

## General Description

The SP3070E - SP3078E differential line transceivers are suitable for bidirectional communication on balanced multi-point bus transmission lines and comply with both RS-485 and RS-422 EIA Standards. Each device consists of a differential driver and differential receiver. All devices operate from a 3.3V power supply.

High receiver input impedance allows a large number of transceivers to share a common data bus while maintaining signal margin and without excessive loading or use of expensive repeaters. The high impedance driver output is maintained over the entire common-mode voltage range from -7 to +12V. Receivers will failsafe to logic 1 output when inputs are open, shorted or terminated. Drivers include built-in short-circuit protection and a thermal-overload shutdown to protect against excessive power dissipation from bus contention or cable faults. All RS-485 receiver inputs and driver outputs are ESD protected up to ±15kV (Air-Gap and Human Body Model) and up to ±8kV Contact Discharge (IEC 61000-4-2). The SP3070E - SP3078E devices may not achieve optimal transmit performance if the connected receiver includes a biasing network to 5.0V without a termination resistor. Please see MaxLinear Application Note ANI#21 for further details.

## Applications

Industrial Control, Utility Meters, Building Automation, Instrumentation, Point of Sale

## Features

- ±15kV ESD protection for RS-485 pins
- 3.3V low-power operation
- Advanced receiver-failsafe protection for open, shorted or terminated lines
- Up to 256 transceivers may share Bus
- Very low load for 8x greater fanout
- Hot Swap glitch protection  $\overline{RE}$  and DE
- Thermal shutdown protects against driver contention
- Available in three industry standard footprints
  - SP3070E, SP3073E and SP3076E in Full-Duplex (14-pin)
  - SP3071E, SP3074E and SP3077E in Full-Duplex (8-pin)
  - SP3072E, SP3075E and SP3078E in Half-Duplex (8-pin)
- Three applications-optimized speed grades
  - SP3070E - SP3072E: 250kbps slew-limited
  - SP3073E - SP3075E: 500kbps slew-limited
  - SP3076E - SP3078E: 16Mbps high speed
- Small form factor NSOIC packages
- Industrial (-40 to 85°C) and Extended (-40 to 125°C) temperature grades

Ordering Information - [page 19](#)

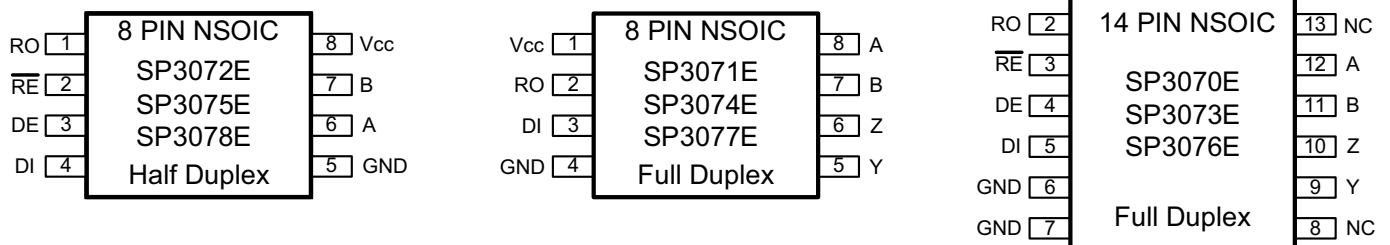


Figure 1: Pinouts

## Revision History

| Document No. | Release Date | Change Description   |
|--------------|--------------|--|
|              | -            | Legacy Sipex Datasheet.  |
| 1.0.0        | 06/10/09     | Convert to Exar format, update ordering information, correct subscript on pages 5-7 and change revision to 1.0.0.  |
| 1.0.1        | 09/30/10     | Correct type error on page 7 on driver switching characteristics table. Change SP3076E,3077E and 3078E Receiver enable time from shutdown from 1800ns to 3000ns. |
| 1.0.2        | 12/02/10     | Add reference to Application Note ANI#21 and change ESD protection levels to IEC 61000-4-2.  |
| 1.0.3        | 2/24/20      | Update to MaxLinear format, update Ordering Information. Move ESD Protection to page 2. Corrected 14-pin block diagram (pin 3).                                  |

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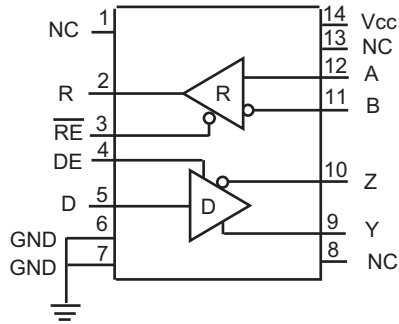
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## Device Architecture and Block Diagrams

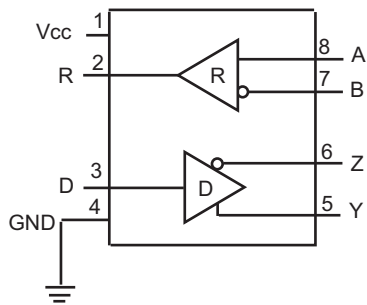
Devices are available in three industry standard architectures and footprints. In each footprint, there are three speed grades available.



**Figure 2: 14-pin Full Duplex**

### 14-pin Full Duplex:

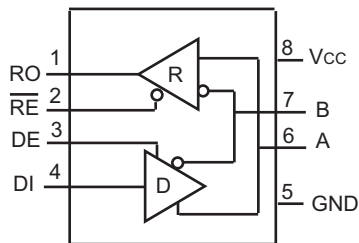
- SP3070E, 250kbps slew limited
- SP3073E, 500kbps slew limited
- SP3076E, 16Mbps



**Figure 3: 8-pin Full Duplex**

### 8-pin Full Duplex:

- SP3071E, 250kbps slew limited
- SP3074E, 500kbps slew limited
- SP3077E, 16Mbps



**Figure 4: 8-pin Half Duplex**

### 8-pin Half Duplex:

- SP3072E, 250kbps slew limited
- SP3075E, 500kbps slew limited
- SP3078E, 16Mbps

## Specifications

### Absolute Maximum Ratings

**Important:** 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.

**Table 1: Absolute Maximum Ratings**

| Parameter   | Minimum | Maximum | Units |
|---|---------|---------|-------|
| $V_{CC}$  |         | 6.0     | V     |
| Input voltage at control input pins ( $\overline{RE}$ , DE) | -0.3    | 6.0     | V     |
| Driver input voltage ( $\overline{RE}$ , DE)                | -0.3    | 6.0     | V     |
| Driver output voltage (A, B, Y & Z)                         | -8      | 13      | V     |
| Receiver input voltage (A, B)                               | -8      | 13      | V     |
| Continuous Power Dissipation at $T_A = 70^\circ\text{C}$    |         |         |       |
| 8-pin NSOIC (derate 5.88mW/°C above 70°C)                   |         | 471     | mW    |
| 14-pin NSOIC (derate 8.33mW/°C above 70°C)                  |         | 667     | mW    |
| Operating Temperature Ranges                                |         |         |       |
| SP307xE_MN  | -40     | 125     | °C    |
| SP307xE_EN  | -40     | 85      | °C    |
| Junction temperature  |         | 150     | °C    |
| Storage temperature range                                   | -65     | 150     | °C    |
| Lead temperature (soldering, 10s)                           |         | 300     | °C    |

### ESD Ratings

**Table 2: ESD Ratings**

| Parameter   | Limit | Units |
|---|-------|-------|
| HBM - Human Body Model (pins Y, Z, A & B)         | ±15   | kV    |
| IEC 1000-4-2 Airgap Discharge (pins Y, Z, A & B)  | ±15   | kV    |
| IEC 1000-4-2 Contact Discharge (pins Y, Z, A & B) | ±8    | kV    |



## Electrical Characteristics

Unless otherwise noted,  $V_{CC} = 3.3V \pm 0.3V$ , ambient temperature  $T_{MIN} < T_A < T_{MAX}$ . Typical values are at  $V_{CC} = 3.3V$ , ambient temperature  $T_A = 25^\circ C$ . The "\*" denotes the specifications which apply over the full operating range unless otherwise noted.

**Table 3: Electrical Characteristics**

| Parameter  | Symbol     | Test Condition  | Minimum        | Typical        | Maximum   | Units      |            |
|--|------------|---|----------------|----------------|-----------|------------|------------|
| Differential driver output                         | $V_{OD}$   | RL = 100 (RS-422), <a href="#">Figure 5</a>                               | 2              |                | $V_{CC}$  | V          |            |
|  |            | RL = 54 (RS-485), <a href="#">Figure 5</a>                                | 1.5            |                | $V_{CC}$  |            |            |
|  |            | No load   | *              |                | $V_{CC}$  |            |            |
| Change in magnitude of differential output voltage | $V_{OD}$   | RL = 54 or 100, <a href="#">Figure 5</a>                                  | *              |                | 0.2       | V          |            |
| Driver common mode output voltage                  | $V_{OC}$   | RL = 54 or 100, <a href="#">Figure 5</a>                                  | *              | $V_{CC}/2$     | 3         | V          |            |
| Change in magnitude of common mode output voltage  | $ V_{OC} $ | RL = 54 or 100, <a href="#">Figure 5</a>                                  |                |                | $\pm 0.2$ | V          |            |
| Input high voltage                                 | $V_{IH}$   | DE, DI, $\overline{RE}$   | *              | 2              |           | V          |            |
| Input low voltage                                  | $V_{IL}$   | DE, DI, $\overline{RE}$   |                |                | 0.8       | V          |            |
| Input hysteresis                                   | $V_{HYS}$  | DE, DI, $\overline{RE}$   | *              | 100            |           | mV         |            |
| Input current                                      | $I_{IN}$   | DE, DI, $\overline{RE}$   | *              | -1             | 1         | $\mu A$    |            |
| Input impedance first transition (hot swap)        |            | DE, $\overline{RE}$<br>First transition will draw more current (hot swap) | *              | 1              | 10        | k $\Omega$ |            |
| Output leakage (Y and Z)<br>Full duplex (A and B)  | $I_O$      | DE = GND<br>$V_{CC} = GND$ or 3.6V  | $V_{IN} = 12V$ | *              |           | 125        | $\mu A$    |
|  |            |   | $V_{IN} = -7V$ | *              | -100      |            |            |
| Driver short-circuit current                       | $I_{OSD}$  | $-7V \leq V_{OUT} \leq 12V$ , ( <a href="#">Figure 9</a> )                |                |                | 0         | $\pm 250$  | mA         |
|  |            |   |                |                | -250      | 0          |            |
| Input current (A and B) half duplex                | $I_{A,B}$  | DE = GND<br>$V_{CC} = GND$ or 3.6V  | $V_{IN} = 12V$ | *              |           | 125        | $\mu A$    |
|  |            |   | $V_{IN} = -7V$ | *              | -100      |            |            |
| Thermal-shutdown threshold                         | $T_{TS}$   |   | *              | 165            |           | $^\circ C$ |            |
| Thermal-shutdown hysteresis                        | $T_{TSH}$  |   | *              | 15             |           | $^\circ C$ |            |
| <b>Receiver</b>                                    |            |   |                |                |           |            |            |
| Receiver differential threshold (sensitivity)      | $V_{TH}$   | $-7V \leq V_{CM} \leq 12V$  |                | -200           | -125      | -50        | mV         |
| Receiver input hysteresis                          | $V_{TH}$   | $V_a + V_b = 0V$  | *              |                | 15        |            | mV         |
| RO output high voltage                             | $V_{OH}$   | $I_O = -1mA$  | *              | $V_{CC} - 0.6$ |           |            | V          |
| RO output low voltage                              | $V_{OL}$   | $I_O = 1mA$   | *              |                | 0.4       |            | V          |
| Tri-State output current at receiver               | $I_{OZR}$  | $0 \leq V_O \leq V_{CC}$  | *              |                | $\pm 1$   |            | $\mu A$    |
| Receiver input resistance                          | $R_{IN}$   | $-7V \leq V_{CM} \leq 12V$  | *              | 96             |           |            | k $\Omega$ |
| Receiver output short-circuit current              | $I_{OZR}$  | $0V \leq V_{RO} \leq V_{CC}$  |                |                | $\pm 60$  |            | mA         |

**Table 3: Electrical Characteristics**

| Parameter                       | Symbol     | Test Condition                                    |   | Minimum | Typical | Maximum | Units   |
|---------------------------------|------------|---|---|---------|---------|---------|---------|
| Supply Current                  |            |   |   |         |         |         |         |
| Supply current                  | $I_{CC}$   | No load, $\overline{RE} = 0$ , $DE = V_{CC}$      | • |         | 0.8     | 1.5     | mA      |
|                                 |            | No load, $\overline{RE} = V_{CC}$ , $DE = V_{CC}$ | • |         | 0.8     | 1.5     |         |
|                                 |            | No load, $\overline{RE} = 0$ , $DE = 0$           | • |         | 0.8     | 1.5     |         |
| Supply current in shutdown mode | $I_{SHDN}$ | $\overline{RE} = V_{CC}$ , $DE = GND$             |   |         | 0.05    | 3       | $\mu A$ |

## Driver Switching Characteristics - SP3070E, SP3071E & SP3072E

Unless otherwise noted,  $V_{CC} = 3.3 \pm 0.3V$ , ambient temperature  $T_{MIN} < T_A < T_{MAX}$ . Typical values are at  $V_{CC} = 3.3V$ , ambient temperature  $T_A = 25^\circ C$ .

**Table 4: SP3070E, SP3071E & SP3072E Driver Switching Characteristics**

| Driver Characteristic   | Conditions   | Minimum | Typical | Maximum | Unit |
|---|--|---------|---------|---------|------|
| Data signaling rate   | Duty cycle 40 to 60%                                       | 250     |         |         | kbps |
| Driver propagation delay ( $t_{PHL}$ , $t_{PLH}$ )            | $R_L = 54\Omega$ , $C_L = 50pF$ ,<br>Figure 6 & Figure 7   | 250     |         | 1500    | ns   |
| Driver output rise / fall time ( $t_R$ , $t_F$ )              |  | 350     |         | 1600    | ns   |
| Driver differential skew ( $t_{PLH} - t_{PHL}$ )              |  |         |         | 200     | ns   |
| Driver enable to output high ( $t_{ZH}$ )                     | $R_L = 500\Omega$ , $C_L = 50pF$ ,<br>Figure 8 & Figure 10 |         |         | 2500    | ns   |
| Driver enable to output low ( $t_{ZL}$ )                      |  |         |         | 2500    | ns   |
| Driver disable from output high ( $t_{HZ}$ )                  |  |         |         | 100     | ns   |
| Driver disable from output low ( $t_{LZ}$ )                   |  |         |         | 100     | ns   |
| Driver enable from shutdown to output high ( $t_{ZH(SHDN)}$ ) | Figure 8   |         |         | 5500    | ns   |
| Driver enable from shutdown to output low ( $t_{ZL(SHDN)}$ )  | Figure 10  |         |         | 5500    | ns   |
| Time to shutdown ( $t_{SHDN}$ )                               |  | 50      | 200     | 600     | ns   |

## Receiver Switching Characteristics - SP3070E, SP3071E & SP3072E

Unless otherwise noted,  $V_{CC} = 3.3 \pm 0.3V$ , ambient temperature  $T_{MIN} < T_A < T_{MAX}$ . Typical values are at  $V_{CC} = 3.3V$ , ambient temperature  $T_A = 25^\circ C$ .

**Table 5: SP3070E, SP3071E & SP3072E Receiver Switching Characteristics**

| Receiver Characteristic                              | Conditions                              | Minimum | Typical | Maximum | Unit |
|--|---|---------|---------|---------|------|
| Data signaling rate                                  | Duty cycle 40 to 60%                    | 250     |         |         | kbps |
| Receiver propagation delay ( $t_{PHL}$ , $t_{PLH}$ ) | $C_L = 15pF$ , Figure 11 &<br>Figure 12 |         |         | 200     | ns   |
| Propagation delay skew ( $t_{PLH} - t_{PHL}$ )       |   |         |         | 30      | ns   |
| Receiver enable to output high ( $t_{ZH}$ )          | Figure 13                               |         |         | 50      | ns   |
| Receiver enable to output low ( $t_{ZL}$ )           | Figure 13                               |         |         | 50      | ns   |
| Receiver disable from output high ( $t_{HZ}$ )       | Figure 13                               |         |         | 100     | ns   |
| Receiver disable from output low ( $t_{LZ}$ )        | Figure 13                               |         |         | 200     | ns   |
| Receiver enable from shutdown to output high         | Figure 13                               |         |         | 4000    | ns   |
| Receiver enable from shutdown to output low          | Figure 13                               |         |         | 4000    | ns   |
| Time to shutdown ( $t_{SHDN}$ )                      |   | 50      | 200     | 600     | ns   |

## Driver Switching Characteristics - SP3073E, SP3074E & SP3075E

Unless otherwise noted,  $V_{CC} = 3.3 \pm 0.3V$ , ambient temperature  $T_{MIN} < T_A < T_{MAX}$ . Typical values are at  $V_{CC} = 3.3V$ , ambient temperature  $T_A = 25^\circ C$ .

**Table 6: SP3073E, SP3074E & SP3075E Driver Switching Characteristics**

| Driver Characteristic   | Conditions   | Minimum | Typical | Maximum | Unit |
|---|--|---------|---------|---------|------|
| Data signaling rate   | Duty cycle 40 to 60%                                       | 500     |         |         | kbps |
| Driver propagation delay ( $t_{PHL}$ , $t_{PLH}$ )            | $R_L = 54\Omega$ , $C_L = 50pF$ ,<br>Figure 6 & Figure 7   | 180     |         | 800     | ns   |
| Driver output rise / fall time ( $t_R$ , $t_F$ )              |  | 200     |         | 800     | ns   |
| Driver differential skew ( $t_{PLH} - t_{PHL}$ )              |  |         |         | 100     | ns   |
| Driver enable to output high ( $t_{ZH}$ )                     | $R_L = 500\Omega$ , $C_L = 50pF$ ,<br>Figure 8 & Figure 10 |         |         | 2500    | ns   |
| Driver enable to output low ( $t_{ZL}$ )                      |  |         |         | 2500    | ns   |
| Driver disable from output high ( $t_{HZ}$ )                  |  |         |         | 100     | ns   |
| Driver disable from output low ( $t_{LZ}$ )                   |  |         |         | 100     | ns   |
| Driver enable from shutdown to output high ( $t_{ZH(SHDN)}$ ) | Figure 8   |         |         | 4500    | ns   |
| Driver enable from shutdown to output low ( $t_{ZL(SHDN)}$ )  | Figure 10  |         |         | 4500    | ns   |
| Time to shutdown ( $t_{SHDN}$ )                               |  | 50      | 200     | 600     | ns   |

## Receiver Switching Characteristics - SP3073E, SP3074E & SP3075E

Unless otherwise noted,  $V_{CC} = 3.3 \pm 0.3V$ , ambient temperature  $T_{MIN} < T_A < T_{MAX}$ . Typical values are at  $V_{CC} = 3.3V$ , ambient temperature  $T_A = 25^\circ C$ .

**Table 7: SP3073E, SP3074E & SP3075E Receiver Switching Characteristics**

| Receiver Characteristic                              | Conditions                              | Minimum | Typical | Maximum | Unit |
|--|---|---------|---------|---------|------|
| Data signaling rate                                  | Duty cycle 40 to 60%                    | 500     |         |         | kbps |
| Receiver propagation delay ( $t_{PHL}$ , $t_{PLH}$ ) | $C_L = 15pF$ , Figure 11 &<br>Figure 12 |         |         | 200     | ns   |
| Propagation delay skew ( $t_{PLH} - t_{PHL}$ )       |   |         |         | 30      | ns   |
| Receiver enable to output high ( $t_{ZH}$ )          | Figure 13                               |         |         | 50      | ns   |
| Receiver enable to output low ( $t_{ZL}$ )           | Figure 13                               |         |         | 50      | ns   |
| Receiver disable from output high ( $t_{HZ}$ )       | Figure 13                               |         |         | 50      | ns   |
| Receiver disable from output low ( $t_{LZ}$ )        | Figure 13                               |         |         | 50      | ns   |
| Receiver enable from shutdown to output high         | Figure 13                               |         |         | 4000    | ns   |
| Receiver enable from shutdown to output low          | Figure 13                               |         |         | 4000    | ns   |
| Time to shutdown ( $t_{SHDN}$ )                      |   | 50      | 200     | 600     | ns   |

## Driver Switching Characteristics - SP3076E, SP3077E & SP3078E

Unless otherwise noted,  $V_{CC} = 3.3 \pm 0.3V$ , ambient temperature  $T_{MIN} < T_A < T_{MAX}$ . Typical values are at  $V_{CC} = 3.3V$ , ambient temperature  $T_A = 25^\circ C$ .

**Table 8: SP3076E, SP3077E & SP3078E Driver Switching Characteristics**

| Driver Characteristic   | Conditions   | Minimum | Typical | Maximum | Unit |
|---|--|---------|---------|---------|------|
| Data signaling rate   | Duty cycle 40 to 60%                                       | 16      |         |         | Mbps |
| Driver propagation delay ( $t_{PHL}$ , $t_{PLH}$ )            | $R_L = 54\Omega$ , $C_L = 50pF$ ,<br>Figure 6 & Figure 8   |         |         | 50      | ns   |
| Driver output rise / fall time ( $t_R$ , $t_F$ )              |  |         |         | 15      | ns   |
| Driver differential skew ( $t_{PLH} - t_{PHL}$ )              |  |         |         | 8       | ns   |
| Driver enable to output high ( $t_{ZH}$ )                     | $R_L = 500\Omega$ , $C_L = 50pF$ ,<br>Figure 8 & Figure 10 |         |         | 150     | ns   |
| Driver enable to output low ( $t_{ZL}$ )                      |  |         |         | 150     | ns   |
| Driver disable from output high ( $t_{HZ}$ )                  |  |         |         | 100     | ns   |
| Driver disable from output low ( $t_{LZ}$ )                   |  |         |         | 100     | ns   |
| Driver enable from shutdown to output high ( $t_{ZH(SHDN)}$ ) | Figure 8   |         |         | 1800    | ns   |
| Driver enable from shutdown to output low ( $t_{ZL(SHDN)}$ )  | Figure 10  |         |         | 1800    | ns   |
| Time to shutdown ( $t_{SHDN}$ )                               |  | 50      | 200     | 600     | ns   |

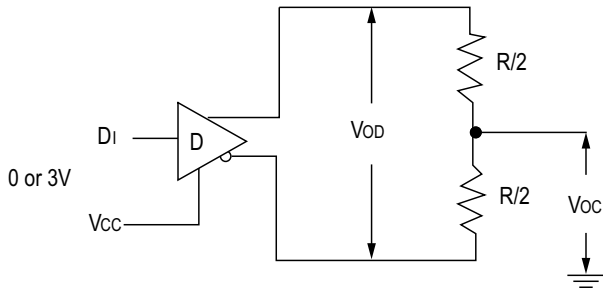
## Receiver Switching Characteristics - SP3076E, SP3077E & SP3078E

Unless otherwise noted,  $V_{CC} = 3.3 \pm 0.3V$ , ambient temperature  $T_{MIN} < T_A < T_{MAX}$ . Typical values are at  $V_{CC} = 3.3V$ , ambient temperature  $T_A = 25^\circ C$ .

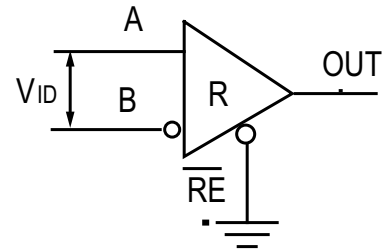
**Table 9: SP3076E, SP3077E & SP3078E Receiver Switching Characteristics**

| Receiver Characteristic                              | Conditions   | Minimum | Typical | Maximum | Unit |
|--|--|---------|---------|---------|------|
| Data signaling rate                                  | Duty cycle 40 to 60%   | 16      |         |         | Mbps |
| Receiver propagation delay ( $t_{PHL}$ , $t_{PLH}$ ) | $C_L = 15pF$ , Figure 11 &<br>Figure 12, $-40$ to $85^\circ C$ |         | 40      | 75      | ns   |
| Propagation delay skew ( $t_{PLH} - t_{PHL}$ )       |  |         |         | 8       | ns   |
| Receiver enable to output high ( $t_{ZH}$ )          | Figure 13  |         |         | 60      | ns   |
| Receiver enable to output low ( $t_{ZL}$ )           | Figure 13  |         |         | 60      | ns   |
| Receiver disable from output high ( $t_{HZ}$ )       | Figure 13  |         |         | 50      | ns   |
| Receiver disable from output low ( $t_{LZ}$ )        | Figure 13  |         |         | 50      | ns   |
| Receiver enable from shutdown to output high         | Figure 13  |         |         | 3000    | ns   |
| Receiver enable from shutdown to output low          | Figure 13  |         |         | 3000    | ns   |
| Time to shutdown ( $t_{SHDN}$ )                      |  | 50      | 200     | 600     | ns   |

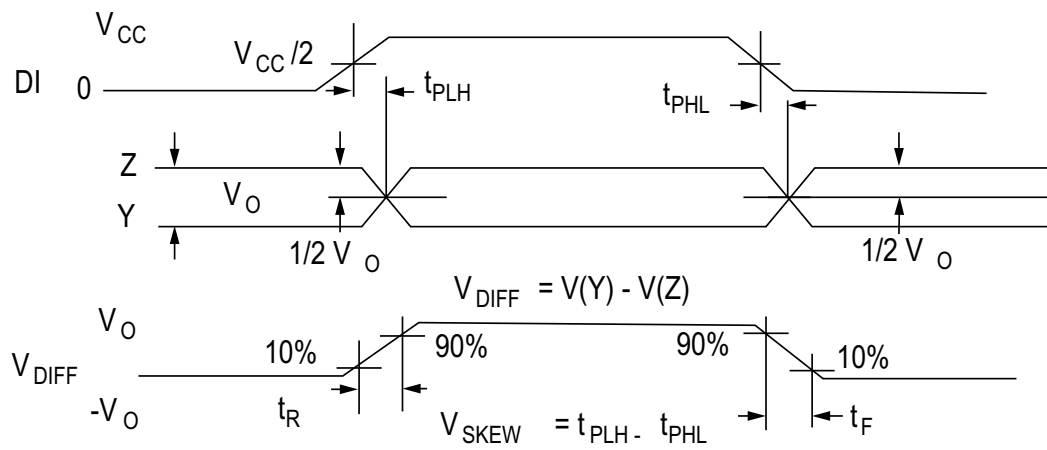
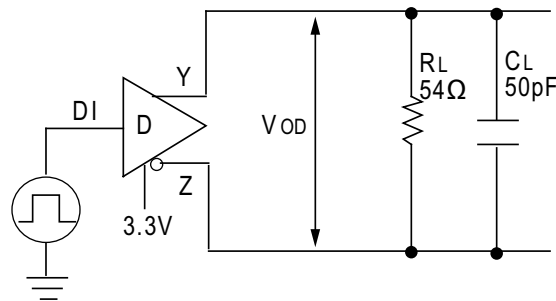
## Test Circuits and Timing Diagrams



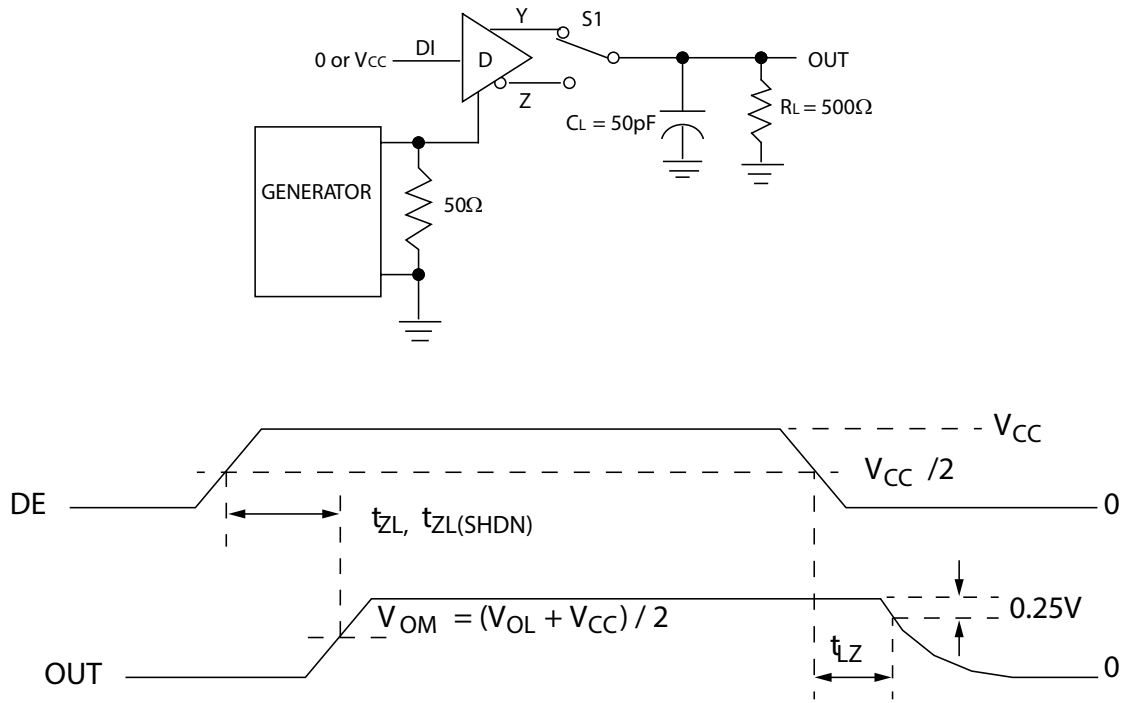
**Figure 5: Driver DC Test Circuit**



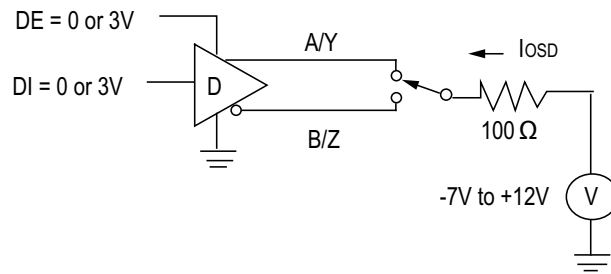
**Figure 6: Receiver DC Test Circuit**



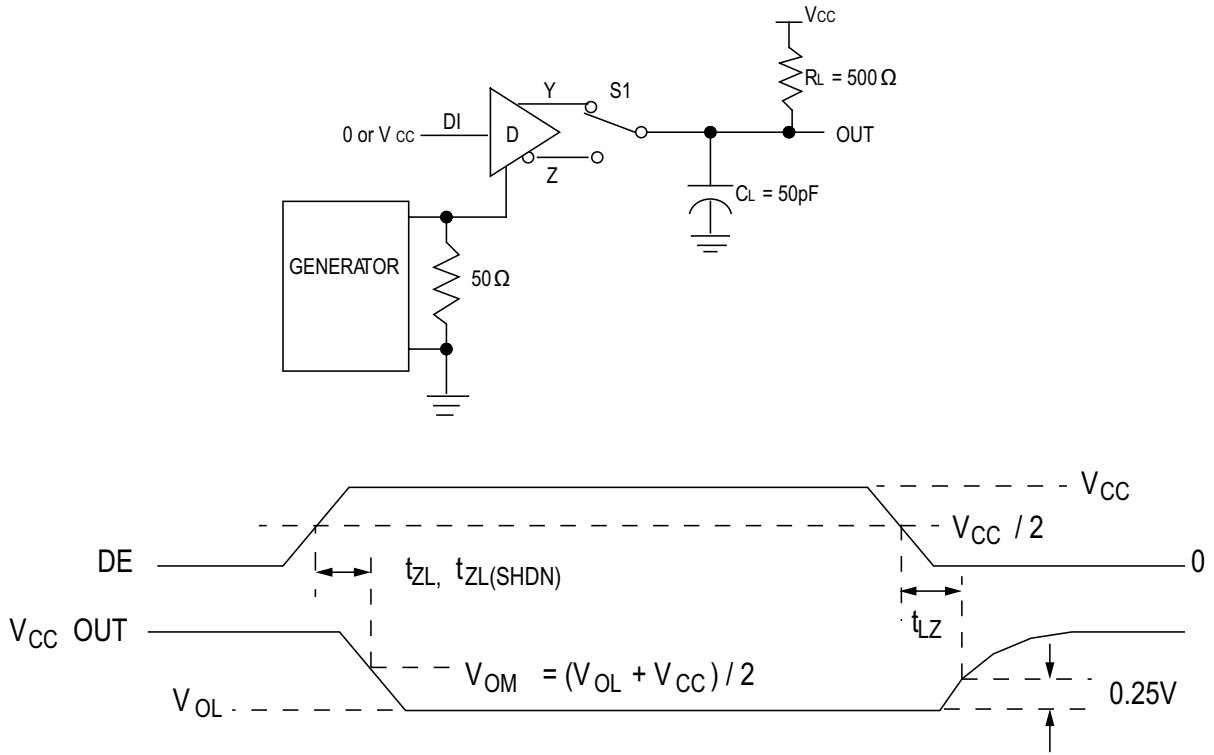
**Figure 7: Driver Propagation Delay Time Test Circuit and Timing Diagram**



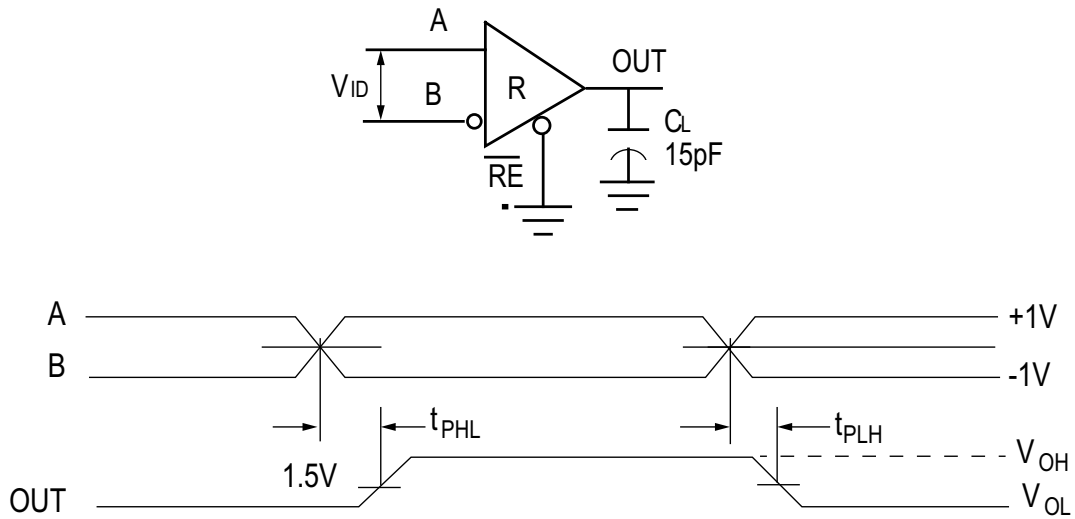
**Figure 8: Driver Enable and Disable Times Test Circuit and Timing Diagram**



**Figure 9: Driver Contention Test**

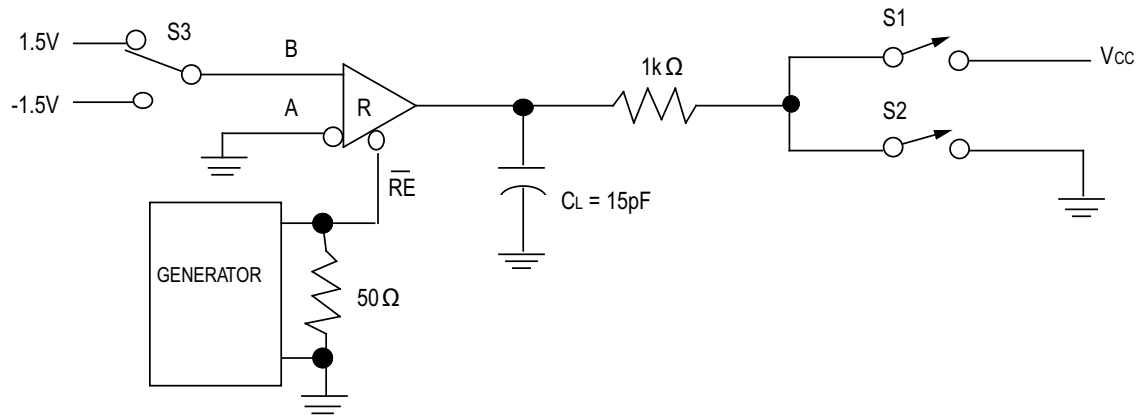


**Figure 10: Driver Enable and Disable Times Test Circuit and Timing Diagram**

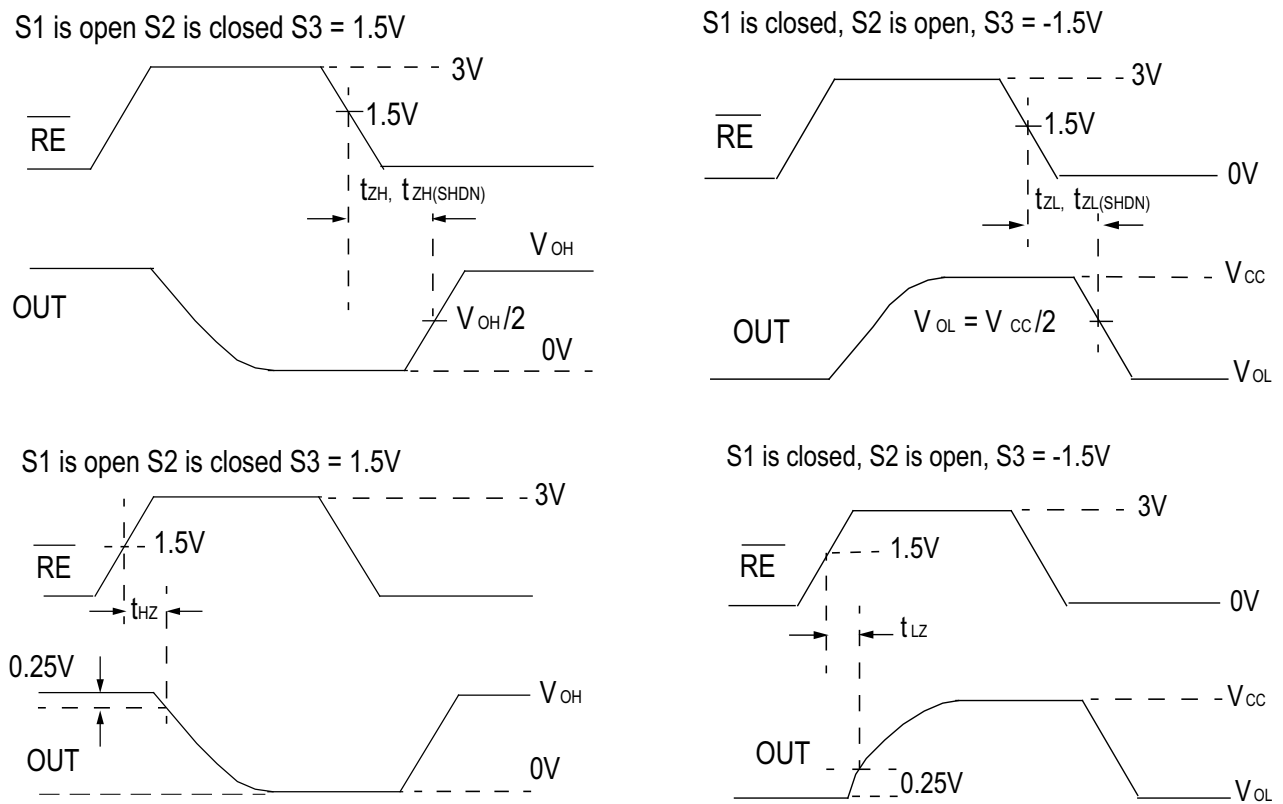


**Figure 11: Receiver Propagation Delay Test Circuit and Timing Diagram**





**Figure 12: Receiver Enable and Disable Times Test Circuit**



**Figure 13: Receiver Enable and Disable Timing Diagram**

## Function Tables

**Table 10: SP3070E, SP3073E, SP3076E (Full Duplex)**

| Transmitting           |    |    |          |   |
|------------------------|----|----|----------|---|
| Inputs                 |    |    | Outputs  |   |
| $\overline{\text{RE}}$ | DE | DI | Z        | Y |
| X                      | 1  | 1  | 0        | 1 |
| X                      | 1  | 0  | 1        | 0 |
| 0                      | 0  | X  | High-Z   |   |
| 1                      | 0  | X  | Shutdown |   |

**Table 11: SP3070E, SP3073E, SP3076E (Full Duplex)**

| Receiving              |    |               |          |
|------------------------|----|---------------|----------|
| Inputs                 |    |               | Output   |
| $\overline{\text{RE}}$ | DE | A B           | RO       |
| 0                      | X  | -50mV         | 1        |
| 0                      | X  | -200mV        | 0        |
| X                      | X  | Open, Shorted | 1        |
| 1                      | 1  | X             | High-Z   |
| 1                      | 0  | X             | Shutdown |

**Table 12: SP3071E, SP3074E, SP3077E (Full Duplex)**

| Transmitting |         |   |
|--------------|---------|---|
| Input        | Outputs |   |
| DI           | Z       | Y |
| 1            | 0       | 1 |
| 0            | 1       | 0 |

**Table 13: SP3071E, SP3074E, SP3077E (Full Duplex)**

| Receiving      |        |
|----------------|--------|
| Inputs         | Output |
| A, B           | RO     |
| -50mV          | 1      |
| -200mV         | 0      |
| Open / shorted | 1      |

**Table 14: SP3072E, SP3075E, SP3078E (Half Duplex)**

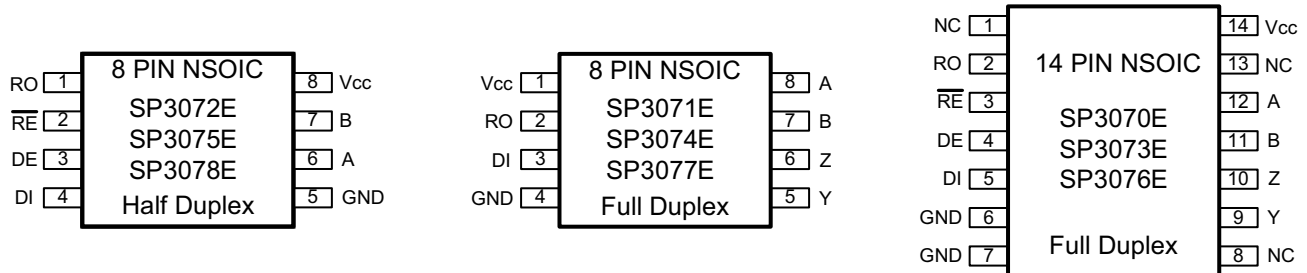
| Transmitting           |    |    |          |       |
|------------------------|----|----|----------|-------|
| Inputs                 |    |    | Outputs  |       |
| $\overline{\text{RE}}$ | DE | DI | B / Z    | A / Y |
| X                      | 1  | 1  | 0        | 1     |
| X                      | 1  | 0  | 1        | 0     |
| 0                      | 0  | X  | High-Z   |       |
| 1                      | 0  | X  | Shutdown |       |

**Table 15: SP3072E, SP3075E, SP3078E (Half Duplex)**

| Receiving              |    |                |          |
|------------------------|----|----------------|----------|
| Inputs                 |    |                | Output   |
| $\overline{\text{RE}}$ | DE | A B            | RO       |
| 0                      | X  | -50mV          | 1        |
| 0                      | X  | -200mV         | 0        |
| X                      | X  | Open / shorted | 1        |
| 1                      | 1  | X              | High-Z   |
| 1                      | 0  | X              | Shutdown |

# Pin Information

## Pin Configurations



**Figure 14: Pin Configurations**

## Pin Descriptions

**Table 16: Pin Descriptions**

| Pin Number          |         |                     | Pin Name        | Pin Function   |
|---------------------|---------|---------------------|-----------------|--|
| Full Duplex Devices |         | Half Duplex Devices |                 |  |
| SP3070E             | SP3071E | SP3072E             | RO              | Receiver Output. When $\overline{RE}$ is low and if (A-B) $\geq$ -50mV, RO is High. If (A-B) $\leq$ -200mV, RO is low.   |
| SP3073E             | SP3074E | SP3075E             |                 |  |
| SP3076E             | SP3077E | SP3078E             |                 |  |
|                     |         |                     |                 |  |
| 3                   | -       | 2                   | $\overline{RE}$ | Receiver Output Enable. When $\overline{RE}$ is low, RO is enabled. When $\overline{RE}$ is high, RO is high impedance. $\overline{RE}$ should be high and DE low to enter shutdown mode. $\overline{RE}$ is a hot swap input. |
| 4                   | -       | 3                   | DE              | Driver Output Enable. When DE is high, outputs are enabled. When DE is low, outputs are high impedance. DE should be low and $\overline{RE}$ high to enter shutdown mode. DE is a hot-swap input.                              |
| 5                   | 3       | 4                   | DI              | Driver Input. With DE high, a low level on DI forces noninverting output low and inverting output high. Similarly, a high level on DI forces noninverting output high and inverting output low.                                |
| 6, 7                | 4       | 5                   | GND             | Ground   |
| 9                   | 5       | -                   | Y               | Noninverting Driver Output   |
| 10                  | 6       | -                   | Z               | Inverting Driver Output  |
| 11                  | 7       | -                   | B               | Inverting Receiver Input   |
| -                   | -       | 7                   | B               | Inverting Receiver Input and Inverting Driver Output   |
| 12                  | 8       | -                   | A               | Noninverting Receiver Input  |
| -                   | -       | 6                   | A               | Noninverting Receiver Input and Noninverting Driver Output   |
| 14                  | 1       | 8                   | V <sub>CC</sub> | Positive Supply V <sub>CC</sub> . Bypass V <sub>CC</sub> to GND with a 0.1 $\mu$ F capacitor   |
| 1, 8, 13            | -       | -                   | NC              | No connect.  |

## Detailed Description

The SP307XE family of high speed transceivers for RS-485/RS-422 communication contain one driver and one receiver. These devices feature fail-safe circuitry, which guarantees a logic-high receiver output when the receiver inputs are open or shorted, or when they are connected to a terminated transmission line with all drivers disabled. The SP3070E, SP3072E, SP3073E, SP3075E, SP3076E and SP3078E also feature a hot-swap capability allowing live insertion without error data transfer. The SP3070E, SP3071E and SP3072E feature reduced slew-rate drivers that minimize EMI and reduce reflections caused by improperly terminated cables, allowing error-free data transmission up to 250kbps. The SP3073E, SP3074E and SP3075E also offer slew-rate limits allowing transmit speeds up to 500kbps. The SP3076E, SP3077E, SP3078E driver slew rates are not limited, making transmit speeds up to 16Mbps possible.

The SP3072E, SP3075E and SP3078E are half-duplex transceivers, while the SP3070E, SP3071E, SP3073E, SP3074E, SP3076E and SP3077E are full duplex transceivers.

All devices operate from a single 3.3V supply. Drivers are output short-circuit current limited. Thermal-shutdown circuitry protects drivers against excessive power dissipation. When activated, the thermal-shutdown circuitry places the driver outputs into a high-impedance state.

### Receiver Input Filtering

SP3070E-SP3075E receivers incorporate input filtering in addition to input hysteresis. This filtering enhances noise immunity with differential signals that have very slow rise and fall times. Receiver propagation delay increases by 25% due to this filtering.

### Fail Safe

The SP3070E family guarantees a logic-high receiver output when the receiver inputs are shorted, open, or when they are connected to a terminated transmission line with all drivers disabled. If A - B is less than or equal to -200mV, RO is logic low. In the case of a terminated bus with all transmitters disabled, the receiver's differential input voltage is pulled to 0V by the termination. With the receiver thresholds of the SP3070E family, this results in a logic high with a 50mV minimum noise margin. In compliance with the EIA / TIA-485 standard, the SP3070E family has a 50mV - 200mV threshold.

### Hot-Swap Capability

When circuit boards are inserted into a hot backplane, differential disturbances to the data bus can lead to data errors. Upon initial circuit board insertion, the data communication processor undergoes its own power-up sequence. During this period, the processor's logic-output drivers are high impedance and are unable to drive the DE and  $\overline{RE}$  inputs of these devices to a defined logic level. Leakage currents up to 10 $\mu$ A from the high-impedance state of the processor's logic drivers could cause standard CMOS enable inputs of a transceiver to drift to an incorrect logic level. Additionally, parasitic circuit board capacitance could cause coupling of  $V_{CC}$  or GND to the enable inputs. Without the hot-swap capability, these factors could improperly enable the transceiver's driver or receiver.

When  $V_{CC}$  rises, an internal pulldown circuit holds DE low and  $\overline{RE}$  high for approximately 10 microseconds. After the initial power-up sequence, the pulldown circuit becomes transparent, resetting the hot-swap tolerable input.

### 15kV ESD Protection

As with all MaxLinear devices, ESD-protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The driver output and receiver inputs of the SP3070E family of devices have extra protection against static electricity. MaxLinear's engineering team have developed state of the art structures to protect these pins against ESD of 15kV without damage. The ESD structures withstand high ESD in all states: normal operation, shutdown and powered down. After an ESD event, the SP3070E - SP3078E keep working without latchup or damage.

ESD protection can be tested in various ways. The transmitter outputs and receiver inputs of the SP3070E - SP3078E are characterized for protection to the following limits:

- $\pm 15$ kV using the Human Body Model
- $\pm 8$ kV using the Contact Discharge method specified in IEC 61000-4-2
- $\pm 15$ kV Airgap

## ESD Test Conditions

ESD performance depends on a variety of conditions. Contact MaxLinear for a reliability report that documents test setup, methodology and results.

## IEC 61000-4-2

The IEC 61000-4-2 standard covers ESD testing and performance of finished equipment. However, it does not specifically refer to integrated circuits. The SP3070E family of devices helps you design equipment to meet IEC 61000-4-2, without the need for additional ESD-protection components.

The major difference between tests done using the Human Body Model and IEC 61000-4-2 is higher peak current in IEC 61000-4-2, because series resistance is lower in the IEC 1000-4-2 model. Hence, the ESD withstand voltage measured to IEC 61000-4-2 is generally lower than that measured using the Human Body Model.

The air-gap test involves approaching the device with a charged probe. The contact-discharge method connects the probe to the device before the probe is energized.

## Machine Model

The machine model for ESD tests all pins using a 200pF storage capacitor and zero discharge resistance. The objective is to emulate the stress caused when I/O pins are contacted by handling equipment during test and assembly.

## 256 Transceivers on the Bus

The standard RS-485 receiver input impedance is 12k $\Omega$  (1 unit load), and the standard driver can drive up to 32 unit loads. The SP3070E family of transceivers has a 1/8-unit load receiver input impedance (96k $\Omega$ ), allowing up to 256 transceivers to be connected in parallel on one communication line. Any combination of these devices as well as other RS-485 transceivers with a total of 32 unit loads or fewer can be connected to the line.

## Reduced EMI and Reflections

The SP3070E, SP3071E and SP3072E feature reduced slew-rate drivers that minimize EMI and reduce reflections caused by improperly terminated cables, allowing error-

free data transmission up to 250kbps. The SP3073E, SP3074E and SP3075E offer higher driver output slew-rate limits, allowing transmit speeds up to 500kbps.

## Low Power Shutdown Mode

Low-power shutdown mode is initiated by bringing both  $\overline{RE}$  high and DE low. In shutdown, the devices typically draw only 50nA of supply current.

$\overline{RE}$  and DE can be driven simultaneously; the parts are guaranteed not to enter shutdown if  $\overline{RE}$  is high and DE is low for less than 50ns. If the inputs are in this state for at least 600ns, the parts are guaranteed to enter shutdown.

Enable times  $t_{ZH}$  and  $t_{ZL}$  assume the part was not in a low-power shutdown state. Enable times  $t_{ZH(SHDN)}$  and  $t_{ZL(SHDN)}$  assume the parts were shut down. It takes drivers and receivers longer to become enabled from low-power shutdown mode  $t_{ZH(SHDN)}$  and  $t_{ZL(SHDN)}$  than from driver / receiver-disable mode ( $t_{ZH}$ ,  $t_{ZL}$ ).

## Driver Output Protection

Two mechanisms prevent excessive output current and power dissipation caused by faults or by bus contention. First, current limit on the output stage, provides immediate protection against short circuits over the whole common-mode voltage range.

Second, a thermal-shutdown circuit, forces the driver outputs into a high-impedance state if the die temperature becomes excessive.

## Line Length

The RS-485/RS422 standard covers line lengths up to 4000ft.

## Typical Applications

The SP3072E, SP3075E and SP3078E transceivers are designed for bidirectional data communications on multipoint bus transmission lines.

To minimize reflections, terminate the line at both ends in its characteristic impedance, and keep stub lengths off the main line as short as possible. The slew-rate-limited SP3070E - SP3075E are more tolerant of imperfect termination.

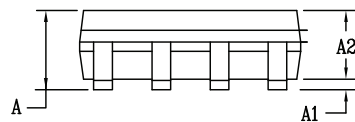
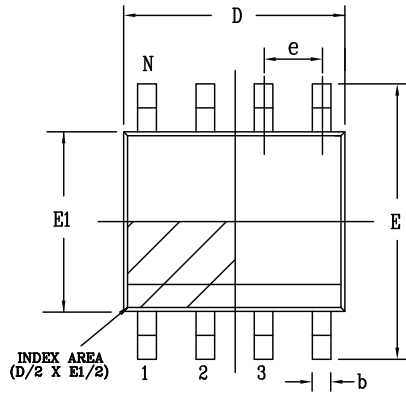
## Parts Selector Guide

**Table 17: Parts Selector Guide**

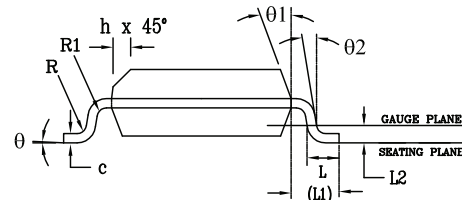
| Part Number | Half / Full Duplex | Data Rate (Mbps) | Shutdown | Receiver Driver Enable | Transceivers on Bus | Pin Count | Industry Standard Pinout | Pin Compatible Upgrade from: |
|-------------|--------------------|------------------|----------|------------------------|---------------------|-----------|--------------------------|------------------------------|
| SP3070E     | Full               | 0.25             | Yes      | Yes                    | 256                 | 14        | MAX3070E, 75180          |                              |
| SP3071E     | Full               | 0.25             | No       | No                     | 256                 | 8         | MAX3071E, 75179          | SP3493                       |
| SP3072E     | Half               | 0.25             | Yes      | Yes                    | 256                 | 8         | MAX3072E, 75176          | SP3483                       |
| SP3073E     | Full               | 0.5              | Yes      | Yes                    | 256                 | 14        | MAX3073E, 75180          |                              |
| SP3074E     | Full               | 0.5              | No       | No                     | 256                 | 8         | MAX3074E, 75179          |                              |
| SP3075E     | Half               | 0.5              | Yes      | Yes                    | 256                 | 8         | MAX3075E, 75176          | SP3494                       |
| SP3076E     | Full               | 16               | Yes      | Yes                    | 256                 | 14        | MAX3076E, 75180          | SP3491                       |
| SP3077E     | Full               | 16               | No       | No                     | 256                 | 8         | MAX3077E, 75179          | SP3490                       |
| SP3078E     | Half               | 16               | Yes      | Yes                    | 256                 | 8         | MAX3078E, 75176          | SP3485, SP3481               |

# Mechanical Dimensions

## NSOIC8



Side View



Front View

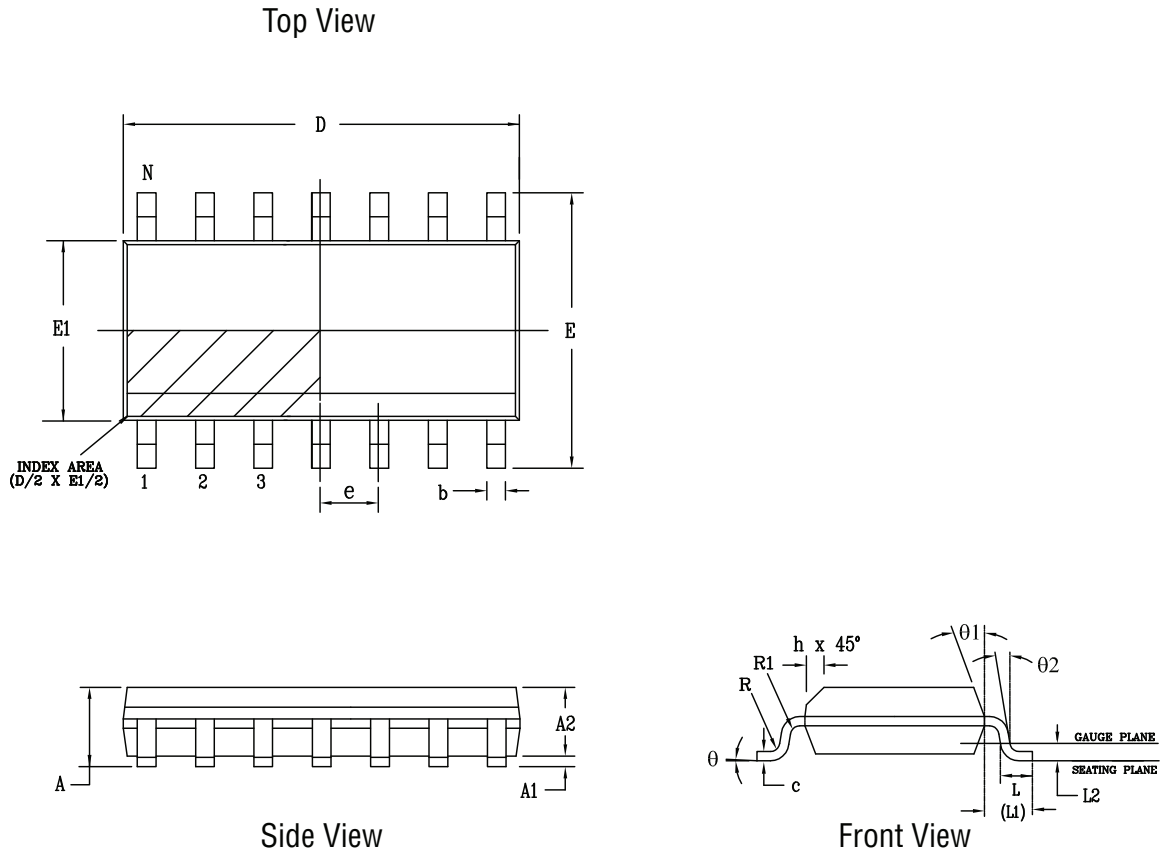
| PACKAGE OUTLINE NSOIC .150" BODY<br>JEDEC MS-012 VARIATION AA |   |     |      |   |     |       |
|---|---|-----|------|---|-----|-------|
| SYMBOLS   | COMMON DIMENSIONS IN MM<br>(Control Unit) |     |      | COMMON DIMENSIONS IN INCH<br>(Reference Unit) |     |       |
|   | MIN                                       | 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   |     |       |

Drawing No: POD-00000108  
Revision: A

Figure 15: Mechanical Dimension, NSOIC8

# Mechanical Dimensions

## NSOIC14



| PACKAGE OUTLINE NSOIC .150" BODY<br>JEDEC MS-012 VARIATION AB |   |     |      |   |     |       |
|---|---|-----|------|---|-----|-------|
| SYMBOLS   | COMMON DIMENSIONS IN MM<br>(Control Unit) |     |      | COMMON DIMENSIONS IN INCH<br>(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

**Figure 16: Mechanical Dimensions, NSOIC14**



## Ordering Information

**Table 18: Ordering Information**

| Ordering Part Number | Operating Temperature Range | Package | Packaging Method | Lead-Free <sup>(2)</sup> | Duplex / Data Rate |
|----------------------|-----------------------------|---------|------------------|--------------------------|--------------------|
| SP3070E              |                             |         |                  |                          |                    |
| SP3070EEN-L          | -40°C to 85°C               | NSOIC14 | Tube             | Yes                      | Full / 250kbps     |
| SP3070EEN-L/TR       | -40°C to 85°C               | NSOIC14 | Reel             | Yes                      | Full / 250kbps     |
| SP3071E              |                             |         |                  |                          |                    |
| SP3071EEN-L          | -40°C to 85°C               | NSOIC8  | Tube             | Yes                      | Full / 250kbps     |
| SP3071EEN-L/TR       | -40°C to 85°C               | NSOIC8  | Reel             | Yes                      | Full / 250kbps     |
| SP3072E              |                             |         |                  |                          |                    |
| SP3072EEN-L          | -40°C to 85°C               | NSOIC8  | Tube             | Yes                      | Half / 250kbps     |
| SP3072EEN-L/TR       | -40°C to 85°C               | NSOIC8  | Reel             | Yes                      | Half / 250kbps     |
| SP3072EMN-L/TR       | -40°C to 125°C              | NSOIC8  | Reel             | Yes                      | Half / 250kbps     |
| SP3073E              |                             |         |                  |                          |                    |
| SP3073EEN-L/TR       | -40°C to 85°C               | NSOIC14 | Reel             | Yes                      | Full / 500kbps     |
| SP3074E              |                             |         |                  |                          |                    |
| SP3074EEN-L/TR       | -40°C to 85°C               | NSOIC8  | Reel             | Yes                      | Full / 500kbps     |
| SP3075E              |                             |         |                  |                          |                    |
| SP3075EEN-L          | -40°C to 85°C               | NSOIC8  | Tube             | Yes                      | Half / 500kbps     |
| SP3075EEN-L/TR       | -40°C to 85°C               | NSOIC8  | Reel             | Yes                      | Half / 500kbps     |
| SP3076E              |                             |         |                  |                          |                    |
| SP3076EEN-L          | -40°C to 85°C               | NSOIC14 | Tube             | Yes                      | Full / 16Mbps      |
| SP3076EEN-L/TR       | -40°C to 85°C               | NSOIC14 | Reel             | Yes                      | Full / 16Mbps      |
| SP3076EMN-L/TR       | -40°C to 125°C              | NSOIC14 | Reel             | Yes                      | Full / 16Mbps      |
| SP3077E              |                             |         |                  |                          |                    |
| SP3077EEN-L          | -40°C to 85°C               | NSOIC8  | Tube             | Yes                      | Full / 16Mbps      |
| SP3077EEN-L/TR       | -40°C to 85°C               | NSOIC8  | Reel             | Yes                      | Full / 16Mbps      |
| SP3078E              |                             |         |                  |                          |                    |
| SP3078EEN-L          | -40°C to 85°C               | NSOIC8  | Tube             | Yes                      | Half / 16Mbps      |
| SP3078EEN-L/TR       | -40°C to 85°C               | NSOIC8  | Reel             | Yes                      | Half / 16Mbps      |
| SP3078EMN-L/TR       | -40°C to 125°C              | NSOIC8  | Reel             | Yes                      | Half / 16Mbps      |

1. Refer to <http://www.maxlinear.com/SP3070E>, <http://www.maxlinear.com/SP3071E>, <http://www.maxlinear.com/SP3072E>, <http://www.maxlinear.com/SP3073E>, <http://www.maxlinear.com/SP3074E>, <http://www.maxlinear.com/SP3075E>, <http://www.maxlinear.com/SP3076E>, <http://www.maxlinear.com/SP3077E> and <http://www.maxlinear.com/SP3078E> for most up-to-date Ordering Information.

2. Visit [www.maxlinear.com](http://www.maxlinear.com) for additional information on Environmental Rating.