

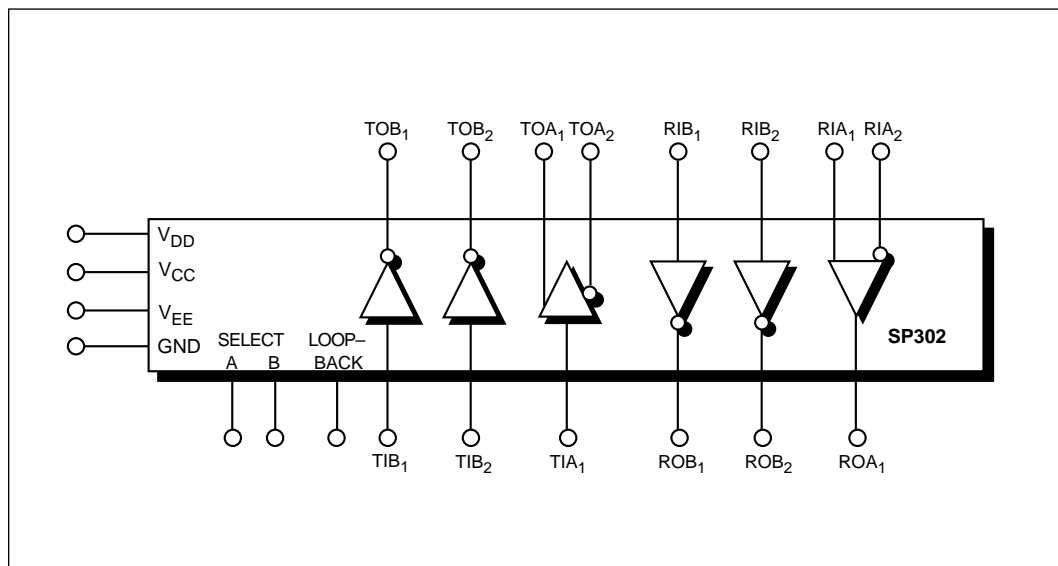
## RS-232/RS-422 Line Drivers/Receivers

- RS-232 and RS-422 on One Chip
- Multiple Drivers and Receivers
- Software-selectable Modes
- Loopback for Self-Testing
- Short-circuit Protected
- 24-pin Single-width DIP or SOIC Package



### DESCRIPTION...

The **SP301** and **SP302** are proprietary single-chip devices that contain both RS-232 and RS-422 protocol line drivers and receivers. Their configuration may be changed at any time by logic levels on two control lines. In any configuration, both the **SP301** and **SP302** fully meet the requirements of the EIA RS-232D and RS-422 data communication standards. A loopback test mode is provided. The **SP301** and **SP302** are available in 24-pin single width plastic, and 28-pin SOIC packages for commercial and industrial temperature range operation.



## SPECIFICATIONS

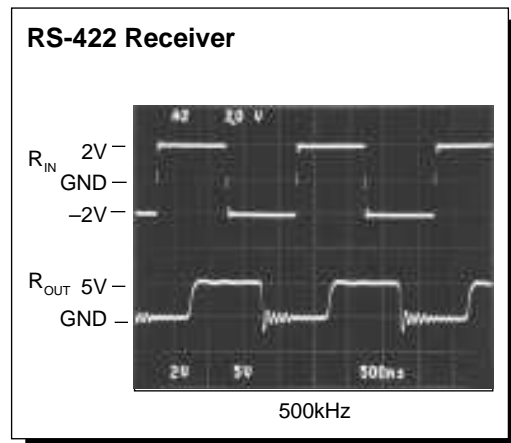
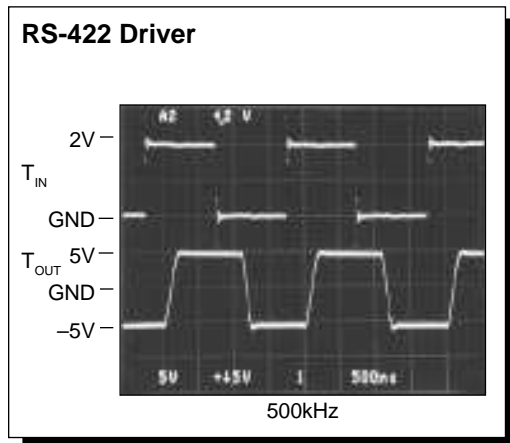
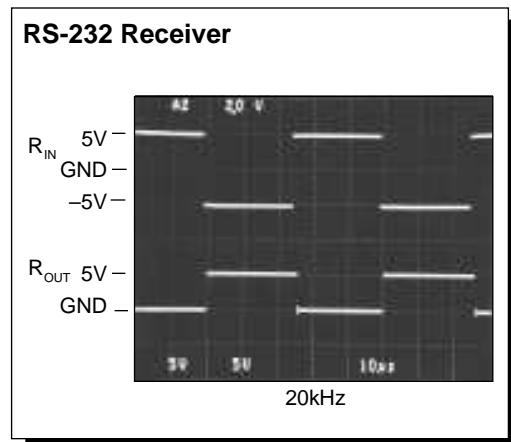
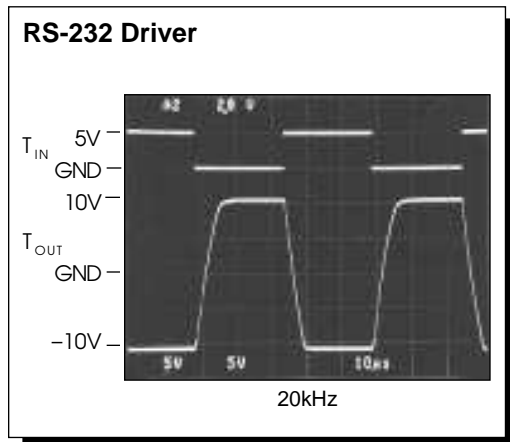
( $T_{MIN} \leq T_A \leq T_{MAX}$  and nominal supply voltages unless otherwise noted)

PARAMETER	MIN.	TYP.	MAX.	UNITS	CONDITIONS
<b>RS-232 DRIVER</b>					
TTL Input Level					
$V_{IL}$	0		0.8	V	
$V_{IH}$	2.0			V	
High Level Output	+5.0			V	$R_L = 3k\Omega, V_{IN} = 0.8V$
Low Level Output			-5.0	V	$R_L = 3k\Omega, V_{IN} = 2.0V$
Short Circuit Current			$\pm 30$	mA	$V_{OUT} = 0V$
Loopback Output Voltage		-1.5		V	$R_L = 3k\Omega, V_{EE} = -12.0V$ ; Note 1
Slew rate			30	V/ $\mu s$	$C_L = 50pF, R_L = 3k\Omega, T_A = 25^\circ C$
Transition Time		3		$\mu s$	$V_{OUT}$ from +3V to -3V or -3V to +3V
Maximum Transmission Rate	200			kbps	
<b>RS-232 RECEIVER</b>					
Input Voltage Range	-15		+15	V	Note 6
Input High Threshold	+1.75		+2.5	V	Positive-going
Input Low Threshold	+0.75		+1.35	V	Negative-going
Input Impedance	3		7	k $\Omega$	$V_{SS} \leq V_{IN} \leq V_{DD}$
TTL Output Level					
$V_{OL}$			0.4	V	$V_{CC} = +4.75V, I_{OUT} = +1.6mA$
$V_{OH}$	2.4			V	$V_{CC} = +4.75V, I_{OUT} = -0.5mA$
Maximum Receiving Rate	200			kbps	
<b>RS-422 DRIVER</b>					
TTL Input Level					
$V_L$	0		0.8	V	
$V_H$	2.0			V	
High Level Output	2.75		6.0	V	$I_{OH} = -20mA$
Low Level Output			1.0	V	$I_{OL} = +20mA$
Differential Output	$\pm 2$			V	$R_L = 100\Omega$
			$\pm 6$	V	$R_L = \infty$
Short Circuit Current			$\pm 100$	mA	Note 2
Output Current			$\pm 500$	$\mu A$	$-0.25V \leq V_o \leq 6V$ ; power off
Transition Time			400	ns	$R_L = 100\Omega, C_L = 15pF$ ; Note 3
Maximum Transmission Rate	1,000			kbps	
<b>RS-422 RECEIVER</b>					
Common Mode Range			$\pm 7$	V	Note 4
Differential Input			$\pm 15$	V	Note 4 and 6
Differential Input Threshold	-0.2		+0.2	V	$T_A = 25^\circ C$
Input Voltage Hysteresis	30			mV	$V_{CM} = 0V, T_A = 25^\circ C$
Input Resistance	3			k $\Omega$	$-7V \leq V_{CM} \leq +7V$
TTL Output Level					
$V_{OL}$			0.4	V	$V_{CC} = +4.75V, I_{OUT} = +1.6mA$
$V_{OH}$	2.4			V	$V_{CC} = +4.75V, I_{OUT} = -0.5mA$
Maximum Receiving Rate	1,000			kbps	
Short Circuit Output Current			$\pm 120$	mA	$V_{OUT} = 0V$
<b>POWER REQUIREMENTS</b>					
$V_{DD} = +12V, \pm 10\%$		7	15	mA	Note 5
$V_{CC} = +5V; \pm 10\%$		5	7	mA	Note 5
$V_{EE} = -12V, \pm 10\%$		11	20	mA	Note 5
<b>ENVIRONMENTAL</b>					
Operating Temperature					
-CS, -CT	0		+70	$^\circ C$	
-MR	-55		+125	$^\circ C$	
Storage Temperature	-65		+150	$^\circ C$	

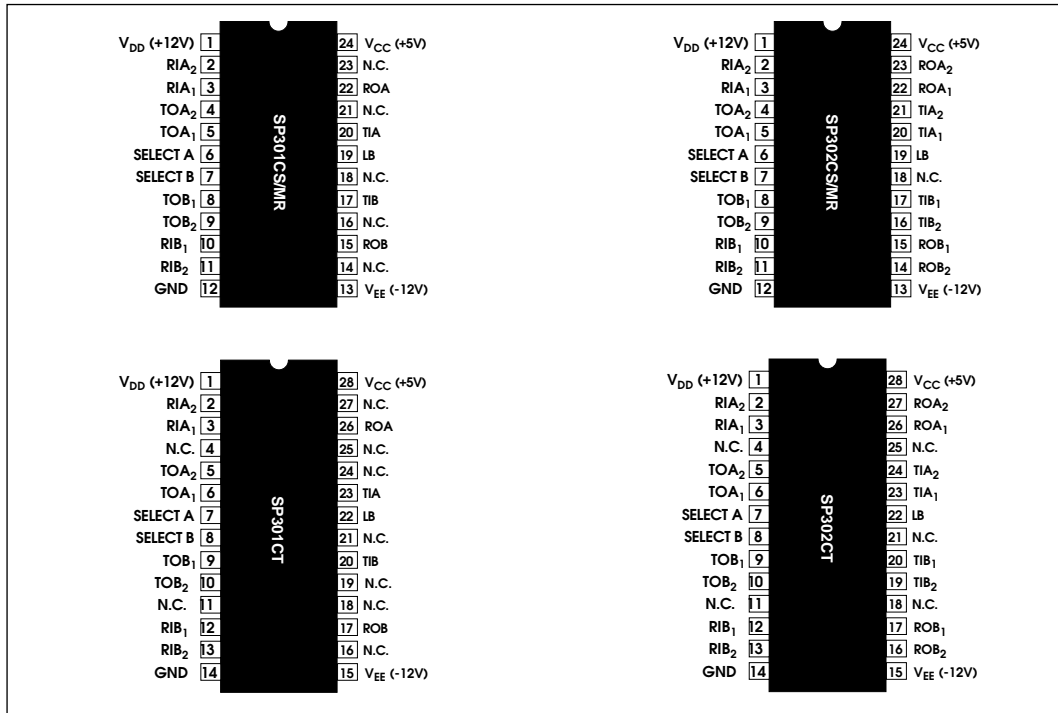
Notes:

1. In Loop-back mode
2. Only one output drive pin per package will be shorted at any time
3. From 10% to 90% of steady-state
4. This is an absolute maximum rating; normal operating levels are  $V_{in} < 5V$
5. Outputs unloaded; Inputs tied to GND;  $T_j = +25^{\circ}C$ ;  $V_e = 0V$ ; LB=0  
Typical SP302 current drains under full load are:  
18mA (+12V), 10mA (-12V) and 7mA (+5V) in RS-232 mode only;  
5mA (+12V), 7mA (-12V) and 56mA (+5V) in RS-422 mode only;  
12mA (+12V), 14mA (-12V) and 31mA (+5V) in RS-232 and RS-422 modes;  
RS-232 loads 3k $\Omega$ , 2500pF, 20kHz; RS-422 outputs across 100 $\Omega$ , 500kHz.
6. In Loopback mode, the external voltage input to the receiver must not exceed  $\pm 10V$ , otherwise the loopback test may be adversely affected.

## TYPICAL PERFORMANCE CURVES



## PIN ASSIGNMENTS



### FEATURES...

The **SP301** and **SP302** are proprietary single-chip devices that contain both RS-232 and RS-422 protocol line drivers and receivers. They differ only in the total number of line drivers and receivers of each protocol that may be active at any given time. Their configuration may be changed at any time by logic levels on two control lines. In any configuration, both the **SP301** and **SP302** fully meet the requirements of the EIA RS-232D and RS-422 data communication standards.

The RS-232 line driver circuits convert TTL logic level inputs into inverted RS-232 output signals. The RS-422 line drivers convert TTL logic levels into RS-422 differential output signals. The RS-422 line driver outputs feature high source and sink current capability. All line drivers are internally protected against short circuits on their outputs.

The RS-232 receivers convert the EIA RS-232 input signals to inverted TTL output logic levels.

The RS-422 receivers convert the EIA RS-422 differential input signals into non-inverted TTL output logic levels. Receiver input filtering provides excellent high frequency noise immunity. Input pulses with widths less than 1 $\mu$ s are completely ignored. The RS-232 receivers have the additional feature of voltage hysteresis, which helps eliminate spurious output transitions that might result from low amplitude noise voltages during slower-speed signal transitions.

A loopback test mode is provided that puts the driver outputs to a high impedance tri-state level, and routes the driver outputs to their associated receiver inputs. In this configuration, the signal path is non-inverting from the TTL driver input to the receiver TTL output. This operating mode allows the controlling system to perform diagnostic self-test of the RS-232/RS-422 driver/receiver circuitry at speeds up to 3,000 bits per second.

The **SP301** and **SP302** are available in 24-pin single-width (0.300") plastic DIP and 28-pin

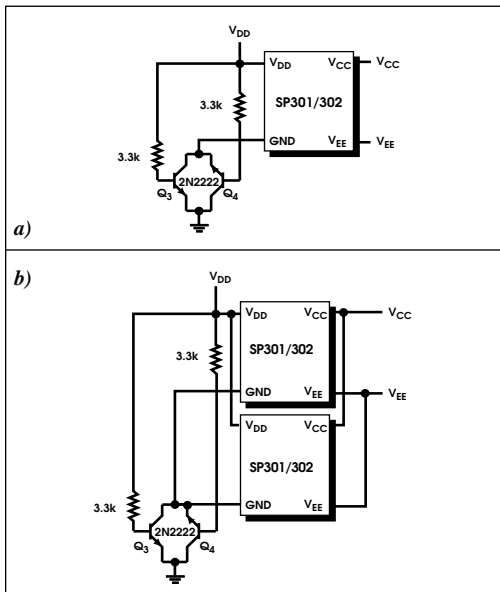


Figure 1. Isolating SP301/302 From Ground; a) Single SP301/302; b) Multiple SP301/302

SOIC packages for operation over the commercial temperature range.

### USING THE SP301/302 POWER SUPPLIES

The SP301/SP302 require  $\pm 12\text{V}$  and  $+5\text{V}$  for full RS-232 and RS-422 operation. The  $\pm 12\text{V}$  supplies set up the RS-232  $\pm 9\text{V}$  voltage swings, and the  $+5\text{V}$  is used for the internal logic that formats the communications mode and controls the loopback function. The supply voltages can be decreased to as low as  $\pm 7\text{V}$  for  $V_{DD}$  and  $V_{EE}$ , and  $4.0\text{V}$  for  $V_{CC}$ . Under these supply conditions, derated performance can be expected.

### POWER SUPPLY SEQUENCING

There are two requirements for power supply sequencing for the SP301/302. The first is that  $V_{DD}$  is always greater than  $V_{CC}$ . The second is that when the part is powered up,  $V_{DD}$  must be applied 20ms before  $V_{CC}$ .

### GENERAL USAGE

#### RS232 Operation

The SP301 and SP302 are fully compliant RS-232 devices. Their outputs are fully protected against shorts to  $\pm 20\text{V}$  with no external

circuitry. If the potential exists for momentary shorts to voltages greater than  $\pm 20\text{V}$ , it is recommended that a  $220\Omega$  resistor be wired in series with each driver output. This will limit any damage from the higher short-circuit current from these higher voltage potentials. Voltage clamps such as back-to-back Zener diodes can be used to clamp the driver outputs to "safe" levels. Short circuit current to ground is internally limited, and can therefore be sustained infinitely. Under normal operating conditions, the drivers can typically source  $7\text{mA}$  at  $\pm 5\text{V}$  output, which exceeds the minimum RS-232 standards requirement.

If an SP301/302 transmitter output occupies a data transmission line with other RS-232 devices which are not powered by the same power supplies, it is possible that a device that is not powered will have a low impedance path to ground at its driver output. The RS-232 standards require that with no power applied to the device, the impedance from a transmitter output to ground must be greater than  $300\Omega$ . This can be easily achieved as shown in Figure 1a, where an external transistor is used as a switch to

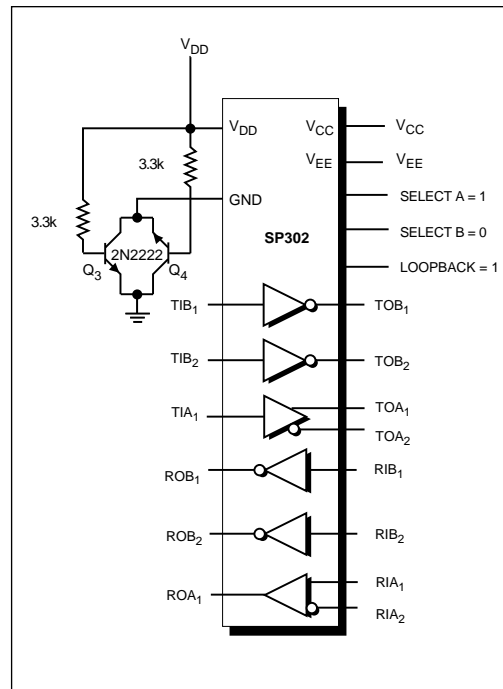


Figure 2. Typical Circuit

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isolate an **SP301/302** from ground in the power-off condition. With  $V_{DD}$  turned on, the transistor switch is on, connecting ground (GND) for the device to the circuit ground. In a power-off condition, this transistor is switched off, thus isolating the unit from circuit ground, and thereby leaving the driver in a high impedance state. Multiple **SP301/302s** can be connected as shown in *Figure 1b*.

### RS-422 OPERATION

The **SP301** and **SP302** are fully compliant RS-422 devices when operating in the RS-422 mode. Baud rate and drive capability have been balanced to provide as much versatility as possible. The **SP301** and **SP302** are both guaranteed for a 1Mbps data rate, supplying  $\pm 2V$  minimum into a  $100\Omega$  load. Short circuit protection for the RS-422 operating mode is the same as in the RS-232 mode. The driver outputs can be shorted to ground for an infinite duration, with a maximum current of  $\pm 100mA$ .

The RS-422 receivers accept differential signals at a 1Mbps rate, and translate them to a non-inverted TTL output. The receivers are specified with a  $\pm 15V$  differential input voltage,

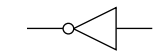
which means that to operate normally, the difference between the voltages at the inputs cannot exceed  $\pm 15V$ . The common mode voltage is specified as  $\pm 7V$ . This identifies the midpoint of the range about which the differential input must lie so that the receiver can detect a change of state. Within this  $\pm 7V$  range, the receivers will recognize a change in state with a  $\pm 200mV$  differential threshold voltage. Since the RS-232 and RS-422 inputs are shared, all receiver inputs are protected to  $\pm 30V$  to guard against inadvertently applying an RS-232 signal to an input that is configured for RS-422. *Figure 2* shows a typical circuit for the **SP301/302**. In this case the **SP302** is shown configured for one (1) duplex RS-422 and two (2) duplex RS-232 communication paths.

### CONFIGURING THE SP301/302

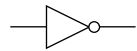
*Figures 3, 5 and 6* show the various combinations of simultaneous RS-232 and RS-422 operation that can be achieved with the **SP301**. Similarly, *Figures 4, 7 and 8* show the various combinations for the **SP302**. Each of these configurations are software selectable by logic level on the SELECT A and SELECT B control lines. Configuration can be changed “on-the-fly”.

**FIGURE 3: SP301 CONTROL LOGIC CONFIGURATION**

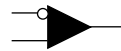
SELECTION	LOGIC VALUE	LOGIC VALUE	LOGIC VALUE	LOGIC VALUE
SELECT A: SELECT B:	0 0	0 1	1 0	1 1
NON- LOOPBACK (LB = 1)				
	LOOPBACK (LB=0)			



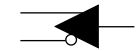
RS-232 DRIVER  
\* Tri-state Output



RS-232 RECEIVER



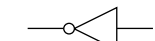
RS-422 RECEIVER



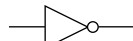
RS-422 DRIVER

**FIGURE 4: SP302 CONTROL LOGIC CONFIGURATION**

SELECTION	LOGIC VALUE	LOGIC VALUE	LOGIC VALUE	LOGIC VALUE	
SELECT A: SELECT B:	0 0	0 1	1 0	1 1	
NON- LOOPBACK (LB = 1)	       	       	       	       	
	LOOPBACK (LB=0)	       	       	       	       



RS-232 DRIVER  
\* Tri-state Output



RS-232 RECEIVER



RS-422 RECEIVER



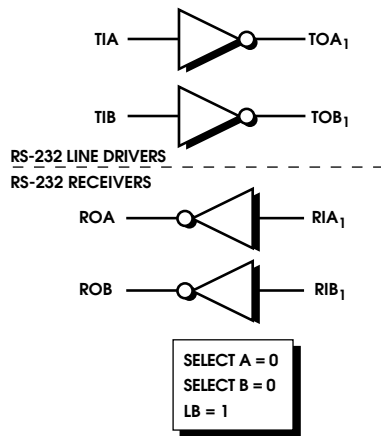
RS-422 DRIVER



**FIGURE 5: SP301 CONFIGURATIONS**

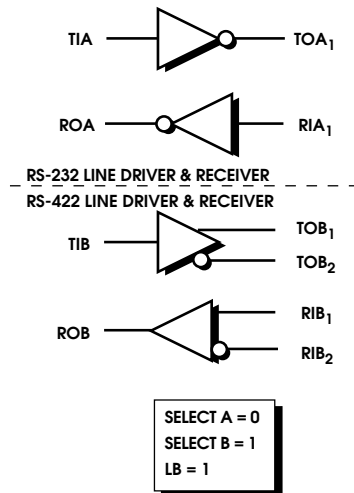
**Two-Channel Full Duplex RS-232**

Two independent channels of RS-232 line driver and two channels of RS-232 receiver.



**One-Channel Full Duplex RS-232 & One-Channel Full Duplex RS-422**

A single RS-232 line driver and receiver, and a single RS-422 line driver and receiver.



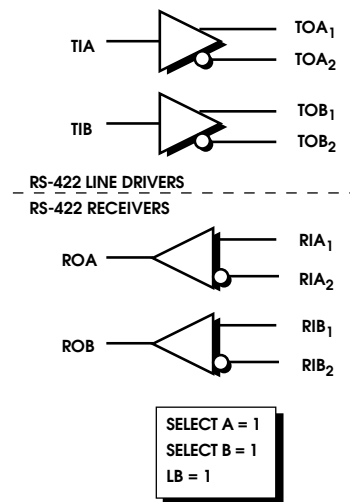
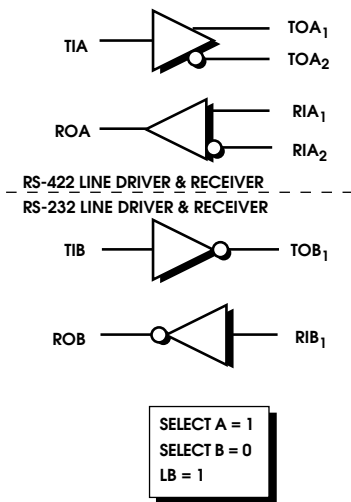
**FIGURE 6: SP301 CONFIGURATIONS**

**One-Channel Full Duplex RS-232 & One-Channel Full Duplex RS-422 Opposite Drivers**

A single RS-232 line driver and receiver, and a single RS-422 line driver and receiver. At first glance, this is the same configuration as that in *Figure 5*. Note however that functions are activated on the opposite channels as that of those in *Figure 1b*.

**Two-Channel Full Duplex RS-422**

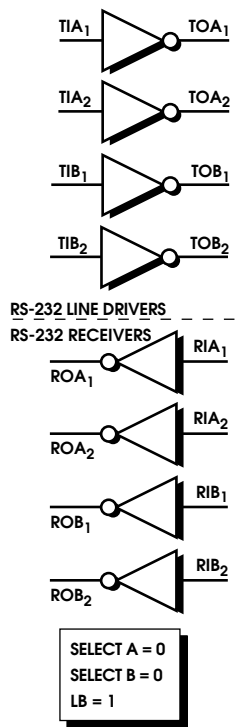
Two RS-422 line drivers and two RS-422 receivers.



**FIGURE 7: SP302 CONFIGURATIONS**

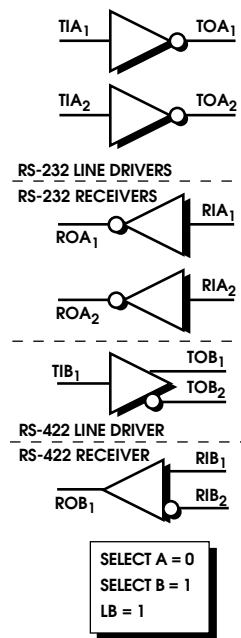
**Four-Channel Duplex RS-232**

Four independent channels of RS-232 line driver and four channels of RS-232 receiver.



**Two-Channel Duplex RS-232 & One-Channel Duplex RS-422**

Two RS-232 line drivers and receivers, and a single RS-422 line driver and receiver.



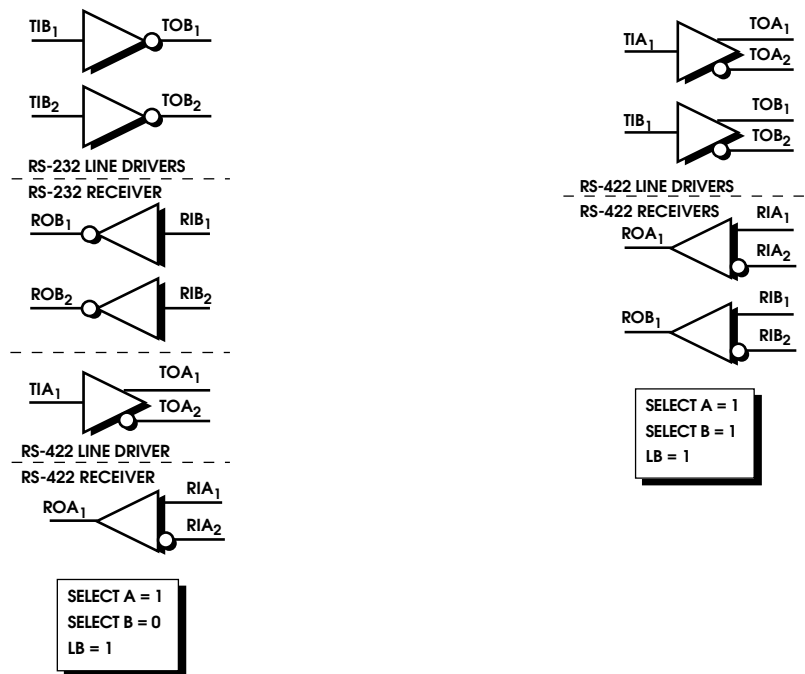
**FIGURE 8: SP302 CONFIGURATIONS**

**Two-Channel Duplex RS-232 & One-Channel Duplex RS-422 Opposite Drivers**

Two RS-232 line drivers and receivers, and a single RS-422 line driver and receiver. At first glance, this is the same configuration in *Figure 7*. Note however that functions are activated on the opposite channels.

**Two-Channel Duplex RS-422**

Two RS-422 line drivers and two RS-422 receivers.



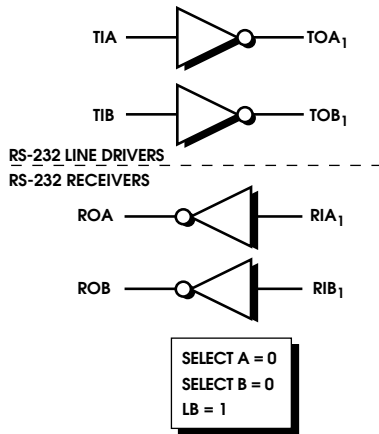
## LOOPBACK

Both the **SP301** and **SP302** have a function called loopback, which is essentially a chip self-test. However, by connecting system test loops with the inputs and outputs of the **SP301/302**, a system-level diagnostic can be run on power-up or on command. The

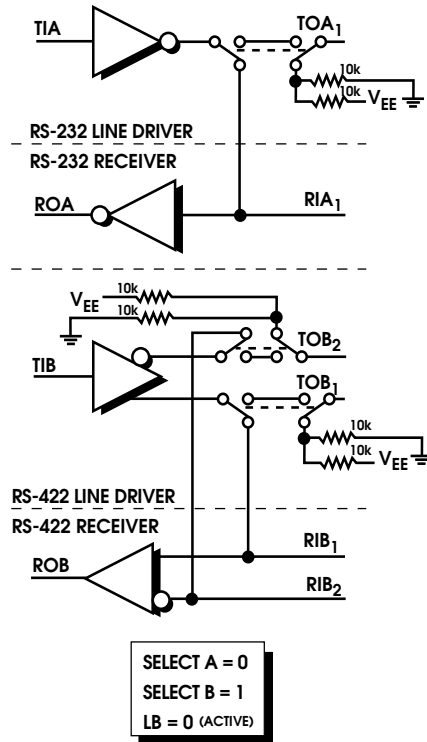
test loops can be enabled and disabled allowing both system test and operation with the same components. A maximum data rate for loopback of 3kbps is recommended. Loopback is a pin-programmable function, activated by a logic low on the **LB** pin (19). As

## SP301 CONFIGURATIONS IN LOOPBACK MODE

### Two -Channel Full Duplex RS-232



### One-Channel Full Duplex RS-232 & One-Channel Full Duplex RS-422

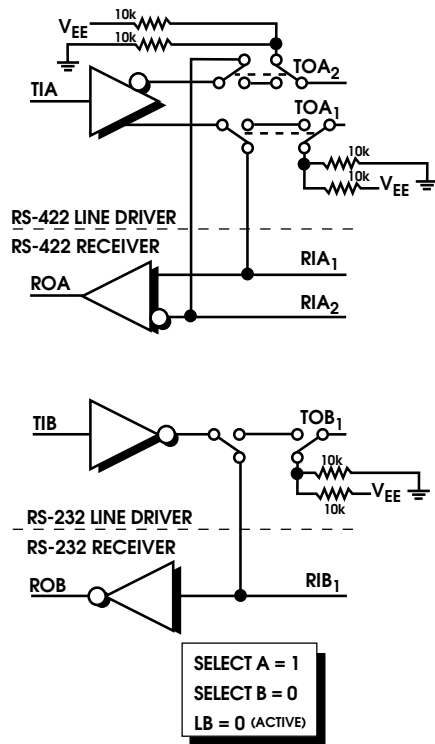


shown in these figures, the loopback function internally connects the driver outputs to the corresponding receiver inputs, and switches the output pin to a resistive divider of 10kΩ nominal impedance from  $V_{EE}$  to ground. Receiver outputs are left active for signal verification. During loopback, the receiver inputs are tied to

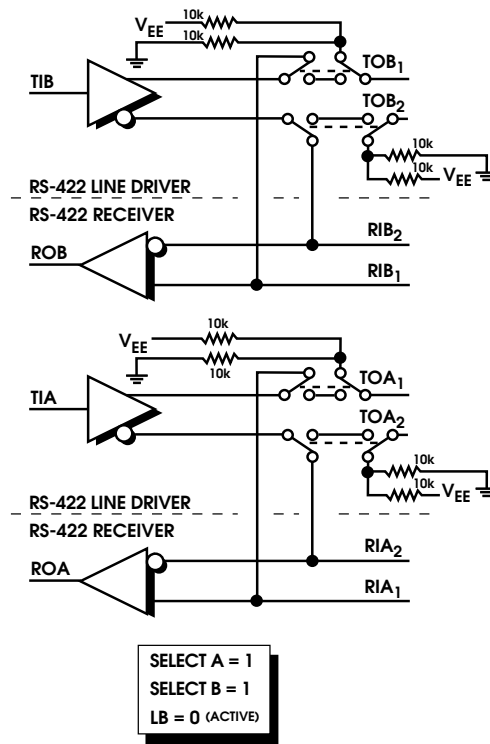
ground via a 5kΩ pulldown resistor. To minimize loopback errors, the receiver inputs must be limited to  $\pm 10V$  swings.

### SP301 CONFIGURATIONS IN LOOPBACK MODE

#### One-Channel Full Duplex RS-232 & One-Channel Full Duplex RS-422 Opposite Drivers

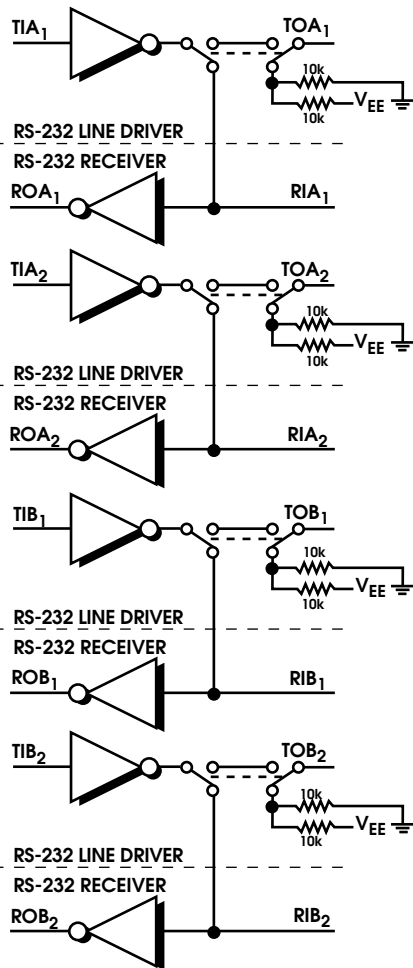


#### Two-Channel Full Duplex RS-422



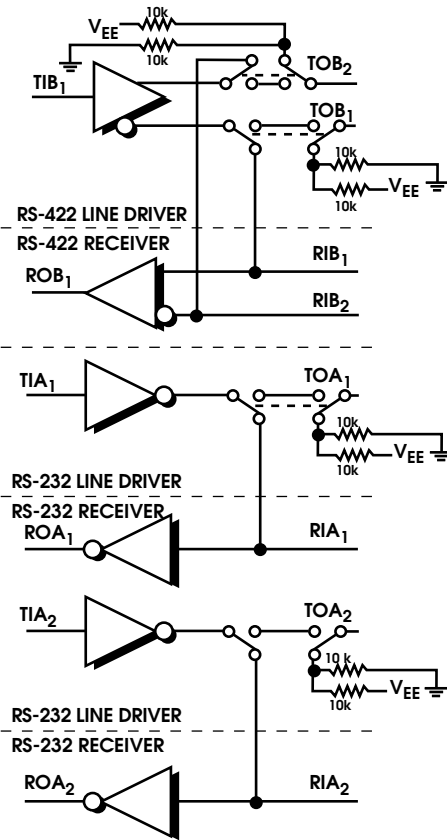
## SP302 CONFIGURATIONS IN LOOPBACK MODE

### Four-Channel Duplex RS-232



SELECT A = 0  
 SELECT B = 0  
 LB = 0 (ACTIVE)

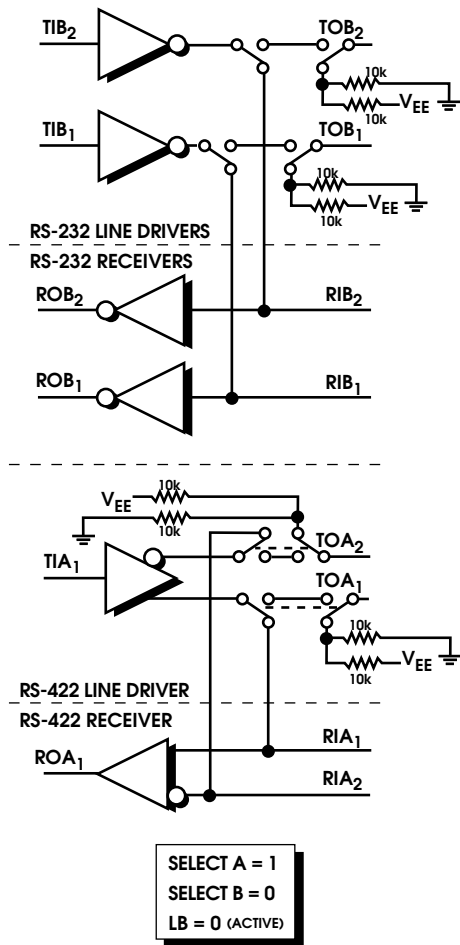
### Two-Channel Duplex RS-232 & One-Channel Duplex RS-422



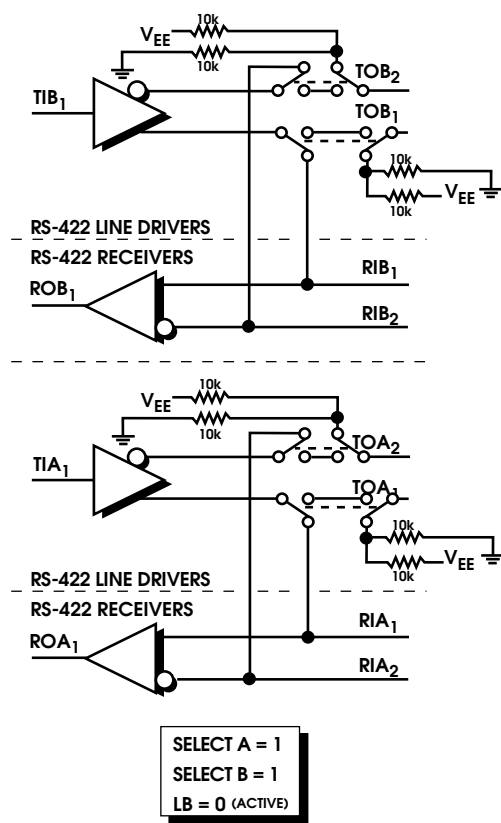
SELECT A = 0  
 SELECT B = 1  
 LB = 0 (ACTIVE)

SP302 CONFIGURATIONS IN LOOPBACK MODE

Two-Channel Duplex RS-232 & One-Channel Duplex RS-422 Opposite Drivers



Two-Channel Duplex RS-422





## ORDERING INFORMATION

Model	Max # of Duplex Channels		Temperature	Package
	RS232	RS422		
SP301CS	2	2	0°C to +70°C	24-pin single-width plastic DIP
SP301CT	2	2	0°C to +70°C	28-pin SOIC
SP301ES	2	2	-40°C to +85°C	24-pin single-width plastic DIP
SP301ET	2	2	-40°C to +85°C	28-pin SOIC
SP302CS	4	2	0°C to +70°C	24-pin single-width plastic DIP
SP302CT	4	2	0°C to +70°C	28-pin SOIC
SP302ES	4	2	-40°C to +85°C	24-pin single-width plastic DIP
SP302ET	4	2	-40°C to +85°C	28-pin SOIC

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