## GENERAL DESCRIPTION

The **SP3495E - SP3497E** transceivers are suitable for high speed bidirectional communication on multipoint bus transmission lines. They are designed for balanced data transmission and comply with both RS-485 and RS-422 EIA standards. Each device contains one differential driver and one differential receiver

Driver differential outputs and receiver differential inputs are connected internally to form a half-duplex input/output to the RS-485 bus. Separate $\overline{RE}$ and DE pins enable and disable the driver and receiver independently or may be externally connected together as a direct control. The device enters a low power shutdown mode if both driver and receiver are disabled. the bus-pin outputs of disabled or powered down devices are in high impedance state. The high impedance driver output is maintained over the entire common-mode voltage range of -7V to +12V.

SP3495E - SP3497E operates from a single 3.3V power supply. SP3495E - SP3497E transceivers load the data bus only half as much as a standard RS-485 unit load. This allows up to 64 devices to be connected simultaneously on a bus without violating required RS-485 signal margin and without using repeaters. Excessive power dissipation caused by bus contention or by shorting outputs to ground or a voltage source is prevented by short circuit protection and thermal shutdown. This feature forces the driver output into high impedance state if the absolute value of the output current exceeds 250mA or if junction temperature exceeds 165°C. Receivers will fail-safe to a logic high output state if the inputs are unconnected (floating) or shorted. All RS-485 inputs and outputs are ESD protected up to +/-15kV Human Body Model.

## FEATURES

- 3.3V Single Supply Operation
- High Speed up to 32Mbps
- Robust +/-15kV ESD protection
- Hot Swap glitch protection
- Advanced Fail-safe Receiver Inputs
- Half Unit Load, 64 Transceivers on bus
- Driver short circuit current limit and thermal shutdown for overload protection
- Low Current 1uA shutdown mode

## TYPICAL APPLICATIONS

- Factory Automation Controls
- Motor Control
- Industrial Process Control
- Building Automation
- Security Systems
- Remote Utility Meter Reading
- Long or unterminated transmission lines

The product(s) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

**FIGURE 1. TYPICAL APPLICATION CIRCUIT**

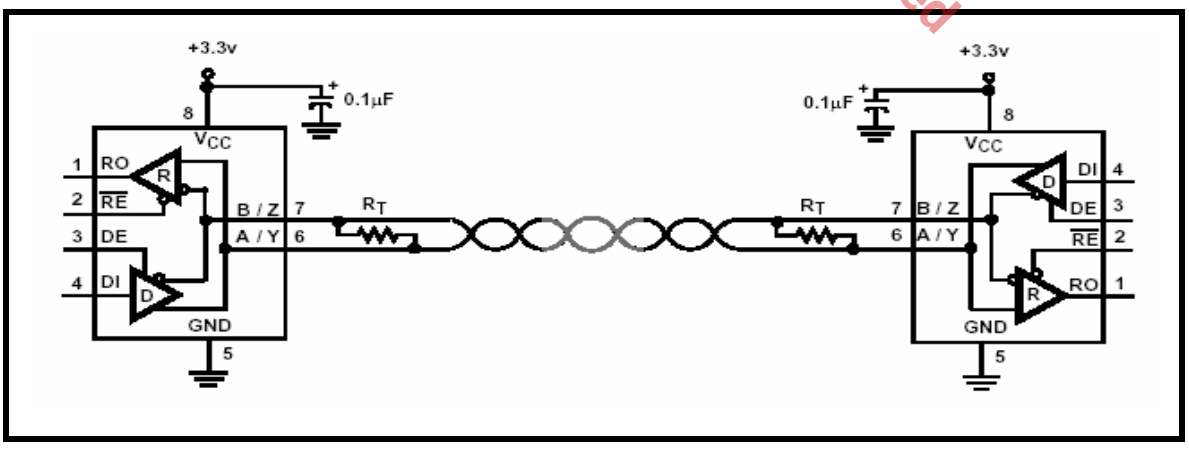
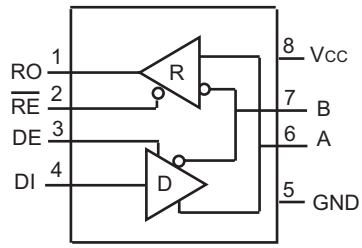
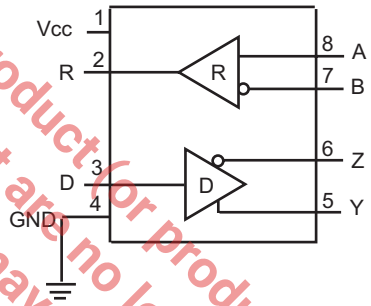


**FIGURE 2. PIN OUT ASSIGNMENT**

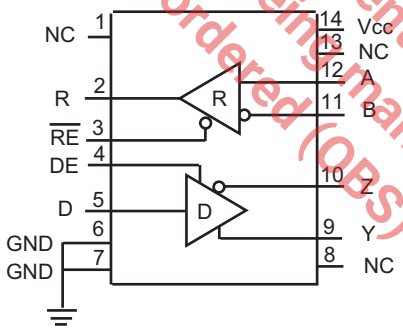
SP3495E 8-Pin Half Duplex




SP3496E 8-pin Full Duplex




SP3497E 14-pin Full Duplex




The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

## *ORDERING INFORMATION*

| PART NUMBER | PACKAGE | OPERATING TEMPERATURE RANGE | DEVICE STATUS |
|---|---|---|---|
| SP3495EEN-L | 8-pin Narrow SOIC | -40°C to +85°C | Active |
| SP3495EEN-L/TR | 8-pin Narrow SOIC | -40°C to +85°C | Active |
| SP3496EEN-L | 8-pin Narrow SOIC | -40°C to +85°C | Active |
| SP3496EEN-L/TR | 8-pin Narrow SOIC | -40°C to +85°C | Active |
| SP3497EEN-L | 14-pin Narrow SOIC | -40°C to +85°C | Active |
| SP3497EEN-L/TR | 14-pin Narrow SOIC | -40°C to +85°C | Active |

Note: To order Tape and Reel option include "/TR" in ordering part number. All packages are Pb-free/ RoHS compliant.

## PIN DESCRIPTIONS

### Pin Assignments

| Pin Number | | | Pin Name | Type | Description |
|---|---|---|---|---|---|
| Half Duplex | Full Duplex | | | | |
| SP3495E | SP3496E | SP3497E | | | |
| 1 | 2 | 2 | RO | O | Receiver Output. When $\overline{RE}$ is low and if (A-B) ≥ -40mV, RO is High. If (A-B) ≤ -200mV, RO is Low. |
| 2 | - | 3 | $\overline{RE}$ | I | 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 should be low to enter shutdown mode. $\overline{RE}$ is a hot-swap input. |
| 3 | - | 4 | DE | I | Driver Output Enable. When DE is High, outputs are enabled. When DE is low, outputs are high impedance. DE should be low and $\overline{RE}$ should be High to enter shutdown mode. DE is a hot-swap input |
| 4 | 3 | 5 | DI | I | Driver Input. With DE high, a low level on DI forces Non-Inverting output low and inverting output high. Similarly, a high level on DI forces Non-Inverting output High and Inverting output Low. |
| 5 | 4 | 6, 7 | GND | Pwr | Ground |
| 6 | - | - | A | O | Non-Inverting Receiver Input and Non-Inverting Driver Output |
| 7 | - | - | B | O | Inverting Receiver Input and Inverting Driver Output |
| 8 | 1 | 14 | Vcc | Pwr | +3.3V power supply input. Bypass with 0.1uF capacitor. |
| - | 8 | 12 | A | I | Non-Inverting Receiver Input |
| - | 7 | 11 | B | I | Inverting Reciever Input |
| - | 5 | 9 | Y | O | Non-Inverting Driver Output |
| - | 6 | 10 | Z | O | Inverting Driver Output |
| - | - | 1, 8, 13 | NC | - | No Connect, not internally connected |

**Pin type: I=Input, O=Output.**

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS).

## 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 to the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability and cause permanent damage to the device.

| | |
|---|---|
| $V_{CC}$ | +6.0V |
| Input Voltage at control pins ($\overline{RE}$, DE and DI) | -0.5V to ($V_{CC}$ + 0.3V) |
| Voltage Range on A and B pins | -9V to +14V |
| Storage Temperature Range | -65°C to + 150°C |
| Power Dissipation<br>Maximum Junction Temperature 150°C<br>8-Pin SO $\theta_{JA}$ = 128.4°C/W<br>14-Pin SO $\theta_{JA}$ = 86°C/W | |

**CAUTION:**

ESD (Electrostatic Discharge) sensitive device. Permanent damage may occur on unconnected devices subject to high energy electrostatic fields. Unused devices must be stored in conductive foam or shunts. Personnel should be properly grounded prior to handling this device. The protective foam should be discharged to the destination socket before devices are removed.

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

## ELECTRICAL CHARACTERISTICS

**UNLESS OTHERWISE NOTED: VCC = +3.0V TO +3.6V WITH $T_A$ FROM -40°C TO +85°C. TYPICAL VALUES ARE AT VCC = +3.3V AND 25°C.**

| SYMBOL | PARAMETERS | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|---|---|---|---|---|---|---|
| **DRIVER DC CHARACTERISTICS** | | | | | | |
| $V_{OD}$ | Differential Driver Output | | | Vcc | V | No Load |
| | | 2.0 | | | | $R_L$ = 100Ω (RS-422), Figure 3 |
| | | 1.5 | | | | $R_L$ = 54Ω (RS-485), Figure 3 |
| | | 1.5 | | | | $V_{CM}$ = -7V, Figure 4 |
| | | 1.5 | | | | $V_{CM}$ = +12V, Figure 4 |
| $\Delta V_{OD}$ | Change in Magnitude of Differential Output | -0.20 | | 0.20 | V | $R_L$ = 100Ω (RS-422), Figure 3, See note 1 |
| | | -0.20 | | 0.20 | | $R_L$ = 54Ω (RS-485), Figure 3, See note 1 |
| | | -0.20 | | 0.20 | | $V_{CM}$ = -7V, Figure 4, See note 1 |
| | | -0.20 | | 0.20 | | $V_{CM}$ = +12V, Figure 4, See note 1 |
| $V_{OC}$ | Driver Common Mode Output Voltage steady state | 1.3 | | 2.5 | V | Figure 3 |
| $\Delta V_{OC}$ | Change in Magnitude of Common Mode Output Voltage | -0.2 | | 0.2 | V | Figure 3, See note 1 |
| $I_{DSC}$ | Driver Short Circuit Current Limit | -250 | | | mA | $V_{OUT}$ Forced to -7V, Figure 5 |
| | | | | 250 | mA | $V_{OUT}$ Forced to +12V, Figure 5 |

**UNLESS OTHERWISE NOTED: VCC = +3.0V TO +3.6V WITH $T_A$ FROM -40°C TO +85°C. TYPICAL VALUES ARE AT VCC = +3.3V AND 25°C.**

| SYMBOL | PARAMETERS | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|---|---|---|---|---|---|---|
| $V_{IH}$ | Logic Input Thresholds (DI, DE, $\overline{RE}$) | 2.0 | | | V | Logic Input High |
| $V_{IL}$ | | | | 0.8 | V | Logic Input Low |
| $V_{HYS}$ | Driver Input Hysteresis | | 100 | | mV | $T_A$ = 25°C |
| $I_{IN}$ | Logic Input Current (DI, DE and $\overline{RE}$) | | | 10 | uA | IN = 0V |
| | | -10 | | | uA | IN = Vcc |
| **Driver AC Characteristics** | | | | | | |
| freq | Data Signaling Rate | 32 | | | Mbps | $1/t_{UI}$, Duty Cycle 40 to 60% |
| $t_{PLH}$ | Driver Propagation Delay (low to High) | 5 | 11 | 24 | ns | $C_L$ = 50pF, $R_L$ = 54Ω, freq = 8MHz, Figures 6 and 7 |
| $t_{PHL}$ | Driver Propagation Delay (High to Low) | 5 | 11 | 24 | ns | $C_L$ = 50pF, $R_L$ = 54Ω, freq = 8MHz, Figures 6 and 7 |
| $t_R$ | Driver Rise Time | 2.5 | 4.5 | 10 | ns | $C_L$ = 50pF, $R_L$ = 54Ω, freq = 8MHz, Figures 6 and 7 |
| $t_F$ | Driver Fall time | 2.5 | 4.5 | 10 | ns | $C_L$ = 50pF, $R_L$ = 54Ω, freq = 8MHz, Figures 6 and 7 |
| $\lvert t_{PLH}-t_{PHL}\rvert$ | Differential Pulse Skew | | | 3 | ns | Figures 6 and 7 |
| $t_{OZH}$ | Driver Enable to Output High | | | 50 | ns | $C_L$ = 50pF, $R_L$ = 500Ω, Figures 8 and 9 |
| $t_{OZL}$ | Driver Enable to Outut Low | | | 50 | ns | $C_L$ = 50pF, $R_L$ = 500Ω, Figures 10 and 11 |
| $t_{OHZ}$ | Driver Disable from Output High | | | 50 | ns | $C_L$ = 50pF, $R_L$ = 500Ω, Figures 8 and 9 |
| $t_{OLZ}$ | Driver Disable from Output Low | | | 50 | ns | $C_L$ = 50pF, $R_L$ = 500Ω, Figures 10 and 11 |
| $t_{OZV}$ | Shutdown to Driver Output Valid | | | 6 | us | $C_L$ = 50pF, $R_L$ = 500Ω |
| $t_{SHDN}$ | Time to Shutdown | 50 | | 600 | ns | Note 2 and 3 |
| **RECEIVER DC CHARACTERISTICS** | | | | | | |
| $I_{IN}$ | Input Current (A, B pins) | -290 | | 500 | uA | DE = 0, Vcc = 0 or 3.3V<br>$V_A$ or $V_B$ = 12V, other input 0V<br>$V_A$ or $V_B$ = -7V, other input 0V |
| $V_{IH}$ | Receiver Differential Thresholds ($V_A$ - $V_B$) | | -85 | -40 | mV | -7V ≤ $V_{CM}$ ≤ 12V, rising |
| $V_{IL}$ | | -200 | -125 | | mV | -7V ≤ $V_{CM}$ ≤ 12V, falling |
| | Receiver Input Hysteresis | | 25 | | mV | $V_{CM}$ = 0V |
| $V_{OH}$ | Receiver Output Voltage High | 2.4 | | | V | $I_{OUT}$ = -8mA, $V_{ID}$ = 200mV |
| $V_{OL}$ | Receiver Output Voltage Low | | | 0.4 | V | $I_{OUT}$ = 8mA, $V_{ID}$ = -200mV |

The product (or products) mentioned in this datasheet are no longer being manufactured and may not be ordered (OBS)

**UNLESS OTHERWISE NOTED: VCC = +3.0V TO +3.6V WITH $T_A$ FROM -40°C TO +85°C. TYPICAL VALUES ARE AT VCC = +3.3V AND 25°C.**

| SYMBOL | PARAMETERS | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|---|---|---|---|---|---|---|
| $I_{OZ}$ | High-Z Receiver Output Current | -1 | | | uA | $\overline{RE}$ = Vcc, $V_{OUT}$ = 0V |
| | | | | 1 | uA | $\overline{RE}$ = Vcc, $V_{OUT}$ = Vcc |
| $I_{OSS}$ | Receiver Output Short Circuit Current | -95 | | | mA | $V_{OUT}$ = 0V |
| | | | | 95 | mA | $V_{OUT}$ = Vcc |
| $R_{IN}$ | Receiver Input Resistance | 24 | | | KΩ | -7V ≤ $V_{CM}$ ≤ 12V |
| **RECEIVER AC CHARACTERISTICS** | | | | | | |
| freq | Data Signaling Rate | 32 | | | Mbps | 1/$t_{UI}$, Duty Cycle 40 to 60% |
| $t_{PLH}$ | Receiver Propagation Delay (Low to High) | | 15 | 40 | ns | $V_{ID}$ = +/-2V, $C_L$ = 15pF, Freq = 8MHz, Figure 12 and 13 |
| $t_{PHL}$ | Receiver Propagation Delay (High to Low) | | 15 | 40 | ns | $V_{ID}$ = +/-2V, $C_L$ = 15pF, Freq = 8MHz, Figure 12 and 13 |
| skew | Receiver Propagation Delay Skew | | | 3 | ns | $V_{ID}$ = +/-2V, $C_L$ = 15pF, Freq = 8MHz, Figure 12 and 13 skew = $\lvert t_{PLH}-t_{PHL} \rvert$ |
| $t_R$ | Receiver Output Rise Time | 1 | 2 | 6 | ns | $C_L$ = 15pF, Freq = 8MHz |
| $t_F$ | Receiver Output Fall Time | 1 | 2 | 6 | ns | $C_L$ = 15pF, Freq = 8MHz |
| $t_{ZH}$ | Receiver Enable to Output High | | | 50 | ns | $C_L$ = 15pF, $R_L$ = 1kΩ, Figure 14 |
| $t_{ZL}$ | Receiver Enable to Output Low | | | 50 | ns | $C_L$ = 15pF, $R_L$ = 1kΩ, Figure 14 |
| $t_{HZ}$ | Receiver Output High to Disable | | | 50 | ns | $C_L$ = 15pF, $R_L$ = 1kΩ, Figure 14 |
| $t_{LZ}$ | Receiver Output Low to Disable | | | 50 | ns | $C_L$ = 15pF, $R_L$ = 1kΩ, Figure 14 |
| $t_{ZH(SHDN)}$ | Shutdown to Receiver Output Valid High | | | 6 | us | $C_L$ = 15pF, $R_L$ = 1kΩ |
| $t_{ZL(SHDN)}$ | Shutdown to Receiver Output Valid Low | | | 6 | us | $C_L$ = 15pF, $R_L$ = 1kΩ |
| $t_{SHDN}$ | Time to Shutdown | 50 | | 600 | ns | Note 2 and 3 |
| **POWER REQUIRMENTS AND RECOMMENDED OPERATING CONDITIONS** | | | | | | |
| Vcc | Supply Voltage | 3.0 | 3.3 | 3.6 | V | |
| $I_{CC1}$ | Supply Current - Driver Enabled | | | 5.0 | mA | DE = Vcc, No Load, $\overline{RE}$ and DI = 0V or Vcc |
| $I_{CC2}$ | Supply Current - Receiver Enabled | | | 5.0 | mA | DE = 0V, $\overline{RE}$ = 0V, No Load |
| $I_{CC3}$ | Supply Current - Shutdown Mode | | 1 | 6 | uA | DE = 0V, $\overline{RE}$ = Vcc, DI = Vcc or 0V |
| $T_{SD}$ | Thermal Shutdown Temperature | | 165 | | °C | |

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

**UNLESS OTHERWISE NOTED: VCC = +3.0V TO +3.6V WITH $T_A$ FROM -40°C TO +85°C. TYPICAL VALUES ARE AT VCC = +3.3V AND 25°C.**

| SYMBOL | PARAMETERS | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|---|---|---|---|---|---|---|
| | Thermal Shutdown Hysteresis | | 20 | | °C | |
| | ESD Protection at Pins A, B, Y and Z | | +/-15 | | kV | Human Body Model |

***NOTE:***

1. *Change in Magnitude of Differential Output Voltage and Change in Magnitude of Common Mode Output Voltage are the changes in output voltage when DI input changes state.*
2. *The transceivers are put into shutdown by bringing $\overline{RE}$ High and DE Low simultaneously for at least 600ns. If the control inputs are in this state for less than 50ns, the device is guaranteed not enter shutdown. If the enable inputs are held in this state for at least 600ns the device is assured to be in shutdown. Note that the receiver and driver enable times increase during shutdown*
3. *Gauranteed by design and bench characterization.*

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

**FIGURE 3. DRIVER DC TEST CIRCUIT**

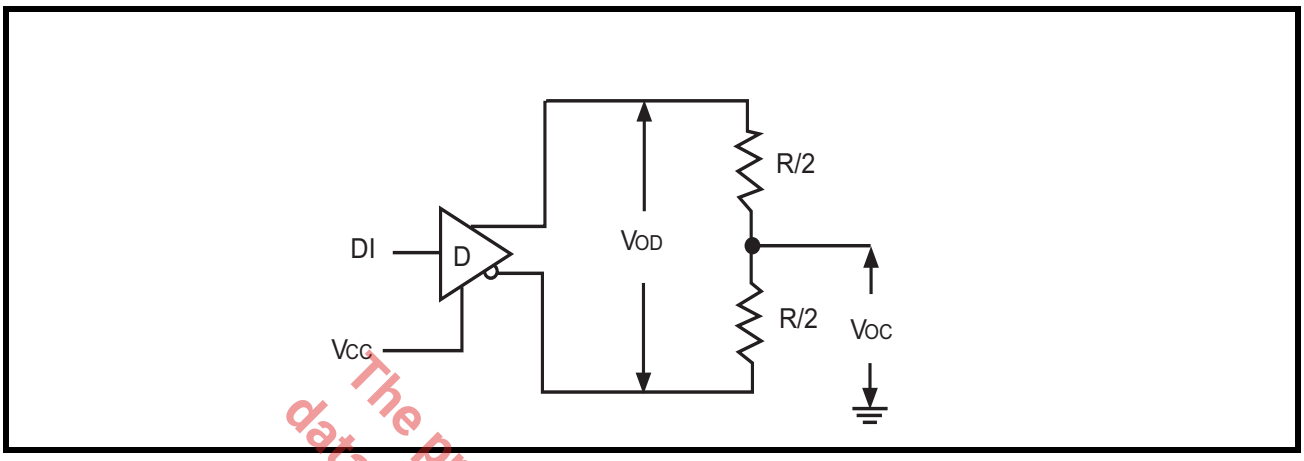



**FIGURE 4. DRIVER COMMON MODE LOAD TEST**

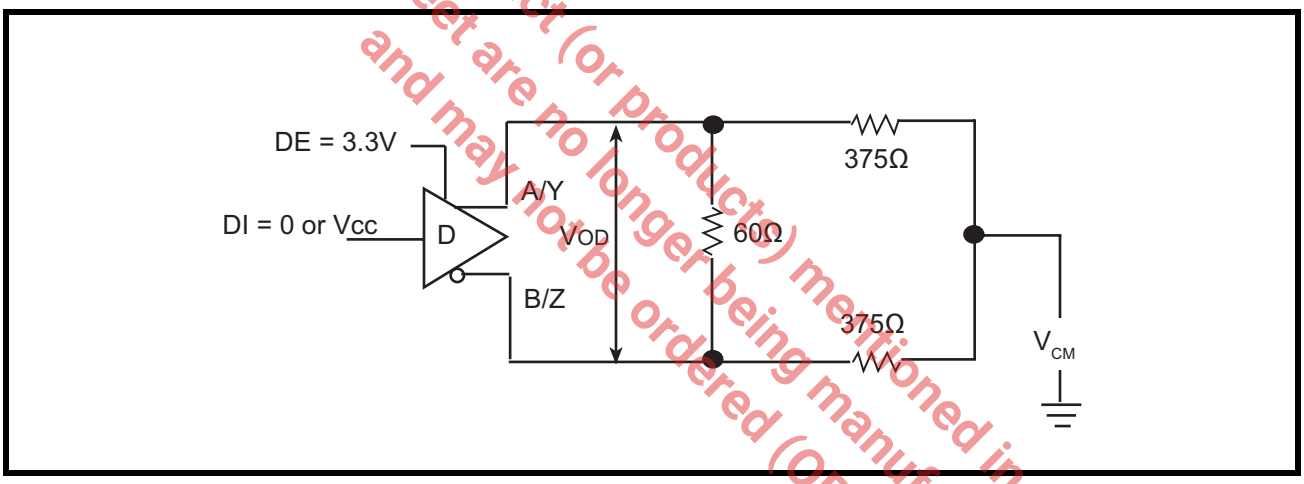
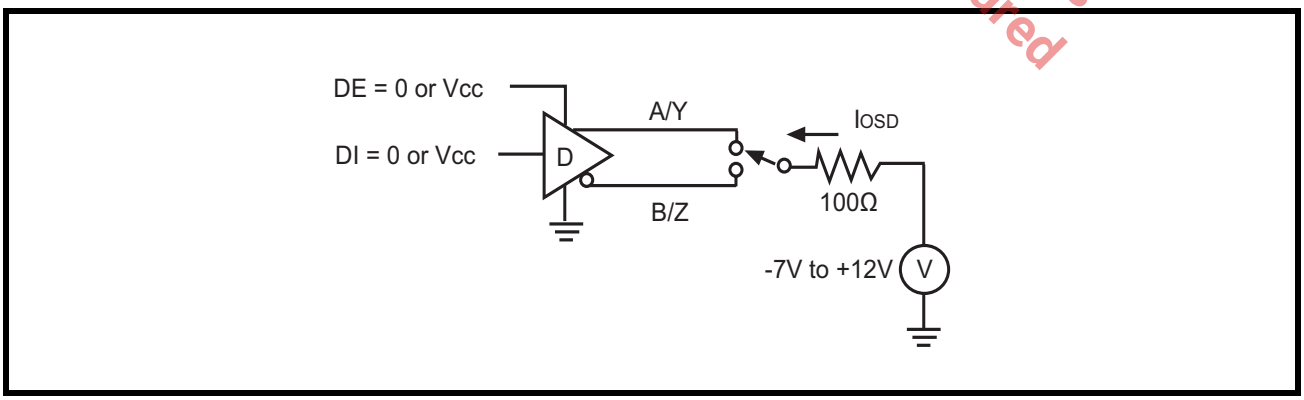



**FIGURE 5. DRIVER SHORT CIRCUIT CURRENT LIMIT TEST**




The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

**FIGURE 6. DRIVER PROPAGATION DELAY TEST CIRCUIT**

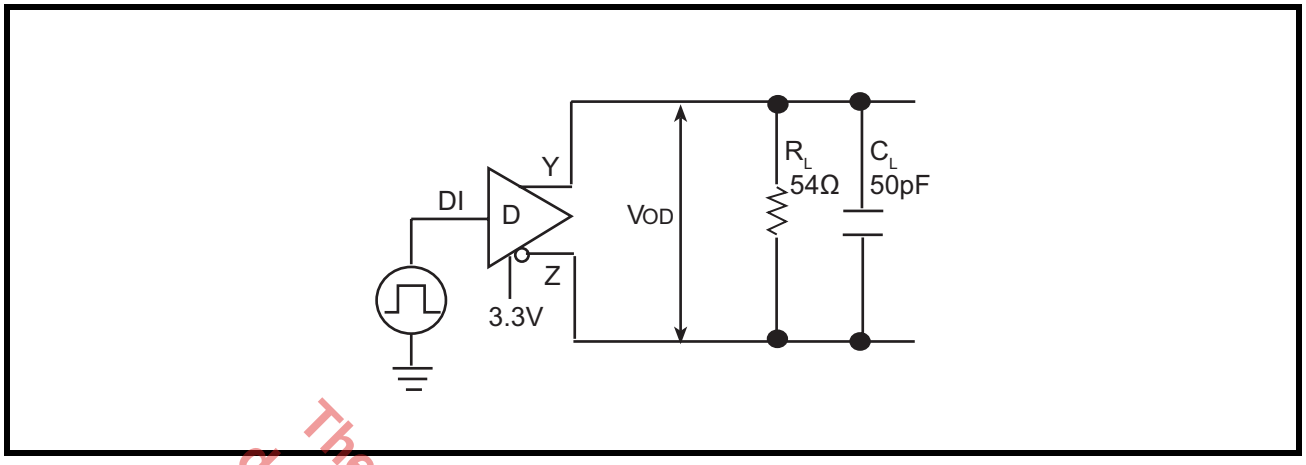



**FIGURE 7. DRIVER PROPAGATION DELAY TIMING DIAGRAM**

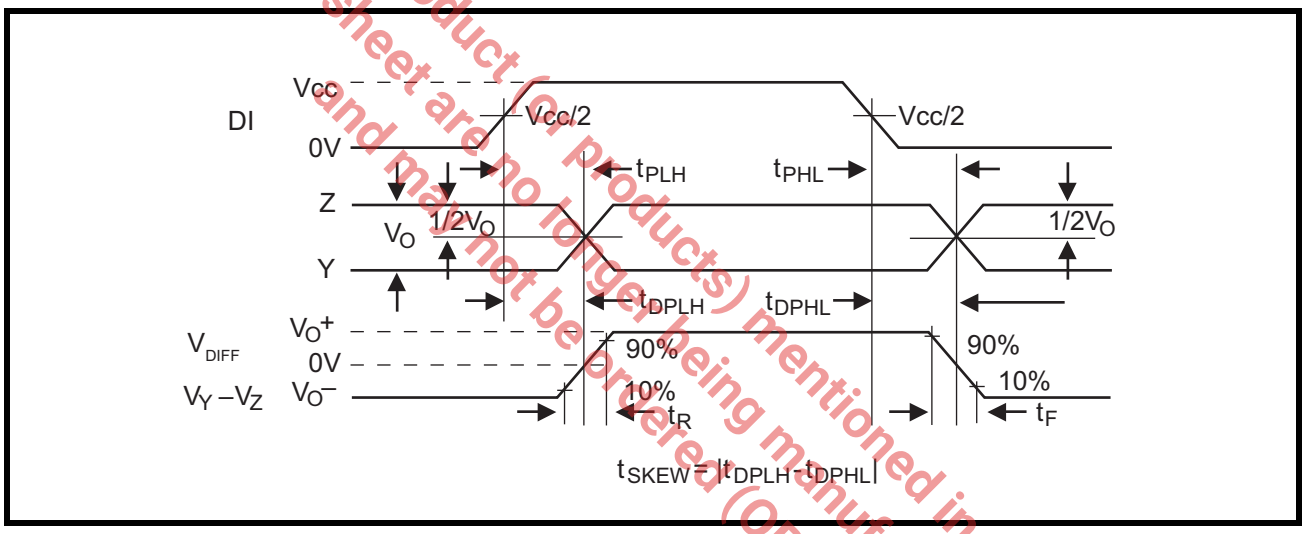
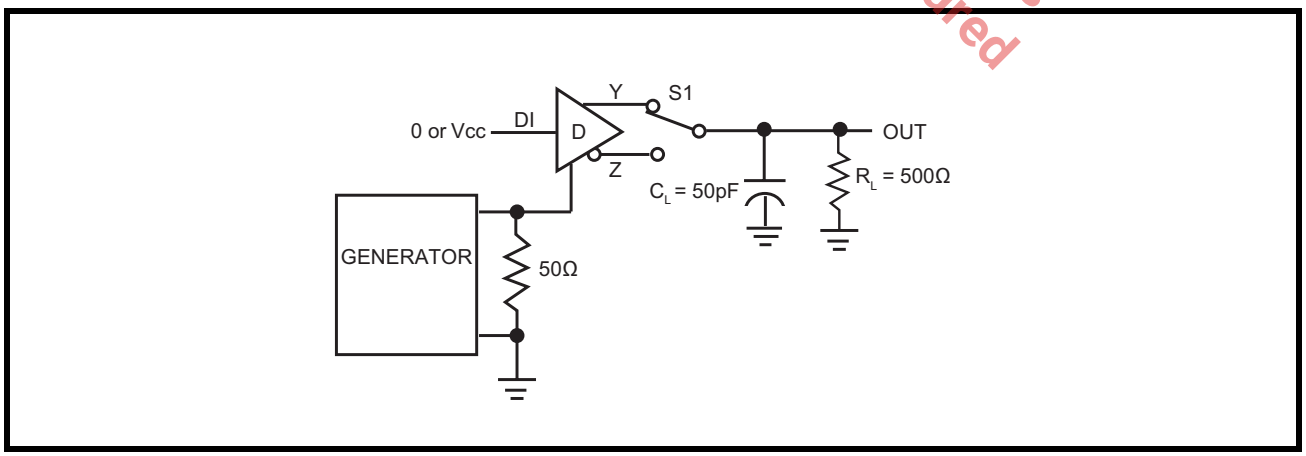
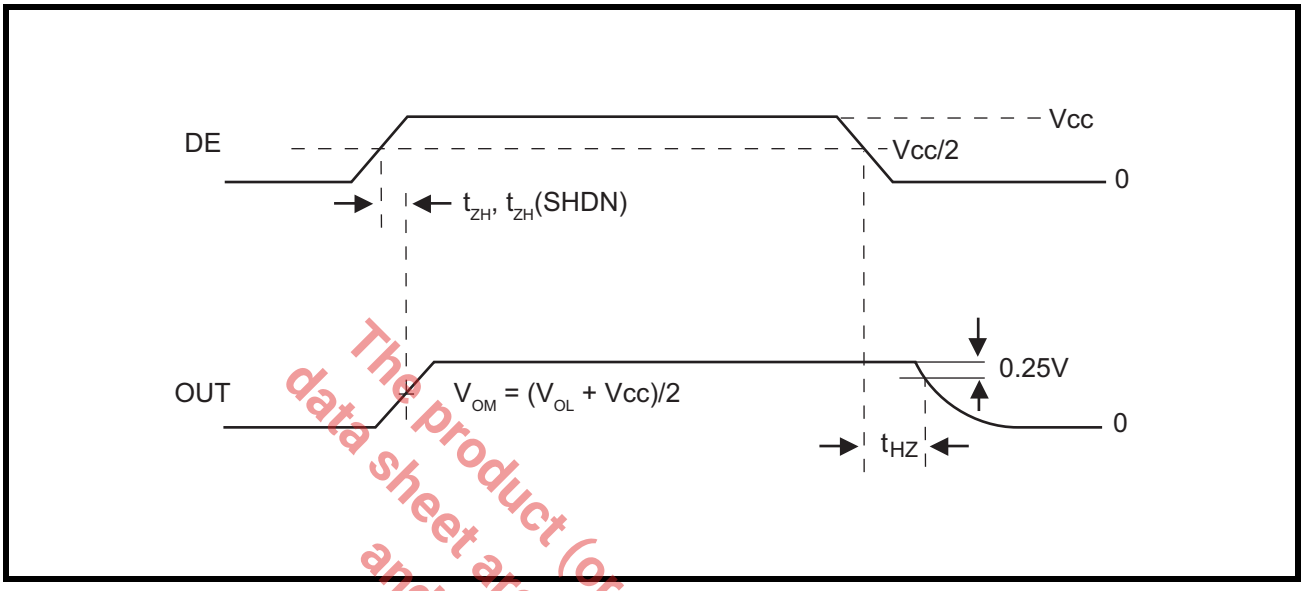



**FIGURE 8. DRIVER ENABLE AND DISABLE TIME TEST CIRCUIT 1**




The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

**FIGURE 9. DRIVER ENABLE DISABLE TIMING DIAGRAM 1**




The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

**FIGURE 10. DRIVER ENABLE AND DISABLE TIME TEST CIRCUIT 2**

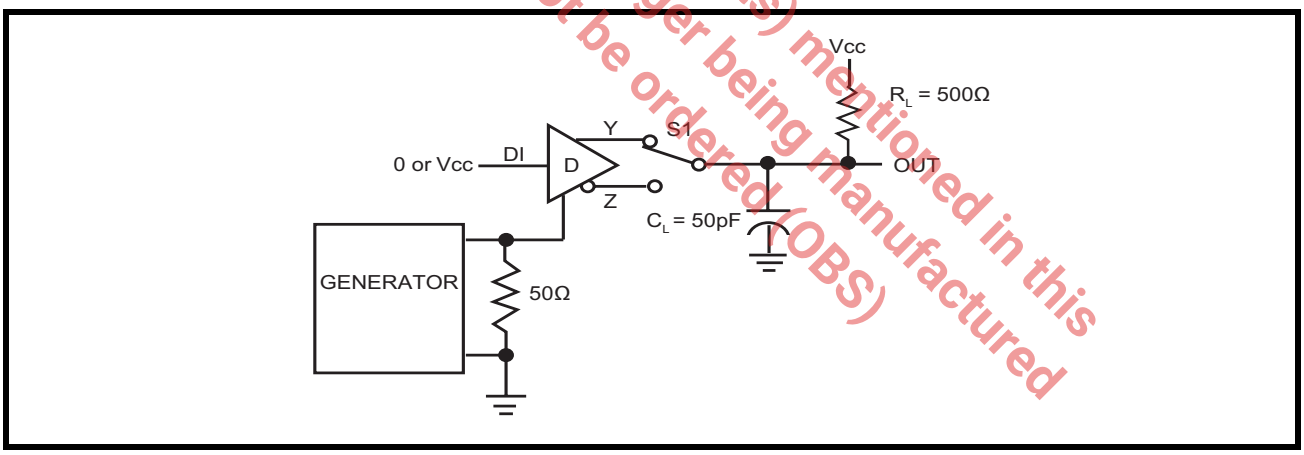
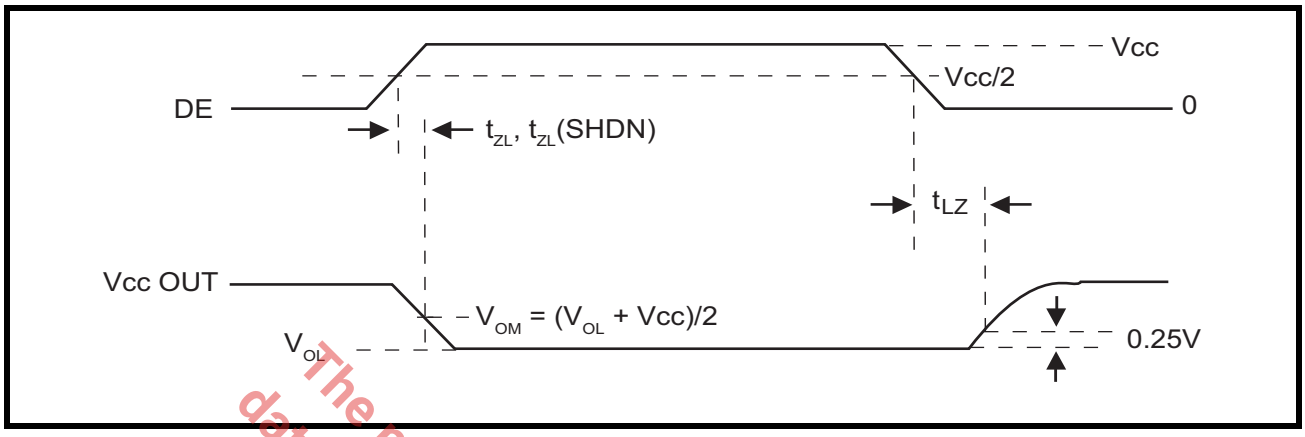


**FIGURE 11. DRIVER ENABLE AND DISABLE TIMING DIAGRAM 2**




The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

**FIGURE 12. RECEIVER PROPAGATION DELAY TEST CIRCUIT**

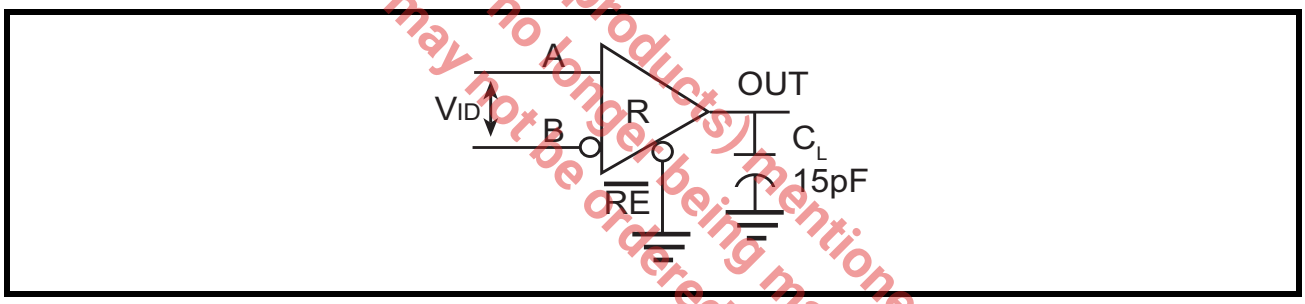



**FIGURE 13. RECEIVER PROPAGATION DELAY TIMING DIAGRAM**

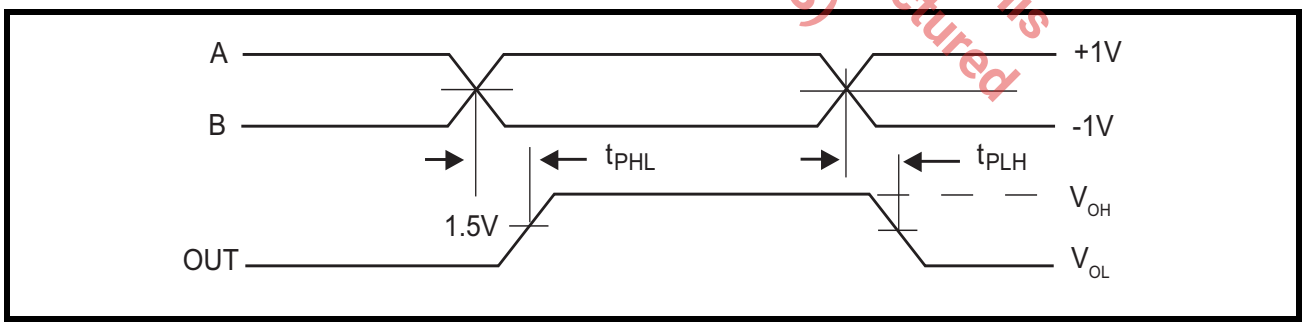
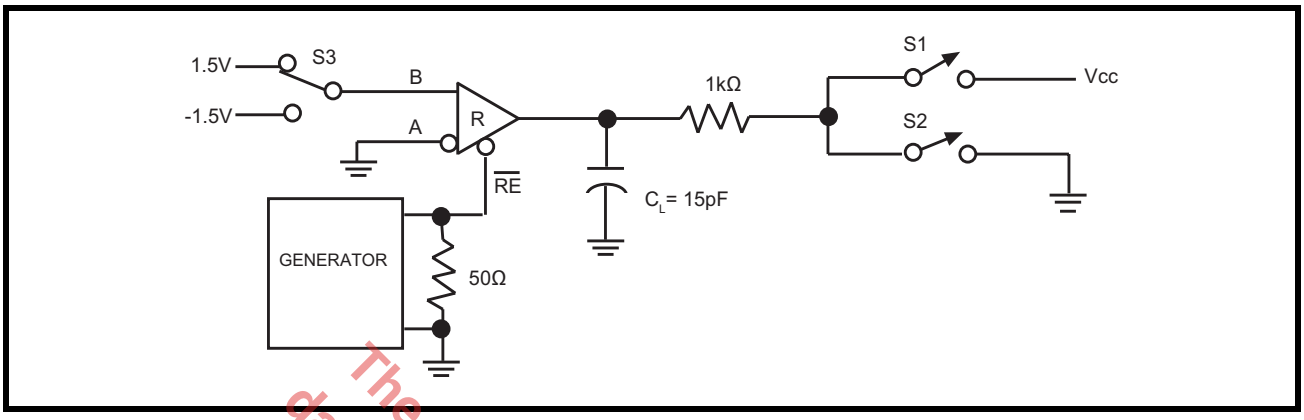


**FIGURE 14. RECEIVER ENABLE AND DISABLE TIMES TEST CIRCUIT**




The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

**FIGURE 15. RECEIVER ENABLE AND DISABLE TIMING DIAGRAM 1**

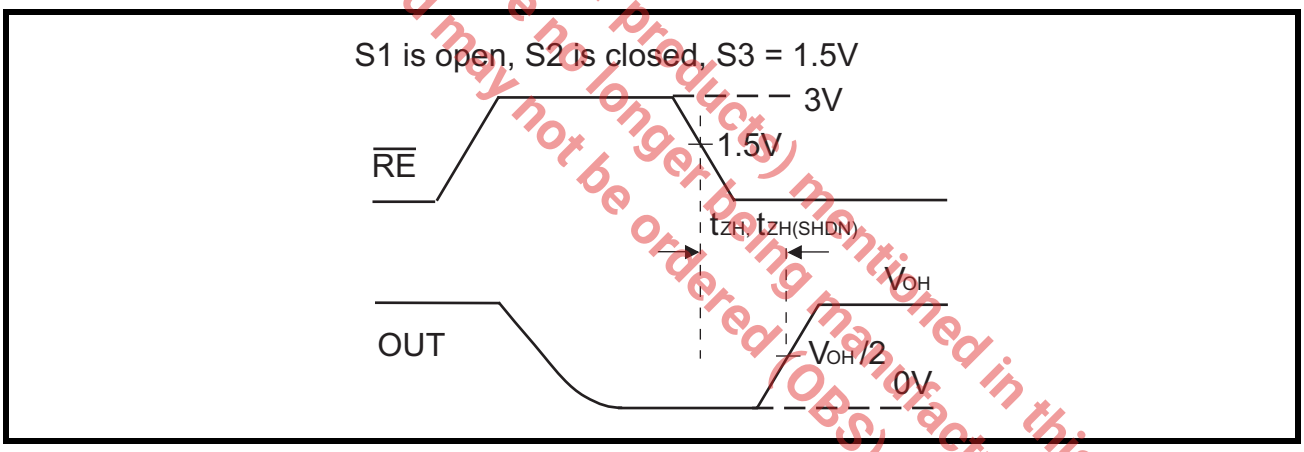



**FIGURE 16. RECEIVER ENABLE AND DISABLE TIMING DIAGRAM 2**

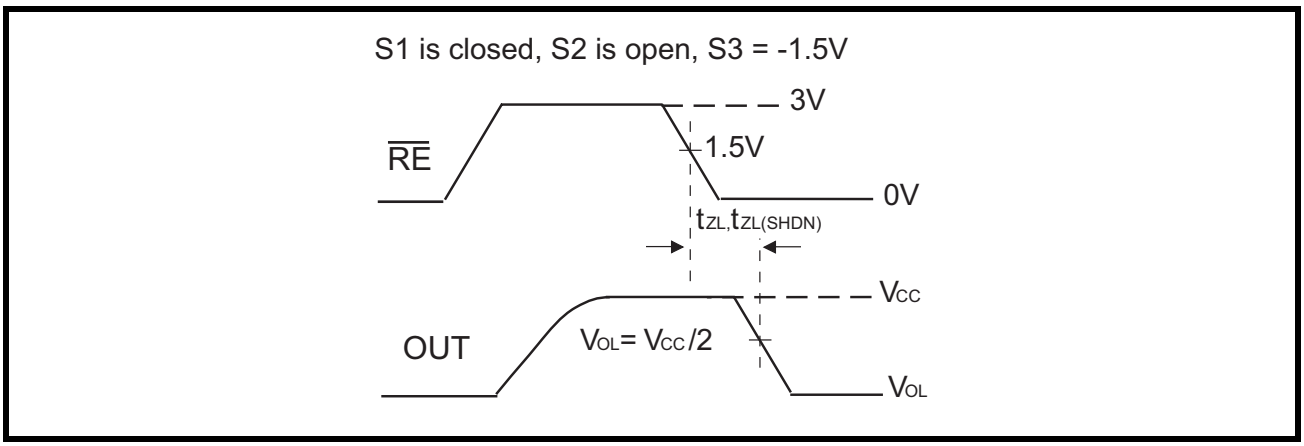
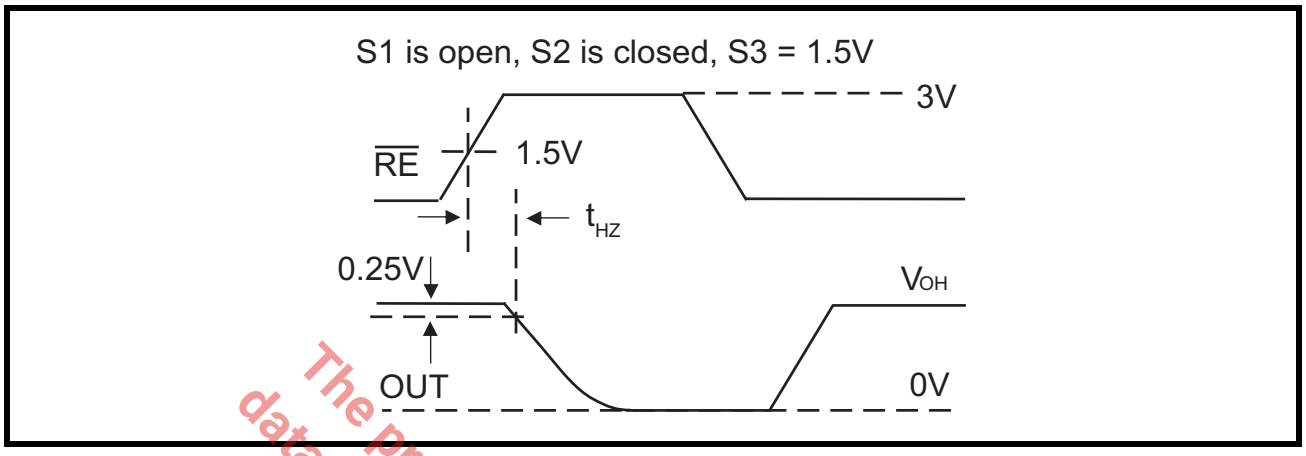
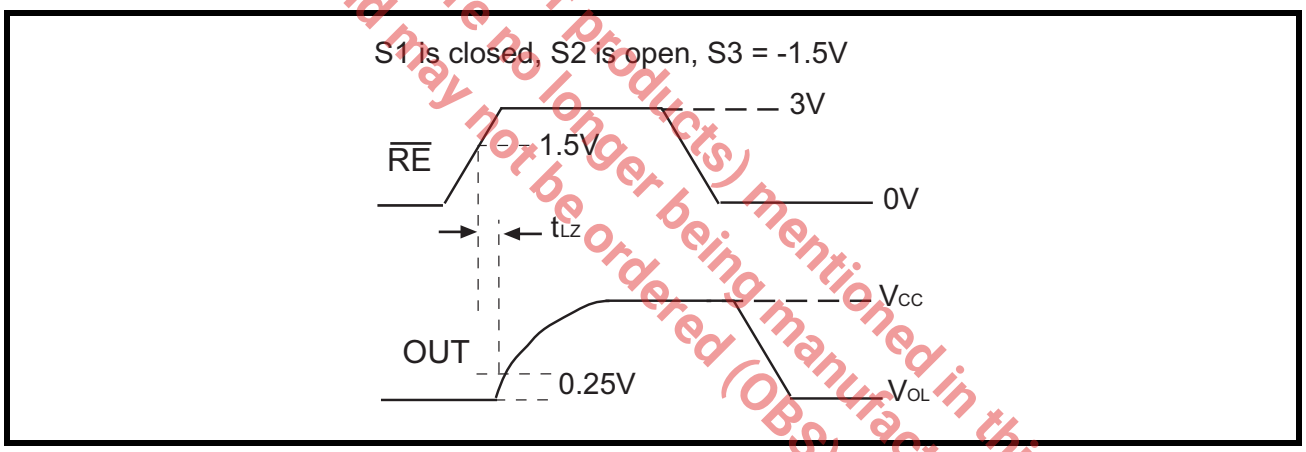


**FIGURE 17. RECEIVER ENABLE AND DISABLE TIMING DIAGRAM 3**




The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

**FIGURE 18. RECEIVER ENABLE AND DISABLE TIMING DIAGRAM 4**



## 1.0 PRODUCT DESCRIPTION

The SP349xE high speed transceivers contain one driver and one receiver. The SP3495 is a half-duplex design while the SP3496E and SP3497E are full-duplex designs. The control pins $\overline{RE}$ and DE feature a hotswap capability allowing live insertion without spurious data transfer. Drivers are output short-circuit current limited. Thermal-shutdown circuitry protects drivers against excessive power dissipation. When activited, the thermal-shutdown circuitry forces the driver outptus into a high-impedance state.

### Advanced Failsafe

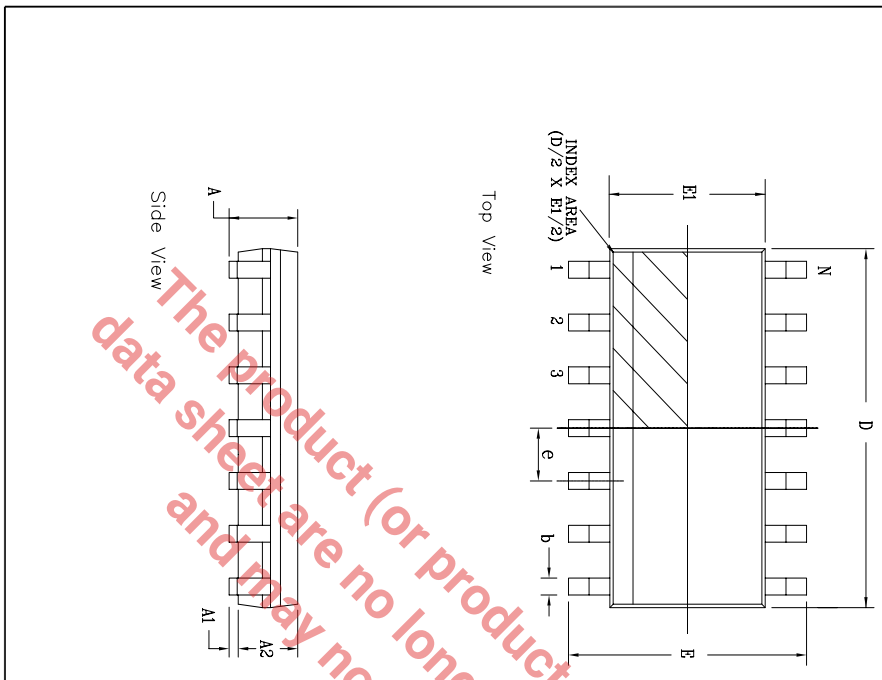
The Receivers incorporate fail-safe circuitry, which guarantees a logic-high receiver output when the receiver inputs are open or shorted, or when they are connected to a terminated transmission line with all drivers disabled. In a terminated bus with all transmitters disabled the receivers differential input voltage is pulled to 0V by the termination. The SP349xE interprets 0V differential as a logic high with a minimum 40mV noise margin.

### HOT-SWAP CAPABILITY

When Vcc is first applied the SP349xE holds the driver enable and receiver enable inactive for approximately 10 microseconds. During power ramp-up other system IC's may drive unpredictable values. Hot-swap capability prevents the SP349xE from driving any output signal until power has stabilized. After the initial power-up sequence, the hot-swap circuit becomes transparent and driver enable and receiver enable resume their normal functions and timings

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

## PACKAGE DIMENSIONS (14 PIN NSOIC)




REVISION HISTORY

| REV. | DISCRIPTION | DATE | APP'D |
|---|---|---|---|
| A | DRAWING ORIGINATION | 04/17/06 | JL |
| B | CHANGE DRAWING LOGO AND COMPANY NAME | 11/21/07 | JL |

14 Pin SOICN JEDEC MS-012 Variation AB

| SYMBOLS | DIMENSIONS IN MM (Control Unit) | | | DIMENSIONS IN INCH (Reference Unit) | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 1.35 | — | 1.75 | 0.053 | — | 0.069 |
| A1 | 0.10 | — | 0.25 | 0.004 | — | 0.010 |
| A2 | 1.25 | — | 1.65 | 0.049 | — | 0.065 |
| b | 0.31 | — | 0.51 | 0.012 | — | 0.020 |
| c | 0.17 | — | 0.25 | 0.007 | — | 0.010 |
| E | 6.00 BSC | | | 0.236 BSC | | |
| E1 | 3.90 BSC | | | 0.154 BSC | | |
| e | 1.27 BSC | | | 0.050 BSC | | |
| h | 0.25 | — | 0.50 | 0.010 | — | 0.020 |
| L | 0.40 | — | 1.27 | 0.016 | — | 0.050 |
| L1 | 1.04 REF | | | 0.041 REF | | |
| L2 | 0.25 BSC | | | 0.010 BSC | | |
| R | 0.07 | — | — | 0.003 | — | — |
| R1 | 0.07 | — | — | 0.003 | — | — |
| θ | 0° | — | 8° | 0° | — | 8° |
| θ1 | 5° | — | 15° | 5° | — | 15° |
| θ2 | 0° | — | — | 0° | — | — |
| D | 8.65 BSC | | | 0.341 BSC | | |
| N | 14 | | | 14 | | |

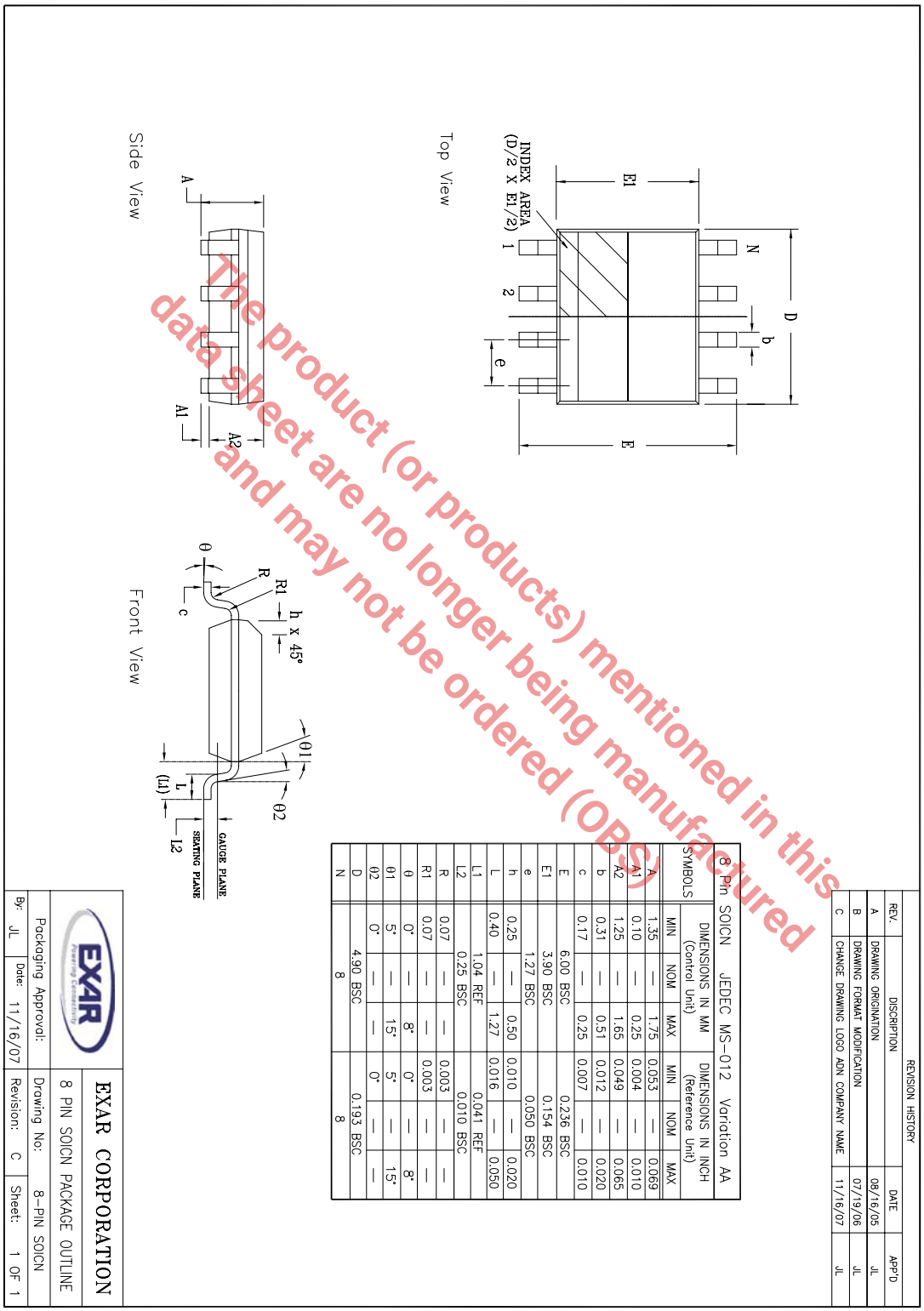
EXAR CORPORATION

14 PIN SOICN PACKAGE OUTLINE

| Packaging Approval: | Drawing No: | 14-PIN SOICN |
|---|---|---|
| By: JL Date: 11/21/07 | Revision: B | Sheet: 1 OF 1 |

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## PACKAGE DIMENSIONS (8 PIN NSOIC)




The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

## REVISION HISTORY

| DATE | REVISION | DESCRIPTION |
|---|---|---|
| 5/01/09 | 1.0.0 | Production Release. |

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