

HIGH-SPEED DIFFERENTIAL LINE DRIVERS

FEATURES

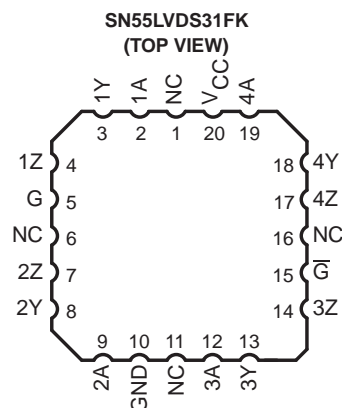
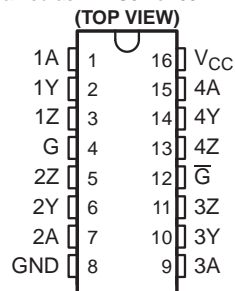
- Meet or Exceed the Requirements of ANSI TIA/EIA-644 Standard
- Low-Voltage Differential Signaling With Typical Output Voltage of 350 mV and 100-Ω Load
- Typical Output Voltage Rise and Fall Times of 500 ps (400 Mbps)
- Typical Propagation Delay Times of 1.7 ns
- Operate From a Single 3.3-V Supply
- Power Dissipation 25 mW Typical Per Driver at 200 MHz
- Driver at High Impedance When Disabled or With $V_{CC} = 0$
- Bus-Terminal ESD Protection Exceeds 8 kV
- Low-Voltage TTL (LVTTTL) Logic Input Levels
- Pin Compatible With AM26LS31, MC3487, and μ A9638
- Cold Sparring for Space and High Reliability Applications Requiring Redundancy

DESCRIPTION

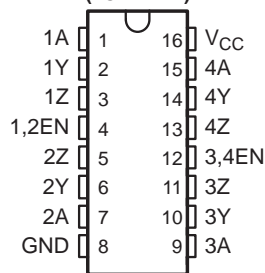
The SN55LVDS31, SN65LVDS31, SN65LVDS3487, and SN65LVDS9638 are differential line drivers that implement the electrical characteristics of low-voltage differential signaling (LVDS). This signaling technique lowers the output voltage levels of 5-V differential standard levels (such as TIA/EIA-422B) to reduce the power, increase the switching speeds, and allow operation with a 3.3-V supply rail. Any of the four current-mode drivers will deliver a minimum differential output voltage magnitude of 247 mV into a 100-Ω load when enabled.

The intended application of these devices and signaling technique is both point-to-point and multidrop (one driver and multiple receivers) data transmission over controlled impedance media of approximately 100 Ω. The transmission media may be printed-circuit board traces, backplanes, or cables. The ultimate rate and distance of data transfer is dependent upon the attenuation characteristics of the media and the noise coupling to the environment.

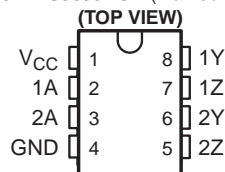
SN55LVDS31 ... J OR W
SN65LVDS31 ... D OR PW
(Marked as LVDS31 or 65LVDS31)



SN65LVDS3487D
(Marked as LVDS3487 or 65LVDS3487)



SN65LVDS9638D (Marked as DK638 or LVDS38)
SN65LVDS9638DGN (Marked as L38)
SN65LVDS9638DGK (Marked as AXG)



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PowerPAD is a trademark of Texas Instruments.



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)

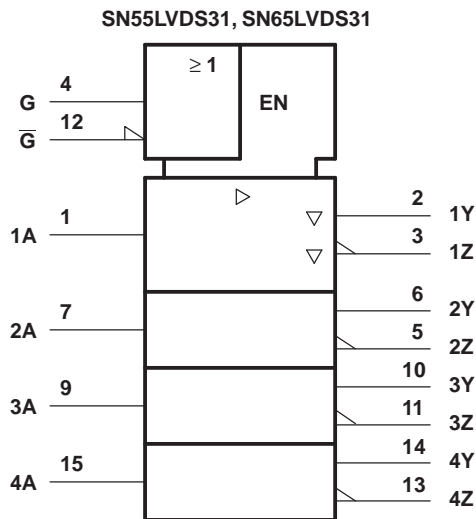
The SN65LVDS31, SN65LVDS3487, and SN65LVDS9638 are characterized for operation from -40°C to 85°C . The SN55LVDS31 is characterized for operation from -55°C to 125°C .

AVAILABLE OPTIONS

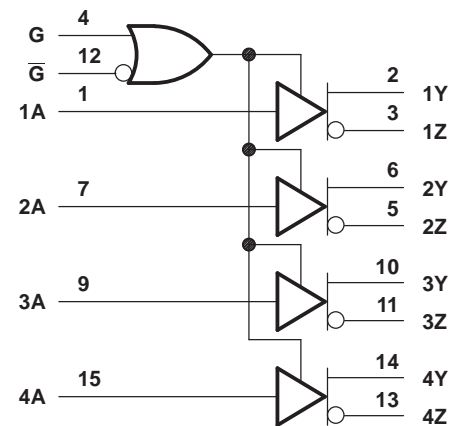
| T _A | PACKAGE ⁽¹⁾ | | | | | |
|--|------------------------|--------------|-----------------|-------------------|-----------------|-----------------------------|
| | SMALL OUTLINE | | MSOP | CHIP CARRIER (FK) | CERAMIC DIP (J) | FLAT PACK (W) |
| | (D) | (PW) | | | | |
| -40°C to 85°C | SN65LVDS31D | SN65LVDS31PW | — | — | — | — |
| | SN65LVDS3487D | — | — | — | — | — |
| | SN65LVDS9638D | — | SN65LVDS9638DGN | — | — | — |
| | — | — | SN65LVDS9638DGK | — | — | — |
| -55°C to 125°C | — | — | — | SNJ55LVDS31FK | SNJ55LVDS31J | SNJ55LVDS31W SN55LVDS31W |

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.

logic symbol†

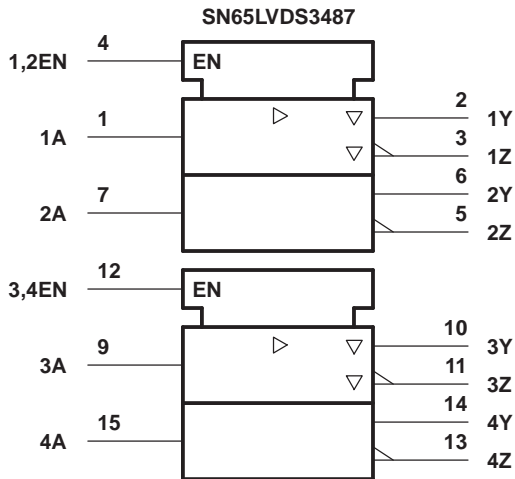


'LVDS31 logic diagram (positive logic)



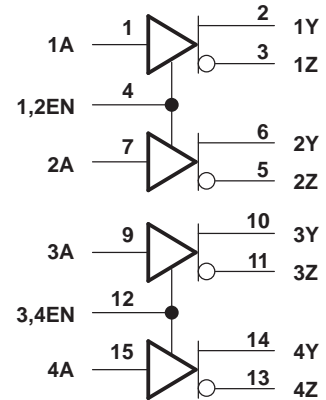
† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

logic symbol†

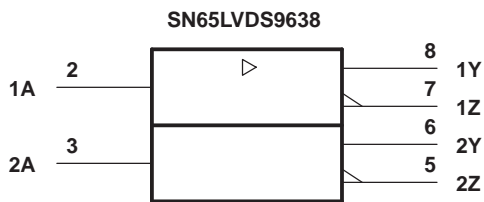


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

**SN65LVDS3487 logic diagram
(positive logic)**

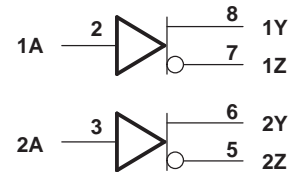


logic symbol†



† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

**SN65LVDS9638 logic diagram
(positive logic)**



FUNCTION TABLES

SN55LVDS31, SN65LVDS31⁽¹⁾

| INPUT A | ENABLES | | OUTPUTS | |
|------------|---------|---|---------|---|
| | G | G | Y | Z |
| H | H | X | H | L |
| L | H | X | L | H |
| H | X | L | H | L |
| L | X | L | L | H |
| X | L | H | Z | Z |
| Open | H | X | L | H |
| Open | X | L | L | H |

(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off)

SN65LVDS3487⁽¹⁾

| INPUT A | ENABLE EN | OUTPUTS | |
|---------|-----------|---------|---|
| | | Y | Z |
| H | H | H | L |
| L | H | L | H |
| X | L | Z | Z |
| Open | H | L | H |

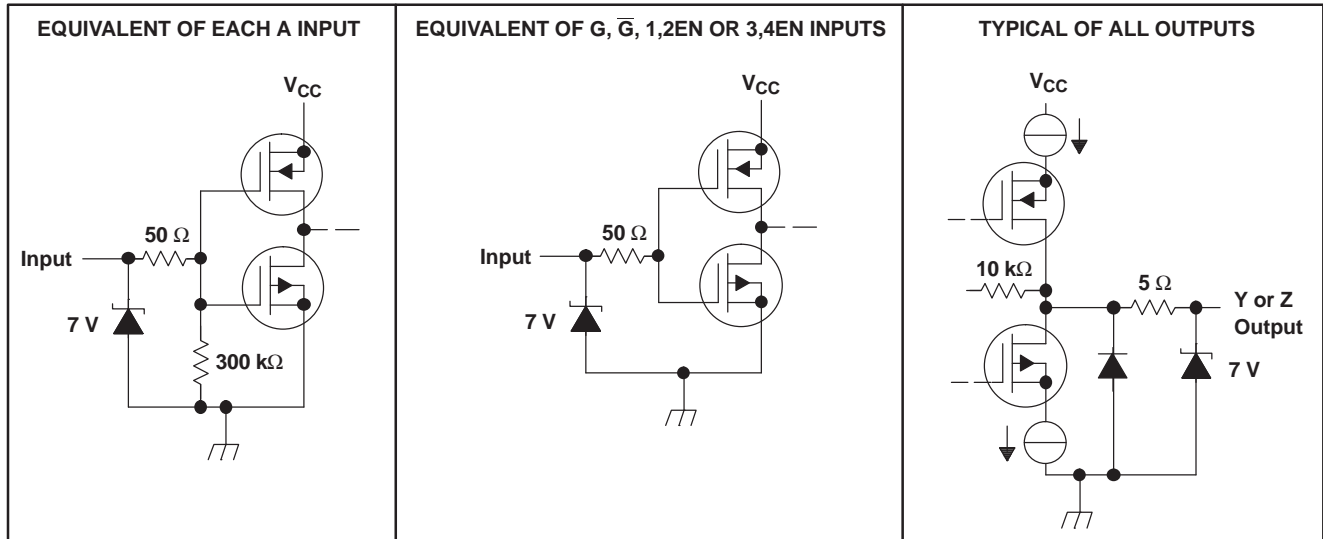
(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off)

SN65LVDS9638⁽¹⁾

| INPUT A | OUTPUTS | |
|---------|---------|---|
| | Y | Z |
| H | H | L |
| L | L | H |
| Open | L | H |

(1) H = high level, L = low level

EQUIVALENT INPUT AND OUTPUT SCHEMATIC DIAGRAMS



ABSOLUTE MAXIMUM RATINGS⁽¹⁾

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

| | UNIT |
|--|------------------------------|
| V_{CC} Supply voltage range ⁽²⁾ | -0.5 V to 4 V |
| V_I Input voltage range | -0.5 V to $V_{CC} + 0.5$ V |
| Continuous total power dissipation | See Dissipation Rating Table |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds | 260°C |
| T_{stg} Storage temperature range | -65°C to 150°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 voltages, except differential I/O bus voltages, are with respect to the network ground terminal.

DISSIPATION RATING TABLE

| PACKAGE | $T_A \leq 25^\circ\text{C}$ POWER RATING | DERATING FACTOR ⁽¹⁾ ABOVE $T_A = 25^\circ\text{C}$ | $T_A = 70^\circ\text{C}$ POWER RATING | $T_A = 85^\circ\text{C}$ POWER RATING | $T_A = 125^\circ\text{C}$ POWER RATING |
|--------------------|---|--|--|--|---|
| D (8) | 725 mW | 5.8 mW/°C | 464 mW | 377 mW | — |
| D (16) | 950 mW | 7.6 mW/°C | 608 mW | 494 mW | — |
| DGK | 425 mW | 3.4 mW/°C | 272 mW | 221 mW | — |
| DGN ⁽²⁾ | 2.14 W | 17.1 mW/°C | 1.37 W | 1.11 W | — |
| FK | 1375 mW | 11.0 mW/°C | 880 mW | 715 mW | 275 mW |
| J | 1375 mW | 11.0 mW/°C | 880 mW | 715 mW | 275 mW |
| PW (16) | 774 mW | 6.2 mW/°C | 496 mW | 402 mW | — |
| W | 1000 mW | 8.0 mW/°C | 640 mW | 520 mW | 200 mW |

- (1) This is the inverse of the junction-to-ambient thermal resistance when board-mounted and with no air flow.
- (2) The PowerPAD™ must be soldered to a thermal land on the printed-circuit board. See the application note *PowerPAD Thermally Enhanced Package (SLMA002)*.

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 | |
| T _A | Operating free-air temperature | SN65 prefix | | –40 | 85 | °C |
| | | SN55 prefix | | –55 | 125 | |

SN55LVDS31 ELECTRICAL CHARACTERISTICS

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

| PARAMETER | TEST CONDITIONS | MIN | TYP ⁽¹⁾ | MAX | UNIT |
|----------------------|--|--|--------------------|-------|------|
| V _{OD} | Differential output voltage magnitude R _L = 100 Ω, See Figure 2 | 247 | 340 | 454 | mV |
| ΔV _{OD} | Change in differential output voltage magnitude between logic states R _L = 100 Ω, See Figure 2 | –50 | | 50 | mV |
| V _{OC(SS)} | Steady-state common-mode output voltage See Figure 3 | 1.125 | 1.2 | 1.375 | V |
| ΔV _{OC(SS)} | Change in steady-state common-mode output voltage between logic states See Figure 3 | –50 | | 50 | mV |
| V _{OC(PP)} | Peak-to-peak common-mode output voltage See Figure 3 | | 50 | 150 | mV |
| I _{CC} | Supply current V _I = 0.8 V or 2 V, Enabled, No load | | 9 | 20 | mA |
| | | V _I = 0.8 or 2 V, R _L = 100 Ω, Enabled | 25 | 35 | |
| | | V _I = 0 or V _{CC} , Disabled | 0.25 | 1 | |
| I _{IH} | High-level input current V _{IH} = 2 | | 4 | 20 | μA |
| I _{IL} | Low-level input current V _{IL} = 0.8 V | | 0.1 | 10 | μA |
| I _{OS} | Short-circuit output current V _{O(Y)} or V _{O(Z)} = 0 | | –4 | –24 | mA |
| | | V _{OD} = 0 | | ±12 | |
| I _{OZ} | High-impedance output current V _O = 0 or 2.4 V | | | ±1 | μA |
| I _{O(OFF)} | Power-off output current V _{CC} = 0, V _O = 2.4 V | | | ±4 | μA |
| C _i | Input capacitance | | 3 | | pF |

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

SN55LVDS31 SWITCHING CHARACTERISTICS

over recommended operating conditions (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP ⁽¹⁾ | MAX | UNIT | |
|--------------------|---|---|--------------------|-----|------|----|
| t _{PLH} | Propagation delay time, low-to-high-level output | 0.5 | 1.4 | 4 | ns | |
| t _{PHL} | Propagation delay time, high-to-low-level output | 1 | 1.7 | 4.5 | ns | |
| t _r | Differential output signal rise time (20% to 80%) | R _L = 100 Ω, C _L = 10 pF, See Figure 2 | 0.4 | 0.5 | 1 | ns |
| t _f | Differential output signal fall time (80% to 20%) | | 0.4 | 0.5 | 1 | ns |
| t _{sk(p)} | Pulse skew (t _{PHL} – t _{PLH}) | | | 0.3 | 0.6 | ns |
| t _{sk(o)} | Channel-to-channel output skew ⁽²⁾ | | | 0.3 | 0.6 | ns |
| t _{PZH} | Propagation delay time, high-impedance-to-high-level output | | 5.4 | 15 | ns | |
| t _{PZL} | Propagation delay time, high-impedance-to-low-level output | See Figure 4 | 2.5 | 15 | ns | |
| t _{PHZ} | Propagation delay time, high-level-to-high-impedance output | | 8.1 | 17 | ns | |
| t _{PLZ} | Propagation delay time, low-level-to-high-impedance output | | 7.3 | 15 | ns | |

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

(2) t_{sk(o)} is the maximum delay time difference between drivers on the same device.

SN65LVDSxxxx ELECTRICAL CHARACTERISTICS

over recommended operating conditions (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | SN65LVDS31 SN65LVDS3487 SN65LVDS9638 | | | UNIT |
|---------------------|--|---|--|--|--------------------|-------|------|
| | | | | MIN | TYP ⁽¹⁾ | MAX | |
| V _{OD} | Differential output voltage magnitude | R _L = 100 Ω, | See Figure 2 | 247 | 340 | 454 | mV |
| ΔV _{OD} | Change in differential output voltage magnitude between logic states | R _L = 100 Ω, | See Figure 2 | –50 | | 50 | mV |
| V _{OC(SS)} | Steady-state common-mode output voltage | See Figure 3 | | 1.125 | 1.2 | 1.375 | V |
| ΔV _{OC(S)} | Change in steady-state common-mode output voltage between logic states | See Figure 3 | | –50 | | 50 | mV |
| V _{OC(PP)} | Peak-to-peak common-mode output voltage | See Figure 3 | | | 50 | 150 | mV |
| I _{CC} | Supply current | SN65LVDS31, SN65LVDS3487 | V _I = 0.8 V or 2 V, Enabled, No load | | 9 | 20 | mA |
| | | | V _I = 0.8 or 2 V, R _L = 100 Ω, Enabled | | 25 | 35 | |
| | | | V _I = 0 or V _{CC} , Disabled | | 0.25 | 1 | |
| | | SN65LVDS9638 | V _I = 0.8 V or 2 V | No load | | 4.7 | 8 |
| | | R _L = 100 Ω | | 9 | 13 | | |
| I _{IH} | High-level input current | V _{IH} = 2 | | | 4 | 20 | μA |
| I _{IL} | Low-level input current | V _{IL} = 0.8 V | | | 0.1 | 10 | μA |
| I _{OS} | Short-circuit output current | V _{O(Y)} or V _{O(Z)} = 0 V _{OD} = 0 | | | –4 | –24 | mA |
| I _{OZ} | High-impedance output current | V _O = 0 or 2.4 V | | | | ±1 | |
| I _{O(OFF)} | Power-off output current | V _{CC} = 0, | V _O = 2.4 V | | | ±1 | μA |
| C _i | Input capacitance | | | | 3 | | pF |

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

SN65LVDSxxxx SWITCHING CHARACTERISTICS

over recommended operating conditions (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | SN65LVDS31 SN65LVDS3487 SN65LVDS9638 | | | UNIT |
|---------------------|---|---|-----|--|--------------------|-----|------|
| | | | | MIN | TYP ⁽¹⁾ | MAX | |
| t _{PLH} | Propagation delay time, low-to-high-level output | R _L = 100 Ω, C _L = 10 pF, See Figure 2 | 0.5 | 1.4 | 2 | ns | |
| t _{PHL} | Propagation delay time, high-to-low-level output | | 1 | 1.7 | 2.5 | ns | |
| t _r | Differential output signal rise time (20% to 80%) | | 0.4 | 0.5 | 0.6 | ns | |
| t _f | Differential output signal fall time (80% to 20%) | | 0.4 | 0.5 | 0.6 | ns | |
| t _{sk(p)} | Pulse skew (t _{PHL} – t _{PLH}) | | | 0.3 | 0.6 | ns | |
| t _{sk(o)} | Channel-to-channel output skew ⁽²⁾ | | | 0 | 0.3 | ns | |
| t _{sk(pp)} | Part-to-part skew ⁽³⁾ | | | 800 | ps | | |
| t _{PZH} | Propagation delay time, high-impedance-to-high-level output | See Figure 4 | | 5.4 | 15 | ns | |
| t _{PZL} | Propagation delay time, high-impedance-to-low-level output | | | 2.5 | 15 | ns | |
| t _{PHZ} | Propagation delay time, high-level-to-high-impedance output | | | 8.1 | 15 | ns | |
| t _{PLZ} | Propagation delay time, low-level-to-high-impedance output | | | 7.3 | 15 | ns | |

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

(2) t_{sk(o)} is the skew between specified outputs of a single device with all driving inputs connected together and the outputs switching in the same direction while driving identical specified loads.

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

PARAMETER MEASUREMENT INFORMATION

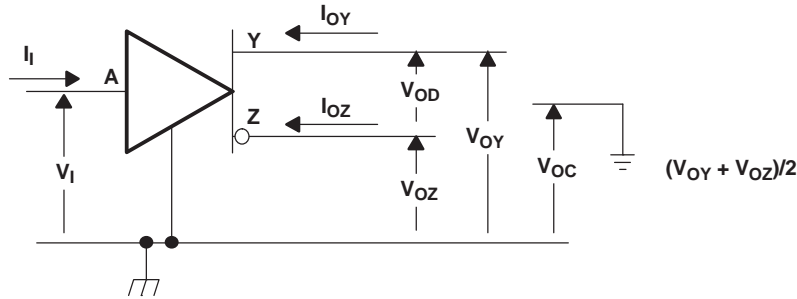
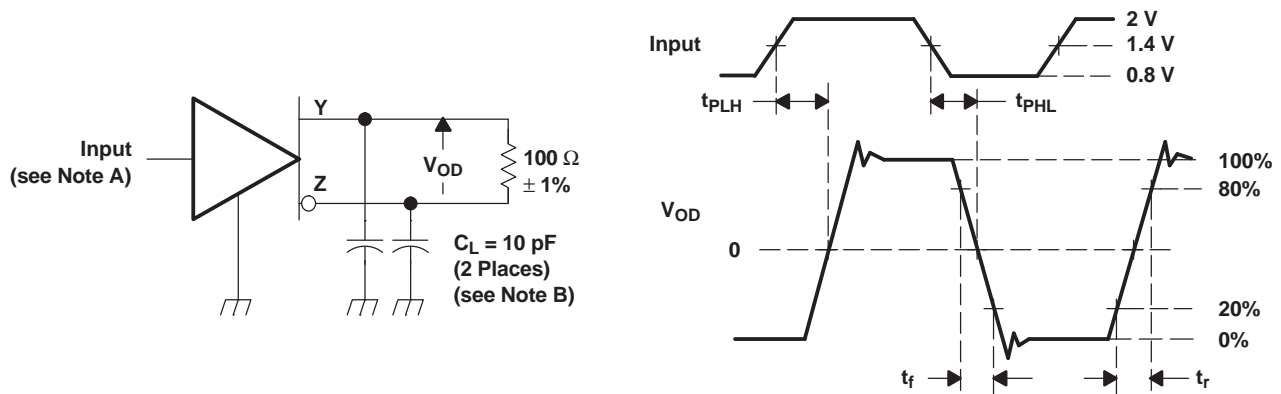
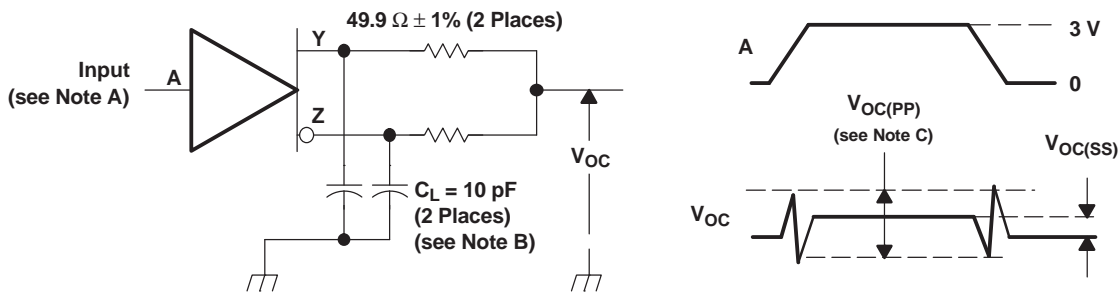


Figure 1. Voltage and Current Definitions



- NOTES: 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, pulse width = 10 ± 0.2 ns.
B. C_L includes instrumentation and fixture capacitance within 6 mm of the D.U.T.

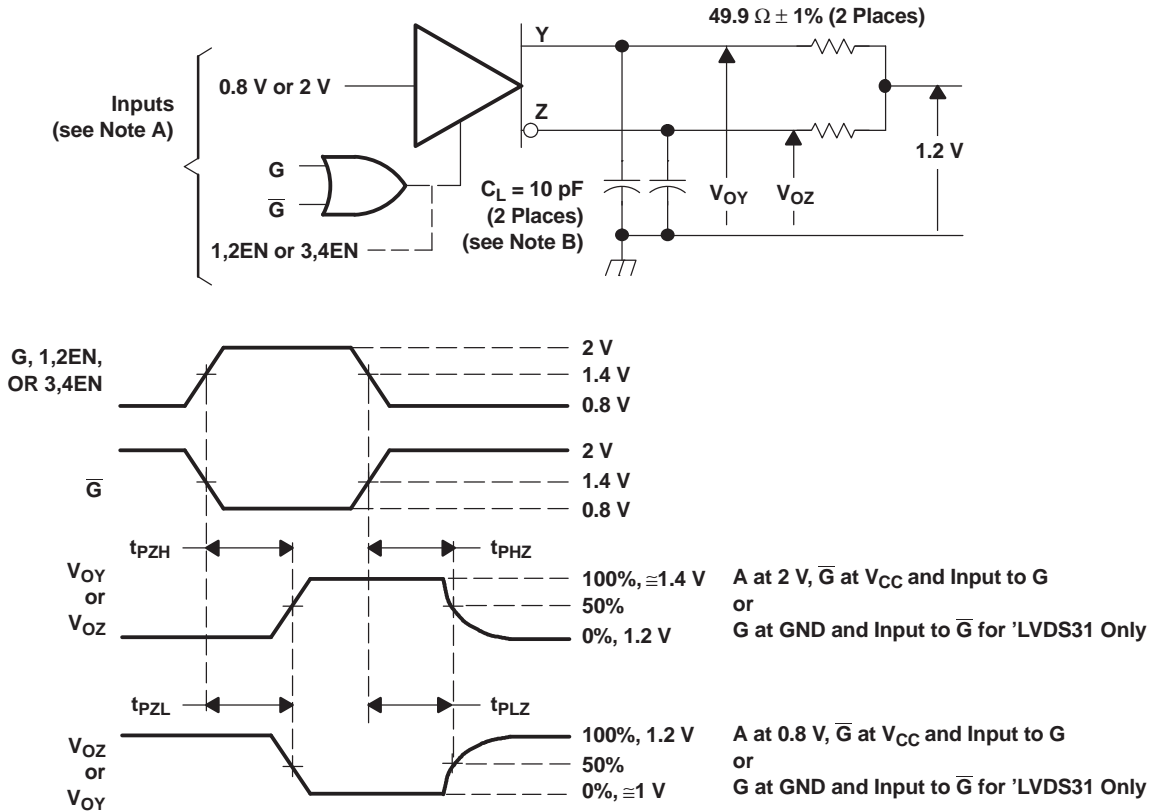
Figure 2. Test Circuit, Timing, and Voltage Definitions for the Differential Output Signal



- NOTES: 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, pulse width = 10 ± 0.2 ns.
B. C_L includes instrumentation and fixture capacitance within 6 mm of the D.U.T.
C. 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

PARAMETER MEASUREMENT INFORMATION (continued)



- NOTES: A. All input pulses are supplied by a generator having the following characteristics: t_r or $t_f < 1 \text{ ns}$, pulse repetition rate (PRR) = 0.5 Mpps, pulse width = $500 \pm 10 \text{ ns}$.
B. C_L includes instrumentation and fixture capacitance within 6 mm of the D.U.T.

Figure 4. Enable-/Disable-Time Circuit and Definitions

TYPICAL CHARACTERISTICS

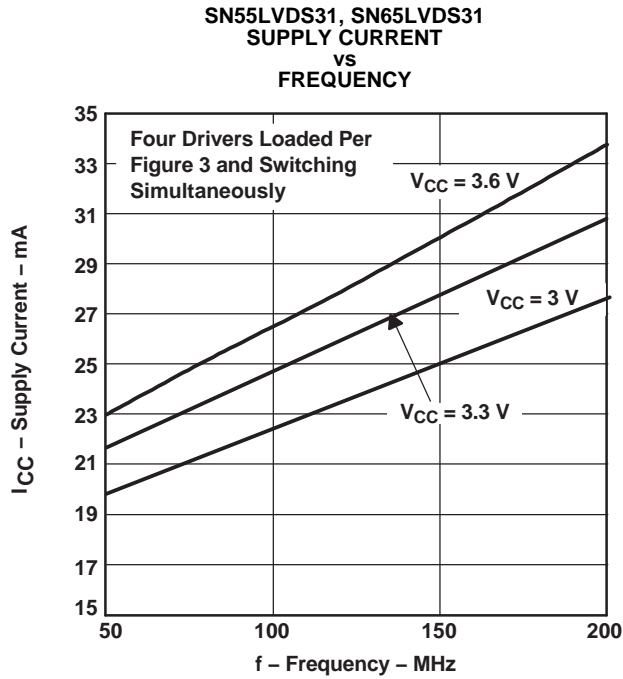


Figure 5.

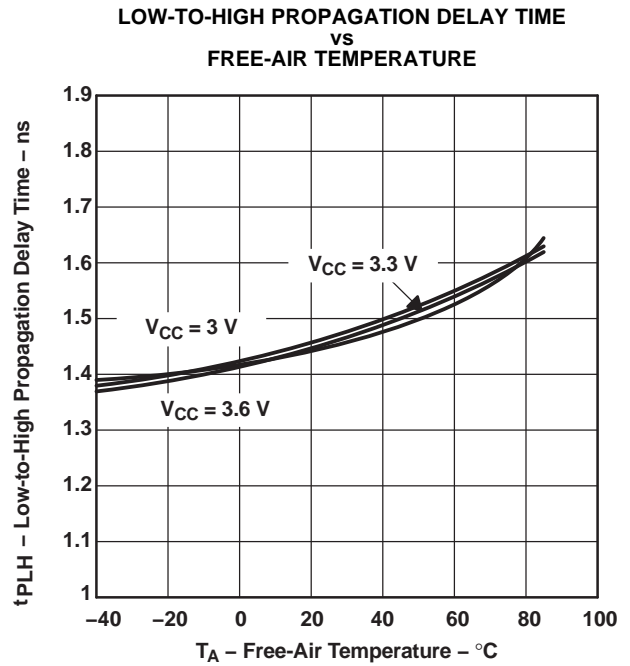


Figure 6.

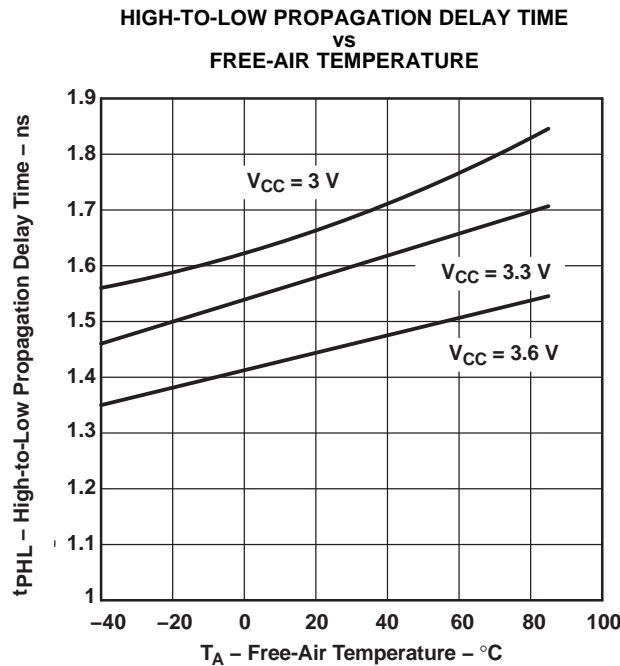
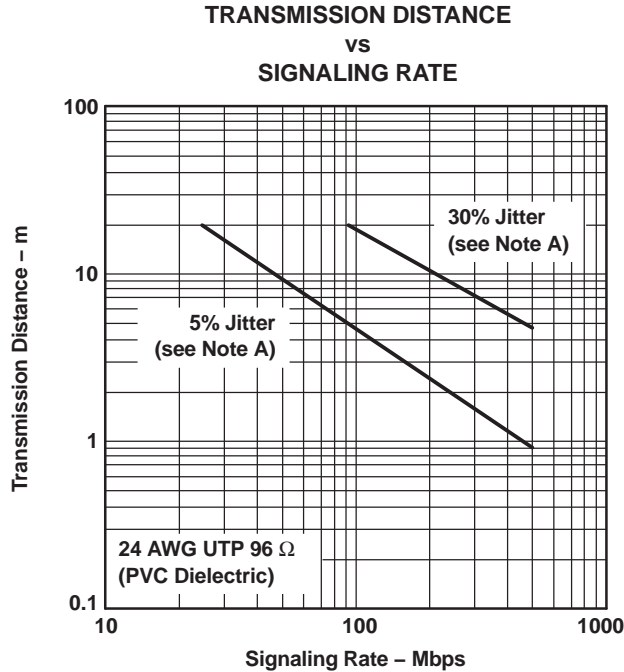


Figure 7.

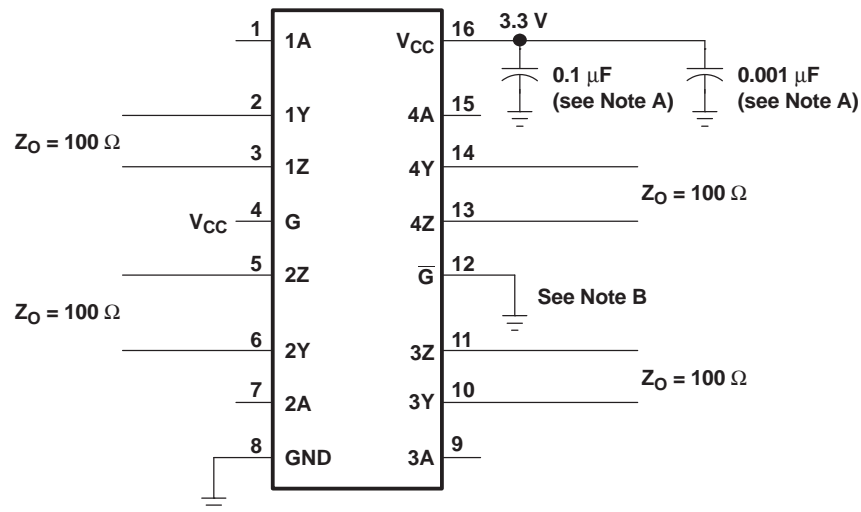
APPLICATION INFORMATION

The devices are generally used as building blocks for high-speed point-to-point data transmission where ground differences are less than 1 V. Devices can interoperate with RS-422, PECL, and IEEE-P1596. Drivers/receivers approach ECL speeds without the power and dual supply requirements.



- A. This parameter is the percentage of distortion of the unit interval (UI) with a pseudorandom data pattern.

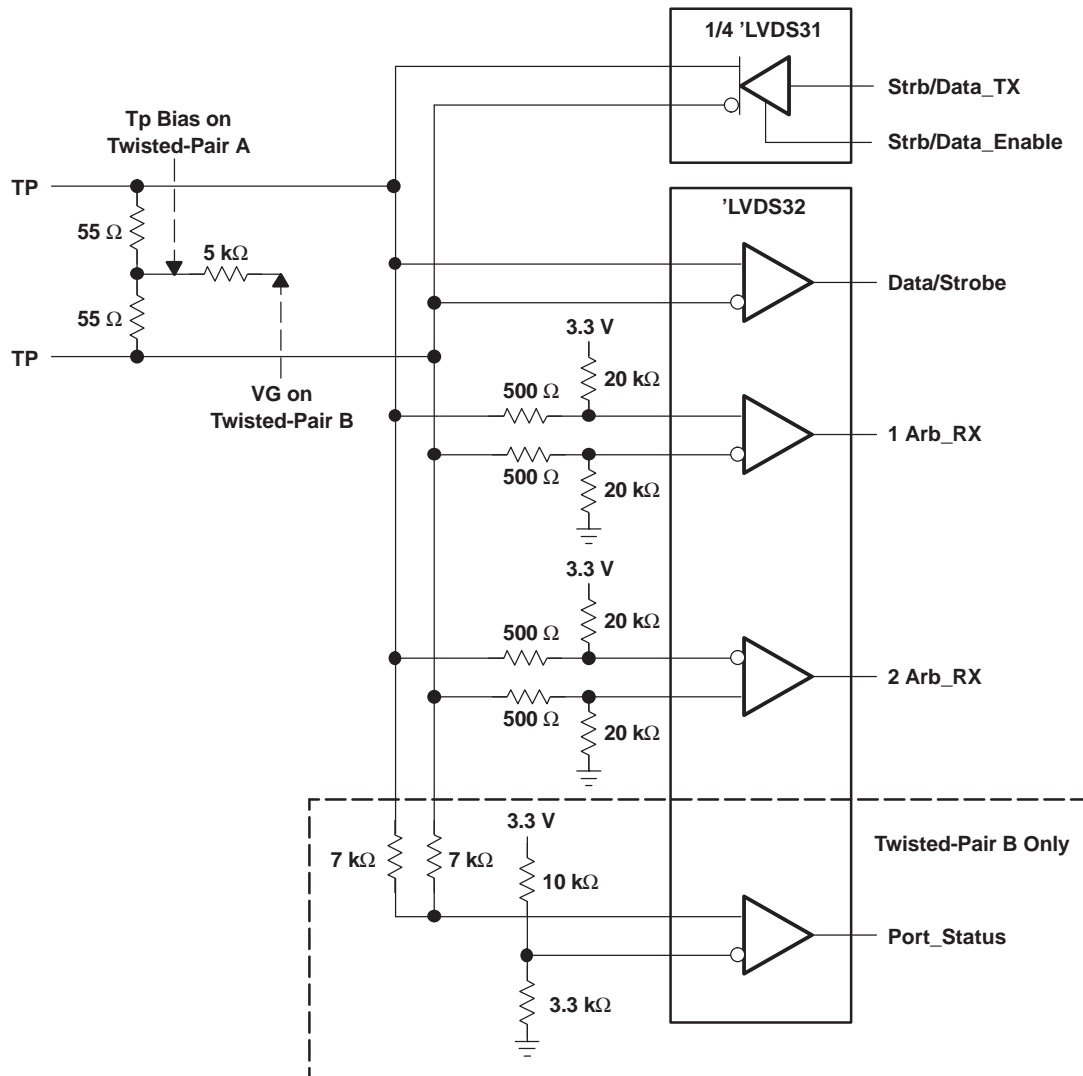
Figure 8. Typical Transmission Distance Versus Signaling Rate



- NOTES: A. Place a 0.1- μ F and a 0.001- μ F Z5U ceramic, mica, or polystyrene dielectric, 0805 size, chip capacitor between V_{CC} and the ground plane. The capacitors should be located as close as possible to the device terminals.
B. Unused enable inputs should be tied to V_{CC} or GND, as appropriate.

Figure 9. Typical Application Circuit Schematic

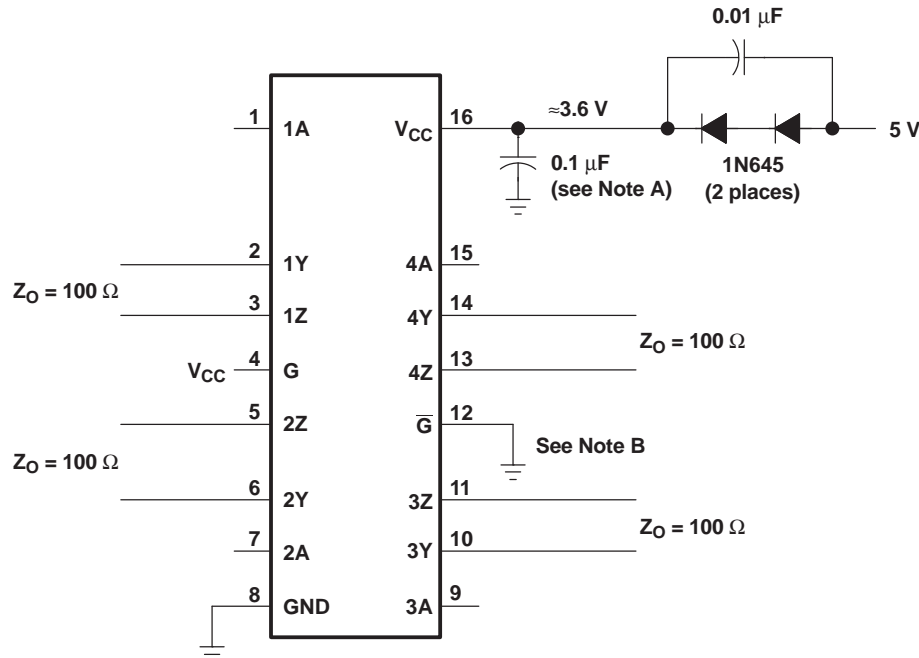
APPLICATION INFORMATION (continued)



- NOTES: A. Resistors are leadless, thick film (0603), 5% tolerance.
 B. Decoupling capacitance is not shown, but recommended.
 C. V_{CC} is 3 V to 3.6 V.
 D. The differential output voltage of the 'LVDS31 can exceed that specified by IEEE1394.

Figure 10. 100-Mbps IEEE 1394 Transceiver

APPLICATION INFORMATION (continued)



- A. Place a 0.1- μF Z5U ceramic, mica, or polystyrene dielectric, 0805 size, chip capacitor between V_{CC} and the ground plane. The capacitor should be located as close as possible to the device terminals.
- B. Unused enable inputs should be tied to V_{CC} or GND, as appropriate.

Figure 11. Operation With 5-V Supply

COLD SPARING

Systems using cold sparing have a redundant device electrically connected without power supplied. To support this configuration, the spare must present a high-input impedance to the system so that it does not draw appreciable power. In cold sparing, voltage may be applied to an I/O before and during power up of a device. When the device is powered off, V_{CC} must be clamped to ground and the I/O voltages applied must be within the specified recommended operating conditions.

RELATED INFORMATION

IBIS modeling is available for this device. Contact the local TI sales office or the TI Web site at www.ti.com for more information.

For more application guidelines, see the following documents:

- *Low-Voltage Differential Signaling Design Notes* (SLLA014)
- *Interface Circuits for TIA/EIA-644 (LVDS)* (SLLA038)
- *Reducing EMI With LVDS* (SLLA030)
- *Slew Rate Control of LVDS Circuits* (SLLA034)
- *Using an LVDS Receiver With RS-422 Data* (SLLA031)
- *Evaluating the LVDS EVM* (SLLA033)

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|--------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| 5962-9762101Q2A | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | N / A for Pkg Type |
| 5962-9762101QEA | ACTIVE | CDIP | J | 16 | 1 | TBD | A42 SNPB | N / A for Pkg Type |
| 5962-9762101QFA | ACTIVE | CFP | W | 16 | 1 | TBD | A42 SNPB | N / A for Pkg Type |
| 5962-9762101VF A | ACTIVE | CFP | W | 16 | 1 | TBD | A42 SNPB | N / A for Pkg Type |
| SN55LVDS31W | ACTIVE | CFP | W | 16 | 1 | TBD | A42 SNPB | N / A for Pkg Type |
| SN65LVDS31D | ACTIVE | SOIC | D | 16 | 40 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS31DG4 | ACTIVE | SOIC | D | 16 | 40 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS31DR | ACTIVE | SOIC | D | 16 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS31DRG4 | ACTIVE | SOIC | D | 16 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS31NSR | ACTIVE | SO | NS | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS31NSRG4 | ACTIVE | SO | NS | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS31PW | ACTIVE | TSSOP | PW | 16 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS31PWG4 | ACTIVE | TSSOP | PW | 16 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS31PWR | ACTIVE | TSSOP | PW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS31PWRG4 | ACTIVE | TSSOP | PW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS31QPWQ1 | OBSOLETE | TSSOP | PW | 16 | | TBD | Call TI | Call TI |
| SN65LVDS31QPWRQ1 | OBSOLETE | TSSOP | PW | 16 | | TBD | Call TI | Call TI |
| SN65LVDS3487D | ACTIVE | SOIC | D | 16 | 40 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS3487DG4 | ACTIVE | SOIC | D | 16 | 40 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS3487DR | ACTIVE | SOIC | D | 16 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS3487DRG4 | ACTIVE | SOIC | D | 16 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS9638D | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS9638DG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS9638DGK | ACTIVE | MSOP | DGK | 8 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS9638DGKG4 | ACTIVE | MSOP | DGK | 8 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS9638DGKR | ACTIVE | MSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS9638DGKRG4 | ACTIVE | MSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS9638DGN | ACTIVE | MSOP- | DGN | 8 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|--------------------|-----------------------|----------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| | | Power PAD | | | | no Sb/Br) | | |
| SN65LVDS9638DGNR | ACTIVE | MSOP-Power PAD | DGN | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS9638DGNRG4 | ACTIVE | MSOP-Power PAD | DGN | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS9638DR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN65LVDS9638DRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SNJ55LVDS31FK | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | N / A for Pkg Type |
| SNJ55LVDS31J | ACTIVE | CDIP | J | 16 | 1 | TBD | A42 SNPB | N / A for Pkg Type |
| SNJ55LVDS31W | ACTIVE | CFP | W | 16 | 1 | TBD | A42 SNPB | N / A for Pkg Type |
| SNLVDS9638DGNG4 | ACTIVE | MSOP-Power PAD | DGN | 8 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

⁽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.

OTHER QUALIFIED VERSIONS OF SN55LVDS31, SN55LVDS31-SP, SN65LVDS31 :

- Catalog: [SN75LVDS31](#)
- Enhanced Product: [SN65LVDS31-EP](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

TAPE AND REEL INFORMATION

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 |
|------------------|----------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| SN65LVDS31DR | SOIC | D | 16 | 2500 | 330.0 | 16.4 | 6.5 | 10.3 | 2.1 | 8.0 | 16.0 | Q1 |
| SN65LVDS31NSR | SO | NS | 16 | 2000 | 330.0 | 16.4 | 8.2 | 10.5 | 2.5 | 12.0 | 16.0 | Q1 |
| SN65LVDS31PWR | TSSOP | PW | 16 | 2000 | 330.0 | 12.4 | 6.8 | 5.4 | 1.6 | 8.0 | 12.0 | Q1 |
| SN65LVDS3487DR | SOIC | D | 16 | 2500 | 330.0 | 16.4 | 6.5 | 10.3 | 2.1 | 8.0 | 16.0 | Q1 |
| SN65LVDS9638DGKR | MSOP | DGK | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| SN65LVDS9638DGNR | MSOP-Power PAD | DGN | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| SN65LVDS9638DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|------------------|---------------|-----------------|------|------|-------------|------------|-------------|
| SN65LVDS31DR | SOIC | D | 16 | 2500 | 333.2 | 345.9 | 28.6 |
| SN65LVDS31NSR | SO | NS | 16 | 2000 | 346.0 | 346.0 | 33.0 |
| SN65LVDS31PWR | TSSOP | PW | 16 | 2000 | 346.0 | 346.0 | 29.0 |
| SN65LVDS3487DR | SOIC | D | 16 | 2500 | 346.0 | 346.0 | 33.0 |
| SN65LVDS9638DGKR | MSOP | DGK | 8 | 2500 | 358.0 | 335.0 | 35.0 |
| SN65LVDS9638DGNR | MSOP-PowerPAD | DGN | 8 | 2500 | 358.0 | 335.0 | 35.0 |
| SN65LVDS9638DR | SOIC | D | 8 | 2500 | 346.0 | 346.0 | 29.0 |

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



4040064/F 01/97

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

J (R-GDIP-T**)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



| DIM \ PINS ** | 14 | 16 | 18 | 20 |
|---------------|------------------------|------------------------|------------------------|------------------------|
| A | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC |
| B MAX | 0.785 (19,94) | .840 (21,34) | 0.960 (24,38) | 1.060 (26,92) |
| B MIN | — | — | — | — |
| C MAX | 0.300 (7,62) | 0.300 (7,62) | 0.310 (7,87) | 0.300 (7,62) |
| C MIN | 0.245 (6,22) | 0.245 (6,22) | 0.220 (5,59) | 0.245 (6,22) |



4040083/F 03/03

- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - This package is hermetically sealed with a ceramic lid using glass frit.
 - Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
 - Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

FK (S-CQCC-N**)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - This package can be hermetically sealed with a metal lid.
 - The terminals are gold plated.
 - Falls within JEDEC MS-004

MECHANICAL DATA

NS (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

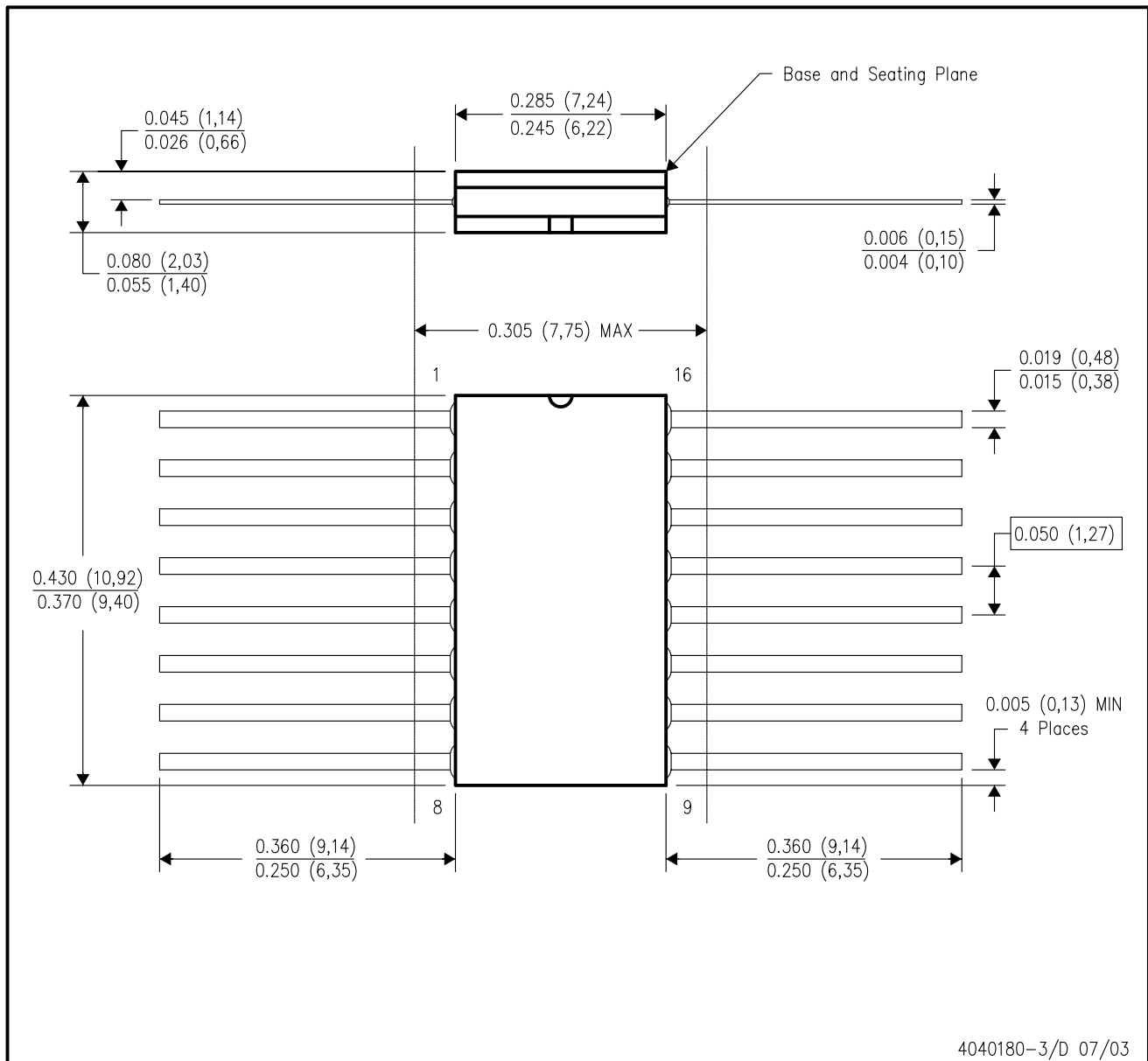
14-PINS SHOWN



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

W (R-GDFP-F16)

CERAMIC DUAL FLATPACK

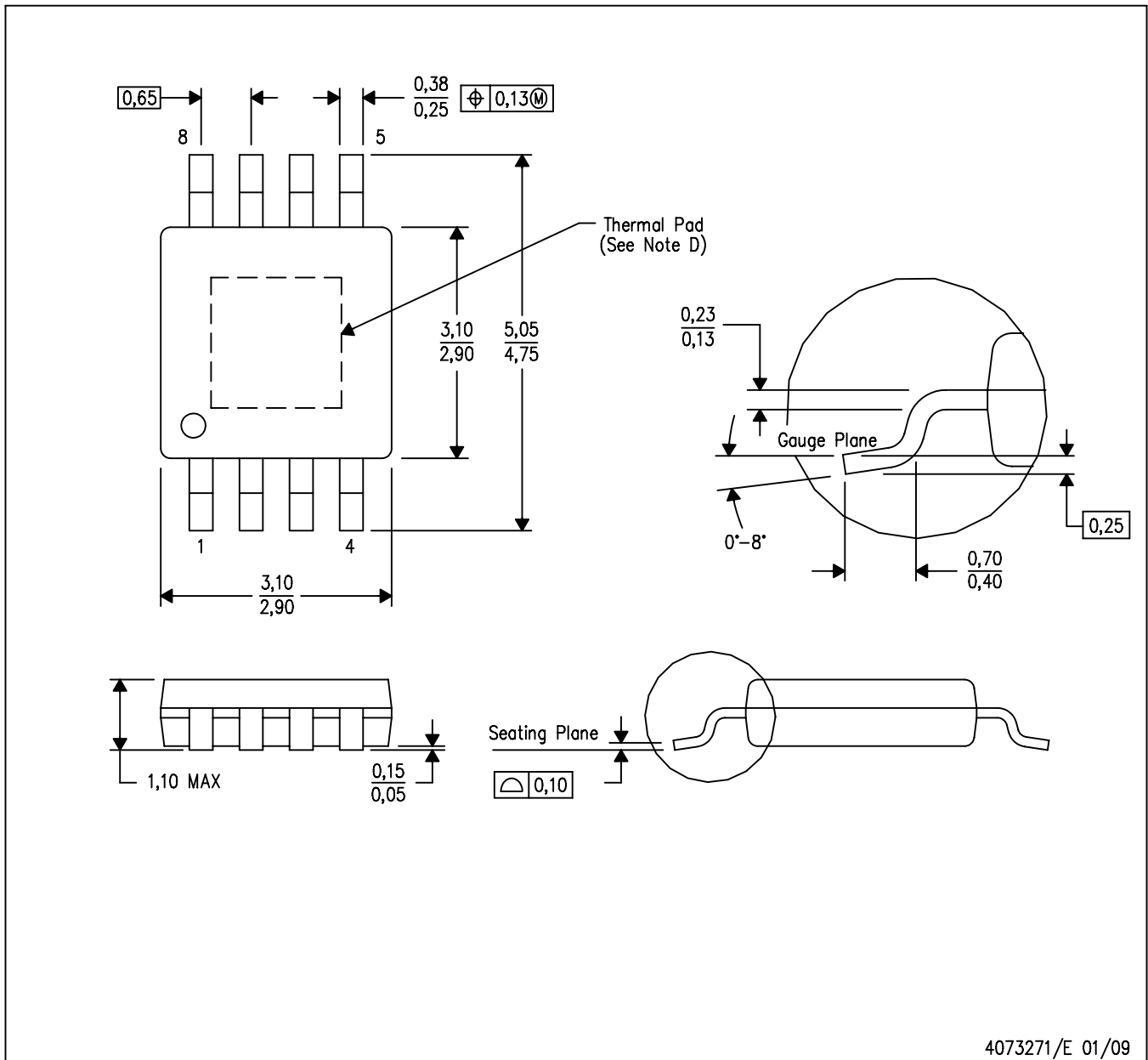


- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. This package can be hermetically sealed with a ceramic lid using glass frit.
 - D. Index point is provided on cap for terminal identification only.
 - E. Falls within MIL STD 1835 GDFP1-F16 and JEDEC MO-092AC

MECHANICAL DATA

DGN (S-PDSO-G8)

PowerPAD™ PLASTIC SMALL-OUTLINE PACKAGE



4073271/E 01/09

- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Body dimensions do not include mold flash or protrusion.
 - This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPAD Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 for information regarding recommended board layout. This document is available at www.ti.com <<http://www.ti.com>>.
 - Falls within JEDEC MO-187 variation AA-T

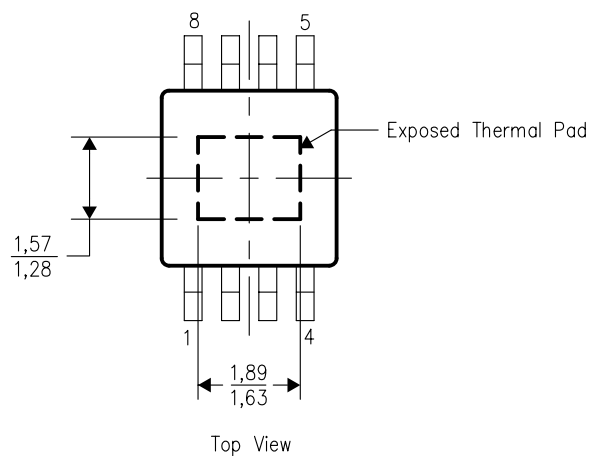
PowerPAD is a trademark of Texas Instruments.

THERMAL INFORMATION

This PowerPAD™ package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For additional information on the PowerPAD package and how to take advantage of its heat dissipating abilities, refer to Technical Brief, PowerPAD Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 and Application Brief, PowerPAD Made Easy, Texas Instruments Literature No. SLMA004. Both documents are available at www.ti.com.

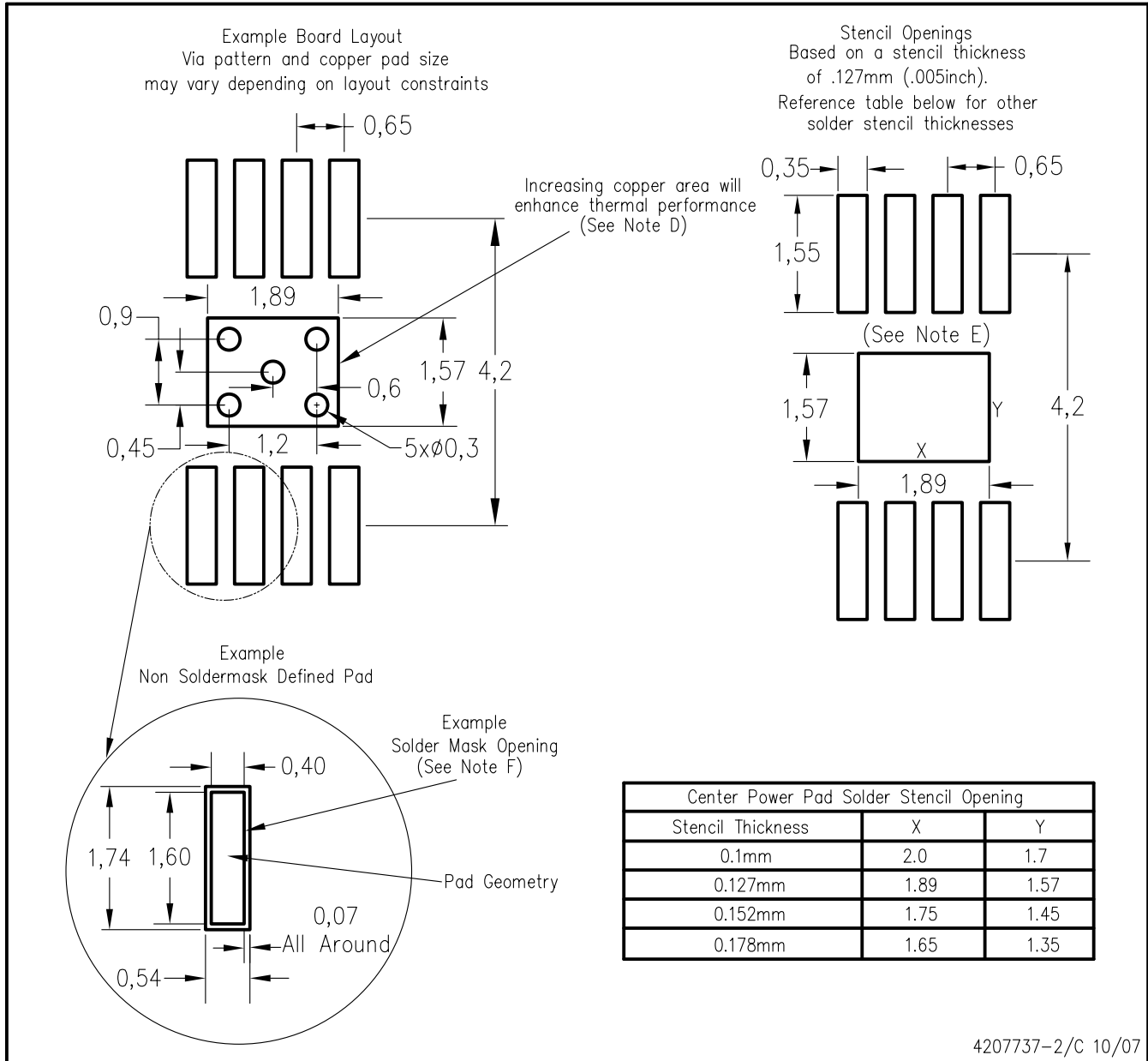
The exposed thermal pad dimensions for this package are shown in the following illustration.



NOTE: All linear dimensions are in millimeters

Exposed Thermal Pad Dimensions

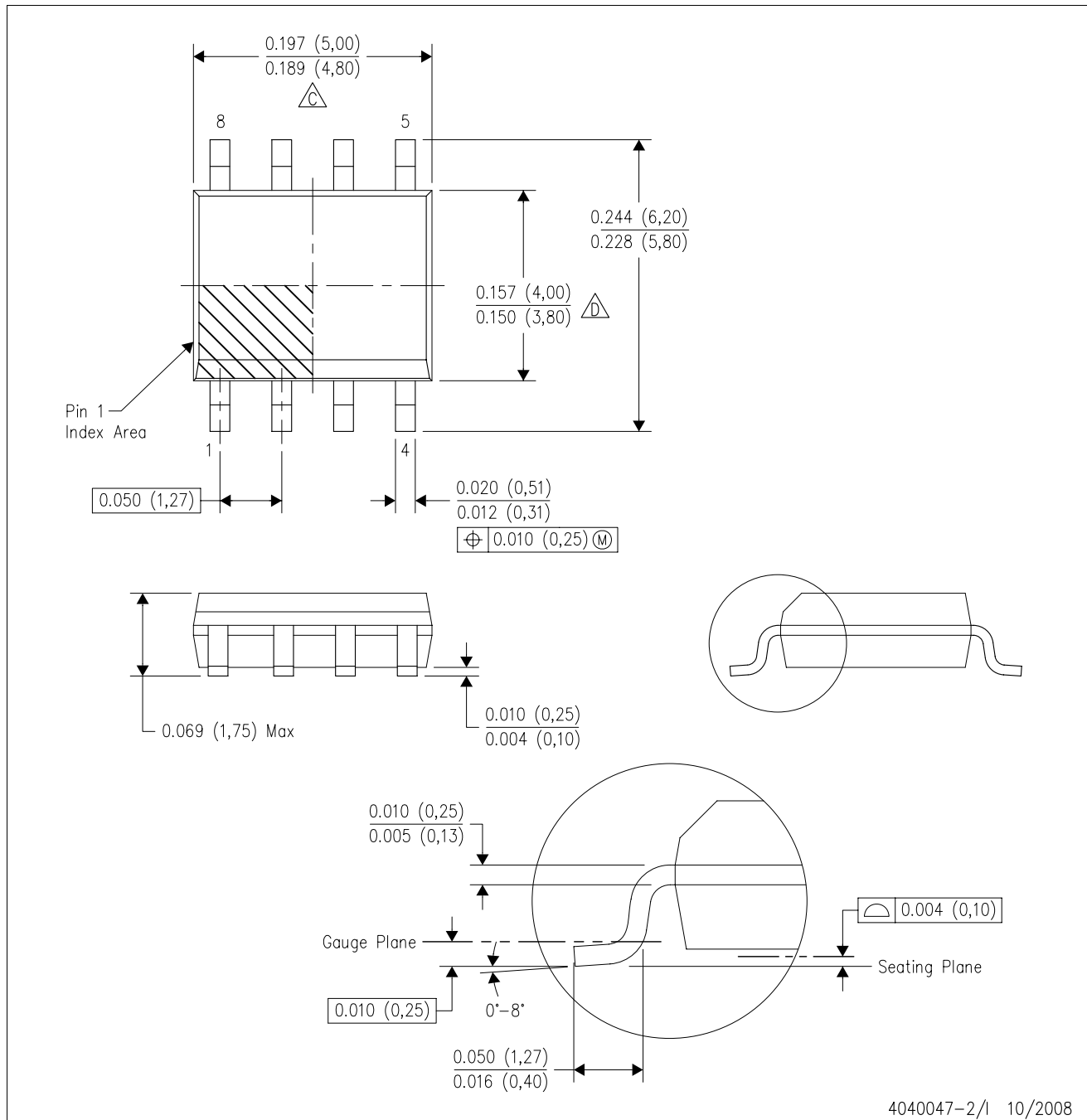
DGN (R-PDS0-G8) PowerPAD™



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
 - D. This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, Texas Instruments Literature No. SLMA002, SLMA004, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <<http://www.ti.com>>. Publication IPC-7351 is recommended for alternate designs.
 - E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.
 - F. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

D (R-PDSO-G8)

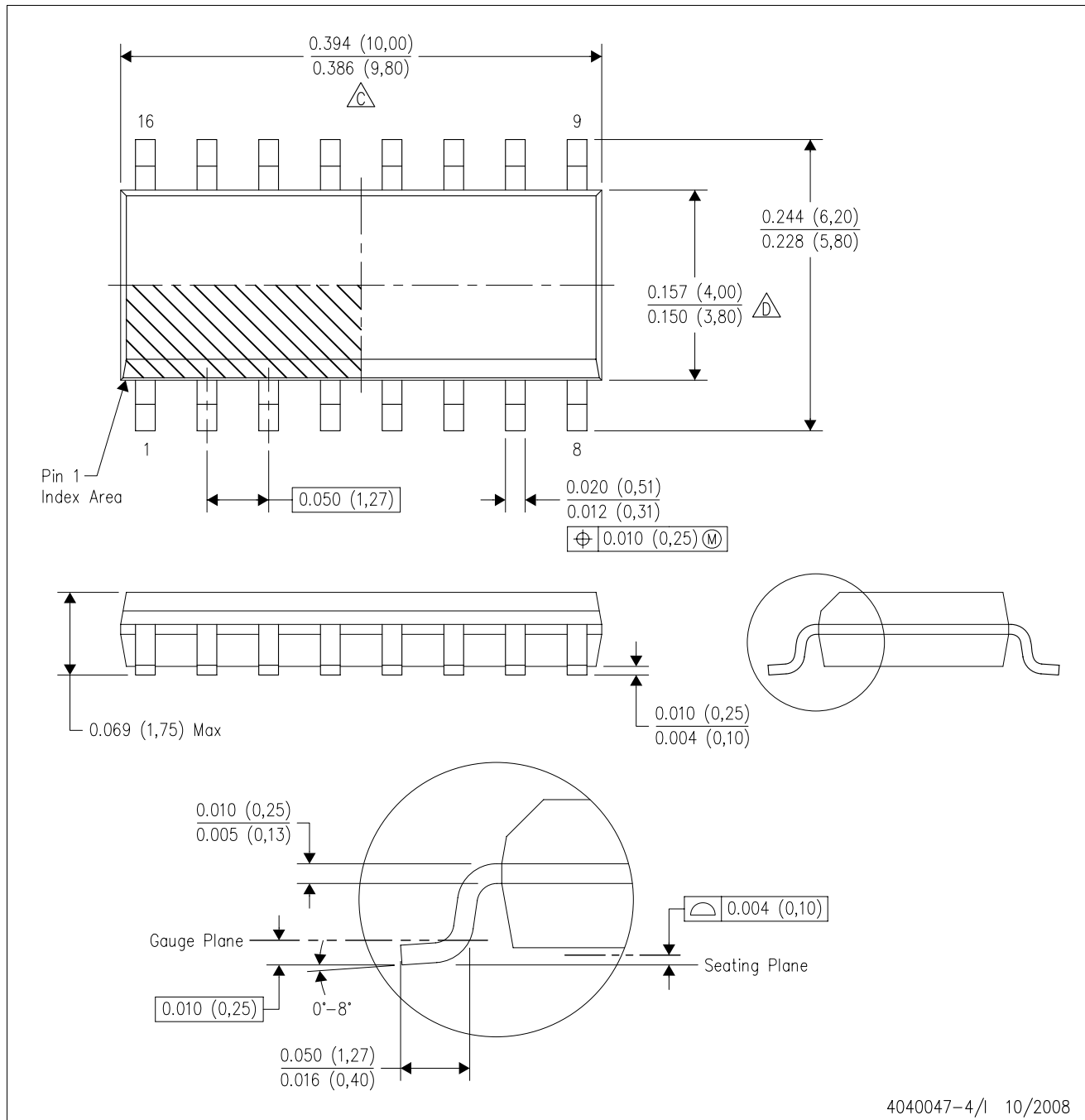
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
 - E. Reference JEDEC MS-012 variation AA.

D (R-PDSO-G16)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
 - E. Reference JEDEC MS-012 variation AC.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

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

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI 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 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. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

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

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

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

Products

| | |
|-----------------------------|--|
| Amplifiers | amplifier.ti.com |
| Data Converters | dataconverter.ti.com |
| DLP® Products | www.dlp.com |
| DSP | dsp.ti.com |
| Clocks and Timers | www.ti.com/clocks |
| Interface | interface.ti.com |
| Logic | logic.ti.com |
| Power Mgmt | power.ti.com |
| Microcontrollers | microcontroller.ti.com |
| RFID | www.ti-rfid.com |
| RF/IF and ZigBee® Solutions | www.ti.com/lprf |

Applications

| | |
|--------------------|--|
| Audio | www.ti.com/audio |
| Automotive | www.ti.com/automotive |
| Broadband | www.ti.com/broadband |
| Digital Control | www.ti.com/digitalcontrol |
| Medical | www.ti.com/medical |
| Military | www.ti.com/military |
| Optical Networking | www.ti.com/opticalnetwork |
| Security | www.ti.com/security |
| Telephony | www.ti.com/telephony |
| Video & Imaging | www.ti.com/video |
| Wireless | www.ti.com/wireless |

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2009, Texas Instruments Incorporated