

## *RS-232, RS-422, RS485 Multiprotocol Transceivers with Internal Termination and Wide Output Swing*

UM3035A QFN40 6.0×6.0

### 1 Description

The UM3035A is highly integrated, robust and advanced multiprotocol transceiver supporting RS-232, RS-422 and RS-485 serial standards. The device offers three transmitters and five receivers in RS-232 mode to support 3T5R DB9 RS-232 connector. The device also integrates one transmitter and one receiver to support half and full duplex RS-485 communication. MODE selection pins enable shared bus and logic pins for the protocols to share a common single connector. Integrated termination resistance for RS-485 bus pins and for RS-232 receiver inputs need no external components to realize a fully-functional and switchable communication port.

The UM3035A operates up to 20Mbps in RS-485/RS-422 modes, and up to 1Mbps in RS-232 mode. What's more, based on the SLR pin setting, the UM3035A can be limited to 0.5Mbps low-speed RS-485 mode and 0.25Mbps low-speed RS-232 mode.

The device features integrated robust IEC ESD protection. What's more, diagnostic loopback mode for RS-232 is provided to check for logic to bus and bus to logic path functional integrity and check for cable and connector shorts. The RS-485 receiver fail-safe feature drives logic high on received logic output when the bus inputs are open or shorted together or when the bus is idle.

The UM3035A needs 3.0V to 5.5V supply that fully powers four external charge pump capacitors for RS-232 and the drivers/receivers for both RS-232 and RS-485. The device is also configured with 1.65V to 5.5V logic supply for logic data and control signals. Additionally, the device also features nSHDN pin to achieve extremely low current consumption when the system disables the device.

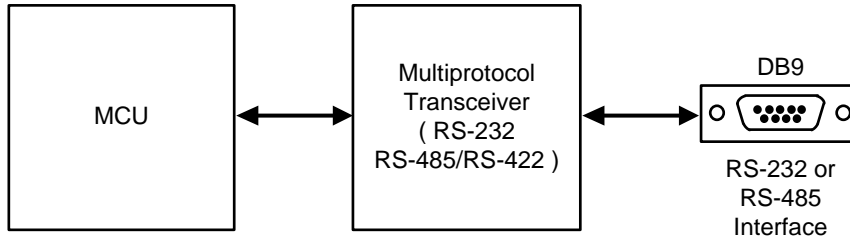
### 2 Features

- Meets or exceeds the requirements of the TIA/EIA-485A and TIA/EIA-232F standards
- 3 transmitters, 5 receivers for RS-232 port
- 1 transmitter, 1 receiver for RS-485 port
- Integrated switchable 120Ω termination resistor for half and full duplex RS-485 mode
- Integrated charge-pump for RS-232
- Large output swing (typical ±8.5V) for RS-232 mode with V<sub>CC</sub> = 5V supply
- Diagnostic loopback for both RS-232 and RS-485 modes
- Open, short, and idle bus failsafe for RS-485 receiver
- 3V to 5.5V supply voltage
- 1.65V to 5.5V supply voltage for logic pins
- RS-485 differential output exceeds 2.1V for PROFIBUS compatibility with 5V supply
- Selectable Data Rates with SLR Pin:
  - RS-232 mode: 250kbps and 1Mbps
  - RS-485 half-duplex and full-duplex mode: 500kbps and 20Mbps
- Glitch-free power-up/down for hot plug-in capability
- Bus short-circuit protection, thermal Shutdown
- Extended ambient temperature range: -40°C to 125°C
- Space-saving QFN40 6.0×6.0 package

### 3 Applications

- Industrial
- HVAC Systems
- Point-of-sale terminals
- Factory automation and control
- Building automation
- Grid infrastructure

### 4 Simplified Schematic



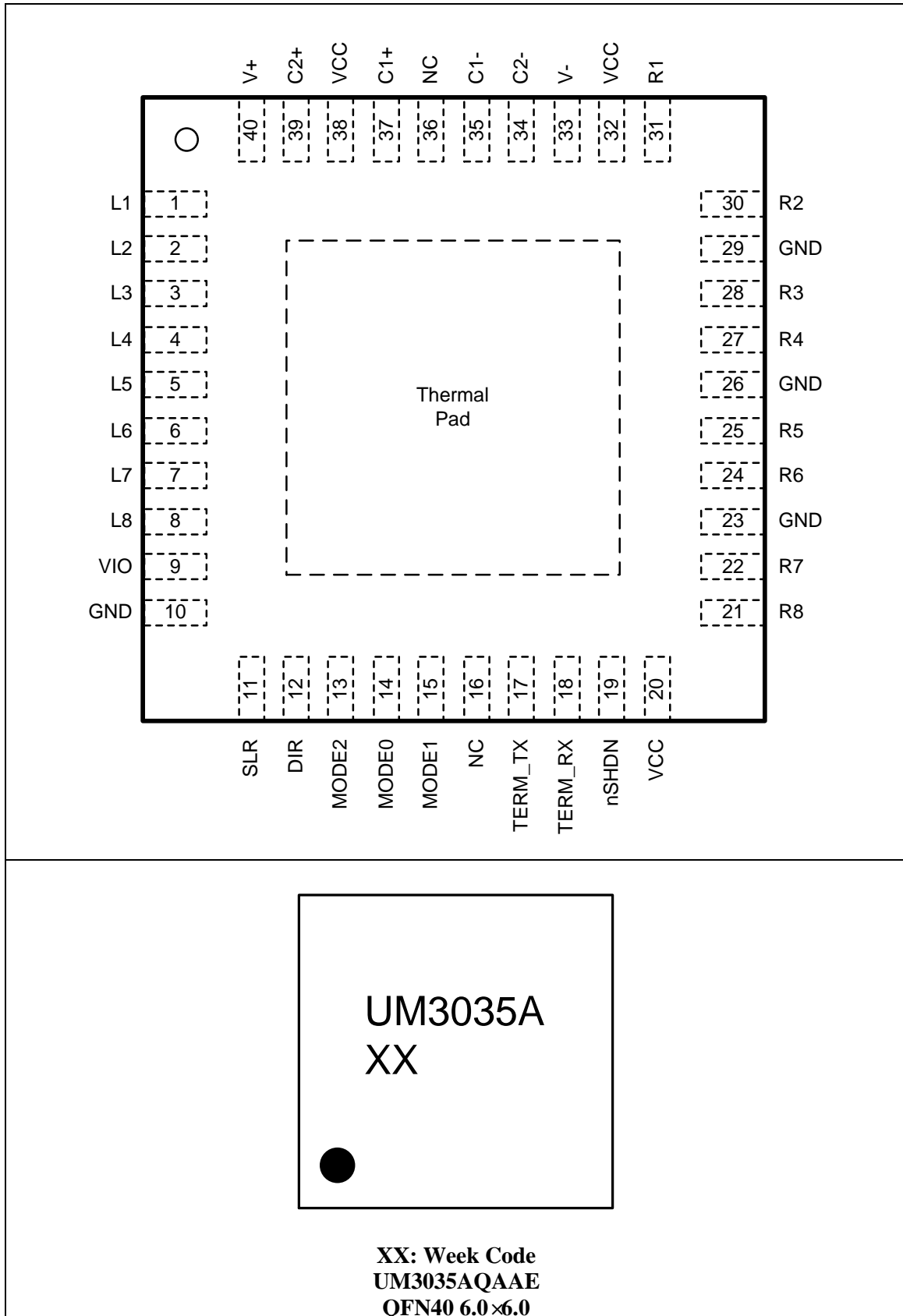
### 5 Selection Guide

Part Number	V <sub>CC</sub> Supply (V)	V <sub>IO</sub> Supply (V)	RS-232 Transceivers Number	RS-485 Transceivers Number	RS-232 Transceivers Data Rate (Mbps)	RS-485 Transceivers Data Rate (Mbps)
UM3035A	3 to 5.5	1.65 to 5.5	3T / 5R	1T / 1R	0.25 / 1	0.5 / 20

### 6 Ordering Information

Part Number	Mark Code	Package Type	Shipping Qty
UM3035AQAAE	UM3035A	QFN40 6.0×6.0	3000pcs/13Inch Tape & Reel

## 7 Pin Configuration and Function



**7 Pin Configuration and Function (continued)**

Table 7-1. Pin Functions of UM3035A

Pin No.	Pin Name	Function
1	L1	Logic output (RS-232)
2	L2	Logic output (RS-232/RS-485)
3	L3	Logic input (RS-232/RS-485). Integrated weak pull-up resistor.
4	L4	Logic input (RS-232). Integrated weak pull-up resistor.
5	L5	Logic output (RS-232)
6	L6	Logic input (RS-232), Integrated weak pull-up resistor.
7	L7	Logic output (RS-232)
8	L8	Logic output (RS-232)
9	VIO	1.65V to 5.5V logic supply voltage.
10	GND	Ground. (Note 2)
11	SLR	Slew rate control, internal pull-down resistor. SLR=H enables slow speed.
12	DIR	RS-485 TX/RX enable/disable. Internal pull-down resistor.
13	MODE2	MODE control pin 2, Integrated weak pull-down resistor.
14	MODE0	MODE control pin 0, Integrated weak pull-down resistor.
15	MODE1	MODE control pin 1, Integrated weak pull-down resistor.
16	NC	Not connected internally. Can be connected to supply, ground or left open on PCB.
17	TERM_TX	120 $\Omega$ Termination resistance enable/disable between R1 and R2. Internal Pull down resistor.
18	TERM_RX	120 $\Omega$ Termination resistance enable/disable between R3 and R4. Internal Pull down resistor.
19	nSHDN	Device enable/disable. Internal pull-down resistor.
20	VCC	3V to 5.5V supply voltage. (Note 1)

**7 Pin Configuration and Function (continued)**

Table 7-1. Pin Functions of UM3035A

Pin No.	Pin Name	Function
21	R8	RS-232 receiver input.
22	R7	RS-232 receiver input.
23	GND	Ground. (Note 2)
24	R6	RS-232 driver output.
25	R5	RS-232 receiver input.
26	GND	Ground. (Note 2)
27	R4	RS-232 driver output or RS-485 inverting receiver input (B).
28	R3	RS-232 driver output or RS-485 non-inverting receiver input (A).
29	GND	Ground. (Note 2)
30	R2	RS-232 receiver input or RS-485 bus pin (Y or A).
31	R1	RS-232 receiver input or RS-485 bus pin (Z or B).
32	VCC	3V to 5.5V supply voltage. (Note 1)
33	V-	Negative charge pump rail.
34	C2-	Negative terminal of charge pump capacitor.
35	C1-	Negative terminal of charge pump capacitor.
36	NC	Not connected internally. Can be connected to supply, ground or left open on PCB.
37	C1+	Positive terminal of charge pump capacitor.
38	VCC	3V to 5.5V supply voltage. (Note 1)
39	C2+	Positive terminal of charge pump capacitor.
40	V+	Positive charge pump rail.

Note 1: All VCC pins must be powered by a common supply on PCB.

Note 2: All GND pins must be grounded on PCB.

## 8 Specifications

### 8.1 Absolute Maximum Ratings (Note 1)

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>CC</sub>	Bus supply voltage	V <sub>CC</sub> to GND	-0.5	6.0	V
V <sub>IO</sub>	Logic supply voltage	V <sub>IO</sub> to GND	-0.5	6.0	V
V <sub>+</sub>	Charge pump positive-output supply voltage	V <sub>+</sub> to GND	-0.3	14	V
V <sub>-</sub>	Charge pump negative-output supply voltage	V <sub>-</sub> to GND	-14	0.3	V
V <sub>BUS</sub>	Bus voltage at any bus pin	R1, R2, R3, R4, R5, R6, R7, R8 with respect to GND	-16	16	V
V <sub>ID</sub>	Differential bus voltage	(R1-R2) or (R2-R1), (R3-R4) or (R4-R3) with termination disabled	-22	22	V
	Differential bus voltage at RS485 mode	(R1-R2) or (R2-R1), (R3-R4) or (R4-R3) with termination enabled	-6	6	V
V <sub>I</sub>	Input voltage at any logic pin	L3, L4, L6, SLR, nSHDN, TERM_TX, TERM_RX, MODE0, MODE1, MODE2, DIR pins	-0.3	V <sub>IO</sub> +0.2	V
V <sub>ESD</sub>	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001	Bus terminals (R1, R2, R3, R4, R5, R6, R7, R8) and GND	-8	8	kV
I <sub>O</sub>	Receiver output current	L1, L2, L5, L7, L8 pins	-8	8	mA
T <sub>STG</sub>	Storage temperature		-65	150	°C
T <sub>J</sub>	Junction temperature		-40	170	°C
T <sub>L</sub>	Lead Temperature for Soldering 10 Seconds			260	°C

Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

**8.2 Recommended Operating Conditions**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>CC</sub>	Bus supply voltage		3		5.5	V
V <sub>IO</sub>	Logic supply voltage		1.65		5.5	V
V <sub>I(RS-485)</sub>	Input voltage at any bus terminal in RS-485 mode	R1, R2, R3, R4 pins	-7		12	V
V <sub>ID</sub>	Differential input voltage in RS-485 receive mode [ (R1-R2) or (R2-R1), (R3-R4) or (R4-R3) ] with on-chip termination resistor disabled		-12		12	V
	Differential input voltage in RS-485 receive mode [ (R1-R2) or (R2-R1), (R3-R4) or (R4-R3) ] with on-chip termination resistor enabled		-5.5		5.5	V
V <sub>I(RS-232)</sub>	Receiver input voltage in RS-232 mode	R1, R2, R5, R7, R8 pins	-15		15	V
V <sub>IH</sub>	High-level input voltage	L3, L4, L6, SLR, nSHDN, TERM_TX, TERM_RX, MODE0, MODE1, MODE2, DIR pins	0.7V <sub>IO</sub>		V <sub>IO</sub>	V
V <sub>IL</sub>	Low-level input voltage		0		0.3V <sub>IO</sub>	V
I <sub>O</sub>	Output current, driver in RS-485 mode		-60		60	mA
I <sub>OR</sub>	Output current, receiver in RS-485 mode	V <sub>IO</sub> = 1.8V or 2.5V	-2		2	mA
		V <sub>IO</sub> = 3.3V or 5V	-4		4	mA
R <sub>L</sub>	Differential load resistance in RS-485 mode		54	60		Ω
1/ t <sub>UI</sub>	Signaling rate in RS-485 mode	SLR = V <sub>IO</sub>			500	kbps
		SLR = GND or floating			20	Mbps
	Signaling rate in RS-232 mode	SLR = V <sub>IO</sub>			250	kbps
		SLR = GND or floating			1	Mbps
1/ t <sub>UI(LOOPBACK)</sub>	Signaling rate in RS-485 loopback mode				0.5	Mbps
	Signaling rate in RS-232 loopback mode				1	Mbps
T <sub>A</sub>	Operating ambient temperature	Note 1	-40		125	°C

Note 1: Operation is specified for internal (junction) temperatures up to 150°C. Self-heating due to internal power dissipation should be considered for each application. Maximum junction temperature is internally limited by the thermal shutdown (T<sub>SD</sub>) circuit which disables the driver and receiver when the junction temperature reaches 170°C.

**8.3 Thermal Information**

Symbol	Parameter	Value	Unit
R <sub>θJA</sub>	Junction to ambient thermal resistance	QFN40 6.0×6.0	27.4 °C/W

**8.4 Power Dissipation**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
P <sub>D(RS-485)</sub>	Full Duplex mode with DIR = V <sub>IO</sub> , MODE2, MODE1, MODE0 = 011, R2/R1 are externally connected to R3/R4 in loopback fashion; V <sub>CC</sub> = V <sub>IO</sub> = 5.5 V, T <sub>A</sub> = 125 °C, L3 = square wave 50% duty	Unterminated, TERM_TX = L, TERM_RX = L, SLR = H (500kbps)		185	300	mW
		Unterminated, TERM_RTX = L, TERM_RX = L, SLR = L (20Mbps)		170	350	
		TERM_TX = V <sub>IO</sub> , TERM_RX = V <sub>IO</sub> , SLR = H (500kbps)		450	500	mW
		TERM_TX = V <sub>IO</sub> , TERM_RX = V <sub>IO</sub> , SLR = L (20Mbps)		370	575	
P <sub>D(RS-232)</sub>	RS-232 mode with MODE2, MODE1, MODE0 = 001	V <sub>CC</sub> = V <sub>IO</sub> = 5.5V, R3, R4, R6 bus lines loaded with 3 kΩ, R3 load cap = 1000 pF, L3 toggling, SLR = L(1Mbps)		340	500	mW
		V <sub>CC</sub> = V <sub>IO</sub> = 5.5V, R3, R4, R6 bus lines loaded with 3 kΩ, R3 load cap = 2500 pF, L3 toggling, SLR = H(250kbps)		250	350	

**8.5 Electrical Characteristics(Static)**

$V_{CC} = 3V$  to  $5.5V$ ,  $V_{IO} = 1.65V$  to  $5.5V$ ,  $T_A = -40\text{ }^\circ\text{C}$  to  $125\text{ }^\circ\text{C}$ , unless otherwise noted. All typical values are at  $25\text{ }^\circ\text{C}$  and supply voltage of  $V_{CC} = 5V$ ,  $V_{IO} = 3.3V$ .

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Supply</b>						
$V_{UVD(RIS)VCC}$	Rising under-voltage threshold on VCC			2.5	2.8	V
$V_{UVD(FAL)VCC}$	Falling under-voltage threshold on VCC		1.9	2.3		V
$V_{UVD(HYS)VCC}$	Hysteresis on under-voltage of VCC		100	200		mV
$V_{UVD(RIS)VIO}$	Rising under-voltage threshold on VIO			1.2	1.6	V
$V_{UVD(FAL)VIO}$	Falling under-voltage threshold on VIO		0.8	1.1		V
$V_{UVD(HYS)VIO}$	Hysteresis on under-voltage of VIO			100		mV
$I_{CC(SHDN)}$	Supply current in shutdown mode	$V_{CC} = 4.5V$ to $5.5V$ , nSHDN = GND, All other logic input pins floating, no load on bus, $T_A \leq 125\text{ }^\circ\text{C}$		0.5	15	$\mu\text{A}$
		$V_{CC} = 3V$ to $3.6V$ , nSHDN = GND, All other logic input pins floating, no load on bus, $T_A \leq 125\text{ }^\circ\text{C}$		0.3	12	$\mu\text{A}$
		$V_{CC} = 4.5V$ to $5.5V$ , nSHDN = GND, All other logic input pins floating, no load on bus, $T_A \leq 105\text{ }^\circ\text{C}$		0.5	12	$\mu\text{A}$
		$V_{CC} = 3V$ to $3.6V$ , nSHDN = GND, All other logic input pins floating, no load on bus, $T_A \leq 105\text{ }^\circ\text{C}$		0.3	10	$\mu\text{A}$
$I_{IO(SHDN)}$	Logic supply current in shutdown mode	$V_{IO} = 1.65V$ to $5.5V$ , nSHDN = GND, All other logic input pins floating			2	$\mu\text{A}$

**8.5 Electrical Characteristics(Static) (continued)**

$V_{CC} = 3V$  to  $5.5V$ ,  $V_{IO} = 1.65V$  to  $5.5V$ ,  $T_A = -40\text{ }^{\circ}\text{C}$  to  $125\text{ }^{\circ}\text{C}$ , unless otherwise noted. All typical values are at  $25\text{ }^{\circ}\text{C}$  and supply voltage of  $V_{CC} = 5V$ ,  $V_{IO} = 3.3V$ .

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_{CC(485)}$	Supply current (quiescent), $V_{CC} = 4.5V$ to $5.5V$ , TERM_TX, TERM_RX = Floating or low, SLR = X	Driver and receiver enabled, DIR = $V_{IO}$ , MODE2, MODE1, MODE0 = 011 (Full duplex), No load		1.9	3.4	mA
		Driver enabled, receiver disabled, DIR = $V_{IO}$ , MODE2, MODE1, MODE0 = 010 (Half duplex), No load		1.9	2.8	mA
		Driver disabled, receiver enabled, DIR = GND, MODE2, MODE1, MODE0 = 010 (Half duplex), No load		1.55	2.5	mA
	Supply current (quiescent), $V_{CC} = 3V$ to $3.6V$ , TERM_TX, TERM_RX = Floating or low, SLR = X	Driver and receiver enabled, DIR = $V_{IO}$ , MODE2, MODE1, MODE0 = 011 (Full duplex), No load		1.7	2.8	mA
		Driver enabled, receiver disabled, DIR = $V_{IO}$ , MODE2, MODE1, MODE0 = 010 (Half duplex), No load		1.7	2.5	mA
		Driver disabled, receiver enabled, DIR = GND, MODE2, MODE1, MODE0 = 010 (Half duplex), No load		1.3	2.3	mA
$I_{IO(485)}$	Logic supply current (quiescent), $V_{IO} = 3V$ to $3.6V$ , TERM_TX, TERM_RX = Floating	Driver disabled, receiver enabled, SLR = GND, DIR = GND, MODE2, MODE1, MODE0 = 010 (Half duplex), No load		9	17	$\mu\text{A}$
		Driver disabled, receiver enabled, SLR = $V_{IO}$ , DIR = GND, MODE2, MODE1, MODE0 = 010 (Half duplex), No load		10.5	21	$\mu\text{A}$

**8.5 Electrical Characteristics(Static) (continued)**

$V_{CC} = 3V$  to  $5.5V$ ,  $V_{IO} = 1.65V$  to  $5.5V$ ,  $T_A = -40\text{ }^\circ\text{C}$  to  $125\text{ }^\circ\text{C}$ , unless otherwise noted. All typical values are at  $25\text{ }^\circ\text{C}$  and supply voltage of  $V_{CC} = 5V$ ,  $V_{IO} = 3.3V$ .

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_{CC(485)DT}$	Supply current in RS-485 driver termination mode	Driver enabled with termination ON; MODE2, MODE1, MODE0 = 011 (full duplex), DIR = $V_{IO}$ , TERM_TX = $V_{IO}$		38	50	mA
$I_{CC(485)RT}$	Supply current in RS-485 receiver termination mode	Receiver enabled with termination ON; MODE2, MODE1, MODE0 = 011 (full duplex), DIR = GND, TERM_RX = $V_{IO}$		2.5	3.8	mA
$I_{CC(232)}$	Supply current in RS-232 mode	MODE2, MODE1, MODE0 = 001, nSHDN = $V_{IO}$ ; other logic inputs floating, No load		4.5	9.3	mA
$I_{CC(232)LB}$	Supply current in RS-232 loopback mode	MODE2=X, MODE1 = 0, MODE0 = 0; L3 = L4 = L6 = static logic high, $-40\text{ }^\circ\text{C} \leq T_A \leq 125\text{ }^\circ\text{C}$ , No extra load on RS-232 drivers or on logic output		22	31	mA
$I_{CC(485)LB}$	Supply current in RS-485 loopback mode	MODE2, MODE1, MODE0 = $V_{IO}$ , L3 = static logic high, No load on bus or logic output		2	4	mA
<b>Integrate termination resistor in RS-485 mode</b>						
$R_{TERM(TX)}$	120 $\Omega$ termination across driver output R1/R2 terminals	MODE2, MODE1, MODE0 = 011 (Full duplex) or 010 (half duplex); DIR=GND, TERM_TX = $V_{IO}$ , $V_{R2R1} = 2V$ , $V_{R1} = -7V, 0V, 10V$ , See Figure 9-9	102	120	138	$\Omega$
$R_{TERM(RX)}$	120 $\Omega$ termination across receiver output R3/R4 terminals	MODE2, MODE1, MODE0 = 011 (Full duplex); TERM_RX = $V_{IO}$ , $V_{R3R4} = 2V$ , $V_{R4} = -7V, 0V, 10V$ , See Figure 9-9	102	120	138	$\Omega$

**8.5 Electrical Characteristics(Static) (continued)**

$V_{CC} = 3V$  to  $5.5V$ ,  $V_{IO} = 1.65V$  to  $5.5V$ ,  $T_A = -40\text{ }^{\circ}\text{C}$  to  $125\text{ }^{\circ}\text{C}$ , unless otherwise noted. All typical values are at  $25\text{ }^{\circ}\text{C}$  and supply voltage of  $V_{CC} = 5V$ ,  $V_{IO} = 3.3V$ .

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Logic</b>						
$I_{IN}$	Input current	$0V \leq V_{IN} \leq V_{CC}$ , (L3, L4, L6, DIR, nSHDN, SLR, TERM_TX, TERM_RX, MODE2, MODE1, MODE0 )	-20		8	$\mu\text{A}$
$V_{IH}$	Input High Voltage	$1.65V \leq V_{IO} \leq 5.5V$			$0.7V_{IO}$	V
$V_{IL}$	Input low Voltage		$0.3V_{IO}$			V
<b>RS-485 Driver</b>						
$ V_{OD} $	Driver differential output voltage magnitude	$R_L = 60\ \Omega$ , $-7V \leq V_{TEST} \leq 12V$ , See Figure 9-1	1.5	3.4		V
		$R_L = 60\ \Omega$ , $-7V \leq V_{TEST} \leq 12V$ , $4.5V \leq V_{CC} \leq 5.5V$ See Figure 9-1	2.1	3.4		V
		$R_L = 100\ \Omega$ , See Figure 9-2	2	3.9		V
		$R_L = 54\ \Omega$ , $4.5V \leq V_{CC} \leq 5.5V$ See Figure 9-2	2.1	3.4		V
		$R_L = 54\ \Omega$ , See Figure 9-2	1.5	3.4		V
$\Delta  V_{OD} $	Change in magnitude of driver differential output voltage	$R_L = 54\ \Omega$ or $100\ \Omega$ , See Figure 9-2	-50		50	mV
$V_{OC}$	Common-mode output voltage	$R_L = 54\ \Omega$ or $100\ \Omega$ , See Figure 9-2		$V_{CC}/2$	3	V
$\Delta V_{OC(SS)}$	Change in steady-state common-mode output voltage	$R_L = 54\ \Omega$ or $100\ \Omega$ , See Figure 9-2	-50		50	mV
$I_{OS}$	Short-circuit output current (Note 2)	DIR = $V_{IO}$ , $-7V \leq (V_{R2}$ or $V_{R1}) \leq 12V$ , or R1 shorted to R2	-250		250	mA
$I_{OZD}$	Driver High impedance output leakage current on R1 and R2 in Full duplex mode	MODE2, MODE1, MODE0 = 011, TERM_TX = GND, DIR = GND, $V_{CC} = \text{GND}$ or $5.5V$ , $V_O = -7V, +12V$	-125		125	$\mu\text{A}$
		MODE2, MODE1, MODE0 = 011, TERM_TX = $V_{IO}$ , DIR = GND, $V_{CC} = 5.5V$ , $V_O = -7V, +12V$	-325		350	$\mu\text{A}$

**8.5 Electrical Characteristics(Static) (continued)**

$V_{CC} = 3V$  to  $5.5V$ ,  $V_{IO} = 1.65V$  to  $5.5V$ ,  $T_A = -40\text{ }^{\circ}\text{C}$  to  $125\text{ }^{\circ}\text{C}$ , unless otherwise noted. All typical values are at  $25\text{ }^{\circ}\text{C}$  and supply voltage of  $V_{CC} = 5V$ ,  $V_{IO} = 3.3V$ .

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>RS-485 Receiver</b>						
$I_I$	Bus input current (termination disabled)	Half and full duplex modes, DIR = GND, $V_{CC} = V_{IO} = 0V$ or $5.5V$ , $V_I = 12V$		75	125	$\mu\text{A}$
		Half and full duplex modes, DIR = GND, $V_{CC} = V_{IO} = 0V$ or $5.5V$ , $V_I = -7V$	-450	-50		$\mu\text{A}$
$I_{RXT}$	Receiver bus input leakage current with termination enabled	Full duplex mode, $V_{CC} = V_{IO} = 5.5V$ , TERM_RX = $V_{IO}$ , $V_I = -7$ to $12V$	-450		325	$\mu\text{A}$
$V_{TH+}$	Positive-going input threshold voltage (Note 1)	Over common-mode range of $-7V$ to $12V$		100	200	mV
$V_{TH-}$	Negative-going input threshold voltage (Note 1)		-200	-100		mV
$V_{HYS}$	Input hysteresis			200		mV
$C_{A,B}$	Input differential capacitance	Measured between R3 and R4, $f = 1\text{ MHz}$		45		pF
$V_{OH}$	Output high voltage L2 pin	$I_{OH} = -4\text{ mA}$ , $V_{IO} = 3$ to $3.6V$ or $4.5V$ to $5.5V$	$V_{IO} - 0.4$	$V_{IO} - 0.2$		V
		$I_{OH} = -2\text{ mA}$ , $V_{IO} = 1.65$ to $1.95V$ or $2.25V$ to $2.75V$	$V_{IO} - 0.4$	$V_{IO} - 0.2$		V
$V_{OL}$	Output low voltage L2 pin	$I_{OL} = 4\text{ mA}$ , $V_{IO} = 3$ to $3.6V$ or $4.5V$ to $5.5V$		0.2	0.4	V
		$I_{OL} = 2\text{ mA}$ , $V_{IO} = 1.65$ to $1.95V$ or $2.25V$ to $2.75V$		0.2	0.4	V
$I_{OZ}$	Output high-impedance current, L2 pin	$V_O = 0V$ or $V_{IO}$ , DIR = $V_{IO}$ , MODE2, MODE1, MODE0 = 010 (half duplex mode)	-1		1	$\mu\text{A}$

**8.5 Electrical Characteristics(Static) (continued)**

$V_{CC} = 3V$  to  $5.5V$ ,  $V_{IO} = 1.65V$  to  $5.5V$ ,  $T_A = -40^\circ C$  to  $125^\circ C$ , unless otherwise noted. All typical values are at  $25^\circ C$  and supply voltage of  $V_{CC} = 5V$ ,  $V_{IO} = 3.3V$ .

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>RS-232 Driver</b>						
$V_{OH}$	High-level output voltage	All DOUT (R3, R4, R6) at $R_L = 3\text{ k}\Omega$ to GND, DIN (L3, L4, L6) = GND; $V_{CC} = 3V$ to $3.6V$	4.2	5.5	7	V
		All DOUT (R3, R4, R6) at $R_L = 3\text{ k}\Omega$ to GND, DIN (L3, L4, L6) = GND; $V_{CC} = 4.5V$ to $5.5V$	6.3	8.5	10	V
$V_{OL}$	Low-level output voltage	All DOUT (R3, R4, R6) at $R_L = 3\text{ k}\Omega$ to GND, DIN (L3, L4, L6) = $V_{IO}$ ; $V_{CC} = 3V$ to $3.6V$	-7	-5.5	-4.2	V
		All DOUT (R3, R4, R6) at $R_L = 3\text{ k}\Omega$ to GND, DIN (L3, L4, L6) = $V_{IO}$ ; $V_{CC} = 4.5V$ to $5.5V$	-10	-8.5	-6.3	V
$I_{OS}$	Short-circuit output current (Note 2)	$V_{CC} = 3.6V$ , $V_O = 0V$		$\pm 35$	$\pm 60$	mA
		$V_{CC} = 5.5V$ , $V_O = 0V$		$\pm 35$	$\pm 60$	mA
$I_{OFF}$	Output leakage current on R3, R4, R6 pins	nSHDN = GND, $V_{CC} = 3V$ to $3.6V$ , $V_O = \pm 12V$ , $T_A = 25^\circ C$	-125		125	$\mu A$
		nSHDN = GND, $V_{CC} = 4.5V$ to $5.5V$ , $V_O = \pm 10V$ , $T_A = 25^\circ C$	-125		125	$\mu A$
<b>RS-232 Receiver</b>						
$V_{OH}$	High-level output voltage on L1/L2/L5/L7/L8 pins	$I_{OH} = -1.5\text{ mA}$ , $V_{IO} = 3$ to $3.6V$ or $4.5V$ to $5.5V$	$V_{IO}-0.5$			V
		$I_{OH} = -1\text{ mA}$ , $V_{IO} = 1.65$ to $1.95V$ or $2.25V$ to $2.75V$	$V_{IO}-0.5$			V
$V_{OL}$	Low-level output voltage on L1/L2/L5/L7/L8 pins	$I_{OL} = 2\text{ mA}$ , $V_{IO} = 3$ to $3.6V$ or $4.5V$ to $5.5V$			0.4	V
		$I_{OL} = 1\text{ mA}$ , $V_{IO} = 1.65$ to $1.95V$ or $2.25V$ to $2.75V$			0.4	V

**8.5 Electrical Characteristics(Static) (continued)**

$V_{CC} = 3V$  to  $5.5V$ ,  $V_{IO} = 1.65V$  to  $5.5V$ ,  $T_A = -40\text{ }^{\circ}\text{C}$  to  $125\text{ }^{\circ}\text{C}$ , unless otherwise noted. All typical values are at  $25\text{ }^{\circ}\text{C}$  and supply voltage of  $V_{CC} = 5V$ ,  $V_{IO} = 3.3V$ .

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{TH+}$	Positive-going input threshold voltage on RS-232 receiver inputs (R1, R2, R5, R7, R8) (Note 1)	$V_{CC} = 3.3V$		1.4	2.4	V
		$V_{CC} = 5V$		2	2.4	V
$V_{TH-}$	Negative-going input threshold voltage on RS-232 receiver inputs (R1, R2, R5, R7, R8) (Note 1)	$V_{CC} = 3.3V$	0.6	1.1		V
		$V_{CC} = 5V$	0.8	1.6		V
$V_{HYS}$	Input hysteresis on receiver inputs ( $V_{TH+} - V_{TH-}$ )			0.4		V
$I_{OFF}$	Output leakage current on receiver output L1/L2/L5/L7/L8 pins	$nSHDN = 0V$		$\pm 0.05$	$\pm 10$	$\mu A$
$R_I$	Input resistance on receiver input pins	$-15V \leq V_I \leq 15V$	3	5	7	$k\Omega$
<b>Thermal Protection</b>						
$T_{SD}$	Thermal shutdown threshold	Temperature rising	150	170		$^{\circ}\text{C}$
$T_{HYS}$	Thermal shutdown hysteresis			10		$^{\circ}\text{C}$

Note 1:  $V_{TH+}$  is assured to be at least  $V_{HYS}$  higher than  $V_{TH-}$ .

Note 2: Short-circuit durations should be controlled to prevent exceeding the device absolute power dissipation ratings, and not more than one output should be shorted at a time.

**8.6 Electrical Characteristics (Dynamic)—RS-485\_500kbps**

500kbps (SLR = V<sub>IO</sub>) V<sub>CC</sub> = 3V to 5.5V, V<sub>IO</sub> = 1.65V to 5.5V, T<sub>A</sub> = -40 °C to 125 °C, unless otherwise noted. All typical values are at 25°C and supply voltage of V<sub>CC</sub> = 5 V, V<sub>IO</sub> = 3.3V. (Note 1)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
<b>Driver</b>							
t <sub>R</sub> , t <sub>F</sub>	Driver differential output rise/fall time	R <sub>L</sub> = 54 Ω, C <sub>L</sub> = 50 pF, see Figure 9-3	V <sub>CC</sub> = 3 to 3.6 V, Typical at 3.3 V	200	310	600	ns
			V <sub>CC</sub> = 4.5 to 5.5 V, Typical at 5 V	200	310	600	ns
t <sub>PHL</sub> , t <sub>PLH</sub>	Driver propagation delay time		V <sub>CC</sub> = 3 to 3.6 V, Typical at 3.3 V		265	450	ns
			V <sub>CC</sub> = 4.5 to 5.5 V, Typical at 5 V		265	450	ns
t <sub>SK(P)</sub>	Driver differential output pulse skew,  t <sub>PHL</sub> - t <sub>PLH</sub>		V <sub>CC</sub> = 3 to 3.6 V, Typical at 3.3 V		1	70	ns
			V <sub>CC</sub> = 4.5 to 5.5 V, Typical at 5 V		2	70	ns
t <sub>PHZ</sub> , t <sub>PLZ</sub>	Disable time	MODE2, MODE1, MODE0 = 010 (half duplex) or 011 (full duplex), see Figure 9-4 and Figure 9-5			300	ns	
t <sub>PZH</sub> , t <sub>PZL</sub>	Enable time	MODE2, MODE1, MODE0 = 011 (full duplex): receiver enabled, see Figure 9-4 and Figure 9-5			10	μs	
<b>Receiver</b>							
t <sub>R</sub> , t <sub>F</sub>	Receiver output rise/fall time	C <sub>L</sub> = 15 pF, see Figure 9-6		8	20	ns	
t <sub>PHL</sub> , t <sub>PLH</sub>	Receiver propagation delay time			640	1200	ns	
t <sub>SK(P)</sub>	Receiver output pulse skew,  t <sub>PHL</sub> - t <sub>PLH</sub>			2	45	ns	
t <sub>PHZ</sub> , t <sub>PLZ</sub>	Disable time in half duplex mode	MODE2, MODE1, MODE0 = 010, TERM_TX = V <sub>IO</sub> , see Figure 9-7			40	ns	
t <sub>PZH</sub> , t <sub>PZL</sub>	Enable time in half duplex mode				150	ns	
t <sub>PSH</sub> , t <sub>PSL</sub>	Enable time from shutdown with TX disabled in full duplex mode	DIR = 0V; MODE2, MODE1, MODE0 = 011, see Figure 9-8		7	16	μs	

Note 1: R3, R4 are receiver inputs, R2, R1 are driver output terminals in Full duplex mode.

**8.7 Electrical Characteristics (Dynamic)—RS-485\_20Mbps**

20Mbps (SLR = GND)  $V_{CC} = 3V$  to  $5.5V$ ,  $V_{IO} = 1.65V$  to  $5.5V$ ,  $T_A = -40\text{ }^\circ\text{C}$  to  $125\text{ }^\circ\text{C}$ , unless otherwise noted. All typical values are at  $25\text{ }^\circ\text{C}$  and supply voltage of  $V_{CC} = 5V$ ,  $V_{IO} = 3.3V$ . (Note 1)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
<b>Driver</b>							
$t_R, t_F$	Driver differential output rise/fall time	$R_L = 54\ \Omega$ , $C_L = 50\ \text{pF}$ , see Figure 9-3	$V_{CC} = 3$ to $3.6V$ , Typical at $3.3V$	4	6	15	ns
			$V_{CC} = 4.5$ to $5.5V$ , Typical at $5V$	4	6	15	ns
$t_{PHL}, t_{PLH}$	Driver propagation delay time		$V_{CC} = 3$ to $3.6V$ , Typical at $3.3V$		10	58	ns
			$V_{CC} = 4.5$ to $5.5V$ , Typical at $5V$		10	46	ns
$t_{SK(P)}$	Driver differential output pulse skew, $ t_{PHL} - t_{PLH} $		$V_{CC} = 3$ to $3.6V$ , Typical at $3.3V$		0.4	3.5	ns
			$V_{CC} = 4.5$ to $5.5V$ , Typical at $5V$		0.2	3.5	ns
$t_{PHZ}, t_{PLZ}$	Disable time	MODE2, MODE1, MODE0 = 010 (half duplex) or 11 (full duplex), see Figure 9-4 and Figure 9-5			90	ns	
$t_{PZH}, t_{PZL}$	Enable time	MODE2, MODE1, MODE0 = 011 (full duplex): receiver enabled, see Figure 9-4 and Figure 9-5			9	$\mu\text{s}$	
<b>Receiver</b>							
$t_R, t_F$	Receiver output rise/fall time	$C_L = 15\ \text{pF}$ , see Figure 9-6		4.5	10	ns	
$t_{PHL}, t_{PLH}$	Receiver propagation delay time			14	70	ns	
$t_{SK(P)}$	Receiver output pulse skew, $ t_{PHL} - t_{PLH} $				10	ns	
$t_{PHZ}, t_{PLZ}$	Disable time in half duplex mode	MODE2, MODE1, MODE0 = 010, TERM_TX = $V_{IO}$ , see Figure 9-7		8	80	ns	
$t_{PZH}, t_{PZL}$	Enable time in half duplex mode (includes driver disable time as per setup)			100	160	ns	
$t_{PSH}, t_{PSL}$	Enable time from shutdown with TX disabled in full duplex mode	DIR = 0V; MODE2, MODE1, MODE0 = 011, see Figure 9-8		6.6	15	$\mu\text{s}$	

Note 1: R3, R4 are receiver inputs, R2, R1 are driver outputs in Full duplex mode.

**8.8 Electrical Characteristics (Dynamic)—RS-232\_250kbps**

$V_{CC} = 3V$  to  $5.5V$ ,  $V_{IO} = 1.65V$  to  $5.5V$ ,  $T_A = -40\text{ }^{\circ}\text{C}$  to  $125\text{ }^{\circ}\text{C}$ , unless otherwise noted. All typical values are at  $25\text{ }^{\circ}\text{C}$  and supply voltage of  $V_{CC} = 5V$ ,  $V_{IO} = 3.3V$ . (Note 1)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Driver</b>						
$DR_{MAX}$	Maximum data rate	$R_L = 3k\Omega$ , $C_L = 2500\text{ pF}$ , one DOUT switching, see Figure 9-10			250	kbps
$t_{PLH}$ , $t_{PHL}$	Transmitter propagation delay	$R_L = 3k\Omega$ to $7k\Omega$ , $C_L = 150\text{ pF}$ to $2500\text{ pF}$ , see Figure 9-10			2	$\mu\text{s}$
$t_{SK(P)}$	Transmitter Pulse skew				600	ns
$SR_{TR}$	Transition region Slew rate	$V_{CC} = 3.3V \pm 10\%$ or $5V \pm 10\%$ , $R_L = 3k\Omega$ to $7k\Omega$ , $C_L = 150\text{ pF}$ to $1000\text{ pF}$ , see Figure 9-11	6		30	$V/\mu\text{s}$
		$V_{CC} = 3.3V \pm 10\%$ or $5V \pm 10\%$ , $R_L = 3k\Omega$ to $7k\Omega$ , $C_L = 150\text{ pF}$ to $2500\text{ pF}$ , see Figure 9-11	4		30	$V/\mu\text{s}$
<b>Receiver</b>						
$t_{PLH}$	Propagation delay time, low- to high-level output	$C_L = 150\text{ pF}$ , see Figure 9-12		150	550	ns
		$C_L = 15\text{ pF}$ , see Figure 9-12		110	520	ns
$t_{PHL}$	Propagation delay time, high- to low-level output	$C_L = 150\text{ pF}$ , see Figure 9-12		150	550	ns
		$C_L = 15\text{ pF}$ , see Figure 9-12		110	520	ns
$t_{R(232)}$ , $t_{F(232)}$	Rise/fall time (receiver buffer output), $V_{IO} = 3$ to $5.5V$	$C_L = 150\text{ pF}$ , see Figure 9-12		20	50	ns
		$C_L = 15\text{ pF}$ , see Figure 9-12		7	13	ns
	Rise/fall time (receiver buffer output), $V_{IO} = 1.65$ to $2.75V$	$C_L = 150\text{ pF}$ , see Figure 9-12		40	110	ns
		$C_L = 15\text{ pF}$ , see Figure 9-12		15	30	ns
$t_{EN}$	Output enable time	$C_L = 150\text{ pF}$ , $R_L = 3k\Omega$ , See Figure 9-13		2.8	14	$\mu\text{s}$
$t_{DIS}$	Output disable time			135	400	ns
$t_{SK(P)}$	Receiver output pulse skew, $ t_{PHL} - t_{PLH} $	$C_L = 150\text{ pF}$ , see Figure 9-12			125	ns
		$C_L = 15\text{ pF}$ , see Figure 9-12			125	ns

Note 1: Test conditions are  $C1-C4 = 0.1\mu\text{F}$  at  $V_{CC} = 3.3V \pm 0.3V$  and  $V_{CC} = 5V \pm 0.5V$ .

**8.9 Electrical Characteristics (Dynamic)—RS-232\_1Mbps**

$V_{CC} = 3V$  to  $5.5V$ ,  $V_{IO} = 1.65V$  to  $5.5V$ ,  $T_A = -40^\circ C$  to  $125^\circ C$ , unless otherwise noted. All typical values are at  $25^\circ C$  and supply voltage of  $V_{CC} = 5V$ ,  $V_{IO} = 3.3V$ . (Note 1)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Driver</b>						
DR <sub>MAX</sub>	Maximum data rate	$R_L = 3k\Omega$ , $C_L = 250$ pF, $V_{CC} = 3$ to $3.6V$ , one DOUT switching, see Figure 9-10			1000	kbps
		$R_L = 3k\Omega$ , $C_L = 1000$ pF, $V_{CC} = 4.5$ to $5.5V$ , one DOUT switching, see Figure 9-10			1000	kbps
$t_{PLH}$ , $t_{PHL}$	Transmitter propagation delay	$R_L = 3k\Omega$ to $7k\Omega$ , $C_L = 150$ pF to $1000$ pF, see Figure 9-11			800	ns
$t_{SK(P)}$	Transmitter Pulse skew				150	ns
SR <sub>TR</sub>	Transition region Slew rate	$V_{CC} = 4.5$ to $5.5V$ , $R_L = 3k\Omega$ to $7k\Omega$ , $C_L = 150$ pF to $1000$ pF, see Figure 9-11	18		150	V/ $\mu$ s
		$V_{CC} = 3$ to $3.6V$ , $R_L = 3k\Omega$ to $7k\Omega$ , $C_L = 150$ pF to $1000$ pF, see Figure 9-11	15		150	V/ $\mu$ s
<b>Receiver</b>						
$t_{PLH}$	Propagation delay time, low- to high-level output	$C_L = 150$ pF, see Figure 9-12		150	550	ns
		$C_L = 15$ pF, see Figure 9-12		110	520	ns
$t_{PHL}$	Propagation delay time, high- to low-level output	$C_L = 150$ pF, see Figure 9-12		150	550	ns
		$C_L = 15$ pF, see Figure 9-12		110	520	ns
$t_{R(232)}$ , $t_{F(232)}$	Rise/fall time (receiver buffer output), $V_{IO} = 3$ to $5.5V$	$C_L = 150$ pF, see Figure 9-12		20	50	ns
		$C_L = 15$ pF, see Figure 9-12		7	13	ns
	Rise/fall time (receiver buffer output), $V_{IO} = 1.65$ to $2.75V$	$C_L = 150$ pF, see Figure 9-12		40	110	ns
		$C_L = 15$ pF, see Figure 9-12		15	30	ns
$t_{EN}$	Output enable time	$C_L = 150$ pF, $R_L = 3k\Omega$ , See Figure 9-13		2.8	14	$\mu$ s
$t_{DIS}$	Output disable time			135	400	ns
$t_{SK(P)}$	Receiver output pulse skew, $ t_{PHL} - t_{PLH} $	$C_L = 150$ pF, see Figure 9-12			125	ns
		$C_L = 15$ pF, see Figure 9-12			125	ns

Note 1: Test conditions are  $C1-C4 = 0.1\mu F$  at  $V_{CC} = 3.3V \pm 0.3V$  and  $V_{CC} = 5V \pm 0.5V$ .

**9 Parameter Measurement Information**

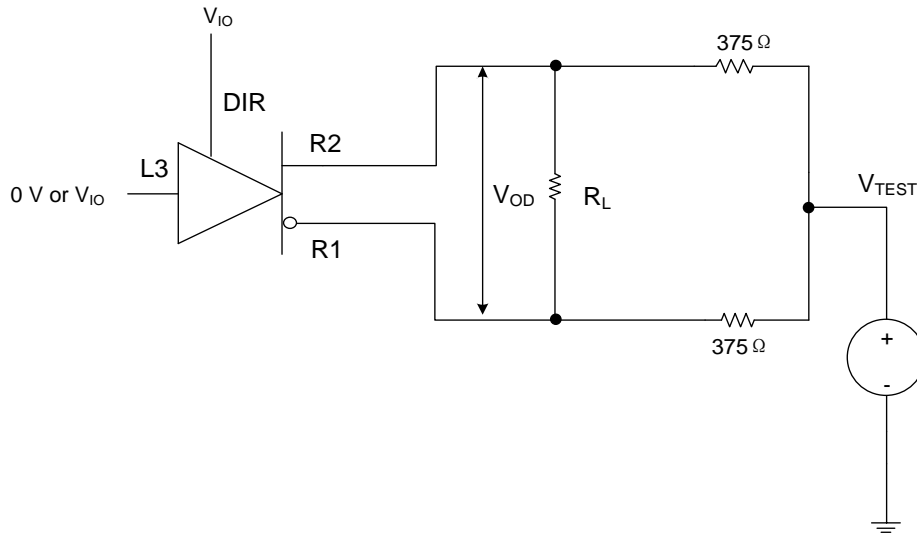


Figure 9-1. Measurement of RS-485 Driver Differential Output Voltage With Common-Mode Load

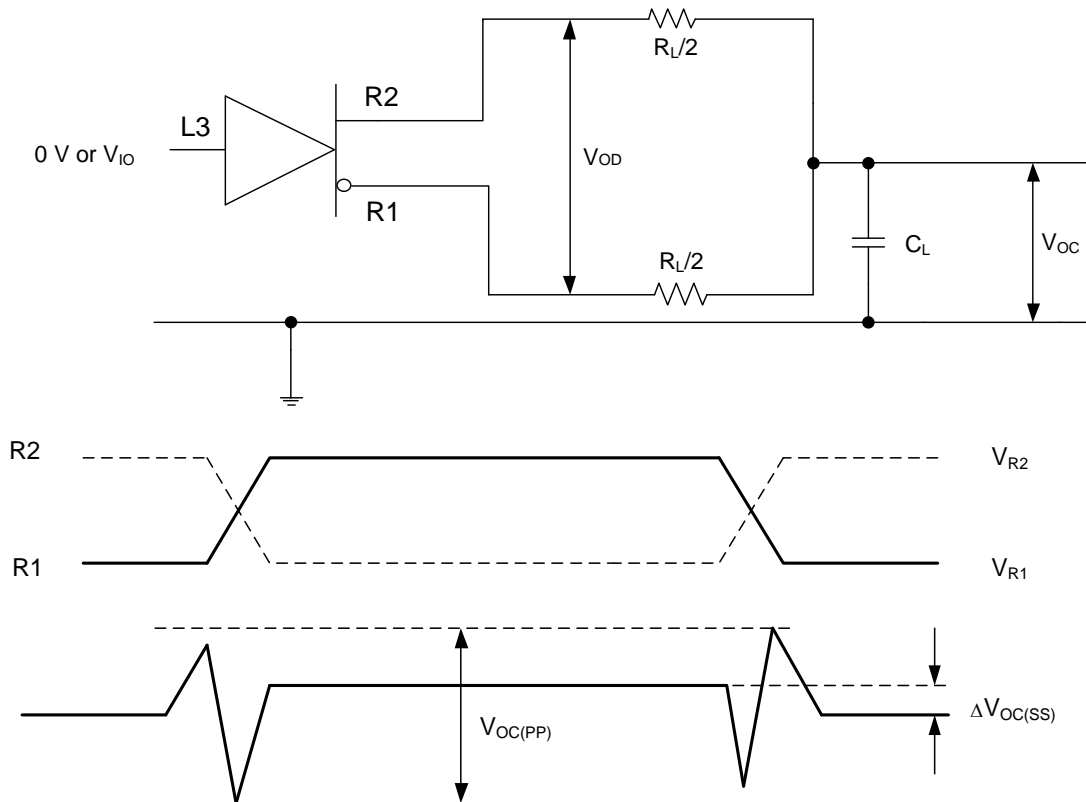


Figure 9-2. Measurement of RS-485 Driver Differential and Common-Mode Output With RS-485 Load

9 Parameter Measurement Information (continued)

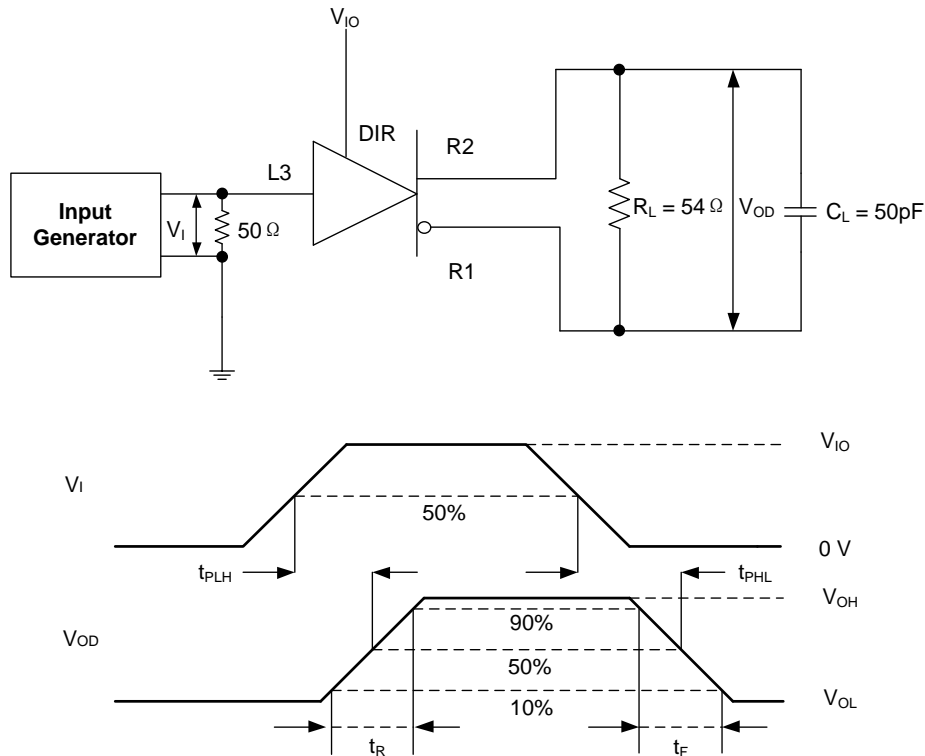


Figure 9-3. Measurement of RS-485 Driver Differential Output Rise and Fall Times and Propagation Delays

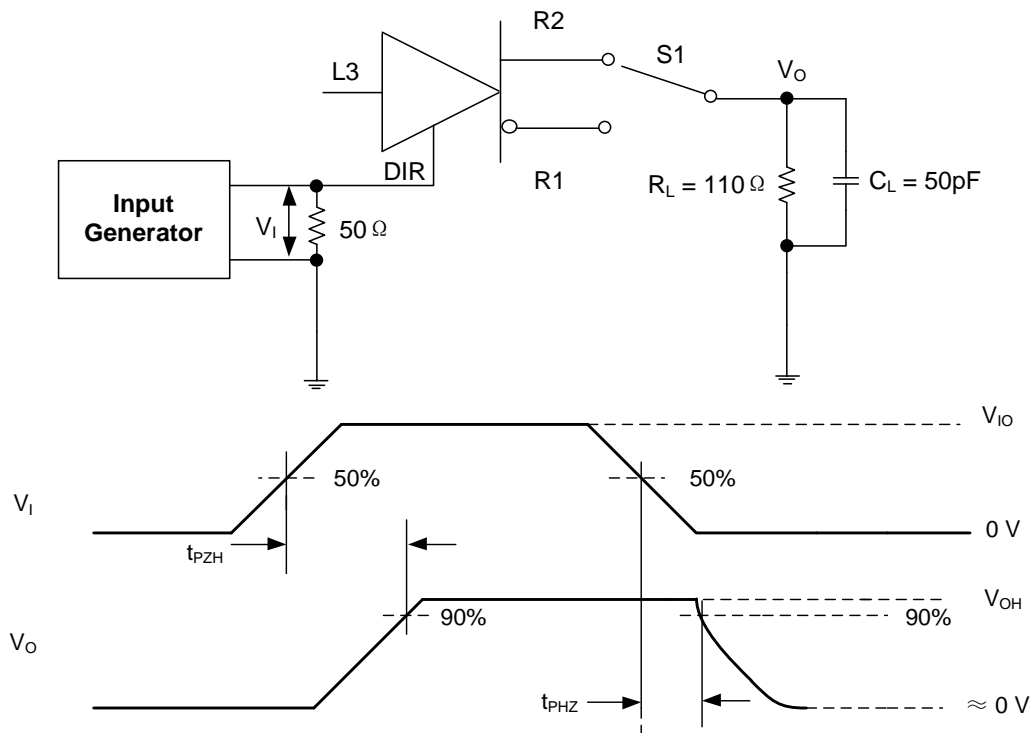


Figure 9-4. Measurement of RS-485 Driver Enable and Disable Times With Active High Output and Pull-Down Load

**9 Parameter Measurement Information (continued)**

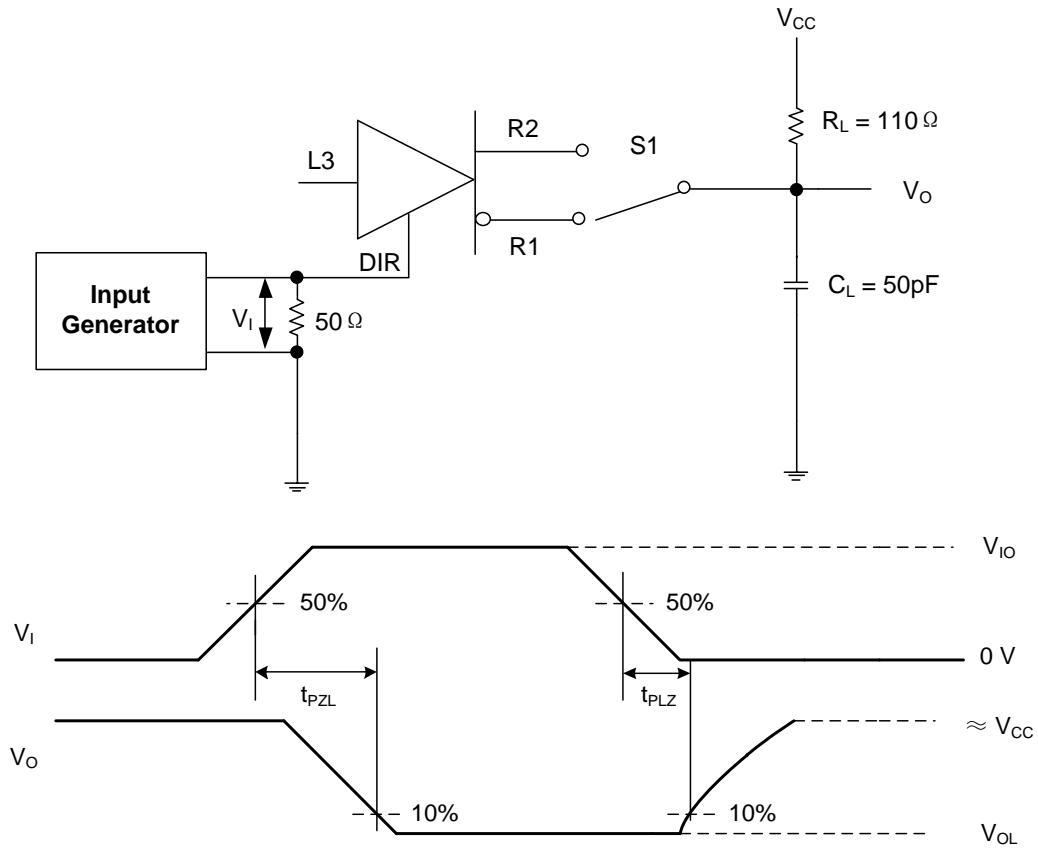
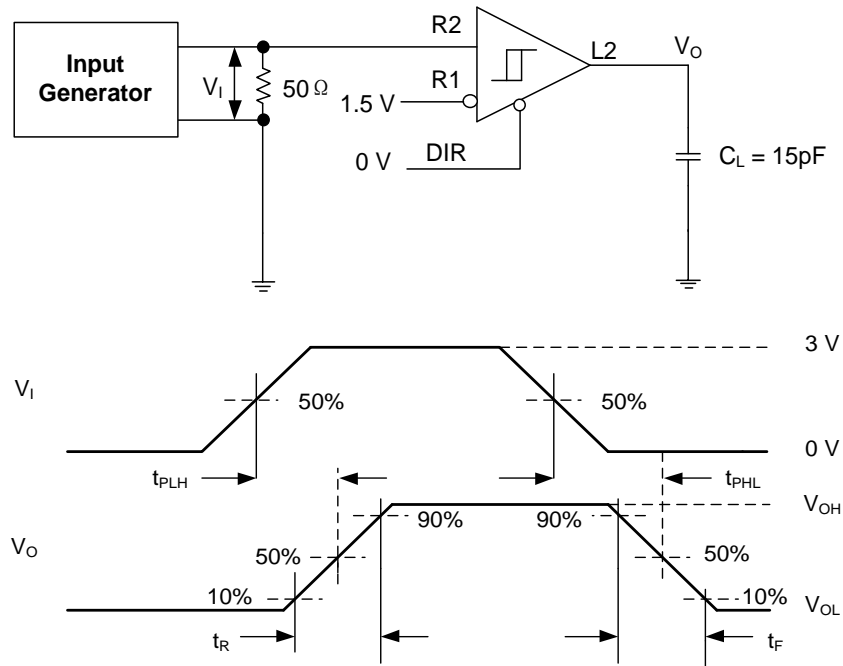


Figure 9-5. Measurement of RS-485 Driver Enable and Disable Times with Active Low Output and Pull-up Load



Note 1: Input terminals are R1 and R2 in half duplex mode, R3 and R4 in Full duplex mode

Figure 9-6. Measurement of RS-485 Receiver Output Rise and Fall Times and Propagation Delays

**9 Parameter Measurement Information (continued)**

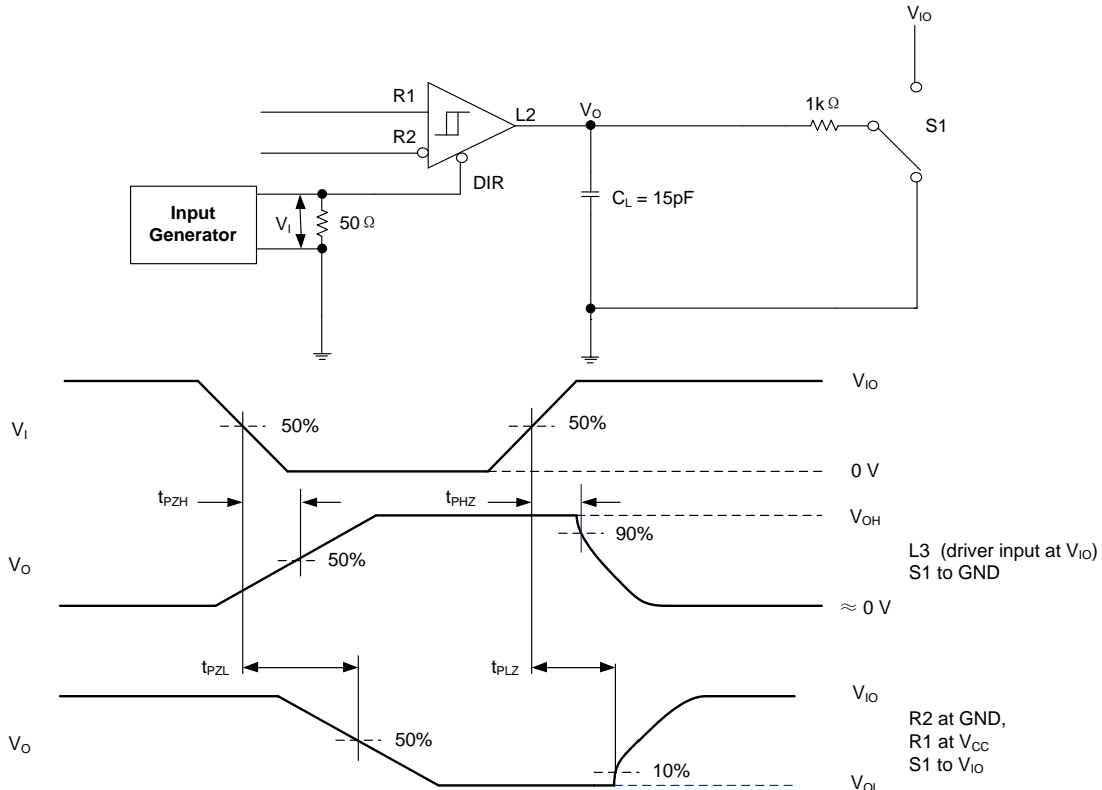


Figure 9-7. Measurement of RS-485 Receiver Enable and Disable Times in Half Duplex Mode

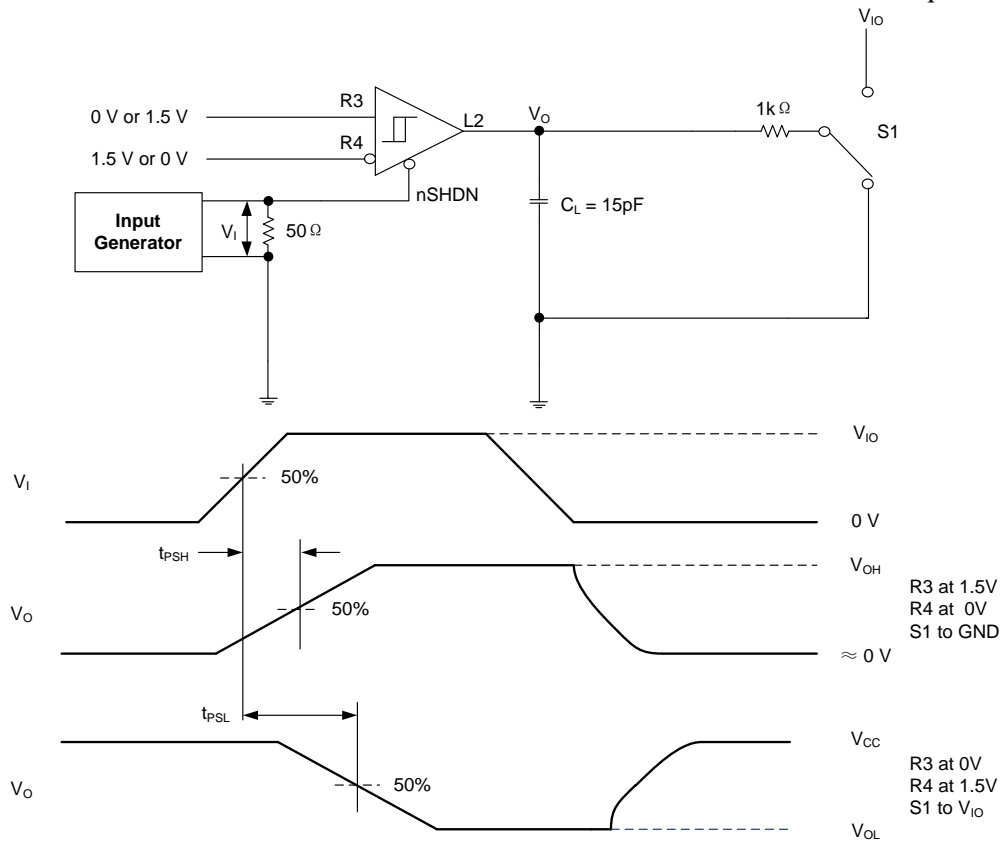


Figure 9-8. Measurement of RS-485 Receiver Enable Time from Shutdown with TX Disabled: Full Duplex Mode

## 9 Parameter Measurement Information(continued)

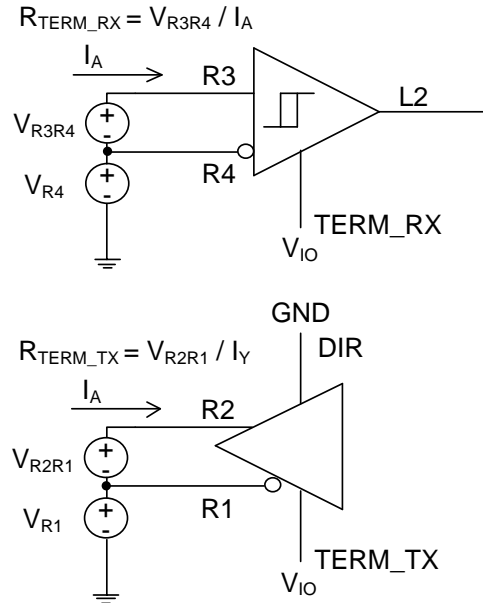
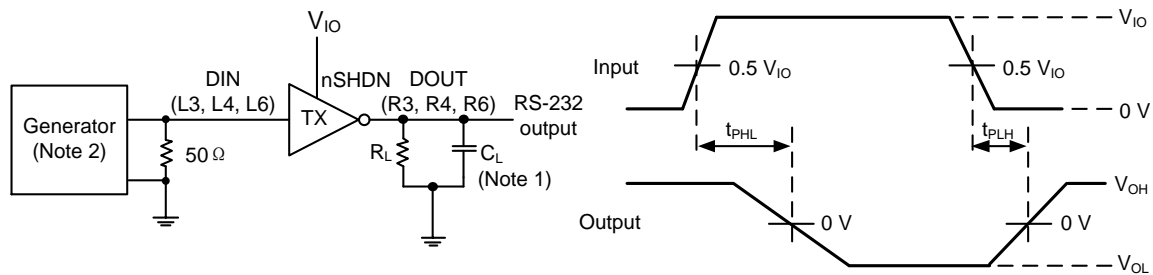


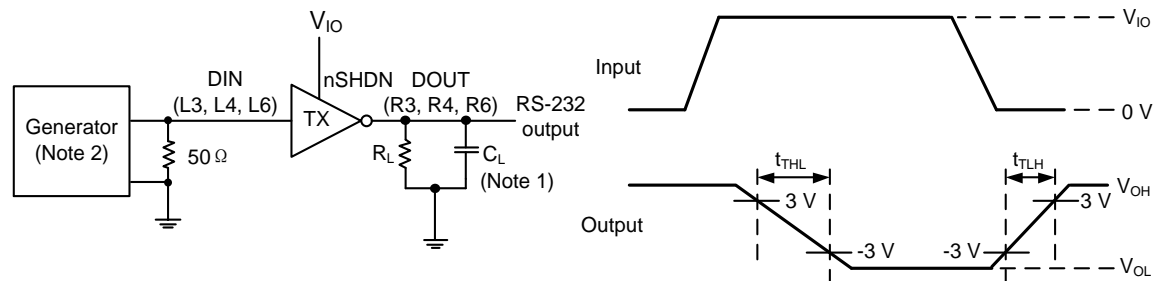
Figure 9-9. Termination Resistor Measurement



Note 1:  $C_L$  includes probe and jig capacitance.

Note 2: The pulse generator has the following characteristics: PRR = 250 kbps and 1 Mbit/s, 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.

Figure 9-10. RS-232 Driver Prop Delay, Pulse Skew



Note 1:  $C_L$  includes probe and jig capacitance.

Note 2: The pulse generator has the following characteristics: PRR = 250 kbps and 1 Mbit/s, 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.

Note 3:  $SR = 6 \text{ V} / (t_{THL} \text{ or } t_{TLH})$ .

Figure 9-11. RS-232 Driver Slew Rate

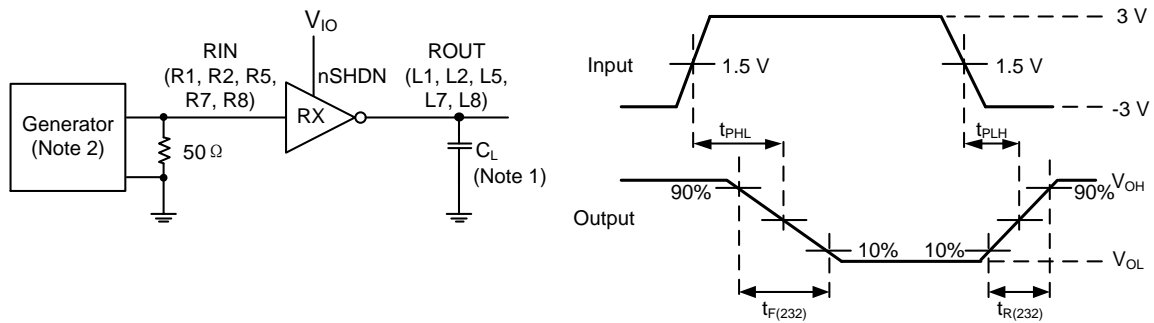
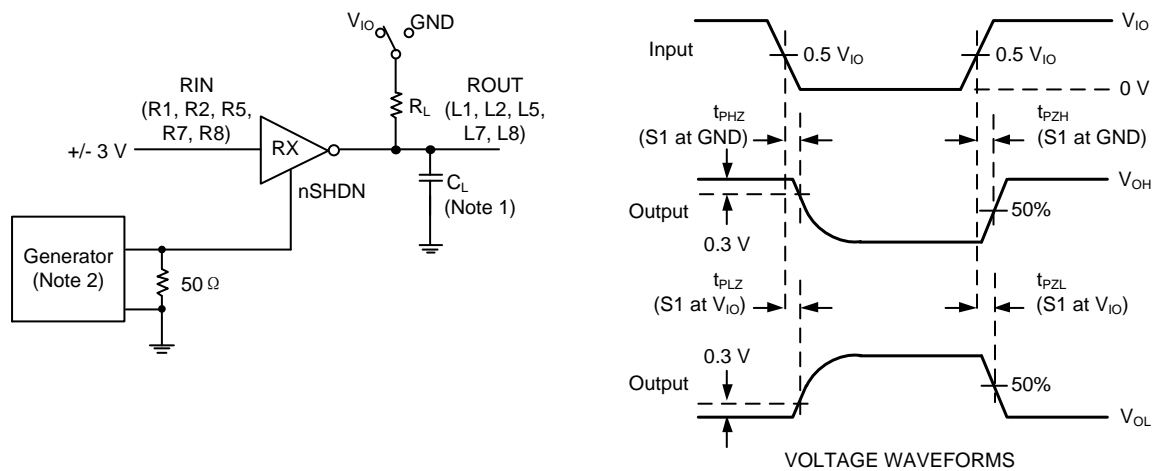
**9 Parameter Measurement Information (continued)**


Figure 9-12. RS-232 Receiver Propagation Delay, Pulse Skew



Note 1:  $C_L$  includes probe and jig capacitance.

Note 2: The pulse generator has the following characteristics: 50% duty cycle,  $t_R \leq 10$  ns,  $t_F \leq 10$  ns.

Note 3:  $t_{PLZ}$  and  $t_{PHZ}$  are same as  $t_{DIS}$ ,  $t_{PZL}$  and  $t_{PZH}$  are same as  $t_{EN}$ .

Figure 9-13. RS-232 Receiver Enable and Disable Time

## 10 Detailed Description

### 10.1 Overview

The UM3035A is an advanced and robust multiprotocol transceiver supporting RS-232, RS-422 and RS-485 physical layers in a 40-pin 6×6 QFN package. Integrated cable termination and configuration modes allow RS-232, RS-422 and RS-485 protocols to be used interchangeably over a single cable or connector with no additional components. The device has three transmitters and five receivers to enable 3T5R RS-232 port. The device also integrates one transmitter and one receiver to enable half and full duplex RS-485 port.

The device has SLR pin which allows it to be used for two different maximum speed settings for RS-232 and for RS-485. This is beneficial as customers can qualify one device and use it in two separate end-applications.

### 10.2 Functional Block Diagram

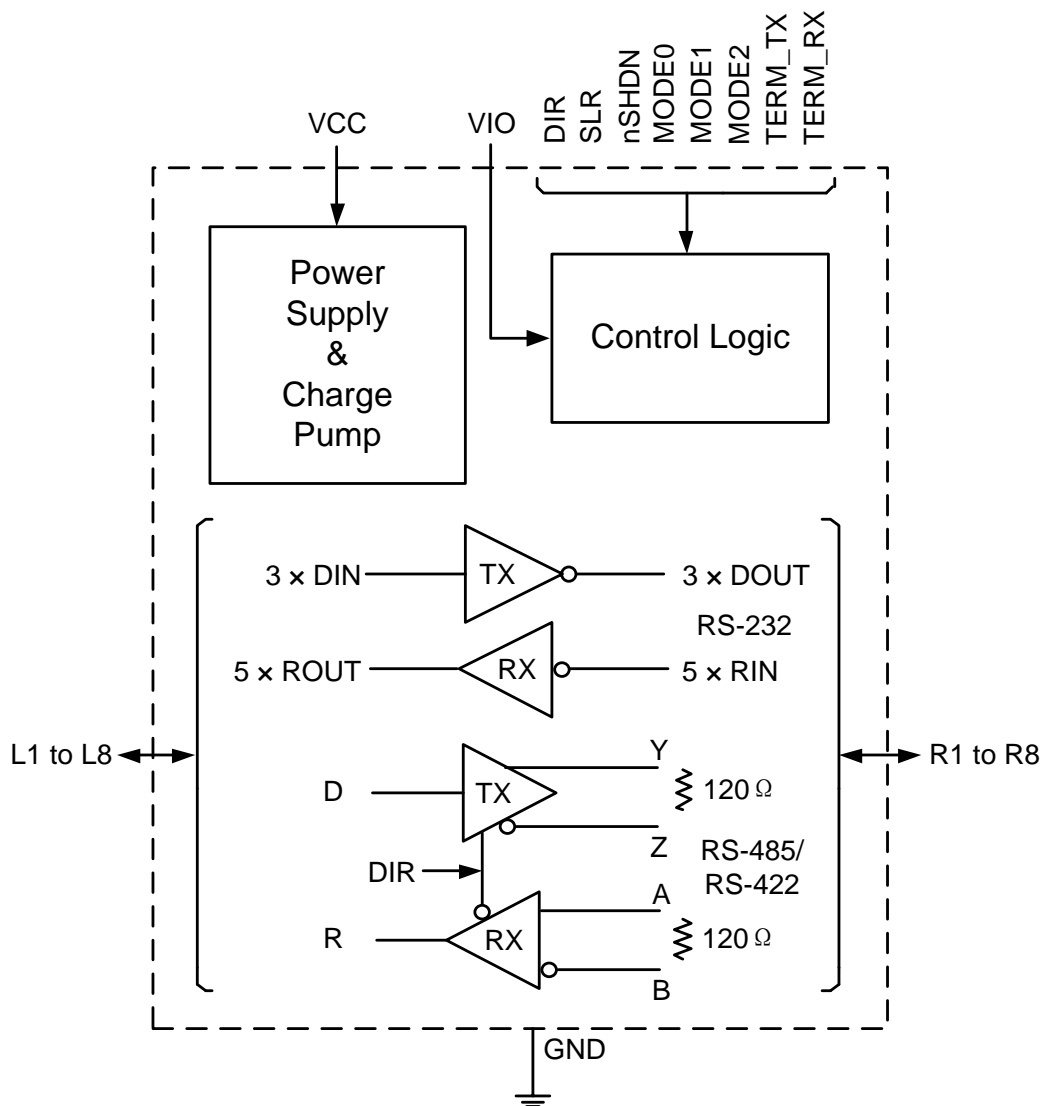
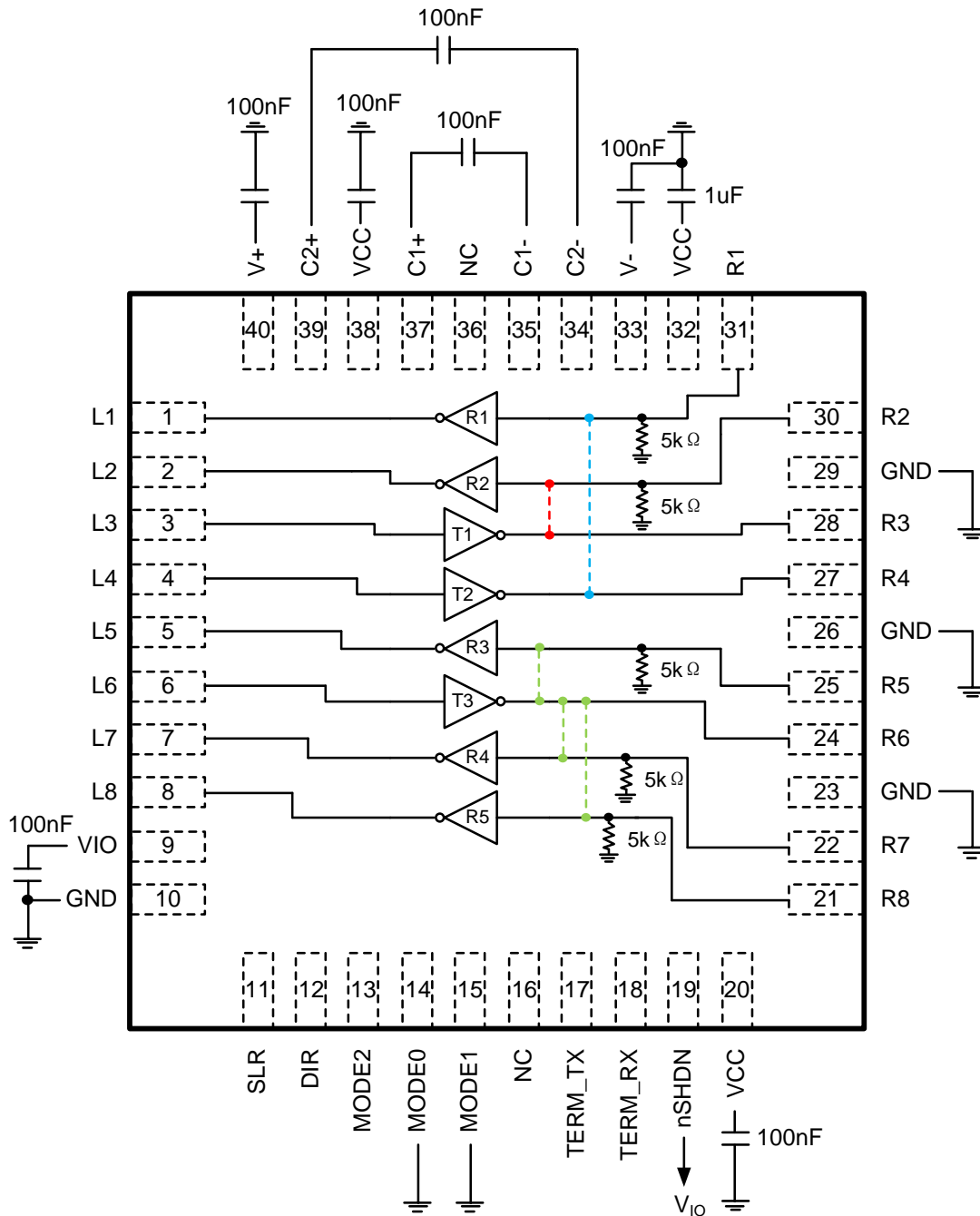


Figure 10-1. UM3035A Block Diagram

## 10.3 Device Functional Modes

The UM3035A is a highly integrated and robust multiprotocol transceiver supporting RS-232, RS-422 and RS-485 physical layers. The device features 3 mode selection pins (MODE2, MODE1, MODE0) to enable switching between five different operating modes (RS-232 Loopback Mode, RS-232 3T5R Mode, RS485 Half duplex, RS-422 Full duplex mode and RS-485 Loopback Mode).

### 10.3.1 RS-232 Loopback Mode: X00 (MODE2, MODE1, MODE0) (Note 1)



Note 1: L3 reflects on L2, R2, R3 (red); L4 reflects on L1, R1, R4 (blue); L6 reflects on L5, L7, L8, R5, R6, R7, R8 (green).

Figure 10-2. UM3035A RS-232 Loopback Mode

**10.3.2 RS-232 3T5R Mode: 001 (MODE2, MODE1, MODE0)**

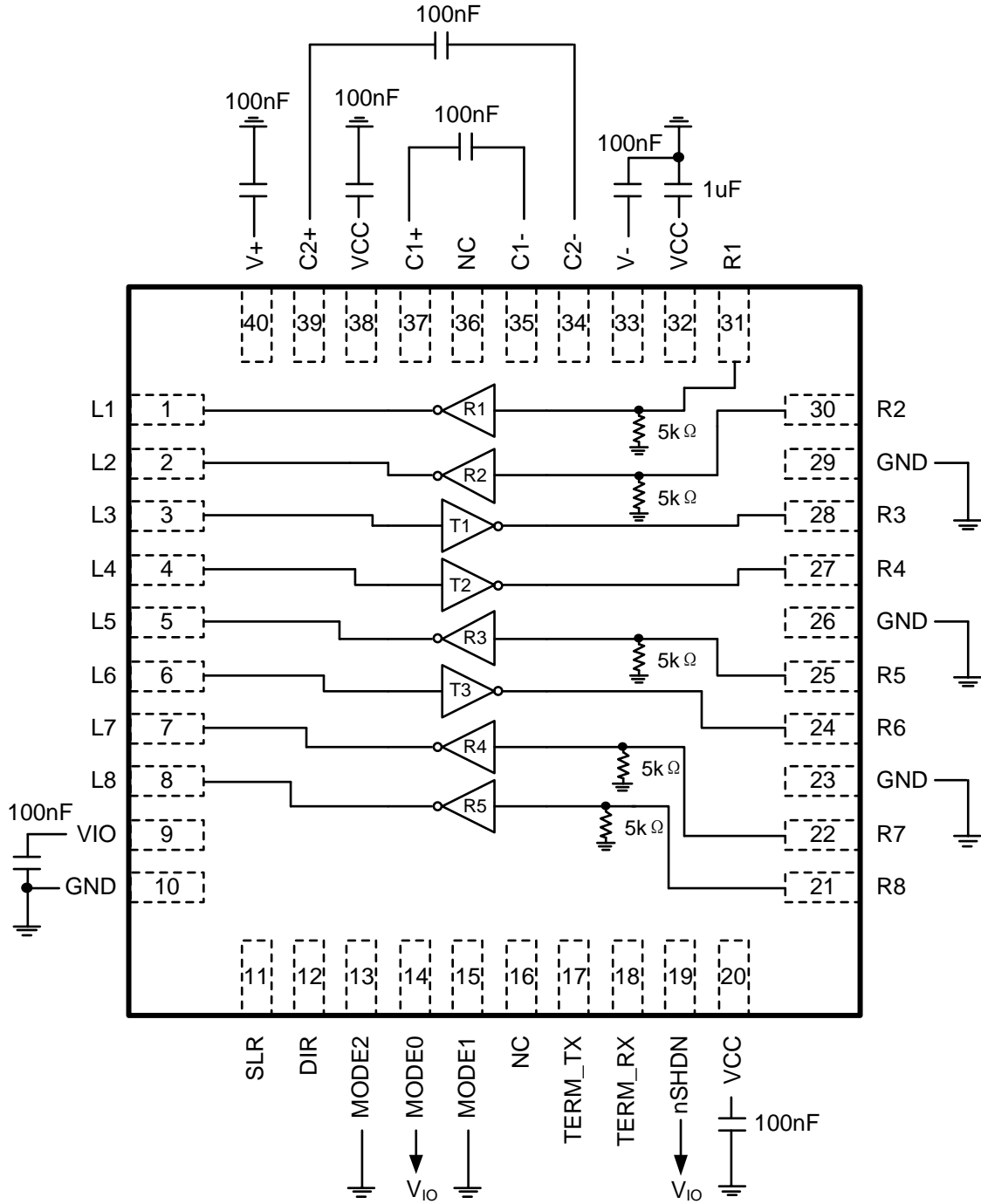


Figure 10-3. UM3035A RS-232 3T5R Mode







## 10.3.6 Mode Control

The UM3035A has 3 mode selection pins (MODE2, MODE1, and MODE0) with 5 different modes. RS-232 3T5R to RS-232 loopback mode transition and RS-232 loopback mode to RS-232 3T5R direct mode transition is not allowed. These 2 mode transitions must go through shutdown mode in between. Rest all combination of mode transitions is allowed. The mode controls for the UM3035A are listed in the table below:

Table 10-1. MODE Control Function Table for UM3035A (Note1)

MODE2	MODE1	MODE0	Operating mode	Function
X	L	L	RS-232 loopback, charge pump is ON, V+/V- are regulated	L3 reflects on L2/R2/R3; L4 reflects on L1/R4/R1; L6 reflects on L5, L7, L8, R5, R6, R7 and R8. See Figure 10-2.
X	L	H	RS-232 3T5R mode, charge pump is ON, V+/V- are regulated	3T5R mode; L3, L4, L6 are Logic inputs for RS232 driver; L1, L2, L5, L7, L8 are Logic outputs. See Figure 10-3.
X	H	L	RS-485 half duplex mode (charge pump is off)	L2 is RX Logic output; L3 is Driver Logic input; R1, R2 are Bus inverting and non-inverting terminals respectively. See Figure 10-4.
L or float	H	H	RS-485 full duplex mode (charge pump is off)	R1, R2 are inverting and non-inverting driver terminals; R3, R4 are non-inverting and inverting receiver terminals. See Figure 10-5.
H	H	H	RS-485 loopback mode (charge pump is off)	R1, R2, R3, R4 continue to be bus terminals and reflect data on L3; DIR is don't care in this mode; TERM_RX not supported. External termination on R3/R4 not supported. R1/R2 can have internal or external termination. See Figure 10-6.

Note 1: 'H' represents logic high, 'L' represents logic low, 'X' represents irrelevant pin.

### 10.3.6 RS-485 Functionality

When the driver enable pin, DIR, is logic high, the differential outputs R2 and R1 follow the logic states at data input L3. A logic high at L3 causes R2 to turn high and R1 to turn low. In this case, the differential output voltage defined as  $V_{OD} = V_{R2} - V_{R1}$  is positive. When L3 is low, the output states reverse: R1 turns high, R2 becomes low, and  $V_{OD}$  is negative.

When DIR is low, both outputs turn high-impedance. In this condition, the logic state at L3 is irrelevant. The DIR pin has an internal pull-down resistor to ground, thus when left open the driver is disabled (high-impedance) by default. The L3 pin has an internal pull-up resistor to  $V_{IO}$ , thus, when left open while the driver is enabled, output R2 turns high and R1 turns low.

Table 10-2 is valid for both RS-485 half duplex and full duplex modes, and is independent of state of TERM\_TX, TERM\_RX and SLR pins.

Table 10-2. Driver Function Table

Enable	Input	Outputs		Function
		R2	R1	
DIR	L3			
H	H	H	L	Actively drive bus high
H	L	L	H	Actively drive bus low
H	Open	H	L	Actively drive bus high by default
L	X	High impedance	High impedance	Driver disabled
Open	X	High impedance	High impedance	Driver disabled by default

In RS-485 full duplex mode, if nSHDN is high, receiver is always enabled. In RS-485 half duplex mode, receiver is enabled if DIR = Low/float and disabled if DIR =  $V_{IO}$ . When the differential input voltage defined as  $V_{ID} = V_{R2} - V_{R1}$  or  $V_{R3} - V_{R4}$  is higher than the positive input threshold,  $V_{TH+}$ , the receiver output, L2, turns high. When  $V_{ID}$  is lower than the negative input threshold,  $V_{TH-}$ , the receiver output, L2, turns low. If  $V_{ID}$  is between  $V_{TH+}$  and  $V_{TH-}$ , the output is indeterminate.

Internal biasing of the receiver inputs causes the output to go failsafe-high when the transceiver is disconnected from the bus (open-circuit), the bus lines are shorted to one another (short-circuit), or the bus is not actively driven (idle bus).

In half duplex mode, when DIR is high, the receiver output is high-impedance and the magnitude and polarity of  $V_{ID}$  are irrelevant.

Table 10-3 is valid irrespective of state of TERM\_TX, TERM\_RX and SLR pins. Other logic outputs L1, L5, L7 and L8 remain high in RS-485 mode.

**10.3.6 RS-485 Functionality (continued)**

Table 10-3. Receiver Function Table

Differential Input	Output	Function
$V_{ID}$	L2	
$V_{TH+} < V_{ID}$	H	Receive valid bus high
$V_{TH-} < V_{ID} < V_{TH+}$	?	Indeterminate bus state
$V_{ID} < V_{TH-}$	L	Receive valid bus low
X	High impedance for DIR = $V_{CC}$ in Half duplex mode	Receiver disabled in half duplex mode for DIR = $V_{CC}$
Open-circuit bus, Short-circuit bus, Idle (terminated) bus	H	Fail-safe high output

**10.3.7 RS-232 Functionality**

In RS-232 mode, only way to disable driver is to go in shutdown mode by pulling nSHDN pin low. A logic high at inputs for driver L3, L4 and L6 causes driver outputs R3, R4 and R6 to be driven low towards negative charge pump output V-. A logic low at inputs for driver L3, L4 and L6 causes driver outputs R3, R4 and R6 to be driven high towards positive charge pump output V+. If logic inputs are left floating due to the pull-up resistors on driver logic inputs, the driver outputs are driven low towards V-. Table 10-4 shows the driver functions.

Table 10-4. Driver Function Table

Enable	Inputs	Outputs	Function
nSHDN	L3, L4, L6	R3, R4, R6	
H	H	L (driven towards V-)	Normal operation with inverting logic
H	L	H (driven towards V+)	Normal operation with inverting logic
H	Open	L (driven towards V-)	Since pull-up on logic input pin, output driven low by default
L	X	High impedance	TX and RX are disabled in shutdown mode

For the RS-232 receiver, if the receiver bus inputs are above rising threshold  $V_{TH+}$ , corresponding received logic output goes low. Also, if the receiver bus inputs are below falling threshold  $V_{TH-}$ , corresponding received logic output goes high. Table 10-5 shows the receiver functions.

**10.3.7 RS-232 Functionality (continued)**

Table 10-5. Receiver Function Table

RS-232 Bus Inputs	Outputs	Function
$V_{IRX}$ (voltage on R1, R2, R5, R7 or R8)	L1, L2, L5, L7, L8	
$V_{TH+} < V_{IRX}$	L	Normal operation with inverting logic
$V_{TH-} < V_{IRX} < V_{TH+}$	?	Indeterminate bus state
$V_{IRX} < V_{TH-}$	H	Since pull-up on logic input pin, output driven low by default
X	High impedance for nSHDN = GND	Receiver disabled in shutdown mode
Open-circuit bus	H	Fail-safe high output

**10.4 Feature Description**
**10.4.1 Device Protection Features**

The UM3035A's bus pins are protected against any DC supply shorts in the range of -16 V to +16 V. In the RS-485 mode, the short circuit current is limited to  $\pm 250$  mA to comply with the TIA/EIA-485A standard. In RS-232 mode, current limiting of  $\pm 60$  mA is applicable for scenarios where bus pins can short to ground.

The UM3035A also features thermal shutdown protection that disables the driver and the receiver if the junction temperature exceeds the  $T_{SD}$  threshold due to excessive power dissipation on-chip.

Supply undervoltage protection is present on  $V_{CC}$  and  $V_{IO}$  supply pins. This maintains the bus output and receiver logic output in known driven state when both the supplies are above their rising undervoltage thresholds. Table 10-6 describes the device behavior in various scenarios of supply levels.

Table 10-6. Supply Function Table

$V_{CC}$	$V_{IO}$	Driver Output	Receiver Output
$> V_{UVD(RIS)VCC}$	$> V_{UVD(RIS)VIO}$	For RS-485 mode, determined by DIR and L3 inputs. For RS-232 mode, determined by L3, L4, L6 inputs. For shutdown mode, Hi-Z	For RS-485 mode, determined by DIR and (R1-R2) or (R3- R4) inputs. For RS-232 mode, determined by R1, R2, R5, R7, R8 inputs input. For shutdown mode, Hi-Z
$> V_{UVD(RIS)VCC}$	$< V_{UVD(RIS)VIO}$	High impedance	High impedance
$< V_{UVD(RIS)VCC}$	$> V_{UVD(RIS)VIO}$	High impedance	Undetermined
$< V_{UVD(RIS)VCC}$	$< V_{UVD(RIS)VIO}$	High impedance	High impedance

## 10.4.2 RS-485 Receiver Fail-Safe Operation

The RS-485 differential receiver of the UM3035A is failsafe to invalid bus states caused by the following conditions:

- Open bus conditions, such as a disconnected connector
- Shorted bus conditions, such as cable damage shorting the twisted-pair together
- Idle bus conditions that occur when no driver on the bus is actively driving

In any of these cases, the fail-safe operation brings a logic high state on receiver outputs so that avoid the indeterminate output of the receiver.

## 10.4.3 Integrated Switchable Termination Resistor

The UM3035A has 2 termination resistors of nominal 120 Ω. When in RS-485 full duplex mode, the termination resistor is configured between R1/R2 and R3/R4 buses. When in RS-485 half duplex mode, the termination resistor is configured between R1/R2 buses. Both termination resistors are enabled or disabled using pins as described in Table 10-7.

Termination resistor is OFF in RS-232 loopback, RS-232 3T5R, RS-485 loopback, unpowered and thermal shutdown modes.

Table 10-7. Integrated Termination Function for UM3035A

Device mode	Signal state	Function	Notes
RS-485 Full duplex mode	TERM_TX = V <sub>IO</sub>	120 Ω enabled between R1 and R2	Termination between R1/R2 is disabled by default
	TERM_TX = GND or floating	120 Ω disabled between R1 and R2	
	TERM_RX = V <sub>IO</sub>	120 Ω enabled between R3 and R4	Termination between R3/R4 is disabled by default
	TERM_RX = GND or floating	120 Ω disabled between R3 and R4	
RS-485 Half duplex mode	TERM_RX = X, TERM_TX = V <sub>IO</sub>	120 Ω enabled between R1 and R2	In half duplex mode, TERM_RX is don't care and TERM_TX has higher priority
	TERM_RX = X, TERM_TX = GND	120 Ω disabled between R1 and R2	

The termination block offers a resistive load to the bus, and does not alter the magnitude or phase of the bus signals from DC to 20Mbps signaling. The Integrated 120 Ω termination resistor is designed for minimum variation across temperature and across common mode voltage on bus pins.

## 10.4.4 Switchable Operating Data Rates

The UM3035A can be used in slow speed or fast speed RS-485 and RS-232 applications by configuring Slew rate control (SLR) pin and. Table 10-8 describes slew rate control function for the UM3035A.

Table 10-8. Slew Rate Control Function for UM3035A

SLR configuration	Maximum speed of Driver	Maximum speed of Receiver	Notes
SLR = V <sub>IO</sub>	RS-485 mode: 500kbps RS-232 mode: 250kbps	RS-485 mode: 500kbps RS-232 mode: 250kbps	Active high slew rate limiting applied on driver output. In this configuration, glitch filter in receiver path for RS-485 is enabled
SLR = GND or float	RS-485 mode: 20Mbps RS-232 mode: 1Mbps	RS-485 mode: 20Mbps RS-232 mode: 1Mbps	Slew rate limiting on driver output disabled.

For RS-485 half and full duplex modes, receiver path in the slow speed mode provides additional noise filtering. To attenuate high frequency noise pulses from the bus which can be wrongly interpreted as valid data.

## 10.4.5 Diagnostic Loopback

The UM3035A provides complete path diagnostic loopback modes for both RS-232 and RS-485. The Diagnostic mode internally shorts bus outputs to bus inputs. So, if data is toggled from logic input, data reaches bus and is reflected back on logic buffer output. This enables MCU to detect bus side short (due to connector/cable) by comparing logic input and logic output.

In RS-232 loopback mode, L3 reflects on L2/R2/R3; L4 reflects on L1/R4/R1; L6 reflects on L5, L7, L8, R5, R6, R7 and R8 enabling to detect short to ground on all bus pins from R1 through R8. RS-232 loopback mode is optimized for -40°C to 125°C ambient temperature. RS-232 diagnostic loopback can be performed on a node (DUT1) even with another node (DUT2) connected via cable, but listening node (DUT2) is not allowed to transmit anything on the RS232 lines while loopback check by DUT1 is ongoing.

In RS-485 loopback mode, internally R2 gets connected to R3 and R1 gets connected to R4. L3 input data is routed to driver output terminals and receiver input terminals and reflects on L2. DIR and TERM\_RX are not supported in this mode. Specific to this mode, external termination on R3/R4 is not supported, but R1/R2 can have internal or external termination. This is able to detect short between R1/R2 and between R3/R4 bus terminals. Recommended maximum data rate for RS-485 diagnostic loopback to detect cable or connector shorts is 500kbps with SLR = V<sub>IO</sub>.

## 10.4.6 Integrated Charge pump for RS-232

The UM3035A has integrated high-efficiency and low-noise charge pump to generate large output voltages for RS-232 signals. Charge pump consists of a voltage doubler and an inverter to regulate the voltage to nominal ±5.5V or to ±8.5V for 3.3V or 5V V<sub>CC</sub> operation respectively. Charge pump needs four external ceramic capacitors (2 flying capacitors and 2 storage capacitors) and allows for single supply operation for RS-232.

## 11 Application and Implementation

### 11.1 Application Information

The UM3035A is highly integrated multiprotocol transceivers supporting RS-232, RS-422 and RS-485 physical layer and is used for asynchronous data transmissions. Three MODE pins allow for the configuration of different operating modes. The device allows point-to-point RS-232 communication port and multipoint RS-485 communication port over common connector. The device also features integrated 120Ω switchable termination resistor on RS-485 bus lines which enables same device to be used for middle nodes or end nodes in an RS-485 network. When the device is configured in RS-232 mode, RS-485 circuits and 120Ω termination are disabled and do not interfere in RS-232 communication. For RS-232 communication, charge pump and 5kΩ resistor to ground on receiver bus pins is integrated in the device. This 5kΩ resistor and charge pump is automatically disabled in RS-485 mode. Slew rate limiting pin is provided so that same device can be used in slow speed or fast speed RS-485 and RS-232 applications. All these features make the devices completely flexible and suitable for various application needs. Integration of termination resistor saves significant PCB area compared to discrete implementation.

### 11.1 Typical Application

The UM3035A consists of 3 drivers and 5 receivers and dual charge pump circuit to enable RS-232 point-to-point serial communication. The device provides the electrical interface between an asynchronous communication controller and the serial-port connector.

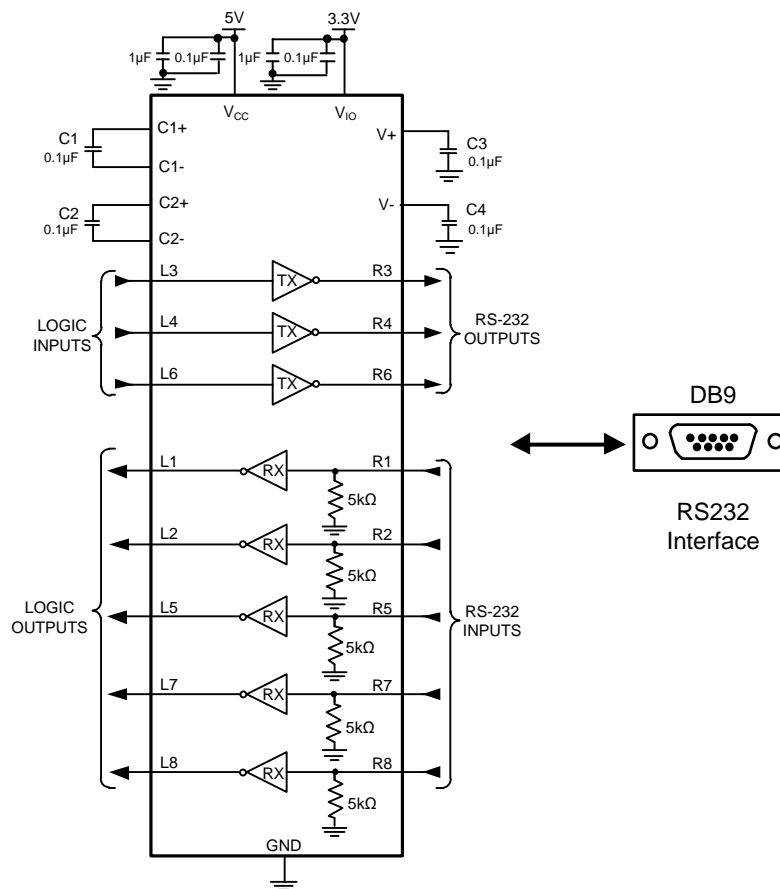


Figure 11-1. RS-232 serial communication

## 11.1 Typical Application (continued)

An RS-485 bus consists of multiple transceivers connecting in parallel to a bus cable. To eliminate line reflections, each cable end is terminated with a termination resistor,  $R_T$ , whose value matches the characteristic impedance,  $Z_0$ , of the cable. This method, known as parallel termination, generally allows for higher data rates over longer cable length.

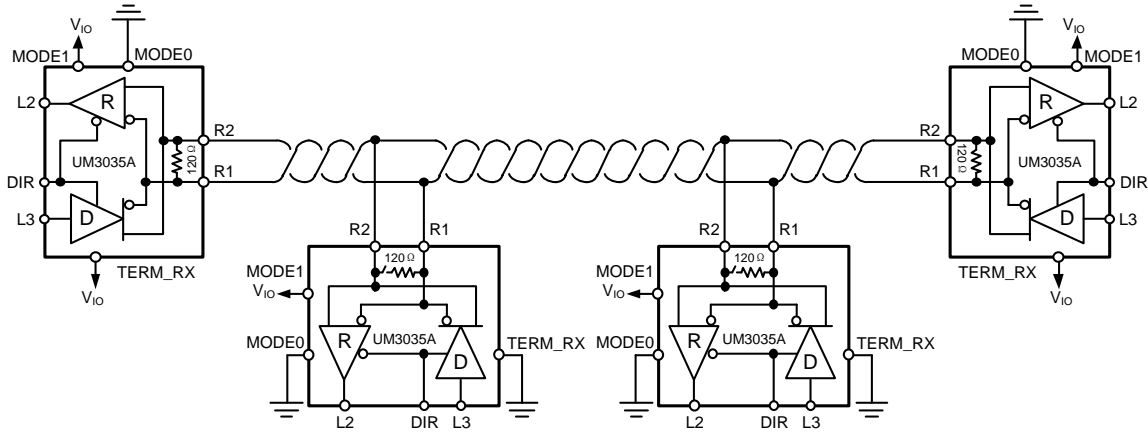


Figure 11-2. Typical RS-485 Network with Half-Duplex Transceivers

The UM3035A can support RS-232, RS-485, and RS-422 protocols over a shared DB9 interface. This significantly reduces the number of required interfaces and simplifies wiring complexity.

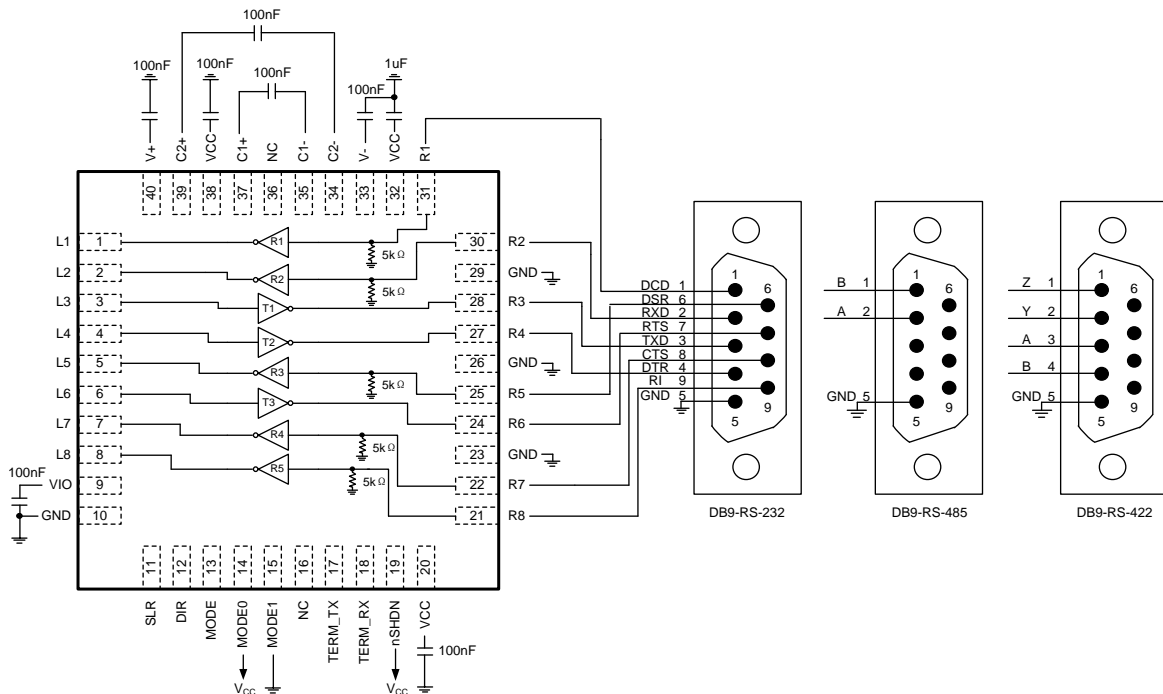
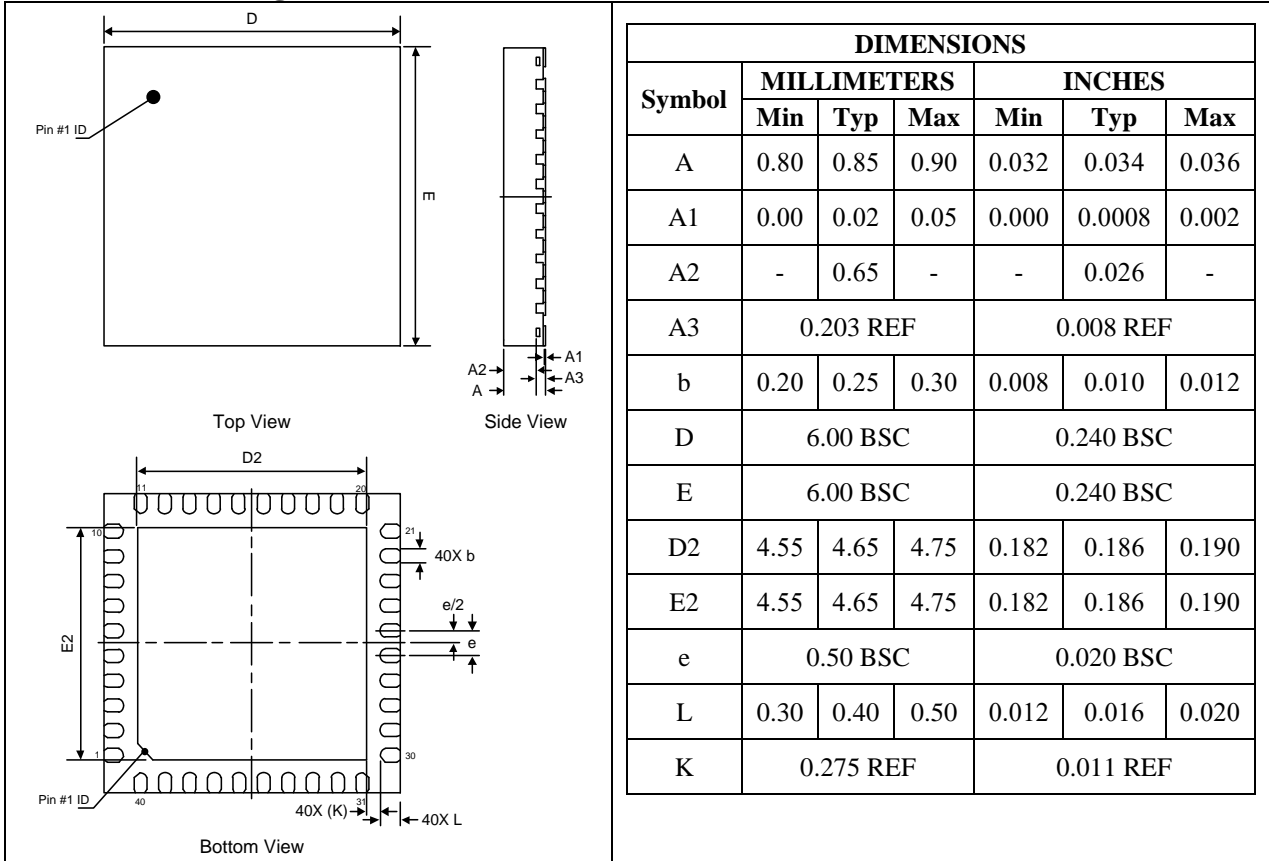


Figure 11-3. UM3035A Application on a shared DB9 connector

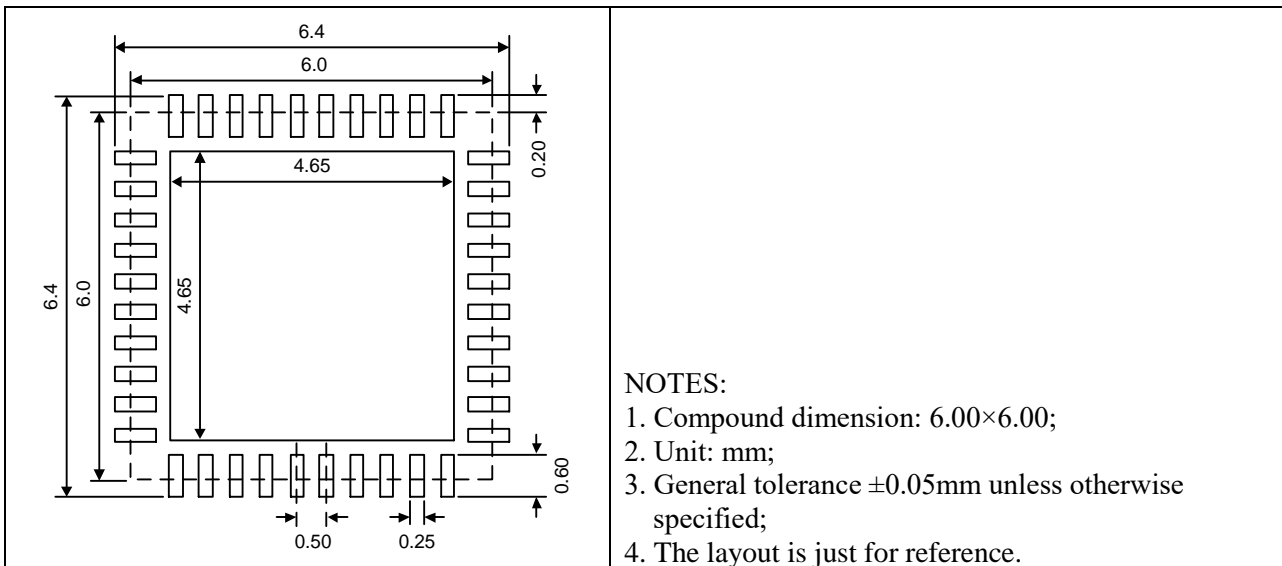
## Package Information

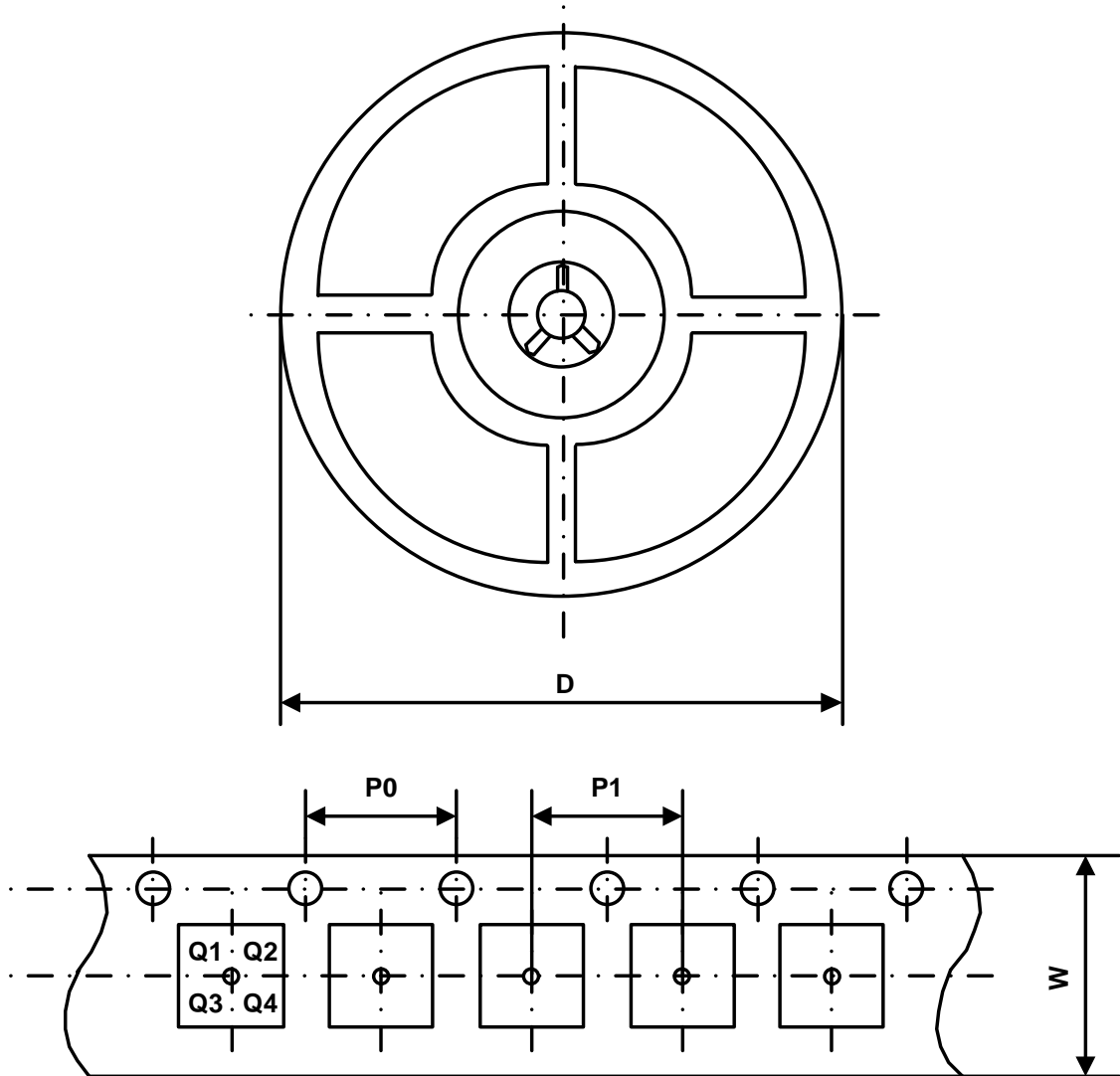
### QFN40 6.0×6.0

#### Outline Drawing



#### Land Pattern



**Packing Information**


Part Number	Package Type	Carrier Width (W)	Pitch (P0)	Pitch (P1)	Reel Size (D)	PIN 1 Quadrant
UM3035AQAAE	QFN40 6.0×6.0	16 mm	4 mm	8 mm	330 mm	Q1

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