

**3.3V Boost LVDS High-Speed Differential Line Drivers and Receivers**

**Product Features**

- Signaling Rates >660 Mbps (330 MHz)
- Single 3.3V Power Supply Design
- Driver:
  - ±350mV Differential Swing into a 50 ohm load
  - Propagation Delay of 1.5ns Typ.
  - Low Voltage TTL (LVTTTL) Inputs are 5V Tolerant
  - Driver is High Impedance when Disabled or V<sub>CC</sub> < 1.5V
- Receiver:
  - Accepts ±50mV (min.) Differential Swing with up to 2.0V ground potential difference
  - Propagation Delay of 3.3ns Typ.
  - Low Voltage TTL (LVTTTL) Outputs
  - Open, Short, and Terminated Fail Safe
- Industrial Temperature Operating Range: -40°C to 85°C
- Package Options: SOIC, TSSOP, MSOP
- Bus-Terminal ESD ≥ 12kV

**Product Description**

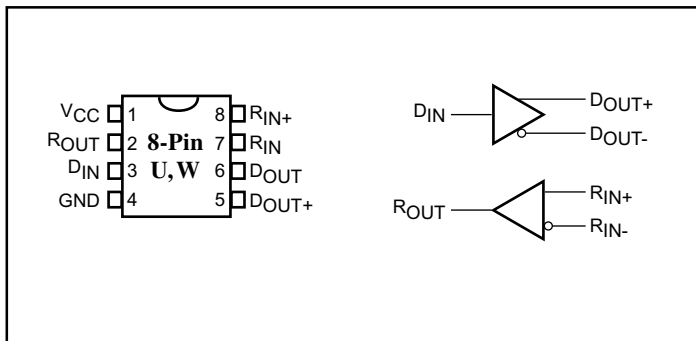
The PI90LVB179, PI90LVB180, PI90LVB050, and PI90LVB051 are differential line drivers and receivers (transceivers) that are similar to the IEEE 1596.3 SCI and ANSI/TIA/EIA-644 LVDS standards (the difference is that the driver output current is doubled). This modification enables true half-duplex operation with more than one LVDS driver or with two line transmission resistors over a 50 ohm differential transmission line. These devices use low-voltage differential signaling (LVDS) to achieve data rates in excess of 660 Mbps while being less susceptible to noise than single-ended transmission.

The drivers translate a low-voltage TTL/CMOS input into a low-voltage (350mV typical) differential output signal into a 50-ohm load. The receivers translate a differential 350mV input signal to a 3V CMOS output level. Driver section can be independently set to a power-down and high-impedance output mode with the DEN pin (active HIGH). Receiver section is controlled by the REN\* pin (active LOW).

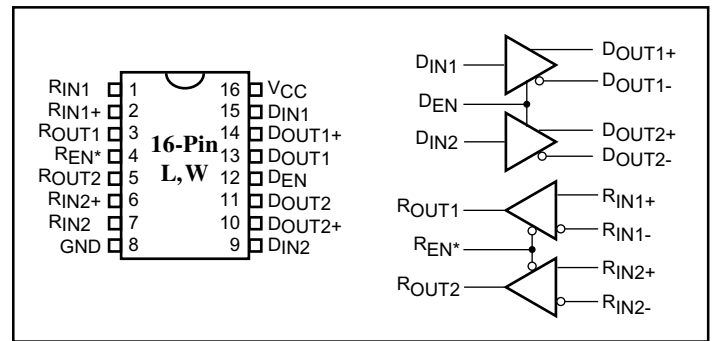
**Applications**

Applications include point-to-point and multidrop baseband data transmission over a controlled impedance media of approximately 50 ohms. These include intra-system connections via printed circuit board traces or cables, hubs and routers for data communications; PBXs, switches, repeaters and base stations for telecommunications and other applications such as digital cameras, printers and copiers.

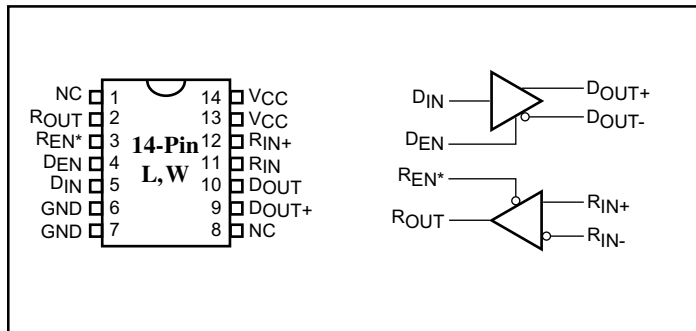
**PI90LVB179**



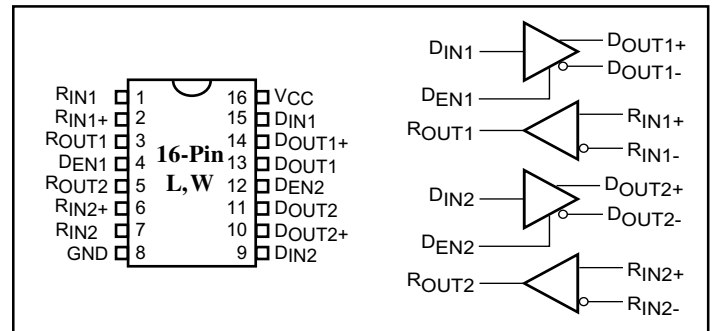
**PI90LVB050**



**PI90LVB180**



**PI90LVB051**



### Function Tables

#### PI90LVB179 Receiver

| Inputs                         | Output    |
|--------------------------------|-----------|
| $V_{ID} = V_{RIN+} - V_{RIN-}$ | $R_{OUT}$ |
| $V_{ID} \geq 50mV$             | H         |
| $-50mV < V_{ID} < 50mV$        | ?         |
| $V_{ID} \leq -50mV$            | L         |
| open                           | H         |

#### PI90LVB179 Driver

| Input    | Output     |            |
|----------|------------|------------|
| $D_{IN}$ | $D_{OUT+}$ | $D_{OUT-}$ |
| L        | L          | H          |
| H        | H          | L          |
| open     | L          | H          |

#### PI90LVB180/PI90LVB050/PI90LVB051 Receiver

| Inputs                         |            | Output    |
|--------------------------------|------------|-----------|
| $V_{ID} = V_{RIN+} - V_{RIN-}$ | $R_{EN}^*$ | $R_{OUT}$ |
| $V_{ID} \geq 50mV$             | L          | H         |
| $-50mV < V_{ID} < 50mV$        | L          | ?         |
| $V_{ID} \leq -50mV$            | L          | L         |
| open                           | L          | H         |
| X                              | H          | Z         |

#### PI90LVB180/PI90LVB050/PI90LVB051 Driver

| Inputs   |          | Output     |            |
|----------|----------|------------|------------|
| $D_{IN}$ | $D_{EN}$ | $D_{OUT+}$ | $D_{OUT-}$ |
| L        | H        | L          | H          |
| H        | H        | H          | L          |
| open     | H        | L          | H          |
| X        | L        | Z          | Z          |

#### Notes:

H = High Level, L = Low Level

? = Indeterminate, Z = High-Impedance, X = Don't Care

### Pin Descriptions

| Name       | Description                                |
|------------|--|
| $D_{IN}$   | TTL/CMOS driver input pins                 |
| $D_{OUT+}$ | Non-inverting driver output pins           |
| $D_{OUT-}$ | Inverting driver output pins               |
| $R_{OUT}$  | TTL/CMOS receiver output pins              |
| $R_{IN+}$  | Non-inverting receiver input pins          |
| $R_{IN-}$  | Inverting receiver input pins              |
| $V_{ID}$   | Input Differential Signal Voltage          |
| GND        | Ground pin                                 |
| $V_{CC}$   | Positive power supply pin, +3.3V $\pm$ 10% |

### Absolute Maximum Ratings

|  |                              |
|--|------------------------------|
| Supply Voltage ( $V_{CC}$ )                        | -0.5V to +4.0V               |
| Driver   |                              |
| Input Voltage ( $D_{IN}$ )                         | -0.3V to ( $V_{CC} + 0.3V$ ) |
| Output Voltage ( $D_{OUT+}$ , $D_{OUT-}$ )         | -0.3V to +3.9V               |
| Short Circuit Duration ( $D_{OUT+}$ , $D_{OUT-}$ ) | Continuous                   |
| Enable Input Voltage ( $D_{EN}$ )                  | -0.3V to ( $V_{CC} + 0.3V$ ) |
| Receiver   |                              |
| Input Voltage ( $R_{IN+}$ , $R_{IN-}$ )            | -0.3V to +3.9V               |
| Output Voltage ( $R_{OUT}$ )                       | -0.3V to ( $V_{CC} + 0.3V$ ) |
| Enable Input Voltage ( $R_{EN}^*$ )                | -0.3V to ( $V_{CC} + 0.3V$ ) |
| Storage Temperature Range                          | -65°C to +150°C              |
| Lead Temperature Range Soldering (4s)              | +260°C                       |
| Maximum Junction Temperature                       | +150°C                       |
| ESD Rating   | >12kV                        |

### Recommended Operating Conditions

|  | Min.         | Typ. | Max.                                 | Units |
|--|--------------|------|--------------------------------------|-------|
| Supply Voltage ( $V_{CC}$ )                        | 3            | 3.3  | 3.6                                  | V     |
| High Level Input Voltage, $V_{IH}$                 | 2            |      |                                      |       |
| Low Level Input Voltage, $V_{IL}$                  |              |      | 0.8                                  |       |
| Magnitude of Differential Input Voltage $ V_{ID} $ | 0.1          |      | 0.6                                  |       |
| Common-mode Input Voltage, $V_{IC}$ (Fig 5)        | $ V_{ID} /2$ |      | $2.4 -  V_{ID} /2$<br>$V_{CC} - 0.8$ |       |
| Operating Free Air Temperature $T_A$               | -40          |      | 85                                   | °C    |

**Electrical Characteristics** (Over recommended operating conditions unless otherwise noted).

| Parameter                        |                            | Test Condition   | Min. | Typ. <sup>†</sup> | Max. | Units |
|----------------------------------|----------------------------|--|------|-------------------|------|-------|
| I <sub>CC</sub> * Supply Current | PI90LVB179                 | No receiver load, Driver R <sub>L</sub> = 50 ohms                                |      | 10                | 14   | mA    |
|                                  | PI90LVB180                 | Driver and receiver enabled. No receiver load, Driver R <sub>L</sub> = 50 ohms   |      | 10.5              | 14   |       |
|                                  |                            | Driver disabled, Receiver disabled, R <sub>L</sub> = 50 ohms                     |      | 1                 | 1.5  |       |
|                                  |                            | Driver disabled, Receiver enabled, No load                                       |      | 0.9               | 1.1  |       |
|                                  |                            | Disabled   |      | 1.3               | 1.7  |       |
|                                  | PI90LVB050                 | Driver and receivers enabled. No receiver loads, Driver R <sub>L</sub> = 50 ohms |      | 20.5              | 24.6 |       |
|                                  |                            | Drivers disabled, Receivers disabled, R <sub>L</sub> = 50 ohms                   |      | 3.1               | 3.7  |       |
|                                  |                            | Drivers disabled, Receivers enabled, No loads                                    |      | 1.0               | 1.2  |       |
|                                  | PI90LVB051                 | Disabled   |      | 1.2               | 1.5  |       |
|                                  |                            | Drivers enabled, No receiver loads, Driver R <sub>L</sub> = 50 ohms              |      | 20.5              | 24.7 |       |
|                                  | Drivers disabled, No loads |  | 1.0  | 1.2               |      |       |

<sup>†</sup>All typical values are at 25°C with a 3.3V supply

\*I<sub>CC</sub> measured with all TTL input. V<sub>IN</sub> = V<sub>CC</sub> or GND.

**Driver Electrical Characteristics** (Over recommended operating conditions unless otherwise noted).

| Parameter            |  | Test Conditions                                 | Min.                   | Typ. | Max.  | Units |
|----------------------|--|---|------------------------|------|-------|-------|
| V <sub>OD</sub>      | Differential output voltage magnitude                                  | R <sub>L</sub> = 50 ohms<br>See Figures 1 and 2 | 247                    | 420  | 520   | 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                  | 1.25 | 1.375 | V     |
| ΔV <sub>OC(SS)</sub> | Change in steady-state common-mode output voltage between logic states |   | -50                    |      | 50    |       |
| V <sub>OC(PP)</sub>  | Peak-to-peak common-mode output voltage                                |   |                        | 50   | 165   |       |
| I <sub>IH</sub>      | High-level input current   | DE  | V <sub>IH</sub> = 5V   | -0.5 | -20   | μA    |
|                      |  | D <sub>IN</sub>                                 |                        | 2    | 20    |       |
| I <sub>IL</sub>      | Low-level input current  | DE  | V <sub>IL</sub> = 0.8V | -0.5 | -10   |       |
|                      |  | D <sub>IN</sub>                                 |                        | 2    | 10    |       |
| I <sub>OS</sub>      | Short-circuit output current   | V <sub>OY</sub> or V <sub>OZ</sub> = 0V         |                        | -6   | -12   | mA    |
|                      |  | V <sub>OD</sub> = 0V                            |                        | -8   | -15   |       |
| I <sub>OZ</sub>      | High-impedance output current  | V <sub>OD</sub> = 600mV                         |                        |      | ±1    | μA    |
|                      |  | V <sub>O</sub> = 0V or V <sub>CC</sub>          |                        |      | ±1    |       |
| I <sub>O(OFF)</sub>  | Power-off output current   | V <sub>CC</sub> = 0V, V <sub>O</sub> = 3.6V     |                        |      | ±1    |       |
| C <sub>IN</sub>      | Input capacitance  |   |                        | 3    | 10.5  | pF    |

**Receiver Electrical Characteristics** (Over recommended operating conditions unless otherwise noted).

| Parameter           |   | Test Conditions          | Min. | Typ. | Max. | Units |    |
|---------------------|---|--------------------------|------|------|------|-------|----|
| V <sub>ITH+</sub>   | Positive-going differential input voltage threshold             | See Figures 5 & Table 1  |      |      | 50   | mV    |    |
| V <sub>ITH-</sub>   | Negative-going differential input voltage threshold             |                          | -50  |      |      |       |    |
| V <sub>OH</sub>     | High-level output voltage                                       | I <sub>OH</sub> = -8mA   | 2.4  |      |      | V     |    |
| V <sub>OL</sub>     | Low-level output voltage  | I <sub>OL</sub> = 8mA    |      |      | 0.4  | V     |    |
| I <sub>I</sub>      | Input current (R <sub>IN+</sub> or R <sub>IN-</sub> )           | V <sub>I</sub> = 0       | -2   | -11  | -20  | μA    |    |
|                     |   | V <sub>I</sub> = 2.4V    | -1.2 | -3   |      |       |    |
| I <sub>I(OFF)</sub> | Power-off input current (R <sub>IN+</sub> or R <sub>IN-</sub> ) | V <sub>CC</sub> = 0      |      |      | ±20  |       |    |
| I <sub>H</sub>      | High-level input current (enables)                              | V <sub>IH</sub> = 2V     |      |      | ±10  |       |    |
| I <sub>L</sub>      | Low-level input current (enables)                               | V <sub>IL</sub> = 0.8V   |      |      | ±10  |       |    |
| I <sub>OZ</sub>     | High-impedance output current                                   | V <sub>O</sub> = 0 or 5V |      |      | ±10  |       |    |
| C <sub>I</sub>      | Input capacitance   |                          |      | 5    |      |       | pF |

†All typical values are at 25°C with a 3.3V supply

**Driver Switching Characteristics** (Over recommended operating conditions unless otherwise noted).

| Parameter           |   | Test Conditions   | Min. | Typ.† | Max. | Units |    |
|---------------------|---|---|------|-------|------|-------|----|
| t <sub>PLH</sub>    | Propagation delay time, low-to-high-level output            | R <sub>L</sub> = 50 ohms<br>C <sub>L</sub> = 10pF<br>See Figure 2 |      | 2.0   | 2.6  | ns    |    |
| t <sub>PHL</sub>    | Propagation delay time, high-to-low-level output            |   |      | 1.9   | 2.5  |       |    |
| t <sub>r</sub>      | Differential output signal rise time                        |   |      | 0.4   | 0.6  |       |    |
| t <sub>f</sub>      | Differential output signal fall time                        |   |      | 0.4   | 0.6  |       |    |
| t <sub>sk(p)</sub>  | Pulse skew (t <sub>PHL</sub> - t <sub>PLH</sub> )           |   |      |       | 200  | 310   | ps |
| t <sub>sk(o)</sub>  | Channel-to-channel output skew‡                             |   |      |       | 90   | 160   |    |
| t <sub>sk(pp)</sub> | Part-part-part skew**                                       |   |      |       | 0.9  | ns    |    |
| t <sub>PZH</sub>    | Propagation delay time, high-impedance-to-high-level output | See Figure 7  |      | 3.3   | 5    |       |    |
| t <sub>PZL</sub>    | Propagation delay time, high-impedance-to-low-level output  |   |      | 2.0   | 3.3  |       |    |
| t <sub>PHZ</sub>    | Propagation delay time, high-level-to-high-impedance output |   |      | 1.7   | 3.3  |       |    |
| t <sub>PLZ</sub>    | Propagation delay time, low-level-to-high-impedance output  |   |      | 1.7   | 3.3  |       |    |

†All typical values are at 25°C with a 3.3V supply

‡t<sub>sk(o)</sub>: the maximum delay time difference between drivers on the same device.

\*\*t<sub>sk(pp)</sub>: magnitude of difference in propagation delay times between any specific terminals of two devices (all things being equal)

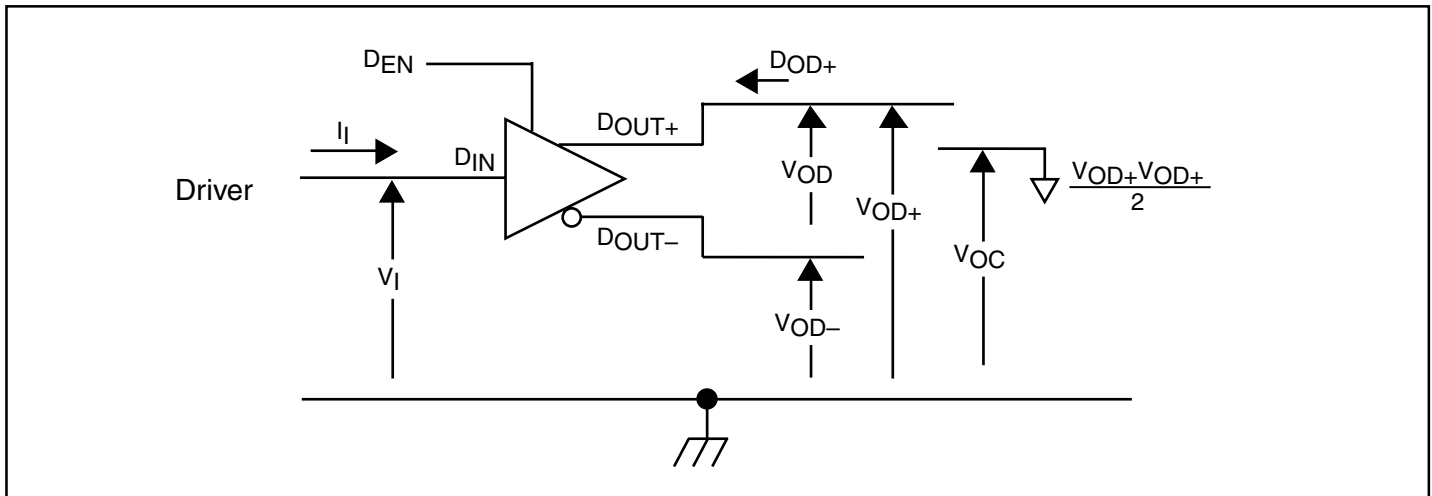
**Receiving Switching Characteristics** (Over recommended operating conditions unless otherwise noted).

| Parameter             |   | Test Conditions                       | Min. | Typ. <sup>†</sup> | Max. | Units |
|-----------------------|---|---------------------------------------|------|-------------------|------|-------|
| t <sub>PLH</sub>      | Propagation delay time, low-to-high-level output            | C <sub>L</sub> = 10pF<br>See Figure 6 |      | 1.9               | 2.9  | ns    |
| t <sub>PHL</sub>      | Propagation delay time, high-to-low-level output            |                                       |      | 2.4               | 3.3  |       |
| t <sub>sk(p)</sub>    | Pulse skew (t <sub>PHL</sub> - t <sub>PLH</sub> )           |                                       |      | 0.1               | 0.4  |       |
| t <sub>sk(pp)**</sub> | Part-part-part skew**                                       |                                       |      |                   | 1.3  |       |
| t <sub>sk(o)</sub>    | Channel-to-channel skew                                     |                                       |      | 40                | 80   | ps    |
| t <sub>r</sub>        | Output signal rise time                                     |                                       |      |                   | 1.1  | 1.7   |
| t <sub>f</sub>        | Output signal fall time                                     |                                       |      | 1.3               | 2.1  |       |
| t <sub>PZH</sub>      | Propagation delay time, high-level-to-high-impedance output | See Figure 7                          |      | 1.6               | 2.4  | ns    |
| t <sub>PZL</sub>      | Propagation delay time, low-level-to-low-impedance output   |                                       |      | 4.1               | 5.9  |       |
| t <sub>PHZ</sub>      | Propagation delay time, high-impedance-to-high-level output |                                       |      | 2.5               | 3.2  |       |
| t <sub>PLZ</sub>      | Propagation delay time, low-impedance-to-high-level output  |                                       |      | 6.0               | 7.8  |       |

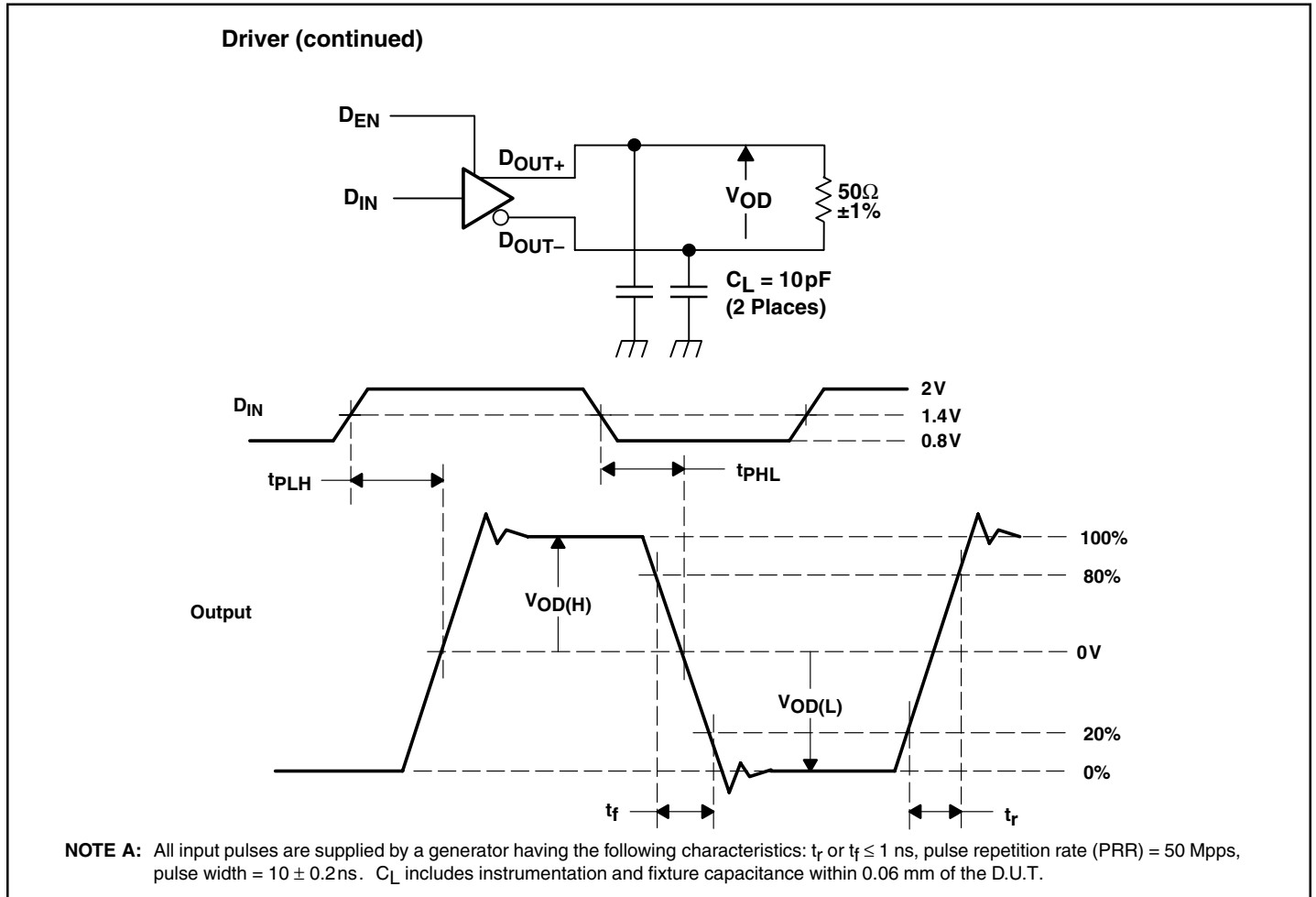
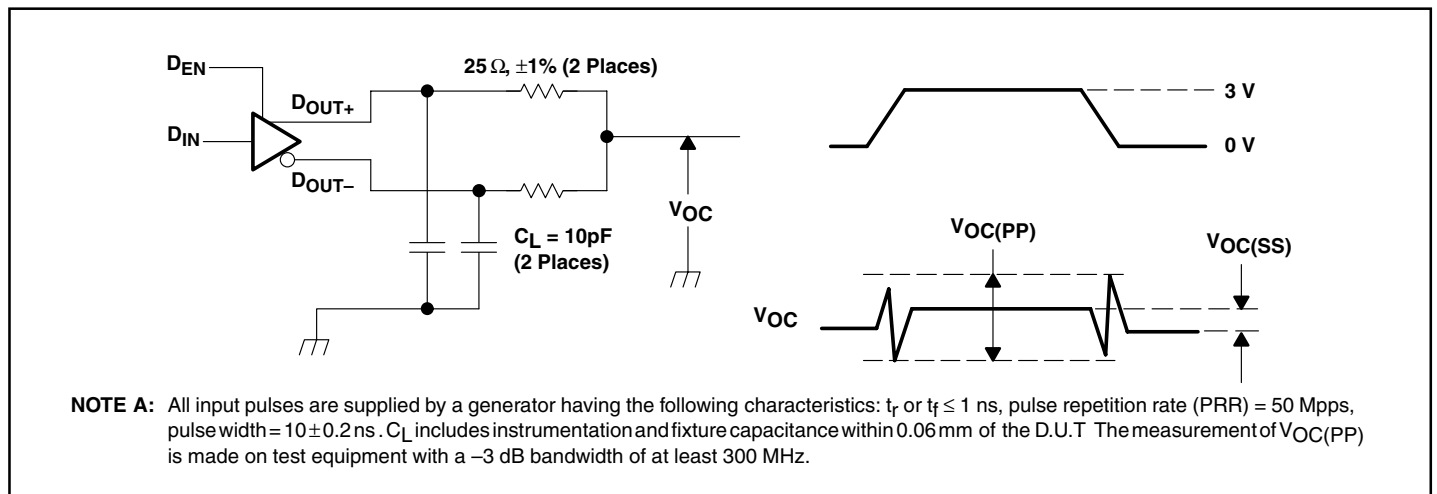
<sup>†</sup>All typical values are at 25°C with a 3.3V supply

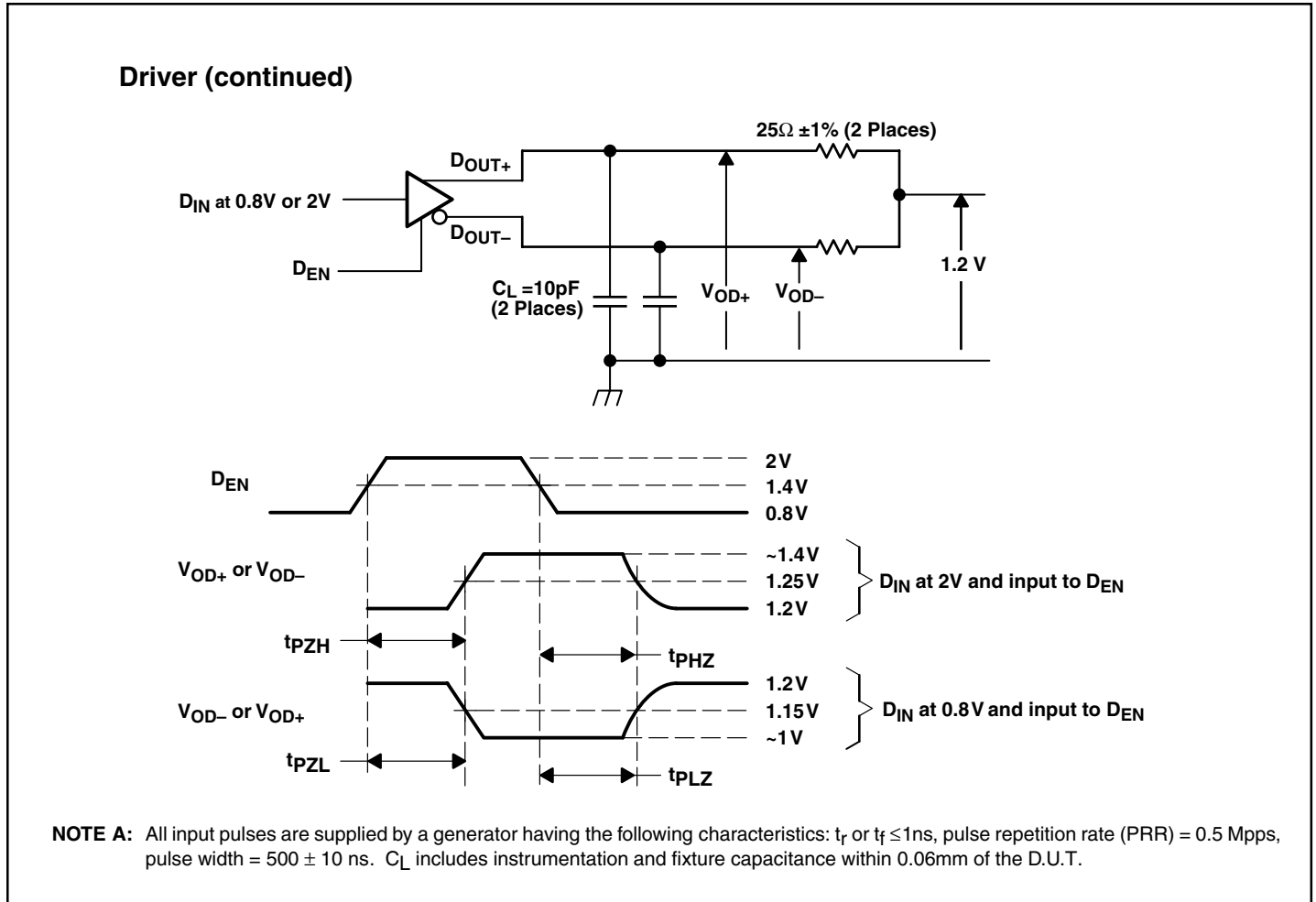
\*\*t<sub>sk(pp)</sub> is magnitude of the difference in propagation delay times between any specific terminals of two devices (all things being equal)

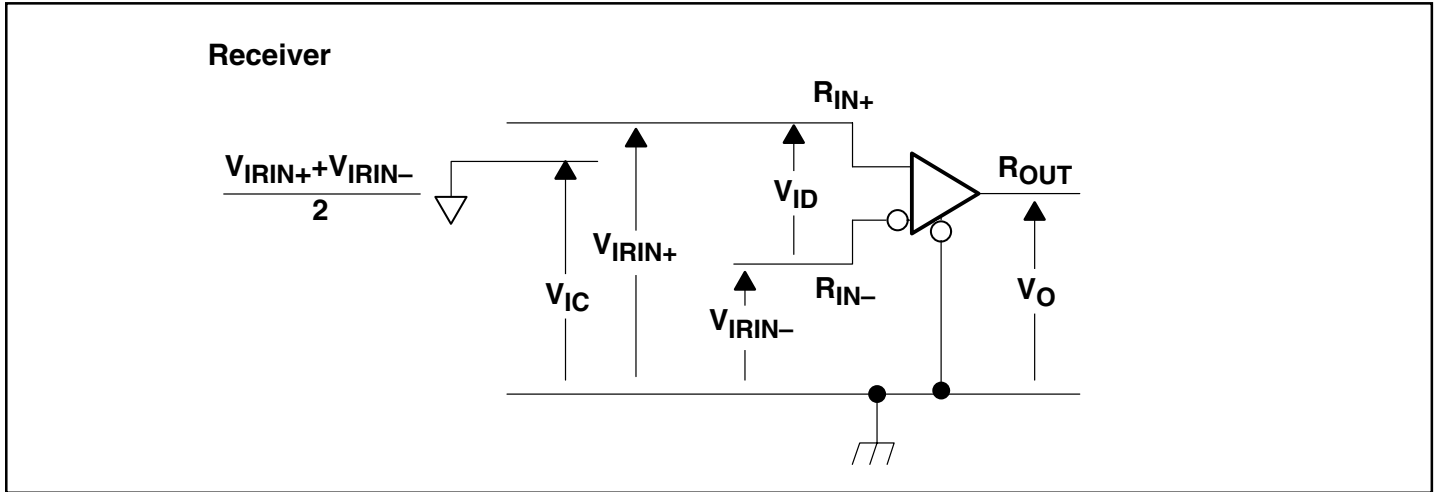
**Parameter Measurement Information**



**Figure 1. Driver Voltage and Current Definitions**

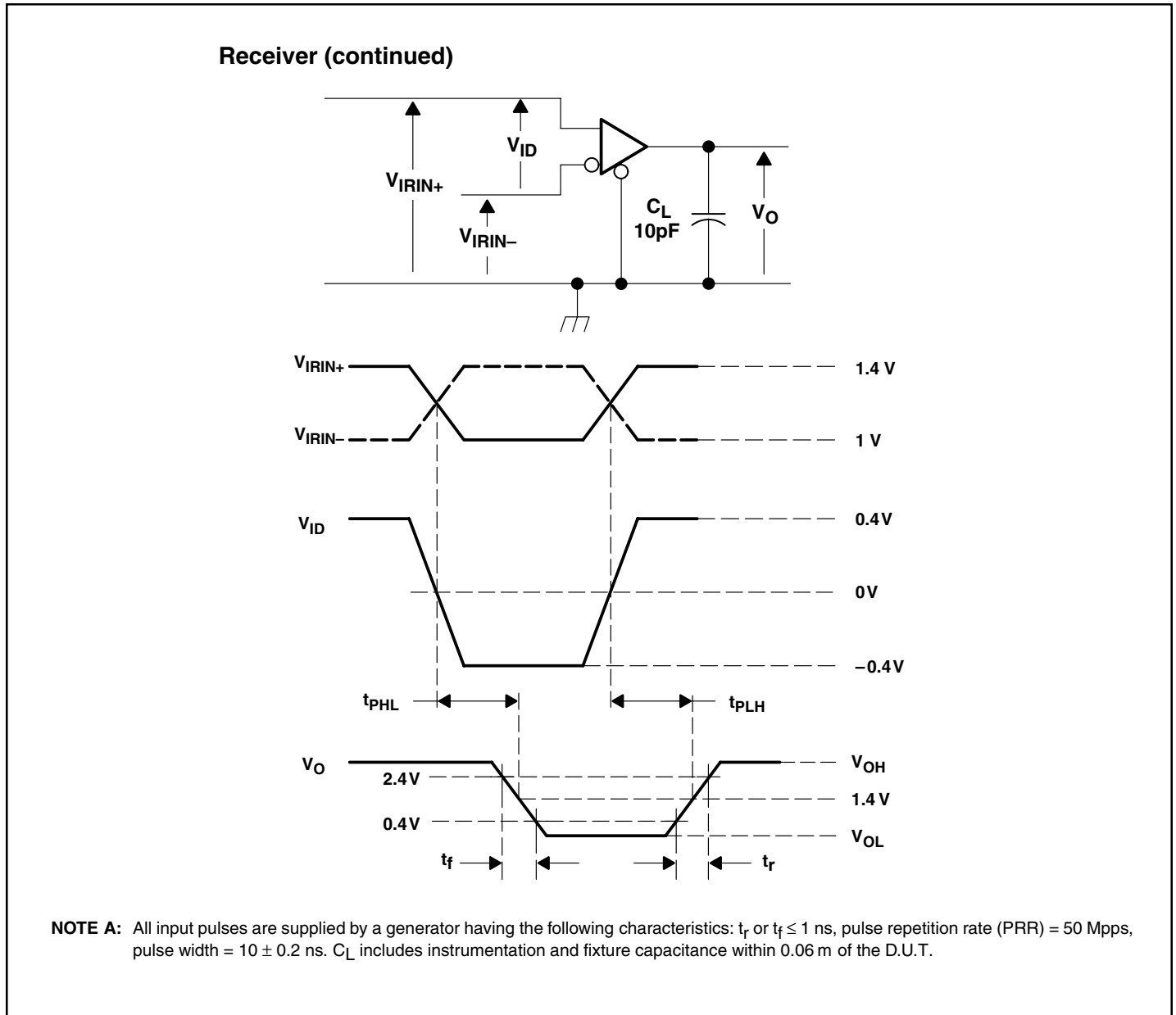
**Parameter Measurement Information**

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

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

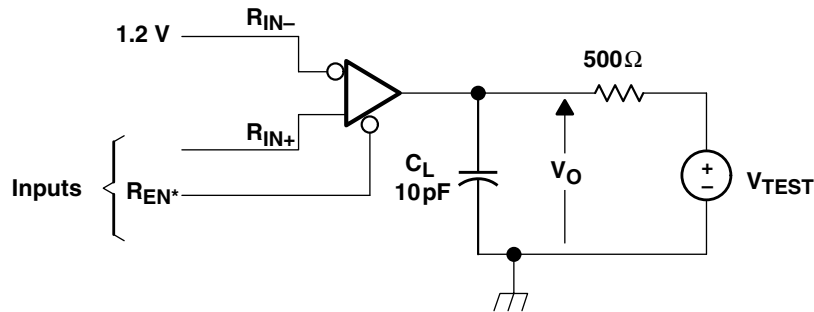
**Parameter Measurement Information**

**Figure 4. Enable and Disable Timing Circuit and Definitions**

**Parameter Measurement Information**

**Figure 5. Receiver Voltage Definitions**
**Table 1. Receiver Minimum and Maximum Input Threshold Test Voltages**

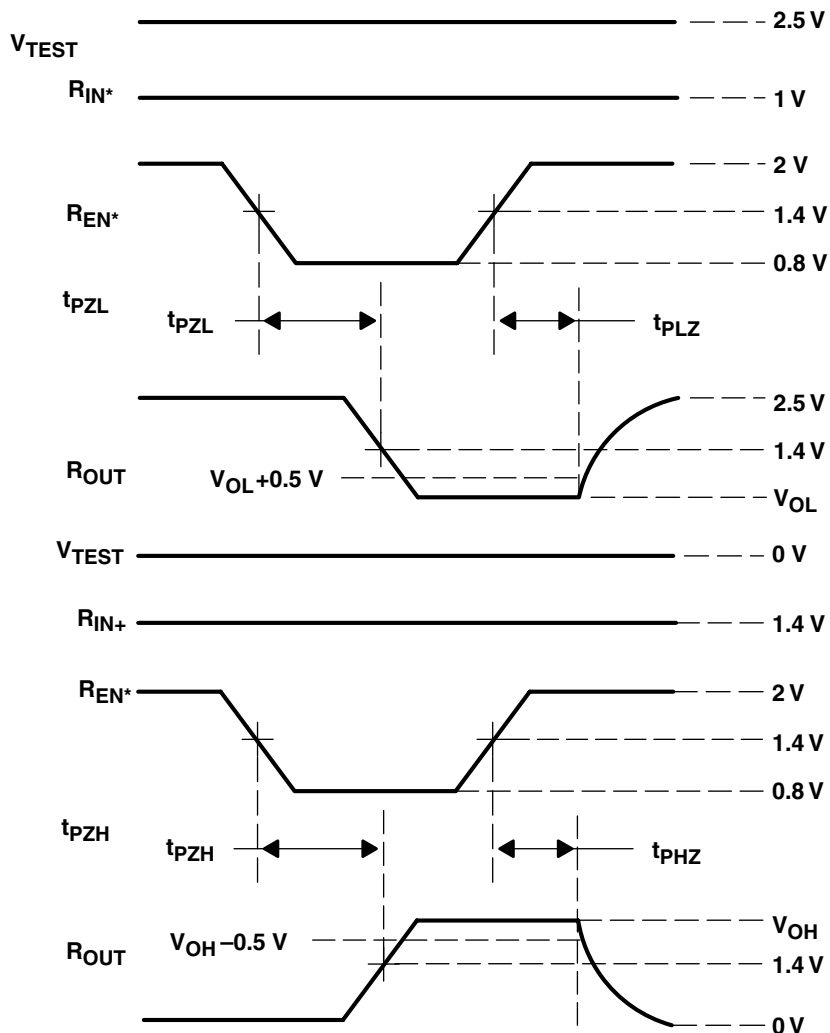
| APPLIED VOLTAGES (V) |             | RESULTING DIFFERENTIAL INPUT VOLTAGE (mV) | RESULTING COMMON-MODE INPUT VOLTAGE (V) |
|----------------------|-------------|---|---|
| $V_{IRIN+}$          | $V_{IRIN-}$ | $V_{ID}$                                  | $V_{IC}$                                |
| 1.225                | 1.175       | 50  | 1.2                                     |
| 1.175                | 1.225       | -50                                       | 1.2                                     |
| 2.375                | 2.325       | 50  | 2.35                                    |
| 2.325                | 2.375       | -50                                       | 2.35                                    |
| 0.1                  | 0           | 50  | 0.05                                    |
| 0                    | 0.05        | -50                                       | 0.05                                    |
| 1.5                  | 0.9         | 600                                       | 1.2                                     |
| 0.9                  | 1.5         | -600                                      | 1.2                                     |
| 2.4                  | 1.8         | 600                                       | 2.1                                     |
| 1.8                  | 2.4         | -600                                      | 2.1                                     |
| 0.6                  | 0           | 600                                       | 0.3                                     |
| 0                    | 0.6         | -600                                      | 0.3                                     |



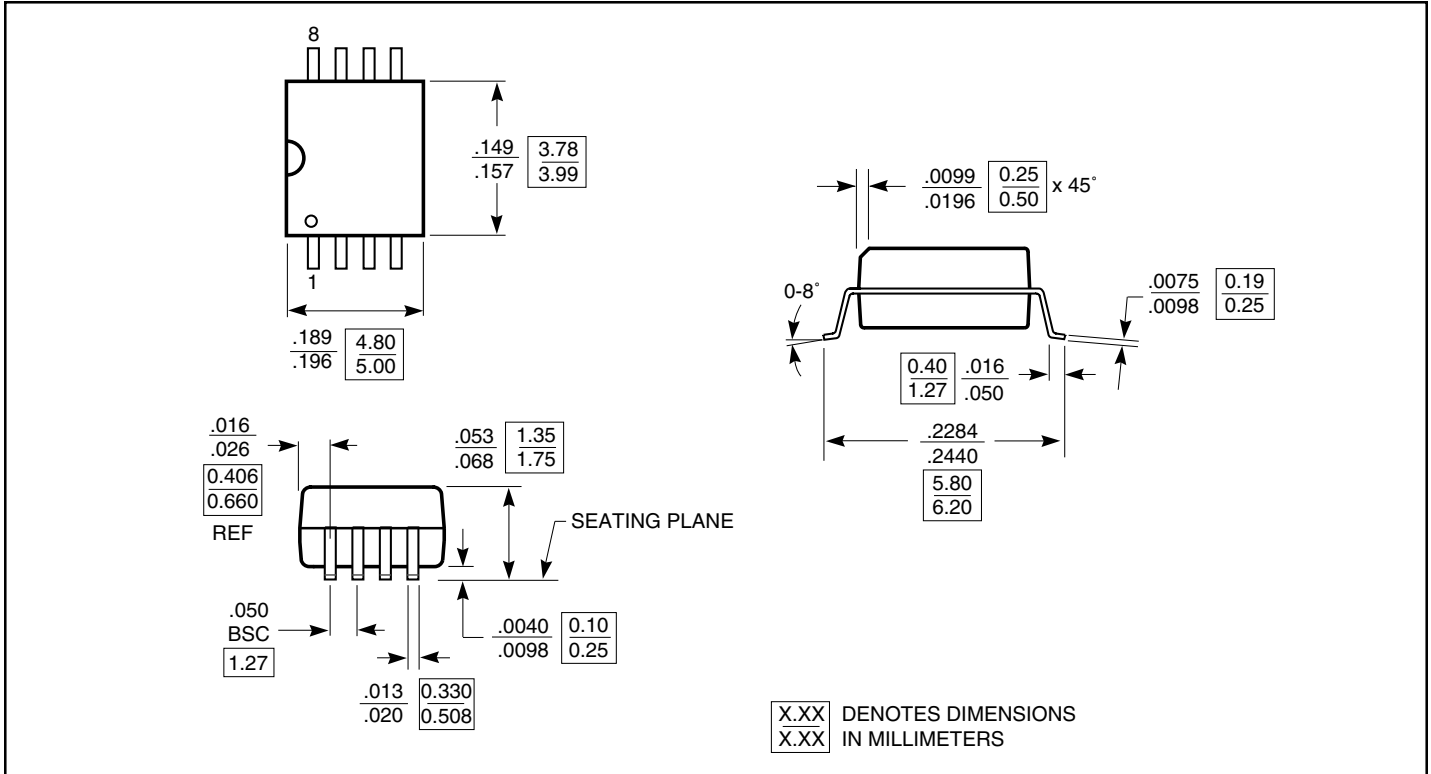
**Parameter Measurement Information**

**Figure 6. Timing Test Circuit and Waveforms**

**Parameter Measurement Information**
**Receiver (continued)**


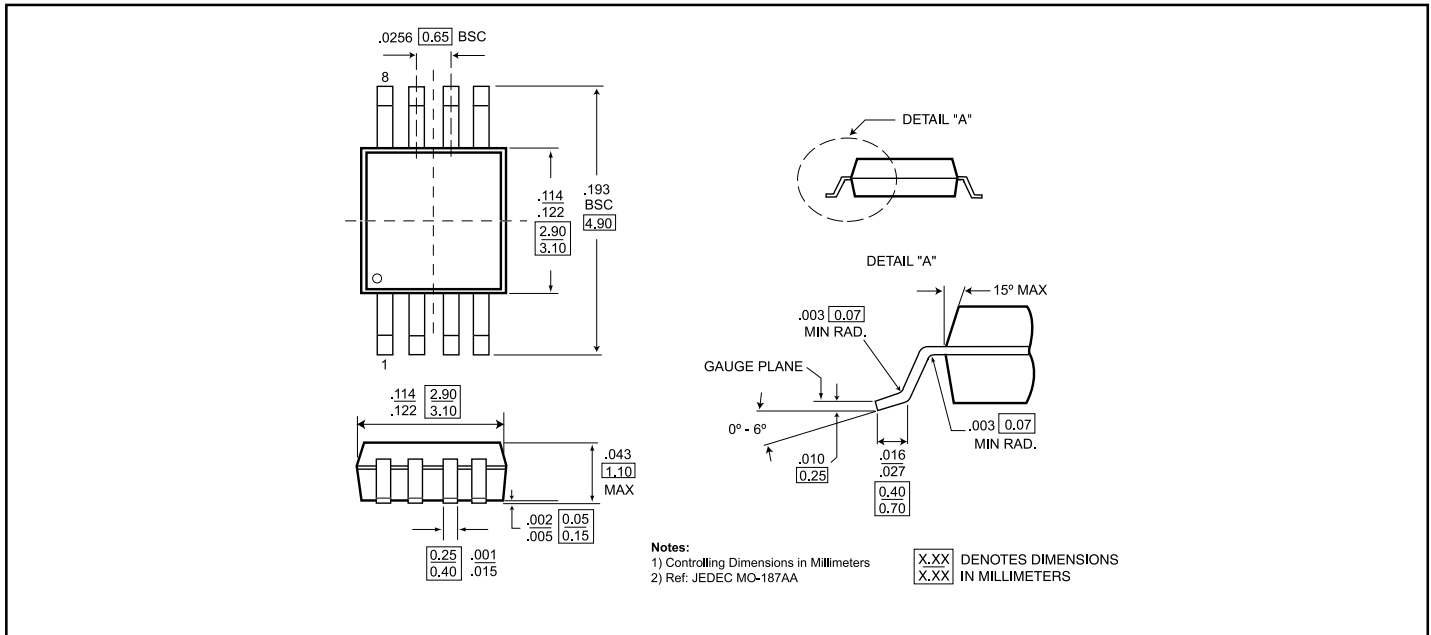
**NOTE A:** All input pulses are supplied by a generator having the following characteristics:  $t_r$  or  $t_f \leq 1$  ns, pulse repetition rate (PRR) = 0.5 Mpps, pulse wide =  $500 \pm 10$  ns.  $C_L$  includes instrumentation and fixture capacitance within 0.06m of the D.U.T.


**Figure 7. Enable/Disable Time Test Circuit and Waveforms**

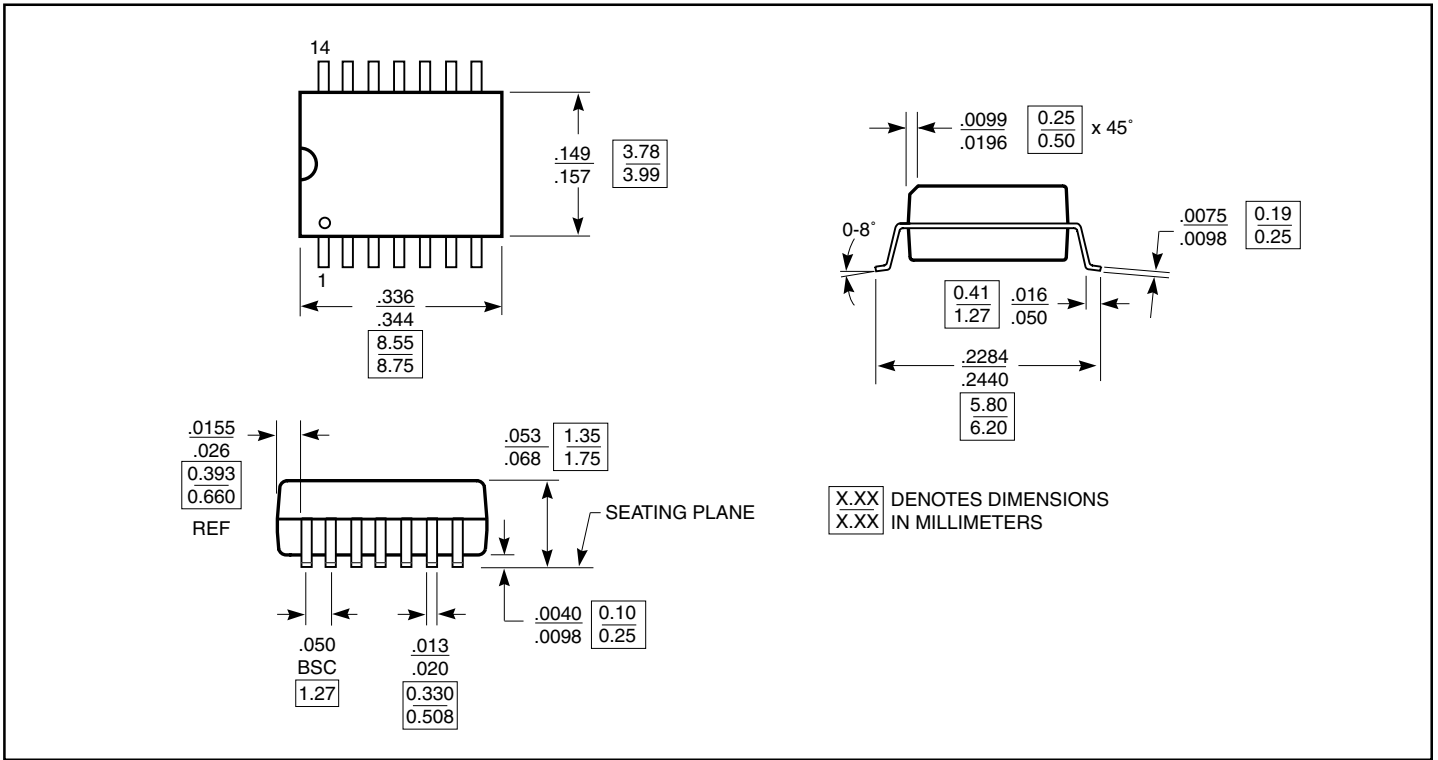
### 8-Pin SOIC W Package



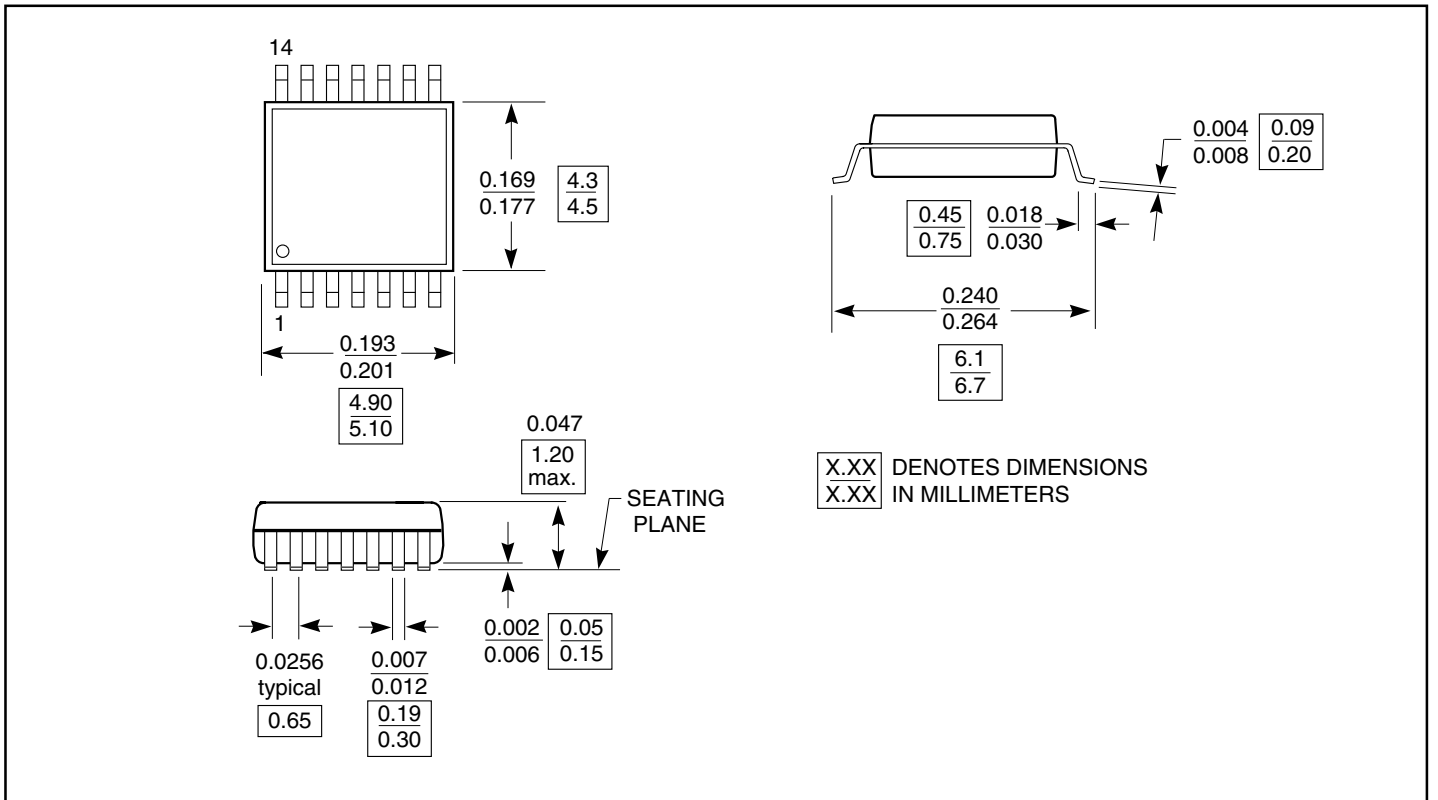
### 8-Pin Mini Small Outline U Package (MSOP)

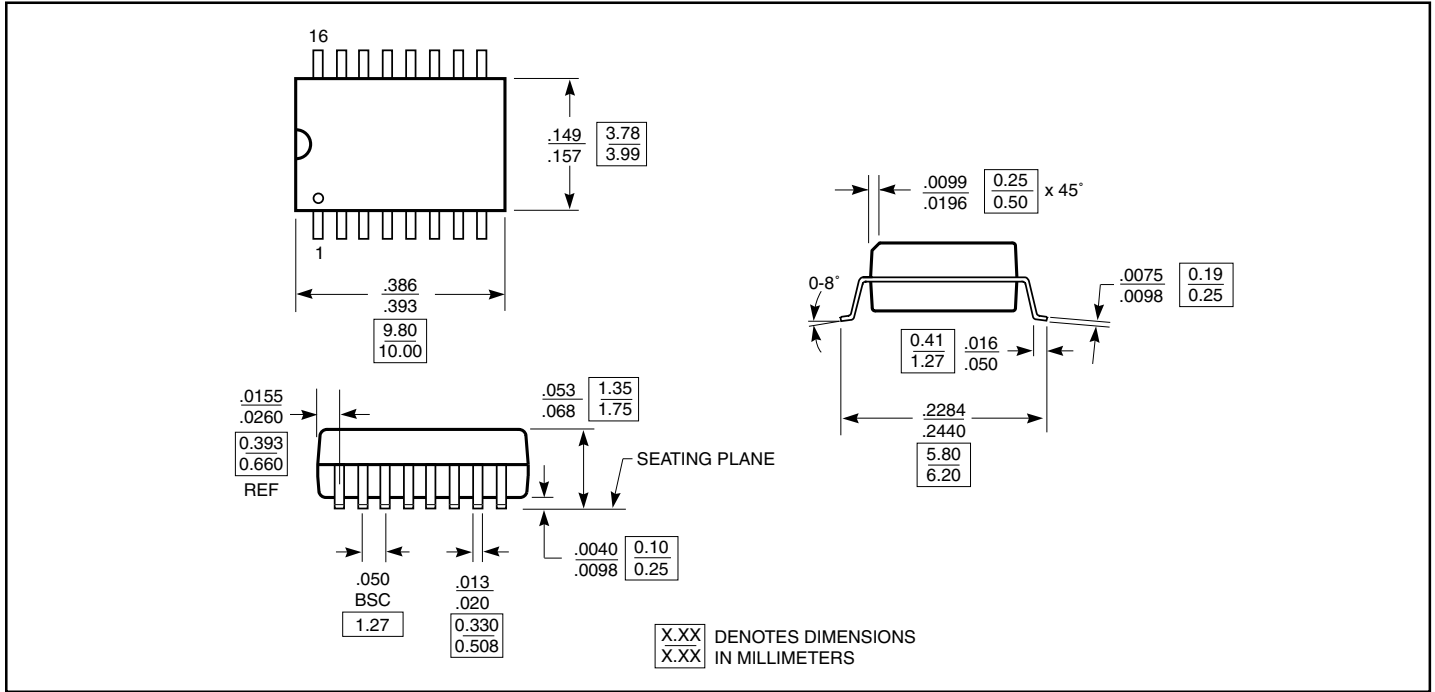
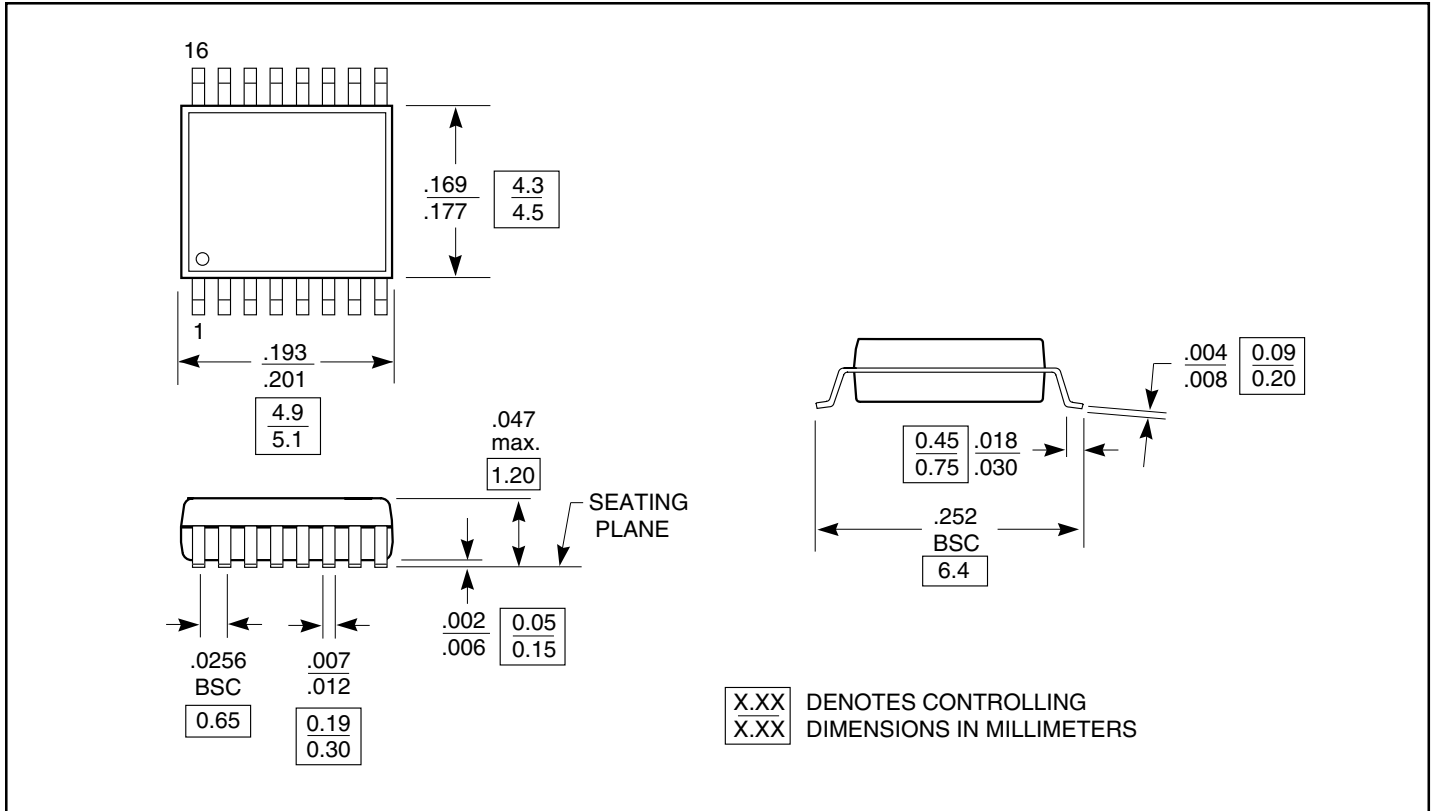


14-Pin SOIC (150 Mil) W Package



14-Pin TSSOP (4.4mm wide) L Package



**16-Pin SOIC (150 Mil) W Package**

**16-Pin TSSOP (4.4mm wide) L Package**




### Ordering Information

| Part        | Pin - Package | Temperature    |
|-------------|---------------|----------------|
| PI90LVB179W | 8-SOIC        | -40°C to +85°C |
| PI90LVB180W | 14-SOIC       | -40°C to +85°C |
| PI90LVB050W | 16-SOIC       | -40°C to +85°C |
| PI90LVB051W | 16-SOIC       | -40°C to +85°C |
| PI90LVB179U | 8-MSOP        | -40°C to +85°C |
| PI90LVB180L | 14-TSSOP      | -40°C to +85°C |
| PI90LVB050L | 16-TSSOP      | -40°C to +85°C |
| PI90LVB051L | 16-TSSOP      | -40°C to +85°C |