XR33152/XR33155/XR33156/XR33158

±60V Fault Tolerant 3.0V to 5.5V RS-485/RS-422 Transceivers

Description

The XR33152, XR33155, XR33156 and XR33158 (XR3315x) family of high performance RS-485/RS-422 devices are designed for improved performance in noisy industrial environments and increased tolerance to system faults.

The analog bus pins can withstand direct shorts up to ±60V and are protected against ESD events up to ±15kV HBM. An extended ±25V common mode operating range allows for more reliable operation in noisy environments.

The XR3315x receivers include full fail-safe circuitry, guaranteeing a logic high receiver output when the receiver inputs are open, shorted or undriven. The XR33152/55 receiver input impedance is at least 120kΩ (1/10 unit load), allowing more than 320 devices on the bus. The XR33156/58 receiver input impedance is at least 30kΩ (1/2.5 unit load), allowing more than 80 devices on the bus.

The drivers are protected by short circuit detection as well as thermal shutdown and maintain high impedance in shutdown or when powered off. The XR33152 driver is slew limited for reduced EMI and error-free communication over long or unterminated data cables.

The XR3315x family of high performance RS-485/RS-422 devices are designed for improved performance in noisy industrial environments and increased tolerance to system faults.

The devices with 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 1nA low current shutdown mode for extreme power savings.

FEATURES

- 3.0V to 5.5V operation
- ±60V fault tolerance on analog bus pins
- Extended ±25V common mode operation
- Robust ESD protection:
  - ±15kV HBM (bus pins)
  - ± 4kV HBM (non-bus pins)
- 1.65V to 5.5V logic Interface VL pin (full-duplex package option)
- Invert control to correct for reversed bus pins
- Enhanced receiver fail-safe protection for open, shorted or terminated but idle data lines
- Hot swap glitch protection on DE and $\overline{RE}$ pins
- Driver short-circuit current limit and thermal shutdown for overload protection
- Reduced unit loads allows up to 320 devices on bus
- Industry standard 8-pin and 14-pin NSOIC packages
- -40°C to 85°C and -40°C to 105°C ambient operating temperature ranges

APPLICATIONS

- Industrial control networks
- HVAC networks
- Building and process automation
- Remote utility meter reading
- Energy monitoring and control
- Long or unterminated transmission lines

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Typical Application

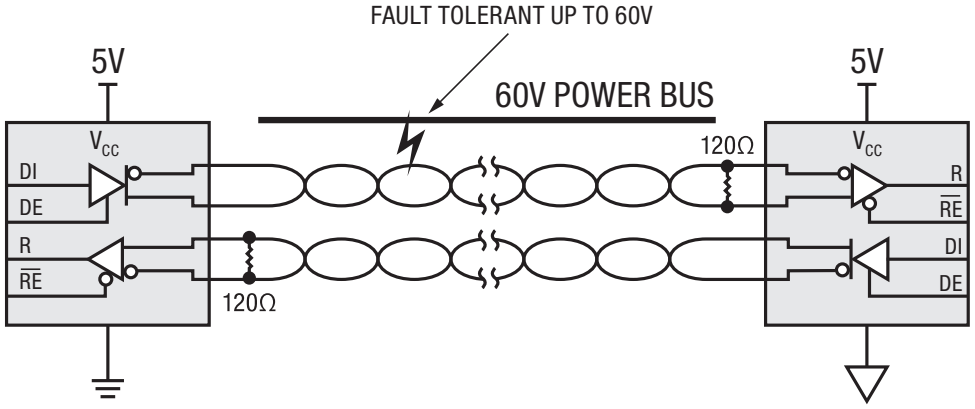


Figure 1. Typical Application

Absolute Maximum Ratings

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

V_{CC} ..... -0.3V to 7.0V

V_L ..... $V_L \le V_{CC}$

Input voltage at control and driver input (DE, DI and INV)
XR33152/55/58..... -0.3V to (V_{CC} + 0.3V)

Receiver output voltage (RO)
XR33152/55/58..... -0.3V to (V_{CC} + 0.3V)

Input voltage at control ($\overline{RE}$) XR33156
..... -0.3V to (V_L + 0.3V)

Input voltage at control and driver input
(DE, DI, R_{INV}, D_{INV}, and INV) XR33156..... -0.3V to 7.0V

Receiver output voltage (RO)
XR33156..... -0.3V to (V_L + 0.3V)

Driver output voltage (Y, Z, A/Y and B/Z)..... ±60V

Receiver input voltage (A, B, A/Y and B/Z) ..... ±60V

Transient voltage pulse, through 100Ω (Figure 7)..... ±100V

Driver output current..... ±250mA

Storage temperature range ..... -65°C to 150°C

Lead temperature (soldering 10 seconds)..... 300°C

Maximum junction temperature ..... 150°C

ESD Ratings

HBM - Human Body Model (A, B, Y and Z pins) ..... ±15kV

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

Operating Conditions

Supply voltage range.....3.0V to 5.5V

Operating temperature range ..... -40°C to 105°C

Package power dissipation,
8-pin NSOIC θ_{JA} ..... 128.4°C/W

Package power dissipation,
14-pin NSOIC θ_{JA} ..... 86°C/W

Electrical Characteristics

Unless otherwise noted: V_{CC} = 3.0V to 5.5V, T_A = T_{MIN} to T_{MAX}. Typical values are at V_{CC} = 5.0V, T_A = 25°C.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
Driver DC Characteristics						
V_{CC}	Supply voltage range		3.0		5.5	V
V_L	I/O logic supply voltage range	$V_L \le V_{CC}$	1.65		5.5	V
V_{OD}	Differential driver output, 4.5V ≤ V_{CC} ≤ 5.5V	R_L = 100Ω (RS-422), Figure 4	2		V_{CC}	V
		R_L = 54Ω (RS-485), Figure 4	1.5		V_{CC}	V
		-25V ≤ V_{CM} ≤ 25V, Figure 5	1.5		V_{CC}	V
V_{OD}	Differential driver output, 3.0V ≤ V_{CC} ≤ 4.5V	R_L = 100Ω (RS-422), Figure 4	0.85		V_{CC}	V
		R_L = 54Ω (RS-485), Figure 4	0.65		V_{CC}	V
ΔV_{OD}	Change in magnitude of differential output voltage, Note 1	RL = 100Ω (RS-422) or RL = 54Ω (RS-485), Figure 4			±0.2	V
V_{CM}	Driver common-mode output voltage (steady state)		1		3	V
ΔV_{CM}	Change in magnitude of common-mode output voltage, Note 1				±0.2	V
V_{IH}	Logic high input thresholds (DI, DE and INV)	V_{CC} = 3.3V, for XR33152/55/58	2.0			V
		V_{CC} = 5.0V, for XR33152/55/58	2.4			V
V_{IL}	Logic low input thresholds (DI, DE and INV)	For XR33152/55/58			0.8	V
V_{IH}	Logic high input thresholds (DI, DE, $\overline{RE}$, D_{INV} and R_{INV})	$V_L \le V_{CC}$, for XR33156	(2/3)V_L			V
V_{IL}	Logic low input thresholds (DI, DE, $\overline{RE}$, D_{INV} and R_{INV})	$V_L \le V_{CC}$, for XR33156			(1/3)V_L	V
V_{HYS}	Input hysteresis (DI, DE, $\overline{RE}$, D_{INV}, R_{INV} and INV)			100		mV
I_{IN}	Logic input current (DI, DE and $\overline{RE}$)	0V ≤ V_{IN} ≤ V_{CC}, for XR33152/55/58 After first transition, Note 2			±1	µA
	Logic input current (INV)	V_{IN} = V_{CC} = 5.5V, for XR33152/55/58	25	33	55	µA
	Logic input current (DI, DE and $\overline{RE}$)	0V ≤ V_{IN} ≤ V_L = V_{CC} = 5.5V, for XR33156 After first transition, Note 2			±1	µA
	Logic input current (D_{INV} and R_{INV})	V_{IN} = V_L = V_{CC} = 5.5V, for XR33156	25	33	55	µA
I_{INHS}	Logic input current hot swap (DE and $\overline{RE}$)	Until first transition, Note 2		100	±200	µA
$I_{A, B}$	Input current (A and B)	V_{CC} = 0V or 5.5V, V_{OUT} = 12V, DE = 0V, for XR33152/55			100	µA
		V_{CC} = 0V or 5.5V, V_{OUT} = -7V, DE = 0V, for XR33152/55	-80			µA
		V_{OUT} = 12V, DE = 0V, V_{CC} = 0V or 5.5V, for XR33156/58			400	µA
		V_{OUT} = -7V, DE = 0V, V_{CC} = 0V or 5.5V, for XR33156/58	-320			µA

NOTES:

1. Change in magnitude of differential output voltage and change in magnitude of common mode output voltage are the changes in output voltage when DI input changes state.
2. The hot swap feature disables the DE and $\overline{RE}$ inputs for the first 10µs after power is applied. Following this time period, these inputs are weakly pulled to their disabled state (low for DE, high for $\overline{RE}$) until the first transition, after which they become high impedance inputs.

Electrical Characteristics (Continued)

Unless otherwise noted: V_{CC} = 3.0V to 5.5V, T_A = T_{MIN} to T_{MAX}. Typical values are at V_{CC} = 5.0V, T_A = 25°C.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
I_{OL}	Output leakage (Y and Z) Full-duplex	V_{OUT} = 12V, DE = 0V, V_{CC} = 0V or 5.5V			100	µA
		V_{OUT} = -7V, DE = 0V, V_{CC} = 0V or 5.5V	-80			µA
I_{OSD}	Driver short-circuit output current	-60V ≤ V_{OUT} ≤ 60V, Figure 6			±250	mA
Driver Thermal Characteristics						
T_{TS}	Thermal shutdown temperature	Junction temperature, Note 1		175		°C
T_{TSH}	Thermal shutdown hysteresis	Note 1		15		°C
Receiver DC Characteristics						
V_{STH}	Receiver differential input signal threshold voltage (V_A - V_B)	-25V ≤ V_{OUT} ≤ 25V		±85	±200	mV
ΔV_{STH}	Receiver differential input signal hysteresis			170		mV
V_{FSTH-}	Negative going receiver differential input failsafe threshold voltage (V_A - V_B)	-25V ≤ V_{OUT} ≤ 25V	-200	-125	-40	mV
V_{FSTH+}	Positive going receiver differential input failsafe threshold voltage (V_A - V_B)	-25V ≤ V_{OUT} ≤ 25V		-100	-10	mV
ΔV_{FSTH}	Receiver differential input failsafe hysteresis			25		mV
V_{OH}	Receiver output high voltage (RO)	I_{OUT} = -4mA, for XR33152/55/58	V_{CC} - 0.6			V
V_{OL}	Receiver output low voltage (RO)	I_{OUT} = 4mA, for XR33152/55/58			0.4	V
V_{OH}	Receiver output high voltage (RO)	3.0V ≤ V_L ≤ 5.5V, I_{OUT} = -4mA, 1.6V ≤ V_L ≤ 3.0V, I_{OUT} = -1mA, for XR33156	V_L - 0.6			V
V_{OL}	Receiver output low voltage (RO)	3.0V ≤ V_L ≤ 5.5V, I_{OUT} = 4mA, 1.6V ≤ V_L ≤ 3.0V, I_{OUT} = 1mA, for XR33156			0.4	V
I_{OZR}	High-Z receiver output current	0V ≤ V_{OUT} ≤ V_{CC}, for XR33152/55/58 0V ≤ V_{OUT} ≤ V_L, for XR33156			±1	µA
R_{IN}	RX input resistance	-25V ≤ V_{CM} ≤ 25V, for XR33152/55	120			kΩ
		-25V ≤ V_{CM} ≤ 25V, for XR33156/58	30			kΩ
I_{OSC}	RX output short-circuit current	0V ≤ V_{RO} ≤ V_{CC}, for XR33152/55/58			110	mA
	RX output short-circuit current	0V ≤ V_{RO} ≤ V_L, for XR33156			110	mA
Supply Current						
I_{CC}	Supply current	No load, $\overline{RE}$ = 0V or V_{CC}, DE = V_{CC}, DI = 0V or V_{CC}			4	mA
I_{SHDN}	Supply current in shutdown mode	$\overline{RE}$ = V_{CC}, DE = 0V		0.001	1	µA

NOTES:
1. This spec is guaranteed by design and bench characterization.

Electrical Characteristics (Continued)

Driver AC Characteristics - XR33152 (250kbps)

Unless otherwise noted: V_{CC} = 3.0V to 5.5V, $T_A = T_{MIN}$ to T_{MAX}. Typical values are at V_{CC} = 5.0V, T_A = 25°C.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{DPLH}	Driver propagation delay (low to high)	C_L = 50pF, R_L = 54Ω, Figure 7	350		1500	ns
t_{DPHL}	Driver propagation delay (high to low)		350		1600	ns
$\lvert t_{DPLH}-t_{DPHL}\rvert$	Differential driver output skew			20	200	ns
t_{DR}, t_{DF}	Driver differential output rise or fall time		400		1500	ns
	Maximum data rate	$1/t_{UI}$, duty cycle 40% to 60%	250			kbps
t_{DZH}	Driver enable to output high	C_L = 50pF, R_L = 500Ω, Figure 8		200	2500	ns
t_{DZL}	Driver enable to output low			200	2500	ns
t_{DHZ}	Driver disable from output high				250	ns
t_{DLZ}	Driver disable from output low				250	ns
$t_{RZH(SHDN)}$	Driver enable from shutdown to output high	C_L = 50pF, R_L = 500Ω, Figure 8			5500	ns
$t_{RZL(SHDN)}$	Driver enable from shutdown to output low				5500	ns
t_{SHDN}	Time to shutdown	Notes 1 and 2	50	200	600	ns

Receiver AC Characteristics -XR33152 (250kbps)

Unless otherwise noted: V_{CC} = 3.0V to 5.5V, $T_A = T_{MIN}$ to T_{MAX}. Typical values are at V_{CC} = 5.0V, T_A = 25°C.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{RPLH}	Receiver propagation delay (low to high)	C_L = 15pF, V_{ID} = ±2V, V_{ID} rise and fall times < 15ns, Figure 9			200	ns
t_{RPHL}	Receiver propagation delay (high to low)				200	ns
$\lvert t_{RPLH}-t_{RPHL}\rvert$	Receiver propagation delay skew				30	ns
	Maximum data rate	$1/t_{UI}$, duty cycle 40% to 60%	250			kbps
t_{RZH}	Receiver enable to output high	C_L = 15pF, R_L = 1kΩ, Figure 10			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 = 15pF, R_L = 1kΩ, Figure 10			3500	ns
$t_{RZL(SHDN)}$	Receiver enable from shutdown to output low				3500	ns
t_{SHDN}	Time to shutdown	Notes 1 and 2	50	200	600	ns

NOTES:

1. The transceivers are put into shutdown by bringing $\overline{RE}$ high and DE low simultaneously for at least 600ns. If the control inputs are in this state for less than 50ns, the device is guaranteed to not enter shutdown. If the enable inputs are held in this state for at least 600ns, the device is ensured to be in shutdown. Note that the receiver and driver enable times increase significantly when coming out of shutdown.
2. This spec is guaranteed by design and bench characterization.

Electrical Characteristics (Continued)

Driver AC Characteristics - XR33155 (1Mbps)

Unless otherwise noted: V_{CC} = 3.0V to 5.5V, $T_A = T_{MIN}$ to T_{MAX}. Typical values are at V_{CC} = 5.0V, T_A = 25°C.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{DPLH}	Driver propagation delay (low to high)	C_L = 50pF, R_L = 54Ω, Figure 7		150	500	ns
t_{DPHL}	Driver propagation delay (high to low)			150	500	ns
$\lvert t_{DPLH}-t_{DPHL}\rvert$	Differential driver output skew			5	50	ns
t_{DR}, t_{DF}	Driver differential output rise or fall time		100	200	300	ns
	Maximum data rate	$1/t_{UI}$, duty cycle 40% to 60%	1			Mbps
t_{DZH}	Driver enable to output high	C_L = 50pF, R_L = 500Ω, Figure 8		1000	2500	ns
t_{DZL}	Driver enable to output low			1000	2500	ns
t_{DHZ}	Driver disable from output high				250	ns
t_{DLZ}	Driver disable from output low				250	ns
$t_{DZH(SHDN)}$	Driver enable from shutdown to output high	C_L = 50pF, R_L = 500Ω, Figure 8		2500	4500	ns
$t_{DZL(SHDN)}$	Driver enable from shutdown to output low			2500	4500	ns
t_{SHDN}	Time to shutdown	Notes 1 and 2	50	200	600	ns

Receiver AC Characteristics - XR33155 (1Mbps)

Unless otherwise noted: V_{CC} = 3.0V to 5.5V, $T_A = T_{MIN}$ to T_{MAX}. Typical values are at V_{CC} = 5.0V, T_A = 25°C.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{RPLH}	Receiver propagation delay (low to high)	C_L = 15pF, V_{ID} = ±2V, V_{ID} rise and fall times < 15ns, Figure 9			200	ns
t_{RPHL}	Receiver propagation delay (high to low)				200	ns
$\lvert t_{RPLH}-t_{RPHL}\rvert$	Receiver propagation delay skew				30	ns
	Maximum data rate	$1/t_{UI}$, duty cycle 40% to 60%	1			Mbps
t_{RZH}	Receiver enable to output high	C_L = 15pF, R_L = 1kΩ, Figure 10			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 = 15pF, R_L = 1kΩ, Figure 10			3500	ns
$t_{RZL(SHDN)}$	Receiver enable from shutdown to output low				3500	ns
t_{SHDN}	Time to shutdown	Notes 1 and 2	50	200	600	ns

NOTES:

1. The transceivers are put into shutdown by bringing $\overline{RE}$ high and DE low simultaneously for at least 600ns. If the control inputs are in this state for less than 50ns, the device is guaranteed to not enter shutdown. If the enable inputs are held in this state for at least 600ns, the device is ensured to be in shutdown. Note that the receiver and driver enable times increase significantly when coming out of shutdown.
2. This spec is guaranteed by design and bench characterization.

Electrical Characteristics (Continued)

Driver AC Characteristics - XR33156 and XR33158 (20Mbps)

Unless otherwise noted: V_{CC} = 3.0V to 5.5V, $T_A = T_{MIN}$ to T_{MAX}. Typical values are at V_{CC} = 5.0V, T_A = 25°C.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{DPLH}	Driver prop. delay (low to high)	C_L = 50pF, R_L = 54Ω, Figure 7			25	ns
t_{DPHL}	Driver prop. delay (high to low)				25	ns
$\lvert t_{DPLH}-t_{DPHL}\rvert$	Differential driver output skew				5	ns
t_{DR}, t_{DF}	Driver differential output rise or fall time				15	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, Figure 8			60	ns
t_{DZL}	Driver enable to output low				60	ns
t_{DHZ}	Driver disable from output high				250	ns
t_{DLZ}	Driver disable from output low				250	ns
$t_{DZH(SHDN)}$	Driver enable from shutdown to output high	C_L = 50pF, R_L = 500Ω, Figure 8			2200	ns
$t_{DZL(SHDN)}$	Driver enable from shutdown to output low				2200	ns
t_{SHDN}	Time to shutdown	Notes 1 and 2	50	200	600	ns

Receiver AC Characteristics - XR33156 and XR33158 (20Mbps)

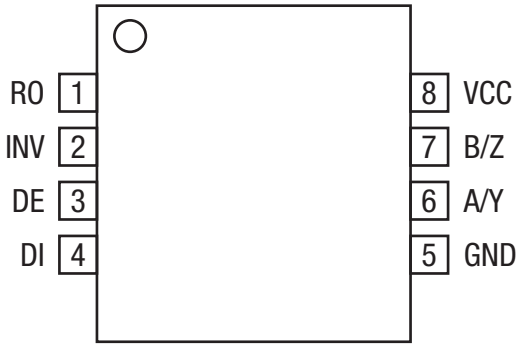
Unless otherwise noted: V_{CC} = 3.0V to 5.5V, $T_A = T_{MIN}$ to T_{MAX}. Typical values are at V_{CC} = 5.0V, T_A = 25°C.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{RPLH}	Receiver prop. delay (low to high)	C_L = 15pF, V_{ID} = ±2V, V_{ID} rise and fall times < 15ns, Figure 9			60	ns
t_{RPHL}	Receiver prop. delay (high to low)				60	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 = 15pF, R_L = 1kΩ, Figure 10, for XR33156			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 = 15pF, R_L = 1kΩ, Figure 10, for XR33156			2200	ns
$t_{RZL(SHDN)}$	Receiver enable from shutdown to output low				2200	ns
t_{SHDN}	Time to shutdown	Notes 1 and 2, for XR33156	50	200	600	ns

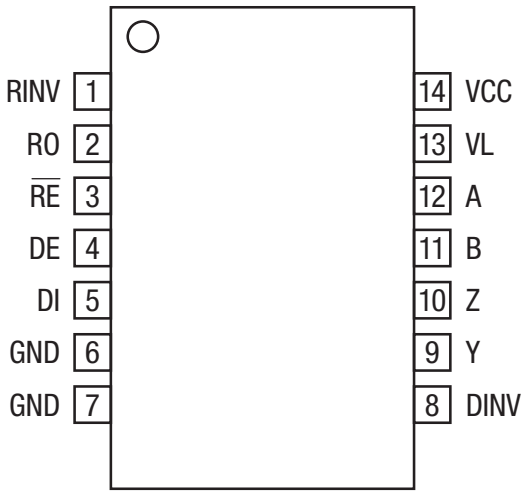
NOTES:

1. The transceivers are put into shutdown by bringing $\overline{RE}$ high and DE low simultaneously for at least 600ns. If the control inputs are in this state for less than 50ns, the device is guaranteed to not enter shutdown. If the enable inputs are held in this state for at least 600ns, the device is ensured to be in shutdown. Note that the receiver and driver enable times increase significantly when coming out of shutdown.
2. This spec is guaranteed by design and bench characterization.

Pin Configurations



XR33152, XR33155 and XR33158 Half-duplex



XR33156 Full-duplex

Pin Functions

Pin Number		Pin Name	Type	Description
Half-duplex XR33152 XR33155 XR33158	Full-duplex XR33156			
-	1	RINV	I	Receiver invert control (active high). When enabled, the polarity of the receiver bus pins (A & B) is reversed: A = inverting and B = non-inverting. When disabled, the receiver bus pins (A & B) operate normally: A = non-inverting and B = inverting. The R_{INV} pin has a 150KΩ pull-down resistor.
1	2	RO	O	Receiver output, when $\overline{RE}$ is low and if (A-B) ≥ 200mV, RO is high. If (A-B) ≤ -200mV, RO is low If inputs are left floating, shorted together or terminated and undriven for more than 2µs the output is high.
2	-	INV	I	Driver and receiver invert control (active high). When enabled, the polarity of the driver input and receiver input bus pins is inverted. When disabled, the driver input and receiver inputs operate normally: A = non-inverting and B = inverting. The INV pin has a 150kΩ pull-down resistor.
-	3	$\overline{RE}$	I	Receiver output enable (hot swap). When $\overline{RE}$ is low, RO is enabled. When $\overline{RE}$ is high, RO is high impedance. $\overline{RE}$ should be high and DE should be low to enter shutdown mode.
3	4	DE	I	Driver output enable (hot swap). When DE is high, outputs are enabled. When DE is low, outputs are high impedance. DE should be low and $\overline{RE}$ should be high to enter shutdown mode.
4	5	DI	I	Driver input. With DE high, a low level on DI forces non-inverting output low and inverting output high. Similarly, a high level on DI forces non-inverting output high and inverting output low.
5	6, 7	GND	PWR	Ground.
6	-	A/Y	I/O	Non-inverting receiver input and non-Inverting driver output.
7	-	B/Z	I/O	Inverting receiver input and Inverting driver output.

NOTE:
Type: I = Input, O = Output, I/O = Input/Output, PWR = Power.

Pin Functions (Continued)

Pin Number		Pin Name	Type	Description
Half-duplex XR33152 XR33155 XR33158	Full-duplex XR33156			
8	14	VCC	PWR	3.0V to 5.5V power supply input bypass to ground with 0.1µF capacitor.
-	12	A	I	Non inverting receiver input.
-	11	B	I	Inverting receiver input.
-	9	Y	O	Non-inverting driver output.
-	10	Z	O	Inverting driver output.
-	8	DINV	I	Driver invert control (active high). When enabled, the polarity of the driver input pin is inverted causing the driver output (Y & Z) polarities to be inverted. When disabled, the driver bus pins (Y & Z) operate normally: Y = non-inverting and Z = inverting. The D_{INV} pin has a 150kΩ pull-down resistor.
-	13	VL	PWR	Logic interface power supply.

NOTE:
Type: I = Input, O = Output, I/O = Input/Output, PWR = Power.

Pin Functions (Continued)

XR33156 (Full-duplex - 14 Pins)

Transmitting					
Inputs				Outputs	
D_{INV}	$\overline{RE}$	DE	DI	Y	Z
0	X	1	1	1	0
0	X	1	0	0	1
1	X	1	1	0	1
1	X	1	0	1	0
X	0	0	X	High-Z	
X	1	0	X	High-Z (shutdown)	

XR33156 (Full-duplex - 14 Pins)

Receiving				
Inputs				Output
R_{INV}	$\overline{RE}$	DE	V_A - V_B	RO
0	0	X	≥ 200mV	1
0	0	X	≤ -200mV	0
0	0	X	Open/shorted	1
1	0	X	≥ 200mV	0
1	0	X	≤ -200mV	1
1	0	X	Open/shorted	1
X	1	1	X	High-Z
X	1	0	X	High-Z (shutdown)

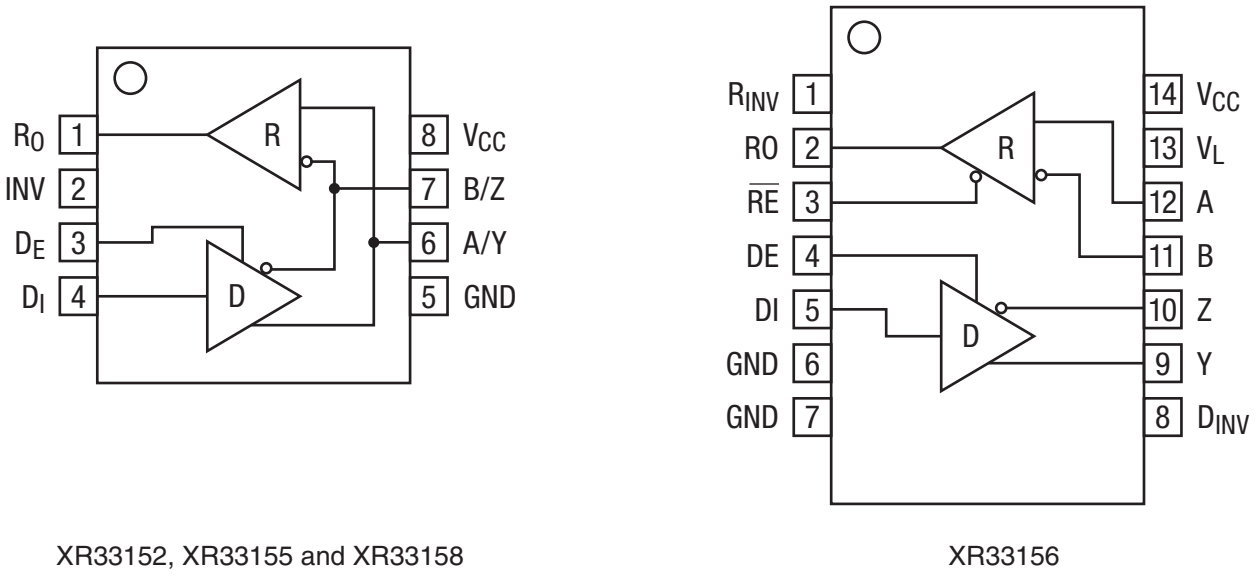
XR33152, XR33155 and XR33158 (Half-duplex - 8 Pins)

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

XR33152, XR33155 and XR33158 (Half-duplex - 8 Pins)

Receiving			
Inputs			Output
INV	DE	V_A - V_B	RO
0	0	≥ 200mV	1
0	0	≤ -200mV	0
1	0	Open/shorted	1
1	0	≥ +200mV	0
1	0	≤ -200mV	1
1	0	Open/shorted	1

Applications Information



XR33152, XR33155 and XR33158 XR33156

Figure 2. XR33152, XR33155 and XR33158 Half-duplex and XR33156 Full-duplex

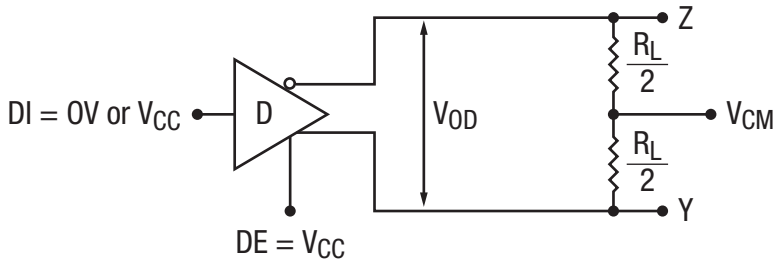


Figure 3. Differential Driver Output Voltage

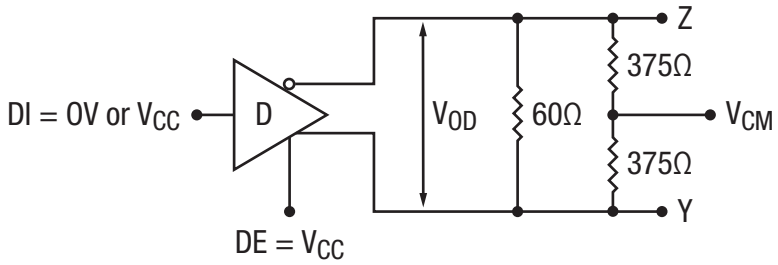


Figure 4. Differential Driver Output Voltage Over Common Mode

Applications Information (Continued)

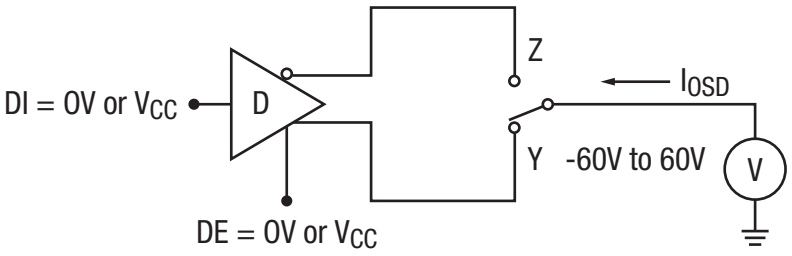


Figure 5. Driver Output Short Circuit Current

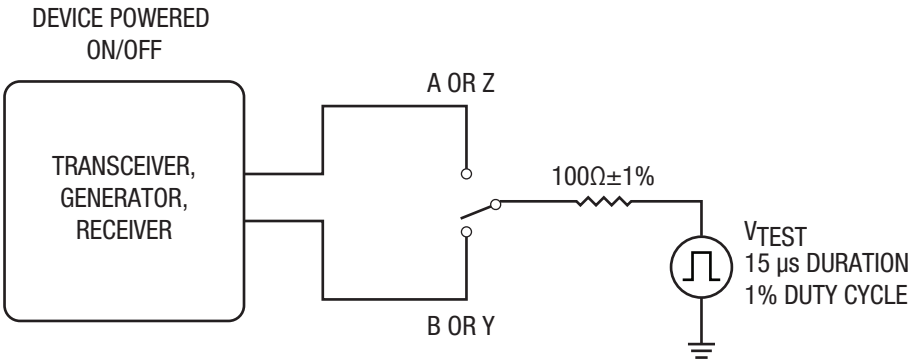
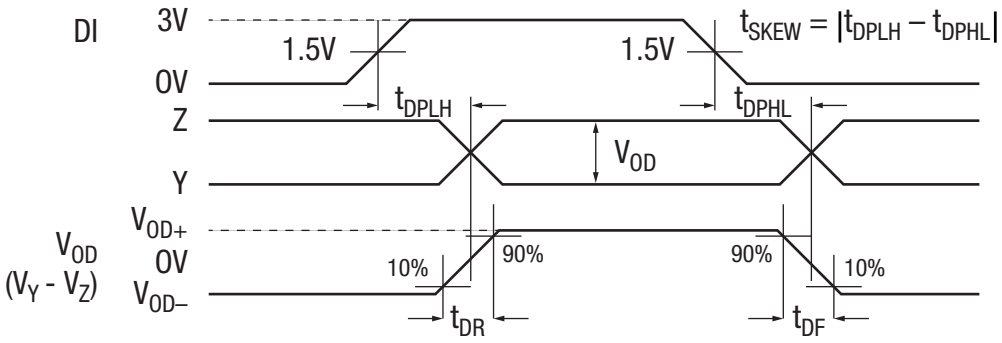


Figure 6. Transient Overvoltage Test Circuit



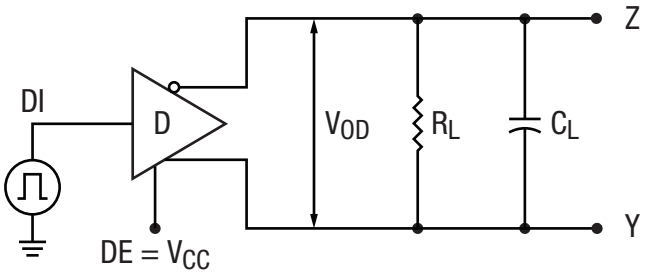


Figure 7. Driver Propagation Delay Test Circuit and Timing Diagram

Applications Information (Continued)

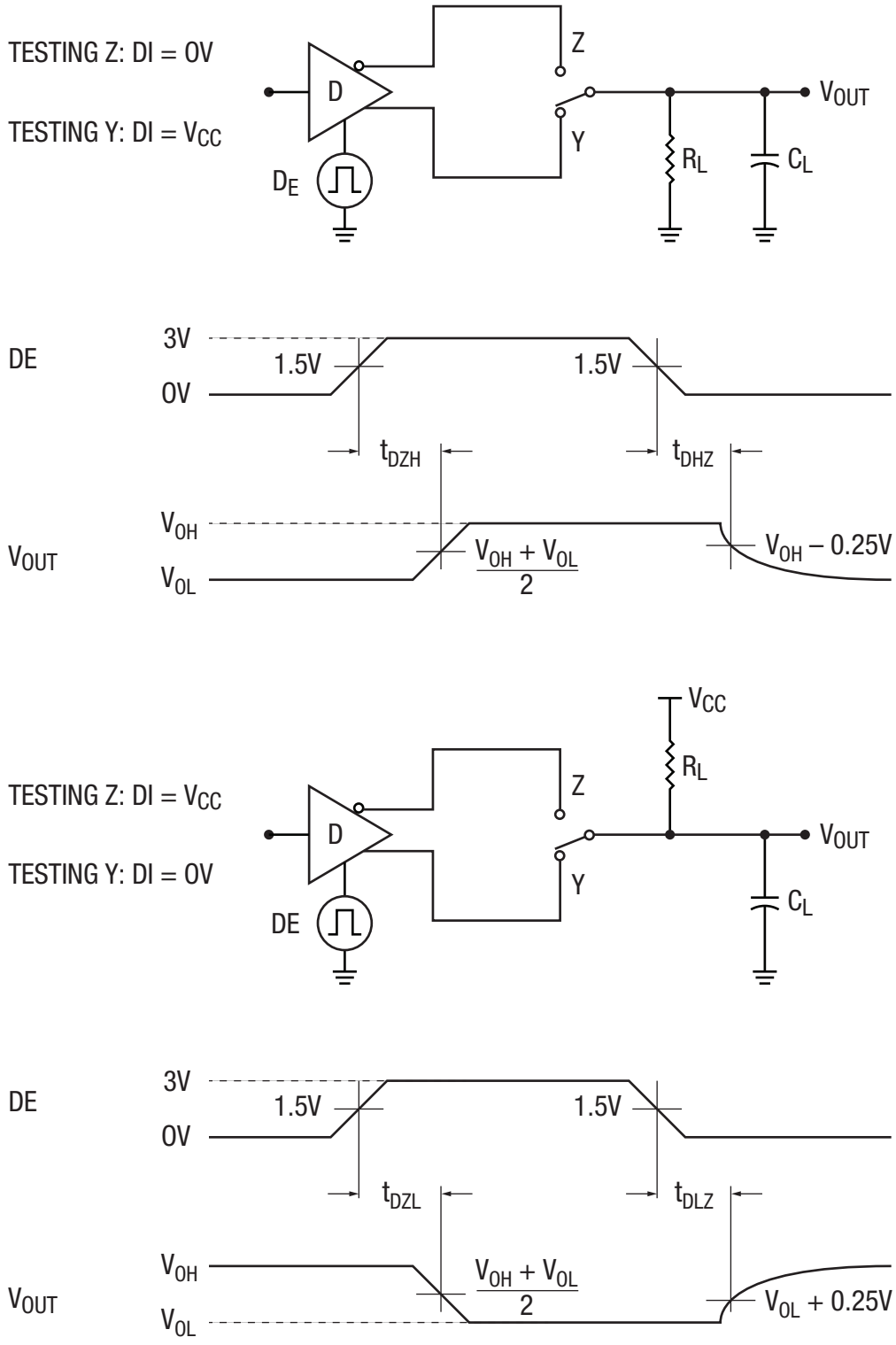


Figure 8. Driver Enable and Disable Timing Test Circuits and Timing Diagrams

Applications Information (Continued)

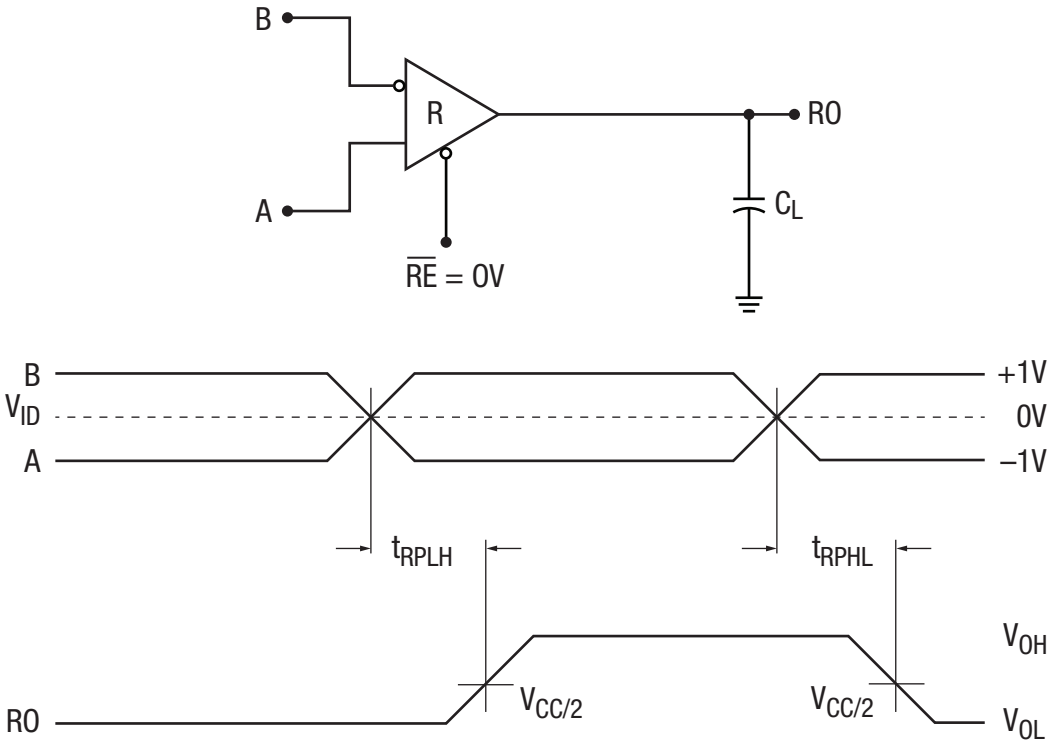


Figure 9. Receiver Propagation Delay Test Circuit and Timing Diagram

Applications Information (Continued)

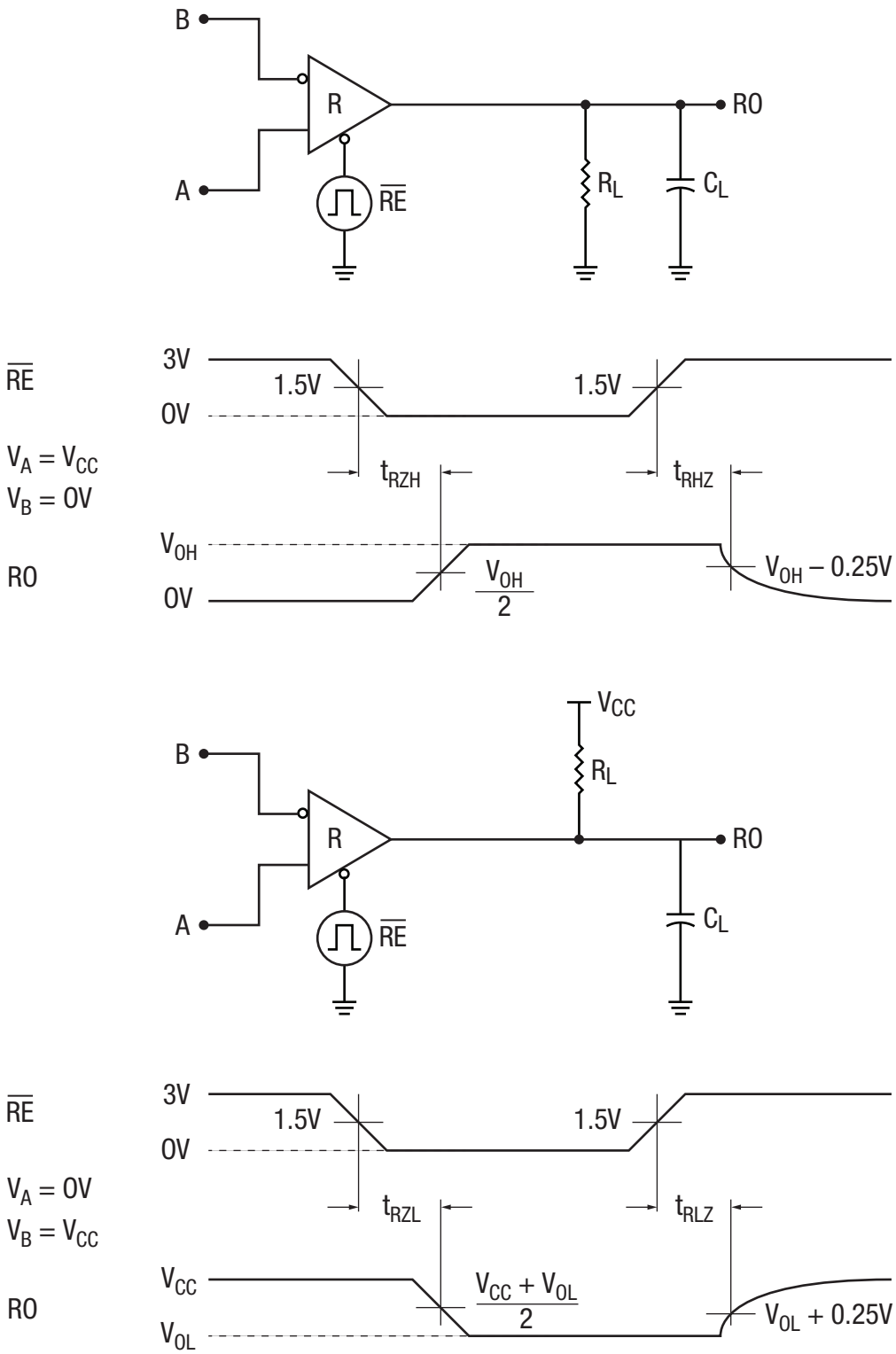


Figure 10. Receiver Enable and Disable Test Circuits and Timing Diagrams

Applications Information (Continued)

The XR3315x RS-485/RS-422 devices are part of MaxLinear's high performance serial interface product line. The analog bus pins can survive direct shorts up to ±60V and are protected against ESD events up to ±15kV.

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 XR3315x family 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 XR3315x family 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 XR3315x family 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 XR3315x family 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 XR3315x family 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 line lengths up to 4000ft. Maximum achievable line length is a function of signal attenuation and noise. Termination prevents signal reflections by eliminating the impedance mismatches on a transmission line. Line termination is generally used if rise and fall times are shorter than the round trip signal propagation time. Higher output drivers may allow longer cables to be used.

±15kV HBM ESD Protection (Unpowered Part)

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 XR3315x family have extra protection against static electricity. MaxLinear uses state-of-the-art structures to protect these pins against ESD damage:

- ±15kV HBM for bus pins to GND
- ±4kV HBM for 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 12kΩ (1 unit load). A standard driver can drive up to 32 unit loads. The XR33152 transceiver has a 1/10th unit load receiver input impedance of 120kΩ, allowing up to 320 transceivers to be connected in parallel on a communication line. The XR33156/58 transceivers have a 1/2.5 unit load receiver input impedance of 30kΩ, allowing up to 80 transceivers to be connected in parallel on a communication line. Any combination of these devices and other RS-485 transceivers up to a total of 32 unit loads may be connected to the line.

Low Power Shutdown Mode

The XR33156 has a low-power shutdown mode that is initiated by bringing both $\overline{RE}$ high and DE low simultaneously. While in shutdown the XR33156 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.

XR33156 enable times, t_{ZH} and t_{ZL}, apply when the part is not in low power shutdown state. Enable times, $t_{ZH(SHDN)}$ and $t_{ZL(SHDN)}$ apply when the part is shutdown. The driver and receiver take longer to become enabled from low power shutdown $t_{ZH(SHDN)}$ and $t_{ZL(SHDN)}$ than from driver or receiver disable mode (t_{ZH} and t_{ZL}).

Applications Information (Continued)

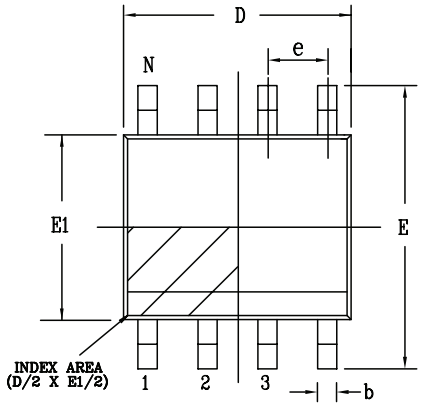
Product Selector Guide

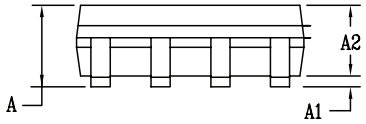
Part Number	Operation	Data Rate	Shutdown	Receiver/Driver Enable	Nodes On Bus	Footprint
XR33152	Half-duplex	250kbps	No	No/Yes	320	8-NSOIC
XR33155	Half-duplex	1Mbps				
XR33156	Full-duplex	20Mbps	Yes	Yes/Yes	80	14-NSOIC
XR33158	Half-duplex		No	No/Yes	80	8-NSOIC

Mechanical Dimensions

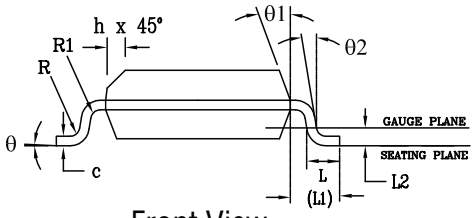
NSOIC-8

Top View





Side View



Front View

PACKAGE OUTLINE NSOIC .150" BODY JEDEC MS-012 VARIATION AA						
SYMBOLS	COMMON DIMENSIONS IN MM (Control Unit)			COMMON DIMENSIONS IN INCH (Reference Unit)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.35	—	1.75	0.053	—	0.069
A1	0.10	—	0.25	0.004	—	0.010
A2	1.25	—	1.65	0.049	—	0.065
b	0.31	—	0.51	0.012	—	0.020
c	0.17	—	0.25	0.007	—	0.010
E	6.00 BSC			0.236 BSC		
E1	3.90 BSC			0.154 BSC		
e	1.27 BSC			0.050 BSC		
h	0.25	—	0.50	0.010	—	0.020
L	0.40	—	1.27	0.016	—	0.050
L1	1.04 REF			0.041 REF		
L2	0.25 BSC			0.010 BSC		
R	0.07	—	—	0.003	—	—
R1	0.07	—	—	0.003	—	—
q	0°	—	8°	0°	—	8°
q1	5°	—	15°	5°	—	15°
q2	0°	—	—	0°	—	—
D	4.90 BSC			0.193 BSC		
N	8					

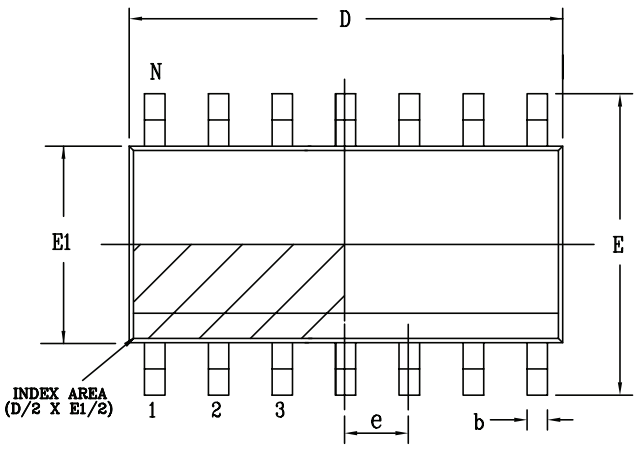
Drawing No: POD-00000108

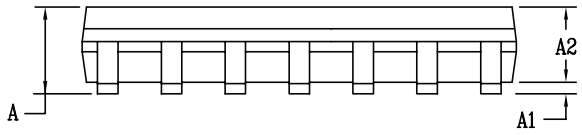
Revision: A

Mechanical Dimensions

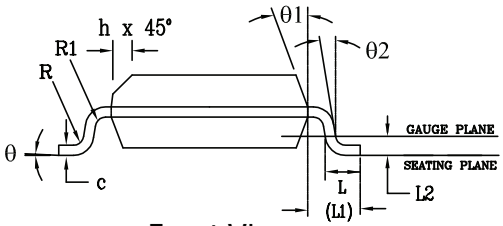
NSOIC-14

Top View





Side View



Front View

PACKAGE OUTLINE NSOIC .150" BODY JEDEC MS-012 VARIATION AB						
SYMBOLS	COMMON DIMENSIONS IN MM (Control Unit)			COMMON DIMENSIONS IN INCH (Reference Unit)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.35	—	1.75	0.053	—	0.069
A1	0.10	—	0.25	0.004	—	0.010
A2	1.25	—	1.65	0.049	—	0.065
b	0.31	—	0.51	0.012	—	0.020
c	0.17	—	0.25	0.007	—	0.010
E	6.00 BSC			0.236 BSC		
E1	3.90 BSC			0.154 BSC		
e	1.27 BSC			0.050 BSC		
h	0.25	—	0.50	0.010	—	0.020
L	0.40	—	1.27	0.016	—	0.050
L1	1.04 REF			0.041 REF		
L2	0.25 BSC			0.010 BSC		
R	0.07	—	—	0.003	—	—
R1	0.07	—	—	0.003	—	—
q	0°	—	8°	0°	—	8°
q1	5°	—	15°	5°	—	15°
q2	0°	—	—	0°	—	—
D	8.65 BSC			0.341 BSC		
N	14					

Drawing No: POD-00000109

Revision: A

Ordering Information[1]

Part Number	Operation	Data Rate	Operating Temperature Range	Lead-Free	Package	Packaging Method
XR33152ID-F	Half-duplex	250kbps	-40°C to 85°C	Yes[2]	8-pin SOIC	Tube
XR33152IDTR-F						Tape and Reel
XR33152HD-F			-40°C to 105°C			Tube
XR33152HDTR-F						Tape and Reel
XR33155ID-F	Half-duplex	1Mbps	-40°C to 85°C		8-pin SOIC	Tube
XR33155IDTR-F						Tape and Reel
XR33155HD-F			-40°C to 105°C			Tube
XR33155HDTR-F						Tape and Reel
XR33156ID-F	Full-duplex	20Mbps	-40°C to 85°C		14-pin SOIC	Tube
XR33156IDTR-F						Tape and Reel
XR33156HD-F			-40°C to 105°C			Tube
XR33156HDTR-F						Tape and Reel
XR33158ID-F	Half-duplex	20Mbps	-40°C to 85°C		8-pin SOIC	Tube
XR33158IDTR-F						Tape and Reel
XR33158HD-F			-40°C to 105°C			Tube
XR33158HDTR-F						Tape and Reel
XR33152IDEVB XR33152HDEVB XR33155IDEVB XR33155HDEVB XR33156IDEVB XR33156HDEVB XR33158IDEVB XR33158HDEVB	Evaluation Boards					

NOTE:
1. Refer to www.exar.com/XR33152, www.exar.com/XR33155, www.exar.com/XR33156, www.exar.com/XR33158 for most up-to-date Ordering Information.
2. Visit www.exar.com for additional information on Environmental Rating.

Revision History

Revision	Date	Description
1A	Jan 2016	Initial Release
2A	July 2016	Add XR33155, -40°C to 105°C parts, and Revision History.
2B	Jan 2017	Corrected XR33158 max temperature typo
2C	Feb 2018	Updated to MaxLinear logo. Updated format and Ordering Information. Moved ESD ratings to page 2.

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