

## 3.3V Low Power Full-Duplex RS-485 Transceivers with 10Mbps Data Rate

### Description

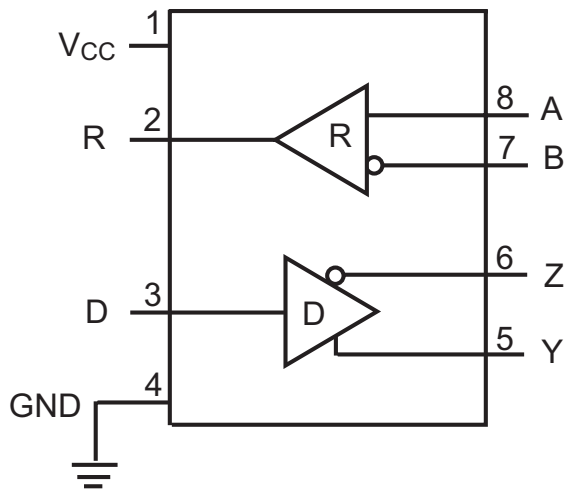
The [SP3490](#) and [SP3491](#) devices are 3.3V low power full-duplex transceivers that meet the specifications of the RS-485 and RS-422 serial protocols. These devices are pin-to-pin compatible with the MaxLinear SP490 and SP491 devices as well as popular industry standards. The SP3490 and SP3491 feature MaxLinear's BiCMOS process, allowing low power operation without sacrificing performance. The SP3490 and SP3491 meet the electrical specifications of the RS-485 and RS-422 serial protocols up to 10Mbps under load. The SP3491 is identical to the SP3490 with the addition of driver and receiver tri-state enable lines.

### FEATURES

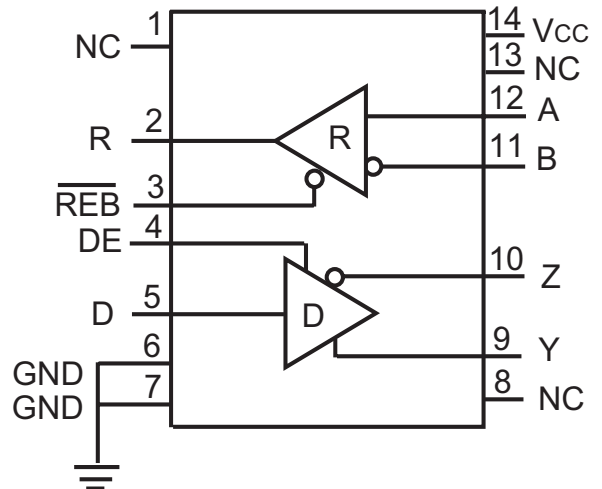
- Full-duplex RS-485 and RS-422 transceivers
- Operates from a single 3.3V supply
- Interoperable with 5.0V logic
- Driver/receiver tri-state enable lines (SP3491)
- -7V to 12V common-mode input voltage range
- $\pm 200\text{mV}$  receiver input sensitivity
- Allows up to 32 transceivers on the serial bus
- Compatibility with LTC490 and SN75179 (SP3490)
- Compatibility with LTC491 and SN75180 (SP3491)

Ordering Information - [Back Page](#)

### Block Diagrams



SP3490



SP3491

## Absolute Maximum Ratings

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

V<sub>CC</sub> ..... 6.0V

### Input Voltages

Logic ..... -0.3V to 6.0V

Drivers ..... -0.3V to 6.0V

Receivers..... ±14V

### Output Voltages

Drivers ..... ±14V

Receivers..... -0.3V to 6.0V

Storage Temperature ..... -65°C to +150°C

Maximum Junction Temperature, T<sub>J</sub> ..... 125°C

### Power Dissipation

8-pin NSOIC ..... 600mW

(derate 6.90mW/°C above +70°C)

14-pin NSOIC ..... 700mW

(derate 8.33mW/°C above +70°C)

## Operating Conditions

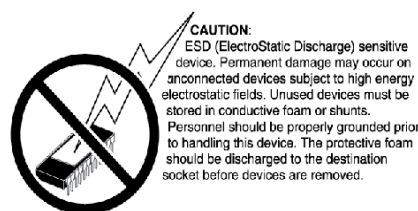
### Package Power Dissipation

8-pin NSOIC  $\Theta_{JA}$  ..... 128.4°C/W

14-pin NSOIC  $\Theta_{JA}$  ..... 88.2°C/W

## ESD Rating

Human Body Model (HBM)..... ±2kV



## Electrical Characteristics

T<sub>AMB</sub> = T<sub>MIN</sub> to T<sub>MAX</sub> and V<sub>CC</sub> = 3.3V ±5% unless otherwise noted.

PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
<b>SP3490 Driver DC Characteristics</b>					
Differential output voltage			V <sub>CC</sub>	V	Unloaded; R = ∞Ω ; Figure 1
Differential output voltage	2		V <sub>CC</sub>	V	With load; R = 50Ω (RS-422); Figure 1
Differential output voltage	1.5		V <sub>CC</sub>	V	With load; R = 27Ω (RS-485); Figure 1
Change in magnitude of driver differential output voltage for complimentary states			0.2	V	R = 27Ω or R = 50Ω; Figure 1
Driver common-mode output voltage			3	V	R = 27Ω or R = 50Ω; Figure 1
Input high voltage	2.0			V	
Input low voltage			0.8	V	
Input current			±10	μA	
Driver short circuit current V <sub>OUT</sub> = HIGH			±250	mA	-7V ≤ V <sub>O</sub> ≤ 12V; Figure 8
Driver short circuit current V <sub>OUT</sub> = LOW			±250	mA	-7V ≤ V <sub>O</sub> ≤ 12V; Figure 8
<b>SP3490 Driver AC Characteristics</b>					
Maximum data rate	10			Mbps	
Driver input to output, t <sub>PLH</sub>	20	40	60	ns	R = 27Ω, Figures 2 & 9
Driver input to output, t <sub>PHL</sub>	20	40	60	ns	R = 27Ω, Figures 2 & 9

## Electrical Characteristics (Continued)

$T_{AMB} = T_{MIN}$  to  $T_{MAX}$  and  $V_{CC} = 3.3V \pm 5\%$  unless otherwise noted.

PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
<b>SP3490 Driver AC Characteristics (Continued)</b>					
Differential driver skew		2		ns	$ t_{PHL}(Y) - t_{PLH}(Y) ,  t_{PHL}(Z) - t_{PLH}(Z) $ , Figures 2 and 9
Driver rise or fall time		5	20	ns	From 10%-90%; Figures 3 and 10
<b>SP3490 Receiver DC Characteristics</b>					
Differential input threshold	-0.2		0.2	Volts	$-7V \leq V_{CM} \leq 12V$
Input hysteresis		25		mV	$V_{CM} = 0V$
Output voltage HIGH	$V_{CC} - 0.4$			Volts	$V_{ID} = 200mV, I_O = -1.5mA$
Output voltage LOW			0.4	Volts	$V_{ID} = -200mV, I_O = 2.5mA$
Input resistance	12	15		k $\Omega$	$-7V \leq V_{CM} \leq 12V$
Input current (A, B); $V_{IN} = 12V$			1.0	mA	$V_{IN} = 12V$
Input current (A, B); $V_{IN} = -7V$			-0.8	mA	$V_{IN} = -7V$
Short circuit current			60	mA	$0V \leq V_O \leq V_{CC}$
<b>SP3490 Receiver AC Characteristics</b>					
Maximum data rate	10			Mbps	
Receiver input to output, $t_{PLH}$	40	70	120	ns	Figures 6 and 12
Receiver input to output, $t_{PLH}$			85	ns	$T_{AMB} = 25^\circ C, V_{CC} = 3.3V$ , Figures 6 and 12
Receiver input to output, $t_{PHL}$	40	70	120	ns	Figures 6 and 12
Receiver input to output, $t_{PHL}$			85	ns	$T_{AMB} = 25^\circ C, V_{CC} = 3.3V$ , Figures 6 and 12
Differential receiver skew		4		ns	$ t_{PHL}(A) - t_{PLH}(A) ,  t_{PHL}(B) - t_{PLH}(B) $ , Figures 6 and 12
<b>Power Requirements</b>					
Supply Voltage	3.0	3.3	3.6	V	
Supply Current		1000	2000	$\mu A$	$D = 0V$ or $V_{CC}$
ESD Protection for D, R, A, B, Y and Z pins		$\pm 2$		kV	Human Body Model

## Electrical Characteristics, Continued

$T_{AMB} = T_{MIN}$  to  $T_{MAX}$  and  $V_{CC} = 3.3V \pm 5\%$  unless otherwise noted

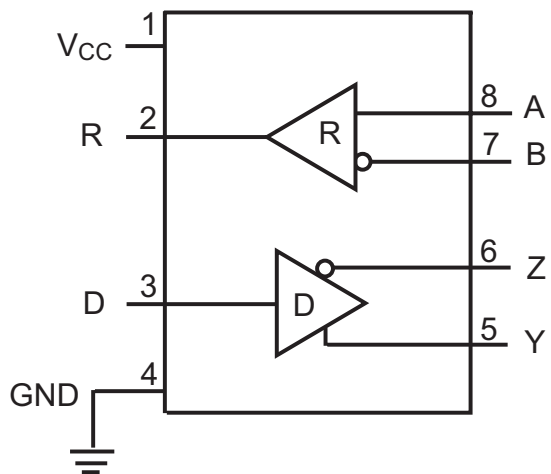
PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
<b>SP3491 Driver DC Characteristics</b>					
Differential output voltage			$V_{CC}$	V	Unloaded; $R = \infty\Omega$ ; Figure 1
Differential output voltage	2		$V_{CC}$	V	With load; $R = 50\Omega$ (RS-422); Figure 1
Differential output voltage	1.5		$V_{CC}$	V	With load; $R = 27\Omega$ (RS-485); Figure 1
Change in magnitude of driver differential output voltage for complimentary states			0.2	V	$R = 27\Omega$ or $R = 50\Omega$ ; Figure 1
Driver common-mode output voltage			3	V	$R = 27\Omega$ or $R = 50\Omega$ ; Figure 1
Input high voltage	2.0			V	Applies to DE, D, $\overline{REB}$
Input low voltage			0.8	V	Applies to DE, D, $\overline{REB}$
Input current			$\pm 10$	$\mu A$	Applies to DE, D, $\overline{REB}$
Driver short circuit current $V_{OUT} = HIGH$			$\pm 250$	mA	$-7V \leq V_O \leq 12V$ ; Figure 8
Driver short circuit current $V_{OUT} = LOW$			$\pm 250$	mA	$-7V \leq V_O \leq 12V$ ; Figure 8
<b>SP3491 Driver AC Characteristics</b>					
Maximum data rate	10			Mbps	
Driver input to output, $t_{PLH}$	20	40	60	ns	Figures 2 & 9
Driver input to output, $t_{PHL}$	20	40	60	ns	Figures 2 & 9
Differential driver skew		2		ns	$ t_{PHL}(Y) - t_{PLH}(Y) ,  t_{PHL}(Z) - t_{PLH}(Z) $ , Figures 2 and 9
Driver rise or fall time		5	20	ns	From 10%-90%; Figures 3 and 10
Driver enable to output HIGH		52	120	ns	Figures 4 and 11
Driver enable to output LOW		60	120	ns	Figures 5 and 11
Driver disable from LOW		40	120	ns	Figures 5 and 11
Driver disable from HIGH		60	120	ns	Figures 4 and 11

## Electrical Characteristics, Continued

$T_{AMB} = T_{MIN}$  to  $T_{MAX}$  and  $V_{CC} = 3.3V \pm 5\%$  unless otherwise noted

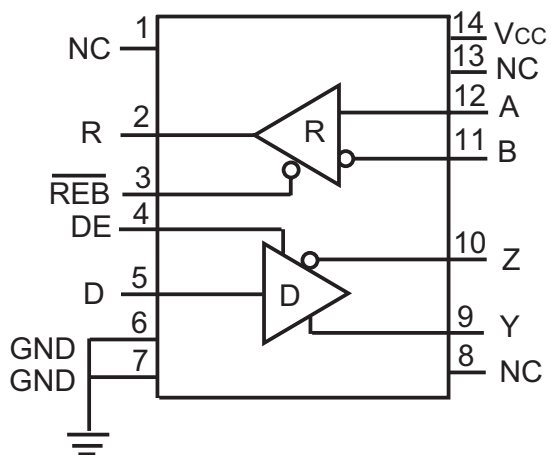
PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
<b>SP3491 Receiver DC Characteristics</b>					
Differential input threshold	-0.2		0.2	Volts	$-7V \leq V_{CM} \leq 12V$
Input hysteresis		25		mV	$V_{CM} = 0V$
Output voltage HIGH	$V_{CC}-0.4$			Volts	$V_{ID} = 200mV, I_O = -1.5mA$
Output voltage LOW			0.4	Volts	$V_{ID} = -200mV, I_O = 2.5mA$
Three-State ( High Impedance) Output Current			$\pm 1$	$\mu A$	$0V \leq V_O \leq V_{CC}; \overline{REB} = V_{CC}$
Input resistance	12	15		k $\Omega$	$-7V \leq V_{CM} \leq 12V$
Input current (A, B); $V_{IN} = 12V$			1.0	mA	$DE = 0V, V_{CC} = 0V$ or $3.6V, V_{IN} = 12V$
Input current (A, B); $V_{IN} = -7V$			-0.8	mA	$DE = 0V, V_{CC} = 0V$ or $3.6V, V_{IN} = -7V$
Short circuit current			60	mA	$0V \leq V_O \leq V_{CC}$
<b>SP3491 Receiver AC Characteristics</b>					
Maximum data rate	10			Mbps	$\overline{REB} = 0V, DE = 0V$
Receiver input to output, $t_{PLH}$	40	70	120	ns	Figures 6 and 12
Receiver input to output, $t_{PLH}$			85	ns	$T_{AMB} = 25^\circ C, V_{CC} = 3.3V$ , Figures 6 and 12
Receiver input to output, $t_{PHL}$	40	70	120	ns	Figures 6 and 12
Receiver input to output, $t_{PHL}$			85	ns	$T_{AMB} = 25^\circ C, V_{CC} = 3.3V$ , Figures 6 and 12
Differential receiver skew		4		ns	$ t_{PHL}(A) - t_{PLH}(A) ,  t_{PHL}(B) - t_{PLH}(B) $ , Figures 6 and 12
Receiver enable to output LOW		65	150	ns	Figures 7 and 13; $S_1$ Closed, $S_2$ open
Receiver enable to output HIGH		65	150	ns	Figures 7 and 13; $S_2$ Closed, $S_1$ open
Receiver disable from LOW		65	200	ns	Figures 7 and 13; $S_1$ Closed, $S_2$ open
Receiver disable from HIGH		65	200	ns	Figures 7 and 13; $S_2$ Closed, $S_1$ open
<b>Power Requirements</b>					
Supply voltage	3.0		3.6	V	
Supply current		1000	2000	$\mu A$	$\overline{REB}, D = 0V$ or $V_{CC}; DE = V_{CC}$
Supply current		800	1500	$\mu A$	$DE = 0V$
ESD protection for R, D, DE, $\overline{REB}$ , A, B, Y and Z pins		$\pm 2$		kV	Human Body Model

Pin Functions



SP3490  
Pinout (Top View)

Pin Number	Pin Name	Description
1	V <sub>CC</sub>	Positive supply 3.00V < V <sub>CC</sub> < 3.60V
2	R	Receiver output
3	D	Driver Input
4	GND	Ground connection
5	Y	Non-inverting driver output
6	Z	Inverting driver output
7	B	Inverting receiver Input
8	A	Non-inverting receiver input



SP3491  
Pinout (Top View)

Pin Number	Pin Name	Description
1	NC	No connect <sup>(1)</sup>
2	R	Receiver output
3	$\overline{\text{REB}}$	Receiver output enable active LOW
4	DE	Driver output enable active HIGH
5	D	Driver input
6	GND	Ground connection
7	GND	Ground connection
8	NC	No connect <sup>(1)</sup>
9	Y	Non-inverting driver output
10	Z	Inverting driver output
11	B	Inverting receiver input
12	A	Non-Inverting receiver input
13	NC	No connect <sup>(1)</sup>
14	V <sub>CC</sub>	Positive supply 3.00V < V <sub>CC</sub> < 3.60V

Note:  
1. Not internally bonded, can be connected to V<sub>CC</sub> without harm.

Test Circuits

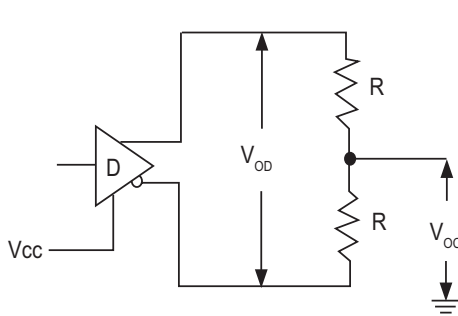


Figure 1: Driver DC Test Load Circuit

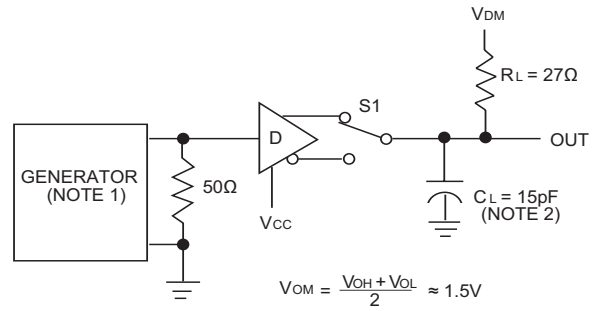


Figure 2: Driver Propagation Delay Test Circuit

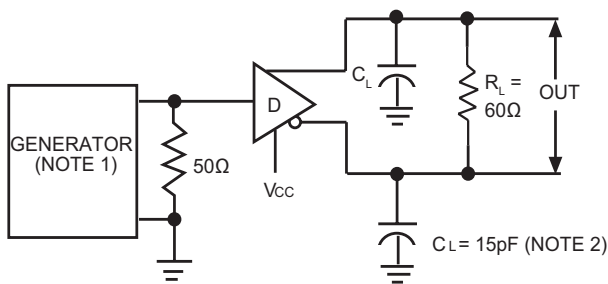


Figure 3: Driver Differential Output Delay and Transition Time Circuit.

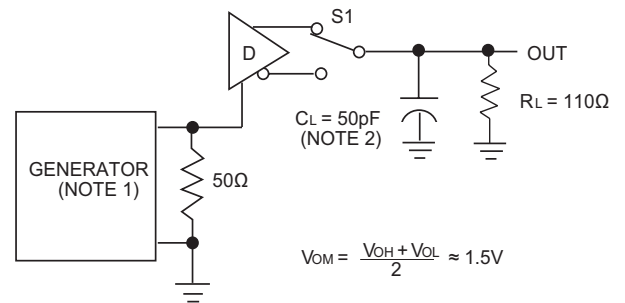


Figure 4: Driver Enable and Disable Timing Circuit, Output High

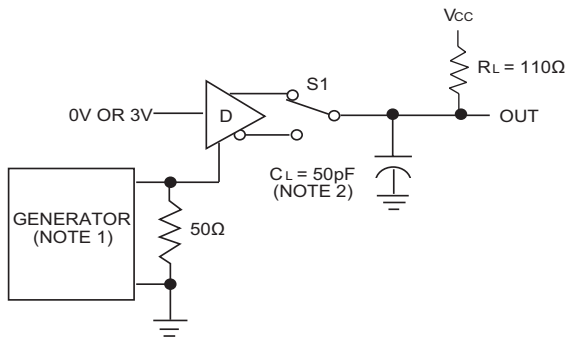


Figure 5: Driver Enable and Disable Timing Circuit, Output Low

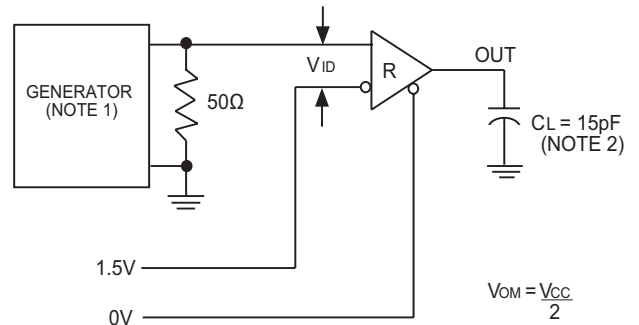


Figure 6: Receiver Propagation Delay Test Circuit

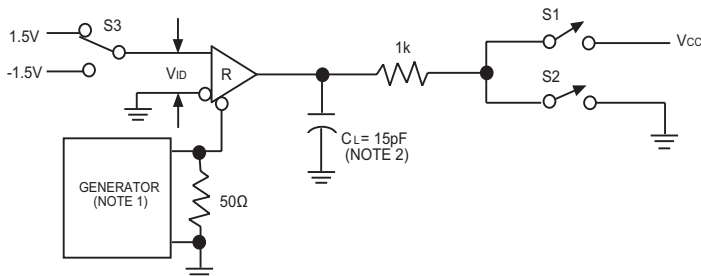


Figure 7: Receiver Enable and Disable Timing Circuit

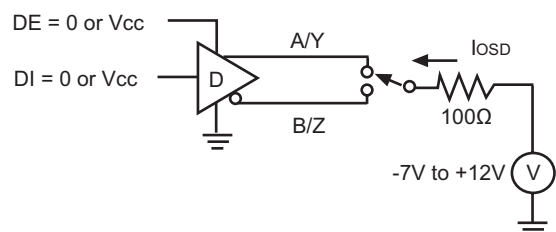


Figure 8: Driver Short Circuit Current Limit Test

## Switching Waveforms

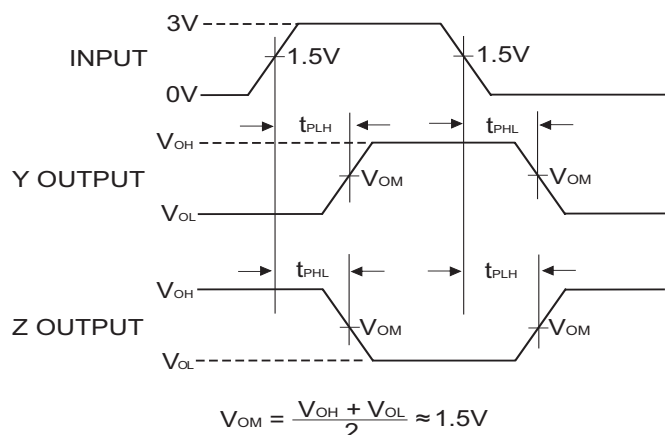


Figure 9: Driver Propagation Delay Waveforms

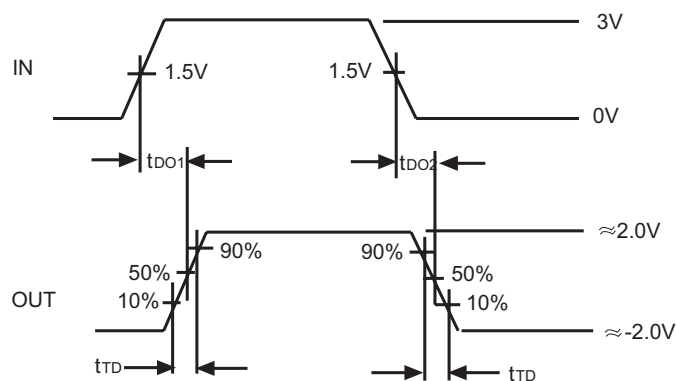


Figure 10: Driver Differential Output Delay and Transition Time Waveforms

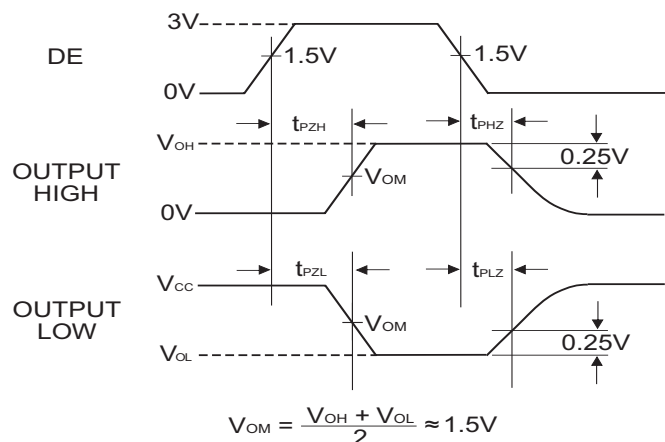


Figure 11: Driver Enable and Disable Timing Waveforms

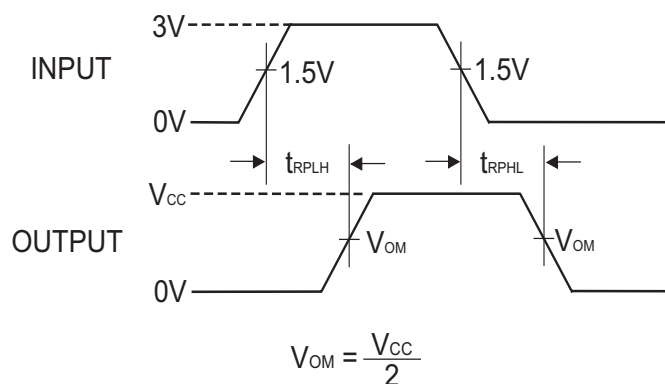


Figure 12: Receiver Propagation Delay Waveforms

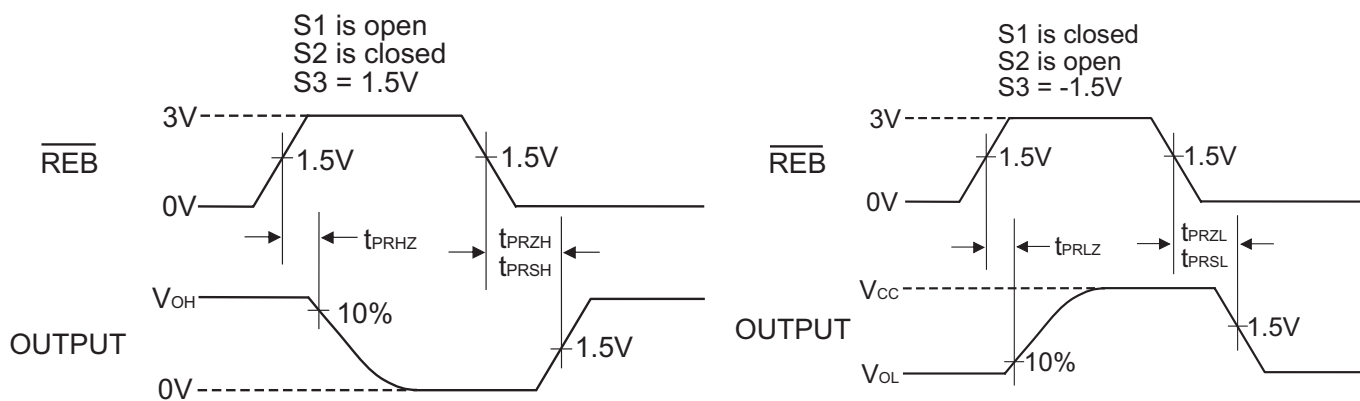


Figure 13: Receiver Enable and Disable Waveforms

### NOTES

1. The input pulse is supplied by a generator with the following characteristics:  
 PRR = 250kHz, 50% duty cycle,  $t_r < 6.0ns$ ,  $Z_0 = 50\Omega$ .
2.  $C_L$  includes probe and stray capacitance.



## Description

The SP3490 and SP3491 are two members in the family of 3.3V low power full-duplex transceivers that meet the electrical specifications of the RS-485 and RS-422 serial protocols. These devices are pin-to-pin compatible with the MaxLinear SP490 and SP491 devices as well as popular industry standards. The SP3490 and SP3491 feature MaxLinear's BiCMOS process allowing low power operation without sacrificing performance.

The RS-485 standard is ideal for multi-drop applications and for long-distance interfaces. RS-485 allows up to 32 drivers and 32 receivers to be connected to a data bus, making it an ideal choice for multi-drop applications. Since the cabling can be as long as 4,000 feet, RS-485 transceivers are equipped with a wide (-7V to 12V) common mode range to accommodate ground potential differences. Because RS-485 is a differential interface, data is virtually immune to noise in the transmission line.

## Drivers

The drivers for both the SP3490 and SP3491 have differential outputs. The typical voltage output swing with no load will be 0 volts to  $V_{cc}$ . With worst case loading of  $54\Omega$  across the differential outputs, the drivers can maintain greater than 1.5V voltage levels.

The driver of the SP3491 has a driver enable control line which is active HIGH. A logic HIGH on DE (pin 4) of the SP3491 will enable the differential driver outputs. A logic LOW on the DE (pin 4) will tri-state the driver outputs. The SP3490 does not have a driver enable.

## Receivers

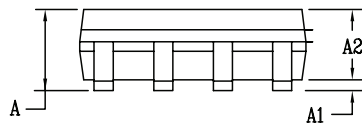
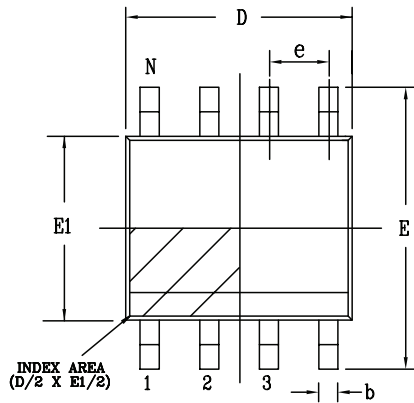
The receivers of the SP3490 and SP3491 have differential inputs with an input sensitivity of  $\pm 200\text{mV}$ . Input impedance of the receivers is typically  $15\text{k}\Omega$  ( $12\text{k}\Omega$  minimum). A wide common mode range of -7V to 12V allows for large ground potential differences between systems. The receivers for both the SP3490 and SP3491 are equipped with a fail-safe feature that guarantees the receiver output will be in a HIGH state when the input is left unconnected.

The receiver of the SP3491 has an enable control line which is active LOW. A logic LOW on  $\overline{\text{REB}}$  (pin 3) of the SP3491 will enable the differential receiver. A logic HIGH on  $\overline{\text{REB}}$  (pin 3) of the SP3491 will tri-state the receiver.

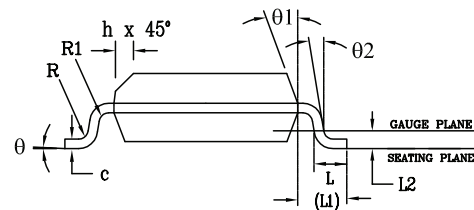
Mechanical Dimensions

NSOIC8

Top View



Side View



Front View

PACKAGE OUTLINE NSOIC .150" BODY JEDEC MS-012 VARIATION AA						
SYMBOLS	COMMON DIMENSIONS IN MM (Control Unit)			COMMON DIMENSIONS IN INCH (Reference Unit)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.35	—	1.75	0.053	—	0.069
A1	0.10	—	0.25	0.004	—	0.010
A2	1.25	—	1.65	0.049	—	0.065
b	0.31	—	0.51	0.012	—	0.020
c	0.17	—	0.25	0.007	—	0.010
E	6.00 BSC			0.236 BSC		
E1	3.90 BSC			0.154 BSC		
e	1.27 BSC			0.050 BSC		
h	0.25	—	0.50	0.010	—	0.020
L	0.40	—	1.27	0.016	—	0.050
L1	1.04 REF			0.041 REF		
L2	0.25 BSC			0.010 BSC		
R	0.07	—	—	0.003	—	—
R1	0.07	—	—	0.003	—	—
q	0°	—	8°	0°	—	8°
q1	5°	—	15°	5°	—	15°
q2	0°	—	—	0°	—	—
D	4.90 BSC			0.193 BSC		
N	8			8		

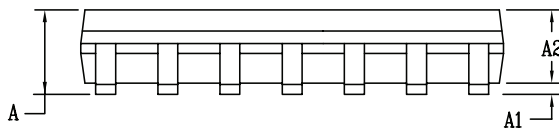
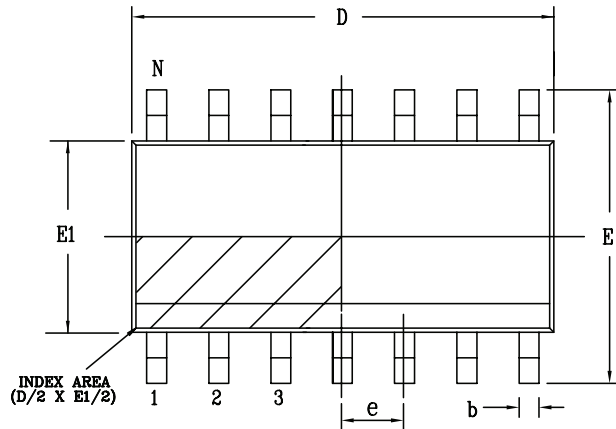
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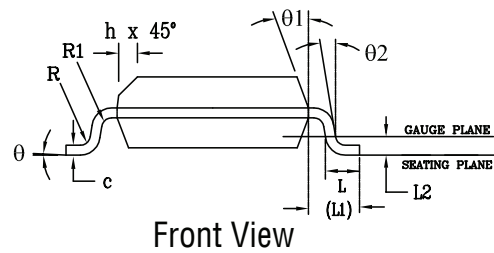
Mechanical Dimensions

NSOIC14

Top View



Side View



Front View

PACKAGE OUTLINE NSOIC .150" BODY JEDEC MS-012 VARIATION AB						
SYMBOLS	COMMON DIMENSIONS IN MM (Control Unit)			COMMON DIMENSIONS IN INCH (Reference Unit)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.35	—	1.75	0.053	—	0.069
A1	0.10	—	0.25	0.004	—	0.010
A2	1.25	—	1.65	0.049	—	0.065
b	0.31	—	0.51	0.012	—	0.020
c	0.17	—	0.25	0.007	—	0.010
E	6.00 BSC			0.236 BSC		
E1	3.90 BSC			0.154 BSC		
e	1.27 BSC			0.050 BSC		
h	0.25	—	0.50	0.010	—	0.020
L	0.40	—	1.27	0.016	—	0.050
L1	1.04 REF			0.041 REF		
L2	0.25 BSC			0.010 BSC		
R	0.07	—	—	0.003	—	—
R1	0.07	—	—	0.003	—	—
q	0°	—	8°	0°	—	8°
q1	5°	—	15°	5°	—	15°
q2	0°	—	—	0°	—	—
D	8.65 BSC			0.341 BSC		
N	14					

Drawing No: POD-00000109

Revision: A