

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

**Product Features**

- Signaling Rates >660 Mbps (330 MHz)
- Single 3.3V Power Supply Design
- Driver:
  - $\pm 350\text{mV}$  Differential Swing into a 100-Ohm load
  - Propagation Delay of 1.5ns Typ.
  - Low Voltage TTL (LVTTTL) Inputs are 5V Tolerant
  - Driver is High Impedance when Disabled or  $V_{CC} < 1.5\text{V}$
- Receiver:
  - Accepts  $\pm 50\text{mV}$  (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:  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$
- Package Options: SOIC, TSSOP, MSOP
- Meets or Exceeds IEEE 1596.3 SCI Standard
- Meets or Exceeds ANSI/TIA/EIA-644 LVDS Standard
- Bus-Terminal ESD exceeds 12kV

**Product Description**

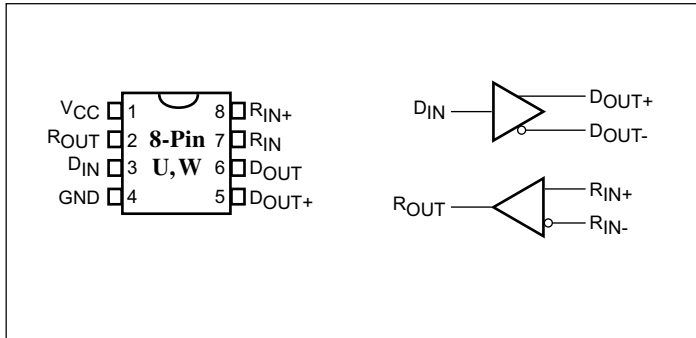
The PI90LV179, PI90LV180, PI90LV050, and PI90LV051 are differential line drivers and receivers (transceivers) that are compliant with the IEEE 1596.3 SCI and ANSI/TIA/EIA-644 LVDS standards. These devices use low-voltage differential signaling (LVDS) to achieve data rates in excess of 660 Mbps while 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. The receivers translate a differential 350mV input signal to a 3V CMOS output level. The driver section can be independently set to a power-down and high-impedance output mode with the DEN pin (active HIGH). The receiver section is controlled by the REN\* pin (active LOW).

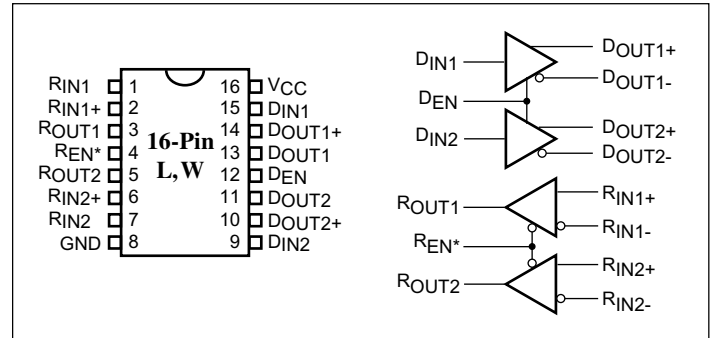
**Applications**

Applications include point-to-point and multidrop baseband data transmission over a controlled impedance media of approximately 100 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.

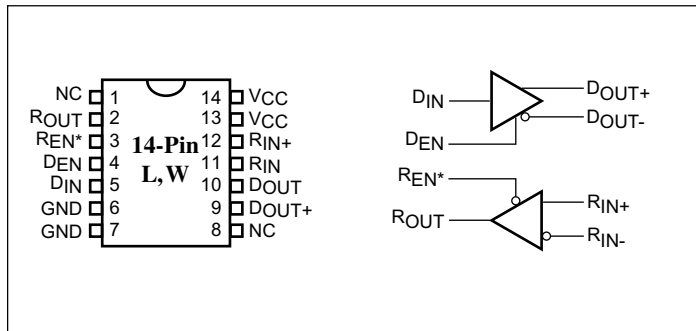
**PI90LV179**



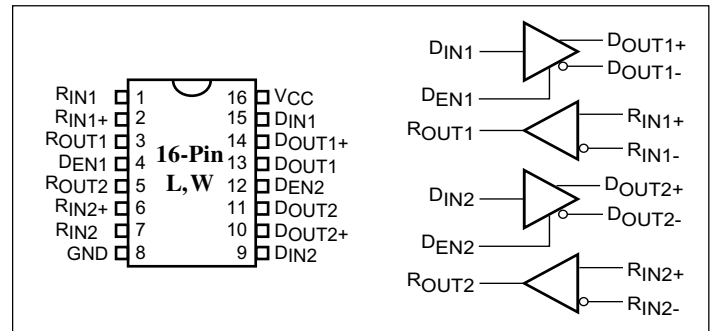
**PI90LV050**



**PI90LV180**



**PI90LV051**



### Function Tables

#### PI90LV179 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

#### PI90LV179 Driver

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

#### PI90LV180/PI90LV050/PI90LV051 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

#### PI90LV180/PI90LV050/PI90LV051 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$		$2.4 -  V_{ID}  / 2$	°C
			$V_{CC} - 0.8$	
Operating Free Air Temperature $T_A$	-40		85	

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

Parameter		Test Condition	Min.	Typ. <sup>†</sup>	Max.	Units
I <sub>CC</sub> * Supply Current	PI90LV179	No receiver load, Driver R <sub>L</sub> = 100 ohms		6	9	mA
	PI90LV180	Driver and receiver enabled. No receiver load, Driver R <sub>L</sub> = 100 ohms		6	9	
		Driver disabled, Receiver disabled, R <sub>L</sub> = 100 ohms		2.7	4	
		Driver disabled, Receiver enabled, No load		1.6	2.1	
		Disabled		1.5	2.5	
	PI90LV050	Driver and receivers enabled. No receiver loads, Driver R <sub>L</sub> = 100 ohms		12	15	
		Drivers disabled, Receivers disabled, R <sub>L</sub> = 100 ohms		2.5	3	
		Drivers disabled, Receivers enabled, No loads		1.0	1.2	
		Disabled		1.3	1.6	
	PI90LV051	Drivers enabled, No receiver loads, Driver R <sub>L</sub> = 100 ohms		12.3	14.8	
Drivers disabled, No loads			1.0	1.2		

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

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

**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> = 100 ohms 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	mV
V <sub>OC(PP)</sub>	Peak-to-peak common-mode output voltage			50	150	
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	-8	mA
		V <sub>OD</sub> = 0V		-8	-10	
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	8.5	pF

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

Parameter		Test Conditions	Min.	Typ.	Max.	Units
$V_{IH+}$	Positive-going differential input voltage threshold	See Figures 5 & Table 1			50	mV
$V_{IH-}$	Negative-going differential input voltage threshold		-50			
$V_{OH}$	High-level output voltage	$I_{OH} = -8\text{mA}$	2.4			V
$V_{OL}$	Low-level output voltage	$I_{OL} = 8\text{mA}$			0.4	V
$I_I$	Input current ( $R_{IN+}$ or $R_{IN-}$ )	$V_I = 0$	-2	-11	-20	$\mu\text{A}$
		$V_I = 2.4\text{V}$	-1.2	-3		
$I_{I(OFF)}$	Power-off input current ( $R_{IN+}$ or $R_{IN-}$ )	$V_{CC} = 0$			$\pm 20$	
$I_{IH}$	High-level input current (enables)	$V_{IH} = 2\text{V}$			$\pm 10$	
$I_{IL}$	Low-level input current (enables)	$V_{IL} = 0.8\text{V}$			$\pm 10$	
$I_{OZ}$	High-impedance output current	$V_O = 0$ or $5\text{V}$			$\pm 10$	
$C_I$	Input capacitance			5		

†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
$t_{PLH}$	Propagation delay time, low-to-high-level output	$R_L = 100\ \text{ohms}$ $C_L = 10\text{pF}$ See Figure 2		1.9	2.5	ns
$t_{PHL}$	Propagation delay time, high-to-low-level output			1.9	2.4	
$t_r$	Differential output signal rise time			1	1.3	
$t_f$	Differential output signal fall time			1	1.3	
$t_{sk(p)}$	Pulse skew ( $t_{PHL} - t_{PLH}$ )				200	ps
$t_{sk(o)}$	Channel-to-channel output skew‡				80	
$t_{sk(pp)}$	Part-part-part skew**				0.9	ns
$t_{PZH}$	Propagation delay time, high-impedance-to-high-level output	See Figure 7		3.4	5	
$t_{PZL}$	Propagation delay time, high-impedance-to-low-level output			2.5	5	
$t_{PHZ}$	Propagation delay time, high-level-to-high-impedance output			3	5	
$t_{PLZ}$	Propagation delay time, low-level-to-high-impedance output			3.2	5	

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

‡ $t_{sk(o)}$ : maximum delay time difference between drivers on the same device.

\*\* $t_{sk(pp)}$ : magnitude of difference in propagation delay times between any specific terminals of two devices (all things being equal).

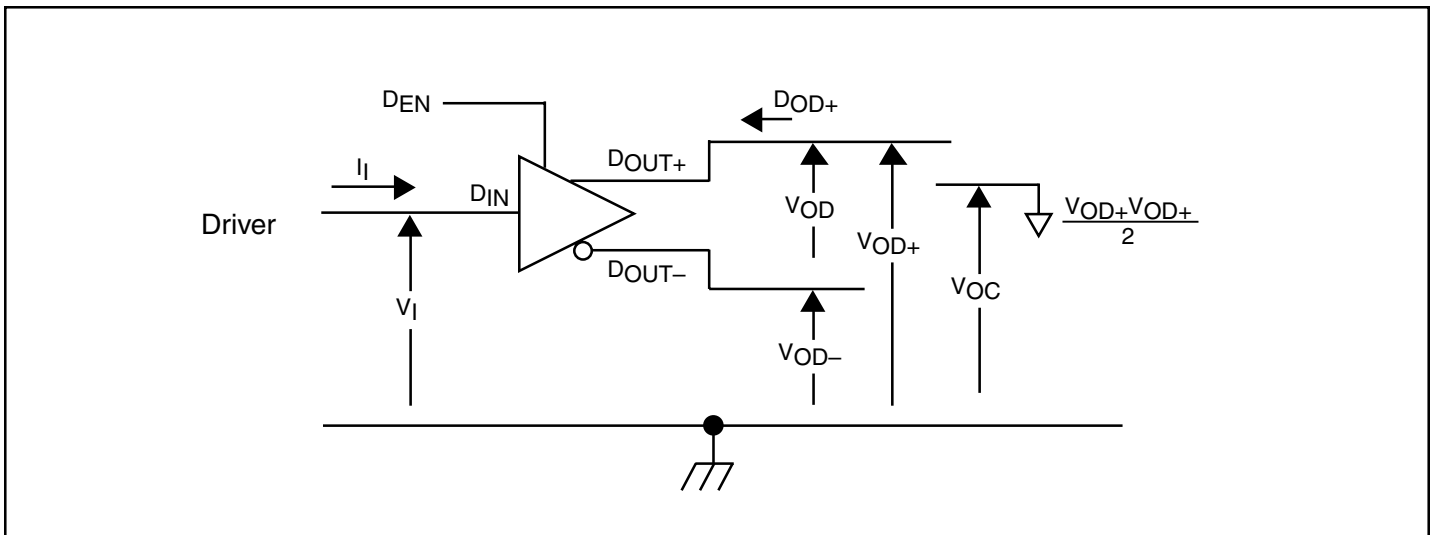
**Receiver Switching Characteristics** (over recommended operating conditions unless otherwise noted).

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 See Figure 6		1.9	2.9	ns
t <sub>PHL</sub>	Propagation delay time, high-to-low-level output			2.1	3.1	
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			50	100	ps
t <sub>r</sub>	Output signal rise time	See Figure 7		1.2	1.7	ns
t <sub>f</sub>	Output signal fall time			1.4	2.0	
t <sub>PZH</sub>	Propagation delay time, high-level-to-high-impedance output			1.5	2.7	
t <sub>PZL</sub>	Propagation delay time, low-level-to-low-impedance output			4.5	6.8	
t <sub>PHZ</sub>	Propagation delay time, high-impedance-to-high-level output			2.4	3.1	
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>: magnitude of 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

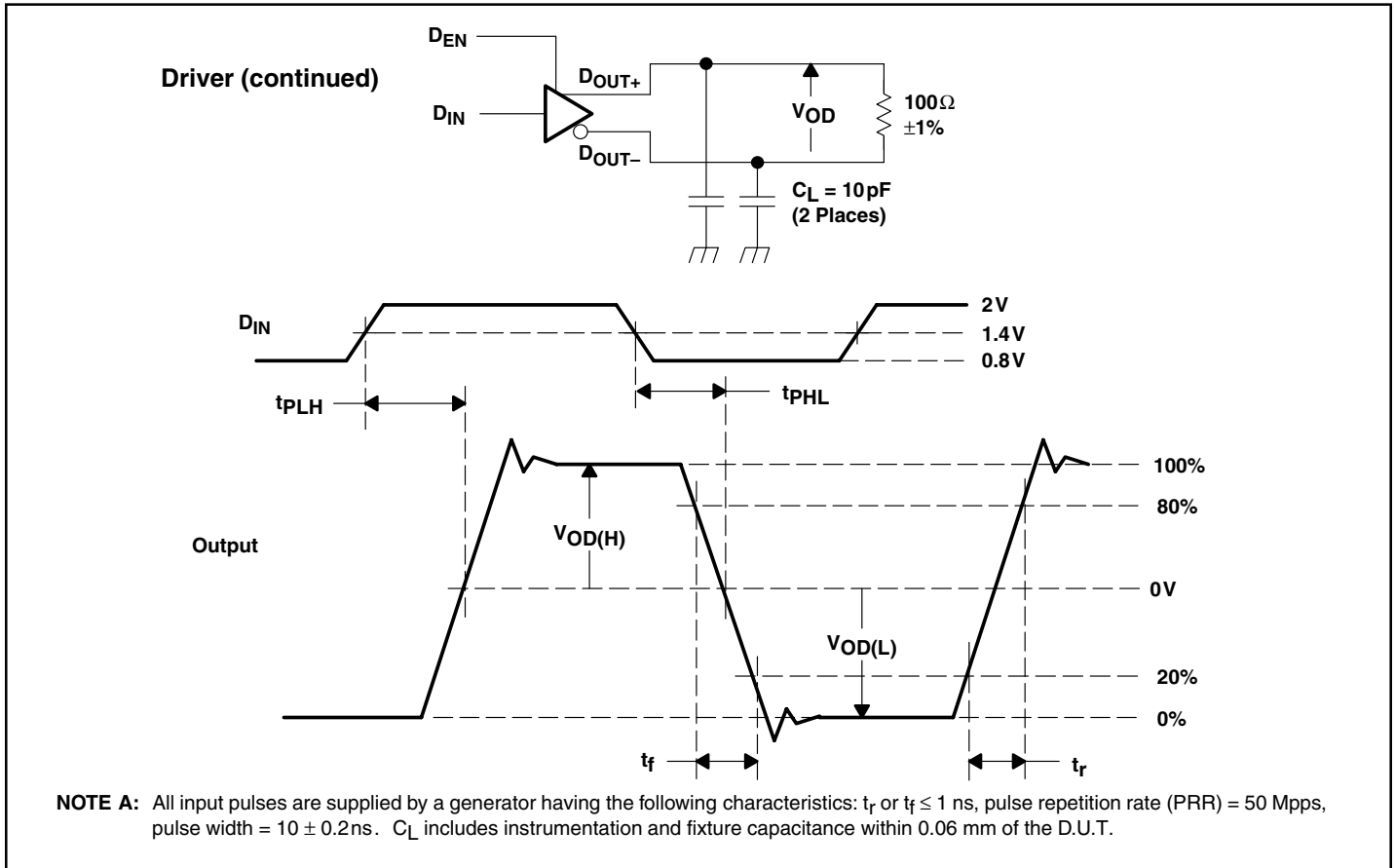


Figure 2. Test Circuit, Timing, and Voltage Definitions for the Differential Output Signal

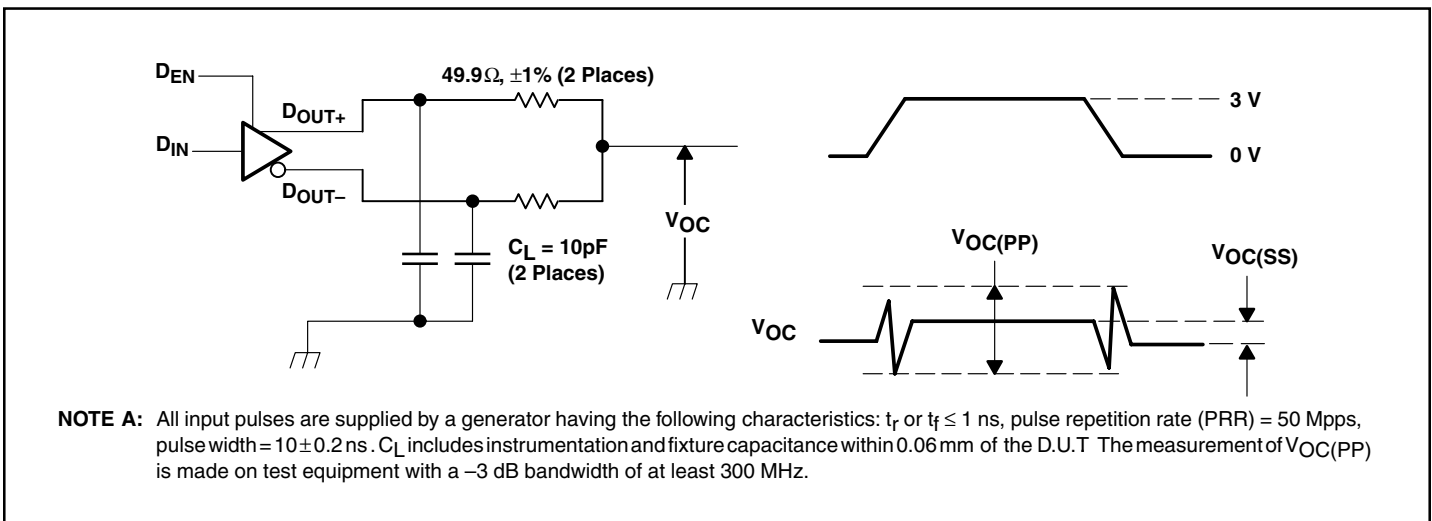


Figure 3. Test Circuit and Definitions for the Driver Common-Mode Output Voltage

Parameter Measurement Information

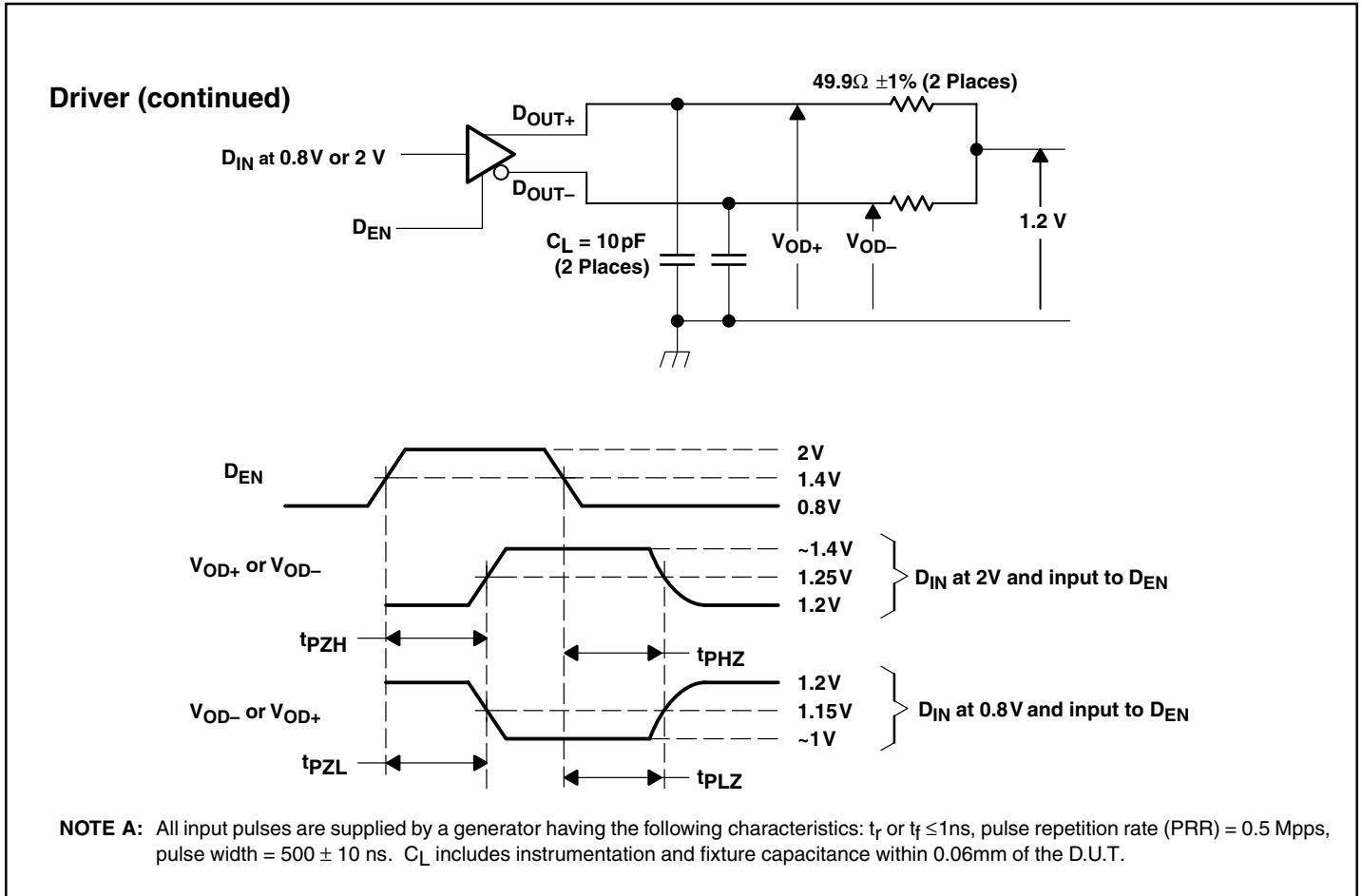


Figure 4. Enable and Disable Timing Circuit and Definitions

Parameter Measurement Information

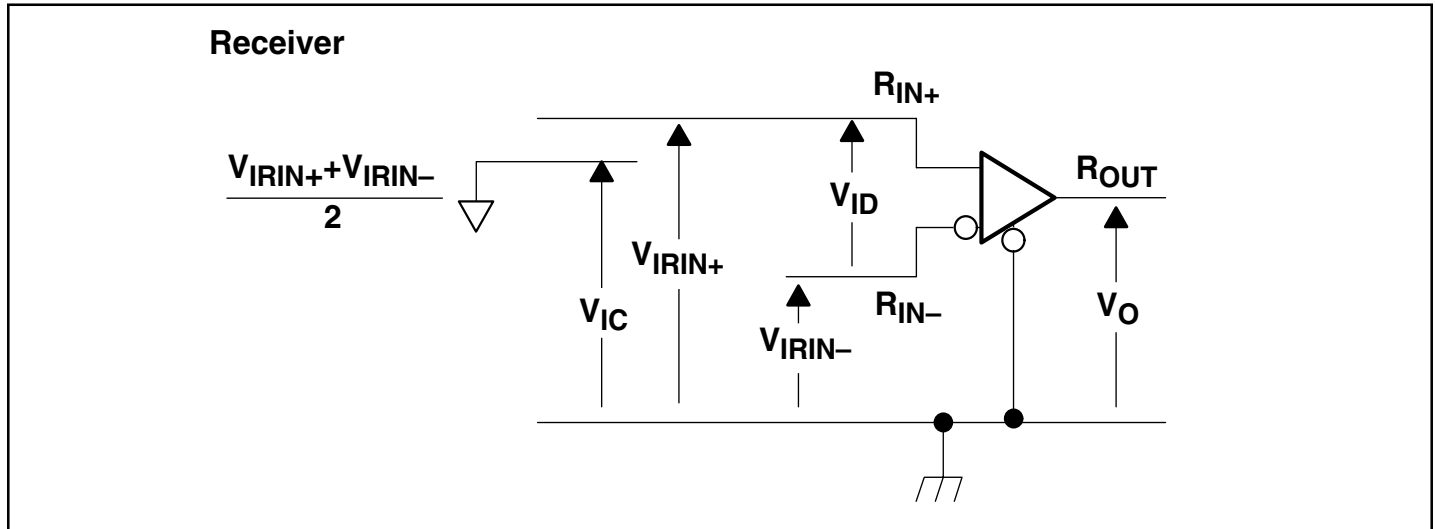


Figure 5. Receiver Voltage Definitions

Table 1. Receiver Minimum and Maximum Input Threshold Test Voltages

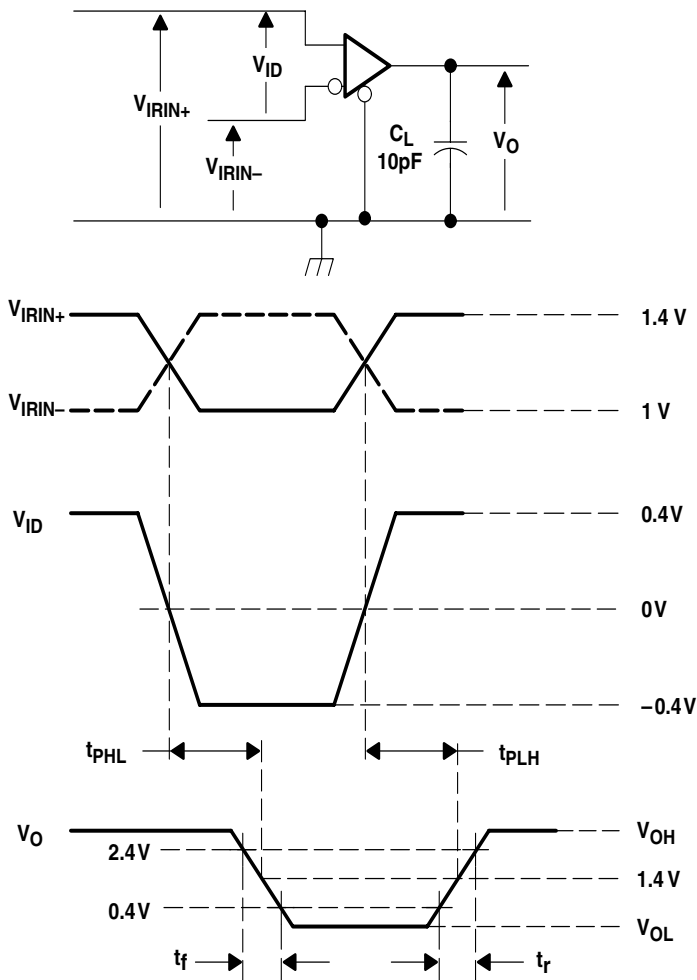
APPLIED VOLTAGES (V)		RESULTING DIFFERENTIAL INPUT VOLTAGE (mV)	RESULTING COMMON-MODE INPUT VOLTAGE (V)
$V_{IRIN+}$	$V_{IRIN-}$	$V_{ID}$	$V_{IC}$
1.225	1.175	50	1.2
1.175	1.225	-50	1.2
2.375	2.325	50	2.35
2.325	2.375	-50	2.35
0.1	0	50	0.05
0	0.05	-50	0.05
1.5	0.9	600	1.2
0.9	1.5	-600	1.2
2.4	1.8	600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



Parameter Measurement Information

PARAMETER MEASUREMENT INFORMATION

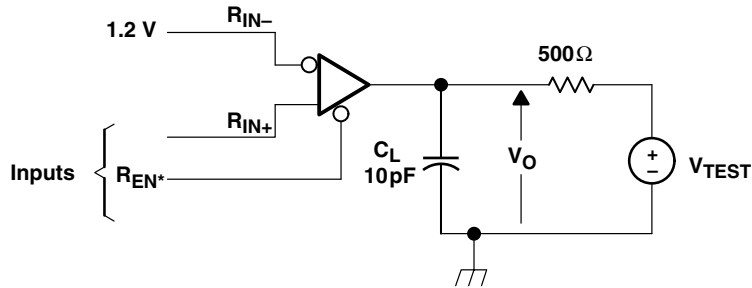
Receiver (continued)



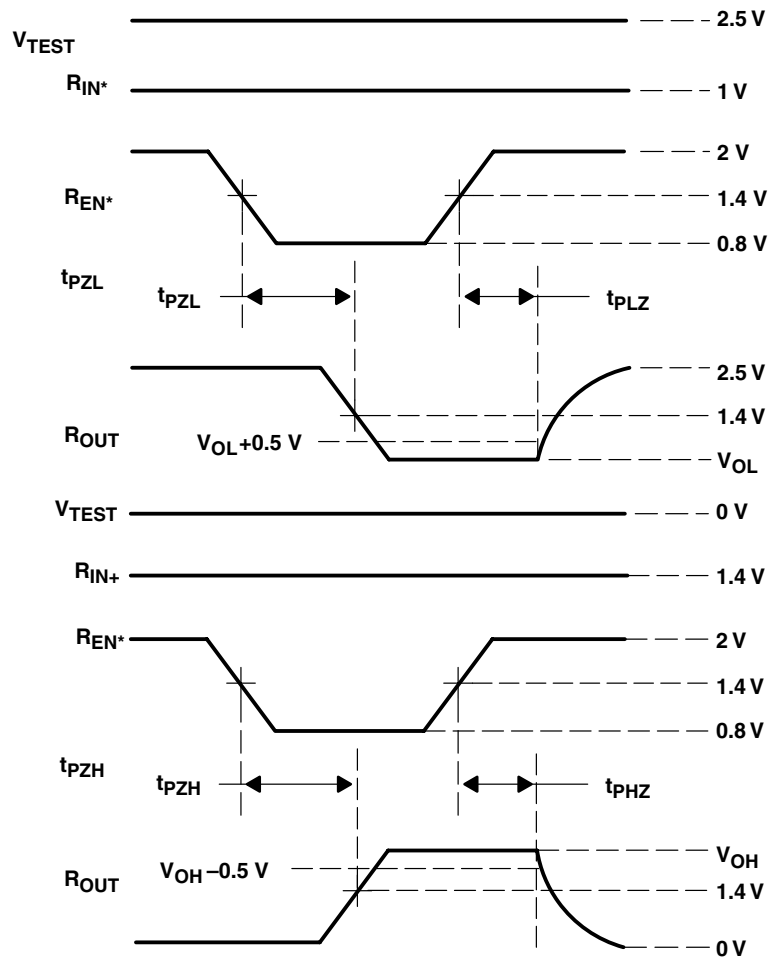
**NOTE A:** All input pulses are supplied by a generator having the following characteristics:  $t_f$  or  $t_r \leq 1$  ns, pulse repetition rate (PRR) = 50 Mpps, pulse width =  $10 \pm 0.2$  ns.  $C_L$  includes instrumentation and fixture capacitance within 0.06 m of the D.U.T.

Figure 6. Timing Test Circuit and Waveforms

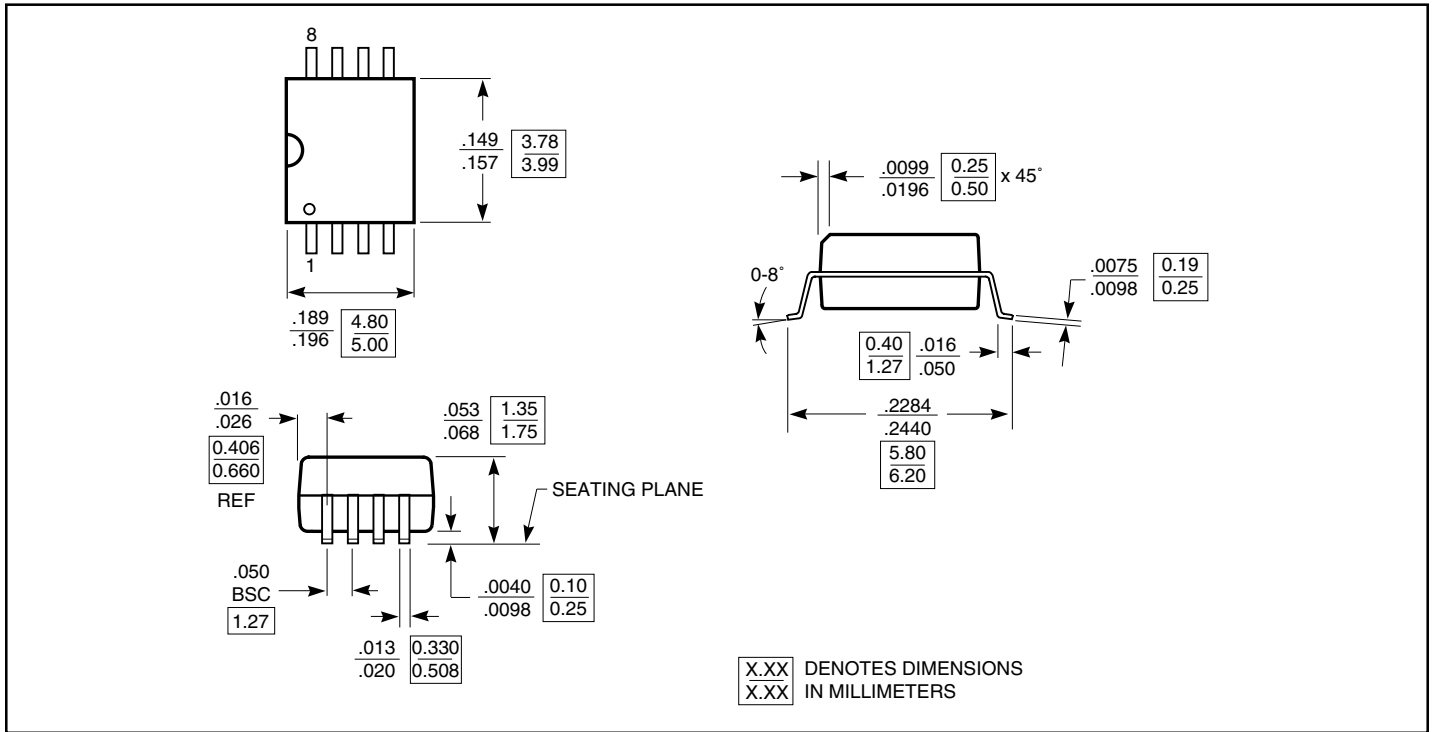
Figure 6. Timing Test Circuit and Waveforms

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


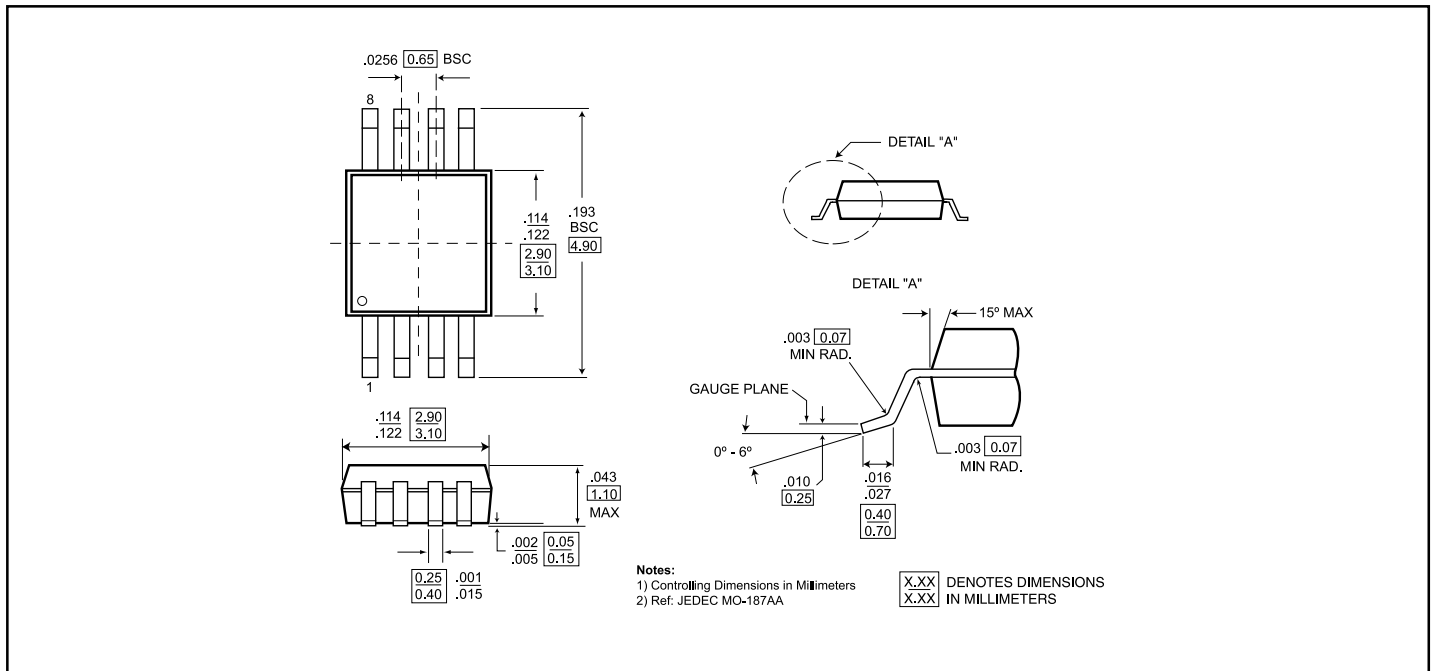
**NOTE A:** All input pulses are supplied by a generator having the following characteristics:  $t_r$  or  $t_f \leq 1\text{ns}$ , pulse repetition rate (PRR) = 0.5 Mpps, pulse wide =  $500 \pm 10\text{ns}$ .  $C_L$  includes instrumentation and fixture capacitance within 0.06m of the D.U.T.

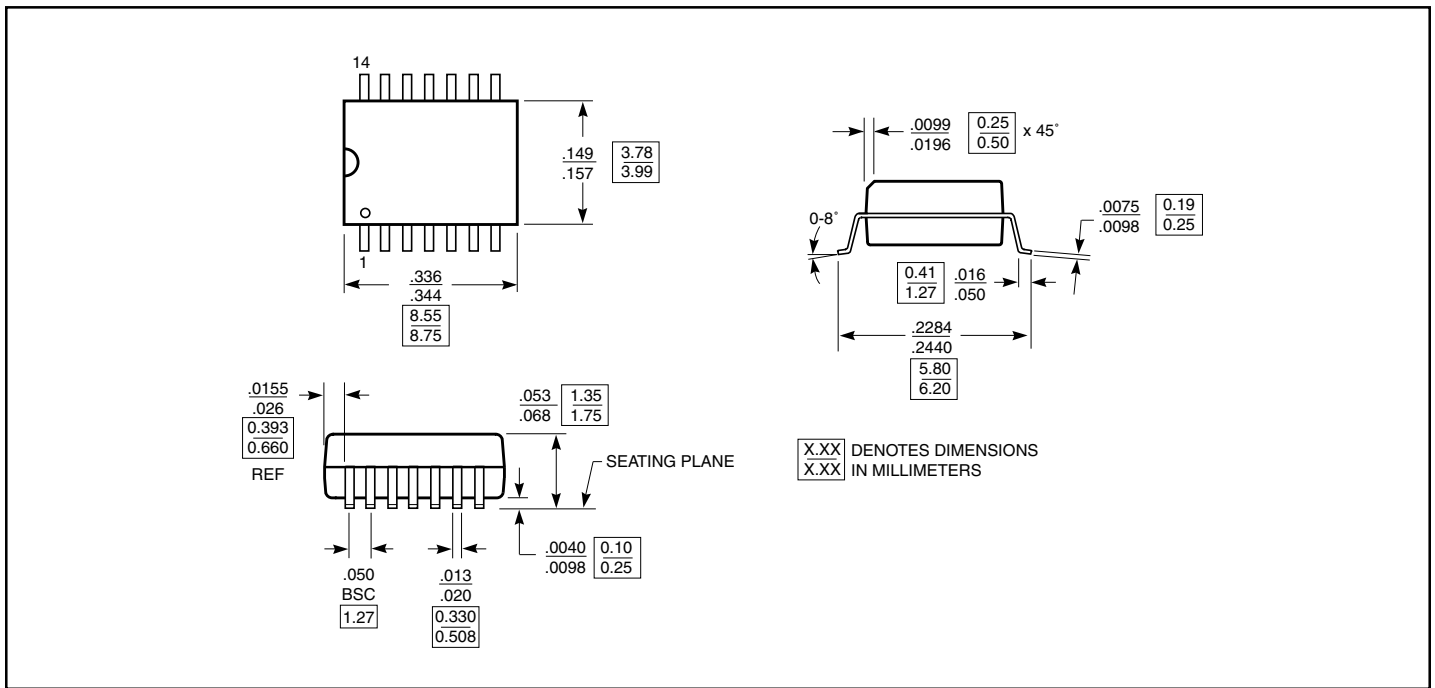
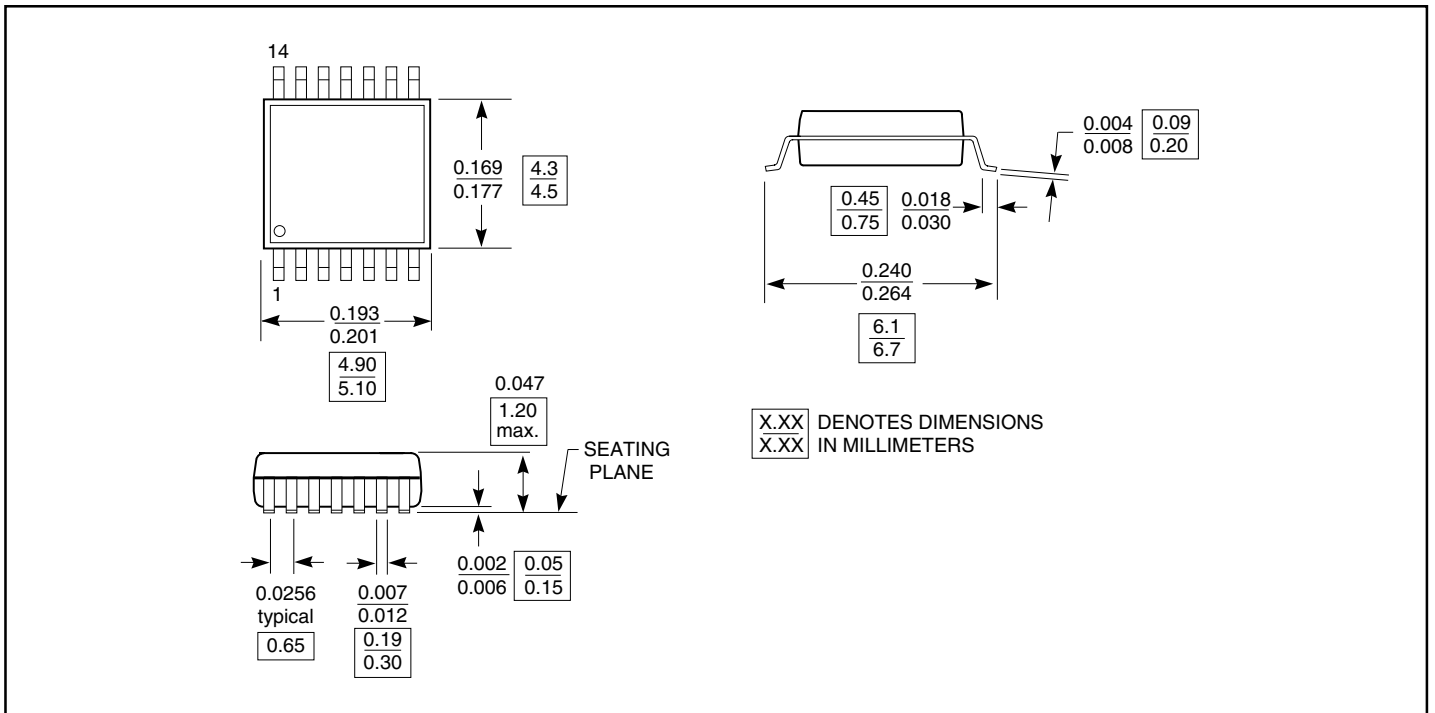

**Figure 7. Enable/Disable Time Test Circuit and Waveforms**

### 8-Pin SOIC W Package

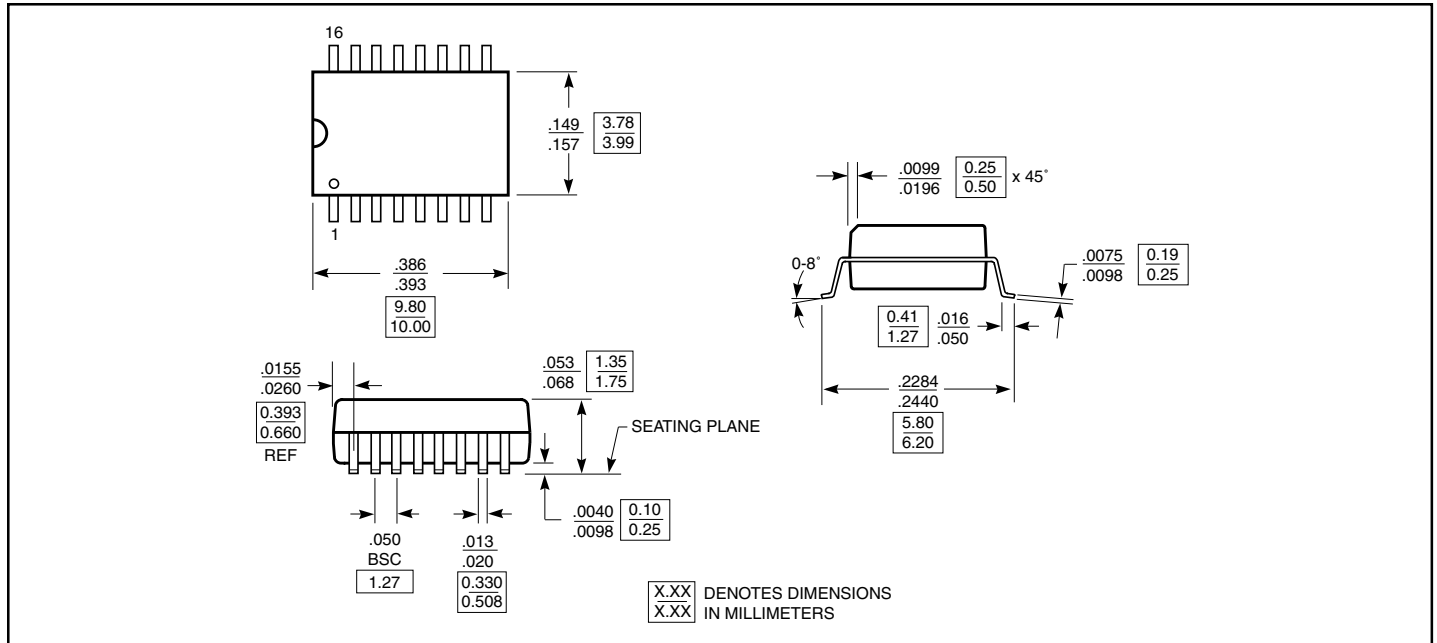


### 8-Pin Mini Small Outline U Package (MSOP)

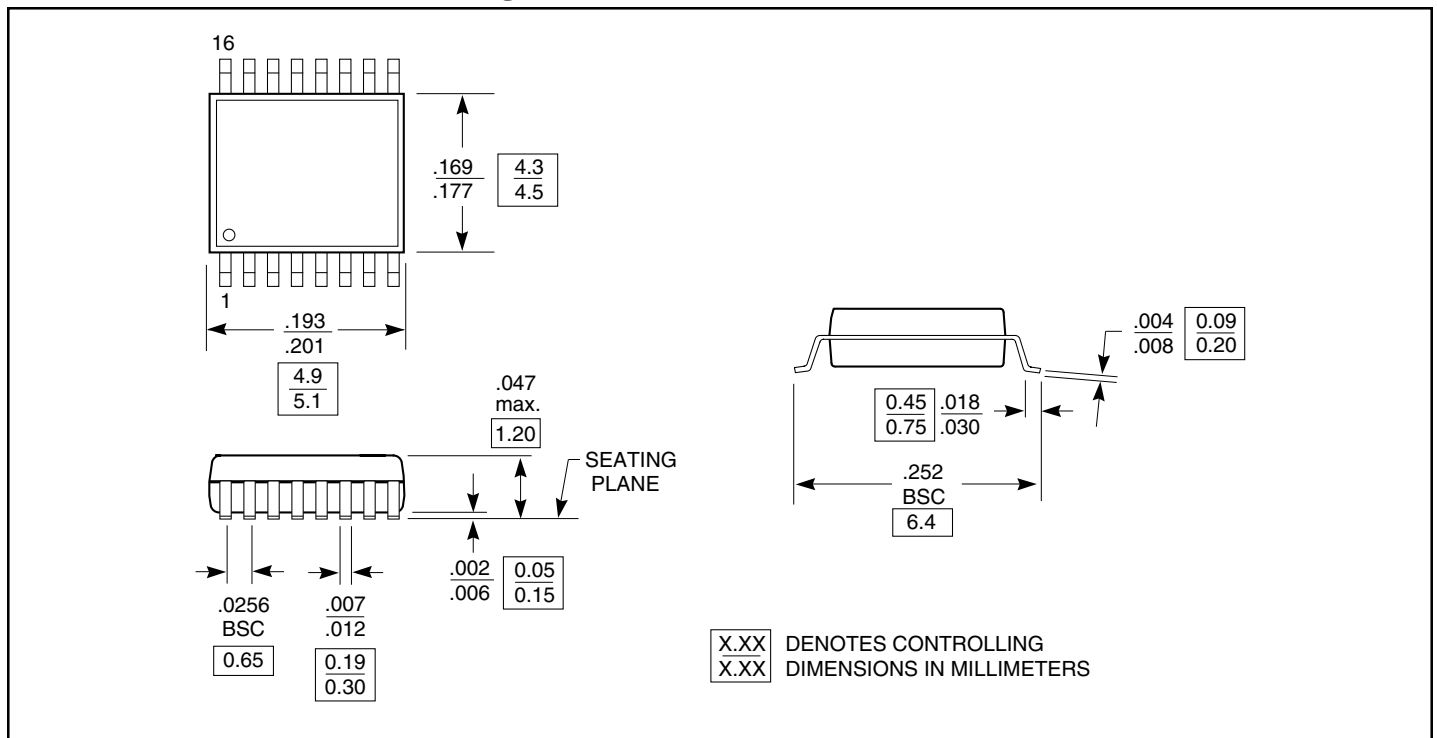


**14-Pin SOIC (150 Mil) W Package**

**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
PI90LV179W	8-SOIC	-40°C to +85°C
PI90LV180W	14-SOIC	-40°C to +85°C
PI90LV050W	16-SOIC	-40°C to +85°C
PI90LV051W	16-SOIC	-40°C to +85°C
PI90LV179U	8-MSOP	-40°C to +85°C
PI90LV180L	14-TSSOP	-40°C to +85°C
PI90LV050L	16-TSSOP	-40°C to +85°C
PI90LV051L	16-TSSOP	-40°C to +85°C