GENERAL DESCRIPTION

The WS330E 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. Full operation requires only four external charge pump capacitors.

The RS-485/422 modes feature one drivers and one receivers (1TX/1RX) in both half and full duplex configurations. The RS-232 mode (2TX/2RX) provides signals commonly used with the DB9 RS-232 connector. A dedicated diagnostic loopback mode is also provided.

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).

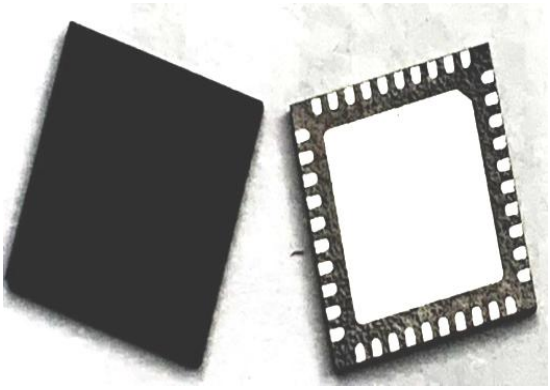
All transmitter outputs and receiver inputs feature robust electrostatic discharge (ESD) protection to ±15kV IEC-61000-4-2 Air Gap, ±8kV IEC-61000-4-2 Contact, and ±15kV Human Body Model (HBM). Each receiver output has full fail-safe protection to avoid system lockup, oscillation, or indeterminate states by defaulting to logic-high output level when the inputs are open, shorted, or terminated but undriven.

The RS-232 receiver inputs include a 5kΩ pull-down to ground. The RS-485/422 receiver inputs are high impedance (>96kΩ), allowing up to 256 devices on a single communication bus (1/8th unit load).

The WS330E operates from a single power supply, either 3.3V or 5V, with low idle current (2mA typical in all modes). The shutdown mode consumes less than 10μA for low power standby operation.

WS330E

3.3V or 5V Single Supply Operation
RS232/RS485/RS422 multiprotocol



FEATURES

- **Need external resistors required for RS485/RS422 termination and biasing**
- **Max Data Rate up to 20Mbps in RS-485/422 modes, and up to 1Mbps in RS-232 mode.**
- **Pin selectable 250Kbps Slew Limiting**
- **2 Drivers,2 Receivers RS232/V.28**
- **1 Drivers,1 Receivers RS485/422**
- **RS485/422** enhanced failsafe for open, shorted, or terminated but idle/undriven.
- **Robust ESD protection on bus pins**
  ±15kV IEC-61000-4-2 Air Gap
  ±15kV Human Body Model(HBM)
  ±8kV IEC-61000-4-2 Contact

APPLICATIONS

- **Industrial Computers**
- **Networking Equipment**
- **HVAC Controls Equipment**
- **Dual Protocol Serial Ports**

ORDERING INFORMATION

PART NUMBER	PACKAGE	OPERATING TEMPERATURE RANGE	DEVICE STATUS
WS330EER1	40-pin QFN	-40°C to +85°C	Active

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
Power Dissipation 40-pin QFN (derate 17mW/°C above +70°C)	500mW

CAUTION:

ESD (Electro Static 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 PROTECTION

		MIN.	TYP.	MAX.	UNITS	
R1-R4	Tx Output & Rx Input Pins		±15		kV	Human Body Model (HBM)
			±8		kV	IEC 61000-4-2 (Contact)
			±15		kV	IEC 61000-4-2 (Air Gap)
	All Other Pins		±2		kV	Human Body Model (HBM)

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	NC	This pin is not used and is not connected internally			
6	NC	This pin is not used and is not connected internally			
7	NC	This pin is not used and is not connected internally			
8	NC	This pin is not used and is not connected internally			
9	VCC	VCC			
10	GND	GND			
11	SLEW		SLEW=VCC enables 250k bps slew limiting		
12	DIR1			T1 Enable R1 Disable	T1 Enable
13	NC	This pin is not used and is not connected internally			
14	MODE0	0	1	0	1
15	MODE1	0	0	1	1
16	NC	This pin is not used and is not connected internally			
17	NC	This pin is not used and is not connected internally			
18	NC	This pin is not used and is not connected internally			
19	ENABLE	ENABLE = VCC for operation, ENABLE = 0V for shutdown			
20	VCC	VCC			

PIN DESCRIPTIONS BY MODE (MODE2, MODE1, MODE0)

Pin	Name	00 Figure 1	01 Figure 2	10 Figure 3	11 Figure 4
21	NC	This pin is not used and is not connected internally			
22	NC	This pin is not used and is not connected internally			
23	GND	GND			
24	NC	This pin is not used and is not connected internally			
25	NC	This pin is not used and is not connected internally			
26	GND	GND			
27	R4		T2 Output		R1 Input B
28	R3		T1 Output		R2 Input A
29	GND	GND			
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	VCC			
33	V-	V- Charge pump negative supply, 0.1uF from ground			
34	C2-	C2+ Charge pump cap 2 negative lead			
35	C1-	C1- Charge pump cap 1 negative lead			
36	GND	GND			
37	C1+	C1+ Charge pump cap 1 positive lead, 0.1uF			
38	VCC	VCC			
39	C2+	C2+ Charge pump cap 2 positive lead, 0.1uF			
40	V+	V+ Charge pump positive supply, 0.1uF 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			
7			
8			
9			

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, 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
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						
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 < V_O <V_{CC}
I_{OZ}	Receiver Output Leakage Current		±0.1	±1	µA	0 < V_O < 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	-7V <V_{IN}< +12V
V_{TH}	Receiver Differential Threshold Voltage	-200	-125	-50	mV	
$\triangle V_{TH}$	Receiver Input Hysteresis		25		mV	V_{CM} = 0V
I_{IN}	Receiver Input Current			125	µA	V_{IN} = +12V
				-100	µA	V_{IN} = -7V
DIFFERENTIAL DRIVER OUTPUTS (RS-485 / RS-422)						
V_{OD}	Differential Driver Output	2		V_{CC}	V	R_L = 100Ω (RS-422), Figure 5
		1.5		V_{CC}	V	R_L = 54Ω (RS-485), Figure 5
		1.5		V_{CC}	V	-7V<V_{CM}<+12V, Figure 6
				V_{CC}	V	No Load
$\triangle V_{OD}$	Change In Magnitude of Differential Output Voltage	-0.2		+0.2	V	R_L = 54Ω or 100Ω, Figure 5
V_{CM}	Driver Common Mode Output Voltage			3	V	R_L = 54Ω or 100Ω, Figure 5
$\triangle V_{CM}$	Change In Magnitude of Common Mode Output Voltage			0.2	V	R_L = 54Ω or 100Ω, Figure 5
I_{OSD}	Driver Output Short Circuit Current	-250		250	mA	-7V< V_O < +12V, Figure 7
I_O	Driver Output Leakage Current			100	µA	ENABLE = 0V, or DIR1 = 0V and DIR2 = 0V in full duplex modes, V_O = +12V, V_{CC} = 0V or 5.25V
		-100			µA	ENABLE = 0V, or DIR1 = 0V and DIR2 = 0V in full duplex modes, 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 8
$\lvert t_{RHL}-t_{RLH} \rvert$	Receiver Propagation Delay Skew			100	ns	
t_{DHL}, t_{DLH}	Driver Propagation Delay		1400		ns	R_L = 3kΩ, C_L = 2500pF, Figure 9
$\lvert t_{DHL}-t_{DLH} \rvert$	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 9
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 9
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 8
$\lvert t_{RHL}-t_{RLH} \rvert$	Receiver Propagation Delay Skew			100	ns	
t_{DHL}, t_{DLH}	Driver Propagation Delay		300		ns	R_L = 3kΩ, C_L = 1000pF, Figure 9
$\lvert t_{DHL}-t_{DLH} \rvert$	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 = 3kΩto 7kΩ, C_L = 150pF to 1000pF, Figure 9
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 = 3kΩto 7kΩ, C_L = 150pF to 1000pF, T_A = 25°C, Figure 9

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		150	200	ns	C_L = 15pF, Figure 10
$\lvert t_{RPHL}-t_{RPLH} \rvert$	Receiver Propagation Delay Skew			20	ns	
t_{DPHL}, t_{DPLH}	Driver Propagation Delay		500	1000	ns	R_L = 54Ω, C_L = 50pF, Figure 11
$\lvert t_{DPHL}-t_{DPLH} \rvert$	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 12
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 13
t_{DHZ}, t_{DLZ}	Driver Output Disable Time			1800	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		150	200	ns	C_L = 15pF, Figure 10
$\lvert t_{RPHL}-t_{RPLH} \rvert$	Receiver Propagation Delay Skew			50	ns	
t_{DPHL}, t_{DPLH}	Driver Propagation Delay		30	100	ns	R_L = 54Ω, C_L = 50pF, Figure 11
$\lvert t_{DPHL}-t_{DPLH} \rvert$	Driver Propagation Delay Skew			20	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 12
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 13
t_{DHZ}, t_{DLZ}	Driver Output Disable Time			200	ns	

BLOCK DIAGRAM BY MODE (MODE1, MODE0)

FIGURE 1. MODE 00 - LOOPBACK

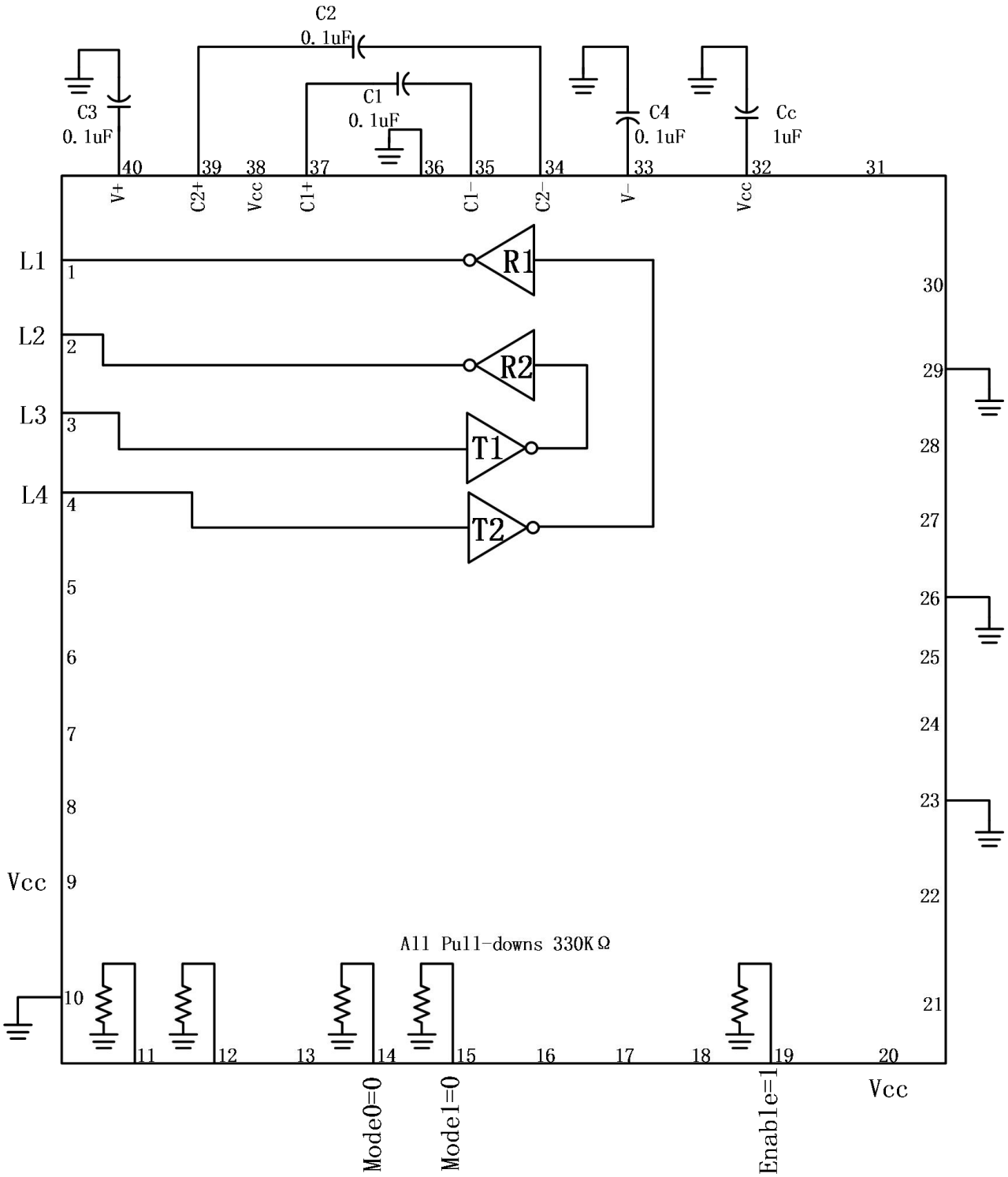


FIGURE 2. MODE 01 - RS-232

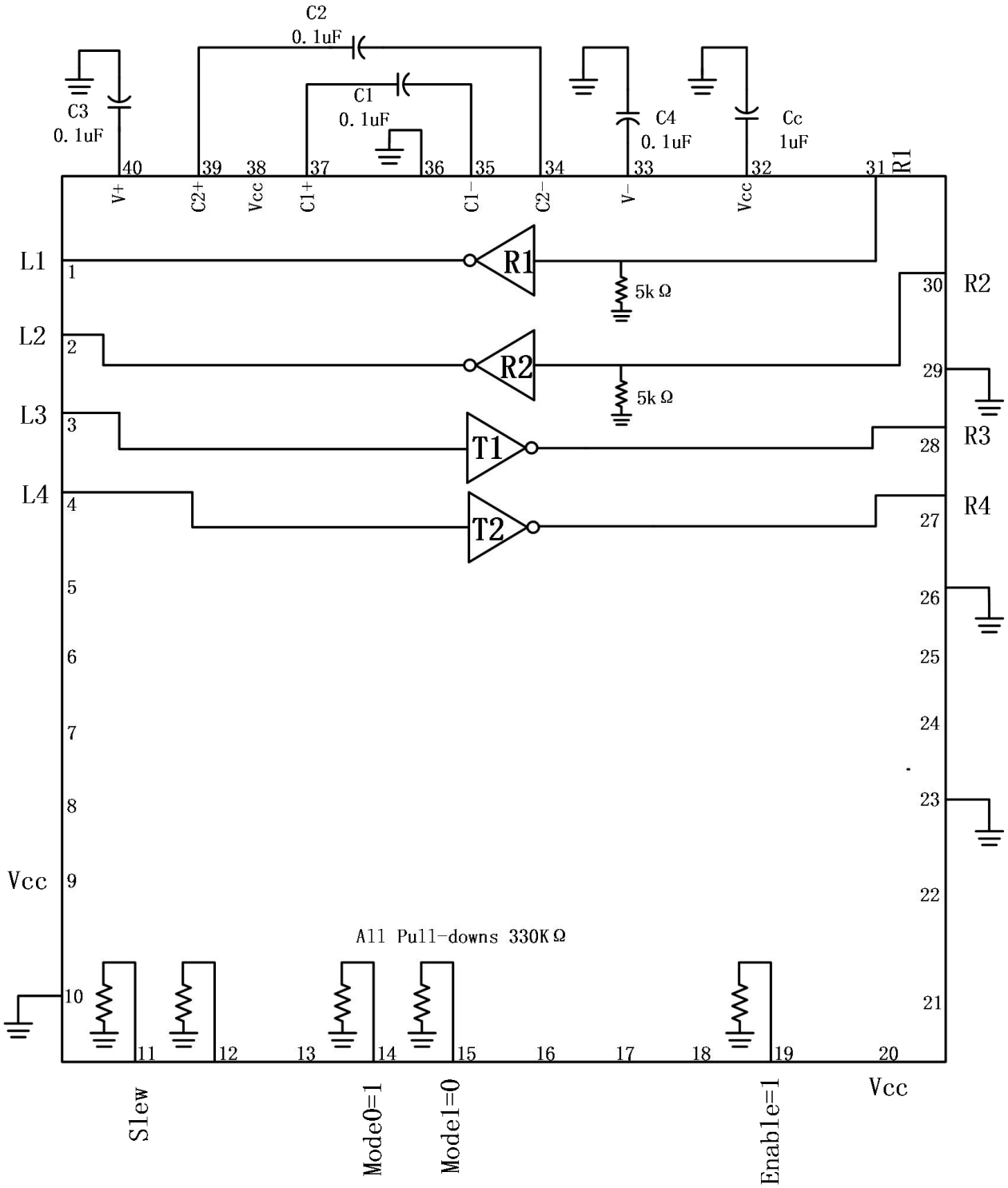


FIGURE 3. MODE 10 - RS-485 HALF DUPLEX

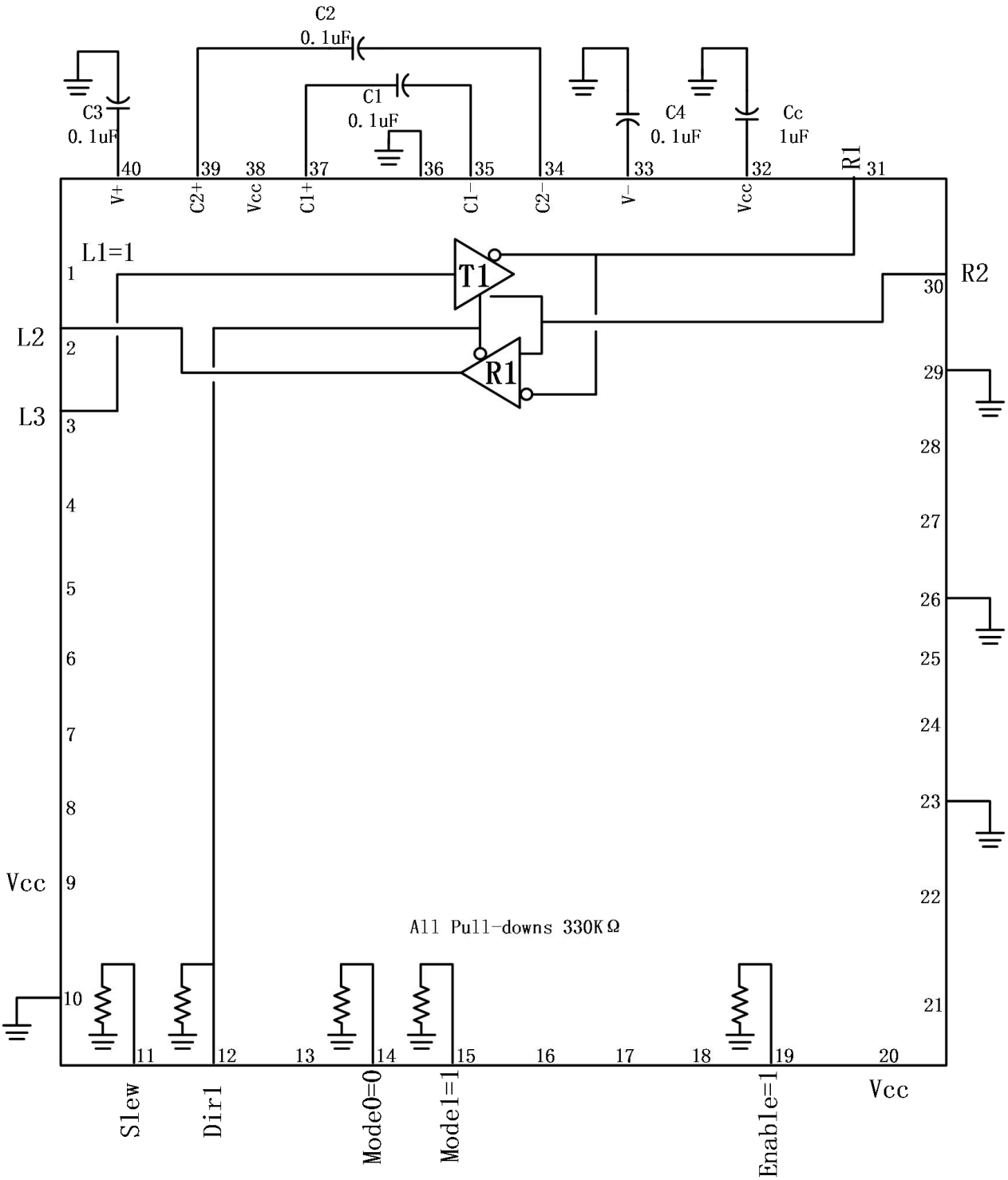
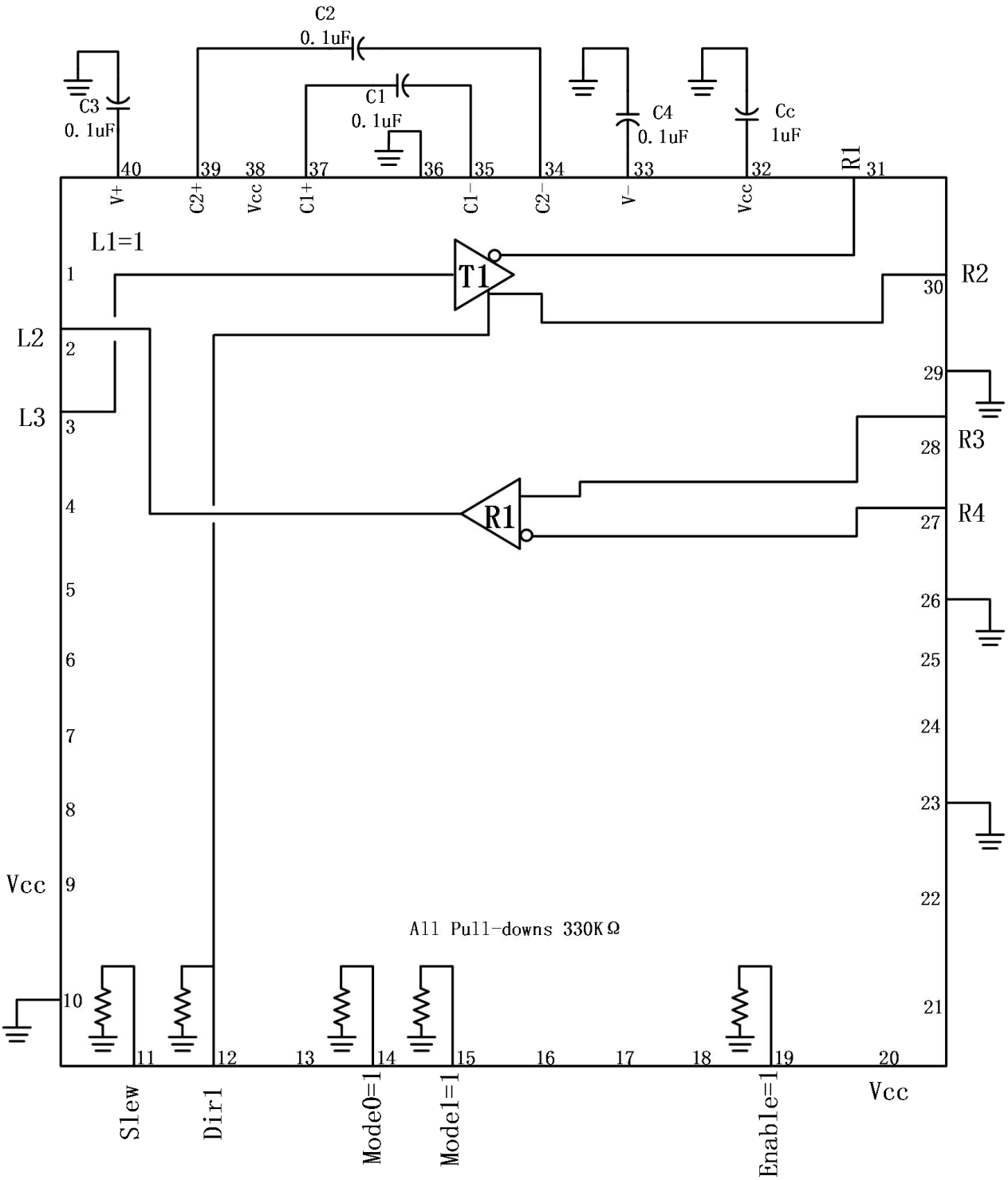


FIGURE 4. MODE 11 - RS-485/422 FULL DUPLEX



TEST CIRCUITS

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

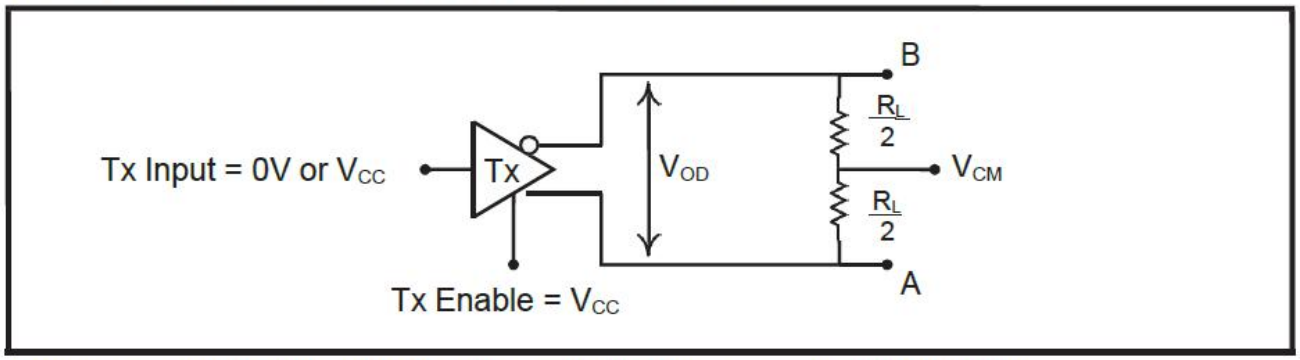


FIGURE 6. RS-485/422 DIFFERENTIAL DRIVER OUTPUT VOLTAGE OVER COMMON MODE

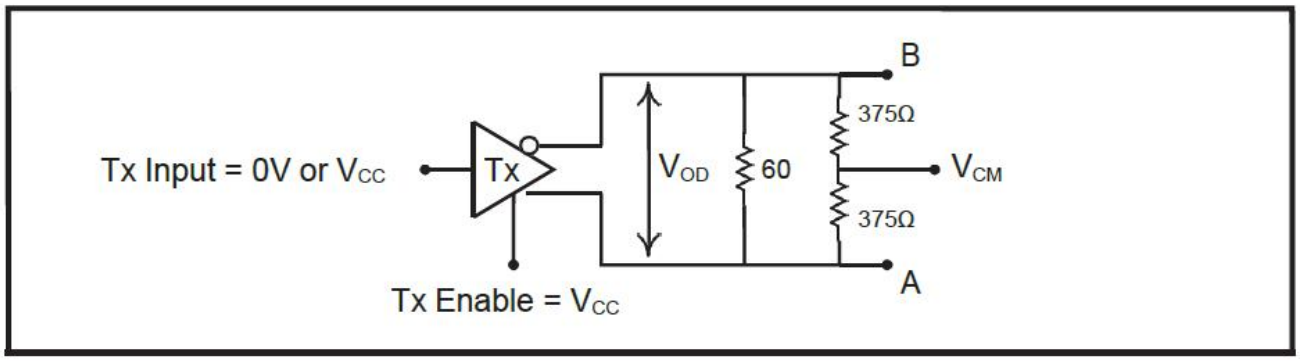


FIGURE 7. RS-485/422 DRIVER OUTPUT SHORT CIRCUIT CURRENT

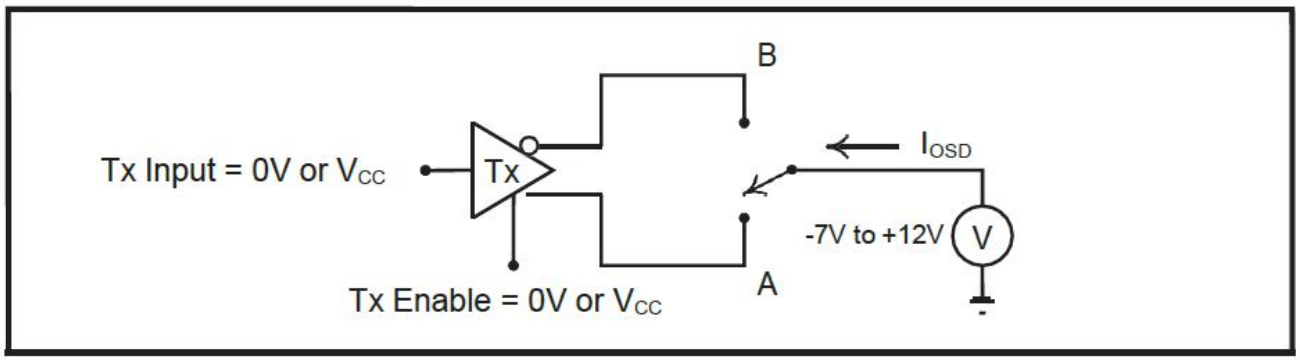


FIGURE 8. RS-232 RECEIVER PROPAGATION DELAY

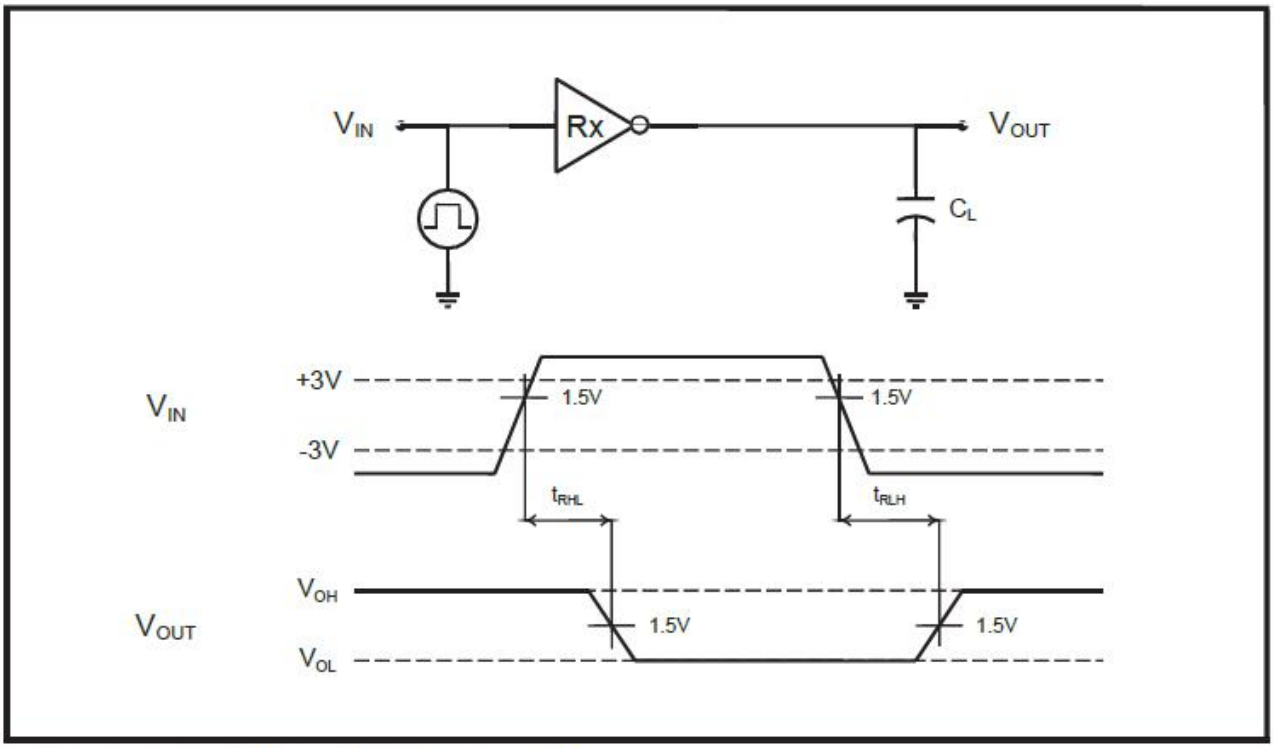


FIGURE 9. RS-232 DRIVER PROPAGATION DELAY

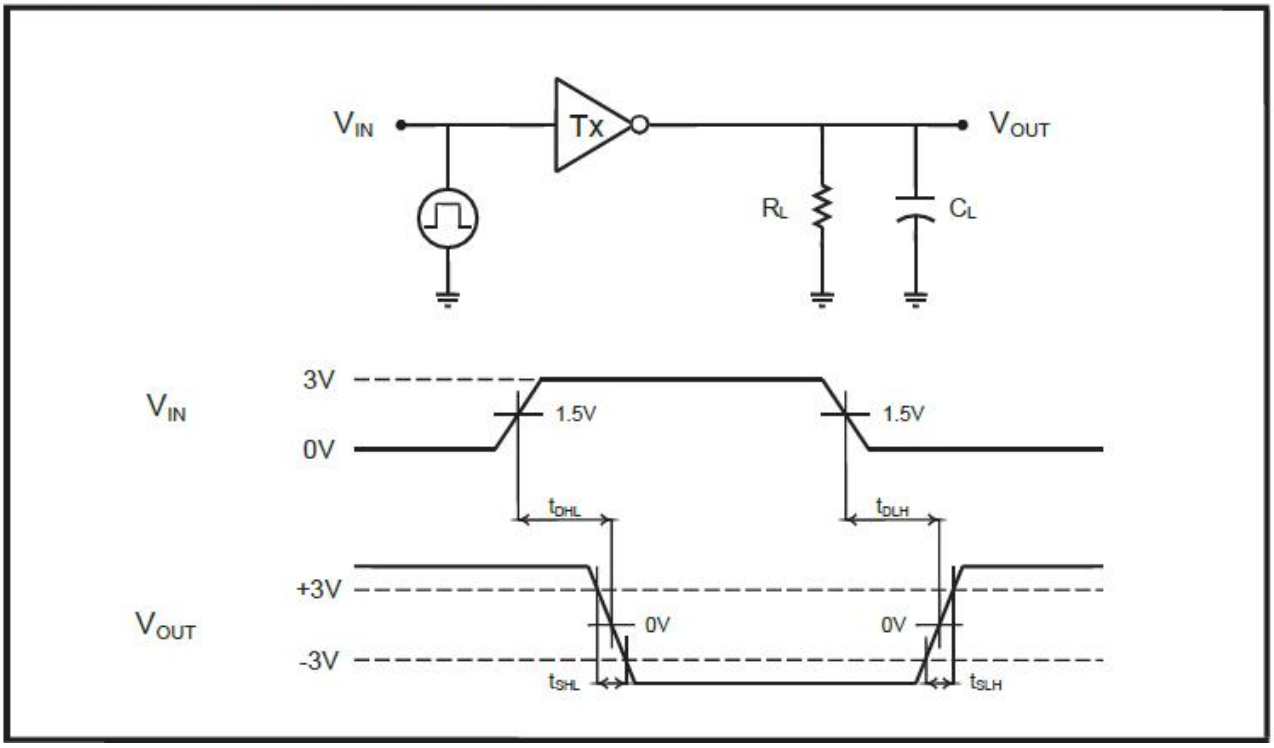


FIGURE 10. RS-485/422 RECEIVER PROPAGATION DELAY

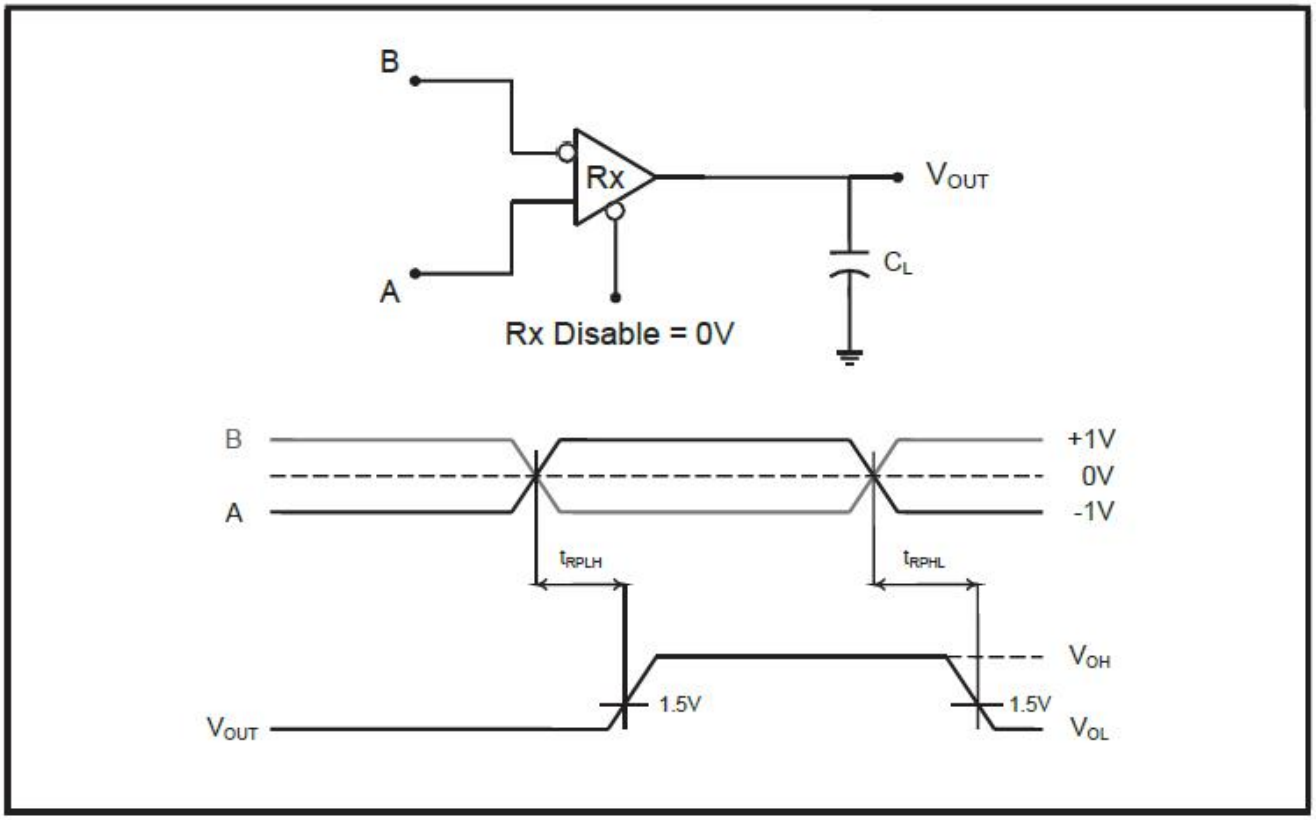


FIGURE 11. RS-485/422 DRIVER PROPAGATION DELAY AND RISE/FALL TIMES

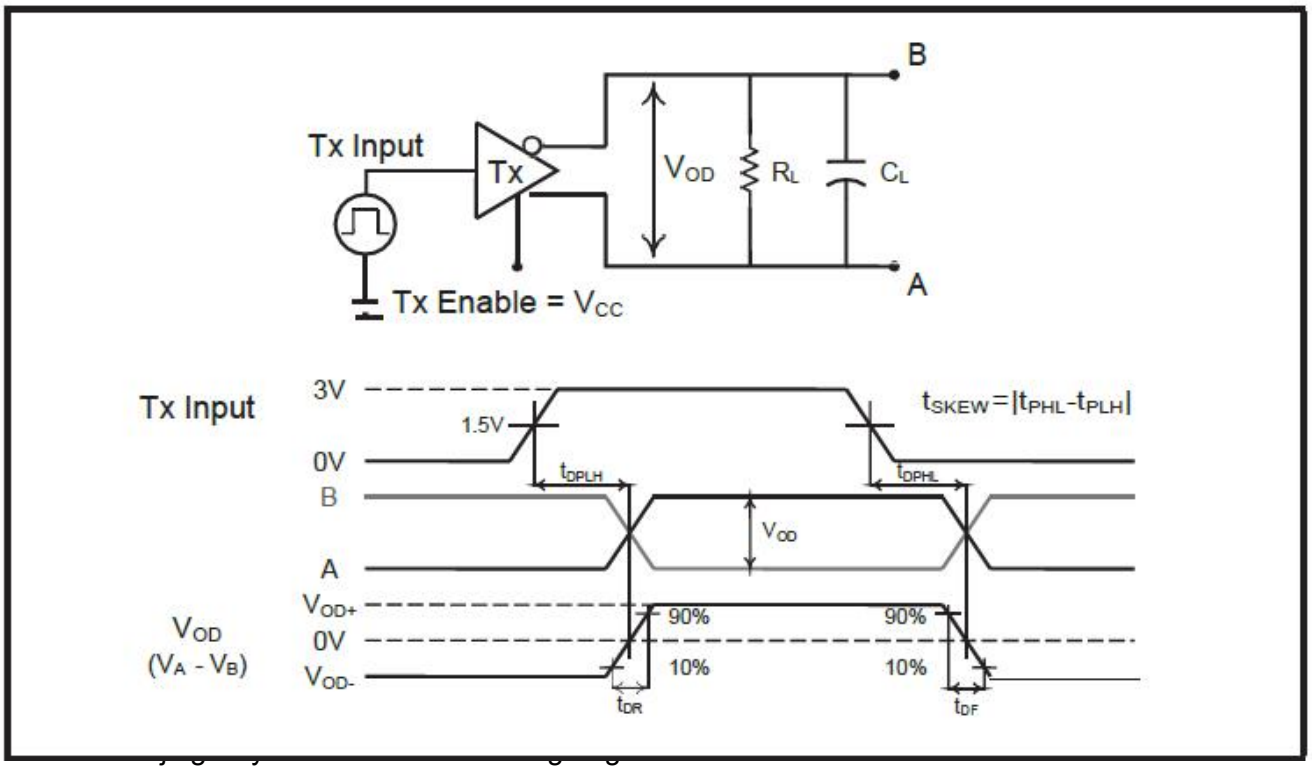


FIGURE 12. RS-485/422 RECEIVER OUTPUT ENABLE/DISABLE TIMES

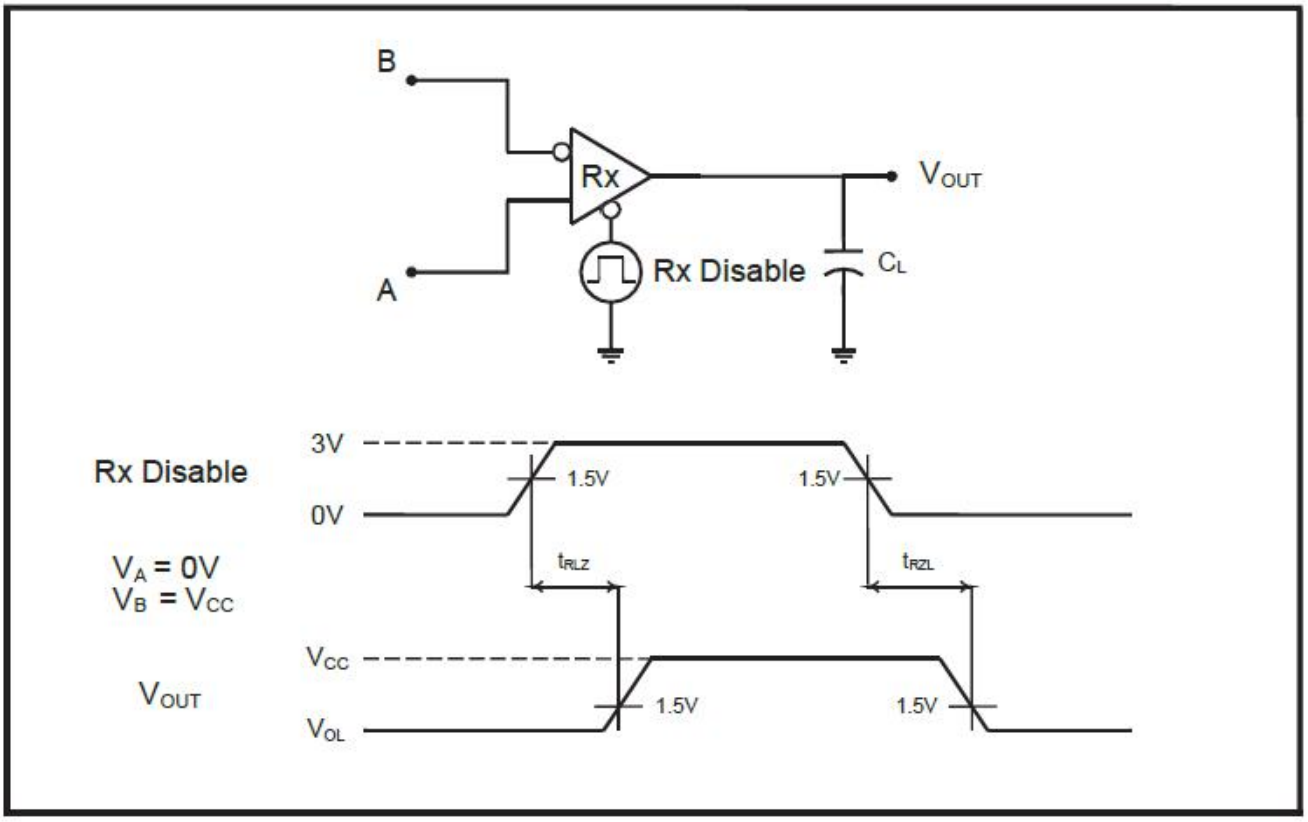
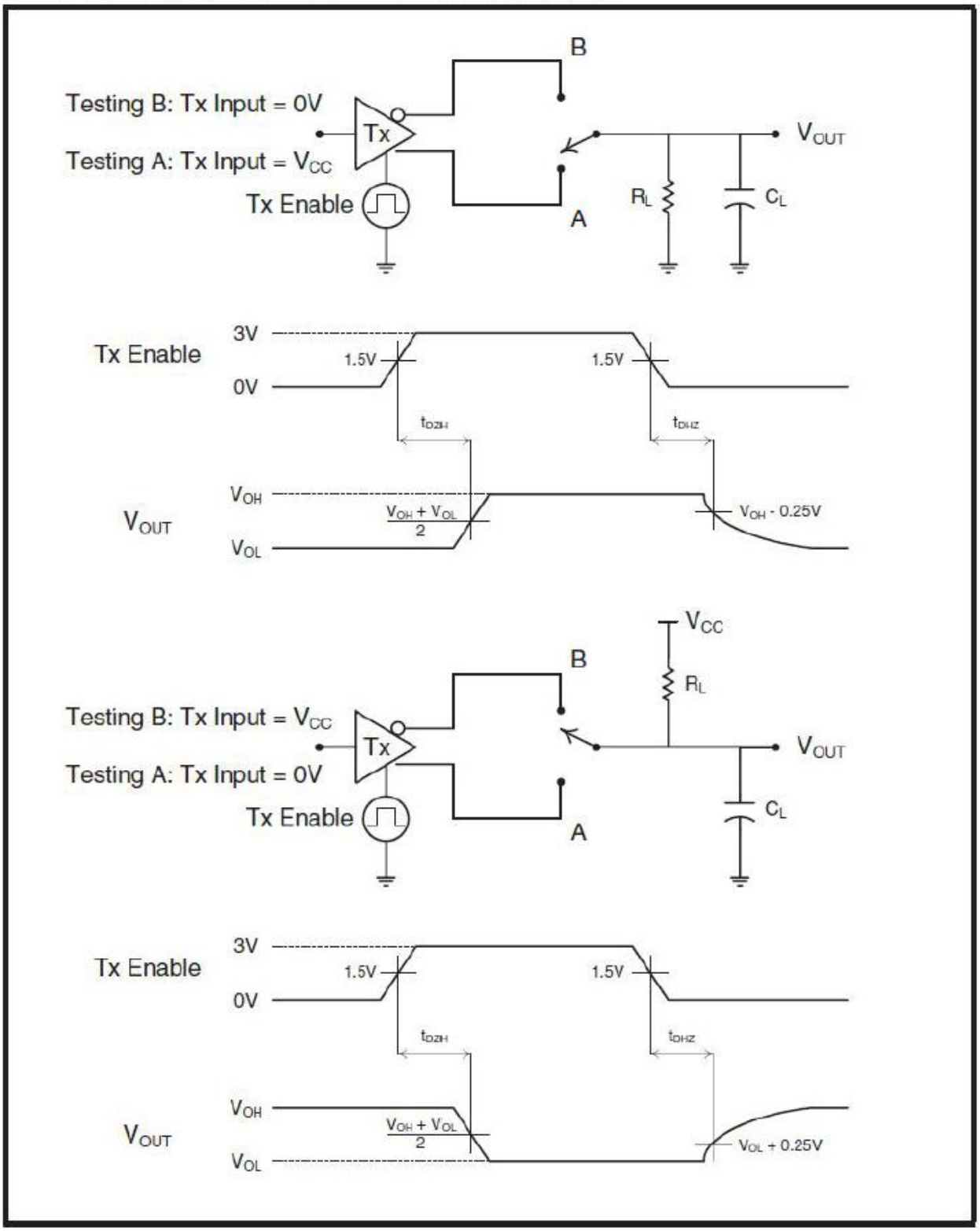


FIGURE 13. RS-485/422 DRIVER OUTPUT ENABLE/DISABLE TIMES



PRODUCT SUMMARY

The WS330E is an advanced multiprotocol transceiver supporting RS-232, RS-485, and RS-422 serial standards in a 40 pin QFN package. Integrated 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 (2TX/2RX) provides four signals commonly used with the DB9 RS-232 connector. A dedicated mode is also available for diagnostic loopback testing.

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 WS330E 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. Guobo Electronic uses the following methods to qualify the protection structures designed into WS330E:

±15kV using the Human Body Model (HBM)

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

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

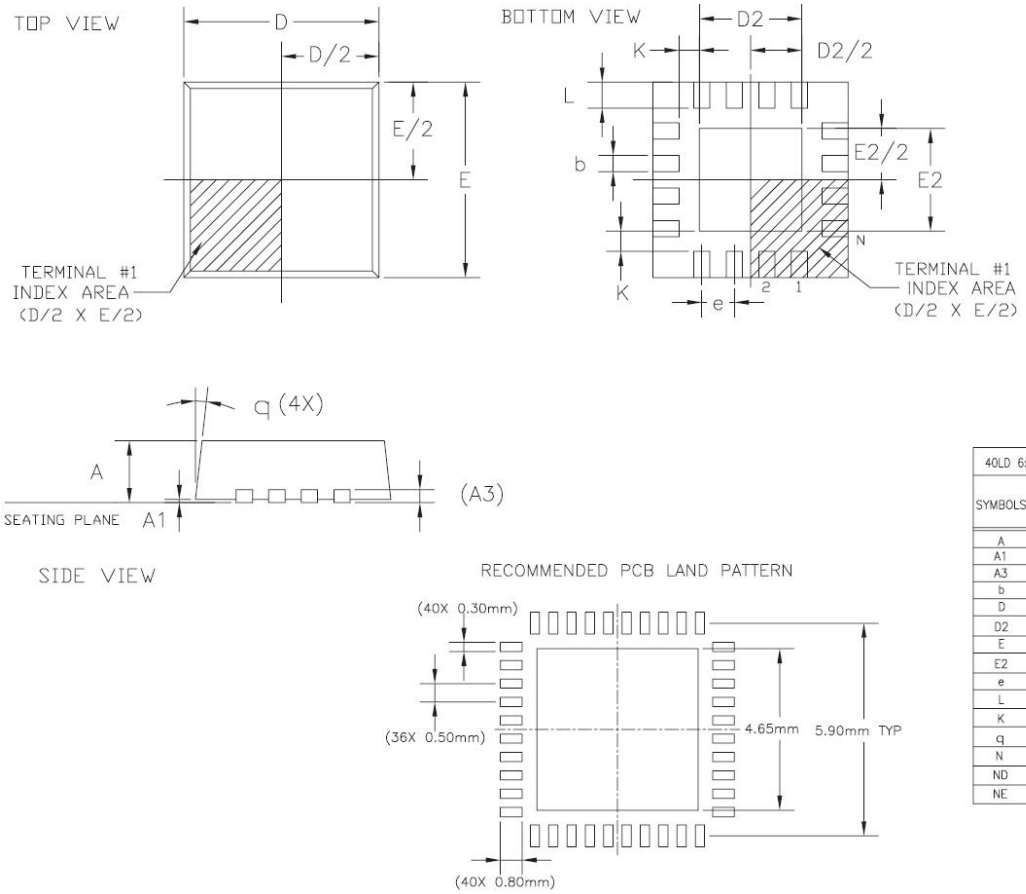
The IEC 61000-4-2 standard is more rigorous than HBM, resulting in lower voltage levels compared with HBM for the same level of ESD protection. Because IEC 61000-4-2 specifies a lower series resistance, the peak current is higher than HBM. The WS330E has passed both HBM and IEC 61000-4-2 testing without damage.

DIAGNOSTIC LOOPBACK MODE

The WS330E 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.

PACKAGE DRAWINGS

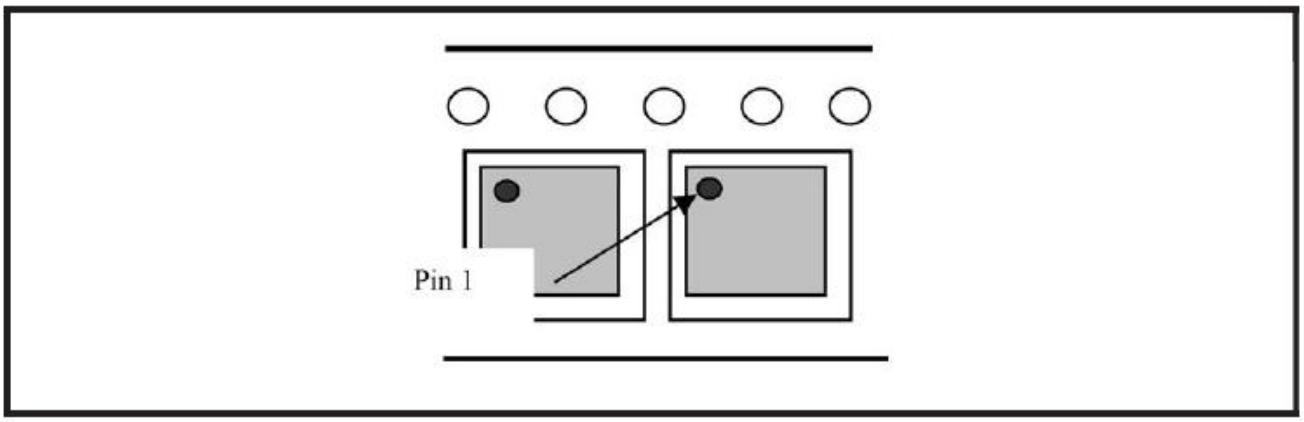
FIGURE 14. QFN-40 PACKAGE OUTLINE DRAWING AND RECOMMENDED PCB LAND PATTERN



40LD 6x6 QFN

SYMBOLS	DIMENSIONS IN MM (Control Unit)			DIMENSIONS IN INCH (Reference Unit)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.80	0.90	1.00	0.032	0.035	0.039
A1	0.00	0.02	0.05	0.000	0.001	0.002
A3	0.20 REF			0.008 REF		
b	0.18	0.25	0.30	0.007	0.010	0.012
D	6.00 BSC			0.236 BSC		
D2	4.50	4.65	4.80	0.177	0.183	0.189
E	6.00 BSC			0.236 BSC		
E2	4.50	4.65	4.80	0.177	0.183	0.189
e	0.50 BSC			0.020 BSC		
L	0.35	0.40	0.45	0.014	0.016	0.018
K	0.20	—	—	0.008	—	—
q	0°	—	14°	0°	—	14°
N	40			40		
ND	10			10		
NE	10			10		

FIGURE 15. PIN 1 ORIENTATION IN TAPE



Package Information

Part number	package	MOQ	TAPE SIZE	MSL	Humidity sensitive label	baking time /H	baking temp
WS330EER1	QFN40-6*6	2000	13 INCH	3	Y	6	125

REVISION HISTORY

DATE	REVISION	DESCRIPTION
April 2023	1.0	Product release