



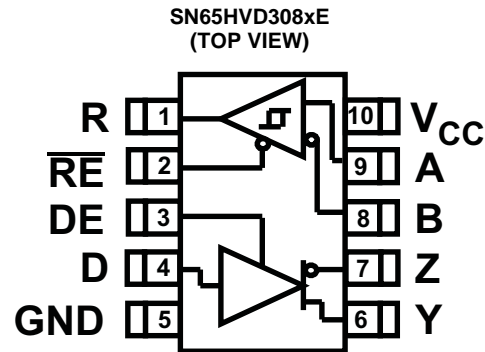
LOW-POWER RS-485 FULL-DUPLEX DRIVERS/RECEIVERS

FEATURES

- **Low Quiescent Power**
 - 375 μA (Typical) Enabled Mode
 - 2 nA (Typical) Shutdown Mode
- **Small MSOP Package**
- **1/8 Unit-Load—Up to 256 Nodes per Bus**
- **16 kV Bus-Pin ESD Protection, 6 kV All Pins**
- **Failsafe Receiver (Bus Open, Short, Idle)**
- **TIA/EIA-485A Standard Compliant**
- **RS-422 Compatible**

APPLICATIONS

- **Motion Controllers**
- **Point-of-Sale (POS) Terminals**
- **Rack-to-Rack Communications**
- **Industrial Networks**
- **Power Inverters**
- **Battery-Powered Applications**
- **Building Automation**



| DEVICE | SIGNAL RATE |
|--------------|-------------|
| SN65HVD3080E | 200 kbps |
| SN65HVD3083E | 1 Mbps |
| SN65HVD3086E | 20 Mbps |

DESCRIPTION

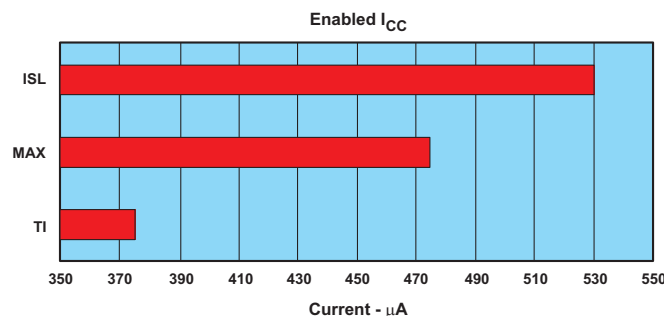
Each of these devices is a balanced driver and receiver designed for full-duplex RS-485 or RS-422 data bus networks. Powered by a 5-V supply, they are fully compliant with the TIA/EIA-485A standard.

With controlled bus output transition times, the devices are suitable for signaling rates from 200 kbps to 20 Mbps.

The devices are designed to operate with a low supply current, less than 1 mA (typical), exclusive of the load. When in the inactive shutdown mode, the supply current drops to a few nanoamps, making these devices ideal for power-sensitive applications.

The wide common-mode range and high ESD protection levels of these devices make them suitable for demanding applications such as motion controllers, electrical inverters, industrial networks, and cabled chassis interconnects where noise tolerance is essential.

These devices are characterized for operation over the temperature range -40°C to 85°C



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.



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

ORDERING INFORMATION

| PART NUMBER | PACKAGE ⁽¹⁾ | MARKED AS |
|--------------|--------------------------|-----------|
| SN65HVD3080E | DGS, DGSR ⁽²⁾ | BTT |
| SN65HVD3083E | | BTU |
| SN65HVD3086E | | BTF |

- (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.
 (2) The R suffix indicated tape and reel.

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range unless otherwise noted⁽¹⁾

| | | UNIT |
|---|---|----------------------------------|
| V _{CC} | Supply voltage range ⁽²⁾ | –0.3 V to 7 V |
| V _(A) , V _(B) , V _(Y) , V _(Z) | Voltage range at any bus terminal (A, B, Y, Z) | –9 V to 14 V |
| V _(TRANS) | Voltage input, transient pulse through 100 Ω. See Figure 10 (A, B, Y, Z) | –50 to 50 V |
| V _I | Input voltage range (D, DE, \overline{RE}) | –0.3 V to V _{CC} +0.3 V |
| P _D | Continuous total power dissipation | See the dissipation rating table |
| T _J | Junction temperature | 170°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.

POWER DISSIPATION RATINGS

| PACKAGE | T _A < 25°C | DERATING FACTOR ⁽¹⁾ ABOVE T _A < 25°C | T _A = 85°C |
|---------|-----------------------|---|-----------------------|
| DGS-10 | 463 mW | 3.71 mW/°C | 241 mW |

- (1) This is the inverse of the junction-to-ambient thermal resistance when board-mounted and with no air flow.

ELECTROSTATIC DISCHARGE PROTECTION

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|------------------|-----|------|-----|------|
| Human Body Model ⁽¹⁾ | A,B,Y,Z, and GND | | 16k | | V |
| | All pins | | 6k | | V |
| Field-induced-Charged Device Mode ⁽²⁾ | All pins | | 1.5k | | V |
| Machine Model | | | 200 | | V |

- (1) Tested in accordance JEDEC Standard 22, Test Method A114-A. Bus pin stressed with respect to a common connection of GND and V_{CC}.
 (2) Tested in accordance JEDEC Standard 22, Test Method C101.

SUPPLY CURRENT

over recommended operating conditions unless otherwise noted

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-----------------|----------------|--|-----|-----|------|------|
| I _{CC} | Supply current | \overline{RE} at 0 V, D and DE at V _{CC} , No load | | 375 | 750 | μA |
| | | \overline{RE} at 0 V, D and DE at 0 V, No load | | 300 | 680 | μA |
| | | \overline{RE} at V _{CC} , D and DE at V _{CC} , No load | | 240 | 600 | μA |
| | | \overline{RE} at V _{CC} , D and DE at 0 V, No load | | 2 | 1000 | nA |

RECOMMENDED OPERATING CONDITIONS

over operating free-air temperature range unless otherwise noted

| | | MIN | NOM | MAX | UNIT |
|-----------------------------------|---|------------------------|-----|-----------------|------|
| V _{CC} | Supply voltage | 4.5 | 5 | 5.5 | V |
| V _I or V _{IC} | Voltage at any bus terminal (separately or common mode) | −7 ⁽¹⁾ | | 12 | |
| V _{IH} | High-level input voltage | D, DE, \overline{RE} | | V _{CC} | V |
| V _{IL} | Low-level input voltage | D, DE, \overline{RE} | | 0.8 | |
| V _{ID} | Differential input voltage | −12 | | 12 | |
| I _{OH} | High-level output current | Driver | | −60 | mA |
| | | Receiver | | −10 | |
| I _{OL} | Low-level output current | Driver | | 60 | mA |
| | | Receiver | | 10 | |
| T _J | Junction temperature | | | 150 | °C |
| T _A | Ambient still-air temperature | −40 | | 85 | |

(1) The algebraic convention, in which the least positive (most negative) limit is designated as minimum is used in this data sheet.

DRIVER ELECTRICAL CHARACTERISTICS

over recommended operating conditions unless otherwise noted

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|--|--|--|-----|-----------------|------|
| V _{OD} | Differential output voltage | No load, I _O = 0 | 3 | 4.3 | V _{CC} | V |
| | | R _L = 54 Ω, See Figure 1 | 1.5 | 2.3 | | |
| | | V _{test} = -7 V to 12 V, See Figure 2 | 1.5 | | | |
| | | R _L = 100 Ω, See Figure 1 | 2 | | | |
| Δ V _{OD} | Change in magnitude of differential output voltage | R _L = 54 Ω, See Figure 1 and Figure 2 | -0.2 | 0 | 0.2 | V |
| V _{OC(SS)} | Steady-state common-mode output voltage | See Figure 3 | 1 | 2.6 | 3 | V |
| ΔV _{OC(SS)} | Common-mode output voltage (Dominant) | | -0.1 | 0 | 0.1 | |
| V _{OC(PP)} | Peak-to-peak common-mode output voltage | | 0.5 | | | |
| I _{Z(Y)} or I _{Z(Z)} | High-impedance state output current | | V _{CC} = 0 V, V _Z or V _(Y) = 12 V Other input at 0 V | | | |
| | | V _{CC} = 0 V, V _Z or V _(Y) = -7 V Other input at 0 V | -1 | | | A |
| | | V _{CC} = 5 V, V _Z or V _(Y) = 12 V Other input at 0 V | | | 1 | |
| | | V _{CC} = 5 V, V _Z or V _(Y) = -7 V Other input at 0 V | -1 | | | |
| I _I | Input current | D, DE | -100 | | 100 | A |
| I _{OS} | Short-circuit output current | -7 V ≤ V _O ≤ 12 V | -250 | | 250 | mA |

DRIVER SWITCHING CHARACTERISTICS

over recommended operating conditions unless otherwise noted

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT | |
|--|--|---|---|-----|-----|------|----|
| t _{PLH} , t _{PHL} | Propagation delay time, low-to-high-level output Propagation delay time, high-to-low-level output | HVD3080E | | 0.7 | 1.3 | μs | |
| | | HVD3083E | | 150 | 500 | ns | |
| | | HVD3086E | | 12 | 20 | ns | |
| t _r , t _f | Differential output signal rise time Differential output signal fall time | HVD3080E | R _L = 54 Ω, C _L = 50 pF, See Figure 4 | 0.5 | 0.9 | 1.5 | μs |
| | | HVD3083E | | 200 | 300 | ns | |
| | | HVD3086E | | 7 | 15 | ns | |
| t _{sk(p)} | Pulse skew (t _{PHL} - t _{PLH}) | HVD3080E | | 20 | 200 | ns | |
| | | HVD3083E | | 5 | 50 | ns | |
| | | HVD3086E | | 1.4 | 5 | ns | |
| t _{PZH} | Propagation delay time, high-impedance-to-high-level output | HVD3080E | R _L = 110 Ω, R _E at 0 V, See Figure 5 | 2.5 | 7 | μs | |
| | | HVD3083E | | 1 | 2.5 | μs | |
| | | HVD3086E | | 13 | 30 | ns | |
| t _{PHZ} | Propagation delay time, high-level-to-high-impedance output | HVD3080E | | 80 | 200 | ns | |
| | | HVD3083E | | 60 | 100 | ns | |
| | | HVD3086E | | 12 | 30 | ns | |
| t _{PZL} | Propagation delay time, high-impedance-to-low-level output | HVD3080E | R _L = 110 Ω, R _E at 0 V, See Figure 6 | 2.5 | 7 | μs | |
| | | HVD3083E | | 1 | 2.5 | μs | |
| | | HVD3086E | | 13 | 30 | ns | |
| t _{PLZ} | Propagation delay time, low-level-to-high-impedance output | HVD3080E | | 80 | 200 | ns | |
| | | HVD3083E | | 60 | 100 | ns | |
| | | HVD3086E | | 12 | 30 | ns | |
| t _{PZH} , | Propagation delay time, standby-to-high-level output (See Figure 5) | R _L = 110 Ω, R _E at 3 V | | 3.5 | 7 | μs | |
| t _{PZL} | Propagation delay time, standby-to-low-level output (See Figure 6) | | | | | | |

RECEIVER ELECTRICAL CHARACTERISTICS

over recommended operating conditions unless otherwise noted

| PARAMETER | | TEST CONDITIONS | MIN | TYP ⁽¹⁾ | MAX | UNIT | |
|------------------|---|---|--|--------------------|-------|-------|----|
| V _{IT+} | Positive-going differential input threshold voltage | I _O = -10 mA | | -0.08 | -0.01 | V | |
| V _{IT-} | Negative-going differential input threshold voltage | I _O = 10 mA | -0.2 | -0.1 | | | |
| V _{hys} | Hysteresis voltage (V _{IT+} - V _{IT-}) | | | 30 | | mV | |
| V _{OH} | High-level output voltage | V _{ID} = 200 mV, I _{OH} = -10 mA, See Figure 7 and Figure 8 | 4 | 4.6 | | V | |
| V _{OL} | Low-level output voltage | V _{ID} = -200 mV, I _{OH} = 10 mA, See Figure 7 and Figure 8 | 0.15 | | 0.4 | V | |
| I _{OZ} | High-impedance-state output current | V _O = 0 or V _{CC} | -1 | | 1 | A | |
| I _I | Bus input current | Other input at 0V | V _A or V _B = 12 V | | 0.04 | 0.11 | mA |
| | | | V _A or V _B = 12 V, V _{CC} = 0 V | | 0.06 | 0.13 | |
| | | | V _A or V _B = -7 V | | -0.1 | -0.04 | |
| | | | V _A or V _B = -7 V, V _{CC} = 0 V | | -0.05 | -0.03 | |
| I _{IH} | High-level input current | V _{IH} = 2 V | -60 | -30 | | A | |
| I _{IL} | Low-level input current | V _{IL} = 0.8 V | -60 | -30 | | A | |
| C _{ID} | Differential input capacitance | V _I = 0.4 sin (4E6πt) + 0.5 V | | 7 | | pF | |

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

RECEIVER SWITCHING CHARACTERISTICS

over recommended operating conditions unless otherwise noted

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--------------------|---|---|---|-----|-----|------|
| t _{PLH} | Propagation delay time, low-to-high-level output | V _{ID} = -1.5 V to 1.5 V, C _L = 15 pF, See Figure 8 | | 75 | 100 | ns |
| t _{PHL} | Propagation delay time, high-to-low-level output | | | 79 | 100 | |
| t _{sk(p)} | Pulse skew ((t _{PHL} - t _{PLH})) | | | 4 | 10 | |
| t _r | Output signal rise time | | | 1.5 | 3 | |
| t _f | Output signal fall time | | | 1.8 | 3 | |
| t _{PZH} | Output disable time to high level | DE at 5 V, See Figure 9 | | 5 | 50 | ns |
| | | From standby | DE at 5 V, See Figure 9 | 1.6 | 3.5 | μs |
| t _{PHZ} | Output enable time from high level | DE at 5 V, See Figure 9 | | 5 | 50 | ns |
| t _{PZL} | Output disable time to low level | DE at 0 V, See Figure 9 | | 10 | 50 | ns |
| | | From standby | DE at 5 V, See Figure 9 | 1.7 | 3.5 | μs |
| t _{PLZ} | Output enable time from low level | DE at 5 V, See Figure 9 | | 8 | 50 | ns |

PARAMETER MEASUREMENT INFORMATION

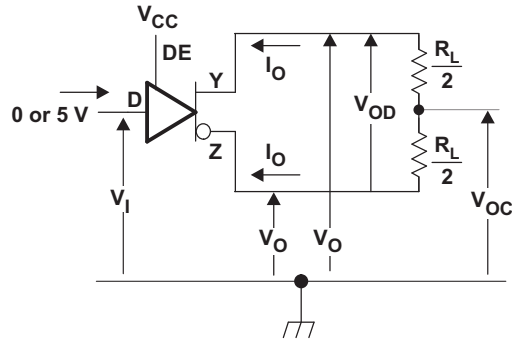


Figure 1. Driver V_{OD} Test Circuit and Current Definitions

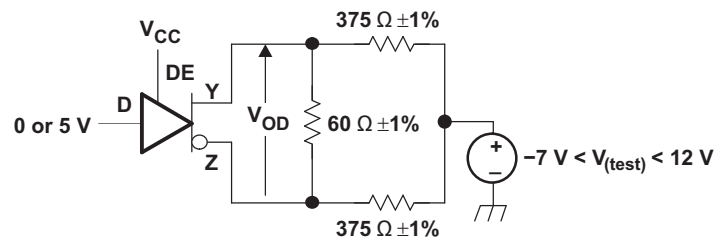


Figure 2. Driver V_{OD} With Common-Mode Loading Test Circuit

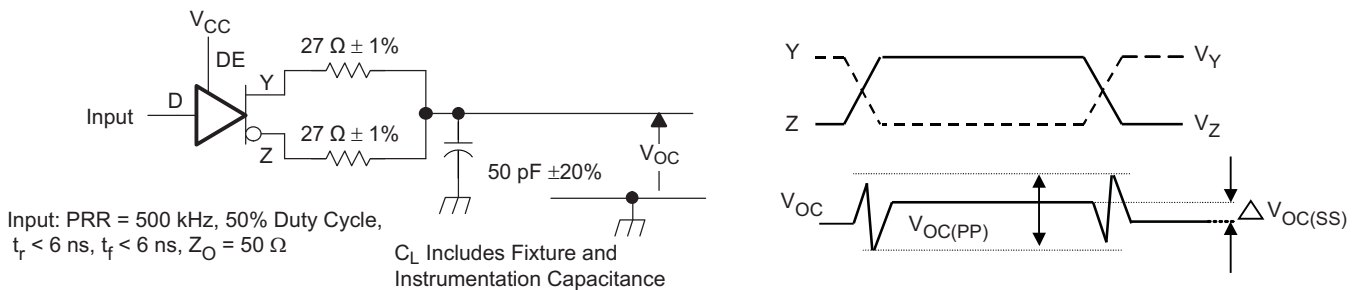


Figure 3. Test Circuit and Definitions for the Driver Common-Mode Output Voltage

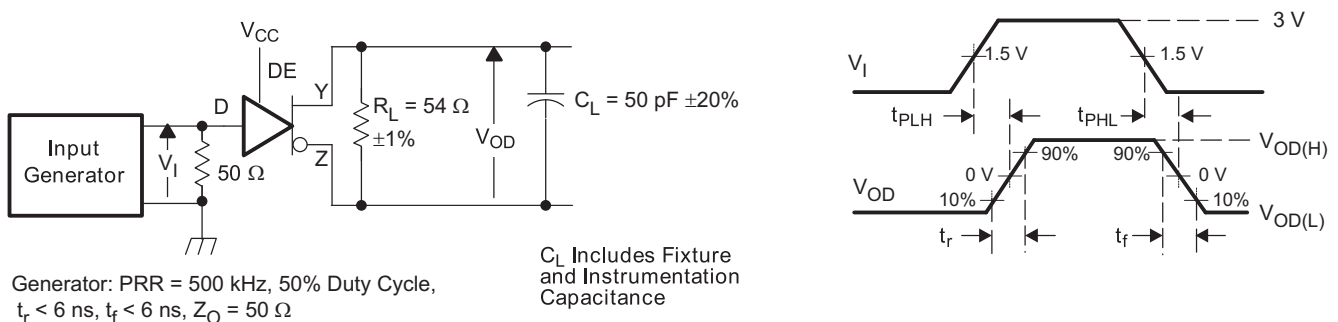


Figure 4. Driver Switching Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION (continued)

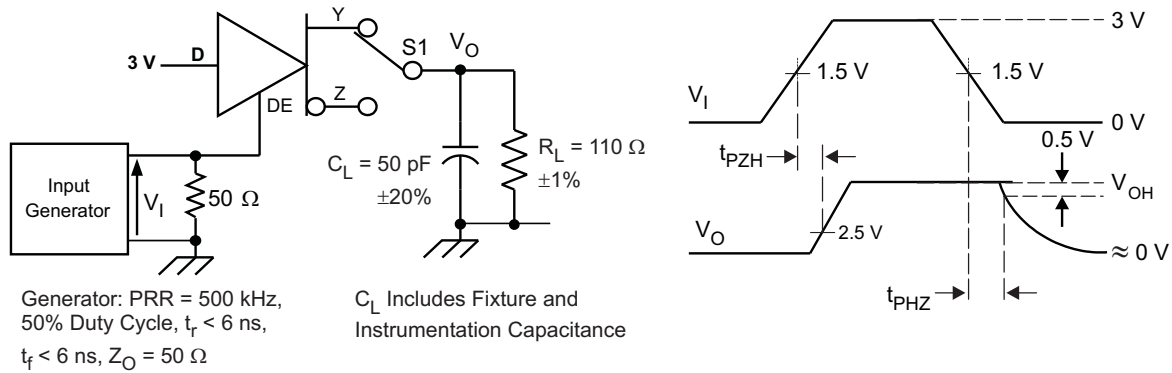


Figure 5. Driver High-Level Output Enable and Disable Time Test Circuit and Voltage Waveforms

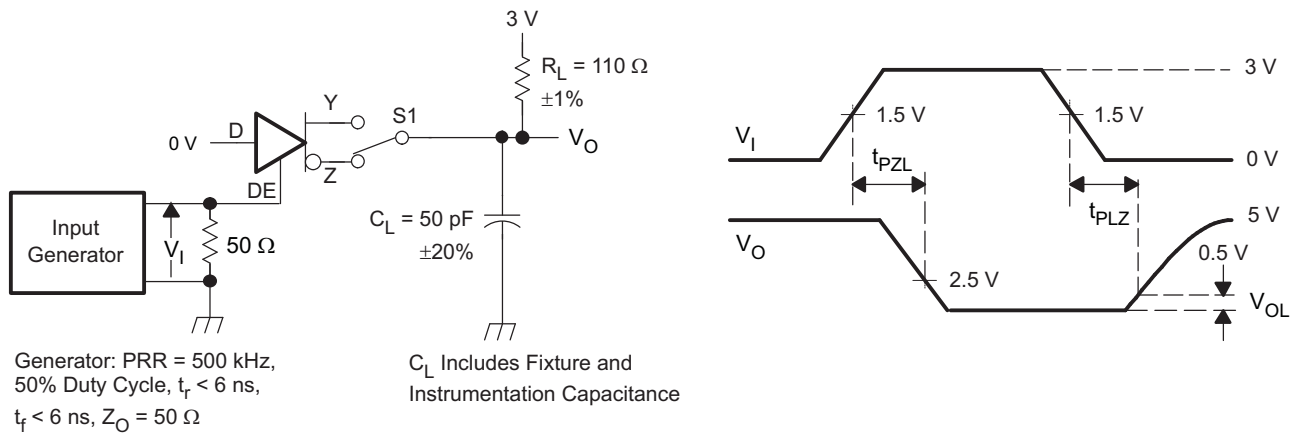


Figure 6. Driver Low-Level Output Enable and Disable Time Test Circuit and Voltage Waveforms

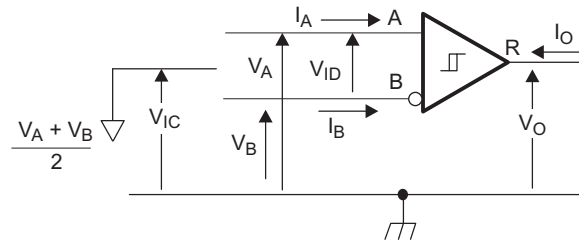


Figure 7. Receiver Voltage and Current Definitions

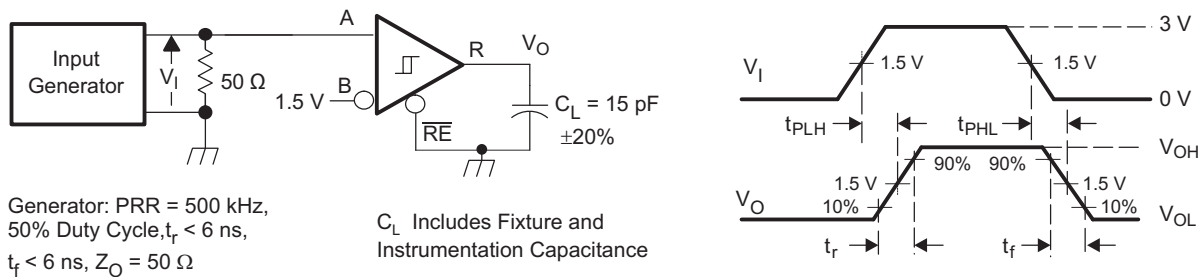


Figure 8. Receiver Switching Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION (continued)

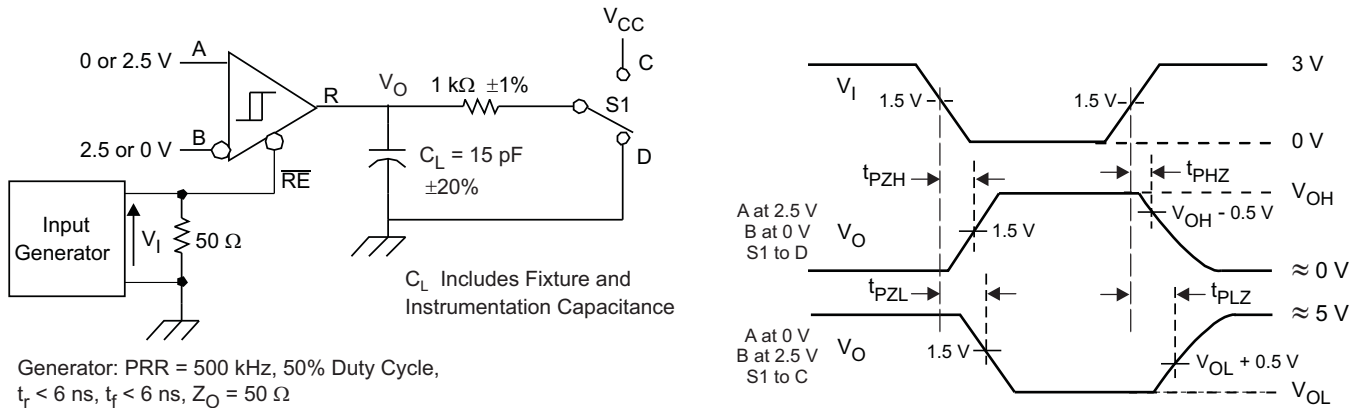
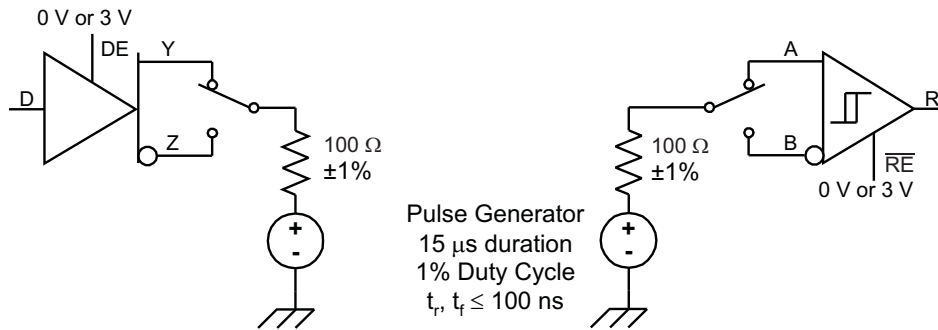


Figure 9. Receiver Enable and Disable Test Circuit and Voltage Waveforms



A. This test is conducted to test survivability only. Data stability at the R output is not specified.

Figure 10. Transient Overvoltage Test Circuit

DEVICE INFORMATION

FUNCTION TABLES

DRIVER⁽¹⁾

| INPUT | Enable | OUTPUTS | |
|-------|--------|---------|---|
| D | DE | Y | Z |
| H | H | H | L |
| L | H | L | H |
| X | L | Z | Z |
| Open | H | H | L |

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

RECEIVER⁽¹⁾

| DIFFERENTIAL INPUTS $V_{ID} = V_{(A)} - V_{(B)}$ | ENABLE \overline{RE} | OUTPUT R |
|---|---------------------------|-------------|
| $V_{ID} \leq -0.2 \text{ V}$ | L | L |
| $-0.2 \text{ V} < V_{ID} < -0.01 \text{ V}$ | L | ? |
| $-0.01 \text{ V} \leq V_{ID}$ | L | H |
| X | H | Z |
| Open Circuit | L | H |
| BUS Idle | L | H |
| Short Circuit | L | H |

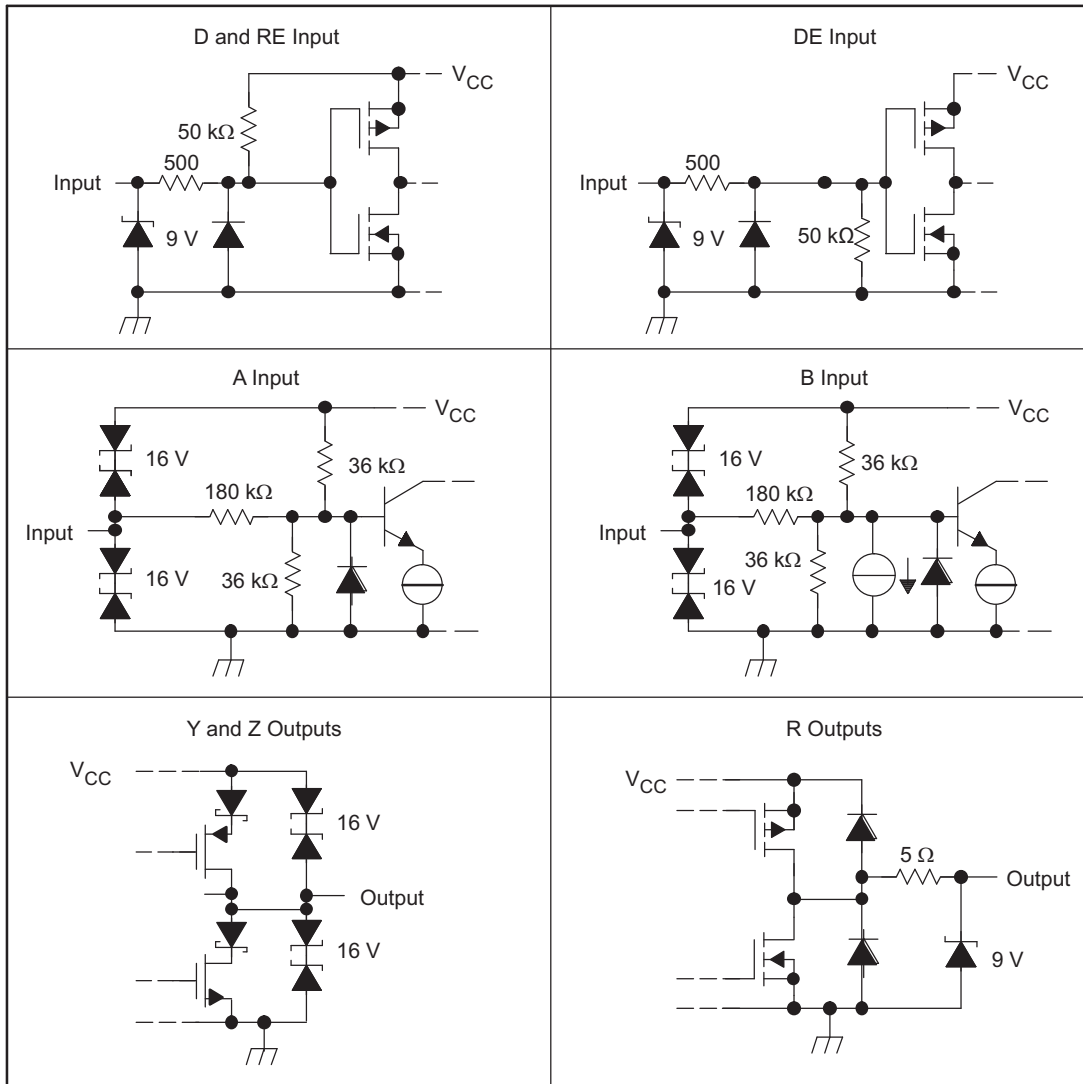
(1) H = high level, L = low level, Z = high impedance, X = irrelevant, ? = indeterminate

DEVICE ELECTRICAL CHARACTERISTICS

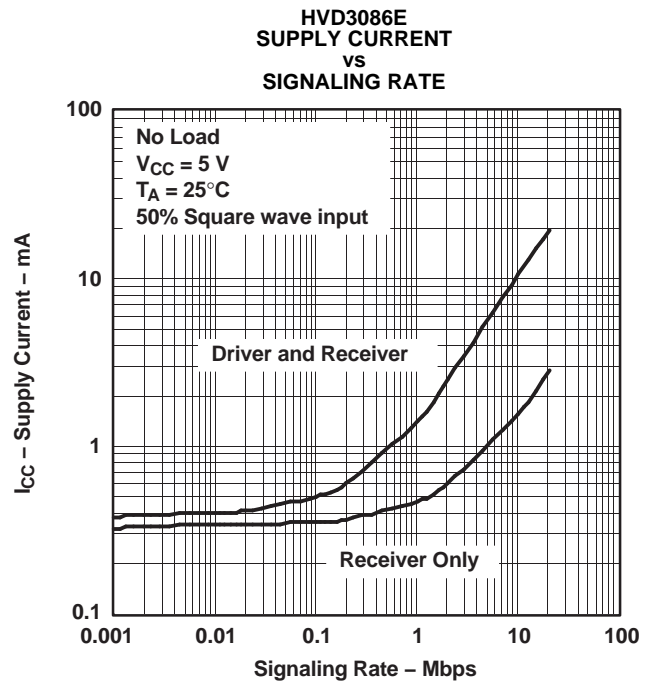
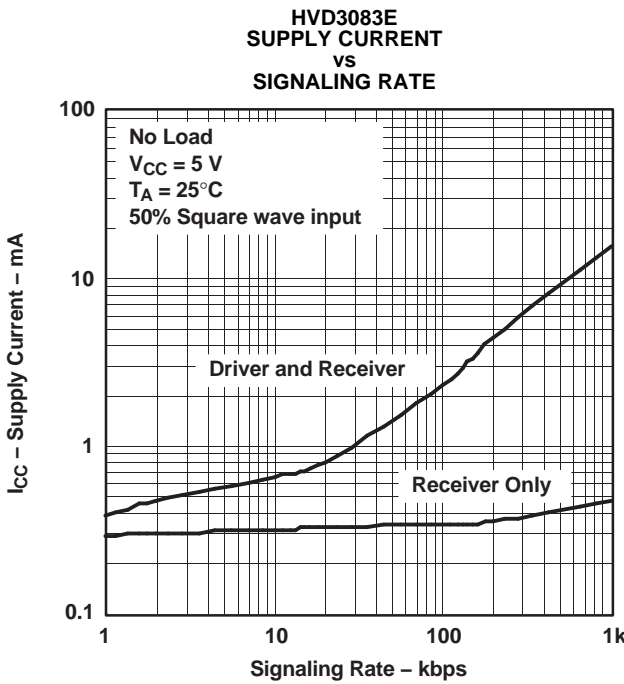
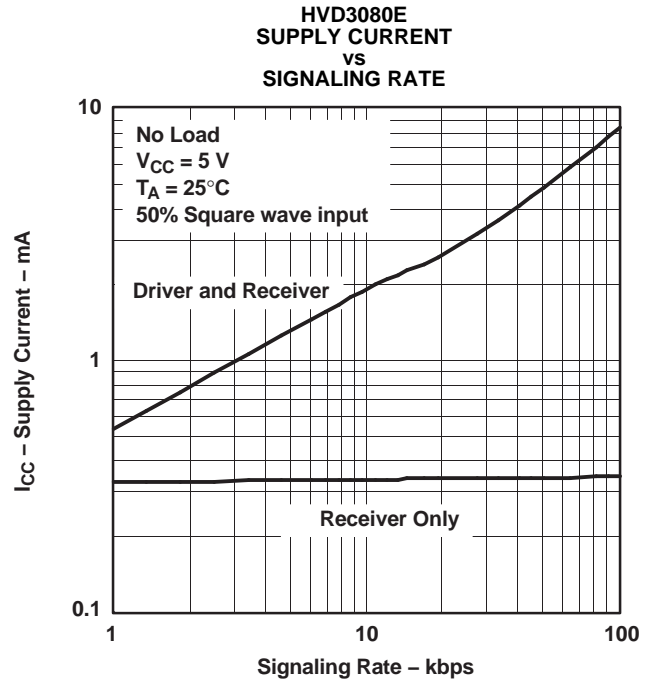
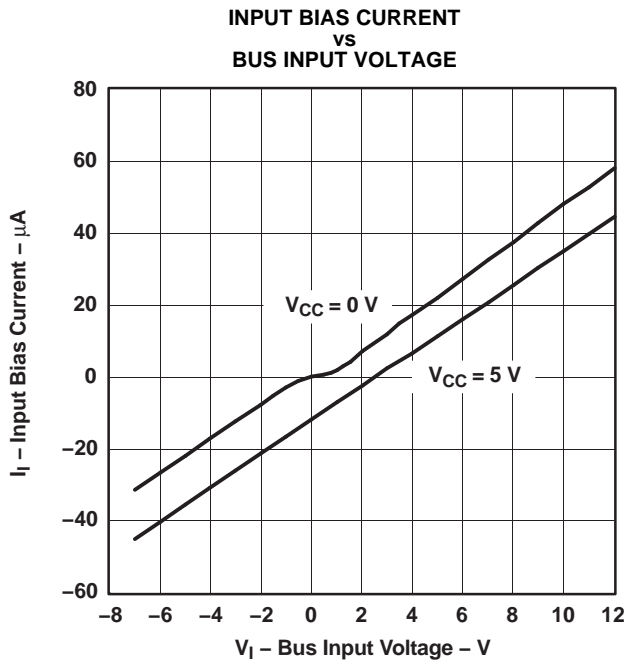
over operating free-air temperature range (unless otherwise noted)

| | PARAMETERS | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-------------|---------------------------|---|-----|-----|-----|------|
| $P_{(AVG)}$ | Average power dissipation | $R_L = 60 \Omega$, Input to D a 500-kHz 50% duty cycle square-wave | 85 | 109 | 136 | mW |

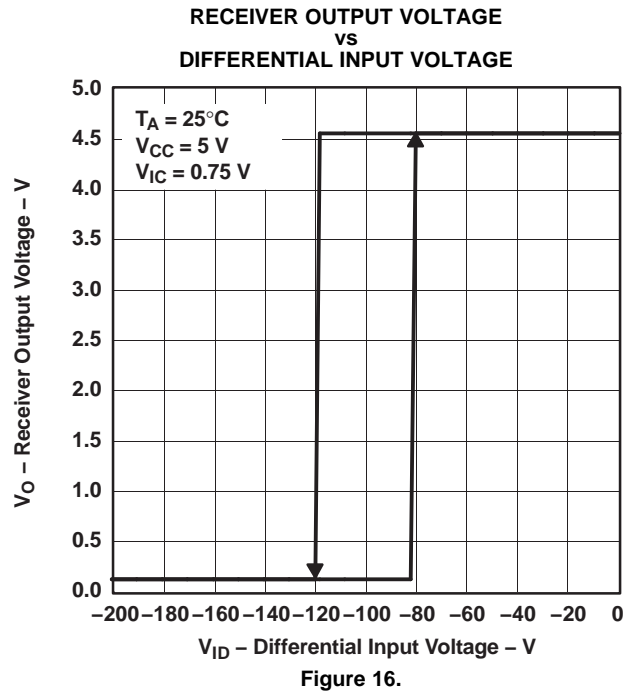
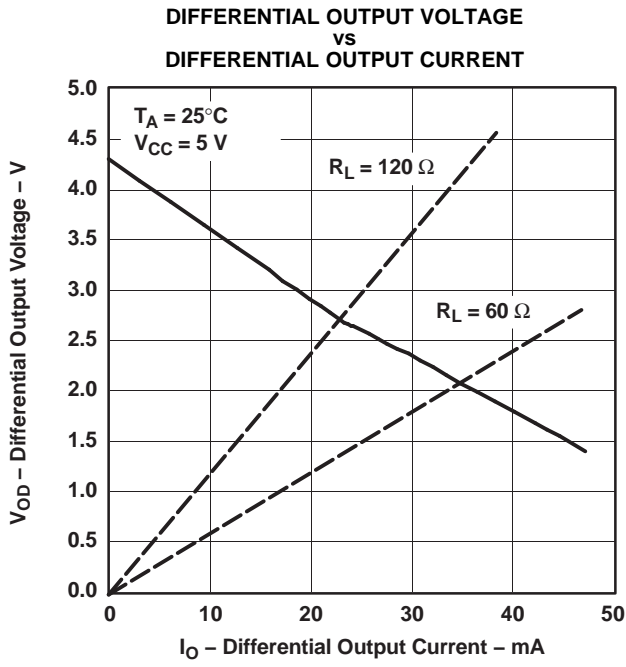
Equivalent Input and Output Schematic Diagrams



TYPICAL CHARACTERISTICS



TYPICAL CHARACTERISTICS (continued)



Changes from Revision A (December 2006) to Revision B

Page

-
- Changed $V_{OH} + 0.5\text{ V}$ to $V_{OH} - 0.5\text{ V}$ in [Figure 9](#) **8**
-

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|--------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| SN65HVD3080EDGS | ACTIVE | MSOP | DGS | 10 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| SN65HVD3080EDGSG4 | ACTIVE | MSOP | DGS | 10 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| SN65HVD3080EDGSR | ACTIVE | MSOP | DGS | 10 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| SN65HVD3080EDGSRG4 | ACTIVE | MSOP | DGS | 10 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| SN65HVD3083EDGS | ACTIVE | MSOP | DGS | 10 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| SN65HVD3083EDGSG4 | ACTIVE | MSOP | DGS | 10 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| SN65HVD3083EDGSR | ACTIVE | MSOP | DGS | 10 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| SN65HVD3083EDGSRG4 | ACTIVE | MSOP | DGS | 10 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| SN65HVD3086EDGS | ACTIVE | MSOP | DGS | 10 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| SN65HVD3086EDGSG4 | ACTIVE | MSOP | DGS | 10 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| SN65HVD3086EDGSR | ACTIVE | MSOP | DGS | 10 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| SN65HVD3086EDGSRG4 | ACTIVE | MSOP | DGS | 10 | 2500 | 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.

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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 |
|------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| SN65HVD3080EDGSR | MSOP | DGS | 10 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| SN65HVD3083EDGSR | MSOP | DGS | 10 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| SN65HVD3086EDGSR | MSOP | DGS | 10 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS

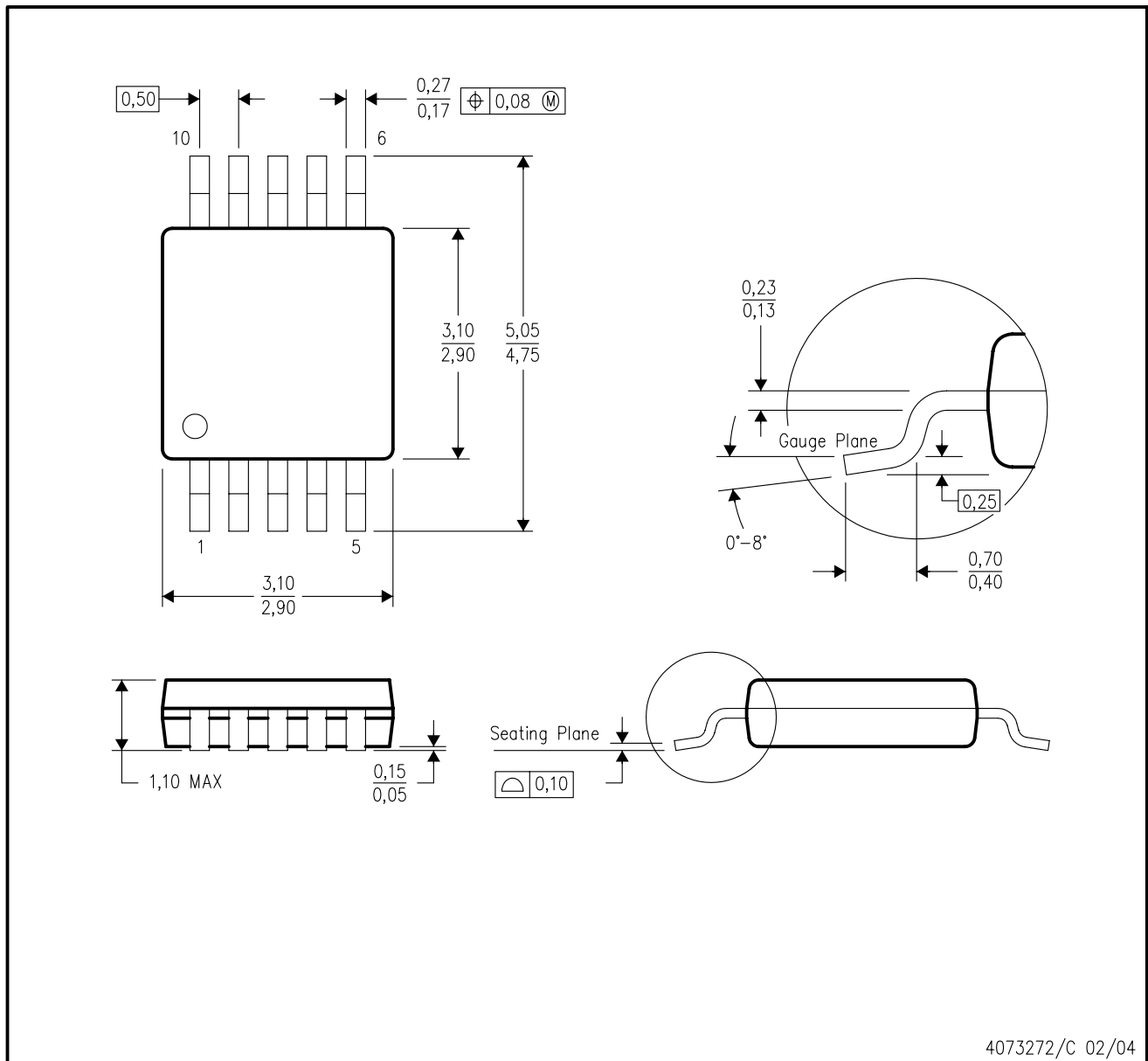


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| SN65HVD3080EDGSR | MSOP | DGS | 10 | 2500 | 346.0 | 346.0 | 29.0 |
| SN65HVD3083EDGSR | MSOP | DGS | 10 | 2500 | 346.0 | 346.0 | 29.0 |
| SN65HVD3086EDGSR | MSOP | DGS | 10 | 2500 | 346.0 | 346.0 | 29.0 |

DGS (S-PDSO-G10)

PLASTIC SMALL-OUTLINE PACKAGE



- 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.
 - D. Falls within JEDEC MO-187 variation BA.

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