

# SP301 - SP302

## RS232/RS422 Line Drivers/Receivers

### FEATURES

- RS232 and RS422 on One Chip
- Multiple Drivers and Receivers
- Software-selectable Modes
- Loopback for Self-Testing
- Short-circuit Protected
- $\pm 15V$  Receiver Input Levels
- Single-width 24-pin DIP Package

### APPLICATIONS

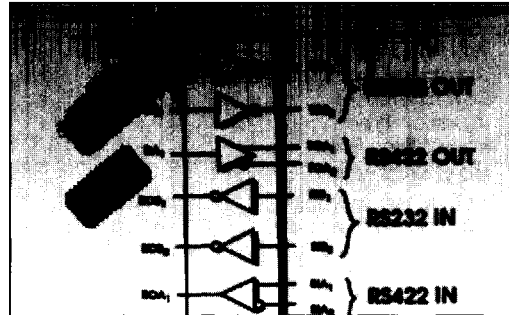
- Data Comm Ports
- Local Area Networks
- DTE-DCE Interface
- Packet Switching
- Data Concentrators
- Data Multiplexers

### DESCRIPTION

The **SP301** and **SP302** are proprietary single-chip devices that contain both RS232 and RS422 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 RS232D and RS422 data communication standards.

The RS232 line driver circuits convert TTL logic level inputs into inverted RS232 output signals. The RS422 line drivers convert TTL logic levels into RS422 differential output signals. The RS422 line driver outputs feature high source and sink current capability. All line drivers are internally protected against short circuits on their outputs.

The RS232 receivers convert the EIA RS232 input signals to inverted TTL output logic levels. The RS422 receivers convert the EIA RS422 differential input signals into non-inverted TTL output logic levels. Receiver input filtering provides excellent high



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frequency noise immunity. Input pulses with widths less than  $1\mu s$  are completely ignored. The RS232 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 RS232/RS422 driver/receiver circuitry at speeds up to 3,000 baud.

The **SP301** and **SP302** are available in 24-pin single width (0.300") DIP packages in plastic ( $0^{\circ}C$  to  $+70^{\circ}C$ ) and ceramic ( $-55^{\circ}C$  to  $+125^{\circ}C$ ). Both are also available in 28-pin surface-mount (SOIC) packages in both plastic DIP and ceramic LCC. Please consult the factory for product screened to MIL-STD-883.

# SPECIFICATIONS

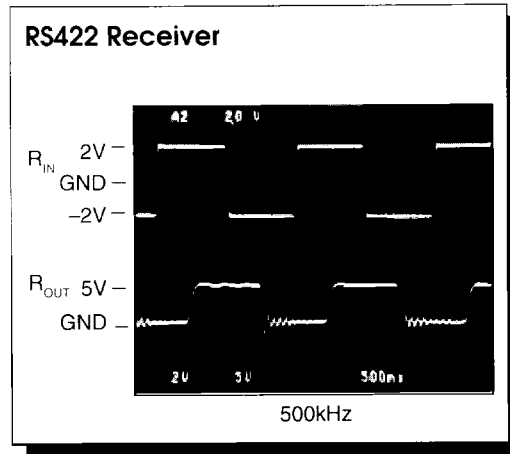
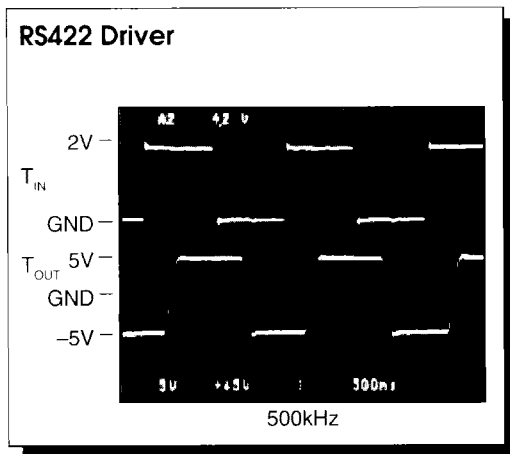
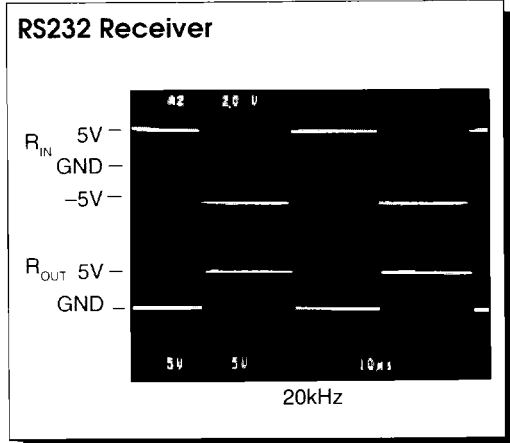
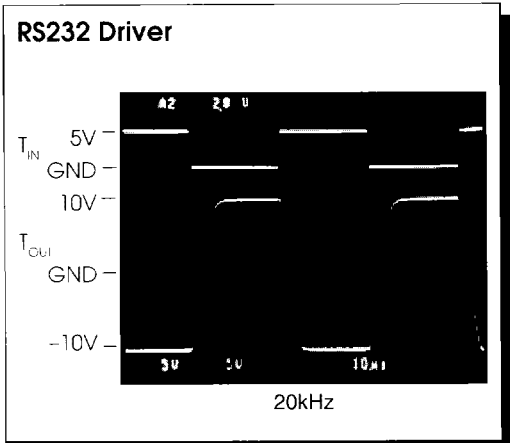
( $T_{MIN} \leq T_A \leq T_{MAX}$  and nominal supply voltages unless otherwise noted)

MODEL	SPS301/SP302			UNITS	CONDITIONS
	MIN	TYP	MAX		
<b>RS232 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
Transmission Rate			200	kbits	
<b>RS232 RECEIVER</b>					
Input Voltage Range	-15		+15	V	Positive-going
Input High Threshold	+1.75		+2.5	V	Negative-going
Input Low Threshold	+0.75		+1.35	V	
Input Impedance	3		7	k $\Omega$	
TTL Output Level					
$V_{OL}$			0.4	V	$V_{CC} = +4.75V, I_{OUT} = +1.6mA$
$V_{OH}$	2.4			V	$V_{CC} = +4.75V, I_{OUT} = -0.5mA$
Receiving Rate			200	kbits	
<b>RS422 DRIVER</b>					
TTL Input Level					
$V_{IL}$	0		0.8	V	
$V_{IH}$	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			$\pm 500$	$\mu A$	$-0.25V < V_O < 6V$ ; power off
Transition Time			400	ns	$R_L = 100\Omega, C_L = 15pF$ ; Note 3
Transmission Rate			1,000	Kbits	
<b>RS422 RECEIVER</b>					
Common Mode Range			$\pm 7$	V	Note 4
Differential Input			$\pm 15$	V	Note 4
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 $\Omega$	$-7V < V_{CM} < +7V$
TTL Output Level					
$V_{OL}$			0.4	V	$V_{CC} = +4.75V, I_{OUT} = +1.6mA$
$V_{OH}$	2.4			V	$V_{CC} = +4.75V, I_{OUT} = -0.5mA$
Receiving Rate			1,000	Kbits	
Short Circuit Output Current			$\pm 120$	mA	$V_{OUT} = 0V$
<b>POWER REQUIREMENTS</b>					
$V_{DD} = +12V$		7	15	mA	Note 5
$V_{CC} = +5V$		5	7	mA	Note 5
$V_{EE} = -12V$		11	20	mA	Note 5
<b>ENVIRONMENTAL</b>					
Operating Temperature					
-CS	0		+70	$^\circ C$	
-MR, -MR/883	-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  $V_{OL} < 5V$
  5. Outputs unloaded: Inputs tied to GND;  $T_c = +25^\circ C$ ;  $V_{in} = 0V$ ;  $LB=0$
- Typical SP302 current drains under full load are:  
 18mA (+12V), 10mA (-12V) and 7mA (+5V) in RS232 mode only;  
 5mA (+12V), 7mA (-12V) and 56mA (+5V) in RS422 mode only;  
 12mA (+12V), 14mA (-12V) and 31mA (+5V) in RS232 and RS422 modes;  
 RS232 loads 3K $\Omega$ , 2500pF, 20kHz; RS422 outputs across 100 $\Omega$ , 500kHz

**TYPICAL PERFORMANCE CURVES**

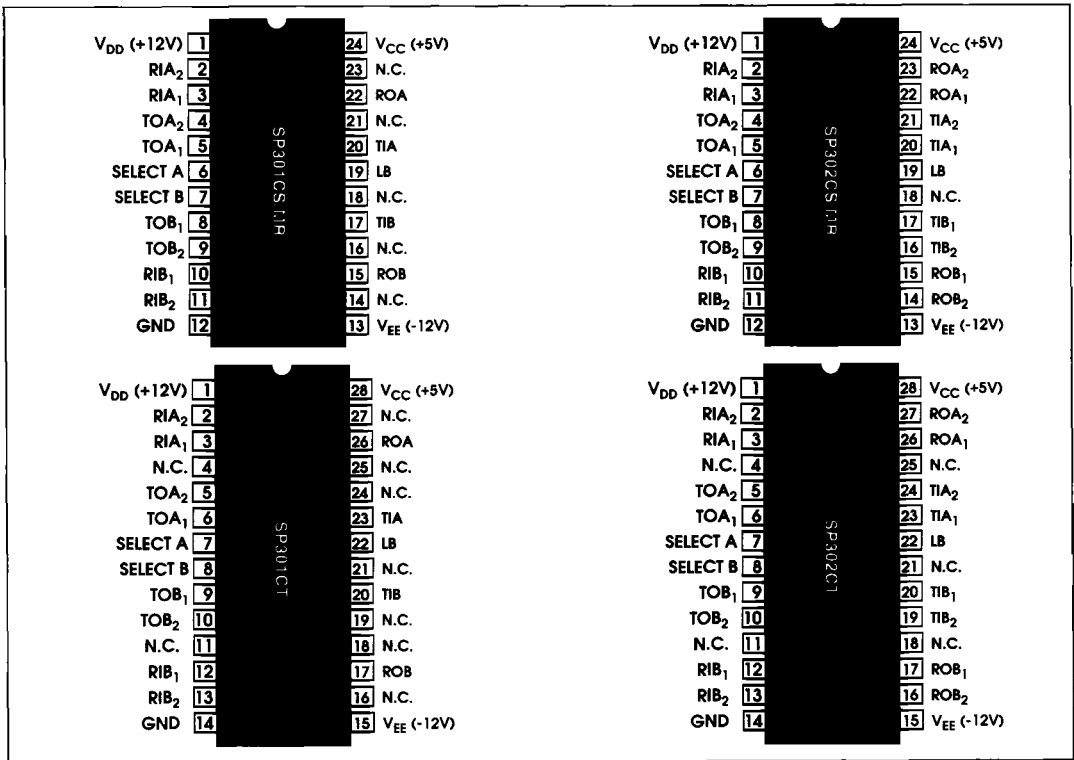


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**Ordering Information**

Model	Max # of Duplex Channels		Temperature	Package
	RS232	RS422		
SP301CS	2	2	0°C to +70°C	24-pin plastic DIP
SP301CT	2	2	0°C to +70°C	28-pin SOIC
SP301ES	2	2	-40°C to +85°C	24-pin plastic DIP
SP301ET	2	2	-40°C to +85°C	28-pin SOIC
SP301MR	2	2	-55°C to +125°C	24-pin ceramic DIP
SP302CS	4	2	0°C to +70°C	24-pin plastic DIP
SP302CT	4	2	0°C to +70°C	28-pin SOIC
SP302ES	4	2	-40°C to +85°C	24-pin plastic DIP
SP302ET	4	2	-40°C to +85°C	28-pin SOIC
SP302MR	4	2	-55°C to +125°C	24-pin ceramic DIP

## PIN ASSIGNMENTS



## POWER SUPPLIES

The SP301/SP302 require  $\pm 12V$  and  $+5V$  for full RS232 and RS422 operation. The  $\pm 12V$  supplies set up the RS232  $\pm 9V$  voltage swings, and the  $+5V$  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  $\pm 7V$  for  $V_{DD}$  and  $V_{EE}$ , and  $4.0V$  for  $V_{CC}$ . Under these supply conditions, derated performance can be expected.

## GENERAL USAGE

### RS232 Operation

The SP301 and SP302 are fully compliant RS232 devices. Their outputs are fully protected against shorts to  $\pm 20V$  with no external circuitry. If the potential exists for momentary shorts to voltages greater than  $\pm 20V$ , 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

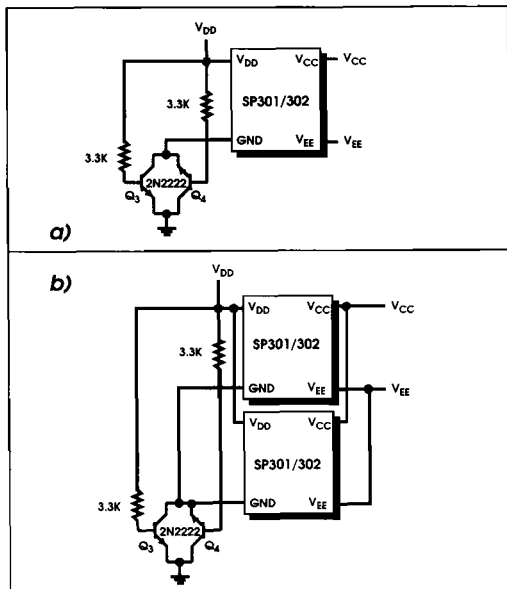


Figure 1. Isolating SP301/302 From Ground; a) Single SP301/302; b) Multiple SP301/302

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 indefinitely. Under normal operating conditions, the drivers can typically source 7mA at  $\pm 5V$  output, which exceeds the minimum RS232 standards requirement. If an **SP301/302** transmitter output occupies a data transmission line with other RS232 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 RS232 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 7a*, where an external transistor is used as a switch to 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 7b* below.

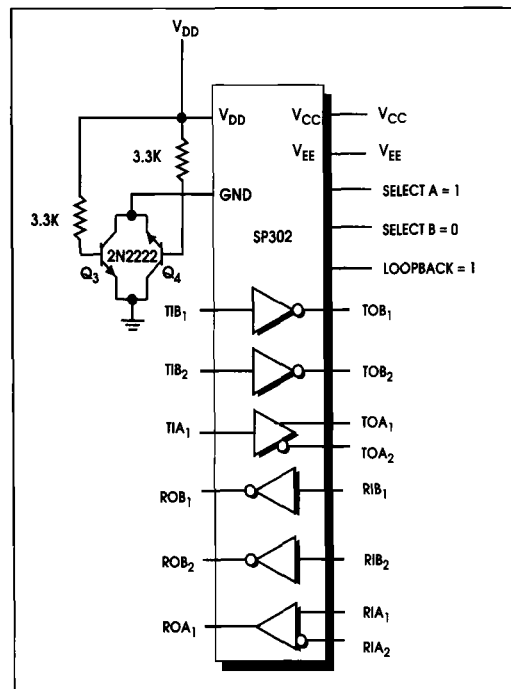
### RS422 Operation

The **SP301** and **SP302** are fully compliant RS422 devices when operating in the RS422 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 RS422 operating mode is the same as in the RS232 mode. The driver outputs can be shorted to ground for an infinite duration, with a maximum current of  $\pm 100mA$ .

The RS422 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 RS232 and RS422 inputs are shared, all receiver inputs are protected to  $\pm 30V$  to guard against inadvertently applying an RS232 signal to an input that is configured for RS422.

*Figure 2* shows a typical circuit for the **SP301/302**. In this case the **SP302** is shown configured for one (1) duplex RS422 and two (2) duplex RS232 communication paths.



**Figure 2. Typical Circuit**

# 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)				

**RS232 DRIVER**  
 \* Tri-state Output

**RS232 RECEIVER**

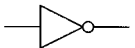
**RS422 RECEIVER**

**RS422 DRIVER**

# 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)				

  
RS232 DRIVER  
\* Tri-state Output

  
RS232 RECEIVER

  
RS422 RECEIVER

  
RS422 DRIVER

## CONFIGURING THE SP301/302

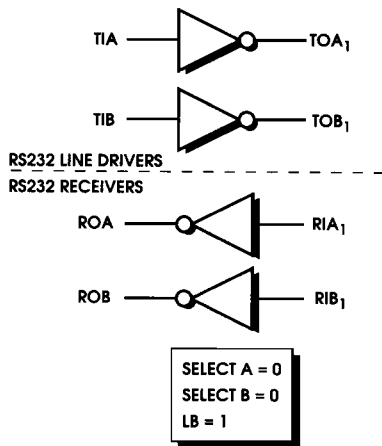
The Figures on the following pages show the various combinations of simultaneous RS232 and RS422 operation that can be achieved with the **SP301**. Similarly, the

various combinations for the **SP302** are also shown. 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".

## SP301 CONFIGURATIONS

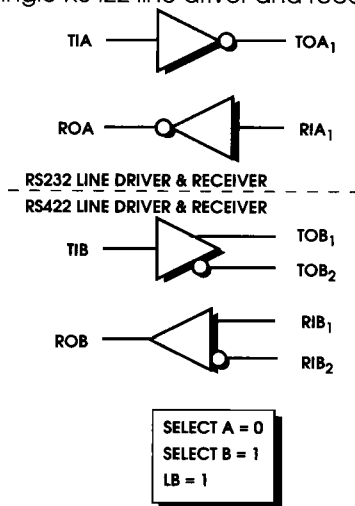
### Two-Channel Full Duplex RS232

Two independent channels of RS232 line driver and two channels of RS232 receiver.



### One-Channel Full Duplex RS232 & One-Channel Full Duplex RS422

A single RS232 line driver and receiver, and a single RS422 line driver and receiver.

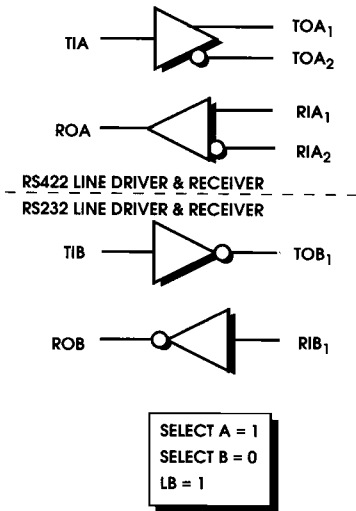




## SP301 CONFIGURATIONS

### One-Channel Full Duplex RS232 & One-Channel Full Duplex RS422 Opposite Drivers

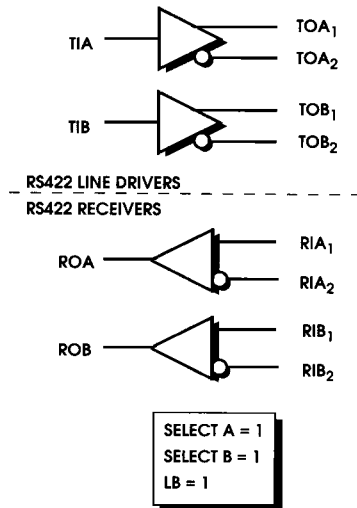
A single RS232 line driver and receiver, and a single RS422 line driver and receiver. At first glance, this is the same configuration as that in the figure immediately to the left. Note however that functions are activated on the opposite channels



### Two-Channel Full Duplex RS422

Two RS422 line drivers and two RS422 receivers.

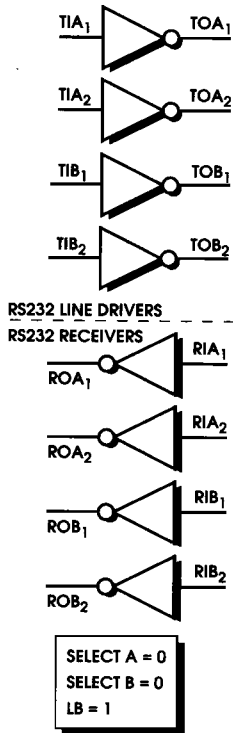
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## SP302 CONFIGURATIONS

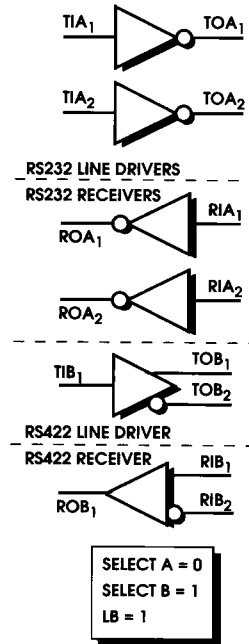
### Four-Channel Duplex RS232

Four independent channels of RS232 line driver and four channels of RS232 receiver.



### Two-Channel Duplex RS232 & One-Channel Duplex RS422

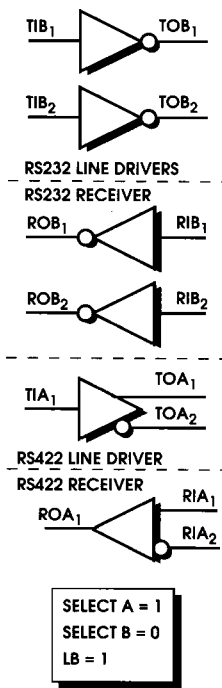
Two RS232 line drivers and receivers, and a single RS422 line driver and receiver.



## SP302 CONFIGURATIONS

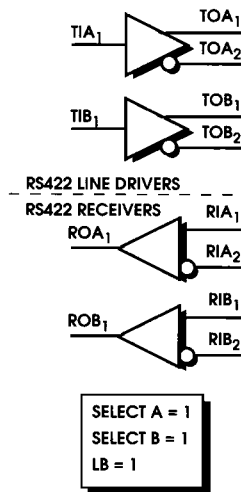
### Two-Channel Duplex RS232 & One-Channel Duplex RS422 Opposite Drivers

Two RS232 line drivers and receivers, and a single RS422 line driver and receiver. At first glance, this is the same configuration as that on Page 10, right hand column. Note however that the functions are activated on the opposite channels.



### Two-Channel Duplex RS422

Two RS422 line drivers and two RS422 receivers.



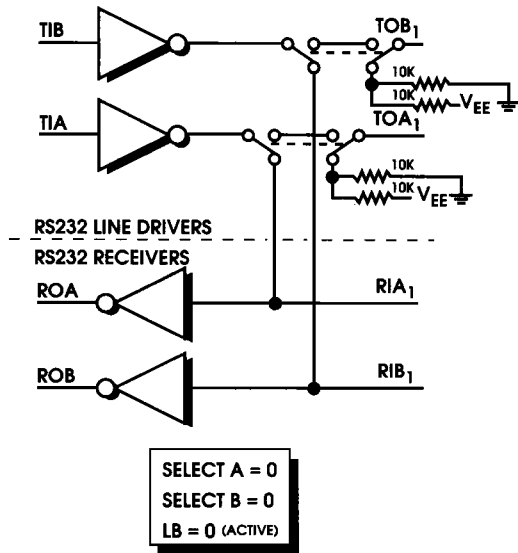
## Loopback

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

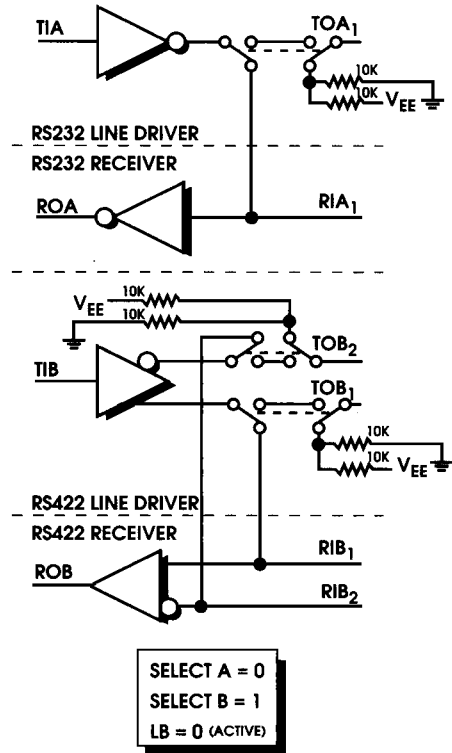
be enabled and disabled allowing both system test and operation with the same components. A maximum data rate for loopback of 3Kbps is recommended. Loopback is a pin-programmable function, activated by a logic low on the **LB** pin (19). As shown in these figures, the loopback function

## SP301 CONFIGURATIONS IN LOOPBACK MODE

### Two-Channel Full Duplex RS232



### One-Channel Full Duplex RS232 & One-Channel Full Duplex RS422

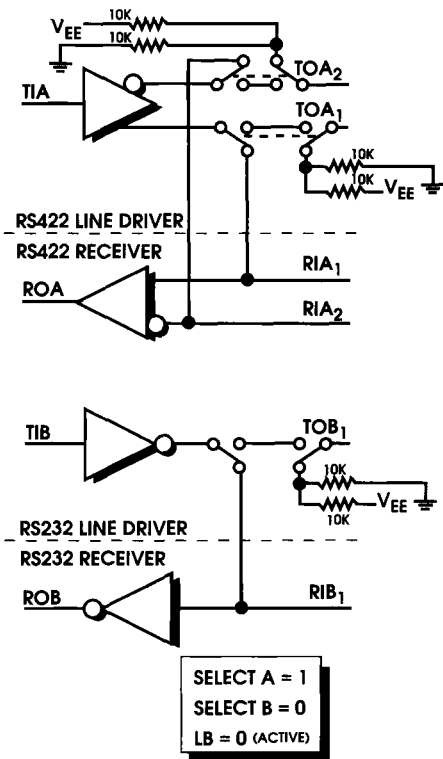


internally connects the driver outputs to the corresponding receiver inputs, and switches the output pin to a resistive divider of  $10k\Omega$  nominal impedance from  $V_{EE}$  to ground. Receiver outputs are left active for signal verification.

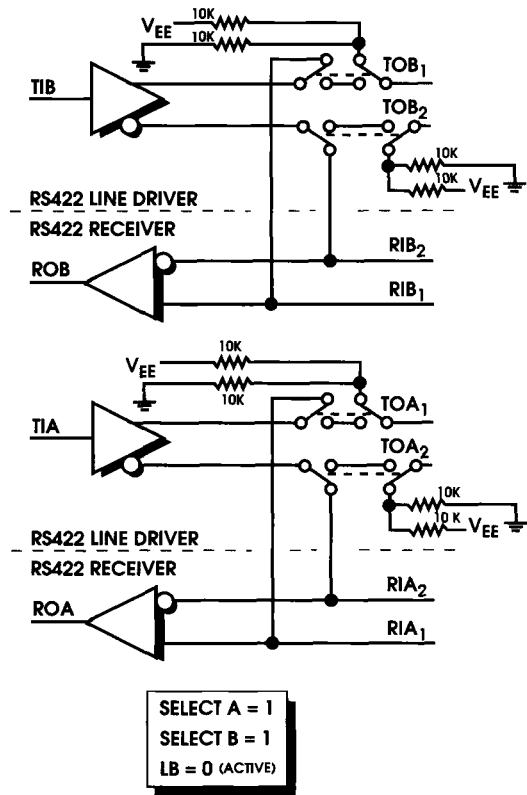
During loopback, the receiver inputs are tied to ground via a  $5k\Omega$  pull-down resistor. To minimize loopback errors, the receiver inputs must be limited to  $\pm 10V$  swings.

### SP301 CONFIGURATIONS IN LOOPBACK MODE

#### One-Channel Full Duplex RS232 & One-Channel Full Duplex RS422 Opposite Drivers



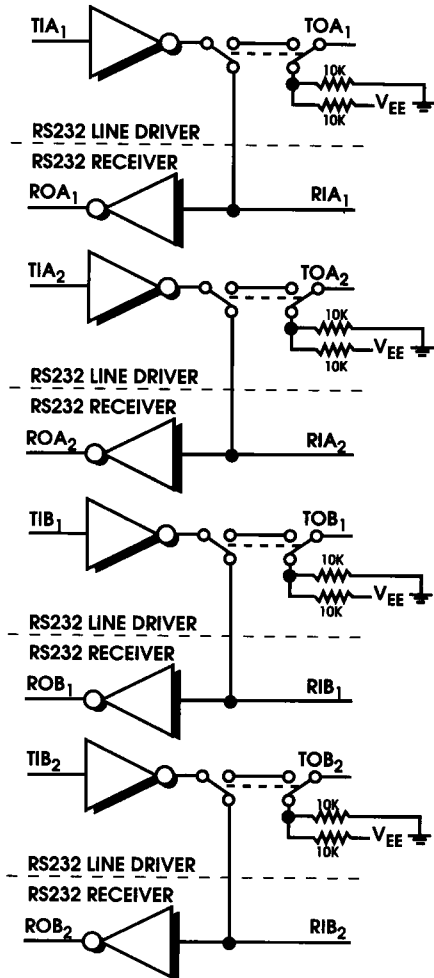
#### Two-Channel Full Duplex RS422



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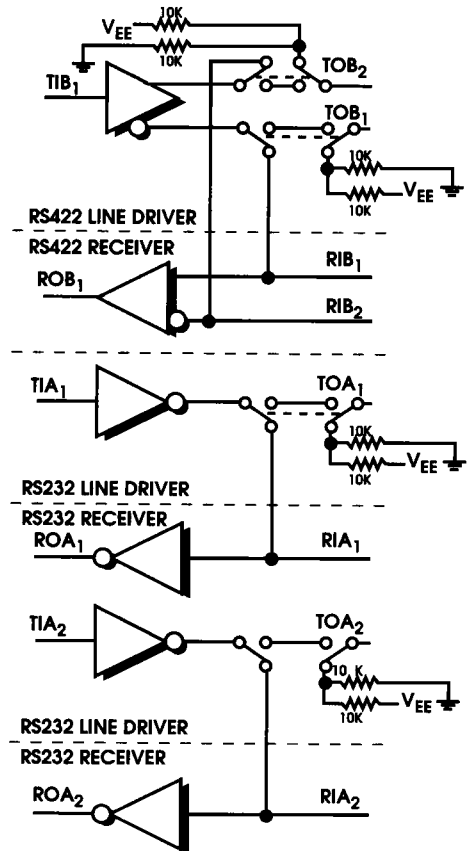
## SP302 CONFIGURATIONS IN LOOPBACK MODE

### Four-Channel Duplex RS232



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

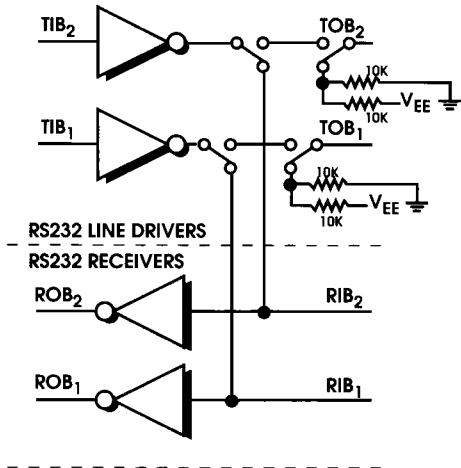
### Two-Channel Duplex RS232 & One-Channel Duplex RS422



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

## SP302 CONFIGURATIONS IN LOOPBACK MODE

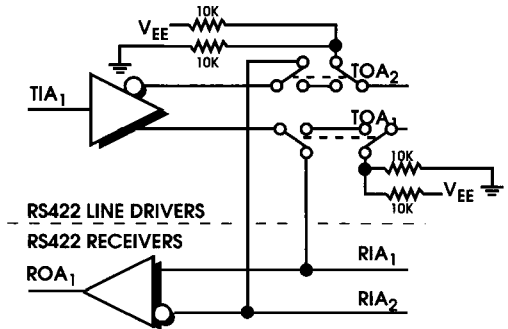
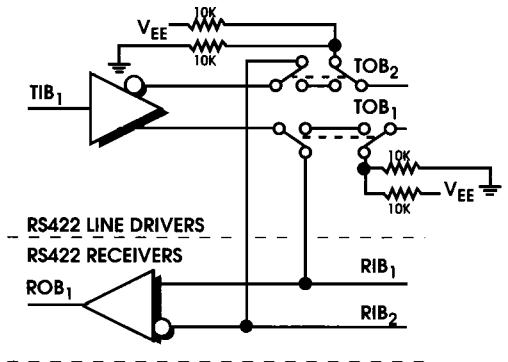
### Two-Channel Duplex RS232 & One-Channel Duplex RS422 Opposite Drivers



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

### Two-Channel Duplex RS422

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

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