

## 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 and cause permanent damage to the device.

|                                            |               |
|--------------------------------------------|---------------|
| $V_{CC}$ .....                             | -0.3V to 6.0V |
| $V_{+}^{(1)}$ .....                        | -0.3V to 7.0V |
| $V_{-}^{(1)}$ .....                        | 0.3V to -7.0V |
| $V_{+} +  V_{-} ^{(1)}$ .....              | 13V           |
| $I_{CC}$ (DC $V_{CC}$ or GND current)..... | $\pm 100$ mA  |

### Input Voltages

|                                                    |                              |
|----------------------------------------------------|------------------------------|
| $TxIN$ , $\overline{EN}$ , $\overline{SHDN}$ ..... | -0.3V to ( $V_{CC} + 0.3$ V) |
| $RxIN$ .....                                       | $\pm 25$ V                   |

### Output Voltages

|               |                              |
|---------------|------------------------------|
| $TxOUT$ ..... | $\pm 13.2$ V                 |
| $RxOUT$ ..... | -0.3V to ( $V_{CC} + 0.3$ V) |

### Short-Circuit Duration

|               |            |
|---------------|------------|
| $TxOUT$ ..... | Continuous |
|---------------|------------|

|                          |                 |
|--------------------------|-----------------|
| Storage Temperature..... | -65°C to +150°C |
|--------------------------|-----------------|

### Power Dissipation per package

|                                                  |        |
|--------------------------------------------------|--------|
| 20-pin SSOP (derate 9.25mW/°C above 70°C).....   | 750mW  |
| 18-pin SOIC (derate 15.7mW/°C above 70°C).....   | 1260mW |
| 20-pin TSSOP (derate 11.1mW/°C above 70°C).....  | 890mW  |
| 16-pin SSOP (derate 9.69mW/°C above 70°C).....   | 775mW  |
| 16-pin PDIP (derate 14.3mW/°C above 70°C).....   | 1150mW |
| 16-pin WSOIC (derate 11.2mW/°C above 70°C).....  | 900mW  |
| 16-pin TSSOP (derate 10.5mW/°C above 70°C).....  | 850mW  |
| 16-pin NSOIC (derate 13.57mW/°C above 70°C)..... | 1086mW |

#### NOTE:

1.  $V_{+}$  and  $V_{-}$  can have maximum magnitudes of 7V, but their absolute difference cannot exceed 13V.

## Electrical Characteristics

Unless otherwise noted, the following specifications apply for  $V_{CC} = 3.0$ V to 5.5V with  $T_{AMB} = T_{MIN}$  to  $T_{MAX}$ , typical values apply at  $V_{CC} = 3.3$ V or 5.0V and  $T_{AMB} = 25^{\circ}\text{C}$ .

| PARAMETERS                               | MIN.           | TYP.           | MAX.      | UNITS         | CONDITIONS                                                                                                 |
|------------------------------------------|----------------|----------------|-----------|---------------|------------------------------------------------------------------------------------------------------------|
| <b>DC Characteristics</b>                |                |                |           |               |                                                                                                            |
| Supply current                           |                | 0.3            | 1.0       | mA            | no load, $V_{CC} = 3.3$ V, $T_{AMB} = 25^{\circ}\text{C}$ , $TxIN = \text{GND}$ or $V_{CC}$                |
| Shutdown supply current                  |                | 1.0            | 10        | $\mu\text{A}$ | $\overline{SHDN} = \text{GND}$ , $V_{CC} = 3.3$ V, $T_{AMB} = 25^{\circ}\text{C}$ , $TxIN = V_{CC}$ or GND |
| <b>Logic Inputs and Receiver Outputs</b> |                |                |           |               |                                                                                                            |
| Input logic threshold LOW                |                |                | 0.8       | V             | $TxIN$ , $\overline{EN}$ , $\overline{SHDN}^{(2)}$                                                         |
| Input logic threshold HIGH               | 2.0            |                | $V_{CC}$  | V             | $V_{CC} = 3.3\text{V}^{(2)}$                                                                               |
| Input logic threshold HIGH               | 2.4            |                | $V_{CC}$  | V             | $V_{CC} = 5.0\text{V}^{(2)}$                                                                               |
| Input leakage current                    |                | $\pm 0.01$     | $\pm 1.0$ | $\mu\text{A}$ | $TxIN$ , $\overline{EN}$ , $\overline{SHDN}$ , $T_{AMB} = 25^{\circ}\text{C}$ , $V_{IN} = 0$ V to $V_{CC}$ |
| Output leakage current                   |                | $\pm 0.05$     | $\pm 10$  | $\mu\text{A}$ | Receivers disabled, $V_{OUT} = 0$ V to $V_{CC}$                                                            |
| Output voltage LOW                       |                |                | 0.4       | V             | $I_{OUT} = 1.6$ mA                                                                                         |
| Output voltage HIGH                      | $V_{CC} - 0.6$ | $V_{CC} - 0.1$ |           | V             | $I_{OUT} = -1.0$ mA                                                                                        |
| <b>Driver Outputs</b>                    |                |                |           |               |                                                                                                            |
| Output voltage swing                     | $\pm 5.0$      | $\pm 5.4$      |           | V             | All driver outputs loaded with 3k $\Omega$ to GND, $T_{AMB} = 25^{\circ}\text{C}$                          |
| Output resistance                        | 300            |                |           | $\Omega$      | $V_{CC} = V_{+} = V_{-} = 0$ V, $T_{OUT} = \pm 2$ V                                                        |
| Output short-circuit current             |                | $\pm 35$       | $\pm 60$  | mA            | $V_{OUT} = 0$ V                                                                                            |
| Output leakage current                   |                |                | $\pm 25$  | $\mu\text{A}$ | $V_{CC} = 0$ V or 3.0V to 5.5V, $V_{OUT} = \pm 12$ V, drivers disabled                                     |

## Electrical Characteristics (Continued)

Unless otherwise noted, the following specifications apply for  $V_{CC} = 3.0V$  to  $5.5V$  with  $T_{AMB} = T_{MIN}$  to  $T_{MAX}$ , typical values apply at  $V_{CC} = 3.3V$  or  $5.0V$  and  $T_{AMB} = 25^{\circ}C$ .

| PARAMETERS                            | MIN. | TYP. | MAX. | UNITS      | CONDITIONS                                                                                                                                     |
|---------------------------------------|------|------|------|------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Receiver Inputs</b>                |      |      |      |            |                                                                                                                                                |
| Input voltage range                   | -15  |      | 15   | V          |                                                                                                                                                |
| Input threshold LOW                   | 0.6  | 1.2  |      | V          | $V_{CC} = 3.3V$                                                                                                                                |
| Input threshold LOW                   | 0.8  | 1.5  |      | V          | $V_{CC} = 5.0V$                                                                                                                                |
| Input threshold HIGH                  |      | 1.5  | 2.4  | V          | $V_{CC} = 3.3V$                                                                                                                                |
| Input threshold HIGH                  |      | 1.8  | 2.4  | V          | $V_{CC} = 5.0V$                                                                                                                                |
| Input hysteresis                      |      | 0.3  |      | V          |                                                                                                                                                |
| Input resistance                      | 3    | 5    | 7    | k $\Omega$ |                                                                                                                                                |
| <b>Timing Characteristics</b>         |      |      |      |            |                                                                                                                                                |
| Maximum data rate                     | 120  | 235  |      | kbps       | $R_L = 3k\Omega$ , $C_L = 1000pF$ , one driver switching                                                                                       |
| Driver propagation delay, $t_{PHL}$   |      | 1.0  |      | $\mu s$    | $R_L = 3k\Omega$ , $C_L = 1000pF$                                                                                                              |
| Driver propagation delay, $t_{PLH}$   |      | 1.0  |      | $\mu s$    | $R_L = 3k\Omega$ , $C_L = 1000pF$                                                                                                              |
| Receiver propagation delay, $t_{PHL}$ |      | 0.3  |      | $\mu s$    | Receiver input to receiver output, $C_L = 150pF$                                                                                               |
| Receiver propagation delay, $t_{PLH}$ |      | 0.3  |      | $\mu s$    | Receiver input to receiver output, $C_L = 150pF$                                                                                               |
| Receiver output enable time           |      | 200  |      | ns         |                                                                                                                                                |
| Receiver output disable time          |      | 200  |      | ns         |                                                                                                                                                |
| Driver skew                           |      | 100  | 500  | ns         | $ t_{PHL} - t_{PLH} $ , $T_{AMB} = 25^{\circ}C$                                                                                                |
| Receiver skew                         |      | 200  | 1000 | ns         | $ t_{PHL} - t_{PLH} $                                                                                                                          |
| Transition-region slew rate           |      |      | 30   | V/ $\mu s$ | $V_{CC} = 3.3V$ , $R_L = 3k\Omega$ , $C_L = 1000pF$ , $T_{AMB} = 25^{\circ}C$ , measurements taken from $-3.0V$ to $3.0V$ or $3.0V$ to $-3.0V$ |

**NOTE:**

2. Driver input hysteresis is typically 250mV.

## Typical Performance Characteristics

Unless otherwise noted, the following performance characteristics apply for  $V_{CC} = 3.3V$ , 120kbps data rate, all drivers loaded with  $3k\Omega$ ,  $0.1\mu F$  charge pump capacitors, and  $T_{AMB} = 25^{\circ}C$ .

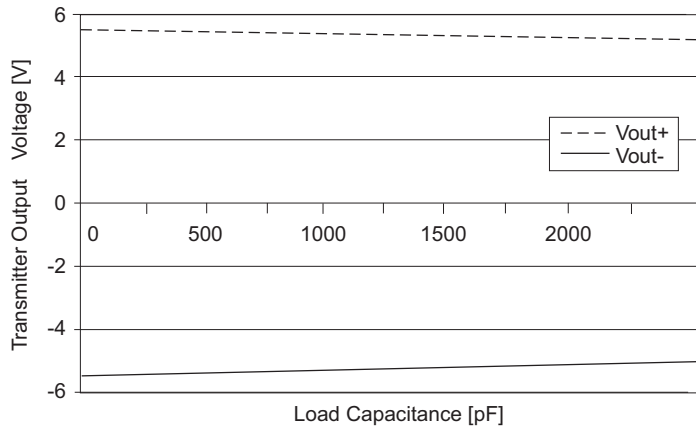


Figure 1: Transmitter Output Voltage vs Load Capacitance for the SP3222E and SP3232E

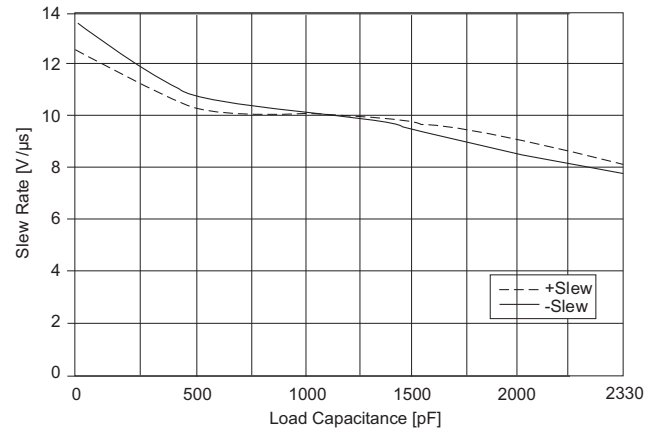


Figure 2: Slew Rate vs Load Capacitance for the SP3222E and SP3232E

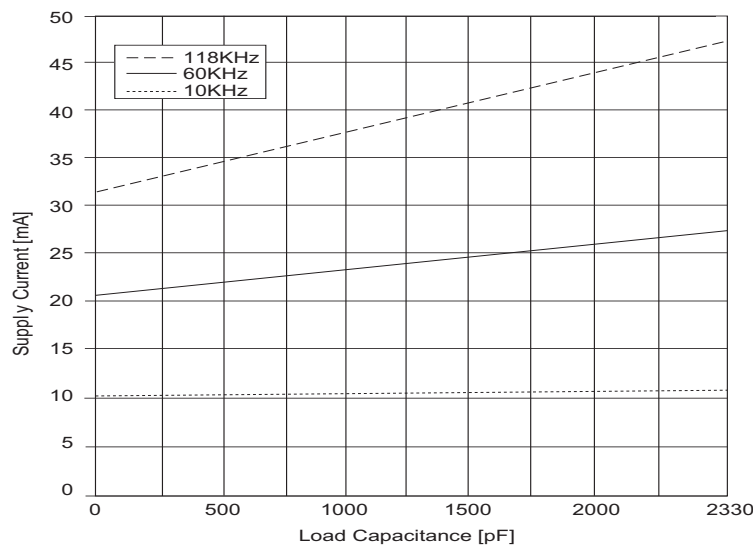


Figure 3: Supply Current VS. Load Capacitance when Transmitting Data

## Pin Functions

| Pin Name                 | Pin Function / Description                                                                                                                       | Pin Number |               |         |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------------|---------|
|                          |                                                                                                                                                  | SP3222E    |               | SP3232E |
|                          |                                                                                                                                                  | SOIC       | SSOP<br>TSSOP |         |
| $\overline{\text{EN}}$   | Receiver Enable. Apply logic LOW for normal operation. Apply logic HIGH to disable the receiver outputs (high-Z state).                          | 1          | 1             | -       |
| C1+                      | Positive terminal of the voltage doubler charge-pump capacitor                                                                                   | 2          | 2             | 1       |
| V+                       | 5.5V output generated by the charge pump                                                                                                         | 3          | 3             | 2       |
| C1-                      | Negative terminal of the voltage doubler charge-pump capacitor                                                                                   | 4          | 4             | 3       |
| C2+                      | Positive terminal of the inverting charge-pump capacitor                                                                                         | 5          | 5             | 4       |
| C2-                      | Negative terminal of the inverting charge-pump capacitor                                                                                         | 6          | 6             | 5       |
| V-                       | -5.5V output generated by the charge pump                                                                                                        | 7          | 7             | 6       |
| T <sub>1</sub> OUT       | RS-232 driver output                                                                                                                             | 15         | 17            | 14      |
| T <sub>2</sub> OUT       | RS-232 driver output                                                                                                                             | 8          | 8             | 7       |
| R <sub>1</sub> IN        | RS-232 receiver input                                                                                                                            | 14         | 16            | 13      |
| R <sub>2</sub> IN        | RS-232 receiver input                                                                                                                            | 9          | 9             | 8       |
| R <sub>1</sub> OUT       | TTL/CMOS receiver output                                                                                                                         | 13         | 15            | 12      |
| R <sub>2</sub> OUT       | TTL/CMOS receiver output                                                                                                                         | 10         | 10            | 9       |
| T <sub>1</sub> IN        | TTL/CMOS driver input                                                                                                                            | 12         | 13            | 11      |
| T <sub>2</sub> IN        | TTL/CMOS driver input                                                                                                                            | 11         | 12            | 10      |
| GND                      | Ground                                                                                                                                           | 16         | 18            | 15      |
| V <sub>CC</sub>          | 3.0V to 5.5V supply voltage                                                                                                                      | 17         | 19            | 16      |
| $\overline{\text{SHDN}}$ | Shutdown Control Input. Drive HIGH for normal device operation. Drive LOW to shutdown the drivers (high-Z output) and the on-board power supply. | 18         | 20            | -       |
| N.C.                     | No connect                                                                                                                                       | -          | 11, 14        | -       |

Table 1: Device Pin Description

## Pinouts

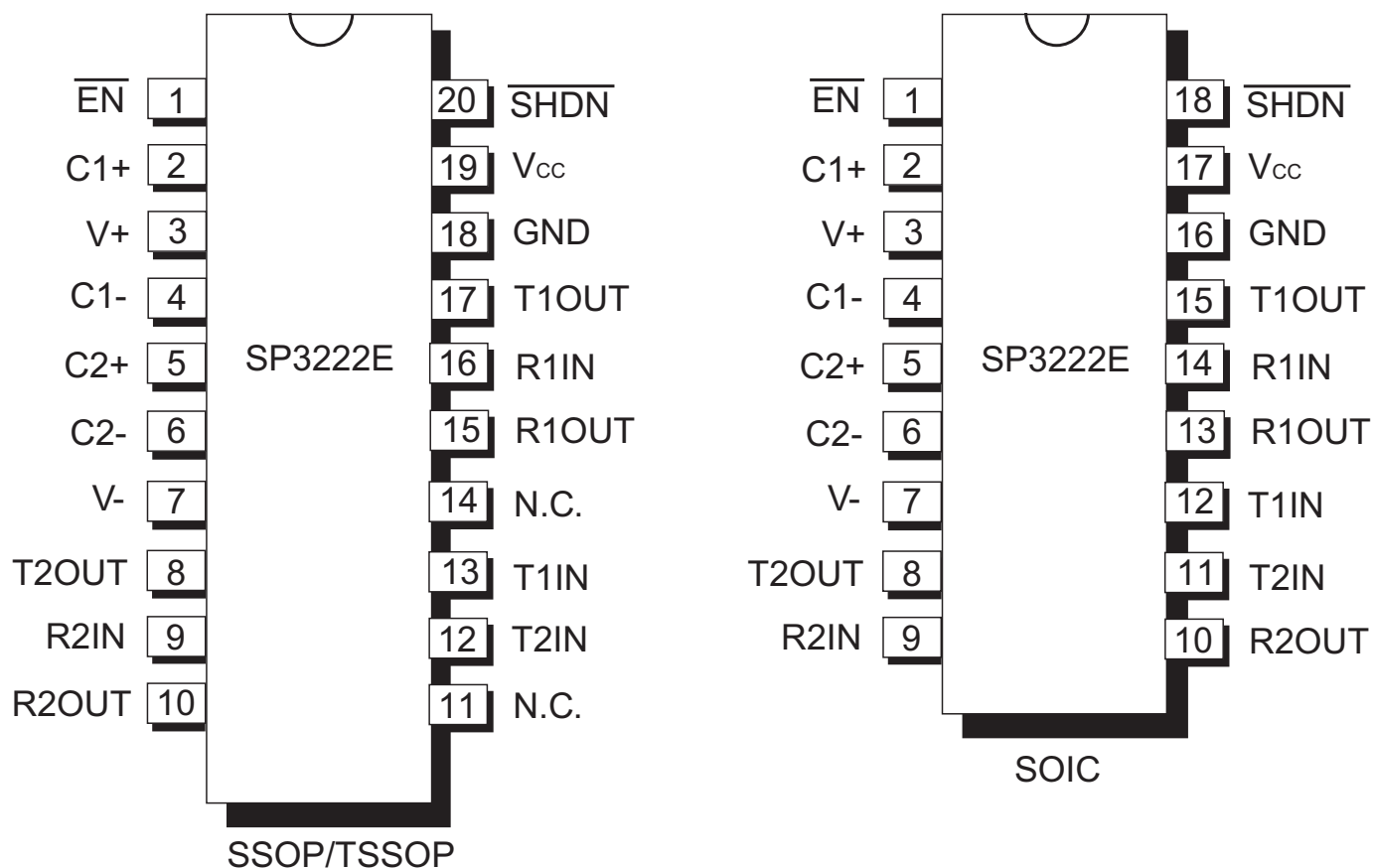


Figure 4: Pinout Configurations for the SP3222E

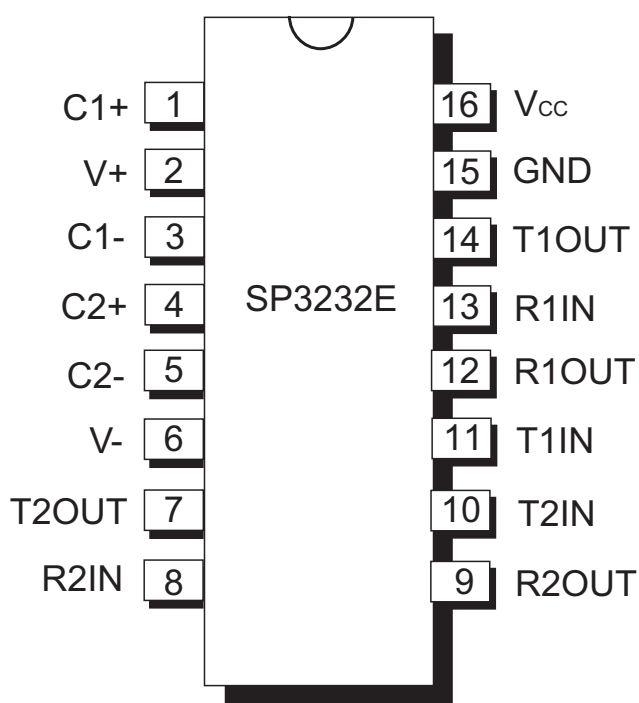


Figure 5: Pinout Configurations for the SP3232E

## Typical Operating Circuits

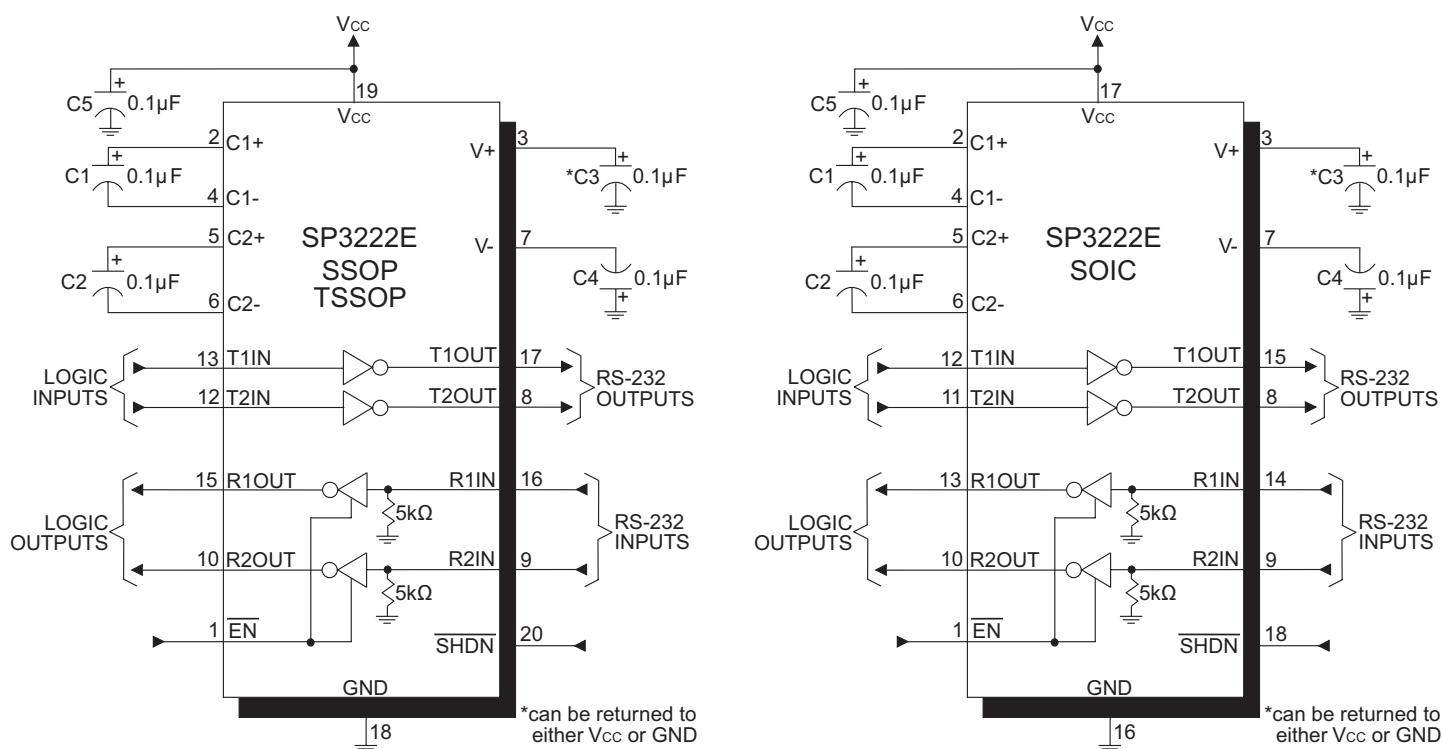


Figure 6: SP3222E Typical Operating Circuits

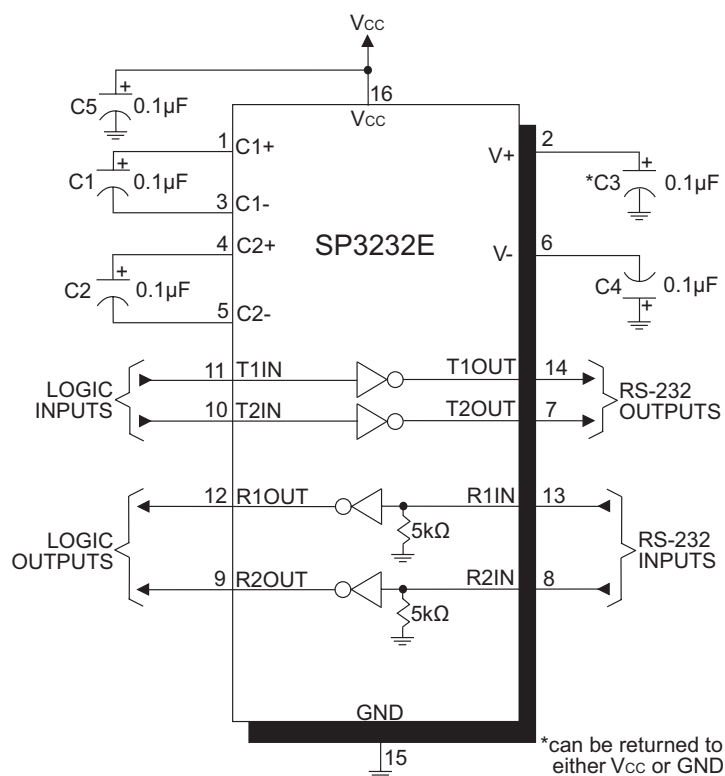


Figure 7: SP3232E Typical Operating Circuit

The SP3222E and SP3232E are 2-driver / 2-receiver devices ideal for portable or hand-held applications. The SP3222E features a 1 $\mu$ A shutdown mode that reduces power consumption and extends battery life in portable systems. Its receivers remain active in shutdown mode, allowing external devices such as modems to be monitored using only 1 $\mu$ A supply current.

## Theory of Operation

The SP322E/SP3232E series is made up of three basic circuit blocks:

1. Drivers
2. Receivers
3. The MaxLinear proprietary charge pump

## Drivers

The drivers are inverting level transmitters that convert TTL or CMOS logic levels to 5.0V EIA/TIA-232 levels with an inverted sense relative to the input logic levels. Typically, the RS-232 output voltage swing is 5.4V with no load and 5V minimum fully loaded. The driver outputs are protected against infinite short-circuits to ground without degradation in reliability. Driver outputs will meet EIA/TIA-562 levels of  $\pm 3.7V$  with supply voltages as low as 2.7V.

The drivers can guarantee a data rate of 120kbps fully loaded with 3k $\Omega$  in parallel with 1000pF, ensuring compatability with PC-to-PC communication software.

The slow rate of the driver is internally limited to a maximum of 30V/ $\mu$ s in order to meet the EIA standards (EIA RS-232D 2.1.7, Paragraph 5). The transition of the loaded output from HIGH to LOW also meet the monotonicity requirements of the standard.

Figure 8 shows a loopback test circuit used to test the RS-232 Drivers. Figure 9 shows the test results of the loopback circuit with all drivers active at 120kbps with RS-232 loads in parallel with a 1000pF capacitor.

Figure 10 shows the test results where one driver was active at 235kbps and all drivers loaded with an RS-232 receiver in parallel with 1000pF capacitors. A solid RS-232 data transmission rate of 120kbps provides compatibility with many designs in personal computer peripherals and LAN applications.

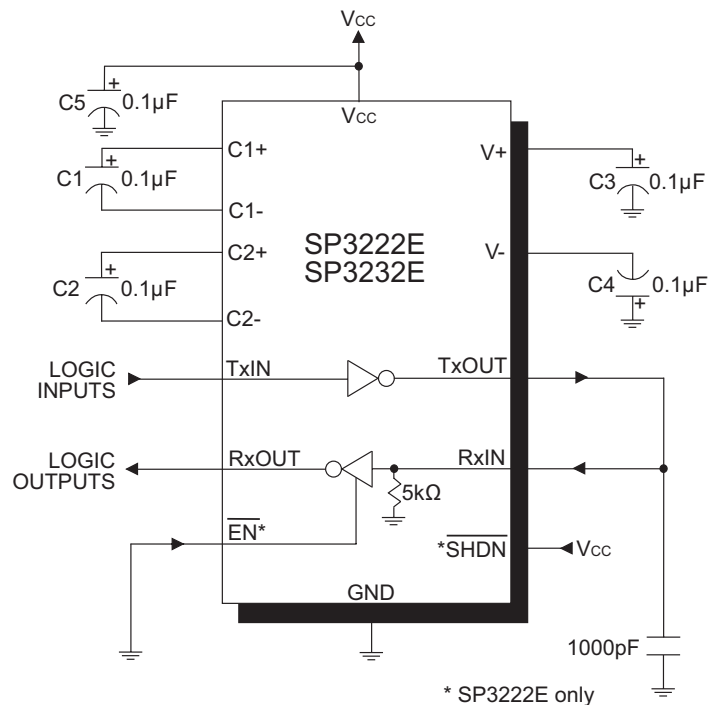


Figure 8: SP3222E/SP3232E Driver Loopback Test Circuit

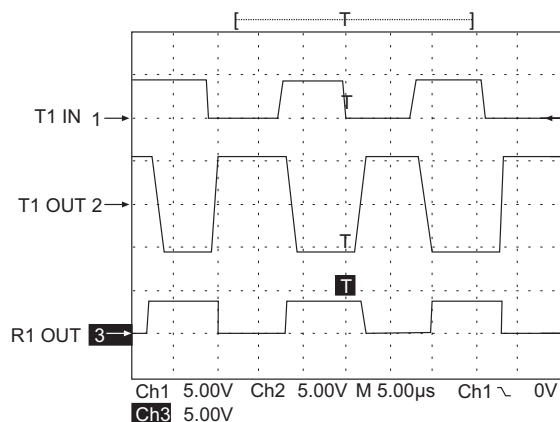


Figure 9: Loopback Test results at 120kbps

## Applications Information (Continued)

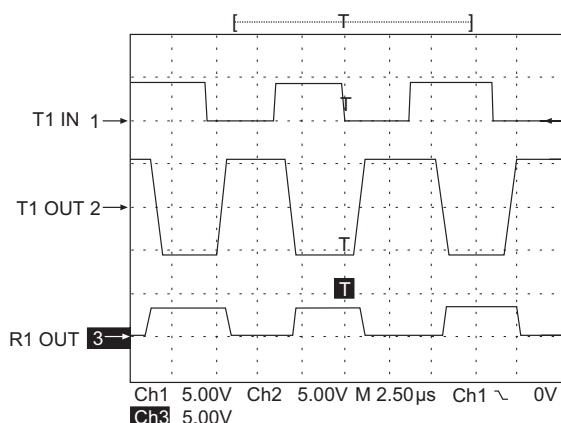


Figure 10: Loopback Test results at 235kbps

The SP3222E driver's output stages are turned off (tri-state) when the device is in shutdown mode. When the power is off, the SP3222E device permits the outputs to be driven up to  $\pm 12\text{V}$ . The driver's inputs do not have pull-up resistors. Designers should connect unused inputs to  $V_{CC}$  or GND.

In the shutdown mode, the supply current falls to less than  $1\mu\text{A}$ , where  $\overline{\text{SHDN}} = \text{LOW}$ . When the SP3222E device is shut down, the device's driver outputs are disabled (tri-stated) and the charge pumps are turned off with  $V+$  pulled down to  $V_{CC}$  and  $V-$  pulled to GND. The time required to exit shutdown is typically  $100\mu\text{s}$ . Connect  $\overline{\text{SHDN}}$  to  $V_{CC}$  if the shutdown mode is not used.

## Receivers

The Receivers convert EIA/TIA-232 levels to TTL or CMOS logic output levels. The SP3222E receivers have an inverting tri-state output. These receiver outputs (RxOUT) are tri-stated when the enable control  $\overline{\text{EN}} = \text{HIGH}$ . In the shutdown mode, the receivers can be active or inactive.  $\overline{\text{EN}}$  has no effect on TxOUT. The truth table logic of the SP3222E driver and receiver outputs can be found in Table 2.

| $\overline{\text{SHDN}}$ | $\overline{\text{EN}}$ | TxOUT     | RxOUT     |
|--------------------------|------------------------|-----------|-----------|
| 0                        | 0                      | Tri-state | Active    |
| 0                        | 1                      | Tri-state | Tri-state |
| 1                        | 0                      | Active    | Active    |
| 1                        | 1                      | Active    | Tri-state |

Table 2: SP3222E Truth Table Logic for Shutdown and Enable Control

Since receiver input is usually from a transmission line where long cable lengths and system interference can degrade the signal, the inputs have a typical hysteresis margin of  $300\text{mV}$ . This ensures that the receiver is virtually immune to noisy transmission lines. Should an input be left unconnected, an internal  $5\text{k}\Omega$  pulldown resistor to ground will commit the output of the receiver to a HIGH state.

## Charge Pump

The charge pump is an MaxLinear-patented design (U.S. 5,306,954) and uses a unique approach compared to older less-efficient designs. The charge pump still requires four external capacitors, but uses a four-phase voltage shifting technique to attain symmetrical  $5.5\text{V}$  power supplies. The internal power supply consists of a regulated dual charge pump that provides output voltages of  $\pm 5.5\text{V}$  regardless of the input voltage ( $V_{CC}$ ) over the  $3.0\text{V}$  to  $5.5\text{V}$  range.

In most circumstances, decoupling the power supply can be achieved adequately using a  $0.1\mu\text{F}$  bypass capacitor at C5 (refer to figures 6 and 7). In applications that are sensitive to power-supply noise, decouple  $V_{CC}$  to ground with a capacitor of the same value as charge-pump capacitor C1. Physically connect bypass capacitors as close to the IC as possible.

The charge pump operates in a discontinuous mode using an internal oscillator. If the output voltages are less than a magnitude of  $5.5\text{V}$ , the charge pump is enabled. If the output voltages exceed a magnitude of  $5.5\text{V}$ , the charge pump is disabled. This oscillator controls the four phases of the voltage shifting. A description of each phase follows.

Phase 1:  $V_{SS}$  charge storage

During this phase of the clock cycle, the positive side of capacitors  $C_1$  and  $C_2$  are initially charged to  $V_{CC}$ .  $C_1^+$  is then switched to GND and the charge in  $C_1^-$  is transferred to  $C_2^-$ . Since  $C_2^+$  is connected to  $V_{CC}$ , the voltage potential across capacitor  $C_2$  is now 2 times  $V_{CC}$ .

Phase 2:  $V_{SS}$  transfer

Phase two of the clock connects the negative terminal of  $C_2$  to the  $V_{SS}$  storage capacitor and the positive terminal of  $C_2$  to GND. This transfers a negative generated voltage to  $C_3$ . This generated voltage is regulated to a minimum voltage of  $-5.5\text{V}$ . Simultaneous with the transfer of the voltage to  $C_3$ , the positive side of capacitor  $C_1$  is switched to  $V_{CC}$  and the negative side is connected to GND.



## Applications Information (Continued)

### Phase 3: $V_{DD}$ charge storage

The third phase of the clock is identical to the first phase; the charge transferred in  $C_1$  produces  $-V_{CC}$  in the negative terminal of  $C_1$ , which is applied to the negative side of capacitor  $C_2$ . Since  $C_2^+$  is at  $V_{CC}$ , the voltage potential across  $C_2$  is 2 times  $V_{CC}$ .

### Phase 4: $V_{DD}$ transfer

The fourth phase of the clock connects the negative terminal of  $C_2$  to GND, and transfers this positive generated voltage across  $C_2$  to  $C_4$ , the  $V_{DD}$  storage capacitor. This voltage is regulated to 5.5V. At this voltage, the internal oscillator is disabled. Simultaneous with the transfer of the voltage to  $C_4$ , the positive side of capacitor  $C_1$  is switched to  $V_{CC}$  and the negative side is connected to GND, allowing the charge pump cycle to begin again. The charge pump cycle will continue as long as the operational conditions for the internal oscillator are present.

Since both  $V^+$  and  $V^-$  are separately generated from  $V_{CC}$ , in a no-load condition  $V^+$  and  $V^-$  will be symmetrical. Older charge pump approaches that generate  $V^-$  from  $V^+$  will show a decrease in the magnitude of  $V^-$  compared to  $V^+$  due to the inherent inefficiencies in the design.

The clock rate for the charge pump typically operates at greater than 250kHz. The external capacitors can be as low as 0.1 $\mu$ F with a 16V breakdown voltage rating.

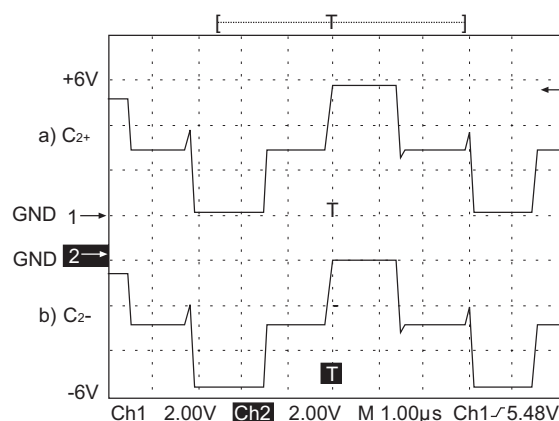


Figure 13: Charge Pump Waveforms

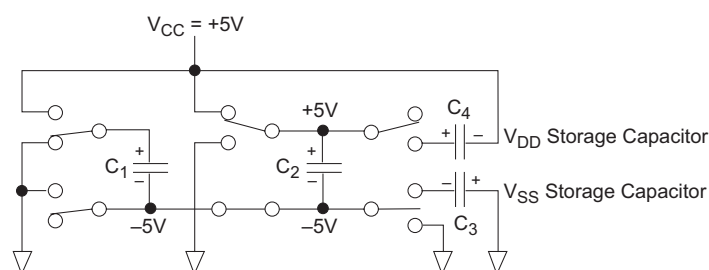


Figure 14: Charge Pump - Phase 3

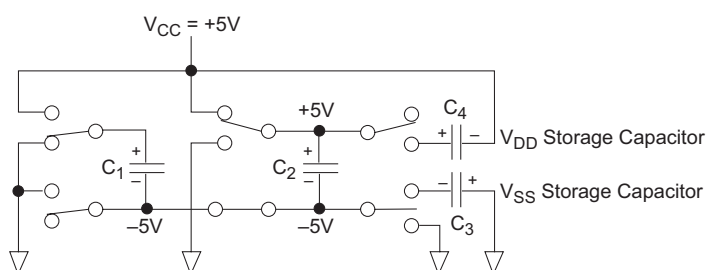


Figure 11: Charge Pump - Phase 1

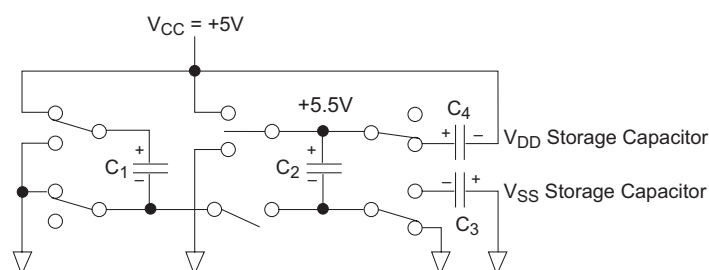


Figure 15: Charge Pump - Phase 4

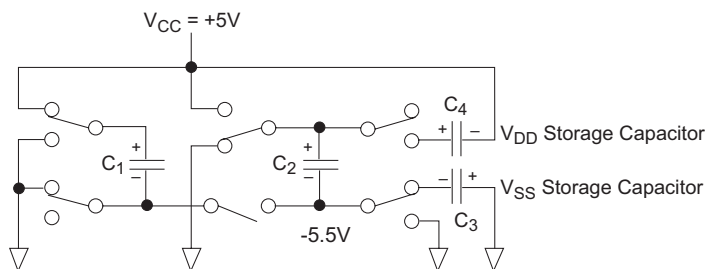


Figure 12: Charge Pump - Phase 2

## ESD Tolerance

The SP3222E / SP3232E Series incorporates ruggedized ESD cells on all driver output and receiver input pins. The ESD structure is improved over our previous family for more rugged applications and environments sensitive to electrostatic discharges and associated transients. The improved ESD tolerance is at least  $\pm 15\text{kV}$  without damage or latch-up.

There are different methods of ESD testing applied:

- a) MIL-STD-883, Method 3015.7
- b) IEC61000-4-2 Air-Discharge
- c) IEC61000-4-2 Direct Contact

The Human Body Model has been the generally accepted ESD testing method for semiconductors. This method is also specified in MIL-STD-883, Method 3015.7 for ESD testing. The premise of this ESD test is to simulate the human body's potential to store electro-static energy and

discharge it to an integrated circuit. The simulation is performed by using a test model as shown in Figure 16. This method will test the IC's capability to withstand an ESD transient during normal handling such as in manufacturing areas where the IC's tend to be handled frequently.

The IEC61000-4-2, formerly IEC801-2, is generally used for testing ESD on equipment and systems. For system manufacturers, they must guarantee a certain amount of ESD protection since the system itself is exposed to the outside environment and human presence. The premise with IEC61000-4-2 is that the system is required to withstand an amount of static electricity when ESD is applied to points and surfaces of the equipment that are accessible to personnel during normal usage. The transceiver IC receives most of the ESD current when the ESD source is applied to the connector pins. The test circuit for IEC61000-4-2 is shown on Figure 17. There are two methods within IEC61000-4-2, the Air Discharge method and the Contact Discharge method.

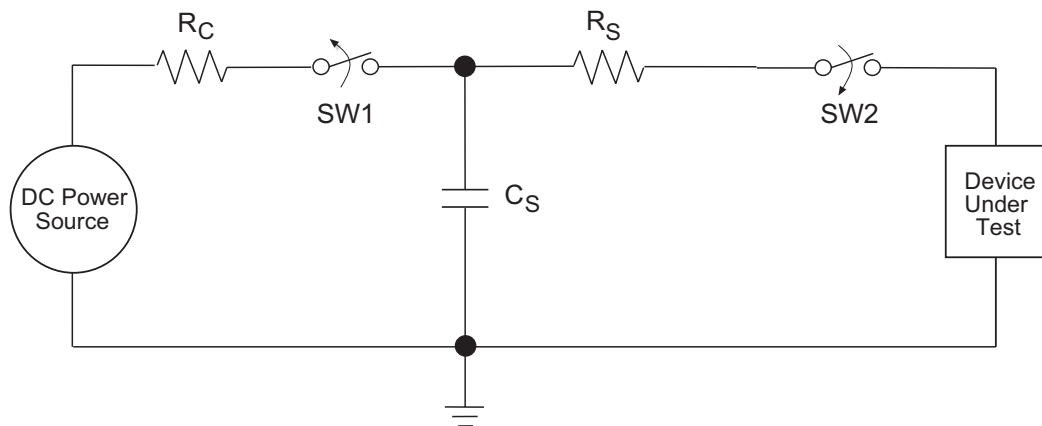


Figure 16: ESD Test Circuit for Human Body Model

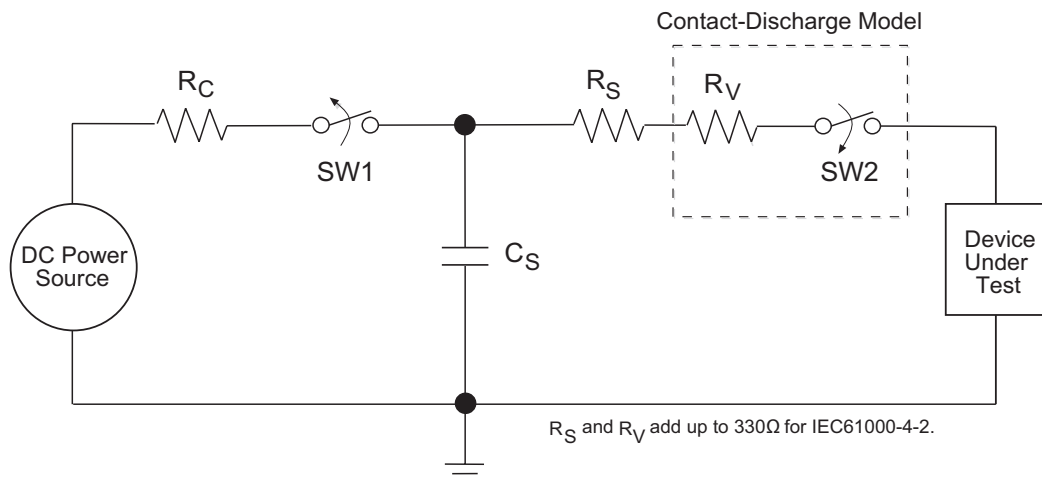


Figure 17: ESD Test Circuit for IEC61000-4-2

## ESD Tolerance (Continued)

With the Air Discharge Method, an ESD voltage is applied to the equipment under test (EUT) through air. This simulates an electrically charged person ready to connect a cable onto the rear of the system only to find an unpleasant zap just before the person touches the back panel. The high energy potential on the person discharges through an arcing path to the rear panel of the system before he or she even touches the system. This energy, whether discharged directly or through air, is predominantly a function of the discharge current rather than the discharge voltage. Variables with an air discharge such as approach speed of the object carrying the ESD potential to the system and humidity will tend to change the discharge current. For example, the rise time of the discharge current varies with the approach speed.

The Contact Discharge Method applies the ESD current directly to the EUT. This method was devised to reduce the unpredictability of the ESD arc. The discharge current rise time is constant since the energy is directly transferred without the air-gap arc. In situations such as hand held systems, the ESD charge can be directly discharged to the equipment from a person already holding the equipment. The current is transferred on to the keypad or the serial port of the equipment directly and then travels through the PCB and finally to the IC.

The circuit model in Figures 16 and 17 represent the typical ESD testing circuit used for all three methods. The  $C_S$  is initially charged with the DC power supply when the first switch (SW1) is on. Now that the capacitor is charged, the second switch (SW2) is on while SW1 switches off. The voltage stored in the capacitor is then applied through  $R_S$ , the current limiting resistor, onto the device under test (DUT). In ESD tests, the SW2 switch is pulsed so that the device under test receives a duration of voltage.

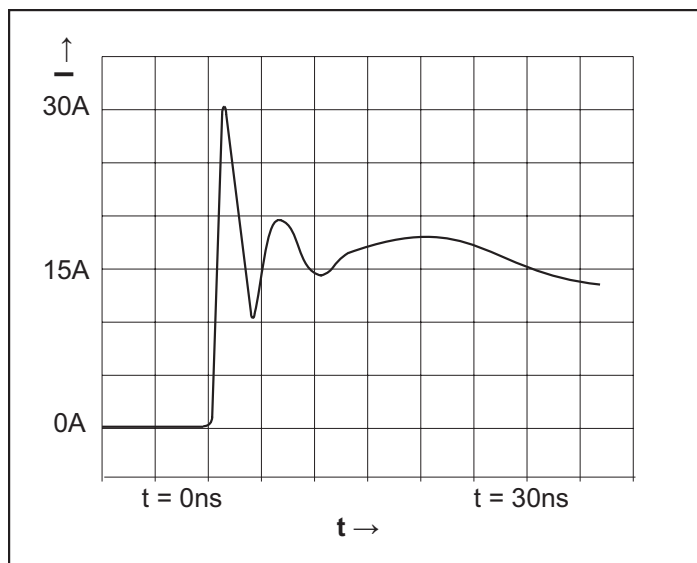


Figure 18: ESD Test Waveform for IEC61000-4-2

For the Human Body Model, the current limiting resistor ( $R_S$ ) and the source capacitor ( $C_S$ ) are  $1.5k\Omega$  and  $100pF$ , respectively. For IEC-61000-4-2, the current limiting resistor ( $R_S$ ) and the source capacitor ( $C_S$ ) are  $330\Omega$  and  $150pF$ , respectively.

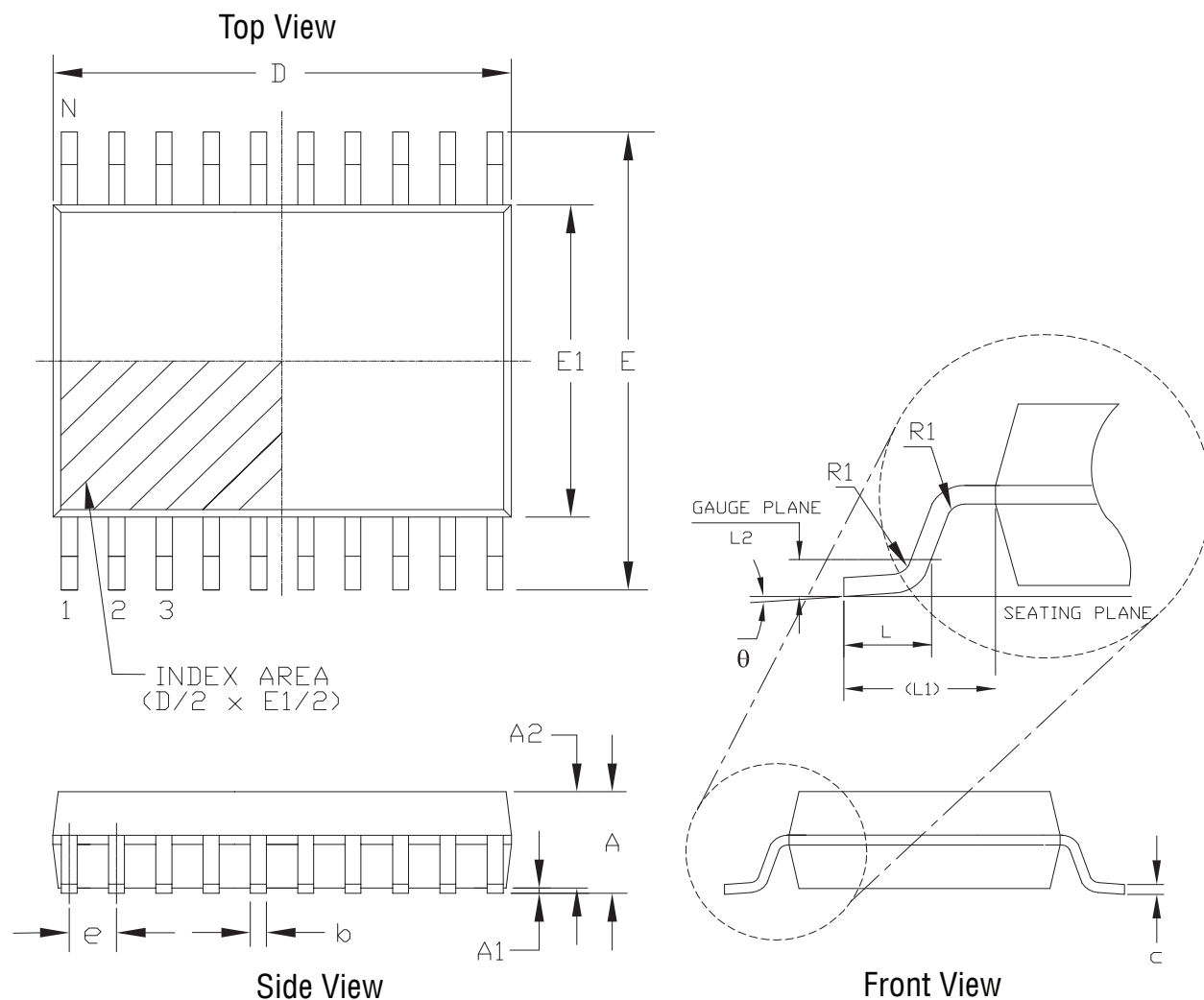
The higher  $C_S$  value and lower  $R_S$  value in the IEC61000-4-2 model are more stringent than the Human Body Model. The larger storage capacitor injects a higher voltage to the test point when SW2 is switched on. The lower current limiting resistor increases the current charge onto the test point.

| DEVICE PIN TESTED | HUMAN BODY MODEL | IEC61000-4-2  |                |       |
|-------------------|------------------|---------------|----------------|-------|
|                   |                  | Air Discharge | Direct Contact | Level |
| Driver Outputs    | $\pm 15kV$       | $\pm 15kV$    | $\pm 8kV$      | 4     |
| Receiver Inputs   | $\pm 15kV$       | $\pm 15kV$    | $\pm 8kV$      | 4     |

Table 3: Transceiver ESD Tolerance Levels

## Mechanical Dimensions

## SSOP20



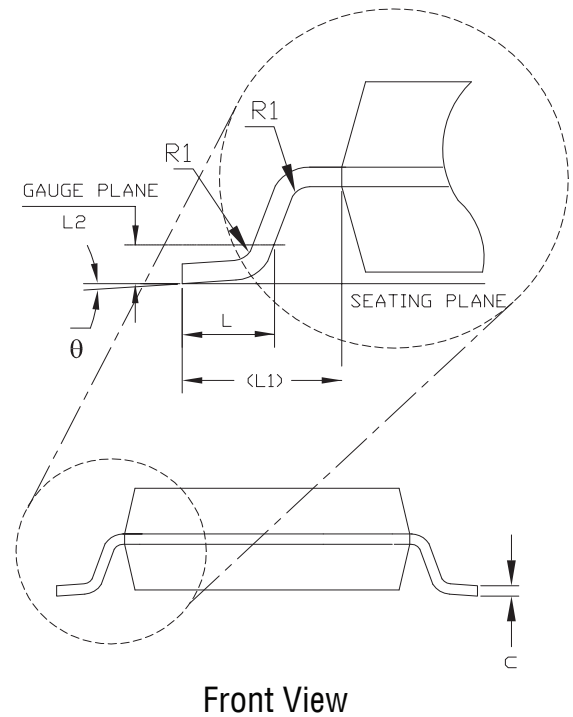
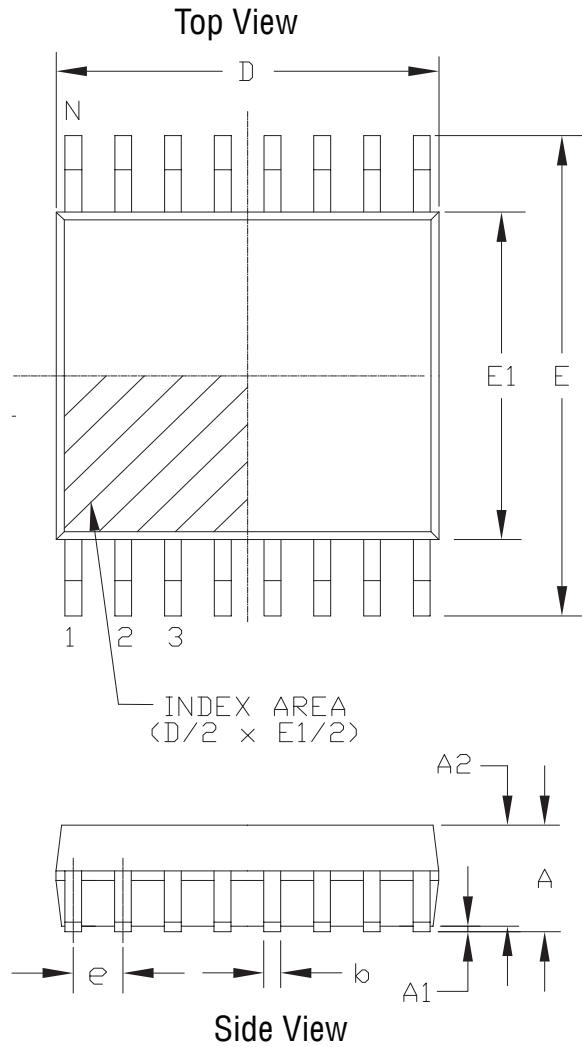
| PACKAGE OUTLINE SSOP 5.3mm BODY<br>JEDEC MO-150 VARIATION AE |                                           |      |      |                                               |       |       |
|--------------------------------------------------------------|-------------------------------------------|------|------|-----------------------------------------------|-------|-------|
| SYMBOLS                                                      | COMMON DIMENSIONS IN MM<br>(Control Unit) |      |      | COMMON DIMENSIONS IN INCH<br>(Reference Unit) |       |       |
|                                                              | MIN                                       | NOM  | MAX  | MIN                                           | NOM   | MAX   |
| A                                                            | —                                         | —    | 2.00 | —                                             | —     | 0.079 |
| A1                                                           | 0.05                                      | —    | —    | 0.002                                         | —     | —     |
| A2                                                           | 1.65                                      | 1.75 | 1.85 | 0.065                                         | 0.069 | 0.073 |
| b                                                            | 0.22                                      | —    | 0.38 | 0.009                                         | —     | 0.015 |
| c                                                            | 0.09                                      | —    | 0.25 | 0.004                                         | —     | 0.010 |
| E                                                            | 7.40                                      | 7.80 | 8.20 | 0.291                                         | 0.307 | 0.323 |
| E1                                                           | 5.00                                      | 5.30 | 5.60 | 0.197                                         | 0.209 | 0.220 |
| e                                                            | 0.65 BSC                                  |      |      | 0.026 BSC                                     |       |       |
| L                                                            | 0.55                                      | 0.75 | 0.95 | 0.022                                         | 0.030 | 0.037 |
| L1                                                           | 1.25 REF                                  |      |      | 0.049 REF                                     |       |       |
| L2                                                           | 0.25 BSC                                  |      |      | 0.010 BSC                                     |       |       |
| R1                                                           | 0.09                                      | —    | —    | 0.004                                         | —     | —     |
| θ                                                            | 0°                                        | 4°   | 8°   | 0°                                            | 4°    | 8°    |
| D                                                            | 6.90                                      | 7.20 | 7.50 | .272                                          | 0.283 | 0.295 |
| N                                                            | 20                                        |      |      |                                               |       |       |

Drawing No: POD-00000119

Revision: A

## Mechanical Dimensions

### SSOP16



| PACKAGE OUTLINE SSOP 5.3mm BODY<br>JEDEC MO-150 VARIATION AC |                                           |      |      |                                               |       |       |
|--------------------------------------------------------------|-------------------------------------------|------|------|-----------------------------------------------|-------|-------|
| SYMBOLS                                                      | COMMON DIMENSIONS IN MM<br>(Control Unit) |      |      | COMMON DIMENSIONS IN INCH<br>(Reference Unit) |       |       |
|                                                              | MIN                                       | NOM  | MAX  | MIN                                           | NOM   | MAX   |
| A                                                            | —                                         | —    | 2.00 | —                                             | —     | 0.079 |
| A1                                                           | 0.05                                      | —    | —    | 0.002                                         | —     | —     |
| A2                                                           | 1.65                                      | 1.75 | 1.85 | 0.065                                         | 0.069 | 0.073 |
| b                                                            | 0.22                                      | —    | 0.38 | 0.009                                         | —     | 0.015 |
| c                                                            | 0.09                                      | —    | 0.25 | 0.004                                         | —     | 0.010 |
| E                                                            | 7.40                                      | 7.80 | 8.20 | 0.291                                         | 0.307 | 0.323 |
| E1                                                           | 5.00                                      | 5.30 | 5.60 | 0.197                                         | 0.209 | 0.220 |
| e                                                            | 0.65 BSC                                  |      |      | 0.026 BSC                                     |       |       |
| L                                                            | 0.55                                      | 0.75 | 0.95 | 0.022                                         | 0.030 | 0.037 |
| L1                                                           | 1.25 REF                                  |      |      | 0.049 REF                                     |       |       |
| L2                                                           | 0.25 BSC                                  |      |      | 0.010 BSC                                     |       |       |
| R1                                                           | 0.09                                      | —    | —    | 0.004                                         | —     | —     |
| θ                                                            | 0°                                        | 4°   | 8°   | 0°                                            | 4°    | 8°    |
| D                                                            | 5.90                                      | 6.20 | 6.50 | 0.232                                         | 0.244 | 0.256 |
| N                                                            | 16                                        |      |      |                                               |       |       |

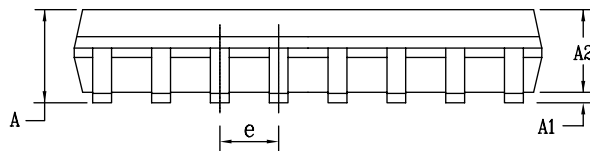
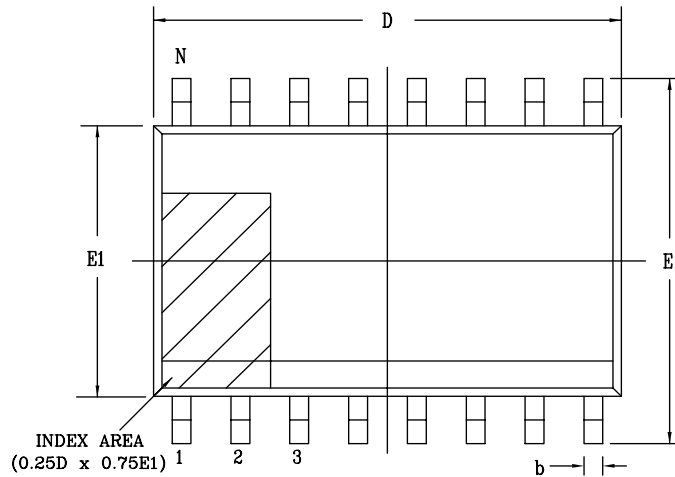
Drawing No: **POD-00000116**

Revision: **A**

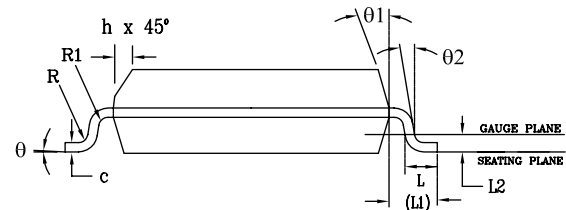
## Mechanical Dimensions

WSOIC16

Top View



Side View



Front View

| PACKAGE OUTLINE: SOIC .300" BODY<br>JEDEC MS-013 VARIATION AA |                                           |     |      |                                                 |     |       |
|---------------------------------------------------------------|-------------------------------------------|-----|------|-------------------------------------------------|-----|-------|
| SYMBOLS                                                       | COMMON DIMENSIONS IN MM<br>(Control Unit) |     |      | COMMON DIMENSIONS IN INCHES<br>(Reference Unit) |     |       |
|                                                               | MIN                                       | NOM | MAX  | MIN                                             | NOM | MAX   |
| A                                                             | 2.35                                      | —   | 2.65 | 0.093                                           | —   | 0.104 |
| A1                                                            | 0.10                                      | —   | 0.30 | 0.004                                           | —   | 0.012 |
| A2                                                            | 2.05                                      | —   | 2.55 | 0.081                                           | —   | 0.100 |
| b                                                             | 0.31                                      | —   | 0.51 | 0.012                                           | —   | 0.020 |
| c                                                             | 0.20                                      | —   | 0.33 | 0.008                                           | —   | 0.013 |
| E                                                             | 10.30 BSC                                 |     |      | 0.406 BSC                                       |     |       |
| E1                                                            | 7.50 BSC                                  |     |      | 0.295 BSC                                       |     |       |
| e                                                             | 1.27 BSC                                  |     |      | 0.050 BSC                                       |     |       |
| h                                                             | 0.25                                      | —   | 0.75 | 0.010                                           | —   | 0.030 |
| L                                                             | 0.40                                      | —   | 1.27 | 0.016                                           | —   | 0.050 |
| L1                                                            | 1.40 REF                                  |     |      | 0.055 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                                                             | 10.30 BSC                                 |     |      | 0.405 BSC                                       |     |       |
| N                                                             | 16                                        |     |      |                                                 |     |       |

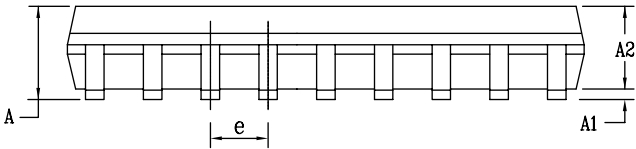
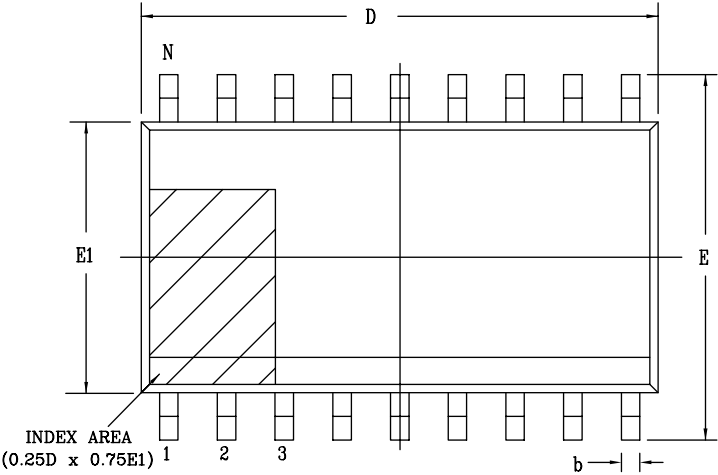
Drawing No: POD-00000115

Revision: B

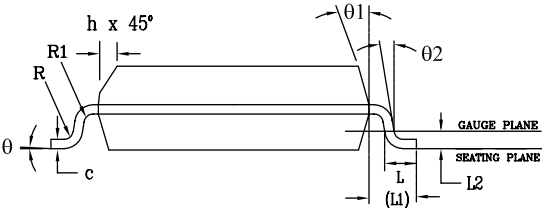
Mechanical Dimensions

WSOIC18

Top View



Side View



Front View

| PACKAGE OUTLINE SOIC .300" BODY<br>JEDEC MS-013 VARIATION AB |                                           |     |      |                                                 |     |       |
|--------------------------------------------------------------|-------------------------------------------|-----|------|-------------------------------------------------|-----|-------|
| SYMBOLS                                                      | COMMON DIMENSIONS IN MM<br>(Control Unit) |     |      | COMMON DIMENSIONS IN INCHES<br>(Reference Unit) |     |       |
|                                                              | MIN                                       | NOM | MAX  | MIN                                             | NOM | MAX   |
| A                                                            | 2.35                                      | —   | 2.65 | 0.093                                           | —   | 0.104 |
| A1                                                           | 0.10                                      | —   | 0.30 | 0.004                                           | —   | 0.012 |
| A2                                                           | 2.05                                      | —   | 2.55 | 0.081                                           | —   | 0.100 |
| b                                                            | 0.31                                      | —   | 0.51 | 0.012                                           | —   | 0.020 |
| c                                                            | 0.20                                      | —   | 0.33 | 0.008                                           | —   | 0.013 |
| E                                                            | 10.30 BSC                                 |     |      | 0.406 BSC                                       |     |       |
| E1                                                           | 7.50 BSC                                  |     |      | 0.295 BSC                                       |     |       |
| e                                                            | 1.27 BSC                                  |     |      | 0.050 BSC                                       |     |       |
| h                                                            | 0.25                                      | —   | 0.75 | 0.010                                           | —   | 0.030 |
| L                                                            | 0.40                                      | —   | 1.27 | 0.016                                           | —   | 0.050 |
| L1                                                           | 1.40 REF                                  |     |      | 0.055 REF                                       |     |       |
| L2                                                           | 0.25 BSC                                  |     |      | 0.010 BSC                                       |     |       |
| R                                                            | 0.07                                      | —   | —    | 0.003                                           | —   | —     |
| R1                                                           | 0.07                                      | —   | —    | 0.003                                           | —   | —     |
| theta                                                        | 0°                                        | —   | 8°   | 0°                                              | —   | 8°    |
| theta1                                                       | 5°                                        | —   | 15°  | 5°                                              | —   | 15°   |
| theta2                                                       | 0°                                        | —   | —    | 0°                                              | —   | —     |
| D                                                            | 11.55 BSC                                 |     |      | 0.455 BSC                                       |     |       |
| N                                                            | 18                                        |     |      |                                                 |     |       |

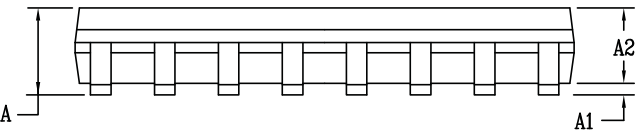
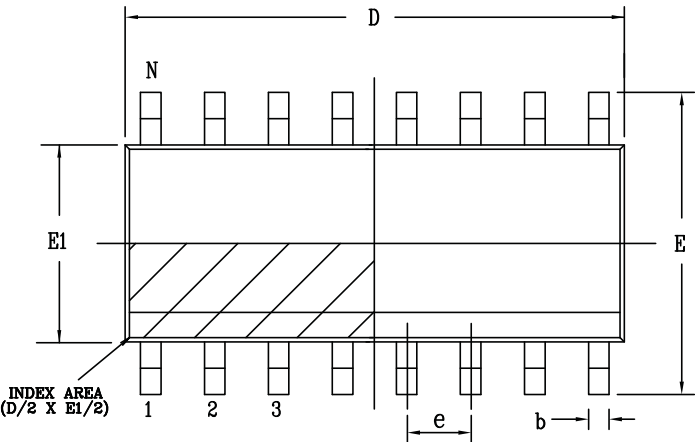
Drawing No: POD-00000118

Revision: B

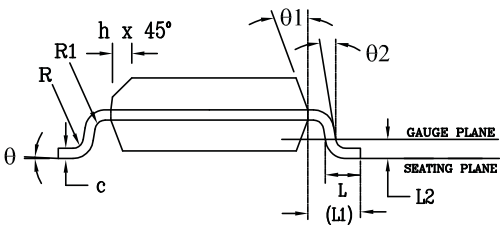
Mechanical Dimensions

NSOIC16

Top View



Side View



Front View

| PACKAGE OUTLINE NSOIC .150" BODY<br>JEDEC MS-012 VARIATION AC |                                           |     |      |                                               |     |       |
|---------------------------------------------------------------|-------------------------------------------|-----|------|-----------------------------------------------|-----|-------|
| SYMBOLS                                                       | COMMON DIMENSIONS IN MM<br>(Control Unit) |     |      | COMMON DIMENSIONS IN INCH<br>(Reference Unit) |     |       |
|                                                               | MIN                                       | NOM | MAX  | MIN                                           | NOM | MAX   |
| A                                                             | 1.35                                      | —   | 1.75 | 0.053                                         | —   | 0.069 |
| A1                                                            | 0.10                                      | —   | 0.25 | 0.004                                         | —   | 0.010 |
| A2                                                            | 1.25                                      | —   | 1.65 | 0.049                                         | —   | 0.065 |
| b                                                             | 0.31                                      | —   | 0.51 | 0.012                                         | —   | 0.020 |
| c                                                             | 0.17                                      | —   | 0.25 | 0.007                                         | —   | 0.010 |
| E                                                             | 6.00 BSC                                  |     |      | 0.236 BSC                                     |     |       |
| E1                                                            | 3.90 BSC                                  |     |      | 0.154 BSC                                     |     |       |
| e                                                             | 1.27 BSC                                  |     |      | 0.050 BSC                                     |     |       |
| h                                                             | 0.25                                      | —   | 0.50 | 0.010                                         | —   | 0.020 |
| L                                                             | 0.40                                      | —   | 1.27 | 0.016                                         | —   | 0.050 |
| L1                                                            | 1.04 REF                                  |     |      | 0.041 REF                                     |     |       |
| L2                                                            | 0.25 BSC                                  |     |      | 0.010 BSC                                     |     |       |
| R                                                             | 0.07                                      | —   | —    | 0.003                                         | —   | —     |
| R1                                                            | 0.07                                      | —   | —    | 0.003                                         | —   | —     |
| q                                                             | 0°                                        | —   | 8°   | 0°                                            | —   | 8°    |
| q1                                                            | 5°                                        | —   | 15°  | 5°                                            | —   | 15°   |
| q2                                                            | 0°                                        | —   | —    | 0°                                            | —   | —     |
| D                                                             | 9.90 BSC                                  |     |      | 0.390 BSC                                     |     |       |
| N                                                             | 16                                        |     |      |                                               |     |       |

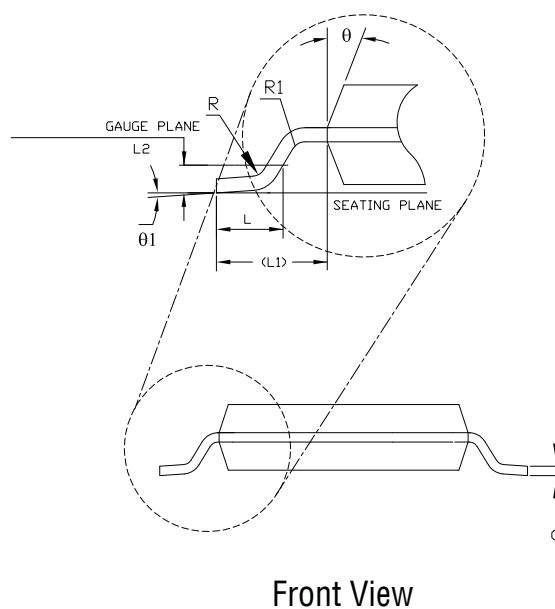
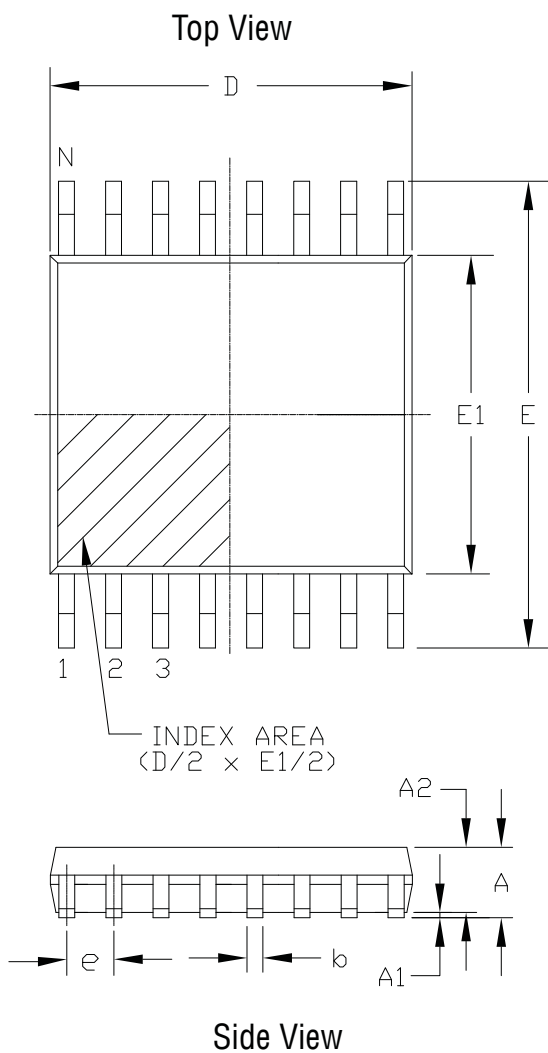
Drawing No: POD-00000114

Revision: A



## Mechanical Dimensions

## TSSOP16



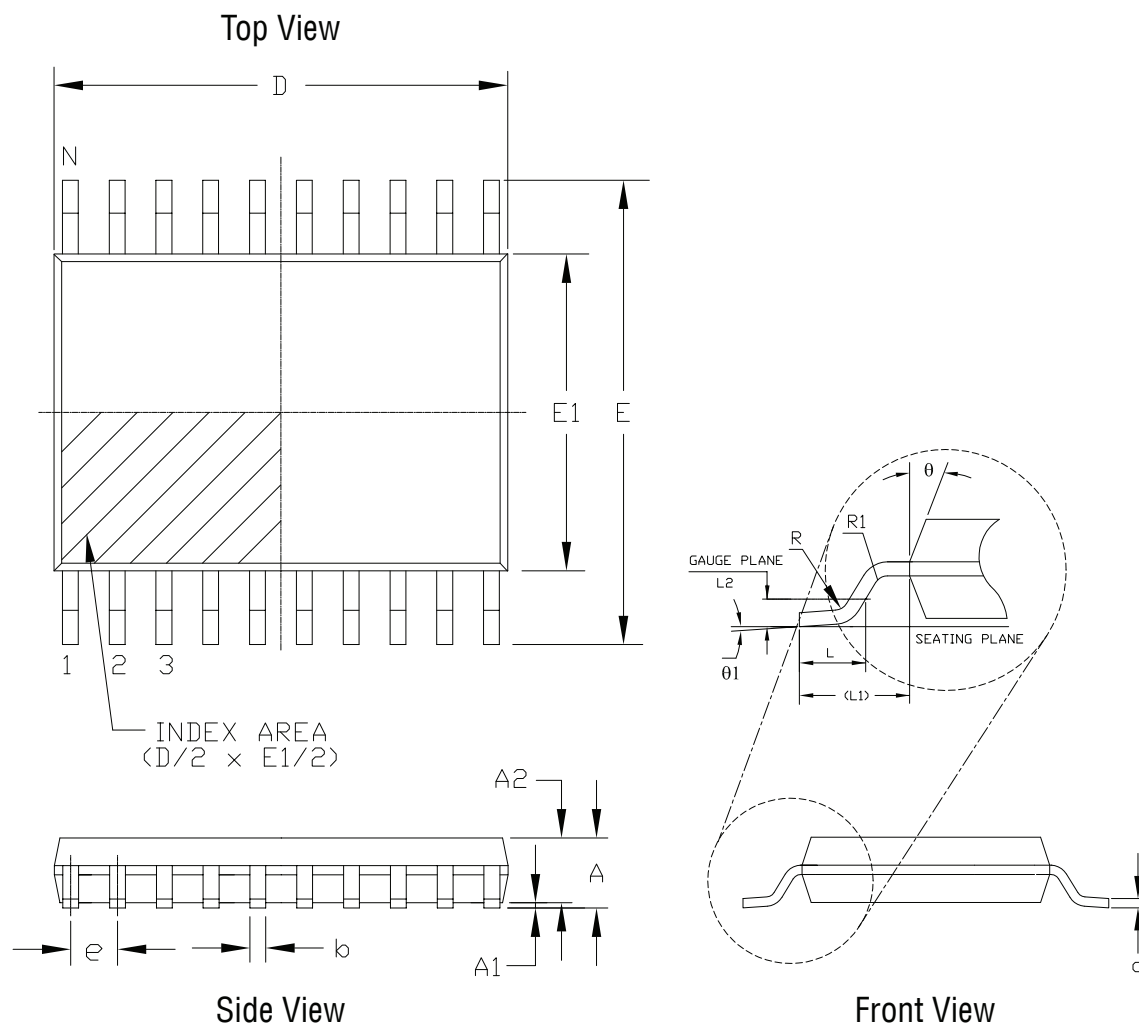
| 16 Pin TSSOP JEDEC MO-153 Variation AB |                                    |      |      |                                        |       |       |
|----------------------------------------|------------------------------------|------|------|----------------------------------------|-------|-------|
| SYMBOLS                                | DIMENSIONS IN MM<br>(Control Unit) |      |      | DIMENSIONS IN INCH<br>(Reference Unit) |       |       |
|                                        | MIN                                | NOM  | MAX  | MIN                                    | NOM   | MAX   |
| A                                      | —                                  | —    | 1.20 | —                                      | —     | 0.047 |
| A1                                     | 0.05                               | —    | 0.15 | 0.002                                  | —     | 0.006 |
| A2                                     | 0.80                               | 1.00 | 1.05 | 0.031                                  | 0.039 | 0.041 |
| b                                      | 0.19                               | —    | 0.30 | 0.007                                  | —     | 0.012 |
| c                                      | 0.09                               | —    | 0.20 | 0.004                                  | —     | 0.008 |
| E                                      | 6.40 BSC                           |      |      | 0.252 BSC                              |       |       |
| E1                                     | 4.30                               | 4.40 | 4.50 | 0.169                                  | 0.173 | 0.177 |
| e                                      | 0.65 BSC                           |      |      | 0.026 BSC                              |       |       |
| L                                      | 0.45                               | 0.60 | 0.75 | 0.018                                  | 0.024 | 0.030 |
| L1                                     | 1.00 REF                           |      |      | 0.039 REF                              |       |       |
| L2                                     | 0.25 BSC                           |      |      | 0.010 BSC                              |       |       |
| R                                      | 0.09                               | —    | —    | 0.035                                  | —     | —     |
| R1                                     | 0.09                               | —    | —    | 0.035                                  | —     | —     |
| θ                                      | 12° REF                            |      |      | 12° REF                                |       |       |
| θ1                                     | 0°                                 | —    | 8°   | 0°                                     | —     | 8°    |
| D                                      | 4.90                               | 5.00 | 5.10 | 0.193                                  | 0.197 | 0.200 |
| N                                      | 16                                 |      |      | 16                                     |       |       |

Drawing No: POD-00000117

Revision: A

## Mechanical Dimensions

## TSSOP20



| 20 Pin TSSOP JEDEC MO-153 Variation AC |                                    |      |      |                                        |       |       |
|----------------------------------------|------------------------------------|------|------|----------------------------------------|-------|-------|
| SYMBOLS                                | DIMENSIONS IN MM<br>(Control Unit) |      |      | DIMENSIONS IN INCH<br>(Reference Unit) |       |       |
|                                        | MIN                                | NOM  | MAX  | MIN                                    | NOM   | MAX   |
| A                                      | —                                  | —    | 1.20 | —                                      | —     | 0.047 |
| A1                                     | 0.05                               | —    | 0.15 | 0.002                                  | —     | 0.006 |
| A2                                     | 0.80                               | 1.00 | 1.05 | 0.031                                  | 0.039 | 0.041 |
| b                                      | 0.19                               | —    | 0.30 | 0.007                                  | —     | 0.012 |
| c                                      | 0.09                               | —    | 0.20 | 0.004                                  | —     | 0.008 |
| E                                      | 6.40 BSC                           |      |      | 0.252 BSC                              |       |       |
| E1                                     | 4.30                               | 4.40 | 4.50 | 0.169                                  | 0.173 | 0.177 |
| e                                      | 0.65 BSC                           |      |      | 0.026 BSC                              |       |       |
| L                                      | 0.45                               | 0.60 | 0.75 | 0.018                                  | 0.024 | 0.030 |
| L1                                     | 1.00 REF                           |      |      | 0.039 REF                              |       |       |
| L2                                     | 0.25 BSC                           |      |      | 0.010 BSC                              |       |       |
| R                                      | 0.09                               | —    | —    | 0.035                                  | —     | —     |
| R1                                     | 0.09                               | —    | —    | 0.035                                  | —     | —     |
| θ                                      | 12° REF                            |      |      | 12° REF                                |       |       |
| θ1                                     | 0°                                 | —    | 8°   | 0°                                     | —     | 8°    |
| D                                      | 6.40                               | 6.50 | 6.60 | 0.252                                  | 0.256 | 0.260 |
| N                                      | 20                                 |      |      | 20                                     |       |       |

Drawing No: POD-00000120

Revision: A

Ordering Information<sup>(1)</sup>

| Part Number    | Operating Temperature Range | Package      | Packaging Method | Lead-Free <sup>(2)</sup> |
|----------------|-----------------------------|--------------|------------------|--------------------------|
| SP3222E        |                             |              |                  |                          |
| SP3222ECA-L/TR | 0°C to +70°C                | 20 Pin SSOP  | Reel             | Yes                      |
| SP3222ECT-L/TR | 0°C to +70°C                | 18 Pin WSOIC | Reel             | Yes                      |
| SP3222ECY-L/TR | 0°C to +70°C                | 20 Pin TSSOP | Reel             | Yes                      |
| SP3222EEA-L/TR | -40°C to +85°C              | 20 Pin SSOP  | Reel             | Yes                      |
| SP3222EEY-L/TR | -40°C to +85°C              | 20 Pin TSSOP | Reel             | Yes                      |
| SP3232E        |                             |              |                  |                          |
| SP3232ECA-L    | 0°C to +70°C                | 16 Pin SSOP  | Tube             | Yes                      |
| SP3232ECA-L/TR | 0°C to +70°C                | 16 Pin SSOP  | Reel             | Yes                      |
| SP3232ECN-L    | 0°C to +70°C                | 16 Pin NSOIC | Tube             | Yes                      |
| SP3232ECN-L/TR | 0°C to +70°C                | 16 Pin NSOIC | Reel             | Yes                      |
| SP3232ECT-L/TR | 0°C to +70°C                | 16 Pin WSOIC | Reel             | Yes                      |
| SP3232ECY-L    | 0°C to +70°C                | 16 Pin TSSOP | Tube             | Yes                      |
| SP3232ECY-L/TR | 0°C to +70°C                | 16 Pin TSSOP | Reel             | Yes                      |
| SP3232EEA-L    | -40°C to +85°C              | 16 Pin SSOP  | Tube             | Yes                      |
| SP3232EEA-L/TR | -40°C to +85°C              | 16 Pin SSOP  | Reel             | Yes                      |
| SP3232EEN-L    | -40°C to +85°C              | 16 Pin NSOIC | Tube             | Yes                      |
| SP3232EEN-L/TR | -40°C to +85°C              | 16 Pin NSOIC | Reel             | Yes                      |
| SP3232EET-L    | -40°C to +85°C              | 16 Pin WSOIC | Tube             | Yes                      |
| SP3232EET-L/TR | -40°C to +85°C              | 16 Pin WSOIC | Reel             | Yes                      |
| SP3232EEY-L    | -40°C to +85°C              | 16 Pin TSSOP | Tube             | Yes                      |
| SP3232EEY-L/TR | -40°C to +85°C              | 16 Pin TSSOP | Reel             | Yes                      |

## NOTE:

1. Refer to [www.maxlinear.com/SP3222E](http://www.maxlinear.com/SP3222E) and [www.maxlinear.com/SP3232E](http://www.maxlinear.com/SP3232E) for most up-to-date Ordering Information.

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

## Selection Table

| MODEL   | Power Supplies | RS-232 Drivers | RS-232 Receivers | External Components | Shutdown | TTL 3-State | # of Pins |
|---------|----------------|----------------|------------------|---------------------|----------|-------------|-----------|
| SP3222E | +3.0V to +5.5V | 2              | 2                | 4 Capacitors        | Yes      | Yes         | 18, 20    |
| SP3232E | +3.0V to +5.5V | 2              | 2                | 4 Capacitors        | No       | No          | 16        |

## Revision History

| Revision | Date  | Description                                                                                                     |
|----------|-------|-----------------------------------------------------------------------------------------------------------------|
| 08/22/05 | --    | Legacy Sipex Datasheet                                                                                          |
| 12/08/10 | 1.0.0 | Convert to Exar Format and update ordering information.                                                         |
| 03/14/13 | 1.0.1 | Correct type error to driver Transition-Region Slew Rate conditions.                                            |
| 10/16/17 | 1.0.2 | Correct SP3222E nSOIC pinout to SOIC. Updated to MaxLinear logo. Updated format and ordering information table. |
| 04/22/20 | 1.0.3 | Change RxIN absolute maximum from $\pm 15V$ to $\pm 25V$ . Update Ordering Information.                         |



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