19-0259; Rev 5; 5/05

# Complete, Isolated RS-485/RS-422 Data Interface



## General Description

The MAX1480A/MAX1480B/MAX1480C/MAX1490A/MAX1490B are complete, electrically isolated, RS-485/RS-422 data-communications interface solutions in a hybrid microcircuit. Transceivers, optocouplers, and a transformer provide a complete interface in a standard DIP package. A single +5V supply on the logic side powers both sides of the interface.

The MAX1480B/MAX1480C/MAX1490B feature reduced-slew-rate drivers that minimize EMI and reduce reflections caused by improperly terminated cables, allowing error-free data transmission at data rates up to 250kbps. The MAX1480A/MAX1490A driver slew rate is not limited, allowing transmission rates up to 2.5Mbps. The MAX1480A/B/C are designed for half-duplex communication, while the MAX1490A/B feature full-duplex communication.

Drivers are short-circuit current limited and protected against excessive power dissipation by thermal shutdown circuitry that places the driver outputs into a high-impedance state. The receiver input has a fail-safe feature that guarantees a known output ($\overline{RO}$ low for the MAX1480A/B/C, RO high for the MAX1490A/B) if the input is open circuit.

The MAX1480A/MAX1480B/MAX1480C/MAX1490A/MAX1490B typically withstand 1600$V_{RMS}$ (1 minute) or 2000$V_{RMS}$ (1 second). Their isolated outputs meet all RS-485/RS-422 specifications. The MAX1480A/B/C are available in a 28-pin DIP package, and the MAX1490A/B are available in a 24-pin DIP package.

## Applications

Isolated RS-485/RS-422 Data Interface

Transceivers for EMI-Sensitive Applications

Industrial-Control Local Area Networks

Automatic Test Equipment

HVAC/Building Control Networks

## Next-Generation Device Features

- **For Integrated ESD Protection**
  **MAX1480E/MAX1490E: ±15kV ESD-Protected, Isolated RS-485/RS-422 Data Interfaces**
- **For Space-Constrained Applications**
  **MAX3157: High CMRR, RS-485 Transceiver with ±50V Isolation**

## Ordering Information

| PART† | TEMP RANGE | PIN-PACKAGE |
|---|---|---|
| **MAX1480A**CPI | 0°C to +70°C | 28 Wide Plastic DIP |
| MAX1480AEPI | -40°C to +85°C | 28 Wide Plastic DIP |

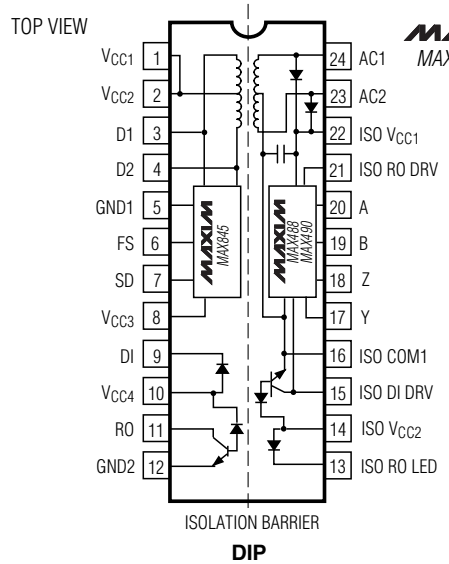
***Ordering Information continued at end of data sheet.***

†*Data rate for "A" parts is up to 2.5Mbps. Data rate for "B" and "C" parts is up to 250kbps.*

## Selection Table

| PART | HALF/ FULL DUPLEX | DATA RATE (MBPS) | SLEW-RATE LIMITED | DRIVER ENABLE TIME (µs) |
|---|---|---|---|---|
| MAX1480A | Half | 2.5 | No | 0.2 |
| MAX1480B | Half | 0.25 | Yes | 35 |
| MAX1480C | Half | 0.25 | Yes | 0.5 |
| MAX1490A | Full | 2.5 | No | — |
| MAX1490B | Full | 0.25 | Yes | — |

## Pin Configurations




**DIP**

*Pin Configurations continued at end of data sheet.*



***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.***

# Complete, Isolated RS-485/RS-422 Data Interface

## ABSOLUTE MAXIMUM RATINGS

With Respect to GND_
- Supply Voltage ($V_{CC_}$).....-0.3V to +6V
- Control Input Voltage (SD, $\overline{FS}$).....-0.3V to ($V_{CC_}$ + 0.3V)
- Receiver Output Voltage ($\overline{RO}$, RO).....-0.3V to ($V_{CC_}$ + 0.3V)
- Output Switch Voltage (D1, D2).....+12V

With Respect to ISO COM_
- Control Input Voltage (ISO DE_ ) ....-0.3V to (ISO $V_{CC_}$ + 0.3V)
- Driver Input Voltage (ISO DI_ ) .....-0.3V to (ISO $V_{CC_}$ + 0.3V)
- Receiver Output Voltage (ISO RO_) ...-0.3V to (ISO $V_{CC_}$ + 0.3V)
- Driver Output Voltage (A, B, Y, Z ) .....-8V to +12.5V
- Receiver Input Voltage (A, B).....-8V to +12.5V

LED Forward Current (DI, DE, ISO RO LED) .....50mA
Continuous Power Dissipation ($T_A$ = +70°C)
- 24-Pin Plastic DIP (derate 8.7mW°C above +70°C) .....696mW
- 28-Pin Plastic DIP (derate 9.09mW/°C above +70°C) ..727mW

Operating Temperature Ranges
- MAX1480_CPI/MAX1490_CPG.....0°C to +70°C
- MAX1480_EPI/MAX1490_EPG .....-40°C to +85°C

Storage Temperature Range .....-65°C to +160°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.*

## ELECTRICAL CHARACTERISTICS

($V_{CC_}$ = 5V ±10%, $V_{FS}$ = $V_{CC_}$, $T_A$ = $T_{MIN}$ to $T_{MAX}$, unless otherwise noted. Typical values are at $V_{CC_}$ = 5V and $T_A$ = +25°C.) (Notes 1, 2)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Switch Frequency | $f_{SWL}$ | $V_{FS}$ = 0V | | | 535 | | kHz |
| | $f_{SWH}$ | FS = $V_{CC_}$ or open | | | 725 | | |
| Operating Supply Current | $I_{CC}$ | MAX1480A, DE´ = $V_{CC_}$ or open | $R_L$ = ∞, +25°C only | | 60 | 90 | mA |
| | | | $R_L$ = 54Ω | | 120 | | |
| | | MAX1480B, DE´ = $V_{CC_}$ or open | $R_L$ = ∞, +25°C only | | 35 | 45 | |
| | | | $R_L$ = 54Ω | | 95 | | |
| | | MAX1480C, DE´ = $V_{CC_}$ or open | $R_L$ = ∞, +25°C only | | 35 | 75 | |
| | | | $R_L$ = 54Ω | | 95 | | |
| | | MAX1490A | $R_L$ = ∞, +25°C only | | 100 | 150 | |
| | | | $R_L$ = 54Ω | | 170 | | |
| | | MAX1490B | $R_L$ = ∞, +25°C only | | 65 | 125 | |
| | | | $R_L$ = 54Ω | | 130 | | |
| Shutdown Supply Current (Note 3) | $I_{SHDN}$ | SD = $V_{CC_}$ | | | 0.2 | | µA |
| Shutdown Input Threshold | $V_{SDH}$ | High | | 2.4 | | | V |
| | $V_{SDL}$ | Low | | | | 0.8 | |
| Shutdown Input Leakage Current | | | | | 10 | | pA |
| FS Input Threshold | $V_{FSH}$ | High | | 2.4 | | | V |
| | $V_{FSL}$ | Low | | | | 0.8 | |
| FS Input Pullup Current | | FS low | | | | 50 | µA |
| FS Input Leakage Current | | FS high | | | 10 | | pA |
| Input High Voltage | $V_{IH}$ | DE´, DI´ | | $V_{CC_}$ - 0.4 | | | V |
| Input Low Voltage | $V_{IL}$ | DE´, DI´ | | | | 0.4 | V |
| Isolation Resistance | $R_{ISO}$ | $T_A$ = +25°C, $V_{ISO}$ = 50VDC | | 100 | 10,000 | | MΩ |
| Isolation Capacitance | $C_{ISO}$ | $T_A$ = +25°C, $V_{ISO}$ = 50VDC | | | 10 | | pF |
| Differential Driver Output (No Load) | $V_{OD1}$ | | | | | 8 | V |

## ELECTRICAL CHARACTERISTICS (continued)

($V_{CC_}$ = 5V ±10%, $V_{FS}$ = $V_{CC_}$, $T_A$ = $T_{MIN}$ to $T_{MAX}$, unless otherwise noted. Typical values are at $V_{CC_}$ = 5V and $T_A$ = +25°C.) (Notes 1, 2)

| PARAMETER | SYMBOL | CONDITIONS | | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| Differential Driver Output (With Load) | $V_{OD2}$ | R = 50Ω (RS-422) | | | 2 | | | V |
| | | R = 27Ω (RS-485), Figure 4 | | | 1.5 | | 5.0 | |
| Change in Magnitude of Differential Output Voltage for Complementary Output States | $\Delta V_{OD}$ | R = 27Ω or 50Ω, Figure 4 | Differential | | | | 0.3 | V |
| | | | Common mode | | | | 0.3 | |
| Driver Common-Mode Output Voltage | $V_{OC}$ | R = 27Ω or 50Ω, Figure 4 | | | | | 4 | V |
| Input Current (A, B) | ISO $I_{IN}$ | DE´ = 0V, $V_{CC_}$ = 0V or 5.5V | $V_{IN}$ = 12V | MAX1480A/B/C | | | 1 | mA |
| | | | | MAX1490A/B | | | 0.25 | |
| | | | $V_{IN}$ = -7V | MAX1480A/B/C | | | 0.8 | |
| | | | | MAX1490A/B | | | 0.2 | |
| Receiver Input Resistance | $R_{IN}$ | -7V ≤ $V_{CM}$ ≤ 12V | | MAX1480A/B/C | 48 | | | kΩ |
| | | | | MAX1490A/B | 12 | | | |
| Receiver Differential Threshold Voltage | $V_{TH}$ | -7V ≤ $V_{CM}$ ≤ 12V | | | -0.2 | | +0.2 | V |
| Receiver Input Hysteresis | $\Delta V_{TH}$ | $V_{CM}$ = 0V | | | | 70 | | mV |
| $\overline{\text{Receiver Output}}$/Receiver Output Low Voltage | $V_{OL}$ | Using resistor values listed in Tables 1 and 2 | | | | | 0.4 | V |
| $\overline{\text{Receiver Output}}$/Receiver Output High Current | $I_{OH}$ | $V_{OUT}$ = 5.5V | | | | | 250 | µA |
| Driver Short-Circuit Current | ISO $I_{OSD}$ | -7V ≤ $V_O$ ≤ 12V (Note 4) | | | | 100 | | mA |

## SWITCHING CHARACTERISTICS—MAX1480A/MAX1490A

($V_{CC_}$ = 5V ±10%, FS = $V_{CC_}$, $T_A$ = $T_{MIN}$ to $T_{MAX}$, unless otherwise noted. Typical values are at $V_{CC_}$ = 5V and $T_A$ = +25°C.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Driver Input to Output Propagation Delay | $t_{PLH}$ | Figures 5 and 7, $R_{DIFF}$ = 54Ω, $C_{L1}$ = $C_{L2}$ = 100pF | | 100 | 275 | ns |
| | $t_{PHL}$ | | | 100 | 275 | |
| Driver Output Skew | $t_{SKEW}$ | Figures 5 and 7, $R_{DIFF}$ = 54Ω, $C_{L1}$ = $C_{L2}$ = 100pF | | 25 | 90 | ns |
| Driver Rise or Fall Time | $t_R$, $t_F$ | Figures 5 and 7, $R_{DIFF}$ = 54Ω, $C_{L1}$ = $C_{L2}$ = 100pF | | 15 | 40 | ns |
| Driver Enable to Output High (MAX1480A Only) | $t_{ZH}$ | Figures 6 and 8, $C_L$ = 100pF, S2 closed | | 0.2 | 1.5 | µs |
| Driver Enable to Output Low (MAX1480A Only) | $t_{ZL}$ | Figures 6 and 8, $C_L$ = 100pF, S1 closed | | 0.2 | 1.5 | µs |
| Driver Disable Time from Low (MAX1480A Only) | $t_{LZ}$ | Figures 6 and 8, $C_L$ = 15pF, S1 closed | | 0.2 | 1.5 | µs |
| Driver Disable Time from High (MAX1480A Only) | $t_{HZ}$ | Figures 6 and 8, $C_L$ = 15pF, S2 closed | | 0.2 | 1.5 | µs |
| Receiver Input to Output Propagation Delay | $t_{PLH}$ | Figures 5 and 10, $R_{DIFF}$ = 54Ω, $C_{L1}$ = $C_{L2}$ = 100pF | | 100 | 225 | ns |
| | $t_{PHL}$ | | | 100 | 225 | |

## SWITCHING CHARACTERISTICS—MAX1480A/MAX1490A (continued)

($V_{CC_}$ = 5V ±10%, FS = $V_{CC_}$, $T_A$ = $T_{MIN}$ to $T_{MAX}$, unless otherwise noted. Typical values are at $V_{CC_}$ = 5V and $T_A$ = +25°C.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $\lvert t_{PLH} - t_{PHL} \rvert$ Differential Receiver Skew | $t_{SKD}$ | Figures 5 and 10, $R_{DIFF}$ = 54Ω, $C_{L1}$ = $C_{L2}$ = 100pF | | 20 | | ns |
| Maximum Data Rate | $f_{MAX}$ | $t_{PLH}$, $t_{PHL}$ < 50% of data period | 2.5 | | | Mbps |
| Time to Shutdown | $t_{SHDN}$ | | | 100 | | µs |
| Shutdown to Driver Output High | $t_{ZH(SHDN)}$ | Figures 6 and 9, $C_L$ = 100pF, S2 closed | | 3 | 10 | µs |
| Shutdown to Driver Output Low | $t_{ZL(SHDN)}$ | Figures 6 and 9, $C_L$ = 100pF, S1 closed | | 3 | 10 | µs |

## SWITCHING CHARACTERISTICS—MAX1480B/MAX1480C/MAX1490B

($V_{CC_}$ = 5V ±10%, FS = $V_{CC_}$, $T_A$ = $T_{MIN}$ to $T_{MAX}$, unless otherwise noted. Typical values are at $V_{CC_}$ = 5V and $T_A$ = +25°C.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Driver Input to Output Propagation Delay | $t_{PLH}$ | Figures 5 and 7, $R_{DIFF}$ = 54Ω, $C_{L1}$ = $C_{L2}$ = 100pF | | 2 | 3.0 | µs |
| | $t_{PHL}$ | | | 2 | 3.0 | |
| Driver Output Skew | $t_{SKEW}$ | Figures 5 and 7, $R_{DIFF}$ = 54Ω, $C_{L1}$ = $C_{L2}$ = 100pF | | 900 | 1600 | ns |
| Driver Rise or Fall Time | $t_R$, $t_F$ | Figures 5 and 7, $R_{DIFF}$ = 54Ω, $C_{L1}$ = $C_{L2}$ = 100pF | | 1.0 | 2.0 | µs |
| Driver Enable to Output High (MAX1480B Only) | $t_{ZH}$ | Figures 6 and 8, $C_L$ = 100pF, S2 closed | | 35 | 100 | µs |
| Driver Enable to Output Low (MAX1480B Only) | $t_{ZL}$ | Figures 6 and 8, $C_L$ = 100pF, S1 closed | | 35 | 100 | µs |
| Driver Disable Time from Low (MAX1480B Only) | $t_{LZ}$ | Figures 6 and 8, $C_L$ = 15pF, S1 closed | | 13 | 50 | µs |
| Driver Disable Time from High (MAX1480B Only) | $t_{HZ}$ | Figures 6 and 8, $C_L$ = 15pF, S2 closed | | 13 | 50 | µs |
| Driver Enable to Output High (MAX1480C Only) | $t_{ZH}$ | Figures 6 and 8, $C_L$ = 100pF, S2 closed | | 0.5 | 4.5 | µs |
| Driver Enable to Output Low (MAX1480C Only) | $t_{ZL}$ | Figures 6 and 8, $C_L$ = 100pF, S1 closed | | 0.5 | 4.5 | µs |

## SWITCHING CHARACTERISTICS—MAX1480B/MAX1480C/MAX1490B (continued)

($V_{CC_}$ = 5V ±10%, FS = $V_{CC_}$, $T_A$ = $T_{MIN}$ to $T_{MAX}$, unless otherwise noted. Typical values are at $V_{CC_}$ = 5V and $T_A$ = +25°C.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Driver Disable Time from Low (MAX1480C Only) | $t_{LZ}$ | Figures 6 and 8, $C_L$ = 15pF, S1 closed | | 2.0 | 4.5 | µs |
| Driver Disable Time from High (MAX1480C Only) | $t_{HZ}$ | Figures 6 and 8, $C_L$ = 15pF, S2 closed | | 2.0 | 4.5 | µs |
| Receiver Input to Output Propagation Delay | $t_{PLH}$ | Figures 5 and 10, $R_{DIFF}$ = 54Ω, $C_{L1}$ = $C_{L2}$ = 100pF | | 2 | 3.0 | µs |
| | $t_{PHL}$ | | | 2 | 3.0 | |
| $\lvert t_{PLH} - t_{PHL} \rvert$ Differential Receiver Skew | $t_{SKD}$ | Figures 5 and 10, $R_{DIFF}$ = 54Ω, $C_{L1}$ = $C_{L2}$ = 100pF | | 1200 | | ns |
| Maximum Data Rate | $f_{MAX}$ | $t_{PLH}$, $t_{PHL}$ < 50% of data period | 0.25 | | | Mbps |
| Time to Shutdown | $t_{SHDN}$ | | | 100 | | µs |
| Shutdown to Driver Output High | $t_{ZH(SHDN)}$ | Figures 6 and 9, $C_L$ = 100pF, S2 closed | | 35 | 100 | µs |
| Shutdown to Driver Output Low | $t_{ZL(SHDN)}$ | Figures 6 and 9, $C_L$ = 100pF, S1 closed | | 35 | 100 | µs |

**Note 1:** All currents into device pins are positive; all currents out of device pins are negative. All voltages are referenced to logic-side ground (GND_), unless otherwise specified.

**Note 2:** For DE´ and DI´ pin descriptions, see *Detailed Block Diagram and Typical Application Circuit* (Figure 1 for MAX1480A/MAX1480B/MAX1480C, Figure 2 for MAX1490A/MAX1490B).

**Note 3:** Shutdown supply current is the current at $V_{CC1}$ and $V_{CC2}$ when shutdown is enabled.

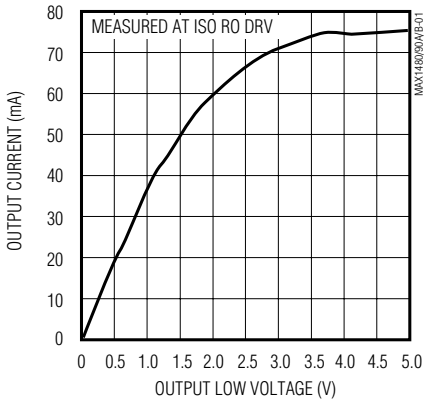
**Note 4:** Applies to peak current (see *Typical Operating Characteristics*). Although the MAX1480A/B/C and MAX1490A/B provide electrical isolation between logic ground and signal paths, they do not provide isolation between external shields and the signal paths (see *Isolated Common Connection* section).

# Complete, Isolated RS-485/RS-422 Data Interface

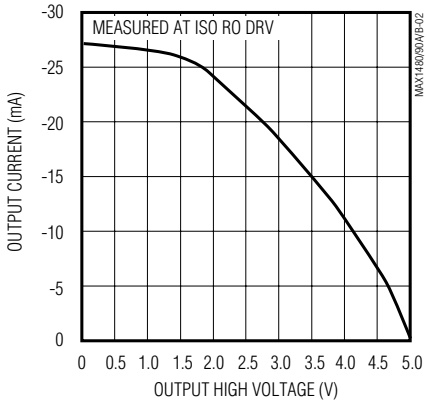
## Typical Operating Characteristics

($V_{CC_}$ = 5V, FS = $V_{CC_}$, $T_A$ = +25°C, unless otherwise noted.)

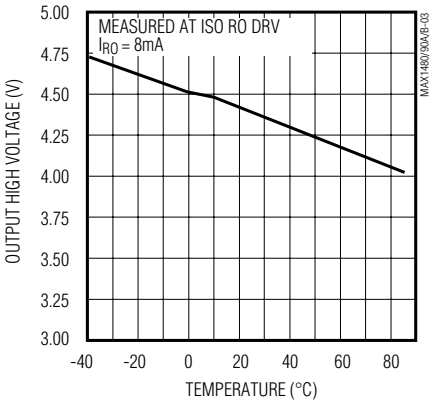
**OUTPUT CURRENT vs. RECEIVER OUTPUT LOW VOLTAGE**



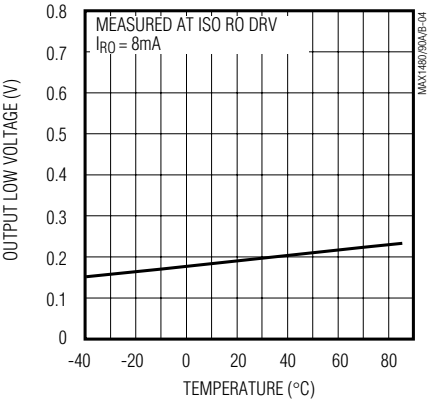

**OUTPUT CURRENT vs. RECEIVER OUTPUT HIGH VOLTAGE**



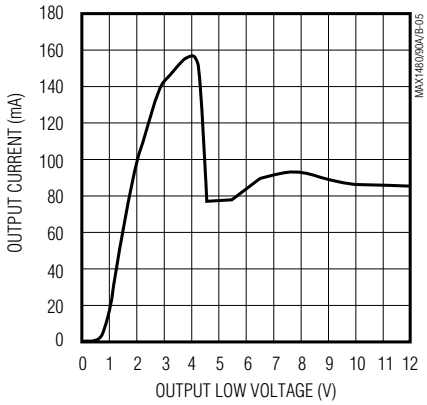

**RECEIVER OUTPUT HIGH VOLTAGE vs. TEMPERATURE**



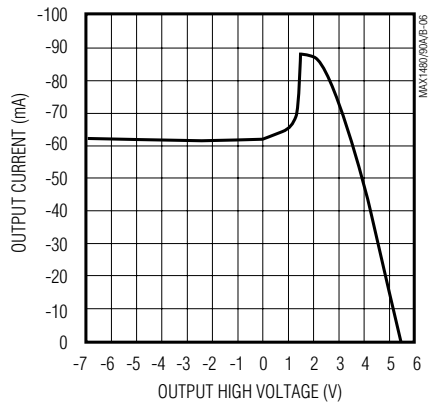

**RECEIVER OUTPUT LOW VOLTAGE vs. TEMPERATURE**



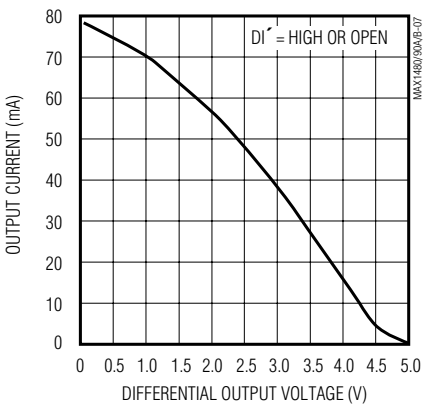

**OUTPUT CURRENT vs. DRIVER OUTPUT LOW VOLTAGE**



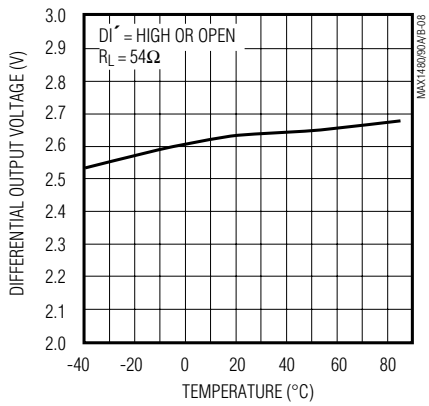

**OUTPUT CURRENT vs. DRIVER OUTPUT HIGH VOLTAGE**



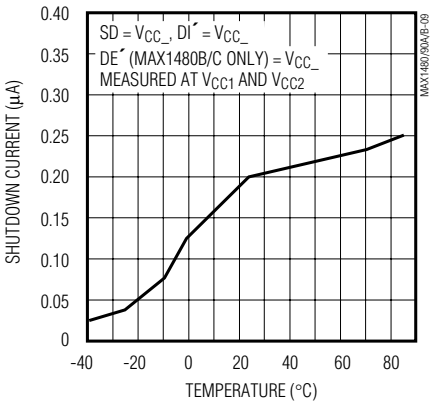

**DRIVER OUTPUT CURRENT vs. DIFFERENTIAL OUTPUT VOLTAGE**




**DRIVER DIFFERENTIAL OUTPUT VOLTAGE vs. TEMPERATURE**



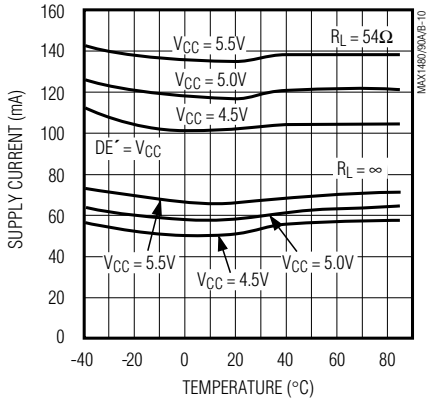

**MAX1480B/MAX1480C/MAX1490B SHUTDOWN CURRENT vs. TEMPERATURE**



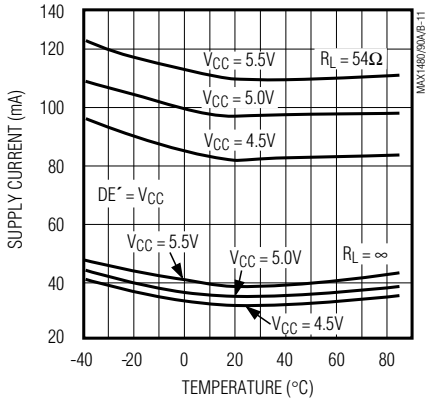
## Typical Operating Characteristics (continued)

($V_{CC_}$ = 5V, FS = $V_{CC_}$, $T_A$ = +25°C, unless otherwise noted.)

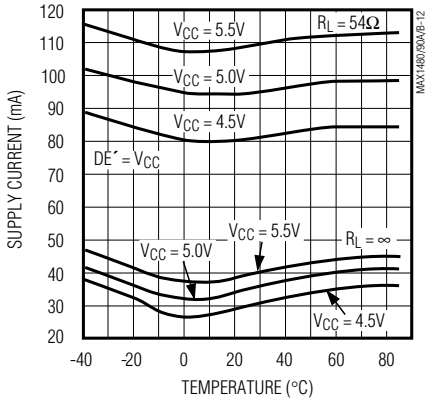
**MAX1480A**
**SUPPLY CURRENT vs. TEMPERATURE**



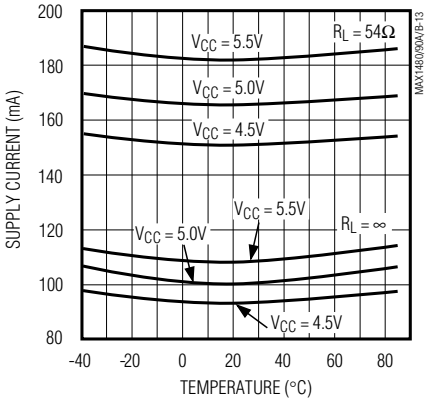

**MAX1480B**
**SUPPLY CURRENT vs. TEMPERATURE**



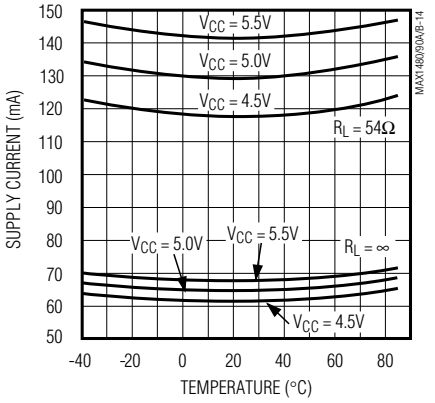

**MAX1480C**
**SUPPLY CURRENT vs. TEMPERATURE**



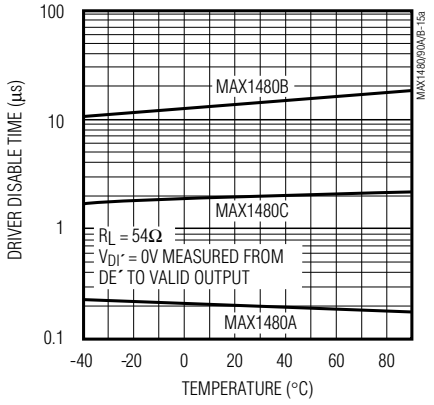

**MAX1490A**
**SUPPLY CURRENT vs. TEMPERATURE**



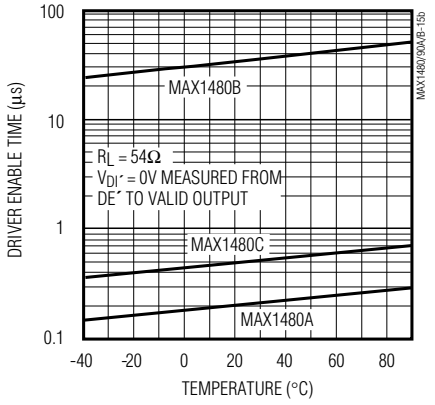

**MAX1490B**
**SUPPLY CURRENT vs. TEMPERATURE**




**DRIVER DISABLE TIME**
**vs. TEMPERATURE**




**DRIVER ENABLE TIME**
**vs. TEMPERATURE**

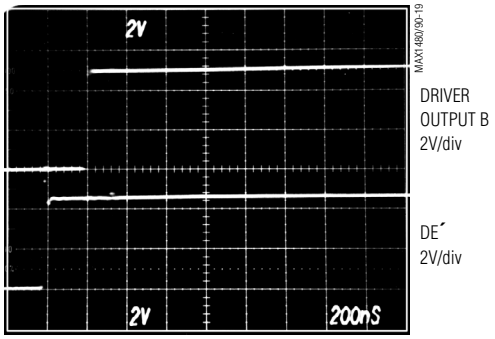


# Complete, Isolated RS-485/RS-422 Data Interface

## Typical Operating Characteristics (continued)

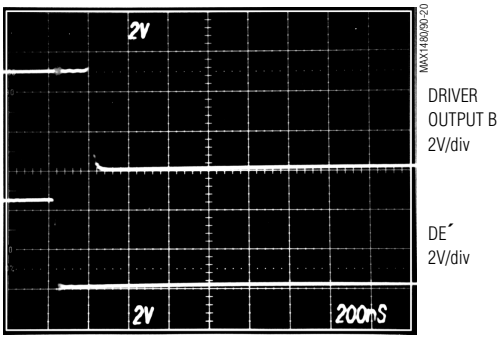
($V_{CC_}$ = 5V, FS = $V_{CC_}$, $V_{DI}$´ = 0V, DE´ toggled 0V to 5V at 5kHz, $T_A$ = +25°C, unless otherwise noted.)

**MAX1480A**
**DRIVER ENABLE TIME**



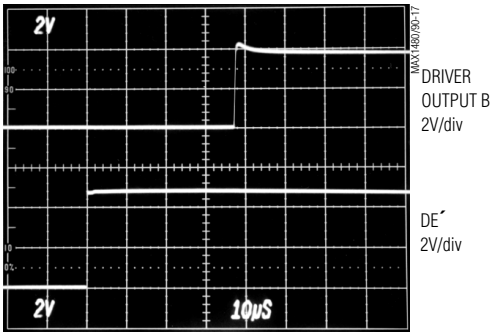

200ns/div

**MAX1480A**
**DRIVER DISABLE TIME**



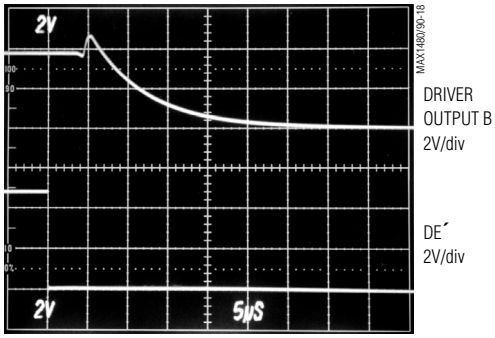

200ns/div

**MAX1480B**
**DRIVER ENABLE TIME**



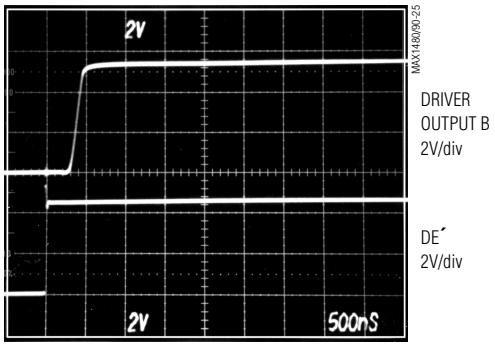

10µs/div

**MAX1480B**
**DRIVER DISABLE TIME**



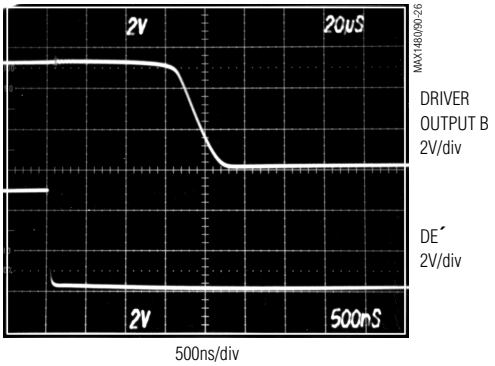

5µs/div

**MAX1480C**
**DRIVER ENABLE TIME**




500ns/div

**MAX1480C**
**DRIVER DISABLE TIME**

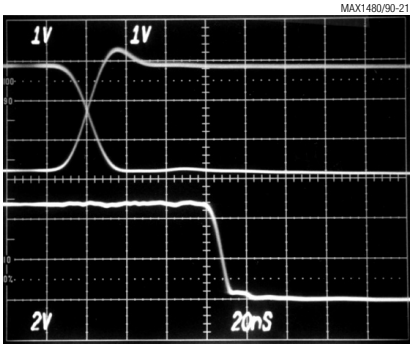



500ns/div

## Typical Operating Characteristics (continued)

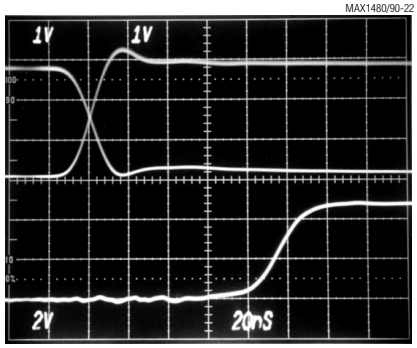
($V_{CC_}$ = 5V, FS = $V_{CC_}$, DE´ = $V_{CC_}$, $V_{DI}$´ = 0V to 5V at 1.25MHz, $T_A$ = +25°C, unless otherwise noted.)

**MAX1480A/MAX1490A**
**RECEIVER $t_{PHL}$**



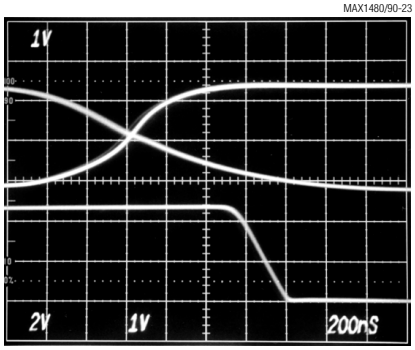

20ns/div

**MAX1480A/MAX1490A**
**RECEIVER $t_{PLH}$**



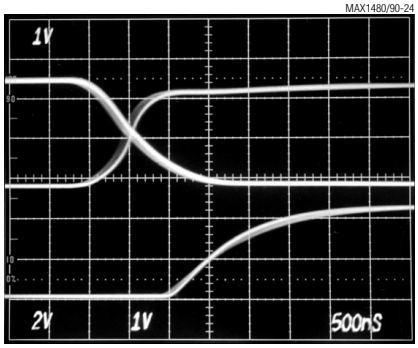

20ns/div

**MAX1480B/MAX1480C/MAX1490B**
**RECEIVER $t_{PHL}$**



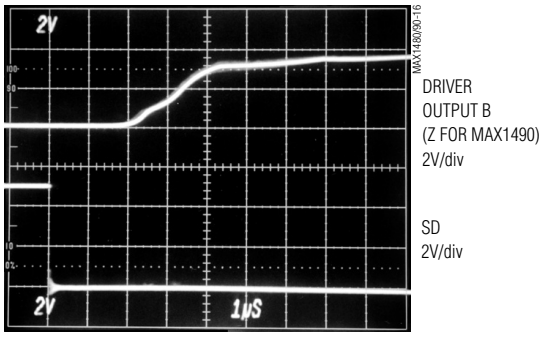

200ns/div

**MAX1480B/MAX1480C/MAX1490B**
**RECEIVER $t_{PLH}$**




500ns/div

**POWER-UP DELAY TO DRIVER OUTPUTS VALID**




1µs/div

$V_{DI}$´ = 0V
$V_{SD}$ = 5V TO 0V AT 1kHz

# Complete, Isolated RS-485/RS-422 Data Interface

## Pin Description

| PIN | | NAME | FUNCTION |
|---|---|---|---|
| MAX1480A/B/C | MAX1490A/B | | |
| **PINS ON THE NON-ISOLATED SIDE** | | | |
| 1, 2, 8, 10 | 1, 2, 8, 10 | $V_{CC1}$–$V_{CC4}$ | Logic-Side (nonisolated side) +5V Supply Voltages |
| 3, 4 | 3, 4 | D1, D2 | Internal Connections. Leave these pins unconnected. |
| 5 | 5 | GND1 | Logic-Side Ground. Connect to GND2 (pin 12). |
| 6 | 6 | FS | Frequency Select Input. If FS = $V_{CC_}$ or is open, switch frequency is high; if FS = GND, switch frequency is low. For optimal performance and minimal supply current, connect FS to $V_{CC_}$ or leave unconnected. |
| 7 | 7 | SD | Shutdown Input. Ground for normal operation. When high, the power oscillator is disabled. |
| 9 | 9 | DI | Driver Input. With DE´ high (MAX1480A/B/C only), a low on DI´ forces output A low and output B high. Similarly, a high on DI´ forces output A high and output B low. Drives internal LED cathode through a resistor (Table 1 of Figure 1 for MAX1480A/B/C, Table 2 of Figure 2 for MAX1490A/B). |
| 11 | — | DE | Driver-Enable Input. The driver outputs, A and B, are enabled by bringing DE´ high. The driver outputs are high impedance when DE´ is low. If the driver outputs are enabled, the device functions as a line driver. While the driver outputs are high impedance, the device functions as a line receiver. Drives internal LED cathode through a resistor (Table 1 of Figure 1). |
| — | 11 | RO | Receiver Output. If A > B by 200mV, RO will be high; if A < B by 200mV, RO will be low. Open collector; must have pullup to $V_{CC}$ (Table 2 of Figure 2). |
| 12 | 12 | GND2 | Logic-Side Ground. Connect to GND1 (pin 5). |
| 13 | — | $\overline{RO}$ | $\overline{\text{Receiver Output}}$. If A > B by 200mV, $\overline{RO}$ will be low; if A < B by 200mV, $\overline{RO}$ will be high. Open collector; must have pullup to $V_{CC_}$ (Table 1 of Figure 1). |
| 14 | — | $V_{CC5}$ | Logic-Side (non-isolated side) +5V Supply Voltage |
| **PINS ON THE ISOLATED RS-485/RS-422 SIDE** | | | |
| 15 | 13 | ISO RO LED | Isolated Receiver Output LED. Internal LED anode in MAX1480A/B/C and LED cathode in MAX1490A/B. Connect to ISO RO DRV through a resistor (Table 1 of Figure 1 for MAX1480A/B/C; Table 2 of Figure 2 for MAX1490A/B). |
| 16 | — | ISO COM2 | Isolated Common. Connect to ISO COM1 (pin 20). |
| 17 | — | ISO DE DRV | Isolated Driver-Enable Drive. The driver outputs, A and B, are enabled by bringing DE´ high. The driver outputs are high impedance when DE´ is low. If the driver outputs are enabled, the device functions as a line driver. While the driver outputs are high impedance, the device functions as a line receiver. Open-collector output; must have pullup to ISO $V_{CC_}$ and be connected to ISO DE IN for normal operation (Table 1 of Figure 1). |
| 18 | 14 | ISO $V_{CC2}$ | Isolated Supply Voltage. Connect to ISO $V_{CC1}$ (pin 26 for MAX1480A/B/C, or pin 22 for MAX1490A/B). |
| 19 | 15 | ISO DI DRV | Isolated Driver-Input Drive. With DE´ high (MAX1480A/B/C only), a low on DI´ forces output A low and output B high. Similarly, a high on DI´ forces output A high and output B low. Connect to ISO DI IN (on the MAX1480A/B/C only) for normal operation. Open-collector output; connect a pullup resistor to ISO $V_{CC_}$ (Table 1 of Figure 1 for MAX1480A/B/C; Table 2 of Figure 2 for MAX1490A/B). |
| 20 | 16 | ISO COM1 | Isolated Common. For MAX1480A/B/C, connect to ISO COM2 (pin 16) (Figures 1 and 2). |

## Pin Description (continued)

| PIN | | NAME | FUNCTION |
|---|---|---|---|
| MAX1480A/B/C | MAX1490A/B | | |
| **PINS ON THE ISOLATED RS-485/RS-422 SIDE (continued)** | | | |
| — | 17 | Y | Noninverting Driver Output |
| — | 18 | Z | Inverting Driver Output |
| — | 19 | B | Inverting Receiver Input |
| — | 20 | A | Noninverting Receiver Input |
| 21 | — | ISO DE IN | Isolated Driver-Enable Input. Connect to ISO DE DRV for normal operation. |
| 22 | — | ISO DI IN | Isolated Driver Input. Connect to ISO DI DRV for normal operation. |
| 23 | — | A | Noninverting Driver Output and Noninverting Receiver Input |
| 24 | 21 | ISO RO DRV | Isolated Receiver-Output Drive. Connect to ISO RO LED through a resistor (Table 1 of Figure 1 for MAX1480A/B/C, Table 2 of Figure 2 for MAX1490A/B). |
| 25 | — | B | Inverting Driver Output and Inverting Receiver Input |
| 26 | 22 | ISO $V_{CC1}$ | Isolated Supply Voltage Source |
| 27, 28 | 23, 24 | AC2, AC1 | Internal Connections. Leave these pins unconnected. |

**Note:** For DE´ and DI´ pin descriptions, see *Detailed Block Diagram and Typical Application Circuit* (Figure 1 for MAX1480A/B/C, Figure 2 for MAX1490A/B).

## Detailed Description

The MAX1480A/MAX1480B/MAX1480C/MAX1490A/MAX1490B are complete, electrically isolated, RS-485/RS-422 data-communications interface solutions. Transceivers, optocouplers, a power driver, and a transformer in one standard 28-pin DIP package (24-pin for the MAX1490A/B) provide a complete interface. Signals and power are internally transported across the isolation barrier (Figures 1, 2). Power is transferred from the logic side (nonisolated side) to the isolated side of the barrier through a center-tapped transformer. Signals cross the barrier through high-speed optocouplers. A single +5V supply on the logic side powers both sides of the interface. The MAX1480A/B/C offer half-duplex communications while the MAX1490A/B feature full-duplex communication. The functional input/output relationships are shown in Tables 3–6.

The MAX1480B/MAX1480C/MAX1490B feature reduced-slew-rate drivers that minimize EMI and reduce reflections caused by improperly terminated cables, allowing error-free transmission at data rates up to 250kbps. The MAX1480A/MAX1490A driver slew rate is not limited, allowing transmission rates up to 2.5Mbps.

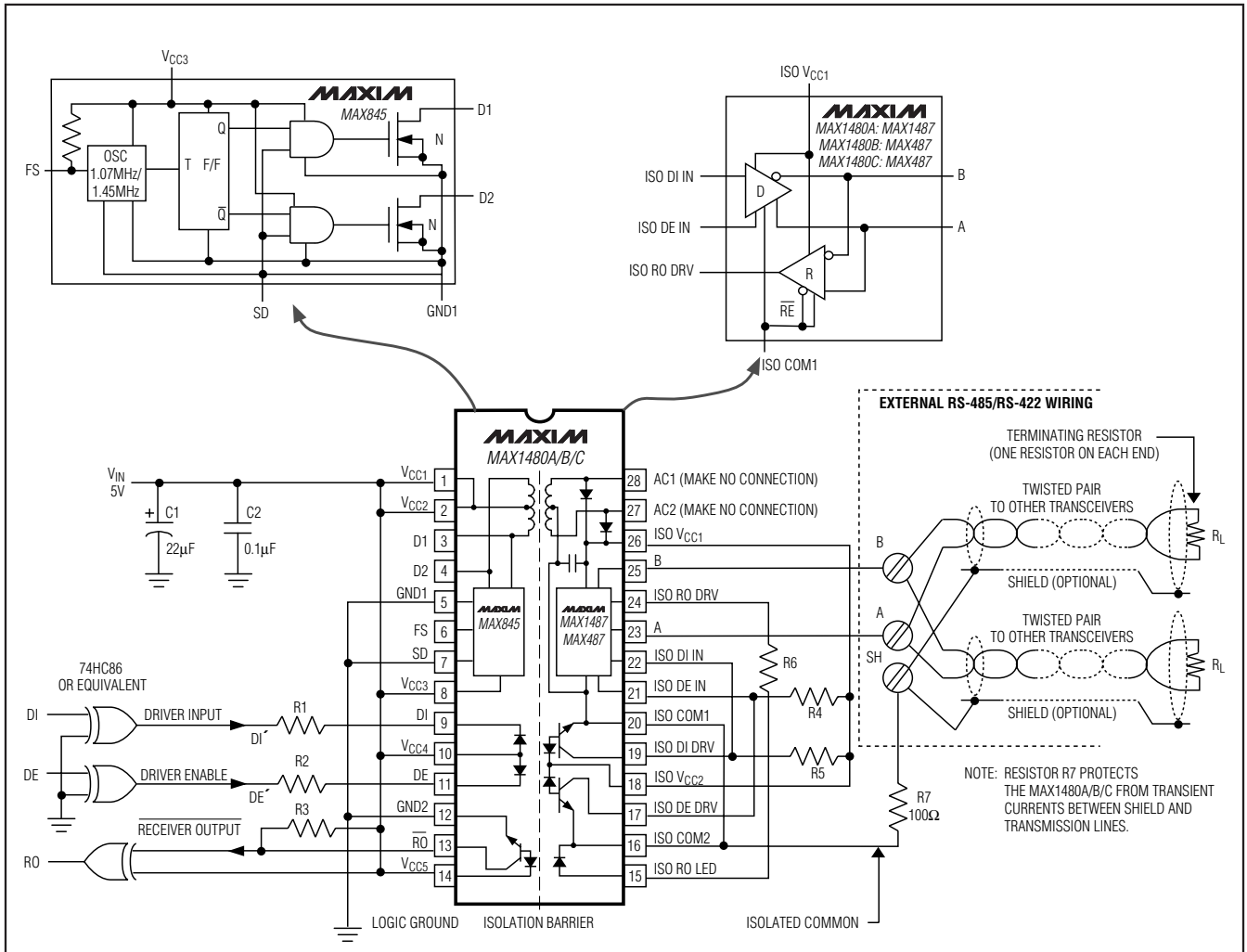
The MAX1480B/MAX1480C/MAX1490B shutdown feature reduces supply current to as low as 0.2µA by using the SD pin (see the *Low-Power Shutdown Mode* section).

Use the FS pin to select between high and low switching frequencies for the isolated power driver. The driver switches at the lower frequency 535kHz when FS is low, and at the higher frequency 725kHz when FS is high. The FS pin has a weak internal pull-up that switches the device to the high-frequency mode when FS is left unconnected. With FS high or open, no-load supply current is reduced by approximately 4mA, and by up to 8mA when fully loaded. For optimal performance and minimal supply current, connect FS to $V_{CC_}$ or leave unconnected.

Drivers are short-circuit current limited and are protected against excessive power dissipation by thermal shutdown circuitry that puts the driver outputs into a high-impedance state. The receiver input has a fail-safe feature that guarantees a logic-high RO (logic-low $\overline{RO}$) output if the input is open circuit.

On the MAX1480A/B/C, the driver outputs are enabled by bringing DE´ high. Driver-enable times are typically 0.2µs for the MAX1480A, 35µs for the MAX1480B, and 0.5µs for the MAX1480C. Allow time for the devices to be enabled before sending data (see the Driver Enable Time vs. Temperature graph in the *Typical Operating Characteristics*). When enabled, driver outputs function as line drivers. Driver outputs are high impedance when DE´ is low. While outputs are high impedance, they function as line receivers.

# Complete, Isolated RS-485/RS-422 Data Interface




## Table 1. Pull-Up and LED Drive Resistors

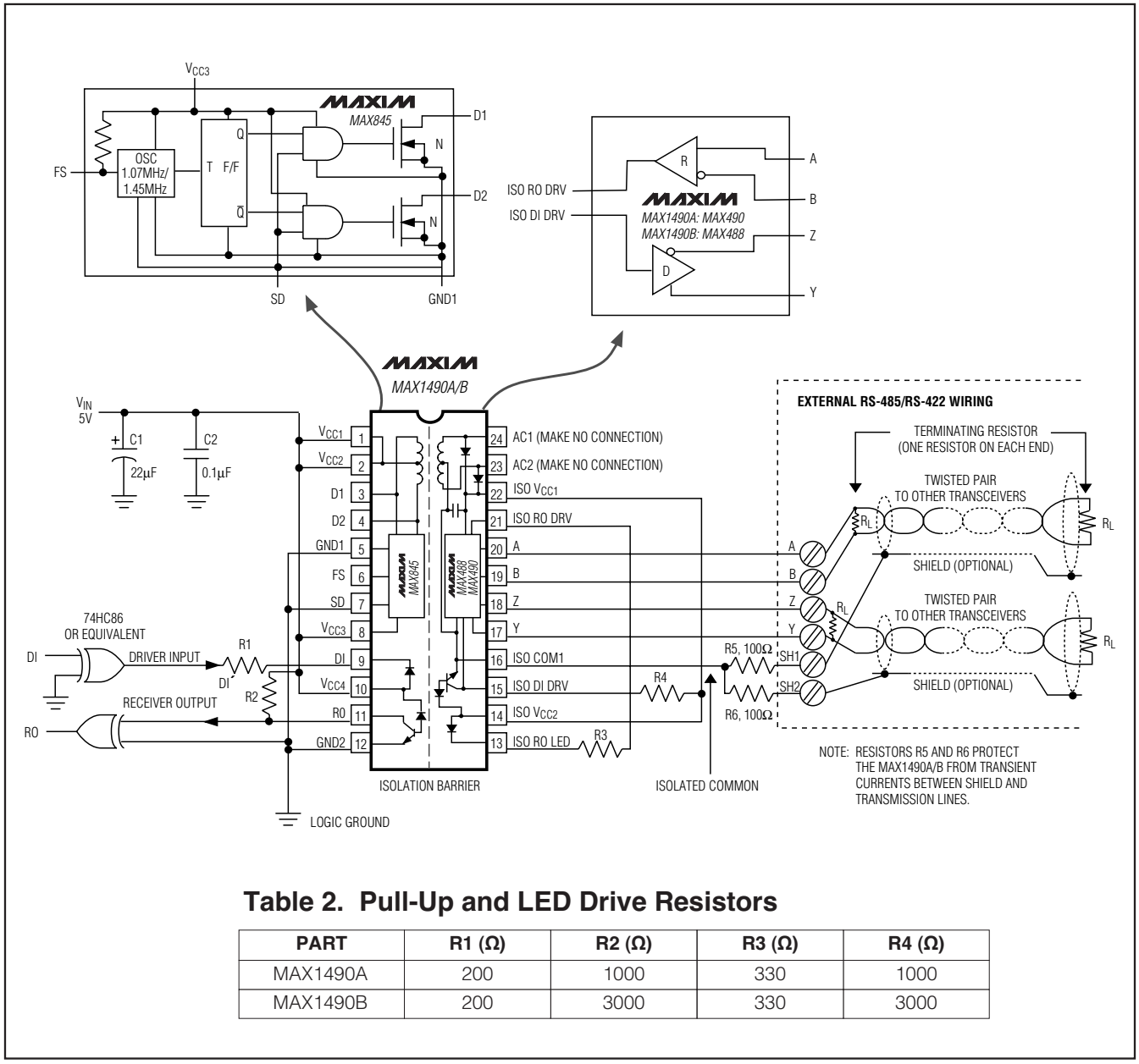
| PART | R1 (Ω) | R2 (Ω) | R3 (Ω) | R4 (Ω) | R5 (Ω) | R6 (Ω) |
|---|---|---|---|---|---|---|
| MAX1480A | 200 | 200 | 1000 | 4300 | 1000 | 200 |
| MAX1480B | 200 | 510 | 3000 | 2200 | 3000 | 200 |
| MAX1480C | 200 | 200 | 3000 | 3000 | 3000 | 200 |

*Figure 1. MAX1480A/MAX1480B/MAX1480C Detailed Block Diagram and Typical Application Circuit*

The MAX1480A/MAX1480B/MAX1480C/MAX1490A/MAX1490B typically withstand 1600$V_{RMS}$ (1 minute) or 2000$V_{RMS}$ (1 second). The logic inputs can be driven from TTL/CMOS-logic with a series resistor, and the received data output can directly drive TTL or CMOS-logic families with only resistive pullup.

### Low-Power Shutdown Mode

The SD pin shuts down the oscillator on the internal power driver. With the primary side in shutdown, no power is transferred across the isolation barrier. The DI and DE optocouplers, however, still consume current if the drive signals on the nonisolated side are low. Therefore, leave DI´ and DE´ high or floating when in shutdown mode.




## Table 2. Pull-Up and LED Drive Resistors

| PART | R1 (Ω) | R2 (Ω) | R3 (Ω) | R4 (Ω) |
|---|---|---|---|---|
| MAX1490A | 200 | 1000 | 330 | 1000 |
| MAX1490B | 200 | 3000 | 330 | 3000 |

*Figure 2. MAX1490A/MAX1490B Detailed Block Diagram and Typical Application Circuit*

Under these conditions, the MAX1480B/MAX1480C/MAX1490B supply current is reduced to as low as 0.2µA.

The high-speed optocouplers on the MAX1480A/MAX1480C/MAX1490A consume an additional 10mA through $V_{CC5}$ ($V_{CC4}$ for the MAX1490A). Therefore, to completely shut down these devices, use an external P-channel MOSFET as shown in Figure 3. In normal operation, SD is low, turning the MOSFET on and thereby providing power to all the $V_{CC_}$ pins. When SD is pulled high, the power oscillator is disabled and the switch is turned off, disconnecting power from the DI and DE optocouplers. In normal operating mode, the switch carries only the optocoupler currents, so an on-resistance of several ohms will not significantly degrade efficiency.

# Complete, Isolated RS-485/RS-422 Data Interface

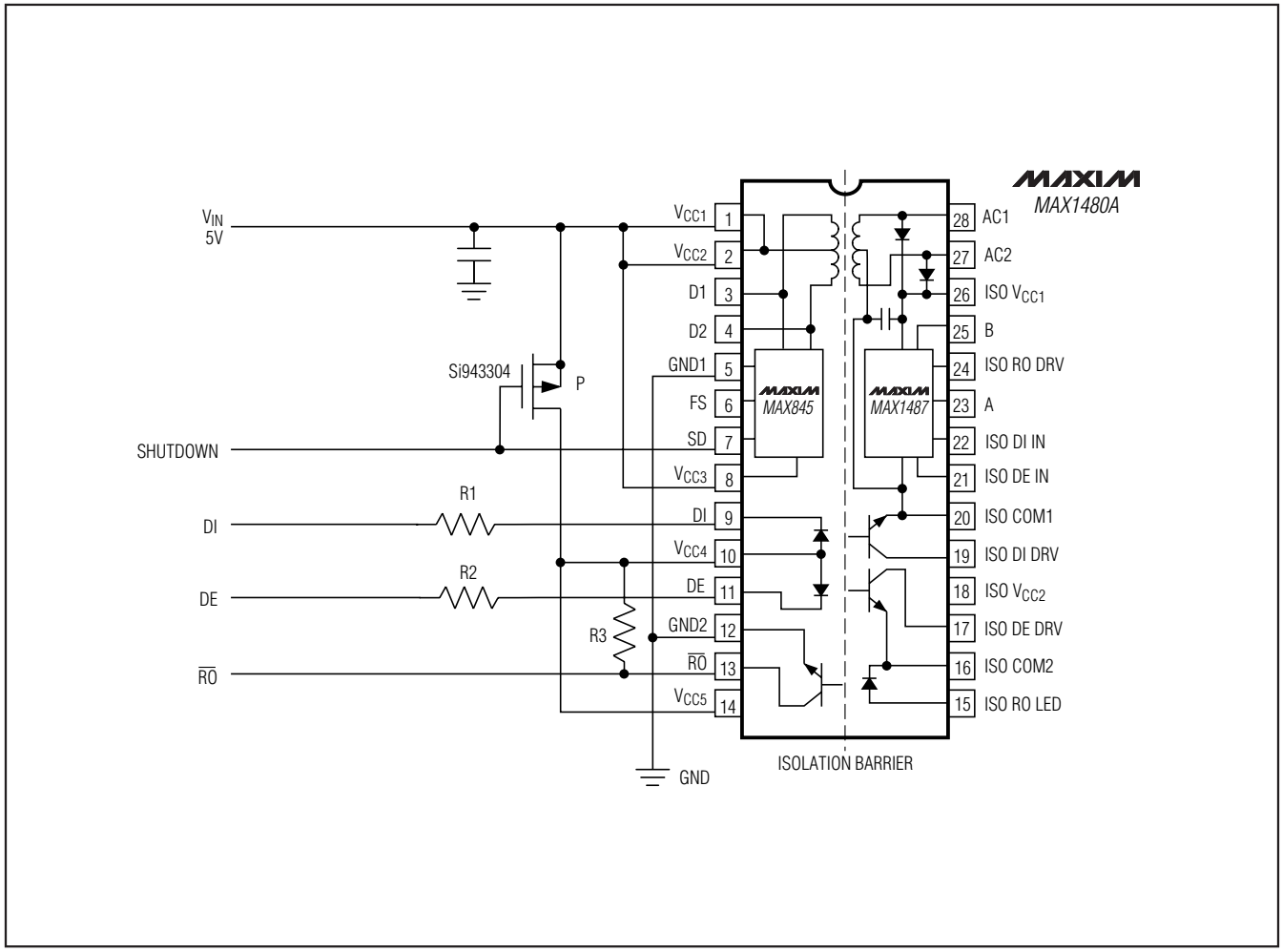



*Figure 3. MAX1480A Low-Power Shutdown Mode*

## Test Circuits

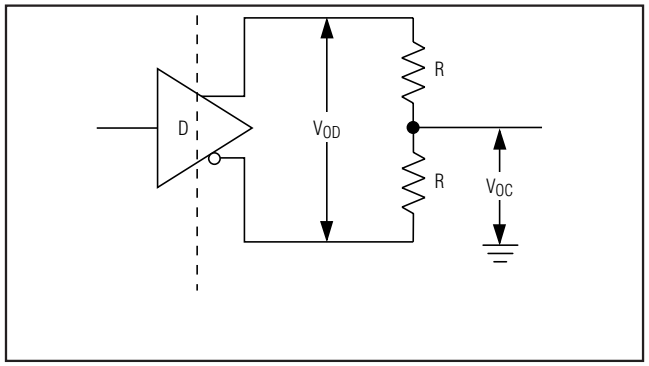



*Figure 4. Driver DC Test Load*

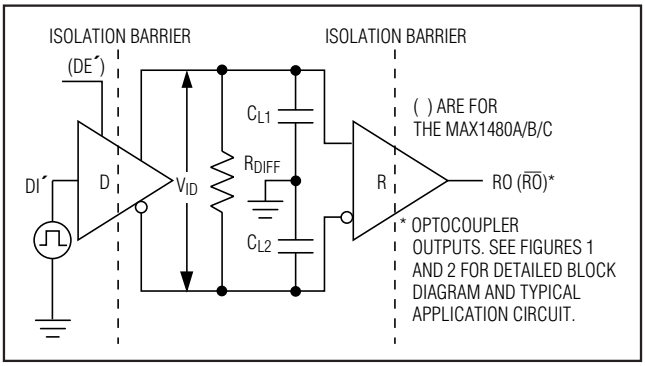



*Figure 5. Driver/Receiver Timing Test Circuit*

## Test Circuits (continued)

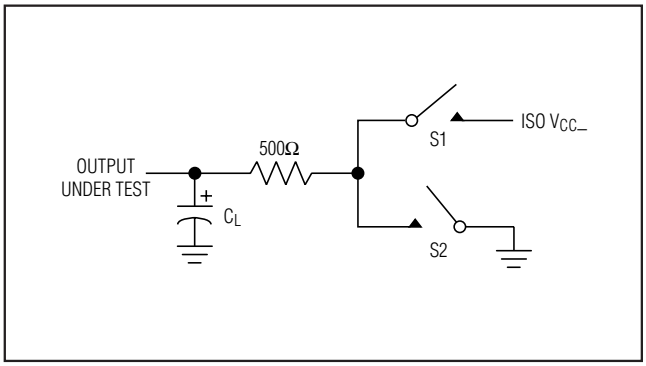



*Figure 6. Driver Timing Test Load*

## Switching Waveforms

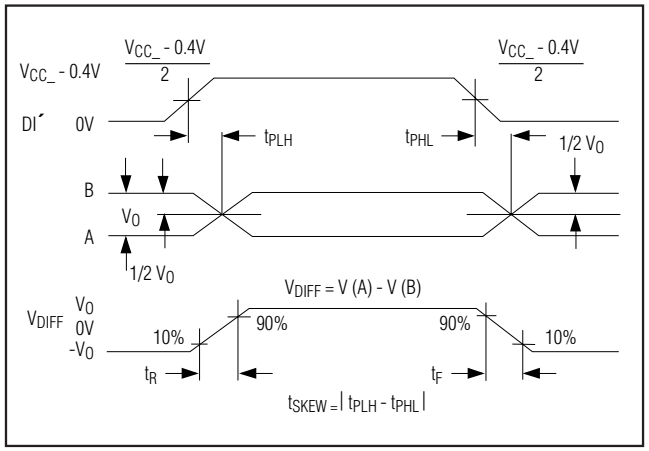



*Figure 7. Driver Propagation Delays and Transition Times*

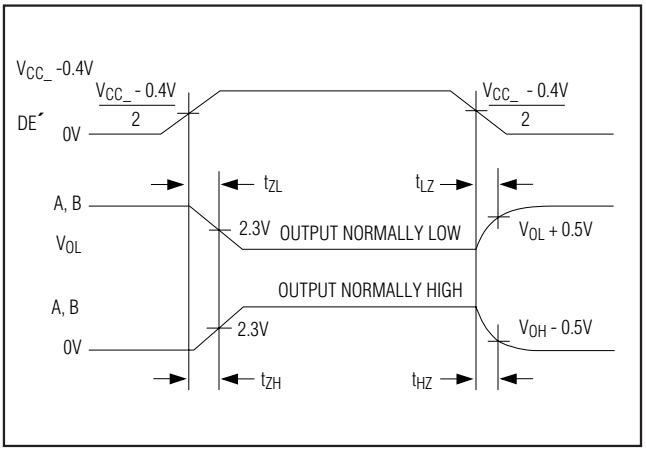



*Figure 8. Driver Enable and Disable Times*

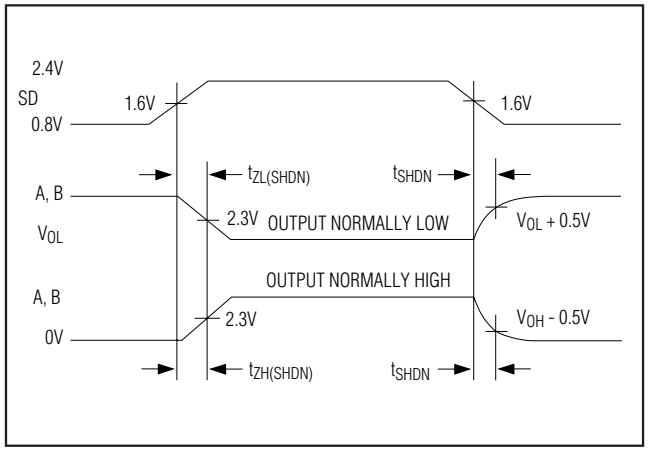



*Figure 9. Times to/from Shutdown*

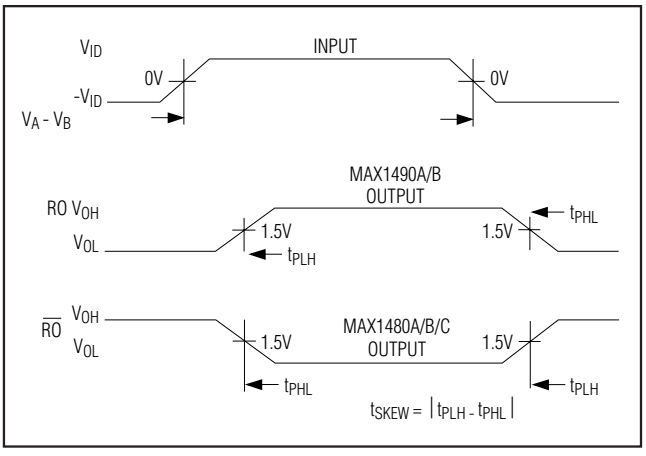



*Figure 10. Receiver Propagation Delays*

# Complete, Isolated RS-485/RS-422 Data Interface

### MAX1480B/MAX1480C/MAX1490B: Reduced EMI and Reflections

The MAX1480B/MAX1480C/MAX1490B are slew-rate-limited, minimizing EMI and reducing reflections caused by improperly terminated cables. Figure 11 shows both the driver output waveform of a MAX1480A/MAX1490A transmitting a 150kHz signal and the Fourier analysis of that waveform. High-frequency harmonics with large amplitudes are evident. Figure 12 shows the same information for the slew-rate-limited MAX1480B/MAX1480C/MAX1490B transmitting the same signal. The high-frequency harmonics have much lower amplitudes, and therefore the potential for EMI is significantly reduced.

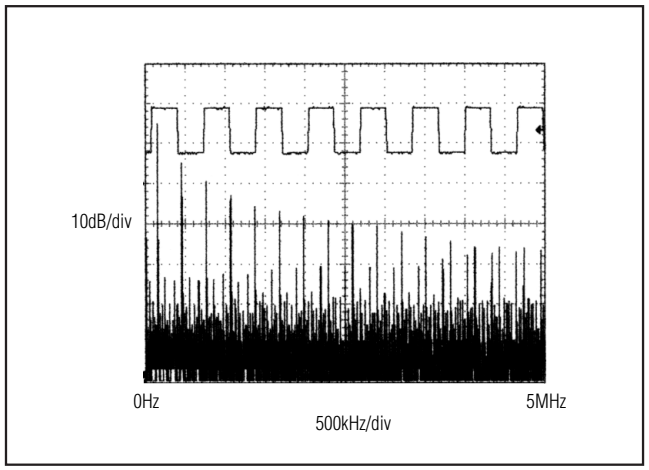



*Figure 11. Driver Output Waveform and FFT Plot of MAX1480A/MAX1490A Transmitting a 150kHz Signal*

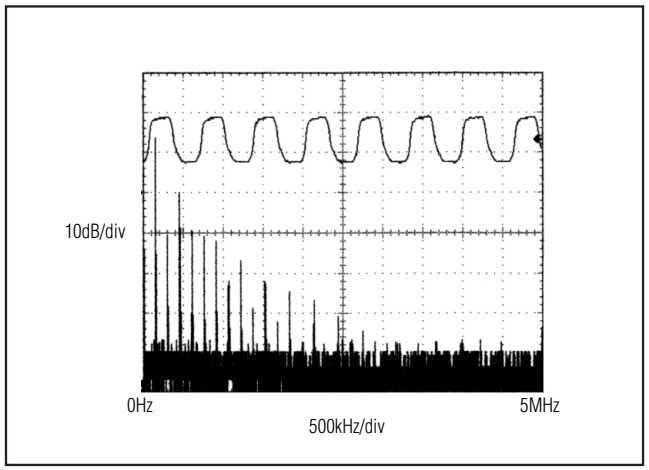



*Figure 12. Driver Output Waveform and FFT Plot of MAX1480B/MAX1480C/MAX1490B Transmitting a 150kHz Signal*

## Function Tables

### Half-Duplex Devices (MAX1480A/MAX1480B/MAX1480C)

**Table 3. Transmitting**

| INPUTS* | | OUTPUTS | |
|---|---|---|---|
| DE´ | DI´ | B | A |
| 1 | 1 | 0 | 1 |
| 1 | 0 | 1 | 0 |
| 0 | X | High-Z | High-Z |

*X = Don't care*

*High-Z = High impedance*

**Table 4. Receiving**

| INPUTS* | | OUTPUT (RO) |
|---|---|---|
| DE´ | $V_A$ - $V_B$ | |
| 0 | ≥ +0.2V | 0 |
| 0 | ≤ -0.2V | 1 |
| 0 | Open | 0 |

### Full-Duplex Devices (MAX1490A/MAX1490B)

**Table 5. Transmitting**

| INPUT* (DI´) | OUTPUTS | |
|---|---|---|
| | Z | Y |
| 1 | 0 | 1 |
| 0 | 1 | 0 |

** For DE´ and DI´ pin descriptions, see Detailed Block Diagram and Typical Application Circuit (Figure 1 for MAX1480A/B/C, Figure 2 for MAX1490A/B).*

**Table 6. Receiving**

| INPUT ($V_A$ - $V_B$) | OUTPUT (RO) |
|---|---|
| ≥ +0.2V | 1 |
| ≤ -0.2V | 0 |
| Open | 1 |

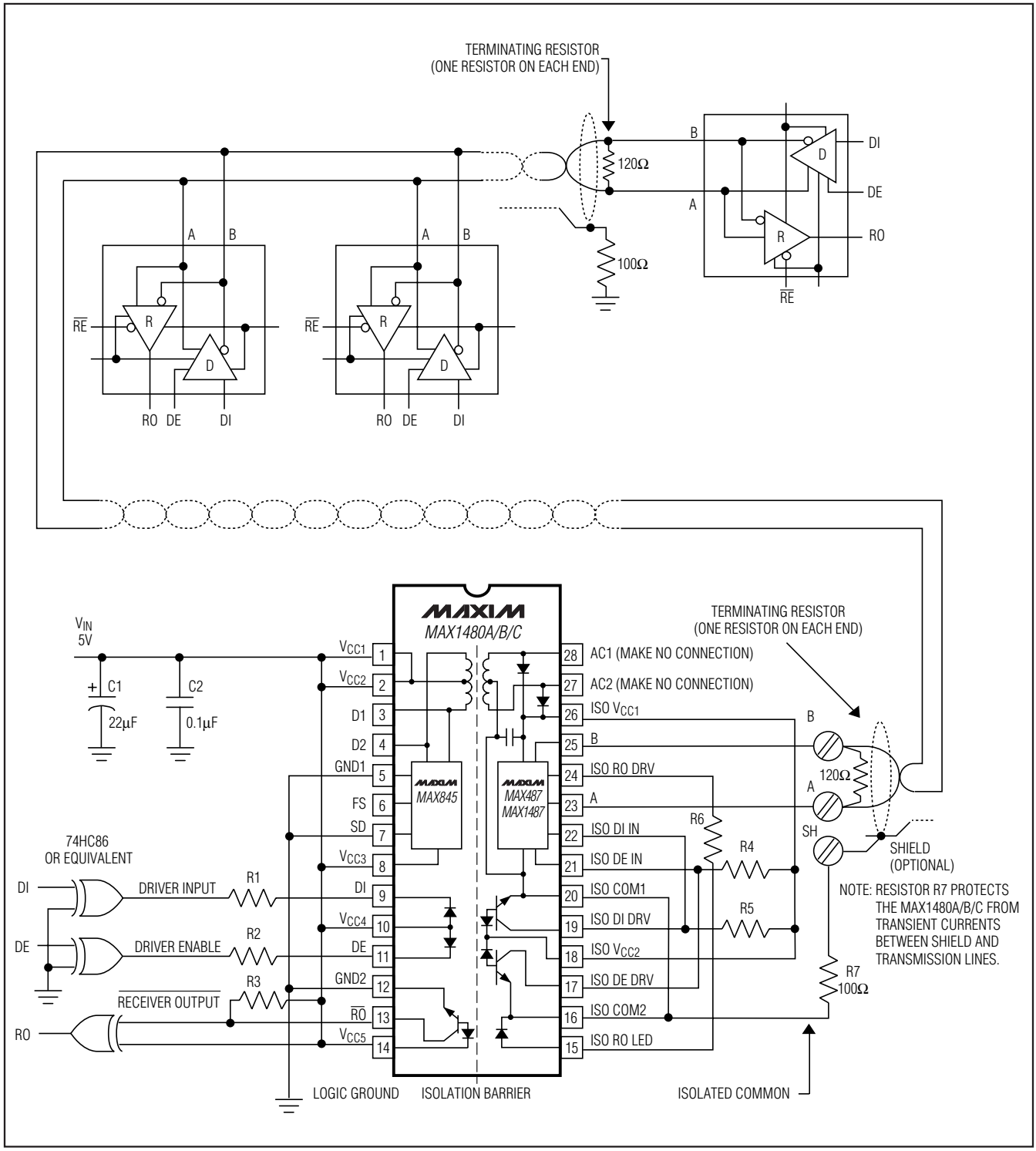



*Figure 13. Typical Half-Duplex RS-485/RS-422 Network*

# Complete, Isolated RS-485/RS-422 Data Interface

### Driver Output Protection

There are two mechanisms to prevent excessive output current and power dissipation caused by faults or by bus contention. A foldback current limit on the output stage provides immediate protection against short circuits over the entire common-mode range (see the *Typical Operating Characteristics*). In addition, a thermal shutdown circuit forces the driver outputs into a high-impedance state if the die temperature rises excessively.

### Propagation Delay Skew

Typical propagation delays are shown in the *Typical Operating Characteristics* using the test circuit of Figure 5. Propagation delay skew is simply the difference between the low-to-high and high-to-low propagation delay. Small driver/receiver skew times help reduce EMI and reflections by maintaining balanced differential signals.

The receiver skew time, $|t_{PLH} - t_{PHL}|$, is typically under 100ns for the MAX1480A/MAX1490A and under 1µs for the MAX1480B/MAX1480C/MAX1490B.

The driver skew time is typically 25ns for the MAX1480A/MAX1490A and 100ns for the MAX1480B/MAX1480C/MAX1490B.

## Applications Information

**DI and DE are intended to be driven through a series current-limiting resistor. Directly grounding these pins destroys the device.**

The MAX1480A/MAX1480B/MAX1480C are designed for bidirectional data communications on multipoint bus-transmission lines. The MAX1490A/MAX1490B are designed for full-duplex bidirectional communications that are primarily point-to-point. Figures 13 and 14 show half-duplex and full-duplex typical network application circuits, respectively. 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. The slew-rate-limited MAX1480B/MAX1480C/MAX1490B are more tolerant of imperfect termination and stubs off the main line.

### Layout Considerations

The MAX1480A/MAX1480B/MAX1480C/MAX1490A/MAX1490B pinouts enable optimal PC board layout by minimizing interconnect lengths and crossovers.

- For maximum isolation, the “isolation barrier” should not be breached except by the MAX1480A/MAX1480B/MAX1480C/MAX1490A/MAX1490B.

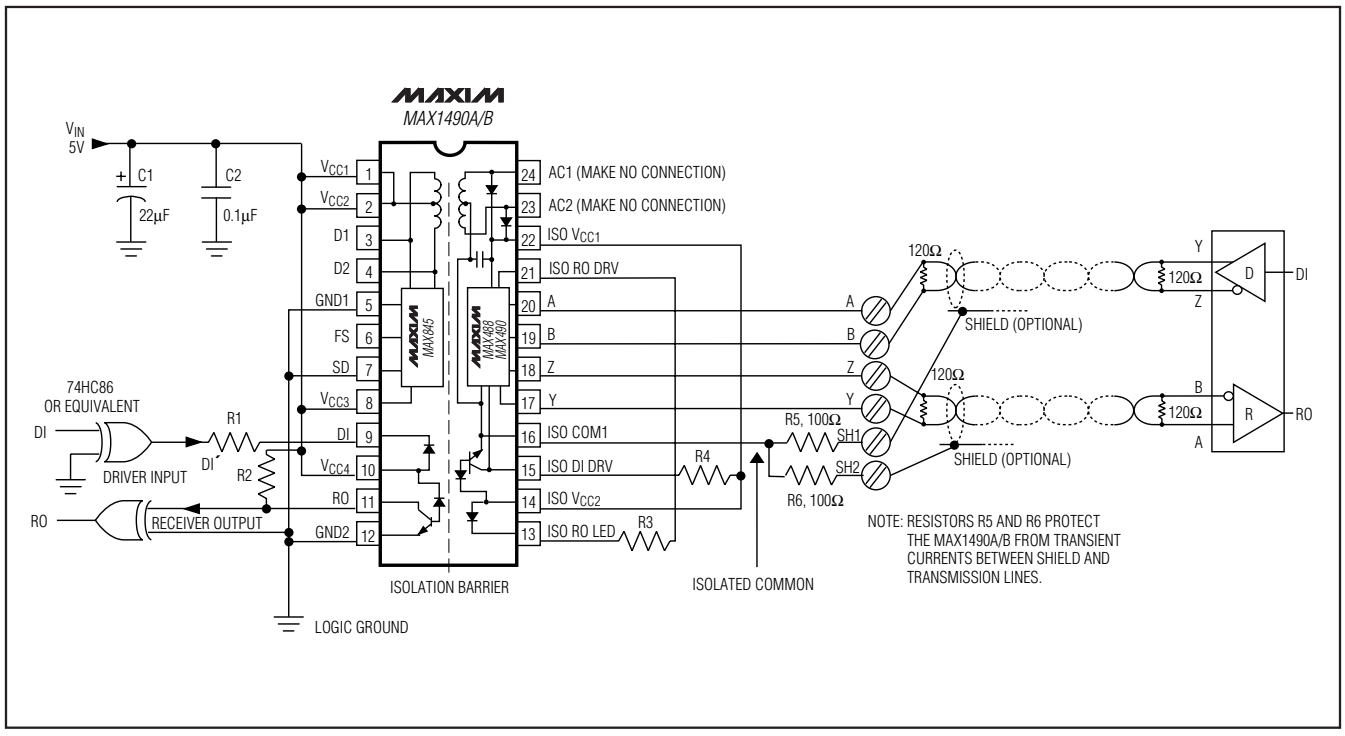



*Figure 14. Typical Full-Duplex RS-485/RS-422 Network*

Connections and components from one side should not be located near those of the other side.

- A shield trace connected to the ground on each side of the barrier can help intercept capacitive currents that might otherwise couple into the signal path. In a double-sided or multilayer board, these shield traces should be present on all conductor layers.
- Try to maximize the width of the isolation barrier wherever possible; a clear space of at least 0.25 inches between ground and isolated common is suggested.

### Pullup and LED Drive Resistors

The MAX1480A/MAX1480B/MAX1480C/MAX1490A/MAX1490B are specified and characterized using the resistor values shown in Table 1 of Figure 1 and Table 2 of Figure 2. Altering the recommended values can degrade performance.

The DI and DE (MAX1480A/B/C only) inputs are the cathodes of LEDs whose anodes are connected to the supply. These points are best driven by a CMOS-logic gate with a series resistor to limit the current. The resistor values shown in Tables 1 and 2 are recommended when the 74HC86 gate or equivalent is used. These values may need to be adjusted if a driving gate with dissimilar series resistance is used.

All pull-up resistors are based on optocoupler specifications in order to optimize the devices' data-transfer rates.

### Isolated Common Connection

The isolated common may be completely floating with respect to the logic ground and the effective network ground. The receiver input resistors will cause the isolated common voltage to go to the mean voltage of the receiver inputs. If using shielded cable, connect the isolated common to the shield through a 100Ω resistor. In the case of the MAX1490, each shield should have its own 100Ω resistor (Figures 1, 2, 13, and 14).

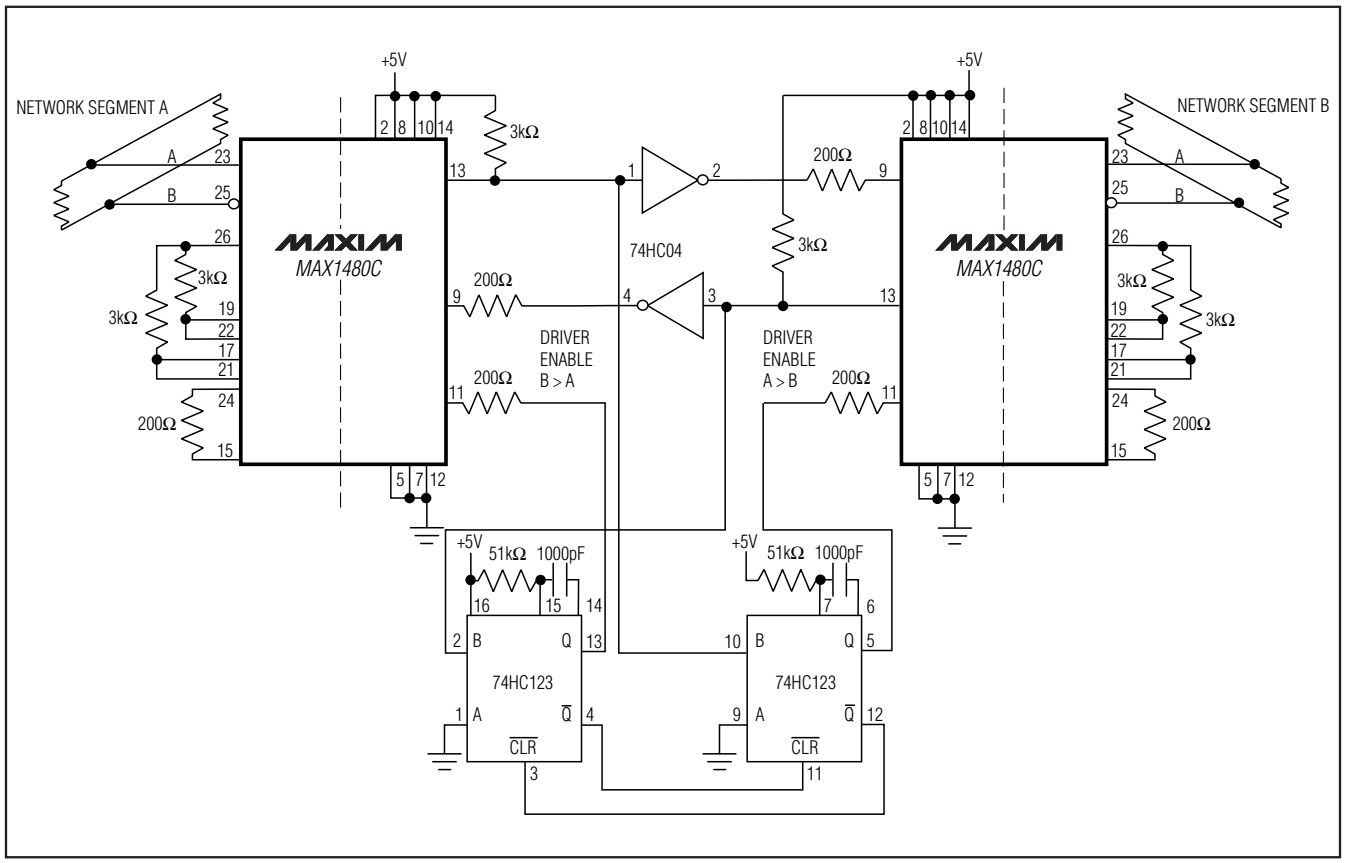



*Figure 15. Doubly Isolated RS-485 Repeater*

# Complete, Isolated RS-485/RS-422 Data Interface

### Doubly Isolated RS-485 Repeater

The RS-422/RS-485 standard is specified for cable lengths up to 4000 feet. When approaching or exceeding the specified maximum cable length, a ground-potential difference of several tens of volts can easily develop. This difference can be either DC, AC, at power-line frequency, or any imaginable noise or impulse waveform. It is typically very low impedance so that if a connection between the two grounds is attempted, very large currents may flow. These currents are by their nature unstable and unpredictable. In addition, they may cause noise to be injected into sensitive instrumentation and, in severe cases, might actually cause physical damage to such equipment.

Figure 15 shows a half-duplex (two-wire), bidirectional, party-line repeater system that prevents interference and/or damage from ground-potential differences. Two MAX1480A/MAX1480B/MAX1480C isolated RS-485 transceivers are used to isolate each of the network segments from the electrical environment of the repeater. The MAX1480A/MAX1480B/MAX1480C also regenerate bus signals that may have been degraded by line attenuation or dispersion.

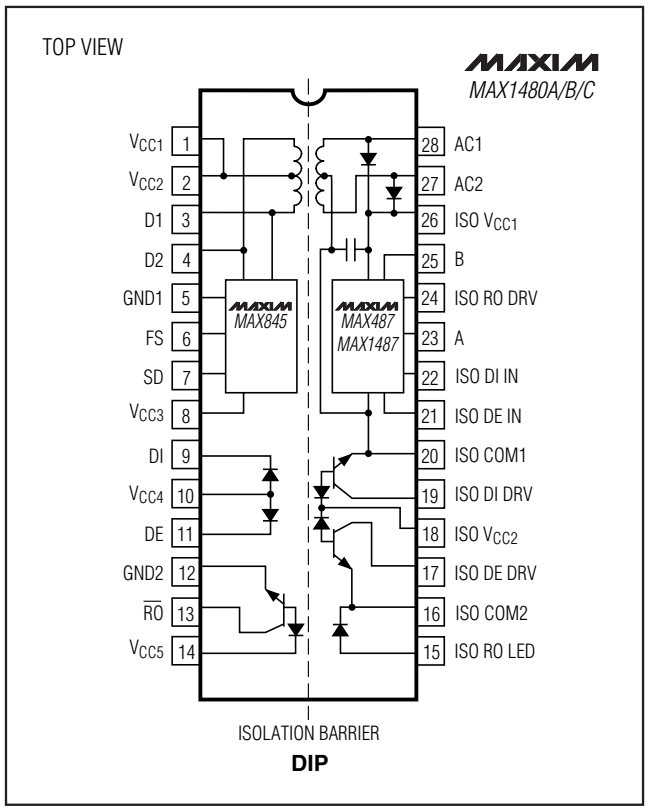
In the idle state, both transmitters are disabled, while all receivers in the system are enabled. If any device on the system has information for any other device, it starts sending its data onto the bus. Each data transmission on the bus retriggers the one-shot, keeping the sending transmitter enabled until there are no more transmissions. All receivers receive all data; if this is undesirable, the protocol must allow for an address field so receivers can ignore data not directed to them.

Each node must refrain from transmitting when data already exists on the bus, and must resend data that is corrupted by the collisions that inevitably occur with a party-line system. With the repeater of Figure 15, there might be transmitters up to 8000 feet apart. That represents more than 8µs (assuming 1ns/foot of delay) in which two nodes could be transmitting simultaneously.

The circuit in Figure 15 can be used either directly as shown, with the slew-rate-limited MAX1480B/MAX1480C, for data transfer rates up to 250kbps, or with the MAX1480A for data rates up to 2.5Mbps (see Table 1 for pullup and LED resistor values when using the MAX1480A, MAX1480B, or MAX1480C). If dual-port isolation is not needed, one of the MAX1480C devices can be replaced by a MAX487 for 250kbps applications.

# Complete, Isolated RS-485/RS-422 Data Interface

## Pin Configurations (continued)




**DIP**

## Ordering Information (continued)

| PART† | TEMP RANGE | PIN-PACKAGE |
|---|---|---|
| **MAX1480B**CPI | 0°C to +70°C | 28 Wide Plastic DIP |
| MAX1480BEPI | -40°C to +85°C | 28 Wide Plastic DIP |
| **MAX1480C**CPI | 0°C to +70°C | 28 Wide Plastic DIP |
| MAX1480CEPI | -40°C to +85°C | 28 Wide Plastic DIP |
| **MAX1490A**CPG | 0°C to +70°C | 24 Wide Plastic DIP |
| MAX1490AEPG | -40°C to +85°C | 24 Wide Plastic DIP |
| **MAX1490B**CPG | 0°C to +70°C | 24 Wide Plastic DIP |
| MAX1490BEPG | -40°C to +85°C | 24 Wide Plastic DIP |

†*Data rate for "A" parts is up to 2.5Mbps. Data rate for "B" and "C" parts is up to 250kbps.*

## Package Information

For the latest package outline information and land patterns, go to **www.maxim-ic.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 | DOCUMENT NO. |
|---|---|---|
| 28 PDIP | P28M-1 | 21-0044 |

*Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.*



© 2005 Maxim Integrated Products Maxim is a registered trademark of Maxim Integrated Products, Inc.

# Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

Analog Devices Inc.:

MAX1480ACPI+ MAX1480AEPI+ MAX1480BCPI+ MAX1480BEPI+ MAX1480CCPI+ MAX1490ACPG+ MAX1490AEPG+ MAX1490BCPG+ MAX1490BEPG+ MAX1480CEPI+