

## DUAL 4-PORT AND DUAL 8-PORT LVDS REPEATERS

### FEATURES

- Two Line Receivers and Eight ('109) or Sixteen ('117) Line Drivers Meet or Exceed the Requirements of ANSI EIA/TIA-644 Standard
- Typical Data Signaling Rates to 400 Mbps or Clock Frequencies to 400 MHz
- Outputs Arranged in Pairs From Each Bank
- Enabling Logic Allows Individual Control of Each Driver Output Pair, Plus All Outputs
- Low-Voltage Differential Signaling With Typical Output Voltage of 350 mV and a 100-Ω Load
- Electrically Compatible With LVDS, PECL, LVPECL, LVTTTL, LVCMOS, GTL, BTL, CTT, SSTL, or HSTL Outputs With External Termination Networks
- Propagation Delay Times < 4.5 ns
- Output Skew Less Than 550 ps Bank Skew Less Than 150 ps Part-to-Part Skew Less Than 1.5 ns
- Total Power Dissipation Typically <500 mW With All Ports Enabled and at 200 MHz
- Driver Outputs or Receiver Input Equals High Impedance When Disabled or With  $V_{CC} < 1.5$  V
- Bus-Pin ESD Protection Exceeds 12 kV
- Packaged in Thin Shrink Small-Outline Package With 20-Mil Terminal Pitch

### DESCRIPTION

The SN65LVDS109 and SN65LVDS117 are configured as two identical banks, each bank having one differential line receiver connected to either four ('109) or eight ('117) differential line drivers. The outputs are arranged in pairs having one output from each of the two banks. Individual output enables are provided for each pair of outputs and an additional enable is provided for all outputs.

The line receivers and line drivers implement the electrical characteristics of low-voltage differential signaling (LVDS). LVDS, as specified in EIA/TIA-644, is a data signaling technique that offers low power, low noise emission, high noise immunity, and high switching speeds. (Note: The ultimate rate and distance of data transfer is dependent upon the attenuation characteristics of the media, the noise coupling to the environment, and other system characteristics.)

The intended application of these devices, and the LVDS signaling technique, is for point-to-point or point-to-multipoint (distributed simplex) baseband data transmission on controlled impedance media of approximately 100 Ω. The transmission media may be printed-circuit board traces, backplanes, or cables. The large number of drivers integrated into the same silicon substrate, along with the low pulse skew of balanced signaling, provides extremely precise timing alignment of the signals being repeated from the inputs. This is particularly advantageous for implementing system clock and data distribution trees.

The SN65LVDS109 and SN65LVDS117 are characterized for operation from –40°C to 85°C.

| SN65LVDS109<br>DBT PACKAGE<br>(TOP VIEW) |    |    |     | SN65LVDS117<br>DGG PACKAGE<br>(TOP VIEW) |    |    |     |
|------------------------------------------|----|----|-----|------------------------------------------|----|----|-----|
| GND                                      | 1  | 38 | A1Y | GND                                      | 1  | 64 | A1Y |
| V <sub>CC</sub>                          | 2  | 37 | A1Z | V <sub>CC</sub>                          | 2  | 63 | A1Z |
| GND                                      | 3  | 36 | A2Y | V <sub>CC</sub>                          | 3  | 62 | A2Y |
| NC                                       | 4  | 35 | A2Z | GND                                      | 4  | 61 | A2Z |
| ENM                                      | 5  | 34 | NC  | NC                                       | 5  | 60 | B1Y |
| ENA                                      | 6  | 33 | B1Y | ENM                                      | 6  | 59 | B1Z |
| ENB                                      | 7  | 32 | B1Z | ENA                                      | 7  | 58 | B2Y |
| 1A                                       | 8  | 31 | B2Y | ENB                                      | 8  | 57 | B2Z |
| 1B                                       | 9  | 30 | B2Z | ENC                                      | 9  | 56 | C1Y |
| GND                                      | 10 | 29 | NC  | END                                      | 10 | 55 | C1Z |
| 2A                                       | 11 | 28 | C1Y | NC                                       | 11 | 54 | C2Y |
| 2B                                       | 12 | 27 | C1Z | GND                                      | 12 | 53 | C2Z |
| ENC                                      | 13 | 26 | C2Y | 1A                                       | 13 | 52 | D1Y |
| END                                      | 14 | 25 | C2Z | 1B                                       | 14 | 51 | D1Z |
| NC                                       | 15 | 24 | NC  | GND                                      | 15 | 50 | D2Y |
| NC                                       | 16 | 23 | D1Y | V <sub>CC</sub>                          | 16 | 49 | D2Z |
| GND                                      | 17 | 22 | D1Z | V <sub>CC</sub>                          | 17 | 48 | E1Y |
| V <sub>CC</sub>                          | 18 | 21 | D2Y | GND                                      | 18 | 47 | E1Z |
| GND                                      | 19 | 20 | D2Z | 2A                                       | 19 | 46 | E2Y |
|                                          |    |    |     | 2B                                       | 20 | 45 | E2Z |
|                                          |    |    |     | GND                                      | 21 | 44 | F1Y |
|                                          |    |    |     | NC                                       | 22 | 43 | F1Z |
|                                          |    |    |     | ENE                                      | 23 | 42 | F2Y |
|                                          |    |    |     | ENF                                      | 24 | 41 | F2Z |
|                                          |    |    |     | ENG                                      | 25 | 40 | G1Y |
|                                          |    |    |     | ENH                                      | 26 | 39 | G1Z |
|                                          |    |    |     | NC                                       | 27 | 38 | G2Y |
|                                          |    |    |     | NC                                       | 28 | 37 | G2Z |
|                                          |    |    |     | GND                                      | 29 | 36 | H1Y |
|                                          |    |    |     | V <sub>CC</sub>                          | 30 | 35 | H1Z |
|                                          |    |    |     | V <sub>CC</sub>                          | 31 | 34 | H2Y |
|                                          |    |    |     | GND                                      | 32 | 33 | H2Z |

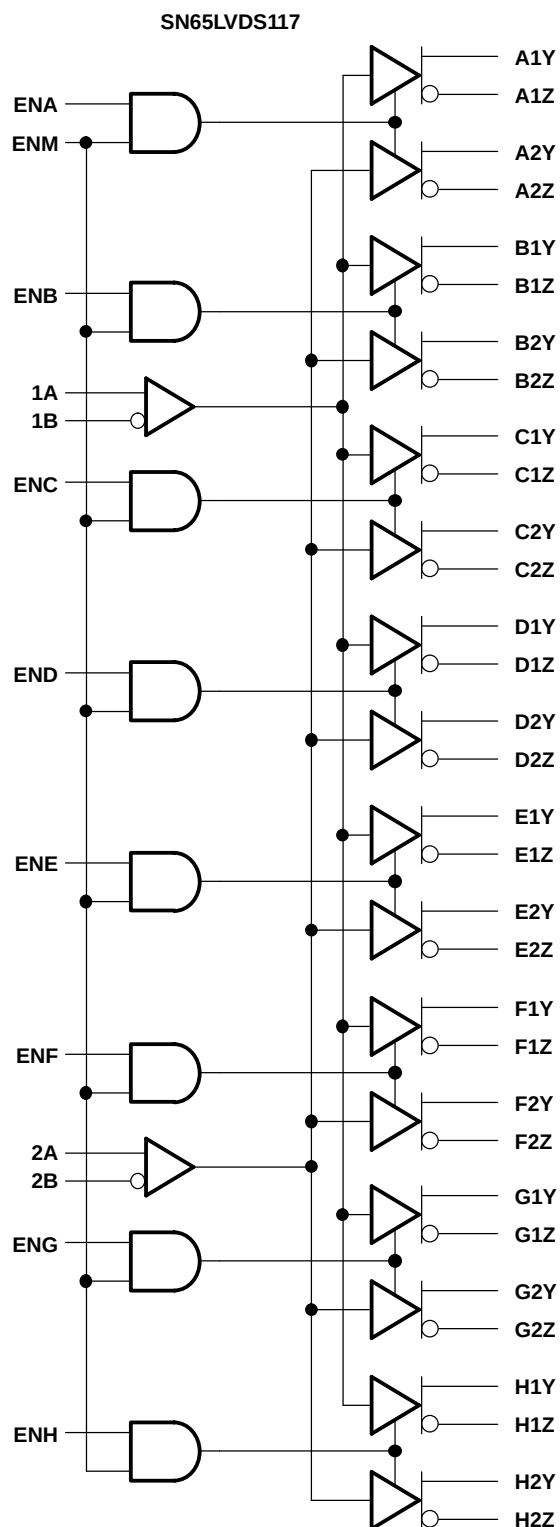
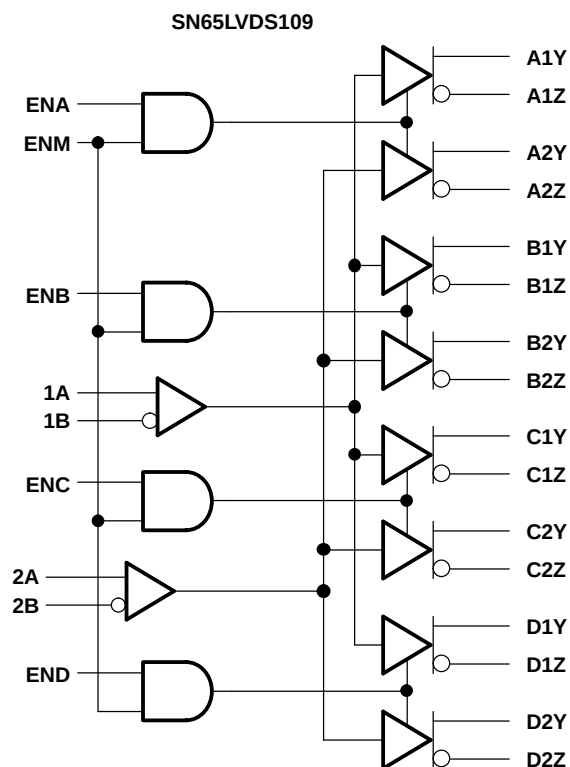


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These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## LOGIC DIAGRAM (POSITIVE LOGIC)



## SELECTION GUIDE TO LVDS SPLITTERS

The SN65LVDS109 and SN75LVDS117 are both members of a family of LVDS splitters and repeaters. A brief overview of the family is provided by Table 1.

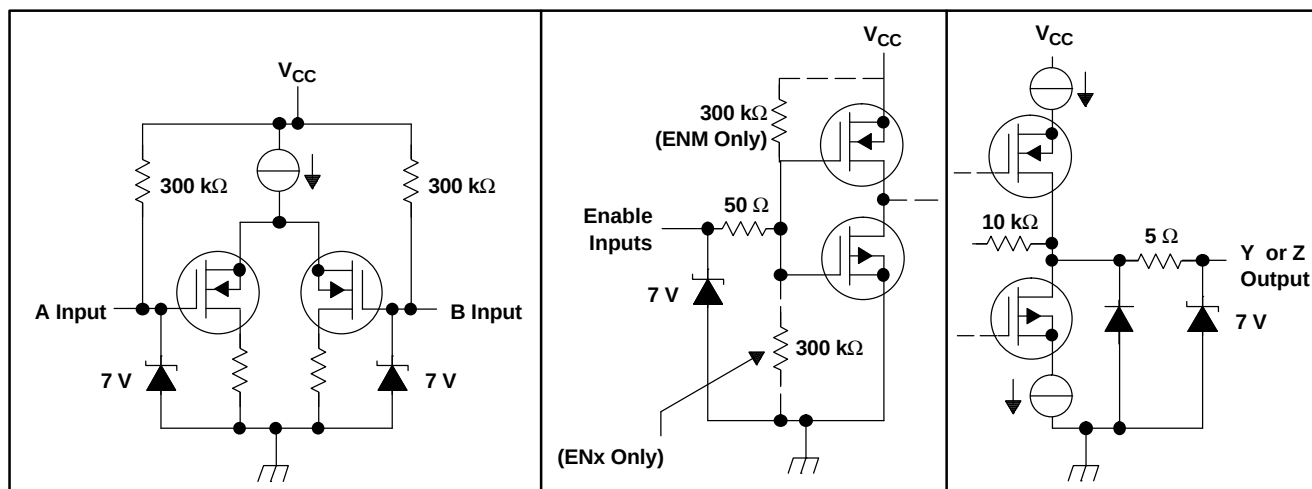
**Table 1. LVDS SPLITTER AND REPEATER FAMILY**

| DEVICE      | NUMBER OF INPUTS | NUMBER OF OUTPUTS | PACKAGE    | COMMENTS                    |
|-------------|------------------|-------------------|------------|-----------------------------|
| SN65LVDS104 | 1 LVDS           | 4 LVDS            | 16-pin D   | 4-Port LVDS repeater        |
| SN65LVDS105 | 1 LVTTTL         | 4 LVDS            | 16-pin D   | 4-Port TTL-to-LVDS repeater |
| SN65LVDS108 | 1 LVDS           | 8 LVDS            | 38-pin DBT | 8-Port LVDS repeater        |
| SN65LVDS109 | 2 LVDS           | 8 LVDS            | 38-pin DBT | Dual 4-port LVDS repeater   |
| SN65LVDS116 | 1 LVDS           | 16 LVDS           | 64-pin DGG | 16-Port LVDS repeater       |
| SN65LVDS117 | 2 LVDS           | 16 LVDS           | 64-pin DGG | Dual 8-Port LVDS repeater   |

**FUNCTION TABLE**

| INPUTS                                      |     |     | OUTPUTS         |                 |
|---------------------------------------------|-----|-----|-----------------|-----------------|
| $V_{ID} = V_A - V_B$                        | ENM | ENx | $\overline{xY}$ | $\overline{xZ}$ |
| X                                           | L   | X   | Z               | Z               |
| X                                           | X   | L   | Z               | Z               |
| $V_{ID} \geq 100 \text{ mV}$                | H   | H   | H               | L               |
| $-100 \text{ mV} < V_{ID} < 100 \text{ mV}$ | H   | H   | ?               | ?               |
| $V_{ID} \leq -100 \text{ mV}$               | H   | H   | L               | H               |

## EQUIVALENT INPUT AND OUTPUT SCHEMATIC DIAGRAMS



## ABSOLUTE MAXIMUM RATINGS

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

|                                                              |                                    | UNIT                         |
|--------------------------------------------------------------|------------------------------------|------------------------------|
| Supply voltage range, $V_{CC}$ <sup>(2)</sup>                |                                    | –0.5 V to 4 V                |
| Input voltage range                                          | Enable inputs                      | –0.5 V to 6 V                |
|                                                              | A, B, Y or Z                       | –0.5 V to 4 V                |
| Electrostatic discharge                                      | A, B, Y, Z, and GND <sup>(3)</sup> | Class 3, A:12 kV, B: 500 V   |
| Continuous power dissipation                                 |                                    | See Dissipation Rating Table |
| 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, except differential I/O bus voltages, are with respect to network ground terminal.
- (3) Tested in accordance with MIL-STD-883C Method 3015.7.

## DISSIPATION RATING TABLE

| PACKAGE | $T_A \leq 25^\circ\text{C}$<br>POWER RATING | DERATING FACTOR <sup>(1)</sup><br>ABOVE $T_A = 25^\circ\text{C}$ | $T_A = 85^\circ\text{C}$<br>POWER RATING |
|---------|---------------------------------------------|------------------------------------------------------------------|------------------------------------------|
| DBT     | 1277 mW                                     | 10.2 mW/°C                                                       | 644 mW                                   |
| DGG     | 2094 mW                                     | 16.7 mW/°C                                                       | 1089 mW                                  |

- (1) This is the inverse of the junction-to-ambient thermal resistance when board-mounted (low-k) 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    |
| $V_I$ or $V_{IC}$ | Voltage at any bus terminal (separately or common-mode) | 0   |     | $V_{CC} - 0.8$ | V    |
| $T_A$             | Operating free-air temperature                          | –40 |     | 85             | °C   |

## ELECTRICAL CHARACTERISTICS

over recommended operating conditions (unless otherwise noted)

| PARAMETER            |                                                                        | TEST CONDITIONS                                                                 | MIN   | TYP <sup>(1)</sup> | MAX   | UNIT |
|----------------------|------------------------------------------------------------------------|---------------------------------------------------------------------------------|-------|--------------------|-------|------|
| V <sub>ITH+</sub>    | Positive-going differential input voltage threshold                    | See Figure 1 and Table 2                                                        |       |                    | 100   | mV   |
| V <sub>ITH-</sub>    | Negative-going differential input voltage threshold                    |                                                                                 | –100  |                    |       |      |
| V <sub>OD</sub>      | Differential output voltage magnitude                                  | R <sub>L</sub> = 100 Ω, V <sub>ID</sub> = ±100 mV,<br>See Figure 1 and Figure 2 | 247   | 340                | 454   | mV   |
| Δ V <sub>OD</sub>    | Change in differential output voltage magnitude between logic states   |                                                                                 | –50   |                    | 50    |      |
| V <sub>OC(SS)</sub>  | Steady-state common-mode output voltage                                | See Figure 3                                                                    | 1.125 |                    | 1.375 | V    |
| ΔV <sub>OC(SS)</sub> | Change in steady-state common-mode output voltage between logic states |                                                                                 | –50   |                    | 50    | mV   |
| V <sub>OC(PP)</sub>  | Peak-to-peak common-mode output voltage                                |                                                                                 |       | 50                 | 150   |      |
| I <sub>CC</sub>      | Supply current                                                         | Enabled, R <sub>L</sub> = 100 Ω                                                 |       | 46                 | 64    | mA   |
|                      |                                                                        | Disabled                                                                        |       | 6                  | 8     |      |
|                      |                                                                        | Enabled, R <sub>L</sub> = 100 Ω                                                 |       | 85                 | 122   |      |
|                      |                                                                        | Disabled                                                                        |       | 6                  | 8     |      |
| I <sub>I</sub>       | Input current (A or B inputs)                                          | V <sub>I</sub> = 0 V                                                            | –2    |                    | –20   | μA   |
|                      |                                                                        | V <sub>I</sub> = 2.4 V                                                          | –1.2  |                    |       |      |
| I <sub>I(OFF)</sub>  | Power-off input current (A or B inputs)                                | V <sub>CC</sub> = 1.5 V, V <sub>I</sub> = 2.4 V                                 |       |                    | 20    | μA   |
| I <sub>IH</sub>      | High-level input current (enables)                                     | V <sub>IH</sub> = 2 V                                                           |       |                    | 20    | μA   |
| I <sub>IL</sub>      | Low-level input current (enables)                                      | V <sub>IL</sub> = 0.8 V                                                         |       |                    | 10    | μA   |
| I <sub>OS</sub>      | Short-circuit output current                                           | V <sub>OY</sub> or V <sub>OZ</sub> = 0 V                                        |       |                    | ±24   | mA   |
|                      |                                                                        | V <sub>OD</sub> = 0 V                                                           |       |                    | ±12   |      |
| I <sub>OZ</sub>      | High-impedance output current                                          | V <sub>O</sub> = 0 V or V <sub>CC</sub>                                         |       |                    | ±1    | μA   |
| I <sub>O(OFF)</sub>  | Power-off output current                                               | V <sub>CC</sub> = 1.5 V, V <sub>O</sub> = 3.6 V                                 |       |                    | ±1    | μA   |
| C <sub>IN</sub>      | Input capacitance (A or B inputs)                                      | V <sub>I</sub> = 0.4 sin (4E6πt) + 0.5 V                                        |       | 5                  |       | pF   |
| C <sub>O</sub>       | Output capacitance (Y or Z outputs)                                    | V <sub>I</sub> = 0.4 sin (4E6πt) + 0.5 V, Disabled                              |       | 9.4                |       |      |

(1) All typical values are at 25°C and with a 3.3-V supply.

## SWITCHING CHARACTERISTICS

over recommended operating conditions (unless otherwise noted)

| PARAMETER                                                             | TEST CONDITIONS                                               | MIN | TYP <sup>(1)</sup> | MAX | UNIT |
|-----------------------------------------------------------------------|---------------------------------------------------------------|-----|--------------------|-----|------|
| $t_{PLH}$ Propagation delay time, low-to-high-level output            | $R_L = 100\ \Omega$ , $C_L = 10\ \text{pF}$ ,<br>See Figure 4 | 1.6 | 2.8                | 4.5 | ns   |
| $t_{PHL}$ Propagation delay time, high-to-low-level output            |                                                               | 1.6 | 2.8                | 4.5 |      |
| $t_r$ Differential output signal rise time                            |                                                               | 0.3 | 0.8                | 1.2 | ns   |
| $t_f$ Differential output signal fall time                            |                                                               | 0.3 | 0.8                | 1.2 |      |
| $t_{sk(p)}$ Pulse skew ( $ t_{PHL} - t_{PLH} $ ) <sup>(2)</sup>       |                                                               |     | 140                | 500 | ps   |
| $t_{sk(o)}$ Output skew <sup>(3)</sup>                                |                                                               |     | 100                | 550 |      |
| $t_{sk(b)}$ Bank skew <sup>(4)</sup>                                  |                                                               |     | 40                 | 150 | ps   |
| $t_{sk(pp)}$ Part-to-part skew <sup>(5)</sup>                         |                                                               |     |                    | 1.5 | ns   |
| $t_{PZH}$ Propagation delay time, high-impedance-to-high-level output | See Figure 5                                                  |     | 5.7                | 15  | ns   |
| $t_{PZL}$ Propagation delay time, high-impedance-to-low-level output  |                                                               |     | 7.7                | 15  |      |
| $t_{PHZ}$ Propagation delay time, high-level-to-high-impedance output |                                                               |     | 3.2                | 15  |      |
| $t_{PLZ}$ Propagation delay time, low-level-to-high-impedance output  |                                                               |     | 3.2                | 15  |      |

(1) All typical values are at 25°C and with a 3.3-V supply.

(2)  $t_{sk(p)}$  is the magnitude of the time difference between the  $t_{PLH}$  and  $t_{PHL}$  of any output of a single device.

(3)  $t_{sk(o)}$  is the magnitude of the time difference between the  $t_{PLH}$  or  $t_{PHL}$  of any outputs with both inputs tied together.

(4)  $t_{sk(b)}$  is the magnitude of the time difference between the  $t_{PLH}$  and  $t_{PHL}$  of the two outputs of any bank of a single device.

(5)  $t_{sk(pp)}$  is the magnitude of the time difference in propagation delay times between any specified terminals of two devices when both devices operate with the same supply voltages, at the same temperature, and have identical packages and test circuits.

## PARAMETER MEASUREMENT INFORMATION

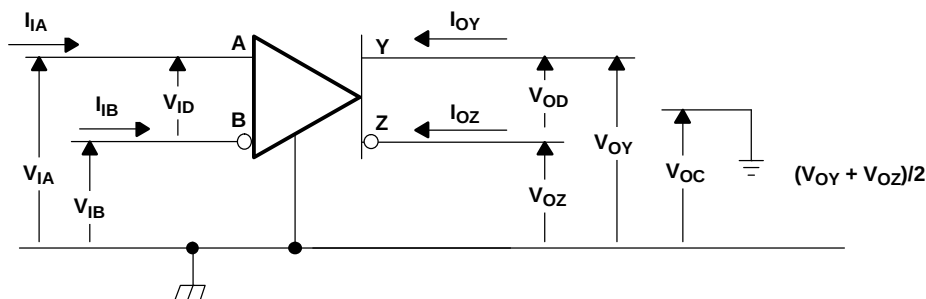


Figure 1. Voltage and Current Definitions

Table 2. Receiver Minimum and Maximum Input Threshold Test Voltages

| APPLIED VOLTAGES |                 | RESULTING DIFFERENTIAL<br>INPUT VOLTAGE | RESULTING COMMON-<br>MODE INPUT VOLTAGE |
|------------------|-----------------|-----------------------------------------|-----------------------------------------|
| V <sub>IA</sub>  | V <sub>IB</sub> | V <sub>ID</sub>                         | V <sub>IC</sub>                         |
| 1.25 V           | 1.15 V          | 100 mV                                  | 1.2 V                                   |
| 1.15 V           | 1.25 V          | –100 mV                                 | 1.2 V                                   |
| 2.4 V            | 2.3 V           | 100 mV                                  | 2.35 V                                  |
| 2.3 V            | 2.4 V           | –100 mV                                 | 2.35 V                                  |
| 0.1 V            | 0 V             | 100 mV                                  | 0.05 V                                  |
| 0 V              | 0.1 V           | –100 mV                                 | 0.05 V                                  |
| 1.5 V            | 0.9 V           | 600 mV                                  | 1.2 V                                   |
| 0.9 V            | 1.5 V           | –600 mV                                 | 1.2 V                                   |
| 2.4 V            | 1.8 V           | 600 mV                                  | 2.1 V                                   |
| 1.8 V            | 2.4 V           | –600 mV                                 | 2.1 V                                   |
| 0.6 V            | 0 V             | 600 mV                                  | 0.3 V                                   |
| 0 V              | 0.6 V           | –600 mV                                 | 0.3 V                                   |

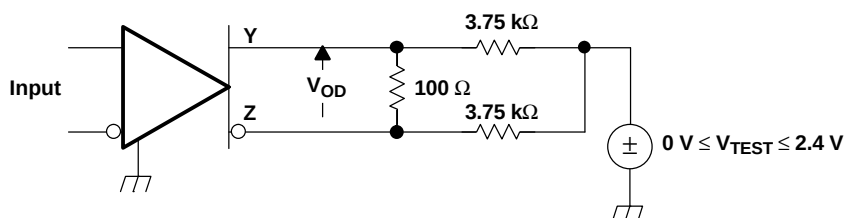
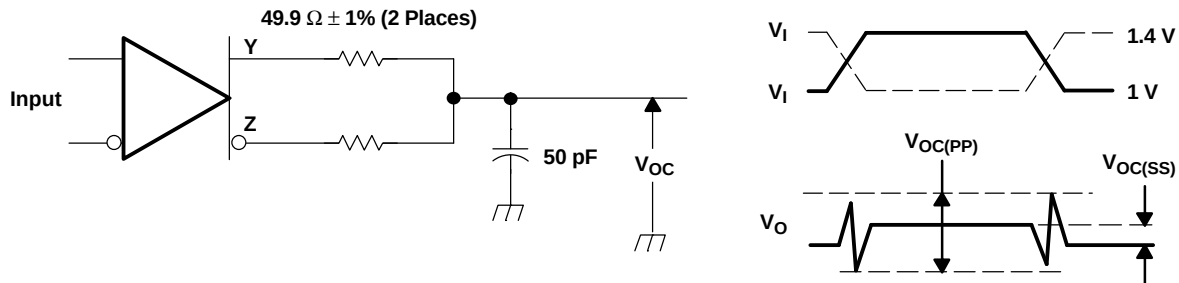
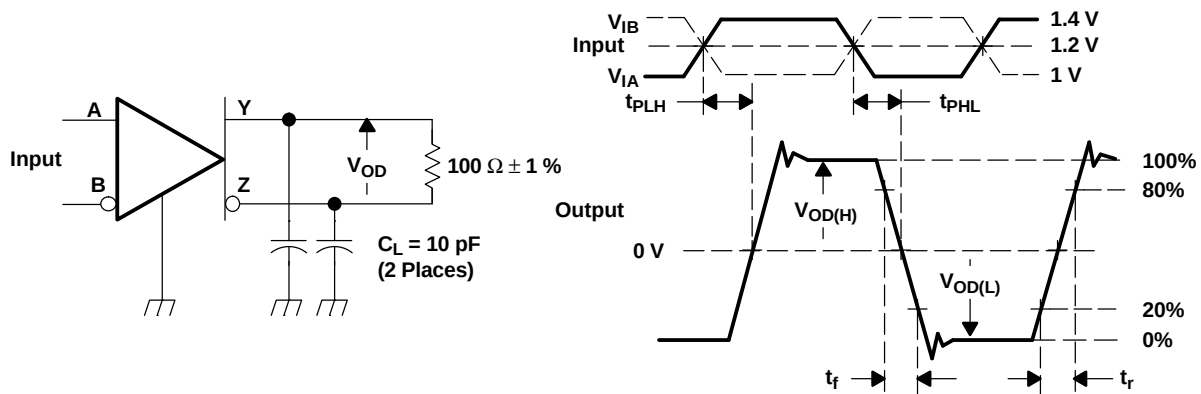


Figure 2. V<sub>OD</sub> Test Circuit



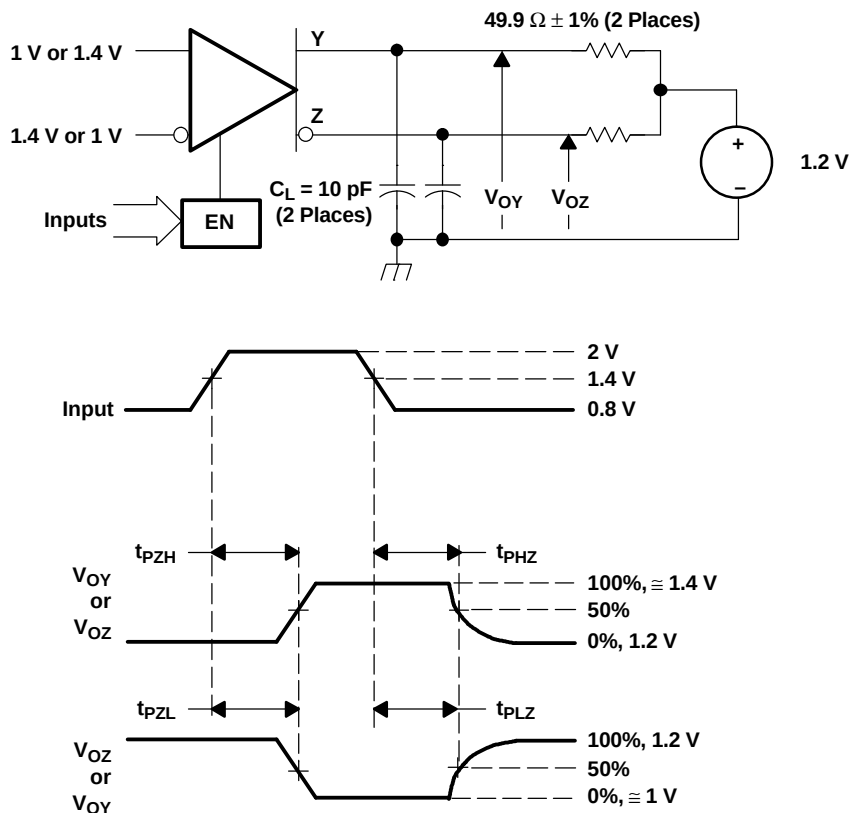
- A. All input pulses are supplied by a generator having the following characteristics:  $t_r$  or  $t_f \leq 1$  ns, pulse repetition rate (PRR) = 0.5 Mpps, pulsewidth =  $500 \pm 10$  ns.  $C_L$  includes instrumentation and fixture capacitance within 0,06 mm of the D.U.T. The measurement of  $V_{OC(PP)}$  is made on test equipment with a –3 dB bandwidth of at least 300 MHz.

**Figure 3. Test Circuit and Definitions for the Driver Common-Mode Output Voltage**



- A. All input pulses are supplied by a generator having the following characteristics:  $t_r$  or  $t_f \leq 1$  ns, pulse repetition rate (PRR) = 50 Mpps, pulsewidth =  $10 \pm 0.2$  ns.  $C_L$  includes instrumentation and fixture capacitance within 0,06 mm of the D.U.T.

**Figure 4. Test Circuit, Timing, and Voltage Definitions for the Differential Output Signal**



- A. All input pulses are supplied by a generator having the following characteristics:  $t_r$  or  $t_f \leq 1 \text{ ns}$ , pulse repetition rate (PRR) = 0.5 Mpps, pulsewidth =  $500 \pm 10 \text{ ns}$ .  $C_L$  includes instrumentation and fixture capacitance within 0.06 mm of the D.U.T.

Figure 5. Enable and Disable Time Circuit and Definitions

## TYPICAL CHARACTERISTICS

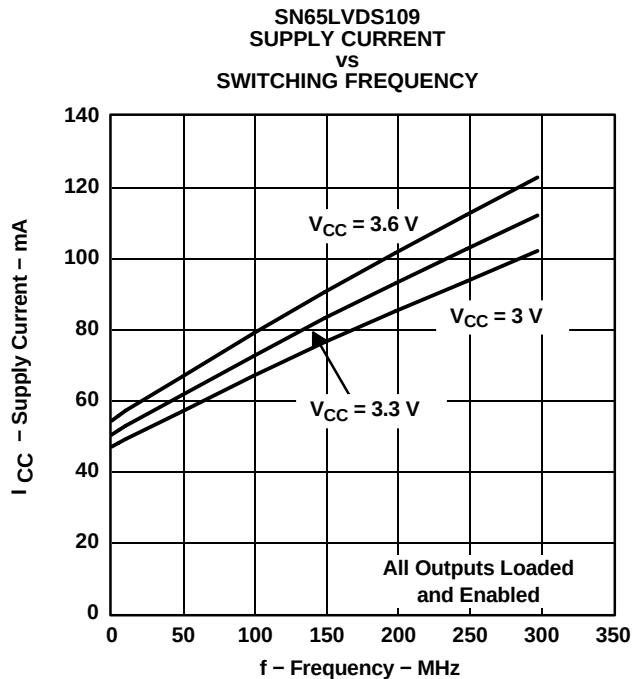


Figure 6.

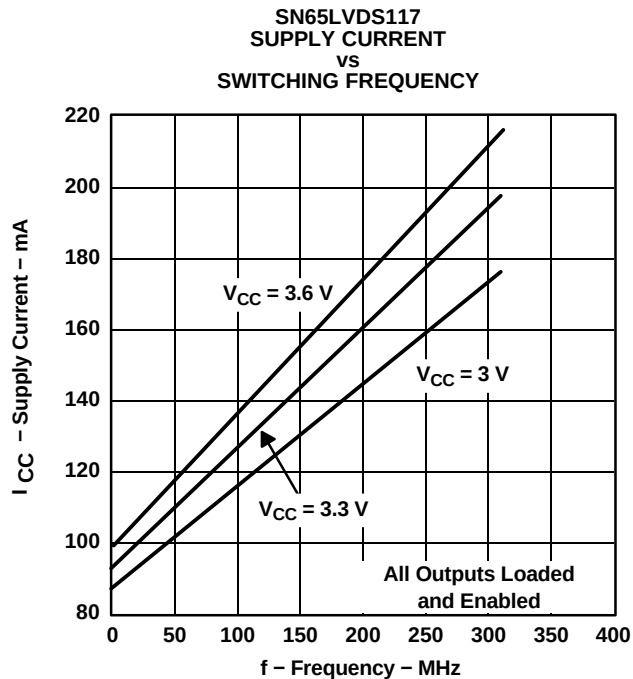


Figure 7.

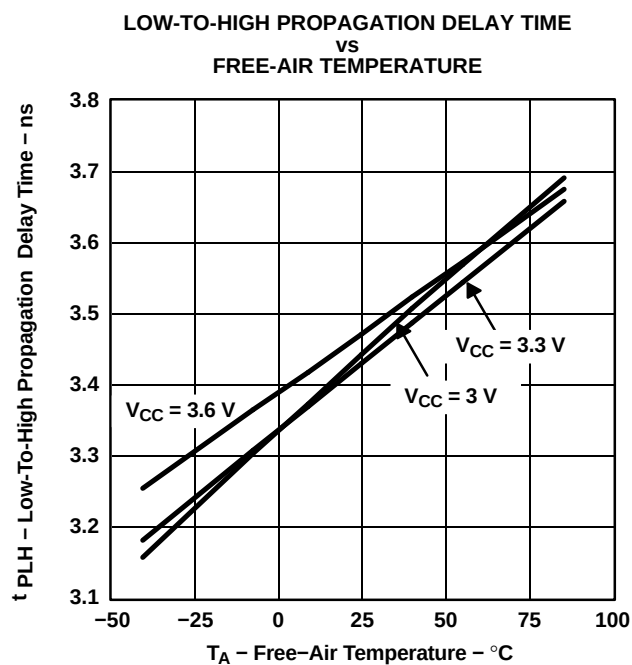


Figure 8.

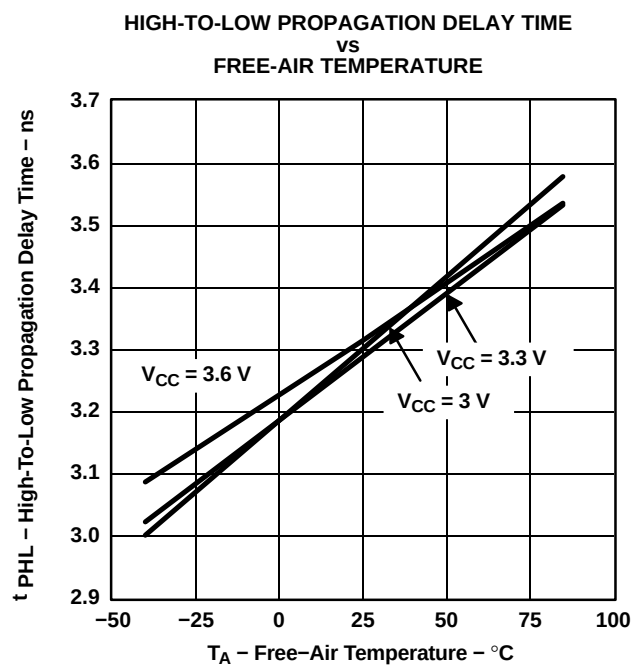
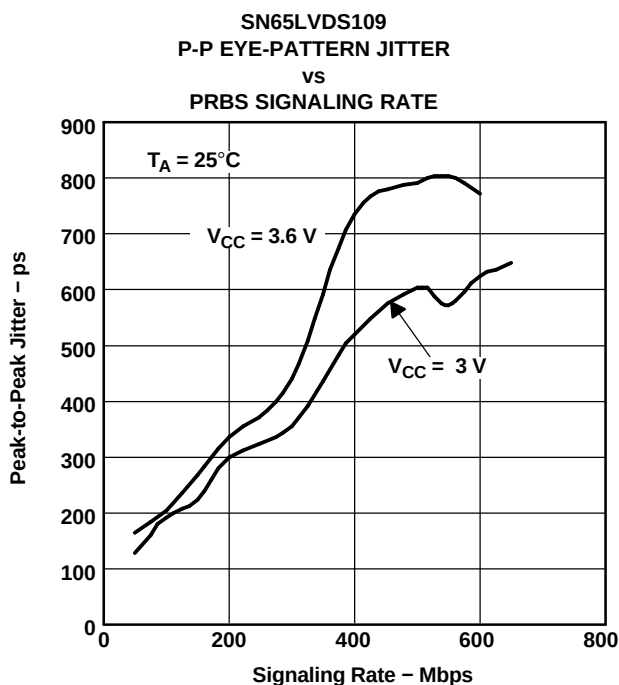


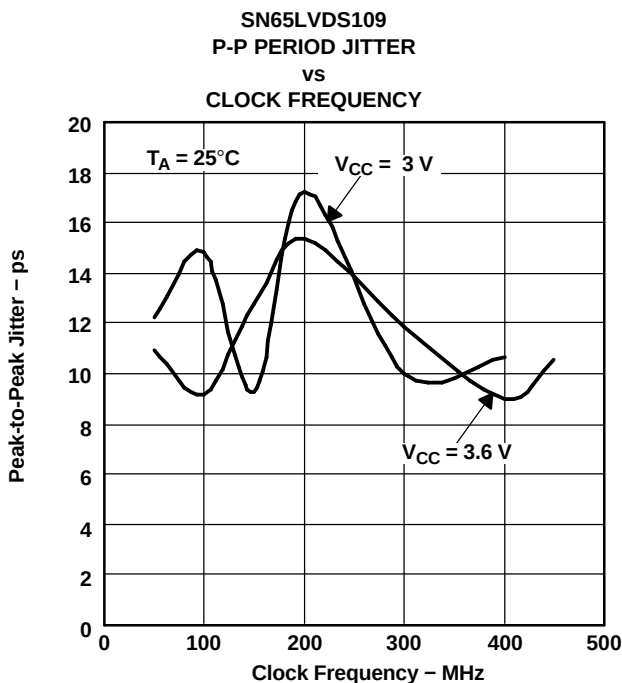
Figure 9.

## TYPICAL CHARACTERISTICS (continued)



NOTES: Input:  $2^{15}$  PRBS with peak-to-peak jitter < 100 ps at 100 Mbps, all outputs enabled and loaded with differential 100- $\Omega$  loads, worst-case output, supply decoupled with 0.1- $\mu$ F and 0.001- $\mu$ F ceramic 0603-style capacitors placed 1 cm from the device.

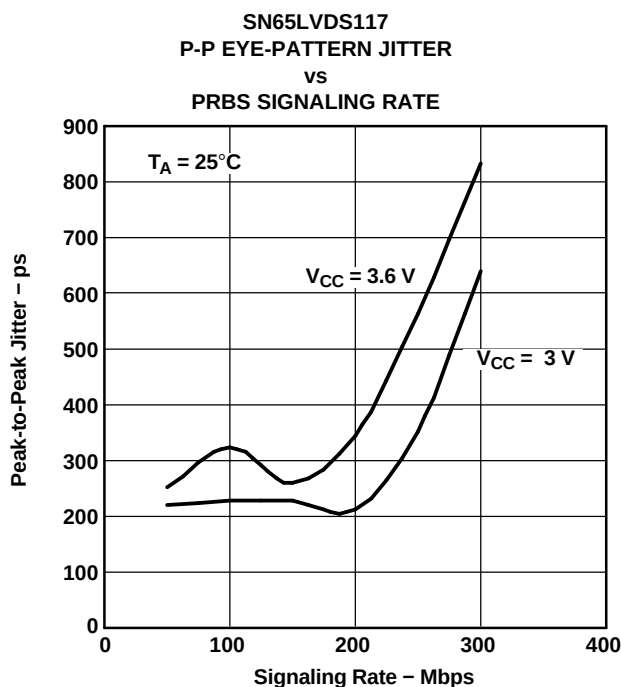
Figure 10.



NOTES: Input: 50% duty cycle square wave with jitter period < 10 ps at 100 MHz, all outputs enabled and loaded with differential 100- $\Omega$  loads, worst-case output, supply decoupled with 0.1- $\mu$ F and 0.001- $\mu$ F ceramic 0603-style capacitors 1 cm from the device.

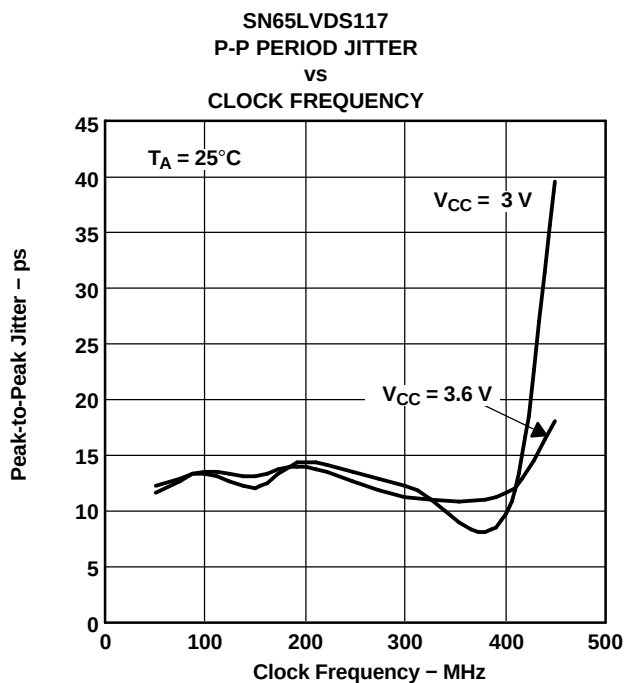
Figure 11.

## TYPICAL CHARACTERISTICS (continued)



NOTES: Input:  $2^{15}$  PRBS with peak-to-peak jitter < 115 ps at 100 Mbps, all outputs enabled and loaded with differential 100- $\Omega$  loads, worst-case output, supply decoupled with 0.1- $\mu\text{F}$  and 0.001- $\mu\text{F}$  ceramic 0805-style capacitors 1 cm from the device.

Figure 12.



NOTES: Input: 50% duty cycle square wave with jitter period < 10 ps at 100 MHz, all outputs enabled and loaded with differential 100- $\Omega$  loads, worst-case output, supply decoupled with 0.1- $\mu\text{F}$  and 0.001- $\mu\text{F}$  ceramic 0805-style capacitors 1 cm from the device.

Figure 13.

## TYPICAL CHARACTERISTICS (continued)

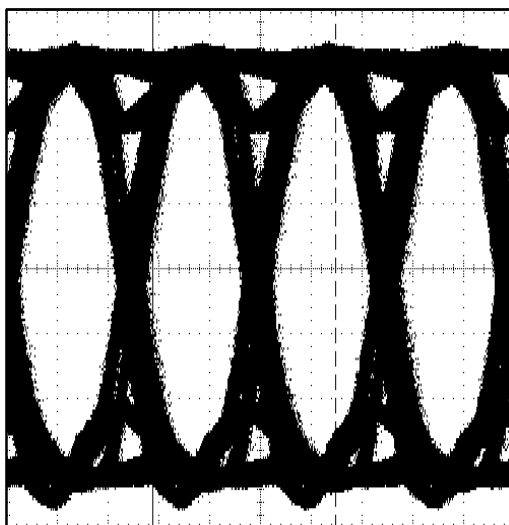


Figure 14. Typical Differential Eye Pattern at 400 Mbps

## APPLICATION INFORMATION

### FAIL SAFE

A common problem with differential signaling applications is how the system responds when no differential voltage is present on the signal pair. The LVDS receiver is like most differential line receivers, in that its output logic state can be indeterminate when the differential input voltage is between  $-100\text{ mV}$  and  $100\text{ mV}$  and within its recommended input common-mode voltage range. However, TI LVDS receivers handle the open-input circuit situation differently.

Open-circuit means that there is little or no input current to the receiver from the data line itself. This could be when the driver is in a high-impedance state or the cable is disconnected. When this occurs, the LVDS receiver pulls each line of the signal pair to near  $V_{CC}$  through  $300\text{-k}\Omega$  resistors as shown in Figure 15. The fail-safe feature uses an AND gate with input voltage thresholds at about  $2.3\text{ V}$  to detect this condition and force the output to a high-level regardless of the differential input voltage.

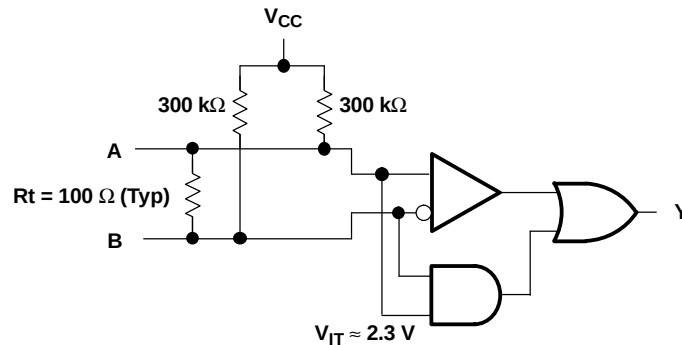


Figure 15. Open-Circuit Fail Safe of the LVDS Receiver

It is only under these conditions that the output of the receiver will be valid with less than a  $100\text{ mV}$  differential input voltage magnitude. The presence of the termination resistor,  $R_t$ , does not affect the fail-safe function as long as it is connected as shown in Figure 15. Other termination circuits may allow a dc current to ground that could defeat the pullup currents from the receiver and the fail-safe feature.

### CLOCK DISTRIBUTION

The SN65LVDS109 and SN65LVDS117 devices solve several problems common to the distribution of timing critical clock and data signals. These problems include:

- Excessive skew between the signals
- Noise pickup over long signaling paths
- High power consumption
- Control of which signal paths are enabled or disabled
- Elimination of radiation from unterminated lines

Buffering and splitting the two related signals on the same silicon die minimizes corruption of the timing relation between the two signals. Buffering and splitting the two signals in separate devices will introduce considerably higher levels of uncontrolled timing skew between the two signals. Higher speed operation and more timing tolerance for other components of the system is enabled by the tighter system timing budgets provided by the single die implementations of the SN65LVDS109 and SN65LVDS117.

The use of LVDS signaling technology for both the inputs and the outputs provides superior common-mode and noise tolerance compared to single-ended I/O technologies. This is particularly important because the signals that are being distributed must be transmitted over longer distances, and at higher rates, than can be accommodated with single-ended I/Os. In addition, LVDS consumes considerably less power than other high-performance differential signaling schemes.

## APPLICATION INFORMATION (continued)

The enable inputs provided for each output pair may be used to turn on or off any of the paths. This function is required to prevent radiation of signals from the unterminated signal lines on open connectors, such as when boards or devices are being swapped in the end equipment. The individual bank enables are also required if redundant paths are being utilized for reliability reasons.

The diagram below shows how a pair of clock (C) and data (D) input signals is being identically repeated out two of the available output pairs. A third output pair is shown in the disabled state.

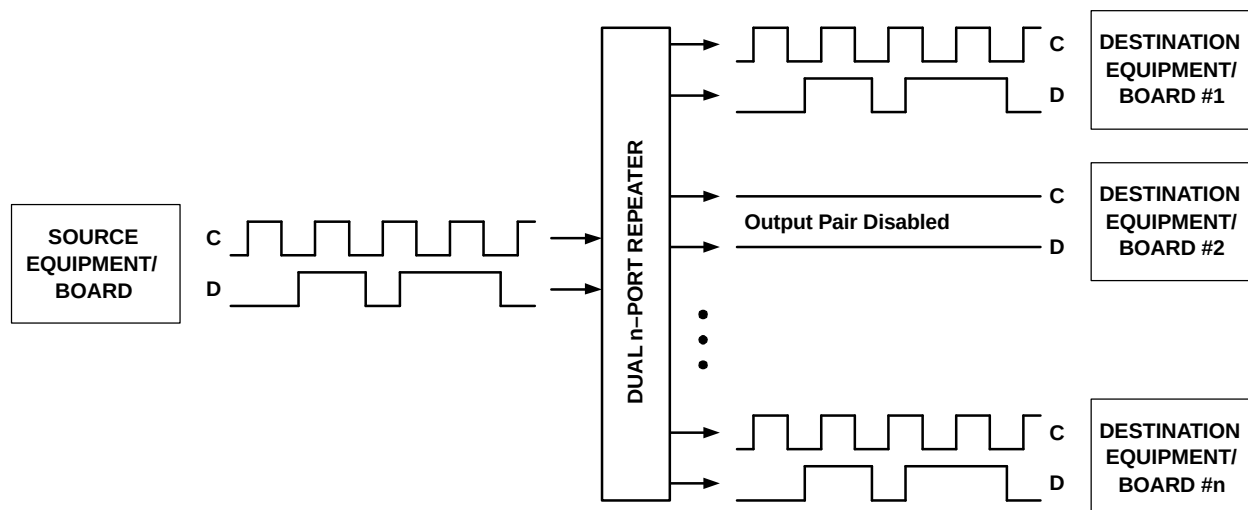


Figure 16. LVDS Repeating Splitter Application Example Showing Individual Path Control

## INPUT LEVEL TRANSLATION

An LVDS receiver can be used to receive various other types of logic signals. Figure 17 through Figure 25 show the termination circuits for SSTL, HSTL, GTL, BTL, LVPECL, PECL, CMOS, and TTL.

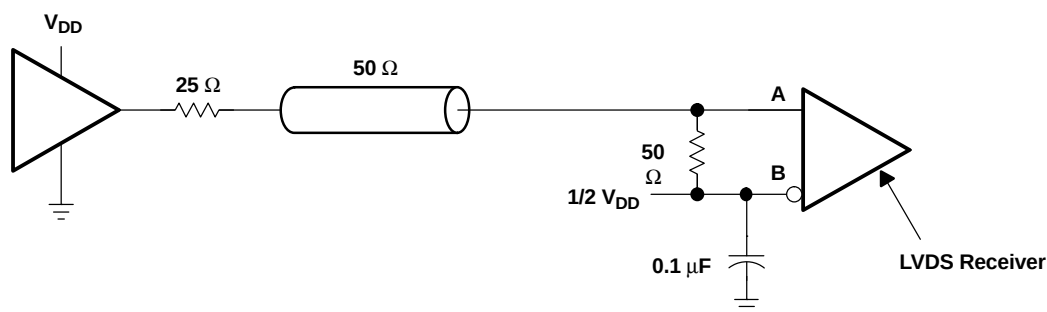


Figure 17. Stub-Series Terminated (SSTL) or High-Speed Transceiver Logic (HSTL)

APPLICATION INFORMATION (continued)

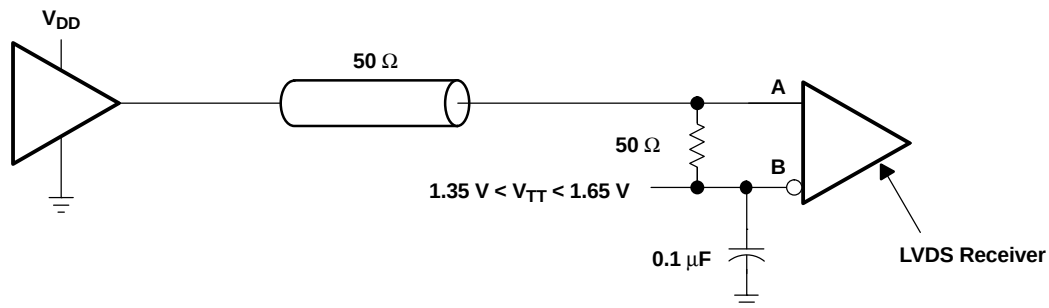


Figure 18. Center-Tap Termination (CTT)

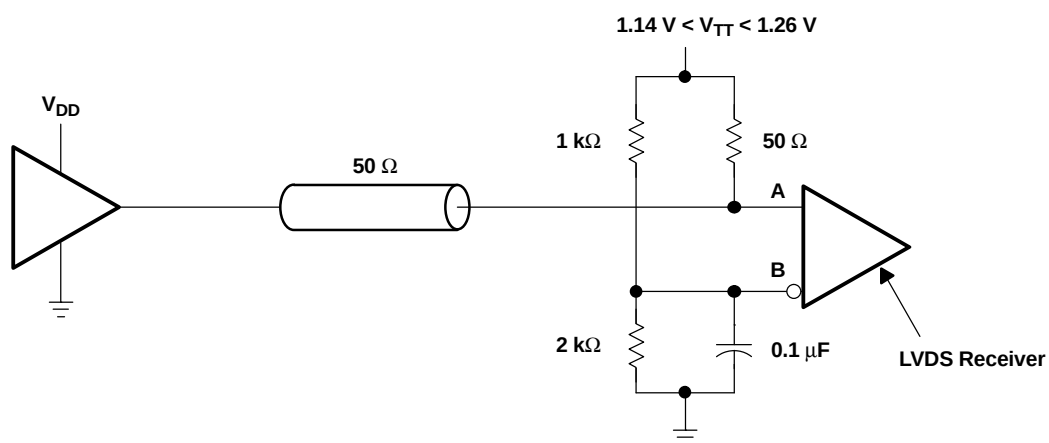


Figure 19. Gunning Transceiver Logic (GTL)

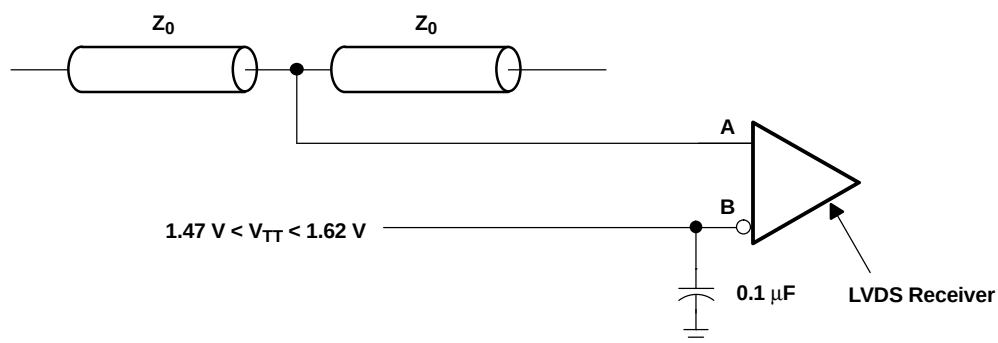


Figure 20. Backplane Transceiver Logic (BTL)

## APPLICATION INFORMATION (continued)

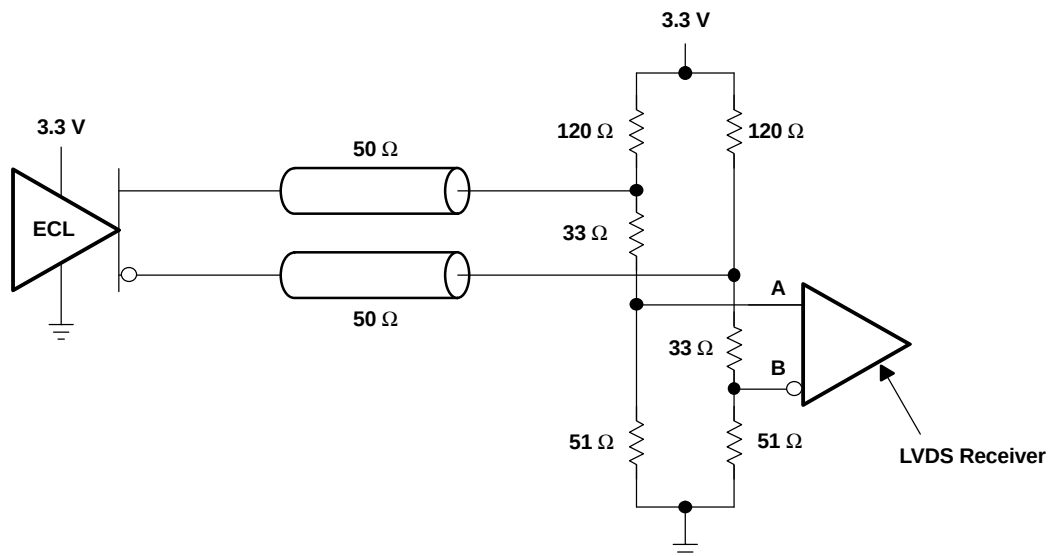


Figure 21. Low-Voltage Positive Emitter-Coupled Logic (LVPECL)

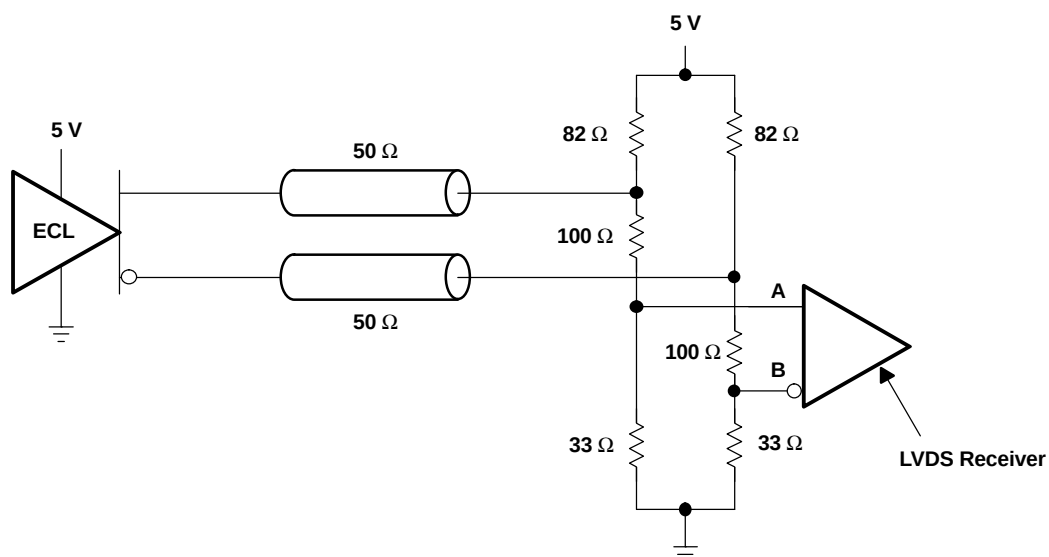


Figure 22. Positive Emitter-Coupled Logic (PECL)

## APPLICATION INFORMATION (continued)

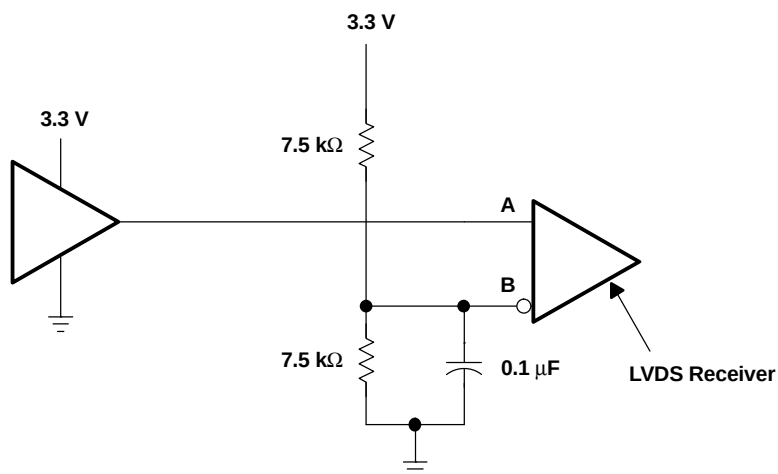


Figure 23. 3.3-V CMOS

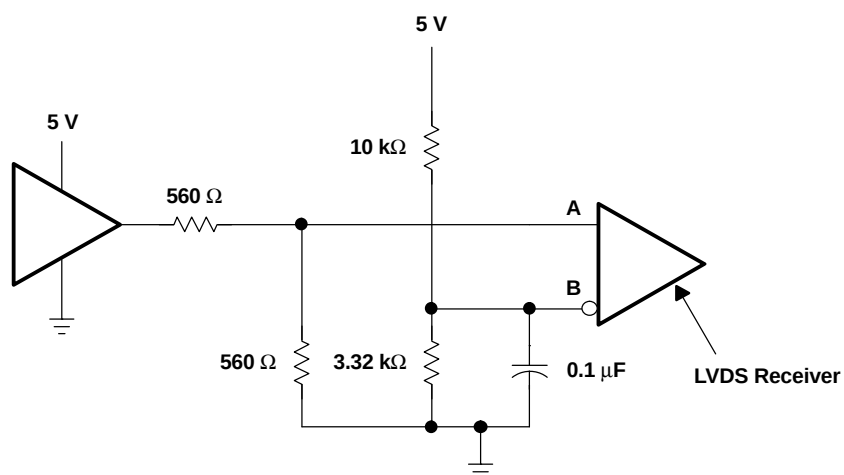


Figure 24. 5-V CMOS

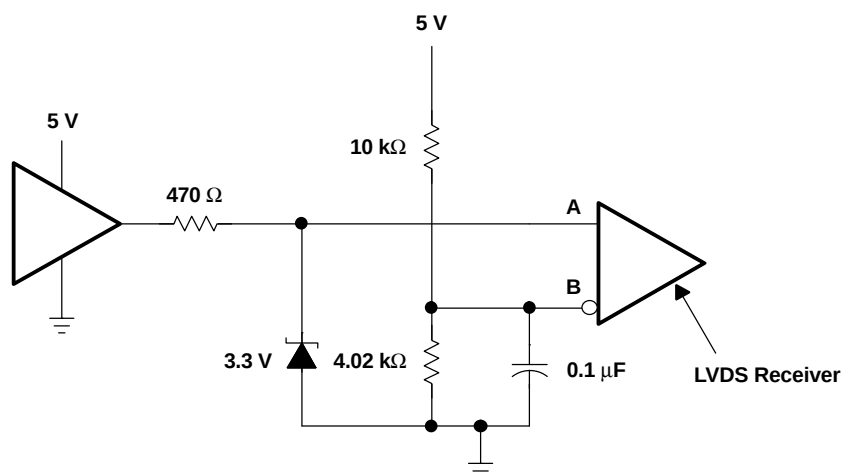


Figure 25. TTL

## PACKAGING INFORMATION

| Orderable part number            | Status<br>(1) | Material type<br>(2) | Package   Pins   | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|----------------------------------|---------------|----------------------|------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| <a href="#">SN65LVDS109DBT</a>   | Active        | Production           | TSSOP (DBT)   38 | 50   TUBE             | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 85    | LVDS109             |
| SN65LVDS109DBT.B                 | Active        | Production           | TSSOP (DBT)   38 | 50   TUBE             | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 85    | LVDS109             |
| <a href="#">SN65LVDS117DGG</a>   | Active        | Production           | TSSOP (DGG)   64 | 25   TUBE             | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 85    | LVDS117             |
| SN65LVDS117DGG.B                 | Active        | Production           | TSSOP (DGG)   64 | 25   TUBE             | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 85    | LVDS117             |
| SN65LVDS117DGGG4                 | Active        | Production           | TSSOP (DGG)   64 | 25   TUBE             | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 85    | LVDS117             |
| <a href="#">SN65LVDS117DGGGR</a> | Active        | Production           | TSSOP (DGG)   64 | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 85    | LVDS117             |
| SN65LVDS117DGGGR.B               | Active        | Production           | TSSOP (DGG)   64 | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 85    | LVDS117             |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **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.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **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.

<sup>(5)</sup> **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.

<sup>(6)</sup> **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.

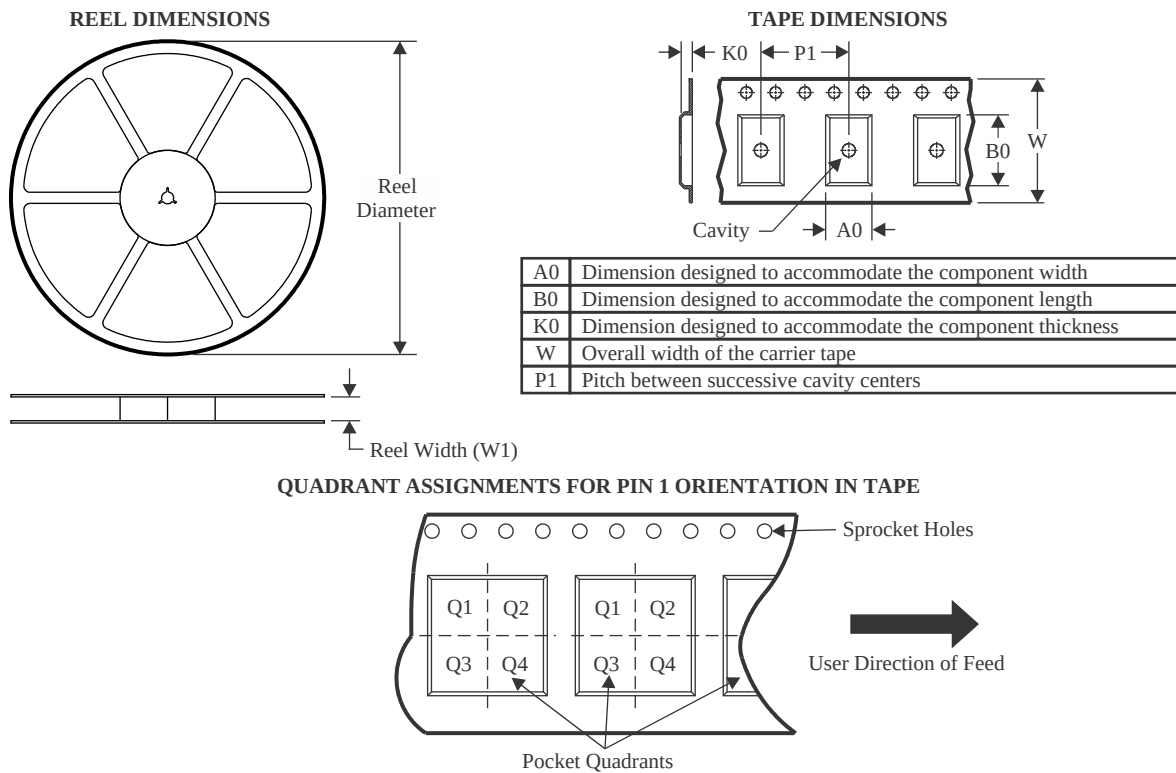
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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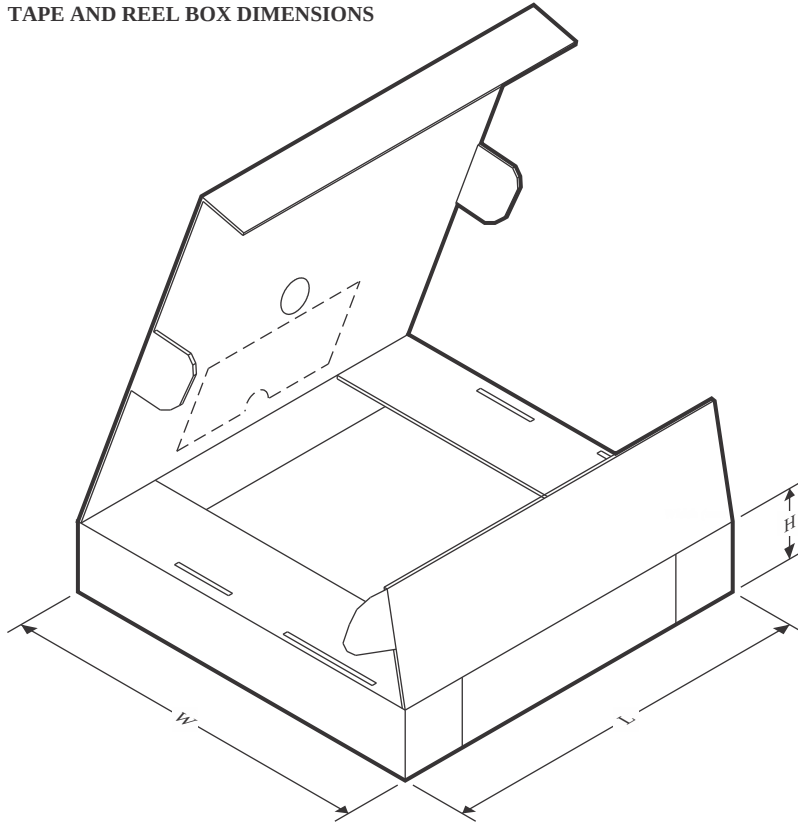
## TAPE AND REEL INFORMATION



\*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 |
|-----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| SN65LVDS117DGGR | TSSOP        | DGG             | 64   | 2000 | 330.0              | 24.4               | 8.4     | 17.3    | 1.7     | 12.0    | 24.0   | Q1            |

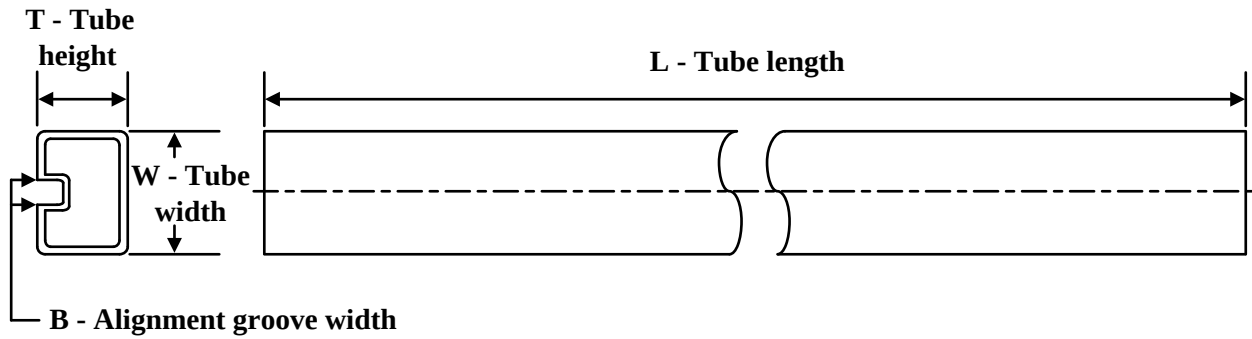
## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

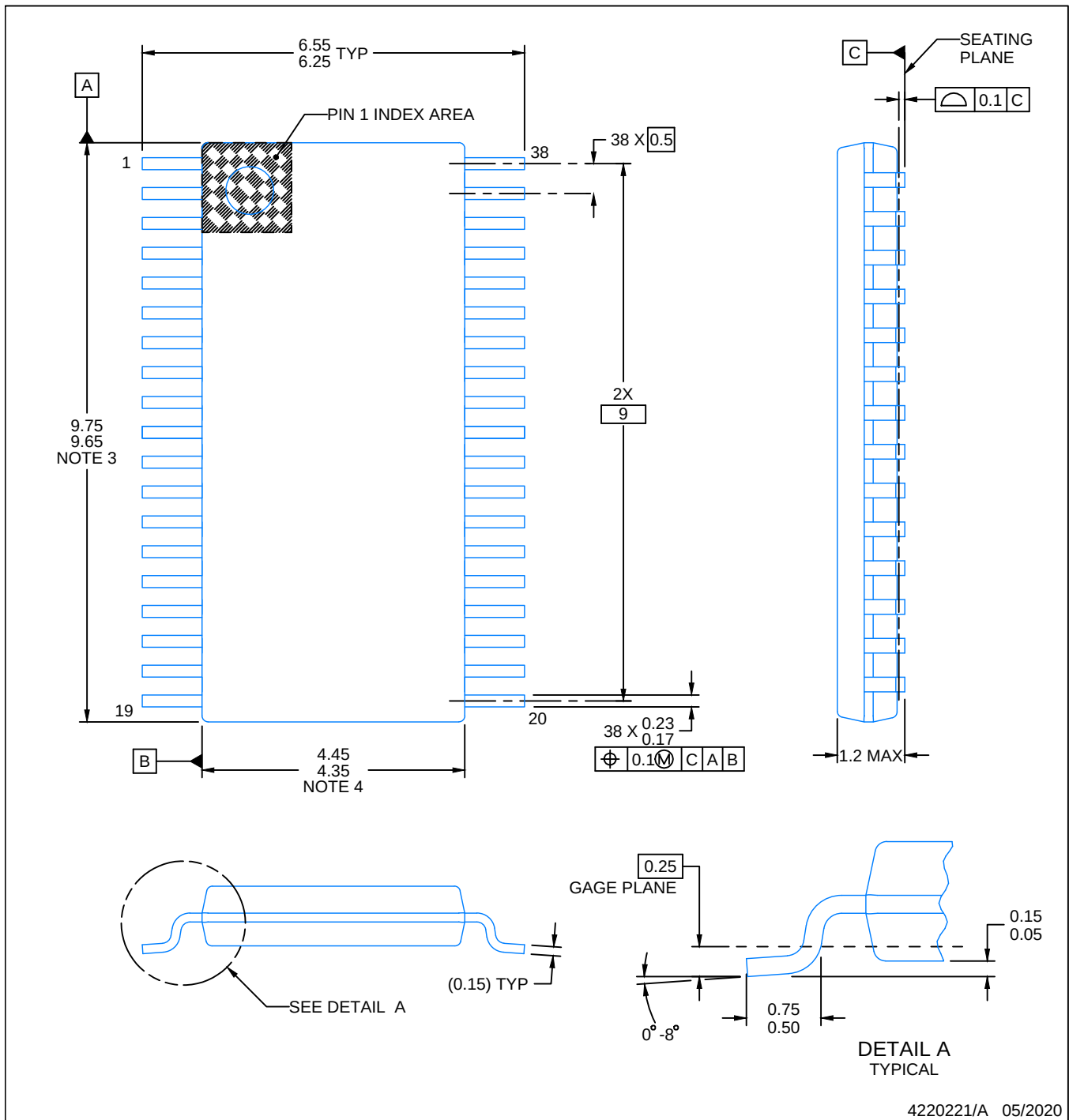
| Device          | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|-----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| SN65LVDS117DGGR | TSSOP        | DGG             | 64   | 2000 | 367.0       | 367.0      | 45.0        |

## TUBE



\*All dimensions are nominal

| Device           | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|------------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| SN65LVDS109DBT   | DBT          | TSSOP        | 38   | 50  | 530    | 10.2   | 3600   | 3.5    |
| SN65LVDS109DBT.B | DBT          | TSSOP        | 38   | 50  | 530    | 10.2   | 3600   | 3.5    |
| SN65LVDS117DGG   | DGG          | TSSOP        | 64   | 25  | 530    | 11.89  | 3600   | 4.9    |
| SN65LVDS117DGG.B | DGG          | TSSOP        | 64   | 25  | 530    | 11.89  | 3600   | 4.9    |
| SN65LVDS117DGGG4 | DGG          | TSSOP        | 64   | 25  | 530    | 11.89  | 3600   | 4.9    |



4220221/A 05/2020

#### NOTES:

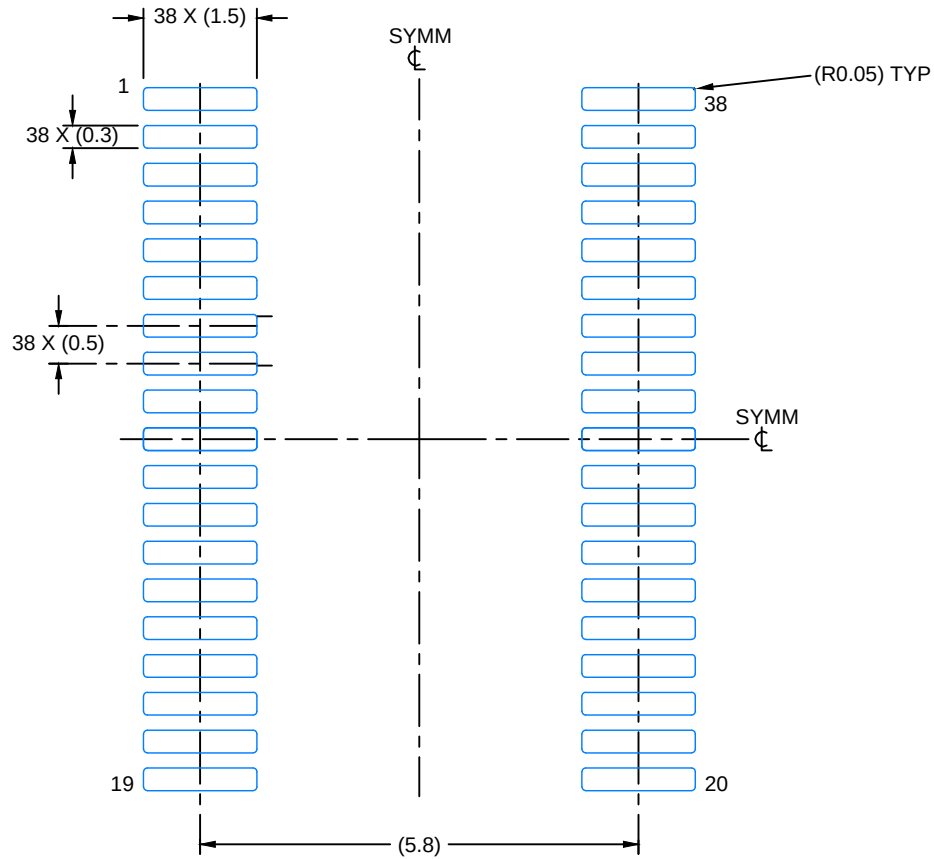
- All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
- This drawing is subject to change without notice.
- This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
- This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
- Reference JEDEC registration MO-153.

# EXAMPLE BOARD LAYOUT

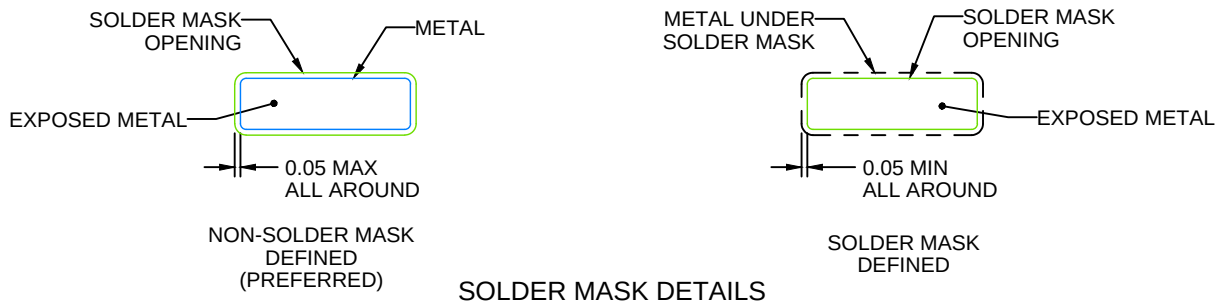
DBT0038A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



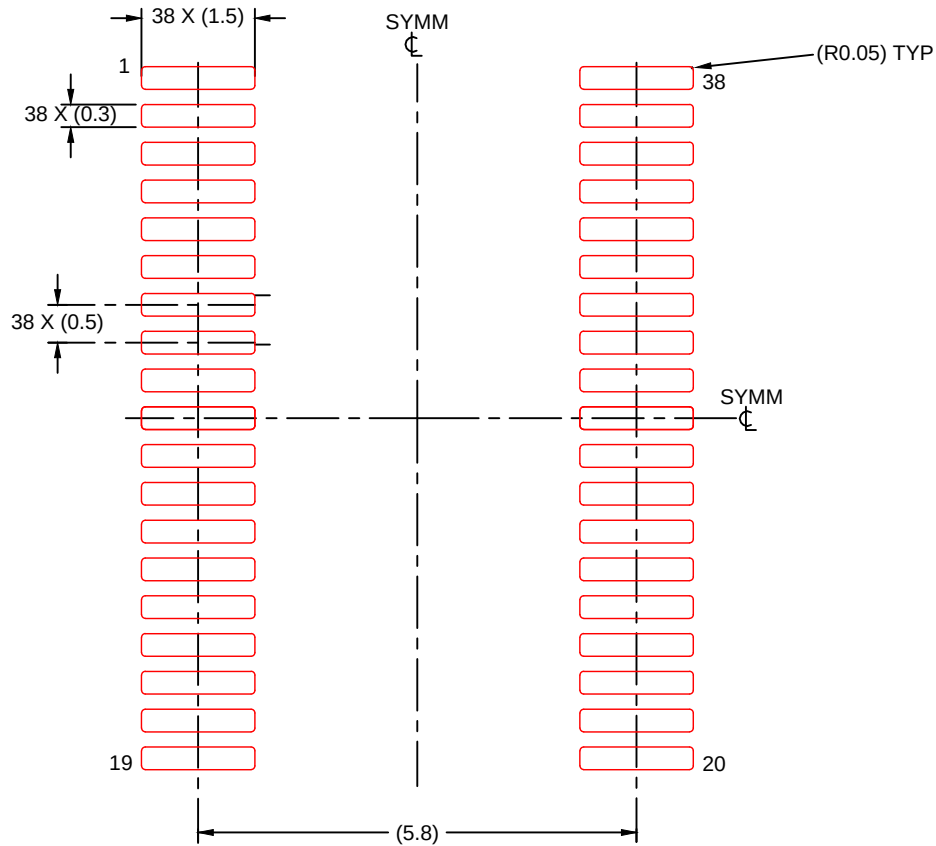
LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



4220221/A 05/2020

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. 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: 10X

4220221/A 05/2020

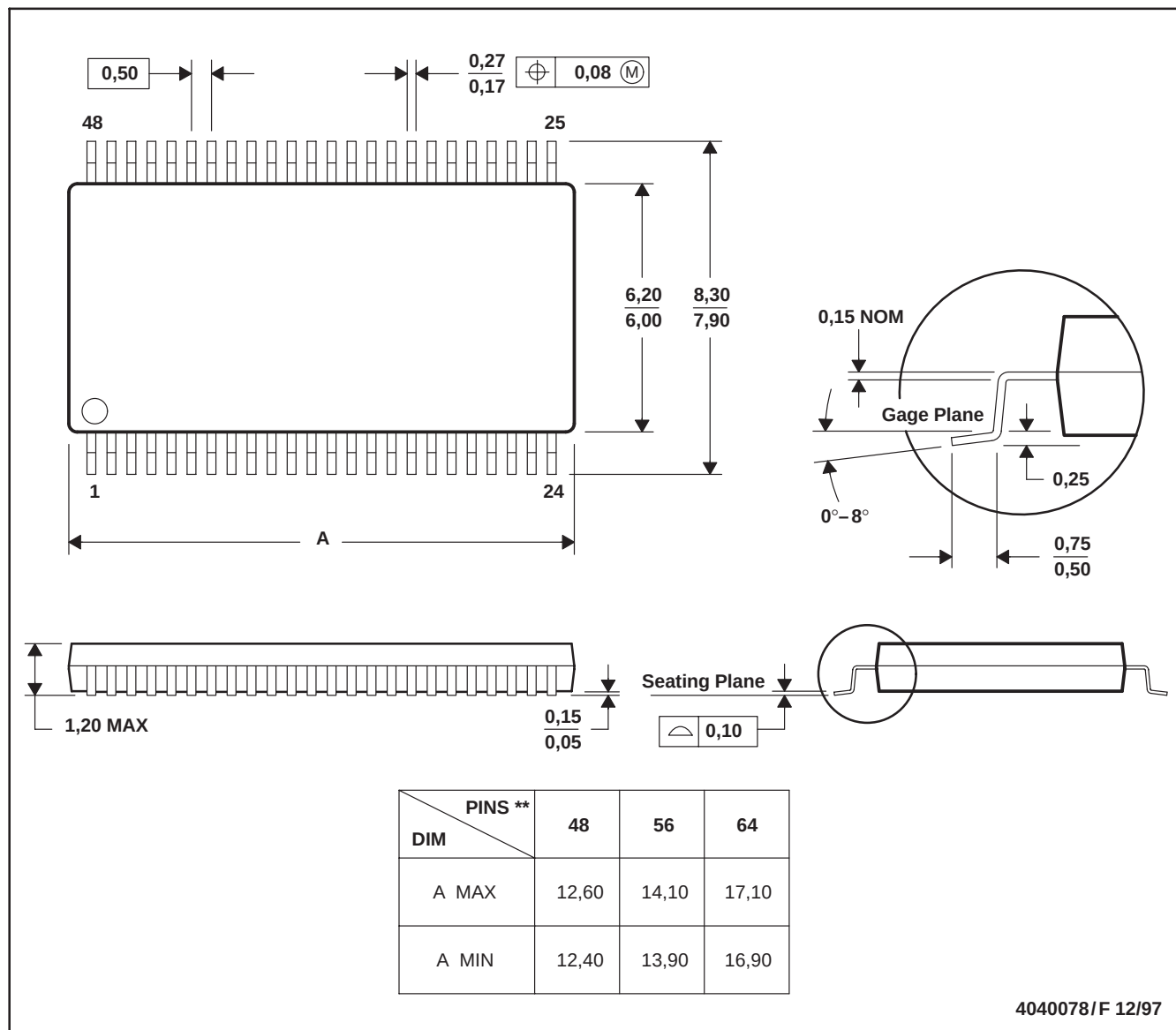
NOTES: (continued)

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

## DGG (R-PDSO-G\*\*)

## PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



- 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

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