

GENERAL DESCRIPTION

The SP330 is an advanced multiprotocol transceiver supporting RS-232, RS-485, and RS-422 serial standards and featuring a variable low voltage logic interface, down to 1.65V. Full operation requires only four external charge pump capacitors.

The RS-485/RS-232 mode pin selects RS-485 mode when high, and RS-232 mode when low. In RS-485 mode the HALF/FULL pin configures the transceiver as either half or full duplex.

The high speed drivers operate up to 20Mbps in RS-485/422 modes, and up to 1Mbps in RS-232 mode. All drivers can be slew limited to 250kbps in any mode to minimize electromagnetic interference (EMI) by setting the dedicated SLEW pin low.

All transmitter outputs and receiver inputs feature robust electrostatic discharge (ESD) protection to $\pm 15\text{kV}$ IEC 61000-4-2 Airgap, $\pm 15\text{kV}$ Human Body Model (HBM) and $\pm 8\text{kV}$ IEC 61000-4-2 Contact. Each receiver output has full fail-safe protection to avoid system lockup, oscillation, or indeterminate states by defaulting to logic-high output level when the inputs are open, shorted, or terminated but undriven. No external biasing resistors are required.

The RS-232 receiver inputs include a $5\text{k}\Omega$ pull-down to ground when in RS-232 mode. The RS-485/422 receiver inputs are high impedance ($>96\text{k}\Omega$), allowing up to 256 devices on a single communication bus (1/8th unit load).

The SP330 operates from a single power supply, either 3.3V or 5V, with low idle current. The shutdown mode consumes less than $1\mu\text{A}$ in low power standby operation with RS-232 receivers enabled.

FEATURES

- Robust ESD Protection:
 - $\pm 15\text{kV}$ IEC 61000-4-2 Air Gap Discharge
 - $\pm 8\text{kV}$ IEC 61000-4-2 Contact Discharge
 - $\pm 15\text{kV}$ Human Body Model (HBM)
- **20Mbps RS-485** and 1Mbps RS-232 Data Rates
- Pin-Selectable 250kbps Slew Limiting
- **Single Supply Operation from +3V to +5.5V**
- **1.65V to 5.5V Logic Interface V_L pin**
- 2 Drivers, 2 Receivers RS-232/V.28
- 1 Driver, 1 Receiver RS-485/422
 - Full or Half Duplex Configuration
 - 1/8th Unit Load, up to 256 receivers on bus
- RS-485/422 Enhanced Receiver Fail-safe for open, shorted, or terminated but idle inputs
- **10nA Shutdown Supply Current** (typical)
- **Small 24 TSSOP package**

TYPICAL APPLICATIONS

- Software Programmable Serial Ports (RS-232, RS-422, RS-485)
- Industrial and Single Board Computers
- Industrial and Process Control Equipment
- Point-Of-Sale Equipment
- HVAC Controls and Networking Equipment
- Building Security and Automation

ORDERING INFORMATION⁽¹⁾

PART NUMBER	OPERATING TEMPERATURE RANGE	LEAD-FREE	PACKAGE	PACKAGING METHOD
SP330EEY-L	-40°C to +85°C	Yes ⁽²⁾	24-pin TSSOP	Tube
SP330EEY-L/TR				Tape and Reel
SP330EEY-0A-EB	SP330E Evaluation Board			

NOTES:

1. Refer to www.exar.com/SP330E for most up-to-date Ordering Information.
2. Visit www.exar.com for additional information on Environmental Rating.

ABSOLUTE MAXIMUM RATINGS

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections to the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability and cause permanent damage to the device.

Supply Voltage V_{CC}	-0.3V to +6.0V
Logic Interface Voltage V_L	$V_L \leq V_{CC}$
Voltage at TTL Input Pins	-0.3V to +6.0V
Receiver Input Voltage (from Ground)	$\pm 18V$
Driver Output Voltage (from Ground)	$\pm 18V$
Short Circuit Duration, TX out to Ground	Continuous
Storage Temperature Range	-65°C to +150°C
Lead Temperature (soldering, 10s)	+300°C
Power Dissipation 24-pin TSSOP (derate 26.0mW/°C above +70°C)	900mW

CAUTION:

ESD (ElectroStatic Discharge) sensitive device. Permanent damage may occur on unconnected devices subject to high energy electrostatic fields. Unused devices must be stored in conductive foam or shunts. Personnel should be properly grounded prior to handling this device. The protective foam should be discharged to the destination socket before devices are removed.

ESD RATINGS

HBM - Human Body Model (TX Output & RX Input Pins)	$\pm 15kV$
HBM - Human Body Model (all other pins)	$\pm 3kV$
IEC 61000-4-2 Airgap Discharge (TX Output & RX Input Pins)	$\pm 15kV$
IEC 61000-4-2 Contact Discharge (TX Output & RX Input Pins)	$\pm 8kV$

ELECTRICAL CHARACTERISTICS
UNLESS OTHERWISE NOTED:
 $V_{CC} = +3.0V$ to $+5.5V$, $C1-C4 = 0.1\mu F$; $T_A = T_{MIN}$ to T_{MAX} . Typical values are at $V_L = V_{CC} = 3.3V$, $T_A = +25^\circ C$.

SYMBOL	PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
DC CHARACTERISTICS						
I_{CC}	Supply Current (RS-232)		1	2.5	mA	No load, Idle inputs, RS-485/RS-232 = 0V
I_{CC}	Supply Current (RS-485/422)		1.8	4.5	mA	No load, Idle inputs, RS-485/RS-232 = V_{CC}
I_{CC}	Vcc Shutdown Current		0.01	1	μA	$\overline{SHDN} = 0V$, Receiver inputs open or grounded
TRANSMITTER and LOGIC INPUTS (PINS 11 - 14 & 18 - 20)						
V_{IL}	Logic Input Voltage Low			$\frac{V_L}{3}$	V	
V_{IH}	Logic Input Voltage High	$\frac{2V_L}{3}$			V	
I_{INL}	Logic Input Leakage Current		± 0.01	± 1	μA	
I_{INPD}	Logic Input Pulldown Current		10	50	μA	\overline{RE} pin 18, $V_{IN} = V_L$
V_{HYS}	Logic Input Hysteresis		200		mV	
RS-232 and RS-485/422 RECEIVER OUTPUTS (PINS 8 & 9)						
V_{OL}	Receiver Output Voltage Low			0.4	V	$I_{OUT} = 1.5mA$
V_{OH}	Receiver Output Voltage High	$V_L - 0.6$			V	$I_{OUT} = -1.5mA$
I_{OSS}	Receiver Output Short Circuit Current		± 20	± 85	mA	$0 \leq V_O \leq V_L$
I_{OZ}	Receiver Output Leakage Current		± 0.05	± 1	μA	$0 \leq V_O \leq V_L$, Receivers disabled

ELECTRICAL CHARACTERISTICS (Continued)

UNLESS OTHERWISE NOTED:

 $V_{CC} = +3.0V$ to $+5.5V$, $C1-C4 = 0.1\mu F$; $T_A = T_{MIN}$ to T_{MAX} . Typical values are at $V_{CC} = 3.3V$, $T_A = +25^{\circ}C$.

SYMBOL	PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
RS-232 SINGLE-ENDED RECEIVER INPUTS (PINS 16 & 17)						
V_{IN}	Input Voltage Range	-15		+15	V	
V_{IL}	Input Threshold Low	0.6	1.2		V	$V_{CC} = 3.3V$
		0.8	1.5		V	$V_{CC} = 5.0V$
V_{IH}	Input Threshold High		1.5	2.0	V	$V_{CC} = 3.3V$
			1.8	2.4	V	$V_{CC} = 5.0V$
V_{HYS}	Input Hysteresis		0.5		V	
R_{IN}	Input Resistance	3	5	7	$k\Omega$	$-15V \leq V_{IN} \leq +15V$
RS-232 SINGLE-ENDED TRANSMITTER OUTPUTS (PINS 6 & 7)						
V_{OUT}	Output Voltage Swing	± 5.0	± 5.5		V	Outputs loaded with $3k\Omega$ to Gnd
R_{OFF}	Output Power Off Impedance	300	10M		Ω	$V_{CC} = 0V$, $V_{OUT} = \pm 2V$
I_{SC}	Output Short Circuit Current		± 30	± 60	mA	$V_{OUT} = 0V$
I_O	Output Leakage Current			± 125	μA	$\overline{SHDN} = 0V$, $V_{OUT} = \pm 9V$, $V_{CC} = 0V$ or $5.5V$

ELECTRICAL CHARACTERISTICS (Continued)
UNLESS OTHERWISE NOTED:
 $V_{CC} = +3.0V$ to $+5.5V$, $C1-C4 = 0.1\mu F$; $T_A = T_{MIN}$ to T_{MAX} . Typical values are at $V_{CC} = 3.3V$, $T_A = +25^\circ C$.

SYMBOL	PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
RS-485/422 DIFFERENTIAL RECEIVER INPUTS (A,B)						
R_{IN}	Receiver Input Resistance	96			$k\Omega$	$-7V \leq V_{CM} \leq +12V$
I_{IN}	Receiver Input Current			125	μA	$V_{IN} = +12V$
				-100	μA	$V_{IN} = -7V$
V_{TH}	Receiver Differential Threshold Voltage	-200	-125	-50	mV	$-7V \leq V_{CM} \leq +12V$
ΔV_{TH}	Receiver Input Hysteresis		25		mV	
RS-485/422 DIFFERENTIAL DRIVER OUTPUTS (Y, Z)						
V_{OD}	Differential Driver Output	1.5		V_{CC}	V	$R_L = 54\Omega$ (RS-485), Figure 4
		1.5		V_{CC}	V	$-7V \leq V_{CM} \leq +12V$, Figure 5
		2		V_{CC}	V	$R_L = 100\Omega$ (RS-422), Figure 4
$ \Delta V_{OD} $	Change In Magnitude of Differential Output Voltage			0.2	V	$R_L = 54\Omega$ or 100Ω , Figure 4
V_{CM}	Driver Common Mode Output Voltage			3	V	$R_L = 54\Omega$ or 100Ω , Figure 4
$ \Delta V_{CM} $	Change In Magnitude of Common Mode Output Voltage			0.2	V	$R_L = 54\Omega$ or 100Ω , Figure 4
I_{OSD}	Driver Output Short Circuit Current			± 250	mA	$-7V \leq V_Y$ or $V_Z \leq +12V$, Figure 6
I_O	Driver Output Leakage Current			± 125	μA	$DE = 0V$ or $\overline{SHDN} = 0V$, V_Y or $V_Z = -7V$ or $+12V$, $V_{CC} = 0V$ or $5.5V$

TIMING CHARACTERISTICS

UNLESS OTHERWISE NOTED:

$V_{CC} = +3.0V$ to $+5.5V$, $C1-C4 = 0.1\mu F$; $T_A = T_{MIN}$ to T_{MAX} . Typical values are at $V_{CC} = 3.3V$, $T_A = +25^\circ C$.

SYMBOL	PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
ALL MODES						
t_{ENABLE}	Enable from Shutdown		1000		ns	
$t_{SHUTDOWN}$	Enable to Shutdown		1000		ns	
RS-232, DATA RATE = 250kbps ($\overline{SLEW} = 0V$), ONE TRANSMITTER SWITCHING						
	Maximum Data Rate	250			kbps	$R_L = 3k\Omega$, $C_L = 1000pF$
t_{RHL}, t_{RLH}	Receiver Propagation Delay		100		ns	$C_L = 150pF$, Figure 7
$ t_{RHL}-t_{RLH} $	Receiver Propagation Delay Skew			100	ns	
t_{DHL}, t_{DLH}	Driver Propagation Delay		1400		ns	$R_L = 3k\Omega$, $C_L = 2500pF$, Figure 8
$ t_{DHL}-t_{DLH} $	Driver Propagation Delay Skew			600	ns	
t_{SHL}, t_{SLH}	Transition Region Slew Rate from +3.0V to -3.0V or -3.0V to +3.0V	6		30	V/ μs	$V_{CC} = +3.3V$, $R_L = 3k\Omega$ to $7k\Omega$, $C_L = 150pF$ to $2500pF$, $T_A = 25^\circ C$, Figure 8
t_{SHL}, t_{SLH}	Transition Region Slew Rate from +3.0V to -3.0V or -3.0V to +3.0V	4		30	V/ μs	$V_{CC} = +3.3V$, $R_L = 3k\Omega$ to $7k\Omega$, $C_L = 150pF$ to $2500pF$, Figure 8
RS-232, DATA RATE = 1Mbps ($\overline{SLEW} = V_{CC}$), ONE TRANSMITTER SWITCHING						
	Maximum Data Rate	1			Mbps	$R_L = 3k\Omega$, $C_L = 250pF$
t_{RHL}, t_{RLH}	Receiver Propagation Delay		100		ns	$C_L = 150pF$, Figure 7
$ t_{RHL}-t_{RLH} $	Receiver Propagation Delay Skew			100	ns	
t_{DHL}, t_{DLH}	Driver Propagation Delay		300		ns	$R_L = 3k\Omega$, $C_L = 1000pF$, Figure 8
$ t_{DHL}-t_{DLH} $	Driver Propagation Delay Skew			150	ns	
t_{SHL}, t_{SLH}	Transition Region Slew Rate from +3.0V to -3.0V or -3.0V to +3.0V	13		150	V/ μs	$V_{CC} = +3.3V$, $R_L = 3k\Omega$ to $7k\Omega$, $C_L = 150pF$ to $1000pF$, Figure 8
t_{SHL}, t_{SLH}	Transition Region Slew Rate from +3.0V to -3.0V or -3.0V to +3.0V	24		150	V/ μs	$V_{CC} = +3.3V$, $R_L = 3k\Omega$ to $7k\Omega$, $C_L = 150pF$ to $1000pF$, $T_A = 25^\circ C$, Figure 8

TIMING CHARACTERISTICS (Continued)
UNLESS OTHERWISE NOTED:
 $V_{CC} = +3.0V$ to $+5.5V$, $C1-C4 = 0.1\mu F$; $T_A = T_{MIN}$ to T_{MAX} . Typical values are at $V_{CC} = 3.3V$, $T_A = +25^{\circ}C$.

SYMBOL	PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
RS-485/RS-422, DATA RATE = 250kbps ($\overline{SLEW} = 0V$), ONE TRANSMITTER SWITCHING						
	Maximum Data Rate	250			kbps	$R_L = 54\Omega$, $C_L = 50pF$
t_{RPHL} , t_{RPLH}	Receiver Propagation Delay		50	150	ns	$C_L = 15pF$, Figure 9
$ t_{RPHL} - t_{RPLH} $	Receiver Propagation Delay Skew			10	ns	
t_{DPHL} , t_{DPLH}	Driver Propagation Delay		500	1000	ns	$R_L = 54\Omega$, $C_L = 50pF$, Figure 10
$ t_{DPHL} - t_{DPLH} $	Driver Propagation Delay Skew			100	ns	
t_{DR} , t_{DF}	Driver Rise and Fall Time	300	650	1200	ns	
RS-485/RS-422, DATA RATE = 20Mbps ($\overline{SLEW} = V_{CC}$), ONE TRANSMITTER SWITCHING						
	Maximum Data Rate	20			Mbps	$R_L = 54\Omega$, $C_L = 50pF$
t_{RPHL} , t_{RPLH}	Receiver Propagation Delay		50	150	ns	$C_L = 15pF$, Figure 9
$ t_{RPHL} - t_{RPLH} $	Receiver Propagation Delay Skew			10	ns	
t_{DPHL} , t_{DPLH}	Driver Propagation Delay		30	100	ns	$R_L = 54\Omega$, $C_L = 50pF$, Figure 10
$ t_{DPHL} - t_{DPLH} $	Driver Propagation Delay Skew			10	ns	
t_{DR} , t_{DF}	Driver Rise and Fall Time		10	20	ns	
RS-485/RS-422, DATA RATE = 20Mbps ($\overline{SLEW} = V_{CC}$), ONE TRANSMITTER SWITCHING						
t_{RZH} , t_{RZL}	Receiver Output Enable Time			200	ns	$C_L = 15pF$, Figure 11
t_{RHZ} , t_{RLZ}	Receiver Output Disable Time			200	ns	
t_{DZH} , t_{DZL}	Driver Output Enable Time			200	ns	$R_L = 500\Omega$, $C_L = 50pF$, Figure 12
t_{DZH} , t_{DLZ}	Driver Output Disable Time			200	ns	

PIN DESCRIPTIONS

Pin	Name	RS-232	RS-485 Full Duplex	RS-485 Half Duplex
1	C1+	Charge pump cap 1 positive lead, 0.1µF		
2	VL	Logic Supply for TTL Inputs and Outputs, $V_L = +1.65V$ to $+5.5V$ or tie to V_{CC}		
3	VCC	Main Supply, $V_{CC} = +3.0V$ to $+5.5V$, bypass to ground with 1.0µF		
4	C1-	Charge pump cap 1 negative lead		
5	GND	Ground		
6	T1OUT, B/Z	Transmitter 1 Output	Z Driver Neg Output	B/Z Neg Input/Output
7	T2OUT, A/Y	Transmitter 2 Output	Y Driver Pos Output	A/Y Pos Input/Output
8	R1OUT	Receiver 1 Output	X	X
9	R2OUT, RO	Receiver 2 Output	Receiver TTL Output	Receiver TTL Output
10				
11	$\overline{\text{SHDN}}$	Low power shutdown mode when low		
12	$\overline{\text{SLEW}}$	Data rate limited to 250kbps when low		
13	RS-485/RS-232	0	1	1
14	HALF/FULL	X	0	1
15	GND	Ground		
16	R2IN, A	Receiver 2 Input	A Pos Receiver Input	X
17	R1IN, B	Receiver 1 Input	B Neg Receiver Input	X
18	$\overline{\text{RE}}$	X	Receiver enabled when low	
19	T2IN, DE	Transmitter 2 Input	Driver enabled when high	
20	T1IN, DI	Transmitter 1 Input	Driver TTL Input	
21	V-	Charge pump negative supply, 0.1µF from ground		
22	C2-	Charge pump cap 2 negative lead		
23	C2+	Charge pump cap 2 positive lead, 0.1µF		
24	V+	Charge pump positive supply, 0.1µF to ground		

SUGGESTED DB9 CONNECTOR PINOUT

DB9 Pin	RS-232	RS-485 Full Duplex	RS-485 Half Duplex
1			
2	RXD	RX+	
3	TXD	TX-	Data-
4			
5	Ground		
6			
7	RTS	TX+	Data+
8	CTS	RX-	
9			

BLOCK DIAGRAMS

FIGURE 1. RS-232 MODE

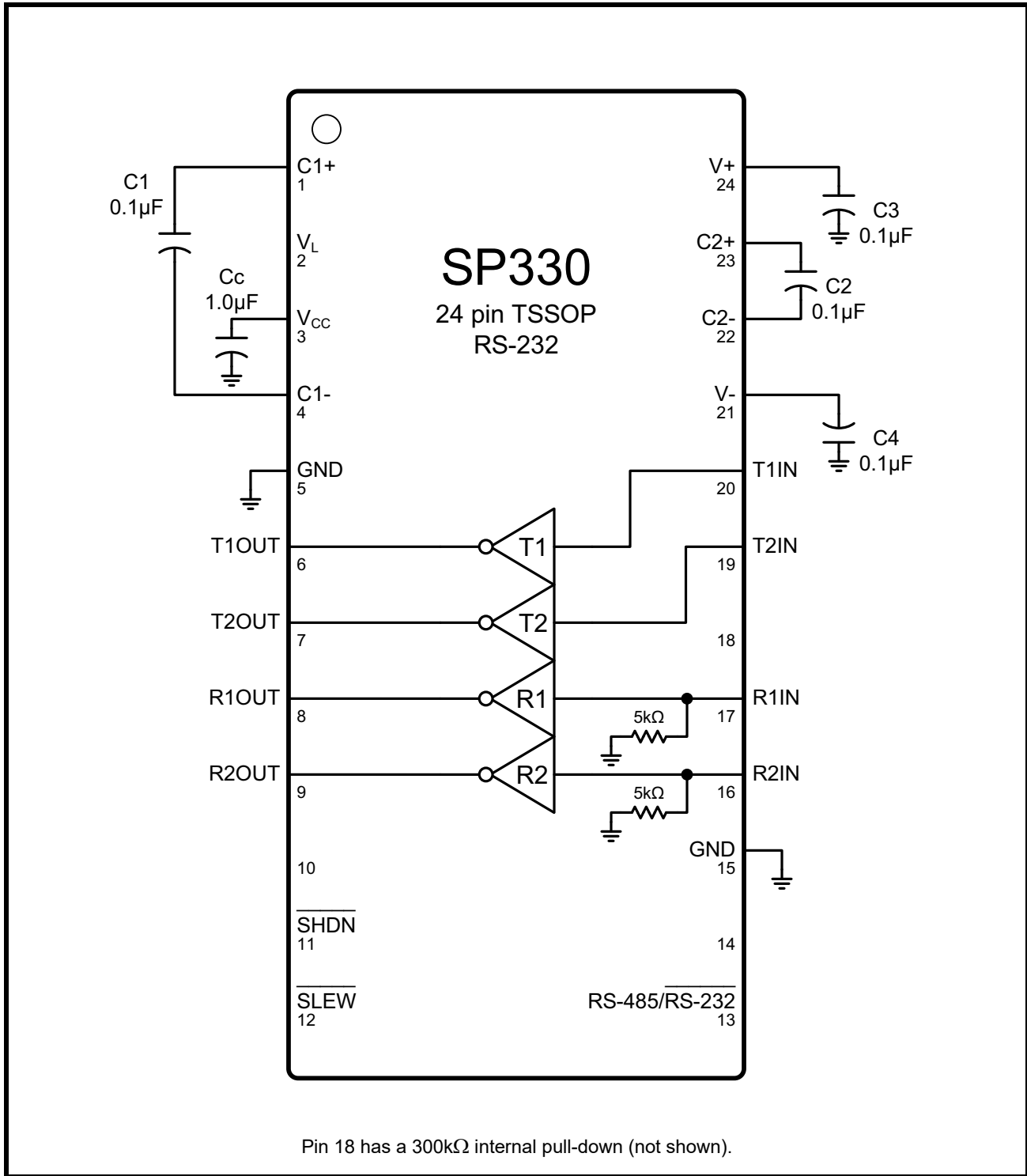


FIGURE 2. RS-485 FULL DUPLEX MODE

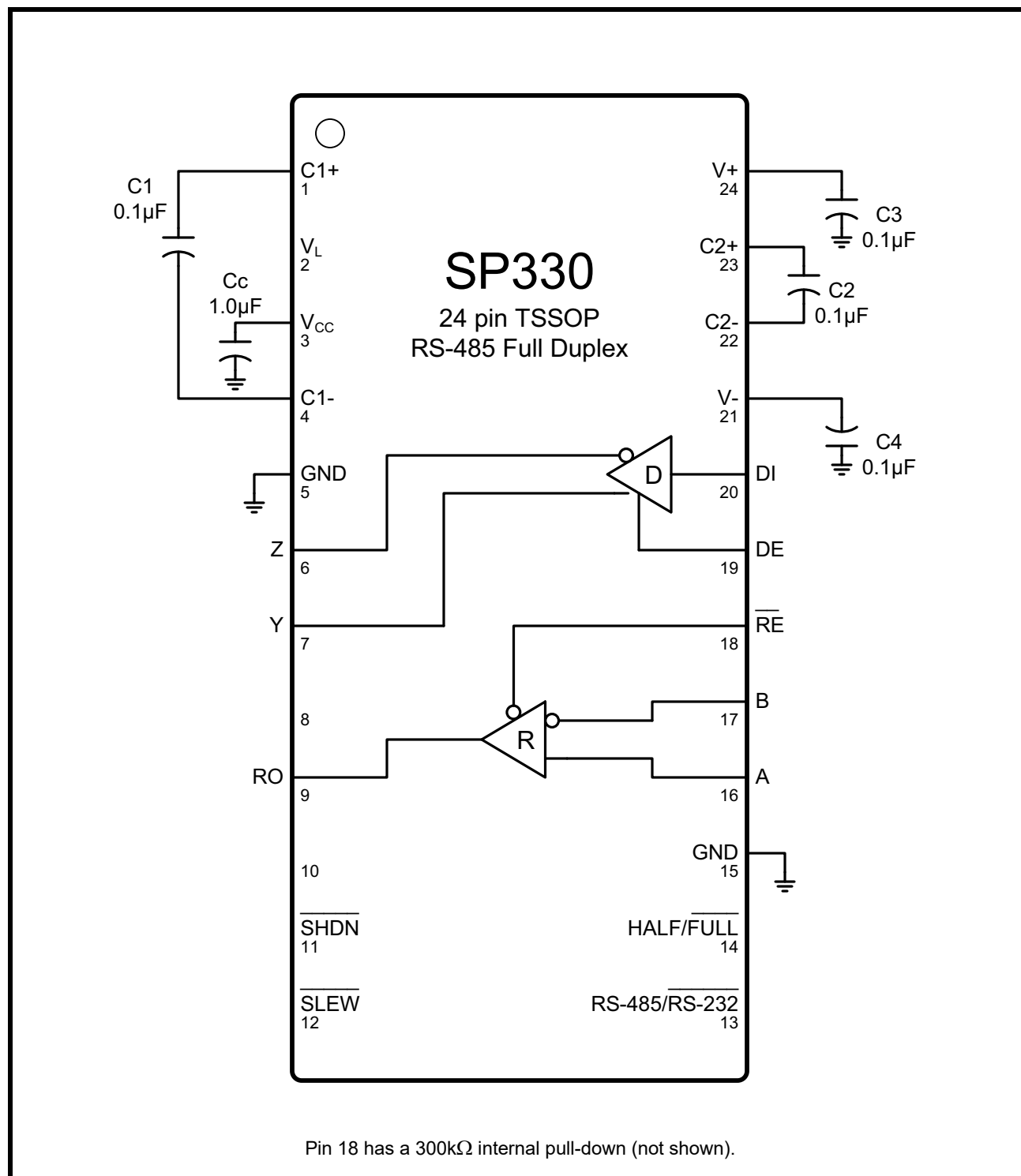
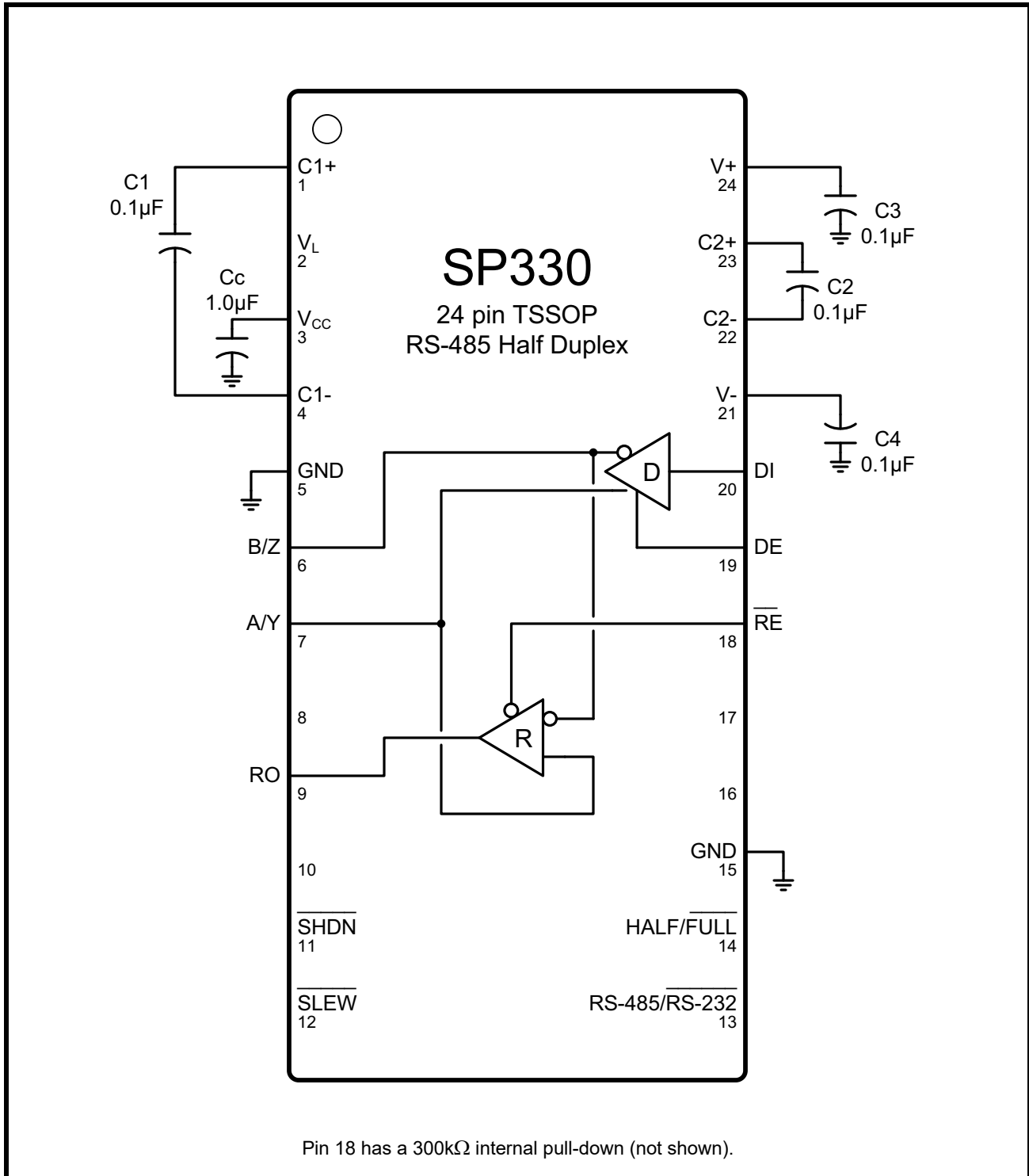


FIGURE 3. RS-485 HALF DUPLEX MODE



TEST CIRCUITS

FIGURE 4. RS-485/422 DIFFERENTIAL DRIVER OUTPUT VOLTAGE

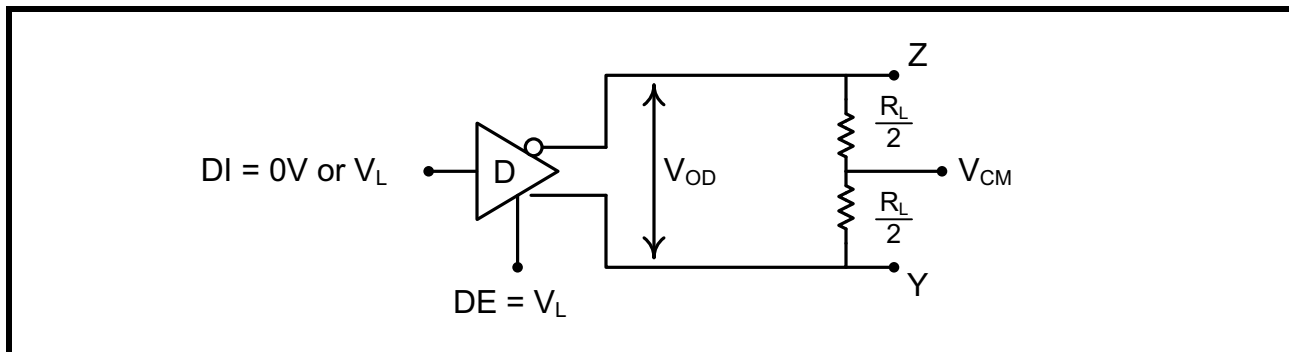


FIGURE 5. RS-485/422 DIFFERENTIAL DRIVER OUTPUT VOLTAGE OVER COMMON MODE

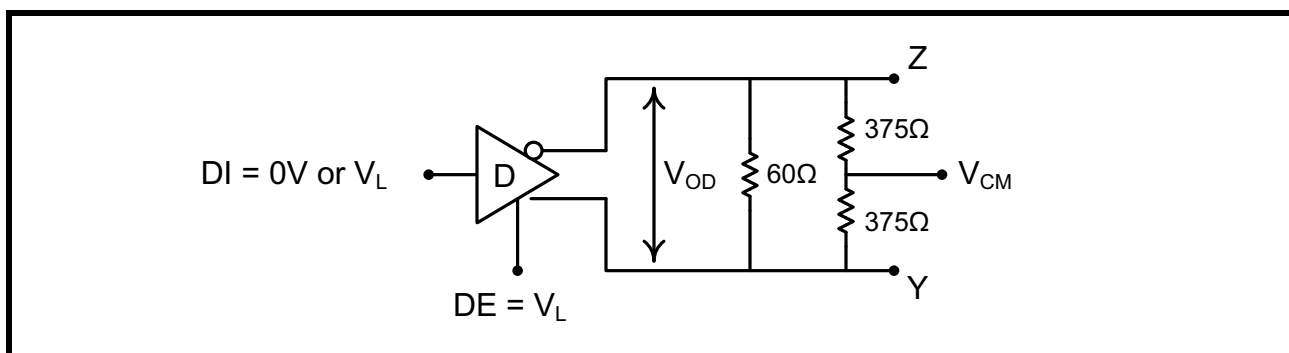


FIGURE 6. RS-485/422 DRIVER OUTPUT SHORT CIRCUIT CURRENT

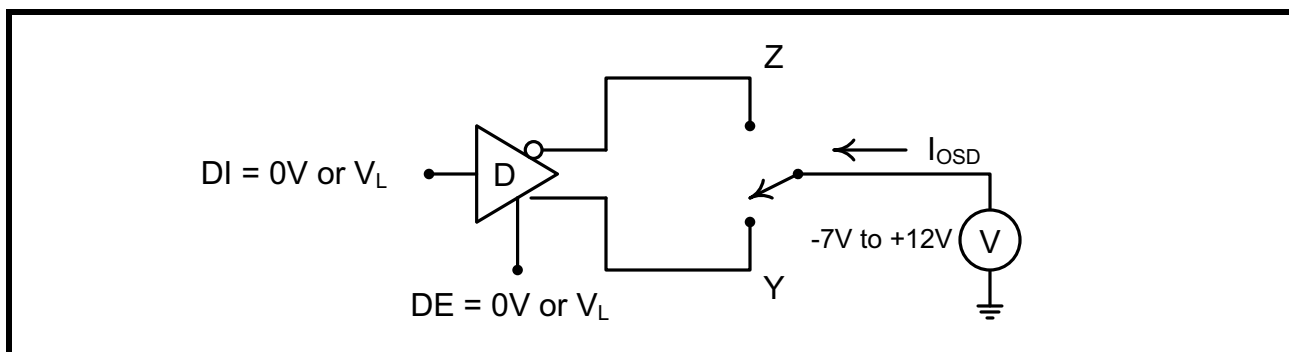


FIGURE 7. RS-232 RECEIVER PROPAGATION DELAY

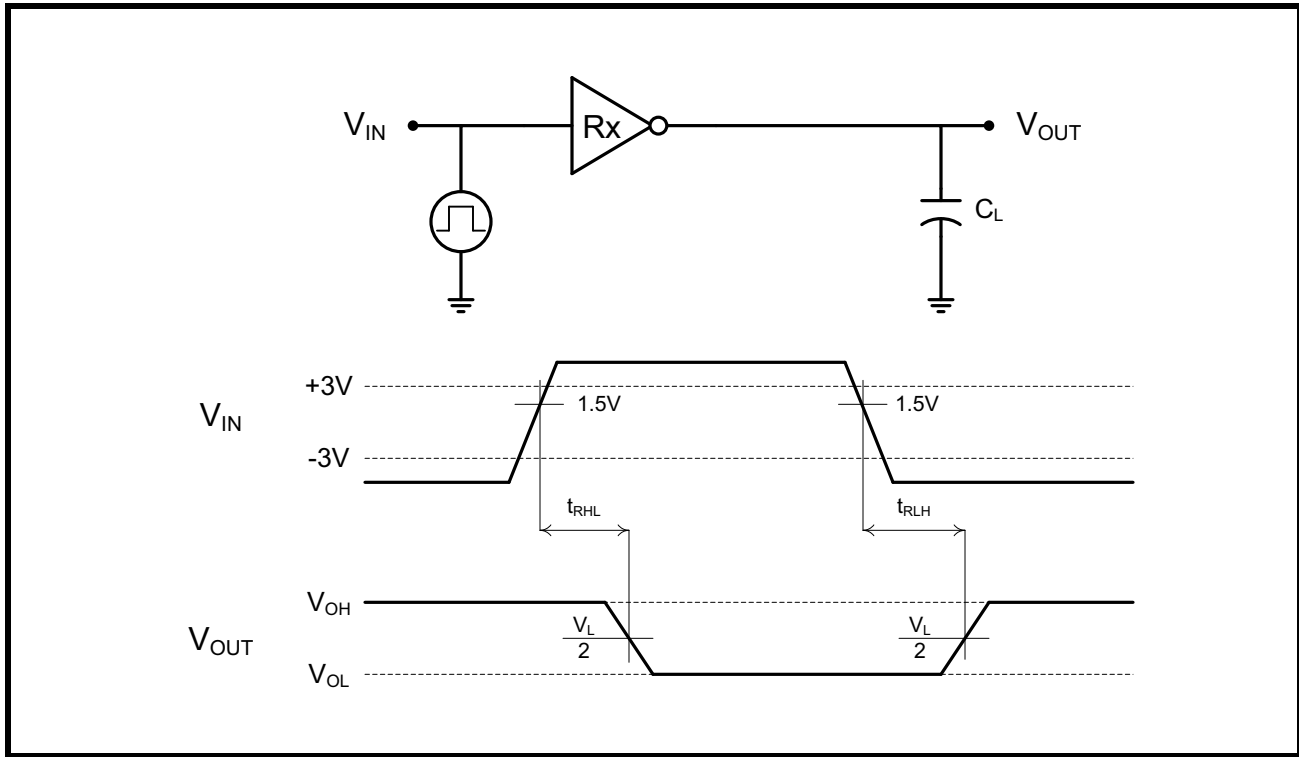


FIGURE 8. RS-232 DRIVER PROPAGATION DELAY

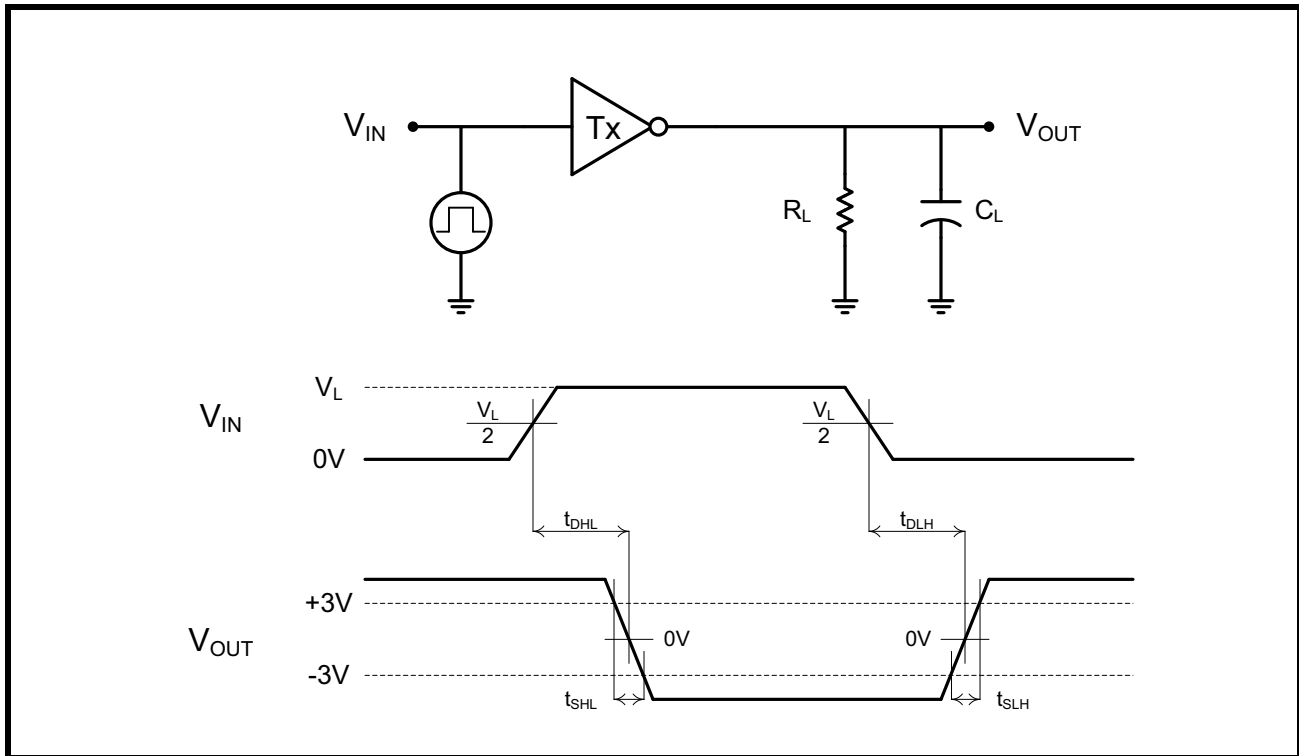


FIGURE 9. RS-485/422 RECEIVER PROPAGATION DELAY

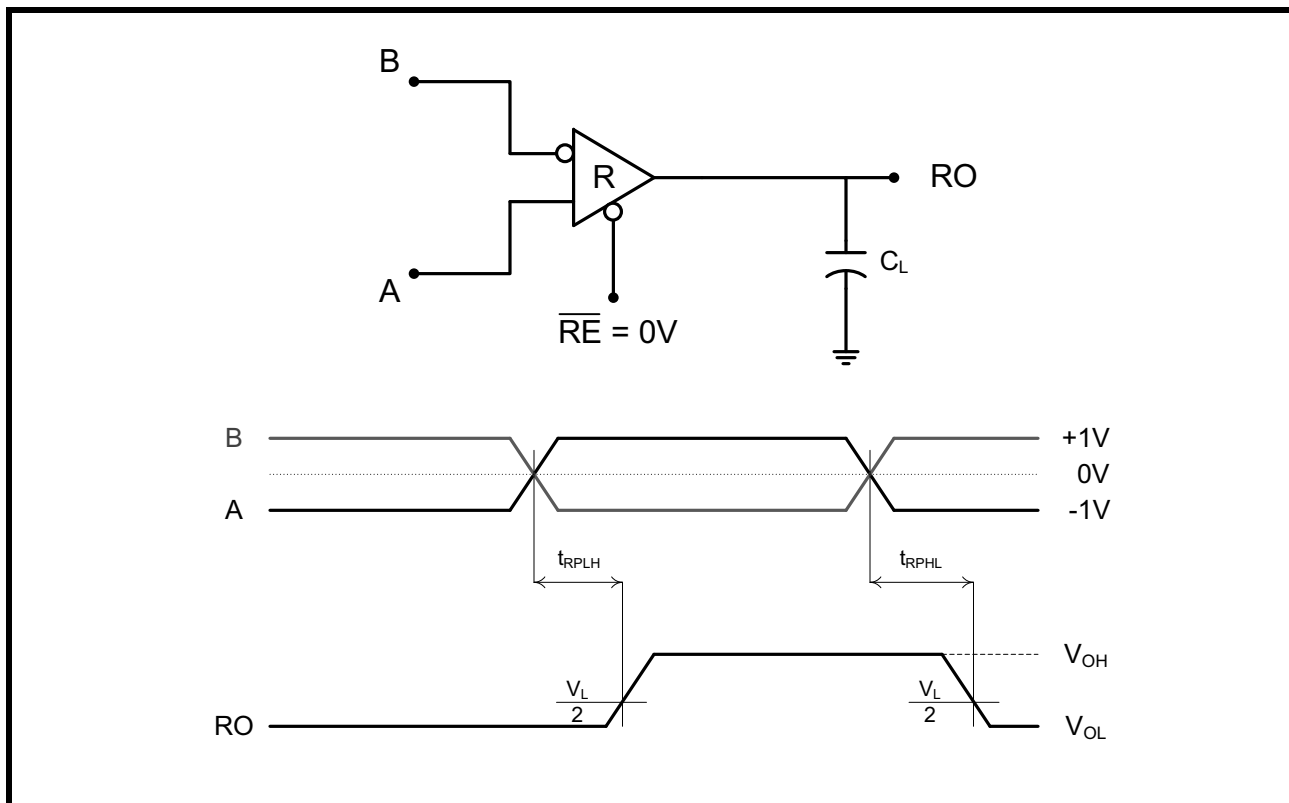


FIGURE 10. RS-485/422 DRIVER PROPAGATION DELAY AND RISE/FALL TIMES

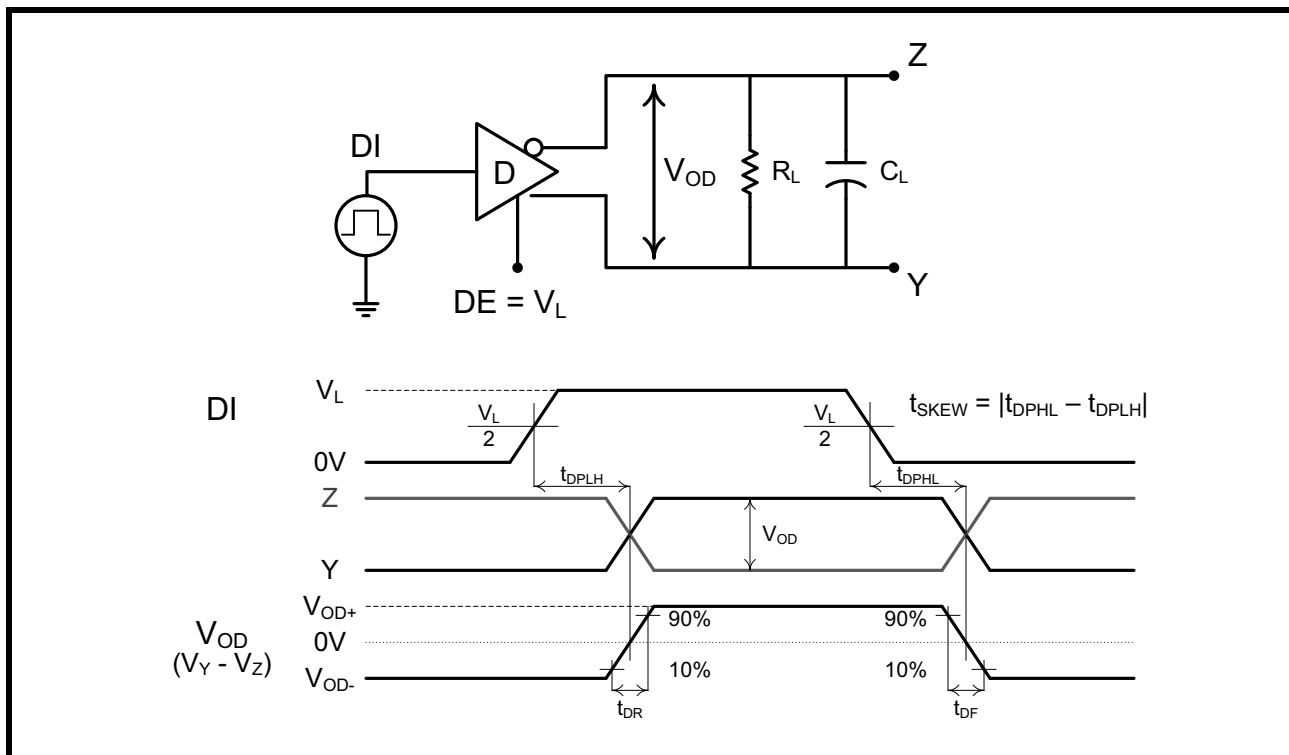


FIGURE 11. RS-485/422 RECEIVER OUTPUT ENABLE/DISABLE TIMES

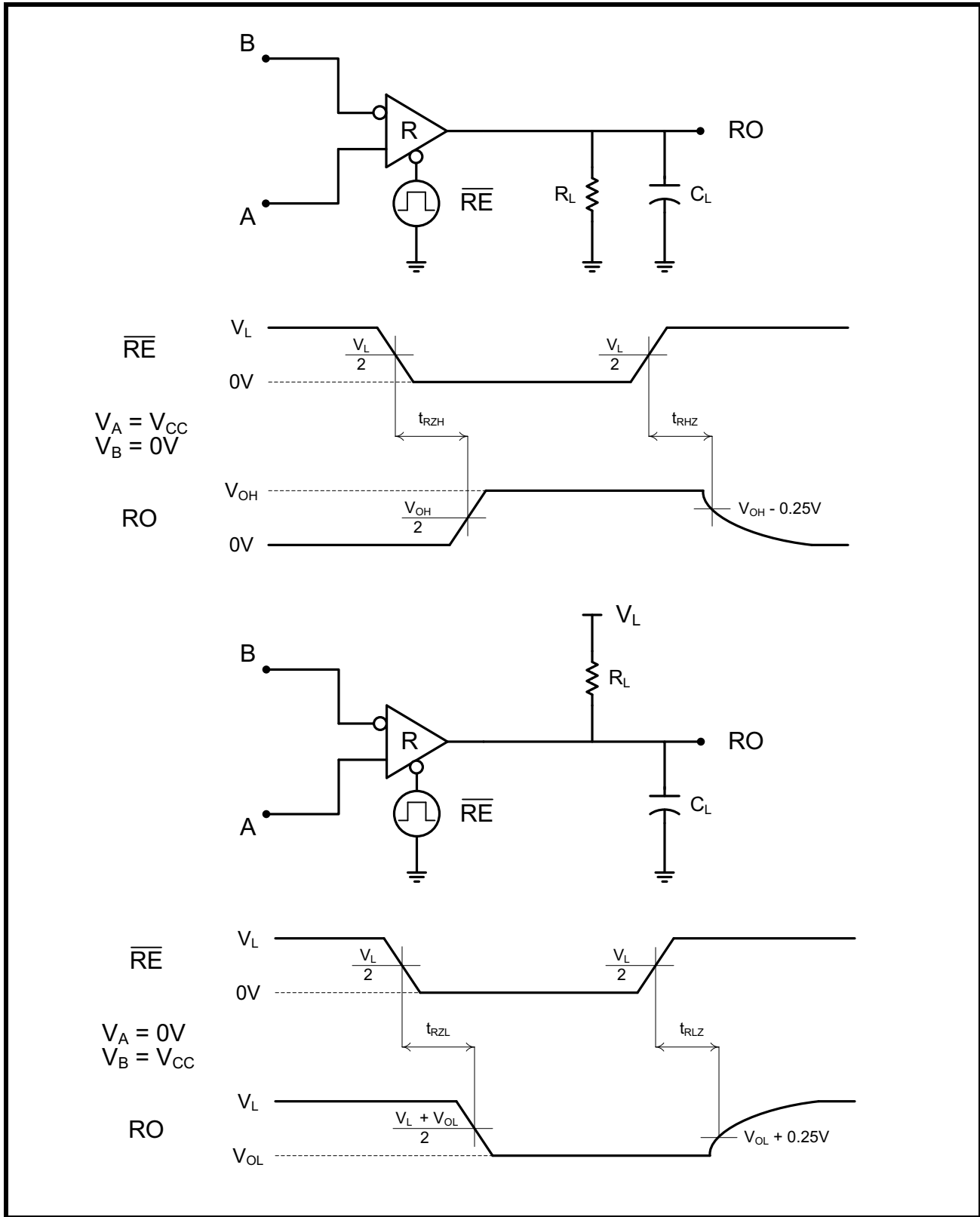
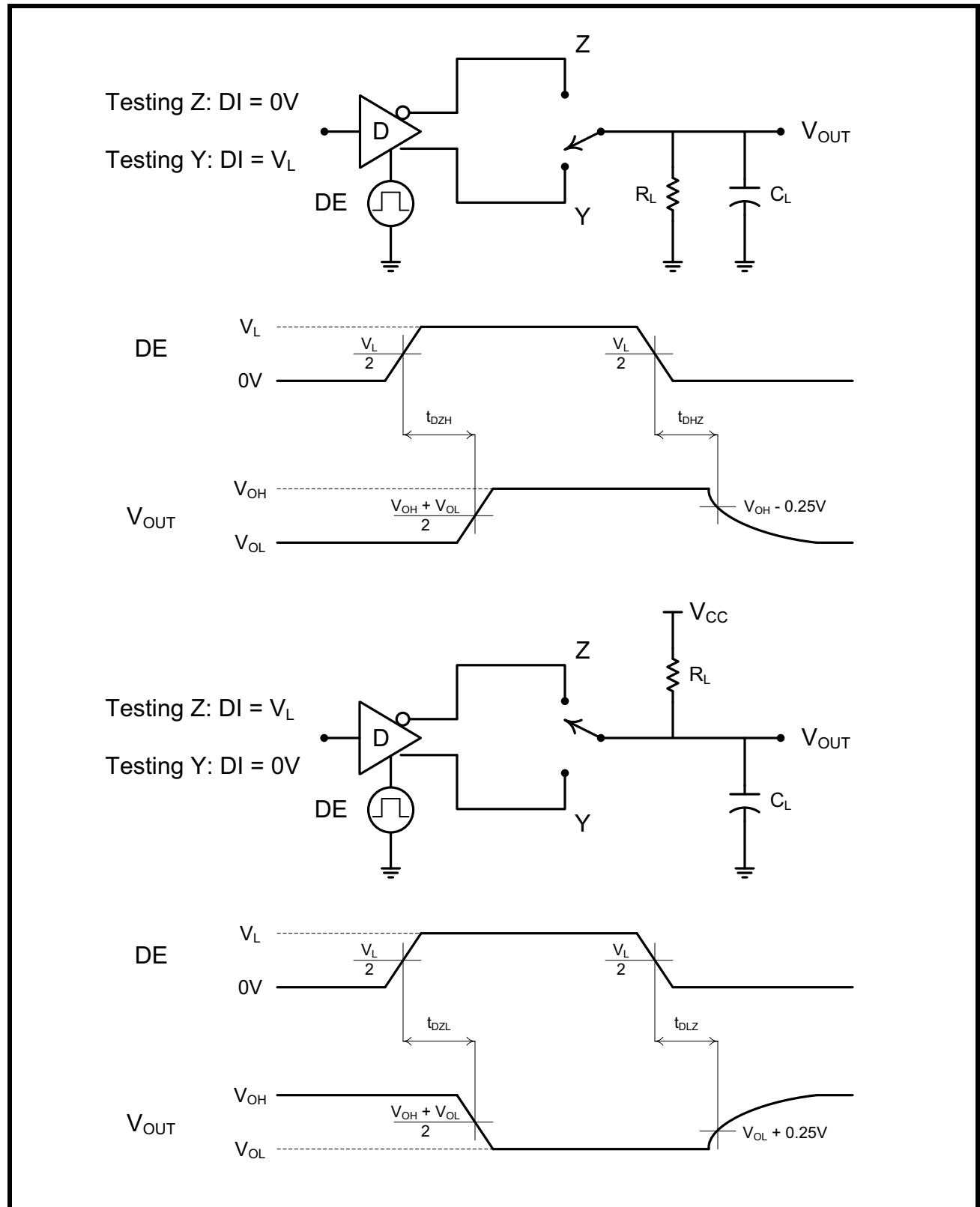


FIGURE 12. RS-485/422 DRIVER OUTPUT ENABLE/DISABLE TIMES



PRODUCT SUMMARY

The SP330 is an advanced multiprotocol transceiver supporting RS-232, RS-485, and RS-422 serial standards. The multiple configuration modes allow all three protocols to be used interchangeably over a single cable or connector with no additional switching components. Full operation requires only four external charge pump capacitors.

ENHANCED FAILSAFE

The enhanced failsafe feature of the SP330 guarantees a logic-high receiver output when the receiver inputs are open, shorted, or terminated but idle/undriven. The enhanced failsafe interprets 0V differential as a logic high with a minimum 50mV noise margin, while maintaining compliance with the EIA/TIA-485 standard of $\pm 200\text{mV}$. No external biasing resistors are required, further easing the usage of multiple protocols over a single connector.

$\pm 15\text{kV}$ ESD PROTECTION

ESD protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The bus pins (driver outputs and receiver inputs) have extra protection structures, which have been tested up to $\pm 15\text{kV}$ without damage. These structures withstand high ESD in all states: normal operation, in shutdown, and when powered off.

ESD protection is tested in various ways. MaxLinear uses the following methods to qualify the protection structures designed into SP330:

- $\pm 8\text{kV}$ using IEC 61000-4-2 Contact Discharge

- $\pm 15\text{kV}$ using IEC 61000-4-2 Airgap Discharge

- $\pm 15\text{kV}$ using the Human Body Model (HBM)

The IEC 61000-4-2 standard is more rigorous than HBM, resulting in lower voltage levels compared with HBM for the same level of ESD protection. Because IEC 61000-4-2 specifies a lower series resistance, the peak current is higher than HBM. The SP330 has passed both HBM and IEC 61000-4-2 testing without damage.

VARIABLE LOGIC LEVEL VOLTAGE

The SP330 includes a V_L pin which reduces the logic level thresholds to interface with processors operating at reduced supply voltages. This pin should be connected to the supply voltage of the processor or UART block, or can be connected to V_{CC} for typical logic levels.

TRUTH TABLES
TABLE 1: RS-232 TX TRUTH TABLE

INPUTS			OUTPUTS
$\overline{\text{SHDN}}$	$\overline{\text{RS-485/RS-232}}$	DI/T1IN, DE/T2IN	Z(B)/T1OUT, Y(A)/T2OUT
0	X	X	1/8th unit load
1	0	0	1
1	0	1	0
1	1	X	RS-485 Mode

TABLE 2: RS-232 RX TRUTH TABLE

INPUTS			OUTPUTS
$\overline{\text{SHDN}}$	$\overline{\text{RS-485/RS-232}}$	B/R1IN, A/R2IN	R1OUT, RO/R2OUT
X	0	0	1
X	0	1	0
X	0	Inputs open	1
X	1	X	R1OUT High-Z, RO/R2OUT in RS-485 Mode

TABLE 3: RS-485/422 TX TRUTH TABLE

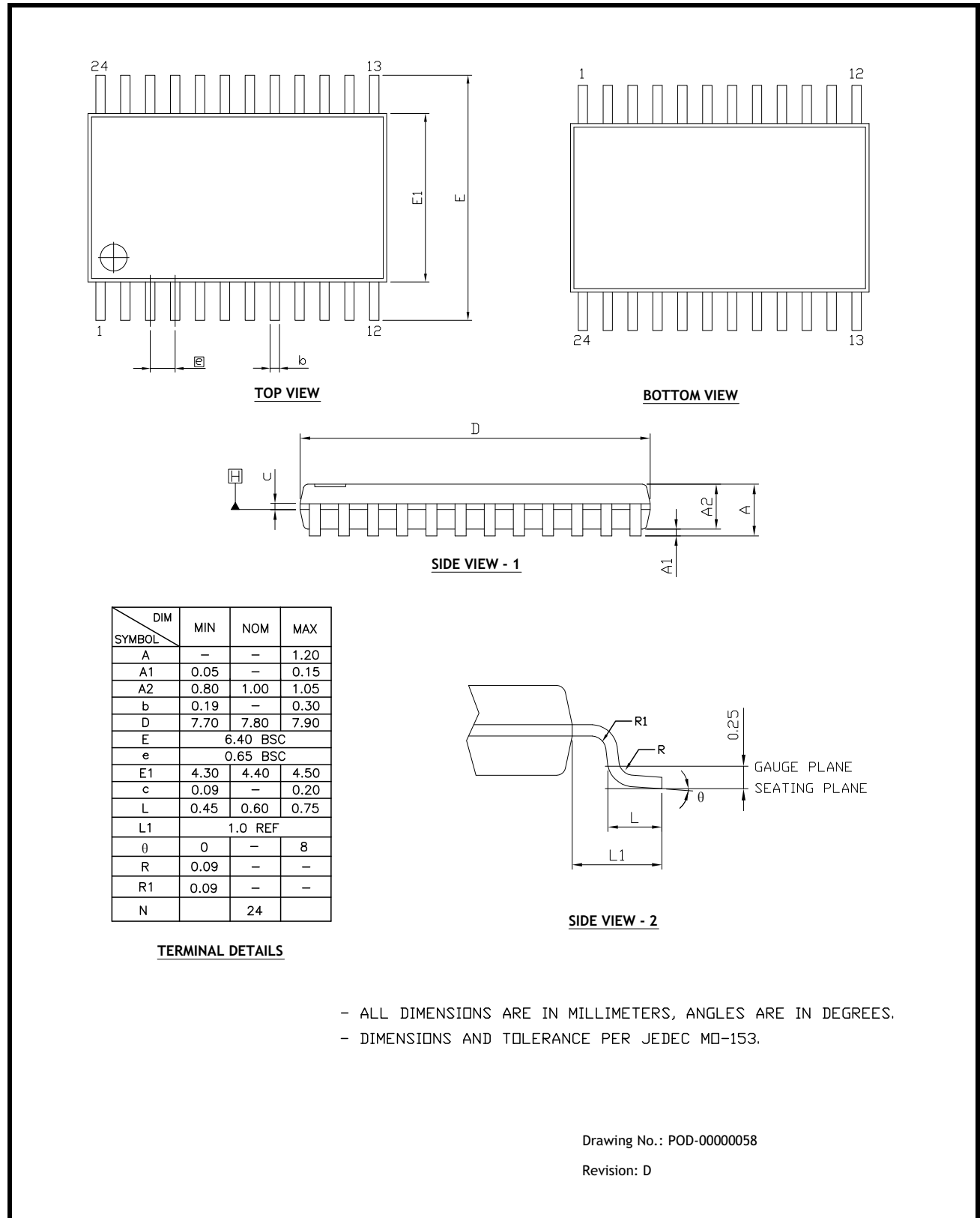
INPUTS				OUTPUTS	
$\overline{\text{SHDN}}$	RS-485/RS-232	DE/T2IN	DI/T1IN	Z(B)/T1OUT	Y(A)/T2OUT
0	X	X	X	1/8th unit load	1/8th unit load
1	1	0	X	1/8th unit load	1/8th unit load
1	1	1	0	1	0
1	1	1	1	0	1
X	0	X	X	RS-232 Mode	

TABLE 4: RS-485/422 RX TRUTH TABLE

INPUTS						OUTPUT
RS-485/RS-232	$\overline{\text{SHDN}}$	HALF/FULL	$\overline{\text{RE}}$	(A-B)	(Y-Z)	RO/R2OUT
1	0	X	X	X	X	High-Z
1	1	0	0	$\geq -50\text{mV}$	X	1
1	1	0	0	$\leq -200\text{mV}$	X	0
1	1	0	0	Floating	X	1
1	1	1	0	X	$\geq -50\text{mV}$	1
1	1	1	0	X	$\leq -200\text{mV}$	0
1	1	1	0	X	Floating	1
1	1	X	1	X	X	High-Z
0	X	X	X	X	X	RS-232 Mode

MECHANICAL DIMENSIONS

FIGURE 13. TSSOP 24 DRAWING



RECOMMENDED LAND PATTERN AND STENCIL

FIGURE 14. TSSOP 24

