Sipex Corporation
SIGNAL PROCESSING EXCELLENCE

SP231A/SP232A/SP233A
SP310A/SP312A

T-75-45-05

Enhanced RS232 Line Drivers/Receivers

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FEATURES

- Operates from Single 5V Power Supply
- Meets All RS232D and V.28 Specifications
- Multiple Drivers and Receivers
- Small Charge Pump Capacitors — 0.1µF
- Operates with 0.1µF and 100µF Capacitors
- High Data Rate — 120Kbps Under Load
- High Output Slew Rate — 10V/µs Under Load
- Low Power Shutdown ≤1µA
- 3-State TTL/CMOS Receiver Outputs
- ±30V Receiver Input Levels
- Low Power CMOS — 15mA Operation

APPLICATIONS

- Computers
- Peripherals
- Keyboards
- Mice
- Modems
- Printers
- Instruments

DESCRIPTION

The **Sipex SP231A**, **SP232A** and **SP233A** are enhanced versions of the **Sipex SP231**, **SP232** and **SP233** RS232 line drivers/receivers. They are pin-for-pin replacements for these earlier versions, will operate in their sockets with capacitors ranging from 0.1 to 100µF, either polarized or non-polarized, and feature several improvements in both performance and ease of use. Performance enhancements include 10V/µs slew rate, 120K bits per second guaranteed transmission rate, and increased drive current for longer and more flexible cable configurations. Ease of use enhancements include smaller, 0.1µF charge pump capacitors, enhanced ESD protection, low power dissipation and overall ruggedized construction for commercial environments.

The **SP232A**, **SP233A**, **SP310A** and **SP312A** include charge pump voltage converters

which allow them to operate from a single +5V supply. These converters convert the +5V input power to the ±10V needed to generate the RS232 output levels. Both meet all EIA RS232D and CCITT V.28 specifications. The **SP231A** has provisions for external V+ supplies. With this power supplied externally, the current drain due to charge pump operation is considerably reduced, typically to 400µA.

The **SP310A** provides identical features as the **SP232A**. The **SP310A** has a single control line which simultaneously shuts down the internal DC/DC converter and puts all transmitter and receiver outputs into a high impedance state. The **SP312A** is identical to the **SP310A** with separate tri-state and shutdown control lines.

The **SP231A** is available in 14-pin plastic DIP, CERDIP and 16-pin SOIC packages for operation over commercial, industrial and military temperature ranges. The **SP232A** is available in 16-pin plastic DIP, SOIC and CERDIP packages, operating over the commercial, industrial and military temperature ranges. The **SP233A** is available in a 20-pin plastic DIP package for operation over the commercial and industrial temperature ranges. The **SP310A** and **SP312A** are available in 18-pin plastic, CERDIP and SOIC packages for operation over the commercial and industrial temperature ranges. Please consult the factory for DIP and surface-mount packaged parts supplied on tape-on-reel, as well as parts screened to MIL-M-38510.

ABSOLUTE MAXIMUM RATINGS†

V_{CC} ..... +6V
V^+ ..... (Vcc-0.3V) to +13.2V
V^- 13.2V

Input Voltages
T_{IN} ..... -0.3 to (Vcc +0.3V)
R_{IN} ..... ±30V

Output Voltages
T_{OUT} ..... (V+, +0.3V) to (V-, -0.3V)
R_{OUT} ..... -0.3V to (Vcc +0.3V)

Short Circuit Duration
T_{OUT} ..... Continuous
Power Dissipation
CERDIP 675mW
(derate 9.5mW/°C above +70°C)
Plastic DIP 375mW
(derate 7mW/°C above +70°C)
Small Outline 375mW
(derate 7mW/°C above +70°C)

† *This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operation sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.*

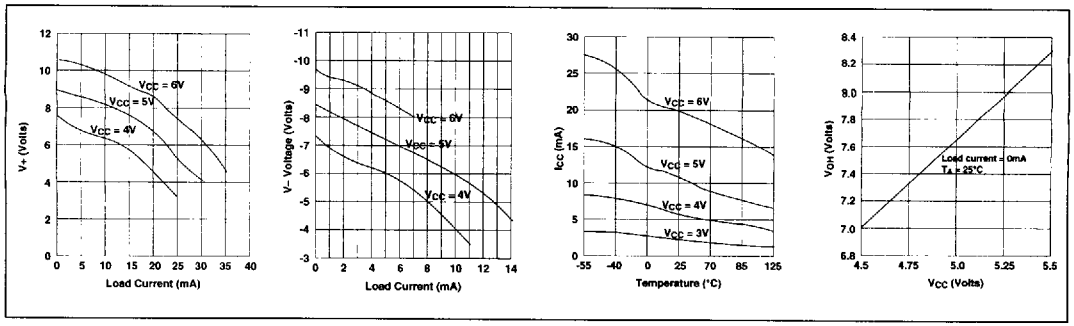
SPECIFICATIONS

V_{CC}=+5V± 10%; V+=+8.5V to +13.2V (SP231A only) 0.1µF charge pump capacitors; T_{MIN} to T_{MAX} unless otherwise noted.

	SP231A/232A/233A/310A/312A				
PARAMETERS	**MIN**	**TYP**	**MAX**	**UNITS**	**CONDITIONS**
TTL INPUT					
Logic Threshold					
Low			0.8	Volts	T_{IN} ; $\overline{EN}$, SD
High	2.0			Volts	T_{IN} ; $\overline{EN}$, SD
Logic Pullup Current		15	200	µA	T_{IN} = 0V
Data Rate	120			Kbps	C_L = 2500pF, R_L= 3KΩ
TTL OUTPUT					
TTL/CMOS Output					
Voltage, Low			0.4	Volts	I_{OUT} = 3.2mA; Vcc = +5V
Voltage, High	3.5			Volts	I_{OUT} = -1.0mA
Leakage Current **; T_A = +25°		0.05	±10	µA	$\overline{EN}$ = Vcc, 0V≤R_{OUT} ≤Vcc
RS232 OUTPUT					
Output Voltage Swing	±5	±9		Volts	All transmitter outputs loaded with 3KΩ to Ground
Output Resistance	300			Ohms	Vcc = 0V; V_{OUT} = ±2V
Output Short Circuit Current		±18		mA	Infinite duration
RS232 INPUT					
Voltage Range	-30		+30	Volts	
Voltage Threshold					
Low	0.8	1.2		Volts	Vcc = 5V, T_A = +25°C
High		1.7	2.4	Volts	Vcc = 5V, T_A = +25°C
Hysteresis	0.2	0.5	1.0	Volts	Vcc = 5V, T_A = +25°C
Resistance	3	5	7	KΩ	
DYNAMIC CHARACTERISTICS					
Propagation Delay, RS232 to TTL		1.5		µS	
Instantaneous Slew Rate			30	V/µS	C_L = 10pF, R_L= 3 - 7KΩ; T_A = +25°C
Transition Region Slew Rate		10		V/µs	C_L = 2500pF, R_L= 3KΩ; measured from +3V to -3V or -3V to +3V
Output Enable Time **		400		ns	SP310A and SP312A only
Output Disable Time **		250		ns	SP310A and SP312A only
POWER REQUIREMENTS					
Vcc Power Supply Current		10	15	mA	No load, T_A= +25°C
		25		mA	All transmitters R_L = 3KΩ; T_A = +25°C
V+ Power Supply Current ***		5	10	mA	No load, V+ = 12V
Shutdown Supply Current **		1	10	µA	Vcc = 5V, T_A = +25°C

SP310A and SP312A only; * SP231A only

PERFORMANCE CURVES



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THEORY OF OPERATION

The **SP231A, SP232A, SP233A, SP310A** and **SP312A** devices are made up of three basic circuit blocks — 1) a driver/transmitter, 2) a receiver and 3) a charge pump. Each block is described below.

Driver/Transmitter

The drivers are inverting transmitters, which accept TTL or CMOS inputs and output the RS232 signals with an inverted sense relative to the input logic levels. Typically the RS232 output voltage swing is ±9V. Even under worst case loading conditions of 3kohms and 2500pF, the output is guaranteed to be ±5V, which is consistent with the RS232 standard specifications. The transmitter outputs are protected against infinite short-circuits to ground without degradation in reliability.

The instantaneous slew rate of the transmitter output is internally limited to a maximum of 30V/µs in order to meet the standards (EIA 232-D 2.1.7, Paragraph (5)). However, the transition region slew rate of these enhanced products is typically 10V/µs. The smooth transition of the loaded output from V_{OL} to V_{OH} clearly meets the monotonicity requirements of the standard (EIA 232-D 2.1.7, Paragraphs (1) & (2)).

Receivers

The receivers convert RS232 input signals to inverted TTL signals. Since the 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.

The input thresholds are 0.8V minimum and 2.4V maximum, again well within the ±3V RS232 requirments. The receiver inputs are also protected against voltages up to ±30V. Should an input be left unconnected, a 5kohm pulldown resistor to ground will commit the output of the receiver to a high state.

In actual system applications, it is quite possible for signals to be applied to the receiver inputs before power is applied to the receiver circuitry. This occurs for example when a PC user attempts to print only to realize the printer wasn't turned on. In this case an RS232 signal from the PC will appear on the receiver input at the printer. When the printer power is turned on, the receiver will operate normally. All of these enhanced devices are fully protected.

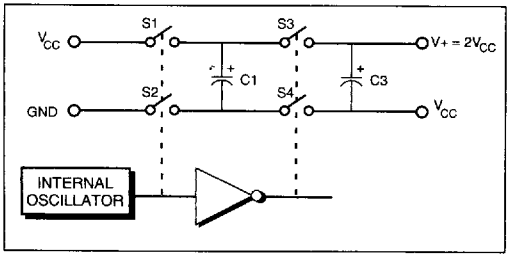

Figure 1. Charge Pump Voltage Doubler

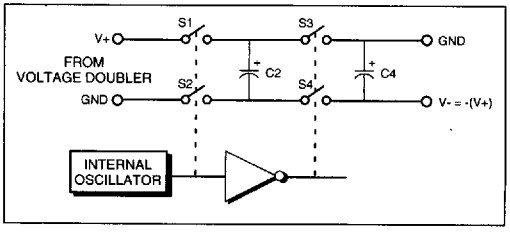

Figure 2. Charge Pump Voltage Inverter

Charge Pump

The charge pump section of the these devices allows the circuit to operate from a single +5V ±10% power supply by generating the required operating voltages internal to the devices. The charge pump consists of two sections — 1) a voltage doubler and 2) a voltage inverter.

As shown in Figure 1, an internal oscillator triggers the charge accumulation and voltage inversion. The voltage doubler momentarily stores a charge on capacitor C_1 equal to V_{cc}, referenced to ground. During the next transition of the oscillator this charge is boot-strapped to transfer charge to capacitor C_3. The voltage across C_3 is now from V_{cc} to V^+.

In the inverter section (*Figure 2*), the voltage across C_3 is transferred to C_2 forcing a range of 0V to V^+ across C_2. Boot-strapping of C_2 will then transfer charge to C_4 to genrate V^-.
One of the significant enhancements over previous products of this type is that the values of the capacitors are no longer critical and have been decreased in size considerably to 0.1µF. Because the charge pump runs at a much higher frequency, the 0.1µF capacitors are sufficient to transfer and sustain charges to the two transmitters.

APPLICATION HINTS

Protection From Shorts to ±15V

The driver outups are protected against shorts to ground, other driver outputs, and V^+ or V^-. If the possibility exists that the outputs could be inadvertently connected to voltages higher than ±15V, then it is recommended that external protection be provided. For protection against voltages exceeding ±15V, two back-to-back zener diodes connected from each output to ground will clamp the outputs to an acceptable voltage level.

Shutdown ($\overline{SD}$) and Enable ($\overline{EN}$) — SP310A/SP312A Only

Both the **SP310A** and **SP312A** have a shut-down/standby mode to conserve power in battery-powered systems. 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 ON/$\overline{OFF}$ (pin 18). Activating the shutdown mode also puts the **SP310A** transmitter and receiver outputs in a high impedance condition (tri-stated). The shutdown mode is controlled on the **SP312A** by a logic "0" on the $\overline{SHUTDOWN}$ control line (pin 18); this also puts the transmitter outputs in a tri-state mode. The receiver outputs can be tri-stated separately during normal operation or shutdown by a logic "1" on the $\overline{ENABLE}$ line (pin 1).

Wake-Up Feature (SP312A Only)

The **SP312A** has a wake-up feature that keeps all the receivers in an enabled state when the device is in the shutdown mode. *Table 1* defines the truth table for the wake-up function.

With only the receivers activated, the **SP312A** typically draws less than 5µA supply current (10µA maximum). In the case of a modem interfaced to a computer in power down mode, the Ring Indicator (RI) signal from the modem

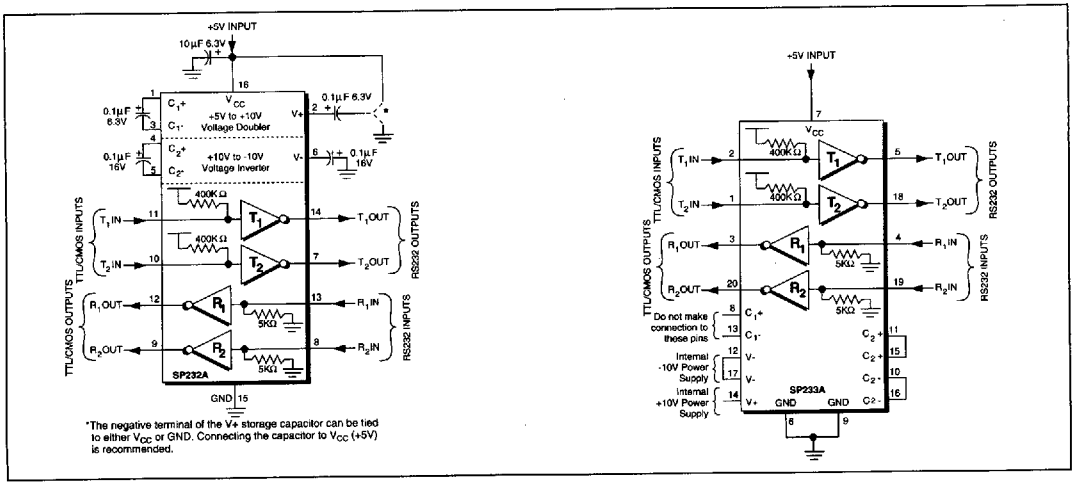

Figure 3. Typical Circuits using the SP232A and SP233A.

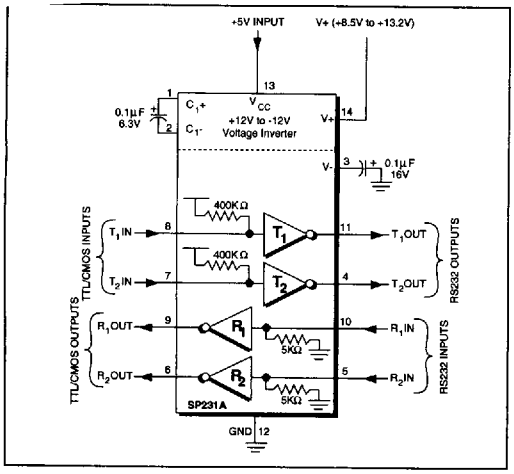

Figure 4. Typical Circuits using the SP231A.

SD	$\overline{EN}$	Power Up/Down	Receiver Outputs
0	0	Up	Enable
0	1	Up	Tri–state
1	0	Down	Enable
1	1	Down	Tri–state

Table 1. Wake–Up Function Truth Table

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would be used to "wake up" the computer, allowing it to accept data transmission.

After the ring indicator signal had 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 SD pin of the **SP312A** to a logic low, taking it out of the shutdown mode. The receiver propagation delay is typically 1µs. 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 and transmit data.

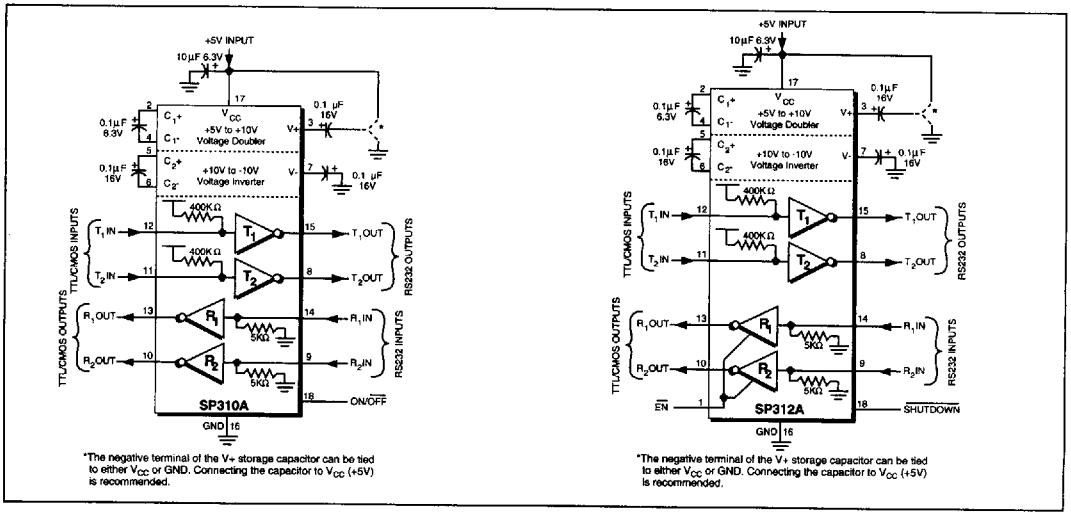

Figure 5. Typical Circuits using the SP310A and SP312A.

ORDERING INFORMATION

SP231A
0°C to +70°C:
SP231ACP .. 14-pin Plastic DIP
SP231ACT ..... 16-pin SOIC
SP231ACX ..... Dice

-40°C to +85°C:
SP231AEP ... 14-pin Plastic DIP
SP231AET ..... 16-pin SOIC
SP231AED ..... 14-pin CERDIP

-55°C to +125°C:
SP231AMD ..... 14-pin CERDIP

SP232A
0°C to +70°C:
SP232ACN ..... 16-pin N-SOIC
SP232ACP .. 16-pin Plastic DIP
SP232ACT ..... 16-pin SOIC
SP232ACX ..... Dice

-40°C to +85°C:
SP232AEP ... 16-pin Plastic DIP
SP232AET ..... 16-pin SOIC
SP232AED ..... 16-pin CERDIP

-55°C to +125°C:
SP232AMD ..... 16-pin CERDIP

SP233A
0°C to +70°C:
SP233ACP ..20-pin Plastic DIP
SP233ACT ..... 20-pin SOIC

-40°C to +85°C:
SP233AEP ... 20-pin Plastic DIP
SP233AET ..... 20-pin SOIC

SP310A
0°C to +70°C:
SP310ACP .. 18-pin Plastic DIP
SP310ACT ..... 18-pin SOIC
SP310ACX ..... Dice

-40°C to +85°C:
SP310AEP ... 18-pin Plastic DIP
SP310AET ..... 18-pin SOIC
SP310AED ..... 18-pin CERDIP

-55°C to +125°C:
SP310AMD ..... 18-pin CERDIP

SP312A
0°C to +70°C:
SP312ACP .. 18-pin Plastic DIP
SP312ACT ..... 18-pin SOIC
SP312ACX ..... Dice

-40°C to +85°C:
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SP312AET ..... 18-pin SOIC
SP312AED ..... 18-pin CERDIP

-55°C to +125°C:
SP312AMD ..... 18-pin CERDIP

CT and ET packages available Tape-on-Reel. Please consult the factory for pricing and availability for this option, and for parts screened to MIL-STD-883.

PIN ASSIGNMENTS