



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

## **General Description**

The MAX13181E–MAX13184E are full-duplex and selectable half/full-duplex RS-485 transceivers in a tiny 2mm x 2mm  $\mu\text{DFN}$  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/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  $\mu\text{DFN}$ . 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.

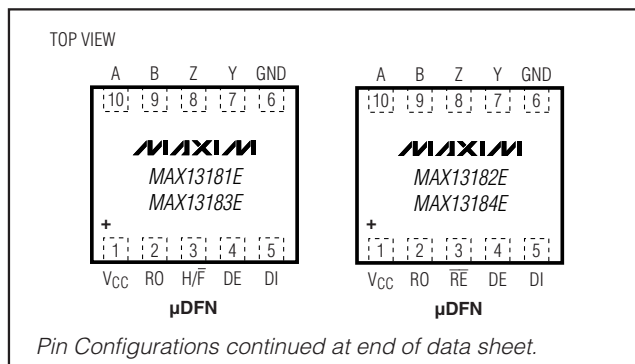
## **Applications**

|                     |                 |
|---------------------|-----------------|
| Industrial Control  | Security System |
| Motor Drive Control | Instrumentation |
| Telecom             |                 |

## **Features**

- ◆ Available in Tiny, 10-Pin, 2mm x 2mm,  $\mu\text{DFN}$  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 |
|------------------|------------------|-------------------|-------------------|--------------------|-----------------|
| <b>MAX13181E</b> | Selectable       | 250 kbps          | Yes               | No                 | No              |
| <b>MAX13182E</b> | Full             | 250 kbps          | Yes               | Yes                | Yes             |
| <b>MAX13183E</b> | Selectable       | 16 Mbps           | No                | No                 | No              |
| <b>MAX13184E</b> | Full             | 16 Mbps           | No                | Yes                | Yes             |

## **Ordering Information**

| PART                 | TEMP RANGE                                     | PIN-PACKAGE        | TOP MARK | PKG CODE |
|----------------------|------------------------------------------------|--------------------|----------|----------|
| <b>MAX13181EELB+</b> | $-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ | 10 $\mu\text{DFN}$ | ABC      | L1022-1  |
| <b>MAX13182EELB+</b> | $-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ | 10 $\mu\text{DFN}$ | ABD      | L1022-1  |
| <b>MAX13182EESD+</b> | $-40^{\circ}\text{C}$ 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**

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

## **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 µDFN (derate 5mW/°C above +70°C) .....403mW

14-Pin SO (derate 8.3mW/°C above +70°C) .....667mW

Operating Temperature Range .....-40°C to +85°C

Storage Temperature Range .....-65°C to +150°C

Junction Temperature .....+150°C

Lead Temperature (soldering, 10s) .....+300°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                                              |                 |      | $V_{CC}$ | V          |
| 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      | $\mu A$    |
|                                                        |                 |                                                      | $V_{IN} = -7V$  | -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  |          | °C         |
| Thermal-Shutdown Hysteresis                            | $T_{TSH}$       |                                                      |                 | 15   |          | °C         |
| Input Current (A and B)                                | $I_{A, B}$      | DE = GND, $V_{CC} = \text{GND or } 5.5V$             | $V_{IN} = +12V$ |      | 125      | $\mu A$    |
|                                                        |                 |                                                      | $V_{IN} = -7V$  | -100 |          |            |

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## **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                                                               |                | ±15 |      | kV        |
|                                             |            | IEC 61000-4-2 Contact Discharge                                                |                | ±6  |      |           |
|                                             |            | IEC 61000-4-2 Air-Gap Discharge                                                |                | ±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    |

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## **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)<br>Figures 2 and 6 |     |     | 50   | ns    |
| Receiver Enable to Output High                 | $t_{RZH}$        | (MAX13182E/MAX13184E)<br>Figures 2 and 6 |     |     | 50   | ns    |
| Receiver Disable Time from Low                 | $t_{RLZ}$        | (MAX13182E/MAX13184E)<br>Figures 2 and 6 |     |     | 50   | ns    |
| Receiver Disable Time from High                | $t_{RHZ}$        | (MAX13182E/MAX13184E)<br>Figures 2 and 6 |     |     | 50   | ns    |
| Receiver Enable from Shutdown to Output High   | $t_{RZH} (SHDN)$ | (MAX13182E/MAX13184E)<br>Figures 2 and 6 |     |     | 2200 | ns    |
| Receiver Enable from Shutdown to Output Low    | $t_{RZL} (SHDN)$ | (MAX13182E/MAX13184E)<br>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.

**MAX13181E-MAX13184E**

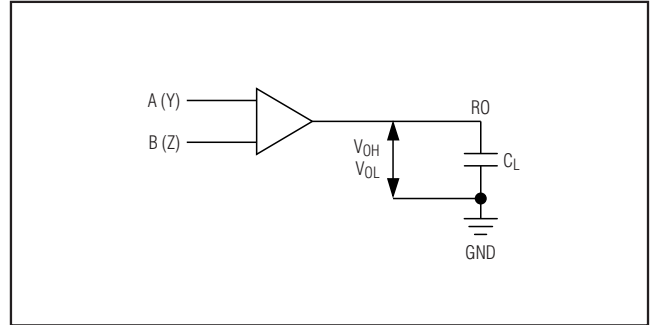
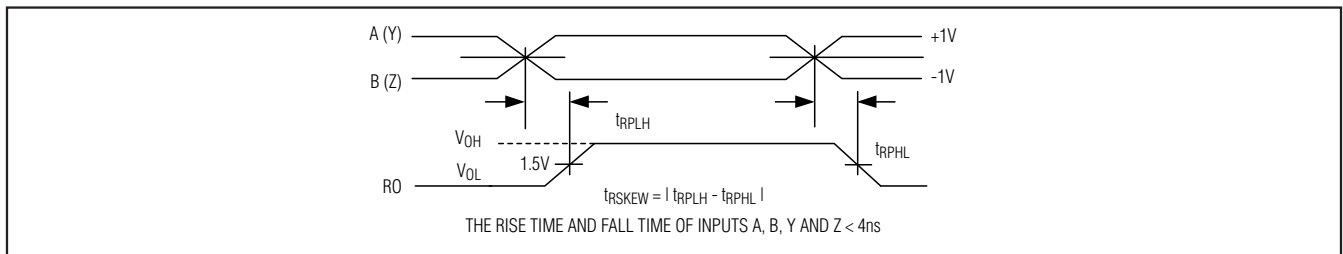
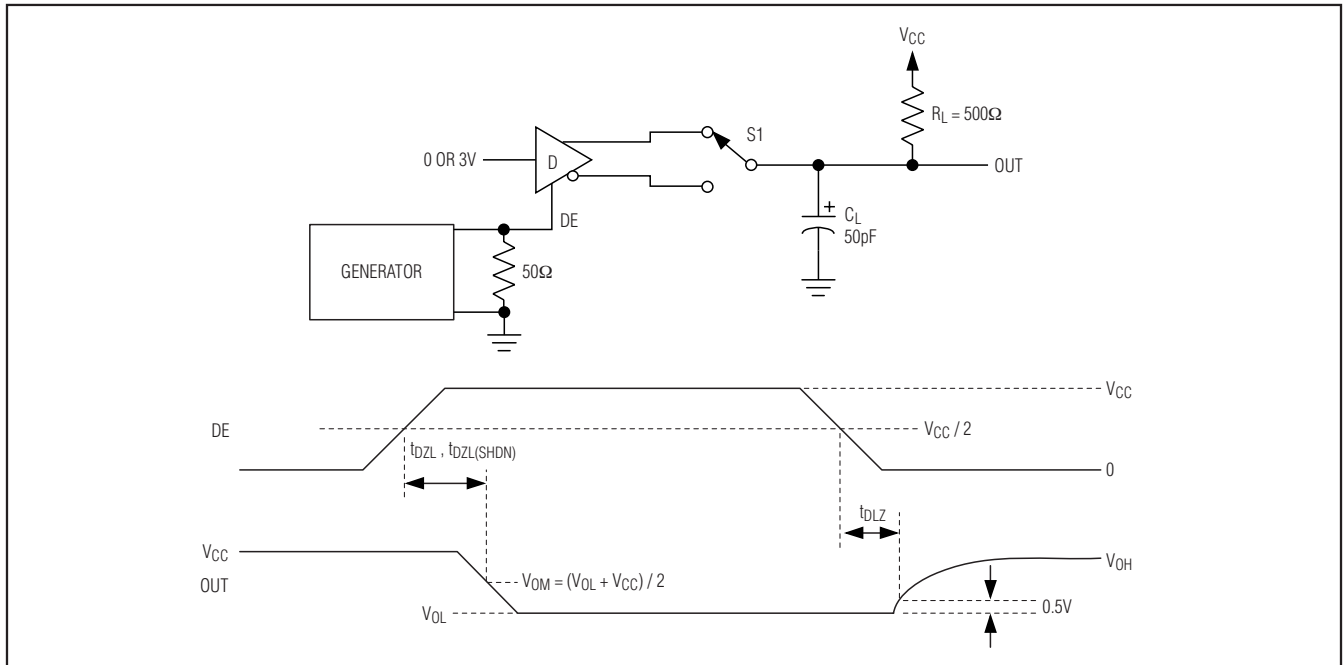


Figure 2. Receiver Differential Input



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



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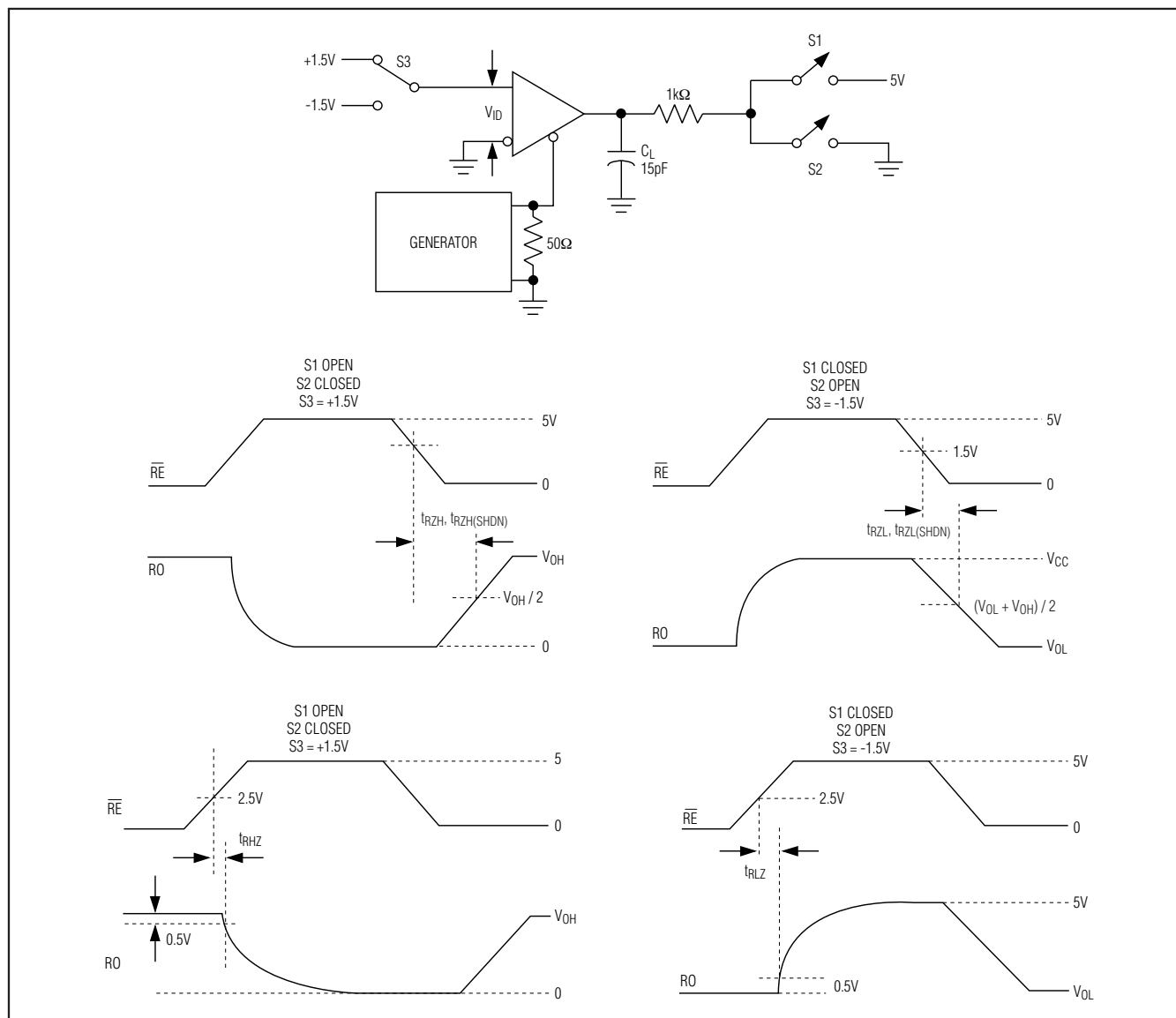
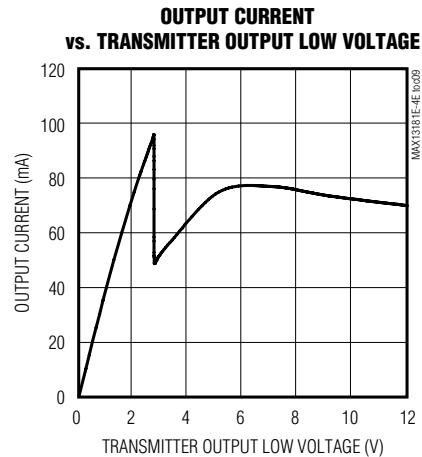
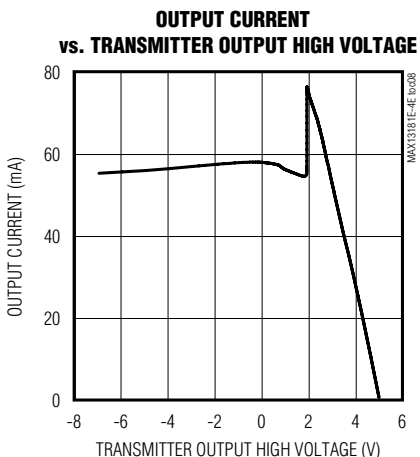
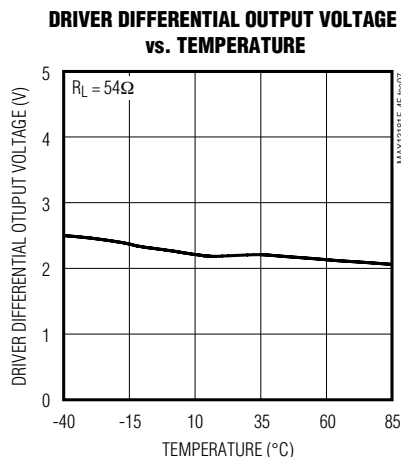
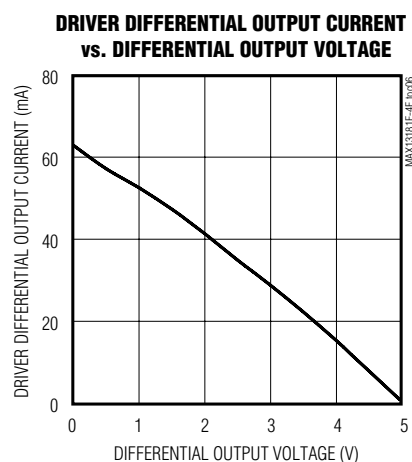
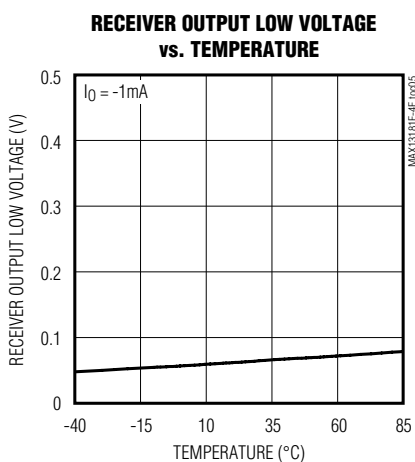
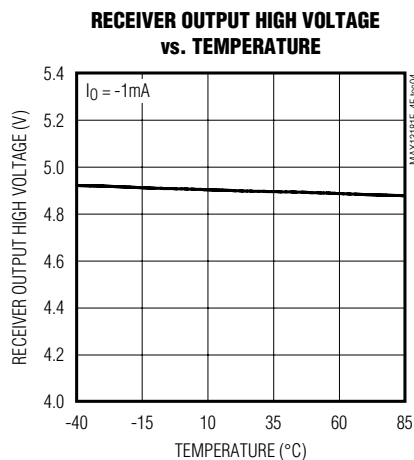
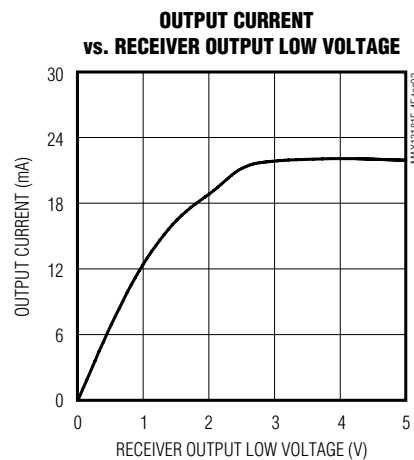
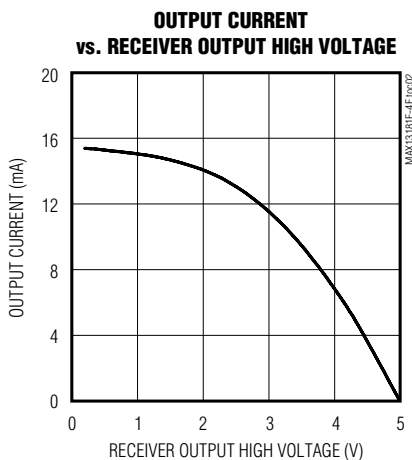
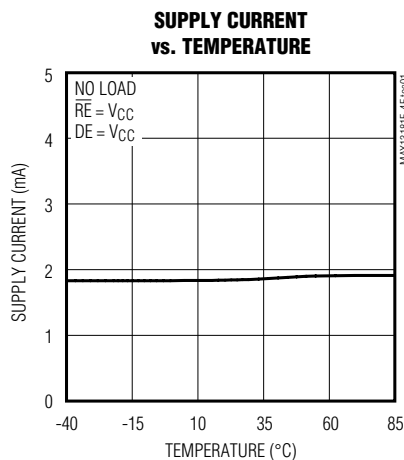


Figure 6. Receiver Disable Time

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

## **Typical Operating Characteristics**

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



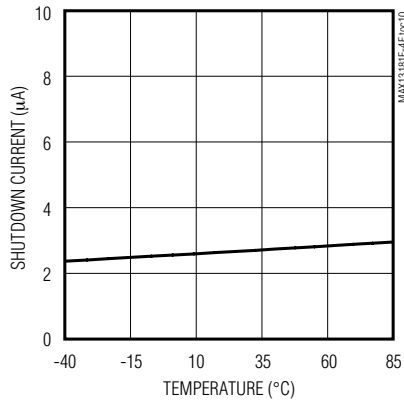
# **+5.0V, $\pm 15\text{kV}$ ESD-Protected, Half-Duplex/ Full-Duplex, RS-485 Transceiver in $\mu\text{DFN}$**

## **Typical Operating Characteristics (continued)**

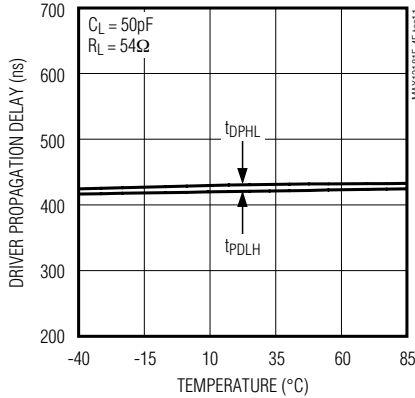
( $V_{CC} = +5\text{V}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.)

**MAX13181E-MAX13184E**

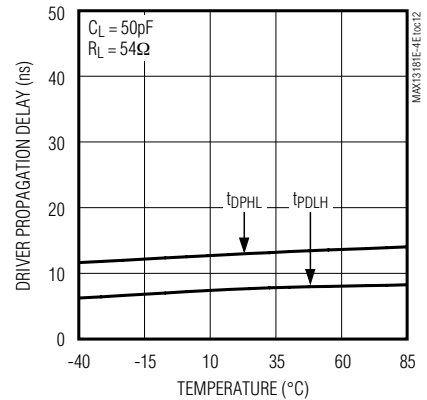
**SHUTDOWN CURRENT  
vs. TEMPERATURE**



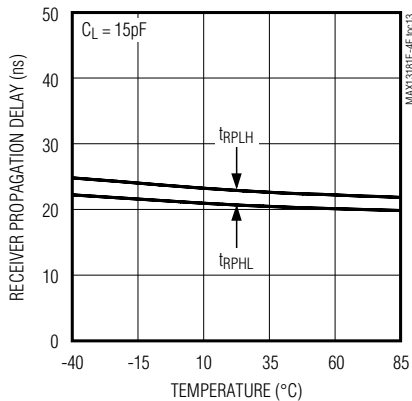
**DRIVER PROPAGATION DELAY  
vs. TEMPERATURE (250kbps) (MAX13182E)**



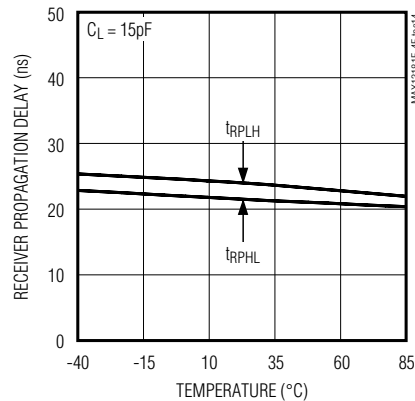
**DRIVER PROPAGATION DELAY  
vs. TEMPERATURE (16Mbps) (MAX13184E)**



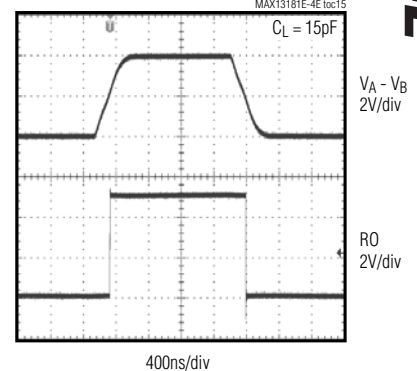
**RECEIVER PROPAGATION DELAY  
vs. TEMPERATURE (250kbps) (MAX13182E)**



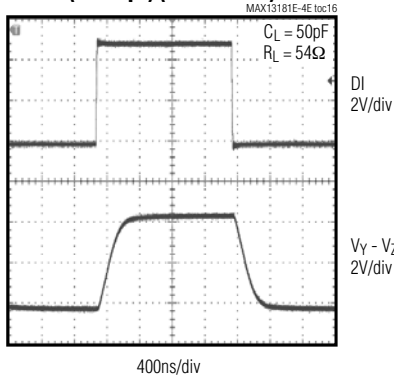
**RECEIVER PROPAGATION DELAY  
vs. TEMPERATURE (16Mbps) (MAX13184E)**



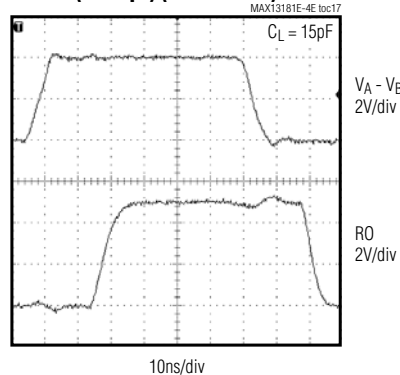
**RECEIVER PROPAGATION DELAY  
(250kbps) (MAX13182E)**



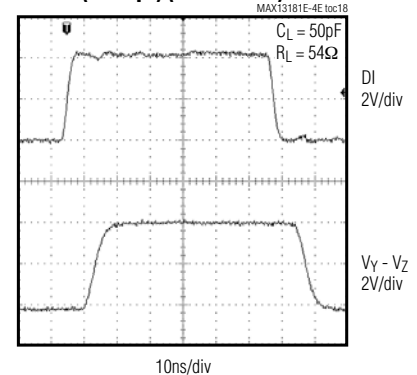
**DRIVER PROPAGATION DELAY  
(250kbps) (MAX13182E)**



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



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



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

## **Functional Tables**

**MAX13182E/MAX13184E**

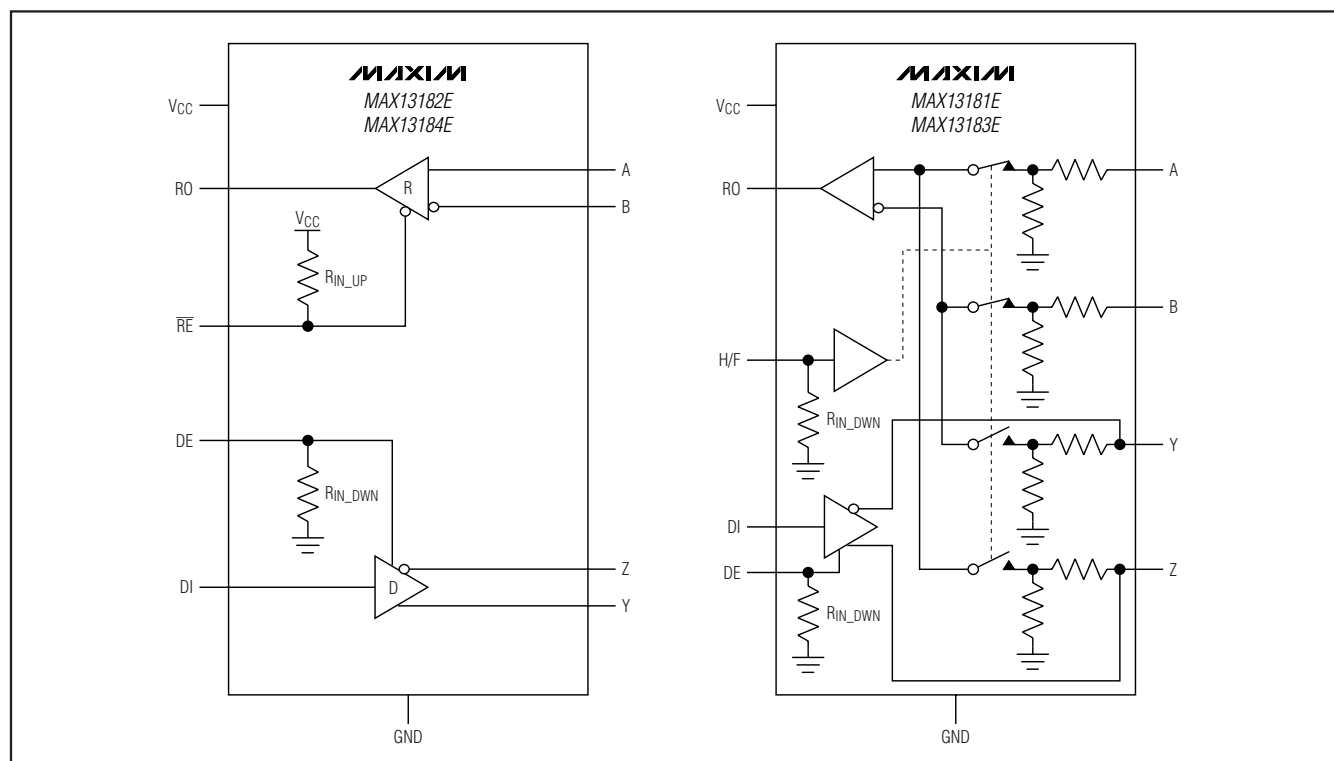
| TRANSMITTING |    |          |                           |                |
|--------------|----|----------|---------------------------|----------------|
| INPUT        |    |          | OUTPUT                    |                |
| RE           | DE | DI       | Z                         | Y              |
| 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                    |                |
| RE           | DE | A-B      | RO                        |                |
| 0            | X  | ≥ 200mV  | 1                         |                |
| 0            | X  | ≤ -200mV | 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/ $\overline{\text{F}}$ | 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 µDFN**

## **Pin Description**

| MAX13181E/<br>MAX13183E | MAX13182E/<br>MAX13184E | MAX13182E/<br>MAX13184E | NAME                     | FUNCTION                                                                                                                                                                                                                                                                                  |
|-------------------------|-------------------------|-------------------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| µDFN                    |                         | 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 0.1µF ceramic capacitor to ground.                                                                                                                                                                       |
| 2                       | 2                       | 2                       | RO                       | Receiver Output. When RE is low and (A-B) ≥ 200mV, RO is high; if (A-B) ≤ -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.                                                                                                                                                                                                                                          |

## **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 ±15kV 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 ±15kV using the Human Body Model, ±12kV using the IEC 61000-4-2 Air-Gap Discharge Model, and to ±6kV 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.

**MAX13181E–MAX13184E**

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

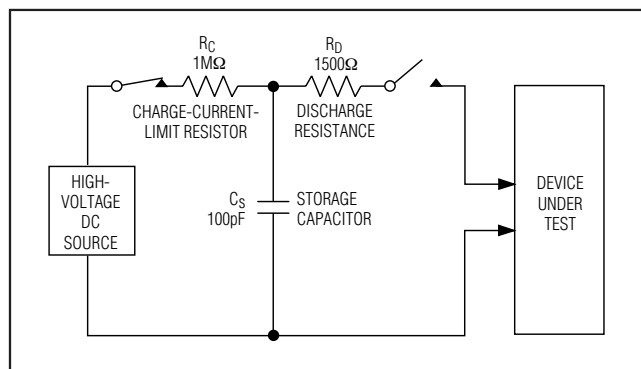


Figure 7a. Human Body ESD Test Model

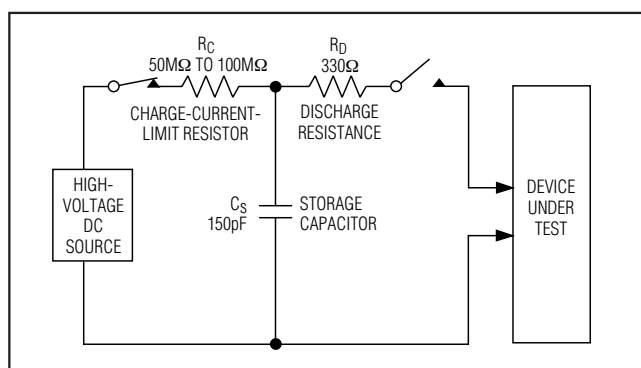


Figure 7c. IEC 61000-4-2 ESD Test Model

## **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.

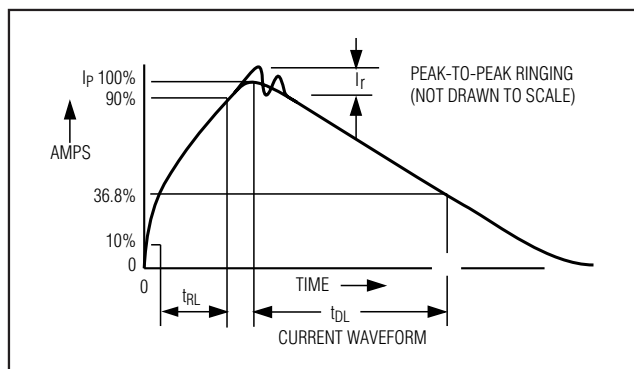


Figure 7b. Human Body Current Waveform

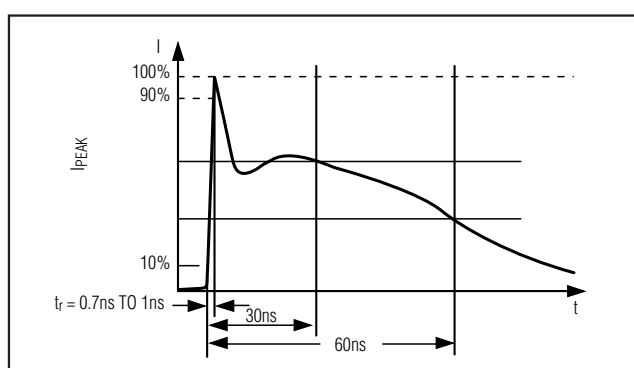


Figure 7d. IEC 61000-4-2 ESD Generator Current Waveform

## **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  $\overline{\text{RE}}$  high and DE low. In shutdown, the devices typically draw only 2.5μA (typ) of supply current.  $\overline{\text{RE}}$  and DE can be driven simultaneously. If  $\overline{\text{RE}}$  is high and

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

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  $t_{ZH}(\text{SHDN})$  and  $t_{ZL}(\text{SHDN})$  assume the devices are in a shutdown state. It takes drivers and receivers longer to become enabled from low-power shutdown mode ( $t_{ZH}(\text{SHDN})$ ,  $t_{ZL}(\text{SHDN})$ ) 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.

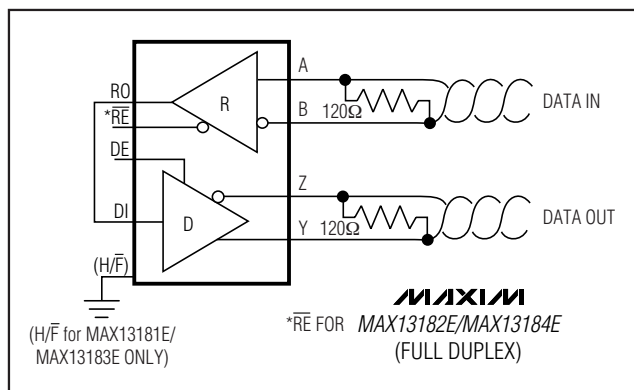


Figure 8. Line Repeater for MAX13181E-MAX13184E

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.

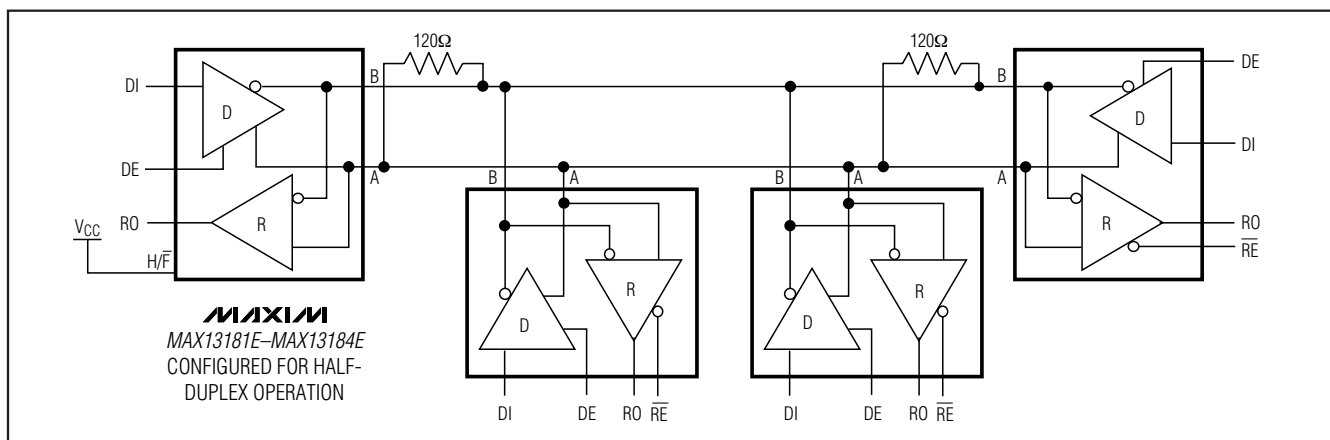


Figure 9. Typical Half-Duplex RS-485 Network

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

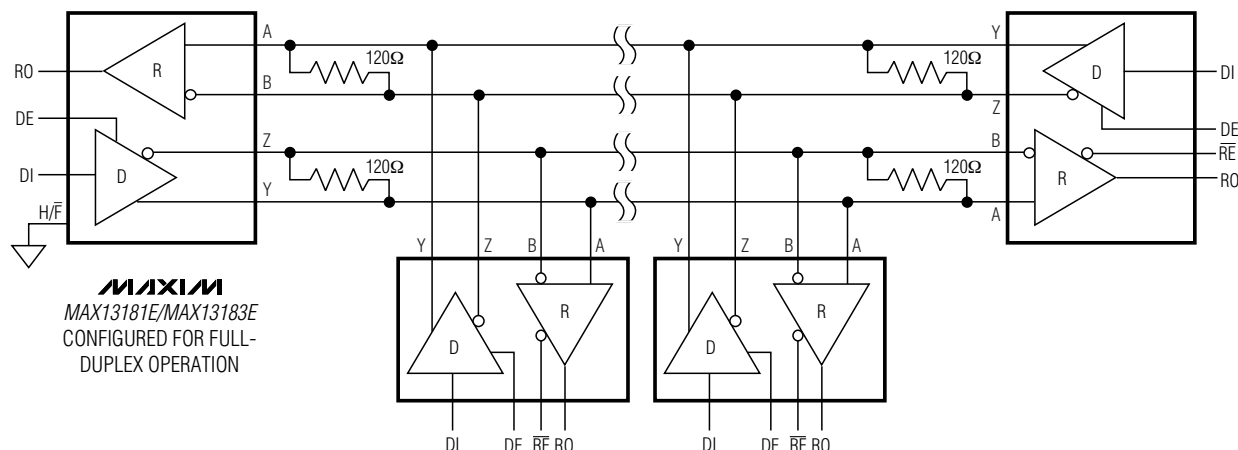


Figure 10. Typical Full-Duplex RS-485 Network

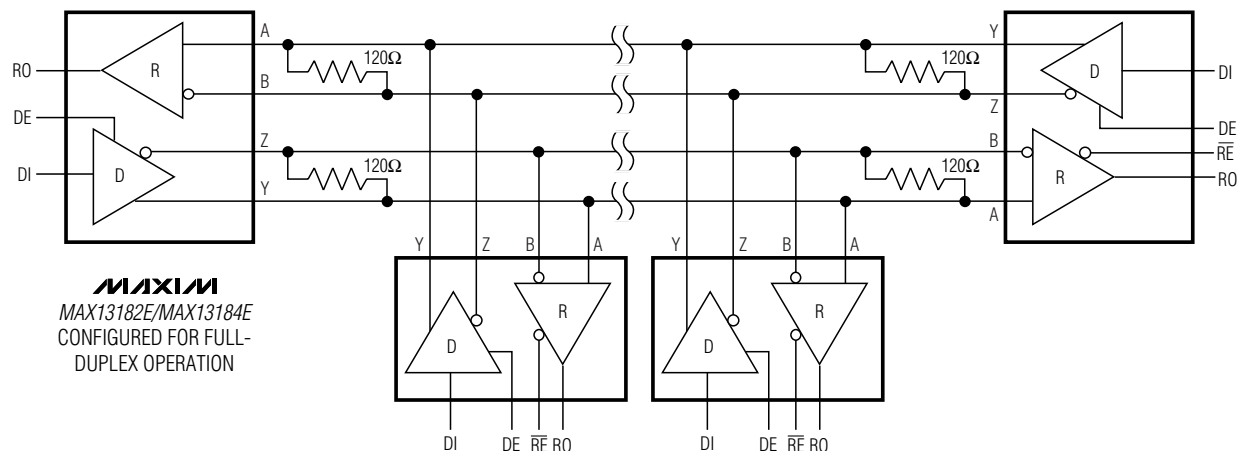


Figure 11. Typical Full-Duplex RS-485 Network

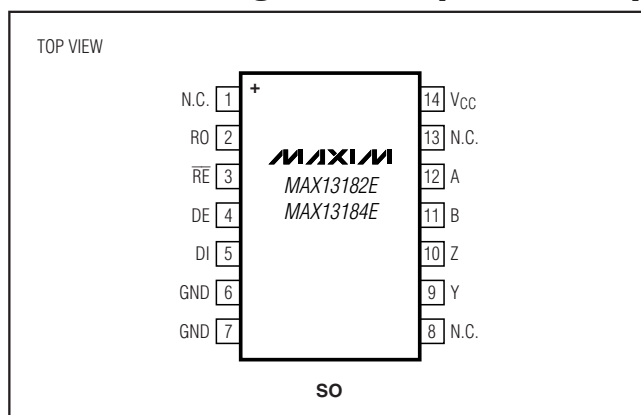
# **+5.0V, ±15kV ESD-Protected, Half-Duplex/ Full-Duplex, RS-485 Transceiver in $\mu$ DFN**

## **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)**



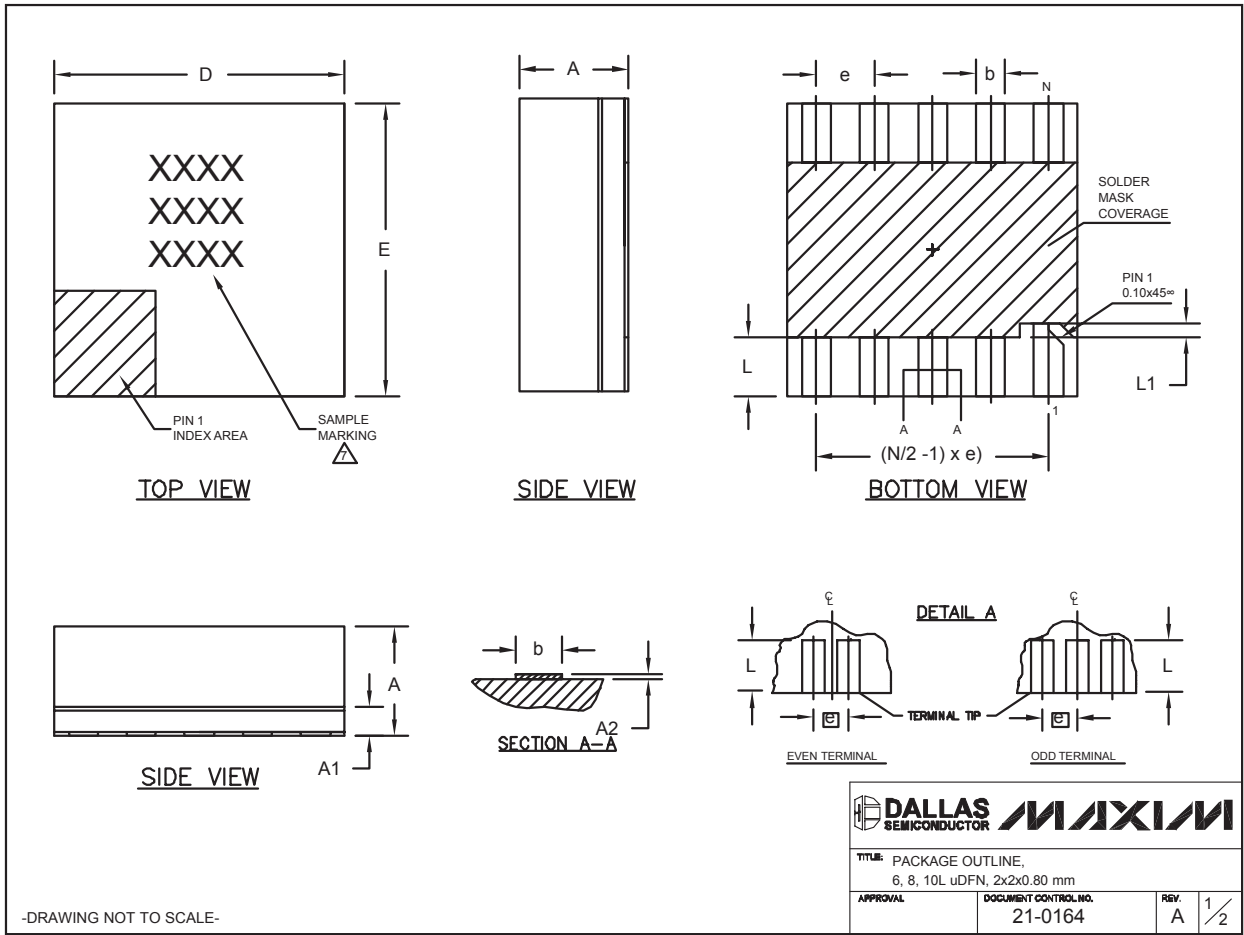
## **Chip Information**

PROCESS: BiCMOS

# **+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 µDFN**

## **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).)

| 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-

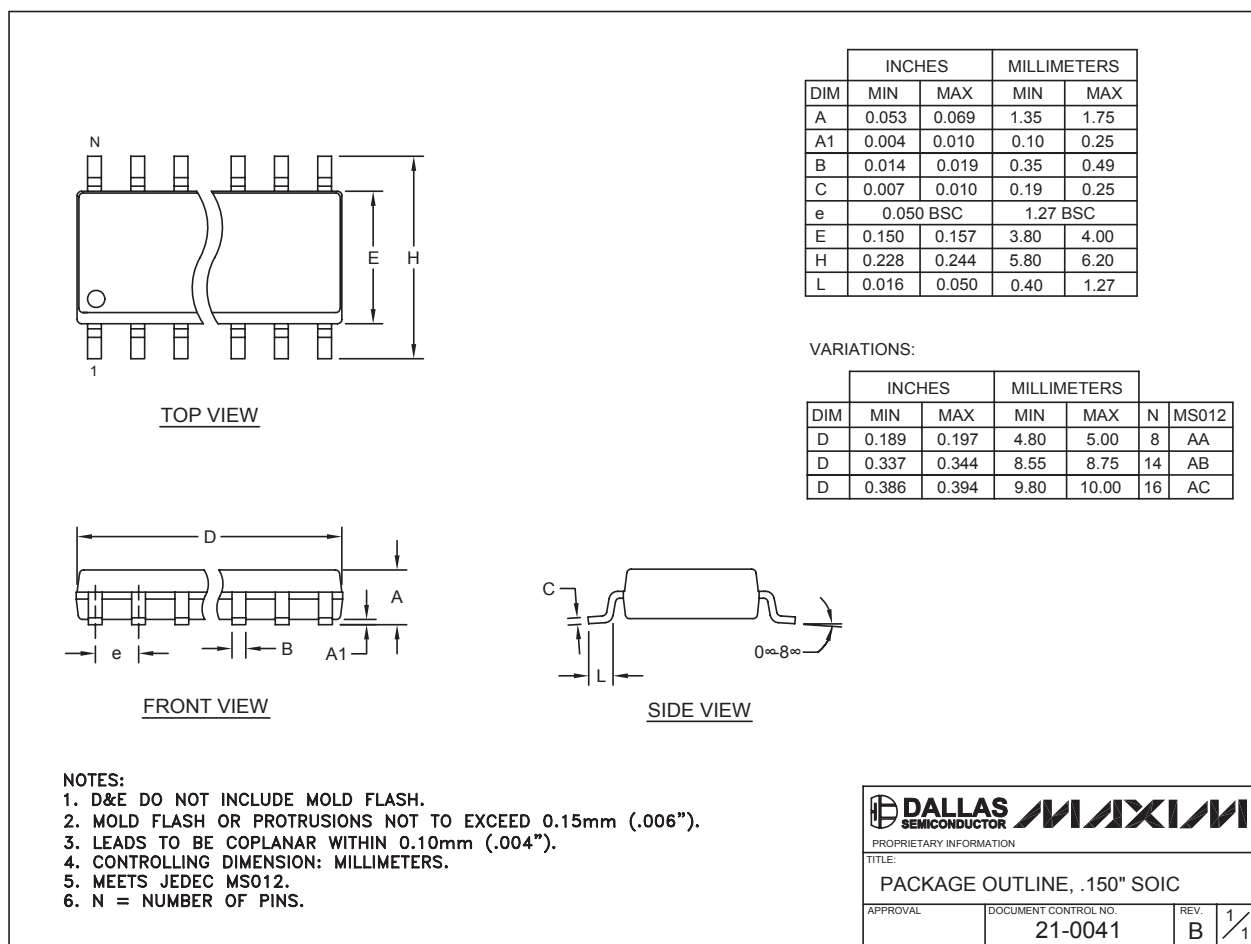
|                                                                                       |                                 |
|---------------------------------------------------------------------------------------|---------------------------------|
|  |                                 |
| TITLE: PACKAGE OUTLINE,<br>6, 8, 10L µDFN, 2x2x0.80 mm                                |                                 |
| APPROVAL                                                                              | DOCUMENT CONTROL NO.<br>21-0164 |
| REV.<br>A                                                                             | 2/2                             |

**MAX13181E-MAX13184E**

# +5.0V, $\pm 15$ kV 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).)



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#### Как с нами связаться

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**Электронная почта:** [org@eplast1.ru](mailto:org@eplast1.ru)

**Адрес:** 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.