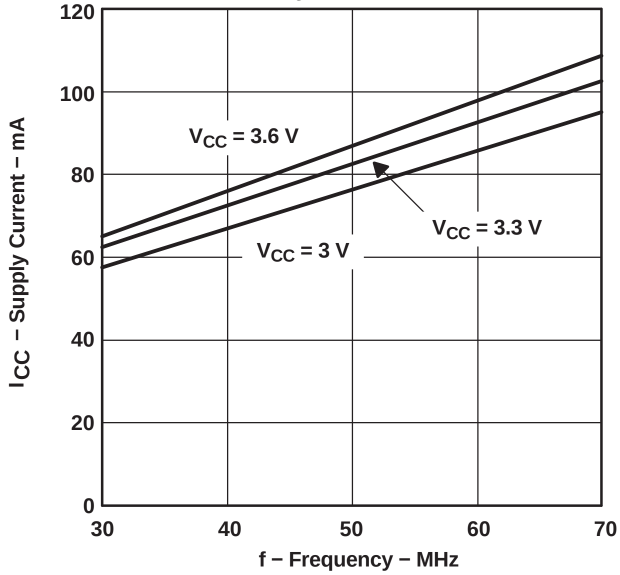


Figure 10.

APPLICATION INFORMATION

16-BIT BUS EXTENSION

In a 16-bit bus application (Figure 11), 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.

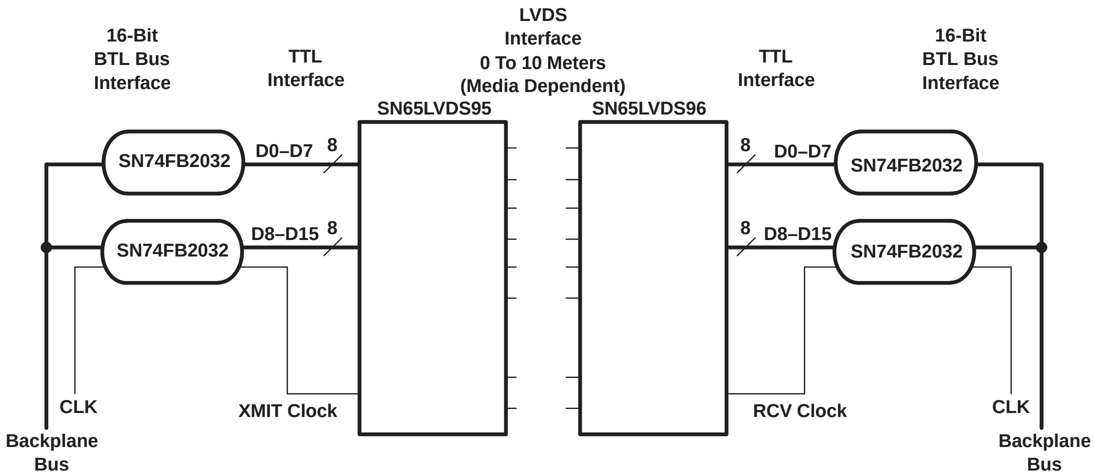


Figure 11. 16-Bit Bus Extension

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 12. 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.

APPLICATION INFORMATION (continued)

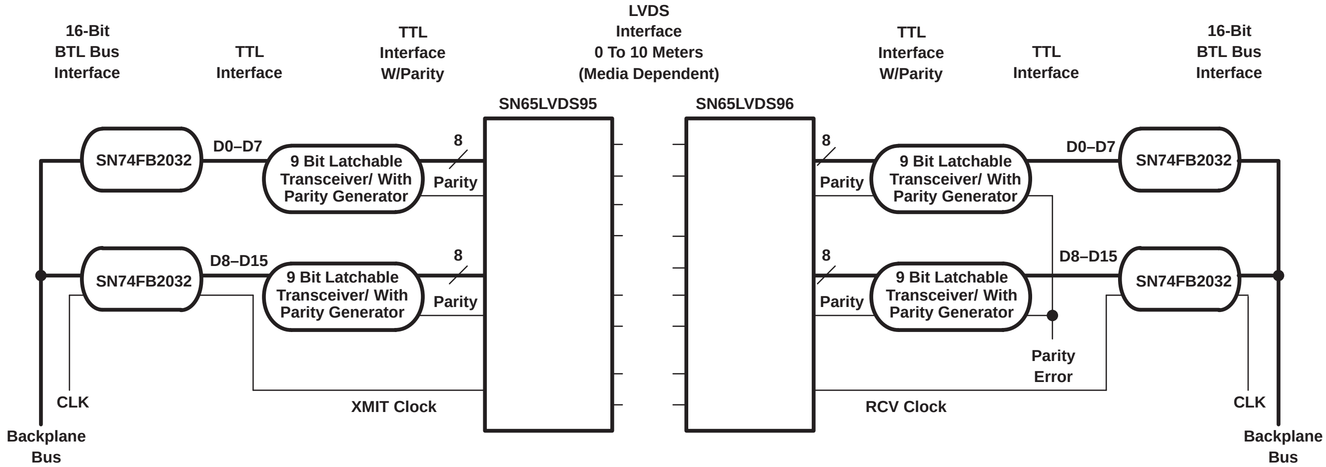


Figure 12. 16-Bit Bus Extension With Parity

LOW COST VIRTUAL BACKPLANE TRANSCEIVER

Figure 13 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 13, 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.

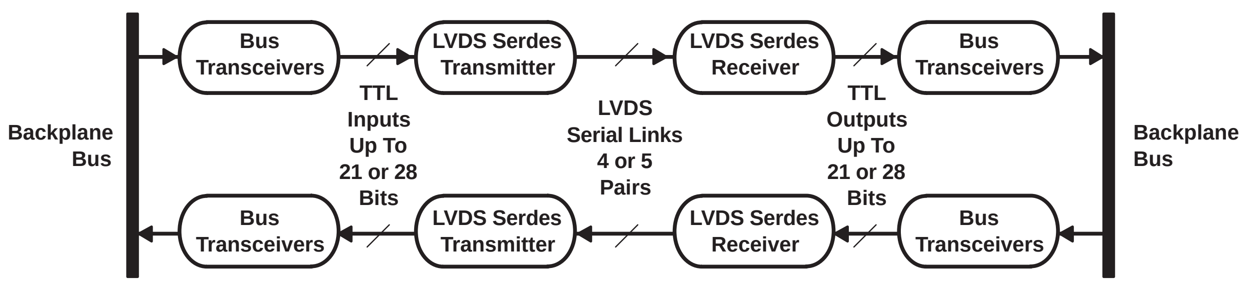


Figure 13. Virtual Backplane Transceiver

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
SN65LVDS96DGG	ACTIVE	TSSOP	DGG	48	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
SN65LVDS96DGGG4	ACTIVE	TSSOP	DGG	48	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
SN65LVDS96DGGR	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
SN65LVDS96DGGRG4	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR

(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)

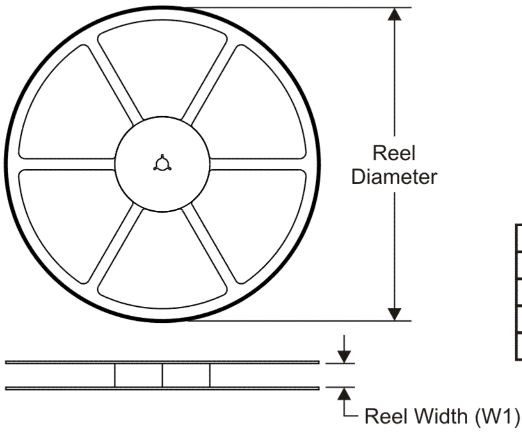
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

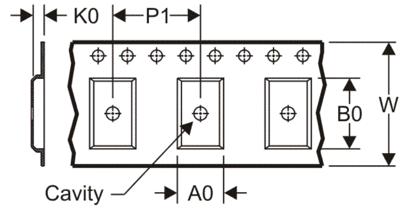
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

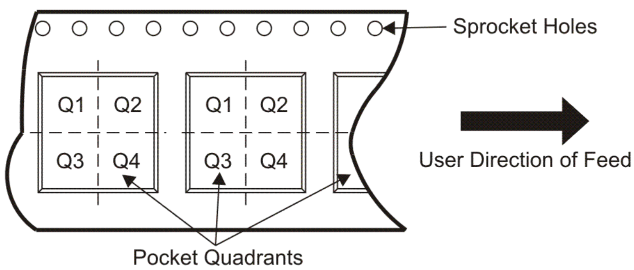


TAPE DIMENSIONS



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

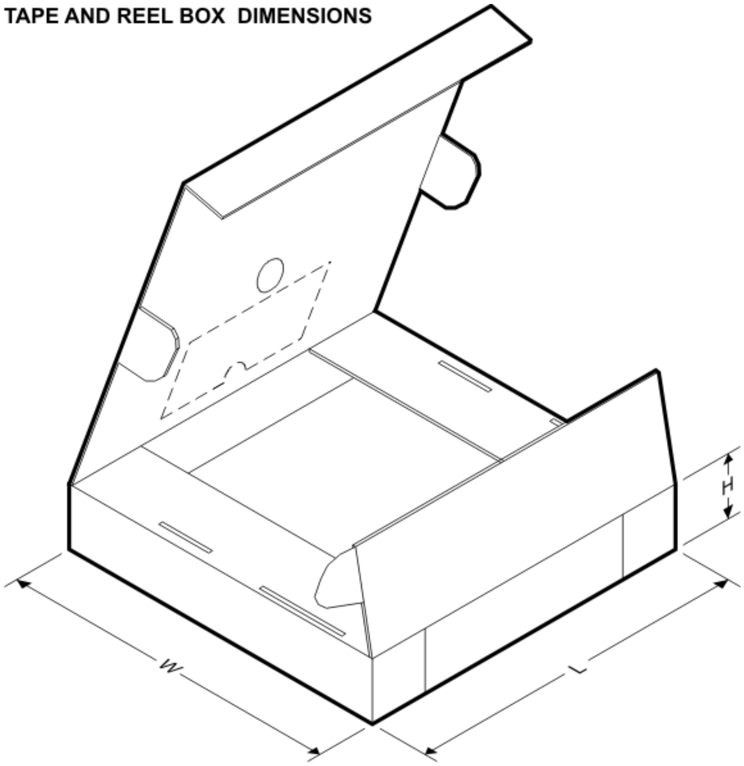
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
SN65LVDS96DGGR	TSSOP	DGG	48	2000	330.0	24.4	8.6	15.8	1.8	12.0	24.0	Q1

TAPE AND REEL BOX DIMENSIONS

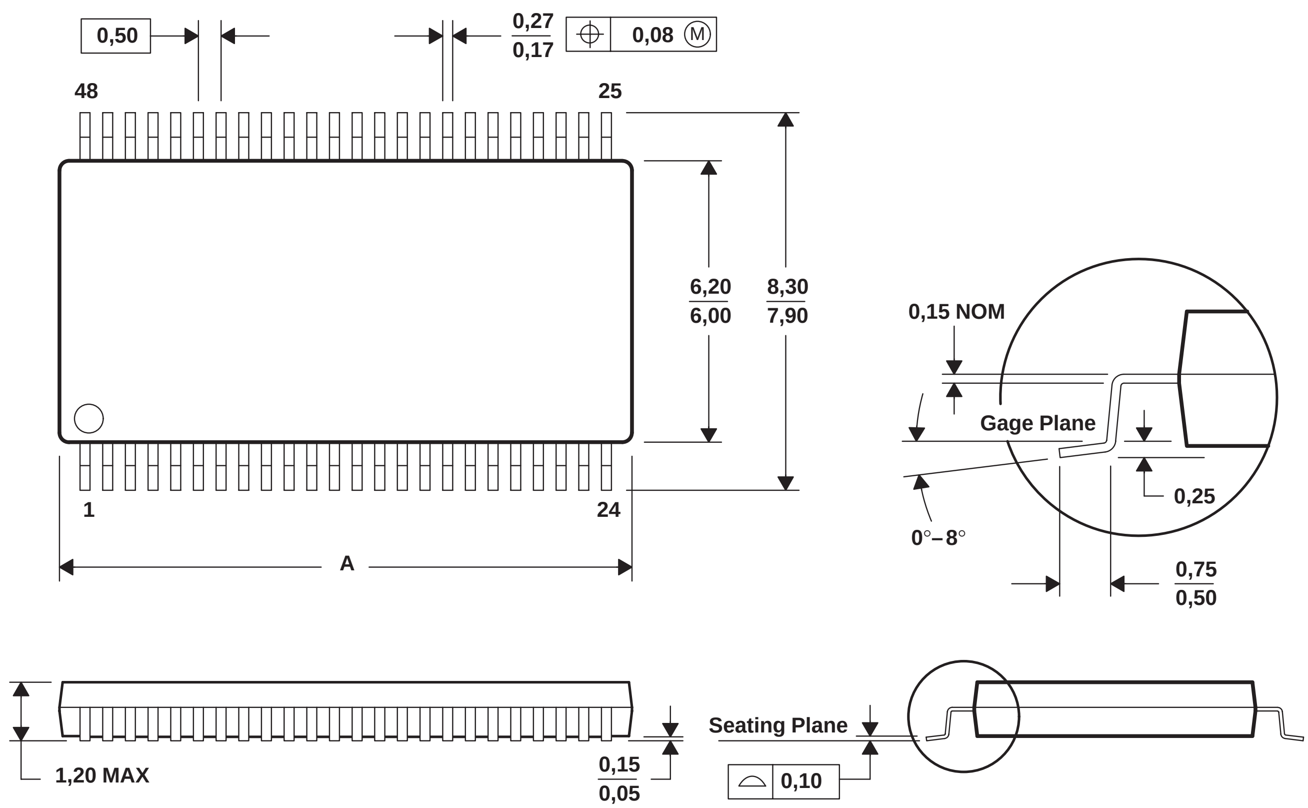


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN65LVDS96DGGR	TSSOP	DGG	48	2000	346.0	346.0	41.0

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

48 PINS SHOWN



PINS ** / DIM	48	56	64
A MAX	12,60	14,10	17,10
A MIN	12,40	13,90	16,90

4040078 / F 12/97

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

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Clocks and Timers	www.ti.com/clocks	Digital Control	www.ti.com/digitalcontrol
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Telephony	www.ti.com/telephony
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

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