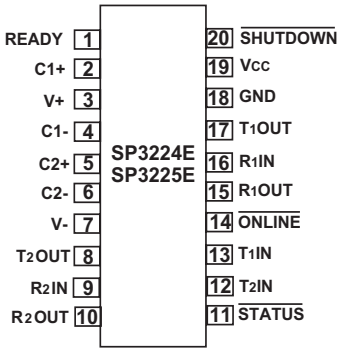
# SP3224E-SP3227E

## 3.0V to 5.5V RS-232 Transceivers with Auto On-Line® Plus

### FEATURES

- 15kV ESD protected RS-232 I/O pins
- Auto On-line® Plus automatic power saving mode
- Meets true EIA/TIA-232-F standards from +3.0V to +5.5V power supply.
- Adheres to EIA/TIA-562 for interoperability with EIA/TIA-232 down to a +2.7V supply voltage
- Regulated charge pump yields stable RS-232 outputs
- Drop-in replacement to MAX3224, ICL3224, MAX3225, ICL3225, MAX3226, ICL3226, MAX3227 and ICL3227
- SP3224E and SP3226E reduced EMI with a slew rate controlled 250kbps data rate
- SP3225E and SP3227E- high speed data rate of 1 Mbps.
- Available in RoHS compliant, Lead Free Packaging




### TYPICAL APPLICATIONS

- Diagnostic/Serial ports on embedded applications
- Handheld Test Equipment
- PC related Peripherals and Equipment
- Battery Powered Equipment
- Point-of-sale Equipment
- Set-top Box

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

### DESCRIPTION

The SP3224E/3225E are 2-driver/2-receiver devices and the SP3226E/SP3227E are 1-driver/1-receiver devices. All are ideal for computer peripherals, point-of-sale equipment, consumer and embedded applications. These devices use an internal high-efficiency, charge-pump power supply that requires only 0.1µF capacitors in 3.3V operation. This charge pump and Exar's driver architecture allow it to deliver compliant RS-232 performance from a single power supply ranging from +3.0V to +5.5V. At voltages between 2.7V and 3.0V the driver outputs are compliant with RS-562 and can interface to RS-232 over short cables.

The Auto On-line® Plus feature allows the device to automatically "wake-up" during a shutdown state upon detecting activity and to enter a low power shutdown if idle. This power saving feature functions without system intervention or modifications to software or drivers.

### SELECTION TABLE

All devices feature 3.0V to 5.5V power supply, 4 small charge pump capacitors, and 15kV ESD protection.

| Device | Data Rate (bps) | No. of Drivers/Receivers | READY pin | Low-Power Shutdown | Package |
|---|---|---|---|---|---|
| SP3224E | 250k | 2/2 | Yes | Auto On-Line® Plus | 20 SSOP/TSSOP |
| SP3225E | 1M | 2/2 | Yes | Auto On-Line® Plus | 20 SSOP/TSSOP |
| SP3226E | 250k | 1/1 | Yes | Auto On-Line® Plus | 16 SSOP/TSSOP |
| SP3227E | 1M | 1/1 | Yes | Auto On-Line® Plus | 16 SSOP/TSSOP |

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage (Vcc).....-0.3V to + 6.0V
V+ (Note 1).....-0.3V to + 7.0V
V- (Note 1).....+0.3V to - 7.0V
|V+| + |V-| .....+13V
Input voltage at TTL input pins .....-0.3V to Vcc+0.3V
RxIN..... ±16V
Driver output (from Ground)..... ±13.2V
RxOUT, $\overline{\text{STATUS}}$.....-0.3V to Vcc+0.3V
Short Circuit Duration, TxOUT to GND,. Continuous
(One output at a time maximum)
Storage Temperature.....-65°C to +150°C
Operating Temperature SP322XECX.....0°C to +70°C
Operating Temperature SP322XEEX.....-40°C to +85°C
Lead Temperature (soldering, 10s)..... +300°C

Note 1: V+ and V- can have maximum magnitudes of 7V, but their absolute difference cannot exceed 13V.

Maximum junction temperature.....150°C
**Thermal Derating, Junction to Ambient**
SSOP20.....$\theta_{JA}$ =83°C/W
TSSOP20.....$\theta_{JA}$ =110.7°C/W
SSOP16.....$\theta_{JA}$ =87°C/W
TSSOP16.....$\theta_{JA}$ =100.4°C/W

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.

## ELECTRICAL SPECIFICATIONS

Unless otherwise noted Vcc = +3.0V to +5.5V, $T_{AMB}$ = $T_{MIN}$ to $T_{MAX}$,. Typical values are at $T_{AMB}$ = +25°C. C1–C4 = 0.1µF tested at 3.3V ±10%. C1=0.047µF C2–C4 = 0.33µF tested at 5V ±10%.

| Parameters | | Symb | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| **DC Characteristics** | | | | | | | |
| Supply Current, Auto On-Line® Plus | | $I_{CC3}$ | Receivers idle, TxIN = Vcc or GND, $\overline{\text{ONLINE}}$ = GND, $\overline{\text{SHUTDOWN}}$ = Vcc Note 2 | | 1 | 10 | µA |
| Supply Current, Shutdown | | $I_{CC2}$ | $\overline{\text{SHUTDOWN}}$ = GND | | 1 | 10 | µA |
| Supply Current, Active | | $I_{CC1}$ | $\overline{\text{ONLINE}}$ = $\overline{\text{SHUTDOWN}}$ = Vcc, No Load | | 1.5 | 3.0 | mA |
| Supply Current, Active | | $I_{CC1}$ | $\overline{\text{ONLINE}}$ = $\overline{\text{SHUTDOWN}}$ = $V_{CC}$=3.3V, No Load | | 0.7 | 2.0 | mA |
| **Driver Input and Logic Input Pins** | | | | | | | |
| Logic Input Voltage | High | $V_{IH}$ | Vcc = 3.3V | 2 | | | V |
| | | $V_{IH}$ | Vcc = 5.0V | 2.4 | | | |
| | Low | $V_{IL}$ | | | | 0.8 | |
| | Logic Threshold | $V_T$ | | | 1.5 | | |
| Logic Input Leakage Current | | $I_{IL}$ | | | 0.05 | ±1.0 | µA |
| Logic Input Hysteresis | | $V_{HYS}$ | | | 100 | | mV |
| **Receiver Outputs and $\overline{\text{STATUS}}$ Output** | | | | | | | |
| Receiver Output Voltage Low | | $V_{OL}$ | $I_{OUT}$ = -1.6mA | | | 0.4 | V |
| Receiver Output Voltage High | | $V_{OH}$ | $I_{OUT}$ = 1mA | Vcc - 0.6 | | | V |

Note 2: Characterized, not 100% tested.

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## ELECTRICAL SPECIFICATIONS

Unless otherwise noted $V_{CC}$ = +3.0V to +5.5V, $T_{AMB}$ = $T_{MIN}$ to $T_{MAX}$,. Typical values are at $T_{AMB}$ = +25°C. C1–C4 = 0.1µF tested at 3.3V ±10%. C1=0.047µF C2–C4 = 0.33µF tested at 5V ±10%.

| Parameters | Symb | Test Conditions | Min. | Typ. | Max. | |
|---|---|---|---|---|---|---|
| **Driver Outputs** | | | | | | |
| Output Voltage Swing | $V_O$ | Output load = 3kΩ to GND | ±5.0 | ±6.0 | | V |
| | | Output load = Open Circuit | | | ±15.0 | |
| Short Circuit Current | | $V_{OUT}$ = 0V | | | ±60 | mA |
| Power-Off Impedance | | Vcc=V+ = V- = 0 transmitter outputs= ±2V | 300 | 10M | | Ω |
| Output Leakage Current | | Vcc = 0 or 3V to 3.3V, $V_{OUT}$ = ±12V, Drivers disabled | | | ±25 | µA |
| **Receiver Inputs** | | | | | | |
| Input Voltage Range | | | -15 | | 15 | V |
| Input Threshold Low | | Vcc = 3.3V | 0.6 | 1.2 | | V |
| | | Vcc = 5.0V | 0.8 | 1.5 | | |
| Input Threshold High | | Vcc = 3.3V | | 1.5 | 2.4 | V |
| | | Vcc = 5.0V | | 1.8 | 2.4 | |
| Input Hysteresis | | | | 500 | | mV |
| Input Resistance | | | 3 | 5 | 7 | kΩ |
| **ESD Protection** | | | | | | |
| ESD Protection for R_In, T_Out pins | | Human Body Model | | ±15 | | kV |
| All Other Pins | | Human Body Model | | ±2 | | kV |
| **Auto On-line® Plus ($\overline{ONLINE}$ = GND, $\overline{SHUTDOWN}$ = Vcc)** | | | | | | |
| Rx Input Threshold to $\overline{STATUS}$ output high | | | | | ±2.7 | V |
| Rx Input Threshold to $\overline{STATUS}$ output low | | | ±0.3 | | | V |
| Threshold to $\overline{STATUS}$ high | $t_{STH}$ | | | 0.5 | | µs |
| Threshold to $\overline{STATUS}$ low | $t_{STL}$ | | | 30 | | µs |
| Rx or Tx transition to drivers enabled | $t_{ONLINE}$ | Note 3 | | 100 | | µs |
| Last Rx or Tx transition to drivers disabled | $t_{OFFLINE}$ | Note 2, 3 | 15 | 30 | 60 | sec |

Note 3: A transmitter/receiver edge is defined as a transition through input logic thresholds.

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## TIMING CHARACTERISTICS

Unless otherwise noted $V_{CC}$ = +3.0V to +5.5V, $T_{AMB}$ = $T_{MIN}$ to $T_{MAX}$,. Typical values are at $T_{AMB}$ = +25°C. C1–C4 = 0.1µF tested at 3.3V ±10%. C1=0.047µF C2–C4 = 0.33µF tested at 5V ±10%

| Parameters | Symbol | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **SP3224E and SP3226E** | | | | | | |
| Maximum Data Rate | | $R_L$ = 3kΩ, $C_L$ = 1000pF. One transmitter switching. | 250 | | | kbps |
| Transition -Region Slew Rate | | Measurement taken from +3.0V to -3.0V or -3.0V to +3.0V, $T_{AMB}$ = 25°C $R_L$ = 3kΩ to 7kΩ, $C_L$ = 150pF to 1000pF | 4 | | 30 | V/µs |
| Receiver Propagation Delay | $t_{RPHL}$ , $t_{RPLH}$ | R_IN to R_OUT, $C_L$ = 150pF | | 0.22 | | µs |
| Receiver Output Enable Time | $t_{RZH}$ , $t_{RZL}$ | $R_L$ = 3kΩ, $C_L$ = 150pF | | 0.2 | 2 | µs |
| Receiver Output Disable Time | $t_{RHZ}$ , $t_{RLZ}$ | | | 0.2 | 2 | µs |
| Receiver Skew | $\lvert t_{PHL} - t_{PLH} \rvert$ | at 1.5V | | 200 | | ns |

| Parameters | Symbol | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **SP3225E and SP3227E** | | | | | | |
| Maximum Data Rate | | $R_L$ = 3kΩ, $C_L$ = 250pF. One transmitter Switching | 1000 | | | kbps |
| | | $R_L$ = 3kΩ, $C_L$ = 1000pF. One transmitter Switching | 500 | | | kbps |
| Instantaneous Slew Rate | | Measurement taken from +3.0V to -3.0V or -3.0V to +3.0V, $T_{AMB}$=25°C $R_L$ = 3kΩ to 7kΩ, $C_L$ = 150pF to 250pF | 24 | | 150 | V/µs |
| Driver Skew | $\lvert t_{DPHL} - t_{DPLH} \rvert$ | at zero crossing | | 75 | | ns |
| Receiver Propagation Delay | $t_{RPHL}$ , $t_{RPLH}$ | R_IN to R_OUT, $C_L$ = 150pF | | 0.20 | | µs |
| Receiver Output Enable Time | $t_{RZH}$ , $t_{RZL}$ | | | 0.3 | 2 | µs |
| Receiver Output Disable Time | $t_{RHZ}$ , $t_{RLZ}$ | | | 0.2 | 2 | µs |
| Receiver Skew | $\lvert t_{PHL} - t_{PLH} \rvert$ | at 1.5V | | 80 | | ns |

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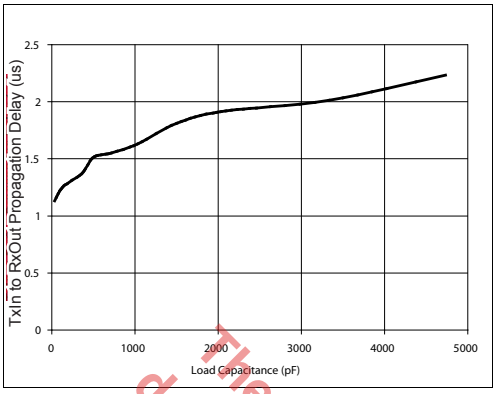
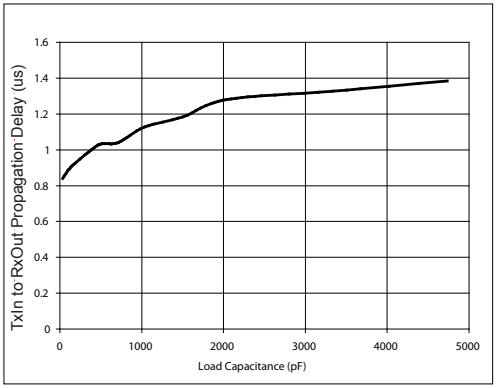
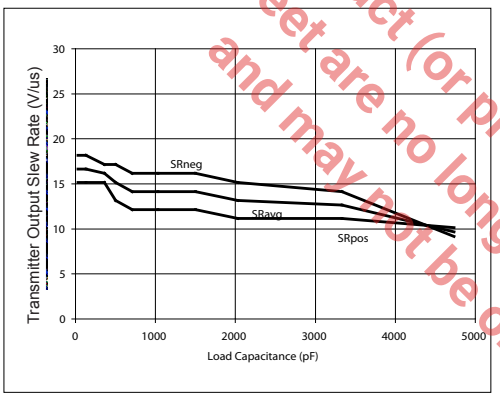


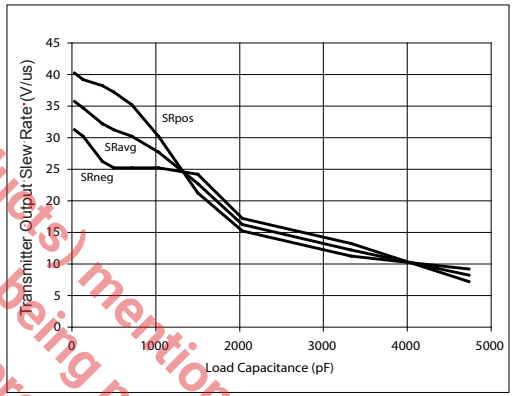

SP3224E/SP3226E Transmitter Input to Receiver Output Propagation Delay vs. Load Capacitance



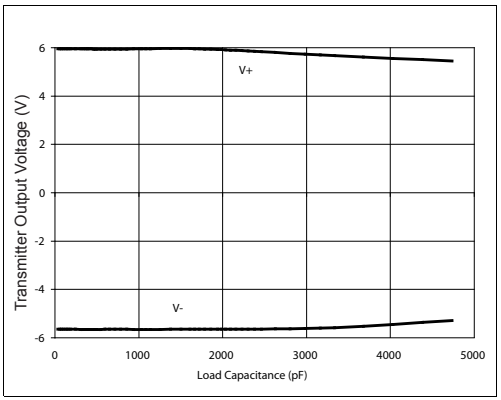

SP3225E/SP3227E Transmitter Input to Receiver Output Propagation Delay vs. Load Capacitance



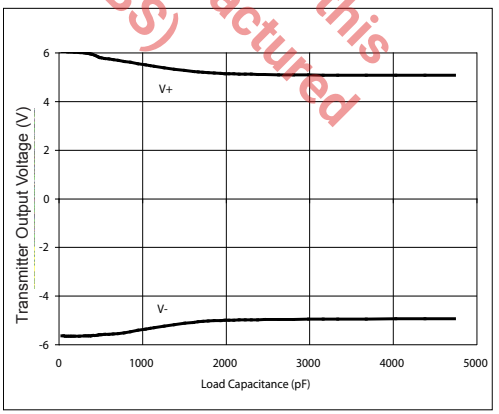

SP3224E/SP3226E Transmitter Output Slew Rate vs. Load Capacitance




SP3225E/SP3227E Transmitter Output Slew Rate vs. Load Capacitance




SP3224E/SP3226E Transmitter Output Voltage vs. Load Capacitance




SP3225E/SP3227E Transmitter Output Voltage

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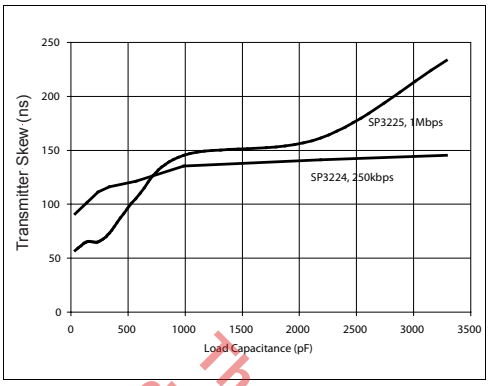
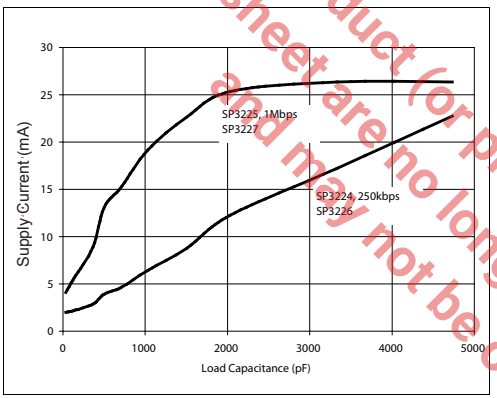
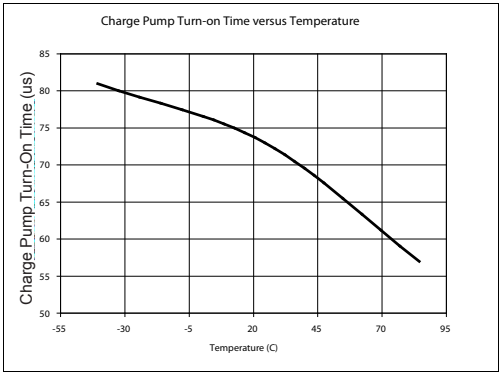



Driver Skew
vs. Load Capacitance




Supply Current
vs. Load Capacitance




Charge Pump Turn-On Time
vs. Temperature

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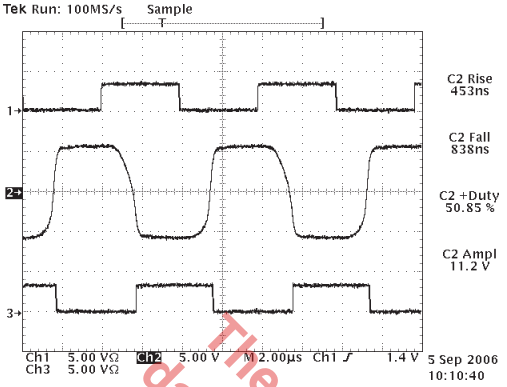
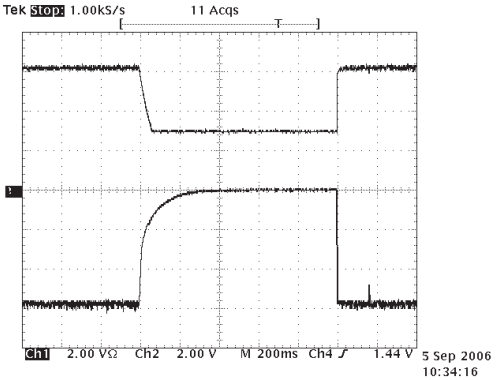
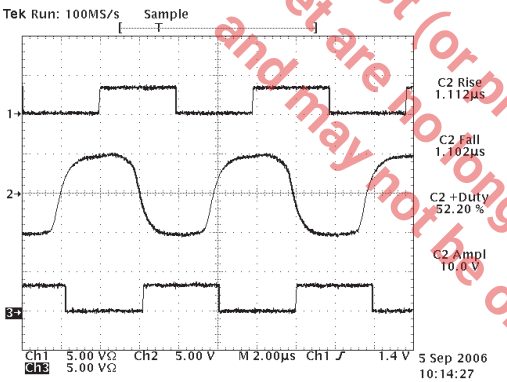


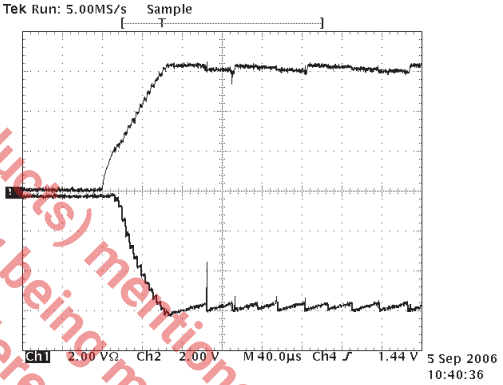

SP3224E/SP3226E Waveforms for 250kbps Clock Rate, RL=3kΩ, CL=1000pF



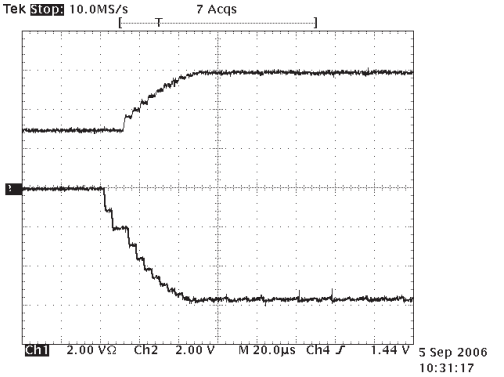

SP3224E/SP3226E Charge Pump Into Shutdown



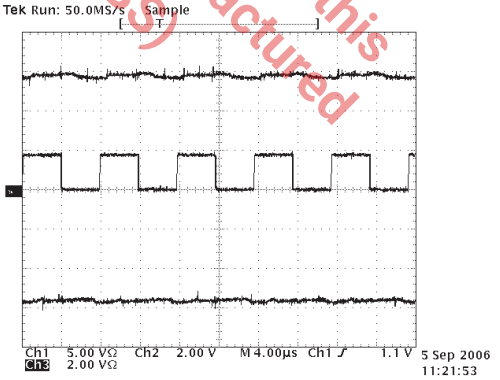

SP3224E/SP3226E Waveforms for 250kbps Clock Rate, RL=3kΩ, CL=4700pF




SP3224E/SP3226E Charge Pump Power On Time, Vcc=3.3V




SP3224E/SP3226E Charge Pump Out of Shutdown




SP3224E/SP3226E Charge Pump Waveforms for 250kbp Clock Rate

All Charge Pump waveforms use charge pump capacitor values C1-C4 = 0.1µF

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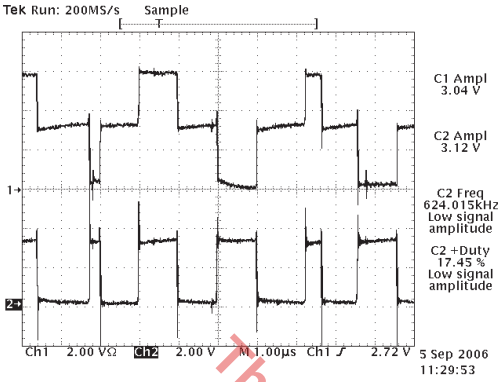
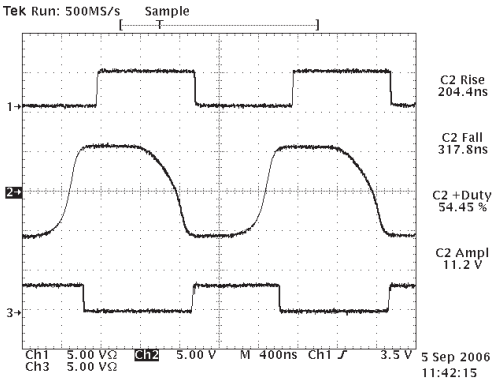
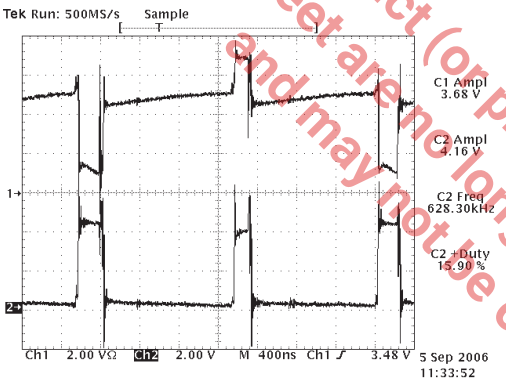


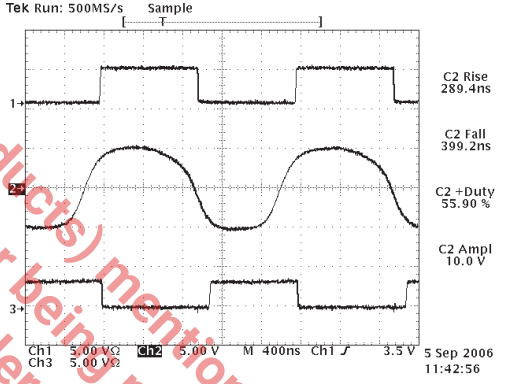

SP3224E/SP3226E C2+ Charge Pump Waveforms, Vcc=3.3V, All Channels switching



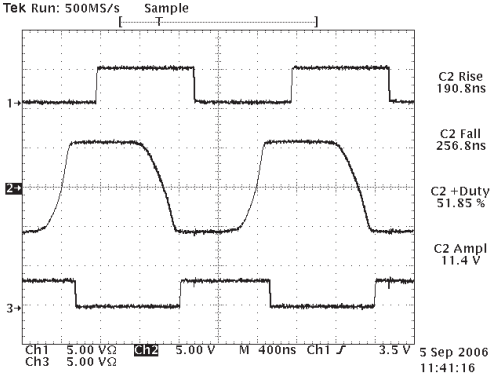

SP3225E/SP3227E Waveforms for 1Mbps Clock Rate, RL=3KΩ, CL=250pF



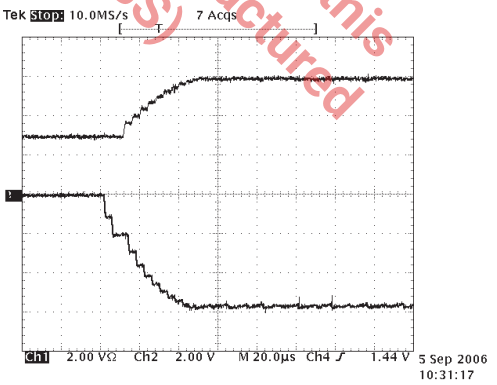

SP3224E/SP3226E C2+ Charge Pump Waveforms, Vcc=5V, All Channels switching




SP3225E/SP3227E Waveforms for 1Mbps Clock Rate, RL=3KΩ, CL=1000pF




SP3225E/SP3227E Waveforms for 1Mbps Clock Rate, RL=3KΩ, CL=50pF




SP3225E/SP3227E Charge Pump Out of Shutdown

All Charge Pump waveforms use charge pump capacitor values C1-C4 = 0.1µF

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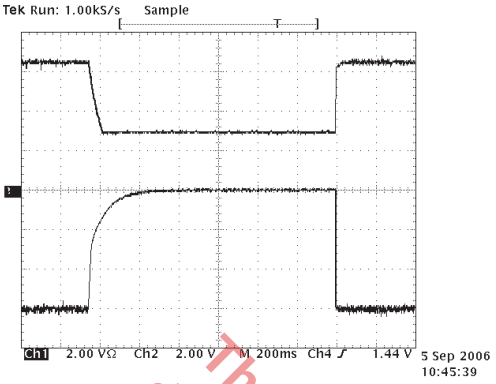
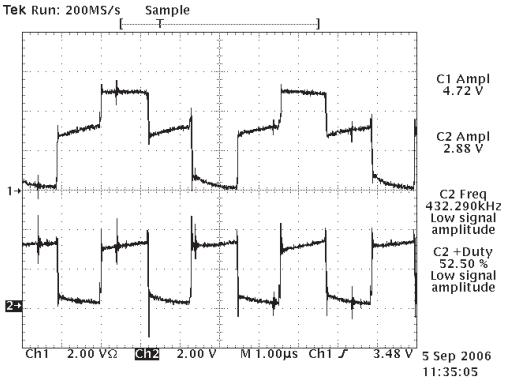
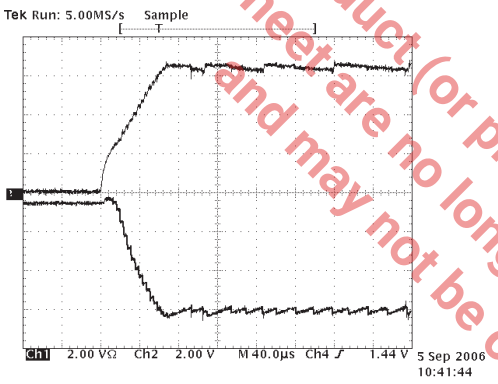


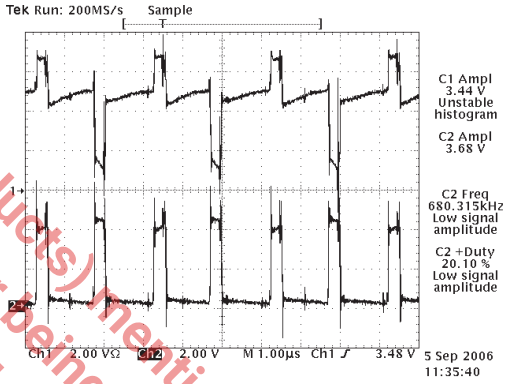

SP3225E/SP3227E Charge Pump Into Shutdown



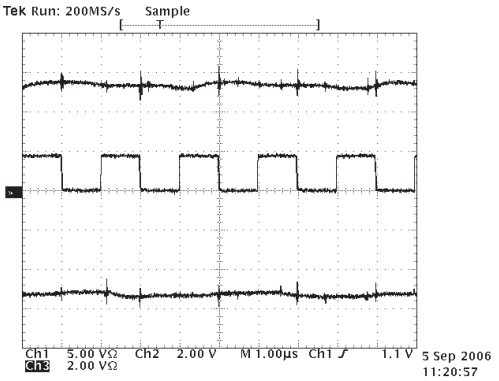

SP3225E/SP3227E Charge Pump Waveforms, Vcc=3.3V, All Channel Switching




SP3225E/SP3227E Charge Pump Power On Time, Vcc=3.3V




SP3225E/SP3227E Charge Pump Waveforms, Vcc=5V, All Channel Switching




SP3225E/SP3227E Charge Pump Waveforms for 1Mbps Clock Rate

All Charge Pump waveforms use charge pump capacitor values C1-C4 = 0.1µF

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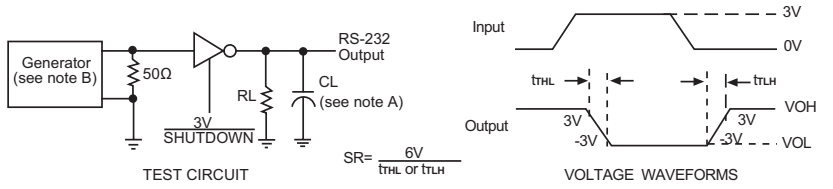
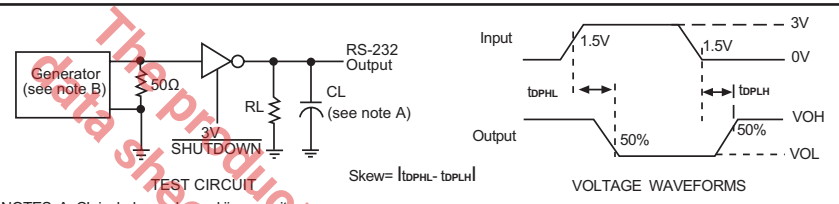


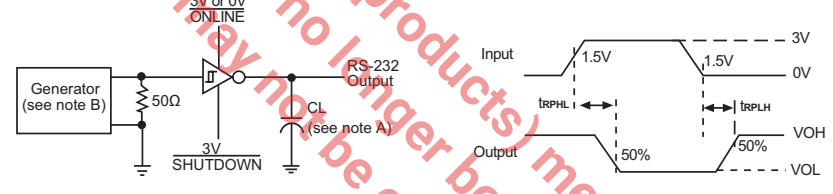

NOTES A. CL includes probe and jig capacitance
B. The pulse generator has the following characteristics: PRR= 250kbit/s, Zo=50Ω, 50% duty cycle, $t_r$ ≤10ns, $t_f$ ≤10ns

Figure 1. Driver Slew Rate



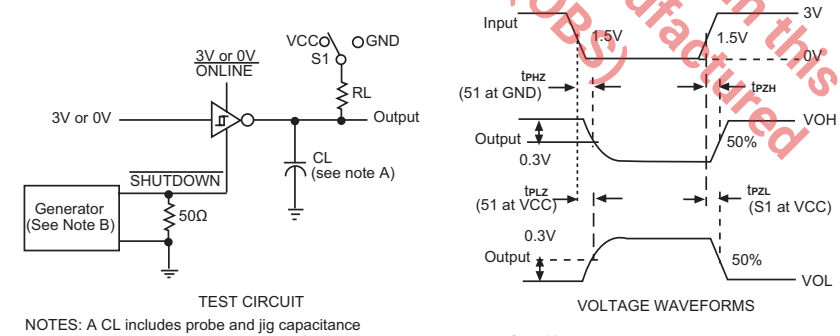

NOTES A. CL includes probe and jig capacitance
B. The pulse generator has the following characteristics: PRR= 250kbit/s, Zo=50Ω, 50% duty cycle, $t_r$ ≤10ns, $t_f$ ≤10ns

Figure 2. Driver Propagation and Skew




NOTES A. CL includes probe and jig capacitance
B. The pulse generator has the following characteristics: PRR= 250kbit/s, Zo=50Ω, 50% duty cycle, $t_r$ ≤10ns, $t_f$ ≤10ns

Figure 3. Receiver Propagation Delay and Skew




NOTES: A CL includes probe and jig capacitance
B. The pulse generator has the folowing characteristics Zo=50Ω, 50% duty cycle, $t_r$ ≤10ns, $t_f$ ≤10ns
C. $t_{PLZ}$ and $t_{PHZ}$ are the same as $t_{dis}$
D. $t_{PZL}$ and $t_{PZH}$ are the same as $t_{en}$

Figure 4. Receiver Enable and Disable Times

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## Description

The SP3224E and SP3225E are 2-driver/2-receiver devices. The SP3226E and SP3227E are 1-driver/1-receiver devices. All are ideal for serial ports in embedded, consumer, portable, or handheld applications. The transceivers meet the EIA/TIA-232 and ITU-T V.28/V.24 communication protocols for reliable serial communication. The devices feature Exar's proprietary and patented (U.S. 5,306,954) on-board charge pump circuitry that generates ±5.5V RS-232 voltage levels from a single +3.0V to +5.5V power supply.

The SP3224E-SP3227E are ideal choices for power sensitive designs. With the Auto On-line® Plus enabled, the SP3224E-SP3227E reduce supply current to 1µA whenever the transceivers are in idle. In shutdown, the internal charge pump and the drivers will shut down. This feature allows design engineers to address power saving concerns without major design changes.

## Theory Of Operation

The SP3224E-SP3227E are made up of four basic circuit blocks: 1. Drivers, 2. Receivers, 3. the Exar proprietary charge pump, and 4. Auto On-line® Plus circuitry.

## 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. These drivers comply with the EIA-TIA-232-F and all previous RS-232 versions. Unused driver inputs should be connected to GND or VCC.

The drivers can guarantee output data rates fully loaded with 3KΩ in parallel with 1000pF (SP3224E/SP3226E), or 3KΩ in parallel with 250pF (SP3225E/SP3227E) ensuring compatibility with PC-to-PC communication software. The slew rate of the driver output on the SP3224E/SP3226E is internally limited to a maximum of 30V/µs in order to meet the EIA standards (EIA RS-232D 2.1.7, Paragraph 5). The Slew Rate of SP3225E/SP3227E is not limited to enable higher speed data transfers. The transition of the loaded output from HIGH to LOW also meets the monotonic signal transition requirements of the standard.

## Receivers

The receivers convert EIA/TIA-232 signal levels to TTL or CMOS logic output levels. Receivers remain active during device shutdown. 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 500mV. This ensures that the receiver is virtually immune to noisy transmission lines. Should an input be left unconnected, an internal 5KΩ pulldown resistor to ground will commit the output of the receiver to a HIGH state.

## Charge Pump

The charge pump is a Exar–patented design (US Patent #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 5.5V power supplies. The internal power supply consists of a regulated dual charge pump that provides output voltages 5.5V regardless of the input voltage (Vcc) over the +3.0V to +5.5V range. This is important to maintain compliant RS-232 levels regardless of power supply fluctuations.

The charge pump operates in a discontinuous mode using an internal oscillator. If the output voltages are less than a magnitude

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of 5.5V, the charge pump is enabled. If the output voltages exceed a magnitude of 5.5V, the charge pump is disabled. This oscillator controls the four phases of the voltage shifting. A description of each phase follows.

**Highly Efficient Charge Pump**

The charge pump is used to generate positive and negative signal voltages for the RS-232 drivers. This enables fully compliant RS-232 and V.28 signals from a single 3.0 or 5.5V power supply.

The charge pumps use four external capacitors to hold and transfer electrical charge. The Exar patented design (US Patent #5,306,954) uses a unique approach compared to older less efficient designs. The pumps use a four–phase voltage shifting technique to attain symmetrical V+ and V- power supplies. An intelligent control oscillator regulates the operation of the charge pump to maintain the proper voltages at maximum efficiency.

**Phase 1**

$V_{SS}$ charge store and double: The positive terminals of capacitors C1 and C2 are charged from $V_{CC}$ 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 $V_{CC}$ the voltage potential across capacitor C2 is now 2 x $V_{CC}$.

**Phase 2**

$V_{SS}$ transfer and invert: Phase two connects the negative terminal of C2 to the $V_{SS}$ storage capacitor and the positive terminal of C2 to ground. This transfers the doubled and inverted (V–) voltage onto C4. Meanwhile, capacitor C1 charged from $V_{CC}$ to prepare it for its next phase.

**Phase 3**

$V_{DD}$ charge store and double: Phase three is identical to the first phase. The positive terminals of capacitors C1 and C2 are charged from $V_{CC}$ 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 $V_{CC}$ the voltage potential across capacitor C2 is now 2 x $V_{CC}$.

**Phase 4**

$V_{DD}$ transfer: The fourth phase connects the negative terminal of C2 to ground and the positive terminal of C2 to the $V_{DD}$ storage capacitor. This transfers the doubled (V+) voltage onto C3. Meanwhile, capacitor C1 charged from $V_{CC}$ to prepare it for its next phase.

The Exar charge pump generates V+ and V– independently from $V_{CC}$. Hence in a no-load condition V+ and V- will be symmetrical. Older charge pump approaches generate V+ and then use part of that stored charge to generate V-. Because of inherent losses the magnitude of V- will be smaller than V+ on these older designs.

Under lightly loaded conditions the intelligent pump oscillator maximizes efficiency by running only as needed to maintain V+ and V–. Since interface transceivers often spend much of their time at idle this power-efficient innovation can greatly reduce total power consumption. This improvement is made possible by the independent phase sequence of the Exar charge pump design.

The clock rate for the charge pump typically operates at greater than 70kHz allowing the pump to run efficiently with small 0.1µF capacitors. Efficient operation depends on rapidly charging and discharging C1 and C2, therefore capacitors should be mounted close to the IC and have low ESR (equivalent series resistance). Inexpensive surface mount ceramic capacitors (such as

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are widely used for power-supply decoupling) are ideal for use on the charge pump. The charge pumps are designed to be able to function properly with a wide range of capacitor styles and values. If polarized capacitors are used the positive and negative terminals should be connected as shown on the Typical Operating Circuit.

Capacitance values may be increased if operating at higher Vcc or to provide greater stability as the capacitors age.

The SP3224E-SP3227E devices have the advanced Auto On-Line® Plus feature RS-232 signals use both positive and negative voltages of greater than ±5V magnitude. Receivers have nominal 5kΩ impedance to ground. Even when idle, drivers will maintain output signal voltage creating a continuous current flow. In low power, battery operated devices this constant current drain can decrease battery life significantly.

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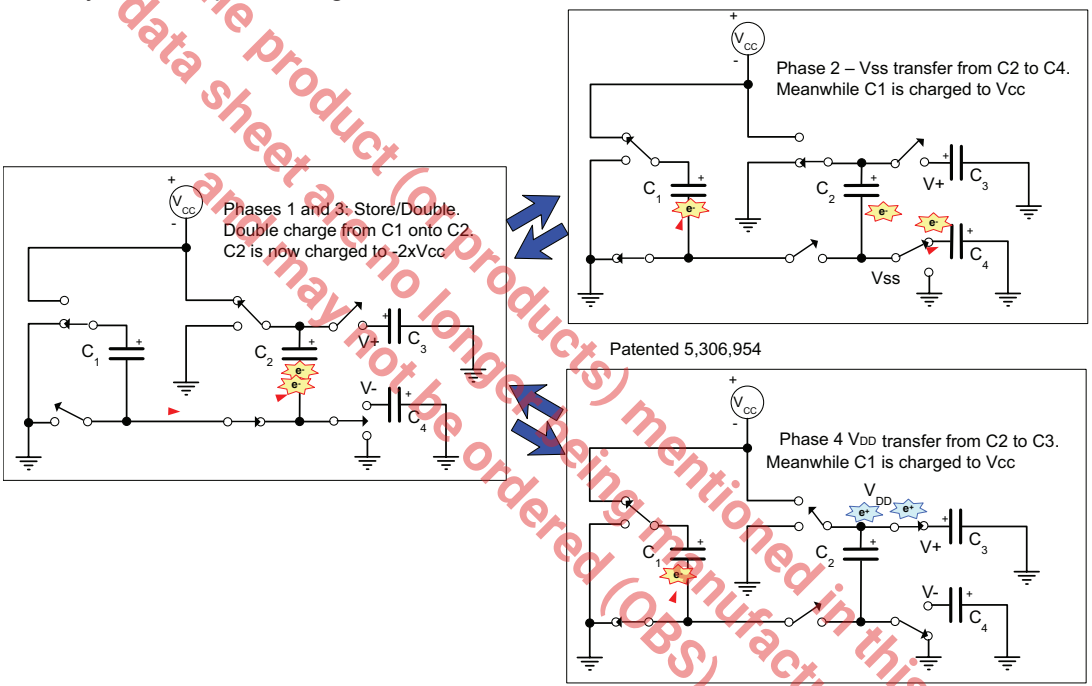


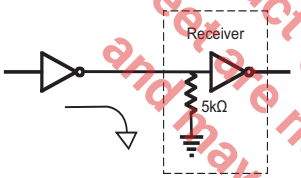

Charge Pump Phases

| Minimum Recommended Charge Pump Capacitor Values | |
|---|---|
| Input Voltage Vcc | Charge Pump Capacitor Value for SP32XX |
| 3.0V to 3.6V | C1-C4=0.1µF |
| 4.5V to 5.5V | C1=0.047µF, C2-C4=0.33µF |
| 3.0V to 5.5V | C1-C4=0.22µF |

Charge Pump Capacitor Values

that saves power by turning off the charge pumps and driver outputs when the transceiver inputs are idle for more than 30 seconds. Auto On-line® Plus is equivalent to Maxim's "Auto Shutdown Plus" feature. It differs from our existing Auto On-line® by relying on signal transitions rather than voltage levels to trigger shutdown and wakeup.

Auto On-Line® Plus automatically puts the device into a standby mode where it draws only 1µA typical. When the device detects activity on either the receiver or driver inputs it will automatically awake and activate to allow serial communication. Both the wakeup and shutdown happen automatically, without any user intervention, special drivers, or software modifications.



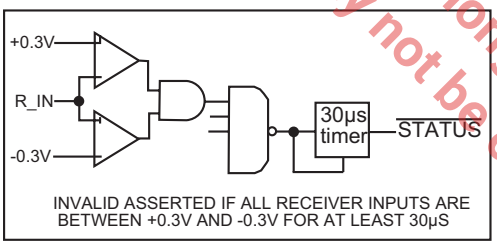




Figure 3a. STATUS Functional Diagram STATUS low

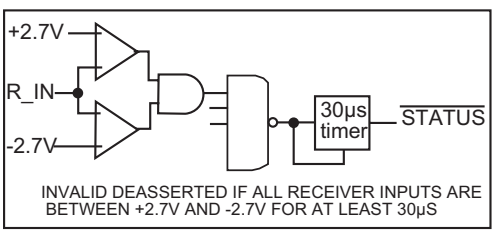



Figure 3b. STATUS Functional Diagram, STATUS high.

Wakeup and shutdown can be externally controlled by the ONLINE and SHUTDOWN pins. When ONLINE is driven to logic LOW, the Auto On-line® Plus function is active. Driving SHUTDOWN to logic LOW forces the device into shutdown state regardless of input activity or the status of the ONLINE pin.

The STATUS output determines whether a valid RS-232 signal voltage is present on the inputs. The STATUS pin goes to a logic LOW when the receiver input signal levels collapse near reference ground. This may occur when the RS-232 cable is disconnected or the RS-232 drivers of the connected peripheral are turned off.

STATUS may be used to indicate DTR or a Ring Indicator signal or to determine whether a live RS232 driver or cable is connected. By connecting the STATUS output to ONLINE input, the SP3224E-SP3227E will shut down when no valid signal level and no input transitions are detected, and wake up on a valid signal level or signal edge. If it detects no signal transitions with the past 30 seconds, the device will go into low power mode. By connecting the STATUS output to both the ONLINE input and SHUTDOWN input pins, the device enters into shutdown when not receiving a valid RS-232 signal voltage input.

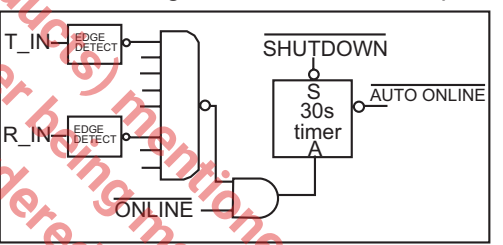



Figure 3c. Auto On-line® Plus Logic

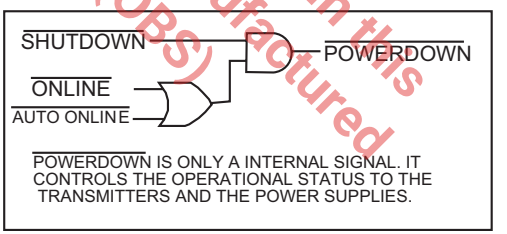



Figure 3d. Powerdown Logic

When the SP3224E-SP3227E devices are

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shut down, the charge pumps are turned off. V+ charge pump output decays to VCC,the V- output decays to GND. The decay time will depend on the size of capacitors used for the charge pump. Once in shutdown, the time required to exit the shutdown state and have valid V+ and V- levels is typically 50µs. When the SP3224E-SP3227E drivers and internal charge pump are disabled, the supply current is reduced to 1µA.

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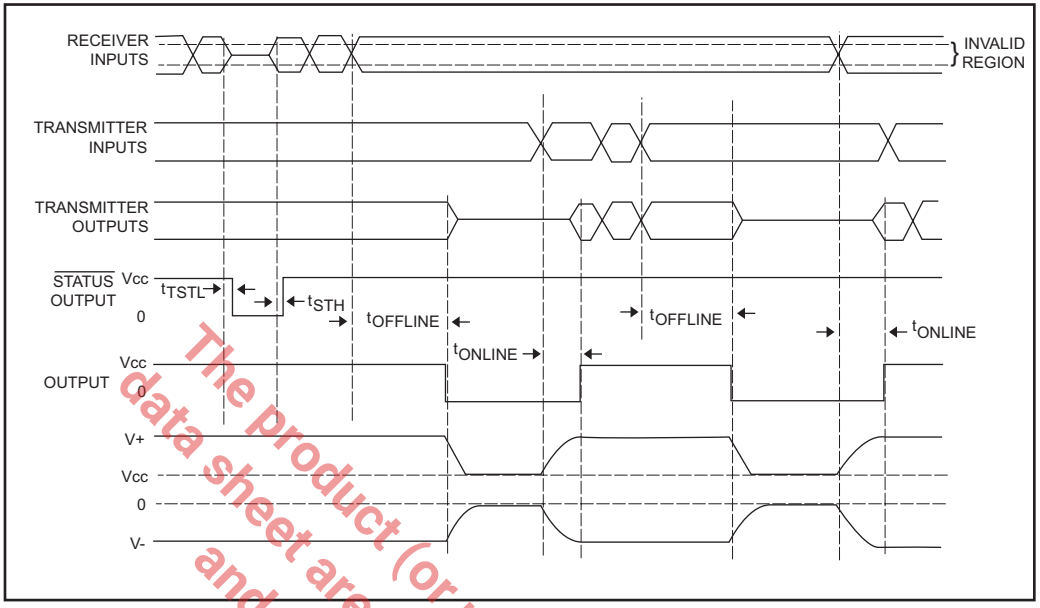
| | |
|---|---|
| Auto On-Line (existing) | Device enters low-power mode if receiver inputs see less than valid +/- 3V. |
| | $\overline{\text{STATUS}}$ (or $\overline{\text{INVALID}}$) signal output indicates if valid signal voltage is at receivers. |
| Auto On-Line Plus (new) | Device enters low-power mode if driver inputs or receiver inputs see no transitions for 30 seconds. Return to full power mode upon any transition on any driver input or receiver input |
| | Shutdown occurs even if data cable is connected to an active driver, as long as all inputs remain unchanged |
| | $\overline{\text{STATUS}}$ (or $\overline{\text{INVALID}}$) signal functions as before. Indicates if valid signal voltage is present. But has no effect on shutdown |
| | For SP3224E the $\overline{\text{EN}}$ input is replaced with a READY output. READY drives high when charge pump achieves greater than -4V Vss (V-). Indicates "ready to transmit." |

Comparison of Auto On-line® Features

| Operating Mode | $\overline{\text{ONLINE}}$ | $\overline{\text{SHDN}}$ | $\lvert R_{IN}\rvert$ > ±2.7V | Idle Inputs ($R_{XIN}$ & $T_{XIN}$) | $T_{XOUT}$ | $R_{XOUT}$ |
|---|---|---|---|---|---|---|
| Forced Shutdown | X | 0 | X | X | Hi-Z | Active |
| Forced On-Line | 1 | 1 | X | X | Active | Active |
| Auto On-Line Plus (Wake when active) | 0 | 1 | X | Active | Active | Active |
| Auto On Line Plus (Off-Line when idle) | 0 | 1 | X | Idle > 30s | Hi-Z | Active |
| Auto On-Line Plus (Wake on cable) | $\overline{\text{STATUS}}$ | 1 | Yes | X | Active | Active |
| Auto On-Line Plus (Wake when active) | $\overline{\text{STATUS}}$ | 1 | No | Active | Active | Active |
| Auto On-Line Plus (Off-Line when idle) | $\overline{\text{STATUS}}$ | 1 | No | Idle > 30s | Hi-Z | Active |
| Auto On-Line (Wake on cable) | $\overline{\text{STATUS}}$ | $\overline{\text{STATUS}}$ | Yes | X | Active | Active |
| Auto On-Line (Auto Shutoff) | $\overline{\text{STATUS}}$ | $\overline{\text{STATUS}}$ | No | X | Hi-Z | Active |

Auto On-line® Plus Truth Table




Auto On-Line® Plus Timing Diagram

$t_{STL}$ (=30µs typ.)

$t_{STH}$ (=0.4µs typ.)

$t_{OFFLINE}$ (=30s typ.)

$t_{ONLINE}$ (=100µs typ.)

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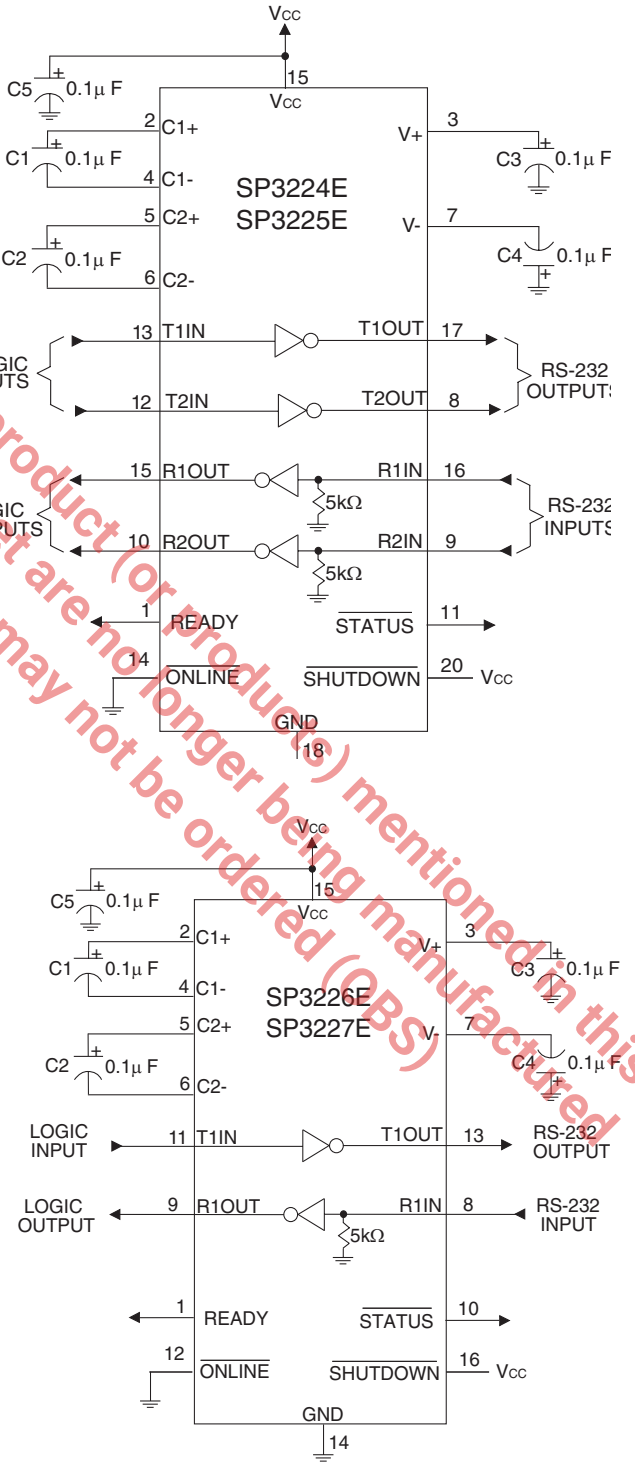


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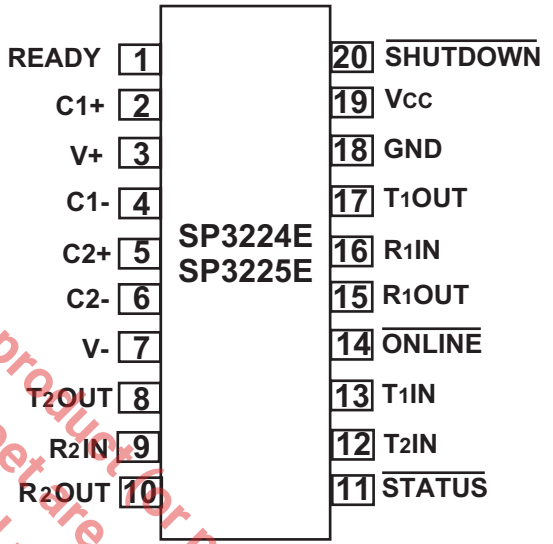


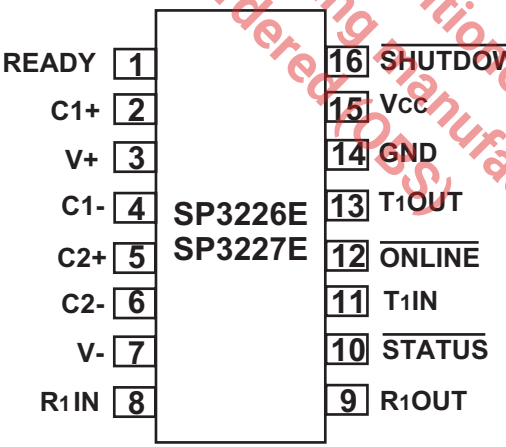


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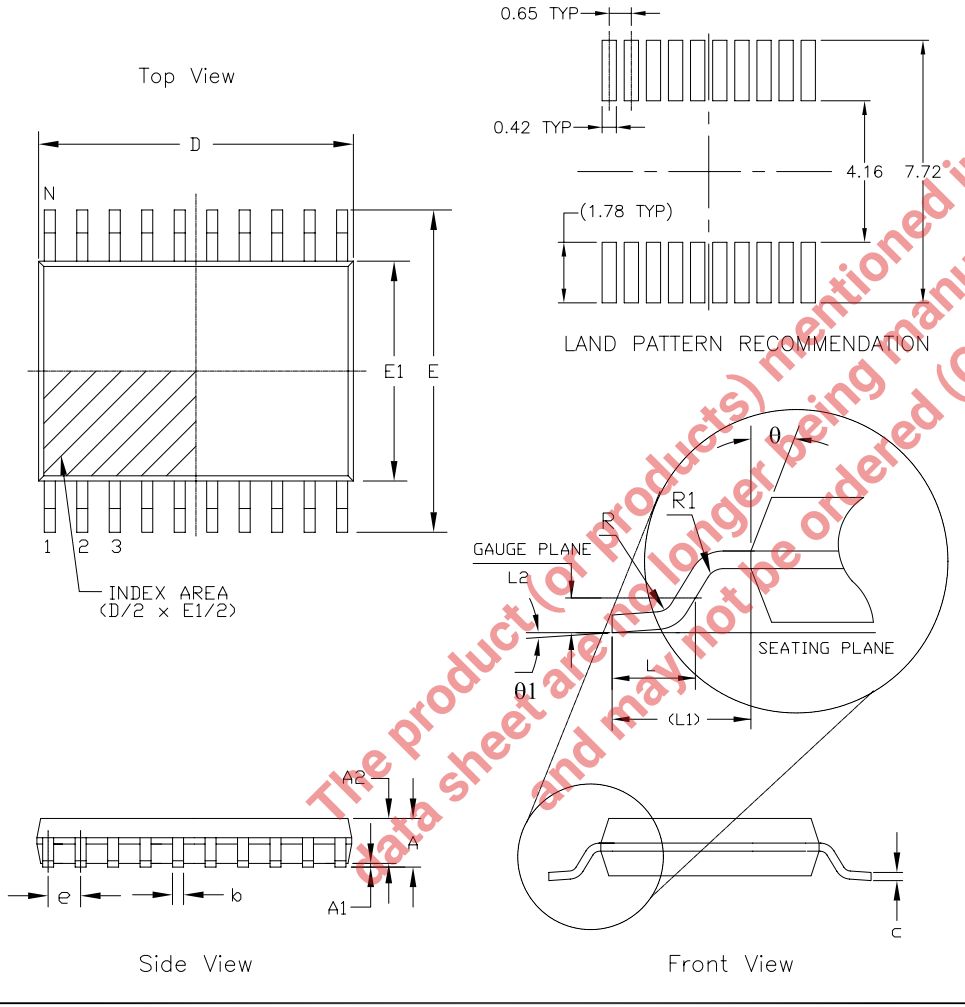


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| REVISION HISTORY | | | |
|---|---|---|---|
| REV. | DISCRIPTION | DATE | APP'D |
| A | DRAWING ORIGINATION | 04/19/06 | JL |
| B | ADD LAND PATTERN RECOMMENDATION | 10/27/06 | JL |
| C | CHANGE DRAWING LOGO AND COMPANY NAME | 11/21/07 | JL |

| 20 Pin TSSOP JEDEC MO-153 Variation AC | | | | | | |
|---|---|---|---|---|---|---|
| SYMBOLS | DIMENSIONS IN MM (Control Unit) | | | DIMENSIONS IN INCH (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 | | |

| | | | |
|---|---|---|---|
| EXAR Powering Connectivity | EXAR CORPORATION | | |
| | 20 PIN TSSOP PACKAGE OUTLINE | | |
| Packaging Approval: | Drawing No: 20-PIN TSSOP | | |
| By: JL Date: 11/21/07 | Revision: C | Sheet: 1 OF 1 | |

| REVISION HISTORY | | | |
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| REV. | DISCRIPTION | DATE | APP'D |
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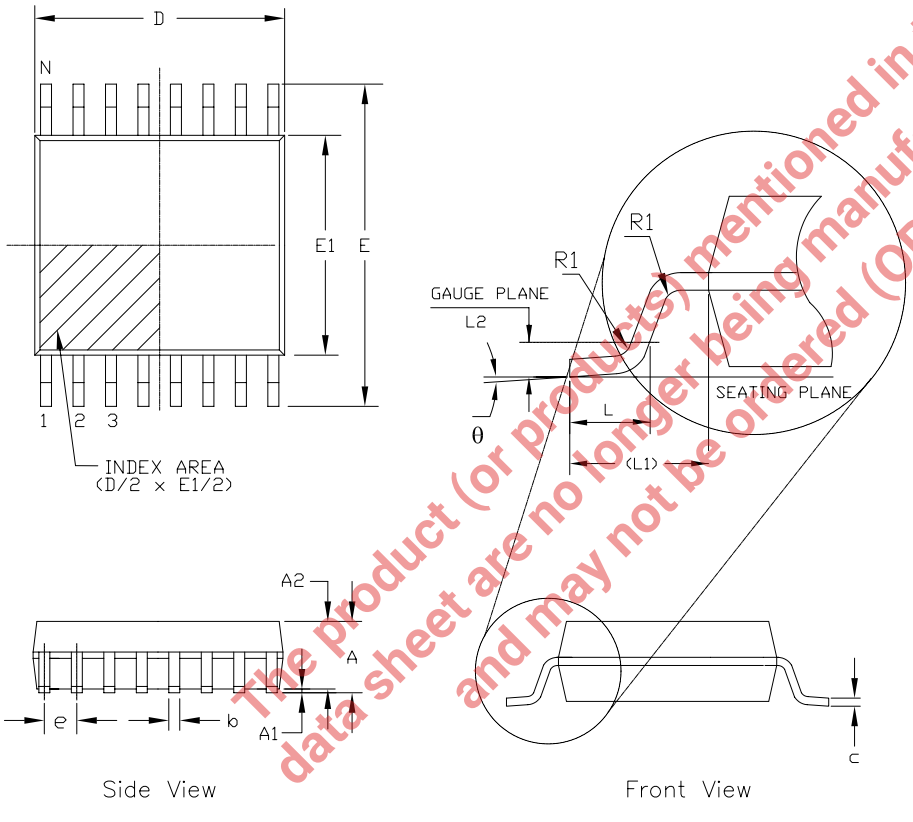
| B | CHANGE DRAWING LOGO AND COMPANY NAME | 11/21/07 | JL |

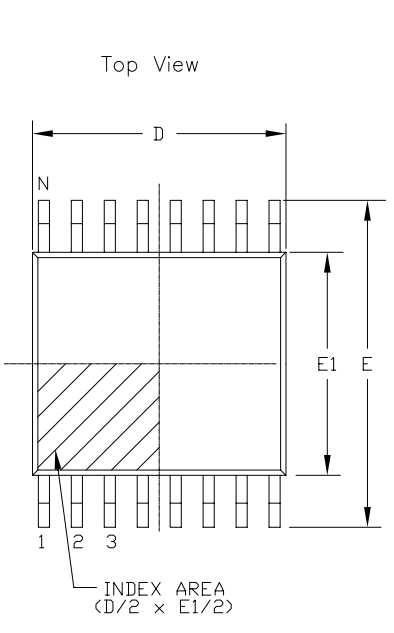


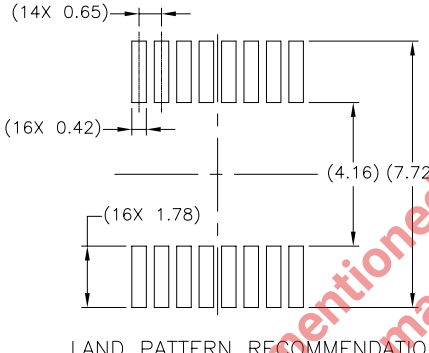

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

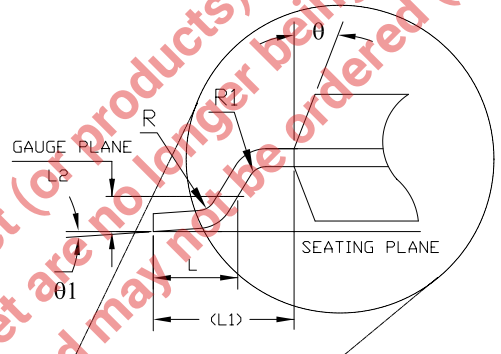
| 16 Pin SSOP JEDEC MO-150 Variation AC | | | | | | |
|---|---|---|---|---|---|---|
| SYMBOLS | DIMENSIONS IN MM (Control Unit) | | | DIMENSIONS IN INCH (Reference Unit) | | |
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | — | — | 2.00 | — | — | 0.079 |
| A1 | 0.05 | — | — | 0.002 | — | — |
| A2 | 1.65 | 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 | | | 16 | | |

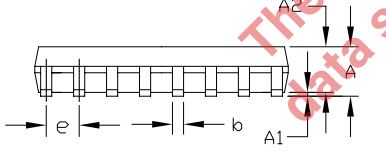
| | | | |
|---|---|---|---|
| EXAR Powering Connectivity | EXAR CORPORATION | | |
| | 16 PIN SSOP PACKAGE OUTLINE | | |
| Packaging Approval: | Drawing No: 16-PIN SSOP | | |
| By: JL | Date: 11/21/07 | Revision: B | Sheet: 1 OF 1 |

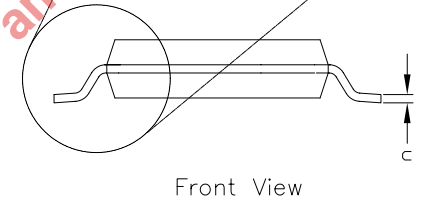
| REVISION HISTORY | | | |
|---|---|---|---|
| REV. | DISCRIPTION | DATE | APP'D |
| A | DRAWING ORIGINATION | 04/19/06 | JL |
| B | ADD LAND PATTERN RECOMMENDATION | 05/22/07 | JL |
| C | CHANGE DRAWING LOGO AND COMPANY NAME | 11/21/07 | JL |



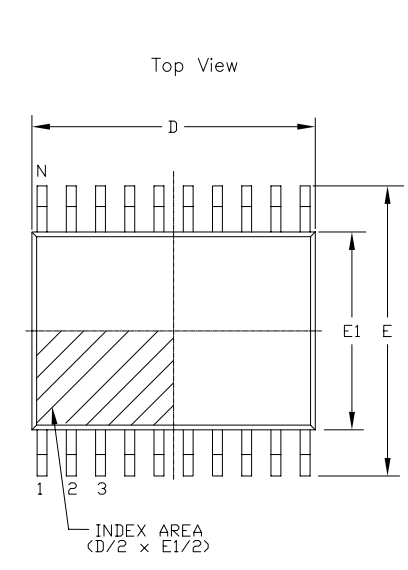



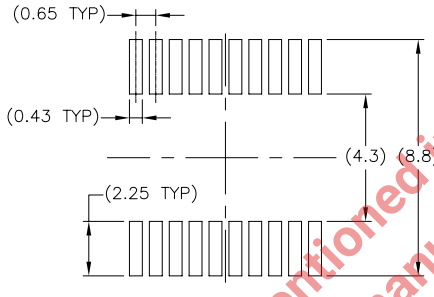

| 16 Pin TSSOP JEDEC MO-153 Variation AB | | | | | | |
|---|---|---|---|---|---|---|
| SYMBOLS | DIMENSIONS IN MM (Control Unit) | | | DIMENSIONS IN INCH (Reference Unit) | | |
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | — | — | 1.20 | — | — | 0.047 |
| A1 | 0.05 | — | 0.15 | 0.002 | — | 0.006 |
| 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 | | |

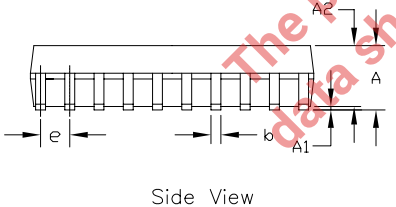
The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

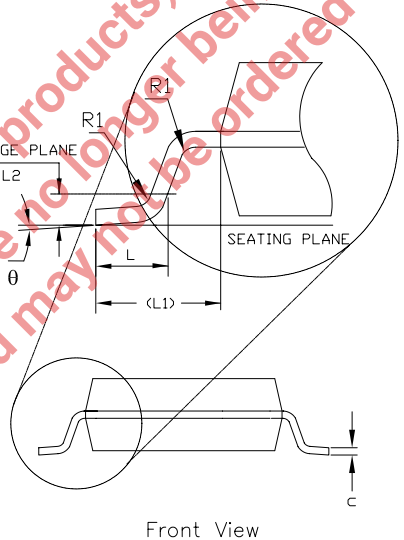
| | | |
|---|---|---|
| EXAR Powering Connectivity | EXAR CORPORATION | |
| | 16 PIN TSSOP PACKAGE OUTLINE | |
| Packaging Approval: | Drawing No: 16-PIN TSSOP | |
| By: JL Date: 11/21/07 | Revision: C | Sheet: 1 OF 1 |

| REVISION HISTORY | | | |
|---|---|---|---|
| REV. | DISCRIPTION | DATE | APP'D |
| A | DRAWING ORIGINATION | 04/24/06 | JL |
| B | ADD LAND PATTERN RECOMMENDATION | 07/25/07 | JL |
| C | CHANGE DRAWING LOGO AND COMPANY NAME | 11/21/07 | JL |




| 20 Pin SSOP JEDEC MO-150 Variation AE | | | | | | |
|---|---|---|---|---|---|---|
| SYMBOLS | DIMENSIONS IN MM (Control Unit) | | | DIMENSIONS IN INCH (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 | 0.272 | 0.283 | 0.295 |
| N | 20 | | | 20 | | |

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

| | | | |
|---|---|---|---|
| EXAR Powering Connectivity | | EXAR CORPORATION | |
| | | 20 PIN SSOP PACKAGE OUTLINE | |
| Packaging Approval: | | Drawing No: | 20-PIN SSOP |
| By: JL | Date: 11/21/07 | Revision: C | Sheet: 1 OF 1 |

| Part number | Temperature range | Package Type |
|---|---|---|
| SP3224ECA-L | From 0°C to +70°C | Lead Free 20 pin SSOP |
| SP3224ECY-L | From 0°C to +70°C | Lead Free 20 pin TSSOP |
| SP3224EEA-L | From -40°C to +85°C | Lead Free 20 pin SSOP |
| SP3224EEY-L | From -40°C to +85°C | Lead Free 20 pin TSSOP |
| SP3225ECA-L | From 0°C to +70°C | Lead Free 20 pin SSOP |
| SP3225ECY-L | From 0°C to +70°C | Lead Free 20 pin TSSOP |
| SP3225EEA-L | From -40°C to +85°C | Lead Free 20 pin SSOP |
| SP3225EEY-L | From -40°C to +85°C | Lead Free 20 pin TSSOP |
| SP3226ECA-L | From 0°C to +70°C | Lead Free 16 pin SSOP |
| SP3226ECY-L | From 0°C to +70°C | Lead Free 16 PIN SSOP |
| SP3226EEA-L | From -40°C to +85°C | Lead Free 16 pin SSOP |
| SP3226EEY-L | From -40°C to +85°C | Lead Free 16 PIN TSSOP |
| SP3227ECA-L | From 0°C to +70°C | Lead Free 16 PIN SSOP |
| SP3227ECY-L | From 0°C to +70°C | Lead Free 16 PIN TSSOP |
| SP3227EEA-L | From -40°C to +85°C | Lead Free 16 PIN SSOP |
| SP3227EEY-L | From -40°C to +85°C | Lead Free 16 PIN TSSOP |

Available in Tape on Reel

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

| DATE | REVISION | DESCRIPTION |
|---|---|---|
| 11-20-06 | P | Legacy Sipex Datasheet |
| 12-14-09 | 1.0.0 | Update to Exar Format. Change revision to 1.0.0. Change Supply Current Active over full Vcc range maximum from 2.0mA to 3.0mA. Change Supply Current Active at Vcc = 3.3V maximum from 1.0mA to 2.0mA. Change RX input voltage ABS Maximum Rating from +/-18V to +/-16V. |
| 08-17-11 | 1.0.1 | Correct type error on front page Features list. |

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Datasheet August 2011

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