



$\pm 15\text{kV}$ ESD-Protected, Slew-Rate-Limited, Low-Power, RS-485/RS-422 Transceivers

General Description

The MAX481E, MAX483E, MAX485E, MAX487E–MAX491E, and MAX1487E are low-power transceivers for RS-485 and RS-422 communications in harsh environments. Each driver output and receiver input is protected against $\pm 15\text{kV}$ electro-static discharge (ESD) shocks, without latchup. These parts contain one driver and one receiver. The MAX483E, MAX487E, MAX488E, and MAX489E feature reduced slew-rate drivers that minimize EMI and reduce reflections caused by improperly terminated cables, thus allowing error-free data transmission up to 250kbps. The driver slew rates of the MAX481E, MAX485E, MAX490E, MAX491E, and MAX1487E are not limited, allowing them to transmit up to 2.5Mbps.

These transceivers draw as little as 120 μA supply current when unloaded or when fully loaded with disabled drivers (see *Selector Guide*). Additionally, the MAX481E, MAX483E, and MAX487E have a low-current shutdown mode in which they consume only 0.5 μA . All parts operate from a single +5V supply.

Drivers are short-circuit current limited, and are protected against excessive power dissipation by thermal shutdown circuitry that places their outputs into a high-impedance state. The receiver input has a fail-safe feature that guarantees a logic-high output if the input is open circuit.

The MAX487E and MAX1487E feature quarter-unit-load receiver input impedance, allowing up to 128 transceivers on the bus. The MAX488E–MAX491E are designed for full-duplex communications, while the MAX481E, MAX483E, MAX485E, MAX487E, and MAX1487E are designed for half-duplex applications. For applications that are not ESD sensitive see the pin-function-compatible MAX481, MAX483, MAX485, MAX487–MAX491, and MAX1487.

Applications

Low-Power RS-485 Transceivers
 Low-Power RS-422 Transceivers
 Level Translators
 Transceivers for EMI-Sensitive Applications
 Industrial-Control Local Area Networks

Next-Generation Device Features

- ◆ **For Fault-Tolerant Applications:**
MAX3430: $\pm 80\text{V}$ Fault-Protected, Fail-Safe, 1/4-Unit Load, +3.3V, RS-485 Transceiver
MAX3080–MAX3089: Fail-Safe, High-Speed (10Mbps), Slew-Rate-Limited, RS-485/RS-422 Transceivers
- ◆ **For Space-Constrained Applications:**
MAX3460–MAX3464: +5V, Fail-Safe, 20Mbps, Profibus, RS-485/RS-422 Transceivers
MAX3362: +3.3V, High-Speed, RS-485/RS-422 Transceiver in a SOT23 Package
MAX3280E–MAX3284E: $\pm 15\text{kV}$ ESD-Protected, 52Mbps, +3V to +5.5V, SOT23, RS-485/RS-422 True Fail-Safe Receivers
MAX3030E–MAX3033E: $\pm 15\text{kV}$ ESD-Protected, +3.3V, Quad RS-422 Transmitters
- ◆ **For Multiple Transceiver Applications:**
MAX3293/MAX3294/MAX3295: 20Mbps, +3.3V, SOT23, RS-485/RS-422 Transmitters
- ◆ **For Fail-Safe Applications:**
MAX3440E–MAX3444E: $\pm 15\text{kV}$ ESD-Protected, $\pm 60\text{V}$ Fault-Protected, 10Mbps, Fail-Safe RS-485/J1708 Transceivers
- ◆ **For Low-Voltage Applications:**
MAX3483E/MAX3485E/MAX3486E/MAX3488E/MAX3490E/MAX3491E: +3.3V Powered, $\pm 15\text{kV}$ ESD-Protected, 12Mbps, Slew-Rate-Limited, True RS-485/RS-422 Transceivers

Ordering Information

| PART | TEMP RANGE | PIN-PACKAGE |
|------------|----------------|---------------|
| MAX481ECPA | 0°C to +70°C | 8 Plastic DIP |
| MAX481ECSA | 0°C to +70°C | 8 SO |
| MAX481EEPA | -40°C to +85°C | 8 Plastic DIP |
| MAX481EESA | -40°C to +85°C | 8 SO |
| MAX483ECPA | 0°C to +70°C | 8 Plastic DIP |
| MAX483ECSA | 0°C to +70°C | 8 SO |
| MAX483EEPA | -40°C to +85°C | 8 Plastic DIP |
| MAX483EESA | -40°C to +85°C | 8 SO |

Ordering Information continued at end of data sheet.

Selector Guide appears at end of data sheet.

MAX481E/MAX483E/MAX485E/MAX487E–MAX491E/MAX1487E



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ABSOLUTE MAXIMUM RATINGS

| | | | |
|---|-----------------------------------|---|-----------------|
| Supply Voltage (V _{CC})..... | 12V | 14-Pin Plastic DIP (derate 10.00mW/°C above +70°C) .. | 800mW |
| Control Input Voltage (\overline{RE} , DE)..... | -0.5V to (V _{CC} + 0.5V) | 8-Pin SO (derate 5.88mW/°C above +70°C)..... | 471mW |
| Driver Input Voltage (DI)..... | -0.5V to (V _{CC} + 0.5V) | 14-Pin SO (derate 8.33mW/°C above +70°C)..... | 667mW |
| Driver Output Voltage (Y, Z: A, B)..... | -8V to +12.5V | Operating Temperature Ranges | |
| Receiver Input Voltage (A, B)..... | -8V to +12.5V | MAX4_ _C_ _/MAX1487EC_ A..... | 0°C to +70°C |
| Receiver Output Voltage (RO)..... | -0.5V to (V _{CC} + 0.5V) | MAX4_ _E_ _/MAX1487EE_ A..... | -40°C to +85°C |
| Continuous Power Dissipation (T _A = +70°C) | | Storage Temperature Range..... | -65°C to +160°C |
| 8-Pin Plastic DIP (derate 9.09mW/°C above +70°C) | 727mW | Lead Temperature (soldering, 10sec)..... | +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 ±5%, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.) (Notes 1, 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|------------------|---|-----------------------|-----|------|-------|
| Differential Driver Output (no load) | V _{OD1} | | | | 5 | V |
| Differential Driver Output (with load) | V _{OD2} | R = 50Ω (RS-422) | 2 | | | V |
| | | R = 27Ω (RS-485), Figure 8 | 1.5 | | 5 | V |
| Change in Magnitude of Driver Differential Output Voltage for Complementary Output States | ΔV _{OD} | R = 27Ω or 50Ω, Figure 8 | | | 0.2 | V |
| Driver Common-Mode Output Voltage | V _{OC} | R = 27Ω or 50Ω, Figure 8 | | | 3 | V |
| Change in Magnitude of Driver Common-Mode Output Voltage for Complementary Output States | ΔV _{OD} | R = 27Ω or 50Ω, Figure 8 | | | 0.2 | V |
| Input High Voltage | V _{IH} | DE, DI, \overline{RE} | 2.0 | | | V |
| Input Low Voltage | V _{IL} | DE, DI, \overline{RE} | | | 0.8 | V |
| Input Current | I _{IN1} | DE, DI, \overline{RE} | | | ±2 | μA |
| Input Current (A, B) | I _{IN2} | DE = 0V; V _{CC} = 0V or 5.25V, all devices except MAX487E/MAX1487E | V _{IN} = 12V | | 1.0 | mA |
| | | | V _{IN} = -7V | | -0.8 | |
| | | MAX487E/MAX1487E, DE = 0V, V _{CC} = 0V or 5.25V | V _{IN} = 12V | | 0.25 | mA |
| | | | V _{IN} = -7V | | -0.2 | |
| Receiver Differential Threshold Voltage | V _{TH} | -7V ≤ V _{CM} ≤ 12V | -0.2 | | 0.2 | V |
| Receiver Input Hysteresis | ΔV _{TH} | V _{CM} = 0V | | 70 | | mV |
| Receiver Output High Voltage | V _{OH} | I _O = -4mA, V _{ID} = 200mV | 3.5 | | | V |
| Receiver Output Low Voltage | V _{OL} | I _O = 4mA, V _{ID} = -200mV | | | 0.4 | V |
| Three-State (high impedance) Output Current at Receiver | I _{OZR} | 0.4V ≤ V _O ≤ 2.4V | | | ±1 | μA |
| Receiver Input Resistance | R _{IN} | -7V ≤ V _{CM} ≤ 12V, all devices except MAX487E/MAX1487E | 12 | | | kΩ |
| | | -7V ≤ V _{CM} ≤ 12V, MAX487E/MAX1487E | 48 | | | kΩ |

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DC ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = 5V ±5%, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.) (Notes 1, 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|-------------------|--|----------------------|---------|-----|-------|
| No-Load Supply Current (Note 3) | I _{CC} | MAX488E/MAX489E, DE, DI, RE = 0V or V _{CC} | | 120 | 250 | μA |
| | | MAX490E/MAX491E, DE, DI, RE = 0V or V _{CC} | | 300 | 500 | |
| | | MAX481E/MAX485E, RE = 0V or V _{CC} | DE = V _{CC} | 500 | 900 | |
| | | | DE = 0V | 300 | 500 | |
| | | MAX1487E, RE = 0V or V _{CC} | DE = V _{CC} | 300 | 500 | |
| | | | DE = 0V | 230 | 400 | |
| | | MAX483E/MAX487E, RE = 0V or V _{CC} | DE = V _{CC} | MAX483E | 350 | |
| MAX487E | 250 | | | 400 | | |
| Supply Current in Shutdown | ISHDN | MAX481E/483E/487E, DE = 0V, RE = V _{CC} | | 0.5 | 10 | μA |
| Driver Short-Circuit Current, V _O = High | I _{OSD1} | -7V ≤ V _O ≤ 12V (Note 4) | 35 | | 250 | mA |
| Driver Short-Circuit Current, V _O = Low | I _{OSD2} | -7V ≤ V _O ≤ 12V (Note 4) | 35 | | 250 | mA |
| Receiver Short-Circuit Current | I _{OSR} | 0V ≤ V _O ≤ V _{CC} | 7 | | 95 | mA |
| ESD Protection | | A, B, Y and Z pins, tested using Human Body Model | | ±15 | | kV |

SWITCHING CHARACTERISTICS—MAX481E/MAX485E, MAX490E/MAX491E, MAX1487E

(V_{CC} = 5V ±5%, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.) (Notes 1, 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | |
|--|-------------------------------------|---|----------------------------|-----|-----|-------|----|
| Driver Input to Output | t _{PLH} | Figures 10 and 12, R _{DIFF} = 54Ω, C _{L1} = C _{L2} = 100pF | 10 | 40 | 60 | ns | |
| | t _{PHL} | | 10 | 40 | 60 | | |
| Driver Output Skew to Output | t _{SKEW} | Figures 10 and 12, R _{DIFF} = 54Ω, C _{L1} = C _{L2} = 100pF | | 5 | 10 | ns | |
| Driver Rise or Fall Time | t _r , t _f | Figures 10 and 12, R _{DIFF} = 54Ω, C _{L1} = C _{L2} = 100pF | MAX481E, MAX485E, MAX1487E | 3 | 20 | 40 | ns |
| | | | MAX490EC/E, MAX491EC/E | 5 | 20 | 25 | |
| Driver Enable to Output High | t _{ZH} | Figures 11 and 13, C _L = 100pF, S2 closed | | 45 | 70 | ns | |
| Driver Enable to Output Low | t _{ZL} | Figures 11 and 13, C _L = 100pF, S1 closed | | 45 | 70 | ns | |
| Driver Disable Time from Low | t _{LZ} | Figures 11 and 13, C _L = 15pF, S1 closed | | 45 | 70 | ns | |
| Driver Disable Time from High | t _{HZ} | Figures 11 and 13, C _L = 15pF, S2 closed | | 45 | 70 | ns | |
| Receiver Input to Output | t _{PLH} , t _{PHL} | Figures 10 and 14, R _{DIFF} = 54Ω, C _{L1} = C _{L2} = 100pF | MAX481E, MAX485E, MAX1487E | 20 | 60 | 200 | ns |
| | | | MAX490EC/E, MAX491EC/E | 20 | 60 | 150 | |
| t _{PLH} - t _{PHL} Differential Receiver Skew | t _{SKD} | Figures 10 and 14, R _{DIFF} = 54Ω, C _{L1} = C _{L2} = 100pF | | 5 | | ns | |
| Receiver Enable to Output Low | t _{ZL} | Figures 9 and 15, C _R L = 15pF, S1 closed | | 20 | 50 | ns | |
| Receiver Enable to Output High | t _{ZH} | Figures 9 and 15, C _R L = 15pF, S2 closed | | 20 | 50 | ns | |
| Receiver Disable Time from Low | t _{LZ} | Figures 9 and 15, C _R L = 15pF, S1 closed | | 20 | 50 | ns | |
| Receiver Disable Time from High | t _{HZ} | Figures 9 and 15, C _R L = 15pF, S2 closed | | 20 | 50 | ns | |
| Maximum Data Rate | f _{MAX} | | 2.5 | | | Mbps | |
| Time to Shutdown | t _{SHDN} | MAX481E (Note 5) | 50 | 200 | 600 | ns | |

MAX481E/MAX483E/MAX485E/MAX487E-MAX491E/MAX1487E

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MAX481E/MAX483E/MAX485E/MAX487E-MAX491E/MAX1487E

**SWITCHING CHARACTERISTICS—MAX481E/MAX485E, MAX490E/MAX491E, MAX1487E
(continued)**

(V_{CC} = 5V ±5%, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.) (Notes 1, 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|------------------------|--|-----|-----|------|-------|
| Driver Enable from Shutdown to Output High (MAX481E) | t _{ZH} (SHDN) | Figures 11 and 13, C _L = 100pF, S2 closed | | 45 | 100 | ns |
| Driver Enable from Shutdown to Output Low (MAX481E) | t _{ZL} (SHDN) | Figures 11 and 13, C _L = 100pF, S1 closed | | 45 | 100 | ns |
| Receiver Enable from Shutdown to Output High (MAX481E) | t _{ZH} (SHDN) | Figures 9 and 15, C _L = 15pF, S2 closed, A - B = 2V | | 225 | 1000 | ns |
| Receiver Enable from Shutdown to Output Low (MAX481E) | t _{ZL} (SHDN) | Figures 9 and 15, C _L = 15pF, S1 closed, B - A = 2V | | 225 | 1000 | ns |

SWITCHING CHARACTERISTICS—MAX483E, MAX487E/MAX488E/MAX489E

(V_{CC} = 5V ±5%, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.) (Notes 1, 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|---------------------------------|---|-----|-----|------|-------|
| Driver Input to Output | t _{PLH} | Figures 10 and 12, R _{DIFF} = 54Ω, C _{L1} = C _{L2} = 100pF | 250 | 800 | 2000 | ns |
| | t _{PHL} | | 250 | 800 | 2000 | |
| Driver Output Skew to Output | t _{SKEW} | Figures 10 and 12, R _{DIFF} = 54Ω, C _{L1} = C _{L2} = 100pF | | 20 | 800 | ns |
| Driver Rise or Fall Time | t _R , t _F | Figures 10 and 12, R _{DIFF} = 54Ω, C _{L1} = C _{L2} = 100pF | 250 | | 2000 | ns |
| Driver Enable to Output High | t _{ZH} | Figures 11 and 13, C _L = 100pF, S2 closed | 250 | | 2000 | ns |
| Driver Enable to Output Low | t _{ZL} | Figures 11 and 13, C _L = 100pF, S1 closed | 250 | | 2000 | ns |
| Driver Disable Time from Low | t _{LZ} | Figures 11 and 13, C _L = 15pF, S1 closed | 300 | | 3000 | ns |
| Driver Disable Time from High | t _{HZ} | Figures 11 and 13, C _L = 15pF, S2 closed | 300 | | 3000 | ns |
| Receiver Input to Output | t _{PLH} | Figures 10 and 14, R _{DIFF} = 54Ω, C _{L1} = C _{L2} = 100pF | 250 | | 2000 | ns |
| | t _{PHL} | | 250 | | 2000 | |
| t _{PLH} - t _{PHL} Differential Receiver Skew | t _{SKD} | Figures 10 and 14, R _{DIFF} = 54Ω, C _{L1} = C _{L2} = 100pF | | 100 | | ns |
| Receiver Enable to Output Low | t _{ZL} | Figures 9 and 15, C _{RL} = 15pF, S1 closed | | 25 | 50 | ns |
| Receiver Enable to Output High | t _{ZH} | Figures 9 and 15, C _{RL} = 15pF, S2 closed | | 25 | 50 | ns |
| Receiver Disable Time from Low | t _{LZ} | Figures 9 and 15, C _{RL} = 15pF, S1 closed | | 25 | 50 | ns |
| Receiver Disable Time from High | t _{HZ} | Figures 9 and 15, C _{RL} = 15pF, S2 closed | | 25 | 50 | ns |
| Maximum Data Rate | f _{MAX} | t _{PLH} , t _{PHL} < 50% of data period | 250 | | | kbps |
| Time to Shutdown | t _{SHDN} | MAX483E/MAX487E (Note 5) | 50 | 200 | 600 | ns |
| Driver Enable from Shutdown to Output High | t _{ZH} (SHDN) | MAX483E/MAX487E, Figures 11 and 13, C _L = 100pF, S2 closed | | | 2000 | ns |
| Driver Enable from Shutdown to Output Low | t _{ZL} (SHDN) | MAX483E/MAX487E, Figures 11 and 13, C _L = 100pF, S1 closed | | | 2000 | ns |
| Receiver Enable from Shutdown to Output High | t _{ZH} (SHDN) | MAX483E/MAX487E, Figures 9 and 15, C _L = 15pF, S2 closed | | | 2500 | ns |
| Receiver Enable from Shutdown to Output Low | t _{ZL} (SHDN) | MAX483E/MAX487E, Figures 9 and 15, C _L = 15pF, S1 closed | | | 2500 | ns |