

# MAX3483AE/MAX3485AE/ MAX3488AE/MAX3490AE/ MAX3491AE

**+3.3V-Powered,  $\pm 20\text{kV}$  ESD-Protected,  
20Mbps and Slew-Rate-Limited  
RS-485/RS-422 Transceivers**

## General Description

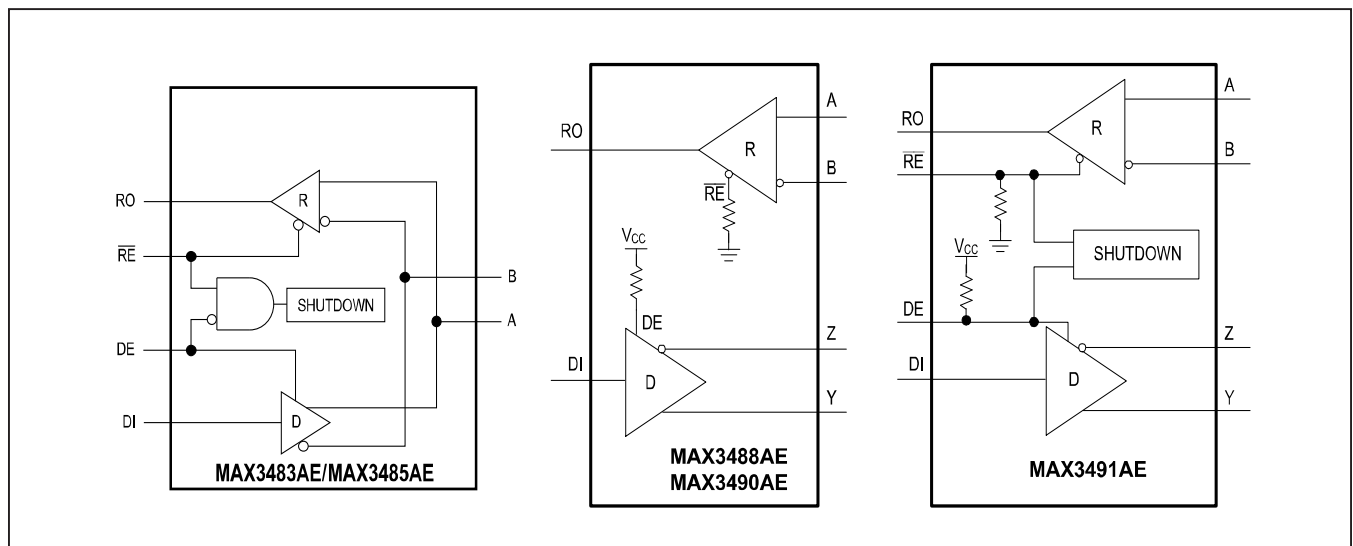
Devices in the MAX3483AE family (MAX3483AE/MAX3485AE/MAX3488AE/MAX3490AE/MAX3491AE) are  $\pm 20\text{kV}$  ESD-protected RS-485/422 transceivers, optimized for extended cable runs in noisy environments. All devices operate from a single 3.3V supply.

The MAX3483AE and MAX3485AE are half-duplex transceivers. The MAX3488AE, MAX3490AE, and MAX3491AE are full-duplex transceivers. The MAX3483AE/85AE have a 1-unit load receiver input impedance, allowing up to 32 transceivers on the bus. The MAX3488AE/90AE/91AE have a 1/4-unit load receiver input impedance, allowing up to 128 transceivers on the bus. Each transceiver includes a fail-safe receiver, ensuring that the receiver output (RO) is high when inputs are shorted, open, or connected to a three-state bus.

All devices feature enhanced electrostatic discharge (ESD) protection. All transmitter outputs and receiver inputs are protected to  $\pm 20\text{kV}$  HBM ESD,  $\pm 15\text{kV}$  Air-Gap ESD and  $\pm 8\text{kV}$  Contact ESD in accordance to IEC 61000-4-2.

The MAX3483AE, MAX3485AE, MAX3488AE, and MAX3490AE are available in industry standard 8-pin SO package, while the MAX3491AE is available in a 14-pin SO package.

## Functional Diagram



## Benefits and Features

- Integrated Protection Increases Robustness
  - High ESD Protection
    - $\pm 20\text{kV}$  HBM ESD per JEDEC JS-001-2012
    - $\pm 15\text{kV}$  Air Gap per IEC 61000-4-2
    - $\pm 8\text{kV}$  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 During Power-Up or Hot Insertion
- High-Speed Data Rates up to 20Mbps
- Up to  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  Operating Temperature
- Allows Up to 128 Transceivers on the Bus

## Applications

- Industrial-Control Local Area Networks
- Transceivers for EMI-Sensitive Applications
- Telecommunications

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

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**Absolute Maximum Ratings**

(Voltages referenced to GND.)

|  |                                   |   |                 |
|--|-----------------------------------|---|-----------------|
| V <sub>CC</sub> .....                                | -0.3V to +4.0V                    | Junction Temperature .....                            | +150°C          |
| RO .....   | -0.3V to (V <sub>CC</sub> + 0.3V) | Storage Temperature Range .....                       | -65°C to +150°C |
| RE, DE, DI .....                                     | -0.3V to +4.0V                    | Continuous Power Dissipation (T <sub>A</sub> = +70°C) |                 |
| A, B, Y, Z .....                                     | -9.0V to +13.0V                   | 8 SO (derate at 7.6mW/°C above +70°C) .....           | 606mW           |
| Short-Circuit Duration (RO, A, B, Y, Z) to GND ..... | Continuous                        | 14 SO (derate at 11.9mW/°C above +70°C) .....         | 952mW           |
| Operating Temperature Range                          |                                   | Lead Temperature (soldering, 10s) .....               | +300°C          |
| MAX3483AE/85AE/88AE/90AE/91AE .....                  | -40°C to +125°C                   | Soldering Temperature (reflow) .....                  | +260°C          |
| MAX3488AE/90AE .....                                 | -40°C to +105°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 Thermal Characteristics (Note 1)**

|  |        |   |         |
|--|--------|---|---------|
| Junction-to-Case Thermal Resistance (θ <sub>JC</sub> ) |        | Junction-to-Ambient Thermal Resistance (θ <sub>JA</sub> ) |         |
| 8-pin SO .....   | 38°C/W | 8-pin SO .....  | 132°C/W |
| 14-pin SO .....  | 34°C/W | 14-pin SO .....   | 84°C/W  |

**Note 1:** 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, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise specified. Typical values are at V<sub>CC</sub> = +3.3V and T<sub>A</sub> = +25°C.) (Notes 2, 3)

| PARAMETER  | SYMBOL            | CONDITIONS  | MIN  | TYP                | MAX  | UNITS |
|--|-------------------|---|------|--------------------|------|-------|
| <b>POWER SUPPLY</b>                                |                   |   |      |                    |      |       |
| Supply Voltage                                     | V <sub>CC</sub>   |   | 3.0  |                    | 3.6  | V     |
| Supply Current                                     | I <sub>CC</sub>   | DE = V <sub>CC</sub> , RE = GND, no load              |      | 1.9                | 4    | mA    |
|  |                   | DE = 0, RE = 0, no load, DI = 0 or V <sub>CC</sub>    | 1.2  |                    | 4.0  |       |
| Shutdown Supply Current                            | I <sub>SHDN</sub> | DE = GND, RE = V <sub>CC</sub> , MAX3483AE/85AE/91AE  |      |                    | 10   | µA    |
| <b>DRIVER</b>                                      |                   |   |      |                    |      |       |
| Differential Driver Output                         | V <sub>OD</sub>   | V <sub>CC</sub> = 3V, R <sub>L</sub> = 100Ω, Figure 1 | 2.0  |                    |      | V     |
|  |                   | V <sub>CC</sub> = 3V, R <sub>L</sub> = 54Ω, Figure 1  | 1.5  |                    |      |       |
| Change in Magnitude of Differential Output Voltage | ΔV <sub>OD</sub>  | R <sub>L</sub> = 54Ω or 100Ω, Figure 1 (Note 4)       | -0.2 |                    | +0.2 | V     |
| Driver Common-Mode Output Voltage                  | V <sub>OC</sub>   | R <sub>L</sub> = 54Ω or 100Ω, Figure 1                |      | V <sub>CC</sub> /2 | 3    | V     |
| Change in Magnitude of Common-Mode Voltage         | ΔV <sub>OC</sub>  | R <sub>L</sub> = 54Ω or 100Ω, Figure 1 (Note 4)       | -0.2 |                    | +0.2 | V     |
| Single-Ended Driver Output High                    | V <sub>OH</sub>   | A or B output, I <sub>A or B</sub> = -20mA            | 2.2  |                    |      | V     |
| Single-Ended Driver Output Low                     | V <sub>OL</sub>   | A or B output, I <sub>A or B</sub> = 20mA             |      |                    | 0.8  | V     |
| Driver Short-Circuit Output Current                | I <sub>OSD</sub>  | V <sub>OUT</sub> = -7V                                | -250 |                    |      | mA    |
|  |                   | V <sub>OUT</sub> = +12V                               |      |                    | 250  |       |

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### Electrical Characteristics (continued)

( $V_{CC} = +3.0V$  to  $+3.6V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise specified. Typical values are at  $V_{CC} = +3.3V$  and  $T_A = +25^{\circ}C$ .) (Notes 2, 3)

| PARAMETER   | SYMBOL          | CONDITIONS   | MIN                 | TYP  | MAX  | UNITS       |
|---|-----------------|--|---------------------|------|------|-------------|
| <b>RECEIVER</b>   |                 |  |                     |      |      |             |
| Input Current   | $I_{A, B}$      | DE = GND, $V_{CC} = GND$<br>or +3.6V                                 | $V_{IN} = +12V$     | 430  | 1000 | $\mu A$     |
|   |                 |  | $V_{IN} = -7V$      | -450 | -300 |             |
| Differential Input Capacitance                                  | $C_{A, B}$      | Between A and B, DE = GND, $f = 4MHz$                                |                     | 12   |      | pF          |
| Receiver Differential Threshold Voltage                         | $V_{TH}$        | $-7V \leq V_{CM} \leq +12V$  | -200                | -105 | -10  | mV          |
| Receiver Input Hysteresis                                       | $\Delta V_{TH}$ | $V_{CM} = 0V$  |                     | 10   |      | mV          |
| Receiver Input Resistance                                       | $R_{IN}$        | $-7V \leq V_{CM} \leq +12V$  | MAX3483AE/85AE      | 12   |      | k $\Omega$  |
|   |                 |  | MAX3488AE/90AE/91AE | 48   |      |             |
| <b>LOGIC INTERFACE (DI, DE, <math>\overline{RE}</math>, RO)</b> |                 |  |                     |      |      |             |
| Input Voltage High  | $V_{IH}$        | DE, DI, $\overline{RE}$  | 2.0                 |      |      | V           |
| Input Voltage Low   | $V_{IL}$        | DE, DI, $\overline{RE}$  |                     |      | 0.8  | V           |
| Input Hysteresis  | $V_{HYS}$       | DE, DI, $\overline{RE}$  |                     | 50   |      | mV          |
| Input Current   | $I_{IN}$        | DE, DI, $\overline{RE}$  |                     |      | ±2   | $\mu A$     |
| Input Impedance on First Transition                             |                 | DE, $\overline{RE}$  | 1                   |      | 10   | k $\Omega$  |
| RO Output Voltage High  | $V_{OHRO}$      | $\overline{RE} = GND$ , $I_{RO} = -2mA$ ,<br>( $V_A - V_B$ ) > 200mV | $V_{CC} - 1.5$      |      |      | V           |
| RO Output Voltage Low   | $V_{OLRO}$      | $\overline{RE} = GND$ , $I_{RO} = 2mA$ ,<br>( $V_A - V_B$ ) < -200mV |                     |      | 0.4  | V           |
| Receiver Three-State Output Current                             | $I_{OZR}$       | $\overline{RE} = V_{CC}$ , $0 \leq V_{RO} \leq V_{CC}$               |                     |      | ±1   | $\mu A$     |
| $\overline{RE}$ Pulldown and DE Pullup Resistance               | $R_{IN}$        |  |                     | 1    |      | M $\Omega$  |
| Receiver Output Short-Circuit Current                           | $I_{OSR}$       | $0 \leq V_{RO} \leq V_{CC}$  |                     |      | ±110 | mA          |
| <b>PROTECTION</b>   |                 |  |                     |      |      |             |
| Thermal Shutdown Threshold                                      | $T_{SHDN}$      | Temperature rising   |                     | +160 |      | $^{\circ}C$ |
| Thermal Shutdown Hysteresis                                     |                 |  |                     | 15   |      | $^{\circ}C$ |
| ESD Protection on A, B, Z, and Y Pins                           |                 | IEC 61000-4-2 Air Gap Discharge to GND                               |                     | ±15  |      | kV          |
|   |                 | IEC 61000-4-2 Contact Discharge to GND                               |                     | ±8   |      |             |
|   |                 | Human Body Model to GND  |                     | ±20  |      |             |
| ESD Protection, All Other Pins                                  |                 | Human Body Model   |                     | ±2   |      | kV          |

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### Switching Characteristics MAX3485AE/MAX3490AE/MAX3491AE

( $V_{CC} = +3V$  to  $+3.6V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise specified. Typical values are at  $V_{CC} = +3.3V$  and  $T_A = +25^{\circ}C$ .) (Notes 2, 3, 5)

| PARAMETER  | SYMBOL              | CONDITIONS   | MIN | TYP | MAX | UNITS   |
|--|---------------------|--|-----|-----|-----|---------|
| <b>DRIVER</b>  |                     |  |     |     |     |         |
| Driver Propagation Delay                                   | $t_{DPLH}$          | $R_L = 54\Omega$ , $C_L = 50pF$ ,<br>Figures 2 and 3                                   |     |     | 30  | ns      |
|  | $t_{DPHL}$          |  |     |     | 30  |         |
| Driver Differential Output Rise or Fall Time               | $t_{HL}$ , $t_{LH}$ | $R_L = 54\Omega$ , $C_L = 50pF$ ,<br>Figures 2 and 3                                   |     |     | 7   | ns      |
| Differential Driver Output Skew<br>$ t_{DPLH} - t_{DPHL} $ | $t_{DSKEW}$         | $R_L = 54\Omega$ , $C_L = 50pF$ ,<br>Figures 2 and 3 (Note 6)                          |     |     | 3   | ns      |
| Maximum Data Rate  | $DR_{MAX}$          |  | 20  |     |     | Mbps    |
| Driver Enable to Output High                               | $t_{DZH}$           | $R_L = 110\Omega$ , $C_L = 50pF$ ,<br>MAX3485AE, MAX3491AE<br>Figures 4 and 5 (Note 7) |     |     | 40  | ns      |
| Driver Enable to Output Low                                | $t_{DZL}$           | $R_L = 110\Omega$ , $C_L = 50pF$ ,<br>MAX3485AE, MAX3491AE<br>Figures 4 and 5 (Note 7) |     |     | 40  | ns      |
| Driver Disable Time from Low                               | $t_{DLZ}$           | $R_L = 110\Omega$ , $C_L = 50pF$ ,<br>MAX3485AE, MAX3491AE<br>Figures 4 and 5          |     |     | 40  | ns      |
| Driver Disable Time from High                              | $t_{DHZ}$           | $R_L = 110\Omega$ , $C_L = 50pF$ ,<br>MAX3485AE, MAX3491AE<br>Figures 4 and 5          |     |     | 40  | ns      |
| Driver Enable from Shutdown to Output High                 | $t_{DLZ}(SHDN)$     | $R_L = 110\Omega$ , $C_L = 15pF$ , MAX3485AE,<br>Figures 4 and 5 (Note 7)              |     |     | 6   | $\mu s$ |
|  |                     | $R_L = 1k\Omega$ , $C_L = 15pF$ ,<br>MAX3491AE, Figure 8                               |     |     | 100 | $\mu s$ |
| Driver Enable from Shutdown to Output Low                  | $t_{DHZ}(SHDN)$     | $R_L = 110\Omega$ , $C_L = 15pF$ , MAX3485AE<br>Figures 4 and 5 (Note 7)               |     |     | 6   | $\mu s$ |
| Time to Shutdown   | $t_{SHDN}$          | (Note 8)   | 50  |     | 800 | ns      |
| <b>RECEIVER</b>  |                     |  |     |     |     |         |
| Receiver Propagation Delay                                 | $t_{RPLH}$          | $C_L = 15pF$ , Figures 6 and 7   |     |     | 35  | ns      |
|  | $t_{RPHL}$          |  |     |     | 35  |         |
| Receiver Output Skew                                       | $t_{RSKEW}$         | $C_L = 15pF$ , Figures 6 and 7<br>(Note 6)   |     |     | 2   | ns      |
| Maximum Data Rate  | $DR_{MAX}$          |  | 20  |     |     | Mbps    |
| Receiver Enable to Output High                             | $t_{RZH}$           | $R_L = 1k\Omega$ , $C_L = 15pF$ , MAX3485AE,<br>MAX3491AE, Figure 8 (Note 7)           |     |     | 40  | ns      |
| Receiver Enable to Output Low                              | $t_{RZL}$           | $R_L = 1k\Omega$ , $C_L = 15pF$ , MAX3485AE,<br>MAX3491AE, Figure 8 (Note 7)           |     |     | 40  | ns      |
| Receiver Disable Time from Low                             | $t_{RLZ}$           | $R_L = 1k\Omega$ , $C_L = 15pF$ , MAX3485AE,<br>MAX3491AE, Figure 8                    |     |     | 40  | ns      |

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### Switching Characteristics MAX3485AE/MAX3490AE/MAX3491AE (continued)

( $V_{CC} = +3V$  to  $+3.6V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise specified. Typical values are at  $V_{CC} = +3.3V$  and  $T_A = +25^\circ C$ .) (Notes 2, 3, 5)

| PARAMETER                                    | SYMBOL          | CONDITIONS   | MIN | TYP | MAX | UNITS   |
|--|-----------------|--|-----|-----|-----|---------|
| Receiver Disable Time from High              | $t_{RHZ}$       | $R_L = 1k\Omega$ , $C_L = 15pF$ , MAX3485AE, MAX3491AE, Figure 8 |     |     | 40  | ns      |
| Receiver Enable from Shutdown to Output High | $t_{RLZ}(SHDN)$ | $R_L = 1k\Omega$ , $C_L = 15pF$ , MAX3485AE, Figure 8 (Note 7)   |     |     | 6   | $\mu s$ |
|  |                 | $R_L = 1k\Omega$ , $C_L = 15pF$ , MAX3491AE, Figure 8            |     |     | 100 | $\mu s$ |
| Receiver Enable from Shutdown to Output Low  | $t_{RHZ}(SHDN)$ | $R_L = 1k\Omega$ , $C_L = 15pF$ , MAX3485AE, Figure 8 (Note 7)   |     |     | 6   | $\mu s$ |
|  |                 | $R_L = 1k\Omega$ , $C_L = 15pF$ , MAX3491AE, Figure 8            |     |     | 100 | $\mu s$ |
| Time to Shutdown                             | $t_{SHDN}$      | (Note 8)   | 50  |     | 800 | ns      |

### Switching Characteristics (MAX3483AE/MAX3488AE)

( $V_{CC} = +3V$  to  $+3.6V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise specified. Typical values are at  $V_{CC} = +3.3V$  and  $T_A = +25^\circ C$ .) (Notes 2, 3, 5)

| PARAMETER  | SYMBOL              | CONDITIONS  | MIN | TYP | MAX  | UNITS   |
|--|---------------------|---|-----|-----|------|---------|
| <b>DRIVER</b>  |                     |   |     |     |      |         |
| Driver Propagation Delay                                   | $t_{DPLH}$          | $R_L = 54\Omega$ , $C_L = 50pF$ ,<br>Figures 2 and 3                        |     |     | 1000 | ns      |
|  | $t_{DPHL}$          |   |     |     | 1000 |         |
| Driver Differential Output Rise or Fall Time               | $t_{HL}$ , $t_{LH}$ | $R_L = 54\Omega$ , $C_L = 50pF$ ,<br>Figures 2 and 3                        | 200 |     | 900  | ns      |
| Differential Driver Output Skew<br>$ t_{DPLH} - t_{DPHL} $ | $t_{DSKEW}$         | $R_L = 54\Omega$ , $C_L = 50pF$ ,<br>Figures 2 and 3                        |     |     | 140  | ns      |
| Maximum Data Rate  | $DR_{MAX}$          |   | 250 |     |      | kbps    |
| Driver Enable to Output High                               | $t_{DZH}$           | $R_L = 110\Omega$ , $C_L = 50pF$ ,<br>MAX3483AE<br>Figures 4 and 5 (Note 6) |     |     | 2500 | ns      |
| Driver Enable to Output Low                                | $t_{DZL}$           | $R_L = 110\Omega$ , $C_L = 50pF$ ,<br>MAX3483AE<br>Figures 4 and 5 (Note 6) |     |     | 2500 | ns      |
| Driver Disable Time from Low                               | $t_{DLZ}$           | $R_L = 110\Omega$ , $C_L = 50pF$ ,<br>MAX3483AE<br>Figures 4 and 5          |     |     | 100  | ns      |
| Driver Disable Time from High                              | $t_{DHZ}$           | $R_L = 110\Omega$ , $C_L = 50pF$ ,<br>MAX3483AE<br>Figures 4 and 5          |     |     | 100  | ns      |
| Driver Enable from Shutdown to Output High                 | $t_{DLZ}(SHDN)$     | $R_L = 110\Omega$ , $C_L = 15pF$ ,<br>MAX3483AE<br>Figures 4 and 5 (Note 6) |     |     | 10   | $\mu s$ |

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### Switching Characteristics (MAX3483AE/MAX3488AE) (continued)

( $V_{CC} = +3V$  to  $+3.6V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise specified. Typical values are at  $V_{CC} = +3.3V$  and  $T_A = +25^\circ C$ .) (Notes 2, 3, 5)

| PARAMETER                                    | SYMBOL          | CONDITIONS   | MIN | TYP | MAX | UNITS   |
|--|-----------------|--|-----|-----|-----|---------|
| Driver Enable from Shutdown to Output Low    | $t_{DZH(SHDN)}$ | $R_L = 110\Omega$ , $C_L = 15pF$ , MAX3483AE<br>Figures 4 and 5 (Note 6) |     |     | 5.5 | $\mu s$ |
| Time to Shutdown                             | $t_{SHDN}$      | (Note 8) MAX3483AE   | 50  | 340 | 700 | ns      |
| <b>RECEIVER</b>                              |                 |  |     |     |     |         |
| Receiver Propagation Delay                   | $t_{RPLH}$      | $C_L = 15pF$ , Figures 6 and 7   |     |     | 200 | ns      |
|  | $t_{RPHL}$      |  |     |     | 200 |         |
| Receiver Output Skew                         | $t_{RSKEW}$     | $C_L = 15pF$ , Figures 6 and 7<br>(Note 6)                               |     |     | 30  | ns      |
| Maximum Data Rate                            | $DR_{MAX}$      |  | 250 |     |     | kbps    |
| Receiver Enable to Output High               | $t_{RZH}$       | $R_L = 1k\Omega$ , $C_L = 15pF$ ,<br>MAX3483AE<br>Figure 8 (Note 6)      |     |     | 50  | ns      |
| Receiver Enable to Output Low                | $t_{RZL}$       | $R_L = 1k\Omega$ , $C_L = 15pF$ ,<br>MAX3483AE<br>Figure 8 (Note 6)      |     |     | 50  | ns      |
| Receiver Disable Time from Low               | $t_{RLZ}$       | $R_L = 1k\Omega$ , $C_L = 15pF$ ,<br>MAX3483AE<br>Figure 8               |     |     | 50  | ns      |
| Receiver Disable Time from High              | $t_{RHZ}$       | $R_L = 1k\Omega$ , $C_L = 15pF$ ,<br>MAX3483AE<br>Figure 8               |     |     | 50  | ns      |
| Receiver Enable from Shutdown to Output High | $t_{RLZ(SHDN)}$ | $R_L = 1k\Omega$ , $C_L = 15pF$ ,<br>MAX3483AE<br>Figure 8 (Note 6)      |     |     | 10  | $\mu s$ |
| Receiver Enable from Shutdown to Output Low  | $t_{RHZ(SHDN)}$ | $R_L = 1k\Omega$ , $C_L = 15pF$ ,<br>MAX3483AE<br>Figure 8 (Note 6)      |     |     | 10  | $\mu s$ |
| Time to Shutdown                             | $t_{SHDN}$      | (Note 8) MAX3483AE   | 50  | 340 | 800 | ns      |

**Note 2:** All devices 100% production tested at  $T_A = +25^\circ C$ . Specifications over temperature are guaranteed by design.

**Note 3:** All currents into the device are positive; all currents out of the device are negative. All voltages are referenced to ground, unless otherwise noted.

**Note 4:**  $\Delta V_{OD}$  and  $\Delta V_{OC}$  are the changes in  $V_{OD}$  and  $V_{OC}$ , respectively, when the DI input changes state.

**Note 5:** Capacitive load includes test probe and fixture capacitance.

**Note 6:** Guaranteed by design; not production tested.

**Note 7:** The timing parameter refers to the driver or receiver enable delay, when the device has exited the initial hot-swap protect state and is in normal operating mode.

**Note 8:** Shutdown is enabled by driving  $\overline{RE}$  high and DE low. The device is guaranteed to have entered shutdown after  $t_{SHDN}$  has elapsed.

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### Test and Timing Diagrams

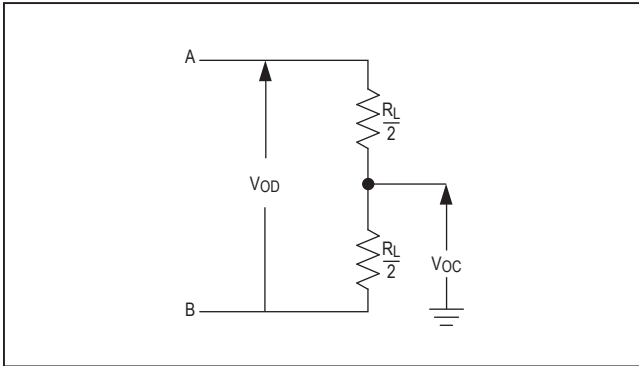


Figure 1. Driver DC Test Load

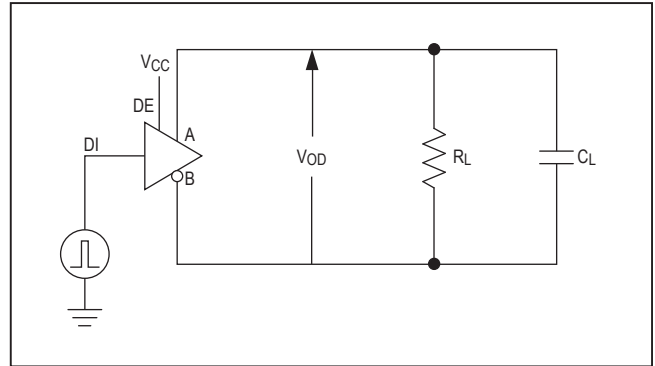


Figure 2. Driver Timing Test Circuit

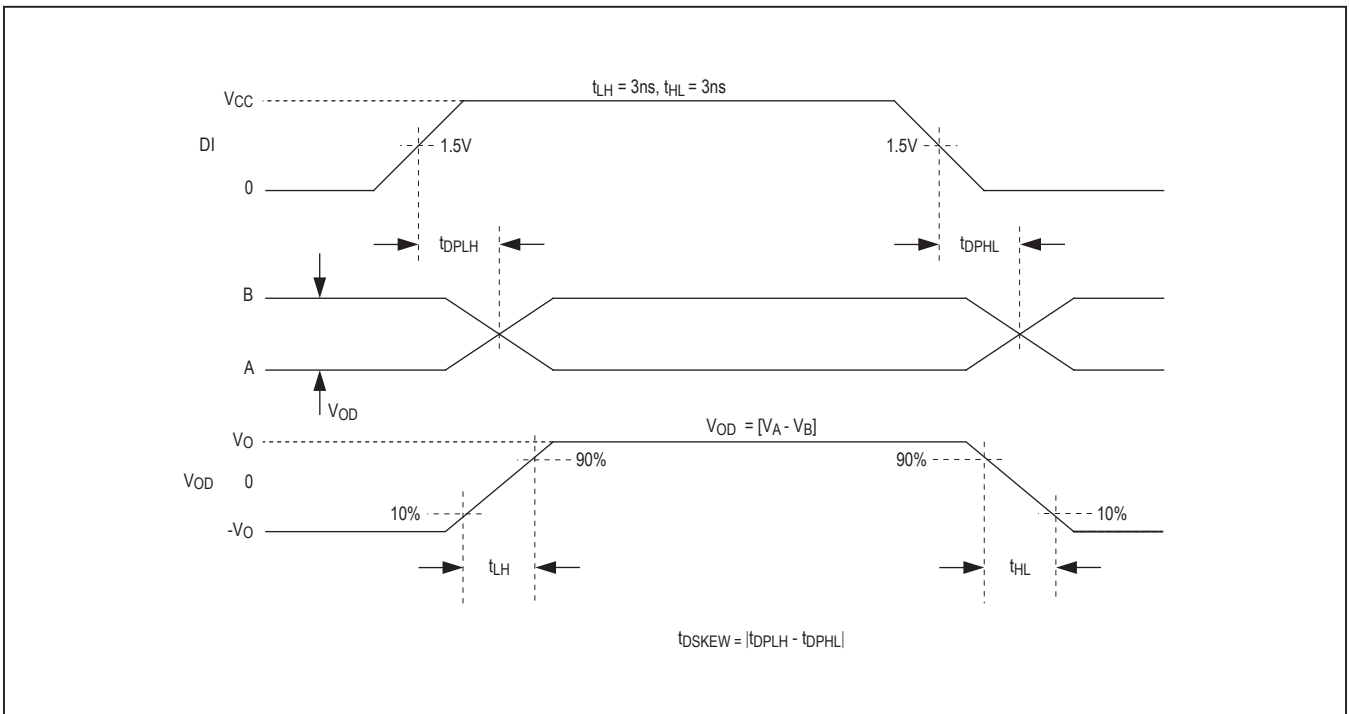


Figure 3. Driver Propagation Delays

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+3.3V-Powered, ±20kV ESD-Protected,  
 20Mbps and Slew-Rate-Limited  
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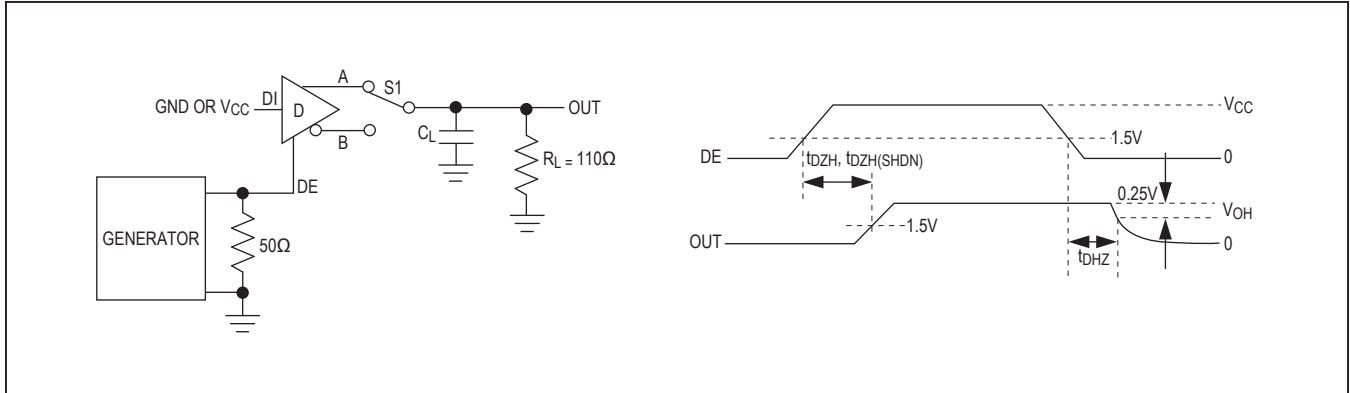


Figure 4. Driver Enable and Disable Times ( $t_{DZH}$ ,  $t_{DZL}$ )

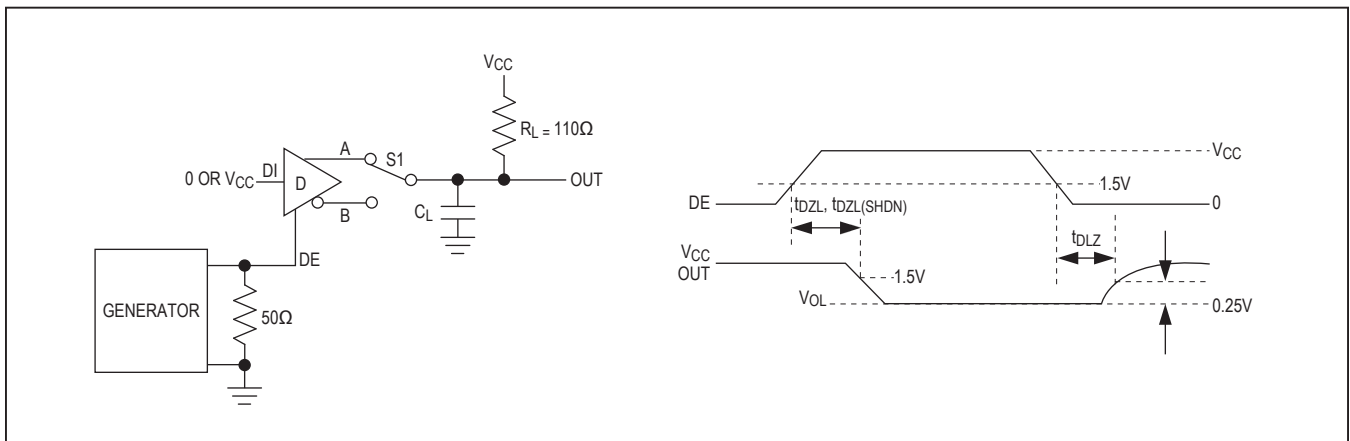


Figure 5. Driver Enable and Disable Times ( $t_{DZL}$ ,  $t_{DLZ}$ )

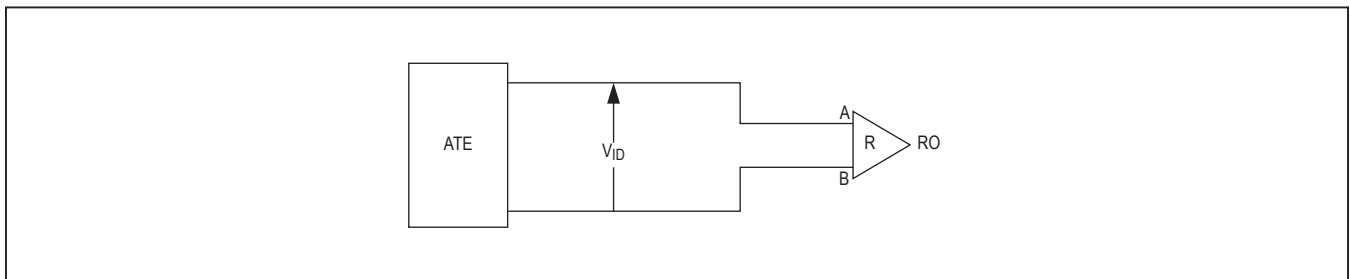


Figure 6. Receiver Propagation Delay Test Circuit



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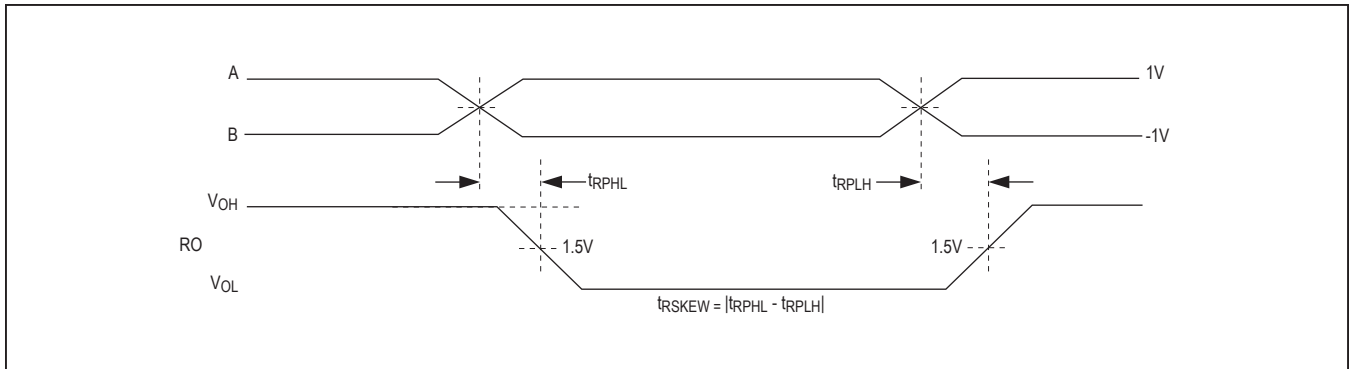


Figure 7. Receiver Propagation Delays

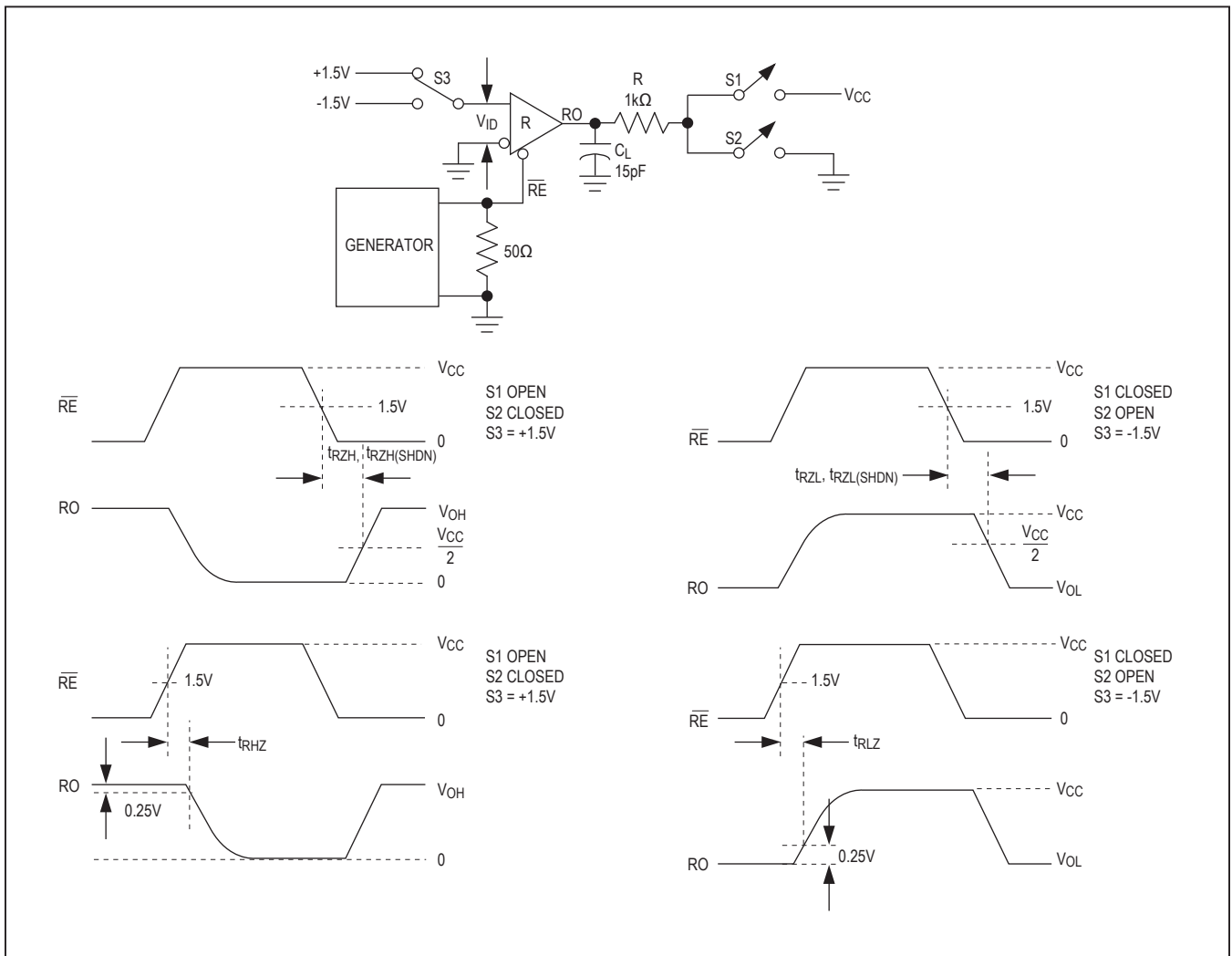


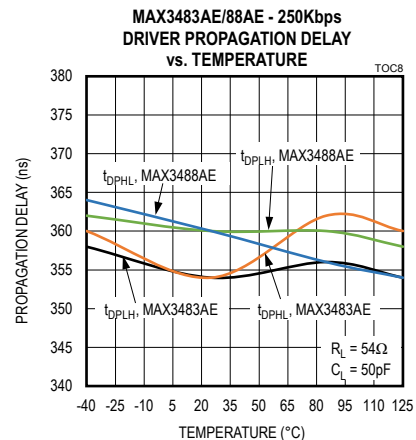
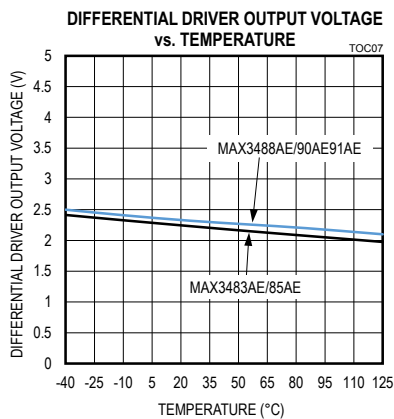
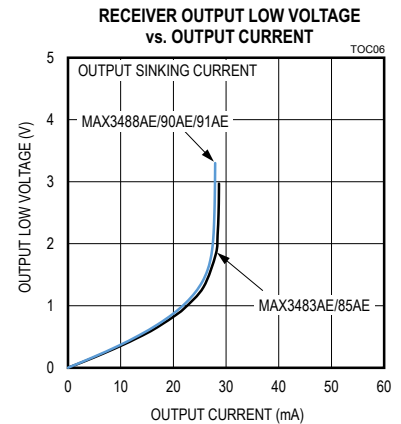
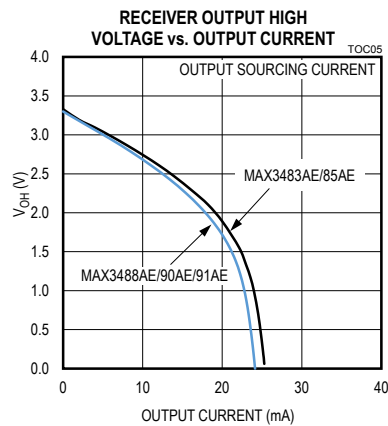
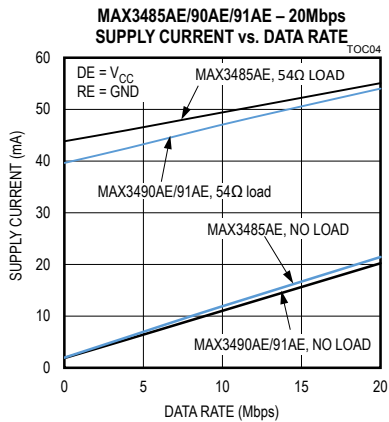
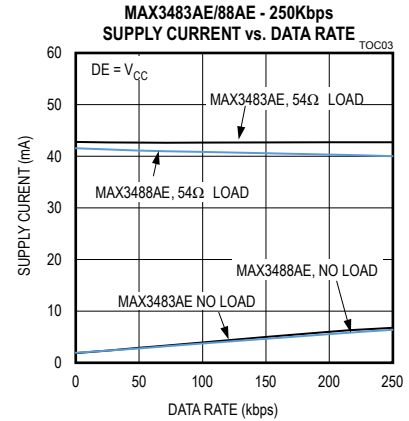
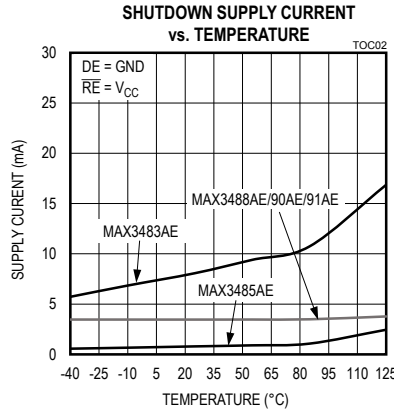
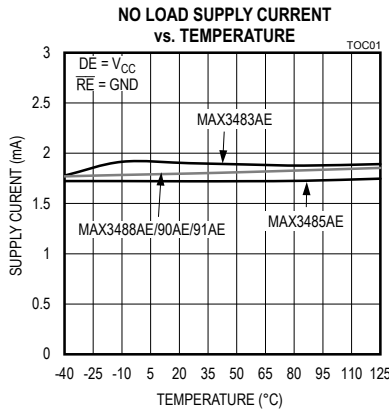
Figure 8. Receiver Enable and Disable Times

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Typical Operating Characteristics

(V<sub>CC</sub> = +3.3V, T<sub>A</sub> = +25°C, unless otherwise specified.)

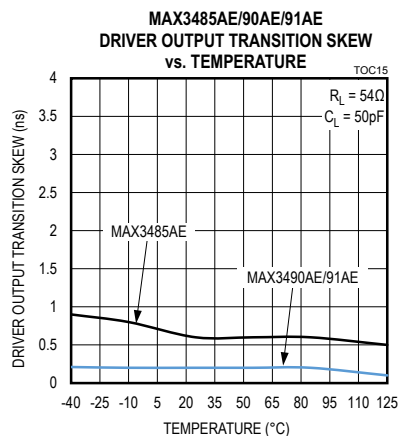
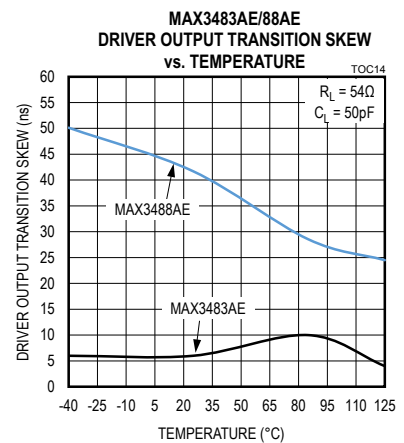
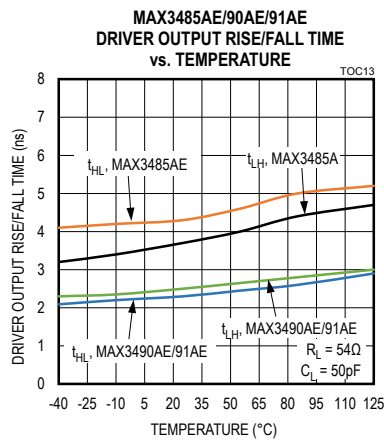
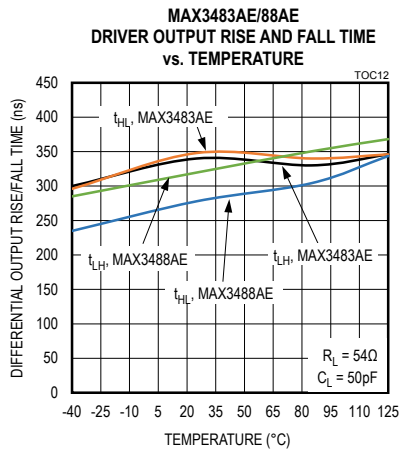
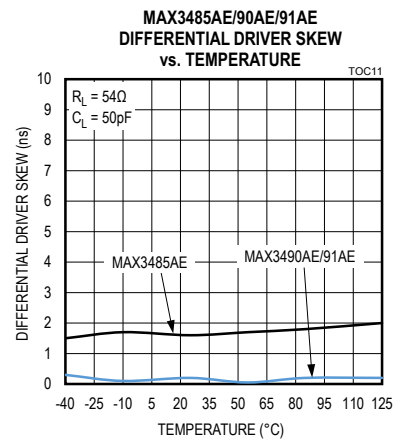
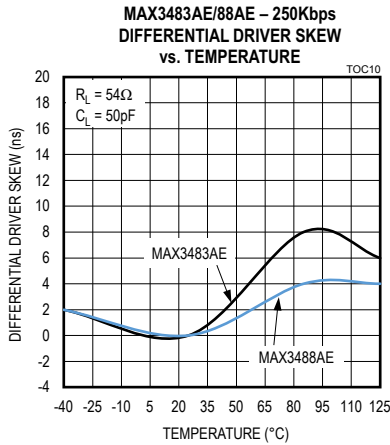
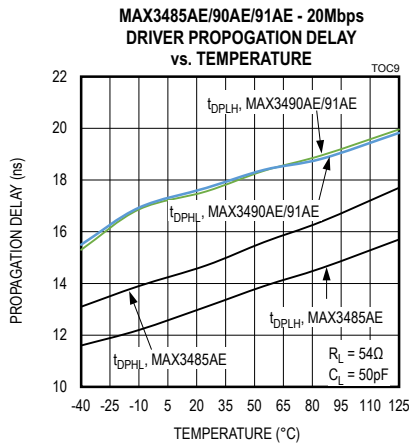


MAX3483AE/MAX3485AE/  
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MAX3491AE

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Typical Operating Characteristics (continued)

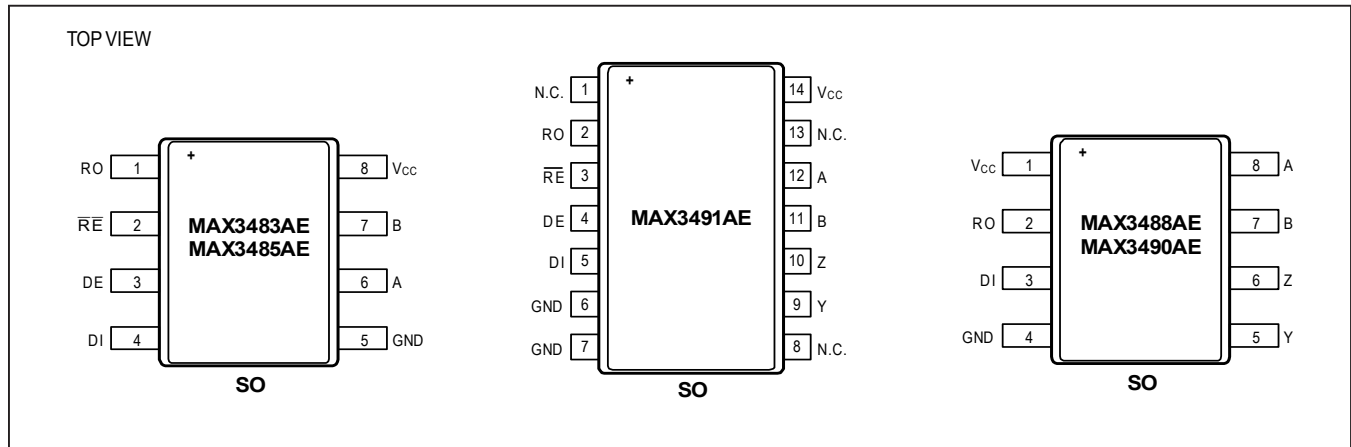
(V<sub>CC</sub> = +3.3V, T<sub>A</sub> = +25°C, unless otherwise specified.)



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## Pin Configuration



## Pin Description

| PIN                    |                        |           | NAME            | FUNCTION  |
|------------------------|------------------------|-----------|-----------------|---|
| MAX3483AE<br>MAX3485AE | MAX3488AE<br>MAX3490AE | MAX3491AE |                 |   |
| —                      | —                      | 1, 8, 13  | N.C.            | No Connection. Not internally connected.  |
| 1                      | 2                      | 2         | RO              | Receiver Output. Drive $\overline{RE}$ low to enable RO. RO is always active on the MAX3488AE and MAX3490AE. RO is high when the receiver inputs ( $V_A - V_B$ ) > -10mV and low when ( $V_A - V_B$ ) $\leq$ 200mV. See the Function Tables.  |
| 2                      | —                      | 3         | $\overline{RE}$ | Receiver Output Enable. Drive $\overline{RE}$ low, or leave unconnected, to enable RO. RO is high impedance when $\overline{RE}$ is high. Drive $\overline{RE}$ high and DE low to enter low-power shutdown mode. $\overline{RE}$ has a weak pulldown to GND.   |
| 3                      | —                      | 4         | DE              | Driver Enable. Drive DE high, or leave unconnected, to enable the driver outputs (Y and Z for full duplex, A and B for half duplex). The driver outputs are high impedance when DE is low. Drive $\overline{RE}$ high and DE low to enter low-power shutdown mode. DE has a weak pullup to $V_{CC}$ . |
| 4                      | 3                      | 5         | DI              | Driver Input. A low on DI forces the noninverting output (Y or A) low and the inverting output (Z or B) high. Similarly, a high on DI forces the noninverting output (Y or A) high and the inverting output (Z or B) low. See the Function Tables.  |
| 5                      | 4                      | 6, 7      | GND             | Ground  |
| —                      | 5                      | 9         | Y               | Noninverting Driver Output  |
| —                      | 6                      | 10        | Z               | Inverting Driver Output   |
| 7                      | 7                      | 11        | B               | Inverting Receiver Input/Driver Output (MAX3483AE/MAX3485AE).<br>Inverting Receiver Input (MAX3488AE/MAX3490AE/MAX3491AE).  |
| 6                      | 8                      | 12        | A               | Noninverting Receiver Input/Driver Output (MAX3483AE/MAX3485AE).<br>Noninverting Receiver Input (MAX3488AE/MAX3490AE/MAX3491AE).  |
| 8                      | 1                      | 14        | $V_{CC}$        | Positive Supply. Bypass $V_{CC}$ to GND with a 0.1 $\mu$ F capacitor as close as possible to the IC.  |

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**Function Tables (MAX3483AE, MAX3485AE)**

| TRANSMITTING    |    |    |                |   |                 |
|-----------------|----|----|----------------|---|-----------------|
| INPUTS          |    |    | OUTPUTS        |   | MODE            |
| $\overline{RE}$ | DE | DI | B              | A |                 |
| X               | 1  | 1  | 0              | 1 | Active          |
| X               | 1  | 0  | 1              | 0 | Active          |
| 0               | 0  | X  | High Impedance |   | Driver Disabled |
| 1               | 0  | X  | High Impedance |   | Shutdown        |

| RECEIVING       |    |               |                |                   |
|-----------------|----|---------------|----------------|-------------------|
| INPUTS          |    |               | OUTPUTS        | MODE              |
| $\overline{RE}$ | DE | A-B           | RO             |                   |
| 0               | X  | $\geq -10mV$  | 1              | Active            |
| 0               | X  | $\leq -200mV$ | 0              | Active            |
| 0               | X  | Open/Shorted  | 1              | Active            |
| 1               | 1  | X             | High Impedance | Receiver Disabled |
| 1               | 0  | X             | High Impedance | Shutdown          |

X = Don't care

**Function Tables MAX3491AE**

| TRANSMITTING      |     |    |                |   |
|-------------------|-----|----|----------------|---|
| INPUTS            |     |    | OUTPUTS        |   |
| $\overline{RE}^*$ | DE* | DI | Y              | Z |
| X                 | 1   | 1  | 1              | 0 |
| X                 | 1   | 0  | 0              | 1 |
| 0                 | 0   | X  | High-Impedance |   |
| 1                 | 0   | X  | Shutdown       |   |

| RECEIVING         |     |               |                |
|-------------------|-----|---------------|----------------|
| INPUTS            |     |               | OUTPUT         |
| $\overline{RE}^*$ | DE* | $V_A - V_B$   | RO             |
| 0                 | X   | $\geq -10mV$  | 1              |
| 0                 | X   | $\leq -200mV$ | 0              |
| 0                 | X   | Open/Shorted  | 1              |
| 1                 | 1   | X             | High-Impedance |
| 1                 | 0   | X             | Shutdown       |

\* $\overline{RE}$  and DE on the MAX3488AE and MAX3490AE are internal. The driver outputs and receiver are always active in these devices.

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**Detailed Description**

The MAX3483AE/85AE and MAX3488AE/90AE/91AE family are 3.3V ESD-protected RS-485/RS-422 transceivers intended for half-duplex or full-duplex communications. Integrated hot-swap functionality eliminates false transitions on the bus during power-up or hot insertion.

The device features fail-safe receiver inputs guaranteeing a logic-high receiver output when inputs are shorted or open. The MAX3483AE/85AE has a 1-unit load receiver input impedance, allowing up to 32 transceivers on the bus. The MAX3488AE/90AE/91AE has a 1/4-unit load receiver input impedance, allowing up to 128 transceivers on the bus.

**True Fail Safe**

The transceiver family guarantee a logic-high receiver output when the receiver inputs are shorted or open, or when they are connected to a terminated transmission line with all drivers disabled. If the differential receiver input voltage (A–B) is greater than or equal to -10mV, RO is logic-high.

**Driver Single-Ended Operation**

The driver outputs can either be used in the standard differential operating mode, or can be used as single-ended outputs. Since the driver outputs swing rail-to-rail, they can individually be used as standard TTL logic outputs.

For half-duplex transceivers, driver outputs are A and B. For full-duplex transceivers, driver outputs are Y and Z.

**Hot-Swap Capability**

**Hot-Swap Inputs**

When circuit boards are inserted in a hot or powered backplane, disturbances on the enable inputs and differential receiver inputs can lead to data errors. Upon initial circuit board insertion, the processor undergoes its power-up sequence. During this period, the processor output drivers are high impedance and are unable to drive the DE and RE inputs MAX3483AE/85AE/91AE to a defined logic level. Leakage currents up to 10µA from the high-impedance outputs of a controller could cause DE and RE to drift to an incorrect logic state. Additionally, parasitic circuit board capacitance could cause coupling of VCC or GND to DE and RE. These factors could improperly enable the driver or receiver. The integrated hot-swap inputs help to avoid these potential problems.

When VCC rises, an internal pulldown circuit holds DE low and RE high. After the initial power-up sequence, the pulldown circuit becomes transparent, resetting the hot-swap-tolerable inputs.

**Hot-Swap Input Circuitry**

The DE and RE enable inputs feature hot-swap capability. At the input, there are two nMOS devices, M1 and M2 (Figure 9). When VCC ramps from 0V, an internal 10µs timer turns on M2 and sets the SR latch that also turns on M1. Transistors M2 (a 500µA current sink) and M1 (a 100µA current sink) pull DE to GND through a 5kΩ (typ)

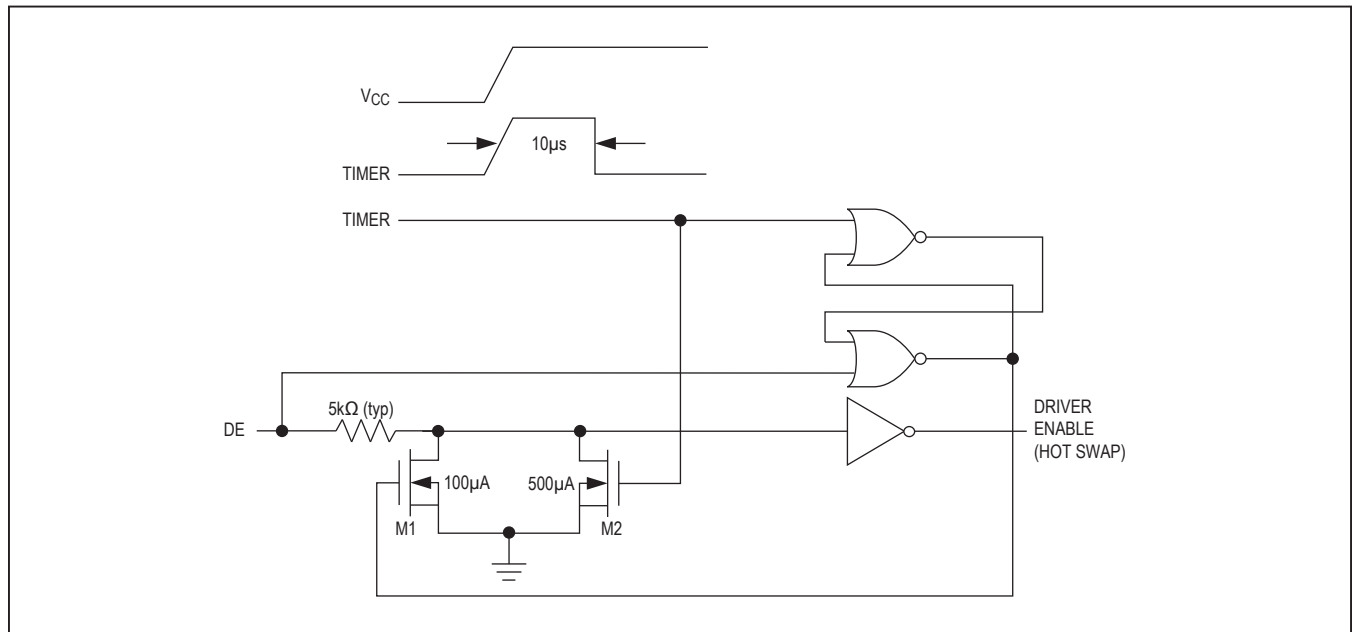


Figure 9. Simplified Structure of the Driver Enable (DE) Pin

MAX3483AE/MAX3485AE/  
MAX3488AE/MAX3490AE/  
MAX3491AE

resistor. M2 is designed to pull DE to the disabled state against an external parasitic capacitance up to 100pF that can drive DE high. After 10μs, the timer deactivates M2 while M1 remains on, holding DE low against three-state leakages that can drive DE high. M1 remains on until an external source overcomes the required input current. At this time, the SR latch resets and M1 turns off. When M1 turns off, DE reverts to a standard, high-impedance CMOS input. Whenever V<sub>CC</sub> drops below 1V, the hot-swap input is reset.

A complementary circuit employing two pMOS devices pulls RE to V<sub>CC</sub>.

**±20kV ESD Protection**

ESD protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The driver outputs and receiver inputs have extra protection against static electricity. The ESD structures withstand high ESD in all states: normal operation, shutdown, and powered down. After an ESD event, the transceiver family keeps working without latch-up or damage.

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

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- ±20kV HBM using JEDEC JS-001-2014.
- ±15kV using the Air-Gap Discharge method specified in IEC 61000-4-2.
- ±8kV using the Contact Discharge method specified in IEC 61000-4-2.

**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.

**Human Body Model (HBM)**

Figure 10 shows the HBM, and Figure 11 shows the current waveform it generates when discharged into a low-impedance state. 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.

**IEC 61000-4-2**

The IEC 61000-4-2 standard covers ESD testing and performance of finished equipment. However, it does not specifically refer to integrated circuits. The transceiver family helps in designing equipment to meet IEC 61000-4-2 without the need for additional ESD protection components.

The major difference between tests done using the HBM 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 HBM.

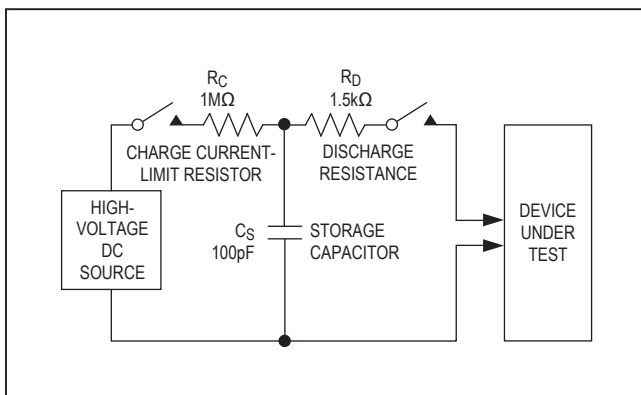


Figure 10. Human Body ESD Test Model

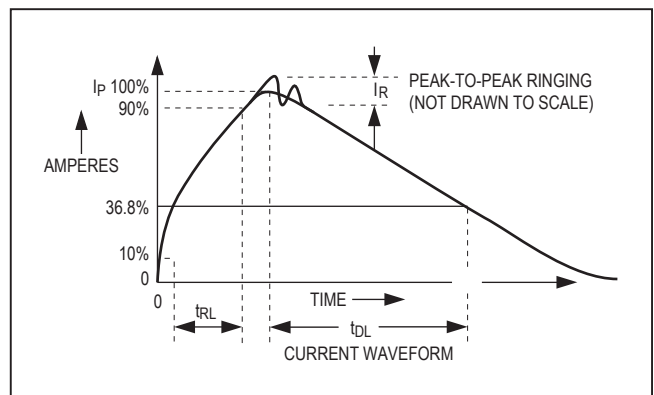


Figure 11. Human Body Current Waveform

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Figure 12 shows the IEC 61000-4-2 model, and Figure 13 shows the current waveform for IEC 61000-4-2 ESD Contact Discharge test.

**Applications Information**

**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°C (typ).

**Low-Power Shutdown Mode (MAX3483AE, MAX3485AE, MAX3491AE)**

Low-power shutdown mode is initiated by bringing  $\overline{RE}$  high and DE low. In shutdown, the devices draw less than 10µA of supply current.

$\overline{RE}$  and DE can be connected together and driven simultaneously. The transceiver is guaranteed not to enter shutdown if  $\overline{RE}$  is high and DE is low for less than 50ns. If the inputs are in this state for at least 800ns (max), the device is guaranteed to enter shutdown.

**Typical Applications**

The transceiver family is designed for bidirectional data communications on multipoint bus transmission lines. Figure 14 and Figure 15 show typical network application circuits. 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.

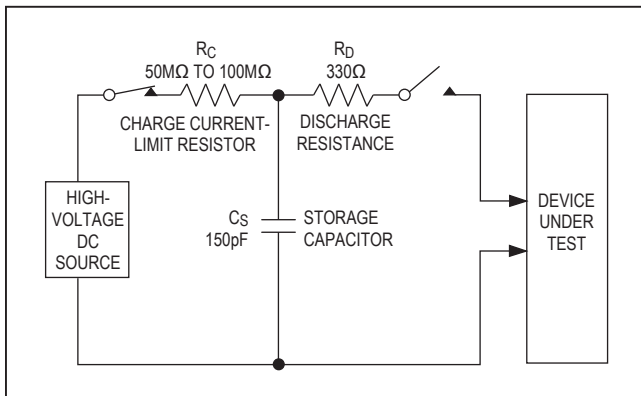


Figure 12. IEC 61000-4-2 ESD Test Model

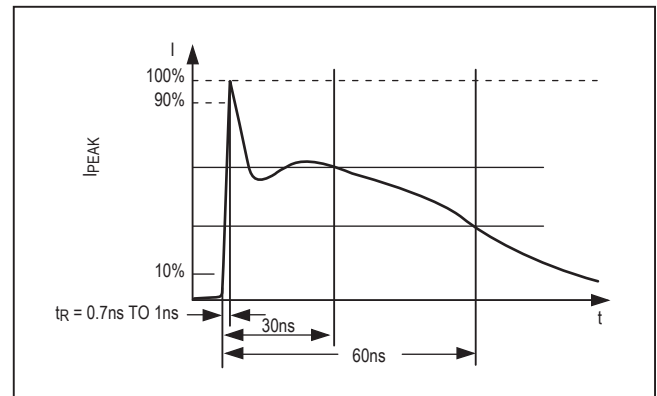


Figure 13. IEC 61000-4-2 ESD Generator Current Waveform

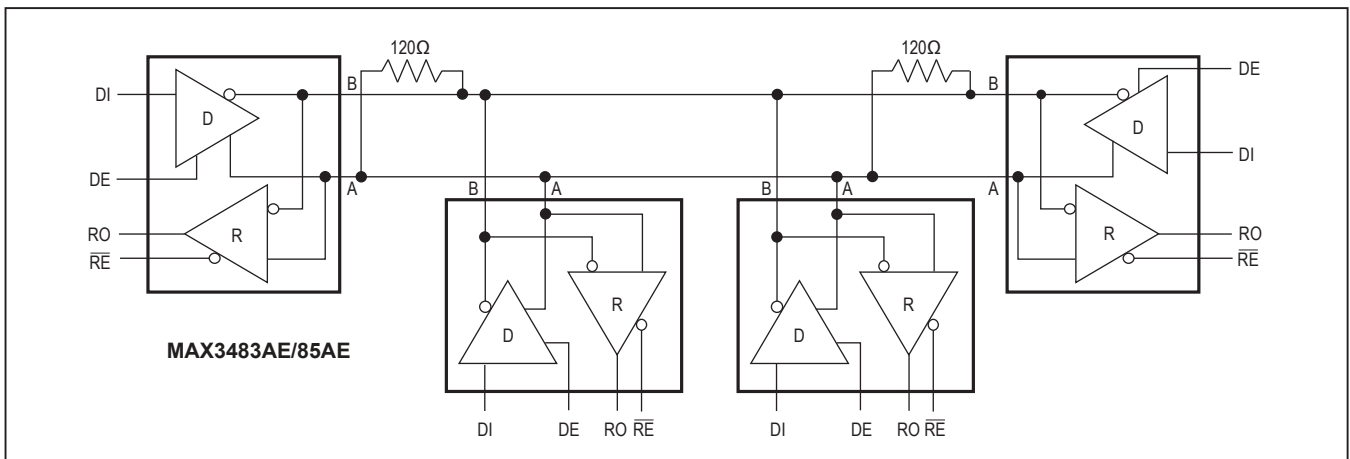


Figure 14. Typical Half-Duplex Application Circuit



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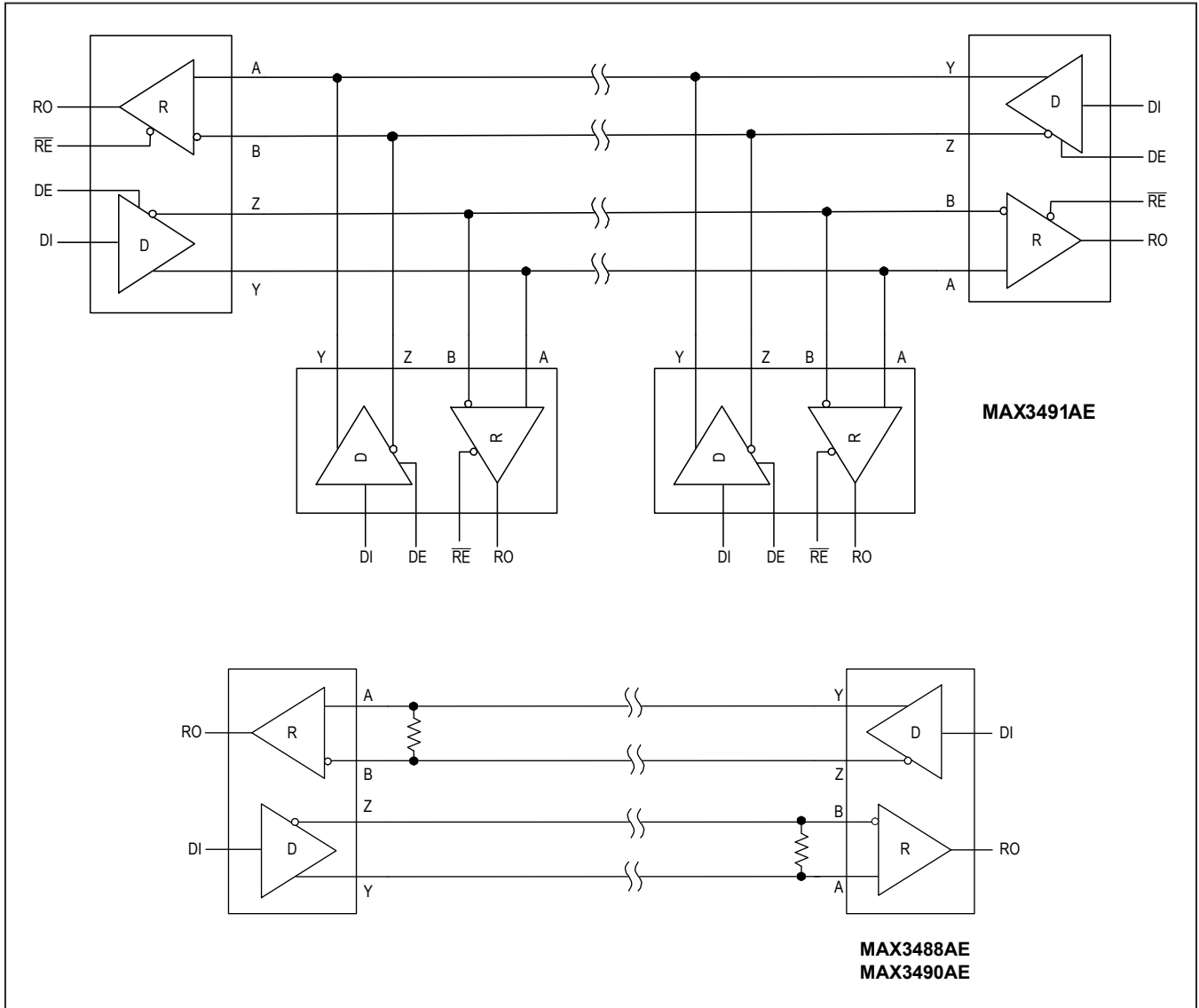


Figure 15. Typical Full-Duplex RS-485 Network

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MAX3488AE/MAX3490AE/  
MAX3491AE

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RS-485/RS-422 Transceivers

## Chip Information

PROCESS: BiCMOS

## Package Information

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 TYPE | PACKAGE CODE | OUTLINE NO.             | LAND PATTERN NO.        |
|--------------|--------------|-------------------------|-------------------------|
| 8 SOIC       | S8+2         | <a href="#">21-0041</a> | <a href="#">90-0096</a> |
| 8 SOIC       | S8+4         | <a href="#">21-0041</a> | <a href="#">90-0096</a> |
| 14 SOIC      | S14+1        | <a href="#">21-0041</a> | <a href="#">90-0112</a> |

## Ordering Information

| PART          | DUPLEX | DATA RATE (MAX) | PIN-PACKAGE | PACKAGE CODE | TEMPERATURE RANGE | NODES |
|---------------|--------|-----------------|-------------|--------------|-------------------|-------|
| MAX3483AEASA+ | Half   | 0.25Mbps        | 8 SO        | S8+2         | -40°C to +125°C   | 32    |
| MAX3485AEASA+ | Half   | 20Mbps          | 8 SO        | S8+2         | -40°C to +125°C   | 32    |
| MAX3488AEGSA+ | Full   | 0.25Mbps        | 8 SO        | S8+4         | -40°C to +105°C   | 128   |
| MAX3490AEGSA+ | Full   | 20Mbps          | 8 SO        | S8+4         | -40°C to +105°C   | 128   |
| MAX3491AEASD+ | Full   | 20Mbps          | 14 SO       | S14+1        | -40°C to +125°C   | 128   |

+Denotes lead(Pb)-free/RoHS-compliant package.

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## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION  | PAGES CHANGED           |
|-----------------|---------------|--|-------------------------|
| 0               | 3/16          | Initial release  | —                       |
| 1               | 9/17          | Updated <i>General Description</i> , <i>Functional Diagram</i> , <i>Absolute Maximum Ratings</i> , <i>Electrical Characteristics</i> table, various figures, and <i>Ordering Information</i> table | 1–6, 8, 10–12,<br>15–18 |

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

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