

# XR33180/81/83/84

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

### 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  $48k\Omega$  (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<sub>L</sub> supply pin allows the XR33184 to interface to other devices running off of supplies from ranging from 1.65V to V<sub>CC</sub>.

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.

### 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

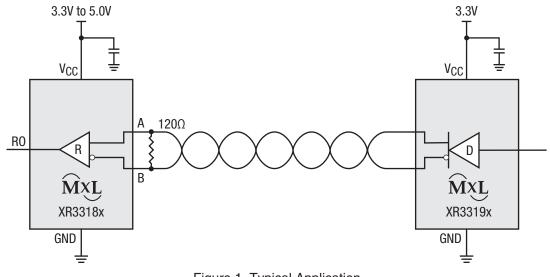


Figure 1. Typical Application

### **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 $\overline{\text{EN}}$ 0.3V to 7.0V	/
Output Voltage	
RO (XR33180/81/83)0.3V to (V <sub>CC</sub> + 0.3V)	)
RO (XR33184)0.3V to (V <sub>L</sub> + 0.3V)	)
Receiver Input Voltages	
A, B±18V	/
Transient voltage pulse, through $100\Omega^{(1)}\pm100V$	/

### **Operating Conditions**

Operating temperature range	40°C to 125°C
V <sub>CC</sub> supply range	3.0V to 5.5V
Thermal Information	
5-pin TSOT23 $\theta_{JA}$	185.5°C/W
5-pin TSOT23 $\theta_{JC}$	61.6°C/W
6-pin TSOT23 $\theta_{JA}$	167.3°C/W
6-pin TSOT23 $\theta_{JC}$	61.6°C/W

#### ESD Ratings

HBM - Human Body Model (A and B pins)±1	5kV
HBM - Human Body Model (all other pins) ±	4kV
IEC61000-4-2 Air Gap Discharge±1	5kV
IEC61000-4-2 Contact Discharge ±	8kV
NOTE: 1. Refer to Figure 3.	

### **Electrical Characteristics**

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

Symbol	Parameter	Conditions	Min	Тур	Max	Units			
Supply	Supply								
V <sub>CC</sub>	Supply voltage range		3.0		5.5	V			
VL	I/O supply voltage range	$V_{L} \leq V_{CC}$	1.65		V <sub>CC</sub>	V			
I <sub>CC</sub>	Supply current	No Load, XR33180/81/83/84		2.5	5	mA			
IL	I/O supply	No Load, XR33184			10	μA			
Receiver D	OC Characteristics								
V <sub>TH</sub>	Receiver differential threshold voltage, $V_{\text{A}}$ - $V_{\text{B}}$	$-7V \le V_{CM} \le 12V$	-200	-125	-50	mV			
ΔV <sub>OH</sub>	Receiver input hysteresis	$V_{CM} = 0V$		25		mV			
R <sub>IN</sub>	Receiver input resistance	$-7V \le V_{CM} \le 12V$	48			kΩ			
I <sub>A,B</sub>	Input current, A and B	$V_{OUT} = 12V, V_{CC} = 0V \text{ or } 5.5V$			250	μΑ			
		$V_{OUT} = -7V, V_{CC} = 0V \text{ or } 5.5V$	-200			μΑ			



### **Electrical Characteristics**

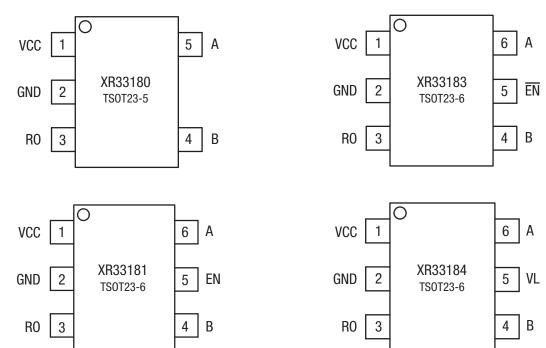
Specifications are at  $T_A = 25^{\circ}C$ ,  $V_{CC} = 3.0V$  to 5.5V unless otherwise noted. Typical values represent the most likely parametric norm at  $T_A = 25^{\circ}C$ , and are provided for reference purposes only.

Symbol	Parameter	Conditions	Min	Тур	Max	Units
Logic Inputs/C	Dutputs					
V <sub>IH</sub>	Logic high input thresholds, EN and $\overline{\text{EN}}$	XR33181/83	2			V
V <sub>IL</sub>	Logic low input thresholds, EN and $\overline{\text{EN}}$	XR33181/83			0.4	V
I <sub>ENLEAK</sub>	Enable pin leakage	XR33181/83	-10		10	μA
V <sub>OH</sub>	Receiver output high voltage, RO	I <sub>OUT</sub> = -4mA, XR33180/81/83	V <sub>CC</sub> - 0.4			V
V <sub>OL</sub>	Receiver output low voltage, RO	I <sub>OUT</sub> = 4mA, XR33180/81/83			0.4	V
V <sub>OH</sub>	Receiver output high voltage, RO	$3.0V \le V_L \le 5.5V$ , $I_{OUT} = -4mA$ $1.65V \le V_L \le 3.0V$ , $I_{OUT} = -1mA$ , XR33184	V <sub>L</sub> - 0.4			v
V <sub>OL</sub>	Receiver output low voltage, RO	$3.0V \le V_L \le 5.5V$ , $I_{OUT} = 4mA$ $1.65V \le V_L \le 3.0V$ , $I_{OUT} = 1mA$ , XR33184			0.4	v
I <sub>OSC</sub>	Receiver output short-circuit current	$0V \le V_{RO} \le V_L$	-120		120	mA
I <sub>OZR</sub>	High-Z receiver output current	$\begin{array}{l} 0V \leq V_{OUT} \leq V_{CC}, XR33180/81/83 \\ 0V \leq V_{OUT} \leq V_{L}, XR33184 \end{array}$	-1		1	μA
Thermal Char	acteristics					
T <sub>TS</sub>	Thermal shutdown temperature			168		°C
T <sub>TSH</sub>	Thermal shutdown hysteresis			15		°C
Receiver AC (	Characteristics					
t <sub>RPLH</sub>	Receiver propagation delay, low to high				15	ns
t <sub>RPHL</sub>	Receiver propagation delay, high to low	$C_L = 15 \text{pF}, V_{\text{ID}} = \pm 2 \text{V}, V_{\text{ID}}$ rise and fall times <15ns, Figure 4			15	ns
lt <sub>RPLH</sub> - t <sub>RPHL</sub> I	Receiver propagation delay skew				2	ns
	Propagation delay matching, device to device <sup>(1)</sup>	Part to part comparisons must have the same supply conditions and temperature difference $\leq$ 30°C (max)			8	ns
	Maximum data rate <sup>(1)</sup>	C <sub>L</sub> = 15pF, Duty Cycle 40 to 60%	52			Mbps
t <sub>RZH</sub>	Receiver enable to output high				500	ns
t <sub>RZL</sub>	Receiver enable to output low				500	ns
t <sub>RHZ</sub>	Receiver disable from output high	$-$ C <sub>L</sub> = 15pF, R <sub>L</sub> = 1K $\Omega$ , Figure 5			500	ns
t <sub>RLZ</sub>	Receiver disable from output low				500	ns

NOTE:

1. Guarenteed by design.

## **Pin Configuration**



# **Pin Functions**

	Pin Number			Din Nome	Tura	Description
XR33180	XR33181	XR33183	XR33184	Pin Name	Туре	Description
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 $(V_A-V_B) \ge -50mV$ , RO is high if $(V_A-V_B) \le -200mV$ , RO is low
4	4	4	4	В	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	-	ĒN	Input	Receiver output enable: when $\overline{\text{EN}}$ is high, RO is disabled, high impedance when $\overline{\text{EN}}$ is low, RO is enabled
-	-	-	5	VL	Supply	Logic interface power supply
5	6	6	6	А	Bus Input	±15KV ESD protected, RS-485/RS-422 non-inverting receiver input

# Pin Functions (Continued)

Receiving							
Inp	Output						
RE	V <sub>A</sub> - V <sub>B</sub>	RO					
0	≥ -50mV	1					
0	≤ -200mV	0					
0	Open/shorted/idle	1					
1	Х	High-Z					



### **Functional Block Diagrams**

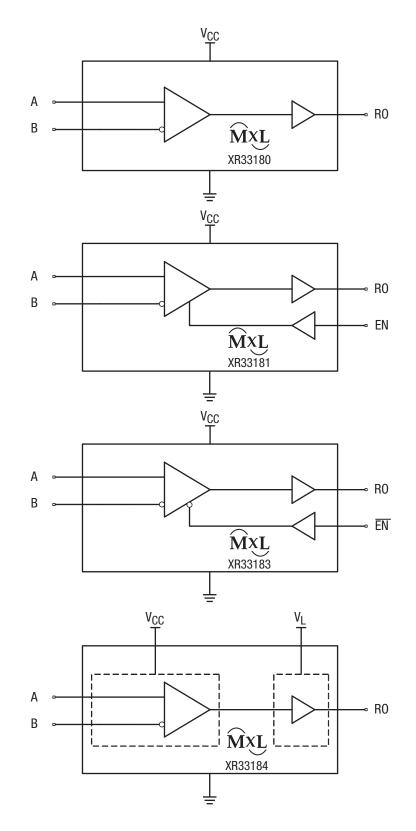


Figure 2. Functional Block Diagrams



### **Applications Information**

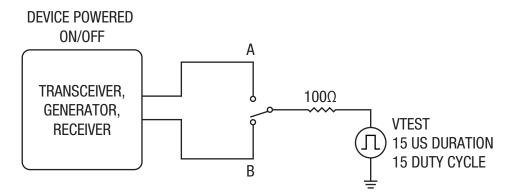


Figure 3. Transient Overvoltage Test Circuit

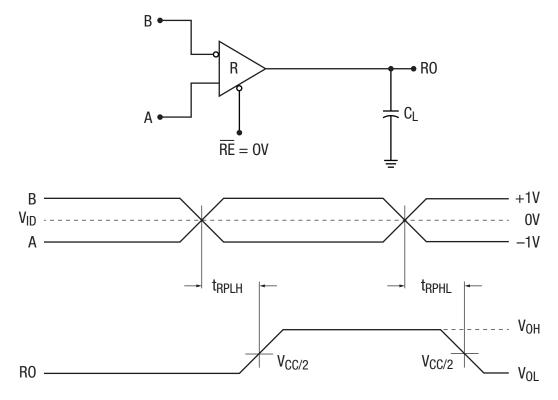


Figure 4. Receiver Propagation Delay Test Circuit and Timing Diagram

**Applications Information (Continued)** 

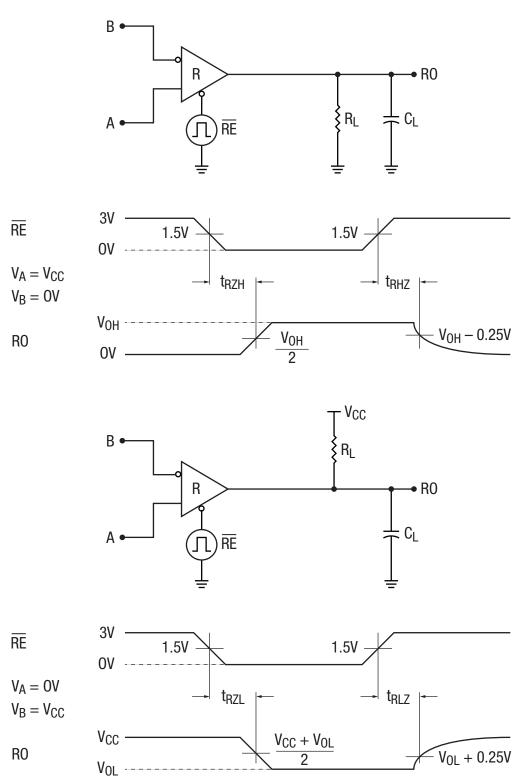


Figure 5. Receiver Enable and Disable Test Circuits and Timing Diagrams

### **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  $\pm$ 18V and are protected against ESD events up to  $\pm$ 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  $12k\Omega$  (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  $48K\Omega$ , 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.

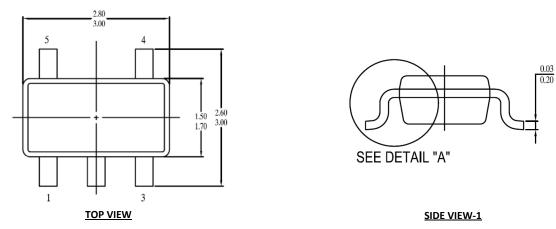
#### Product Selector Guide

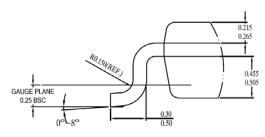
Part Number	Data Rate	Receiver Enable	Nodes On Bus	V <sub>L</sub> Pin	Package
XR33180	- 52Mbps	No	100	No	5-pin TSOT23
XR33181		Yes (active high)		No	
XR33183		Yes (active low)	128	No	6-pin TSOT23
XR33184		No		Yes	



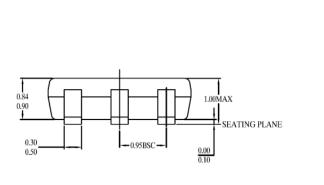
### **Mechanical Dimensions**

#### 5-Pin TSOT23

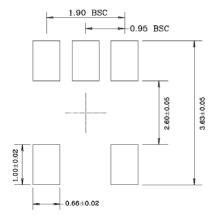








SIDE VIEW - 2



#### TYPICAL RECOMMENDED LAND PATTERN

1. All dimensions are in Millimeters

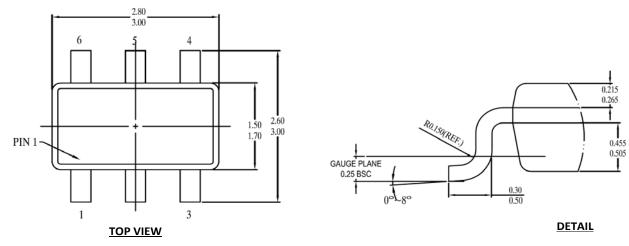
2. Dimensions and tolerance per Jedec MO-193

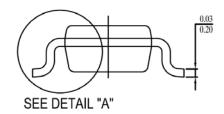
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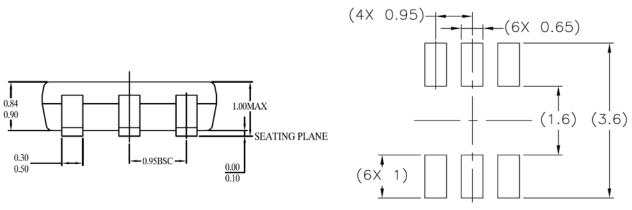
### **Mechanical Dimensions (Continued)**

#### 6-Pin TSOT23





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

