



# +5.0V, ±15kV ESD-Protected, Half-Duplex/ Full-Duplex, RS-485 Transceiver in $\mu$ DFN

## General Description

The MAX13181E–MAX13184E are full-duplex and selectable half/full-duplex RS-485 transceivers in a tiny 2mm x 2mm  $\mu$ DFN package. These devices are designed for space-constrained applications by including extended ESD protection to  $\pm 15\text{kV}$  per Human Body Model (HBM) and integrating pullup/pulldown resistors on the DE,  $\overline{\text{RE}}$  and H/ $\overline{\text{F}}$  inputs to reduce external components. The MAX13182E/MAX13184E feature a low-current shutdown mode for power-sensitive applications.

These devices have a 1/8 unit-load input receiver that allows up to 256 transceivers on the bus. The MAX13181E/MAX13182E feature reduced slew-rate drivers to minimize EMI and reflections that are caused by improperly terminated cables. The slew-rate limited MAX13181E/MAX13182E allow error-free data transmission up to 250kbps. The MAX13183E/MAX13184E feature full-speed drivers, allowing data rates of up to 16Mbps. The MAX13182E/MAX13184E are configured for full-duplex operation, while the MAX13181E/MAX13183E feature pin-selectable half- or full-duplex operation. All driver outputs and receiver inputs include extended ESD protection.

The MAX13181E–MAX13184E are available in a tiny 10-pin, 2mm x 2mm  $\mu$ DFN. The MAX13183E/MAX13184E are also available in industry-standard 14-pin SO packages. The devices operate over the extended  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  temperature range.

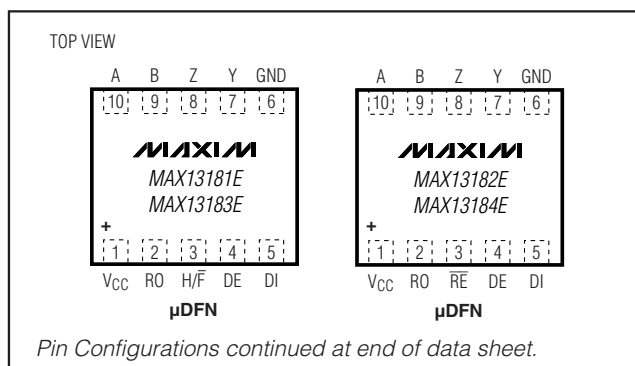
## Applications

Industrial Control	Security System
Motor Drive Control	Instrumentation
Telecom	

## Features

- ◆ Available in Tiny, 10-Pin, 2mm x 2mm,  $\mu$ DFN and 14-Pin SO Packages
- ◆ +5.0V Operation
- ◆ Extended ESD Protection
  - $\pm 15\text{kV}$  Human Body Model
  - $\pm 12\text{kV}$  IEC 61000-4-2 Air-Gap Discharge
  - $\pm 6\text{kV}$  IEC 61000-4-2 Contact Discharge
- ◆ Slew-Rate Limiting Facilitates Error-Free Data Transmission (MAX13181E/MAX13182E)
- ◆ 2.5 $\mu\text{A}$  (typ) Low-Current Shutdown Mode
- ◆ 1/8-Unit Load Allows Up to 256 Transceivers on the Bus

## Pin Configurations



## Selector Guide

PART	HALF/FULL DUPLEX	MAXIMUM DATA RATE	SLEW-RATE LIMITED	LOW-POWER SHUTDOWN	RECEIVER ENABLE
MAX13181E	Selectable	250 kbps	Yes	No	No
MAX13182E	Full	250 kbps	Yes	Yes	Yes
MAX13183E	Selectable	16 Mbps	No	No	No
MAX13184E	Full	16 Mbps	No	Yes	Yes

## Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK	PKG CODE
MAX13181EELB+	$-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$	10 $\mu$ DFN	ABC	L1022-1
MAX13182EELB+	$-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$	10 $\mu$ DFN	ABD	L1022-1
MAX13182EESD+	$-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$	14 SO	—	S14-1

+Denotes a lead-free package.

Ordering Information continued at end of data sheet.



Maxim Integrated Products 1

For pricing delivery, and ordering information please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at [www.maxim-ic.com](http://www.maxim-ic.com).

MAX13181E-MAX13184E

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## ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND.)

Supply Voltage ( $V_{CC}$ )	-0.3V to +6V
Control Voltage ( $\overline{RE}$ , DE, DI, H/ $\overline{F}$ )	-0.3V to +6V
Driver Output Voltage (A, B, Y, Z)	-8V to +12.5V
Receiver Input Voltage (A, B)	-8V to +12.5V
Receiver Input Voltage Full-Duplex (A, B)	-8V to +12.5V
Receiver Output Voltage (RO)	-0.3V to ( $V_{CC} + 0.3V$ )
Short-Circuit Duration (A, B, Y, Z) to GND	Continuous

Continuous Power Dissipation ( $T_A = +70^\circ\text{C}$ )

10-Pin $\mu$ DFN (derate 5mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$ )	403mW
14-Pin SO (derate 8.3mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$ )	667mW
Operating Temperature Range	-40 $^\circ\text{C}$ to +85 $^\circ\text{C}$
Storage Temperature Range	-65 $^\circ\text{C}$ to +150 $^\circ\text{C}$
Junction Temperature	+150 $^\circ\text{C}$
Lead Temperature (soldering, 10s)	+300 $^\circ\text{C}$

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.

## DC ELECTRICAL CHARACTERISTICS

( $V_{CC} = +5V \pm 10\%$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $V_{CC} = +5V$  and  $T_A = +25^\circ\text{C}$ .) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>DRIVER</b>						
Differential Driver Output	$V_{OD}$	$R_L = 100\Omega$ (RS422), Figure 1	2		$V_{CC}$	V
		$R_L = 54\Omega$ (RS485), Figure 1	1.5		$V_{CC}$	V
		No load			$V_{CC}$	
Change in Magnitude of Differential Output Voltage	$\Delta V_{OD}$	$R_L = 100\Omega$ or $54\Omega$ , Figure 1, (Note 2)			0.2	V
Driver Common-Mode Output Voltage	$V_{OC}$	$R_L = 100\Omega$ or $54\Omega$ , Figure 1		$V_{CC}/2$	3	V
Change in Magnitude of Common-Mode Voltage	$\Delta V_{OC}$	$R_L = 100\Omega$ or $54\Omega$ , Figure 1, (Note 2)			0.2	V
Input-High Voltage	$V_{IH}$	DE, DI, $\overline{RE}$ , H/ $\overline{F}$	2			V
Input-Low Voltage	$V_{IL}$	DE, DI, $\overline{RE}$ , H/ $\overline{F}$			0.8	V
Input Hysteresis	$V_{HYS}$	DE, DI, $\overline{RE}$ , H/ $\overline{F}$		100		mV
Internal Pullup Resistance	$R_{IN\_UP}$	Internal pullup $\overline{RE}$	125		400	k $\Omega$
Internal Pulldown Resistance	$R_{IN\_DWN}$	Internal pulldown DE, H/ $\overline{F}$	125		400	k $\Omega$
Output Leakage (Y and Z) Full-Duplex	$I_O$	DE = GND, $V_{CC} = \text{GND}$ or 5.5V	$V_{IN} = +12V$		125	$\mu\text{A}$
			$V_{IN} = -7V$	-100		
Driver Short-Circuit Output Current Threshold (Note 3)	$I_{OSD}$	$0 \leq V_{OUT} \leq 12V$	40		250	mA
		$-7 \leq V_{OUT} \leq V_{CC}$	-250		-40	
Driver Short-Circuit Foldback Output Current (Note 3)	$I_{OSDF}$	$(V_{CC} - 1V) \leq V_{OUT} \leq 12V$	20			mA
		$-7V \leq V_{OUT} \leq 1V$			-20	
Thermal-Shutdown Threshold	$T_{TS}$	$0 \leq V_{OUT} \leq 12V$		140		$^\circ\text{C}$
Thermal-Shutdown Hysteresis	$T_{TSH}$			15		$^\circ\text{C}$
Input Current (A and B)	$I_{A, B}$	DE = GND, $V_{CC} = \text{GND}$ or 5.5V	$V_{IN} = +12V$		125	$\mu\text{A}$
			$V_{IN} = -7V$	-100		

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**MAX13181E-MAX13184E**

## DC ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = +5V \pm 10\%$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $V_{CC} = +5V$  and  $T_A = +25^\circ C$ .) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>RECEIVER</b>						
Receiver Differential Threshold Voltage	$V_{TH}$	$-7V \leq V_{CM} \leq +12V$ , Figure 2	-200	0	+200	mV
Receiver Input Hysteresis	$V_{TH}$	$V_A + V_B = 0$ , Figure 2		25		mV
RO Output-High Voltage	$V_{OH}$	$I_O = -1mA$ , Figure 2	$V_{CC} - 0.6$			V
RO Output-Low Voltage	$V_{OL}$	$I_O = 1mA$ , Figure 2			0.4	V
Tri-State Output Current at Receiver	$I_{OZR}$	$0 \leq V_O \leq V_{CC}$ , Figure 2	-1		+1	$\mu A$
Receiver-Input Resistance	$R_{IN}$	$-7V \leq V_{CM} \leq +12V$ , Figure 2	96			$k\Omega$
Receiver-Output Short-Circuit Current	$I_{OSR}$	$0 \leq V_{RO} \leq V_{CC}$ , Figure 2	-80		+80	mA
<b>SUPPLY CURRENT</b>						
Supply Current	$I_{CC}$	No load, $\overline{RE} = 0$ , $DE = V_{CC}$		2	3	mA
		No load, $\overline{RE} = V_{CC}$ , $DE = V_{CC}$		2	3	
		No load, $\overline{RE} = 0V$ , $DE = 0$ or leave unconnected		2	3	
Shutdown Current (MAX13182E/MAX13184E Only)	$I_{SHDN}$	$\overline{RE} = V_{CC}$ or leave unconnected, $DE = GND$ or leave unconnected		2.5	10	$\mu A$
<b>ESD PROTECTION</b>						
ESD Protection for Y, Z, A and B		Human Body Model		$\pm 15$		kV
		IEC 61000-4-2 Contact Discharge		$\pm 6$		
		IEC 61000-4-2 Air-Gap Discharge		$\pm 12$		

## DRIVER SWITCHING CHARACTERISTICS—MAX13181E/MAX13182E (SLEW-RATE LIMITED TO 250kbps)

( $V_{CC} = +5V \pm 10\%$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $V_{CC} = +5V$  and  $T_A = +25^\circ C$ .) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Propagation Delay	$t_{DPLH}$	$C_L = 50pF$ , $R_L = 54\Omega$ , Figure 3	200		1000	ns
	$t_{DPLH}$	$C_L = 50pF$ , $R_L = 54\Omega$ , Figure 3	200		1000	
Driver Differential Output Rise or Fall Time	$t_{DR}$ , $t_{DF}$	$C_L = 50pF$ , $R_L = 54\Omega$ , Figure 3	400		1200	ns
Differential Driver Output Skew ( $t_{DPLH} - t_{DPLH}$ )	$t_{DSKEW}$	$C_L = 50pF$ , $R_L = 54\Omega$ , Figure 3			140	ns
Maximum Data Rate			250			kbps
Driver Enable to Output High	$t_{DZH}$	Figure 4a			2500	ns
Driver Enable to Output Low	$t_{DZL}$	Figure 4b			2500	ns
Driver Disable Time from Low	$t_{DLZ}$	Figure 4b			100	ns
Driver Disable Time from High	$t_{DHZ}$	Figure 4a			100	ns
Driver Enable from Shutdown to Output High	$t_{DZH(SHDN)}$	(MAX13182E) Figure 4a			5500	ns
Driver Enable from Shutdown to Output Low	$t_{DZL(SHDN)}$	(MAX13182E) Figure 4b			5500	ns
Time to Shutdown	$t_{SHDN}$	(MAX13182E)	50	200	600	ns

# +5.0V, ±15kV ESD-Protected, Half-Duplex/ Full-Duplex, RS-485 Transceiver in $\mu$ DFN

## DRIVER SWITCHING CHARACTERISTICS—MAX13183E/MAX13184E (MAXIMUM DATA RATE OF 16Mbps)

( $V_{CC} = +5V \pm 10\%$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $V_{CC} = +5V$  and  $T_A = +25^\circ C$ .) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Propagation Delay	$t_{DPLH}$	$C_L = 50pF$ , $R_L = 54\Omega$ , Figure 3			25	ns
	$t_{DPLH}$	$C_L = 50pF$ , $R_L = 54\Omega$ , Figure 3			25	
Driver Differential Output Rise or Fall Time	$t_{DR}$ , $t_{DF}$	$C_L = 50pF$ , $R_L = 54\Omega$ , Figure 3			15	ns
Differential Driver Output Skew ( $t_{DPLH} - t_{DPLH}$ )	$t_{DSKEW}$	$C_L = 50pF$ , $R_L = 54\Omega$ , Figure 3			8	ns
Maximum Data Rate			16			Mbps
Driver Enable to Output-High	$t_{DZH}$	Figures 1 and 4a			50	ns
Driver Enable to Output-Low	$t_{DZL}$	Figures 1 and 4b			50	ns
Driver Disable Time from Low	$t_{DLZ}$	Figures 1 and 4b			50	ns
Driver Disable Time from High	$t_{DHZ}$	Figures 1 and 4a			50	ns
Driver Enable from Shutdown to Output High	$t_{DZH} (SHDN)$	Figures 1 and 4a (MAX13184E)			2200	ns
Driver Enable from Shutdown to Output Low	$t_{DZL} (SHDN)$	Figures 1 and 4b (MAX13184E)			2200	ns
Time to Shutdown	$t_{SHDN}$	(MAX13184E)	50	200	600	ns

## RECEIVER SWITCHING CHARACTERISTICS

( $V_{CC} = +5V \pm 10\%$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $V_{CC} = +5V$  and  $T_A = +25^\circ C$ .) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Receiver Propagation Delay	$t_{RPLH}$	$C_L = 15pF$ , Figure 5		40	75	ns
	$t_{RPHL}$			40	75	
Receiver Output Skew ( $t_{RPLH} - t_{RPHL}$ )	$t_{RSKEW}$	$C_L = 15pF$ , Figure 5			8	ns
Maximum Data Rate			16			Mbps
Receiver Enable to Output Low	$t_{RZL}$	(MAX13182E/MAX13184E) Figures 2 and 6			50	ns
Receiver Enable to Output High	$t_{RZH}$	(MAX13182E/MAX13184E) Figures 2 and 6			50	ns
Receiver Disable Time from Low	$t_{RLZ}$	(MAX13182E/MAX13184E) Figures 2 and 6			50	ns
Receiver Disable Time from High	$t_{RHZ}$	(MAX13182E/MAX13184E) Figures 2 and 6			50	ns
Receiver Enable from Shutdown to Output High	$t_{RZH} (SHDN)$	(MAX13182E/MAX13184E) Figures 2 and 6			2200	ns
Receiver Enable from Shutdown to Output Low	$t_{RZL} (SHDN)$	(MAX13182E/MAX13184E) Figures 2 and 6			2200	ns

**Note 1:** All currents into the device are positive. All currents out of the device are negative. All voltages are referred to device ground, unless otherwise noted.  $\mu$ DFN devices are production tested at  $+25^\circ C$ . Overtemperature limits are guaranteed by design.

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

**Note 3:** The short-circuit output current applies to peak current just prior to foldback current limiting. The short-circuit foldback output current applies during current limiting to allow a recovery from bus contention.

# +5.0V, ±15kV ESD-Protected, Half-Duplex/ Full-Duplex, RS-485 Transceiver in $\mu$ DFN

**MAX13181E-MAX13184E**

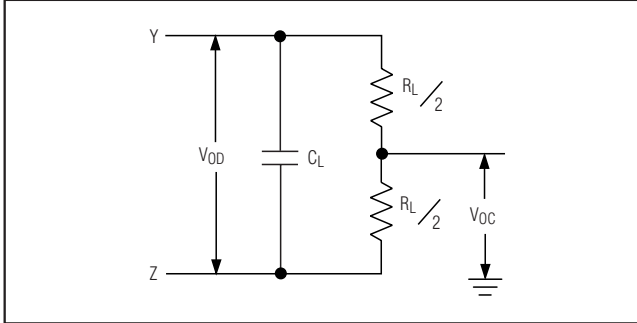


Figure 1. Driver Differential Output

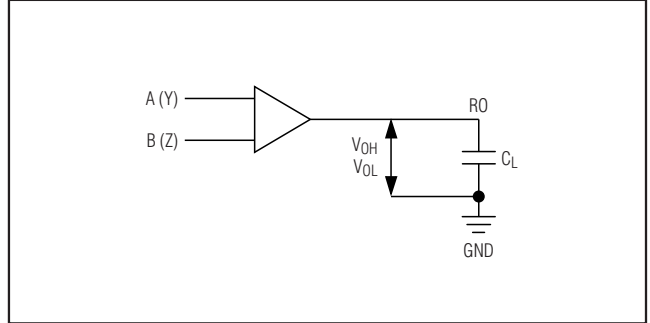


Figure 2. Receiver Differential Input

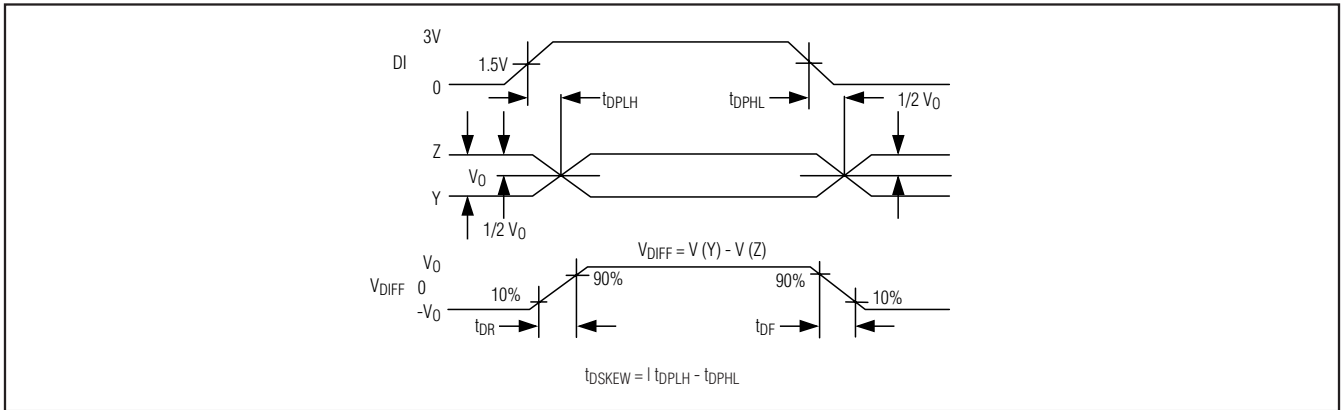


Figure 3. Driver Propagation Delay

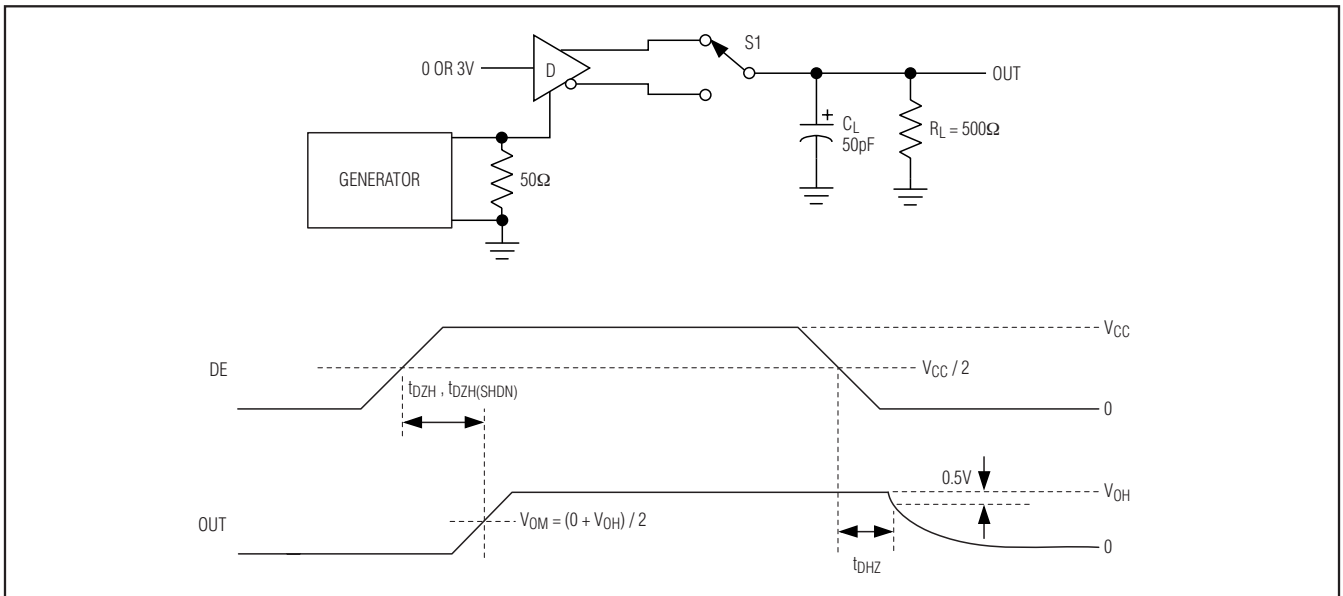


Figure 4a. Driver Enable and Disable Times ( $t_{DZH}$ ,  $t_{DZH(SHDN)}$ ,  $t_{DHZ}$ )

**+5.0V, ±15kV ESD-Protected, Half-Duplex/  
Full-Duplex, RS-485 Transceiver in μDFN**

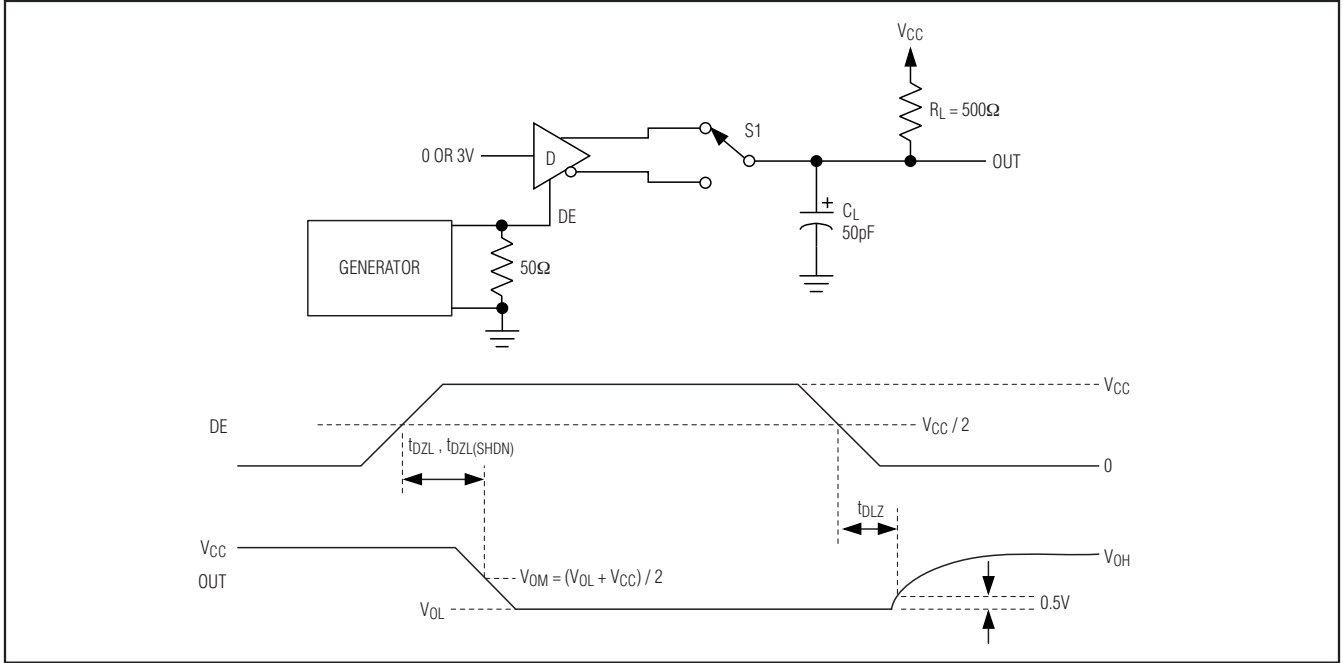


Figure 4b. Driver Enable and Disable Times ( $t_{DLZ}$ ,  $t_{DZL}$ ,  $t_{DZL(SHDN)}$ )

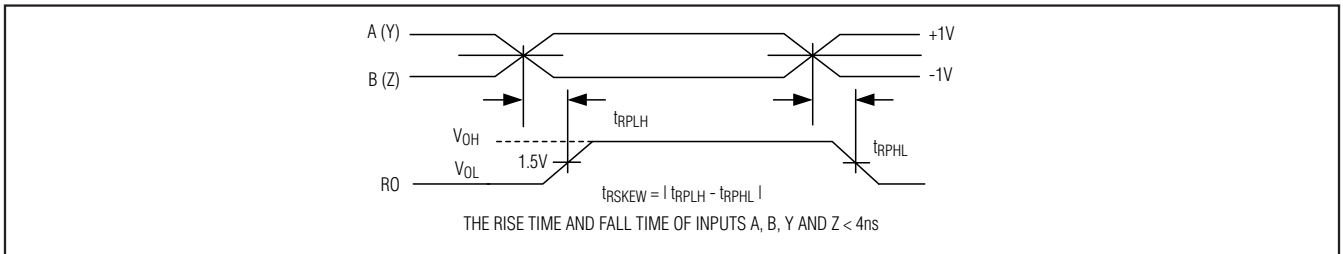


Figure 5. Receiver Propagation Delay

# +5.0V, ±15kV ESD-Protected, Half-Duplex/ Full-Duplex, RS-485 Transceiver in $\mu$ DFN

MAX13181E-MAX13184E

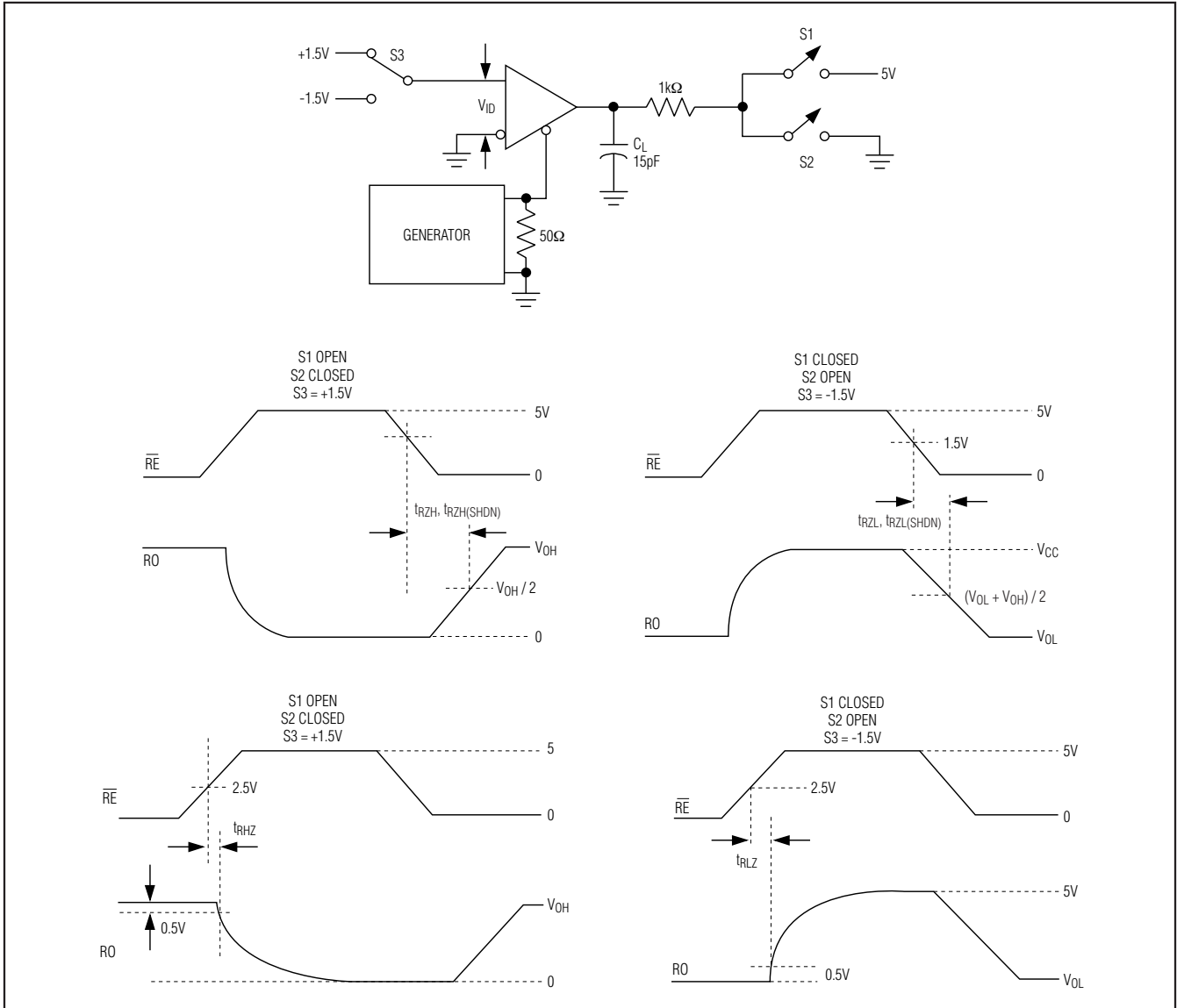
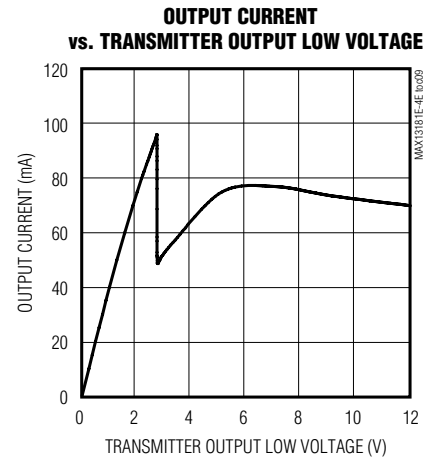
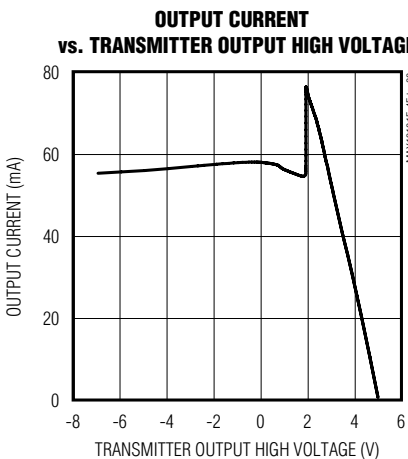
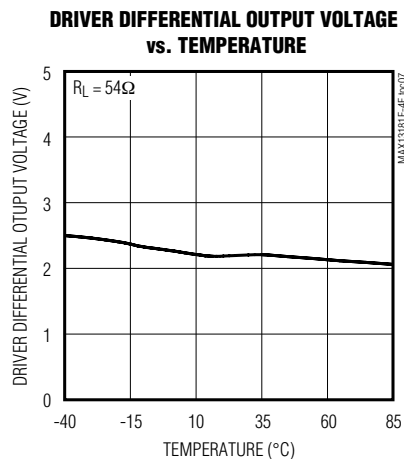
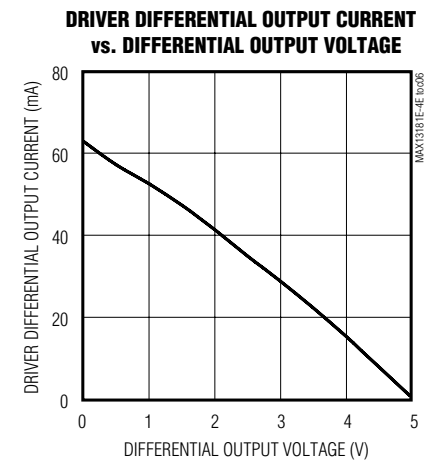
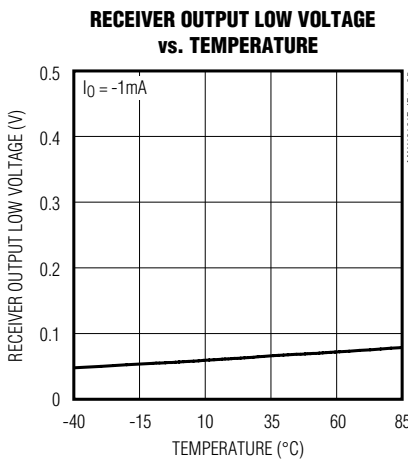
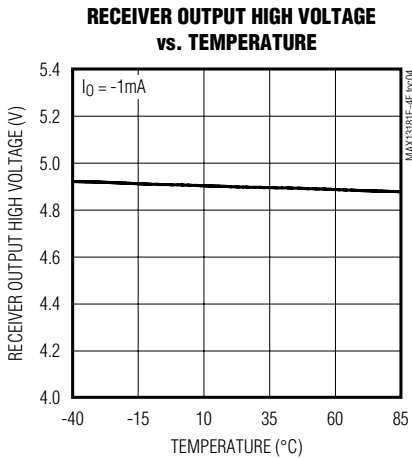
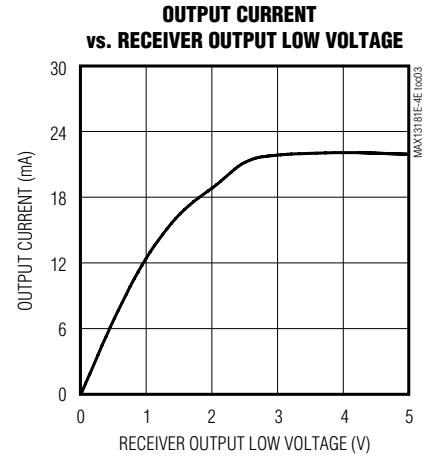
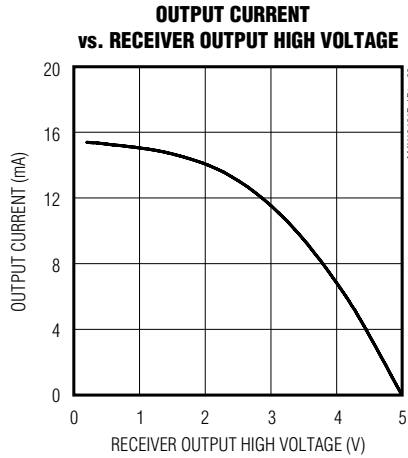
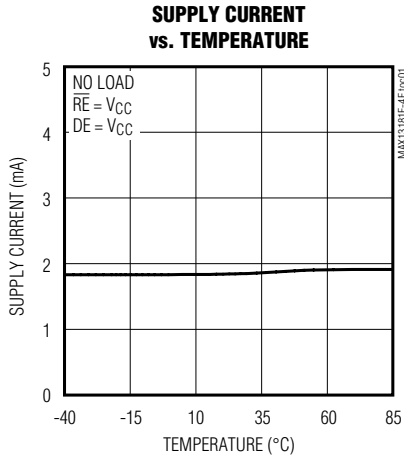


Figure 6. Receiver Disable Time

# +5.0V, ±15kV ESD-Protected, Half-Duplex/ Full-Duplex, RS-485 Transceiver in $\mu$ DFN

## Typical Operating Characteristics

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





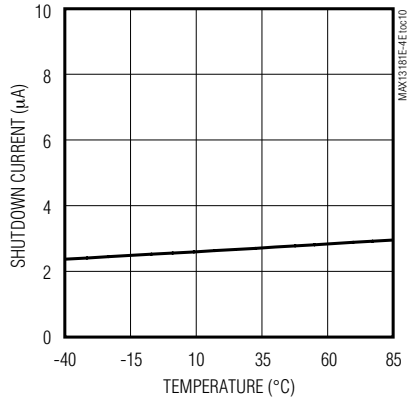
# +5.0V, ±15kV ESD-Protected, Half-Duplex/ Full-Duplex, RS-485 Transceiver in $\mu$ DFN

## Typical Operating Characteristics (continued)

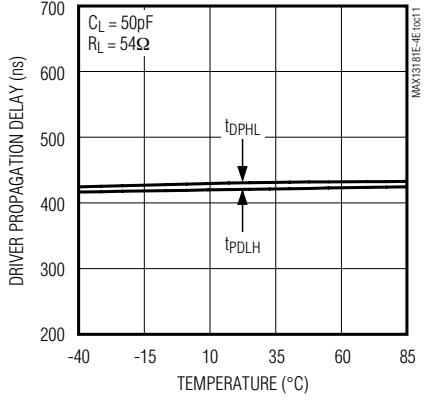
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MAX13181E-MAX13184E

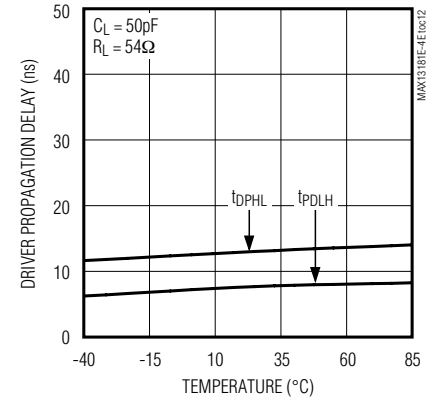
**SHUTDOWN CURRENT vs. TEMPERATURE**



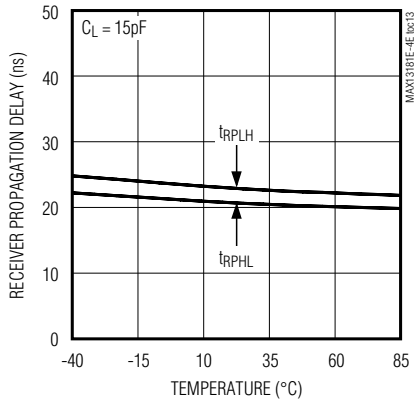
**DRIVER PROPAGATION DELAY vs. TEMPERATURE (250kbps) (MAX13182E)**



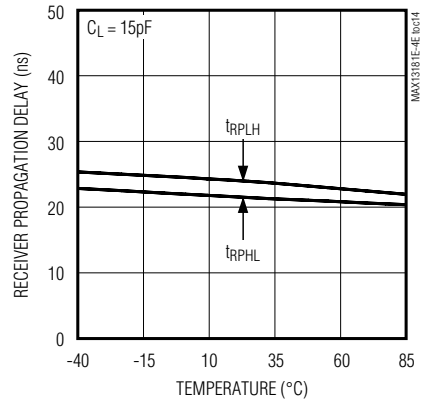
**DRIVER PROPAGATION DELAY vs. TEMPERATURE (16Mbps) (MAX13184E)**



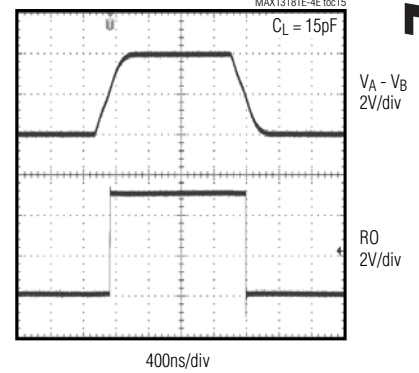
**RECEIVER PROPAGATION DELAY vs. TEMPERATURE (250kbps) (MAX13182E)**



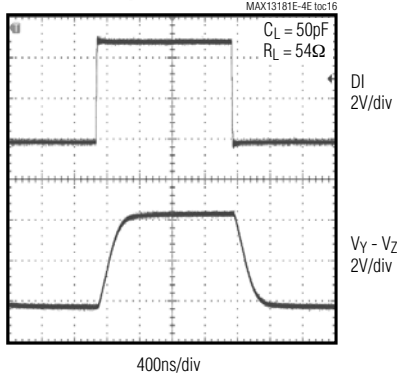
**RECEIVER PROPAGATION DELAY vs. TEMPERATURE (16Mbps) (MAX13184E)**



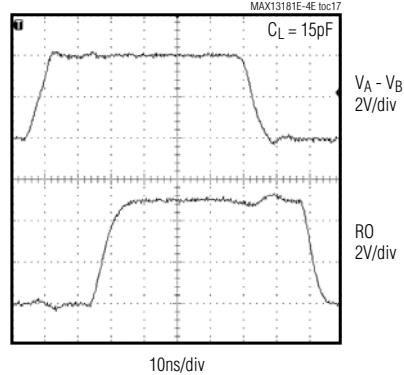
**RECEIVER PROPAGATION DELAY (250kbps) (MAX13182E)**



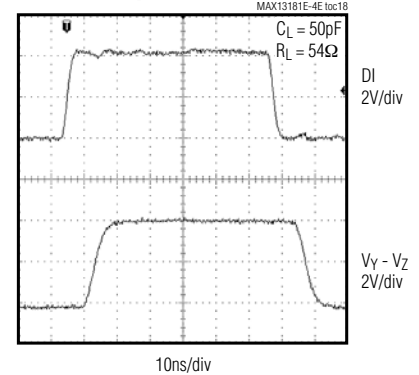
**DRIVER PROPAGATION DELAY (250kbps) (MAX13182E)**



**RECEIVER PROPAGATION DELAY (16Mbps) (MAX13184E)**



**DRIVER PROPAGATION DELAY (16Mbps) (MAX13184E)**



# +5.0V, ±15kV ESD-Protected, Half-Duplex/ Full-Duplex, RS-485 Transceiver in $\mu$ DFN

## Functional Tables

**MAX13182E/MAX13184E**

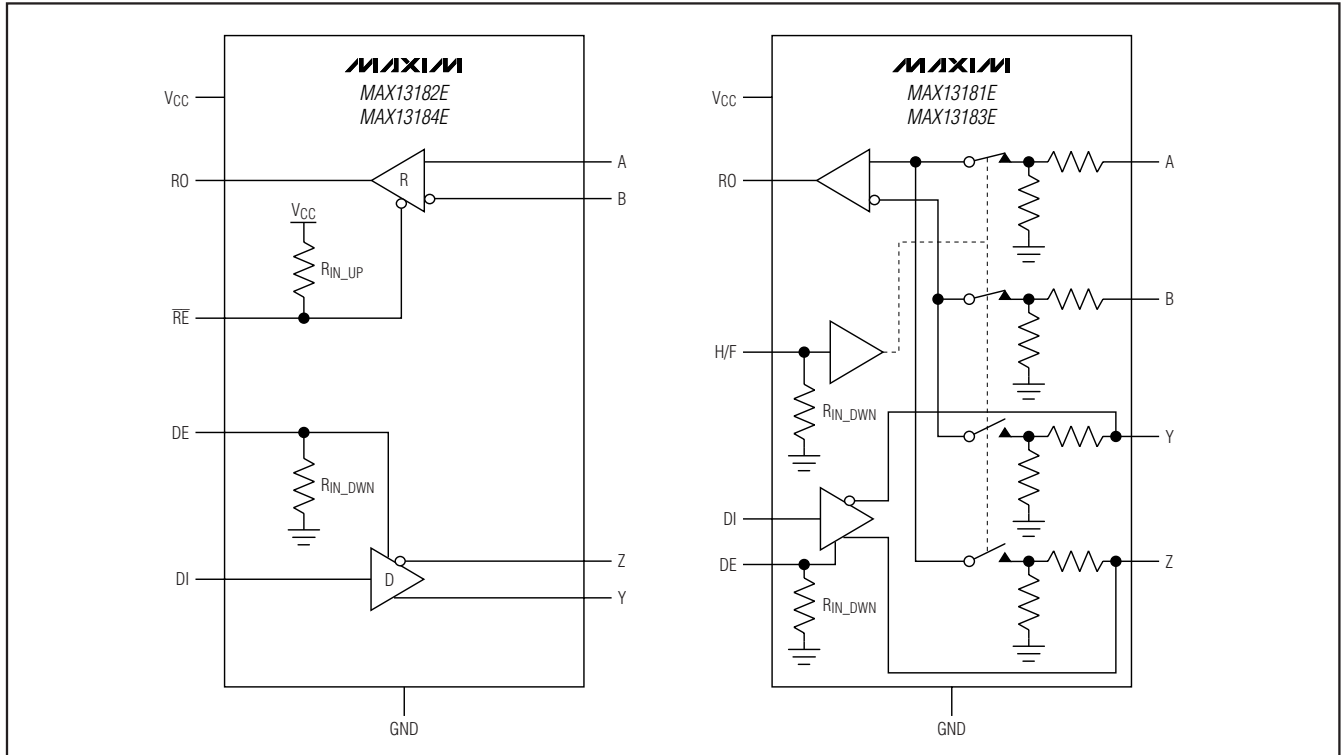
TRANSMITTING				
INPUT			OUTPUT	
$\overline{RE}$	DE	DI	Z	Y
X	1	0	1	0
X	1	1	0	1
0	0	X	High impedance	High impedance
1	0	X	Shutdown (high impedance)	
RECEIVING				
INPUT			OUTPUT	
$\overline{RE}$	DE	A-B	RO	
0	X	$\geq 200\text{mV}$	1	
0	X	$\leq -200\text{mV}$	0	
1	1	X	High impedance	
1	0	X	Shutdown (high impedance)	

**MAX13181E/MAX13183E**

TRANSMITTING				
INPUT		OUTPUT		
DE	DI	Z	Y	
1	0	1	0	
1	1	0	1	
0	X	High impedance	High impedance	
RECEIVING				
INPUT				OUTPUT
H/F	DE	A-B	Y-Z	RO
0	X	$\geq 200\text{mV}$	X	1
0	X	$\leq -200\text{mV}$	X	0
1	0	X	$\geq 200\text{mV}$	1
1	0	X	$\leq -200\text{mV}$	0

X = Don't care.

## Functional Diagram



# +5.0V, ±15kV ESD-Protected, Half-Duplex/ Full-Duplex, RS-485 Transceiver in $\mu$ DFN

## Pin Description

MAX13181E/ MAX13183E	MAX13182E/ MAX13184E	MAX13182E/ MAX13184E	NAME	FUNCTION
$\mu$ DFN		SO		
1	1	14	V <sub>CC</sub>	Positive Supply, V <sub>CC</sub> = +4.5V to +5.5V. Bypass V <sub>CC</sub> with a 0.1 $\mu$ F ceramic capacitor to ground.
2	2	2	RO	Receiver Output. When RE is low and (A-B) $\geq$ 200mV, RO is high; if (A-B) $\leq$ -200mV, RO is low.
—	3	3	$\overline{\text{RE}}$	Receiver Output Enable. Drive $\overline{\text{RE}}$ low to enable RO. Drive $\overline{\text{RE}}$ high to disable the receiver. $\overline{\text{RE}}$ input has an internal pullup resistor.
3	—	—	H/ $\overline{\text{F}}$	Half-/Full-Duplex Selector Input. Connect H/ $\overline{\text{F}}$ to V <sub>CC</sub> for half-duplex mode. Leave H/ $\overline{\text{F}}$ unconnected or connect H/ $\overline{\text{F}}$ to GND for full-duplex mode. H/ $\overline{\text{F}}$ input has an internal pulldown resistor.
4	4	4	DE	Driver Output Enable. Drive DE high to enable the driver. Driver output is high impedance when DE is low. DE input has an internal pulldown resistor.
5	5	5	DI	Driver Input. With DE high, a low on DI forces noninverting output low and inverting output high. Similarly, a high on DI forces noninverting output high and inverting output low.
6	6	6, 7	GND	Ground
7	7	9	Y	Noninverting Driver Output. (Also noninverting receiver input in half-duplex mode.)
8	8	10	Z	Inverting Driver Output. (Also inverting receiver input in half-duplex mode.)
9	9	11	B	Inverting Receiver Input
10	10	12	A	Noninverting Receiver Input
—	—	1, 8, 13	N.C.	No Connection. N.C. is not internally connected.

MAX13181E-MAX13184E

## Detailed Description

The MAX13181E-MAX13184E high-speed transceivers for RS-485 communication contain one driver and one receiver. These devices feature 1/8 unit-load input impedance that allows up to 256 receivers on the bus. All devices feature integrated pullup/pulldown resistors on the DE,  $\overline{\text{RE}}$ , and H/ $\overline{\text{F}}$  inputs to reduce external components. The MAX13182E/MAX13184E feature a low-current shutdown mode for power-sensitive applications.

The MAX13181E/MAX13182E feature reduced slew-rate drivers to minimize EMI and reflections that are caused by improperly terminated cables. The slew-rate limited MAX13181E/MAX13182E allow error-free transmission up to 250Kbps. The MAX13183E/MAX13184E feature full-speed drivers allowing data rate of up to 16Mbps.

The MAX13182E/MAX13184E are configured for full-duplex operation. The MAX13181E/MAX13183E feature selectable half- or full-duplex operation by driving H/ $\overline{\text{F}}$  input high or low, respectively. All devices operate from a single +5.0V supply.

## ±15kV ESD Protection

As with all Maxim devices, ESD-protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The driver outputs of the MAX13181E-MAX13184E family have extra protection against static electricity. Maxim's engineers have developed state-of-the-art structures to protect these driver outputs against ESD of  $\pm 15\text{kV}$  with V<sub>CC</sub> = 5V, and regardless of the logic state of DE and DI.

The ESD-protected pins are tested with reference to the ground pin in a powered-down condition. They are tested to  $\pm 15\text{kV}$  using the Human Body Model,  $\pm 12\text{kV}$  using the IEC 61000-4-2 Air-Gap Discharge Model, and to  $\pm 6\text{kV}$  using the IEC 61000-4-2 Contact Discharge Model.

## ESD Test Conditions

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

# +5.0V, ±15kV ESD-Protected, Half-Duplex/ Full-Duplex, RS-485 Transceiver in µDFN

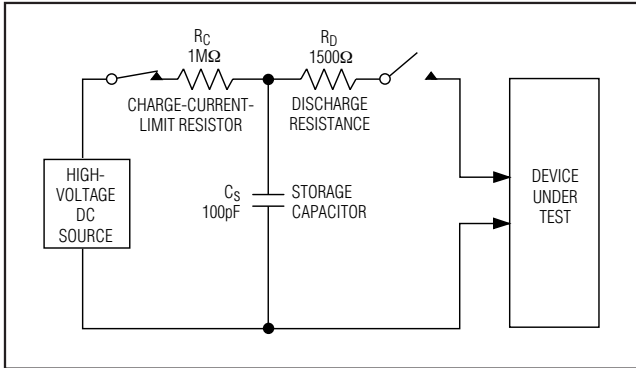


Figure 7a. Human Body ESD Test Model

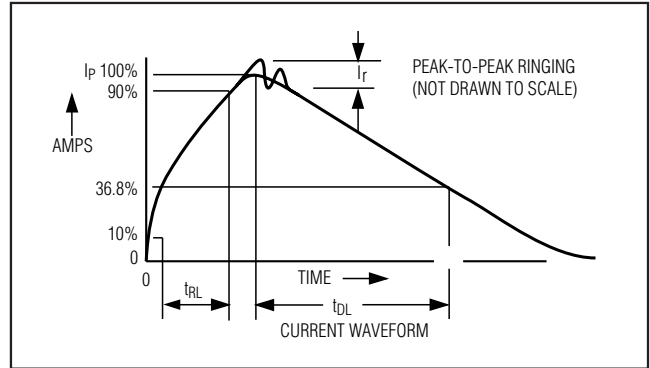


Figure 7b. Human Body Current Waveform

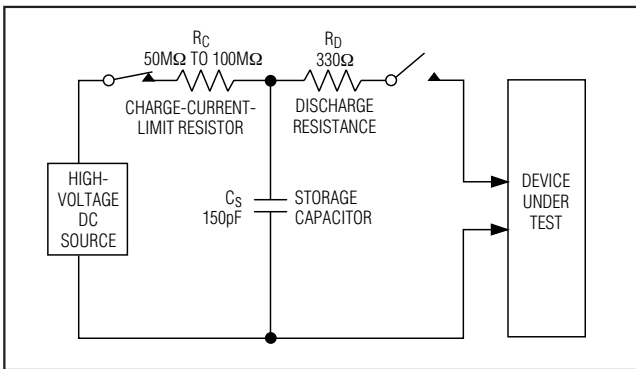


Figure 7c. IEC 61000-4-2 ESD Test Model

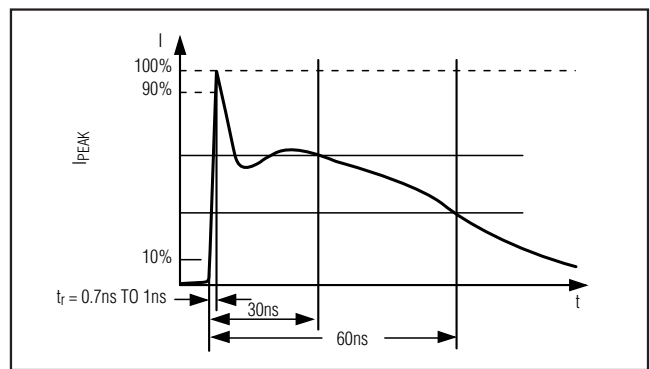


Figure 7d. IEC 61000-4-2 ESD Generator Current Waveform

### Human Body Model

Figure 7a shows the Human Body Model, and Figure 7b shows the current waveform it generates when discharged into a low impedance. This model consists of a 100pF capacitor charged to the ESD voltage of interest, which is then discharged into the test device through a 1.5kΩ resistor.

### Machine Model

The IEC 61000-4-2 standard covers ESD testing and performance of finished equipment. However, it does not specifically refer to integrated circuits. The MAX13485E/MAX13486E help equipment designs to meet IEC 61000-4-2, without the need for additional ESD protection components.

The major difference between tests done using the Human Body Model and IEC 61000-4-2 is higher peak current in IEC 61000-4-2 because series resistance is lower in the IEC 61000-4-2 model. Hence, the ESD withstand voltage measured to IEC 61000-4-2 is generally lower than that measured using the Human Body Model. Figure 7c shows the IEC 61000-4-2 model, and Figure 7d shows the current waveform for the IEC 61000-4-2 ESD Contact Discharge test.

## Applications Information

### 256 Transceiver on the Bus

The standard RS-485 receiver input impedance is 12kΩ (one-unit load), and the standard driver can drive up to 32 unit loads. The MAX13181E-MAX13184E family transceivers have a 1/8-unit load receiver input impedance (96kΩ), allowing up to 256 transceivers to be connected in parallel on one communication line. Any combination of these devices and/or other RS-485 transceivers with a total of 32 unit loads or less can be connected to the line.

### Reduced EMI and Reflections

The MAX13181E/MAX13182E are slew-rate limited, minimizing EMI and reducing reflections caused by improperly terminated cables. This slew-rate limited feature allows error-free data transmission up to 250kbps.

### MAX13181E/MAX13183E Low-Power Shutdown Mode

The MAX13181E/MAX13183E feature low power shutdown mode. Low-power shutdown mode is initiated by bringing  $\overline{RE}$  high and DE low. In shutdown, the devices typically draw only 2.5µA (typ) of supply current.  $\overline{RE}$  and DE can be driven simultaneously. If  $\overline{RE}$  is high and

# +5.0V, ±15kV ESD-Protected, Half-Duplex/ Full-Duplex, RS-485 Transceiver in $\mu$ DFN

MAX13181E-MAX13184E

DE is low for 200ns (typ), the devices are guaranteed to enter shutdown.

Enable times  $t_{ZH}$  and  $t_{ZL}$  (see the *Switching Characteristics*) assume the devices are not in a low-power shutdown state. Enable times  $t_{ZH}(SHDN)$  and  $t_{ZL}(SHDN)$  assume the devices are in a shutdown state. It takes drivers and receivers longer to become enabled from low-power shutdown mode ( $t_{ZH}(SHDN)$ ,  $t_{ZL}(SHDN)$ ) than from driver-/receiver-disable mode ( $t_{ZH}$ ,  $t_{ZL}$ ).

### Line Length

The RS-485 standard covers line lengths up to 4000ft. For line lengths greater than 4000ft, use the repeater application shown in Figure 8.

### Typical Applications

The MAX13181E-MAX13184E transceivers are designed for bidirectional data communications on multipoint bus transmission lines. The MAX13181E/MAX13183E can be used in either half-duplex or full-duplex configuration. The MAX13182E/MAX13184E are for full-duplex only. Figure 9 shows the typical network application circuit for half-duplex, and Figures 10 and 11 show typical network application circuits for full duplex.

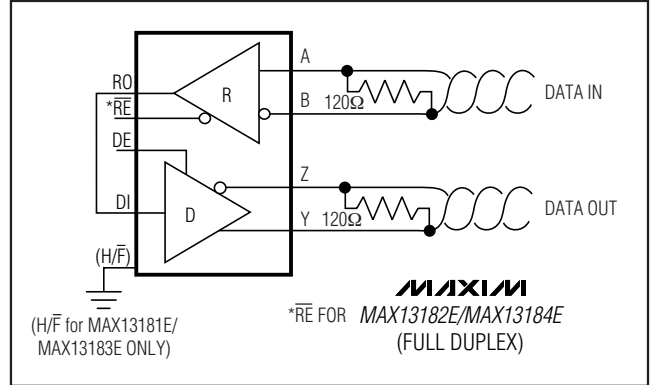


Figure 8. Line Repeater for MAX13181E-MAX13184E

To minimize reflections, terminate the line at both ends in its characteristics impedance, and keep stub lengths off the main line as short as possible. The slew-rate-limited MAX13181E/MAX13182E are more tolerant of imperfect termination.

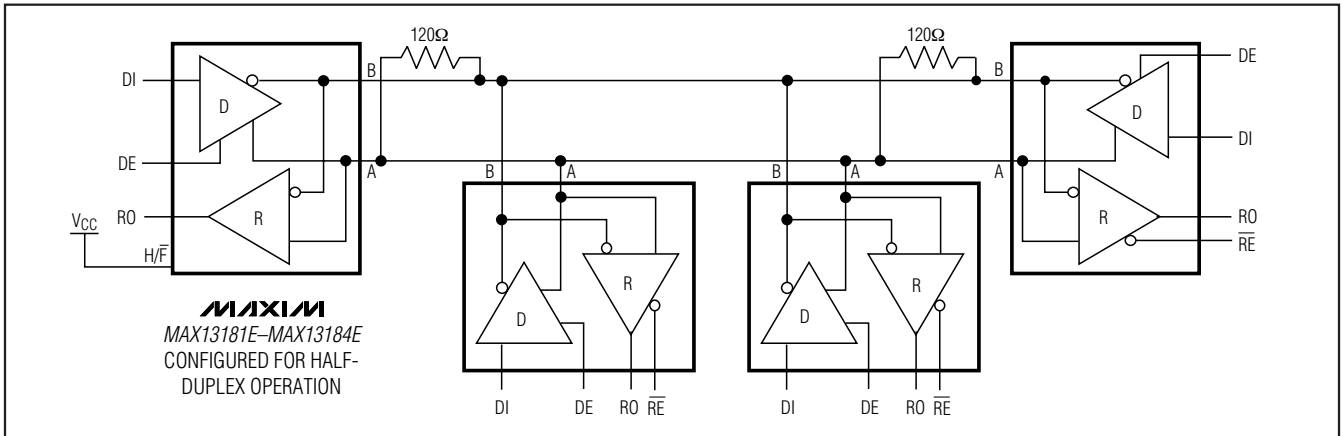


Figure 9. Typical Half-Duplex RS-485 Network

# **+5.0V, ±15kV ESD-Protected, Half-Duplex/ Full-Duplex, RS-485 Transceiver in $\mu$ DFN**

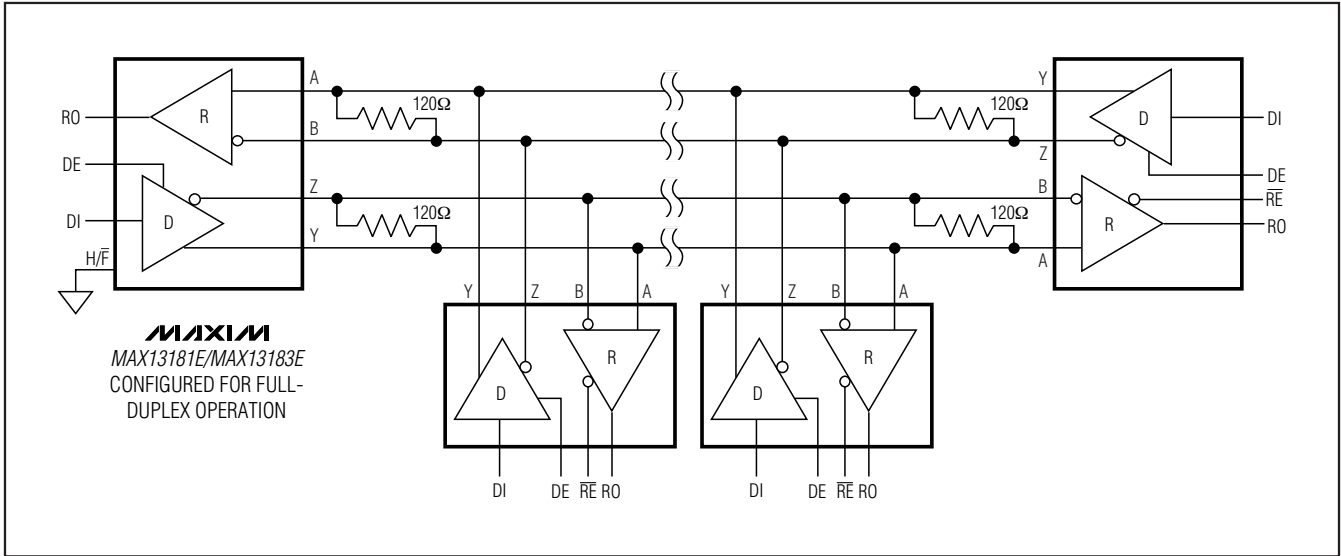


Figure 10. Typical Full-Duplex RS-485 Network

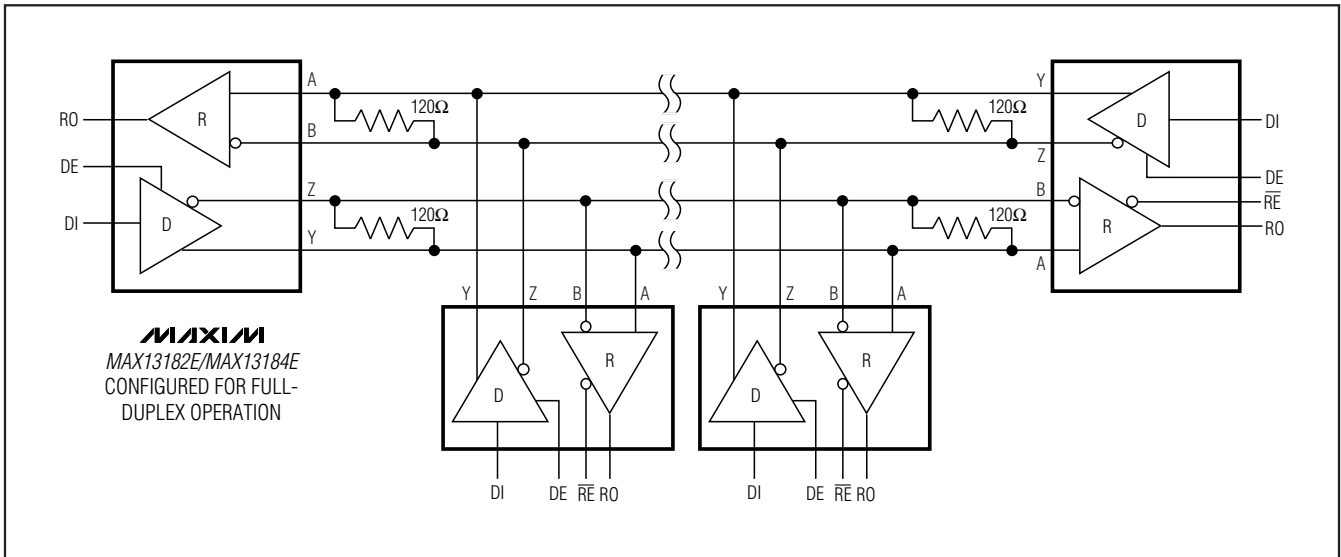


Figure 11. Typical Full-Duplex RS-485 Network

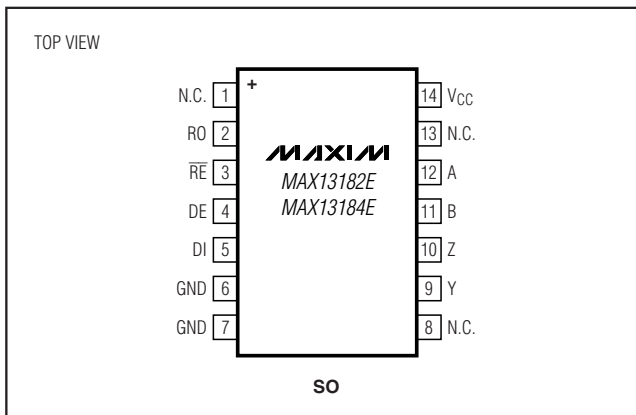
# +5.0V, ±15kV ESD-Protected, Half-Duplex/ Full-Duplex, RS-485 Transceiver in $\mu$ DFN

## Ordering Information (continued)

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK	PKG CODE
MAX13183EELB+	-40°C to +85°C	10 $\mu$ DFN	ABA	L1022-1
MAX13184EELB+	-40°C to +85°C	10 $\mu$ DFN	ABB	L1022-1
MAX13184EESD+	-40°C to +85°C	14 SO	—	S14-1

+Denotes a lead-free package.

## Pin Configurations (continued)



## Chip Information

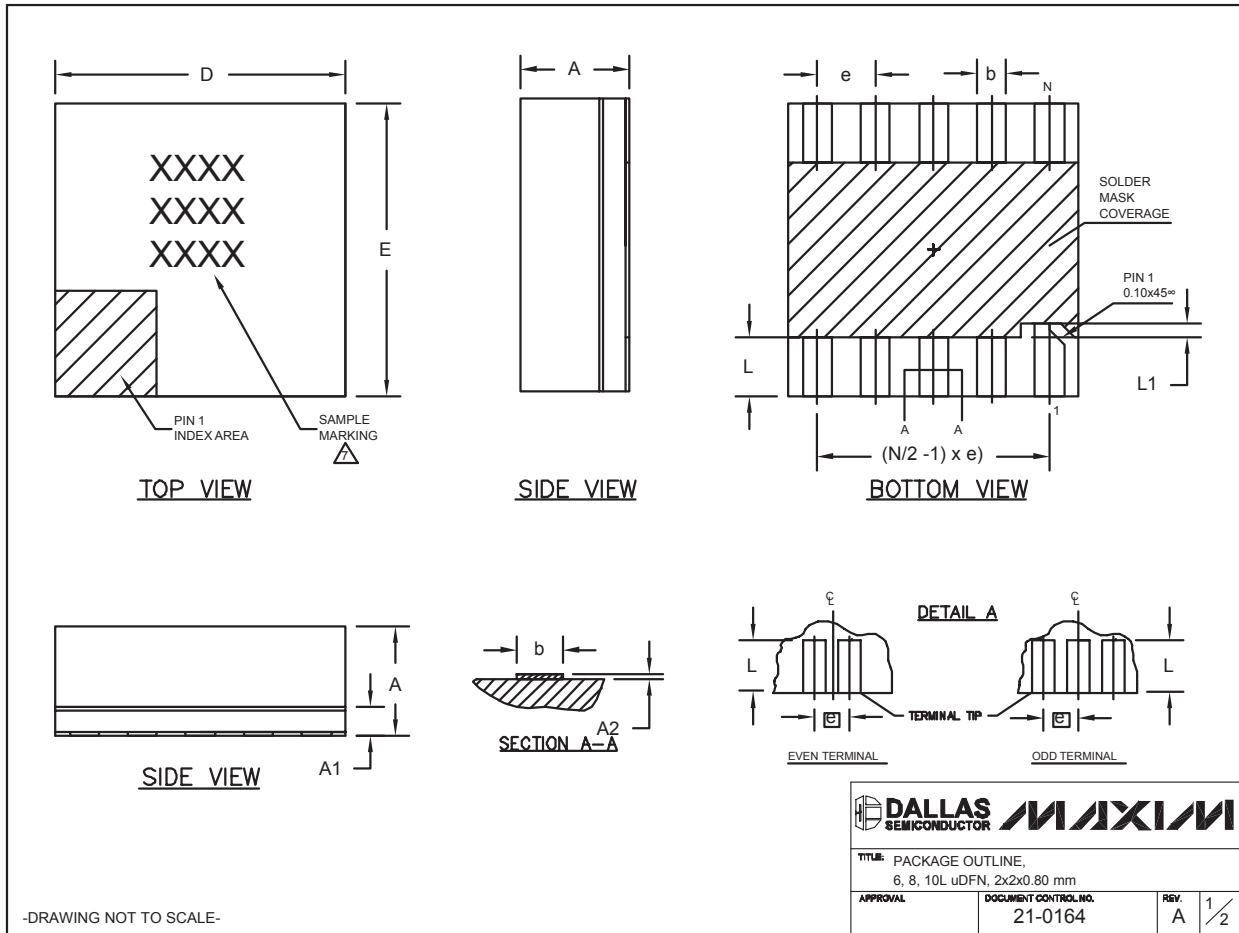
PROCESS: BiCMOS

MAX13181E-MAX13184E

# +5.0V, ±15kV ESD-Protected, Half-Duplex/ Full-Duplex, RS-485 Transceiver in $\mu$ DFN

## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)



6, 8, 10L UDFN:EPS



# +5.0V, ±15kV ESD-Protected, Half-Duplex/ Full-Duplex, RS-485 Transceiver in $\mu$ DFN

## Package Information (continued)


(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)

MAX13181E-MAX13184E

COMMON DIMENSIONS			
SYMBOL	MIN.	NOM.	MAX.
A	0.70	0.75	0.80
A1	0.15	0.20	0.25
A2	0.020	0.025	0.035
D	1.95	2.00	2.05
E	1.95	2.00	2.05
L	0.30	0.40	0.50
L1	0.10 REF.		

PACKAGE VARIATIONS				
PKG. CODE	N	e	b	(N/2 -1) x e
L622-1	6	0.65 BSC	0.30±0.05	1.30 REF.
L822-1	8	0.50 BSC	0.25±0.05	1.50 REF.
L1022-1	10	0.40 BSC	0.20±0.03	1.60 REF.

### NOTES:

1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES.
  2. COPLANARITY SHALL NOT EXCEED 0.08mm.
  3. WARPAGE SHALL NOT EXCEED 0.10mm.
  4. PACKAGE LENGTH/PACKAGE WIDTH ARE CONSIDERED AS SPECIAL CHARACTERISTIC(S).
  5. "N" IS THE TOTAL NUMBER OF LEADS.
  6. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.
-  MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.

-DRAWING NOT TO SCALE-

			
TITLE: PACKAGE OUTLINE, 6, 8, 10L $\mu$ DFN, 2x2x0.80 mm			
APPROVAL	DOCUMENT CONTROL NO. 21-0164	REV. A	2/2

# +5.0V, ±15kV ESD-Protected, Half-Duplex/ Full-Duplex, RS-485 Transceiver in $\mu$ DFN

## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)

SOICN, EPS

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
e	0.050 BSC		1.27 BSC	
E	0.150	0.157	3.80	4.00
H	0.228	0.244	5.80	6.20
L	0.016	0.050	0.40	1.27

VARIATIONS:

DIM	INCHES		MILLIMETERS		N	MS012
	MIN	MAX	MIN	MAX		
D	0.189	0.197	4.80	5.00	8	AA
D	0.337	0.344	8.55	8.75	14	AB
D	0.386	0.394	9.80	10.00	16	AC

**NOTES:**

- D&E DO NOT INCLUDE MOLD FLASH.
- MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm (.006").
- LEADS TO BE COPLANAR WITHIN 0.10mm (.004").
- CONTROLLING DIMENSION: MILLIMETERS.
- MEETS JEDEC MS012.
- N = NUMBER OF PINS.

**DALLAS SEMICONDUCTOR** **MAXIM**

PROPRIETARY INFORMATION

TITLE:  
PACKAGE OUTLINE, .150" SOIC

APPROVAL	DOCUMENT CONTROL NO. 21-0041	REV. B
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