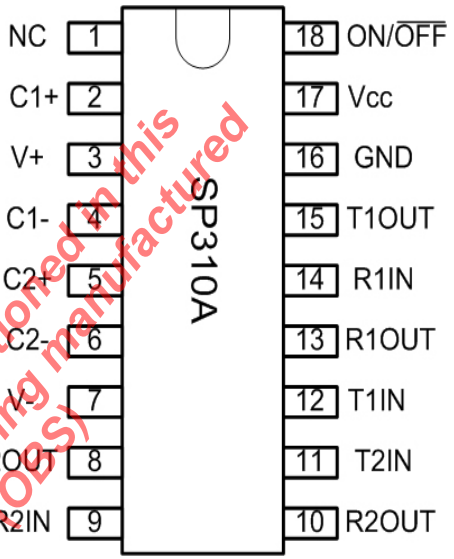
MAXLINEAR

# SP233A

## Enhanced RS-232 Line Drivers/Receivers

### FEATURES

- Operates from a Single +5V Power Supply
- Meets all RS-232F and ITU V.28 Specifications
- Operates with 0.1µF Ceramic Capacitors
- No External Capacitors required (SP233A)
- Low Power Shutdown (SP310A, SP312A)
- High Data Rate - 120kbps under load
- Low power CMOS Operation
- +/-2kV Human Body Model ESD Protection
- Lead Free packaging available






### DESCRIPTION

The SP233A / SP310A / SP312A devices are a family of line driver and receiver pairs that meets the specifications of RS-232 and V.28 serial protocols. The devices are pin-to-pin compatible with popular industry standard pinouts. The SP233A / SP310A / SP312A offer 120kbps data rate under load, small ceramic type 0.1µF charge pump capacitors and overall ruggedness for comercial applications. Features include Exar's BiCMOS design allowing for low power operation without sacrificing performance. These devices are available in plastic DIP and SOIC Wide packages operating over the commercial and industrial temperature ranges.

### SELECTION TABLE

| Model | Number of RS-232 | | No. of RX active in Shutdown | No. of External 0.1µF Capacitors | Shutdown | WakeUp | TTL Tri-State |
|---|---|---|---|---|---|---|---|
| | Drivers | Receivers | | | | | |
| SP233A | 2 | 2 | N/A | 0 | No | No | No |
| SP310A | 2 | 2 | 0 | 4 | Yes | No | Yes |
| SP312A | 2 | 2 | 2 | 4 | Yes | Yes | Yes |

SP310A and SP312A are obsolete

## 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 are not implied. Exposure to absolute maximum ratings conditions for extended periods of time may affect reliability.

Supply Voltage ($V_{CC}$).....+ 6V
V+..... (Vcc-0.3V) to +11.0V
V- .....-11.0V
Input Voltages
Tin.....-0.3V to (Vcc + 0.3V)
Rin.....+/-30V
Output Voltages
Tout.....(V+, +0.3V) to (V-, -0.3V
Rout.....-0.3V to (Vcc + 0.3V)

Short Circuit duration
Tout.....Continuous
Package Power Dissipation:
Plastic DIP.....375mW
(derate 7mW/°C above +70°C)
Small Outline.....375mW
(derate 7mW/°C above +70°C)
Storage Temperature.....-65°C to +150°C
Lead Temperature (soldering, 10s)..... +300°C

## ELECTRICAL CHARACTERISTICS

Vcc=5V ±10%, 0.1µF charge pump capacitors, TMIN to TMAX, unless otherwise noted, Typical values are Vcc=5V and TA=25°C

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| **TTL INPUT** | | | | | |
| Logic Threshold LOW | TIN, $\overline{EN}$, $\overline{SD}$, ON/$\overline{OFF}$ | | | 0.8 | Volts |
| Logic Threshold HIGH | TIN, $\overline{EN}$, $\overline{SD}$, ON/$\overline{OFF}$ | 2.0 | | | Volts |
| Logic Pull-Up Current | TIN = 0V | | 15 | 200 | µA |
| **TTL OUTPUT** | | | | | |
| Output Voltge LOW | IOUT = 3.2mA: Vcc = +5V | | | 0.4 | Volts |
| Output Voltage HIGH | IOUT = -1.0mA | 3.5 | | | Volts |
| Leakage Current; TA=25°C | $\overline{EN}$ = Vcc, 0V ≤ VOUT ≤ Vcc SP310A and SP312A only | | 0.05 | +/-10 | µA |
| **RS-232 OUTPUT** | | | | | |
| Output Voltage Swing | All Transmitter outputs loaded with 3k ohms to GND | +/-5.0 | +/-9V | | Volts |
| Output Resistance | Vcc = 0V, Vout = +/-2V | 300 | | | Ohms |
| Output Short Circuit Current | Infinite Duration | | +/-18 | | mA |
| Maximum Data Rate | CL = 2500pF, RL = 3kΩ | 120 | 240 | | kbps |
| **RS-232 INPUT** | | | | | |
| Voltage Range | | -25 | | +25 | Volts |
| Voltage Threshold LOW | Vcc = 5V, TA=25°C | 0.8 | 1.2 | | Volts |
| Voltage Threshold HIGH | Vcc = 5V, TA=25°C | | 1.7 | 2.4 | Volts |
| Hysteresis | Vcc = 5V, TA=25°C | 0.2 | 0.5 | 1.0 | Volts |
| Resistance | TA=25°C, -25V ≤ VIN ≤ +25V | 3 | 5 | 7 | kΩ |

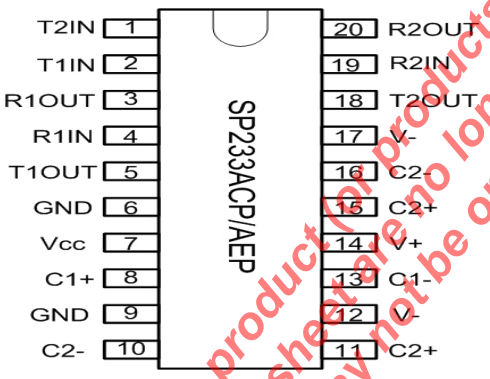
## ELECTRICAL CHARACTERISTICS

Vcc=5V ±10%, 0.1µF charge pump capacitors, TMIN to TMAX, unless otherwise noted, Typical values are Vcc=5V and TA=25°C

| Parameter | TEST CONDITIONS | MIN | TYP | MAX | Unit |
|---|---|---|---|---|---|
| **DYNAMIC CHARACTERISTICS** | | | | | |
| Driver Propagation Delay | TTL to RS_232; CL = 50pF | | 1.5 | 3.0 | µs |
| Receiver Propagation Delay | RS-232 to TTL, | | 0.1 | 1.0 | µs |
| Instantaneous Slew Rate | CL = 10pF, RL = 3-7kΩ | | | 30 | V/ µs |
| Transition Region Slew Rate | CL = 2500pF, RL = 3kΩ; Measured from +3V to -3V or -3V to +3V | | 10 | | V/ µs |
| Output Enable Time | SP310A and SP312A only | | 400 | | ns |
| Output Disable Time | SP310A and SP312A only | | 250 | | ns |
| **POWER REQUIREMENTS** | | | | | |
| Vcc Power Supply Current | No Load, Vcc = 5V, TA=25°C | | 10 | 15 | mA |
| Vcc Power Supply Current, Loaded | All Transmitters RL = 3kΩ, TA=25°C | | 25 | | mA |
| Shutdown Supply Current SP310A and SP312A only | Vcc = 5V, TA=25°C | | 1 | 10 | µA |

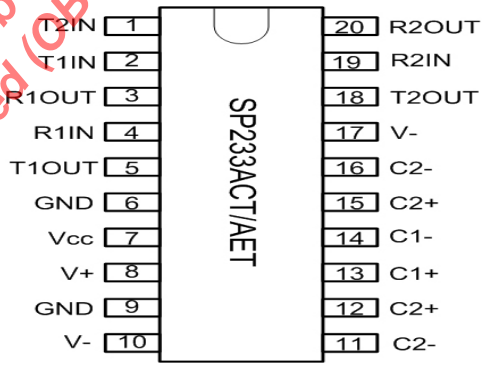


## PIN ASSIGNMENTS

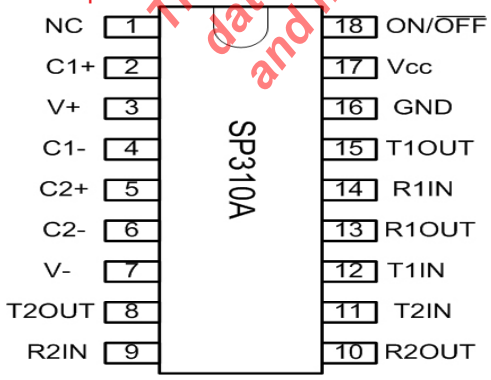



20 pin PDIP

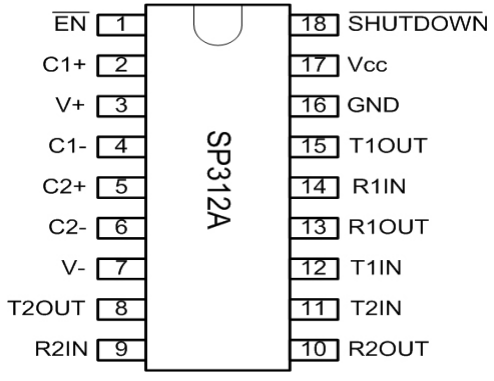
20 pin PDIP version is obsolete




20 pin WSOIC




18 pin WSOIC




18 pin WSOIC

## DETAILED DESCRIPTION

The SP233A, SP310A and SP312A devices are a family of line driver and receiver pairs that meet the EIA/TIA-232 and V.28 serial communication protocols. These devices are pin-to-pin compatible with popular industry standards. The SP233A, SP310A and SP312A devices offer a 120kbps data rate, 10V/µs slew rate and an on-board charge pump that operates from a single 5V supply using 0.1µF ceramic capacitors. The ESD tolerance has been improved on these devices to +/-2kV Human Body Model.

The SP233A device provides internal charge pump capacitors. The SP310A provides an ON/$\overline{\text{OFF}}$ input that simultaneously disables the internal charge pump circuit and puts all transmitter and receiver outputs into a high impedance state. The SP312A is identical to the SP310 but with seperate tri-state and shutdown inputs

### Theory Of Operation

The SP233A, SP310A and SP312A devices are made up of three basic circuit blocks: 1. Drivers, 2. Receivers, and 3. charge pump.

### Drivers

The drivers are inverting level transmitters that convert TTL or CMOS logic levels to EIA/TIA-232 levels with an inverted sense relative to the input logic levels. Typically, the driver output voltage swing is +/-9V. Even under worst case loading conditions of 3k ohms and 2500pF, the driver output is guaranteed to be +/-5.0V minimum, thus satisfying the RS-232 specification. The driver outputs are protected against infinite short-circuits to ground without degradation in reliability.

The drivers can guarantee output data rates of 120kbps under worst case loading of 3k ohms and 2500pF.

The Slew rate of the driver output is internally limited to 30V/ µs in order to meet the EIA standards (EIA-232F). Additionally, the driver outputs LOW to HIGH transition meets the montonic output requirements of the standard.

### Receivers

The receivers convert EIA/TIA-232 signal levels to TTL or CMOS logic output levels. Since the input is usually from a transmission line, where long cable length and system interference can degrade the signal, the inputs have a typical hysteresis margin of 500mV. This ensures that the receiver is virtually immune to noisy transmission lines. Should an input be left unconnected, an internal 5kohm pull-down resistor to ground will commit the output of the receiver to a HIGH state.

### Charge pump

The charge pump is a patented design and uses a unique approach compared to older less efficiant designs. The charge pump requires 4 external capacitors and uses a four phase voltage shifting technique. The internal power supply consists of a dual charge pump that provides a driver output voltage swing of +/-9V. The internal oscillator controls the four phases of the voltage shifting. A description of each phase follows:

#### Phase 1

Vss charge store and double: The positive terminals of capacitors C1 and C2 are charged from Vcc with their negative terminals initially connected to ground. C1+ is then connected to ground and the stored charge from C1- is superimposed onto C2-. Since C2+ is still connected to Vcc the voltage potential across C2 is now 2 x Vcc.

#### Phase 2

Vss transfer and invert: Phase two connects the negative terminal of C2 to the Vss storage capacitor and the positive terminal of C2 to ground. This transfers the doubled and inverted (V-) voltage onto C4. Meanwhile, capacitor C1 is charged from Vcc to prepare it for its next phase.

#### Phase 3

Vdd charge store and double: Phase three is identical to the first phase. The positive terminals of C1 and C2 are charged from Vcc with their negative terminals initially connected to ground. C1+ is then connected to ground and the stored charge from C1- is superimposed onto C2-. Since C2+ is still connected to Vcc the voltage potential across capacitor C2 is now 2 x Vcc.

**Phase 4**
Vdd transfer: The fourth phase connects the negative terminal of C2 to ground and the positive terminal of C2 to the Vdd storage capacitor. This transfers the doubled (V+) voltage onto C3. Meanwhile, capacitor C1 is charged from Vcc to prepare it for its next phase.

The clock rate for the charge pump typically operates at greater than 15kHz allowing the pump to run efficiently with small 0.1uF capacitors. Efficient operation depends on rapid charging and discharging of C1 and C2, therefore capacitors should be mounted as close as possible to the IC and have low ESR (equivalent series resistance). Inexpensive surface mount, ceramic capacitors are ideal for using on charge pump. If polarized capacitors are used the positive and negative terminals should be connected as shown in the typical operating circuit. A diagram of the individual phases are shown in Figure 1.

**Shutdown ($\overline{SD}$) and Enable ($\overline{EN}$) features for the SP310A and SP312A**
Both the SP310A and SP312A have a shutdown / standby mode to conserve power in battery-powered applications. To activate the shutdown mode, which stops the operation of the charge pump, a logic "0" is applied to the appropriate control line. For the SP310A, this control line is the ON/$\overline{OFF}$ (pin 18) input. Activating the shutdown mode puts the SP310A transmitter and receiver ouptuts into a high impedance condition. For the SP312A, this control line is the $\overline{SHUTDOWN}$ (pin18) input; this also puts the transmitter outputs in a tri-state mode. The receiver outputs can be tri-stated seperately during normal operation or shutdown by applying a logic "1" on the $\overline{EN}$ line (pin 1).

**Wake-Up Feature for the SP312A**
The SP312A has a wake-up feature that keeps the receivers active when the device is placed into shutdown. Table 1 defines the truth table for the Wake-Up function. When only the receivers are activated, the SP312A typically draws less than 5uA supply current. In the case of when a modem is interfaced to a computer in power down mode, the Ring Indicator (RI) signal from the modem would be used to "wake-up" the computer, allowing it to accept data transmission.

After the ring indicator has propagated through the SP312A receiver, it can be used to trigger the power management circuitry of the computer to power up the microprocessor, and bring the $\overline{SD}$ pin of the SP312A to a logic high, taking it out of the shutdown mode. The receiver propagation delay is typically 1us. The enable time for V+ and V- is typically 2ms. After V+ and V- have settled to their final values, a signal can be sent back to the modem on the data terminal ready (DTR) pin signifying that the computer is ready to accept the transmit data.

| $\overline{SD}$ | $\overline{EN}$ | Power Up/Down | Receiver outputs |
|---|---|---|---|
| 0 | 0 | Down | Enabled |
| 0 | 1 | Down | Tri-state |
| 1 | 0 | Up | Enabled |
| 1 | 1 | Up | Tri-state |

Table 1. Wake-up Function truth table

**Pin Strapping for the SP233ACT/ACP**
The SP233A packaged in a 20 pin SOICW package (SP233ACT) has a slightly different pinout than the SP233A in PDIP packaging (SP233ACP). To operate properly, the following pairs of pins must be externally wired together as noted in table 2:

| Pins Wired Together | SOICW | PDIP |
|---|---|---|
| Two V- pins | 10 & 17 | 12 & 17 |
| Two C2+ pins | 12 & 15 | 11 & 15 |
| Two C- pins | 11 & 16 | 10 & 16 |
| | No Connections for Pins 8, 13 and 14 | |
| | Connect Pins 6 and 9 to GND | |

Table 2. Pin Strapping table for SP233A

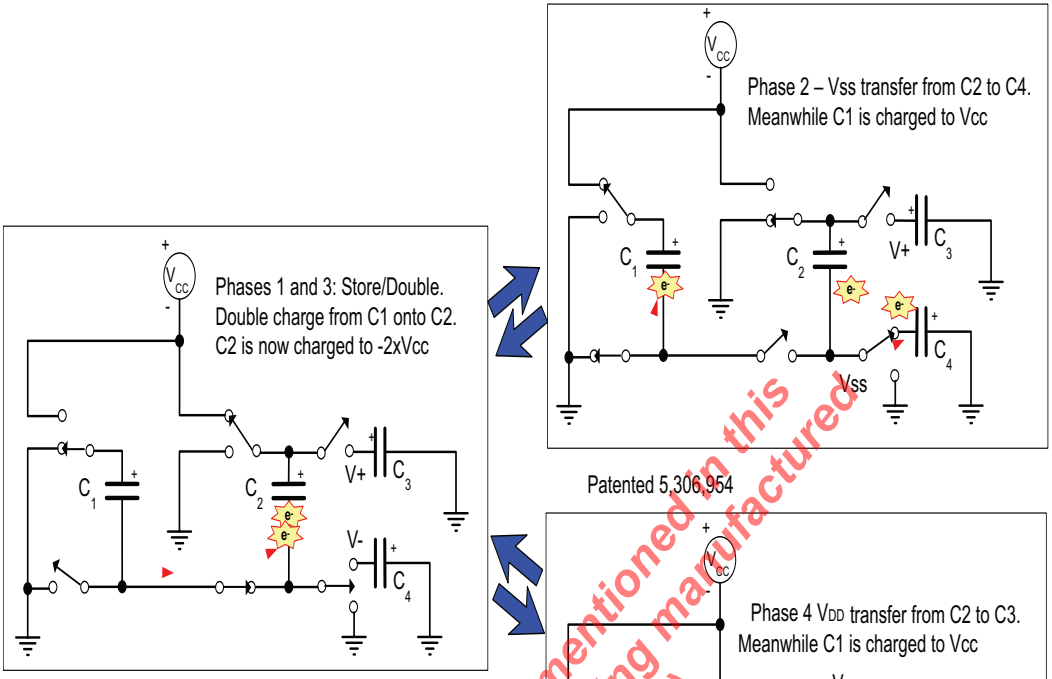



Figure 1. Charge pump phases

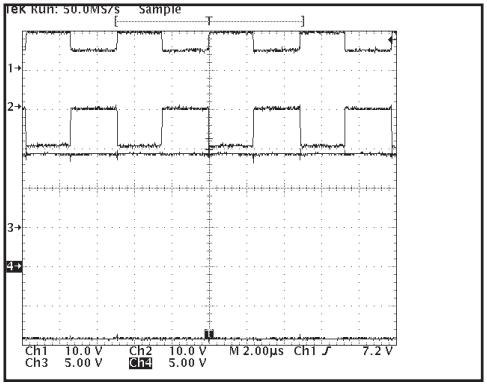



Figure 2, SP233A Charge pump waveforms- no load (1 = C1+, 2 = C2+, 3 = V+, 4 = V-).

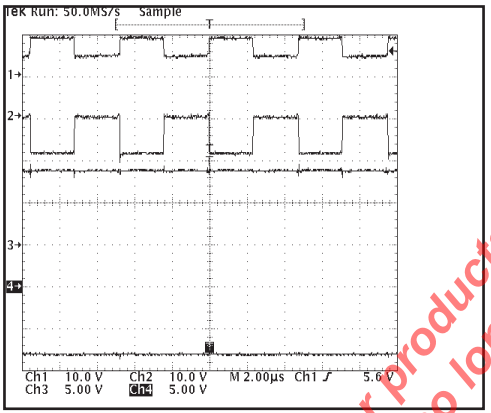



Figure 3, SP233A Charge pump waveforms when fully loaded with 3Kohms (1 = C1+, 2 = C2+, 3 = V+, 4 = V-).

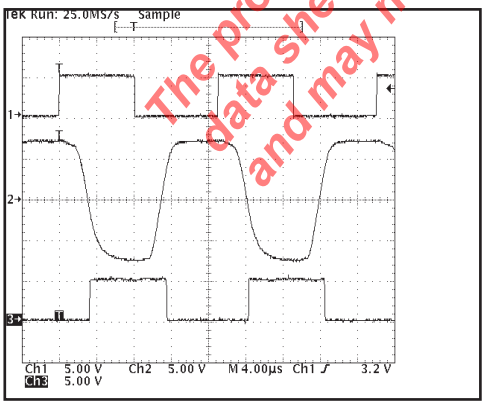



Figure 4, Loopback results at 60KHZ and 2500pF load (1 = TXin, 2 = TXout/RXin, 3 = RXout).

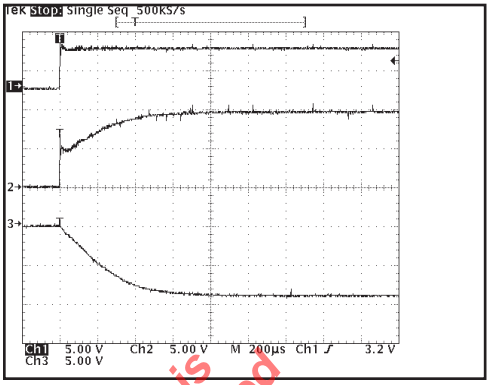



Figure 5, Charge pump outputs at start up (1 = Vcc, 2 = V+, 3 = V-).

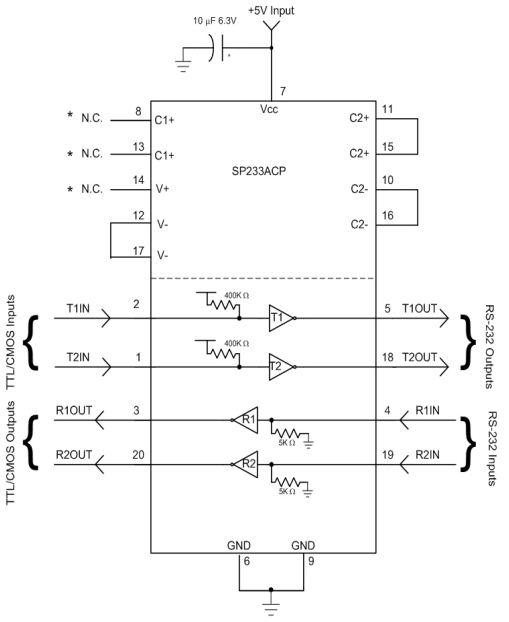



Figure 6, SP233ACP Typical Application circuit

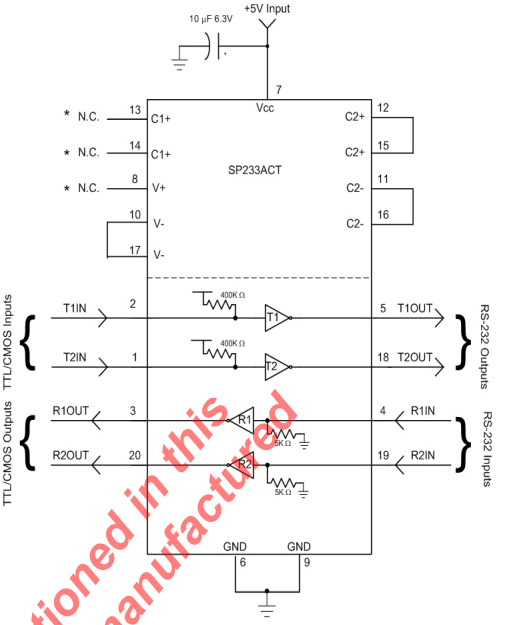



Figure 8, SP233ACT Typical Application circuit

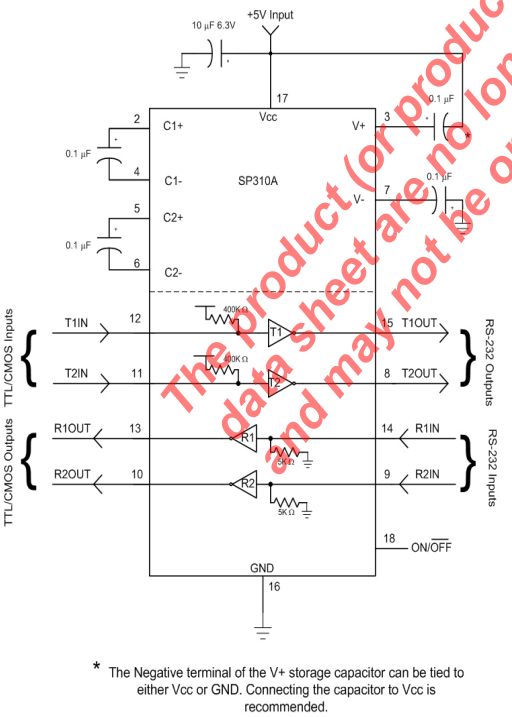



Figure 7, SP310A Typical Application circuit

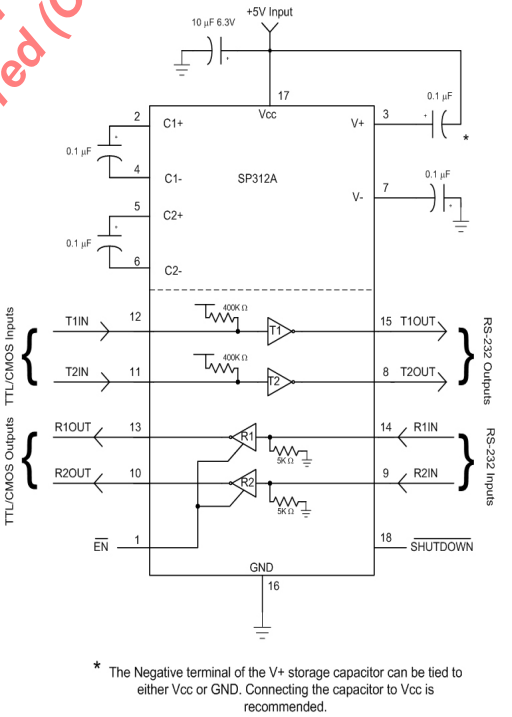
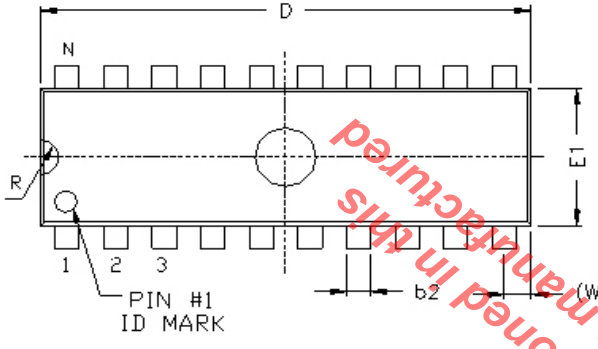


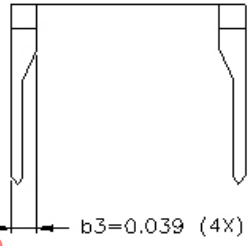

Figure 9, SP312A Typical Application circuit

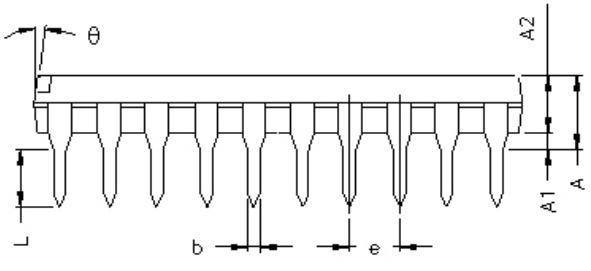
| REVISION HISTORY | | | |
|---|---|---|---|
| REV. | DISCRIPTION | DATE | APP'D |
| A | DRAWING ORIGINATION | 04/28/06 | JL |
| B | CHANGE DRAWING LOGO AND COMPANY NAME | 11/27/07 | JL |

REMARKS:
FOR 8LD AND 16LD
ALL END LEADS (4X)
ARE HALF LEAD TYPES

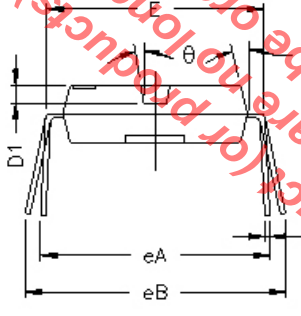



Top View




Side View

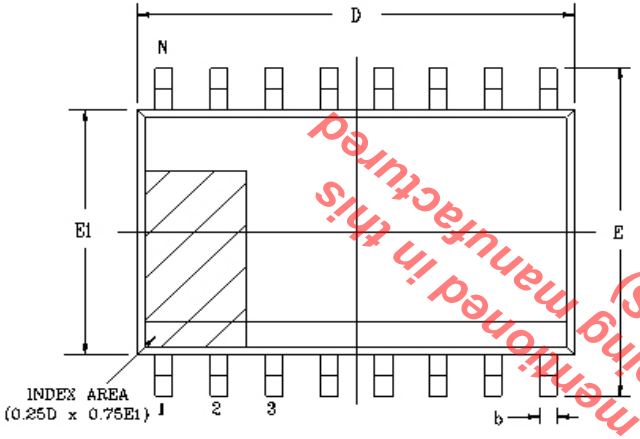



Front View

| 20 Pin PDIP JEDEC MS-001 Variation AD | | | | | | |
|---|---|---|---|---|---|---|
| SYMBOLS | DIMENSIONS IN INCH (Control Unit) | | | DIMENSIONS IN MM (Reference Unit) | | |
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | — | — | 0.210 | — | — | 5.33 |
| A1 | 0.015 | — | — | 0.38 | — | — |
| A2 | 0.115 | 0.130 | 0.195 | 2.92 | 3.30 | 4.95 |
| b | 0.014 | 0.018 | 0.022 | 0.36 | 0.46 | 0.56 |
| b2 | 0.045 | 0.060 | 0.070 | 1.14 | 1.52 | 1.78 |
| c | 0.008 | 0.010 | 0.014 | 0.20 | 0.25 | 0.36 |
| D1 | 0.030 | — | 0.060 | 0.76 | — | 1.52 |
| E | 0.300 | 0.310 | 0.325 | 7.62 | 7.87 | 8.26 |
| E1 | 0.240 | 0.250 | 0.280 | 6.10 | 6.35 | 7.11 |
| e | 0.100 BSC | | | 2.54 BSC | | |
| eA | 0.300 BSC | | | 7.62 BSC | | |
| eB | — | — | 0.430 | — | — | 10.92 |
| L | 0.115 | 0.130 | 0.150 | 2.92 | 3.30 | 3.81 |
| W | 0.075 REF | | | 1.91 REF | | |
| R | 0.030 BSC | | | 0.76 BSC | | |
| θ | 4° | 7° | 10° | 4° | 7° | 10° |
| D | 0.980 | 1.030 | 1.060 | 24.89 | 26.16 | 26.92 |
| N | 20 | | | 20 | | |

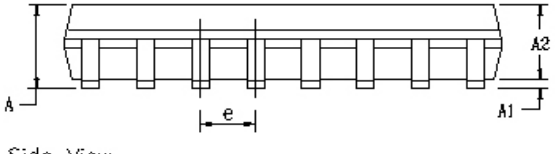
| | | | |
|---|---|---|---|
| EXAR Powering Connectivity | EXAR CORPORATION | | |
| | 20 PIN PDIP PACKAGE OUTLINE | | |
| Packaging Approval: | Drawing No: | 20-PIN PDIP | |
| By JL Date 11/27/07 | Revision: B | Sheet: 1 OF 1 | |

| REVISION HISTORY | | | |
|---|---|---|---|
| REV. | DISCRIPTION | DATE | APP'D |
| A | DRAWING ORIGINATION | 04/24/06 | JL |
| B | CHANGE DRAWING LOGO AND COMPANY NAME | 11/28/07 | JL |

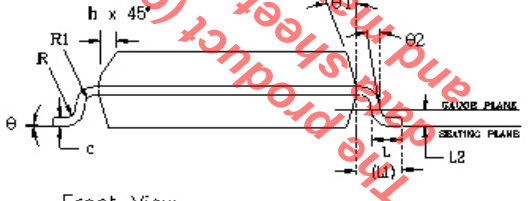



Top View

| 20 Pin SOICW JEDEC MS-013 Variation AC | | | | | | |
|---|---|---|---|---|---|---|
| SYMBOLS | DIMENSIONS IN MM (Control Unit) | | | DIMENSIONS IN INCH (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 | 12.80 BSC | | | 0.504 BSC | | |
| N | 20 | | | 20 | | |




Side View

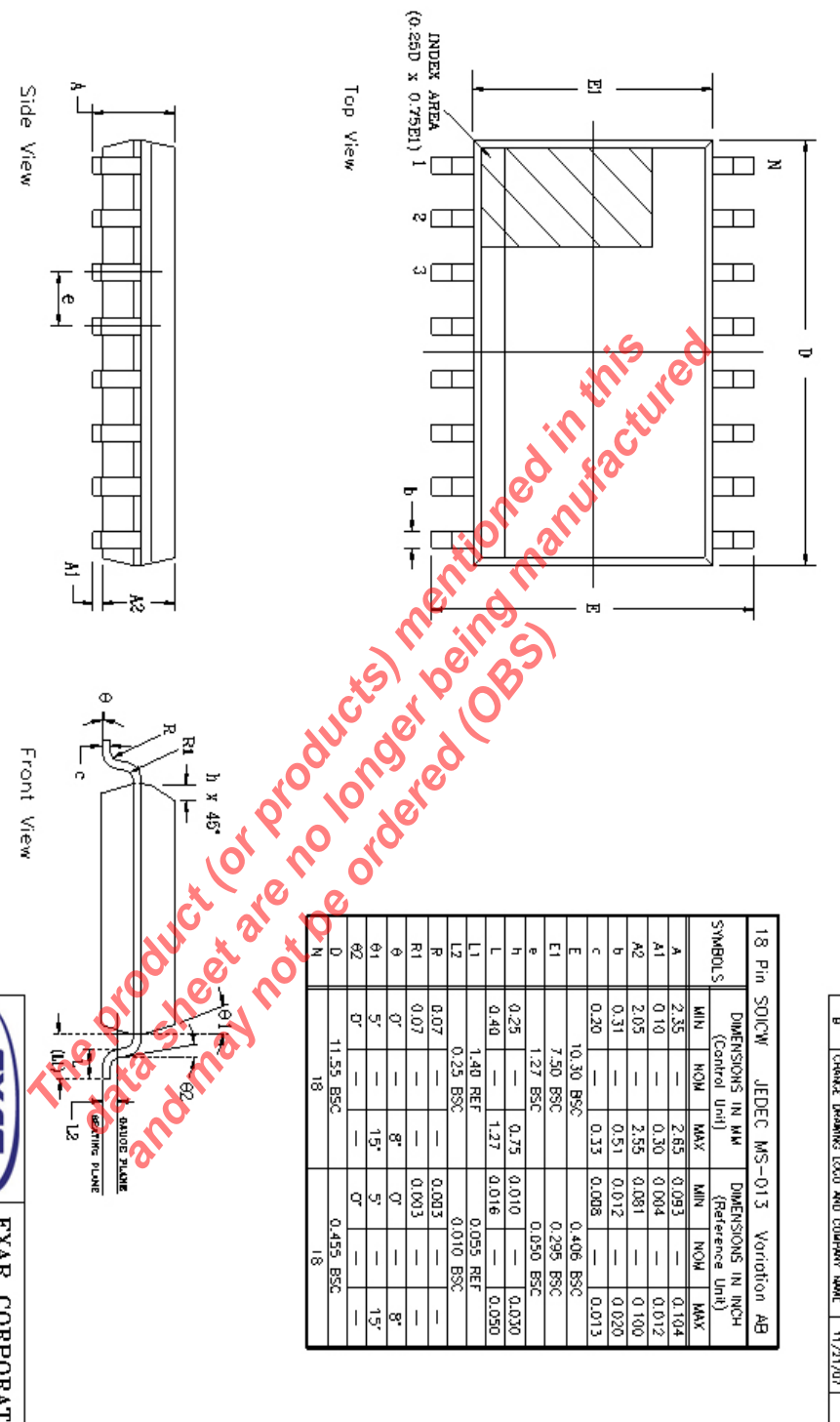



Front View



| EXAR CORPORATION | | | |
|---|---|---|---|
| 20 PIN SOICW PACKAGE OUTLINE | | | |
| Packaging Approval: | | Drawing No: | 20-PIN SOICW |
| By: JL | Date: 11/28/07 | Revision: B | Sheet: 1 OF 1 |

SP310A and SP312A WSOIC18 are obsolete



| Part number | Temperature range | Package | Packaging Method | Lead-Free[2] |
|---|---|---|---|---|
| SP233ACT-L | 0 to +70°C | 20 pin SOICW | Tube | Yes |
| SP233ACT-L/TR | 0 to +70°C | 20 pin SOICW | Tape and Reel | Yes |
| SP233AET-L | -40 to +85°C | 20 pin SOICW | Tube | Yes |
| SP233AET-L/TR | -40 to +85°C | 20 pin SOICW | Tape and Reel | Yes |

NOTES:
1. Refer to www.maxlinear.com/SP233A for the most up-to-date Ordering Information.
2. Visit www.maxlinear.com for additional information on Environmental Rating.
3. SP310A, SP312A and 20 pin PDIP versions of SP233A are obsolete.

| REVISION HISTORY | | |
|---|---|---|
| Date | Revision | Description |
| 1-31-07 | Rev B | Original SP232A/233A/310A/312A Sipex Data sheet |
| 5-13-08 | 100 | Generate new SP233A/310A/312A Data sheet using Exar format. |
| 6-03-11 | 101 | Add Revision History table. Remove SP310ACP-L option per PDN 110510-01. |
| 3-20-20 | 102 | Update to MaxLinear logo. Update Ordering Information. |



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