

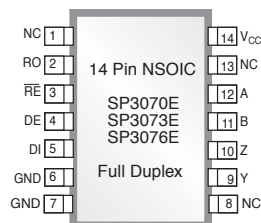
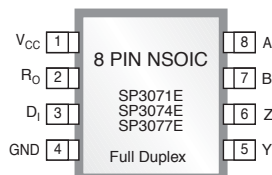
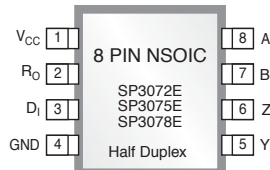


## SP3070E - SP3078E Family

### **±15kV ESD-Protected, 3.3V, 1/8 Load, Failsafe RS-485/RS422 Transceivers**

#### FEATURES

- ±15kV ESD protection for RS485 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 foot-prints
  - SP3070E, 3073 and 3076 in Full-Duplex (14 pin)
  - SP3071E, 3074 and 3077 in Full-Duplex (8 pin)
  - SP3072E, 3075 and 3078 in Full-Duplex (8 pin)
- Three applications-optimized speed grades
  - SP3070-72E: 250kbps slew-limited
  - SP3073-75E: 500kbps slew-limited
  - SP3076-78E: 16Mbps high speed
- Small form factor SO-narrow packages
- Industrial (-40 to +85°C) and Extended (-40 to +85°C) temperature grades



*Now Available in Lead Free Packaging*

#### APPLICATIONS

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

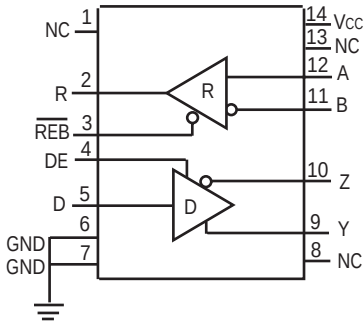
#### DESCRIPTION

The SP3070-3078E differential line transceivers are suitable for bidirectional communication on balanced multipoint bus transmission lines and comply with both RS485 and RS422 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 RS485 inputs are ESD protected up to ±15kV (Air-Gap and Human Body Model) and up to ±8kV Contact discharge (IEC 1000-4-2).

## DEVICE ARCHITECTURE AND BLOCK DIAGRAMS

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

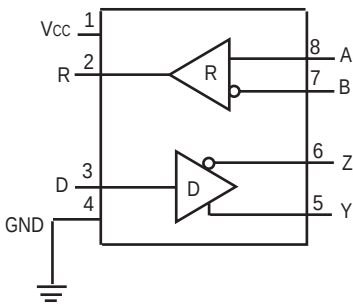


### 14 Pin Full Duplex:

SP3070E, 250kbps slew limited

SP3073E, 500kbps slew limited

SP3076E, 16Mbps

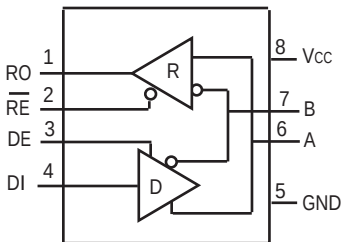


### 8 Pin Full Duplex:

SP3071E, 250kbps slew limited

SP3074E, 500kbps slew limited

SP3077E, 16Mbps



### 8 Pin Half Duplex:

SP3072E, 250kbps slew limited

SP3075E, 500kbps slew limited

SP3078E, 16Mbps

## 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.

$V_{CC}$ .....+6.0V  
Input Voltage at control input pins ( $\overline{RE}$ , DE).....-0.3V to 6V  
Driver Input Voltage ( $\overline{RE}$ , DE).....-0.3V to 6V  
Driver Output Voltage (A, B, Y, & Z).....-8V to +13V  
Receiver Input Voltage (A, B).....-8V to +13V

Continuous Power Dissipation at  $T_a = 70^\circ\text{C}$

8-pin SO (derate 5.88mW/ $^\circ\text{C}$  above  $+70^\circ\text{C}$ ).....471mW

8-pin PDIP (derate 9.29mW/ $^\circ\text{C}$  above  $+70^\circ\text{C}$ ).....727mW

14-pin SO (derate 8.33mW/ $^\circ\text{C}$  above  $+70^\circ\text{C}$ ).....667mW

14-pin PDIP (derate 10mW/ $^\circ\text{C}$  above  $+70^\circ\text{C}$ ).....800mW

Operating Temperature Ranges

SP307\_EMN.....-40 $^\circ\text{C}$  to +125 $^\circ\text{C}$

SP307\_EEN.....-40 $^\circ\text{C}$  to +85 $^\circ\text{C}$

Junction Temperature.....+150 $^\circ\text{C}$

Storage Temperature Range.....-65 $^\circ\text{C}$  to +150 $^\circ\text{C}$

Lead Temperature (soldering, 10s).....+300 $^\circ\text{C}$

## ELECTRICAL CHARACTERISTICS

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

| PARAMETER                                          | SYM.              | MIN. | TYP.       | MAX.      | UNITS         | $\blacklozenge$ | CONDITIONS                                                               |
|----------------------------------------------------|-------------------|------|------------|-----------|---------------|-----------------|--------------------------------------------------------------------------|
| Differential Driver Output                         | $V_{OD}$          | 2    |            | $V_{CC}$  | V             |                 | RL = 100 $\Omega$ (RS-422), Figure 1                                     |
|                                                    |                   | 1.5  |            | $V_{CC}$  |               |                 | RL = 54 $\Omega$ (RS-485), Figure 1                                      |
|                                                    |                   |      |            | $V_{CC}$  |               | $\blacklozenge$ | No Load                                                                  |
| Change in Magnitude of Differential Output Voltage | $\Delta V_{OD}$   |      |            | 0.2       | V             | $\blacklozenge$ | RL = 54 or 100 $\Omega$ , Figure 1                                       |
| Driver Common Mode Output Voltage                  | $V_{OC}$          |      | $V_{CC}/2$ | 3         | V             | $\blacklozenge$ | RL = 54 or 100 $\Omega$ , Figure 1                                       |
| Change in Magnitude of Common Mode Output Voltage  | $ \Delta V_{OC} $ |      |            | $\pm 0.2$ | V             |                 | RL = 54 or 100 $\Omega$ , Figure 1                                       |
| Input High Voltage                                 | $V_{IH}$          | 2    |            |           | V             | $\blacklozenge$ | DE, DI, $\overline{RE}$                                                  |
| Input Low Voltage                                  | $V_{IL}$          |      |            | 0.8       | V             |                 | DE, DI, $\overline{RE}$                                                  |
| Input Hysteresis                                   | $V_{HYS}$         |      | 100        |           | mV            | $\blacklozenge$ | DE, DI, $\overline{RE}$                                                  |
| Input Current                                      | $I_{IN}$          | -1   |            | 1         | $\mu\text{A}$ | $\blacklozenge$ | DE, DI, $\overline{RE}$                                                  |
| Input Impedance First Transition (Hotswap)         |                   | 1    |            | 10        | k $\Omega$    | $\blacklozenge$ | DE, $\overline{RE}$<br>First transition will draw more current (Hotswap) |
| Output Leakage (Y and Z) Full Duplex (A and B)     | $I_O$             |      |            | +125      | $\mu\text{A}$ | $\blacklozenge$ | DE = GND<br>$V_{IN} = +12\text{V}$                                       |
|                                                    |                   | -100 |            |           |               | $\blacklozenge$ | $V_{CC} = \text{GND or } 3.6\text{V}$<br>$V_{IN} = -7\text{V}$           |
| Driver Short-Circuit Current                       | $I_{OSD}$         | 0    |            | $\pm 250$ | mA            |                 | $-7\text{V} \leq V_{OUT} \leq 12\text{V}$ , (Figure 4A)                  |
|                                                    |                   | -250 |            | 0         |               |                 |                                                                          |

## ELECTRICAL CHARACTERISTICS

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

| PARAMETERS                                       | SYM             | MIN            | TYP  | MAX      | UNITS      | ♦ | CONDITIONS                                        |
|--------------------------------------------------|-----------------|----------------|------|----------|------------|---|---------------------------------------------------|
| Input Current (A and B)<br>Half Duplex           | $I_{A,B}$       |                |      | 125      | $\mu A$    | ♦ | DE = GND<br>$V_{CC} = GND$ or 3.6                 |
|                                                  |                 | -100           |      |          |            |   | $V_{IN} = +12V$<br>$V_{IN} = -7V$                 |
| Thermal-Shutdown Threshold                       | $T_{TS}$        |                | 165  |          | $^\circ C$ | ♦ |                                                   |
| Thermal Shutdown Hysteresis                      | $T_{TSH}$       |                | 15   |          | $^\circ C$ | ♦ |                                                   |
| <b>RECEIVER</b>                                  |                 |                |      |          |            |   |                                                   |
| Receiver Differential Threshold<br>(Sensitivity) | $V_{TH}$        | -200           | -125 | -50      | mV         |   | $-7V \leq V_{CM} \leq 12V$                        |
| Receiver Input Hysteresis                        | $\Delta V_{TH}$ |                | 15   |          | mV         | ♦ | $V_a + V_b = 0V$                                  |
| RO Output High Voltage                           | $V_{OH}$        | $V_{CC} - 0.6$ |      |          | V          | ♦ | $I_O = -1mA$                                      |
| RO Output Low Voltage                            | $V_{OL}$        |                |      | 0.4      | V          | ♦ | $I_O = 1mA$                                       |
| Tri-State Output Current at<br>Receiver          | $I_{OZR}$       |                |      | +/-1     | $\mu A$    | ♦ | $0 \leq V_O \leq V_{CC}$                          |
| Receiver Input Resistance                        | $R_{IN}$        | 96             |      |          | k $\Omega$ | ♦ | $-7V \leq V_{CM} \leq 12V$                        |
| Receiver Output Short-Circuit<br>Current         | $I_{OZR}$       |                |      | $\pm 60$ | mA         |   | $0V \leq V_{RO} \leq V_{CC}$                      |
| <b>SUPPLY CURRENT</b>                            |                 |                |      |          |            |   |                                                   |
| Supply Current                                   | $I_{CC}$        |                | 0.8  | 1.5      | mA         | ♦ | No Load, $\overline{RE} = 0$ , DE = $V_{CC}$      |
|                                                  |                 |                | 0.8  | 1.5      |            |   | No Load, $\overline{RE} = V_{CC}$ , DE = $V_{CC}$ |
|                                                  |                 |                | 0.8  | 1.5      |            |   | No Load, $\overline{RE} = 0$ , DE = 0             |
| Supply Current in Shutdown<br>mode               | $I_{SHDN}$      |                | 0.05 | 3        | $\mu A$    |   | $\overline{RE} = V_{CC}$ , DE = GND               |
| <b>ESD PROTECTION</b>                            |                 |                |      |          |            |   |                                                   |
| ESD Protection for Y, Z, A, and B                |                 | $\pm 15$       |      |          | kV         | ♦ | Human Body Model                                  |
|                                                  |                 | $\pm 15$       |      |          |            |   | Air Gap (IEC 1000-4-2)                            |
|                                                  |                 | $\pm 8$        |      |          |            |   | Contact (IEC 1000-4-2)                            |

## DRIVER SWITCHING CHARACTERISTICS

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

| SP3070E, SP3071E & SP3072E DRIVER SWITCHING CHARACTERISTICS |                     |      |      |      |       |                                                   |
|-------------------------------------------------------------|---------------------|------|------|------|-------|---------------------------------------------------|
| PARAMETER                                                   | SYMBOL              | MIN. | TYP. | MAX. | UNITS | CONDITIONS                                        |
| Driver Propagation Delay                                    | $t_{DPLH}$          | 250  | -    | 1500 | ns    | $C_L = 50pF$ , $R_L = 54\Omega$ ,<br>Figure 2 & 3 |
|                                                             | $t_{DPHL}$          | 250  | -    | 1500 | ns    |                                                   |
| Driver Differential Output Rise or Fall Time                | $t_{DR}$ , $t_{DF}$ | 350  | -    | 1600 | ns    | $C_L = 50pF$ , $R_L = 54\Omega$ ,<br>Figure 2 & 3 |
| Driver Differential Output Skew ( $t_{DPLH} - t_{DPHL}$ )   | $t_{DSKEW}$         | -    | -    | 200  | ns    | $C_L = 50pF$ , $R_L = 54\Omega$ ,<br>Figure 2 & 3 |
| Maximum Data Rate                                           |                     | 250  | -    | -    | kbps  |                                                   |
| Driver Enable to Output High                                | $t_{DZH}$           | -    | -    | 2500 | ns    | Figure 4                                          |
| Driver Enable to Output Low                                 | $t_{DZL}$           | -    | -    | 2500 | ns    | Figure 5                                          |
| Driver Disable Time from Low                                | $t_{DLZ}$           | -    | -    | 100  | ns    | Figure 5                                          |
| Driver Disable Time from High                               | $t_{DHZ}$           | -    | -    | 100  | ns    | Figure 4                                          |
| Driver Enable from Shutdown to Output High                  | $t_{DZH(SHDN)}$     | -    | -    | 5500 | ns    | Figure 4                                          |
| Driver Enable from Shutdown to Output Low                   | $t_{DZL(SHDN)}$     | -    | -    | 5500 | ns    | Figure 5                                          |
| Time to Shutdown                                            | $t_{SHDN}$          | 50   | 200  | 600  | ns    |                                                   |

## RECEIVER SWITCHING CHARACTERISTICS

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

| Receiver Switching Characteristics SP3070, SP3071 & SP3072 |                 |      |      |      |       |                             |
|------------------------------------------------------------|-----------------|------|------|------|-------|-----------------------------|
| PARAMETER                                                  | SYMBOL          | MIN. | TYP. | MAX. | UNITS | CONDITIONS                  |
| Receiver Propagation Delay                                 | $t_{RPLH}$      | -    | -    | 200  | ns    | $C_L = 15pF$ , Figure 6 & 7 |
|                                                            | $t_{RPHL}$      | -    | -    | 200  | ns    |                             |
| Receiver Output Skew ( $t_{DPLH} - t_{DPHL}$ )             | $t_{RSKEW}$     | -    | -    | 30   | ns    | $C_L = 15pF$ , Figure 6 & 7 |
| Data Rate                                                  |                 | 250  | -    | -    | kbps  |                             |
| Receiver Enable to Output High                             | $t_{RZH}$       | -    | -    | 50   | ns    | Figure 8                    |
| Receiver Enable to Output Low                              | $t_{RZL}$       | -    | -    | 50   | ns    | Figure 8                    |
| Receiver Disable Time from Low                             | $t_{RLZ}$       | -    | -    | 200  | ns    | Figure 8                    |
| Receiver Disable Time from High                            | $t_{RHZ}$       | -    | -    | 100  | ns    | Figure 8                    |
| Receiver Enable from Shutdown to Output High               | $t_{RZH(SHDN)}$ | -    | -    | 4000 | ns    | Figure 8                    |
| Receiver Enable from Shutdown to Output Low                | $t_{RZL(SHDN)}$ | -    | -    | 4000 | ns    | Figure 8                    |

## DRIVER SWITCHING CHARACTERISTICS

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

| SP3073E, SP3074E & SP3075E DRIVER SWITCHING CHARACTERISTICS |                     |      |      |      |       |                                                   |
|-------------------------------------------------------------|---------------------|------|------|------|-------|---------------------------------------------------|
| PARAMETER                                                   | SYMBOL              | MIN. | TYP. | MAX. | UNITS | CONDITIONS                                        |
| Driver Propagation Delay                                    | $t_{DPLH}$          | 180  | -    | 800  | ns    | $C_L = 50pF$ , $R_L = 54\Omega$ ,<br>Figure 2 & 3 |
|                                                             | $t_{DPHL}$          | 180  | -    | 800  | ns    |                                                   |
| Driver Differential Output Rise or Fall Time                | $t_{DR}$ , $t_{DF}$ | 200  | -    | 800  | ns    | $C_L = 50pF$ , $R_L = 54\Omega$ ,<br>Figure 2 & 3 |
| Driver Differential Output Skew ( $t_{DPLH} - t_{DPHL}$ )   | $t_{DSKEW}$         | -    | -    | 100  | ns    | $C_L = 50pF$ , $R_L = 54\Omega$ ,<br>Figure 2 & 3 |
| Data Rate                                                   |                     | 500  | -    | -    | kbps  |                                                   |
| Driver Enable to Output High                                | $t_{DZH}$           | -    | -    | 2500 | ns    | Figure 4                                          |
| Driver Enable to Output Low                                 | $t_{DZL}$           | -    | -    | 2500 | ns    | Figure 5                                          |
| Driver Disable Time from Low                                | $t_{DLZ}$           | -    | -    | 100  | ns    | Figure 5                                          |
| Driver Disable Time from High                               | $t_{DHZ}$           | -    | -    | 100  | ns    | Figure 4                                          |
| Driver Enable from Shutdown to Output High                  | $t_{DZH(SHDN)}$     | -    | -    | 4500 | ns    | Figure 4                                          |
| Driver Enable from Shutdown to Output Low                   | $t_{DZL(SHDN)}$     | -    | -    | 4500 | ns    | Figure 5                                          |
| Time to Shutdown                                            | $t_{SHDN}$          | 50   | 200  | 600  | ns    |                                                   |

## RECEIVER SWITCHING CHARACTERISTICS

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

| Receiver Switching Characteristics SP3073, SP3074 & SP3075 |                 |      |      |      |       |                             |
|------------------------------------------------------------|-----------------|------|------|------|-------|-----------------------------|
| PARAMETER                                                  | SYMBOL          | MIN. | TYP. | MAX. | UNITS | CONDITIONS                  |
| Receiver Propagation Delay                                 | $t_{RPLH}$      | -    | -    | 200  | ns    | $C_L = 15pF$ , Figure 6 & 7 |
|                                                            | $t_{RPHL}$      | -    | -    | 200  | ns    |                             |
| Receiver Output Skew ( $t_{DPLH} - t_{DPHL}$ )             | $t_{RSKEW}$     | -    | -    | 30   | ns    | $C_L = 15pF$ , Figure 6 & 7 |
| Maximum Data Rate                                          |                 | 500  | -    | -    | kbps  |                             |
| Receiver Enable to Output High                             | $t_{RZH}$       | -    | -    | 50   | ns    | Figure 8                    |
| Receiver Enable to Output Low                              | $t_{RZL}$       | -    | -    | 50   | ns    | Figure 8                    |
| Receiver Disable Time from Low                             | $t_{RLZ}$       | -    | -    | 50   | ns    | Figure 8                    |
| Receiver Disable Time from High                            | $t_{RHZ}$       | -    | -    | 50   | ns    | Figure 8                    |
| Receiver Enable from Shutdown to Output High               | $t_{RZH(SHDN)}$ | -    | -    | 4000 | ns    | Figure 8                    |
| Receiver Enable from Shutdown to Output Low                | $t_{RZL(SHDN)}$ | -    | -    | 4000 | ns    | Figure 8                    |
| Time to Shutdown                                           | $t_{SHDN}$      | 50   | 200  | 600  | ns    |                             |

## DRIVER SWITCHING CHARACTERISTICS

Unless otherwise noted  $V_{CC}=+3.3\pm0.3V$ , ambient temperature  $T_{min} < T_a < T_{max}$ . Typical values are at  $V_{CC} = 3.3$ , ambient temperature  $T_a = +25^{\circ}C$

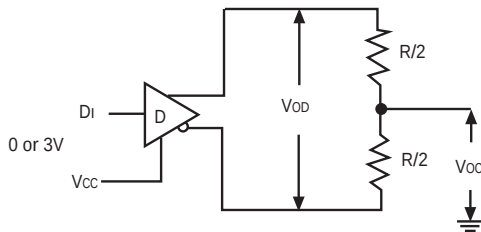
| SP3076E, SP3077E & SP3078E DRIVER SWITCHING CHARACTERISTICS  |                     |      |      |      |       |                                                   |
|--------------------------------------------------------------|---------------------|------|------|------|-------|---------------------------------------------------|
| PARAMETER                                                    | SYMBOL              | MIN. | TYP. | MAX. | UNITS | CONDITIONS                                        |
| Driver Propagation Delay                                     | $t_{DPLH}$          | -    | -    | 50   | ns    | $C_L = 50pF$ , $R_L = 54\Omega$ ,<br>Figure 2 & 3 |
|                                                              | $t_{DPHL}$          | -    | -    | 50   | ns    |                                                   |
| Driver Differential Output Rise or Fall Time                 | $t_{DR}$ , $t_{DF}$ | -    | -    | 15   | ns    | $C_L = 50pF$ , $R_L = 54\Omega$ ,<br>Figure 2 & 3 |
| Driver Differential Output Skew<br>( $t_{DPLH} - t_{DPHL}$ ) | $t_{DSKEW}$         | -    | -    | 8    | ns    | $C_L = 50pF$ , $R_L = 54\Omega$ ,<br>Figure 2 & 3 |
| Data Rate                                                    |                     | 16   | -    | -    | Mbps  |                                                   |
| Driver Enable to Output High                                 | $t_{DZH}$           | -    | -    | 150  | ns    | Figure 4                                          |
| Driver Enable to Output Low                                  | $t_{DZL}$           | -    | -    | 150  | ns    | Figure 5                                          |
| Driver Disable Time from Low                                 | $t_{DLZ}$           | -    | -    | 100  | ns    | Figure 5                                          |
| Driver Disable Time from High                                | $t_{DHZ}$           | -    | -    | 100  | ns    | Figure 4                                          |
| Driver Enable from Shutdown to Output High                   | $t_{DZH(SHDN)}$     | -    | -    | 1800 | ns    | Figure 4                                          |
| Driver Enable from Shutdown to Output Low                    | $t_{DZL(SHDN)}$     | -    | -    | 1800 | ns    | Figure 5                                          |
| Time to Shutdown                                             | $t_{SHDN}$          | 50   | 200  | 600  | ns    |                                                   |

## RECEIVER SWITCHING CHARACTERISTICS

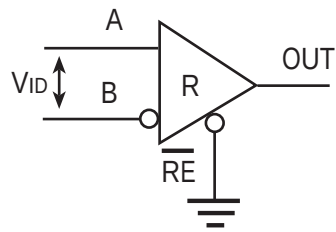
Unless otherwise noted  $V_{CC}=+3.3\pm0.3V$ , ambient temperature  $T_{min} < T_a < T_{max}$ . Typical values are at  $V_{CC} = 3.3$ , ambient temperature  $T_a = +25^{\circ}C$

| Receiver Switching Characteristics SP3076, SP3077 & SP3078 |                 |      |      |      |       |                                              |
|------------------------------------------------------------|-----------------|------|------|------|-------|----------------------------------------------|
| PARAMETER                                                  | SYMBOL          | MIN. | TYP. | MAX. | UNITS | CONDITIONS                                   |
| Receiver Propagation Delay                                 | $t_{RPLH}$      | -    | 40   | 75   | ns    | $C_L = 15pF$ , Figure 6 & 7,<br>-40 to +85°C |
|                                                            | $t_{RPHL}$      | -    | 40   | 75   | ns    |                                              |
| Receiver Output Skew ( $t_{DPLH} - t_{DPHL}$ )             | $t_{RSKEW}$     | -    | -    | 8    | ns    | $C_L = 15pF$ , Figure 6 & 7,                 |
| Data Rate                                                  |                 | 16   | -    | -    | Mbps  |                                              |
| Receiver Enable to Output High                             | $t_{RZH}$       | -    | -    | 60   | ns    | Figure 8, -40 to +85°C                       |
| Receiver Enable to Output Low                              | $t_{RZL}$       | -    | -    | 60   | ns    | Figure 8, -40 to +85°C                       |
| Receiver Disable Time from Low                             | $t_{RLZ}$       | -    | -    | 50   | ns    | Figure 8                                     |
| Receiver Disable Time from High                            | $t_{RHZ}$       | -    | -    | 50   | ns    | Figure 8                                     |
| Receiver Enable from Shutdown to Output High               | $t_{RZH(SHDN)}$ | -    | -    | 1800 | ns    | Figure 8                                     |
| Receiver Enable from Shutdown to Output Low                | $t_{RZL(SHDN)}$ | -    | -    | 1800 | ns    | Figure 8                                     |
| Time to Shutdown                                           | $t_{SHDN}$      | 50   | 200  | 600  | ns    |                                              |

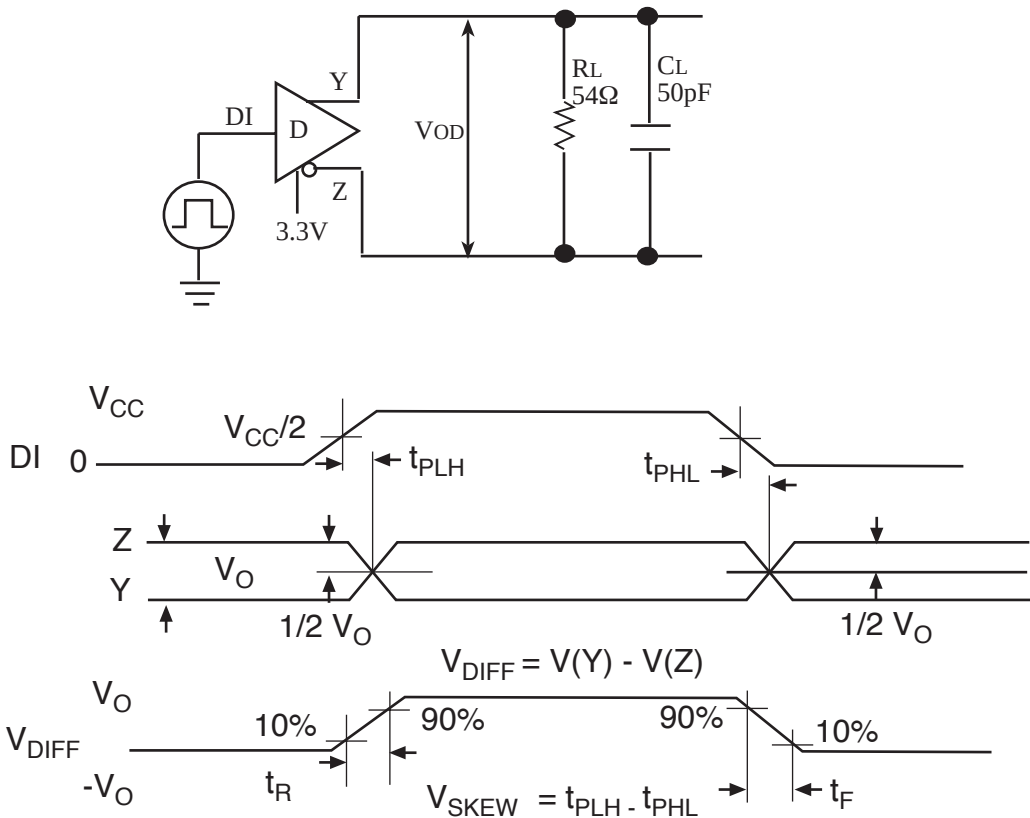
**FIGURE 1. DRIVER DC TEST CIRCUIT**



**FIGURE 2. RECEIVER DC TEST CIRCUIT**

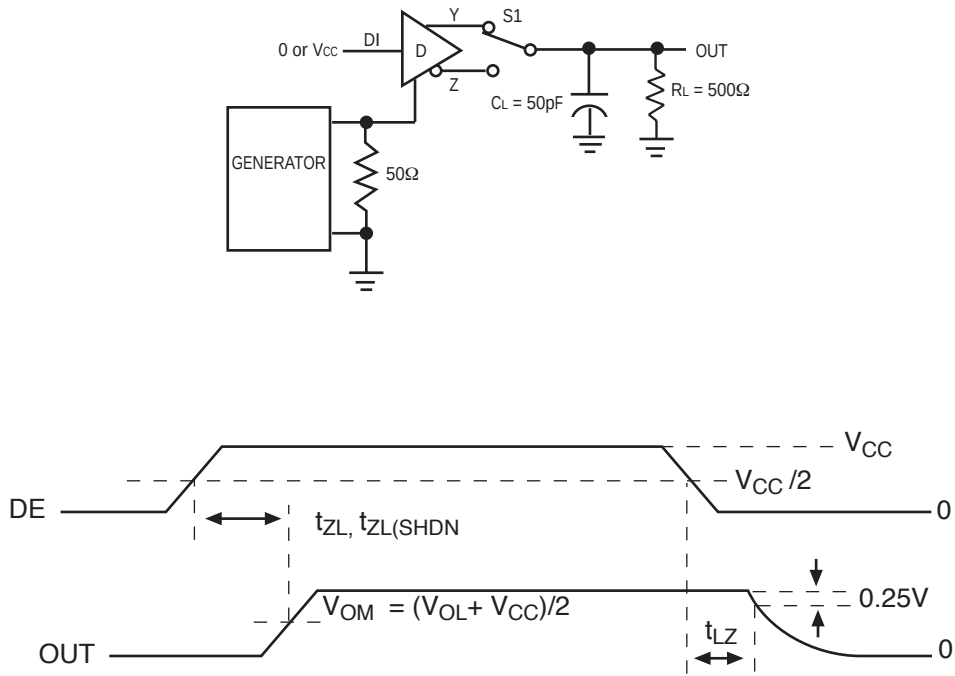


**FIGURE 3. DRIVER PROPAGATION DELAY TIME TEST CIRCUIT AND TIMING DIAGRAM**

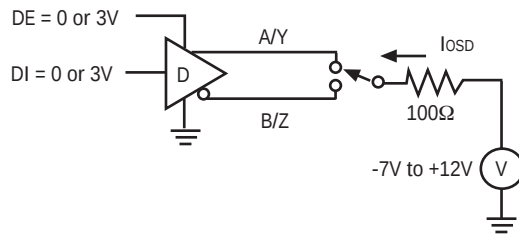




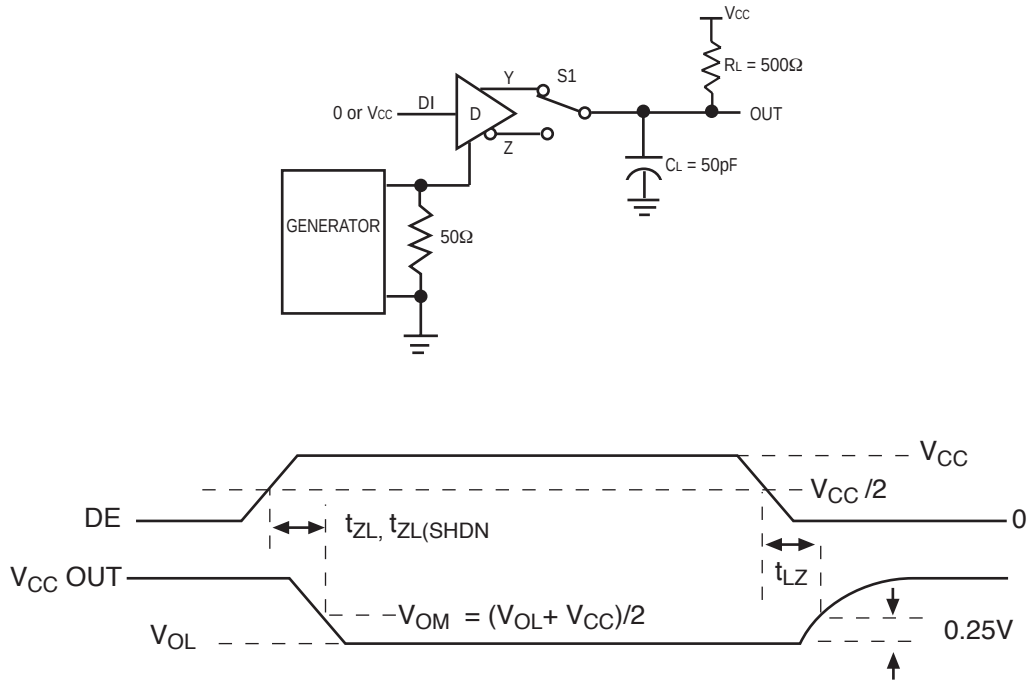
**FIGURE 4. DRIVER ENABLE & DISABLE TIMES TEST CIRCUIT & TIMING DIAGRAM**



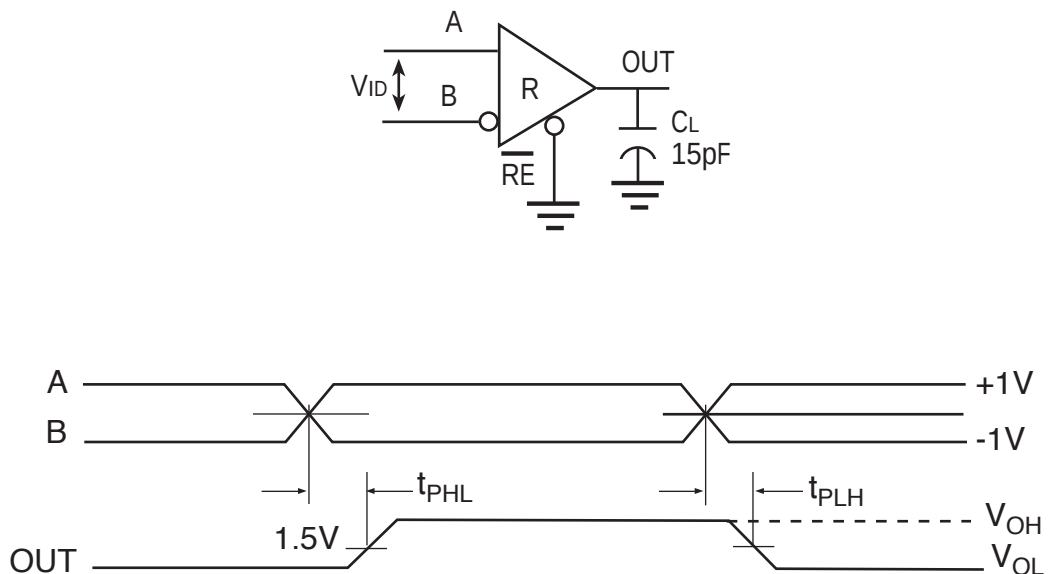
**FIGURE 4A. DRIVER CONTENTION TEST**



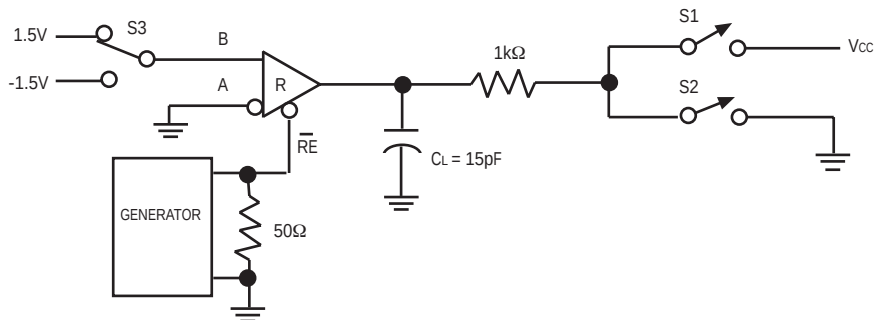
**FIGURE 5. DRIVER ENABLE & DISABLE TIMES TEST CIRCUIT & TIMING DIAGRAM**



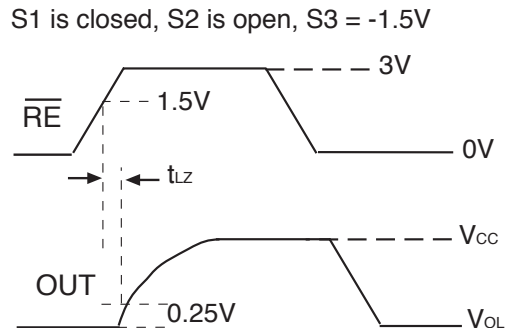
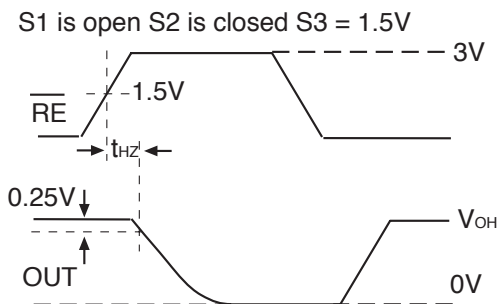
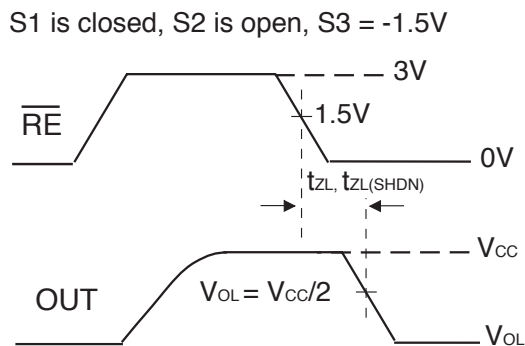
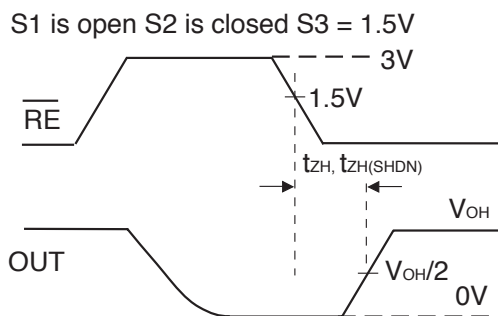
**FIGURE 6. RECEIVER PROPAGATION DELAY TEST CIRCUIT & TIMING DIAGRAM**



**FIGURE 7. RECEIVER ENABLE & DISABLE TIMES TEST CIRCUIT**



**FIGURE 8. RECEIVER ENABLE & DISABLE TIMING DIAGRAM**



| 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 |   |
|                                         |    |    |          |   |

| SP3070E, SP3073E, SP3076E (Full Duplex) |    |                      |          |
|-----------------------------------------|----|----------------------|----------|
| RECEIVING                               |    |                      |          |
| Inputs                                  |    |                      | Output   |
| $\overline{\text{RE}}$                  | DE | A, B                 | RO       |
| 0                                       | X  | $\geq -50\text{mV}$  | 1        |
| 0                                       | X  | $\leq -200\text{mV}$ | 0        |
| X                                       | X  | Open, Shorted        | 1        |
| 1                                       | 1  | X                    | High-Z   |
| 1                                       | 0  | X                    | Shutdown |

| SP3071E, SP3074E, SP3077E (Full Duplex) |         |   |
|-----------------------------------------|---------|---|
| TRANSMITTING                            |         |   |
| Inputs                                  | Outputs |   |
| DI                                      | Z       | Y |
| 1                                       | 0       | 1 |
| 0                                       | 1       | 0 |

| SP3071E, SP3074E, SP3077E (Full Duplex) |        |
|-----------------------------------------|--------|
| RECEIVING                               |        |
| Inputs                                  | Output |
| A, B                                    | RO     |
| $\geq -50\text{mV}$                     | 1      |
| $\leq -200\text{mV}$                    | 0      |
| Open/shorted                            | 1      |

| 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 |     |

| SP3072E, SP3075E, SP3078E (Half Duplex) |    |                      |          |
|-----------------------------------------|----|----------------------|----------|
| RECEIVING                               |    |                      |          |
| Inputs                                  |    |                      | Output   |
| $\overline{\text{RE}}$                  | DE | A, B                 | RO       |
| 0                                       | X  | $\geq -50\text{mV}$  | 1        |
| 0                                       | X  | $\leq -200\text{mV}$ | 0        |
| X                                       | X  | Open/shorted         | 1        |
| 1                                       | 1  | X                    | High-Z   |
| 1                                       | 0  | X                    | Shutdown |

| FULL DUPLEX DEVICES |         | HALF DUPLEX DEVICES | PIN NAME        | PIN FUNCTION                                                                                                                                                                                         |
|---------------------|---------|---------------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SP3070E             | SP3071E | SP3072E             |                 |                                                                                                                                                                                                      |
| SP3073E             | SP3074E | SP3075E             |                 |                                                                                                                                                                                                      |
| SP3076E             | SP3077E | SP3078E             |                 |                                                                                                                                                                                                      |
| PIN NUMBER          |         |                     |                 |                                                                                                                                                                                                      |
| 2                   | 2       | 1                   | RO              | Receiver Output. When $\overline{RE}$ is low and if $(A - B) \geq -50\text{mV}$ , RO is High. If $(A - B) \leq -200\text{mV}$ , RO is low.                                                           |
| 3                   | -       | 2                   | $\overline{RE}$ | Receiver Output Enable. When $\overline{RE}$ is low, RO is enabled. When RE is high, RO is high impedance. 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 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                   | $V_{CC}$        | Positive Supply $V_{CC}$ . Bypass $V_{CC}$ to GND with a 0.1 $\mu\text{F}$ 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 hotswap 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

SP3070-SP3075 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 SP3070 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 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 VCC or GND to the enable inputs. Without the hot-swap capability, these factors could improperly enable the transceiver's driver or receiver.

When VCC rises, an internal pulldown circuit holds DE low and 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 Sipex 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. Sipex'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 op-

eration, 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:

- $\pm 15\text{kV}$  using the Human Body Model
- $\pm 8\text{kV}$  using the Contact Discharge method specified in IEC 1000-4-2
- $\pm 15\text{kV}$  Airgap

### ESD TEST CONDITIONS

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

### IEC 1000-4-2

The IEC 1000-4-2 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 1000-4-2, without the need for additional ESD-protection components.

The major difference between tests done using the Human Body Model and IEC 1000-4-2 is higher peak current in IEC 1000-4-2, because series resistance is lower in the IEC 1000-4-2 model. Hence, the ESD withstand voltage measured to EC 1000-4-2 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  $12\text{k}\Omega$  (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 ( $96\Omega$ ), 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 SP3073, SP3074 and SP3075 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  $\overline{\text{RE}}$  high and DE low. In shutdown, the devices typically draw only 50nA of supply current.

$\overline{\text{RE}}$  and DE can be driven simultaneously; the parts are guaranteed not to enter shutdown if  $\overline{\text{RE}}$  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  $t_{\text{ZH}}$  and  $t_{\text{ZL}}$  assume the part was not in a low-power shutdown state. Enable times  $t_{\text{ZH}(\text{SHDN})}$  and  $t_{\text{ZL}(\text{SHDN})}$  assume the parts were shut down. It takes drivers and receivers longer to become enabled from low-power shutdown mode  $t_{\text{ZH}(\text{SHDN})}$  and  $t_{\text{ZL}(\text{SHDN})}$  than from driver/receiver-disable mode ( $t_{\text{ZH}}$ ,  $t_{\text{ZL}}$ )

**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.

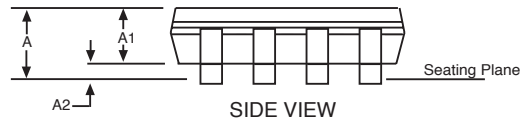
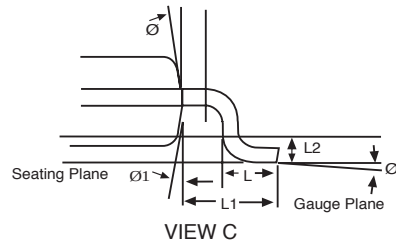
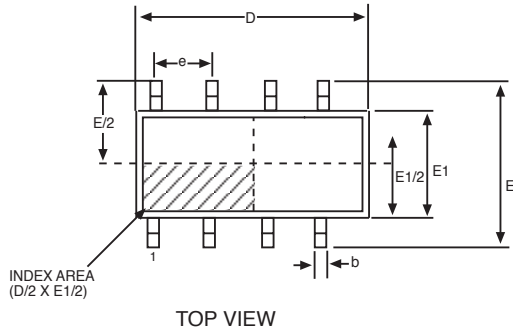
To minimize reflections, terminate the line at both ends in its characteristic impedance, and keep stub lengths off the main line as short as possible. The slew-rate-limited SP3070 - SP3075E are more tolerant of imperfect termination.

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**PARTS SELECTOR GUIDE**

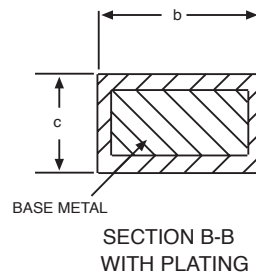
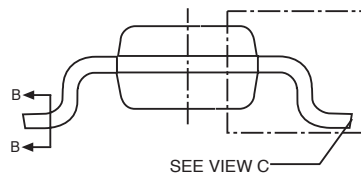
| PART NUMBER | Half/Full Duplex | Datarate Mbps | Shut-down | Receiver Driver Enable | Trans. On Bus | Pin Count | Industry Standard Pinout | Pin Compatible Upgrade from: |
|-------------|------------------|---------------|-----------|------------------------|---------------|-----------|--------------------------|------------------------------|
| SP3070E     | Full             | 0.25          | Yes       | Yes                    | 256           | 14        | MAX3070E, 75180          |                              |
| SP3071E     | Full             | 0.25          | No        | No                     | 256           | 8         | MAX 3071E, 75179         | SP3493                       |
| SP3072E     | Half             | 0.25          | Yes       | Yes                    | 256           | 8         | MAX 3072E, 75176         | SP3483                       |
| SP3073E     | Full             | 0.5           | Yes       | Yes                    | 256           | 14        | MAX 3073E, 75180         |                              |
| SP3074E     | Full             | 0.5           | No        | No                     | 256           | 8         | MAX 3074E, 75179         |                              |
| SP3075E     | Half             | 0.5           | Yes       | Yes                    | 256           | 8         | MAX 3075E, 75176         | SP3494                       |
| SP3076E     | Full             | 16            | Yes       | Yes                    | 256           | 14        | MAX 3076E, 75180         | SP3491                       |
| SP3077E     | Full             | 16            | No        | No                     | 256           | 8         | MAX3077E, 75179          | SP3490                       |
| SP3078E     | Half             | 16            | Yes       | Yes                    | 256           | 8         | MAX 3078E, 75176         | SP3485, SP3481               |

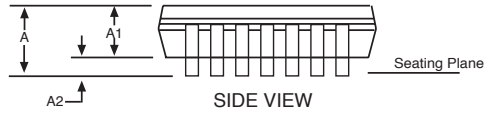
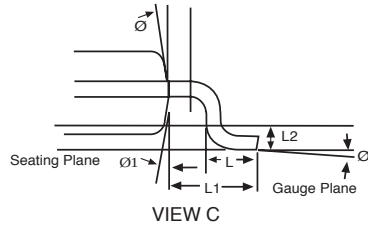
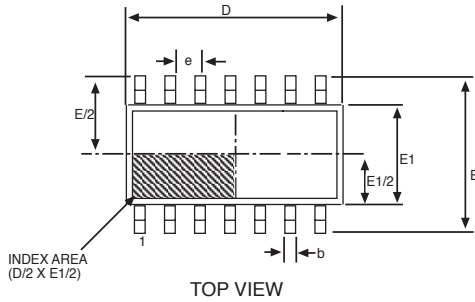




| 8 Pin NSOIC JEDEC MO-012 (AA) Variation |          |     |      |
|-----------------------------------------|----------|-----|------|
| SYMBOL                                  | MIN      | NOM | MAX  |
| A                                       | 1.35     | -   | 1.75 |
| A1                                      | 0.1      | -   | 0.25 |
| A2                                      | 1.25     | -   | 1.65 |
| b                                       | 0.31     | -   | 0.51 |
| c                                       | 0.17     | -   | 0.24 |
| D                                       | 4.90 BSC |     |      |
| E                                       | 6.00 BSC |     |      |
| E1                                      | 3.90 BSC |     |      |
| e                                       | 1.27 BSC |     |      |
| L                                       | 0.4      | -   | 1.27 |
| L1                                      | 1.04 REF |     |      |
| L2                                      | 0.25 BSC |     |      |
| Ø                                       | 0°       | -   | 8°   |
| Ø1                                      | 5°       | -   | 15°  |

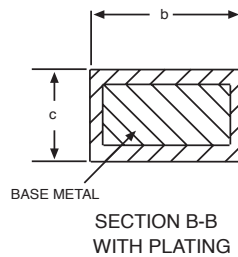
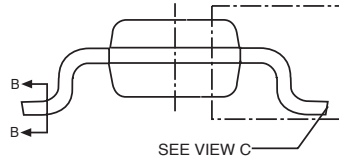
Note: Dimensions in (mm)





| 14 Pin NSOIC JEDEC MO-012 (AB) Variation |          |     |      |
|------------------------------------------|----------|-----|------|
| SYMBOL                                   | MIN      | NOM | MAX  |
| A                                        | 1.35     | -   | 1.75 |
| A1                                       | 0.1      | -   | 0.25 |
| A2                                       | 1.25     | -   | 1.65 |
| b                                        | 0.31     | -   | 0.51 |
| c                                        | 0.17     | -   | 0.25 |
| D                                        | 8.65 BSC |     |      |
| E                                        | 6.00 BSC |     |      |
| E1                                       | 3.90 BSC |     |      |
| e                                        | 1.27 BSC |     |      |
| L                                        | 0.4      | -   | 1.27 |
| L1                                       | 1.04 REF |     |      |
| L2                                       | 0.25 BSC |     |      |
| Ø                                        | 0°       | -   | 8°   |
| Ø1                                       | 5°       | -   | 15°  |

Note: Dimensions in (mm)



| <b>Model</b>       | <b>Temperature Range</b> | <b>Package</b> |
|--------------------|--------------------------|----------------|
| SP3070EEN .....    | -40°C to +85°C .....     | 14-pin NSOIC   |
| SP3070EEN/TR ..... | -40°C to +85°C .....     | 14-pin NSOIC   |
| SP3070EMN .....    | -40°C to +125°C .....    | 14-pin NSOIC   |
| SP3070EMN/TR ..... | -40°C to +125°C .....    | 14-pin NSOIC   |
| SP3071EEN .....    | -40°C to +85°C .....     | 8-pin NSOIC    |
| SP3071EEN/TR ..... | -40°C to +85°C .....     | 8-pin NSOIC    |
| SP3071EMN .....    | -40°C to +125°C .....    | 8-pin NSOIC    |
| SP3071EMN/TR ..... | -40°C to +125°C .....    | 8-pin NSOIC    |
| SP3072EEN .....    | -40°C to +85°C .....     | 8-pin NSOIC    |
| SP3072EEN/TR ..... | -40°C to +85°C .....     | 8-pin NSOIC    |
| SP3072EMN .....    | -40°C to +125°C .....    | 8-pin NSOIC    |
| SP3072EMN/TR ..... | -40°C to +125°C .....    | 8-pin NSOIC    |
| SP3073EEN .....    | -40°C to +85°C .....     | 14-pin NSOIC   |
| SP3073EEN/TR ..... | -40°C to +85°C .....     | 14-pin NSOIC   |
| SP3073EMN .....    | -40°C to +125°C .....    | 14-pin NSOIC   |
| SP3073EMN/TR ..... | -40°C to +125°C .....    | 14-pin NSOIC   |
| SP3074EEN .....    | -40°C to +85°C .....     | 8-pin NSOIC    |
| SP3074EEN/TR ..... | -40°C to +85°C .....     | 8-pin NSOIC    |
| SP3074EMN .....    | -40°C to +125°C .....    | 8-pin NSOIC    |
| SP3074EMN/TR ..... | -40°C to +125°C .....    | 8-pin NSOIC    |
| SP3075EEN .....    | -40°C to +85°C .....     | 8-pin NSOIC    |
| SP3075EEN/TR ..... | -40°C to +85°C .....     | 8-pin NSOIC    |
| SP3075EMN .....    | -40°C to +125°C .....    | 8-pin NSOIC    |
| SP3075EMN/TR ..... | -40°C to +125°C .....    | 8-pin NSOIC    |
| SP3076EEN .....    | -40°C to +85°C .....     | 14-pin NSOIC   |
| SP3076EEN/TR ..... | -40°C to +85°C .....     | 14-pin NSOIC   |
| SP3076EMN .....    | -40°C to +125°C .....    | 14-pin NSOIC   |
| SP3076EMN/TR ..... | -40°C to +125°C .....    | 14-pin NSOIC   |
| SP3077EEN .....    | -40°C to +85°C .....     | 8-pin NSOIC    |
| SP3077EEN/TR ..... | -40°C to +85°C .....     | 8-pin NSOIC    |
| SP3077EMN .....    | -40°C to +125°C .....    | 8-pin NSOIC    |
| SP3077EMN/TR ..... | -40°C to +125°C .....    | 8-pin NSOIC    |
| SP3078EEN .....    | -40°C to +85°C .....     | 8-pin NSOIC    |
| SP3078EEN/TR ..... | -40°C to +85°C .....     | 8-pin NSOIC    |
| SP3078EMN .....    | -40°C to +125°C .....    | 8-pin NSOIC    |
| SP3078EMN/TR ..... | -40°C to +125°C .....    | 8-pin NSOIC    |

For availability of PDIP or other packaging contact factory.

Available in lead free packaging. To order add “-L” suffix to part number.

Example: SP3074EEN/TR = standard; SP3074EEN-L/TR = lead free

/TR = Tape and Reel

Pack quantity is 2,500 for NSOIC.

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**Sipex**  
Corporation  
ANALOG EXCELLENCE

**Sipex Corporation**

**Headquarters and  
Sales Office**  
233 South Hillview Drive  
Milpitas, CA 95035  
TEL: (408) 934-7500  
FAX: (408) 935-7600