



# 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 shut-down 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/C) if the input is open circuit.

The MAX1480A/MAX1480B/MAX1480C/MAX1490A/MAX1490B typically withstand 1600V<sub>RMS</sub> (1 minute) or 2000V<sub>RMS</sub> (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
MAX1480ACPI	0°C to +70°C	28 Wide Plastic DIP
MAX1480AEPI	-40°C to +85°C	28 Wide Plastic DIP

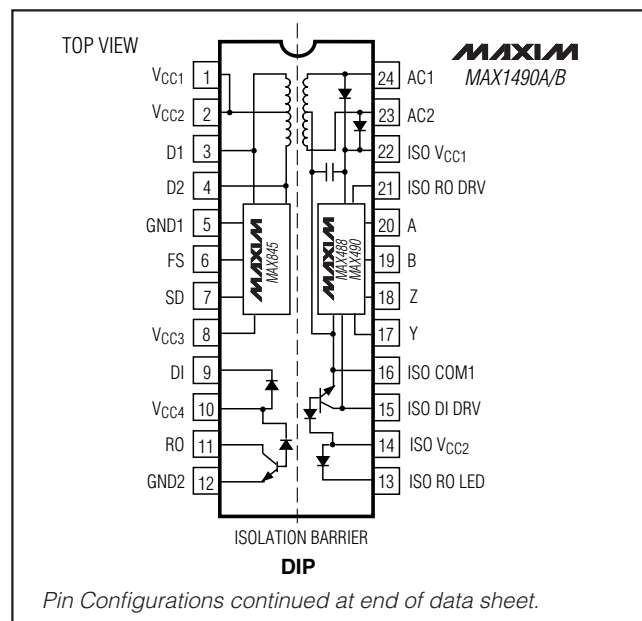
Ordering Information continued at end of data sheet.

†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



MAX1480A/B/C/MAX1490A/B



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## ABSOLUTE MAXIMUM RATINGS

With Respect to GND <sub>-</sub>	LED Forward Current (DI, DE, ISO RO LED) .....50mA
Supply Voltage (VCC <sub>-</sub> ).....-0.3V to +6V	Continuous Power Dissipation (T <sub>A</sub> = +70°C)
Control Input Voltage (SD, FS).....-0.3V to (VCC <sub>-</sub> + 0.3V)	24-Pin Plastic DIP (derate 8.7mW/°C above +70°C) .....696mW
Receiver Output Voltage (RO, RO).....-0.3V to (VCC <sub>-</sub> + 0.3V)	28-Pin Plastic DIP (derate 9.09mW/°C above +70°C) ..727mW
Output Switch Voltage (D1, D2).....+12V	Operating Temperature Ranges
With Respect to ISO COM <sub>-</sub>	MAX1480_CPI/MAX1490_CPG .....0°C to +70°C
Control Input Voltage (ISO DE <sub>-</sub> ) ....-0.3V to (ISO VCC <sub>-</sub> + 0.3V)	MAX1480_EPI/MAX1490_EPG .....-40°C to +85°C
Driver Input Voltage (ISO DI <sub>-</sub> ) .....-0.3V to (ISO VCC <sub>-</sub> + 0.3V)	Storage Temperature Range .....-65°C to +160°C
Receiver Output Voltage (ISO RO <sub>-</sub> ) ...-0.3V to (ISO VCC <sub>-</sub> + 0.3V)	Lead Temperature (soldering, 10s) .....+300°C
Driver Output Voltage (A, B, Y, Z) .....-8V to +12.5V	
Receiver Input Voltage (A, B).....-8V to +12.5V	

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

(VCC<sub>-</sub> = 5V ±10%, VFS = VCC<sub>-</sub>, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at VCC<sub>-</sub> = 5V and T<sub>A</sub> = +25°C.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Switch Frequency	f <sub>SWL</sub>	VFS = 0V		535		kHz
	f <sub>SWH</sub>	FS = VCC <sub>-</sub> or open		725		
Operating Supply Current	I <sub>CC</sub>	MAX1480A, DE' = VCC <sub>-</sub> or open	R <sub>L</sub> = ∞, +25°C only	60	90	mA
			R <sub>L</sub> = 54Ω	120		
		MAX1480B, DE' = VCC <sub>-</sub> or open	R <sub>L</sub> = ∞, +25°C only	35	45	
			R <sub>L</sub> = 54Ω	95		
		MAX1480C, DE' = VCC <sub>-</sub> or open	R <sub>L</sub> = ∞, +25°C only	35	75	
			R <sub>L</sub> = 54Ω	95		
MAX1490A	R <sub>L</sub> = ∞, +25°C only	100	150			
	R <sub>L</sub> = 54Ω	170				
MAX1490B	R <sub>L</sub> = ∞, +25°C only	65	125			
		R <sub>L</sub> = 54Ω	130			
Shutdown Supply Current (Note 3)	I <sub>SHDN</sub>	SD = VCC <sub>-</sub>		0.2		μA
Shutdown Input Threshold	V <sub>SDH</sub>	High	2.4			V
	V <sub>SDL</sub>	Low			0.8	
Shutdown Input Leakage Current				10		pA
FS Input Threshold	V <sub>FSH</sub>	High	2.4			V
	V <sub>FSL</sub>	Low			0.8	
FS Input Pullup Current		FS low			50	μA
FS Input Leakage Current		FS high		10		pA
Input High Voltage	V <sub>IH</sub>	DE', DI'	VCC <sub>-</sub> - 0.4			V
Input Low Voltage	V <sub>IL</sub>	DE', DI'			0.4	V
Isolation Resistance	R <sub>ISO</sub>	T <sub>A</sub> = +25°C, V <sub>ISO</sub> = 50VDC	100	10,000		MΩ
Isolation Capacitance	C <sub>ISO</sub>	T <sub>A</sub> = +25°C, V <sub>ISO</sub> = 50VDC		10		pF
Differential Driver Output (No Load)	V <sub>OD1</sub>				8	V

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

**MAX1480A/B/C/MAX1490A/B**

## ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC-} = 5V \pm 10\%$ ,  $V_{FS} = V_{CC-}$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $V_{CC-} = 5V$  and  $T_A = +25^\circ C$ .) (Notes 1, 2)

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

## SWITCHING CHARACTERISTICS—MAX1480A/MAX1490A

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

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Input to Output Propagation Delay	$t_{PLH}$	Figures 5 and 7, $R_{DIFF} = 54\Omega$ , $C_{L1} = C_{L2} = 100pF$	100		275	ns
	$t_{PHL}$		100			
Driver Output Skew	$t_{SKEW}$	Figures 5 and 7, $R_{DIFF} = 54\Omega$ , $C_{L1} = C_{L2} = 100pF$	25		90	ns
Driver Rise or Fall Time	$t_R, t_F$	Figures 5 and 7, $R_{DIFF} = 54\Omega$ , $C_{L1} = C_{L2} = 100pF$	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, $R_{DIFF} = 54\Omega$ , $C_{L1} = C_{L2} = 100pF$	100		225	ns
	$t_{PHL}$		100			

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**MAX1480A/B/C/MAX1490A/B**

## SWITCHING CHARACTERISTICS—MAX1480A/MAX1490A (continued)

(VCC\_ = 5V ±10%, FS = VCC\_, TA = TMIN to TMAX, unless otherwise noted. Typical values are at VCC\_ = 5V and TA = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
tPLH - tPHL  Differential Receiver Skew	tSKD	Figures 5 and 10, RDIFF = 54Ω, CL1 = CL2 = 100pF		20		ns
Maximum Data Rate	fMAX	tPLH, tPHL < 50% of data period	2.5			Mbps
Time to Shutdown	tSHDN			100		μs
Shutdown to Driver Output High	tZH(SHDN)	Figures 6 and 9, CL = 100pF, S2 closed		3	10	μs
Shutdown to Driver Output Low	tZL(SHDN)	Figures 6 and 9, CL = 100pF, S1 closed		3	10	μs

## SWITCHING CHARACTERISTICS—MAX1480B/MAX1480C/MAX1490B

(VCC\_ = 5V ±10%, FS = VCC\_, TA = TMIN to TMAX, unless otherwise noted. Typical values are at VCC\_ = 5V and TA = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Input to Output Propagation Delay	tPLH	Figures 5 and 7, RDIFF = 54Ω, CL1 = CL2 = 100pF		2	3.0	μs
	tPHL			2	3.0	
Driver Output Skew	tSKEW	Figures 5 and 7, RDIFF = 54Ω, CL1 = CL2 = 100pF		900	1600	ns
Driver Rise or Fall Time	tR, tF	Figures 5 and 7, RDIFF = 54Ω, CL1 = CL2 = 100pF		1.0	2.0	μs
Driver Enable to Output High (MAX1480B Only)	tZH	Figures 6 and 8, CL = 100pF, S2 closed		35	100	μs
Driver Enable to Output Low (MAX1480B Only)	tZL	Figures 6 and 8, CL = 100pF, S1 closed		35	100	μs
Driver Disable Time from Low (MAX1480B Only)	tLZ	Figures 6 and 8, CL = 15pF, S1 closed		13	50	μs
Driver Disable Time from High (MAX1480B Only)	tHZ	Figures 6 and 8, CL = 15pF, S2 closed		13	50	μs
Driver Enable to Output High (MAX1480C Only)	tZH	Figures 6 and 8, CL = 100pF, S2 closed		0.5	4.5	μs
Driver Enable to Output Low (MAX1480C Only)	tZL	Figures 6 and 8, CL = 100pF, S1 closed		0.5	4.5	μs

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

MAX1480A/B/C, MAX1490A/B

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

(V<sub>CC\_</sub> = 5V ±10%, FS = V<sub>CC\_</sub>, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC\_</sub> = 5V and T<sub>A</sub> = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Disable Time from Low (MAX1480C Only)	t <sub>LZ</sub>	Figures 6 and 8, C <sub>L</sub> = 15pF, S1 closed		2.0	4.5	μs
Driver Disable Time from High (MAX1480C Only)	t <sub>HZ</sub>	Figures 6 and 8, C <sub>L</sub> = 15pF, S2 closed		2.0	4.5	μs
Receiver Input to Output Propagation Delay	t <sub>PLH</sub>	Figures 5 and 10, R <sub>DIFF</sub> = 54Ω, C <sub>L1</sub> = C <sub>L2</sub> = 100pF		2	3.0	μs
	t <sub>PHL</sub>			2	3.0	
t <sub>PLH</sub> - t <sub>PHL</sub> Differential Receiver Skew	t <sub>SKD</sub>	Figures 5 and 10, R <sub>DIFF</sub> = 54Ω, C <sub>L1</sub> = C <sub>L2</sub> = 100pF		1200		ns
Maximum Data Rate	f <sub>MAX</sub>	t <sub>PLH</sub> , t <sub>PHL</sub> < 50% of data period	0.25			Mbps
Time to Shutdown	t <sub>SHDN</sub>			100		μs
Shutdown to Driver Output High	t <sub>ZH(SHDN)</sub>	Figures 6 and 9, C <sub>L</sub> = 100pF, S2 closed		35	100	μs
Shutdown to Driver Output Low	t <sub>ZL(SHDN)</sub>	Figures 6 and 9, C <sub>L</sub> = 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<sub>-</sub>), unless otherwise specified.

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

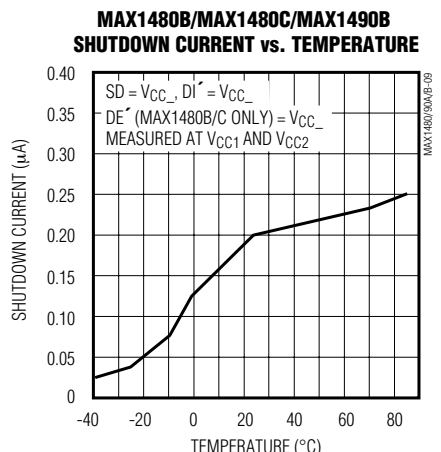
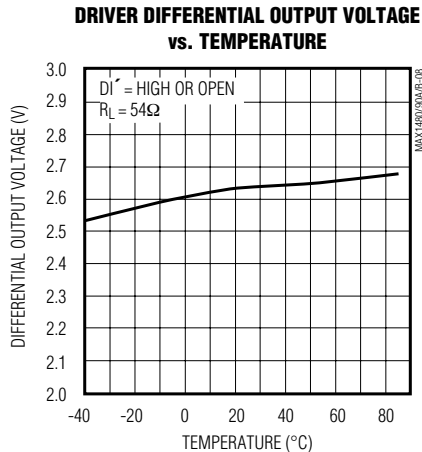
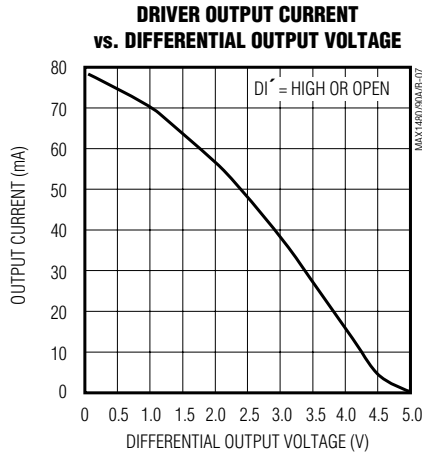
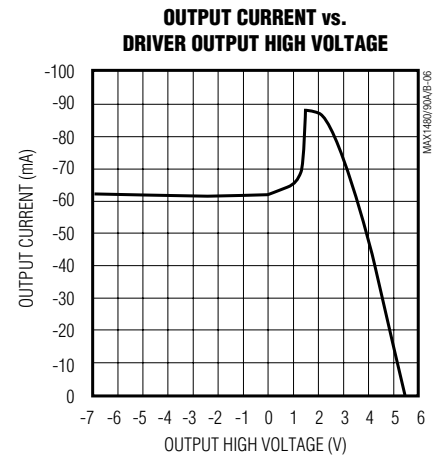
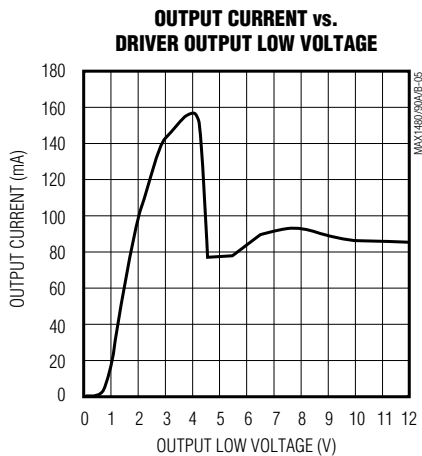
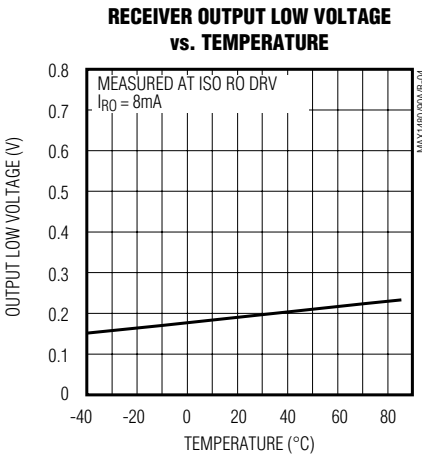
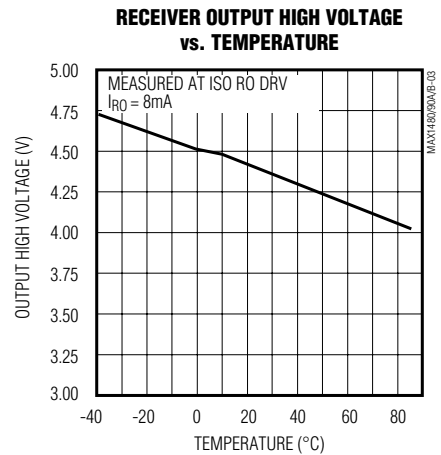
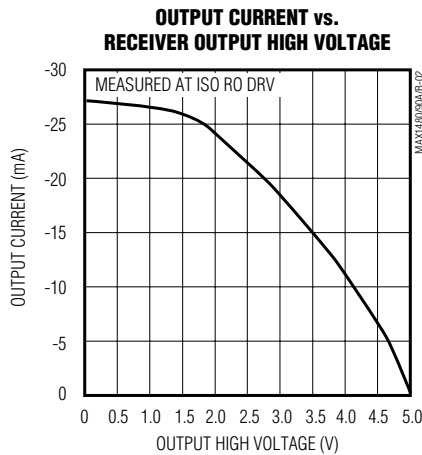
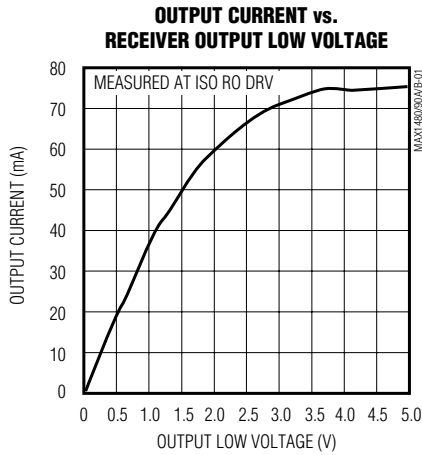
**Note 3:** Shutdown supply current is the current at V<sub>CC1</sub> and V<sub>CC2</sub> when shutdown is enabled.

**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

( $V_{CC+} = 25V$  unless otherwise noted.)

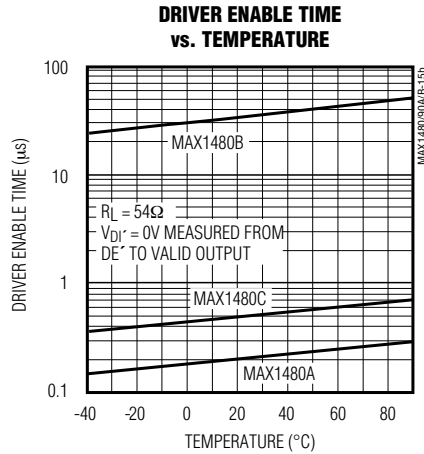
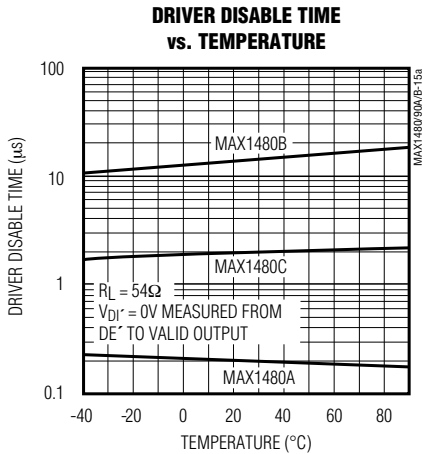
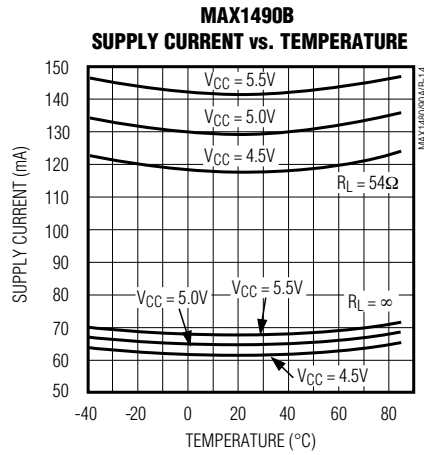
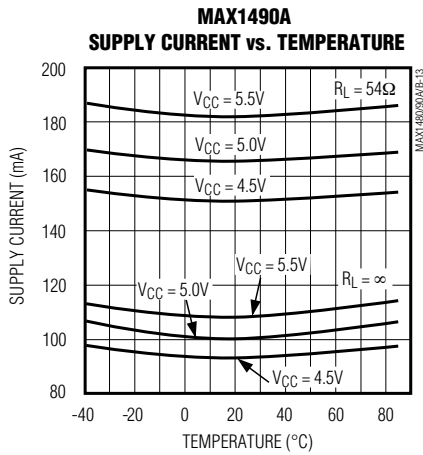
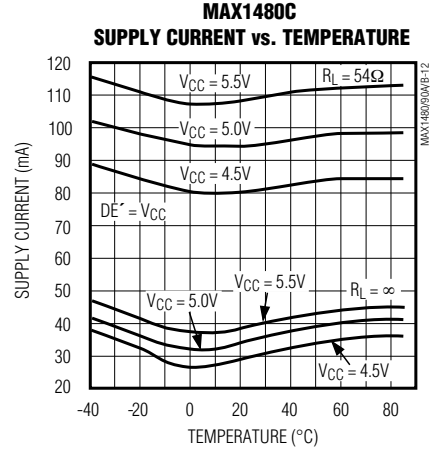
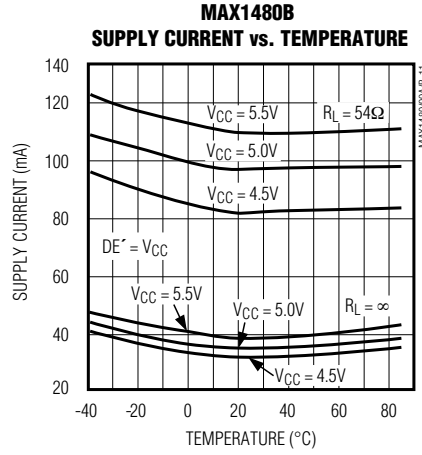
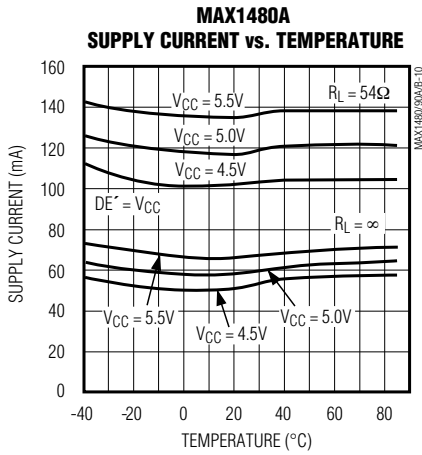


# Complete, Isolated RS-485/RS-422 Data Interface

## Typical Operating Characteristics (continued)

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

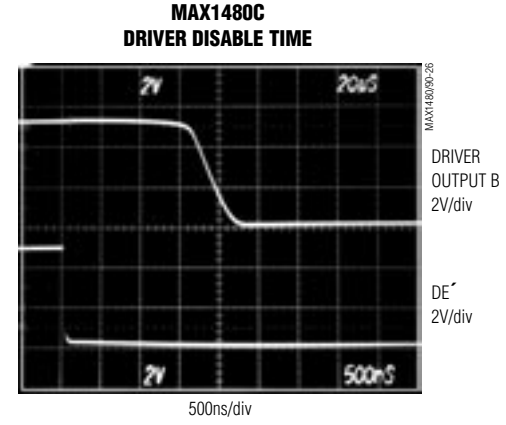
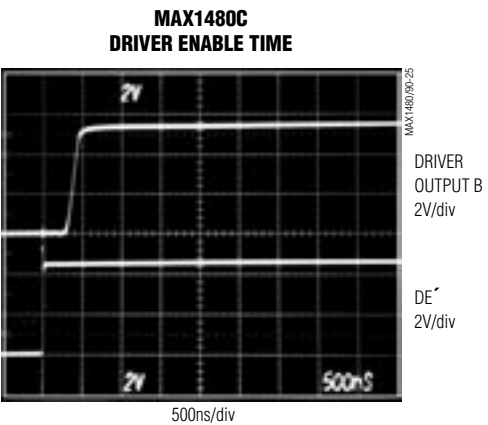
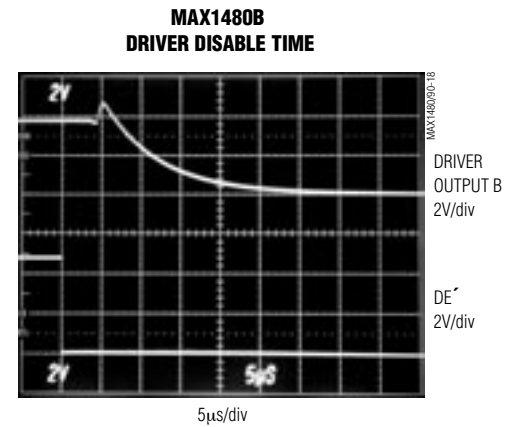
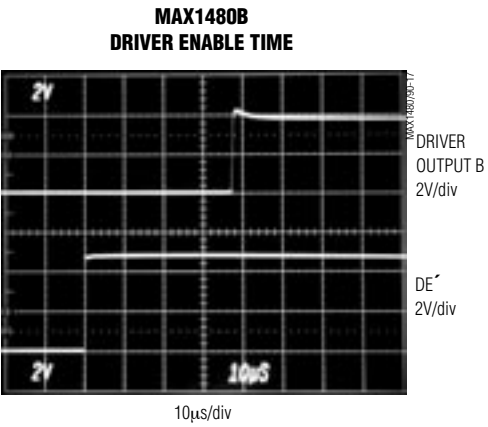
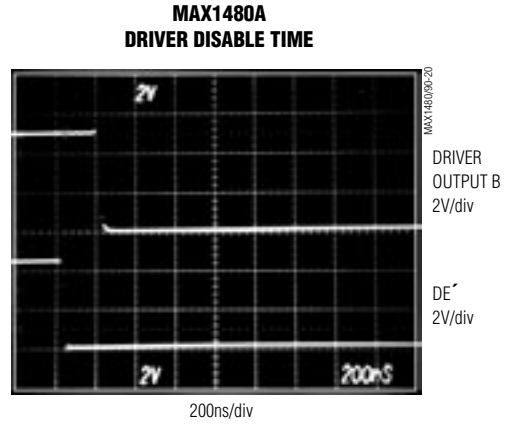
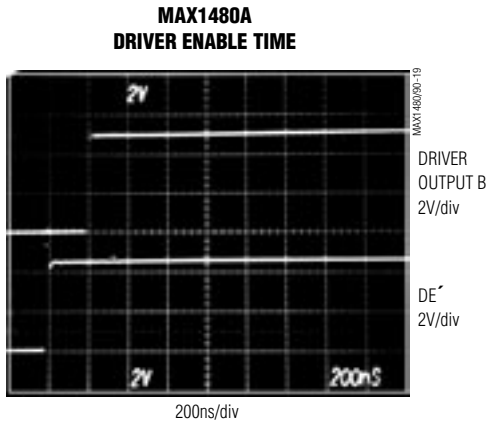
MAX1480A/B/C, MAX1490A/B



# 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,  $T_A = +25^\circ C$ , unless otherwise noted.)



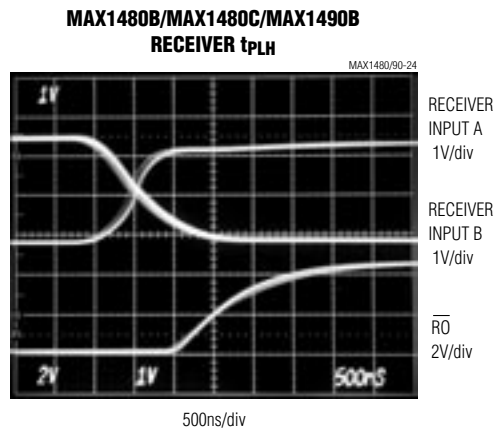
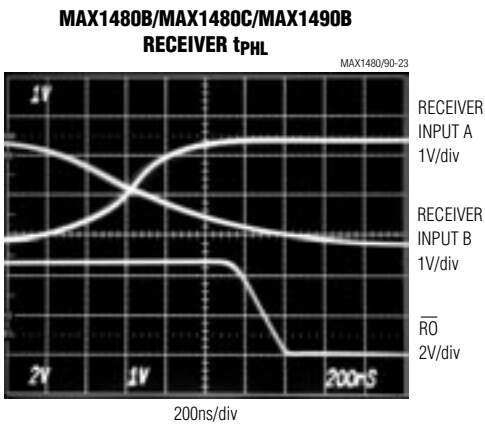
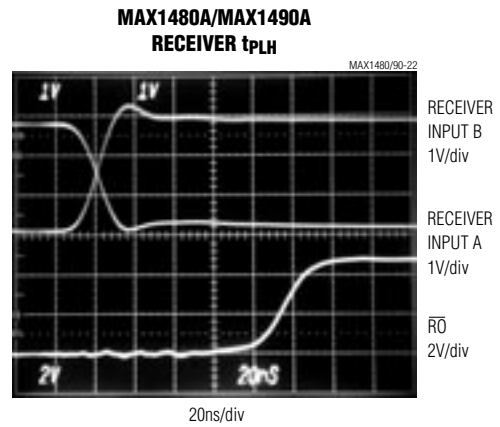
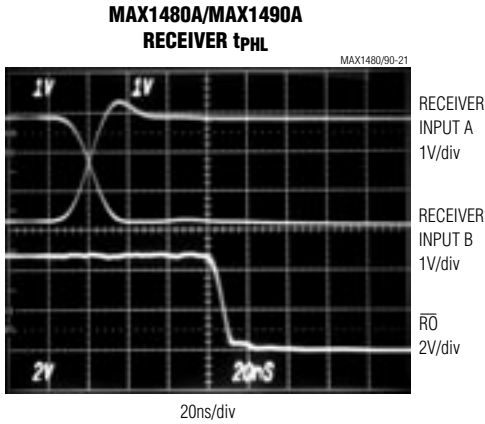


# Complete, Isolated RS-485/RS-422 Data Interface

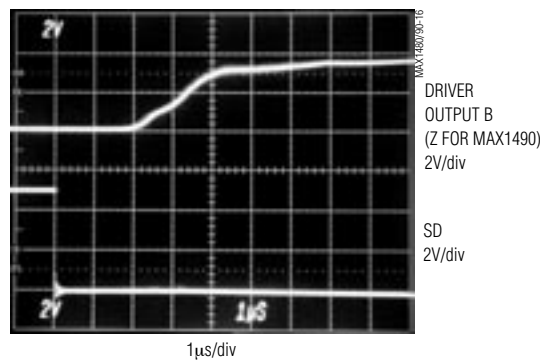
**MAX1480A/B/C, MAX1490A/B**

## Typical Operating Characteristics (continued)

( $V_{CC-} = 5V$ ,  $F_S = V_{CC-}$ ,  $DE' = V_{CC-}$ ,  $V_{DI}' = 0V$  to  $5V$  at  $1.25MHz$ ,  $T_A = +25^{\circ}C$ , unless otherwise noted.)



### POWER-UP DELAY TO DRIVER OUTPUTS VALID



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

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

## Pin Description

PIN		NAME	FUNCTION
MAX1480A/B/C	MAX1490A/B		
<b>PINS ON THE NON-ISOLATED SIDE</b>			
1, 2, 8, 10	1, 2, 8, 10	V <sub>CC1</sub> -V <sub>CC4</sub>	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 <sub>CC_</sub> 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 <sub>CC_</sub> 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 <sup>ˆ</sup> high (MAX1480A/B/C only), a low on DI <sup>ˆ</sup> forces output A low and output B high. Similarly, a high on DI <sup>ˆ</sup> 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 <sup>ˆ</sup> high. The driver outputs are high impedance when DE <sup>ˆ</sup> 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 <sub>CC</sub> (Table 2 of Figure 2).
12	12	GND2	Logic-Side Ground. Connect to GND1 (pin 5).
13	—	$\overline{RO}$	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 <sub>CC_</sub> (Table 1 of Figure 1).
14	—	V <sub>CC5</sub>	Logic-Side (non-isolated side) +5V Supply Voltage
<b>PINS ON THE ISOLATED RS-485/RS-422 SIDE</b>			
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 <sup>ˆ</sup> high. The driver outputs are high impedance when DE <sup>ˆ</sup> 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 <sub>CC_</sub> and be connected to ISO DE IN for normal operation (Table 1 of Figure 1).
18	14	ISO V <sub>CC2</sub>	Isolated Supply Voltage. Connect to ISO V <sub>CC1</sub> (pin 26 for MAX1480A/B/C, or pin 22 for MAX1490A/B).
19	15	ISO DI DRV	Isolated Driver-Input Drive. With DE <sup>ˆ</sup> high (MAX1480A/B/C only), a low on DI <sup>ˆ</sup> forces output A low and output B high. Similarly, a high on DI <sup>ˆ</sup> 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 <sub>CC_</sub> (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).

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

## Pin Description (continued)

MAX1480A/B/C, MAX1490A/B

PIN		NAME	FUNCTION
MAX1480A/B/C	MAX1490A/B		
<b>PINS ON THE ISOLATED RS-485/RS-422 SIDE (continued)</b>			
—	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 VCC1	Isolated Supply Voltage Source
27, 28	23, 24	AC2, AC1	Internal Connections. Leave these pins unconnected.

**Note:** For DE<sup>+</sup> and DI<sup>+</sup> 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 0.2 $\mu$ A by using the SD pin (see *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 VCC<sub>-</sub> 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<sup>+</sup> high. Driver-enable times are typically 0.2 $\mu$ s for the MAX1480A, 35 $\mu$ s for the MAX1480B, and 0.5 $\mu$ s 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<sup>+</sup> is low. While outputs are high impedance, they function as line receivers.

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

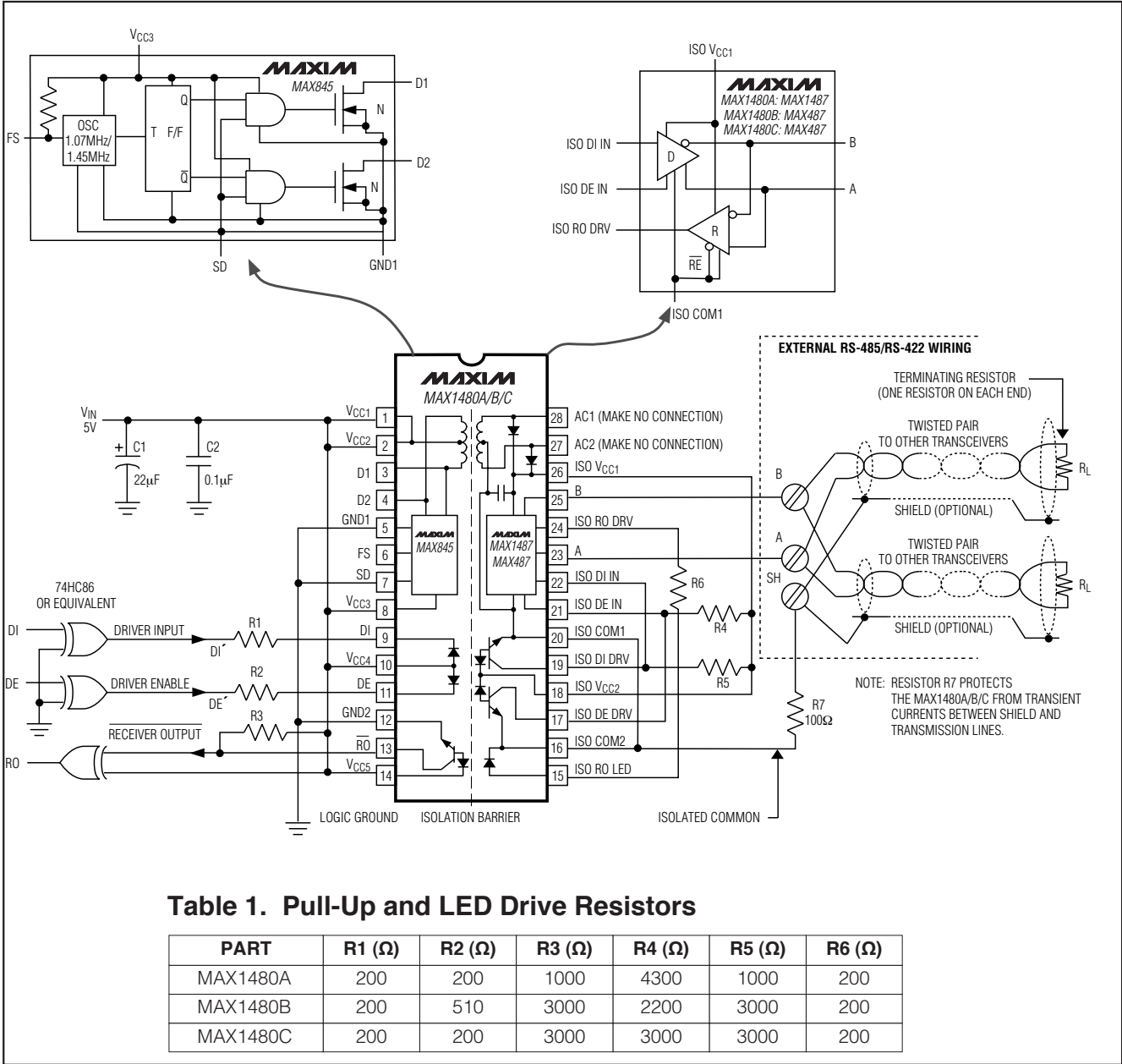


Figure 1. MAX1480A/MAX1480B/MAX1480C Detailed Block Diagram and Typical Application Circuit

The MAX1480A/MAX1480B/MAX1480C/MAX1490A/MAX1490B typically withstand 1600V<sub>RMS</sub> (1 minute) or 2000V<sub>RMS</sub> (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.

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

MAX1480A/B/C, MAX1490A/B

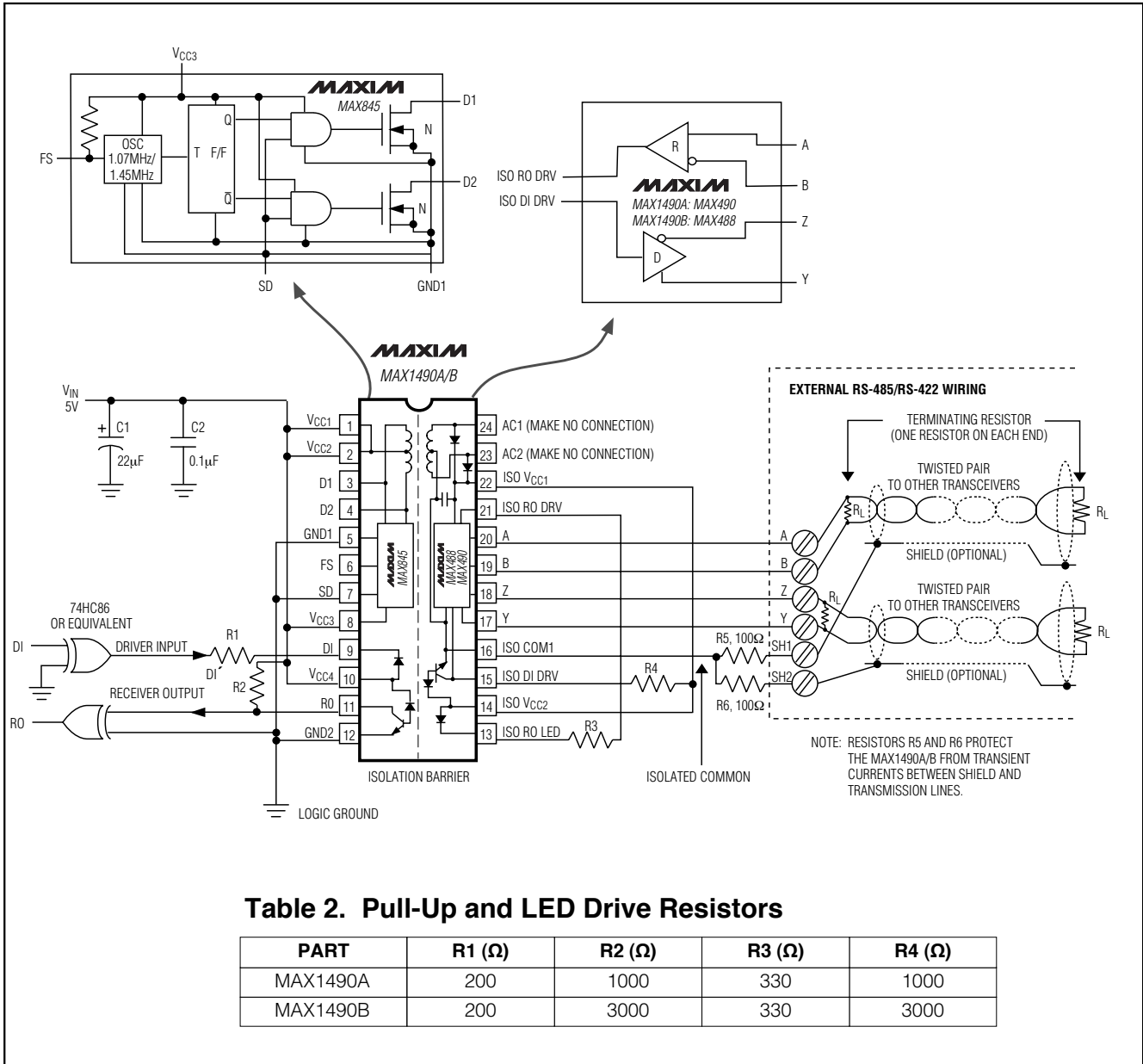


Figure 2. MAX1490A/MAX1490B Detailed Block Diagram and Typical Application Circuit

Under these conditions, the MAX1480B/MAX1480C/MAX1490B supply current is reduced to as low as 0.2 $\mu$ A. The high-speed optocouplers on the MAX1480A/MAX1480C/MAX1490A consume an additional 10mA through VCC5 (VCC4 for the MAX1490A). Therefore, to completely shut down these devices, use an external P-channel MOSFET as shown in Figure 3. In normal opera-

tion, SD is low, turning the MOSFET on and thereby providing power to all the VCC\_ 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

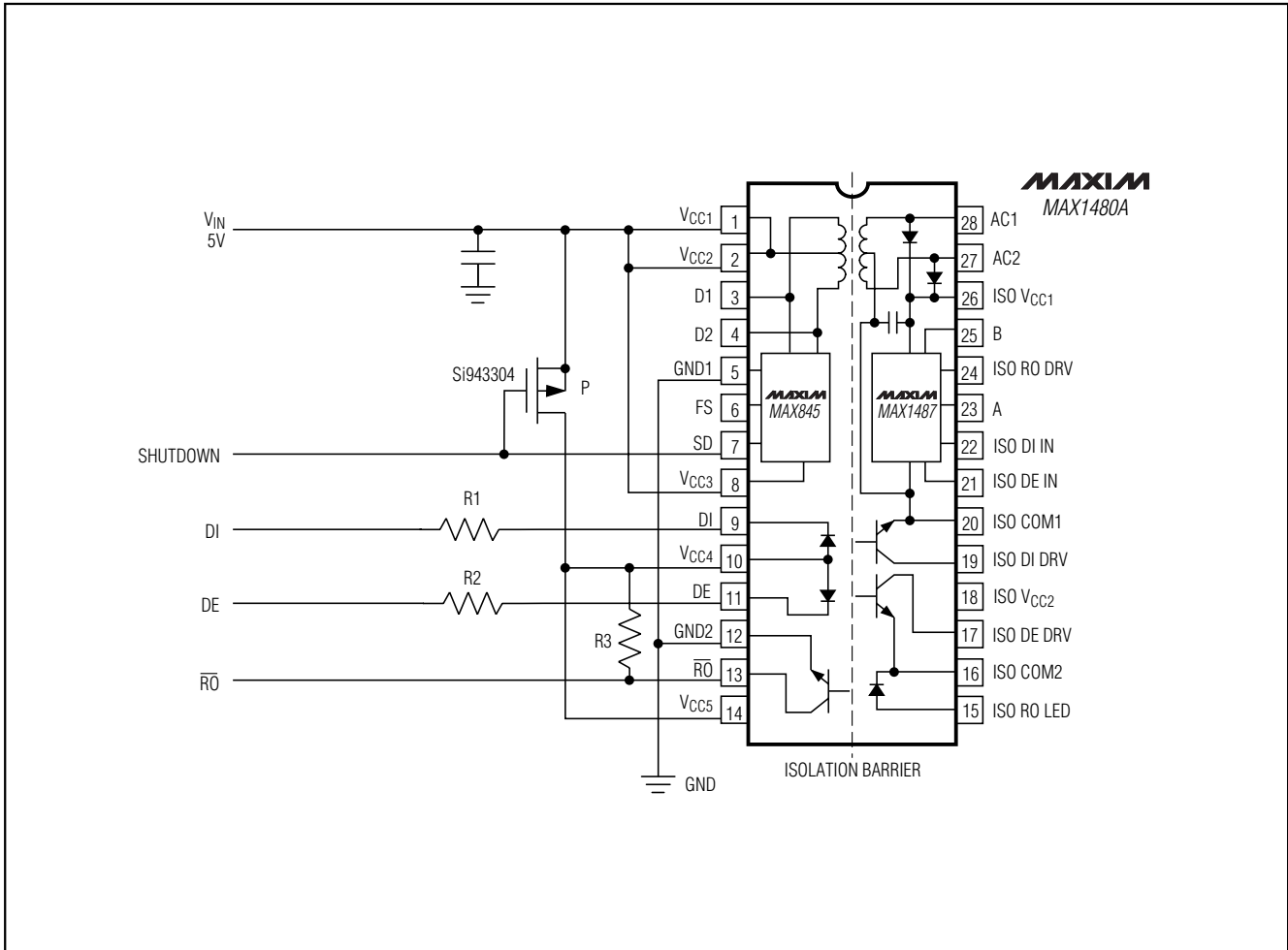


Figure 3. MAX1480A Low-Power Shutdown Mode

## Test Circuits

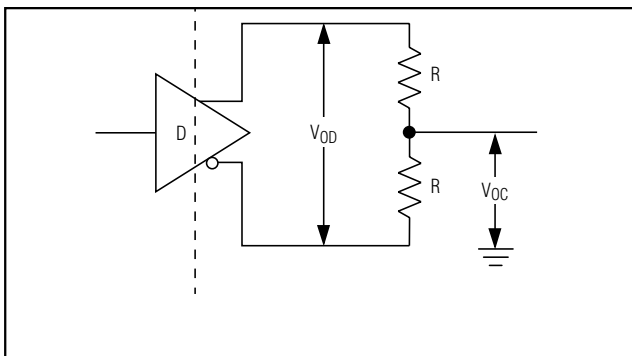


Figure 4. Driver DC Test Load

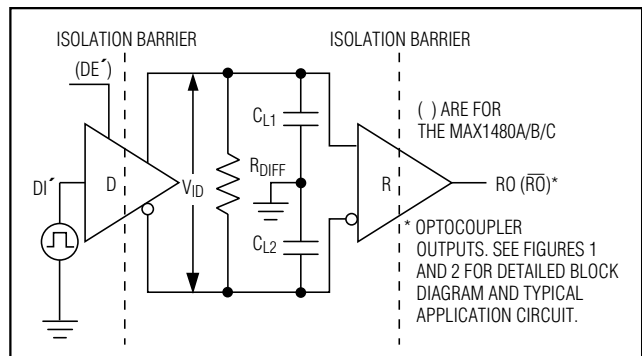


Figure 5. Driver/Receiver Timing Test Circuit

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

## Test Circuits (continued)

MAX1480A/B/C, MAX1490A/B

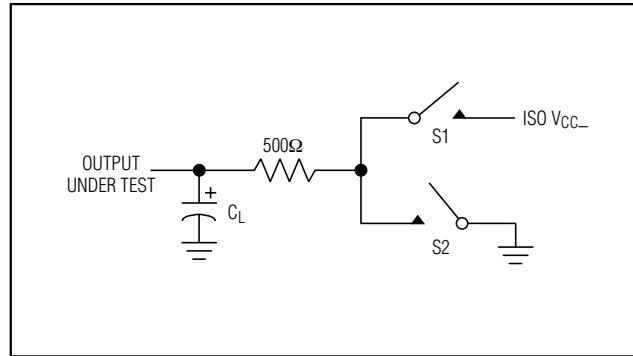


Figure 6. Driver Timing Test Load

## Switching Waveforms

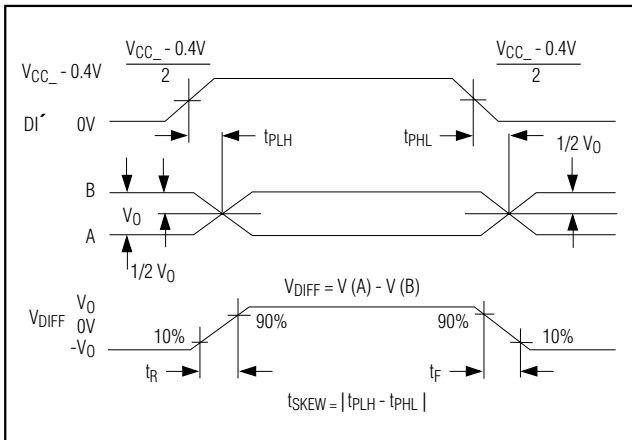


Figure 7. Driver Propagation Delays and Transition Times

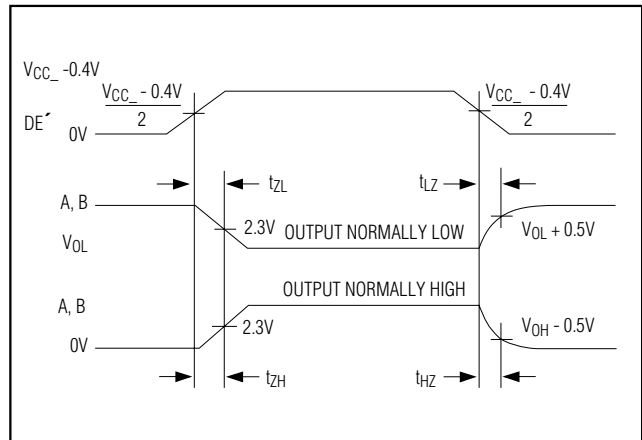


Figure 8. Driver Enable and Disable Times

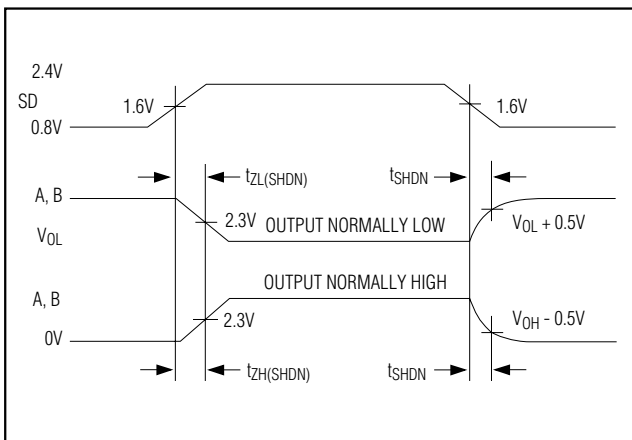


Figure 9. Times to/from Shutdown

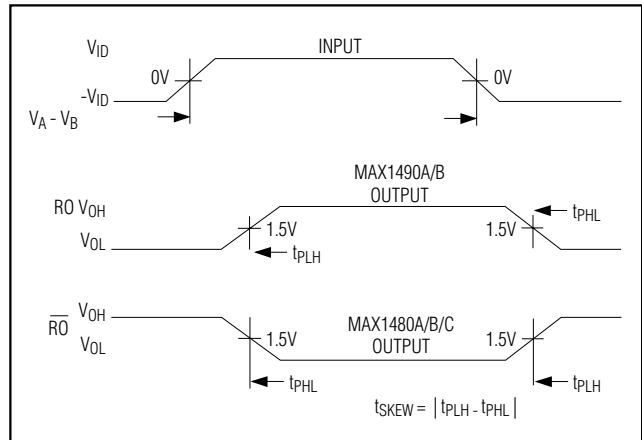


Figure 10. Receiver Propagation Delays

# 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.

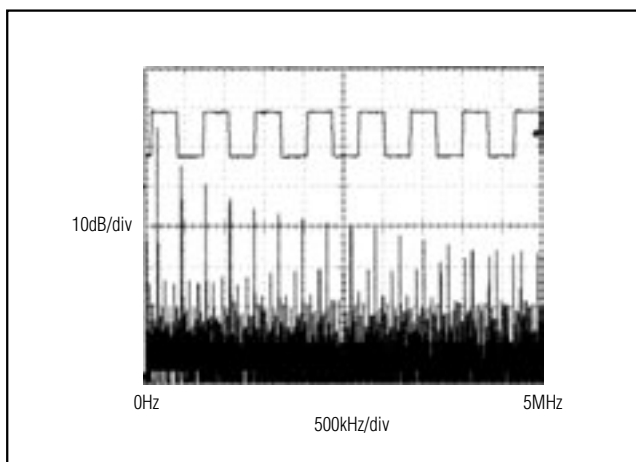


Figure 11. Driver Output Waveform and FFT Plot of MAX1480A/MAX1490A Transmitting a 150kHz Signal

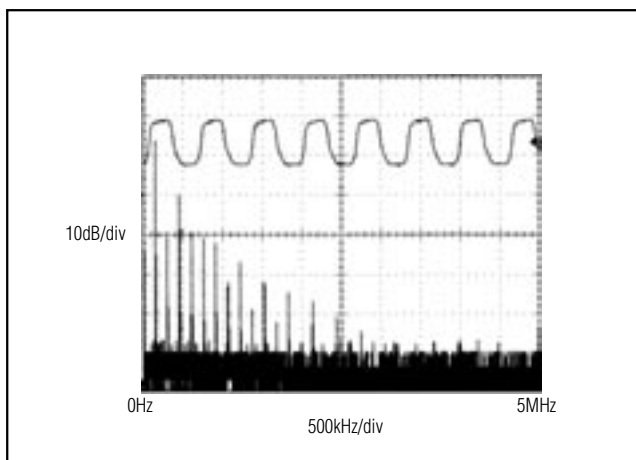


Figure 12. Driver Output Waveform and FFT Plot of MAX1480B/MAX1480C/MAX1490B Transmitting a 150kHz Signal

## Function Tables

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

**Table 3. Transmitting**

INPUTS*		OUTPUTS	
DE <sup>′</sup>	DI <sup>′</sup>	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 <sup>′</sup>	V <sub>A</sub> - V <sub>B</sub>	
0	≥ +0.2V	0
0	≤ -0.2V	1
0	Open	0

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

**Table 5. Transmitting**

INPUT* (DI <sup>′</sup> )	OUTPUTS	
	Z	Y
1	0	1
0	1	0

\* For DE<sup>′</sup> and DI<sup>′</sup> 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 <sub>A</sub> - V <sub>B</sub> )	OUTPUT (RO)
≥ +0.2V	1
≤ -0.2V	0
Open	1







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

MAX1480A/B/C, MAX1490A/B

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).

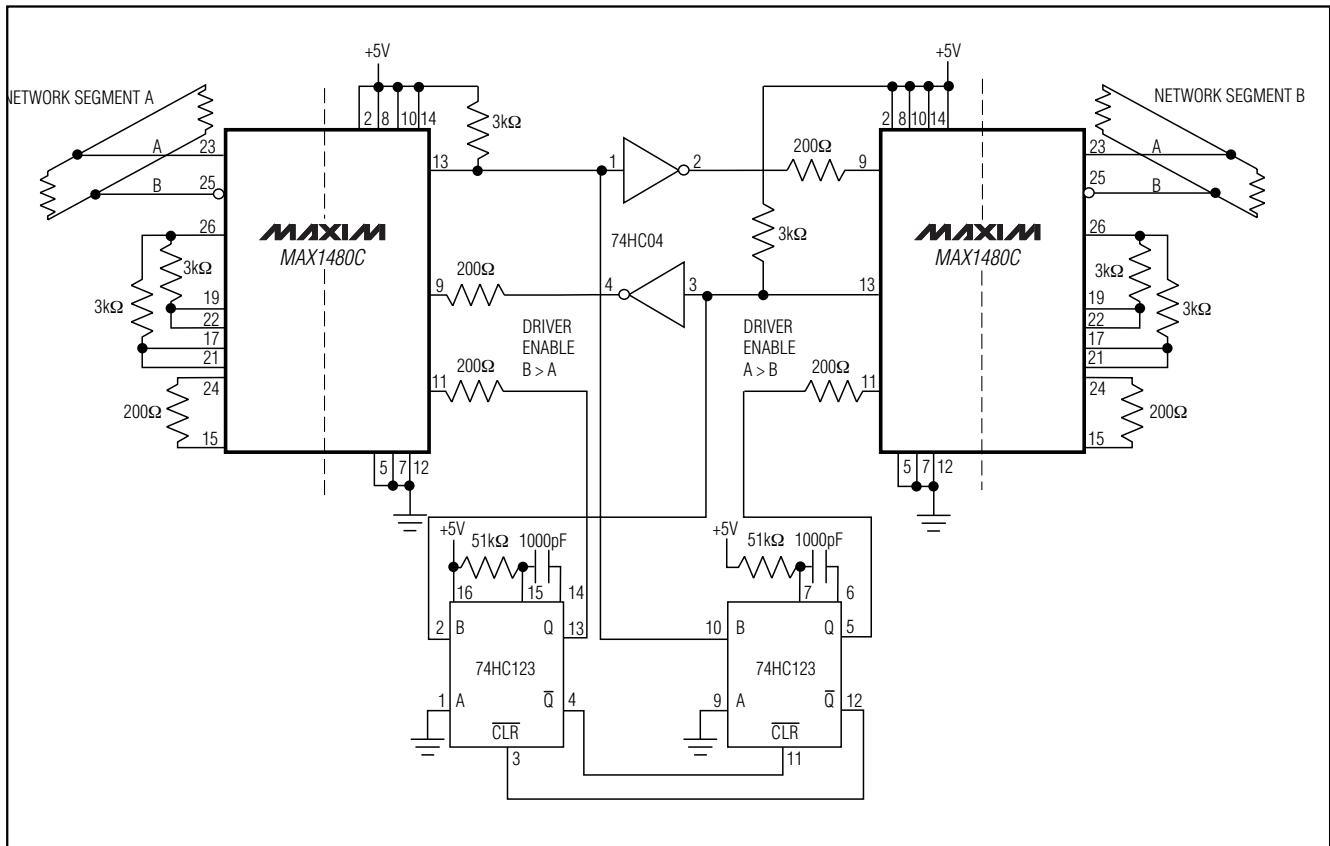


Figure 15. Doubly Isolated RS-485 Repeater

## 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 8 $\mu$ s (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 or MAX1480B). If dual-port isolation is not needed, one of the MAX1480C devices can be replaced by a MAX487 for 250kbps applications.

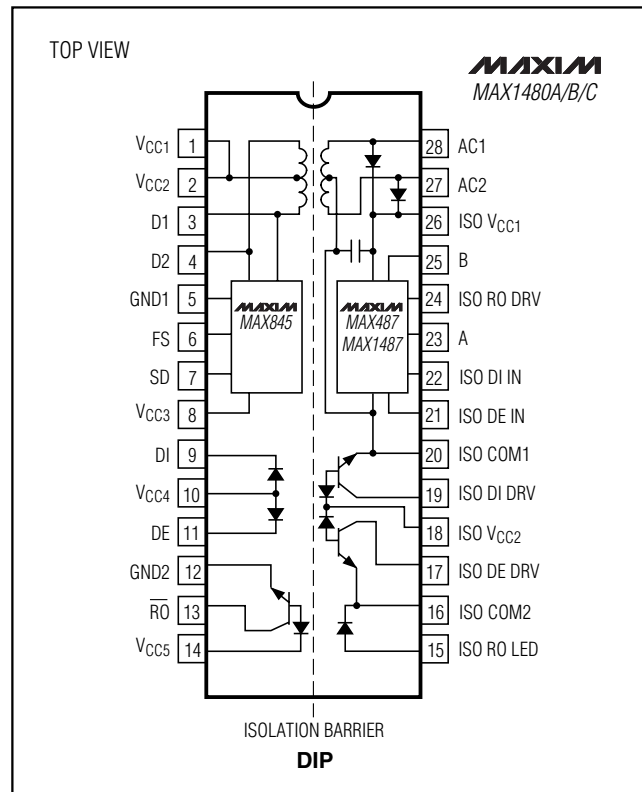
# Complete, Isolated RS-485/RS-422 Data Interface

## Ordering Information (continued)

PART <sup>†</sup>	TEMP RANGE	PIN-PACKAGE
MAX1480BCPI	0°C to +70°C	28 Wide Plastic DIP
MAX1480BEPI	-40°C to +85°C	28 Wide Plastic DIP
MAX1480CCPI	0°C to +70°C	28 Wide Plastic DIP
MAX1480CEPI	-40°C to +85°C	28 Wide Plastic DIP
MAX1490ACPG	0°C to +70°C	24 Wide Plastic DIP
MAX1490AEPG	-40°C to +85°C	24 Wide Plastic DIP
MAX1490BCPG	0°C to +70°C	24 Wide Plastic DIP
MAX1490BEPG	-40°C to +85°C	24 Wide Plastic DIP

<sup>†</sup>Data rate for "A" parts is up to 2500kbps. Data rate for "B" and "C" parts is up to 250kbps.

## Pin Configurations (continued)



MAX1480A/B/C, MAX1490A/B

## Package Information

For the latest package outline information, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).

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