XR33180/81/83/84

3V to 5.5V, 52Mbps, TSOT23 RS-485/RS-422 Receivers with ±15kV ESD Protection

April 27, 2022

Description

The XR33180, XR33181, XR33183 and XR33184 are high performance RS-485/RS-422 receivers designed to meet the increasing system requirements found in today's high performance serial communication applications.

The receiver includes enhanced failsafe circuitry, guaranteeing a logic-high receiver output when the receiver inputs are open, shorted, or undriven. The XR33180/81/83/84 (XR3318x) receiver input impedance is at least 48kΩ (1/4 unit load), allowing more than 128 devices on the bus. The bus pins are ESD protected and pass IEC61000 level 4 (±15kV).

This is a wide supply (3.0V to 5.5V) device that operates at a maximum data rate of 52Mbps and comes in very small 5-pin and 6-pin TSOT23 packages, making this standalone receiver ideal for high speed point-to-point RS-485 applications where space is a concern.

The XR3318x offers several pinout options to maximize performance in different applications while maintaining a minimum pin count. The XR33180 is available in a 5-pin TSOT23 package with the receiver always enabled. The XR33181 is available in a 6-pin TSOT23 package and offers a active high receiver enable pin while the XR33183 has the same pinout but with active low enable pin. The XR33184 is available in a 6-pin TSOT23 package with a I/O logic supply pin to ease the interface to MCU's or FPGA's that run off of different supply voltages. The V_L supply pin allows the XR33184 to interface to other devices running off of supplies from ranging from 1.65V to V_{CC}.

All XR3318x options operate up to a max data rate of 52Mbps, and have excellent propagation delay and skew characteristics making them a good choice for clock fanout or clock distribution systems.

XR33184 OBSOLETE

FEATURES

- Max 52Mbps data rate
- Wide 3.0V to 5.5V supply operation
- Robust Electrostatic Discharge (ESD) protection for RS-485 bus pins
  - ±15kV human body model
  - ±15kV IEC61000-4-2 air discharge
  - ±8kV IEC61000-4-2 contact discharge
- Enhanced receiver failsafe protection for open, shorted, or terminated but idle data lines
- -40°C to 125°C ambient operating temperature range
- Lead-free (RoHS 6) TSOT23-5 and TSOT23-6 packaging
- Absolute minimum pin count option, XR33180 (5-pin TSOT23)
- Tri-state RO options, XR33181 and XR33183
- Adjustable I/O supply option to help interfacing to lower voltage logic, XR33184

APPLICATIONS

- Clock distribution
- Robotic control
- Space constrained systems
- Security camera networks
- Industrial and process control equipment

Typical Application

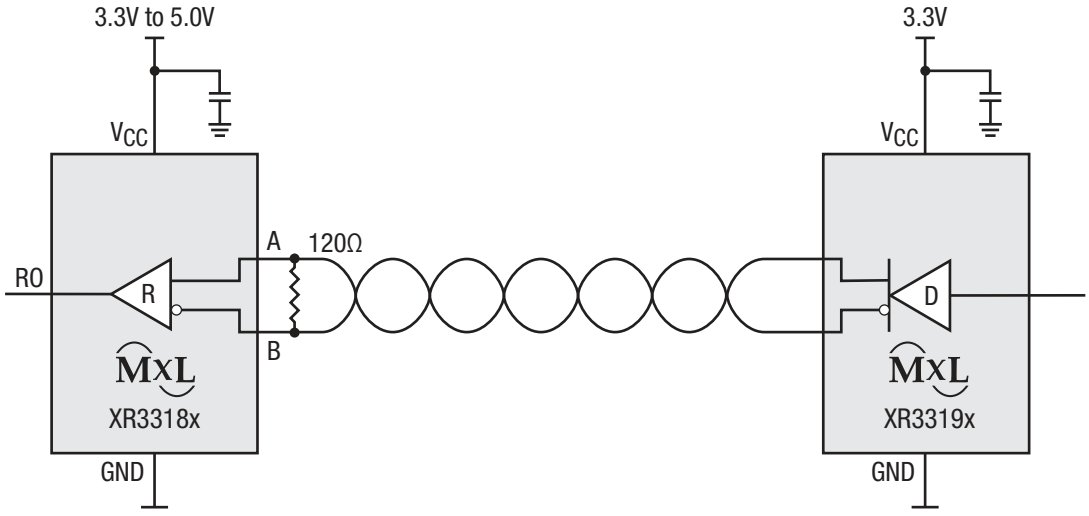


Figure 1. Typical Application

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

Junction temperature ..... 150°C

Input Voltages

EN and $\overline{EN}$ ..... -0.3V to 7.0V

Output Voltage

RO (XR33180/81/83) ..... -0.3V to (V_{CC} + 0.3V)

RO (XR33184) ..... -0.3V to (V_L + 0.3V)

Receiver Input Voltages

A, B ..... ±18V

Transient voltage pulse, through 100Ω[1] ..... ±100V

ESD Ratings

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

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

IEC61000-4-2 Air Gap Discharge ..... ±15kV

IEC61000-4-2 Contact Discharge ..... ±8kV

NOTE:
1. Refer to Figure 3.

Operating Conditions

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

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

Thermal Information

5-pin TSOT23 θ_{JA} ..... 185.5°C/W

5-pin TSOT23 θ_{JC} ..... 61.6°C/W

6-pin TSOT23 θ_{JA} ..... 167.3°C/W

6-pin TSOT23 θ_{JC} ..... 61.6°C/W

Electrical Characteristics

Specifications are at T_A = 25°C, V_{CC} = 3.0V to 5.5V 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
V_L	I/O supply voltage range	$V_L \le V_{CC}$	1.65		V_{CC}	V
I_{CC}	Supply current	No Load, XR33180/81/83/84		2.5	5	mA
I_L	I/O supply	No Load, XR33184			10	µA
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	48			kΩ
$I_{A,B}$	Input current, A and B	V_{OUT} = 12V, V_{CC} = 0V or 5.5V			250	µA
		V_{OUT} = -7V, V_{CC} = 0V or 5.5V	-200			µA

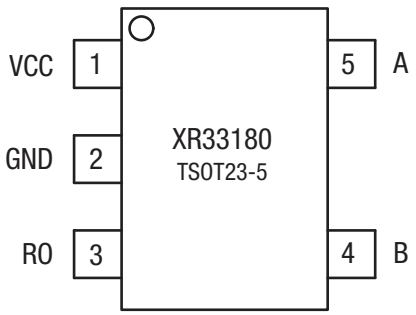
Electrical Characteristics

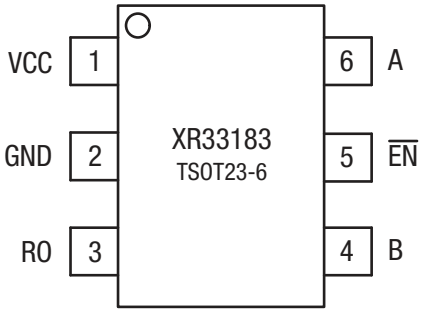
Specifications are at T_A = 25°C, V_{CC} = 3.0V to 5.5V unless otherwise noted. Typical values represent the most likely parametric norm at T_A = 25°C, and are provided for reference purposes only.

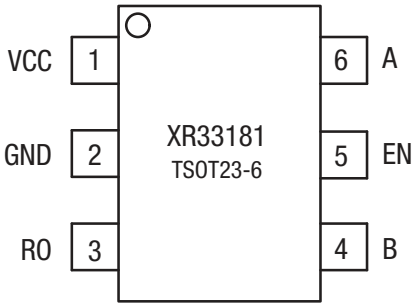
Symbol	Parameter	Conditions	Min	Typ	Max	Units
Logic Inputs/Outputs						
V_{IH}	Logic high input thresholds, EN and $\overline{EN}$	XR33181/83	2			V
V_{IL}	Logic low input thresholds, EN and $\overline{EN}$	XR33181/83			0.4	V
I_{ENLEAK}	Enable pin leakage	XR33181/83	-10		10	µA
V_{OH}	Receiver output high voltage, RO	I_{OUT} = -4mA, XR33180/81/83	V_{CC} - 0.4			V
V_{OL}	Receiver output low voltage, RO	I_{OUT} = 4mA, XR33180/81/83			0.4	V
V_{OH}	Receiver output high voltage, RO	3.0V ≤ V_L ≤ 5.5V, I_{OUT} = -4mA 1.65V ≤ V_L ≤ 3.0V, I_{OUT} = -1mA, XR33184	V_L - 0.4			V
V_{OL}	Receiver output low voltage, RO	3.0V ≤ V_L ≤ 5.5V, I_{OUT} = 4mA 1.65V ≤ V_L ≤ 3.0V, I_{OUT} = 1mA, XR33184			0.4	V
I_{OSC}	Receiver output short-circuit current	0V ≤ V_{RO} ≤ V_L	-120		120	mA
I_{OZR}	High-Z receiver output current	0V ≤ V_{OUT} ≤ V_{CC}, XR33180/81/83 0V ≤ V_{OUT} ≤ V_L, XR33184	-1		1	µA
Thermal Characteristics						
T_{TS}	Thermal shutdown temperature			168		°C
T_{TSH}	Thermal shutdown hysteresis			15		°C
Receiver AC Characteristics						
t_{RPLH}	Receiver propagation delay, low to high	C_L = 15pF, V_{ID} = ±2V, V_{ID} rise and fall times <15ns, Figure 4			15	ns
t_{RPHL}	Receiver propagation delay, high to low				15	ns
$\lvert t_{RPLH} - t_{RPHL} \rvert$	Receiver propagation delay skew				2	ns
	Propagation delay matching, device to device[1]	Part to part comparisons must have the same supply conditions and temperature difference ≤ 30°C (max)			8	ns
	Maximum data rate[1]	C_L = 15pF, Duty Cycle 40 to 60%	52			Mbps
t_{RZH}	Receiver enable to output high	C_L = 15pF, R_L = 1KΩ, Figure 5			500	ns
t_{RZL}	Receiver enable to output low				500	ns
t_{RHZ}	Receiver disable from output high				500	ns
t_{RLZ}	Receiver disable from output low				500	ns

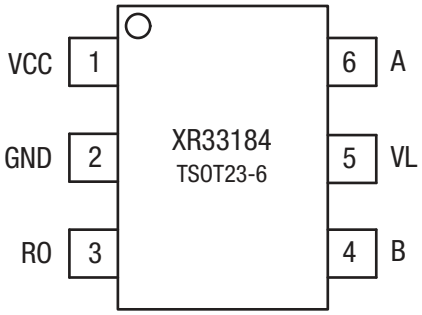
NOTE:
1. Guarenteed by design.

Pin Configuration - XR33184 OBSOLETE









Pin Functions - XR33184 OBSOLETE

Pin Number				Pin Name	Type	Description
XR33180	XR33181	XR33183	XR33184			
1	1	1	1	VCC	Supply	Power supply, bypass with 0.1µf capacitor
2	2	2	2	GND	Supply	Ground

3	3	3	3	RO	Output	Receiver output:
						if (V_A-V_B) ≥ -50mV, RO is high
						if (V_A-V_B) ≤ -200mV, RO is low

4	4	4	4	B	Bus Input	±15KV ESD protected, RS-485/RS-422 inverting receiver input
-	5	-	-	EN	Input	Receiver output enable: when EN is low, RO is disabled, high impedance when EN is high, RO is enabled
-	-	5	-	$\overline{EN}$	Input	Receiver output enable: when $\overline{EN}$ is high, RO is disabled, high impedance when $\overline{EN}$ is low, RO is enabled
-	-	-	5	VL	Supply	Logic interface power supply
5	6	6	6	A	Bus Input	±15KV ESD protected, RS-485/RS-422 non-inverting receiver input

Pin Functions (Continued)

Receiving		
Inputs		Output
$\overline{RE}$	V_A - V_B	RO
0	≥ -50mV	1
0	≤ -200mV	0
0	Open/shorted/idle	1
1	X	High-Z

Functional Block Diagrams - XR33184 OBSOLETE

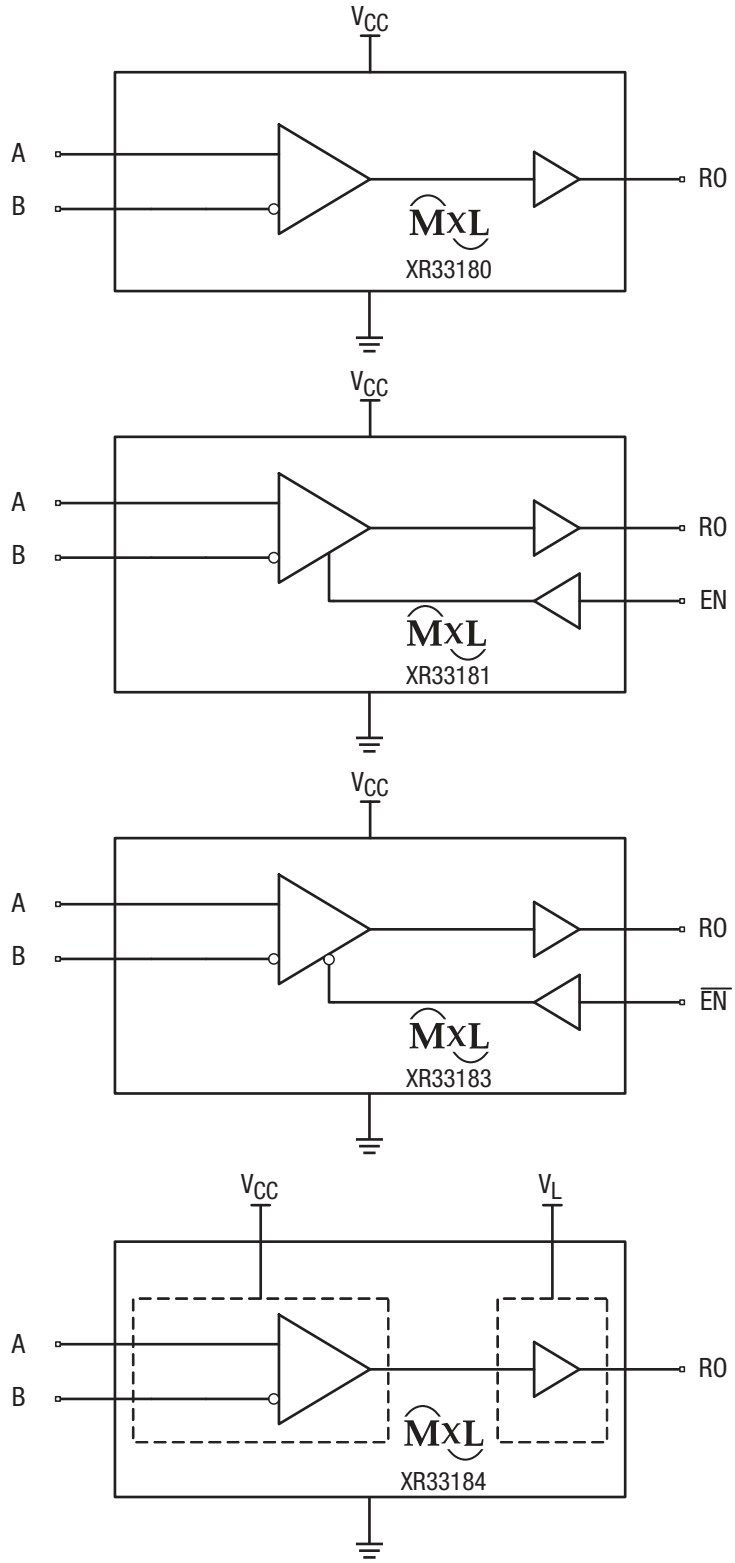


Figure 2. Functional Block Diagrams

Applications Information

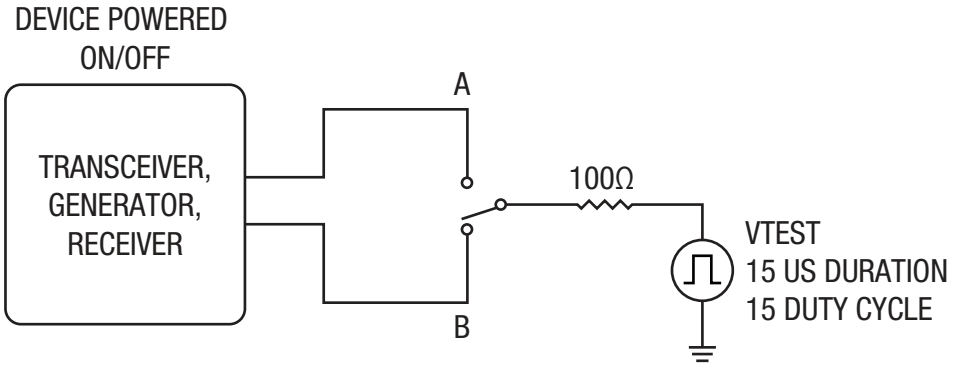


Figure 3. Transient Overvoltage Test Circuit

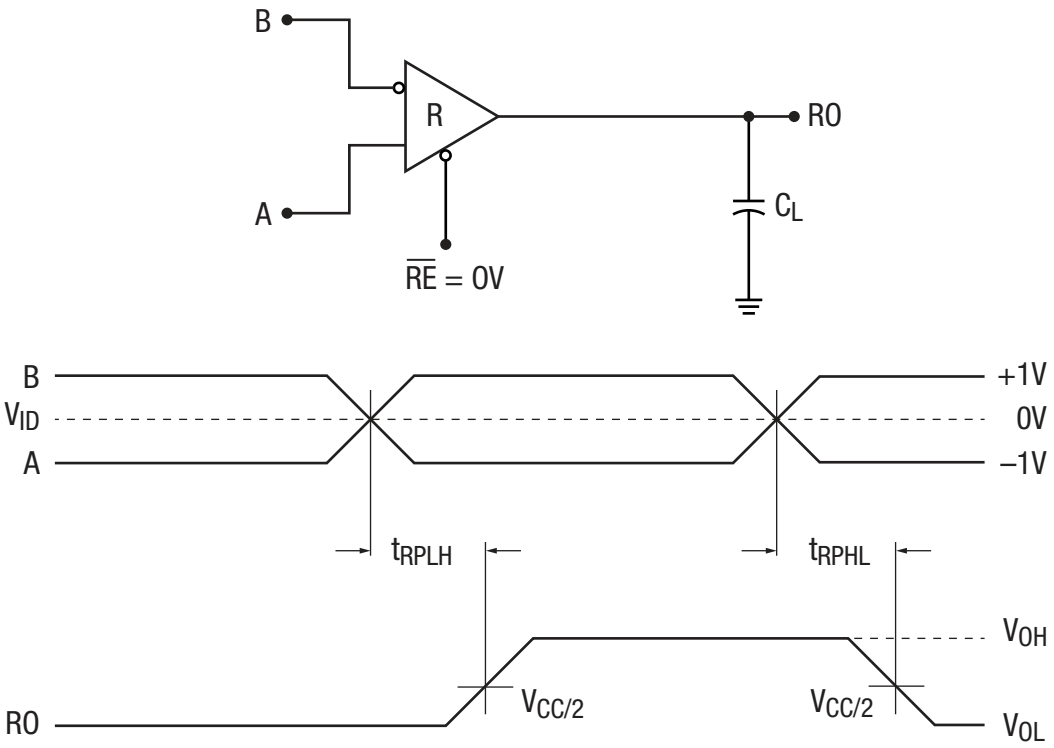


Figure 4. Receiver Propagation Delay Test Circuit and Timing Diagram

Applications Information (Continued)

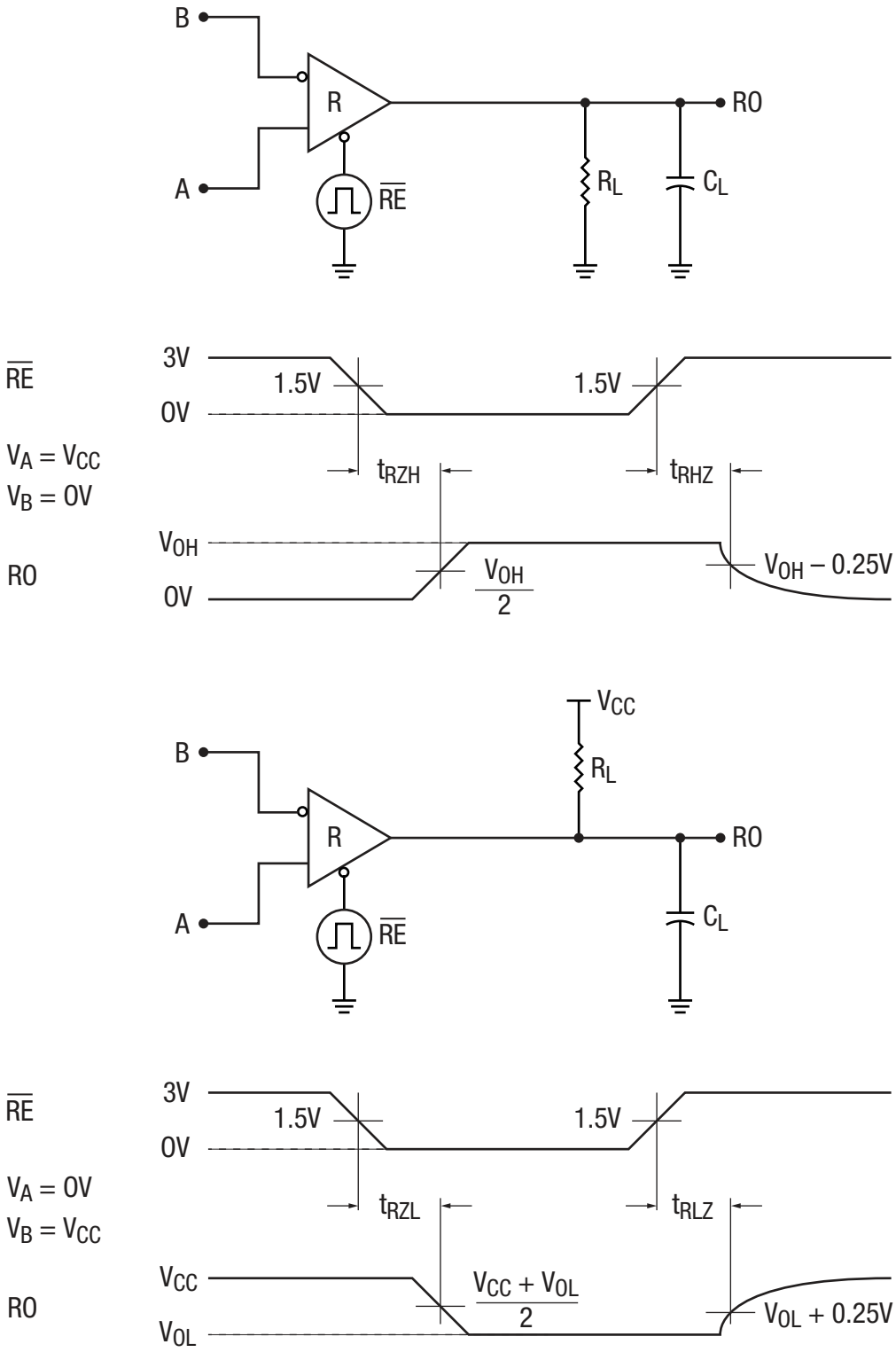


Figure 5. Receiver Enable and Disable Test Circuits and Timing Diagrams

Applications Information (Continued)

The XR3318x RS-485/RS-422 device is part of MaxLinear's high performance serial interface product line. The analog bus pins can survive direct shorts up to ±18V 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 XR3318x 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 XR3318x 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 XR3318x does not need failsafe biasing resistors, it can operate without issue if biasing is used.

±15kV ESD Protection

ESD protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The receiver inputs of the XR3318x have 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 and powered down. After an ESD event, the XR3318x keeps operating without latch-up or damage.

ESD protection can be tested in various ways. The receiver inputs of the XR3318x are characterized for protection to the following limits:

- ±15kV HBM (Human Body Model), bus pins
- ±15kV IEC 61000-4-2 air discharge, bus pins
- ±8kV IEC 61000-4-2 contact discharge, 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 Receivers 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 XR3318x receiver has a 1/4th unit load receiver input impedance of 48KΩ, allowing up to 128 receivers to be connected in parallel on a communication line. Any combination of the XR33180/81/83/84's and other RS-485 receivers up to a total of 32 unit loads may be connected to the line.

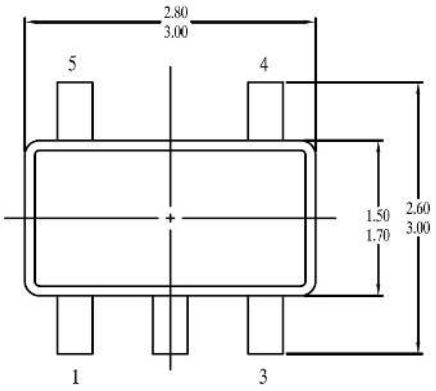
Product Selector Guide

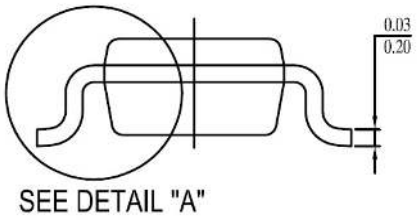
Part Number	Data Rate	Receiver Enable	Nodes On Bus	V_L Pin	Package
XR33180	52Mbps	No	128	No	5-pin TSOT23
XR33181		Yes (active high)		No	6-pin TSOT23
XR33183		Yes (active low)		No	
XR33184		No		Yes	

NOTE: XR33184 OBSOLETE

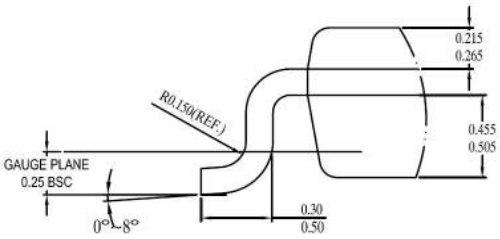
Mechanical Dimensions

5-Pin TSOT23

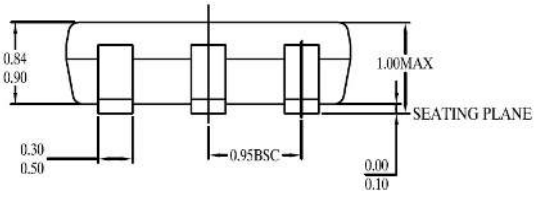




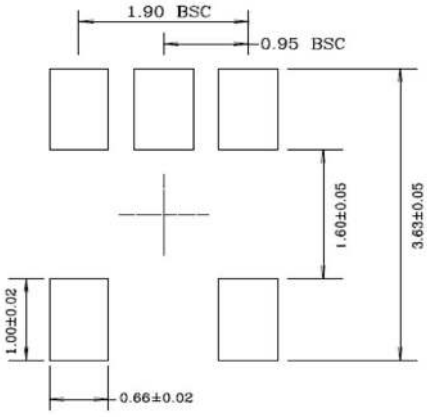
SIDE VIEW-1



DETAIL "A"



SIDE VIEW - 2



TYPICAL RECOMMENDED LAND PATTERN

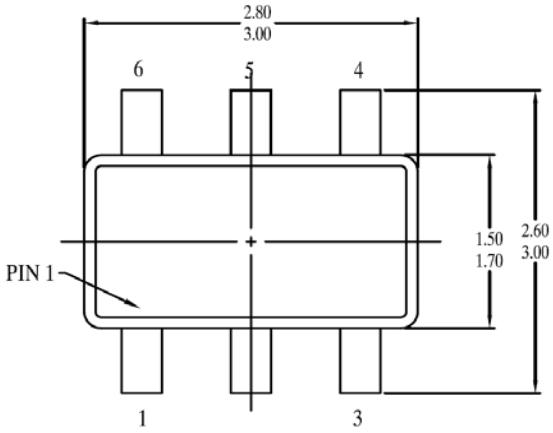
1. All dimensions are in Millimeters
2. Dimensions and tolerance per Jedec MO-193

Drawing No. : POD - 00000076

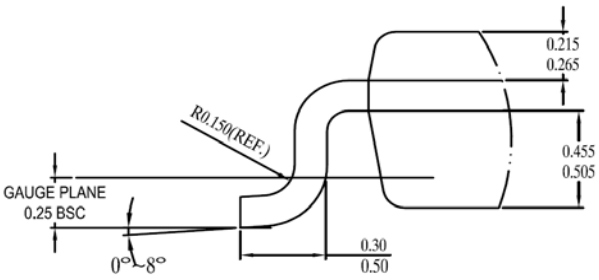
Revision: A.2

Mechanical Dimensions (Continued)

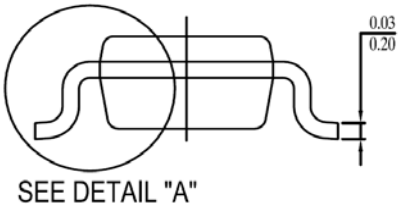
6-Pin TSOT23



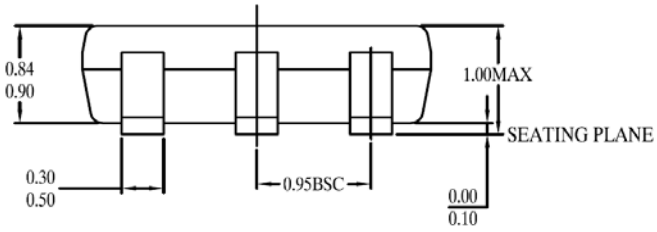
TOP VIEW



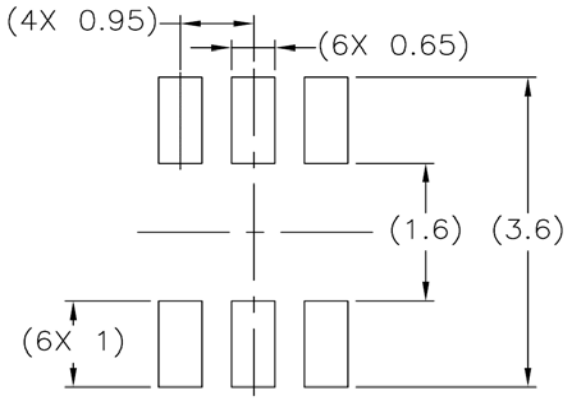
DETAIL



SIDE VIEW-1



SIDE VIEW - 2



TYPICAL RECOMMENDED LAND PATTERN

1. All dimensions are in Millimeters
2. Dimensions and tolerance per Jedec MO-193

Drawing No. : POD - 00000077

Revision: A.1

Ordering Information

Part Number	Additional Feature	Operating Temperature Range	Lead-Free	Package	Packaging Method
XR33180ESBTR	-	-40°C to 125°C	Yes	5-pin TSOT23	Tape and Reel
XR33181ESBTR	Active High Enable			6-pin TSOT23	
XR33183ESBTR	Active Low Enable				
XR33180ESBEVB	Evaluation Board				
XR33181ESBEVB					
XR33183ESBEVB					

NOTE: For more information about part numbers, as well as most up-to-date ordering information and additional information on environmental rating, refer to www.maxlinear.com/XR33180, www.maxlinear.com/XR33181, www.maxlinear.com/XR33183, www.maxlinear.com/XR33184.

Revision History

Revision	Date	Description
1A	June 2016	Initial Release
1B	August 2016	Update tape and reel quantity in Ordering Information table
1C	February 2018	Update to MaxLinear logo. Update format and Ordering Information format. Moved ESD ratings to page 2.
1D	April 27, 2022	**Updated:** • In the “Mechanical Dimensions” figure, POD - 00000076, Rev. A.1 replaced with POD - 00000076, Rev. A.2. **Removed:** • In the “Ordering Information” table, XR33184ESBTR and XR33184ESBEVB part numbers.

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