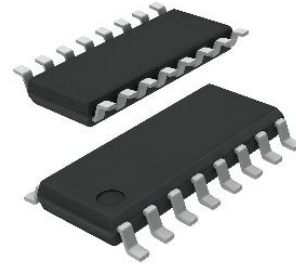


## HX232-S +5V-Powered, Multichannel RS-232 Drivers/Receivers

The HX232-S series of line drivers/receivers are designed for use in all EIA/TIA-232E and V.28/V.24 communication interfaces, particularly in scenarios where  $\pm 12V$  is unavailable. Available in four distinct packages, the HX232-S series can operate within a temperature range of  $-40^{\circ}C$  to  $+85^{\circ}C$ .



SOP-16

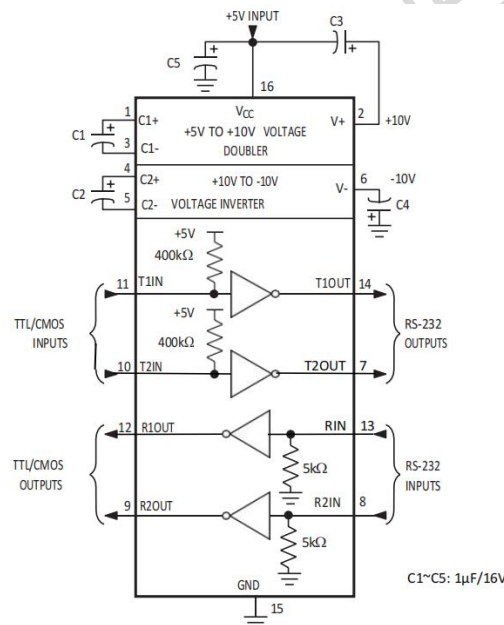
### FEATURES

- Enables operation with a single +5V supply, eliminating the need for a bipolar  $\pm 12V$  supply.
- Saves board space and power with its integrated charge pump circuitry.
- Reduces power requirements, saving energy efficiently.
- Eliminates the need for complex Bipolar  $\pm 12V$  supplies, streamlining the system.
- Integrated circuit design saves valuable space on the circuit board.

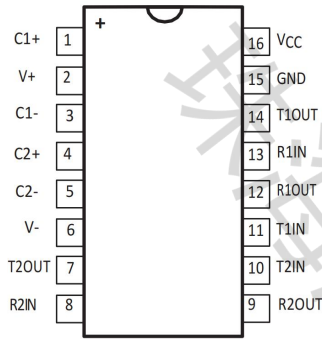
### Applications

- Multidrop RS-232 Network
- Interface Translation
- Portable Diagnostics Equipmen

### TYPICAL OPERATING CIRCUIT



## PIN CONFIGURATIONS AND FUNCTIONS



PIN		TYPE	DESCRIPTION
NAME	NO.		
C1+	1	—	Positive lead of C1 capacitor
VS+	2	O	Positive charge pump output for storage capacitor only
C1-	3	—	Negative lead of C1 capacitor
C2+	4	—	Positive lead of C2 capacitor
C2-	5	—	Negative lead of C2 capacitor
VS-	6	O	Negative charge pump output for storage capacitor only
T2OUT, T1OUT	7, 14	O	RS232 line data output (to remote RS232 system)
R2IN, R1IN	8, 13	I	RS232 line data input (from remote RS232 system)
R2OUT, R1OUT	9, 12	O	Logic data output (to UART)
T2IN, T1IN	10, 11	I	Logic data input (from UART)
GND	15	—	Ground
VCC	16	—	Supply Voltage, Connect to external 5V power supply

## SPECIFICATIONS

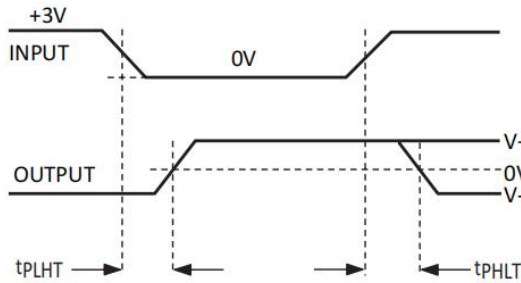
Absolute Maximum Ratings					
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	MAX	UNIT
VCC	Supply voltage range		-0.3	+6	V
V+	(Note 1)		VCC - 0.3	+14	V
V-	(Note 1)		- 14	+0.3	V
VIN	Input voltage				
	TIN		-0.3	VCC+0.3	V
	RIN		-30	+30	V
VOUT	Output voltage				
	TOUT		V- -0.3	V+ +0.3	V
	ROUT		-0.3	VCC + 0.3	V
P	Driver/Receiver Output	Continuous Power Dissipation			
	DIP16	derate 10.53mW/°C above +70°C		820	mW
	SOP16	derate 8.70mW/°C above +70°C		660	mW
	SOP16(W)	derate 9.52mW/°C above +70°C		720	mW
P <sub>DW</sub>	TSSOP16	derate 18.60mW/°C above +70°C		580	mW
T <sub>otr</sub>	Operating Temperature Ranges		-40	+85	°C
T <sub>stg</sub>	Storage temperature range		-45	+125	
TLT	Lead Temperature	soldering, 10s		+300	°C
TST	Soldering Temperature	reflow		+225	°C
T <sub>f</sub>	All other lead(Pb)-free packages			+260	°C
T <sub>c</sub>	All other packages containing lead(Pb)			+240	°C

### Notes

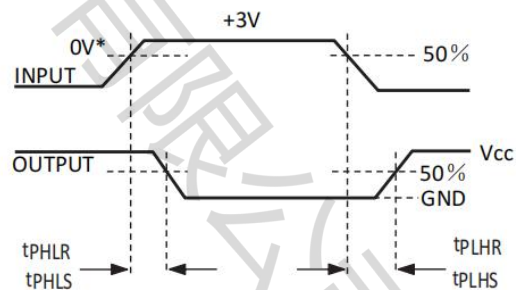
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Electrical Characteristics			
VCC = +5V ±5%, C1-C4 = 1μF/ 16V, TA = free-air temperature range; unless otherwise specified.			
PARAMETER	CONDITIONS	MIN	UNITS
Output Voltage Swing	All transmitter outputs loaded with 3kΩ to ground	±5.0	V
VCC Supply Current	No load, TA = +25°C	8	mA
Logic Pullup Current	VTIN = 0V	1.5	μA
Receiver Input Voltage Operating Range		-30	V
RS-232 Input Hysteresis	VCC = +5V, no hysteresis in shutdown	0.2	V
RS-232 Input Resistance	TA = +25°C, VCC = +5V	3	kΩ
TTL/CMOS Output Voltage Low	IOUT = 1.6mA (IOUT = 3.2mA)	0.4	V
TTL/CMOS Output Voltage High	IOUT = -1 mA	3.5	V
Propagation Delay	RS-232tPHLS	4	μs
	2 INtPLHS	6	
Transition Region Slew Rate	TA = +25°C, VCC = +5V,	4	V/μs
Transmitter Output Resistance	VCC = V+ = V- = 0V, VOUT = ±2V	300	Ω
Transmitter Output Short-Circuit Current		±10	mA

## Test Circuits/Timing Diagrams

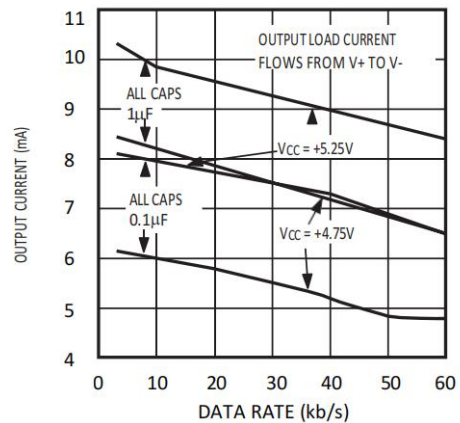
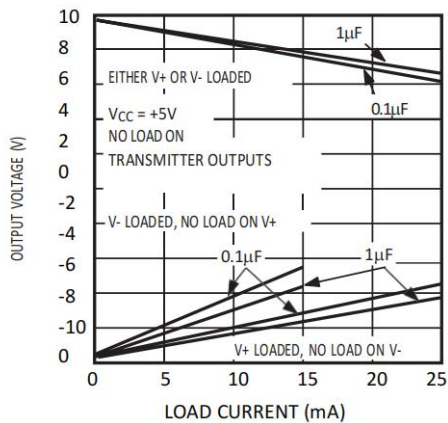


Transmitter Propagation-Delay Timing



Receiver Propagation-Delay Timing

## Typical Operating Characteristics



## Detailed Description

The HX232-S series comprises dual charge-pump DC-DC voltage converters, RS-232 drivers, RS-232 receivers, and enable control inputs for both receiver and transmitter. The organization of these sections allows for a versatile and efficient communication interface solution.

### Dual Charge-Pump Voltage Converter

The HX232-S series incorporates two internal charge-pumps, converting +5V to  $\pm 10V$  (unloaded) for RS-232 driver operation. The first converter utilizes capacitor C1 to double the +5V input, resulting in +10V on C3 at the V+ output. Conversely, the second converter employs capacitor C2 to invert the +10V to -10V on C4, generating the V- output. It is important to note that a small amount of power may be drawn from the +10V (V+) and -10V (V-) outputs to power external circuitry, as detailed in the Typical Operating Characteristics section. However, it's crucial not to overload V+ and V- to a point where it violates the minimum  $\pm 5V$  EIA/TIA-232E driver output voltage requirements when sourcing current from these outputs to external circuitry. It's worth mentioning that V+ and V- are not regulated, meaning the output voltage will decrease as the load current increases.

### RS-232 Drivers

The typical driver output voltage swing of the HX232-S series is  $\pm 8V$  when loaded with a nominal 5k RS-232 receiver and  $VCC = +5V$ . This output swing is guaranteed to meet the EIA/TIA-232E and V.28 specifications, which require a minimum driver output level of  $\pm 5V$  under worst-case conditions, including a minimum load of 3k,  $VCC = +4.5V$ , and maximum operating temperature. Unloaded driver output voltage ranges from (V+ -1.3V) to (V- +0.5V).

Input thresholds of the HX232-S series are compatible with both TTL and CMOS. Unused driver inputs can be left unconnected due to the built-in 400k input pull-up resistors to VCC. These resistors force the outputs of unused drivers low because all drivers invert. Typically, the internal input pull-up resistors source 12 $\mu A$ , except in shutdown mode where the pull-ups are disabled. Driver outputs turn off and enter a high-impedance state with leakage current typically in the microamperes range (maximum 25 $\mu A$ ) when in shutdown mode, three-state mode, or when device power is removed. Outputs can be driven to  $\pm 15V$ .

Power-supply current typically drops to 8 $\mu A$  in shutdown mode. Unused inputs should be connected to GND or VCC. When in low-power shutdown mode, the driver outputs are turned off and their leakage current is less than 1 $\mu A$  with the driver output pulled to ground. The driver output leakage remains less than 1 $\mu A$  even if the transmitter output is backdriven between 0V and (VCC + 6V). Below -0.5V, the transmitter is diode clamped to ground with 1k $\Omega$  series impedance. The transmitter is also zener clamped to approximately VCC + 6V with a series impedance of 1k $\Omega$ .

The driver output slew rate is limited to less than 30V/ $\mu s$  as required by the EIA/TIA-232E and V.28 specifications. Typical slew rates are 24V/ $\mu s$  unloaded and 10V/ $\mu s$  loaded with 3 $\Omega$  and 2500pF. It's worth noting that the HX232-S series of line drivers/receivers currently does not support shutdown mode.

### RS-232 Receivers

RS-232 receivers are designed to comply with the EIA/TIA-232E and V.28 specifications, which define a voltage level greater than 3V as a logic 0. This inversion is applied to all receivers, ensuring compatibility with various input thresholds. TTL level inputs, as well as EIA/TIA-232E and V.28 levels, are effectively recognized by receivers, thanks to thresholds set at 0.8V and 2.4V.

The receiver inputs are designed to withstand input over voltages up to  $\pm 25V$  and include terminating resistors with a nominal value of 5k. These receivers implement Type 1 interpretation of the fault conditions specified by V.28 and EIA/TIA-232E. The input hysteresis of the receiver is typically 0.5V, with a guaranteed minimum of 0.2V. This ensures

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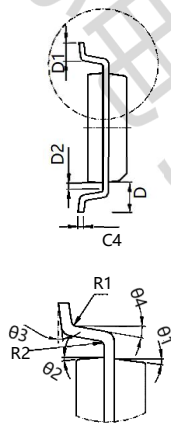
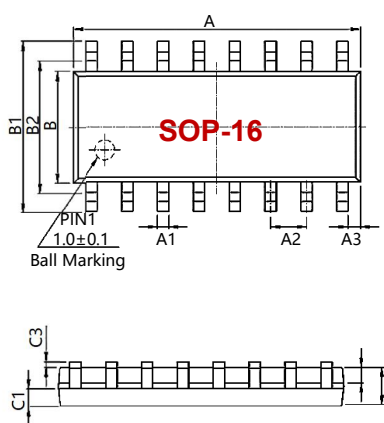
clear output transitions, even with slow-moving input signals and moderate amounts of noise and ringing.

The propagation delay of the receiver is typically 600ns and remains consistent regardless of the direction of the input swing. This consistency ensures reliable performance in a wide range of applications.

### Applications Information

When it comes to power-supply noise sensitive applications, it is recommended to decouple VCC to ground with a capacitor having the same value as C1 and C2. These capacitors should be connected as close as possible to the device to minimize noise interference and ensure stable operation. By following these guidelines, RS-232 receivers can be effectively integrated into a wide range of systems and applications.

### DIMENSIONAL DRAWINGS



Mark	Size	Min(mm)	Max(mm)	Mark	Size	Min(mm)	Max(mm)
A		9.80	10.00	C4		0.203	0.233
Al		0.356	0.456	D		1.05TYP	
A2		1.27TYP		D1		0.40	0.70
A3		0.302TYP		D2		0.15	0.25
B		3.85	3.95	R1		0.20TYP	
B1		5.84	6.24	R2		0.20TYP	
B2		5.00TYP		θ1		8°~ 12° TYP4	
C		1.40	1.60	θ2		8°~ 12° TYP4	
Cl		0.61	0.71	θ3		0°~ 8°	
Cp		0.54	0.64	θ4		4°~12°	
C3		0.05	0.25				

Part Number	Package Type	Package	quantity
HX232-S	SOP-16	Taping	1000