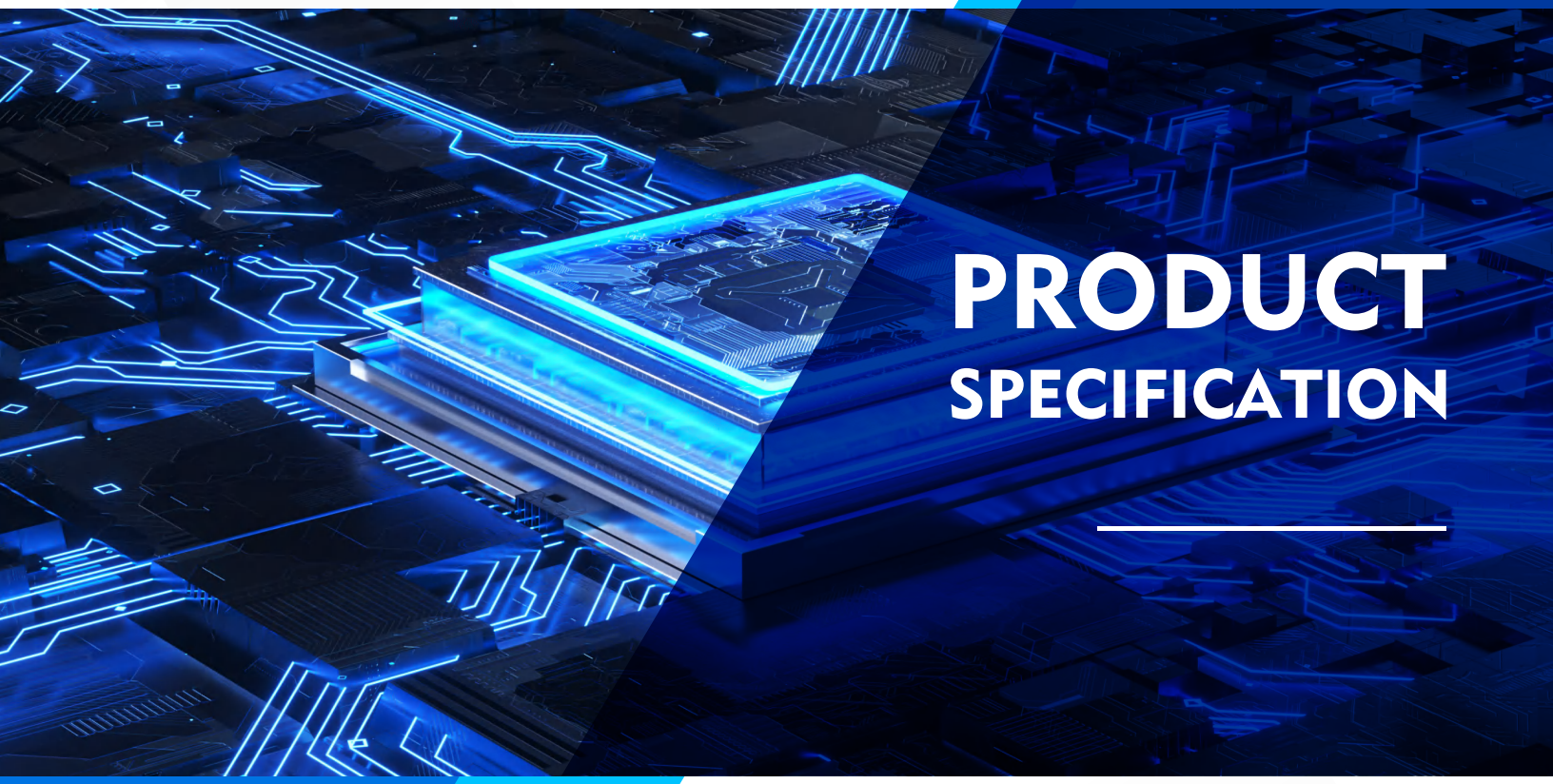
HJKE

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PRODUCT SPECIFICATION

MAIN PRODUCTS

1 Feature

- ESD Protection for RS-485 I/O Pins
  - ±15kV—Human Body Model
  - ±8kV—IEC 1000-4-2, Contact Discharge
  - ±15kV—IEC 1000-4-2, Air-Gap Discharge
- Operate from a Single +3.0V~5.5V Supply—No Charge Pump Required
- Interoperable with +5V Logic
- Guaranteed 12Mbps Data Rate (SP3490 /SP3491)
- -7V to +12V Common-Mode Input Voltage Range
- Current-Limiting and Thermal Shutdown for Driver Overload Protection

2 APPLICATIONS

- Telecommunications
- Industrial-Control Local Area Networks
- Transceivers for EMI-Sensitive Applications
- Integrated Services Digital Networks
- Packet Switching

3 General Description

Devices in the SP3490 /SP3491 family are ±15kV ESD-protected,+3.0V~5.5V, low-power transceivers for RS-422 communications. Each device contains one driver and one receiver. The SP3490 ,and SP3491 transmit at up to 12Mbps.

All devices feature enhanced electrostatic discharge (ESD) protection. All transmitter outputs and receiver inputs are protected to ±15kV using IEC 1000-4-2 Air-Gap Discharge, ±8kV using IEC 1000-4-2 Contact Discharge, and ±15kV using the Human Body Model.

Drivers are short-circuit current limited and are protected against excessive power dissipation by thermal shutdown circuitry that places the driver outputs into a high-impedance state. The receiver input has a fail-safe feature that guarantees a logic-high output if both inputs are open circuit. The SP3490 , and SP3491 feature full duplex communication.

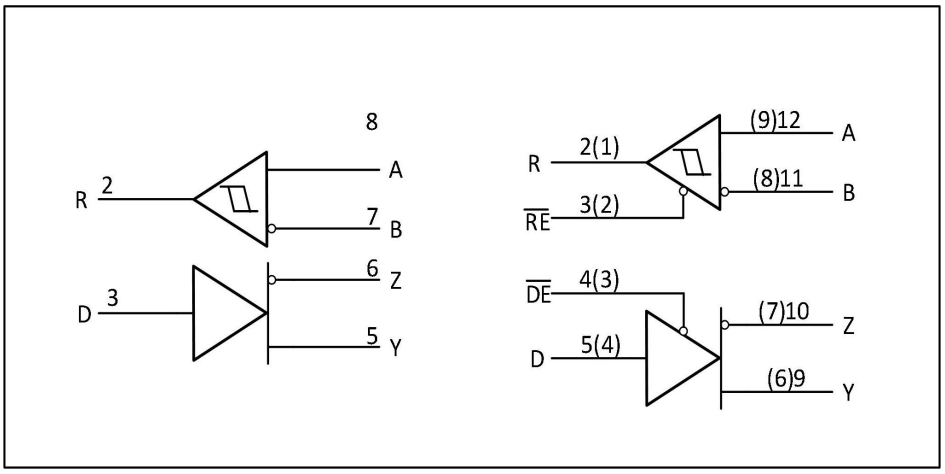


Figure 1 Simplified Schematic

4 Specifications

4.1 ABSOLUTE GMIMUM RATINGS

Parameter	Description	MIN	SP	UNIT
V_{CC}	Supply Voltage		+7	V
$\overline{RE}$, DE	Control Input Voltage	-0.3	+7	V
DI	Driver Input Voltage	-0.3	+7	V
A, B,Y,Z	Driver Output Voltage	-7.5	+12.5V	V
A, B	Receiver Input Voltage	-7.5	+12.5V	V
RO	Receiver Output Voltage	0.3	V_{CC}+0.3V	
	Storage Temperature Range	-65	150	°C

4.2 DC ELECTRICAL CHARACTERISTICS

(V_{CC} = +3.3V ±0.3V, T_A = T_{MIN} to T_{GM}, unless otherwise noted. Typical values are at T_A = +25°C.)

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	SP	UNIT
V_{OD}	Differential Driver Output	R_L = 100Ω (RS-422), Figure 4		2.0			V
		R_L = 54Ω (RS-485), Figure 4		1.5			
		R_L = 60Ω (RS-485), V_{CC} = 3.3V, Figure 5		1.5			
△V_{OD}	Change in Magnitude of Driver Differential Output Voltage for Complementary Output States(Note 1)	R = 54Ω or 100Ω, Figure 4				0.2	V
V_{OC}	Driver Common-Mode Output Voltage	R = 54Ω or 100Ω, Figure 4				3	V
△V_{OC}	Change in Magnitude of Driver Common-Mode Output Voltage for Complementary Output States	R = 54Ω or 100Ω, Figure 4				0.2	V
V_{IH}	Input High Voltage	DE, DI, $\overline{RE}$		2.0			V
V_{IL}	Input Low Voltage	DE, DI, $\overline{RE}$				0.8	V
I_{IN1}	Input Current	DE, DI, $\overline{RE}$ V_{CC} floating				±2	μA
I_{IN2}	Input Current (A, B)	DE = 0V; V_{CC} = 0V or 3.6V	V_{IN} = 12V			1.0	mA
			V_{IN} = -7V			-0.8	
I_O	Output Leakage (Y, Z)	DE = 0V, $\overline{RE}$ = 0V, V_{CC}= 0V or 3.6V, SP3491	V_{OUT} = 12V			100	μA
			V_{OUT} = -7V			-100	
I_O	Output Leakage (Y, Z) in Shutdown Mode	DE = 0V, RE = 3.6V, V_{CC}= 0V or 3.6V, SP3491	V_{OUT} = 12V			100	μA
			V_{OUT} = -7V			-100	
V_{TH}	Receiver Differential ThresholdVoltage	-7V≤V_{CM} ≤12V		-0.2		0.2	V
△V_{TH}	Receiver Input Hysteresis	V_{CM} = 0V			50		mV
V_{OH}	Receiver Output High Voltage	I_O = -4mA, V_{ID} = 200mV,Figure 6		V_{CC}-0.4			V

DC ELECTRICAL CHARACTERISTICS(continued)

(V_{CC} = +3.3V ±0.3V, T_A = T_{MIN} to T_{GM}, unless otherwise noted. Typical values are at T_A = +25°C.)

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	SP	UNIT
V_{OL}	Receiver Output Low Voltage	I_O = 4mA, V_{ID} = -200mV,Figure 6				0.4	V
I_{OZR}	Three-State (high impedance) Output Current at Receiver	V_{CC} = 3.6V, 0V ≤ V_{OUT} ≤ V_{CC}				±1	μA
R_{IN}	Receiver Input Resistance	-7V ≤ V_{CM} ≤ 12V		96			kΩ
V_{CC}	Supply Voltage Range			3.0		5.5	V
I_{CC}	Supply Current	No load, DI = 0 or V_{CC}	DE = V_{CC}, $\overline{RE}$ = 0 or V_{CC}		0.5	1.0	mA
			DE = 0V, $\overline{RE}$ = 0		0.45	0.9	
I_{SHDN}	Supply Current in Shutdown Mode	DE = 0, $\overline{RE}$ = V_{CC}, DI = V_{CC} or 0			1.3	2	μA
I_{OSD}	Driver Short-Circuit Current	V_{OUT} = -7V				-250	mA
		V_{OUT} = 12V				250	
I_{OSR}	Receiver Short-Circuit Output Current	0V ≤ V_O ≤ V_{CC}		±8		±60	mA
	ESD Protection for Y, Z, A, B	IEC 1000-4-2 Air Discharge		±15			KV
		IEC 1000-4-2 Contact Discharge (SP3491)		±8			
		IEC 1000-4-2 Contact Discharge (SP3490)		±8			
		Human Body Model		±15			

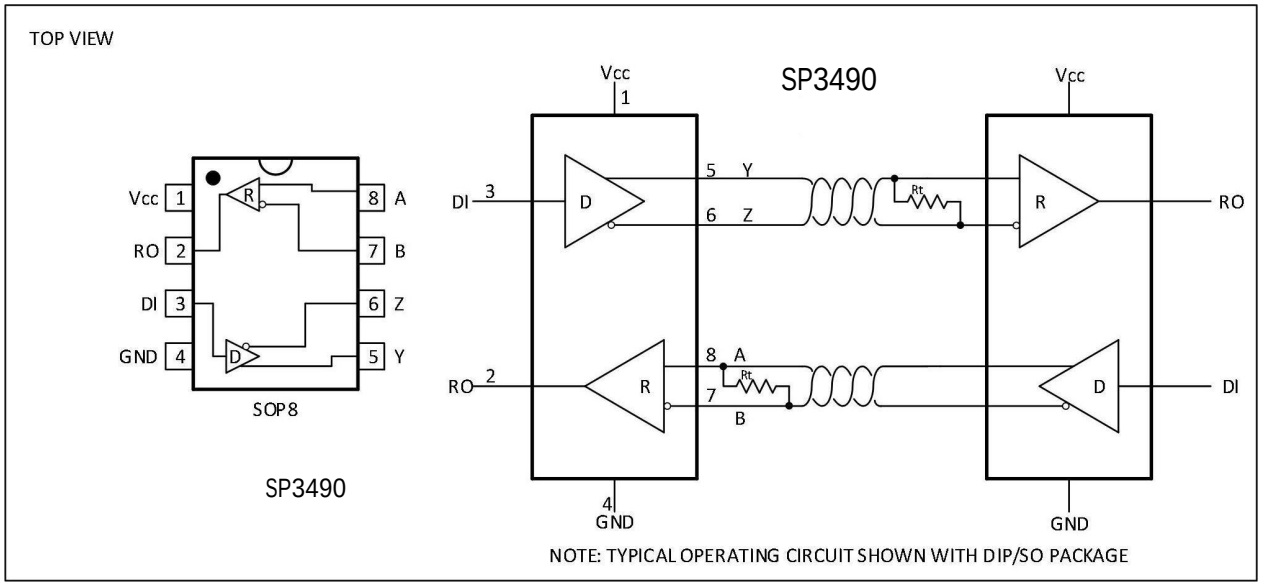
4.3 Switching Characteristics—SP3490 /SP3491

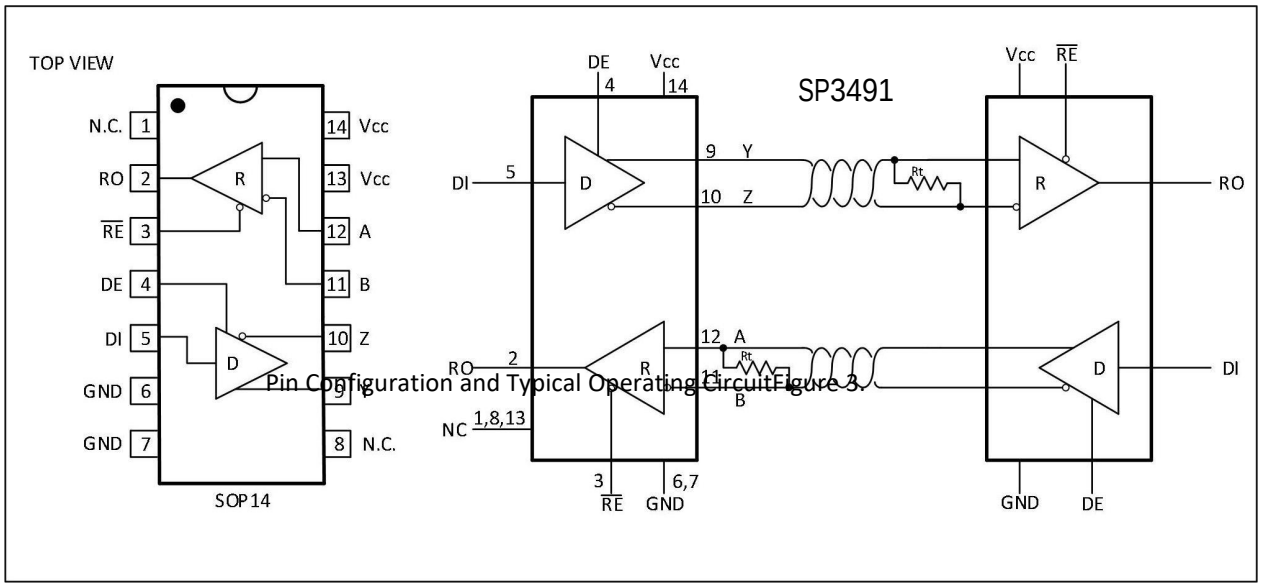
(V_{CC} = +3.3V, T_A = +25° C.)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	SP	UNITS
	Maximum Data Rate		12	15		Mbps
t_{DD}	Driver Differential Output Delay	R_L = 60Ω, Figure 7	1	22	35	ns
t_{DD}	Driver Differential Output Transition Time	R_L = 60Ω, Figure 7	3	11	25	ns
t_{PLH}	Driver Propagation Delay, Low-to-High Level	R_L = 27Ω, Figure 8	7	23	35	ns
t_{PHL}	Driver Propagation Delay, High-to-Low Level	R_L = 27Ω, Figure 8	7	23	35	ns
t_{PDS}	$\lvert t_{PLH} - t_{PHL} \rvert$ Driver Propagation Delay Skew (Note 2)	R_L = 27Ω, Figure 8		-1.4	±8	ns
DRIVER-OUTPUT ENABLE/DISABLE TIMES (SP3491 only)						
t_{PZL}	Driver-Output Enable Time to Low Level	R_L = 110Ω, Figure 10		42	90	ns
t_{PZH}	Driver-Output Enable Time to High Level	R_L = 110Ω, Figure 9		42	90	ns
t_{PHZ}	Driver-Output Disable Time from High Level	R_L = 110Ω, Figure 9		35	80	ns
t_{PLZ}	Driver-Output Disable Time from Low Level	R_L = 110Ω, Figure 10		35	80	ns
t_{PSL}	Driver-Output Enable Time from Shutdown to Low Level	R_L = 110Ω, Figure 10		650	900	ns
t_{PSH}	Driver-Output Enable Time from Shutdown to High Level	R_L = 110Ω, Figure 9		650	900	ns

4.6 Pin Description

PIN		NAME	FUNCTION
SP3490	SP3491		
SOP8	**SOP14**		
2	2	RO	Receiver Output: If A > B by 200mV, RO will be high; If A < B by 200mV, RO will be low.
—	3	$\overline{RE}$	Receiver Output Enable. RO is enabled when $\overline{RE}$ is low; RO is high impedance when RE is high.
—	4	DE	Driver Output Enable. The driver outputs, Y and Z, are enabled by bringing DE high. They are high impedance when DE is low. If the driver outputs are enabled, the parts function as line drivers. While they are high impedance, they function as line receivers if $\overline{RE}$ is low.
3	5	DI	Driver Input. A low on DI forces output Y low and output Z high. Similarly, a high on DI forces output Y high and output Z low.
4	6, 7	GND	Ground
5	9	Y	Non-inverting Driver Output
6	10	Z	Inverting Driver Output
—	—	A	Non-inverting Receiver Input and Non-inverting Driver Output
8	12	A	Non-inverting Receiver Input
—	—	B	Inverting Receiver Input and Inverting Driver Output
7	11	B	Inverting Receiver Input
1	14	V_{CC}	Positive Supply: 3.0V ≤ V_{CC} ≤ 5.5V. Do not operate device with V_{CC} > 5.5V
—	1, 8, 13	N.C.	No Connect—not internally connected





Pin Configuration and Typical Operating CircuitFigure 3.

SP3491
Pin Configuration and Typical Operating Circuit

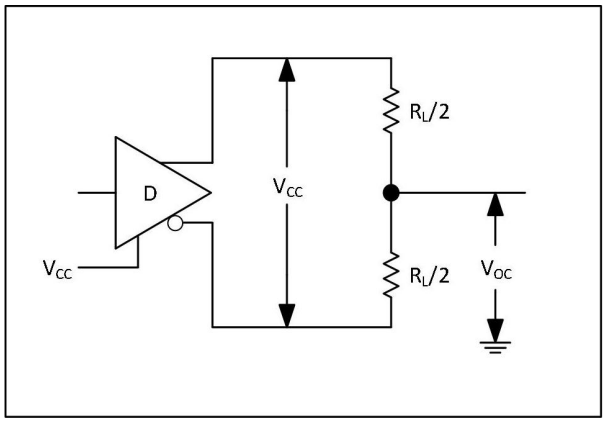


Figure 4. Driver V_{OD} and V_{OC}

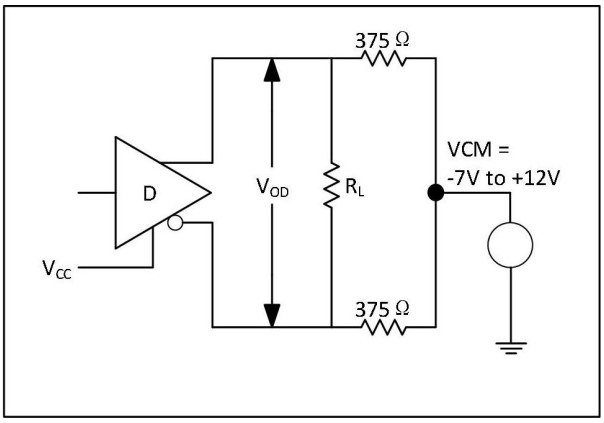


Figure 5.Driver V_{OD} with Varying Common-Mode Voltage

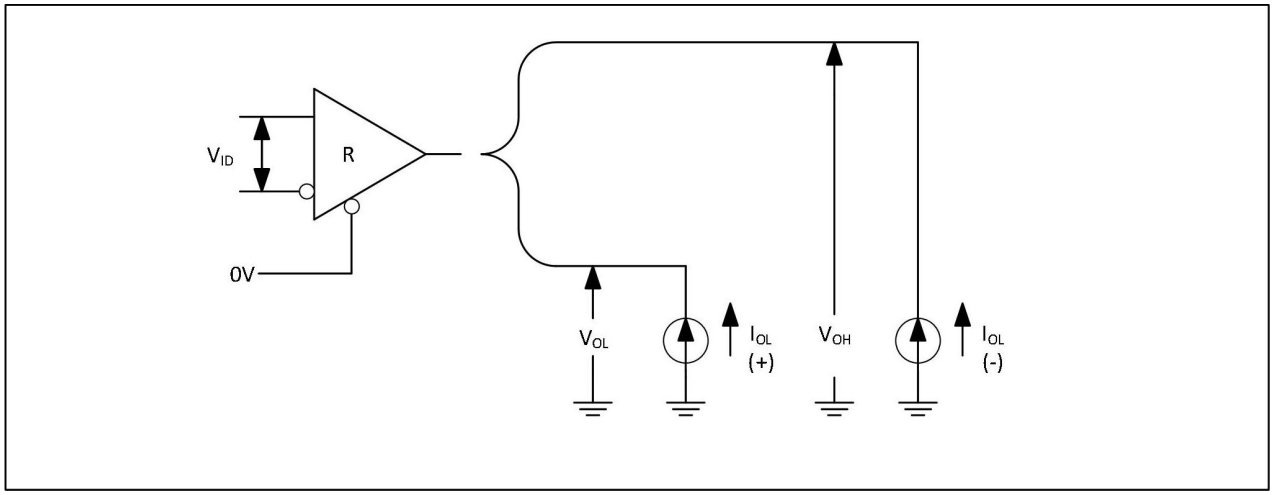


Figure 6. Receiver V_{OH} and V_{OL}

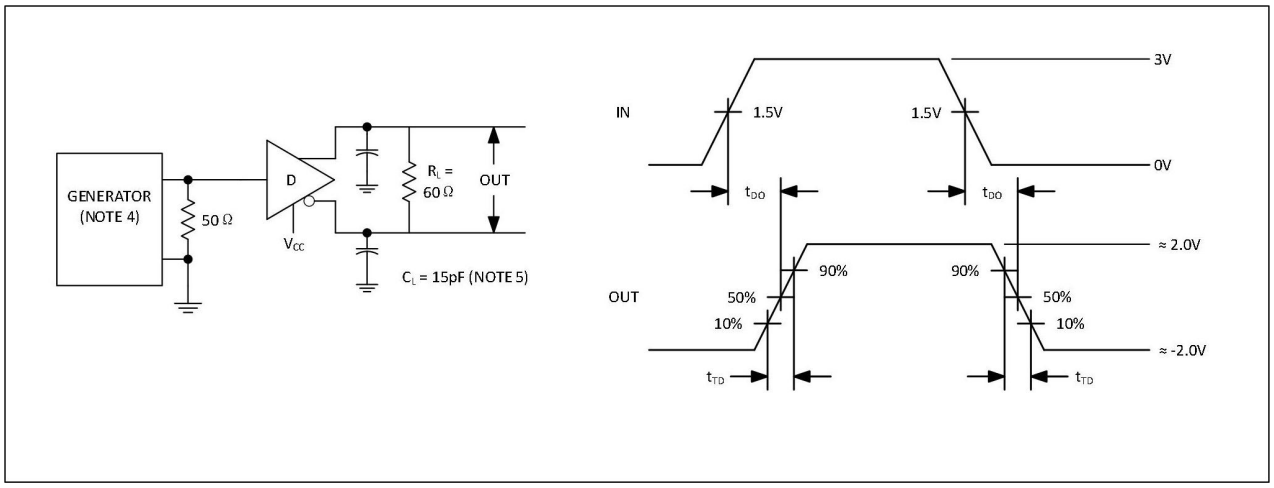


Figure 7. Driver Differential Output Delay and Transition Times

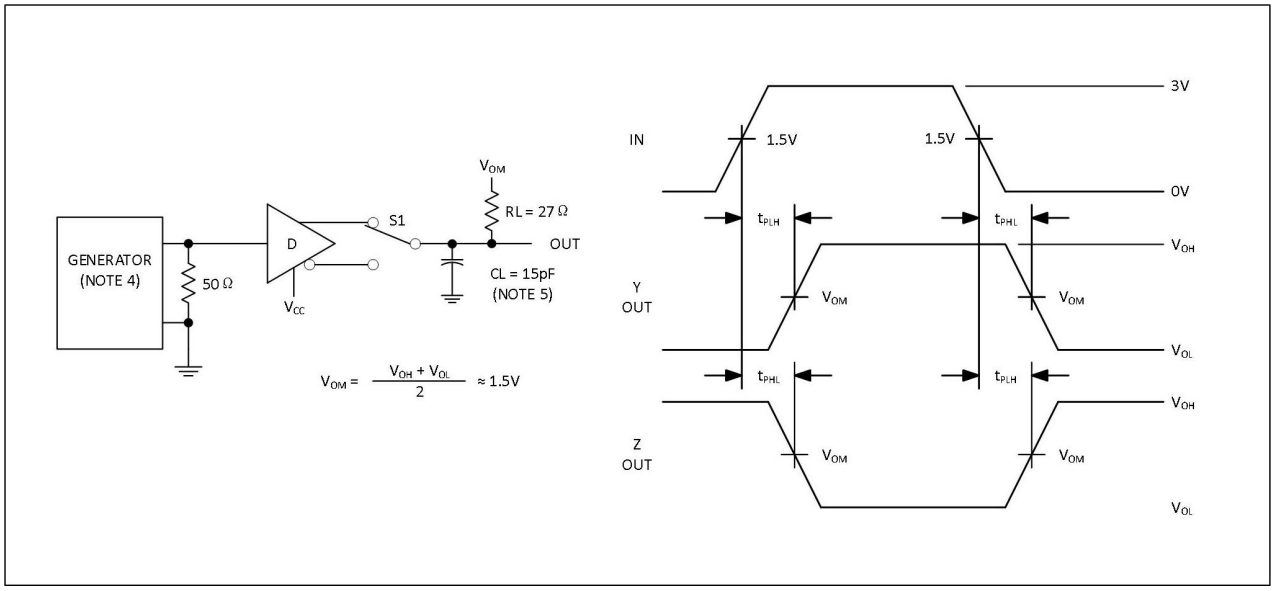


Figure 8. Driver Propagation Times

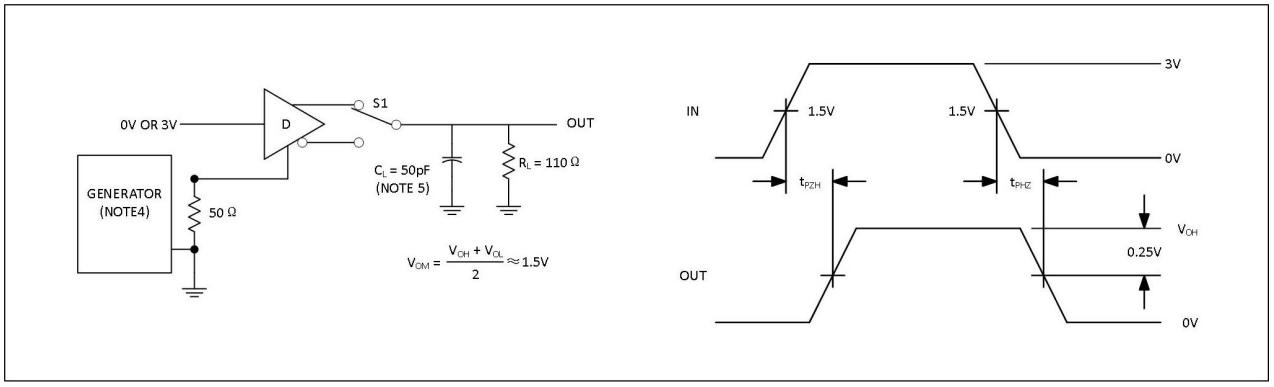


Figure 9. Driver Enable and Disable Times (t_{PZH}, t_{PSH}, t_{PHZ})

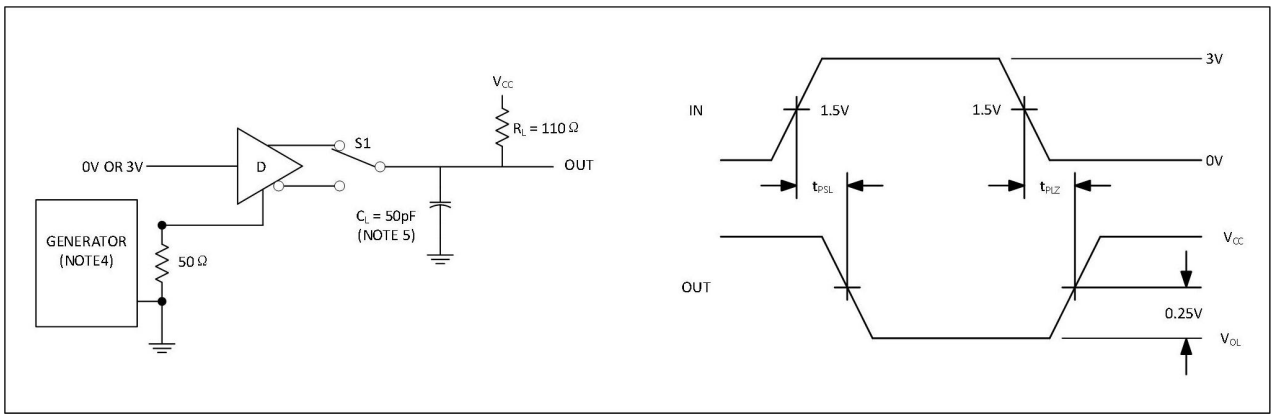


Figure 10. Driver Enable and Disable Times (t_{PZL}, $t_{PS}L$, t_{PLZ})

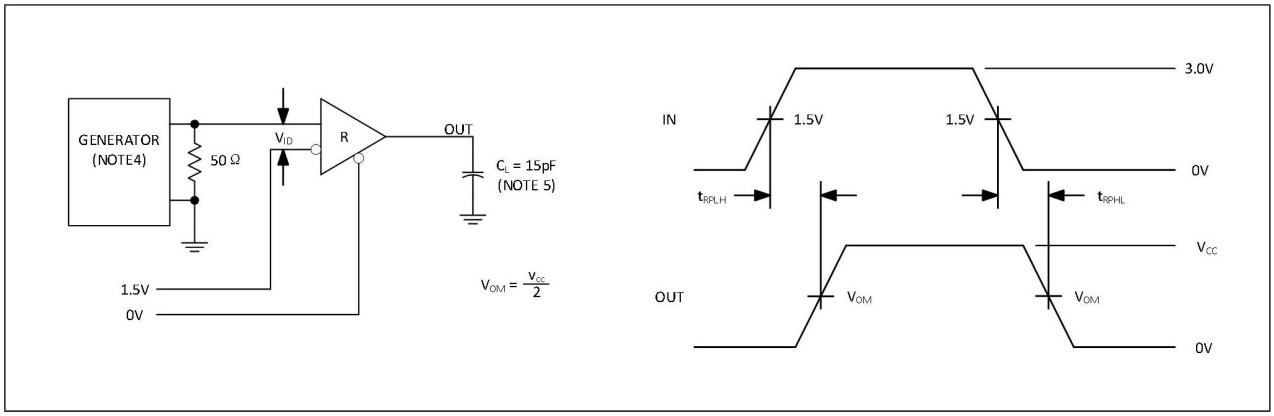


Figure 11. Receiver Propagation Delay

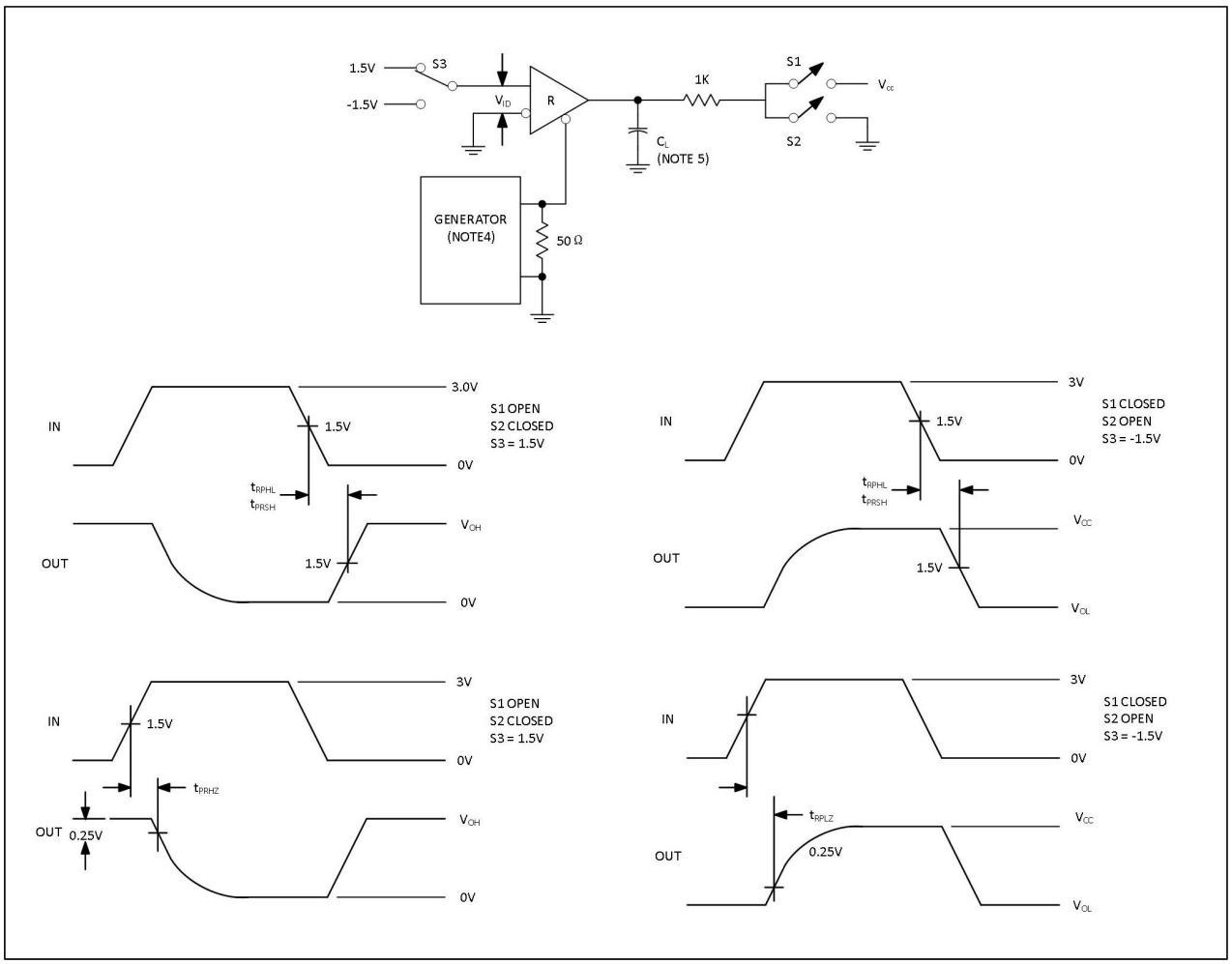


Figure 12. Receiver Enable and Disable Times

Note 4: The input pulse is supplied by a generator with the following characteristics: f = 250kHz, 50% duty cycle, $t_r \le 6.0$ns, $Z_O = 50\Omega$.

Note 5: C_L includes probe and stray capacitance.

5 Function Tables

5.1 Devices with Receiver/Driver Enable (SP3491)

Table 1. Transmitting

INPUTS			OUTPUTS		MODE
$\overline{RE}$	DE	DI	B*	A*	
×	1	1	0	1	Normal
×	1	0	1	0	Normal
0	0	×	High-Z	High-Z	Normal
1	0	×	High-Z	High-Z	Shutdown

* B and A outputs are Z and Y, respectively, for full-duplex part (SP3491).
X = Don't care; High-Z = High impedance

Table 2. Receiving

INPUTS			OUTPUTS	MODE
$\overline{RE}$	DE	A,B	RO	
×	1	≧ +0.2V	1	Normal
×	1	≦ -0.2V	0	Normal
0	0	Inputs Open	1	Normal
1	0	×	High-Z	Shutdown

* DE is a "don't care" (x) for the full-duplex part (SP3491).X =Don't care; High-Z = High impedance

5.2 Devices without Receiver/Driver Enable(SP3490)

Table 3. Transmitting

INPUT	OUTPUTS	
DI	Z	Y
1	0	1
0	1	0

Table 4. Receiving

INPUT	OUTPUT
A,B	RO
≧ +0.2V	1
≦ -0.2V	0
Inputs Open	1

6 Applications Information

The SP3490 /SP3491 are low-power transceivers for RS-485 and RS-422 communications. and the SP3490 /SP3491 at up to 12Mbps.
The 3SP3490 /SP3491 are
full-duplex transceivers, Driver Enable (DE) and Receiver Enable (RE) pins are included on the SP3491 . When disabled, the driver and receiver outputs are high impedance.

7 Low-Power Shutdown Mode SP3491)

A low-power shutdown mode is initiated by bringing both RE high and DE low. The devices will not shut down unless both the driver and receiver are disabled (high impedance). In shutdown, the devices typically draw only 1.3uA of supply current.For these devices, the t_{PSH} and t_{PSL} enable times assume the part was in the low-power shutdown mode; the t_{PZH} and t_{PZL} enable times assume the receiver or driver was disabled, but the part was not shut down.

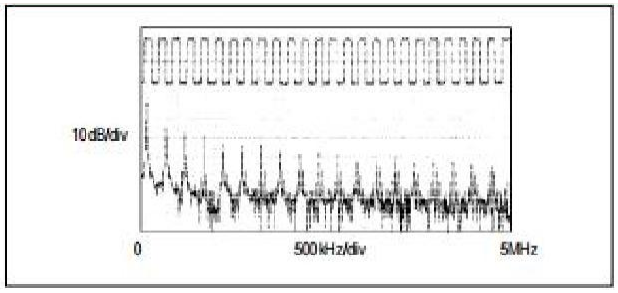


Figure 13. Driver Output Waveform and FFT Plot of SP3490 /SP3491 Transmitting a 125kHz Signal

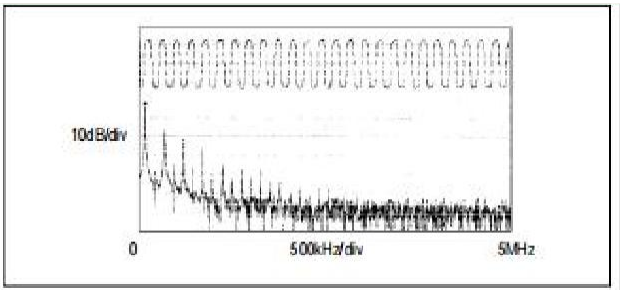


Figure 14. Driver Output Waveform and FFT Plot of SP3490 Transmitting a 125kHz Signal

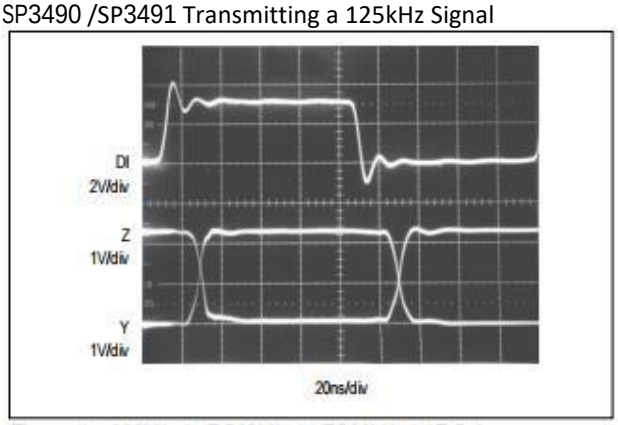


Figure 15. SP3490 /SP3491

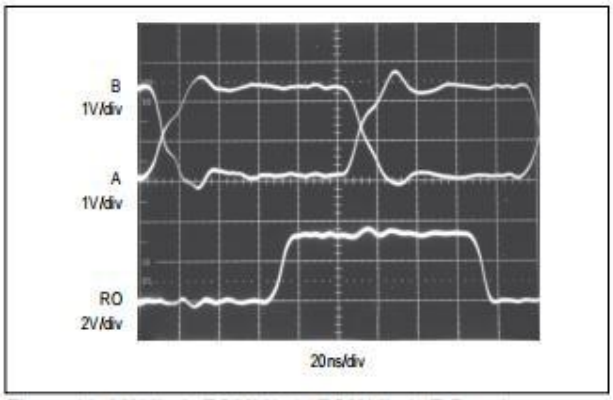
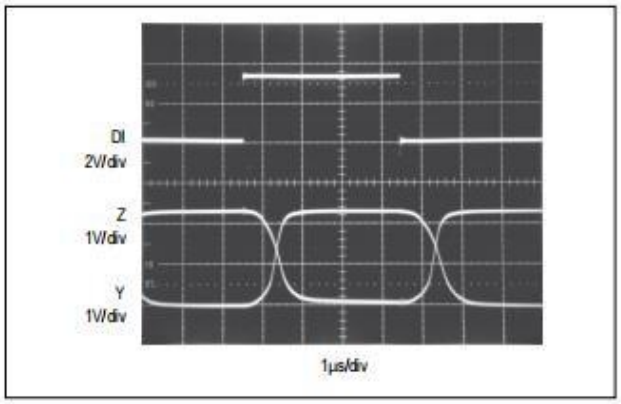
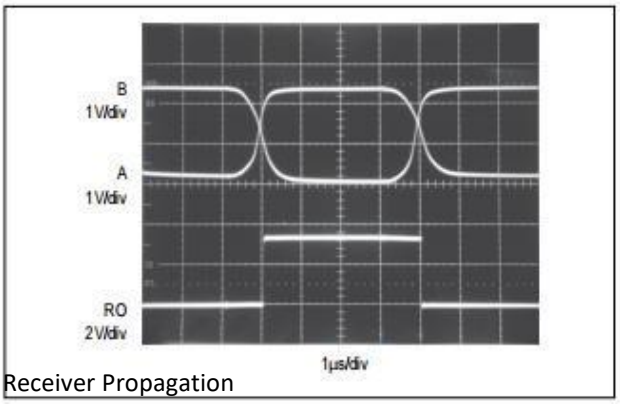


Figure 16. SP3490 /SP3491



Driver Propagation Delay



Receiver Propagation Delay Driven by External RS-485 Device

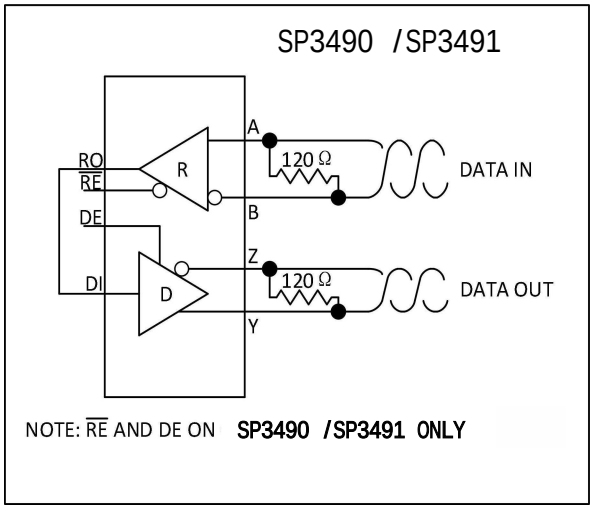


Figure 21. Line Repeater for SP3490 /SP3491

12 ±15kV ESD Protection

ESD-protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The driver outputs and receiver inputs of the SP3490 /SP3491 family of devices have extra protection against static electricity. Engineers have developed state-of the-art structures to protect these pins against ESD of ±15kV without damage. The ESD structures withstand high ESD in all states: normal operation, shutdown, and powered down.

ESD protection can be tested in various ways; the transmitter outputs and receiver inputs of this product family are characterized for protection to the following limits:

1) ±15kV using the Human Body Model
2) ±8kV using the Contact-Discharge method specified in IEC 1000-4-2
3) ±15kV using IEC 1000-4-2's Air-Gap method.

13 ESD Test Conditions

ESD performance depends on a variety of conditions. Contact us for a reliability report that documents test setup, test methodology, and test results.

14 Human Body Model

Figure 22a shows the Human Body Model and Figure 22b shows the current waveform it generates when discharged into a low impedance. This model consists of a 100pF capacitor charged to the ESD voltage of interest, which is then discharged into the test device through a 1.5kΩ resistor.

15 IEC 1000-4-2

The IEC 1000-4-2 standard covers ESD testing and performance of finished equipment; it does not specifically refer to integrated circuits. The SP3490 /SP3491 family of devices helps you design equipment that meets Level 4 (the highest level)of IEC 1000-4-2, without the need for additional ESD-protection components.

The major difference between tests done using the Human Body Model and IEC 1000-4-2 is higher peak current in IEC 1000-4-2, because series resistance is lower in the IEC 1000-4-2 model. Hence, the ESD withstand voltage measured to IEC 1000-4-2 is generally lower than that measured using the Human Body Model. Figure 23a shows the IEC 1000-4-2 model, and Figure 23b shows the current waveform for the ±8kV IEC 1000-4-2, Level 4 ESD contact-discharge test.

The air-gap test involves approaching the device with a charged probe. The contact-discharge method connects the probe to the device before the probe is energized.

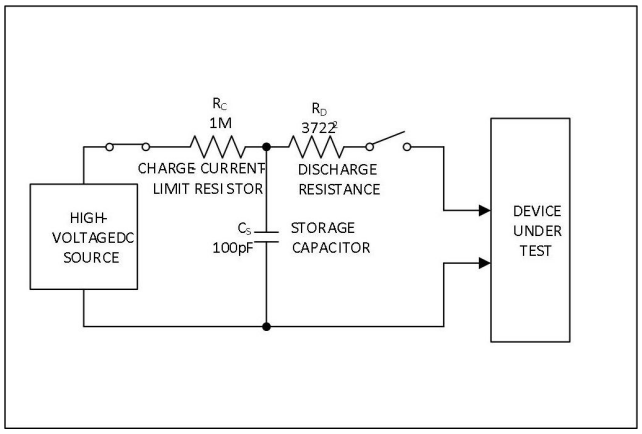


Figure 22a. Human Body ESD Test Model

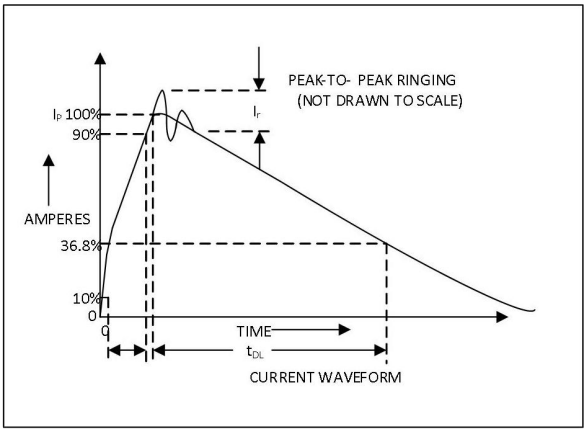


Figure 22b. Human Body Current Waveform

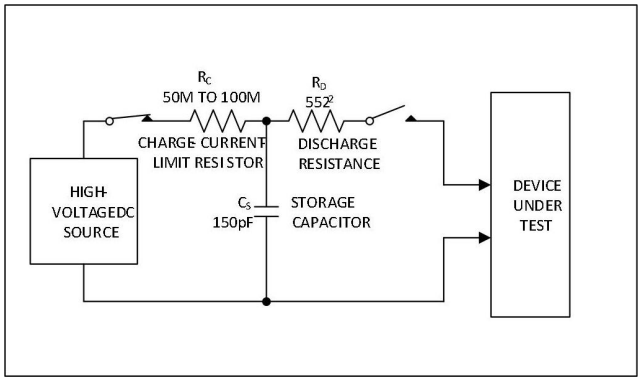


Figure 23a. IEC 1000-4-2 ESD Test Model

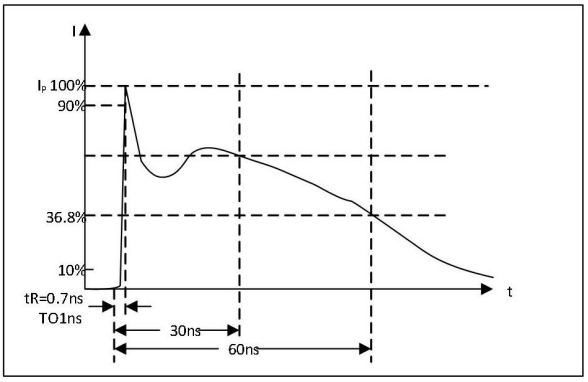


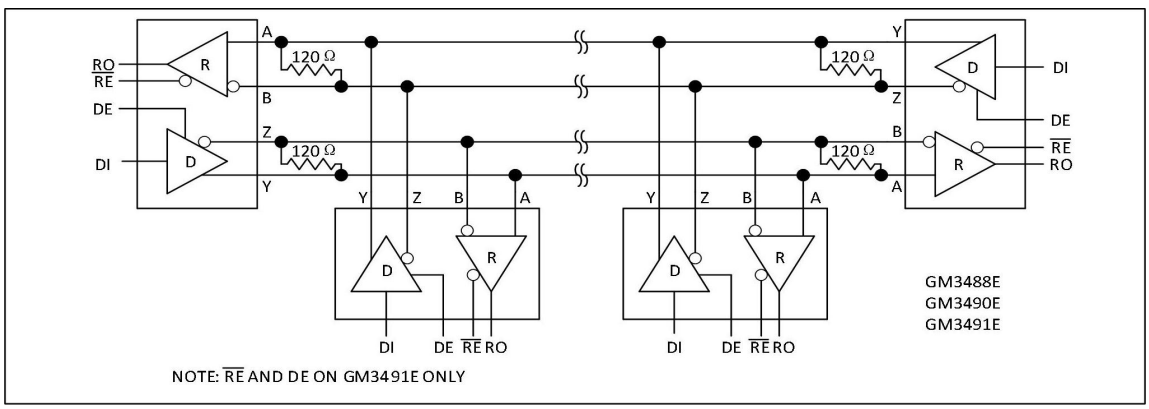
Figure 23b.IEC 1000-4-2 ESD Generator Current Waveform

16 Machine Model

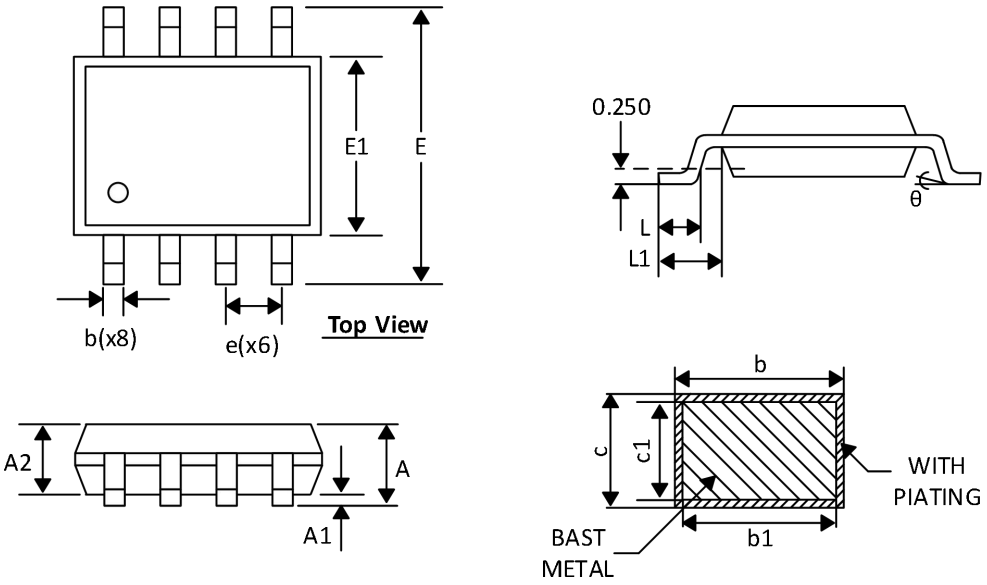
The Machine Model for ESD tests all pins using a 200pF storage capacitor and zero discharge resistance. Its objective is to emulate the stress caused when I/O pins are contacted by handling equipment during test and assembly. of course, all pins require this protection, not just RS-485 inputs and outputs.

17 Typical Applications

The SP3490 /SP3491 transceivers are designed for bidirectional data communications on multi point bus transmission lines. Figures 24 show typical net work applications circuits. These parts can also be used as line repeaters, with cable lengths longer than 4000 feet, as shown in Figure 21.To minimize reflections, the line should be terminated at both ends in its characteristic impedance, and stub lengths off the main line should be kept as short as possible. The slew-rate-limited SP3490 is more tolerant of imperfect termination.

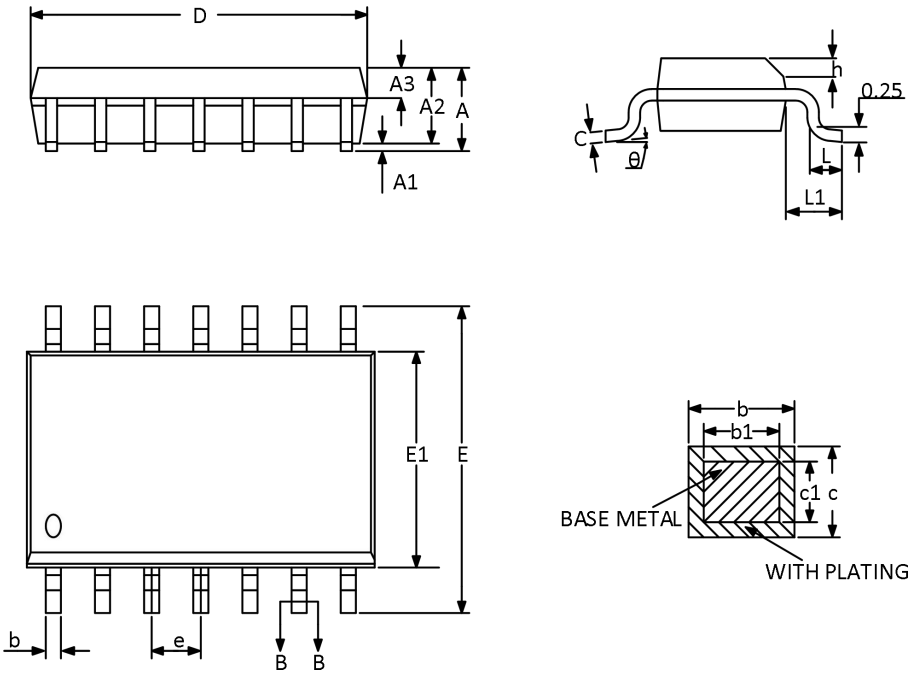


PACKAGE DIMENSION
SOP8



SYMBOLS	MILLIMETER		
	MIN	NOM	SP
A	-	-	1.75
A1	0.10	0.175	0.25
A2	1.30	1.40	1.50
b	0.31	-	0.50
b1	0.30	0.40	0.45
c	0.20	-	0.24
c1	0.19	0.203	0.21
D	4.80	-	5.00
E	5.80	6.00	6.20
E1	3.80	-	4.00
e	1.27 BSC		
L	0.40	-	0.80
L1	1.05 REF		
θ	0°	-	8°

SOP-14



SYMBOLS	MILLIMETER		
	MIN	NOM	SP
A	-	-	1.75
A1	0.05	-	0.225
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	-	0.47
b1	0.38	0.41	0.44
c	0.20	-	0.24
c1	0.19	0.20	0.21
D	8.55	8.65	8.75
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27BSC		
h	0.25	-	0.50
L	0.50	-	0.80
L1	1.05REF		
θ	0°	-	8°

Order Information

Order number	Package	Marking information	Operation Temperature Range	MSL Grade	Ship, Quantity	Green
SP3490EN	SOP8	SP3490EN	-40 to 85°C	3	T&R, 2500	Rohs
SP3491EN	SOP14	SP3491EN	-40 to 85°C	3	T&R, 2500	Rohs