

## MAX33045E/MAX33046E

## 20Mbps, Half-Duplex RS-485/RS-422 Transceivers with $\pm 40\text{kV}$ ESD Protection

### General Description

The MAX33045E/MAX33046E is a half-duplex RS-485/422 transceiver that operates at either 3.3V or 5.0V supply rail for ease of design. Both devices feature enhanced protection for applications in harsh environments. All driver outputs and receiver inputs are protected with both high-fault and high-ESD (electrostatic discharge) protection.

The A/B lines have up to  $\pm 25\text{V}$  fault protection for accidental shorts with local power supplies and  $\pm 40\text{kV}$  ESD (Human Body Model) HBM protection. They are also rated up to  $\pm 15\text{kV}$  Air-Gap Discharge and  $\pm 10\text{kV}$  Contact Discharge per IEC 61000-4-2. Both features ensure robust protection in harsh industrial environments. Drivers are short-circuit current limited and protected against excessive power dissipation by thermal-shutdown circuitry that places the driver outputs into a high-impedance state. The receiver input has a true fail-safe feature that guarantees a logic-high output if both inputs are open or short circuited.

The MAX33045E is rated for a 500kbps (min) data rate, and the MAX33046E is rated for a 20Mbps data rate.

Both devices are packaged in an 8-pin SOIC with an operating ambient temperature from  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

### Applications

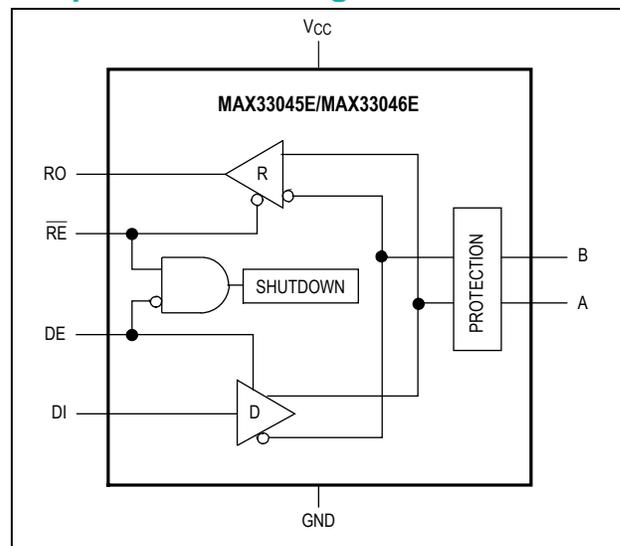
- Programmable Controller
- Factory Automation Equipment
- Motion Controllers
- Encoder Interfaces
- Backplane Buses
- Telecommunication Equipment

**Ordering Information** appears at end of data sheet.

### Benefits and Features

- Integrated Protection Increases Robustness
  - $\pm 25\text{V}$  Fault-Protection Range on Driver Outputs/Receiver Inputs
  - High-ESD Protection
    - $\pm 40\text{kV}$  HBM ESD per JEDEC JS-001
    - $\pm 15\text{kV}$  Air-Gap ESD per IEC 61000-4-2
    - $\pm 10\text{kV}$  Contact ESD per IEC 61000-4-2
  - Short-Circuit-Protected Outputs
  - True Fail-Safe Receiver Prevents False Transition on Receiver Input Short or Open Events
  - Hot-Swap Capability Eliminates False Transitions on Receiver Input Shorts or Open Events
- High-Speed Data Rates up to 20Mbps
- Enables up to 256 Nodes on the Bus
- Wide  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  Operating Temperature Range

### Simplified Block Diagram



**Absolute Maximum Ratings**

V <sub>CC</sub> .....	-0.3V to +6V	Short-Circuit Duration (RO, A, B) .....	Continuous
RO .....	-0.3 to V <sub>CC</sub> + 0.3V	Operating Temperature Range.....	-40°C to +125°C
DE, DI, $\overline{RE}$ .....	-0.3V to +6V	Junction Temperature.....	+150°C
A, B.....	-30V to +30V	Storage Temperature.....	-65°C to +150°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**Package Information**

Package Code	S8+2C
Outline Number	<a href="#">21-0041</a>
Land Pattern Number	<a href="#">90-0096</a>
<b>Thermal Resistance, Four-Layer Board</b>	
Junction to Ambient ( $\theta_{JA}$ )	136°C/W
Junction to Case ( $\theta_{JC}$ )	38°C/W

For the latest package outline information and land patterns (footprints), go to [www.maximintegrated.com/packages](http://www.maximintegrated.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to [www.maximintegrated.com/thermal-tutorial](http://www.maximintegrated.com/thermal-tutorial).

**Electrical Characteristics**

(V<sub>CC</sub> = 3.0V to 3.6V and V<sub>CC</sub> = 4.5V to 5.5V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise specified. Typical values are at V<sub>CC</sub> = +5V and T<sub>A</sub> = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>POWER</b>						
Supply Voltage	V <sub>CC</sub>		3.0		3.6	V
			4.5		5.5	
Supply Current	I <sub>CC</sub>	DE = V <sub>CC</sub> , $\overline{RE}$ = 0V, no load, no switching (DI = 0V or V <sub>CC</sub> )		6.0		mA
		DE = 0V, $\overline{RE}$ = 0V		3.2		
Shutdown Supply Current	I <sub>SHDN</sub>	DE = 0V, $\overline{RE}$ = V <sub>CC_</sub> , no switching (DI = 0V or V <sub>CC</sub> )		1		µA
<b>DRIVER</b>						
Differential Driver Output	V <sub>OD</sub>	R <sub>L</sub> = 54Ω, Figure 1a (Note 2)	1.5			V
		R <sub>L</sub> = 60Ω, Figure 1a (Note 2)	1.5			
		R <sub>L</sub> = 100Ω, Figure 1a (Note 2)	2			
Change in Magnitude of Differential Driver Output Voltage	ΔV <sub>OD</sub>	R <sub>L</sub> = 54Ω or 60Ω or 100Ω, Figure 1a	-0.2		+0.2	V
Driver Common-Mode Output Voltage	V <sub>OC</sub>	R <sub>L</sub> = 54Ω or 60Ω or 100Ω, Figure 1a	1	V <sub>CC</sub> /2	V <sub>CC</sub>	V
Change in Magnitude of Common-Mode Voltage	ΔV <sub>OC</sub>	R <sub>L</sub> = 54Ω or 60Ω or 100Ω, Figure 1a (Note 2)	-0.2		+0.2	V

( $V_{CC} = 3.0\text{V}$  to  $3.6\text{V}$  and  $V_{CC} = 4.5\text{V}$  to  $5.5\text{V}$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise specified. Typical values are at  $V_{CC} = +5\text{V}$  and  $T_A = +25^\circ\text{C}$ .) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Single-Ended Driver Output Voltage High	$V_{OH}$	A or B output, output is high, $I_{SOURCE} = 3\text{mA}$	2.4	$V_{CC} - 0.2$		V
Single-Ended Driver Output Voltage Low	$V_{OL}$	A or B output, output is low, $I_{SINK} = 3\text{mA}$			0.2	V
Driver Short-Circuit Output Current	$I_{SC\_DR}$	$-7\text{V} \leq (V_A \text{ or } V_B) \leq +12\text{V}$			$\pm 250$	mA
Average Driver Short-Circuit Output Current	$I_{AVG\_SCDR}$	$0\text{V} \leq (V_A \text{ or } V_B) \leq V_{CC}$			+250	mA
<b>RECEIVER</b>						
Input Current (A, B)	$I_A, I_B$	$DE = 0\text{V}$ , $0\text{V} \leq V_{CC} \leq 5.5\text{V}$ , $V_{CM} = -7\text{V}$ to $+12\text{V}$	-73		+125	$\mu\text{A}$
Receiver Input Resistance	$R_{IN}$	$-7\text{V} \leq V_{CM} \leq +12\text{V}$	96			k $\Omega$
Common-Mode Voltage Range	$V_{CM}$	Figure 1b	-7		+12	V
Receiver Differential Threshold Voltage Rising	$V_{TLH}$	$-7\text{V} \leq V_{CM} \leq +12\text{V}$			-50	mV
Receiver Differential Threshold Voltage Falling	$V_{THL}$	$-7\text{V} \leq V_{CM} \leq +12\text{V}$	-200			mV
Receiver Input Hysteresis	$\Delta V_{TH}$			100		mV
Differential Input Capacitance	$C_{A\_B}$	Measured between A and B, $f = 1\text{MHz}$		10		pF
<b>LOGIC OUTPUT (RO)</b>						
Output Logic High Voltage	$V_{OH}$	$I_{SOURCE} = 3\text{mA}$ , $(V_A - V_B) \geq -50\text{mV}$	$V_{CC} - 0.4$			V
Output Logic Low Voltage	$V_{OL}$	$I_{SINK} = 3\text{mA}$ , $(V_A - V_B) \leq -200\text{mV}$			0.4	V
Leakage Current	$I_{OZR}$	$0\text{V} \leq V_{RO} \leq V_{CC\_}$	-1		+1	$\mu\text{A}$
Short-Circuit Current	$ I_{OSR} $	$0\text{V} \leq (V_A - V_B) \leq V_{CC}$		200		mA
<b>LOGIC INPUT (DE, <math>\overline{RE}</math>, DI)</b>						
Input Logic High Voltage	$V_{IH}$		2			V
Input Logic Low Voltage	$V_{IL}$				0.8	V
Input Hysteresis	$V_{HYS}$			100		mV
Input Leakage Current	$I_{IN}$	After first transition of DE	-1		+1	$\mu\text{A}$
DE Input Impedance on First Transition	$R_{IN\_FT}$		1		10	k $\Omega$
<b>PROTECTION</b>						

( $V_{CC} = 3.0\text{V}$  to  $3.6\text{V}$  and  $V_{CC} = 4.5\text{V}$  to  $5.5\text{V}$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise specified. Typical values are at  $V_{CC} = +5\text{V}$  and  $T_A = +25^\circ\text{C}$ .) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Thermal Shutdown Threshold	$T_{SHDN}$	Temperature rising		+160		$^\circ\text{C}$
Thermal Shutdown Hysteresis	$T_{HYST}$			12		$^\circ\text{C}$
ESD Protection (A, B Pins to GND)		Human Body Model per JEDEC JS-001-2017		$\pm 40$		kV
		Air-Gap Discharge per IEC 61000-4-2		$\pm 15$		
		Contact Discharge per IEC 61000-4-2		$\pm 10$		
ESD Protection (All Other Pins)		Human Body Model		$\pm 4000$		V
		Charge Device Model		$\pm 2000$		
Fault Protection (A, B Pins to GND)			-25		+25	V
<b>SWITCHING DRIVER (MAX33045E)</b>						
Differential Driver Propagation Delay	$t_{DPLH}, t_{DPLH}$	$R_L = 54\Omega, C_L = 50\text{pF}$ (Figures 2 and 3)			1000	ns
Differential Driver Output Skew $ t_{DPLH} - t_{DPLH} $	$t_{DSKEW}$	$R_L = 54\Omega, C_L = 50\text{pF}$ (Note 4, Figures 2 and 3)			140	ns
Driver Differential Output Rise or Fall Time	$t_{LH}, t_{HL}$	$R_L = 54\Omega, C_L = 50\text{pF}, V_{CC} = V_{CCL}$ (Figures 2 and 3)			600	ns
Maximum Data Rate	$DR_{MAX}$		500			kbps
Driver Enable to Output High	$t_{DZH}$	$R_L = 110\Omega, C_L = 50\text{pF}$ (Figures 4 and 5)			2500	ns
Driver Enable to Output Low	$t_{DZL}$	$R_L = 110\Omega, C_L = 50\text{pF}$ (Figures 4 and 5)			2500	ns
Driver Disable Time from Low	$t_{DLZ}$	$R_L = 110\Omega, C_L = 50\text{pF}$ (Figures 4 and 5)			200	ns
Driver Disable Time from High	$t_{DHZ}$	$R_L = 110\Omega, C_L = 50\text{pF}$ (Figures 4 and 5)			200	ns
Driver Enable Time from Shutdown to Output High	$t_{DZH(SHDN)}$	$R_L = 110\Omega, C_L = 50\text{pF}$ (Note 3, Figures 4 and 5)			170	$\mu\text{s}$
Driver Enable Time from Shutdown to Output Low	$t_{DZL(SHDN)}$	$R_L = 110\Omega, C_L = 50\text{pF}$ (Note 3, Figures 4 and 5)			170	$\mu\text{s}$
Time to Shutdown	$t_{SHDN}$	(Note 3)	50	950	1500	ns
<b>SWITCHING DRIVER (MAX33046E)</b>						
Differential Driver Propagation Delay	$t_{DPLH}, t_{DPLH}$	$R_L = 54\Omega, C_L = 50\text{pF}$ (Figures 2 and 3)			40	ns

( $V_{CC} = 3.0\text{V}$  to  $3.6\text{V}$  and  $V_{CC} = 4.5\text{V}$  to  $5.5\text{V}$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise specified. Typical values are at  $V_{CC} = +5\text{V}$  and  $T_A = +25^\circ\text{C}$ .) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Differential Driver Output Skew $ t_{DPLH} - t_{DPLH} $	$t_{DSKEW}$	$R_L = 54\Omega$ , $C_L = 50\text{pF}$ (Note 4, (Figures 2 and 3))			9	ns
Driver Differential Output Rise or Fall Time	$t_{LH}$ , $t_{HL}$	$R_L = 54\Omega$ , $C_L = 50\text{pF}$ (Figures 2 and 3)		8	15	ns
Maximum Data Rate	$DR_{MAX}$		20			Mbps
Driver Enable to Output High	$t_{DZH}$	$R_L = 110\Omega$ , $C_L = 50\text{pF}$ (Figures 4 and 5)			90	ns
Driver Enable to Output Low	$t_{DZL}$	$R_L = 110\Omega$ , $C_L = 50\text{pF}$ (Figures 4 and 5)			90	ns
Driver Disable Time from Low	$t_{DLZ}$	$R_L = 110\Omega$ , $C_L = 50\text{pF}$ (Figures 4 and 5)			60	ns
Driver Disable Time from High	$t_{DHZ}$	$R_L = 110\Omega$ , $C_L = 50\text{pF}$ (Figures 4 and 5)			60	ns
Driver Enable Time from Shutdown to Output High	$t_{DZH(SHDN)}$	$R_L = 110\Omega$ , $C_L = 50\text{pF}$ (Note 3, Figures 4 and 6)			170	$\mu\text{s}$
Driver Enable Time from Shutdown to Output Low	$t_{DZL(SHDN)}$	$R_L = 110\Omega$ , $C_L = 50\text{pF}$ (Note 3, Figures 4 and 6)			170	$\mu\text{s}$
Time to Shutdown	$t_{SHDN}$	(Note 3)	50	800	1500	ns
<b>SWITCHING RECEIVER (MAX33045E)</b>						
Receiver Propagation Delay	$t_{RPLH}$ , $t_{RPHL}$	$C_L = 15\text{pF}$ (Figures 6 and 7)			200	ns
Receiver Output Skew	$t_{RSKEW}$	$C_L = 15\text{pF}$ (Note 4, Figures 6 and 7)			30	ns
Receiver Enable to Output High	$t_{RZH}$	$R_L = 1\text{k}\Omega$ , $C_L = 15\text{pF}$ (Figure 8)			50	ns
Receiver Enable to Output Low	$t_{RZL}$	$R_L = 1\text{k}\Omega$ , $C_L = 15\text{pF}$ (Figure 8)			50	ns
Receiver Disable Time from Low	$t_{RLZ}$	$R_L = 1\text{k}\Omega$ , $C_L = 15\text{pF}$ (Figure 8)			50	ns
Receiver Disable Time from High	$t_{RHZ}$	$R_L = 1\text{k}\Omega$ , $C_L = 15\text{pF}$ (Figure 8)			50	ns
Receiver Enable from Shutdown to Output Low	$t_{RZL(SHDN)}$	$R_L = 1\text{k}\Omega$ , $C_L = 15\text{pF}$ (Note 3, Figure 8)			170	$\mu\text{s}$
Receiver Enable from Shutdown to Output High	$t_{RZH(SHDN)}$	$R_L = 1\text{k}\Omega$ , $C_L = 15\text{pF}$ (Note 3, Figure 8)			170	$\mu\text{s}$
Time to Shutdown	$t_{SHDN}$	(Note 3)	50	800	1500	ns

( $V_{CC} = 3.0\text{V}$  to  $3.6\text{V}$  and  $V_{CC} = 4.5\text{V}$  to  $5.5\text{V}$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise specified. Typical values are at  $V_{CC} = +5\text{V}$  and  $T_A = +25^\circ\text{C}$ .) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Delay to Fail-Safe Operation	$t_{D\_FS}$			10		$\mu\text{s}$
<b>SWITCHING RECEIVER (MAX33046E)</b>						
Receiver Propagation Delay	$t_{RPLH}, t_{RPHL}$	$C_L = 15\text{pF}$ (Figures 6 and 7)			75	ns
Receiver Output Skew	$t_{RSKEW}$	$C_L = 15\text{pF}$ (Note 4, Figures 6 and 7)			10	ns
Receiver Enable to Output High	$t_{RZH}$	$R_L = 1\text{k}\Omega, C_L = 15\text{pF}$ (Figure 8)			50	ns
Receiver Enable to Output Low	$t_{RZL}$	$R_L = 1\text{k}\Omega, C_L = 15\text{pF}$ (Figure 8)			50	ns
Receiver Disable Time from Low	$t_{RLZ}$	$R_L = 1\text{k}\Omega, C_L = 15\text{pF}$ (Figure 8)			50	ns
Receiver Disable Time from High	$t_{RHZ}$	$R_L = 1\text{k}\Omega, C_L = 15\text{pF}$ (Figure 8)			50	ns
Receiver Enable from Shutdown to Output Low	$t_{RZL(SHDN)}$	$R_L = 1\text{k}\Omega, C_L = 15\text{pF}$ (Note 3, Figure 8)			170	$\mu\text{s}$
Receiver Enable from Shutdown to Output High	$t_{RZH(SHDN)}$	$R_L = 1\text{k}\Omega, C_L = 15\text{pF}$ (Note 3, Figure 8)			170	$\mu\text{s}$
Time to Shutdown	$t_{SHDN}$	(Note 3)	50	800	1500	ns
Delay to Fail-Safe Operation	$t_{D\_FS}$			10		$\mu\text{s}$

**Note 1:** All devices 100% production tested at  $T_A = +25^\circ\text{C}$ . Specifications over temperature are guaranteed by design.

**Note 2:**  $\Delta V_{OD}$  and  $\Delta V_{OC}$  are the changes in  $V_{OD}$  and  $V_{OC}$ , respectively, when DI changes state.

**Note 3:** Shutdown is enabled when  $\overline{RE}$  is high and DE is low. If the enable inputs are in this state for less than 50ns, the device is guaranteed not to enter shutdown. If the enable inputs are held in this state for at least 1500ns, the device is guaranteed to have entered shutdown.

**Note 4:** Capacitive load includes test probe and fixture capacitance.

Timing Diagrams

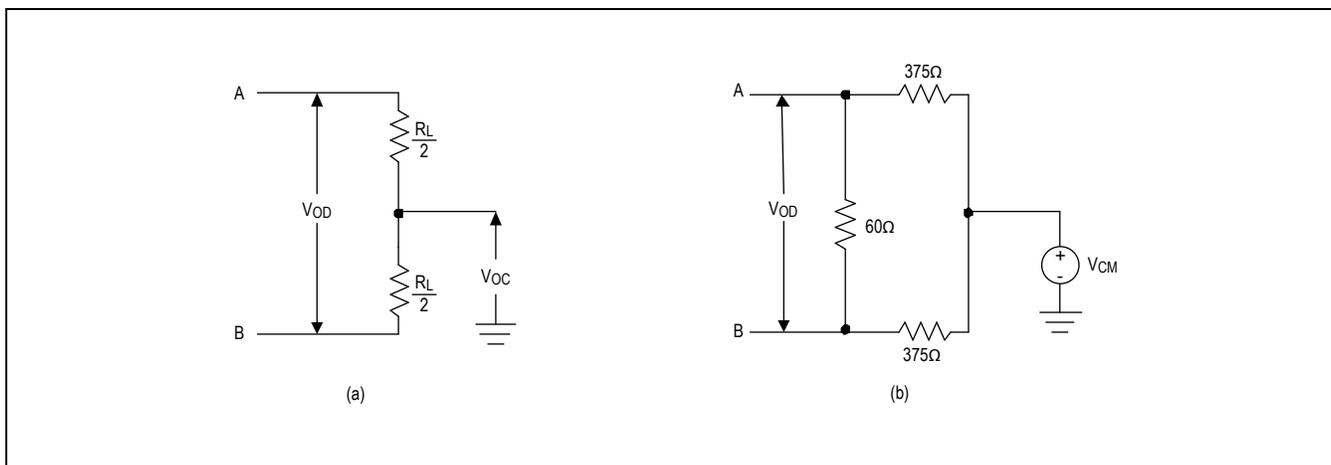


Figure 1. Driver DC Test Load

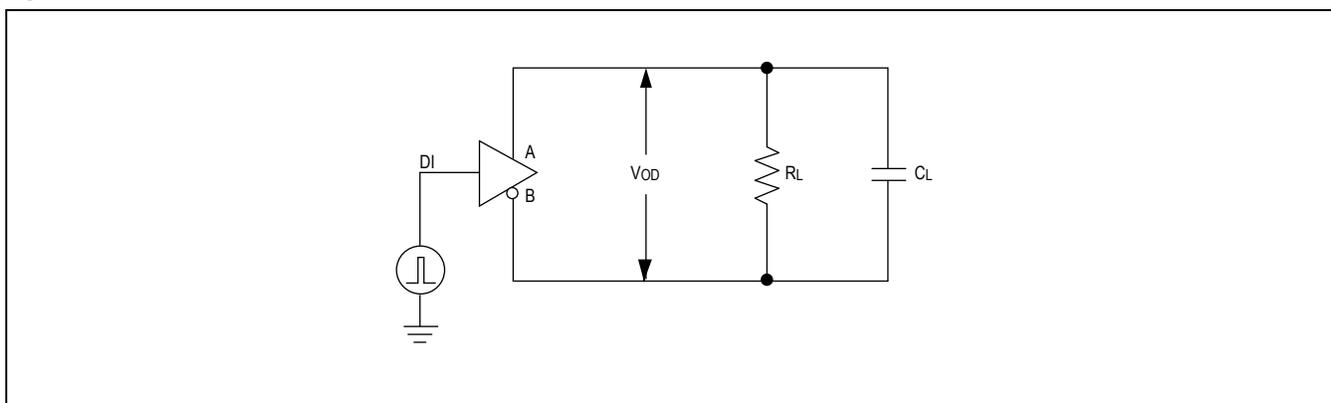


Figure 2. Driver Timer Test Circuit

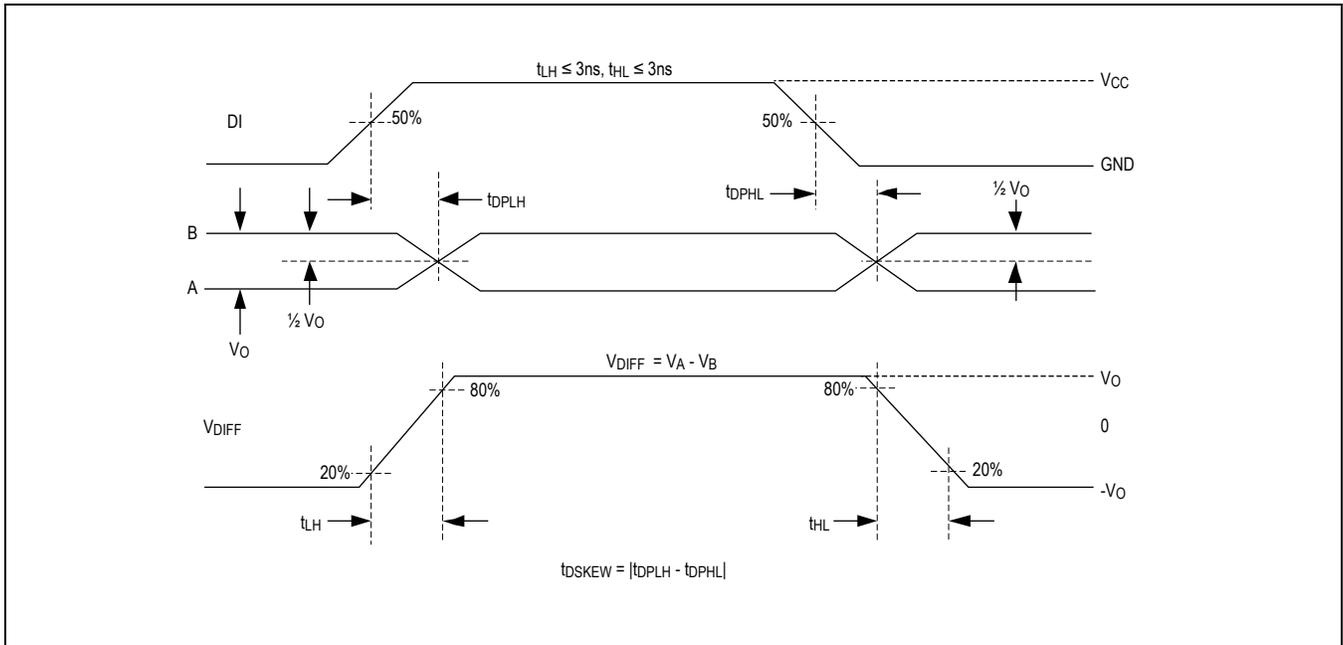


Figure 3. Driver Propagation Delays

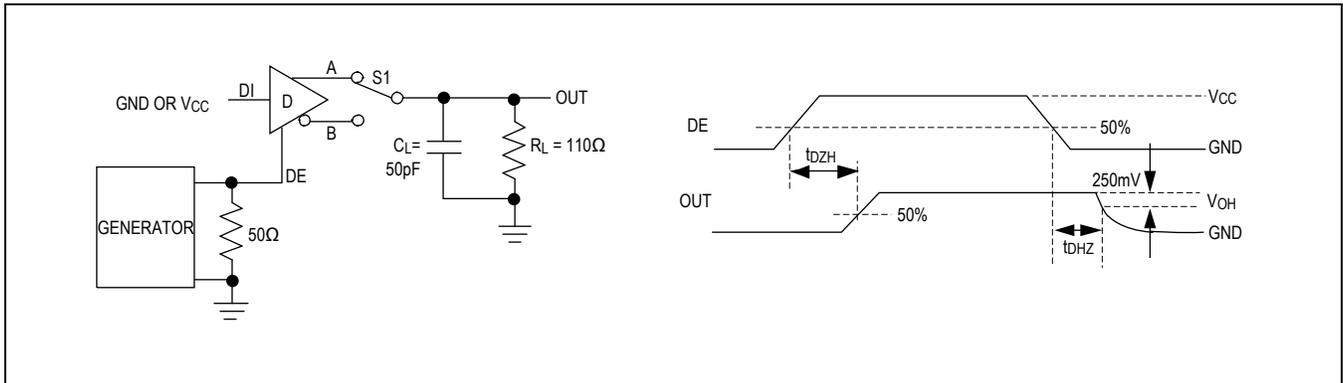


Figure 4. Driver Enable and Disable Times ( $t_{DZH}$ ,  $t_{DZL}$ )

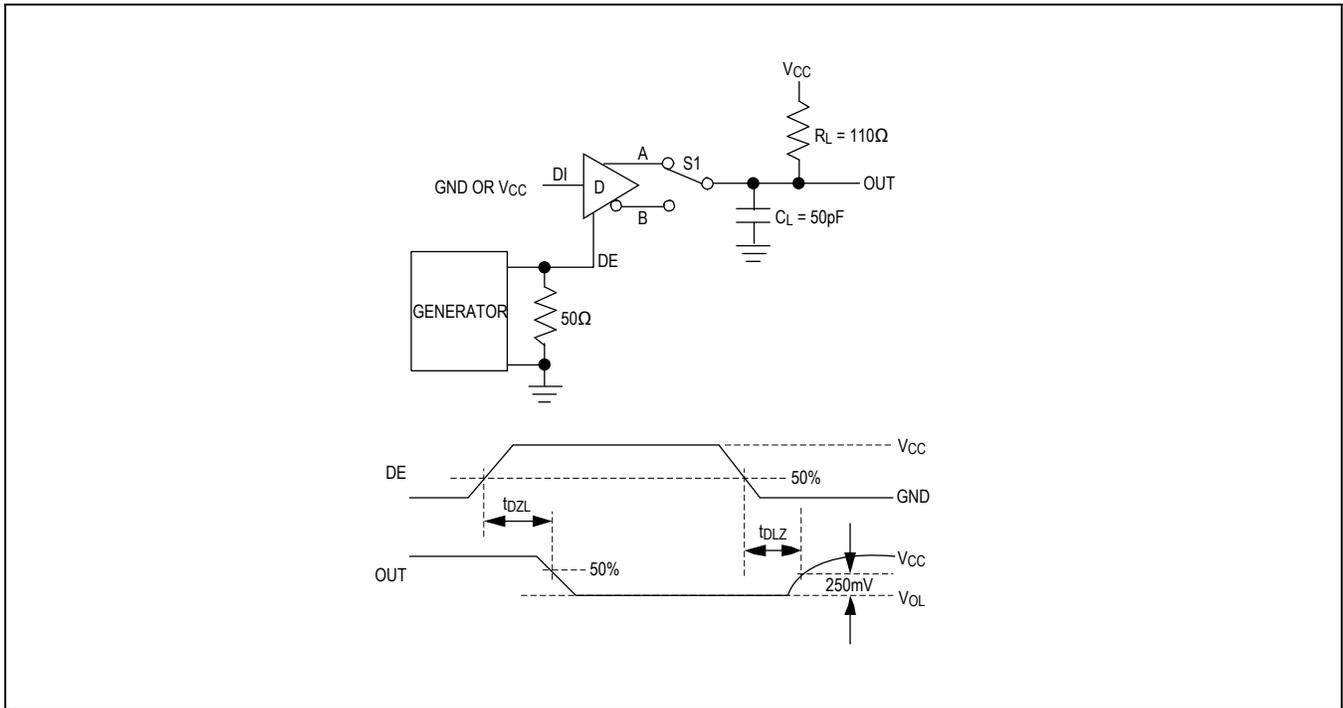


Figure 5. Driver Enable and Disable Times ( $t_{DZ}$ ,  $t_{DLZ}$ )

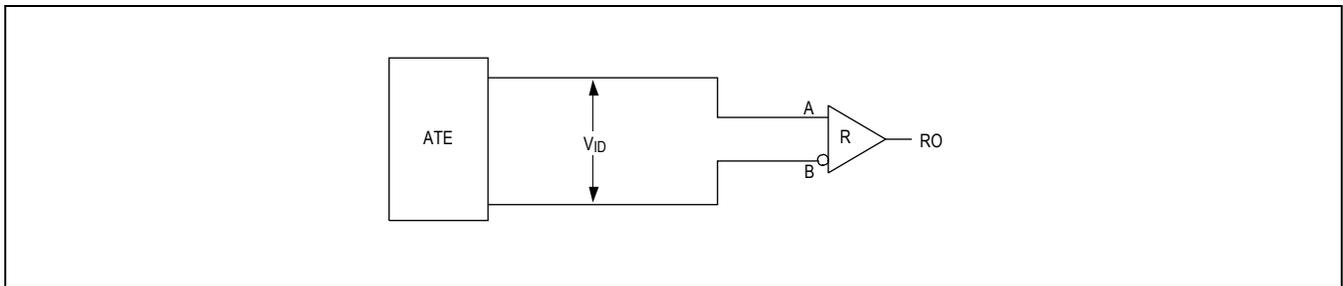


Figure 6. Receiver Propagation Delay Test Circuit

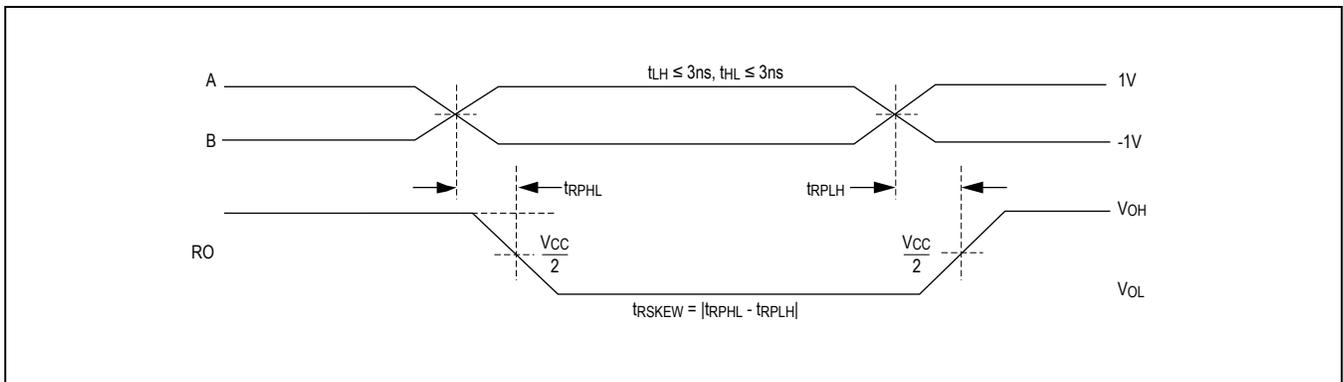


Figure 7. Receiver Propagation Delays

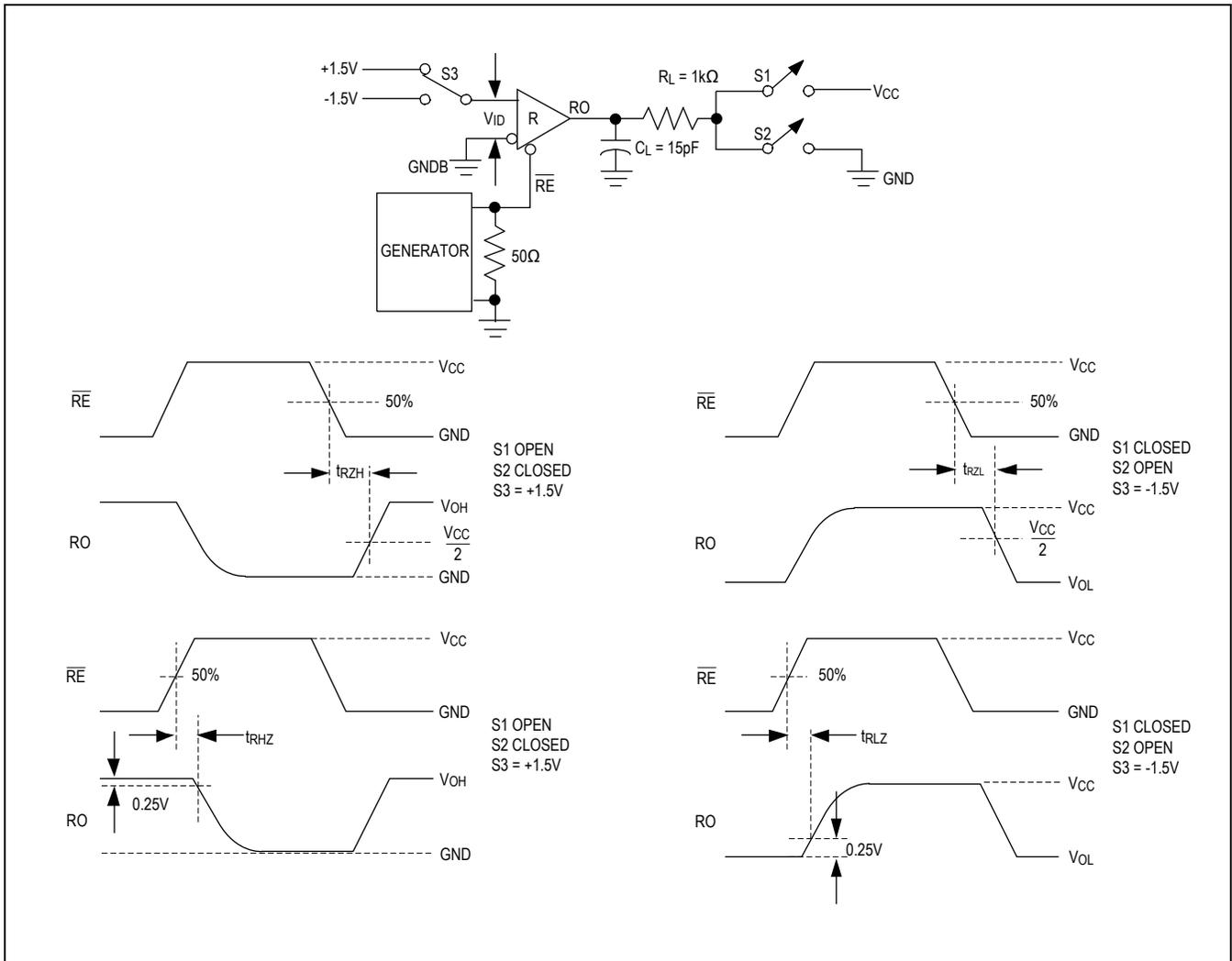
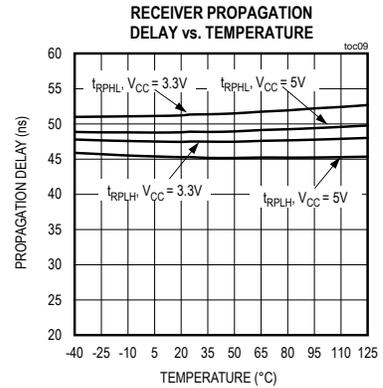
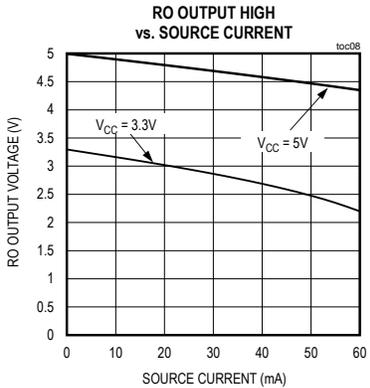
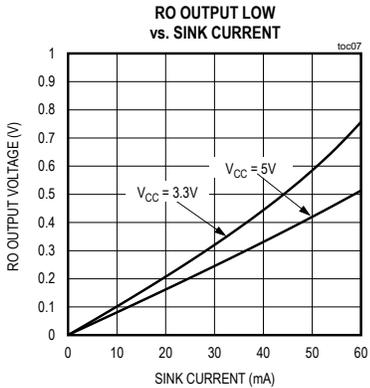
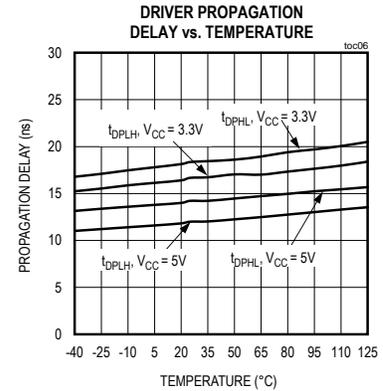
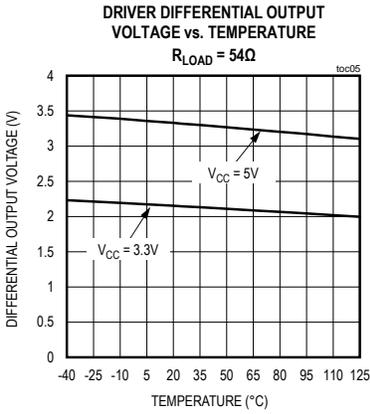
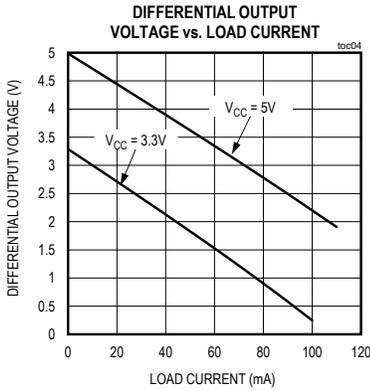
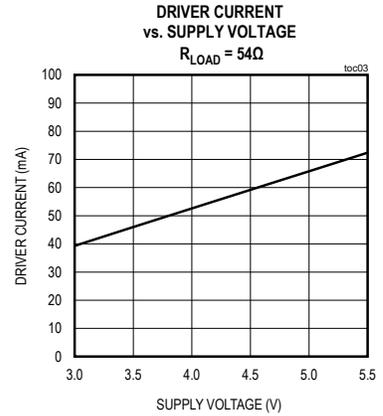
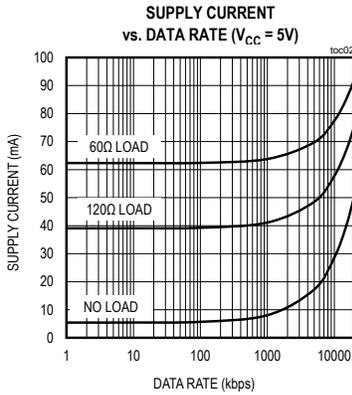
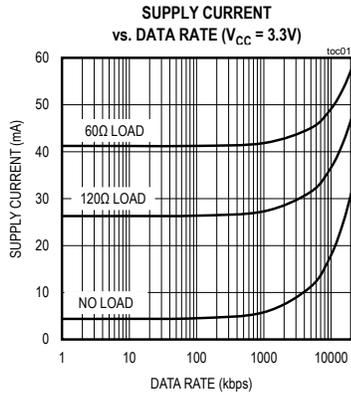
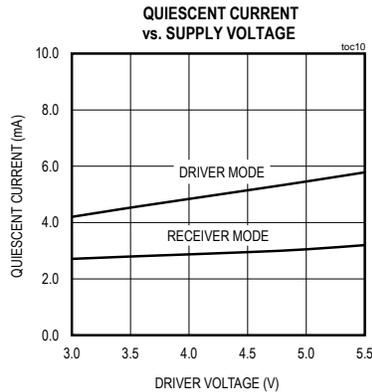


Figure 8. Receiver Enable and Disable Times

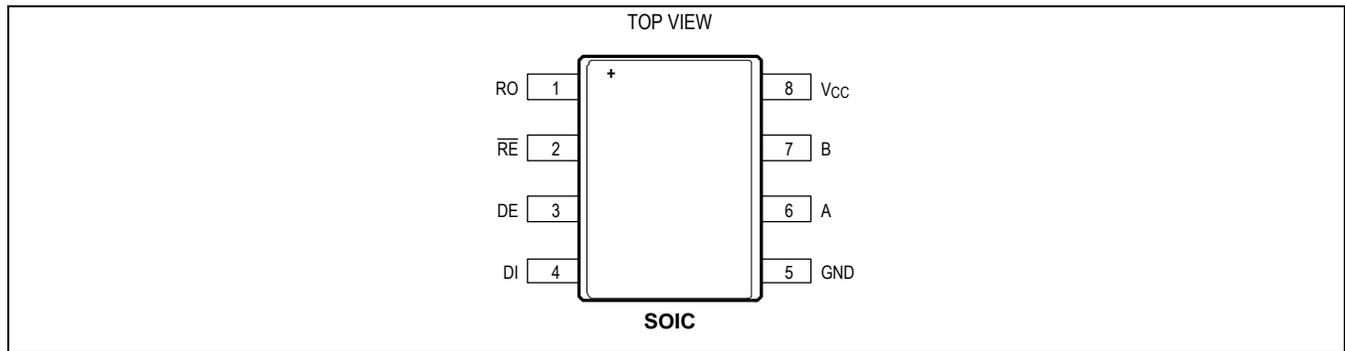
Typical Operating Characteristics

( $V_{CC} = +3.3V/+5V$  and  $T_A = +25^\circ C$ , unless otherwise noted.)





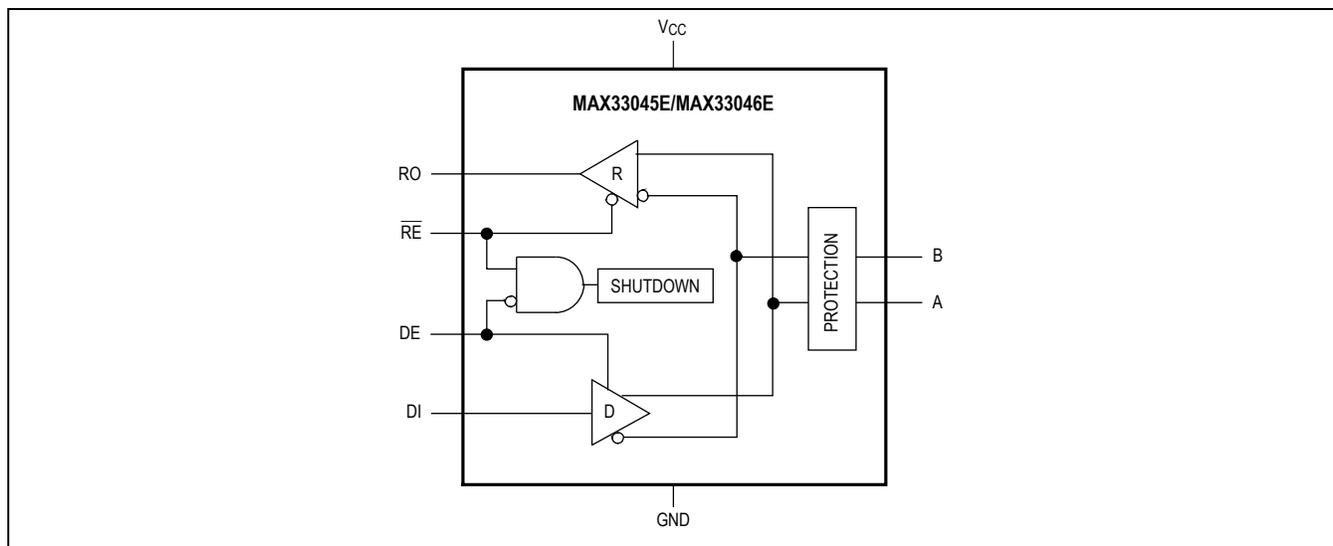
### Pin Configuration



### Pin Descriptions

PIN	NAME	FUNCTION
1	RO	Receiver Data Output. See the Function Table for more information.
2	RE	Receiver Output Enable. Drive RE low or connect to GND to enable RO. Drive RE high to disable the receiver. RO is high impedance when RE is high. Drive RE high and DE low to force the IC into low-power shutdown mode.
3	DE	Driver Output Enable. Drive DE high to enable the driver. Drive DE low or connect to GND to disable the driver.
4	DI	Driver Input. With DE high, a low on DI forces the non-inverting output (A).
5	GND	Ground
6	A	Non-inverting RS-485/RS-422 Receiver Input and Driver Output
7	B	Inverting RS-485/RS-422 Receiver Input and Driver Output
8	VCC	Positive Supply Voltage Input. Bypass VCC with a 0.1µF ceramic capacitor to ground.

Functional Diagram



Detailed Description

The MAX33045E/MAX33046E half-duplex transceivers are optimized for RS-485/RS-422 applications per the EIA/TIA-485 standard. These devices contain one differential driver and one differential receiver. They feature a 1/8-unit load, allowing up to 256 transceivers on a single bus.

The MAX33045E supports data rates up to 500kbps, and the MAX33046E supports data rates up to 20Mbps.

Driver

The driver accepts a single-ended, logic-level input (DI) and transfers it to a differential RS-485/RS-422 level output on the A and B driver outputs. Set the driver enable input (DE) low to disable the driver. A and B are high impedance when the driver is disabled.

RE	DE	DI	A	B
X	1	0	0	1
X	1	1	1	0
0	0	X	High-Z	High-Z
1	0	X	High-Z	High-Z

Receiver

The receiver accepts a differential, RS-485/RS-422 level input on the A and B inputs and transfers it to a single-ended, logic-level output (RO). Drive the receiver enable input (RE) low to enable the receiver. Drive RE high to disable the receiver. RO is high impedance when RE is high.

RE	DE	(VA - VB)	RO
0	X	≥ -50mV	1
0	X	≤ -200mV	0
0	X	Open/short	1
1	1	X	High-Z
1	0	X	High-Z and shutdown

### Fault Protection

These devices feature  $\pm 25\text{V}$  of fault protection. The A/B data lines can withstand a short from  $-25\text{V}$  to  $+25\text{V}$ . This extended overvoltage range makes it suitable for applications where accidental shorts to local power supply lines are possible due to human intervention.

### Low-Power Shutdown

Drive DE low and  $\overline{\text{RE}}$  high for at least 800ns to put the MAX33045E/MAX33046E into low-power shutdown mode. Supply current drops to  $1\mu\text{A}$  when the device is in shutdown mode. A glitch-protection feature ensures that the MAX33045E/MAX33046E will not accidentally enter shutdown mode due to logic skews between DE and  $\overline{\text{RE}}$  when switching between transmit and receive modes.

### Hot-Swap Inputs

Inserting circuit boards into a hot, or powered backplane may cause voltage transients on DE, and receiver inputs A and B that can lead to data errors. For example, upon initial circuit board insertion, the processor undergoes a power-up sequence. During this period, the high-impedance state of the output drivers makes them unable to drive the MAX33045E/MAX33046E DE input to a defined logic level. Meanwhile, leakage currents of up to  $10\mu\text{A}$  from the high-impedance output, or capacitively coupled noise from  $V_{\text{CC}}$  or GND, could cause an input to drift to an incorrect logic state. To prevent such a condition from occurring, the MAX33045E/MAX33046E feature hot-swap input circuitry on DE to safeguard against unwanted driver activation during hot-swap situations. When  $V_{\text{CC}}$  rises, an internal pulldown circuit holds DE low for at least  $10\mu\text{s}$ . After the first transition on DE, the internal pulldown/pullup circuitry becomes transparent, resetting the hot-swap tolerable inputs.

### True Fail-Safe

The MAX33045E/MAX33046E include a true fail-safe feature that ensures the receiver output (RO) is high when the receiver inputs are shorted or open, or when they are connected to a differentially terminated transmission line with all drivers disabled. If the differential receiver input voltage ( $V_A - V_B$ ) is greater than or equal to  $-50\text{mV}$ , RO is logic high.

### Thermal Shutdown Protection

The MAX33045E/MAX33046E feature thermal-shutdown protection circuitry to protect the device. When the internal silicon junction temperature exceeds  $+160^\circ\text{C}$  (typ), the driver outputs are disabled and RO is high impedance. Driver and receiver outputs are re-enabled when the junction temperature falls below  $+148^\circ\text{C}$  (typ).

## Applications Information

### 256 Transceivers on the Bus

The RS-485 standard calls out a single unit load for 32 nodes on a bus. The MAX33045E/MAX33046E have a 1/8 unit load, which enables 256 nodes for applications that require a larger network.

### Driver Output Protection

Two mechanisms prevent excessive output current and power dissipation caused by faults or by bus connection. The first, a current limit on the output stage provides immediate protection against short circuits over the whole common-mode voltage range. The second, a thermal-shutdown circuit, forces the driver outputs into a high-impedance state if the die temperature exceeds  $+160^\circ\text{C}$  (typ).

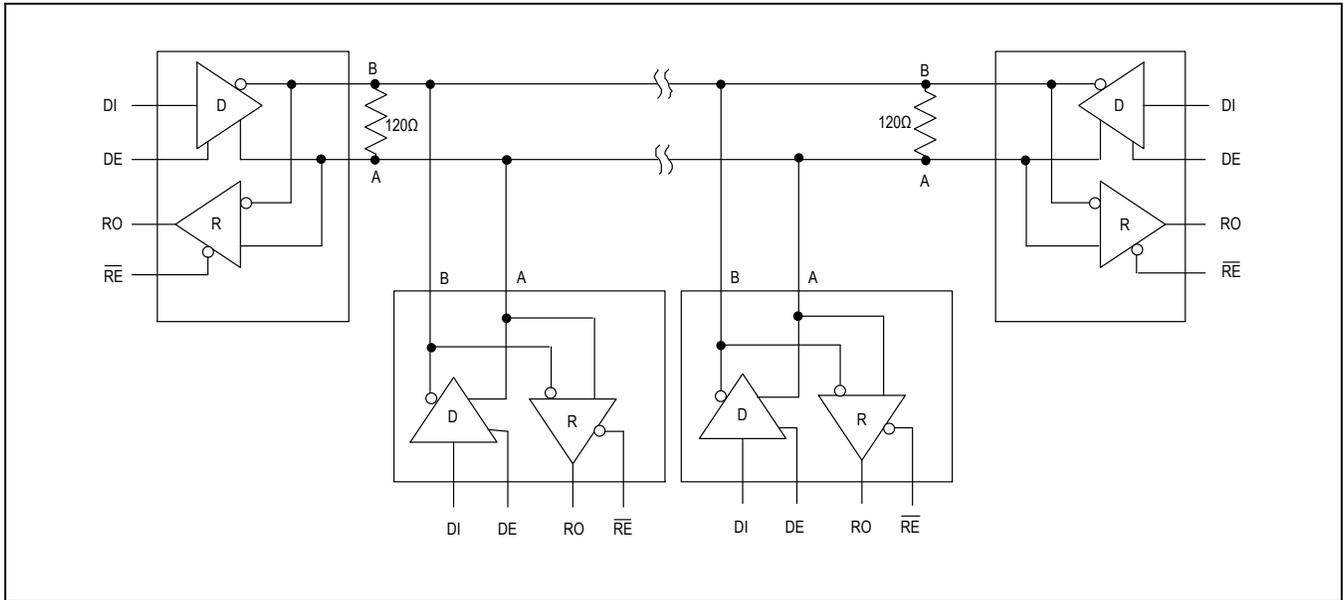
### ESD Protection

ESD protection structures are incorporated on all pins to protect against electrostatic discharge encountered during handling and assembly. The driver outputs and receiver inputs of the MAX33045E/MAX33046E have extra protection against static electricity. The ESD structures withstand high ESD in normal operation and when powered down. After an ESD event, the devices keep working without latchup or damage. ESD protection can be tested in various ways. The transmitter outputs and receiver inputs of the devices are characterized for protection to the cable-side ground to the following limits:

- $\pm 40\text{kV}$  Human Body Model (HBM) per JEDEC JS-001-2017
- $\pm 15\text{kV}$  using the Air-Gap Discharge method specified in the IEC 61000-4-2
- $\pm 10\text{kV}$  using the Contact Discharge method specified in the IEC 61000-4-2

**Typical Application Circuit**

The MAX33045E/MAX33046E transceivers are designed for bidirectional data communications on multipoint bus transmission lines. As seen in the following typical network application circuit, to minimize reflections, terminate the line at both ends with its characteristic impedance and keep stub lengths off the main line as short as possible.



**Ordering Information**

PART NUMBER	TEMP RANGE	PIN-PACKAGE	DATA RANGE	NODES
MAX33045EASA+*	-40°C to +125°C	8 SOIC	500kbps	256
MAX33045EASA+T*	-40°C to +125°C	8 SOIC	500kbps	256
MAX33046EASA+	-40°C to +125°C	8 SOIC	20Mbps	256
MAX33046EASA+T	-40°C to +125°C	8 SOIC	20Mbps	256

\*Future product—contact factory for availability.

MAX33045E/MAX33046E

20Mbps, Half-Duplex RS-485/RS-422  
Transceivers with  $\pm 40\text{kV}$  ESD Protection

## Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	3/21	Initial release	—

For pricing, delivery, and ordering information, please visit Maxim Integrated's online storefront at <https://www.maximintegrated.com/en/storefront/storefront.html>.

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