19-0259; Rev 2a; 2/98

MAXIM

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/C) if the input is open circuit.

The MAX1480A/MAX1480B/MAX1480C/MAX1490A/MAX1490B typically withstand 1600V_{RMS} (1 minute) or 2000V_{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.

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	—

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

Features

- **Isolated Data Interface, Typically to 1600V_{RMS} (1 minute)**
- **Slew-Rate Limited for Errorless Data Transmission (MAX1480B/MAX1480C/MAX1490B)**
- **High-Speed, Isolated, 2.5Mbps RS-485/RS-422 Interface (MAX1480A/MAX1490A)**
- **Full-Duplex Data Communication (MAX1490A/B)**
- **-7V to +12V Common-Mode Input Voltage Range with Respect to Isolated Ground**
- **Single +5V Supply**
- **Current Limiting and Thermal Shutdown for Driver Overload Protection**
- **Standard 0.6" DIP Package:**
  28-Pin DIP (MAX1480A/B/C)
  24-Pin DIP (MAX1490A/B)

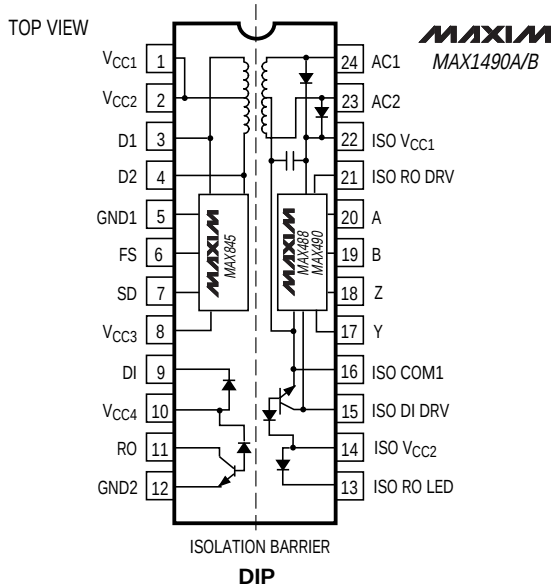
Ordering Information

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.*

Pin Configurations



DIP

Pin Configurations continued at end of data sheet.

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, 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_CPI.....0°C to +70°C
- MAX1480_EPI/MAX1490_EPI .....-40°C to +85°C

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

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 = ∞		60	90	mA
			R_L = 54Ω		120		
		MAX1480B, DE´ = $V_{CC\_}$ or open	R_L = ∞		35	45	
			R_L = 54Ω		95		
		MAX1480C, DE´ = $V_{CC\_}$ or open	R_L = ∞		35	75	
			R_L = 54Ω		95		
		MAX1490A	R_L = ∞		100	150	
			R_L = 54Ω		170		
		MAX1490B	R_L = ∞		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 Pull-Up 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	
Change in Magnitude of Driver Output Voltage for Complementary Output States	ΔV_{OD}	R = 27Ω or 50Ω, Figure 4		Differential			0.3	V
				Common Mode			0.3	
Driver Common-Mode Output	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 ≤ V_{CM} ≤ 12V			12			kΩ
Receiver Differential Threshold	V_{TH}	-7V ≤ V_{CM} ≤ 12V			-0.2		0.2	V
Receiver Input Hysteresis	ΔV_{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	
$\lvert t_{PLH} - t_{PHL} \rvert$ Differential Receiver Skew	t_{SKD}	Figures 5 and 10, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF		20		ns

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
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
Driver Input to Output Propagation Delay	t_{PLH}	Figures 5 and 7, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF		1.0	2.0	µs
	t_{PHL}	Figures 5 and 7, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF		1.0	2.0	
Driver Output Skew	t_{SKEW}	Figures 5 and 7, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF		100	800	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
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		0.8	2.0	µs
	t_{PHL}			0.8	2.0	
$\lvert t_{PLH} - t_{PHL} \rvert$ Differential Receiver Skew	t_{SKD}	Figures 5 and 10, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF		200		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).

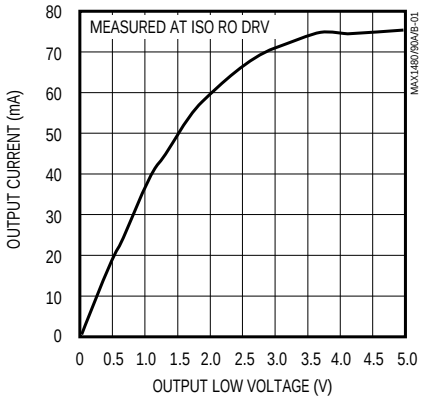
Note 3: Shutdown supply current is the current at V_{CC1} and V_{CC2} when shutdown is enabled.

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).

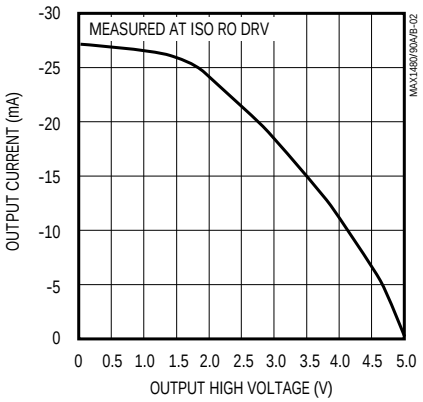
Typical Operating Characteristics

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

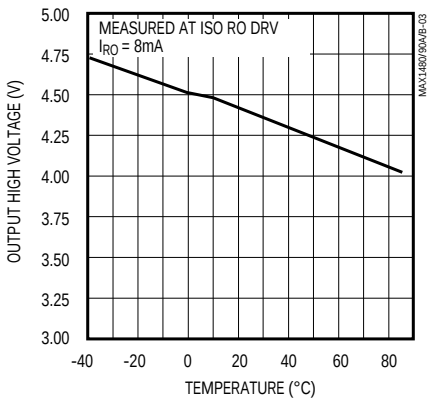
OUTPUT CURRENT vs. RECEIVER OUTPUT LOW VOLTAGE



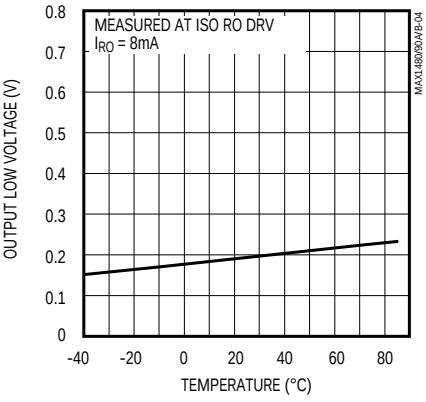
OUTPUT CURRENT vs. RECEIVER OUTPUT HIGH VOLTAGE



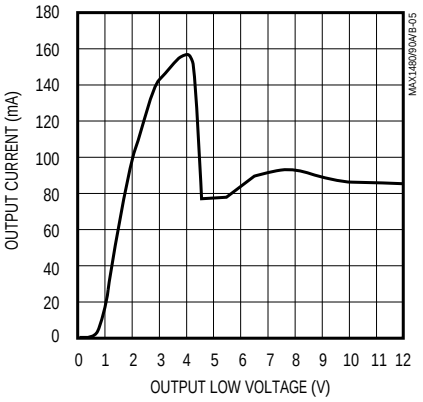
RECEIVER OUTPUT HIGH VOLTAGE vs. TEMPERATURE



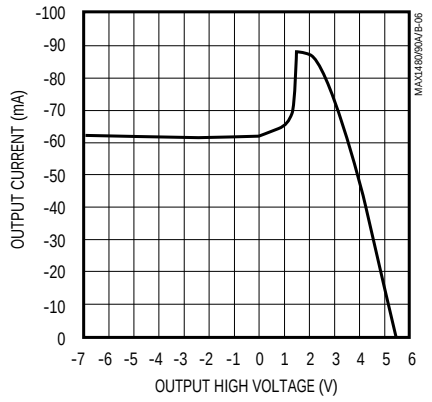
RECEIVER OUTPUT LOW VOLTAGE vs. TEMPERATURE



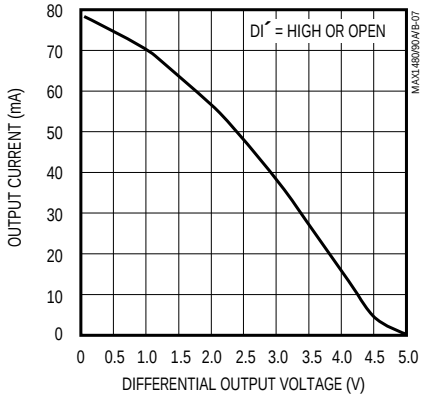
OUTPUT CURRENT vs. DRIVER OUTPUT LOW VOLTAGE



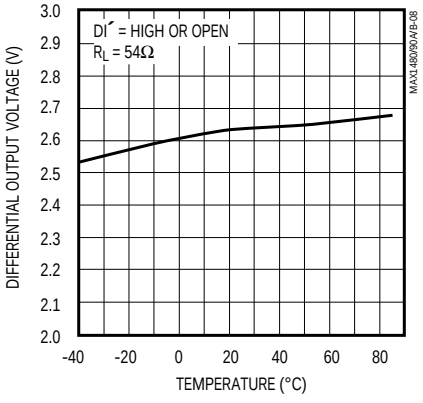
OUTPUT CURRENT vs. DRIVER OUTPUT HIGH VOLTAGE



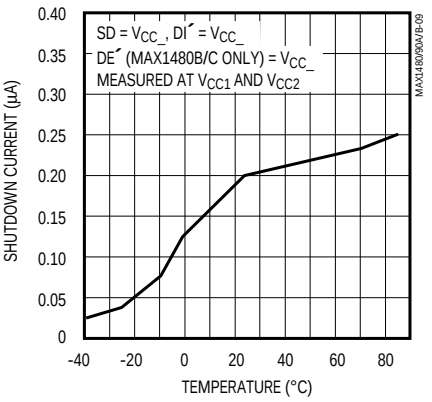
DRIVER OUTPUT CURRENT vs. DIFFERENTIAL OUTPUT VOLTAGE



DRIVER DIFFERENTIAL OUTPUT VOLTAGE vs. TEMPERATURE



MAX1480B/MAX1480C/MAX1490B SHUTDOWN CURRENT vs. TEMPERATURE

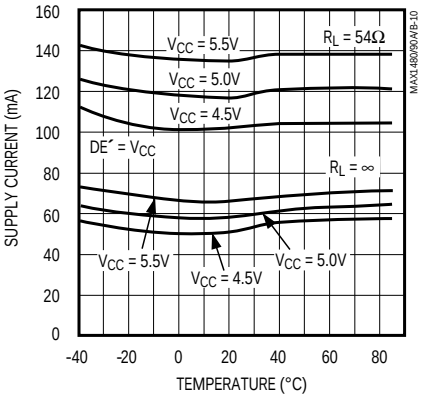


Complete, Isolated RS-485/RS-422 Data Interface

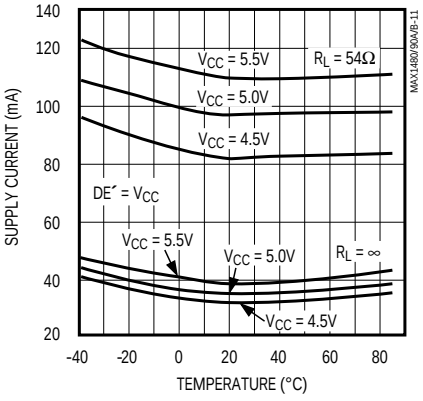
Typical Operating Characteristics (continued)

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

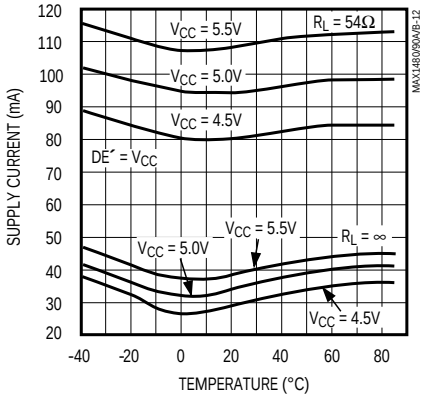
MAX1480A
SUPPLY CURRENT vs. TEMPERATURE



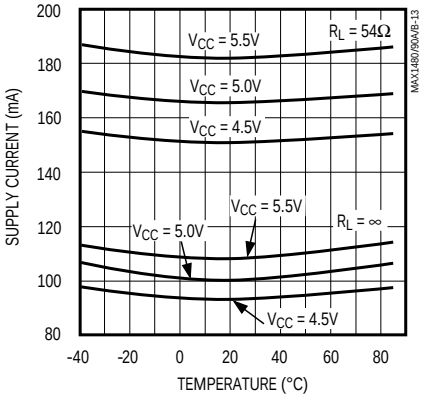
MAX1480B
SUPPLY CURRENT vs. TEMPERATURE



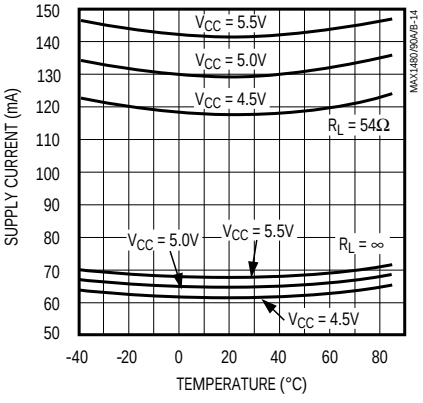
MAX1480C
SUPPLY CURRENT vs. TEMPERATURE



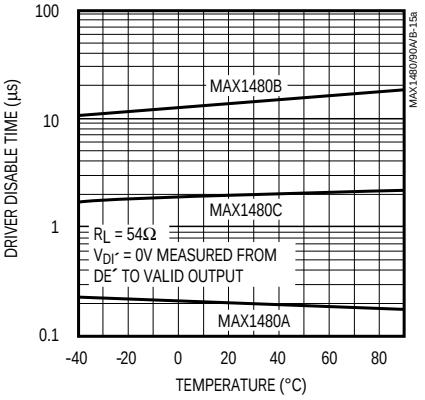
MAX1490A
SUPPLY CURRENT vs. TEMPERATURE



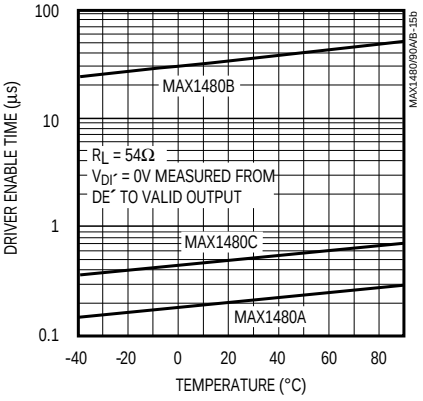
MAX1490B
SUPPLY CURRENT vs. TEMPERATURE



DRIVER DISABLE TIME
vs. TEMPERATURE



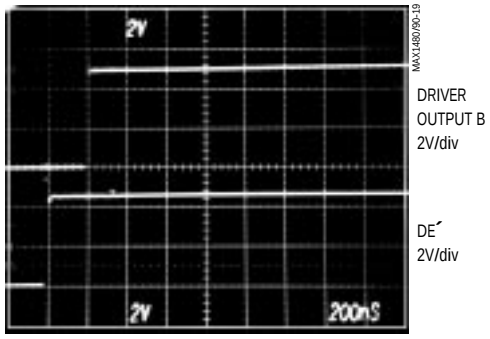
DRIVER ENABLE TIME
vs. TEMPERATURE



Typical Operating Characteristics (continued)

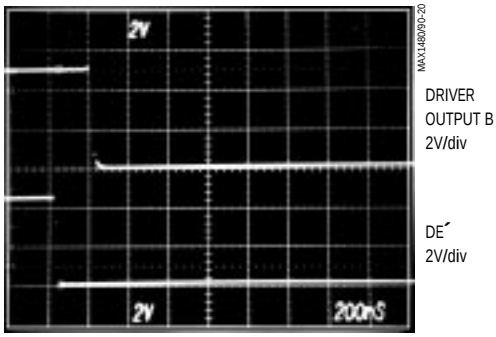
($V_{CC\_}$ = 5V, FS = $V_{CC\_}$, V_{DI}´ = 0V, DE´ toggled 0V to 5V at 5kHz, T_A = +25°C, unless otherwise noted.)

MAX1480A
DRIVER ENABLE TIME



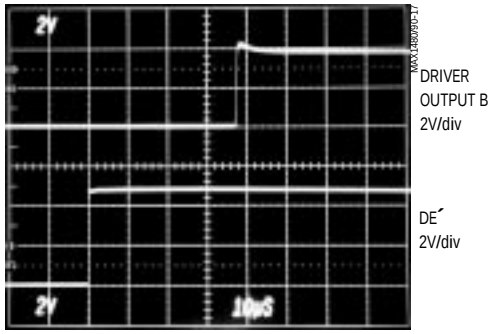
200ns/div

MAX1480A
DRIVER DISABLE TIME



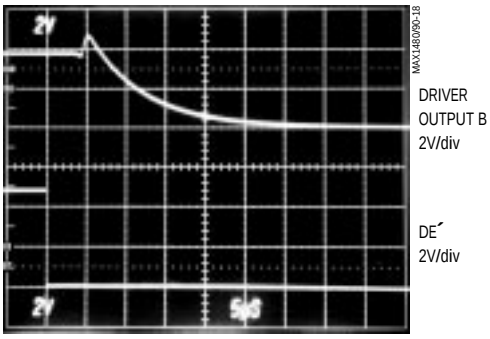
200ns/div

MAX1480B
DRIVER ENABLE TIME



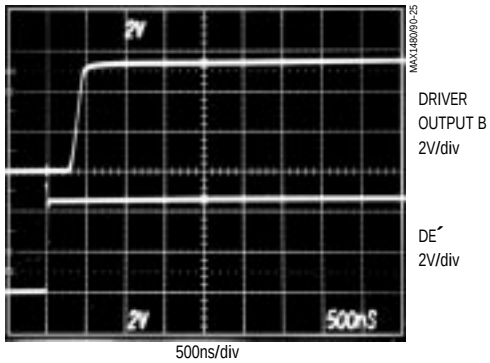
10µs/div

MAX1480B
DRIVER DISABLE TIME



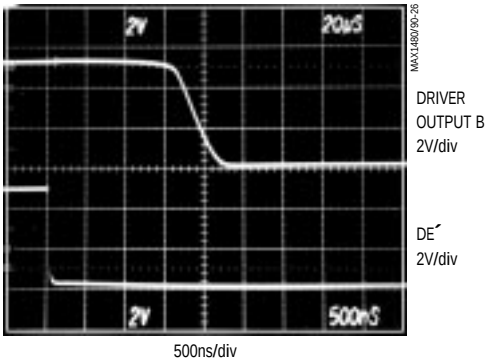
5µs/div

MAX1480C
DRIVER ENABLE TIME



500ns/div

MAX1480C
DRIVER DISABLE TIME

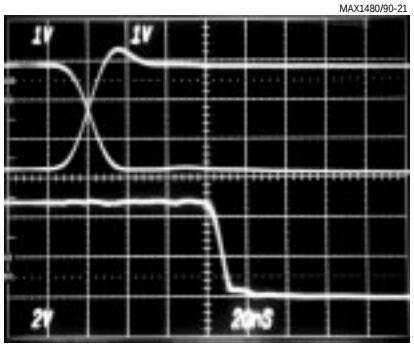


500ns/div

Typical Operating Characteristics (continued)

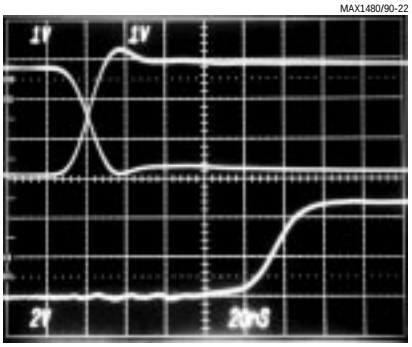
($V_{CC\_}$ = 5V, FS = $V_{CC\_}$, $DE' = V_{CC\_}$, $V_{DI'}$ = 0V to 5V at 1.25MHz, T_A = +25°C, unless otherwise noted.)

MAX1480A/MAX1490A
RECEIVER t_{PHL}



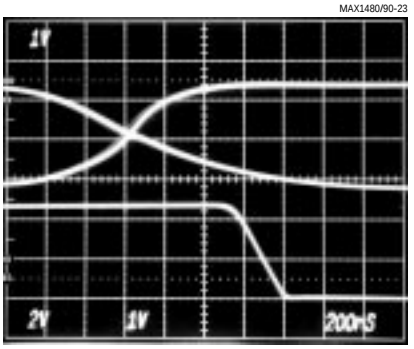
20ns/div

MAX1480A/MAX1490A
RECEIVER t_{PLH}



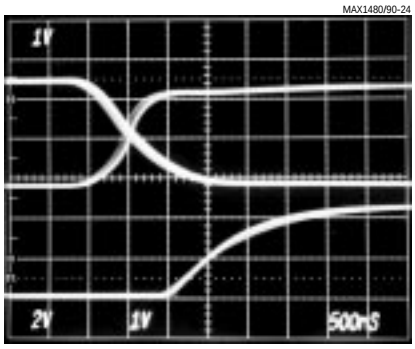
20ns/div

MAX1480B/MAX1480C/MAX1490B
RECEIVER t_{PHL}



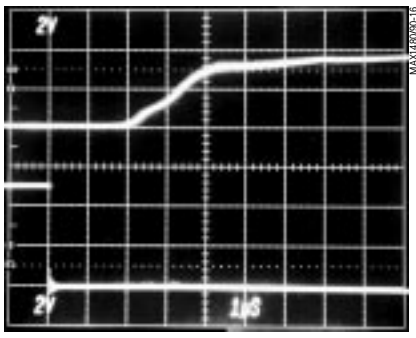
200ns/div

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

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 (non-isolated 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 pull-up 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 pull-up 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 pull-up to ISO VCC_ and be tied 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 pull-up 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 (non-isolated 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 *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.

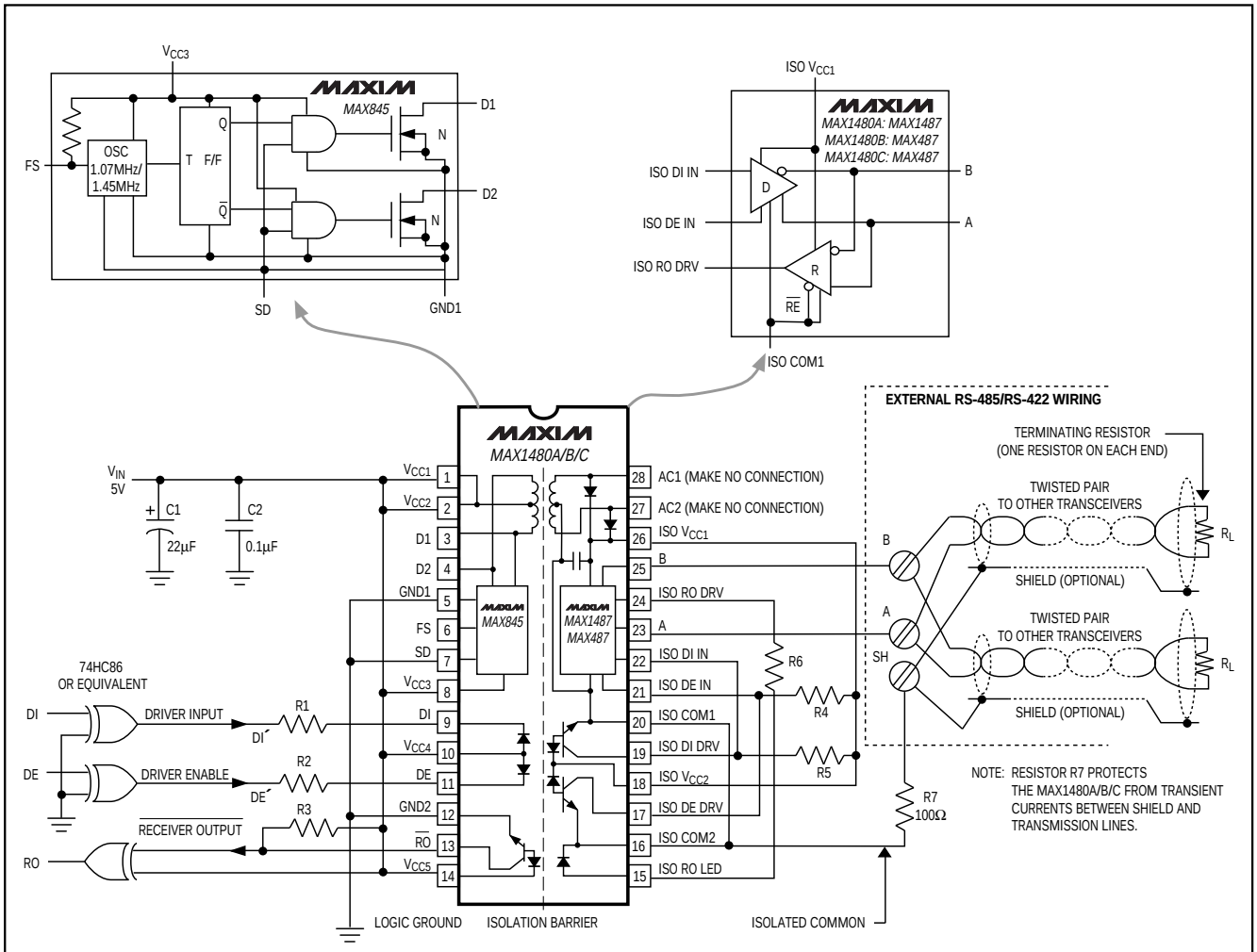


Table 1. Pull-Up and LED Drive Resistors

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 1600V_{RMS} (1 minute) or 2000V_{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 pull-up.

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 non-isolated side are low. Therefore, leave DI´ and DE´ high or floating when in shutdown mode.

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

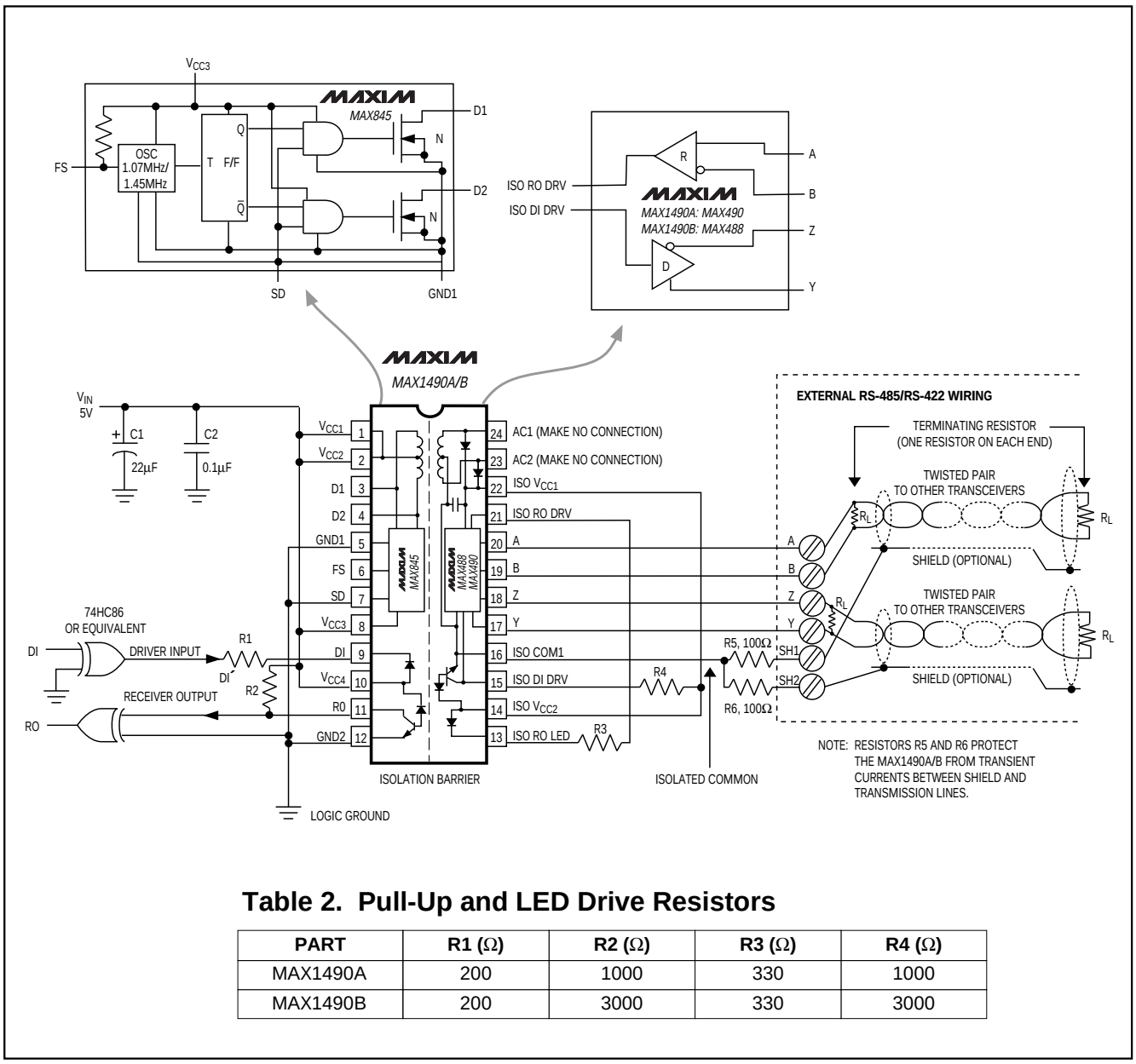


Table 2. Pull-Up and LED Drive Resistors

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.

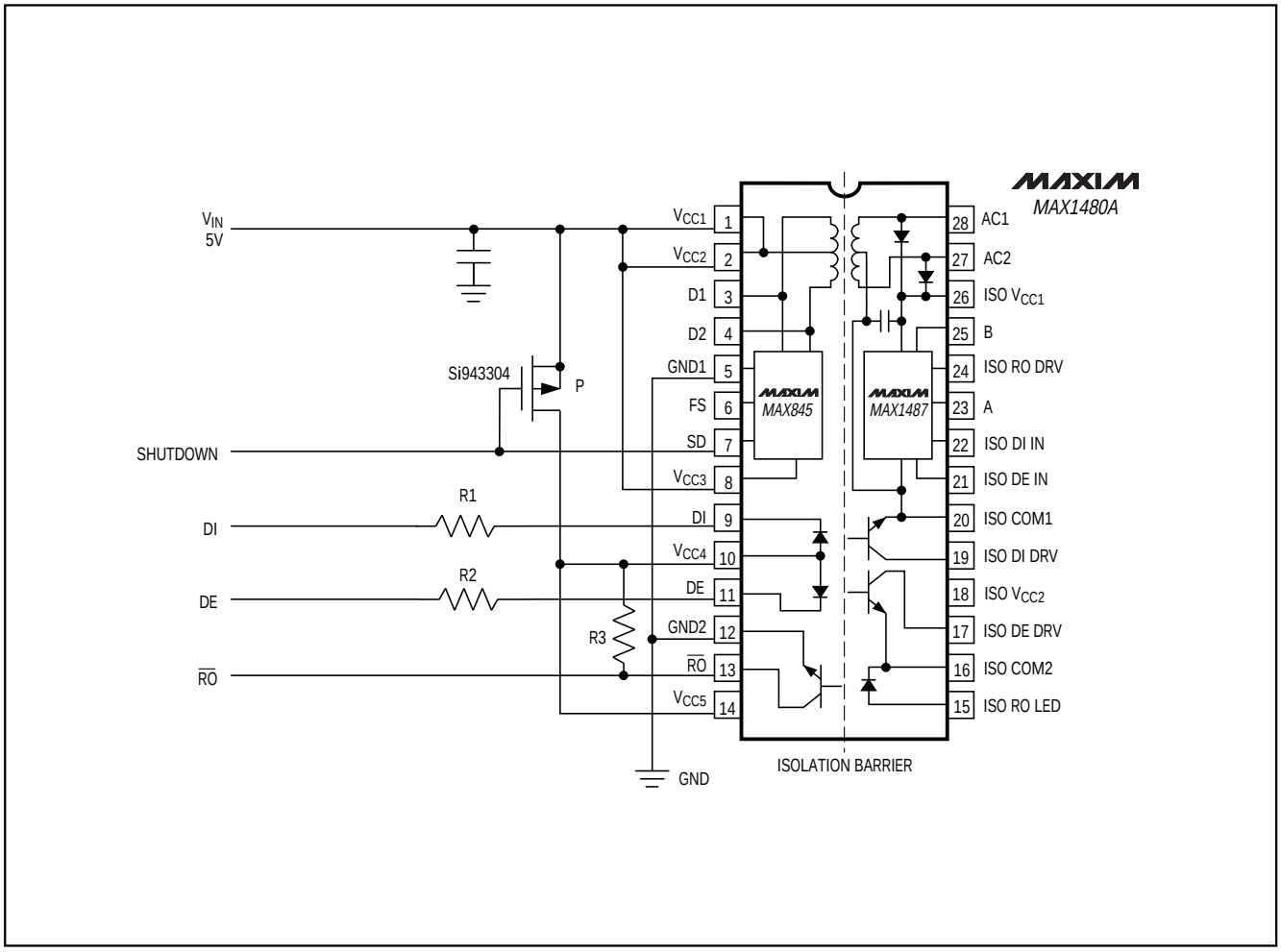


Figure 3. MAX1480A Low-Power Shutdown Mode

Test Circuits

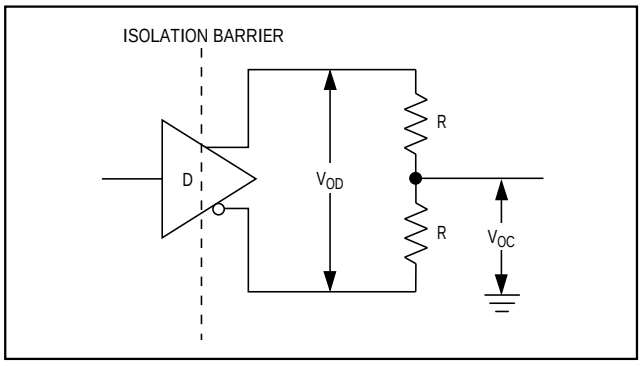


Figure 4. Driver DC Test Load

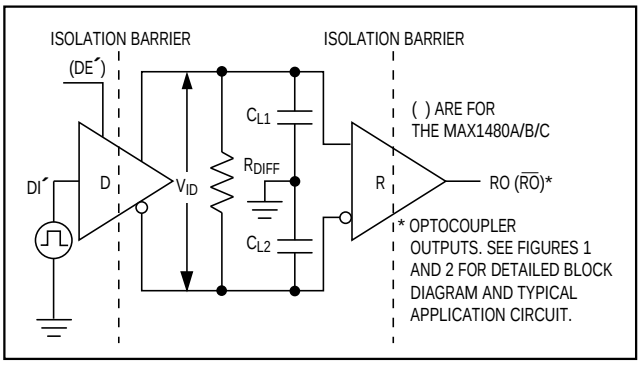


Figure 5. Driver/Receiver Timing Test Circuit

Test Circuits (continued)

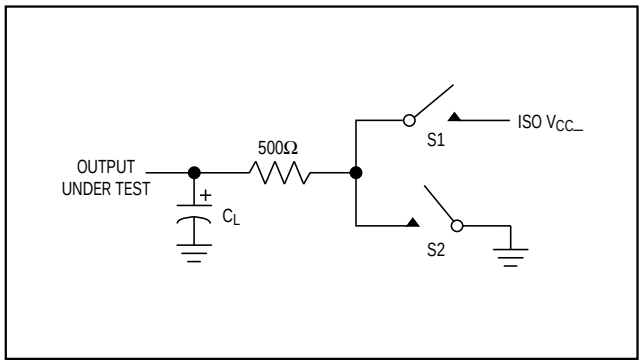


Figure 6. Driver Timing Test Load

Switching Waveforms

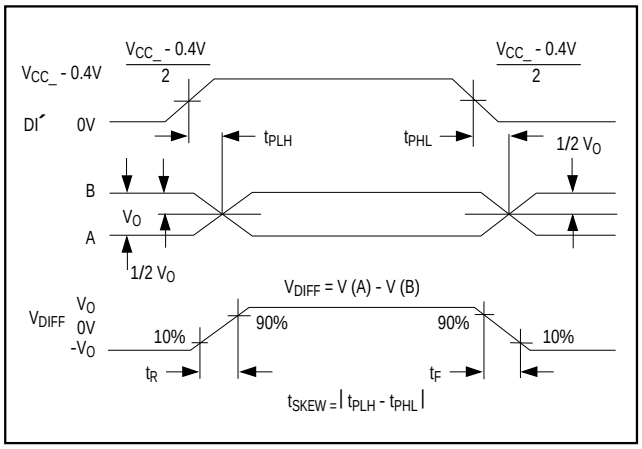


Figure 7. Driver Propagation Delays and Transition Times

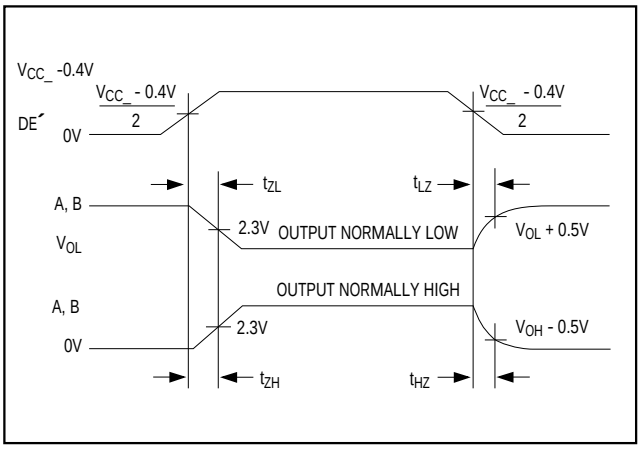


Figure 8. Driver Enable and Disable Times

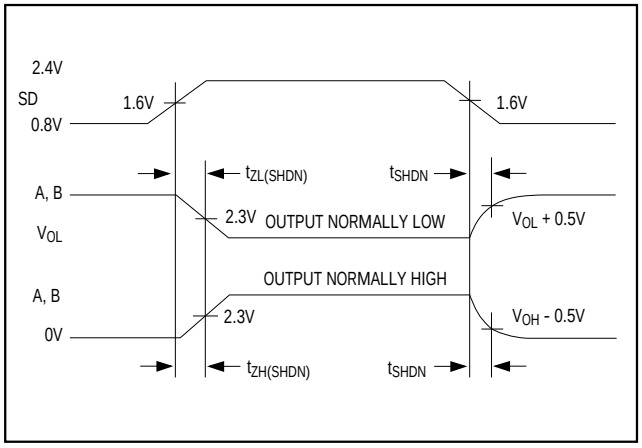


Figure 9. Times to/from Shutdown

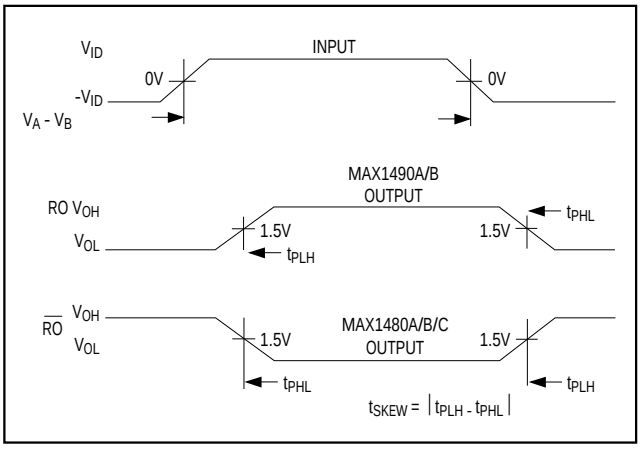


Figure 10. Receiver Propagation Delays

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.

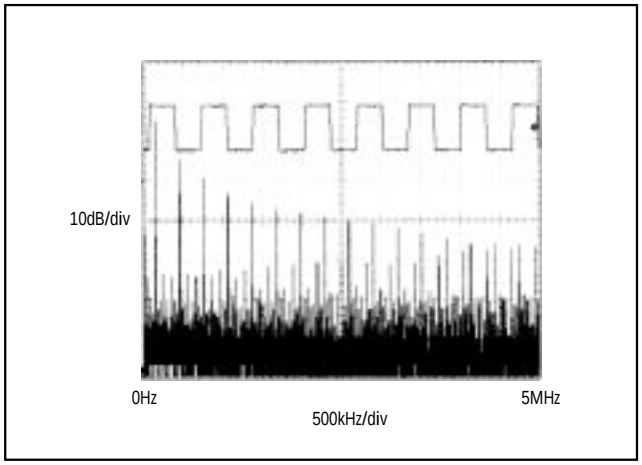


Figure 11. Driver Output Waveform and FFT Plot of MAX1480A/MAX1490A Transmitting a 150kHz Signal

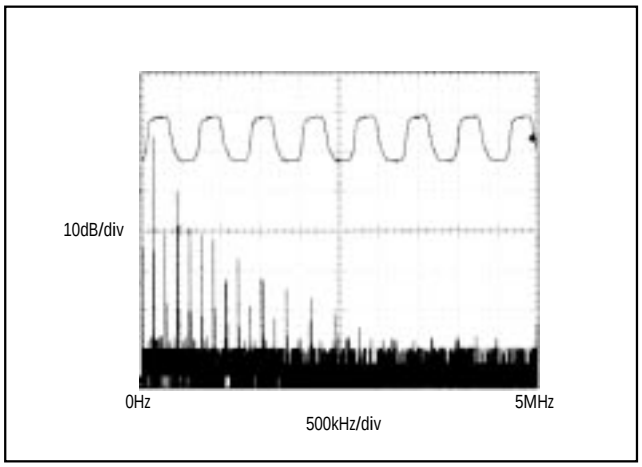


Figure 12. Driver Output Waveform and FFT Plot of MAX1480B/MAX1480C/MAX1490B Transmitting a 150kHz Signal

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 ($\overline{RO}$)
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

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

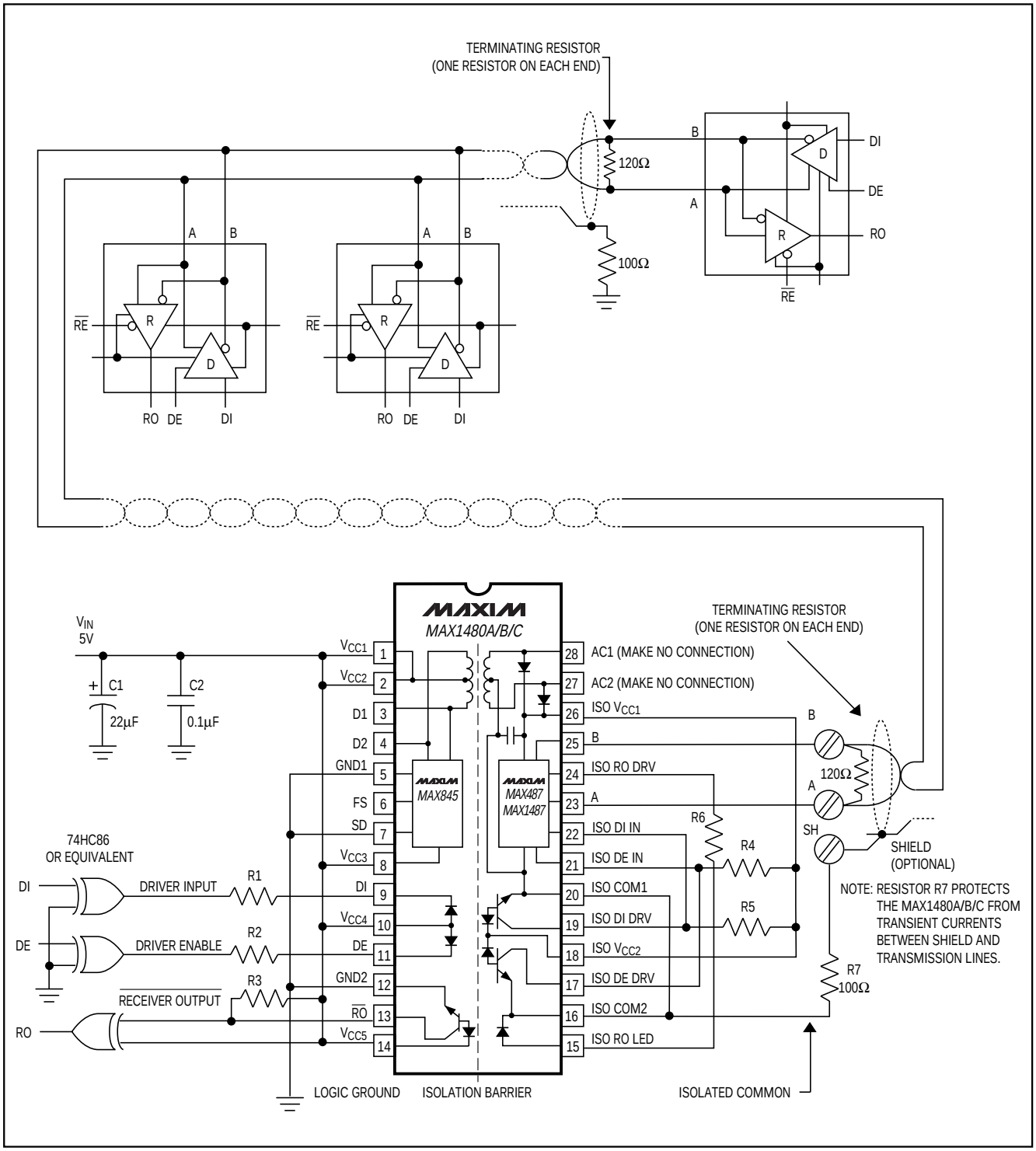


Figure 13. Typical Half-Duplex RS-485/RS-422 Network

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 *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.

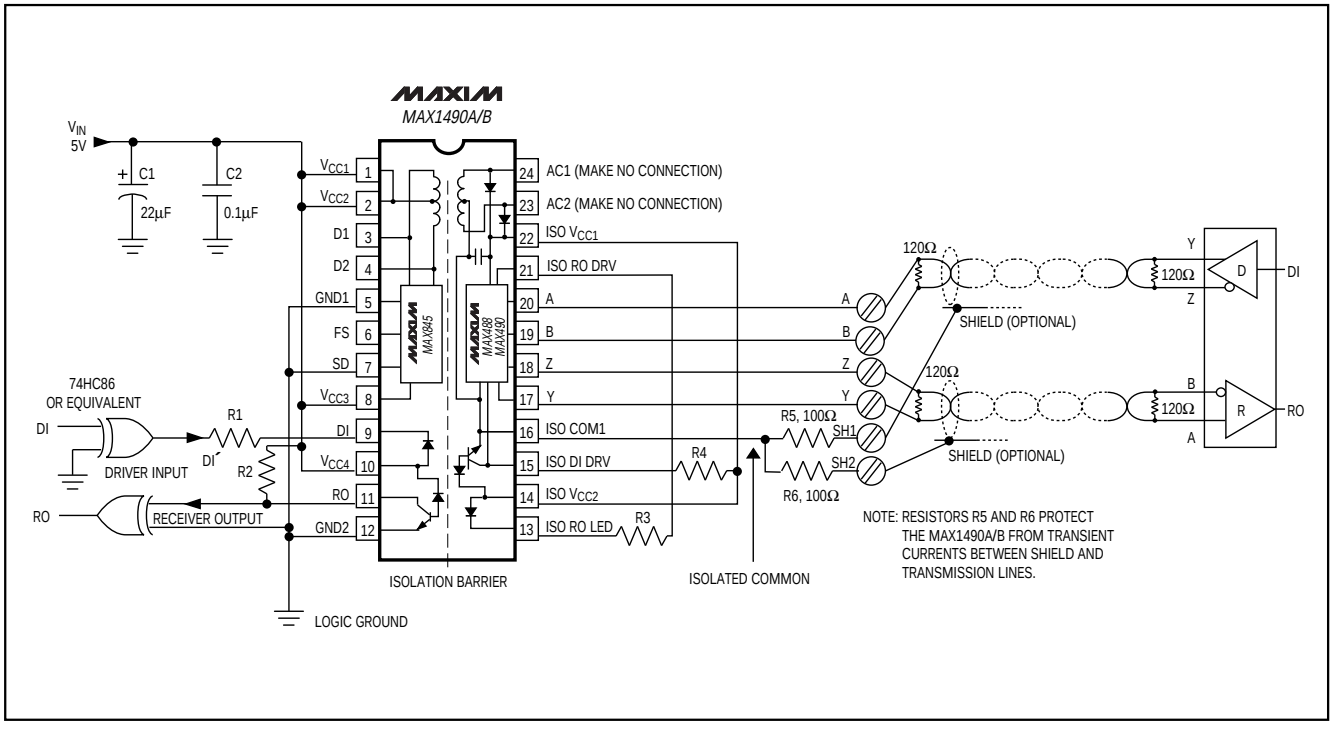


Figure 14. Typical Full-Duplex RS-485/RS-422 Network

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

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.

Pull-Up 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, tie 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).

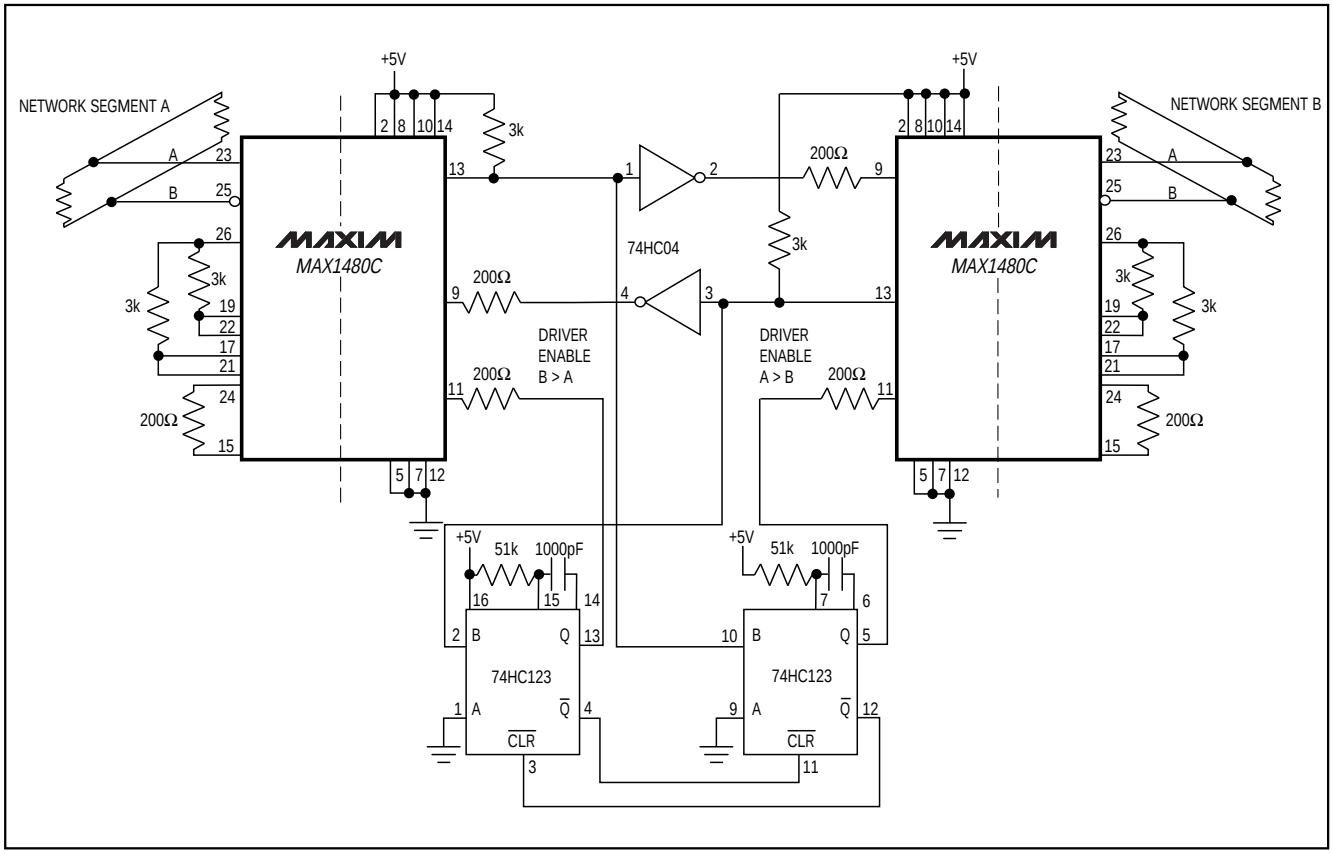


Figure 15. Doubly Isolated RS-485 Repeater

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 pull-up 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.

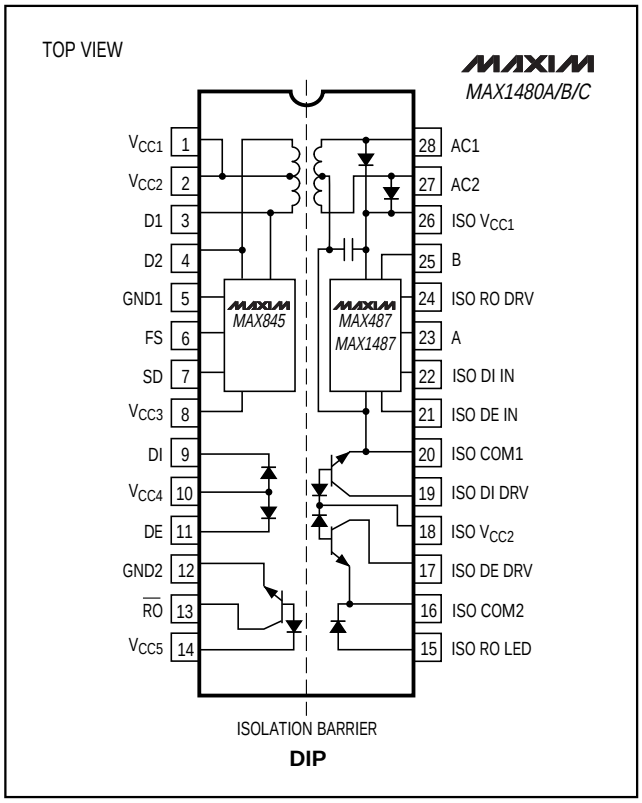
Complete, Isolated RS-485/RS-422 Data Interface

_Ordering Information (continued)

PART†	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

† *Data rate for "A" parts is up to 2500kbps. Data rate for "B" and "C" parts is up to 250kbps.*

____Pin Configurations (continued)



DIP