

DS90LV019

3.3V or 5V LVDS Driver/Receiver

General Description

The DS90LV019 is a Driver/Receiver designed specifically for the high speed low power point-to-point interconnect applications. The device operates from a single 3.3V or 5.0V power supply and includes one differential line driver and one receiver. The DS90LV019 features an independent driver and receiver with TTL/CMOS compatibility (D_{IN} and R_{OUT}). The logic interface provides maximum flexibility as 4 separate lines are provided (D_{IN} , DE , \overline{RE} , and R_{OUT}). The device also features a flow-through pin out which allows easy PCB routing for short stubs between its pins and the connector. The driver has 3.5 mA output loop current.

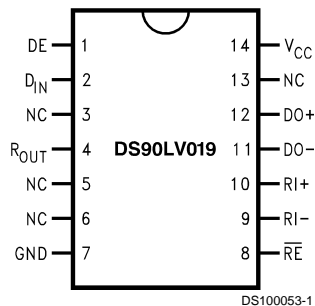
The driver translates between TTL levels (single-ended) to Low Voltage Differential Signaling levels. This allows for high speed operation, while consuming minimal power with reduced EMI. In addition, the differential signaling provides common-mode noise rejection.

The receiver threshold is ± 100 mV over a $\pm 1V$ common-mode range and translates the low swing differential levels to standard (TTL/CMOS) levels.

Features

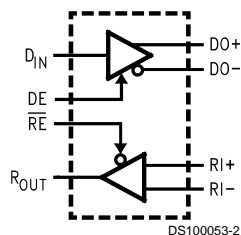
- LVDS Signaling
- 3.3V or 5.0V operation
- Low power CMOS design
- Balanced Output Impedance
- Glitch free power up/down (Driver disabled)
- High Signaling Rate Capacity (above 100 Mbps)
- Ultra Low Power Dissipation
- $\pm 1V$ Common-Mode Range
- ± 100 mV Receiver Sensitivity
- Product offered in SOIC and TSSOP packages
- Flow-Through Pin Out
- Industrial Temperature Range Operation

Connection Diagram



Order Number DS90LV019TM or DS90LV019TMTTC
See NS Package Number M14A or MTC14

Block Diagram



Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

| | |
|---|------------------------------|
| Supply Voltage V_{CC} | 6.0V |
| Enable Input Voltage (DE, \overline{RE}) | -0.3V to ($V_{CC} + 0.3V$) |
| Driver Input Voltage (D_{IN}) | -0.3V to ($V_{CC} + 0.3V$) |
| Receiver Output Voltage (R_{OUT}) | -0.3V to ($V_{CC} + 0.3V$) |
| Driver Output Voltage (DO_{\pm}) | -0.3V to +3.9V |
| Receiver Input Voltage (RI_{\pm}) | -0.3V to ($V_{CC} + 0.3V$) |
| Driver Short Circuit Current | Continuous |
| ESD (Note 4) | |
| (HBM, 1.5 k Ω , 100 pF) | > 2.0 kV |
| (EIAJ, 0 Ω , 200 pF) | > 200 V |
| Maximum Package Power Dissipation at 25°C | |
| SOIC | 960 mW |

| | |
|--------------------------------------|-----------------|
| Derate SOIC Package | 7.7mW/°C |
| TSSOP | 790 mW |
| Derate TSSOP Package | 6.3mW/°C |
| Storage Temperature Range | -65°C to +150°C |
| Lead Temperature (Soldering, 4 sec.) | 260°C |

Recommended Operating Conditions

| | Min | Max | Units |
|--------------------------------------|-----|-----|-------|
| Supply Voltage (V_{CC}) or | 3.0 | 3.6 | V |
| Supply Voltage (V_{CC}) | 4.5 | 5.5 | V |
| Receiver Input Voltage | 0.0 | 2.4 | V |
| Operating Free Air Temperature T_A | -40 | +85 | °C |

DC Electrical Characteristics

$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$ unless otherwise noted, $V_{CC} = 3.3 \pm 0.3V$. (Notes 2, 3)

| Symbol | Parameter | Conditions | Pin | Min | Typ | Max | Units |
|--|------------------------------|---|-----------------------------------|------|---------|----------|---------|
| DIFFERENTIAL DRIVER CHARACTERISTICS | | | | | | | |
| V_{OD} | Output Differential Voltage | $R_L = 100\Omega$ (Figure 1) | DO+, DO- | 250 | 350 | 450 | mV |
| ΔV_{OD} | V_{OD} Magnitude Change | | | | 6 | 60 | mV |
| V_{OS} | Offset Voltage | | | 1 | 1.25 | 1.7 | V |
| ΔV_{OS} | Offset Magnitude Change | | | | 5 | 60 | mV |
| I_{OZD} | TRI-STATE® Leakage | $V_{OUT} = V_{CC}$ or GND, DE = 0V | | -10 | ± 1 | +10 | μA |
| I_{OXD} | Power-Off Leakage | $V_{OUT} = 3.6V$ or GND, $V_{CC} = 0V$ | | -10 | ± 1 | +10 | μA |
| I_{OSD} | Output Short Circuit Current | $V_{OUT} = 0V$, DE = V_{CC} | | -10 | -6 | -4 | mA |
| DIFFERENTIAL RECEIVER CHARACTERISTICS | | | | | | | |
| V_{OH} | Voltage Output High | VID = +100 mV | R_{OUT} | 2.9 | 3.3 | | V |
| | | Inputs Open | | | | | |
| V_{OL} | Voltage Output Low | $I_{OL} = 2.0$ mA, VID = -100 mV | | | 0.1 | 0.4 | V |
| I_{OS} | Output Short Circuit Current | $V_{OUT} = 0V$ | | -75 | -34 | -20 | mA |
| V_{TH} | Input Threshold High | | RI+, RI- | | | +100 | mV |
| V_{TH} | Input Threshold Low | | | -100 | | | mV |
| I_{IN} | Input Current | $V_{IN} = +2.4V$ or 0V, $V_{CC} = 3.6V$ or 0V | | -10 | ± 1 | +10 | μA |
| DEVICE CHARACTERISTICS | | | | | | | |
| V_{IH} | Minimum Input High Voltage | | D_{IN} , DE, \overline{RE} | 2.0 | | V_{CC} | V |
| V_{IL} | Maximum Input Low Voltage | | | GND | | 0.8 | V |
| I_{IH} | Input High Current | $V_{IN} = V_{CC}$ or 2.4V | | | ± 1 | ± 10 | μA |
| I_{IL} | Input Low Current | $V_{IN} = GND$ or 0.4V | | | ± 1 | ± 10 | μA |
| V_{CL} | Input Diode Clamp Voltage | $I_{CLAMP} = -18$ mA | | -1.5 | -0.7 | | V |
| I_{CCD} | Power Supply Current | DE = $\overline{RE} = V_{CC}$ | V_{CC} | | 9 | 12.5 | mA |
| I_{CCR} | | DE = $\overline{RE} = 0V$ | | | 4.5 | 7.0 | mA |
| I_{CCZ} | | DE = 0V, $\overline{RE} = V_{CC}$ | | | 3.7 | 7.0 | mA |
| I_{CC} | | DE = V_{CC} , $\overline{RE} = 0V$ | | | 15 | 20 | mA |
| $C_{D\text{ output}}$ | Capacitance | | DO+, DO- | | 5 | | pF |
| $C_{R\text{ input}}$ | Capacitance | | RI+, RI- | | 5 | | pF |

DC Electrical Characteristics

$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$ unless otherwise noted, $V_{CC} = 5.0 \pm 0.5\text{V}$. (Notes 2, 3)

| Symbol | Parameter | Conditions | Pin | Min | Typ | Max | Units | |
|--|------------------------------|---|-----------------------------|--|------|---------|----------|---------------|
| DIFFERENTIAL DRIVER CHARACTERISTICS | | | | | | | | |
| V_{OD} | Output Differential Voltage | $R_L = 100\Omega$ (Figure 1) | DO+, DO- | 250 | 360 | 450 | mV | |
| ΔV_{OD} | V_{OD} Magnitude Change | | | | 6 | 60 | mV | |
| V_{OS} | Offset Voltage | | | 1 | 1.25 | 1.8 | V | |
| ΔV_{OS} | Offset Magnitude Change | | | | 5 | 60 | mV | |
| I_{OZD} | TRI-STATE Leakage | | | $V_{OUT} = V_{CC}$ or GND, DE = 0V | -10 | ± 1 | +10 | μA |
| I_{OXD} | Power-Off Leakage | | | $V_{OUT} = 5.5\text{V}$ or GND, $V_{CC} = 0\text{V}$ | -10 | ± 1 | +10 | μA |
| I_{OSD} | Output Short Circuit Current | | | $V_{OUT} = 0\text{V}$, DE = V_{CC} | -10 | -6 | -4 | mA |
| DIFFERENTIAL RECEIVER CHARACTERISTICS | | | | | | | | |
| V_{OH} | Voltage High | VID = +100 mV | $I_{OH} = -400 \mu\text{A}$ | R_{OUT} | 4.3 | 5.0 | | V |
| | | Inputs Open | | | 4.3 | 5.0 | | V |
| V_{OL} | Voltage Output Low | $I_{OL} = 2.0 \text{ mA}$, VID = -100 mV | | | 0.1 | 0.4 | V | |
| I_{OS} | Output Short Circuit Current | $V_{OUT} = 0\text{V}$ | | | -150 | -75 | -40 | mA |
| V_{TH} | Input Threshold High | | | RI+, RI- | | | +100 | mV |
| V_{TH} | Input Threshold Low | | | | | | | -100 |
| I_{IN} | Input Current | $V_{IN} = +2.4\text{V}$ or 0V, $V_{CC} = 5.5\text{V}$ or 0V | | | -15 | ± 1 | +15 | μA |
| DEVICE CHARACTERISTICS | | | | | | | | |
| V_{IH} | Minimum Input High Voltage | | | $D_{IN},$ DE, \overline{RE} | 2.0 | | V_{CC} | V |
| V_{IL} | Maximum Input Low Voltage | | | | GND | | 0.8 | V |
| I_{IH} | Input High Current | $V_{IN} = V_{CC}$ or 2.4 V | | | | ± 1 | ± 10 | μA |
| I_{IL} | Input Low Current | $V_{IN} = \text{GND}$ or 0.4V | | | | ± 1 | ± 10 | μA |
| V_{CL} | Input Diode Clamp Voltage | $I_{CLAMP} = -18 \text{ mA}$ | | | -1.5 | -0.8 | | V |
| I_{CCD} | Power Supply Current | DE = $\overline{RE} = V_{CC}$ | | V_{CC} | | 12 | 19 | mA |
| I_{CCR} | | DE = $\overline{RE} = 0\text{V}$ | | | | 5.8 | 8 | mA |
| I_{CCZ} | | DE = 0V, $\overline{RE} = V_{CC}$ | | | | 4.5 | 8.5 | mA |
| I_{CC} | | DE = V_{CC} , $\overline{RE} = 0\text{V}$ | | | | 18 | 48 | mA |
| C_D output | Capacitance | | | DO+, DO- | | 5 | | pF |
| C_R input | Capacitance | | | RI+, RI- | | 5 | | pF |

Note 1: "Absolute Maximum Ratings" are these beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: All currents into device pins are positive; all currents out of device pins are negative. All voltages are referenced to device ground unless otherwise specified.

Note 3: All typicals are given for $V_{CC} = +3.3\text{V}$ or $+5.0\text{V}$ and $T_A = +25^\circ\text{C}$, unless otherwise stated.

Note 4: ESD Rating:

HBM (1.5 k Ω , 100 pF) > 2.0 kV

EIAJ (0 Ω , 200 pF) > 200V.

Note 5: C_L includes probe and fixture capacitance.

Note 6: Generator waveforms for all tests unless otherwise specified; $f = 1 \text{ MHz}$, $Z_O = 50\Omega$, $t_r = t_f \leq 6.0 \text{ ns}$ (0%–100%).

AC Electrical Characteristics

$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, $V_{CC} = 3.3\text{V} \pm 0.3\text{V}$. (Note 6)

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|-----------------------------------|--|---|-----|-----|-----|-------|
| DRIVER TIMING REQUIREMENTS | | | | | | |
| t_{PHLD} | Differential Propagation Delay High to Low | $R_L = 100\Omega$, $C_L = 10 \text{ pF}$ (Figure 2 and Figure 3) | 2.0 | 4.0 | 6.5 | ns |
| t_{PLHD} | Differential Propagation Delay Low to High | | 1.0 | 5.6 | 7.0 | ns |
| t_{SKD} | Differential Skew $ t_{PHLD} - t_{PLHD} $ | | | 0.4 | 1.0 | ns |
| t_{TLH} | Transition Time Low to High | | 0.2 | 0.7 | 3.0 | ns |
| t_{THL} | Transition Time High to Low | | 0.2 | 0.8 | 3.0 | ns |

AC Electrical Characteristics (Continued)

$T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$, $V_{CC} = 3.3\text{V} \pm 0.3\text{V}$. (Note 6)

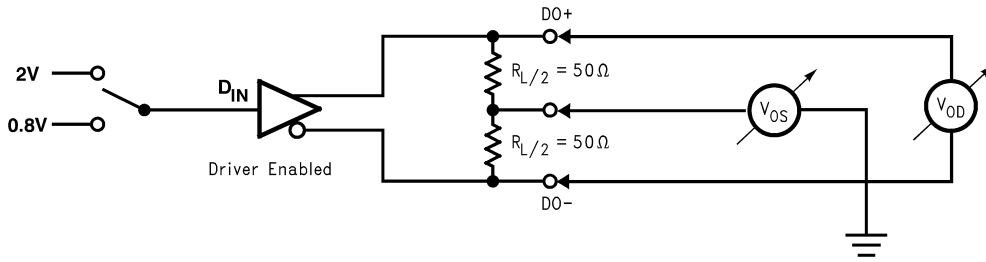
| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|-------------------------------------|--|--|------|------|-----|-------|
| DRIVER TIMING REQUIREMENTS | | | | | | |
| t_{PHZ} | Disable Time High to Z | $R_L = 100\Omega$, $C_L = 10\text{ pF}$ (Figure 4 and Figure 5) | 1.5 | 4.0 | 8.0 | ns |
| t_{PLZ} | Disable Time Low to Z | | 2.5 | 5.3 | 9.0 | ns |
| t_{PZH} | Enable Time Z to High | | 4.0 | 6.0 | 8.0 | ns |
| t_{PZL} | Enable Time Z to Low | | 3.5 | 6.0 | 8.0 | ns |
| RECEIVER TIMING REQUIREMENTS | | | | | | |
| t_{PHLD} | Differential Propagation Delay High to Low | $C_L = 10\text{ pF}$, $VID = 200\text{ mV}$ (Figure 6 and Figure 7) | 3.0 | 5.8 | 7.0 | ns |
| t_{PLHD} | Differential Propagation Delay Low to High | | 3.0 | 5.6 | 9.0 | ns |
| t_{SKD} | Differential Skew $ t_{PHLD} - t_{PLHD} $ | | | 0.55 | 1.5 | ns |
| t_r | Rise Time | | 0.15 | 2.0 | 3.0 | ns |
| t_f | Fall Time | | 0.15 | 0.9 | 3.0 | ns |
| t_{PHZ} | Disable Time High to Z | $R_L = 500\Omega$, $C_L = 10\text{ pF}$ (Figure 8 and Figure 9) | 3.0 | 4.0 | 6.0 | ns |
| t_{PLZ} | Disable Time Low to Z | | 3.0 | 4.5 | 6.0 | ns |
| t_{PZH} | Enable Time Z to High | | 3.0 | 6.0 | 8.0 | ns |
| t_{PZL} | Enable Time Z to Low | | 3.0 | 6.0 | 8.0 | ns |

AC Electrical Characteristics

$T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$, $V_{CC} = 5.0\text{V} \pm 0.5\text{V}$. (Note 6)

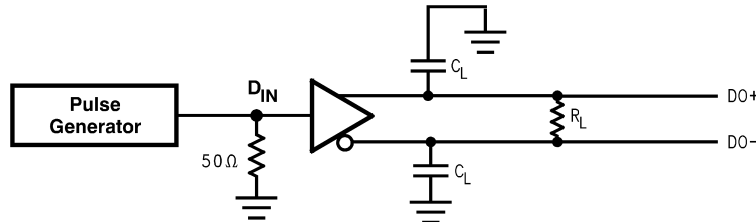
| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|-------------------------------------|--|--|------|-----|-----|-------|
| DRIVER TIMING REQUIREMENTS | | | | | | |
| t_{PHLD} | Differential Propagation Delay High to Low | $R_L = 100\Omega$, $C_L = 10\text{ pF}$ (Figure 2 and Figure 3) | 2.0 | 3.3 | 6.0 | ns |
| t_{PLHD} | Differential Propagation Delay Low to High | | 1.0 | 3.3 | 5.0 | ns |
| t_{SKD} | Differential Skew $ t_{PHLD} - t_{PLHD} $ | | | 0.6 | 1.0 | ns |
| t_{TLH} | Transition Time Low to High | | 0.15 | 0.9 | 3.0 | ns |
| t_{THL} | Transition Time High to Low | | 0.15 | 1.2 | 3.0 | ns |
| t_{PHZ} | Disable Time High to Z | $R_L = 100\Omega$, $C_L = 10\text{ pF}$ (Figure 4 and Figure 5) | 1.5 | 3.5 | 7.0 | ns |
| t_{PLZ} | Disable Time Low to Z | | 3.0 | 5.2 | 9.0 | ns |
| t_{PZH} | Enable Time Z to High | | 2.0 | 4.5 | 7.0 | ns |
| t_{PZL} | Enable Time Z to Low | | 2.0 | 4.5 | 7.0 | ns |
| RECEIVER TIMING REQUIREMENTS | | | | | | |
| t_{PHLD} | Differential Propagation Delay High to Low | $C_L = 10\text{ pF}$, $VID = 200\text{ mV}$ (Figure 6 and Figure 7) | 3.0 | 6.0 | 8.0 | ns |
| t_{PLHD} | Differential Propagation Delay Low to High | | 3.0 | 5.6 | 8.0 | ns |
| t_{SKD} | Differential Skew $ t_{PHLD} - t_{PLHD} $ | | | 0.7 | 1.6 | ns |
| t_r | Rise Time | | 0.15 | 0.8 | 3.0 | ns |
| t_f | Fall Time | | 0.15 | 0.8 | 3.0 | ns |
| t_{PHZ} | Disable Time High to Z | $R_L = 500\Omega$, $C_L = 10\text{ pF}$ (Figure 8 and Figure 9) | 3.0 | 3.5 | 4.5 | ns |
| t_{PLZ} | Disable Time Low to Z | | 3.5 | 3.6 | 7.0 | ns |
| t_{PZH} | Enable Time Z to High | | 3.0 | 5.0 | 7.0 | ns |
| t_{PZL} | Enable Time Z to Low | | 3.0 | 5.0 | 7.0 | ns |

Test Circuits and Timing Waveforms



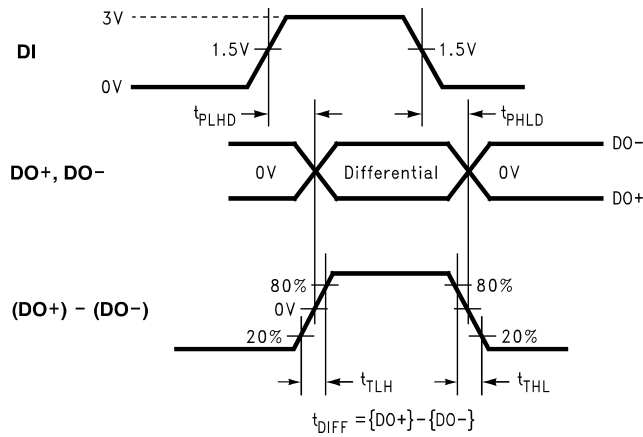
DS100053-3

FIGURE 1. Differential Driver DC Test Circuit



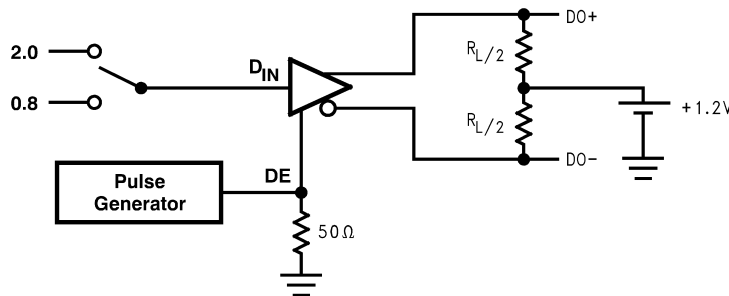
DS100053-4

FIGURE 2. Differential Driver Propagation Delay and Transition Test Circuit



DS100053-5

FIGURE 3. Differential Driver Propagation and Transition Time Waveforms



DS100053-6

FIGURE 4. Driver TRI-STATE Delay Test Circuit

Test Circuits and Timing Waveforms (Continued)

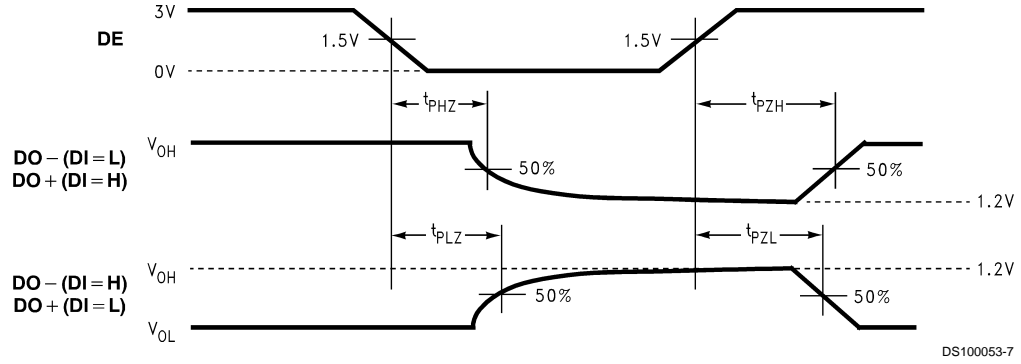
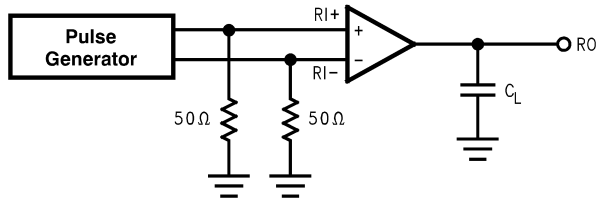
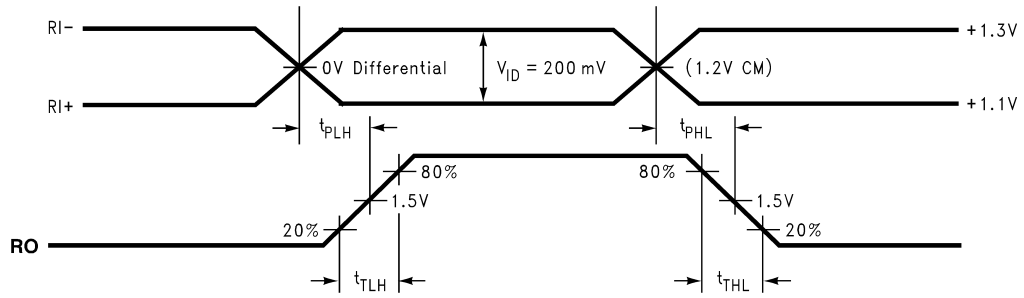


FIGURE 5. Driver TRI-STATE Delay Waveforms



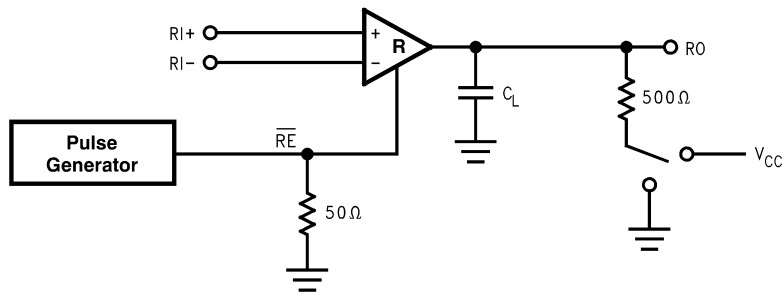
DS100053-8

FIGURE 6. Receiver Propagation Delay and Transition Time Test Circuit



DS100053-9

FIGURE 7. Receiver Propagation Delay and Transition Time Waveforms



DS100053-10

FIGURE 8. Receiver TRI-STATE Delay Test Circuit

Test Circuits and Timing Waveforms (Continued)

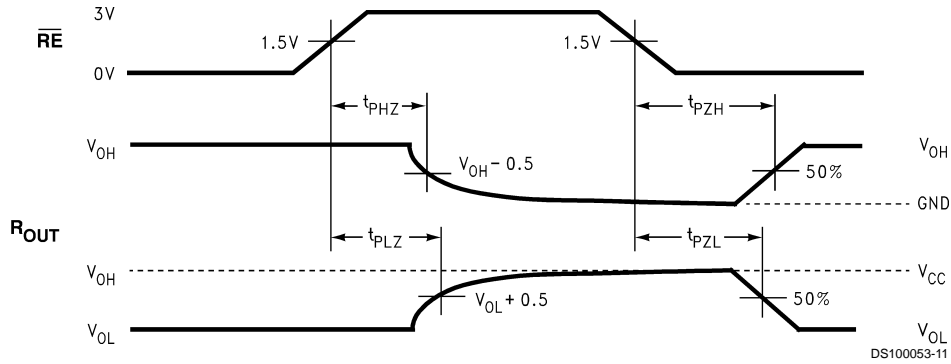


FIGURE 9. Receiver TRI-STATE Delay Waveforms

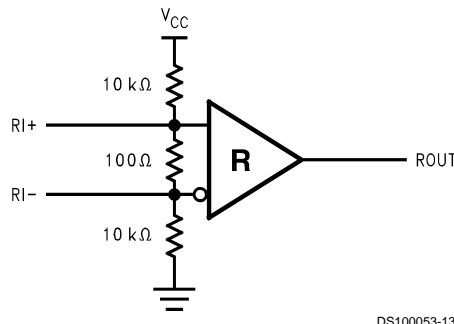
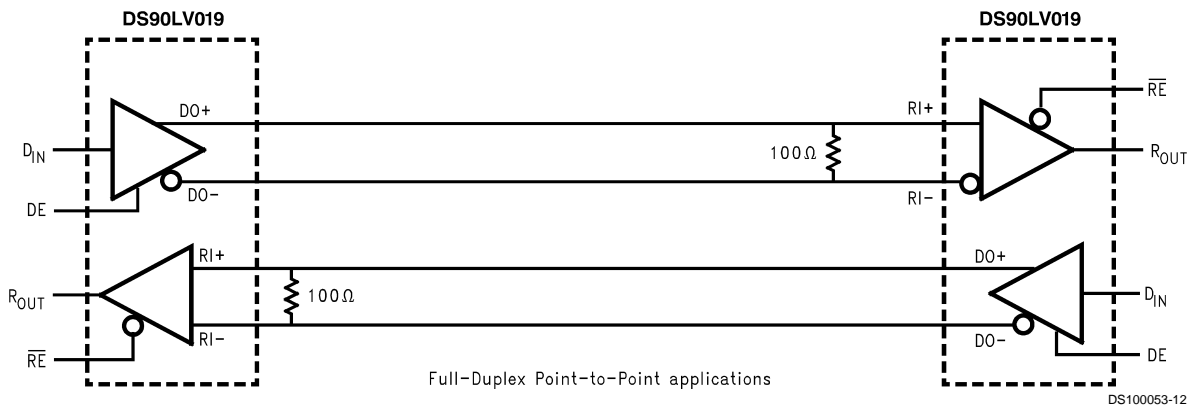


FIGURE 10. Terminated Input Fail-Safe Circuit

Typical Application Diagram



Applications Information

The DS90LV019 has two control pins, which allows the device to operate as a driver, a receiver or both driver and a receiver at the same time. There are a few common practices which should be implied when designing PCB for LVDS signaling. Recommended practices are:

- Use at least 4 PCB board layer (LVDS signals, ground, power and TTL signals).
- Keep drivers and receivers as close to the (LVDS port side) connector as possible.
- Bypass each LVDS device and also use distributed bulk capacitance. Surface mount capacitors placed close to power and ground pins work best. Two or three multi-layer ceramic (MLC) surface mount capacitors 0.1 μF ,

and 0.01 μF in parallel should be used between each V_{CC} and ground. The capacitors should be as close as possible to the V_{CC} pin.

- Use controlled impedance traces which match the differential impedance of your transmission medium (i.e., Cable) and termination resistor.
- Use the termination resistor which best matches the differential impedance of your transmission line.
- Isolate TTL signals from LVDS signals.

MEDIA (CABLE AND CONNECTOR) SELECTION:

- Use controlled impedance media. The cables and connectors should have a matched differential impedance of about 100 Ω .

Applications Information (Continued)

- Balanced cables (e.g., twisted pair) are usually better than unbalanced cables (ribbon cable, simple coax) for noise reduction and signal quality.
- For cable distances $< 0.5\text{m}$, most cables can be made to work effectively. For distances $0.5\text{m} \leq d \leq 10\text{m}$, CAT 3 (category 3) twisted pair cable works well and is readily available and relatively inexpensive. For distances $> 10\text{m}$, and high data rates CAT 5 twisted pair is recommended.
- There are three Fail-Safe scenarios, open input pins, shorted inputs pins and terminated input pins. The first case is guaranteed for DS90LV019. A HIGH state on R_{OUT} pin can be achieved by using two external resistors (one to V_{CC} and one to GND) per *Figure 10* (Terminated Input Fail-Safe Circuit). R_1 and R_2 should be R_T to limit the loading to the LVDS driver. R_T is selected to match the impedance of the cable.

TABLE 1. Functional Table

| MODE SELECTED | DE | \overline{RE} |
|------------------|----|-----------------|
| DRIVER MODE | H | H |
| RECEIVER MODE | L | L |
| TRI-STATE MODE | L | H |
| FULL DUPLEX MODE | H | L |

TABLE 2. Transmitter Mode

| INPUTS | | OUTPUTS | |
|--------|----------------|---------|-----|
| DE | DI | DO+ | DO- |
| H | L | L | H |
| H | H | H | L |
| H | $2 > \& > 0.8$ | X | X |
| L | X | Z | Z |

X = High or Low logic state
 Z = High impedance state
 L = Low state
 H = High state

TABLE 3. Receiver Mode

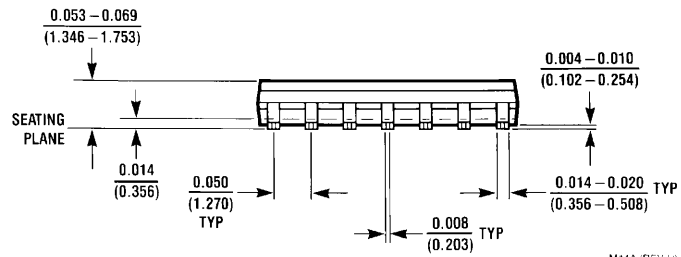
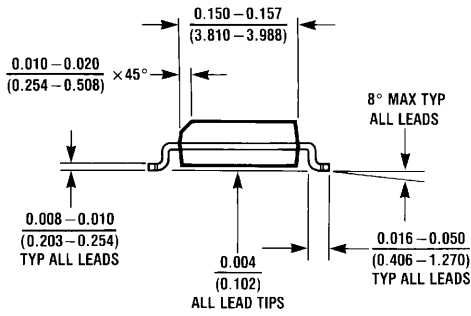
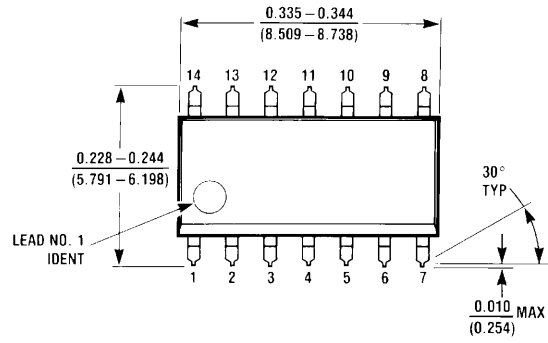
| INPUTS | | OUTPUT |
|-----------------|-------------------------------------|--------|
| \overline{RE} | (RI+) – (RI-) | |
| L | L ($< -100\text{mV}$) | L |
| L | H ($> +100\text{mV}$) | H |
| L | $100\text{mV} > \& > -100\text{mV}$ | X |
| H | X | Z |

X = High or Low logic state
 Z = High impedance state
 L = Low state
 H = High state

TABLE 4. Device Pin Description

| Pin Name | Pin # | Input/Output | Description |
|-----------------|--------|--------------|---|
| D_{IN} | 2 | I | TTL Driver Input |
| DO_{\pm} | 11, 12 | O | LVDS Driver Outputs |
| RI_{\pm} | 9, 10 | I | LVDS Receiver Inputs |
| R_{OUT} | 4 | O | TTL Receiver Output |
| \overline{RE} | 8 | I | Receiver Enable TTL Input (Active Low) |
| DE | 1 | I | Driver Enable TTL Input (Active High) |
| GND | 7 | NA | Ground |
| V_{CC} | 14 | NA | Power Supply ($3.3\text{V} \pm 0.3\text{V}$ or $5.0\text{V} \pm 0.5\text{V}$) |

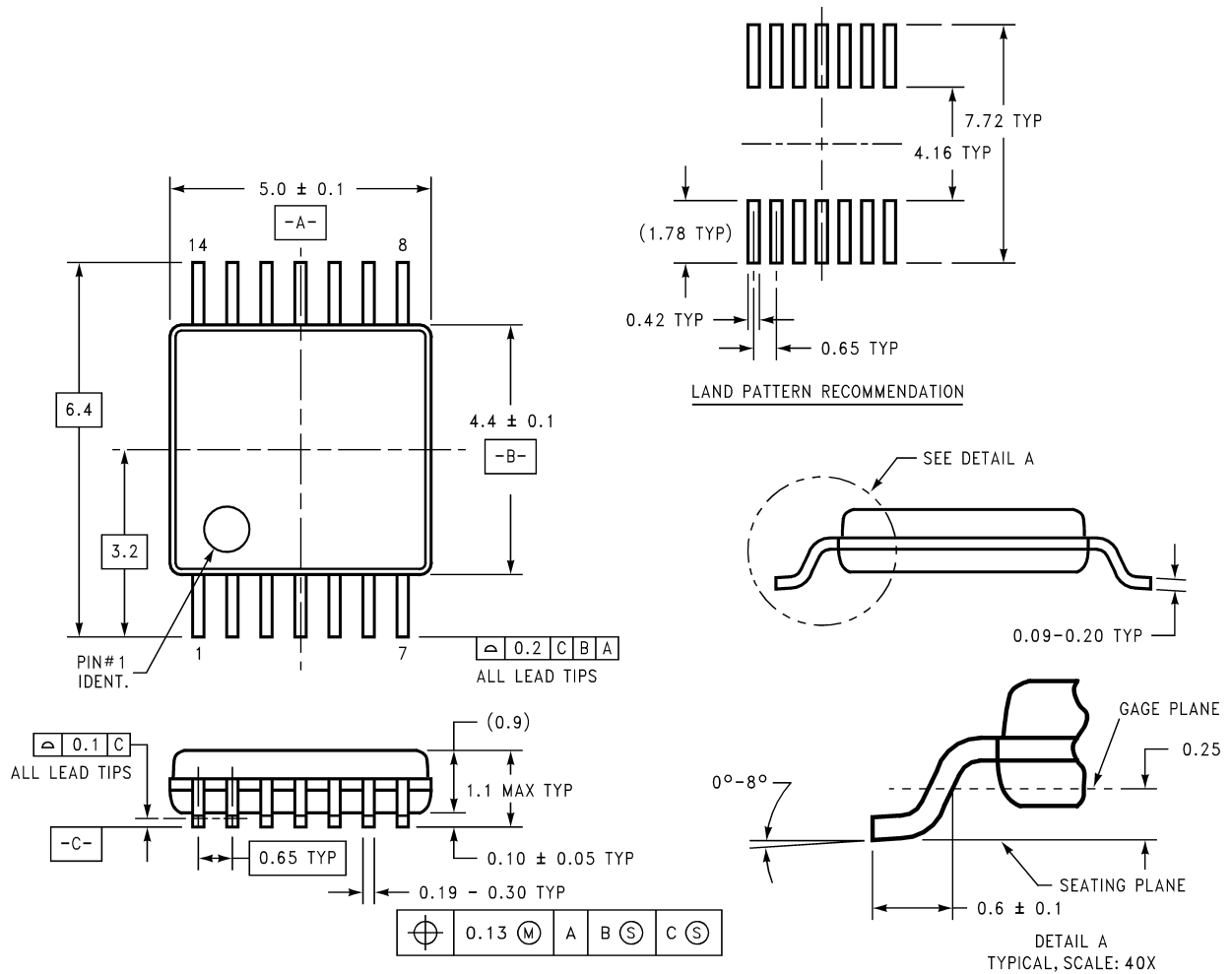
Physical Dimensions inches (millimeters) unless otherwise noted



M14A (REV H)

Order Number DS90LV019TM
NS Package Number M14A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



Order Number DS90LV019TMT
NS Package Number MTC14

LIFE SUPPORT POLICY

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1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

National Semiconductor Corporation
Americas
Tel: 1-800-272-9959
Fax: 1-800-737-7018
Email: support@nsc.com
www.national.com

National Semiconductor Europe
Fax: +49 (0) 180-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 69 9508 6208
English Tel: +44 (0) 870 24 0 2171
Français Tel: +33 (0) 1 41 91 8790

National Semiconductor Asia Pacific Customer Response Group
Tel: 65-2544466
Fax: 65-2504466
Email: ap.support@nsc.com

National Semiconductor Japan Ltd.
Tel: 81-3-5639-7560
Fax: 81-3-5639-7507