XR33202

Wide Supply RS-485/RS-422 Transceiver with 1.65V-5.5V I/O Interface

Description

The XR33202 is a high performance RS-485/RS-422 transceiver designed to meet the increasing system requirements found in today's portable/handheld, process control and industrial equipment environments. This is a wide supply (3.0V to 5.5V) device that operates at maximum data rate of 20Mbps and features a 1.65V to 5.5V I/O logic supply, simplifying multi-voltage system interfacing requirements.

The receiver includes full fail-safe circuitry, guaranteeing a logic-high receiver output when the receiver inputs are open, shorted or undriven. The XR33202 receiver input impedance is at least 96kΩ (1/8 unit load), allowing more than 256 devices on the bus.

The driver is protected by short circuit detection as well as thermal shutdown and maintains high impedance in shutdown or when powered off. The XR33202 does not have slew limiting and is intended for high speed applications requiring data rates up to 20Mbps.

The DE and $\overline{RE}$ pins include hot swap circuitry to prevent false transitions on the bus during power up or live insertion and can enter a 1µA low current shutdown mode for extreme power savings.

The XR33202 is a half-duplex device that operates at max data rates of 20Mbps. It is available in a 10-pin DFN package.

FEATURES

- Wide 3.0V to 5.5V supply operation
- 1.65V to 5.5V I/O logic interface VL pin
- Enhanced receiver fail-safe protection for open, shorted or terminated but idle data lines
- Max data rate of 20Mbps
- 1/8 unit load, up to 256 receivers
- Hot swap glitch protection on DE and $\overline{RE}$ Pins
- Robust ESD (Electrostatic Discharge) protection for RS-485 bus pins
  - ±15kV human body model
  - ±15kV IEC61000-4-2 air discharge
  - ±8kV IEC61000-4-2 contact discharge
- Driver short circuit limit and thermal shutdown for overload protection
- -40°C to 125°C ambient operating temperature range
- Lead-free (RoHS 6) DFN

APPLICATIONS

- Portable and handheld equipment
- Industrial and process control equipment
- Point-of-sale equipment
- Building security and automation

Typical Application

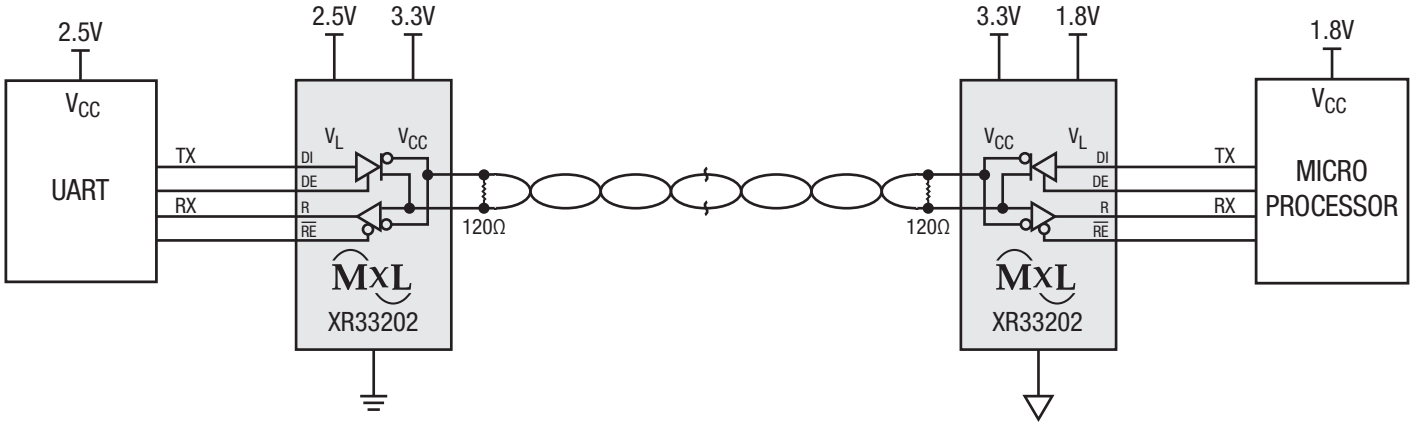


Figure 1. Typical Application

Absolute Maximum Ratings

Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Maximum Rating condition for extended periods may affect device reliability and lifetime.

Supply voltage (V_{CC}) ..... -0.3V to 7.0V

Logic interface voltage (V_L) ..... $V_L \le V_{CC}$

Junction temperature ..... 150°C

Input voltage
DE and DI ..... -0.3V to 6.0V

$\overline{RE}$ ..... -0.3V to (V_L + 0.3V)

Output voltage ..... -0.3V to (V_L + 0.3V)

Driver output voltage A/Y, B/Z ..... ±18V

Receiver input voltage A/Y, B/Z ..... ±18V

ESD Ratings

HBM - Human Body Model
(RS-485 bus pins A/Y, B/Z) ..... ±15kV

HBM - Human Body Model (all other pins) ..... ±4kV

IEC61000-4-2 Air Discharge
(RS-485 bus pins A/Y, B/Z) ..... ±15kV

IEC61000-4-2 Contact Discharge
(RS-485 bus pins A/Y, B/Z) ..... ±8kV

Operating Conditions

Operating temperature range ..... -40°C to 125°C

V_{CC} supply range ..... 3.0V to 5.5V

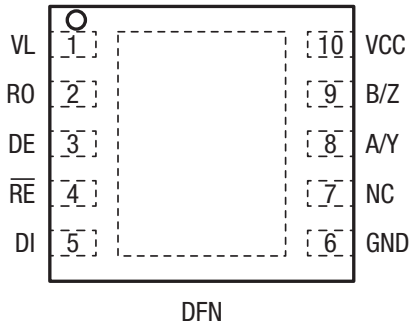
V_L I/O supply range ($V_L \le V_{CC}$) ..... 1.65V to 5.5V

Thermal Information

θ_{JA} ..... 40.5°C/W

θ_{JC} ..... 8.5°C/W

Pin Configuration



DFN

Pin Functions

Pin Number	Pin Name	Type	Description
1	VL	Supply	I/O power supply, sets the logic levels for RO, DE, $\overline{RE}$ and DI
2	RO	Output	Receiver output
3	DE	Input	Driver enable, driver active when DE = 1, disabled when DE = 0
4	$\overline{RE}$	Input	Receiver enable, receiver is disabled when $\overline{RE}$ = 1, enabled when $\overline{RE}$ = 0
5	DI	Input	Driver input
6	GND	Supply	Ground
7	NC		No connection, can be connected to ground
8	A/Y	I/O	±15kV ESD protected, RS-485/RS-422 half-duplex non-inverting receiver input and non-inverting driver output
9	B/Z	I/O	±15kV ESD protected, RS-485/RS-422 half-duplex inverting receiver input and inverting driver output
10	VCC	Supply	Power supply
*	Paddle		Exposed paddle (DFN package), connect to ground

Transmitting				
Inputs			Outputs	
nRE	DE	DI	A/Y	B/Z
X	1	1	1	0
X	1	0	0	1
0	0	X	High-Z	
1	0	X	Shutdown	

Receiving			
Inputs			Output
nRE	DE	$V_{A/Y}$ - $V_{B/Z}$	RO
0	X	≥ -50mV	1
0	X	-200mV < $V_{A/Y}$ - $V_{B/Z}$ < -50mV	Undefined
0	X	≤ -200mV	0
0	X	Open/Shorted/Idle	1
1	1	X	High-Z
1	0	X	Shutdown

Electrical Characteristics

Specifications are at T_A = 25°C, V_{CC} = 3.3V ±10% or 5.0V ±10%, V_L = V_{CC} unless otherwise noted. Typical values represent the most likely parametric norm at T_A = 25°C, and are provided for reference purposes only.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
Driver DC Characteristics						
V_{OD}	Differential driver output	RL = 100Ω (RS-422), V_{CC} = 3.0V	2.0			V
		RL = 54Ω (RS-485), V_{CC} = 3.0V	1.5			V
		RL = 100Ω (RS-422), V_{CC} = 4.5V	2.25			V
		RL = 54Ω (RS-485), V_{CC} = 4.5V	2.25			V
ΔV_{OD}	Change in magnitude of differential output voltage	RL = 100Ω or 54Ω	-0.2		0.2	V
V_{CM}	Driver common-mode output voltage (steady state)	RL = 100Ω or 54Ω		$V_{CC/2}$	3	V
ΔV_{CM}	Change in magnitude of common-mode output voltage	RL = 100Ω or 54Ω	-0.2		0.2	V
$I_{A, B}$	Input current (A and B)	V_{OUT} = 12V, DE = 0V V_{CC} = 0V or 5.5V			125	µA
		V_{OUT} = -7V, DE = 0V V_{CC} = 0V or 5.5V	-100			µA
I_{OL}	Output leakage (Y and Z)	V_{OUT} = 12V, DE = 0V V_{CC} = 0V or 5.5V			125	µA
		V_{OUT} = -7V, DE = 0V V_{CC} = 0V or 5.5V	-100			µA
I_{OSD}	Driver short-circuit output current	-7V ≤ V_{OUT} ≤ +12V	-250		250	mA
Receiver DC Characteristics						
V_{TH}	Receiver differential threshold voltage (V_A - V_B)	-7V ≤ V_{CM} ≤ 12V	-200	-125	-50	mV
ΔV_{OH}	Receiver input hysteresis	V_{CM} = 0V		25		mV
R_{IN}	Receiver input resistance	-7V ≤ V_{CM} ≤ 12V	96			kΩ
I_{OSC}	Receiver output short-circuit current	0V ≤ V_{RO} ≤ V_L	-120		120	mA
Logic Inputs and Outputs						
V_{IH}	Logic input thresholds (DI, DE, $\overline{RE}$) 1.65V ≤ V_L ≤ 5.5V & V_L ≤ V_{CC}	Logic input high	2/3*V_L			V
V_{IL}		Logic input low			1/3*V_L	V
V_{HYS}	Input hysteresis (DI, DE, $\overline{RE}$)			50		mV
I_{IN}	Logic input current (DI, DE, $\overline{RE}$)	0V ≤ V_{IN} ≤ V_L, after first transition			1	µA
I_{INHS}	Logic input current hot swap (DE and $\overline{RE}$)	Until first transition			±320	µA
V_{OH}	Receiver output high voltage (RO)	3.0V ≤ V_L ≤ 5.5V, I_{OUT} = -1mA 1.6V ≤ V_L ≤ 3.0V, I_{OUT} = -1mA	V_L - 0.6			V
V_{OL}	Receiver output low voltage (RO)	3.0V ≤ V_L ≤ 5.5V, I_{OUT} = 1mA 1.6V ≤ V_L ≤ 3.0V, I_{OUT} = 1mA			0.4	V
I_{OZR}	High-Z receiver output current	0V ≤ V_{OUT} ≤ V_L	-1		1	µA

Electrical Characteristics (Continued)

Specifications are at T_A = 25°C, V_{CC} = 3.3V ±10% or 5.0V ±10%, V_L = V_{CC} unless otherwise noted. Typical values represent the most likely parametric norm at T_A = 25°C, and are provided for reference purposes only.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
Supply						
V_{CC}	Supply voltage range		3.0		5.5	V
I_{CC}	Supply current	No load. $\overline{RE}$ = 0V, DE = V_L, DI = 0V		400	600	µA
		No load. $\overline{RE}$ = V_L, DE = V_L, DI = 0V		300	600	µA
		No load. $\overline{RE}$ = 0V, DE = 0V, receiver A and B inputs open		300	500	µA
I_{SHDN}	Supply current in shutdwon mode	$\overline{RE}$ = V_L, DE = 0V		0.05	3	µA

Driver AC Characteristics

Specifications are at T_A = 25°C, V_{CC} = 3.3V ±10% or 5.0V ±10%, V_L = V_{CC} unless otherwise noted. Typical values represent the most likely parametric norm at T_A = 25°C, and are provided for reference purposes only.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{DPLH}	Driver prop. delay (low to high)	C_L = 50pF, R_L = 54Ω,			30	ns
t_{DPHL}	Driver prop. delay (high to low)				30	ns
$\lvert t_{DPLH}-t_{DPHL} \rvert$	Differential driver output skew				5	ns
t_{DR}, t_{DF}	Driver differential output rise or fall time				17	ns
	Maximum data rate	$1/t_{UI}$, duty cycle 40% to 60%	20			Mbps
t_{DZH}	Driver enable to output high	C_L = 50pF, R_L = 500Ω,			50	ns
t_{DZL}	Driver enable to output low				50	ns
t_{DHZ}	Driver disable from output high				50	ns
t_{DLZ}	Driver disable from output low				50	ns
$t_{DZH(SHDN)}$	Driver enable from shutdown to output high	C_L = 50pF, R_L = 500Ω,			250	ns
$t_{DZL(SHDN)}$	Driver enable from shutdown to output low				250	ns
t_{SHDN}	Time to shutdown		50	200	600	ns

Electrical Characteristics (Continued)

Receiver AC Characteristics

Specifications are at T_A = 25°C, V_{CC} = 3.3V±10% or 5.0V±10%, V_L = V_{CC} unless otherwise noted. Typical values represent the most likely parametric norm at T_A = 25°C, and are provided for reference purposes only.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{RPLH}	Receiver prop. delay (low to high)	C_L = 50pF, R_L = 54Ω			50	ns
t_{RPHL}	Receiver prop. delay (high to low)				50	ns
$\lvert t_{RPLH}-t_{RPHL}\rvert$	Receiver propagation delay skew				5	ns
	Maximum data rate	$1/t_{UI}$, duty cycle 40% to 60%	20			Mbps
t_{RZH}	Receiver enable to output high	C_L = 50pF, R_L = 1kΩ,			50	ns
t_{RZL}	Receiver enable to output low				50	ns
t_{RHZ}	Receiver disable from output high				50	ns
t_{RLZ}	Receiver disable from output low				50	ns
$t_{RZH(SHDN)}$	Receiver enable from shutdown to output high	C_L = 50pF, R_L = 1kΩ,			2200	ns
$t_{RZL(SHDN)}$	Receiver enable from shutdown to output low				2200	ns
t_{SHDN}	Time to shutdown		50	200	600	ns

Functional Block Diagram

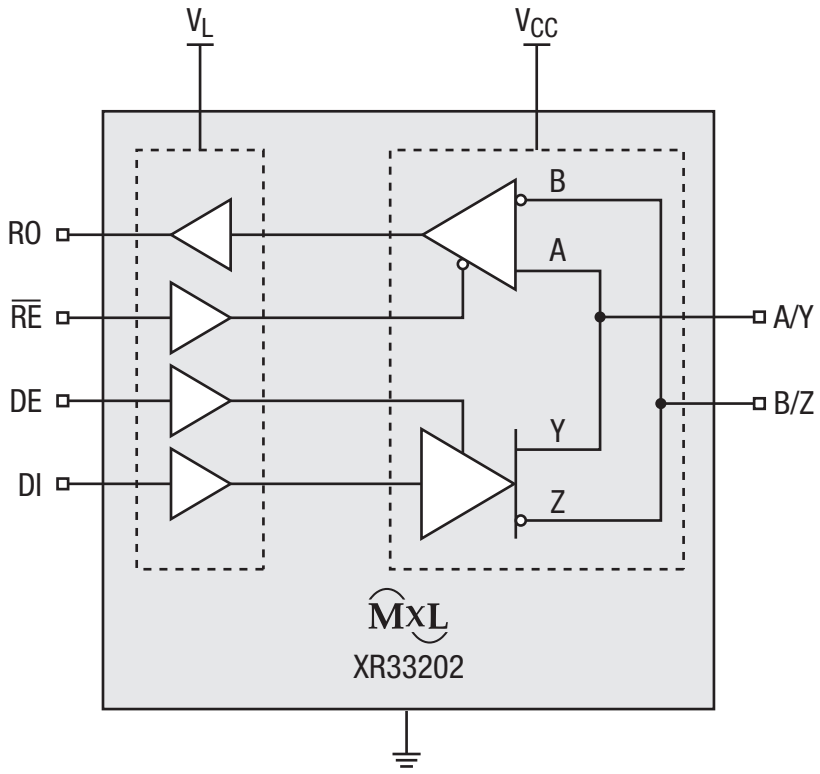


Figure 2. Functional Block Diagram

Applications Information

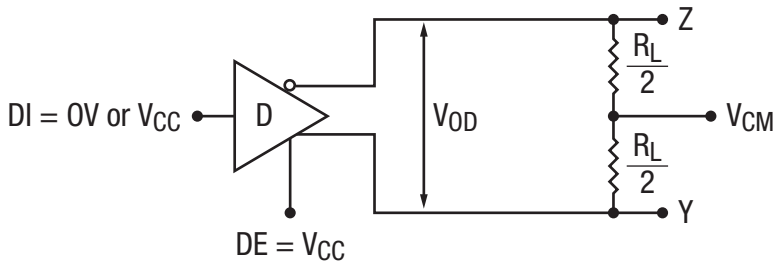


Figure 3. Differential Driver Output Voltage

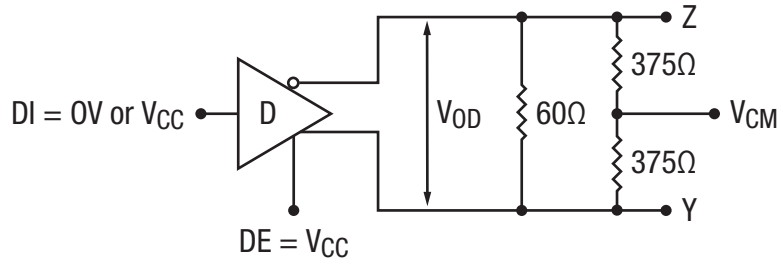


Figure 4. Differential Driver Output Voltage Over Common Mode

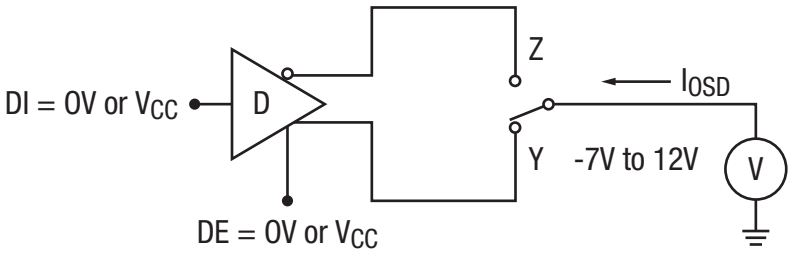


Figure 5. Driver Output Short Circuit Current

Applications Information (Continued)

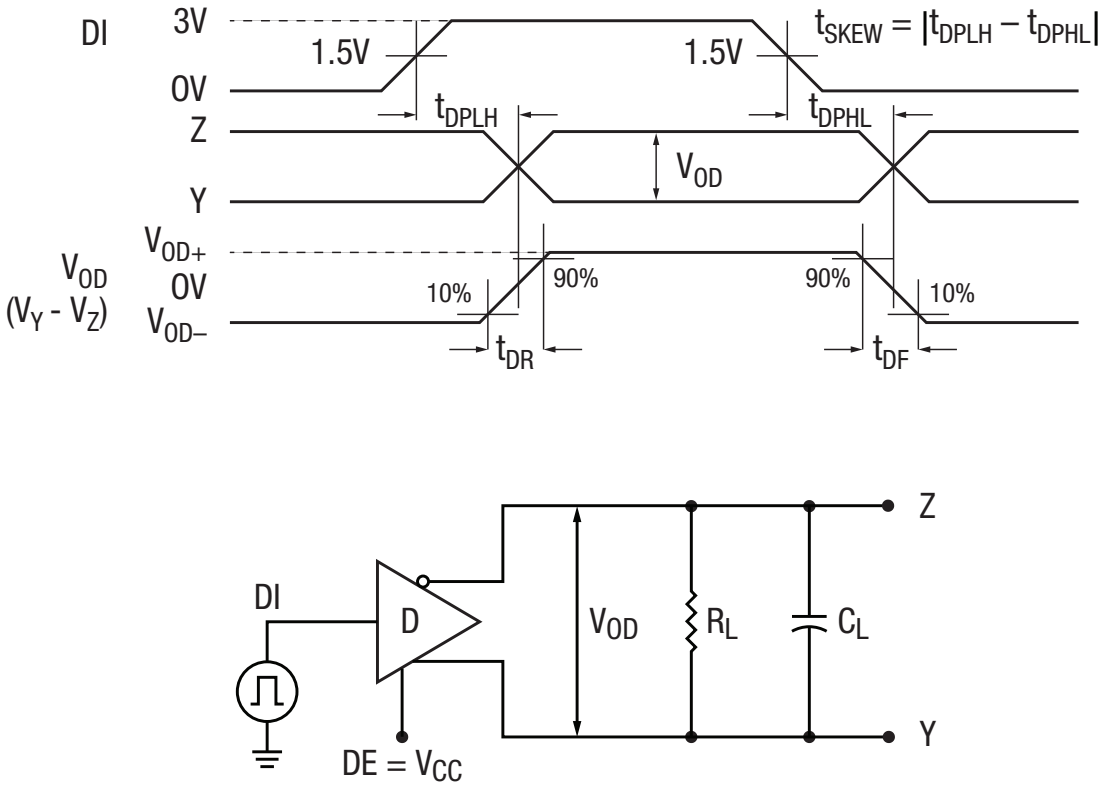


Figure 6. Driver Propagation Delay Test Circuit and Timing Diagram

Applications Information (Continued)

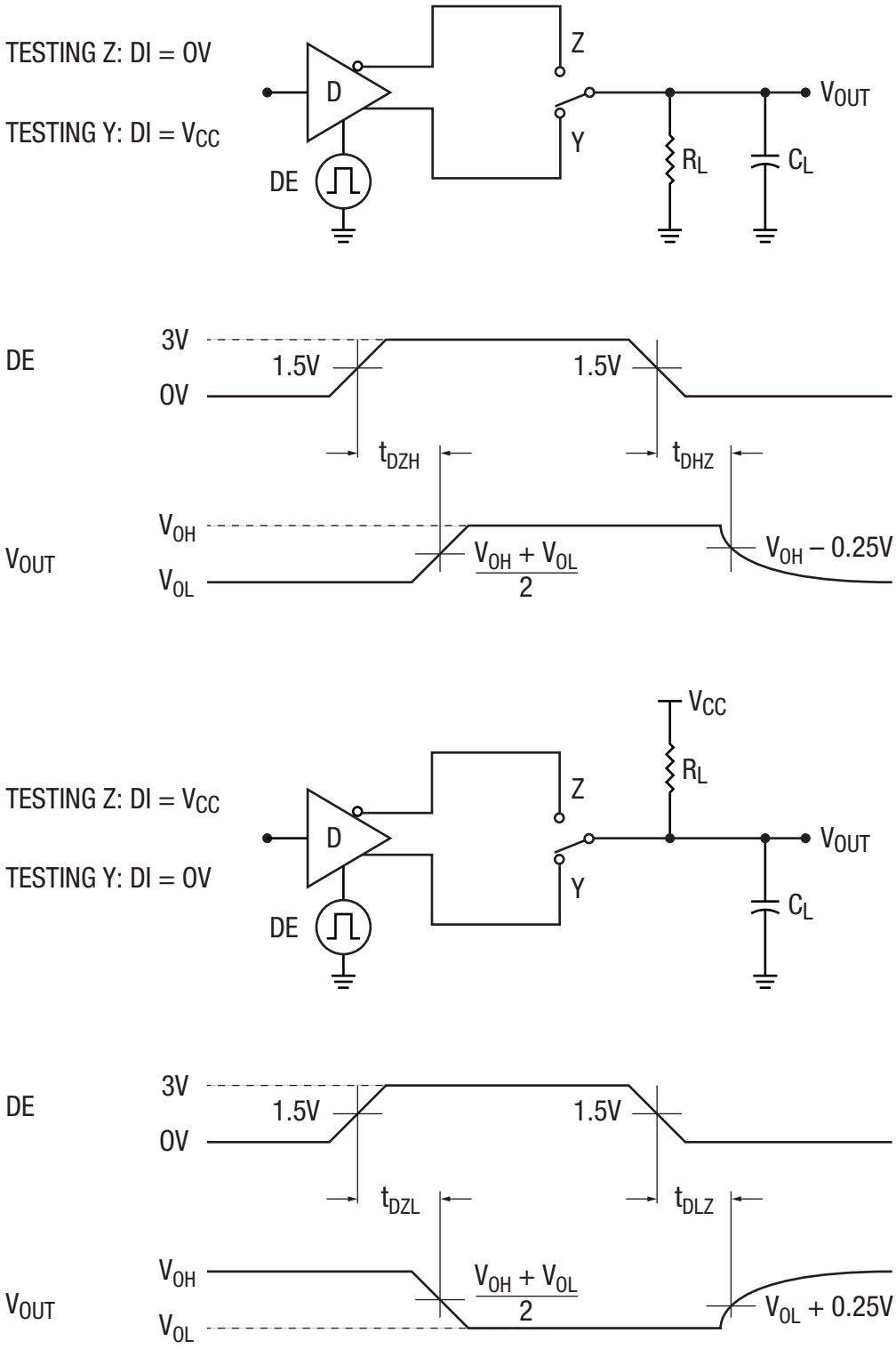


Figure 7. Driver Enable and Disable Timing Test Circuits and Timing Diagrams

Applications Information (Continued)

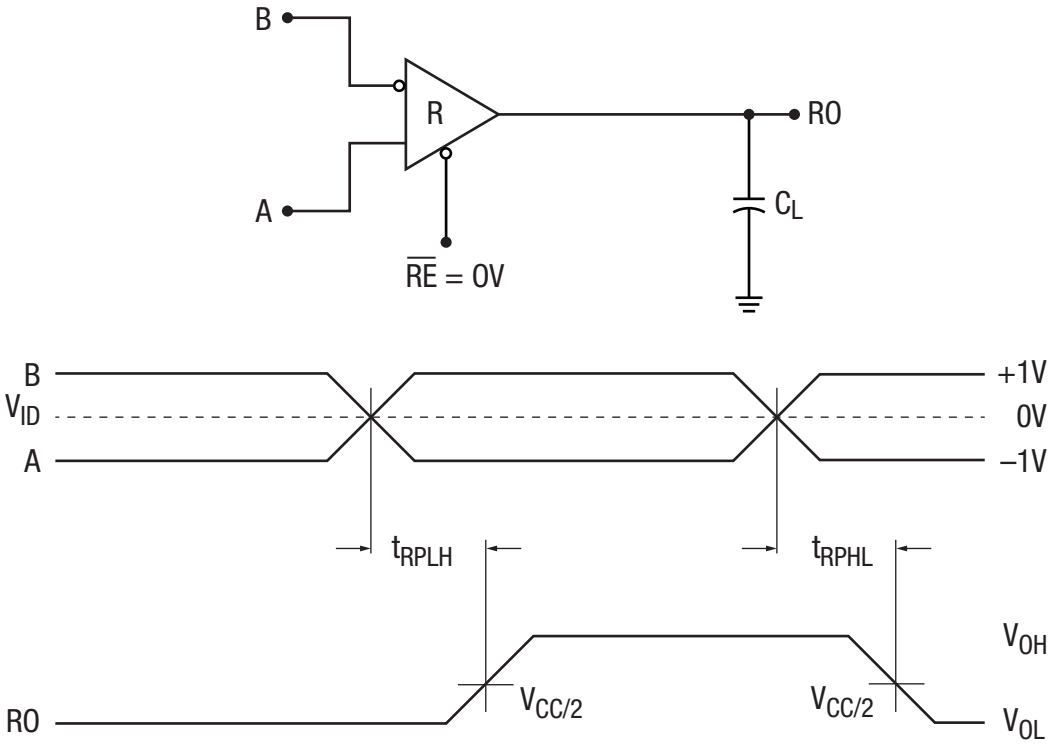


Figure 8. Receiver Propagation Delay Test Circuit and Timing Diagram

Applications Information (Continued)

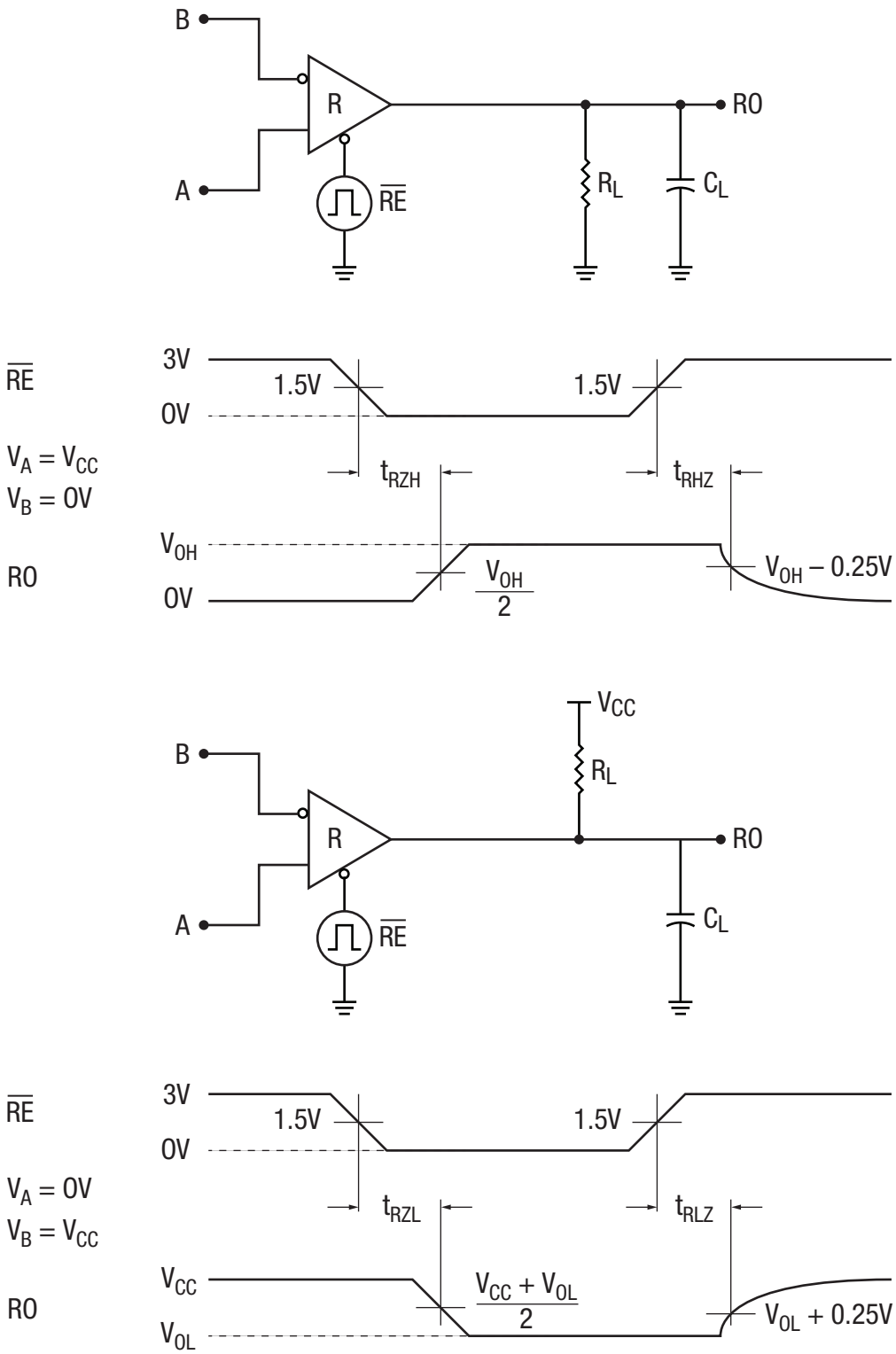


Figure 9. Receiver Enable and Disable Test Circuits and Timing Diagrams

Applications Information (Continued)

The XR33202 RS-485/RS-422 devices are part of MaxLinear's high performance serial interface product line.

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 XR33202 guarantees a logic-high receiver output when the receiver inputs are open, shorted or when they are connected to a terminated transmission line with all drivers disabled. In a terminated bus with all transmitters disabled, the receivers' differential input voltage is pulled to 0V by the termination. The XR33202 interprets 0V differential as a logic high with a minimum 50mV noise margin while maintaining compliance with the RS-485 standard of ±200mV. Although the XR33202 does not need failsafe biasing resistors, it can operate without issue if biasing is used.

Hot Swap Capability

When V_{CC} is first applied the XR33202 holds the driver enable and receiver enable inactive for approximately 10µs. During power ramp-up, other system ICs may drive unpredictable values or tristated lines may be influenced by stray capacitance. The hot swap feature prevents the XR33202 from driving any output signal until power has stabilized. After the initial 10µs, the driver and receiver enable pins are weakly pulled to their disabled states (low for DE and high for $\overline{RE}$) until the first transition. After the first transition, the DE and $\overline{RE}$ pins operate as high impedance inputs.

If circuit boards are inserted into an energized backplane (commonly called "live insertion" or "hot swap") power may suddenly be applied to all circuits. Without the hot swap capability, this situation could improperly enable the transceiver's driver or receiver, driving invalid data onto shared buses and possibly causing driver contention or device damage.

Driver Output Protection

Two mechanisms prevent excessive output current and power dissipation caused by faults or by bus contention. First, a driver current limit on the output stage provides immediate protection against short circuits over the whole common-mode voltage range. Second, a thermal shutdown circuit forces the driver outputs into a high impedance state if junction temperature becomes excessive.

Line Length

The RS-485/RS-422 standard covers cable lengths up to 4000 feet. Maximum achievable line length for a specific application is a function of many factors, the data rate, cable properties, the driver/receiver characteristics and whether or not termination or stubs are used. For lower speed applications, data rates <150Kbps, the maximum cable length is mainly a function of the DC impedance of the cable being used. As data rates increase the capacitive and inductive characteristics tend to dominate and limit the cable lengths that can be achieved. At higher data rates the cable properties will tend to damper the signal resulting in increased rise/fall times at the far end of the cable.

The XR33202 has been designed with stronger drivers to help compensate for these cable affects and is intended for high speed applications.

±15kV ESD Protection

ESD protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The driver outputs and receiver inputs of the XR33202 has extra protection against static electricity. MaxLinear uses state-of-the-art structures to protect these pins against ESD of ±15kV without damage. The ESD structures withstand high ESD in all states: normal operation, shutdown and powered down. After an ESD event, the XR33202 keeps operating without latch up or damage.

ESD protection can be tested in various ways. The transmitter outputs and receiver inputs of the XR33202 is characterized for protection to the following limits:

- ±15kV using the Human Body Model, RS-485 bus pins
- ±4kV using the Human Body Model, all other pins

ESD Test Conditions

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

Maximum Number of Transceivers on the Bus

The standard RS-485 receiver input impedance is 96kΩ (1/8 unit load). A standard driver can drive up to 32 unit loads. The XR33202 transceiver has 1/8 unit load receiver input impedance of 96kΩ, allowing up to 256 transceivers to be connected in parallel on a communication line. Any combination of the XR33202 and other RS-485 transceivers up to a total of 32 unit loads may be connected to the bud line.

Applications Information (Continued)

Low Power Shutdown Mode

The XR33202 has a low-power shutdown mode that is initiated by bringing both $\overline{RE}$ high and DE low simultaneously. While in shutdown the XR33202 draws less than 1µA of supply current. DE and $\overline{RE}$ may be tied together and driven by a single control signal. Devices are guaranteed not to enter shutdown if $\overline{RE}$ is high and DE is low for less than 50ns. If the inputs are in this state for at least 600ns, the parts will enter shutdown.

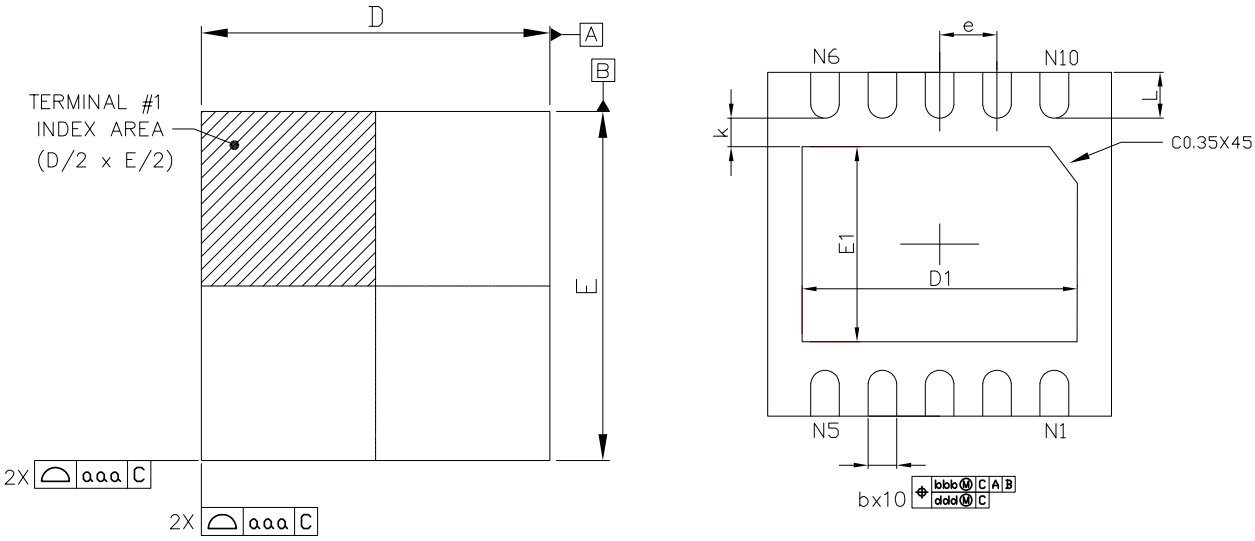
XR33202 enable times, t_{DZH}, t_{DZL}, t_{RZH} and t_{RZL} apply when the part is not in low power shutdown state. Enable times, $t_{DZH(SHDN)}$, $t_{DZL(SHDN)}$, $t_{RZH(SHDN)}$ and $t_{RZL(SHDN)}$apply when the part is shutdown. The driver and receiver take longer to become enabled from low power shutdown than from driver or receiver disable mode.

Product Selector Guide

Part Number	Operation	Data Rate	Shutdown	Receiver/Driver Enable	Nodes On Bus	Footprint
XR33202	Half duplex	20Mbps	Yes	Yes/Yes	80	10-DFN

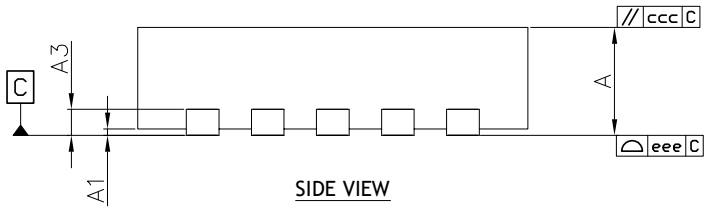
Mechanical Dimensions

10-Pin 3mm x 3mm DFN Package



TOP VIEW

BOTTOM VIEW



SIDE VIEW

DIM / SYMBOL	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3		0.203Ref	
b	0.20	0.25	0.30
D		3.00 BSC	
E		3.00 BSC	
e		0.50 BSC	
D1	2.20	2.30	2.40
E1	1.50	1.60	1.70
L	0.30	0.40	0.50
K	0.20	–	–
aaa		0.10	
bbb		0.10	
ccc		0.10	
ddd		0.05	
eee		0.08	
N		10	

TERMINAL DETAILS

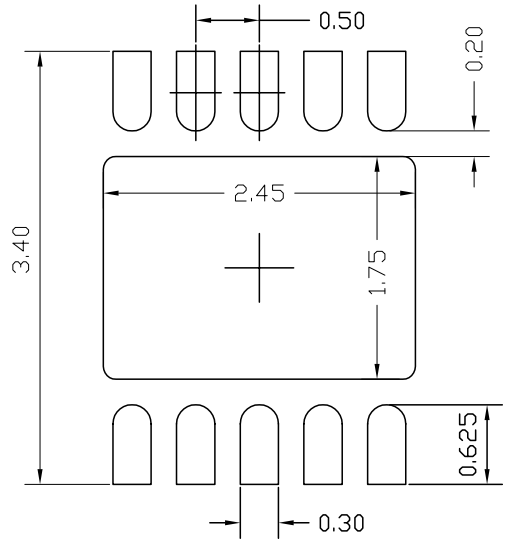
- ALL DIMENSIONS ARE IN MILLIMETERS.
- DIMENSIONS AND TOLERANCE PER JEDEC MO-220.

Drawing No.: POD- 00000135

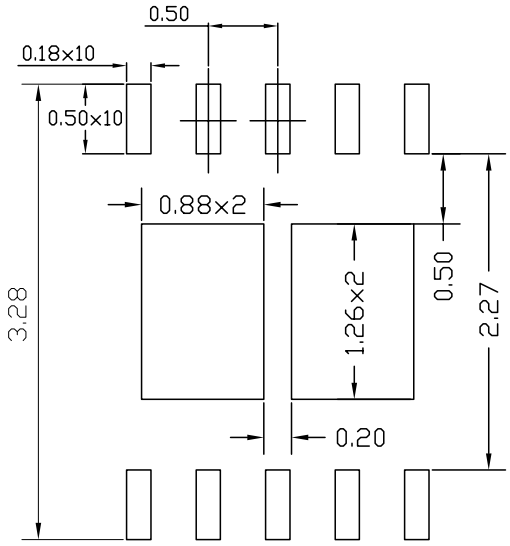
Revision: A

Recommended Land Pattern and Stencil

10-Pin 3mm x 3mm DFN Package



TYPICAL RECOMMENDED LAND PATTERN



TYPICAL RECOMMENDED STENCIL

Drawing No.: POD- 00000135

Revision: A

Order Information[1]

Part Number	Operating Temperature Range	Lead-Free	Package	Packaging Method
XR33202EEHB-F	-40°C to 125°C	Yes[2]	10-pin DFN	Bulk
XR33202EEHBTR-F				Tape and Reel
XR33202EEHB-EVB[3]	XR33202 Evaluation Board			

NOTE:
1. Refer to www.exar.com/XR33202 for most up-to-date Ordering information.
2. Visit www.exar.com for additional information on Environmental Rating.
3. XR33202EEHBEVB updated to XR33202EEHB-EVB.

Revision History

Revision	Date	Description
1A	Nov 2015	Initial Release
2A	June 2016	Add Transmitting and Receiving truth tables and Applications Information section. Update Package Quantity in Order Information.
2B	Apr 2018	Update to MaxLinear logo. Update format and Ordering Information. Moved ESD protection / ratings to Absolute Maximum Ratings section.

MAXLINEAR

Corporate Headquarters:
5966 La Place Court
Suite 100
Carlsbad, CA 92008
Tel.:+1 (760) 692-0711
Fax: +1 (760) 444-8598
www.maxlinear.com

High Performance Analog:
1060 Rincon Circle
San Jose, CA 95131
Tel.: +1 (669) 265-6100
Fax: +1 (669) 265-6101
Email: serialtechsupport@exar.com
www.exar.com

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