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
Receiver Input Voltage (from Ground)	±18V
Driver Output Voltage (from Ground)	±18V
Short Circuit Duration, TX out to Ground	Continuous
Voltage at TTL Input Pins	-0.3V to (V_{CC} + 0.5V)
Storage Temperature Range	-65°C to +150°C
Lead Temperature (soldering, 10s)	+300°C

OPERATING CONDITIONS

Thermal Resistance	from junction to ambient (Θ_{JA})	31.6°C/W
	from junction to ambient (Θ_{JC})	12.4°C/W
Maximum Junction Temperature		125°C
Power Dissipation 40-pin QFN (derate 17mW/°C above +70°C)		500mW

ESD RATINGS

HBM - Human Body Model (Tx Output & Rx Input pins, R1-R9)	±15kV
HBM - Human Body Model (All other pins)	±4kV
IEC 61000-4-2 Airgap Discharge (Tx Output & Rx Input pins, R1-R9)	±15kV
IEC61000-4-2 Contact Discharge (Tx Output & Rx Input pins, R1-R9)	±8kV

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.

PIN DESCRIPTIONS BY MODE (MODE1, MODE0)

Pin	Name	00, Figure 1	01, Figure 2	10, Figure 3	11, Figure 4
1	L1	R1 Output		1	1
2	L2	R2 Output		R1 Output	R1 Output
3	L3	T1 Input		T1 Input	T1 Input
4	L4	T2 Input			
5	L6	R3 Output		1	1
6	L7	T3 Input			
7	L8	R4 Output		1	1
8	L9	R5 Output		1	1
9	VCC	V_{CC}			
10	GND	Ground			
11	SLEW		SLEW = V_{CC} enables 250kbps slew limiting		
12	DIR1			T1 Enable, R1 Disable	T1 Enable
13	N/C	This pin is not used and is not connected internally			
14	MODE0	0	1	0	1
15	MODE1	0	0	1	1
16	N/C	This pin is not used and is not connected internally			
17	TERM			Enables RS-485/422 receiver termination	
18	N/C	This pin is not used and is not connected internally			
19	ENABLE	ENABLE = V_{CC} for operation, ENABLE = 0V for shutdown			
20	VCC	V_{CC}			

PIN DESCRIPTIONS BY MODE (MODE1, MODE0)

Pin	Name	00, Figure 1	01, Figure 2	10, Figure 3	11, Figure 4
21	R9		R5 Input		
22	R8		R4 Input		
23	GND	Ground			
24	R7		T3 Output		
25	R6		R3 Input		
26	GND	Ground			
27	R4		T2 Output		R1 Input B
28	R3		T1 Output		R1 Input A
29	GND	Ground			
30	R2		R2 Input	R1 Input A, T1 Out A	T1 Out A
31	R1		R1 Input	R1 Input B, T1 Out B	T1 Out B
32	VCC	V_{CC} - 1.0µF to ground recommended for supply decoupling			
33	VSS	V_{SS} - Charge pump negative supply, 0.1µF from ground			
34	C2-	C_{2+} - Charge pump cap 2 negative lead			
35	C1-	C_{1-} - Charge pump cap 1 negative lead			
36	GND	Ground			
37	C1+	C_{1+} - Charge pump cap 1 positive lead, 0.1µF			
38	VCC	V_{CC}			
39	C2+	C_{2+} - Charge pump cap 2 positive lead, 0.1µF			
40	VDD	V_{DD} - Charge pump positive supply, 0.1µF to ground			

SUGGESTED DB9 CONNECTOR PINOUT

DB9 Pin	RS-232	RS-485/422 Full Duplex	RS-485 Half Duplex
1	DCD	TX-	Data-
2	RXD	TX+	Data+
3	TXD	RX+	
4	DTR	RX-	
5	Ground		
6	DSR		
7	RTS		
8	CTS		
9	RI		

ELECTRICAL CHARACTERISTICS

UNLESS OTHERWISE NOTED:
V_{CC} = +3.3V ±5% or +5.0V ±5%, C1-C4 = 0.1µF; $T_A = T_{MIN}$ to T_{MAX}. Typical values are at V_{CC} = 3.3V, T_A = +25°C.

SYMBOL	PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
DC CHARACTERISTICS						
I_{CC}	Supply Current (RS-232)		2	8	mA	No load, idle inputs
I_{CC}	Supply Current (RS-485)		2	8	mA	No load, idle inputs
I_{CC}	Vcc Shutdown Current		1	10	µA	ENABLE = 0V
TRANSMITTER and LOGIC INPUT PINS: Pins 3, 4, 6, 11, 12, 14, 15, 17-19						
V_{IH}	Logic Input Voltage High	2.0			V	V_{CC} = 3.3V
V_{IH}	Logic Input Voltage High	2.4			V	V_{CC} = 5.0V
V_{IL}	Logic Input Voltage Low			0.8	V	
I_{IL}	Logic Input Leakage Current Low			1	µA	Input Low (V_{IN} = 0V)
I_{IH}	Logic Input Leakage Current High			1	µA	Input High ($V_{IN} = V_{CC}$), pins 3, 4 and 6
I_{PD}	Logic Input Pull-down Current			50	µA	Input High ($V_{IN} = V_{CC}$), pins 11, 12, 14, 15, 17-19
V_{HYS}	Logic Input Hysteresis		200		mV	
RECEIVER OUTPUTS: Pins 1, 2, 5, 7, 8						
V_{OH}	Receiver Output Voltage High	V_{CC}-0.6			V	I_{OUT} = -1.5mA
V_{OL}	Receiver Output Voltage Low			0.4	V	I_{OUT} = 2.5mA
I_{OSS}	Receiver Output Short Circuit Current		±20	±60	mA	$0 \le V_O \le V_{CC}$
I_{OZ}	Receiver Output Leakage Current		±0.1	±1	µA	$0 \le V_O \le V_{CC}$, Receivers disabled

ELECTRICAL CHARACTERISTICS (Continued)

UNLESS OTHERWISE NOTED:
V_{CC} = +3.3V ±5% or +5.0V ±5%, C1-C4 = 0.1µF; $T_A = T_{MIN}$ to T_{MAX}. Typical values are at V_{CC} = 3.3V, T_A = +25°C.

SYMBOL	PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
SINGLE-ENDED RECEIVER INPUTS (RS-232)						
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		0.3		V	
R_{IN}	Input Resistance	3	5	7	kΩ	-15V ≤ V_{IN} ≤ +15V
SINGLE-ENDED DRIVER OUTPUTS (RS-232)						
V_O	Output Voltage Swing	±5.0	±5.5		V	Output loaded with 3kΩ to Gnd
				±7.0	V	No load output
I_{SC}	Short Circuit Current			±60	mA	V_O = 0V
R_{OFF}	Power Off Impedance	300	10M		Ω	V_{CC} = 0V, V_O = ±2V

ELECTRICAL CHARACTERISTICS (Continued)

UNLESS OTHERWISE NOTED:
V_{CC} = +3.3V ±5% or +5.0V ±5%, C1-C4 = 0.1µF; $T_A = T_{MIN}$ to T_{MAX}. Typical values are at V_{CC} = 3.3V, T_A = +25°C.

SYMBOL	PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
DIFFERENTIAL RECEIVER INPUTS (RS-485 / RS-422)						
R_{IN}	Receiver Input Resistance	96			kΩ	TERM = 0V, -7V ≤ V_{IN} ≤ +12V
V_{TH}	Receiver Differential Threshold Voltage	-200	-125	-50	mV	
ΔV_{TH}	Receiver Input Hysteresis		25		mV	V_{CM} = 0V
I_{IN}	Receiver Input Current			125	µA	V_{IN} = +12V
				-100	µA	V_{IN} = -7V
R_{TERM}	Termination Resistance	100	120	155	Ω	TERM = V_{CC}, Figure 5 -7V ≤ V_{CM} ≤ +12V
R_{TERM}	Termination Resistance	100	120	140	Ω	TERM = V_{CC}, Figure 5 V_{CM} = 0V
DIFFERENTIAL DRIVER OUTPUTS (RS-485 / RS-422)						
V_{OD}	Differential Driver Output	2		V_{CC}	V	R_L = 100Ω (RS-422), Figure 6
		1.5		V_{CC}	V	R_L = 54Ω (RS-485), Figure 6
		1.5		V_{CC}	V	-7V ≤ V_{CM} ≤ +12V, Figure 7
				V_{CC}	V	No Load
ΔV_{OD}	Change In Magnitude of Differential Output Voltage	-0.2		+0.2	V	R_L = 54Ω or 100Ω, Figure 6
V_{CM}	Driver Common Mode Output Voltage			3	V	R_L = 54Ω or 100Ω, Figure 6
ΔV_{CM}	Change In Magnitude of Common Mode Output Voltage			0.2	V	R_L = 54Ω or 100Ω, Figure 6
I_{OSD}	Driver Output Short Circuit Current	-250		250	mA	-7V ≤ V_O ≤ +12V, Figure 8
I_O	Driver Output Leakage Current			100	µA	DIR1 = 0V in Mode 11, or ENABLE = 0V, V_O = +12V, V_{CC} = 0V or 5.25V
		-100			µA	DIR1 = 0V in Mode 11, or ENABLE = 0V, V_O = -7V, V_{CC} = 0V or 5.25V

TIMING CHARACTERISTICS

UNLESS OTHERWISE NOTED:
V_{CC} = +3.3V ±5% or +5.0V ±5%, C1-C4 = 0.1µF; $T_A = T_{MIN}$ to T_{MAX}. Typical values are at V_{CC} = 3.3V, T_A = +25°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 (SLEW = Vcc), ONE TRANSMITTER SWITCHING						
	Maximum Data Rate	250			kbps	R_L = 3kΩ, C_L = 1000pF
t_{RHL}, t_{RLH}	Receiver Propagation Delay		100		ns	C_L = 150pF, Figure 9
$\lvert t_{RHL}-t_{RLH} \rvert$	Receiver Propagation Delay Skew			100	ns	
t_{DHL}, t_{DLH}	Driver Propagation Delay		1400		ns	R_L = 3kΩ, C_L = 2500pF, Figure 10
$\lvert t_{DHL}-t_{DLH} \rvert$	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	4		30	V/µs	V_{CC} = 3.3V, R_L = 3kΩ to 7kΩ, C_L = 150pF to 2500pF, Figure 10
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 = 3kΩ to 7kΩ, C_L = 150pF to 2500pF, T_A = 25°C, Figure 10
RS-232, DATA RATE = 1Mbps (SLEW = 0V), ONE TRANSMITTER SWITCHING						
	Maximum Data Rate	1			Mbps	R_L = 3kΩ, C_L = 250pF
t_{RHL}, t_{RLH}	Receiver Propagation Delay		100		ns	C_L = 150pF, Figure 9
$\lvert t_{RHL}-t_{RLH} \rvert$	Receiver Propagation Delay Skew			100	ns	
t_{DHL}, t_{DLH}	Driver Propagation Delay		300		ns	R_L = 3kΩ, C_L = 1000pF, Figure 10
$\lvert t_{DHL}-t_{DLH} \rvert$	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	15		150	V/µs	V_{CC} = 3.3V, R_L = 3kΩ to 7kΩ, C_L = 150pF to 1000pF, Figure 10
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 = 3kΩ to 7kΩ, C_L = 150pF to 1000pF, T_A = 25°C, Figure 10

TIMING CHARACTERISTICS (Continued)

UNLESS OTHERWISE NOTED:
V_{CC} = +3.3V ±5% or +5.0V ±5%, C1-C4 = 0.1µF; $T_A = T_{MIN}$ to T_{MAX}. Typical values are at V_{CC} = 3.3V, T_A = +25°C.

SYMBOL	PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
RS-485/RS-422, DATA RATE = 250kbps (SLEW = Vcc), ONE TRANSMITTER SWITCHING						
	Maximum Data Rate	250			kbps	R_L = 54Ω, C_L = 50pF
t_{RPHL}, t_{RPLH}	Receiver Propagation Delay		50	150	ns	C_L = 15pF, Figure 11
$\lvert t_{RPHL}-t_{RPLH} \rvert$	Receiver Propagation Delay Skew			20	ns	
t_{DPHL}, t_{DPLH}	Driver Propagation Delay		500	1000	ns	R_L = 54Ω, C_L = 50pF, Figure 12
$\lvert t_{DPHL}-t_{DPLH} \rvert$	Driver Propagation Delay Skew			100	ns	
t_{DR}, t_{DF}	Driver Rise and Fall Time	300	650	1200	ns	
t_{RZH}, t_{RZL}	Receiver Output Enable Time			200	ns	C_L = 15pF, Figure 13
t_{RHZ}, t_{RLZ}	Receiver Output Disable Time			200	ns	
t_{DZH}, t_{DZL}	Driver Output Enable Time			1000	ns	R_L = 500Ω, C_L = 50pF, Figure 14
t_{DHZ}, t_{DLZ}	Driver Output Disable Time			200	ns	
RS-485/RS-422, DATA RATE = 20Mbps (SLEW = 0V), ONE TRANSMITTER SWITCHING						
	Maximum Data Rate	20			Mbps	R_L = 54Ω, C_L = 50pF
t_{RPHL}, t_{RPLH}	Receiver Propagation Delay		50	150	ns	C_L = 15pF, Figure 11
$\lvert t_{RPHL}-t_{RPLH} \rvert$	Receiver Propagation Delay Skew			10	ns	
t_{DPHL}, t_{DPLH}	Driver Propagation Delay		30	100	ns	R_L = 54Ω, C_L = 50pF, Figure 12
$\lvert t_{DPHL}-t_{DPLH} \rvert$	Driver Propagation Delay Skew			10	ns	
t_{DR}, t_{DF}	Driver Rise and Fall Time		10	20	ns	
t_{RZH}, t_{RZL}	Receiver Output Enable Time			200	ns	C_L = 15pF, Figure 13
t_{RHZ}, t_{RLZ}	Receiver Output Disable Time			200	ns	
t_{DZH}, t_{DZL}	Driver Output Enable Time			200	ns	R_L = 500Ω, C_L = 50pF, Figure 14
t_{DHZ}, t_{DLZ}	Driver Output Disable Time			200	ns	

BLOCK DIAGRAM BY MODE (MODE1, MODE0)

FIGURE 1. MODE 00 - LOOPBACK

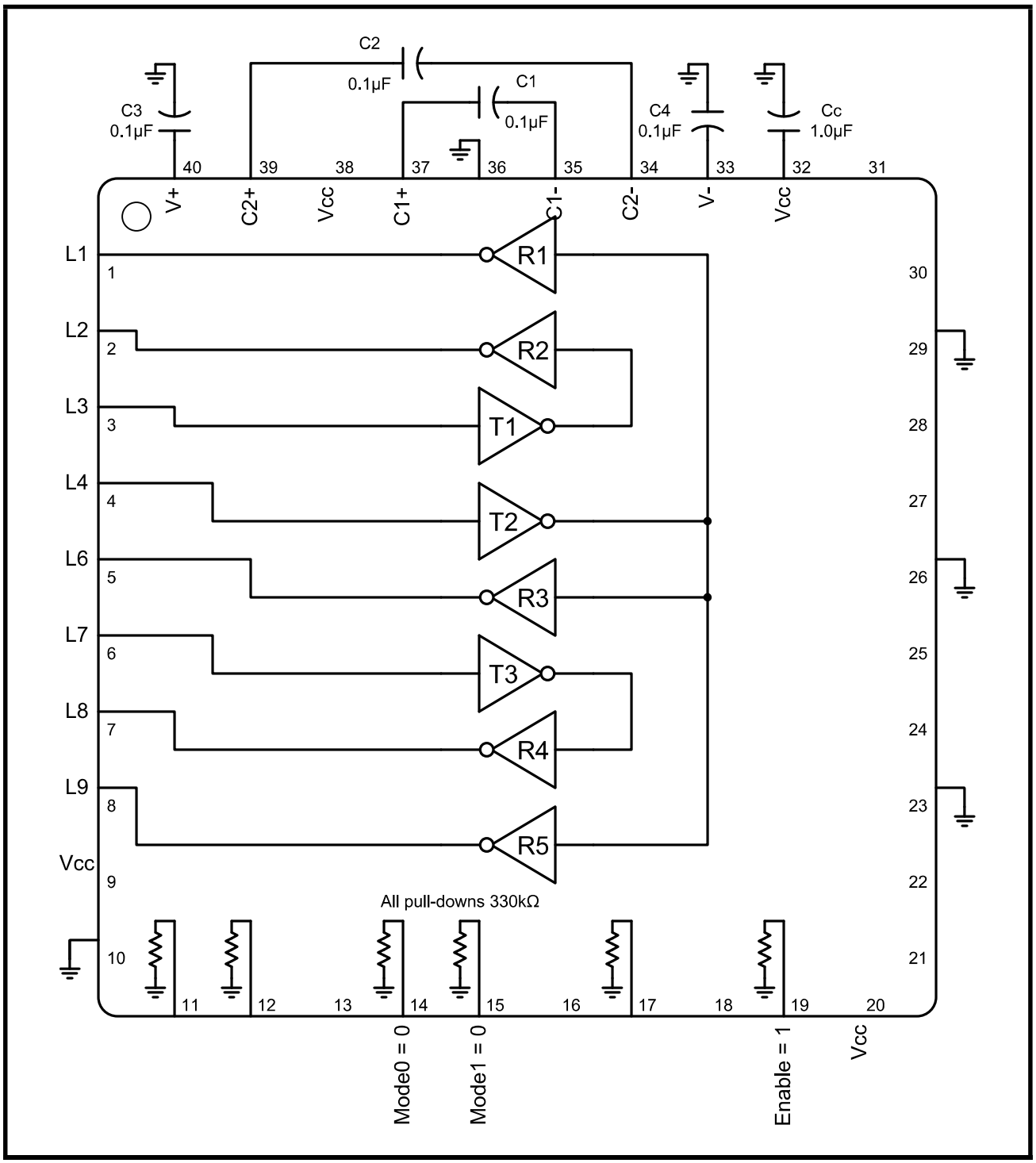


FIGURE 2. MODE 01 - RS-232

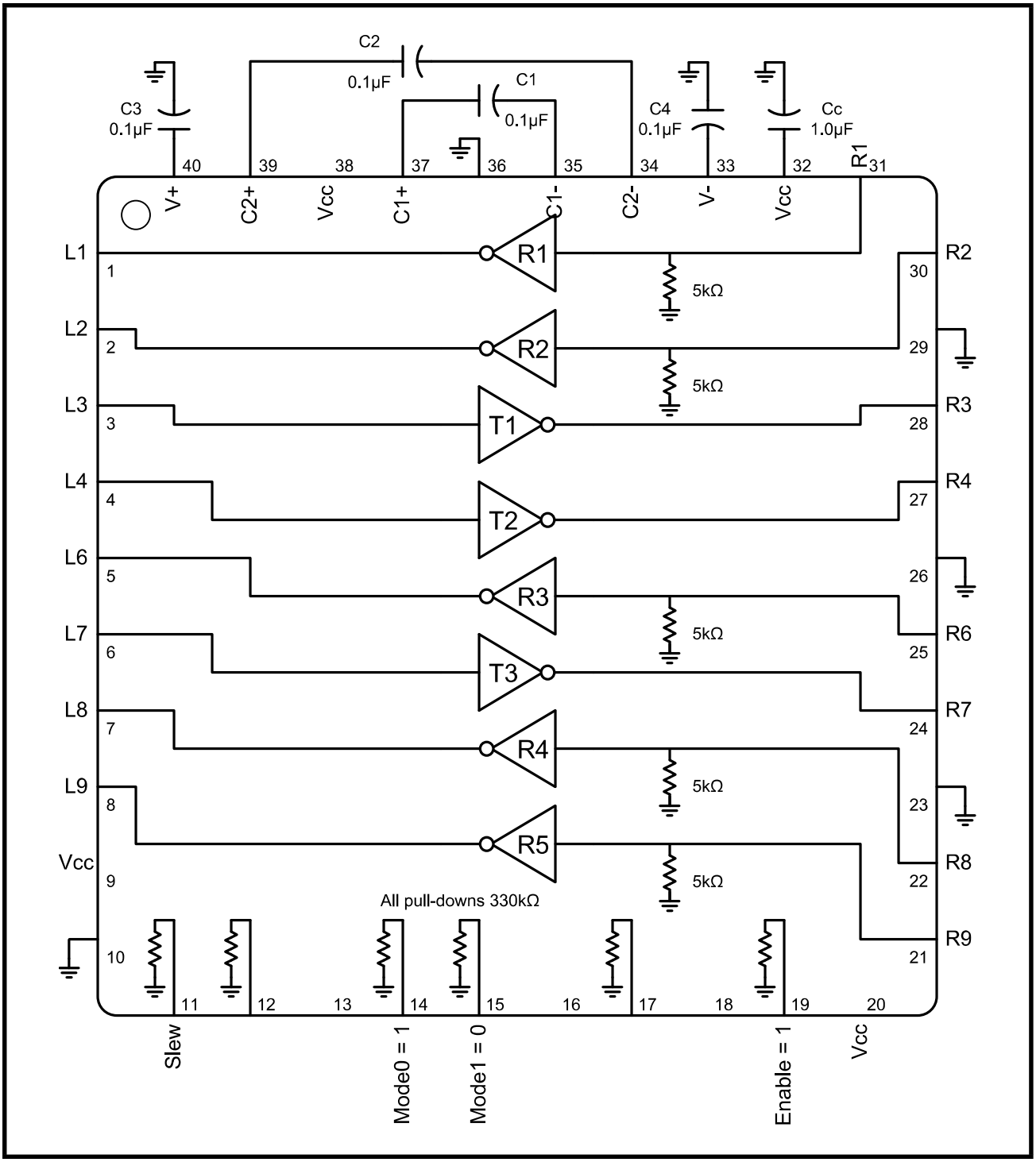


FIGURE 3. MODE 10 - RS-485 HALF DUPLEX

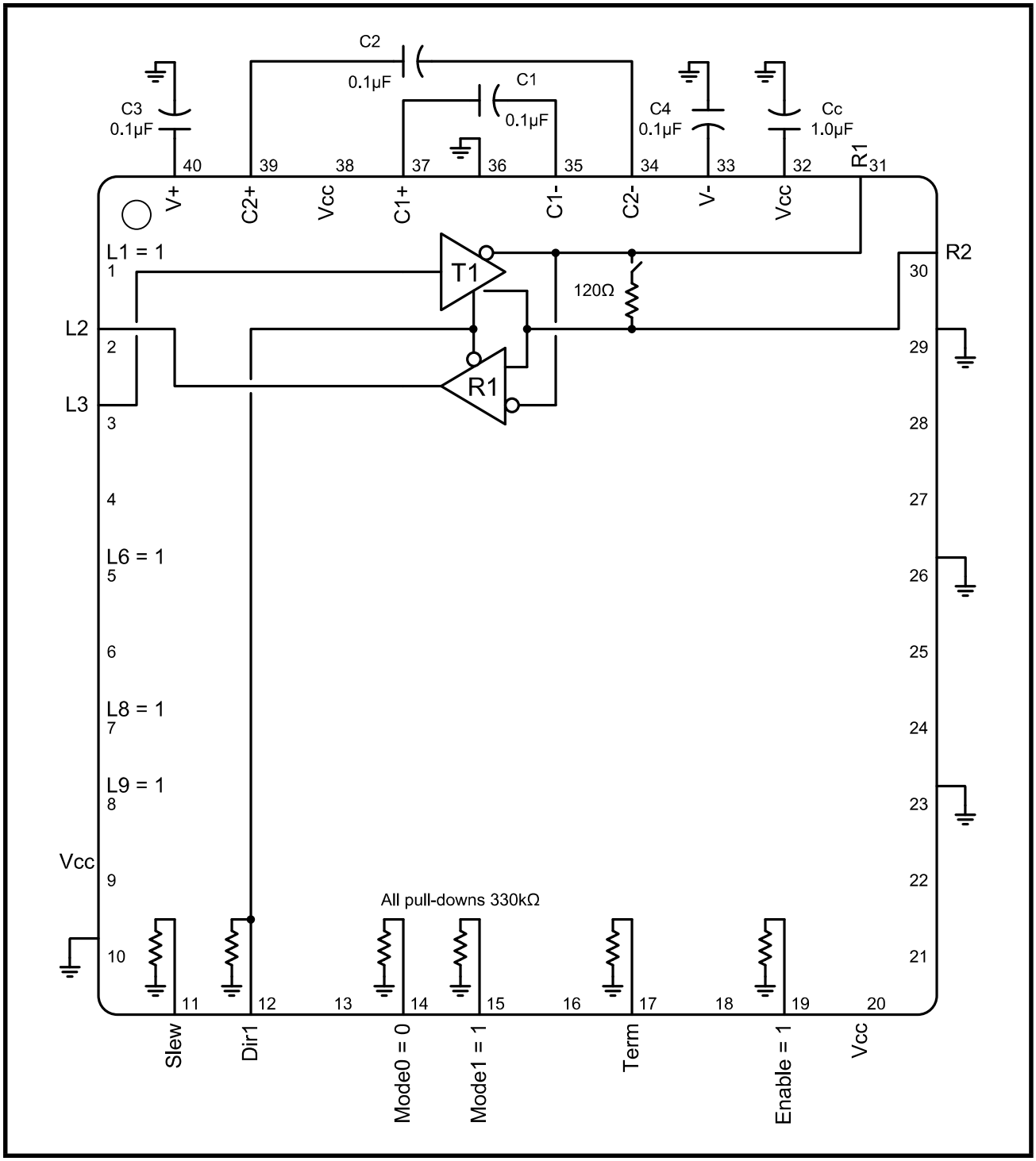
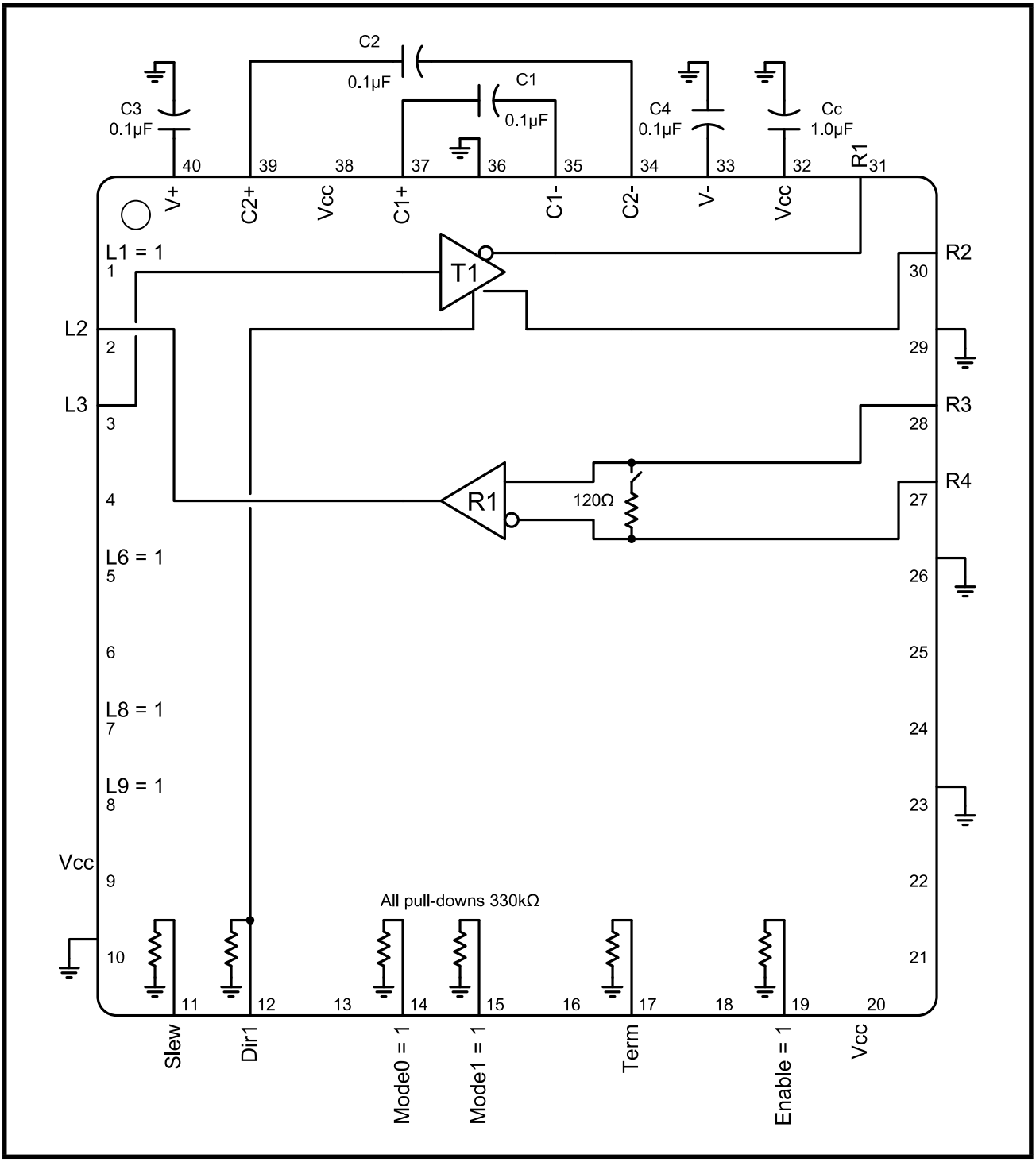


FIGURE 4. MODE 11 - RS-485/422 FULL DUPLEX



TEST CIRCUITS

FIGURE 5. RS-485/422 RECEIVER TERMINATION RESISTANCE

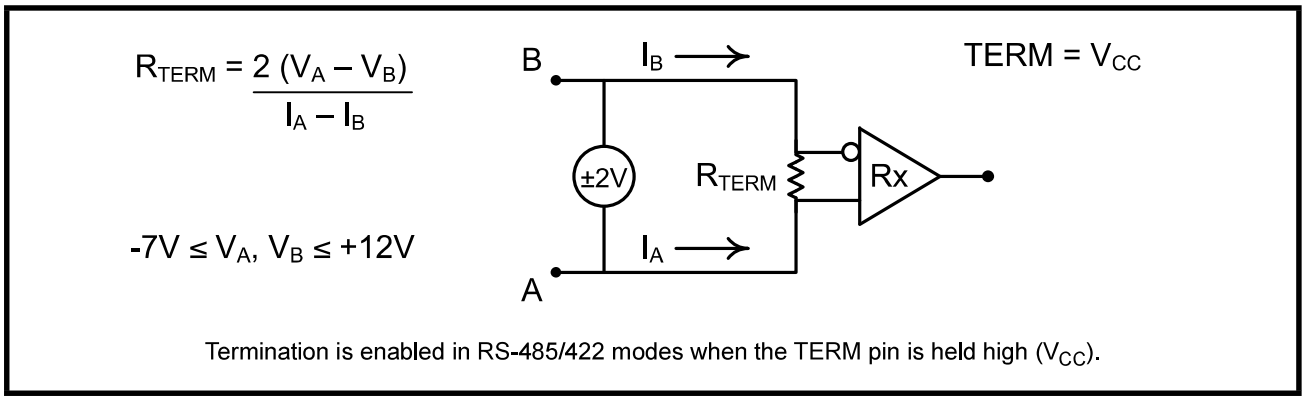


FIGURE 6. RS-485/422 DIFFERENTIAL DRIVER OUTPUT VOLTAGE

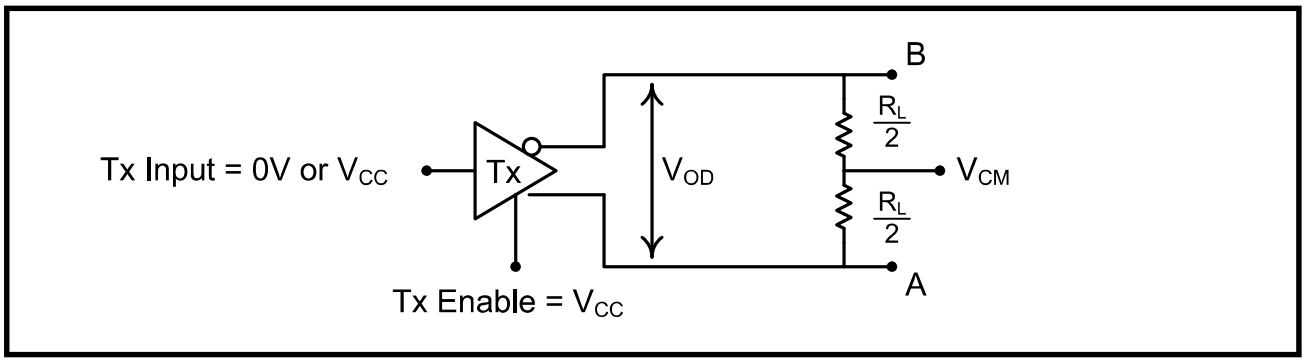


FIGURE 7. RS-485/422 DIFFERENTIAL DRIVER OUTPUT VOLTAGE OVER COMMON MODE

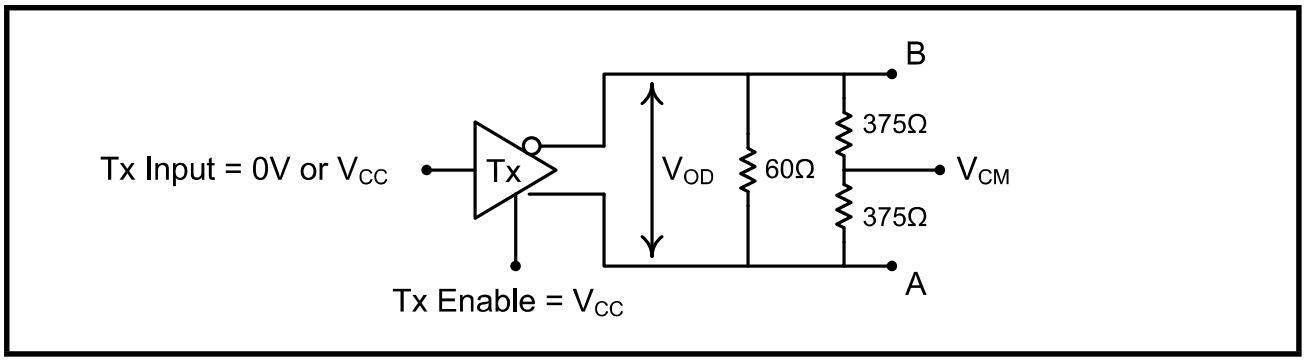


FIGURE 8. RS-485/422 DRIVER OUTPUT SHORT CIRCUIT CURRENT

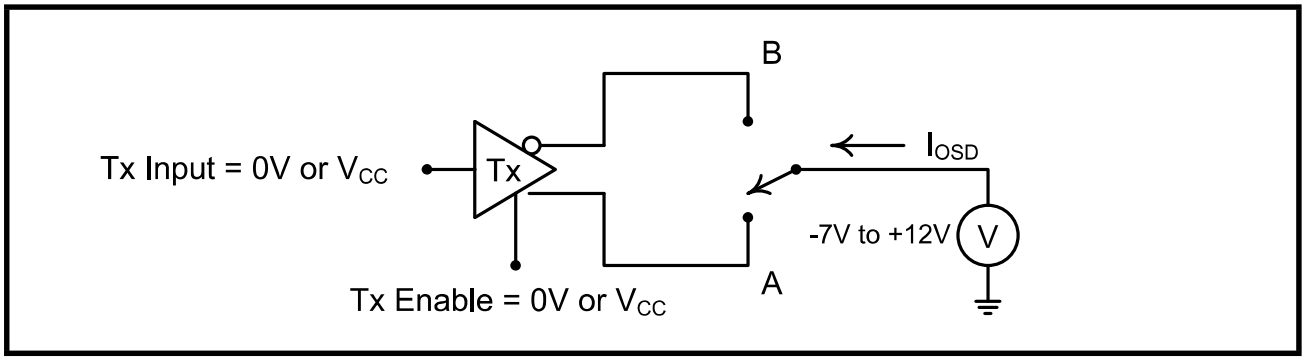


FIGURE 9. RS-232 RECEIVER PROPAGATION DELAY

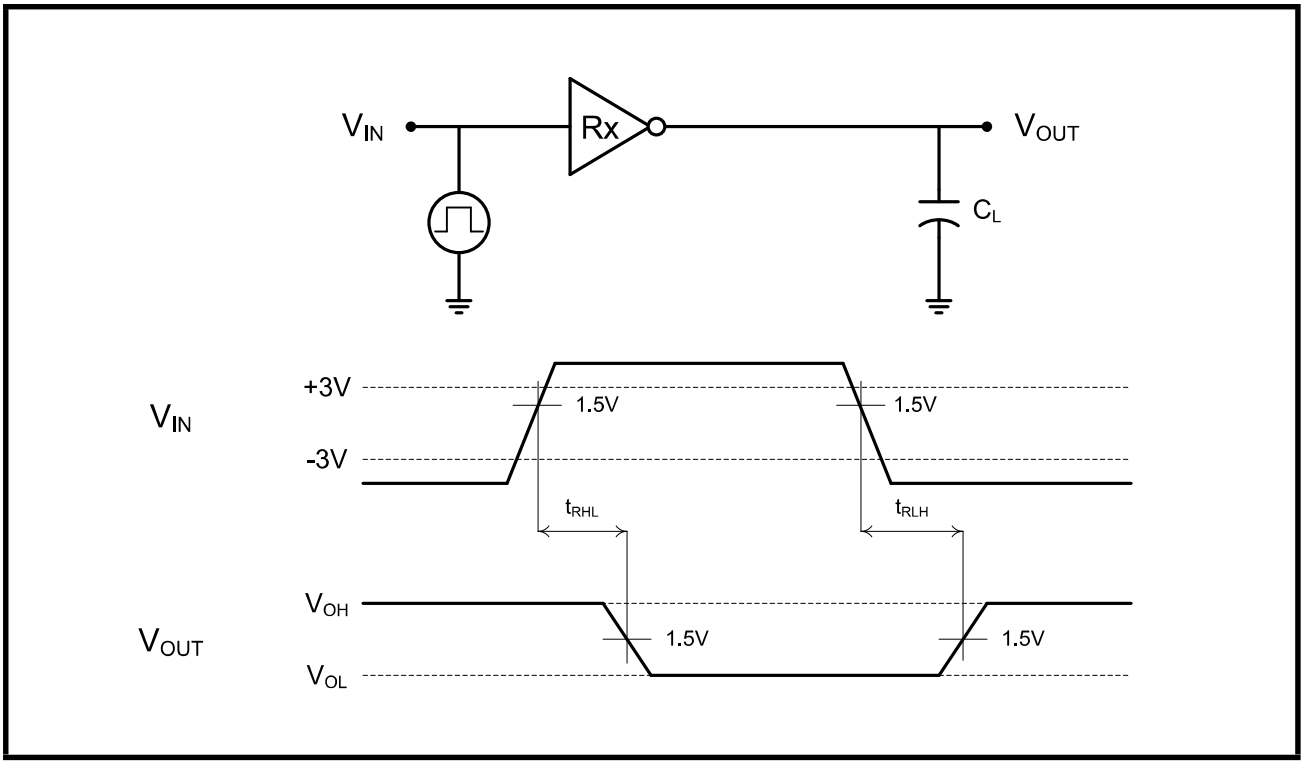


FIGURE 10. RS-232 DRIVER PROPAGATION DELAY

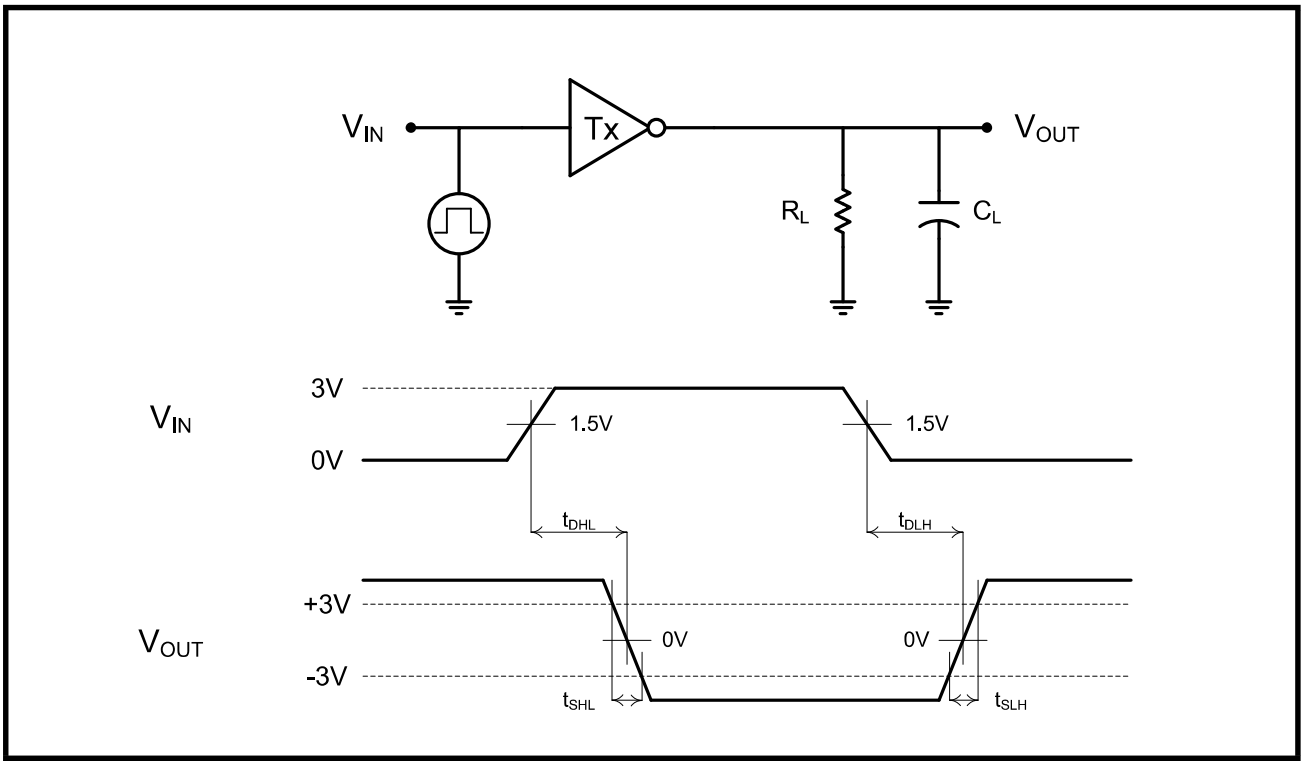


FIGURE 11. RS-485/422 RECEIVER PROPAGATION DELAY

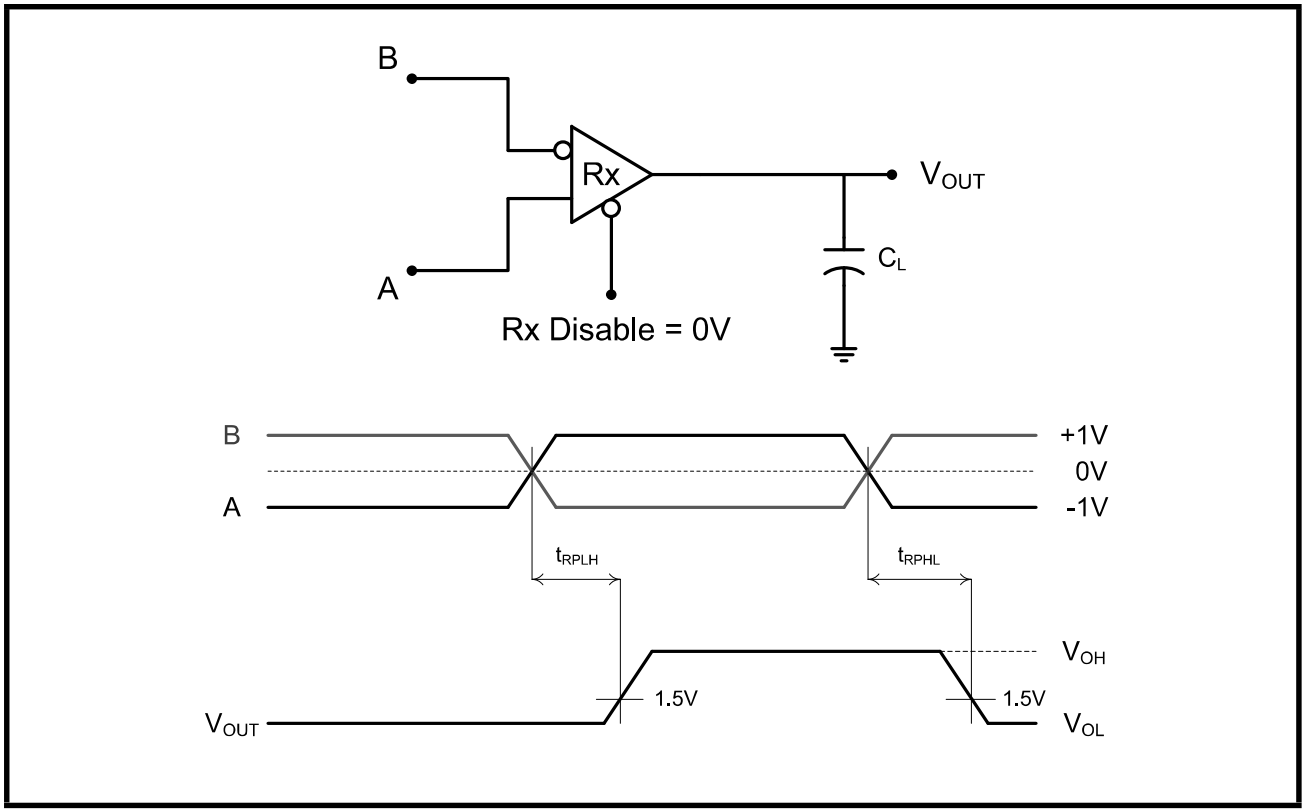


FIGURE 12. RS-485/422 DRIVER PROPAGATION DELAY AND RISE/FALL TIMES

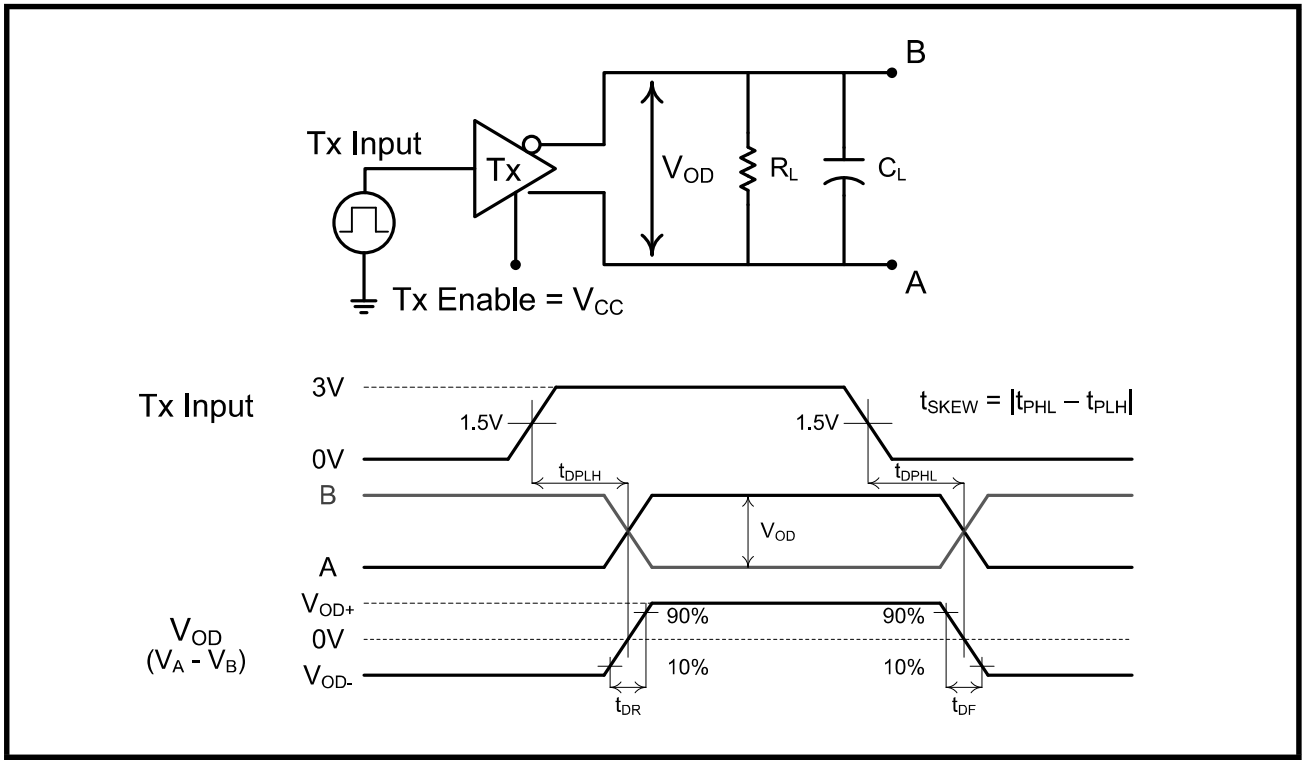


FIGURE 13. RS-485/422 RECEIVER OUTPUT ENABLE/DISABLE TIMES

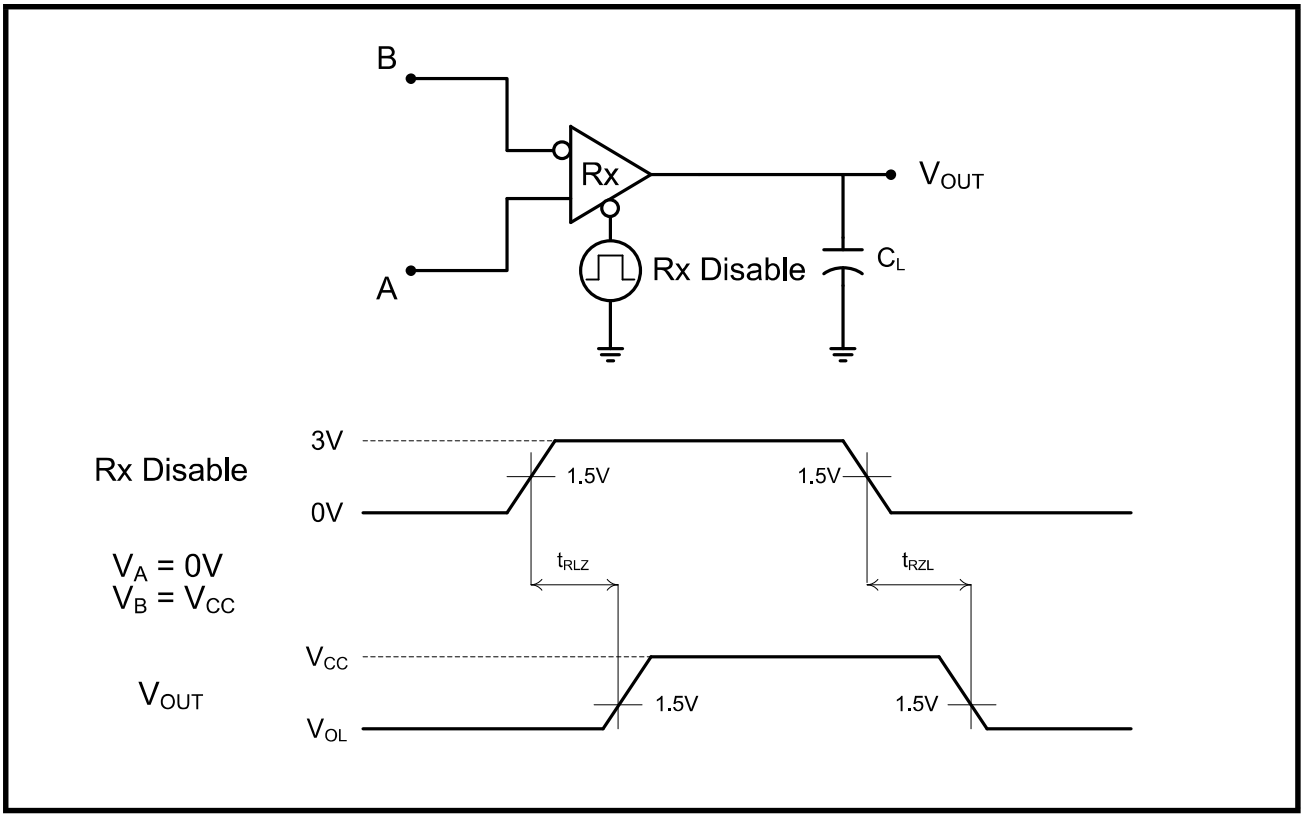
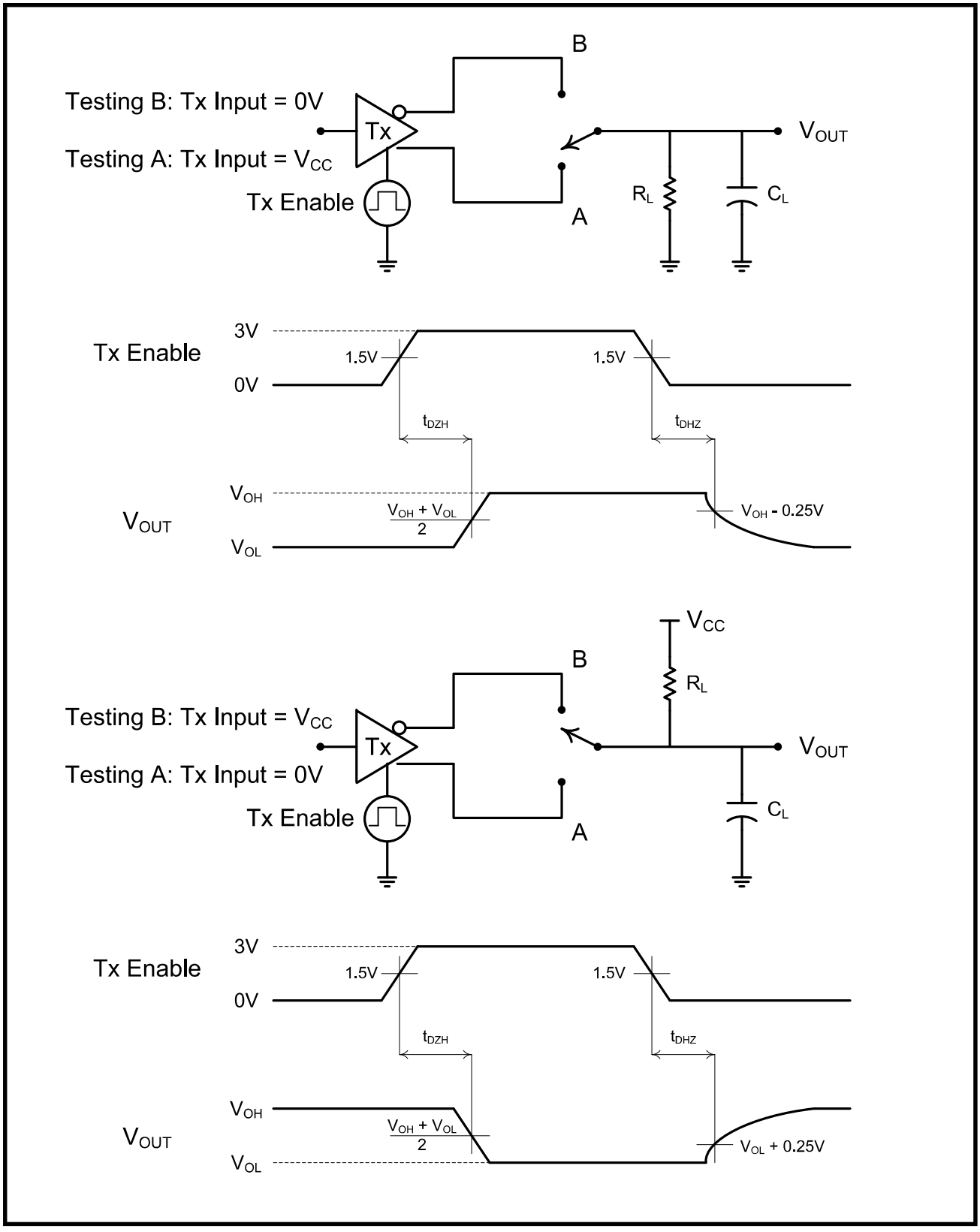


FIGURE 14. RS-485/422 DRIVER OUTPUT ENABLE/DISABLE TIMES



PRODUCT SUMMARY

The SP339 is an advanced multiprotocol transceiver supporting RS-232, RS-485, and RS-422 serial standards in a 40 pin QFN package. Integrated cable termination and four configuration modes allow all three protocols to be used interchangeably over a single cable or connector with no additional switching components. The RS-485/422 modes feature one driver and one receiver (1TX/1RX) in both half and full duplex configurations. The RS-232 mode (3TX/5RX) provides full support of all eight signals commonly used with the DB9 RS-232 connector. A dedicated mode is also available for diagnostic loopback testing.

INTERNALLY SWITCHED CABLE TERMINATION

Enabling and disabling the RS-485/422 termination resistor is one of the largest challenges system designers face when sharing a single connector or pair of lines across multiple serial protocols. A termination resistor may be necessary for accurate RS-485/422 communication, but must be removed when the lines are used for RS-232. SP339 provides an elegant solution to this problem by integrating the termination resistor and switching control, and allowing it to be switched in and out of the circuit with a single pin. No external switching components are required.

ENHANCED FAILSAFE

Ordinary RS-485 differential receivers will be in an indeterminate state whenever the data bus is not being actively driven. The enhanced failsafe feature of the SP339 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 ±200mV. No external biasing resistors are required, further easing the usage of multiple protocols over a single connector.

±15kV 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 ±15kV without damage. These structures withstand high ESD in all states: normal operation, shutdown and powered down.

ESD protection is be tested in various ways. MaxLinear uses the following methods to qualify the protection structures designed into SP339:

±15kV using the Human Body Model (HBM)

± 8kV using IEC 61000-4-2 Contact Discharge

± 15kV using IEC 61000-4-2 Air Gap Discharge

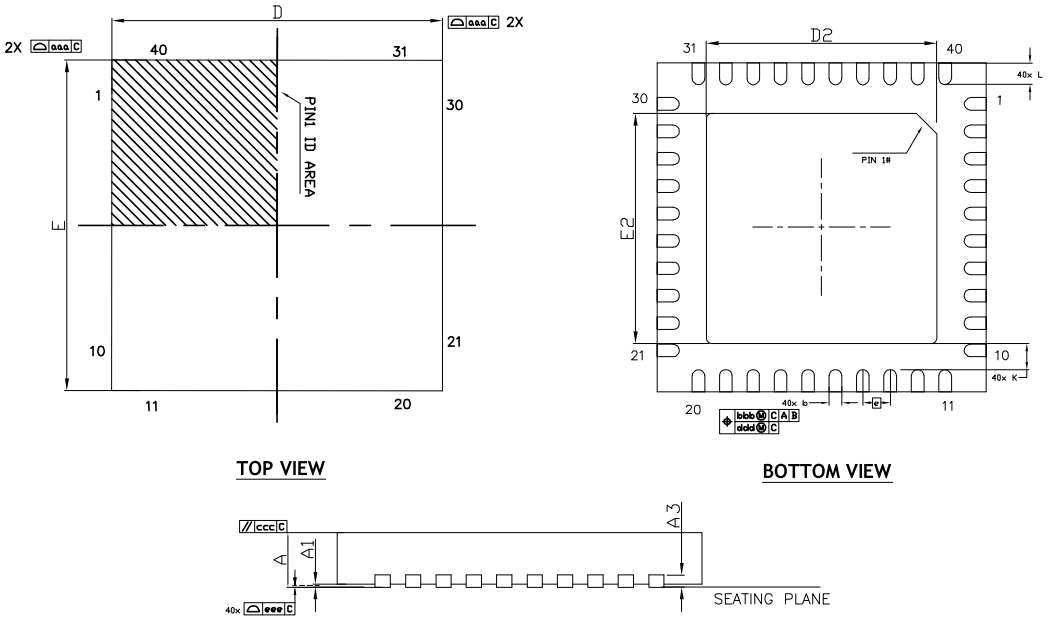
The IEC 61000-4-2 standard is more rigorous than HBM, resulting in lower voltage levels compared with HBM for the same level of ESD protection. Because IEC 61000-4-2 specifies a lower series resistance, the peak current is higher than HBM. The SP339 has passed both HBM and IEC 61000-4-2 testing without damage.

DIAGNOSTIC LOOPBACK MODE

The SP339 includes a diagnostic digital loop back mode for system testing as shown in Figure 1. The loopback mode connects the TTL driver inputs to the TTL receiver outputs, bypassing the analog driver and receiver circuitry. The analog/bus pins are internally disconnected in this mode.

MECHANICAL DIMENSIONS

FIGURE 15. QFN-40 PACKAGE OUTLINE DRAWING



DIMENSION TABLE				
SYMBOL	MIN	NOM	MAX	NOTE
A	0.80	0.90	1.00	
A1	0.00	0.02	0.05	
A3	---	0.20Ref	---	
b	0.20	0.25	0.30	
D		6.00 BSC		
E		6.00 BSC		
e		0.50 BSC		
D2	4.50	4.65	4.80	
E2	4.50	4.65	4.80	
L	0.35	0.40	0.45	
K	0.20	–	–	
aaa		0.15		
bbb		0.10		
ccc		0.10		
ddd		0.05		
eee		0.08		
N		40		

TERMINAL DETAILS

- ALL DIMENSIONS ARE IN MILLIMETERS, ANGLES ARE IN DEGREES.
- DIMENSIONS AND TOLERANCE PER JEDEC MO-220.

Drawing No.: POD-00000041

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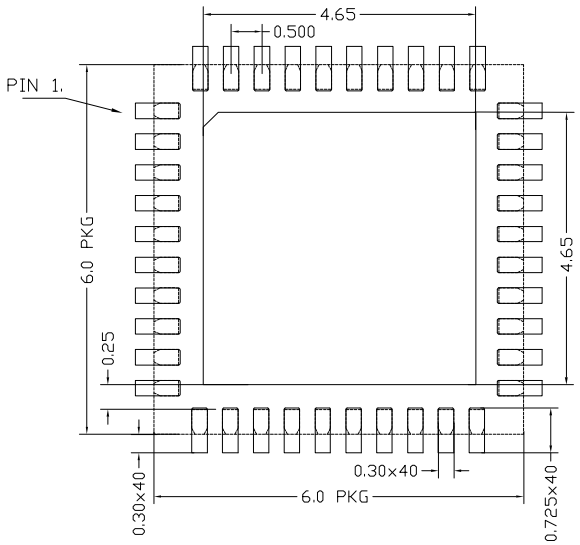
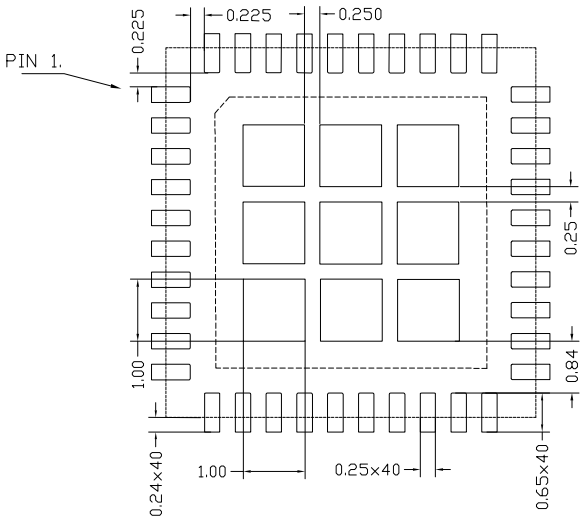
RECOMMENDED LAND PATTERN AND STENCIL

FIGURE 16. QFN-40 RECOMMENDED PCB LAND PATTERN AND STENCIL



TYPICAL RECOMMENDED LAND PATTERN

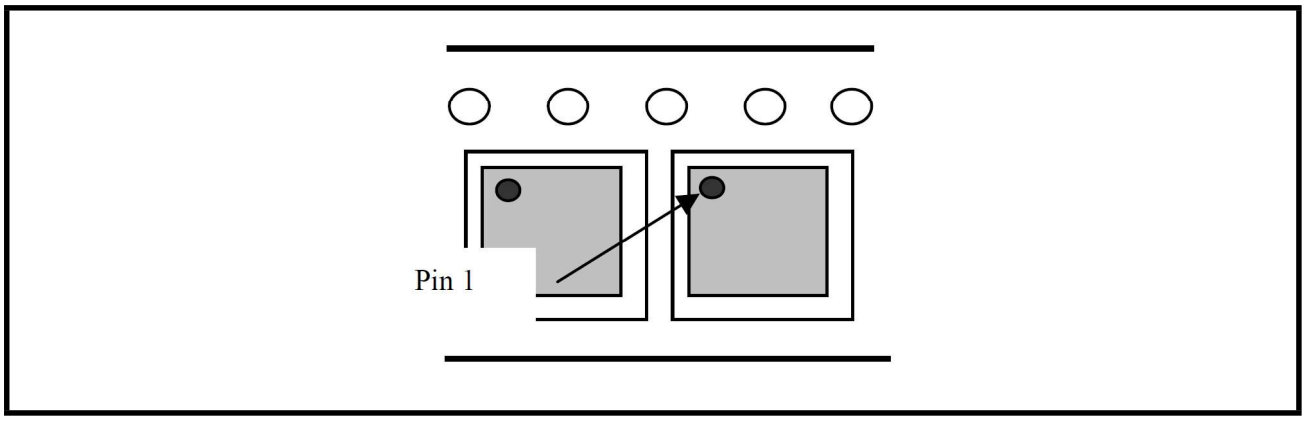


TYPICAL RECOMMENDED STENCIL

Drawing No.: POD-00000041

Revision: B.3

FIGURE 17. PIN 1 ORIENTATION IN TAPE



REVISION HISTORY

DATE	REVISION	DESCRIPTION
October 2011	1.0.0	Production Release
December 2011	1.0.1	Added C_L and R_L test conditions to figures 13 and 14 on page 9 Absolute max rating ±18V on page 2 Text edits in product summary on page 19
February 2013	1.0.2	Clarified test conditions for Driver Output Leakage Current on page 7 Added ±15kV Air Gap ESD per PCN 12-1009-01 Added ±4kV HBM ESD to non-bus pins per PCN 12-1009-01
November 2013	1.0.3	Added recommended PCB land pattern drawing.
December 2013	1.0.4	Combined QFN-40 package outline drawing and recommended PCB land pattern in Figure 16. Added table for "Suggested DB9 Connector Pinout" on page 5 and Figure 17 for pin 1 orientation in tape.
February 2018	1.0.5	Update to MaxLinear logo. Update format and Ordering Information. Corrected typo for pin 28, Mode 11 in Pin Description. Moved ESD ratings on page 2.
January 2019	1.0.6	Corrected typo in recommended stencil. Updated Ordering Information.
April 2020	1.0.7	Added Operating Conditions table and added additional thermal data. Split out ESD Ratings table.

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