# SP490 / SP491

## Full-Duplex RS-485 Transceivers

### Description

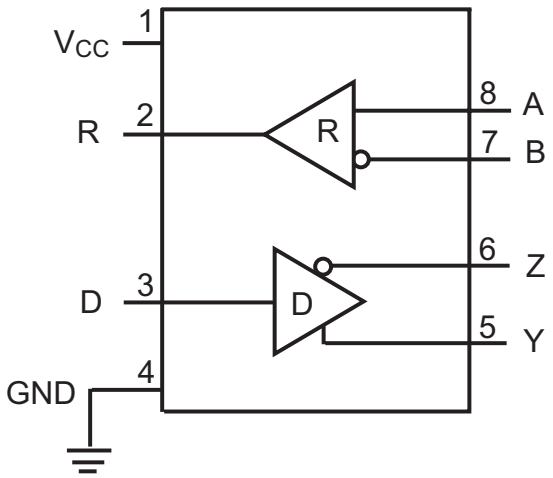
The SP490 is a low power differential line driver/receiver meeting RS-485 and RS-422 standards up to 5Mbps. The SP491 is identical to the SP490 with the addition of driver and receiver tri-state enable lines. Both products feature ±200mV receiver input sensitivity, over wide common mode range. The SP490 is available in 8-pin NSOIC packages for operation over the commercial temperature range. The SP491 is available in 14-pin NSOIC packages for operation over the commercial and industrial temperature ranges.

**FEATURES**

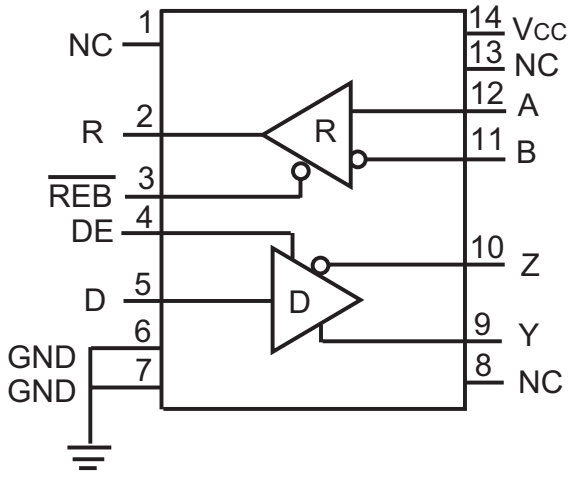
- 5V only
- Low power BiCMOS
- Driver/receiver enable (SP491)
- RS-485 and RS-422 drivers/receivers
- Pin compatible with LTC490 and SN75179 (SP490)
- Pin compatible with LTC491 and SN75180 (SP491)

Ordering Information - Back Page

### Block Diagrams




SP490




SP491

## Absolute Maximum Ratings (SP490)

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.

$V_{CC}$.....7.0V

Input Voltages

Drivers.....-0.5V to ($V_{CC}$+0.5V)

Receivers.....±14V

Output Voltages

Drivers.....±14V

Receivers.....-0.5V to ($V_{CC}$+0.5V)

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

Power Dissipation.....1000mW

## Electrical Characteristics

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

| PARAMETERS | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|---|---|---|---|---|---|
| **SP490 Driver DC Characteristics** | | | | | |
| Differential output voltage | | | $V_{CC}$ | V | Unloaded; R = ∞Ω ; Figure 1 |
| Differential output voltage | 2 | | $V_{CC}$ | V | With load; R = 50Ω (RS-422); Figure 1 |
| Differential output voltage | 1.5 | | $V_{CC}$ | 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 | Applies to D |
| Input low voltage | | | 0.8 | V | Applies to D |
| Input current | | | ±10 | µA | Applies to D |
| Driver short circuit current $V_{OUT}$ = HIGH | | | ±250 | mA | -7V ≤ $V_O$ ≤ 12V |
| Driver short circuit current $V_{OUT}$ = LOW | | | ±250 | mA | -7V ≤ $V_O$ ≤ 12V |
| **SP490 Driver AC Characteristics** | | | | | |
| Maximum data rate | 5 | | | Mbps | |
| Driver input to output, $t_{PLH}$ | | 30 | 60 | ns | $R_{DIFF}$ = 54Ω, $C_{L1}$ = $C_{L2}$ = 100pF; Figures 3 & 5 |
| Driver input to output, $t_{PHL}$ | | 30 | 60 | ns | $R_{DIFF}$ = 54Ω, $C_{L1}$ = $C_{L2}$ = 100pF; Figures 3 & 5 |
| Driver skew | | 5 | | ns | $t_{SKEW}$ = \| $t_{DPLH}$ - $t_{DPHL}$ \|; Figures 3 & 5 |
| Driver rise or fall time | | 15 | 40 | ns | From 10% to 90%; $R_{DIFF}$ = 54Ω, $C_{L1}$ = $C_{L2}$ = 100pF; Figures 3 & 5 |

## Electrical Characteristics (Continued)

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

| PARAMETERS | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|---|---|---|---|---|---|
| **SP490 Receiver DC Characteristics** | | | | | |
| Differential input threshold | -0.2 | | 0.2 | V | -7V ≤ $V_{CM}$ ≤ 12V |
| Input hysteresis | | 70 | | mV | $V_{CM}$ = 0V |
| Output voltage HIGH | 3.5 | | | V | $V_{ID}$ = 200mV, $I_O$ = -4mA |
| Output voltage LOW | | | 0.4 | V | $V_{ID}$ = -200mV, $I_O$ = 4mA |
| Input resistance | 12 | 15 | | kΩ | -7V ≤ $V_{CM}$ ≤ 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 | | | 85 | mA | 0V ≤ $V_O$ ≤ $V_{CC}$ |
| **SP490 Receiver AC Characteristics** | | | | | |
| Maximum data rate | 5 | | | Mbps | |
| Receiver input to output, $t_{PLH}$ | | 45 | 150 | ns | $R_{DIFF}$ = 54Ω, $C_{L1}$ = $C_{L2}$ = 100pF; Figures 3 and 7 |
| Receiver input to output, $t_{PHL}$ | | 45 | 150 | ns | $R_{DIFF}$ = 54Ω, $C_{L1}$ = $C_{L2}$ = 100pF; Figures 3 and 7 |
| Differential receiver skew, $\|t_{PLH} - t_{PHL}\|$ | | 13 | | ns | $R_{DIFF}$ = 54Ω, $C_{L1}$ = $C_{L2}$ = 100pF; Figures 3 and 7 |
| **Power Requirements** | | | | | |
| Supply Voltage | 4.75 | | 5.25 | V | |
| Supply Current | | 900 | | µA | |
| **SP490 Environmental and Mechanical** | | | | | |
| Operating Temperture | | | | | |
| Commercial (_C_) | 0 | | 70 | °C | |
| Storage Temperature | -65 | | 150 | °C | |
| Package | | | | | |
| NSOIC (_N) | | | | | |

## Test Circuits

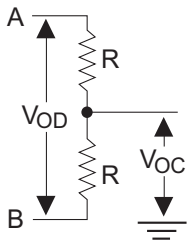



Figure 1: Driver DC Test Load Circuit

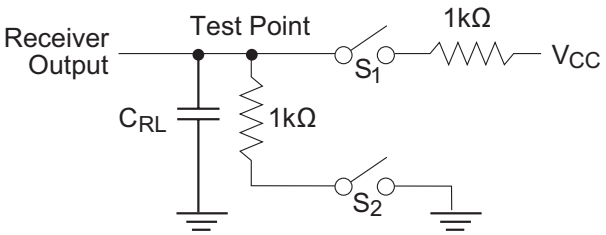



Figure 2: Receiver Timing Test Load Circuit

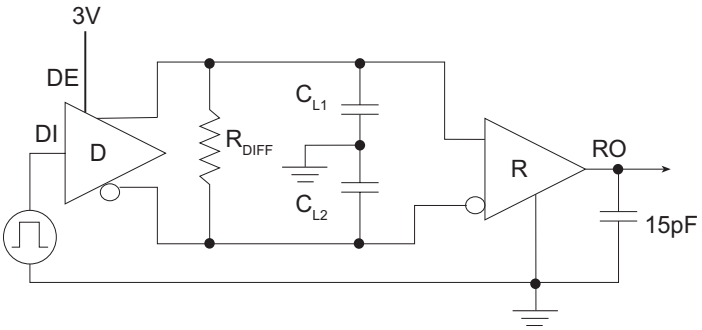



Figure 3: Driver/Receiver Timing Test Circuit

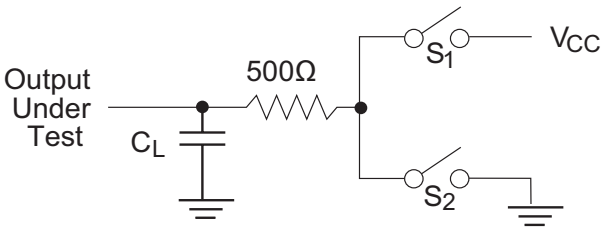



Figure 4: Driver Timing Test Load #2 Circuit

## Switching Waveforms

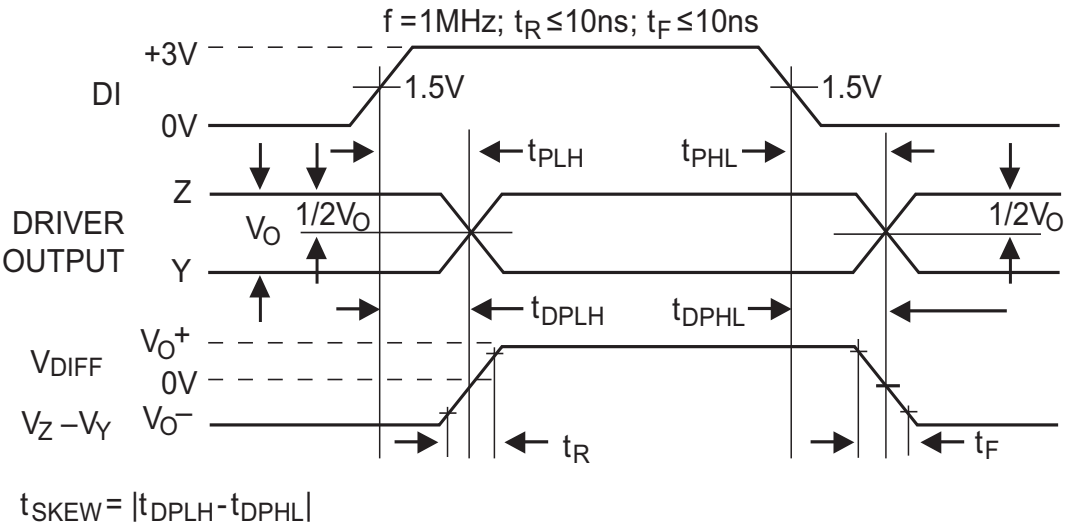



Figure 5: Driver Propagation Delays

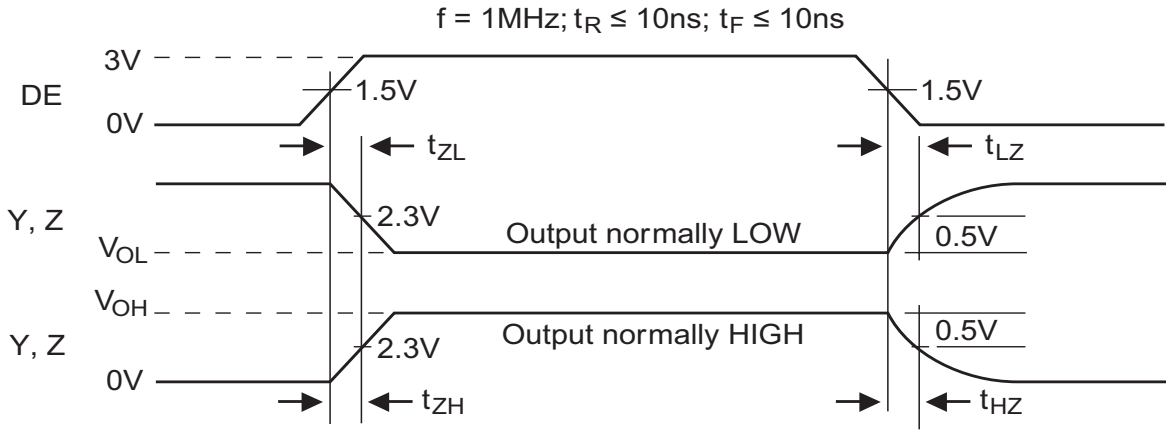



Figure 6: Driver Enable and Disable Times

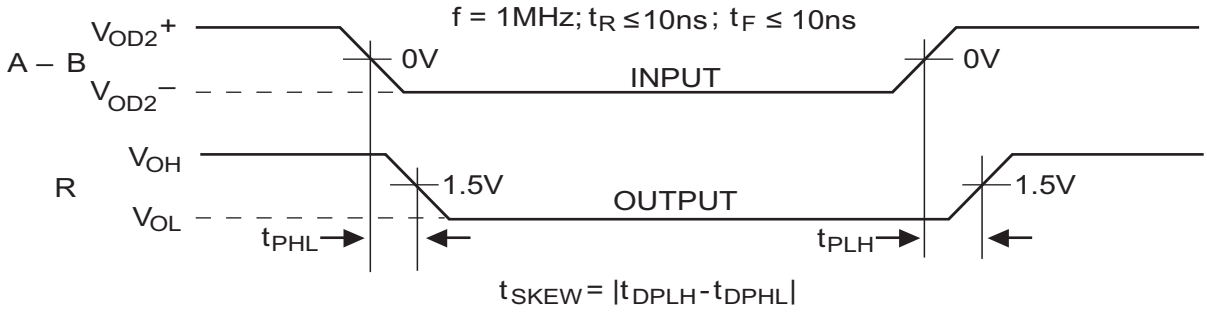



Figure 7: Receiver Propagation Delays

## Absolute Maximum Ratings (SP491)

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.

$V_{CC}$.....7.0V

Input Voltages

Logic.....-0.5V to ($V_{CC}$+0.5V)

Drivers.....-0.5V to ($V_{CC}$+0.5V)

Receivers.....±14V

Output Voltages

Logic.....-0.5V to ($V_{CC}$+0.5V)

Drivers.....±14V

Receivers.....-0.5V to ($V_{CC}$+0.5V)

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

Power Dissipation.....1000mW

## Electrical Characteristics

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

| PARAMETERS | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|---|---|---|---|---|---|
| **SP491 Driver DC Characteristics** | | | | | |
| Differential output voltage | | | $V_{CC}$ | V | Unloaded; R = ∞Ω ; Figure 1 |
| Differential output voltage | 2 | | $V_{CC}$ | V | With load; R = 50Ω (RS-422); Figure 1 |
| Differential output voltage | 1.5 | | $V_{CC}$ | 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 | Applies to DE, D, $\overline{REB}$ |
| Input low voltage | | | 0.8 | V | Applies to DE, D, $\overline{REB}$ |
| Input current | | | ±10 | µA | Applies to DE, D, $\overline{REB}$ |
| Driver short circuit current $V_{OUT}$ = HIGH | | | ±250 | mA | -7V ≤ $V_O$ ≤ 12V |
| Driver short circuit current $V_{OUT}$ = LOW | | | ±250 | mA | -7V ≤ $V_O$ ≤ 12V |

## Electrical Characteristics, Continued

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

| PARAMETERS | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|---|---|---|---|---|---|
| **SP491 Driver AC Characteristics** | | | | | |
| Maximum data rate | 5 | | | Mbps | $\overline{REB}$ = 5V, DE = 5V |
| Driver input to output, $t_{PLH}$ | | 30 | 60 | ns | $R_{DIFF}$ = 54Ω, $C_{L1} = C_{L2}$ = 100pF; Figures 3 & 5 |
| Driver input to output, $t_{PHL}$ | | 30 | 60 | ns | $R_{DIFF}$ = 54Ω, $C_{L1} = C_{L2}$ = 100pF; Figures 3 & 5 |
| Driver skew | | 5 | 10 | ns | $t_{SKEW} = \lvert t_{DPLH} - t_{DPHL} \rvert$; Figures 3 & 5 |
| Driver rise or fall time | | 15 | 40 | ns | From 10%-90%; $R_{DIFF}$ = 54Ω, $C_{L1} = C_{L2}$ = 100pF; Figures 3 & 5 |
| Driver enable to output HIGH | | 40 | 70 | ns | $C_{L1} = C_{L2}$ = 100pF; Figures 4 & 6, $S_2$ closed |
| Driver enable to output LOW | | 40 | 70 | ns | $C_{L1} = C_{L2}$ = 100pF; Figures 4 & 6, $S_1$ closed |
| Driver disable time from LOW | | 40 | 70 | ns | $C_{L1} = C_{L2}$ = 100pF; Figures 4 & 6, $S_1$ closed |
| Driver disable time from HIGH | | 40 | 70 | ns | $C_{L1} = C_{L2}$ = 100pF; Figures 4 & 6, $S_2$ closed |
| **SP491 Receiver DC Characteristics** | | | | | |
| Differential input threshold | -0.2 | | 0.2 | Volts | -7V ≤ $V_{CM}$ ≤ 12V |
| Input hysteresis | | 70 | | mV | $V_{CM}$ = 0V |
| Output voltage HIGH | 3.5 | | | Volts | $V_{ID}$ = 200mV, $I_O$ = -4mA |
| Output voltage LOW | | | 0.4 | Volts | $V_{ID}$ = -200mV, $I_O$ = 4mA |
| Three-State ( High Impedance) Output Current | | | ±1 | µA | 0.4V ≤ $V_O$ ≤ 2.4V; $\overline{REB}$ = 5V |
| Input resistance | 12 | 15 | | kΩ | -7V ≤ $V_{CM}$ ≤ 12V |
| Input current (A, B); $V_{IN}$ = 12V | | | ±1.0 | mA | DE = 0V, $V_{CC}$ = 0V or 5.25V, $V_{IN}$ = 12V |
| Input current (A, B); $V_{IN}$ = -7V | | | -0.8 | mA | DE = 0V, $V_{CC}$ = 0V or 5.25V, $V_{IN}$ = -7V |
| Short circuit current | | | 85 | mA | 0V ≤ $V_O$ ≤ $V_{CC}$ |
| **SP491 Receiver AC Characteristics** | | | | | |
| Maximum data rate | 5 | | | Mbps | $\overline{REB}$ = 0V |
| Receiver input to output, $t_{PLH}$ | 20 | 45 | 150 | ns | $R_{DIFF}$ = 54Ω, $C_{L1} = C_{L2}$ = 100pF; Figures 3 & 7 |
| Receiver input to output, $t_{PHL}$ | 20 | 45 | 150 | ns | $R_{DIFF}$ = 54Ω, $C_{L1} = C_{L2}$ = 100pF; Figures 3 & 7 |
| Differential receiver skew | | 13 | | ns | $\lvert t_{PLH} - t_{PHL} \rvert$; $R_{DIFF}$ = 54Ω, $C_{L1} = C_{L2}$ = 100pF; Figures 3 & 7 |
| Receiver enable to output LOW | | 45 | 70 | ns | $C_{RL}$ = 15pF; Figures 2 & 8; $S_1$ closed |
| Receiver enable to output HIGH | | 45 | 70 | ns | $C_{RL}$ = 15pF; Figures 2 & 8; $S_2$ closed |
| Receiver disable time from LOW | | 45 | 70 | ns | $C_{RL}$ = 15pF; Figures 2 & 8; $S_1$ closed |
| Receiver disable time from HIGH | | 45 | 70 | ns | $C_{RL}$ = 15pF; Figures 2 & 8; $S_2$ closed |

## Electrical Characteristics, Continued

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

| PARAMETERS | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|---|---|---|---|---|---|
| **Power Requirements** | | | | | |
| Supply voltage | 4.75 | | 5.25 | V | |
| Supply current | | 900 | | µA | $\overline{REB}$, D = 0V or $V_{CC}$; DE = $V_{CC}$ |
| **SP491 Environmental and Mechanical** | | | | | |
| Operating Temperture | | | | | |
| Commercial (_C_) | 0 | | 70 | °C | |
| Industrial (_E_) | -40 | | 85 | °C | |
| Storage Temperature | -65 | | 150 | °C | |
| Package | | | | | |
| NSOIC (_N) | | | | | |

## Switching Waveforms

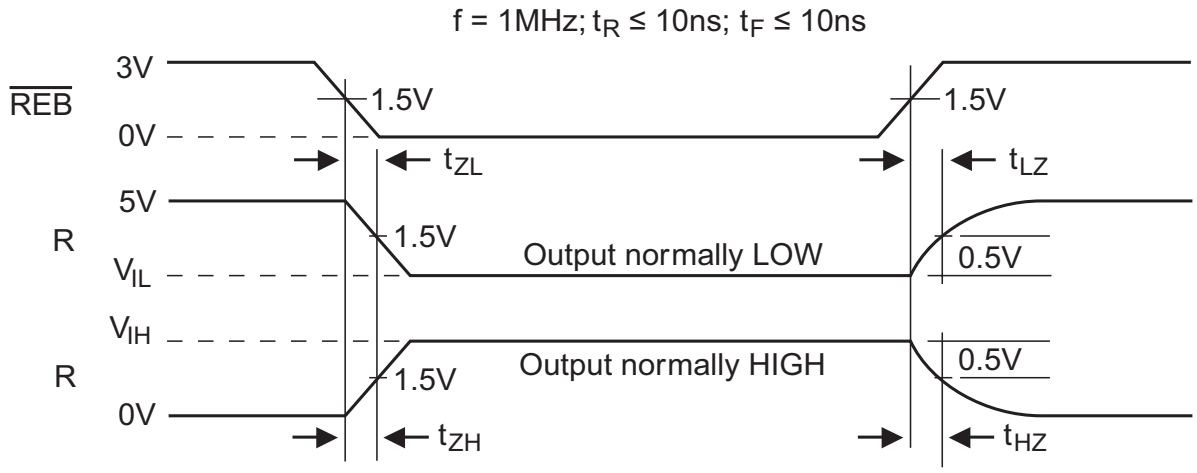
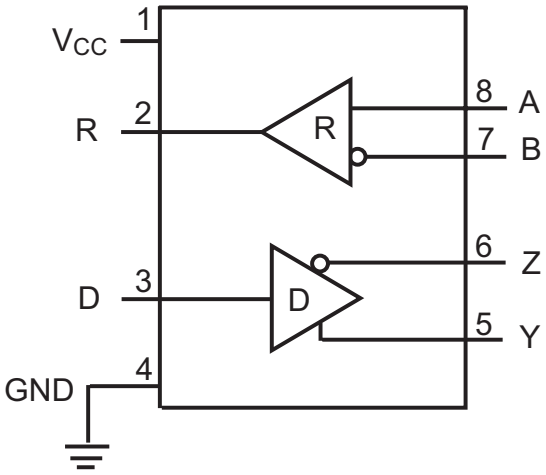


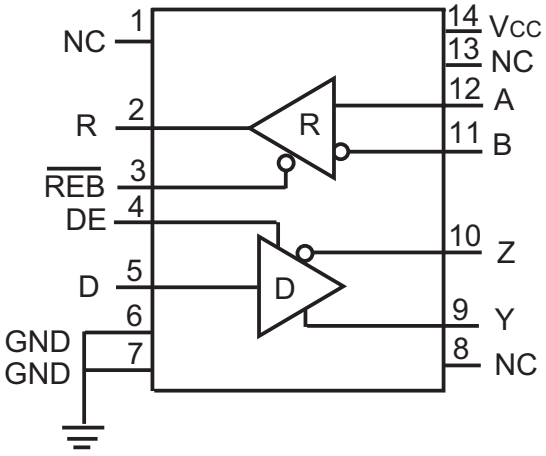

Figure 8: Receiver Enable and Disable Times

## Pin Functions




SP490
Pinout (Top View)

| Pin Number | Pin Name | Description |
|---|---|---|
| 1 | $V_{CC}$ | Positive supply |
| 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 |




SP491
Pinout (Top View)

| Pin Number | Pin Name | Description |
|---|---|---|
| 1 | NC | No connect |
| 2 | R | Receiver output |
| 3 | $\overline{REB}$ | 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 |
| 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 |
| 14 | $V_{CC}$ | Positive supply |

## Description

The SP490 and SP491 are full-duplex differential transceivers that meet the requirements of RS-485 and RS-422. Fabricated with a MaxLinear proprietary BiCMOS process, both products require a fraction of the power of older bipolar designs.

The RS-485 standard is ideal for multi-drop applications or 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 SP490 and SP491 have differential outputs. The typical voltage output swing with no load will be 0 volts to +5 volts. With worst case loading of 54Ω across the differential outputs, the driver can maintain greater than 1.5V voltage levels.

The driver of the SP491 has a driver enable control line which is active high. A logic high on DE (pin 4) of the SP491 will enable the differential driver outputs. A logic low on DE (pin 4) of the SP491 will tri-state the driver outputs. The SP490 does not have a driver enable.

### Receivers

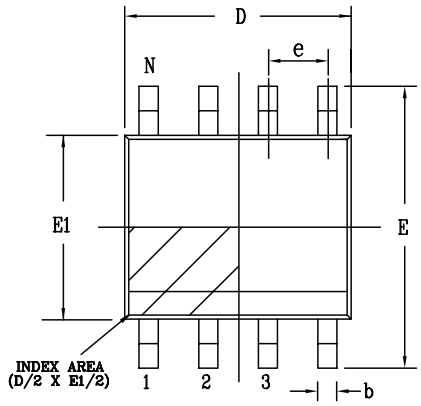
The receivers for both the SP490 and SP491 have differential inputs with an input sensitivity as low as ±200mV. Input impedance of the receivers is typically 15kΩ (12kΩ minimum). A wide common mode range of -7V to 12V allows for large ground potential differences between systems. The receivers for both the SP490 and SP491 are equipped with the fail-safe feature. Fail-safe guarantees that the receiver output will be in a high state when the input is left unconnected.

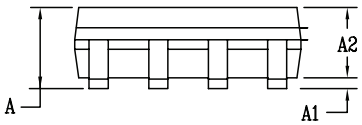
The receiver of the SP491 has a receiver enable control line which is active low. A logic low on $\overline{REB}$ (pin 3) of the SP491 will enable the differential receiver. A logic high on $\overline{REB}$ (pin 3) of the SP491 will tri-state the receiver.

## Mechanical Dimensions

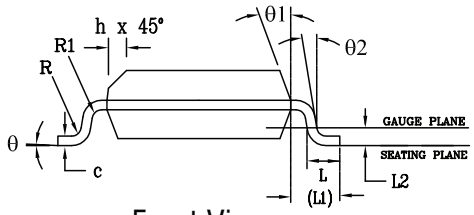
### NSOIC8

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 | | | | | |

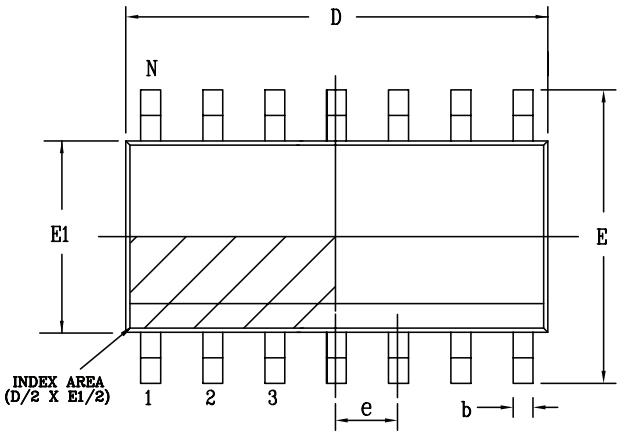
Drawing No: POD-00000108

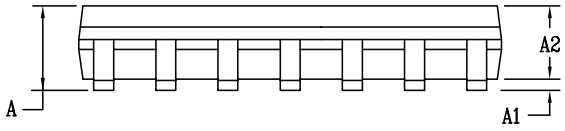
Revision: A

## Mechanical Dimensions

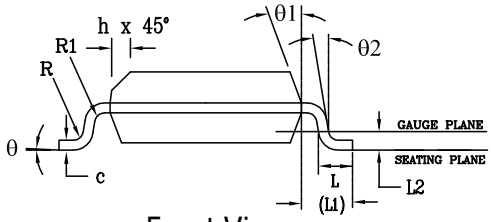
NSOIC14

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

## Ordering Information[1]

| Part Number | Operating Temperature Range | Lead-Free | Package | Packaging Method |
|---|---|---|---|---|
| SP490CN-L/TR | 0°C to 70°C | Yes[2] | 8-pin NSOIC | Reel |
| SP491CN-L/TR | | | 14-pin NSOIC | Reel |
| SP491EN-L/TR | -40°C to 85°C | | | Reel |

**NOTE:**
1. Refer to www.exar.com/SP490 and www.exar.com/SP491 for most up-to-date Ordering Information.
2. Visit www.exar.com for additional information on Environmental Rating.

## Revision History

| Revision | Date | Description |
|---|---|---|
| - | 02/24/05 | Sipex Legacy Data Sheet |
| 1.0.0 | 07/14/08 | Convert to Exar format. |
| 1.0.1 | June 2011 | Remove minimum entry to Driver Short Circuit Current. Change SP490 receiver propagation typical to 45ns. Remove SP491 receiver short circuit current minimum entry. Change SP491 receiver propagation delay MIN and TYP levels to 20 and 45ns respectively. Change SP491 receiver Enable and Disable time TYP and MAX levels to 45 and 70ns respectively. Change SP491 Supply Current TYP to 900µA. Remove SP491 driver rise/fall time minimum. Update ordering information. |
| 1.0.2 | 02/06/18 | Updated format and included MaxLinear logo. Remove GND from Differential Output Voltage min (page 2 & 6). Update ordering information table format. Corrected Figure numbers (after Figure 4). Added Pin Function section. Corrected SP491 pin 3 name. Removed obsolete PDIP reference in description and mechanical section, and industrial for SP490. |

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