

3.3V Low Power Half-Duplex RS-485 Transceiver with 10Mbps Data Rate

Description

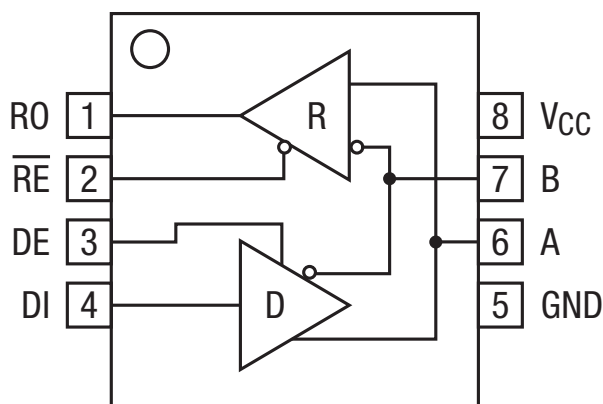
The [SP3485](#) device is a 3.3V low power half-duplex transceiver that meets the specifications of the RS-485 and RS-422 serial protocols. This device is pin-to-pin compatible with the MaxLinear SP481, SP483 and SP485 devices as well as popular industry standards. The SP3485 can meet the electrical specifications of the RS-485 and RS-422 serial protocols up to 10Mbps under load.

FEATURES

- RS-485 and RS-422 transceiver
- Operates from a single 3.3V supply
- Interoperable with 5.0V logic
- Driver/receiver enable
- -7V to +12V common-mode input voltage range
- Allows up to 32 transceivers on the serial bus
- Compatibility with industry standard 75176 pinout
- Driver output short-circuit protection

Ordering Information - [Back Page](#)

Block Diagram



SP3485

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 Voltages

Logic -0.3V to 6.0V

Drivers -0.3V to 6.0V

Receivers..... $\pm 15V$

Output Voltages

Drivers $\pm 15V$

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

Storage Temperature -65°C to 150°C

Maximum Junction Temperature, T_J 125°C

Power Dissipation..... 600mW
(derate 6.90mW/°C above 70°C)

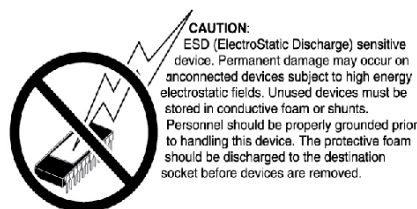
Operating Conditions

Package Power Dissipation

8-pin NSOIC Θ_{JA} 128.4°C/W

ESD Rating

Human Body Model (HBM)..... $\pm 2kV$



Electrical Characteristics

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

| PARAMETERS | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|--|------|------|-----------|---------|--|
| SP3485 Driver DC Characteristics | | | | | |
| Differential output voltage | | | V_{CC} | Volts | Unloaded; $R = \infty\Omega$; Figure 1 |
| Differential output voltage | 2 | | V_{CC} | Volts | With Load; $R = 50\Omega$ (RS-422); Figure 1 |
| Differential output voltage | 1.5 | | V_{CC} | Volts | With Load; $R = 27\Omega$ (RS-485); Figure 1 |
| Change in magnitude of driver differential output voltage for complimentary states | | | 0.2 | Volts | $R = 27\Omega$ or $R = 50\Omega$; Figure 1 |
| Driver common mode output voltage | | | 3 | Volts | $R = 27\Omega$ or $R = 50\Omega$; Figure 1 |
| Input high voltage | 2.0 | | | Volts | Applies to DE, DI, RE |
| Input low voltage | | | 0.8 | Volts | Applies to DE, DI, RE |
| Input current | | | ± 10 | μA | Applies to DE, DI, RE |
| Driver short circuit current $V_{OUT} = HIGH$ | | | ± 250 | mA | $-7V \leq V_O \leq +12V$; Figure 8 |
| Driver short circuit current $V_{OUT} = LOW$ | | | ± 250 | mA | $-7V \leq V_O \leq +12V$; Figure 8 |
| SP3485 Driver AC Characteristics | | | | | |
| Maximum data rate | 10 | | | Mbps | $RE = V_{CC}$, $DE = V_{CC}$ |
| Driver input to output, t_{PLH} | | 17 | 60 | ns | Figures 2 & 9 |
| Driver input to output, t_{PHL} | | 17 | 60 | ns | Figures 2 & 9 |
| Differential driver skew | | 2 | 10 | ns | $ t_{D01} - t_{D02} $, Figures 2 and 10 |
| Driver rise or fall time | | 5 | 20 | ns | From 10%-90%; Figures 3 and 10 |
| Driver enable to output high | | 35 | 120 | ns | Figures 4 and 11 |
| Driver enable to output low | | 30 | 120 | ns | Figures 5 and 11 |
| Driver disable time from low | | 20 | 120 | ns | Figures 5 and 11 |
| Driver disable time from high | | 20 | 120 | ns | Figures 4 and 11 |
| Driver enable from shutdown to output high, t_{PSH} | | | 250 | ns | $C_L = 50pF$, $R_L = 500\Omega$. Figures 4, 5, and 11 |
| Driver enable from shutdown to output low, t_{PSL} | | | 250 | ns | |
| Time to shutdown, t_{SHDN} | 50 | 200 | 600 | ns | Notes 1 and 2 |

Electrical Characteristics (Continued)

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

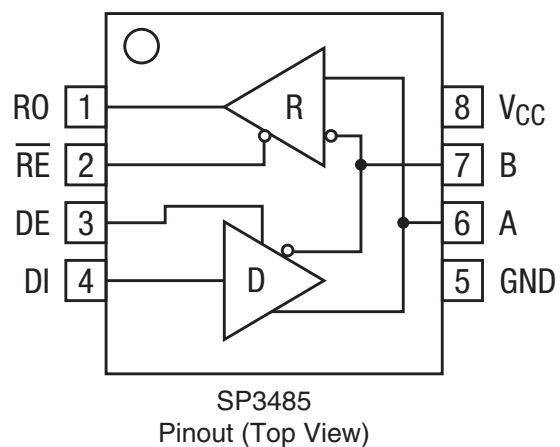
| PARAMETERS | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|--|--------------|------|---------|------------|---|
| SP3485 Receiver DC Characteristics | | | | | |
| Differential input threshold | -0.2 | | 0.2 | Volts | $-7V \leq V_{CM} \leq 12V$ |
| Input hysteresis | | 20 | | mV | $V_{CM} = 0V$ |
| Output voltage HIGH | $V_{CC}-0.4$ | | | Volts | $V_{ID} = 200mV, -1.5mA$ |
| Output voltage LOW | | | 0.4 | Volts | $V_{ID} = -200mV, 2.5mA$ |
| Three-state (high impedance) output current | | | ± 1 | μA | $0V \leq V_O \leq V_{CC}; RE = V_{CC}$ |
| Input resistance | 12 | | | k Ω | $-7V \leq V_{CM} \leq 12V$ |
| Input current (A, B); $V_{IN} = 12V$ | | | 1.0 | mA | $DE = 0V, V_{CC} = 0V$ or $3.6V$, $V_{IN} = 12V$ |
| Input current (A, B); $V_{IN} = -7V$ | | | -0.8 | mA | $DE = 0V, V_{CC} = 0V$ or $3.6V$, $V_{IN} = -7V$ |
| Short circuit current | 7 | | 60 | mA | $0V \leq V_{CM} \leq V_{CC}$ |
| SP3485 Receiver AC Characteristics | | | | | |
| Maximum data rate | 10 | | | Mbps | $RE = 0V, DE = 0V$ |
| Receiver input to output, t_{PLH} | | 40 | 100 | ns | Figures 6 and 12 |
| Receiver input to output, t_{PLH} | | | 70 | ns | $T_{AMB} = 25^\circ C, V_{CC} = 3.3V$, Figures 6 and 12 |
| Receiver input to output, t_{PHL} | | 35 | 100 | ns | Figures 6 and 12 |
| Receiver input to output, t_{PHL} | | | 70 | ns | $T_{AMB} = 25^\circ C, V_{CC} = 3.3V$, Figures 6 and 12 |
| Differential receiver skew | | 4 | | ns | $t_{RSKEW} = t_{RPHL} - t_{RPLH} $, Figures 6 and 12 |
| Receiver enable to output low | | 10 | 60 | ns | Figures 7 and 13, S_1 closed, S_2 open |
| Receiver enable to output high | | 10 | 60 | ns | Figures 7 and 13, S_2 closed, S_1 open |
| Receiver disable from low | | 10 | 60 | ns | Figures 7 and 13, S_1 closed, S_2 open |
| Receiver disable from high | | 10 | 60 | ns | Figures 7 and 13, S_2 closed, S_1 open |
| Receiver enable from shutdown to output high, t_{PRSH} | | | 1800 | ns | $C_L = 15pF, R_L = 1k\Omega$. Figures 7 and 13 |
| Receiver enable from shutdown to output low, t_{PRSL} | | | 1800 | ns | |
| Time to shutdown, t_{SHDN} | 50 | 200 | 600 | ns | Notes 1 and 2 |
| Power Requirements | | | | | |
| Supply current, no load | | 425 | 2000 | μA | $RE, DI = 0V$ or $V_{CC}; DE = V_{CC}$ |
| Supply current, no load | | 300 | 1500 | μA | $RE = 0V, DI = 0V$ or $V_{CC}, DE = 0V$ |

NOTES:

1. The transceivers are put into shutdown by gringing 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 to 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 times increase significantly when coming out of shutdown.
2. This spec is guaranteed by design and bench characterization.

Pin Functions

| Pin | Name | Description |
|-----|------------------------|--|
| 1 | RO | Receiver output |
| 2 | $\overline{\text{RE}}$ | Receiver output enable active LOW |
| 3 | DE | Driver output enable active HIGH |
| 4 | DI | Driver input |
| 5 | GND | Ground connection |
| 6 | A | Non-inverting driver output / receiver input |
| 7 | B | Inverting driver output / receiver input |
| 8 | V _{CC} | Positive supply |



Test Circuits

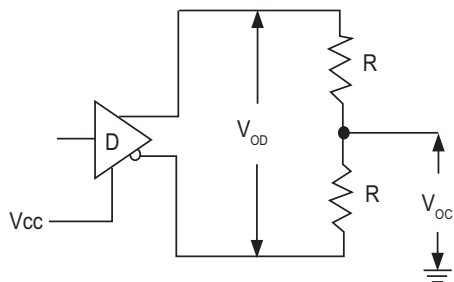


Figure 1: Driver DC Test Load Circuit

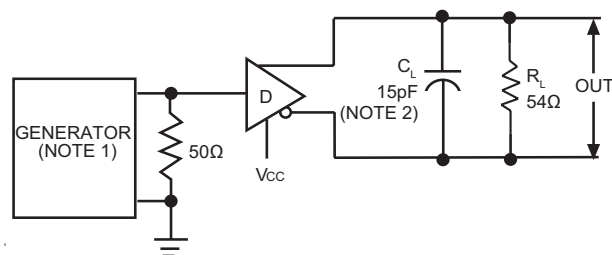


Figure 2: Driver Propagation Delay Test Circuit

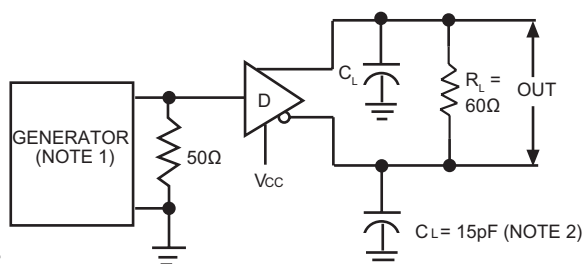


Figure 3: Driver Differential Output Delay and Transition Time Circuit.

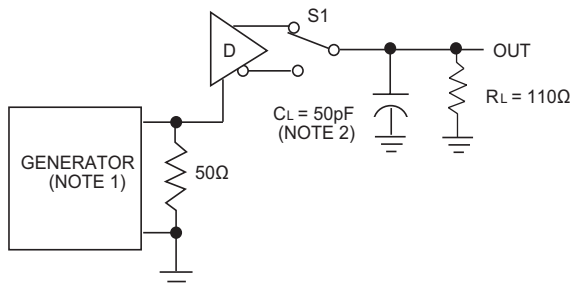


Figure 4: Driver Enable and Disable Timing Circuit, Output High

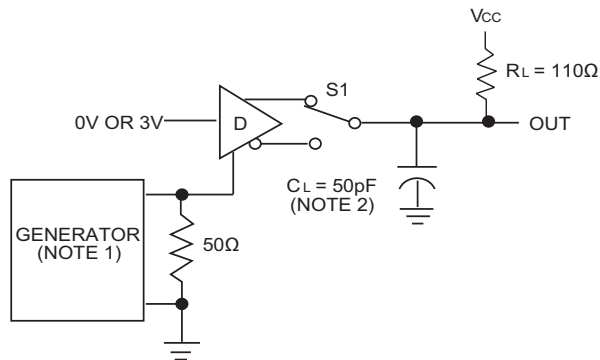


Figure 5: Driver Enable and Disable Timing Circuit, Output Low

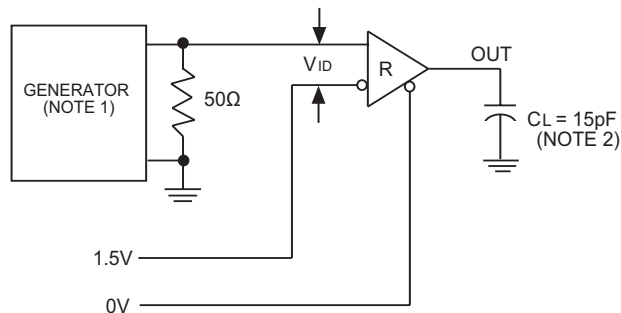


Figure 6: Receiver Propagation Delay Test Circuit

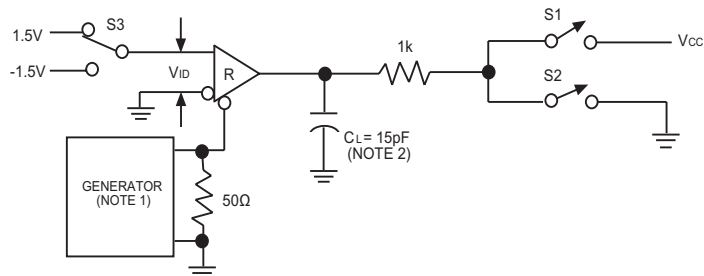


Figure 7: Receiver Enable and Disable Timing Circuit

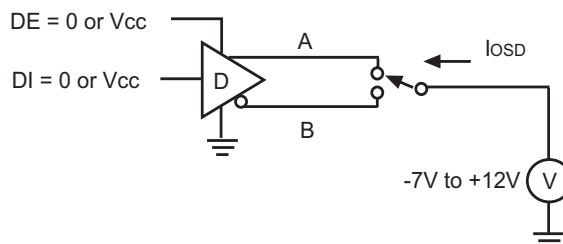


Figure 8: Driver Short Circuit Current Limit Test

NOTES

1: The input pulse is supplied by a generator with the following characteristics:
 PRR = 250kHz, 50% duty cycle, $t_R < 6.0\text{ns}$, $Z_O = 50\Omega$.

2: C_L includes probe and stray capacitance.

Switching Waveforms

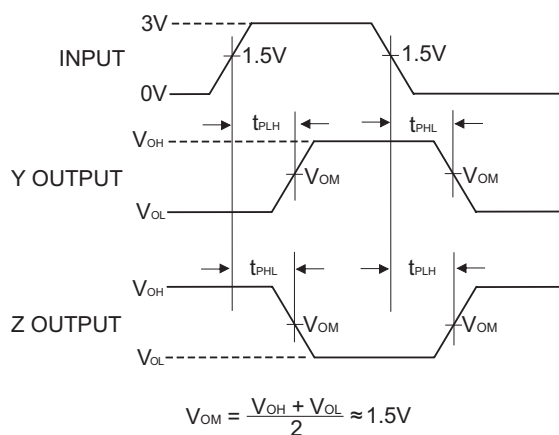


Figure 9: Driver Propagation Delay Waveforms

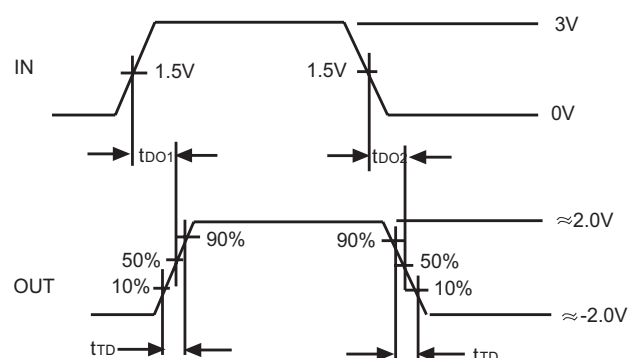


Figure 10: Driver Differential Output Delay and Transition Time Waveforms

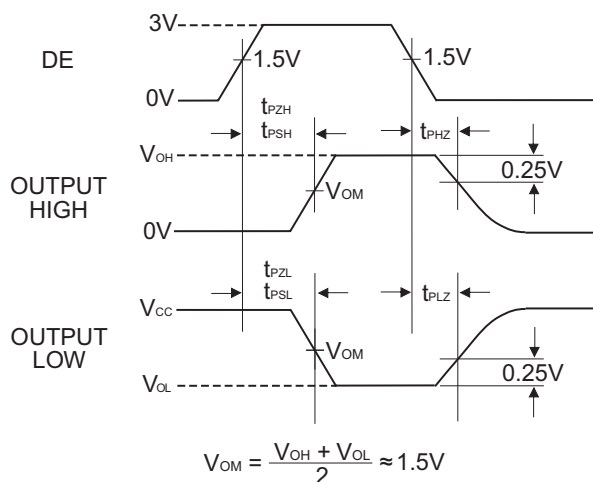


Figure 11: Driver Enable and Disable Timing Waveforms

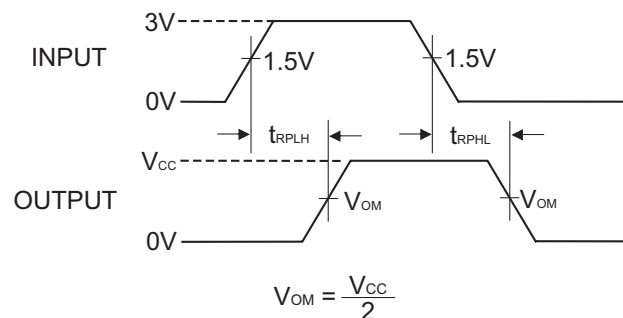


Figure 12: Receiver Propagation Delay Waveforms

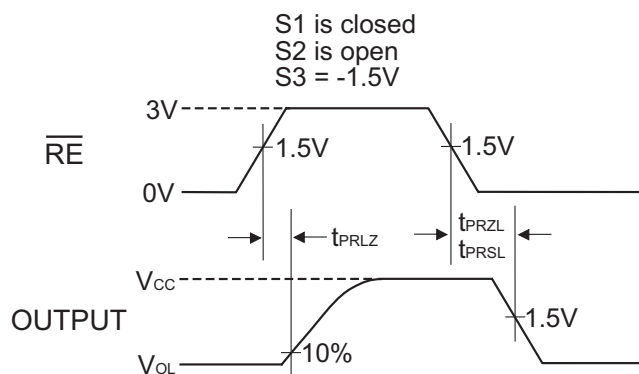
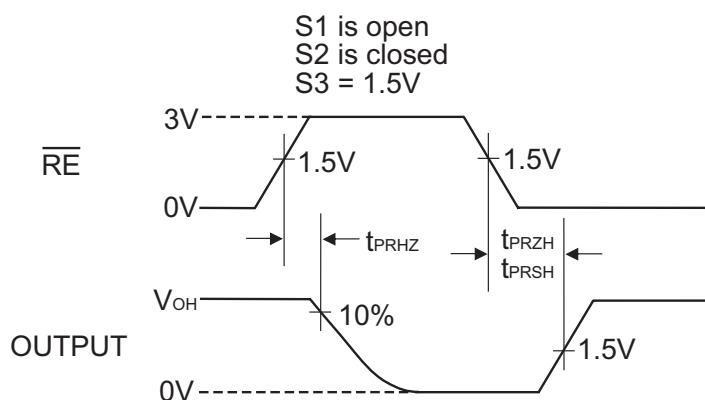


Figure 13: Receiver Enable and Disable Waveforms

Description

The SP3485 is a member in the family of 3.3V low power half-duplex transceivers that meet the electrical specifications of the RS-485 and RS-422 serial protocols. This device is pin-to-pin compatible with the MaxLinear SP481, SP483 and SP485 devices as well as popular industry standards. The SP3485 feature MaxLinear's BiCMOS process allowing low power operation without sacrificing performance.

Driver

The driver outputs of the SP3485 are differential outputs meeting the RS-485 and RS-422 standards. The typical voltage output swing with no load will be 0 volts to 3.3 Volts. With a load of 54Ω across the differential outputs, the drivers can maintain greater than 1.5V voltage levels.

The driver of the SP3485 has a driver enable control line which is active HIGH. A logic HIGH on DE (pin 3) will enable the differential driver outputs. A logic LOW on the DE (pin 3) will tri-state the driver outputs.

The driver of the SP3485 operates up to 10Mbps. The 250mA I_{SC} maximum limit on the driver output allows the SP3485 to withstand an infinite short circuit over the -7.0V to 12V common mode range without catastrophic damage to the IC.

Receiver

The SP3485 receiver has differential inputs with an input sensitivity of $\pm 200\text{mV}$. Input impedance of the receiver is 12kΩ minimum. A wide common mode range of -7V to 12V allows for large ground potential differences between systems. The receiver is equipped with a fail-safe feature that guarantees the receiver output will be in a HIGH state when the input is left unconnected. The receiver of the SP3485 operates up to 10Mbps.

The receiver of the SP3485 has an enable control line which is active LOW. A logic LOW on $\overline{\text{RE}}$ (pin 2) will enable the differential receiver. A logic HIGH on $\overline{\text{RE}}$ (pin 2) of the SP3485 will disable the receiver.

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 part is 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_{PRZH} , t_{PZH} , t_{PRZL} and t_{PZL} assume the part was not in a low-power shutdown state. Enable times t_{PRSH} , t_{PSH} , t_{PRSL} and t_{PSL} assume the parts were shut down. It takes drivers and receivers longer to become enabled from low-power shutdown mode (t_{PRSH} , t_{PSH} , t_{PRSL} , t_{PSL}) than from driver/receiver-disable mode (t_{PRZH} , t_{PZH} , t_{PRZL} , t_{PZL}).

| INPUTS | | | OUTPUTS | |
|------------------------|----|----|----------|---|
| $\overline{\text{RE}}$ | DE | DI | B | A |
| X | 1 | 1 | 0 | 1 |
| X | 1 | 0 | 1 | 0 |
| 0 | 0 | X | High-Z | |
| 1 | 0 | X | Shutdown | |

Table 1: Transmit Function Truth Table

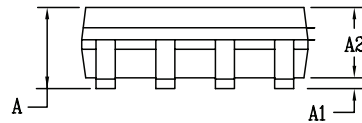
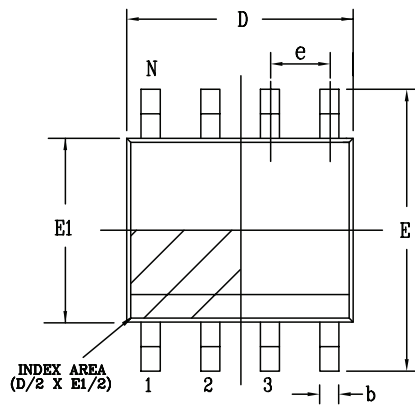
| INPUTS | | | OUTPUTS |
|------------------------|----|--------------|----------|
| $\overline{\text{RE}}$ | DE | $V_A - V_B$ | RO |
| 0 | X | -50mV | 1 |
| 0 | X | -200mV | 0 |
| X | X | Open/Shorted | 1 |
| 1 | 1 | X | High-Z |
| 1 | 0 | X | Shutdown |

Table 2: Receive Function Truth Table

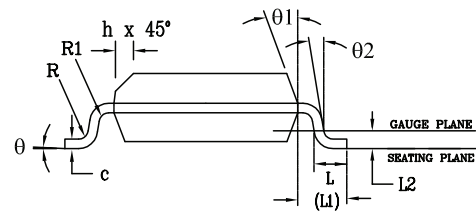
Mechanical Dimensions

NSOIC8

Top View



Side View



Front View

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

Drawing No: POD-00000108

Revision: A

Ordering Information⁽¹⁾

| Part Number | Operating Temperature Range | Lead-Free | Package | Packaging Method |
|---------------|-----------------------------|--------------------|------------|------------------|
| SP3485CN-L | 0°C to 70°C | Yes ⁽²⁾ | 8-pin SOIC | Tube |
| SP3485CN-L/TR | | | | Reel |
| SP3485EN-L | -40°C to 85°C | | | Tube |
| SP3485EN-L/TR | | | | Reel |

NOTE:

1. Refer to www.exar.com/SP3485 for most up-to-date Ordering Information.
2. Visit www.exar.com for additional information on Environmental Rating.

Revision History

| Revision | Date | Description |
|----------|-------|--|
| 10/15/02 | -- | Legacy Sipex Datasheet |
| 06/19/12 | 1.0.0 | Convert to Exar Format. Update ordering information and add new Figure 8 - Driver Short Circuit Current Limit Test Circuit. Remove EOL device SP3481. |
| 06/27/16 | 2.0.0 | Update logo. Update description paragraph on page 1. Update timing specifications in electrical characteristics table on pages 2 and 3. Add Driver and Receiver Enable from Shutdown timing information on pages 3 and 4. Update typical supply current information on page 4. Update Figures 2, 4, 6, and 8. Update Figures 11 and 13 to add shutdown timing labels. Add low power shutdown section to page 7. Update transmit and receive truth tables on page 7. Update Receiver section on page 7. |
| 09/06/17 | 2.0.1 | Remove GND from Differential Output Voltage min (page 2). Added maximum junction temperature, package power dissipation and ESD rating. Update to MaxLinear logo, update format and ordering information table. |



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