



# High CMRR RS-485 Transceiver with $\pm 60V$ Isolation

**MAX3158**

## General Description

The MAX3158 is a high CMRR RS-485/RS-422 data-communications interface providing  $\pm 60V$  isolation in a hybrid microcircuit. A single +5V supply on the logic side powers both sides of the interface, with external 100V capacitors transferring power from the logic side to the isolated side. Each MAX3158 contains one transmitter and one receiver and is guaranteed to operate at data rates up to 250kbps. 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 logic-high receiver output if the inputs are open, shorted, or connected to a terminated transmission line with all drivers disabled.

The MAX3158 typically draws 25mA of supply current when unloaded or when fully loaded with the driver disabled. Supply current drops to 25 $\mu A$  when the device is placed in shutdown mode. The device is pin selectable between half- and full-duplex mode and also features an independently programmable receiver and transmitter output phase through separate pins. The MAX3158 is a low-cost replacement for opto-isolated transceivers. For fully isolated RS-485/RS-422 transceivers, refer to the MAX1480 family data sheet.

## Applications

|                     |                     |
|---------------------|---------------------|
| Industrial Controls | Telecommunications  |
| Level Translators   | Local Area Networks |

## Features

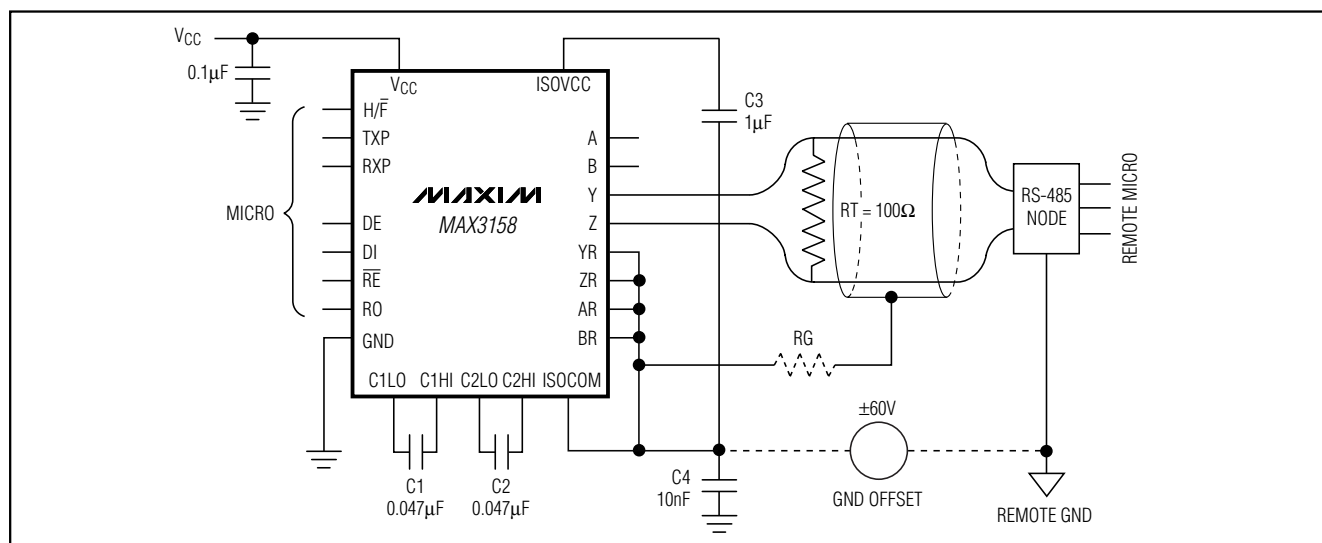
- ◆  $\pm 60V$  Isolated Data Interface
- ◆ +5V Single Supply
- ◆ Low-Cost Replacement for Opto-Isolated Transceivers
- ◆ True Fail-Safe Receiver While Maintaining EIA/TIA-485 Compliance
- ◆ Pin-Selectable Full/Half-Duplex Operation
- ◆ Phase Controls to Correct for Twisted-Pair Reversal
- ◆ 25 $\mu A$  Low-Power Shutdown Mode
- ◆ Thermal Shutdown for Driver Overload Protection
- ◆ 28-Pin SSOP Package
- ◆ Slew-Rate-Limited Reduced EMI

## Ordering Information

| PART       | TEMP RANGE     | PIN-PACKAGE |
|------------|----------------|-------------|
| MAX3158CAI | 0°C to +70°C   | 28 SSOP     |
| MAX3158CPI | 0°C to +70°C   | 28 PDIP     |
| MAX3158EAI | -40°C to +85°C | 28 SSOP     |
| MAX3158EPI | -40°C to +85°C | 28 PDIP     |

Pin Configurations appear at end of data sheet.

## Typical Operating Circuit



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## ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND, unless otherwise noted.)

|                                                                                 |                              |
|---------------------------------------------------------------------------------|------------------------------|
| Supply Voltage ( $V_{CC}$ ).....                                                | +7V                          |
| Cable Ground (ISOCOM) .....                                                     | $\pm 75V$                    |
| Isolated Supply ISOVCC Relative to Cable Ground (ISOCOM) .....                  | +7V                          |
| Digital Input, Output Voltage (DI, DE, $\overline{RE}$ , TXP, RXP, RO).....     | -0.3V to ( $V_{CC} + 0.3V$ ) |
| Digital Inputs (H/ $\overline{F}$ ) Relative to Cable Ground (ISOCOM) .....     | -0.3V to (ISOVCC + 0.3V)     |
| Driver Output Voltage (Y, Z) Relative to Cable Ground (ISOCOM).....             | -8V to +12.5V                |
| Receiver Input Voltage (A, B) Relative to Cable Ground (ISOCOM).....            | -8V to +12.5V                |
| Termination Connections (YR, ZR, AR, BR) Relative to Cable Ground (ISOCOM)..... | -8V to +12.5V                |

|                                                                                   |                                  |
|-----------------------------------------------------------------------------------|----------------------------------|
| Charge-Pump Capacitance Low (C1LO, C2LO) .....                                    | -0.3V to ( $V_{CC} + 0.3V$ )     |
| Charge-Pump Capacitance High (C1HI, C2HI) Relative to Cable Ground (ISOCOM) ..... | -0.3V to (ISOVCC + 0.3V)         |
| Continuous Power Dissipation ( $T_A = +70^\circ C$ )                              |                                  |
| 28-Pin SSOP (derate 10.8mW/ $^\circ C$ above $+70^\circ C$ ) .....                | 860mW                            |
| 28-Pin PDIP (derate 14.3mW/ $^\circ C$ above $+70^\circ C$ ).....                 | 1143mW                           |
| Operating Temperature Ranges                                                      |                                  |
| MAX3158C_I .....                                                                  | 0 $^\circ C$ to $+70^\circ C$    |
| MAX3158E_I .....                                                                  | -40 $^\circ C$ to $+85^\circ C$  |
| Junction Temperature .....                                                        | $+150^\circ C$                   |
| Storage Temperature Range .....                                                   | -65 $^\circ C$ to $+160^\circ C$ |
| Lead Temperature (soldering, 10s) .....                                           | $+300^\circ C$                   |

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

( $V_{CC} = +5V \pm 5\%$ , YR = ZR = AR = BR = ISOCOM, C1 = C2 = 0.047 $\mu F$ , C3 = C4 = 1 $\mu F$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $V_{CC} = +5V$  and  $T_A = +25^\circ C$ .) (Note 1)

| PARAMETER                                                   | SYMBOL          | CONDITIONS                                                                                | MIN | TYP | MAX | UNITS |
|-------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------------|-----|-----|-----|-------|
| <b>DRIVER</b>                                               |                 |                                                                                           |     |     |     |       |
| Differential Driver Output, No Load                         | $V_{OD1}$       | Figure 1, R = 10M $\Omega$                                                                |     |     | 6   | V     |
| Differential Driver Output, Loaded                          | $V_{OD2}$       | Figure 1, R = 50 $\Omega$ (RS-422)                                                        | 2.0 |     |     | V     |
|                                                             |                 | Figure 1, R = 27 $\Omega$ (RS-485)                                                        | 1.5 |     |     |       |
| Change in Magnitude of Differential Output Voltage (Note 2) | $\Delta V_{OD}$ | Figure 1, R = 50 $\Omega$ or R = 27 $\Omega$                                              |     |     | 0.2 | V     |
| Driver Common-Mode Voltage                                  | $V_{OC}$        | Figure 1, R = 50 $\Omega$ or R = 27 $\Omega$ , $V_{OC}$ relative to ISOCOM                |     |     | 3.5 | V     |
| Change in Magnitude of Common-Mode Voltage (Note 2)         | $\Delta V_{OC}$ | Figure 1, R = 50 $\Omega$ or R = 27 $\Omega$                                              |     |     | 0.2 | V     |
| Input High Voltage                                          | $V_{IH}$        | DE, DI, $\overline{RE}$ , TXP, RXP, relative to GND, H/ $\overline{F}$ relative to ISOCOM | 2.0 |     |     | V     |
| Input Low Voltage                                           | $V_{IL}$        | DE, DI, $\overline{RE}$ , TXP, RXP, relative to GND, H/ $\overline{F}$ relative to ISOCOM |     |     | 0.8 | V     |
| DI Input Hysteresis                                         | $V_{HYS}$       |                                                                                           |     | 100 |     | mV    |

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## ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = +5V \pm 5\%$ ,  $YR = ZR = AR = BR = ISOCOM$ ,  $C1 = C2 = 0.047\mu F$ ,  $C3 = C4 = 1\mu F$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $V_{CC} = +5V$  and  $T_A = +25^\circ C$ .) (Note 1)

| PARAMETER                                       | SYMBOL            | CONDITIONS                                                                                                        | MIN                   | TYP  | MAX  | UNITS |
|-------------------------------------------------|-------------------|-------------------------------------------------------------------------------------------------------------------|-----------------------|------|------|-------|
| Input Current                                   | I <sub>IN1</sub>  | DE, DI, $\overline{RE}$                                                                                           |                       |      | ±2   | μA    |
|                                                 | I <sub>IN2</sub>  | H/ $\overline{F}$ , TXP, RXP internal pulldown                                                                    | 10                    |      | 40   |       |
| Input Current (A and B)                         | I <sub>IN3</sub>  | DE = GND, V <sub>CC</sub> = GND or 5.25V, -7V ≤ (V <sub>IN</sub> - V <sub>ISOCOM</sub> ) ≤ +12V, AR = BR = ISOCOM | -5.0                  |      | +8.0 | mA    |
|                                                 |                   | DE = GND, V <sub>CC</sub> = GND or 5.25V, -7V ≤ (V <sub>IN</sub> - V <sub>ISOCOM</sub> ) ≤ +12V, AR open, BR open | -0.58                 |      | +1.0 |       |
| Output Leakage (Y and Z)<br>Full Duplex         | I <sub>O</sub>    | DE = GND, V <sub>CC</sub> = GND or 5.25V, -7V ≤ (V <sub>IN</sub> - V <sub>ISOCOM</sub> ) ≤ +12V, YR = ZR = ISOCOM | -5.0                  |      | +8.0 | mA    |
|                                                 |                   | DE = GND, V <sub>CC</sub> = GND or 5.25V, -7V ≤ (V <sub>IN</sub> - V <sub>ISOCOM</sub> ) ≤ +12V, YR open, ZR open | -0.58                 |      | +1.0 |       |
| Driver Short-Circuit Output<br>Current (Note 3) | I <sub>OSD1</sub> | V <sub>ISOCOM</sub> - 7V ≤ V <sub>OUT</sub> ≤ V <sub>ISOVCC</sub>                                                 | -250                  |      |      | mA    |
|                                                 | I <sub>OSD2</sub> | V <sub>ISOCOM</sub> - 7V ≤ V <sub>OUT</sub> ≤ V <sub>ISOCOM</sub> + 12V                                           |                       |      | 250  |       |
| RECEIVER                                        |                   |                                                                                                                   |                       |      |      |       |
| Receiver Differential Threshold<br>Voltage      | V <sub>TH</sub>   | -7V ≤ V <sub>CM</sub> - V <sub>ISOCOM</sub> ≤ +12V                                                                | -200                  | -125 | -50  | mV    |
| Receiver Input Hysteresis                       | ΔV <sub>TH</sub>  |                                                                                                                   |                       | 25   |      | mV    |
| Receiver Output High Voltage                    | V <sub>OH</sub>   | I <sub>O</sub> = -4mA, V <sub>ID</sub> = -50mV                                                                    | V <sub>CC</sub> - 1.5 |      |      | V     |
| Receiver Output Low Voltage                     | V <sub>OL</sub>   | I <sub>O</sub> = 4mA, V <sub>ID</sub> = -200mV                                                                    | 0.4                   |      |      | V     |
| Three-State Output Current at<br>Receiver       | I <sub>OZR</sub>  | 0.4V ≤ V <sub>O</sub> ≤ 2.4V                                                                                      |                       |      | ±1   | μA    |
| Receiver Input Resistance                       | R <sub>IN</sub>   | -7V ≤ V <sub>CM</sub> - V <sub>ISOCOM</sub> ≤ +12V, AR = BR = ISOCOM                                              | 1.5                   |      |      | kΩ    |
|                                                 |                   | -7V ≤ V <sub>CM</sub> - V <sub>ISOCOM</sub> ≤ +12V, AR open, BR open                                              | 12                    |      |      |       |
| Receiver Output Short-Circuit<br>Current        | I <sub>OSR</sub>  | 0V ≤ V <sub>RO</sub> ≤ V <sub>CC</sub>                                                                            | ±7                    |      | ±100 | mA    |
| SUPPLY CURRENT                                  |                   |                                                                                                                   |                       |      |      |       |
| Supply Current                                  | I <sub>CC</sub>   | No load, $\overline{RE}$ = DE = DI = GND or V <sub>CC</sub>                                                       |                       | 25   | 85   | mA    |
| Supply Current in Shutdown<br>Mode              | I <sub>SHDN</sub> | DE = GND, $\overline{RE}$ = V <sub>CC</sub> , V <sub>ISOCOM</sub> = GND                                           |                       | 25   | 60   | μA    |
|                                                 |                   | DE = GND, $\overline{RE}$ = V <sub>CC</sub> , V <sub>ISOCOM</sub> = ±60V                                          |                       |      | ±650 |       |
| Maximum Ground Differential                     | ΔV <sub>GND</sub> | DE = GND, $\overline{RE}$ = V <sub>CC</sub> ,<br>I ISOCOM leakage I ≤ 650μA                                       | ±60                   |      |      | V     |

# High CMRR RS-485 Transceiver with $\pm 60V$ Isolation

## SWITCHING CHARACTERISTICS

( $V_{CC} = +5V \pm 5\%$ ,  $YR = ZR = AR = BR = ISOCOM$ ,  $C_1 = C_2 = 0.047\mu F$ ,  $C_3 = C_4 = 1\mu F$ . Typical values are at  $V_{CC} = +5V$  and  $T_A = +25^\circ C$ .)

| PARAMETER                                             | SYMBOL                     | CONDITIONS                                                            | MIN | TYP  | MAX  | UNITS |
|-------------------------------------------------------|----------------------------|-----------------------------------------------------------------------|-----|------|------|-------|
| Driver Input to Output                                | $t_{DPLH}$                 | Figures 3 and 5, $R_{DIFF} = 54\Omega$ ,<br>$C_{L1} = C_{L2} = 100pF$ | 400 | 1400 | 2000 | ns    |
|                                                       | $t_{DPHL}$                 | Figures 3 and 5, $R_{DIFF} = 54\Omega$ ,<br>$C_{L1} = C_{L2} = 100pF$ | 400 | 1400 | 2000 |       |
| Driver Output Skew<br>  $t_{DPLH} - t_{DPHL}$         | $t_{DSKEW}$                | Figures 3 and 5, $R_{DIFF} = 54\Omega$ ,<br>$C_{L1} = C_{L2} = 100pF$ |     |      | 250  | ns    |
| Driver Rise or Fall Time                              | $t_{DR}, t_{DF}$           | Figures 3 and 5, $R_{DIFF} = 54\Omega$ ,<br>$C_{L1} = C_{L2} = 100pF$ | 200 | 1200 | 2200 | ns    |
| Maximum Data Rate                                     | $f_{MAX}$                  |                                                                       | 250 |      |      | kbps  |
| Driver Enable to Output High                          | $t_{DZH}$                  | Figures 4 and 6, $C_L = 100pF$ , S2 closed                            |     |      | 3500 | ns    |
| Driver Enable to Output Low                           | $t_{DZL}$                  | Figures 4 and 6, $C_L = 100pF$ , S1 closed                            |     |      | 3500 | ns    |
| Driver Disable Time from Low                          | $t_{DLZ}$                  | Figures 4 and 6, $C_L = 15pF$ , S1 closed                             |     |      | 300  | ns    |
| Driver Disable Time from High                         | $t_{DHZ}$                  | Figures 4 and 6, $C_L = 15pF$ , S2 closed                             |     |      | 300  | ns    |
| Receiver Input to Output                              | $t_{RPLH}$ ,<br>$t_{RPHL}$ | Figures 7 and 9; $ V_{ID}  \geq 2.0V$                                 |     | 440  | 600  | ns    |
| Differential Receiver Skew<br>  $t_{RPLH} - t_{RPHL}$ | $t_{RSKEW}$                | Figures 7 and 9; $ V_{ID}  \geq 2.0V$                                 |     | 20   |      | ns    |
| Receiver Enable to Output Low                         | $t_{RZL}$                  | Figures 2 and 8, $C_L = 100pF$ , S1 closed                            |     | 20   | 50   | ns    |
| Receiver Enable to Output High                        | $t_{RZH}$                  | Figures 2 and 8, $C_L = 100pF$ , S2 closed                            |     | 20   | 50   | ns    |
| Receiver Disable Time from Low                        | $t_{RLZ}$                  | Figures 2 and 8, $C_L = 100pF$ , S1 closed                            |     | 200  | 500  | ns    |
| Receiver Disable Time from High                       | $t_{RHZ}$                  | Figures 2 and 8, $C_L = 100pF$ , S2 closed                            |     | 200  | 500  | ns    |
| Time to Shutdown                                      | $t_{SHDN}$                 | (Note 4)                                                              | 50  | 200  | 700  | ns    |
| Driver Enable from Shutdown to<br>Output High         | $t_{DZH}$<br>(SHDN)        | Figures 4 and 6, $C_L = 15pF$ , S2 closed                             |     | 0.2  | 1    | ms    |
| Driver Enable from Shutdown to<br>Output Low          | $t_{DZL}$<br>(SHDN)        | Figures 4 and 6, $C_L = 15pF$ , S1 closed                             |     | 0.2  | 1    | ms    |
| Receiver Enable from Shutdown<br>to Output High       | $t_{RZH}$<br>(SHDN)        | Figures 2 and 8, $C_L = 100pF$ , S2 closed                            |     | 0.2  | 1    | ms    |
| Receiver Enable from Shutdown<br>to Output Low        | $t_{RZL}$<br>(SHDN)        | Figures 2 and 8, $C_L = 100pF$ , S1 closed                            |     | 0.2  | 1    | ms    |
| Charge-Pump Oscillating<br>Frequency                  | $f_{OSC}$                  |                                                                       |     | 1.3  |      | MHz   |

**Note 1:** All currents into the device are positive; all currents out of the device are negative. All voltages are referred to device ground unless otherwise noted.

**Note 2:**  $\Delta V_{OD}$  and  $\Delta V_{OC}$  are the changes in  $V_{OD}$  and  $V_{OC}$ , respectively, when the DI input changes state.

**Note 3:** Current level applies to peak current just prior to foldback-current limiting.

**Note 4:** The device is put into shutdown by bringing  $RE$  high and  $DE$  low. If the enable inputs are in this state for less than 50ns, the device is guaranteed not to enter shutdown. If the enable inputs are in this state for at least 700ns, the device is guaranteed to have entered shutdown.

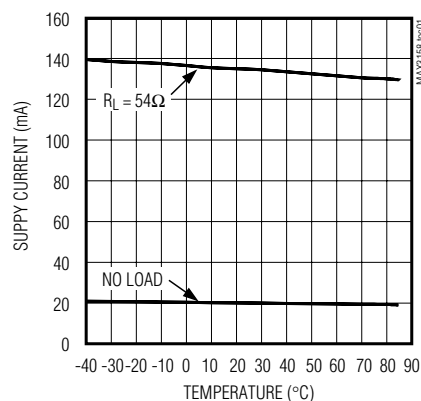
# High CMRR RS-485 Transceiver with $\pm 60V$ Isolation

## Typical Operating Characteristics

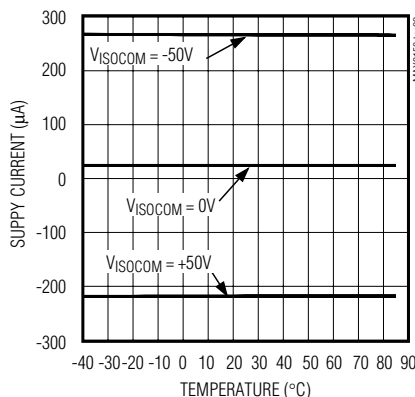
( $V_{CC} = +5V$ ,  $Y_R = Z_R = A_R = B_R = ISOCOM$ ,  $C_1 = C_2 = 0.047\mu F$ ,  $C_3 = 1\mu F$ ,  $C_4 = 10nF$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

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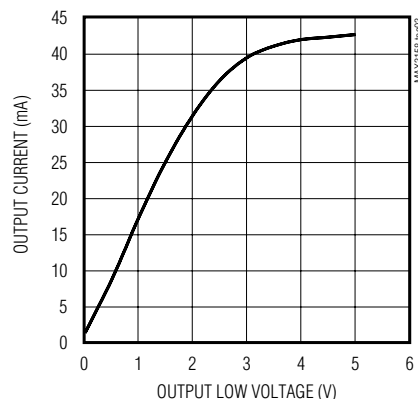
**SUPPLY CURRENT vs. TEMPERATURE**



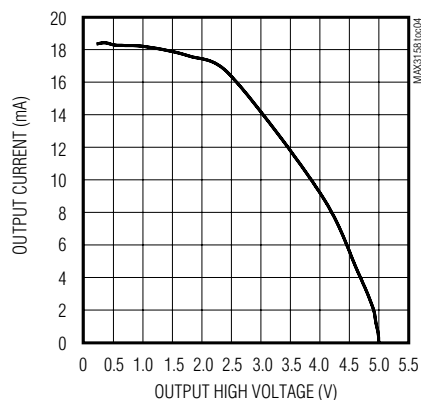
**SHUTDOWN SUPPLY CURRENT vs. TEMPERATURE**



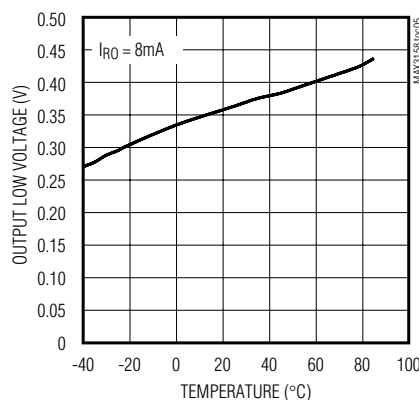
**RECEIVER OUTPUT CURRENT vs. RECEIVER OUTPUT LOW VOLTAGE**



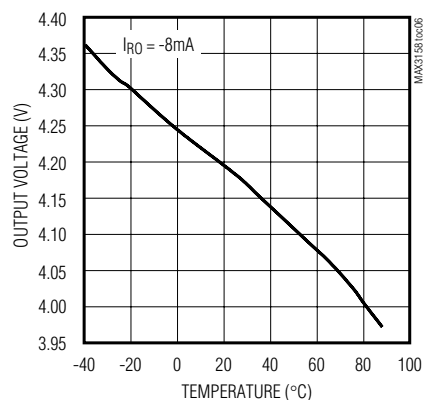
**RECEIVER OUTPUT CURRENT vs. RECEIVER OUTPUT HIGH VOLTAGE**



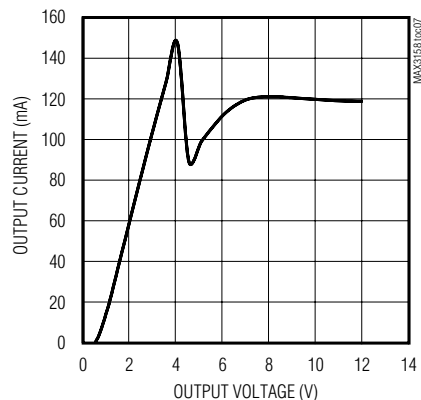
**RECEIVER OUTPUT LOW VOLTAGE vs. TEMPERATURE**



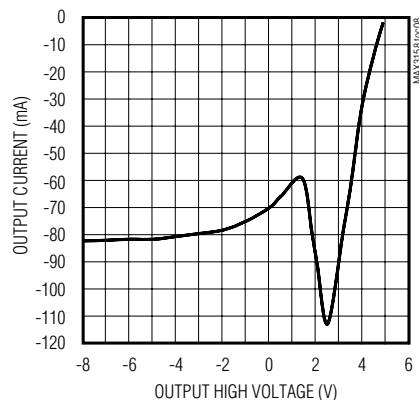
**RECEIVER OUTPUT HIGH VOLTAGE vs. TEMPERATURE**



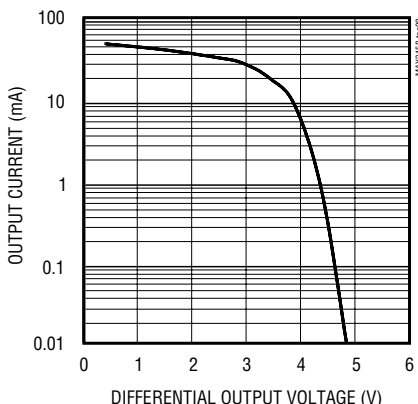
**DRIVER OUTPUT CURRENT vs. DRIVER OUTPUT LOW VOLTAGE**



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



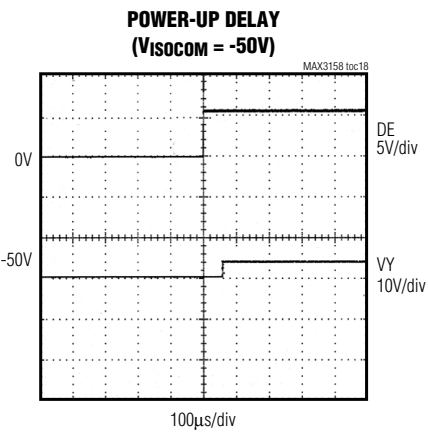
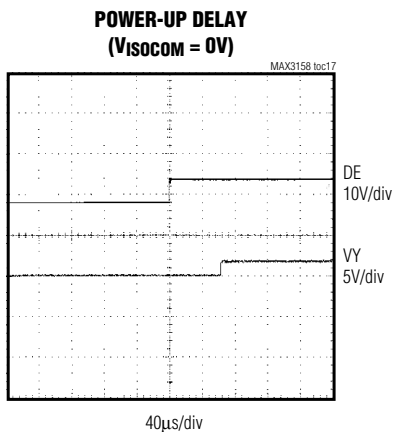
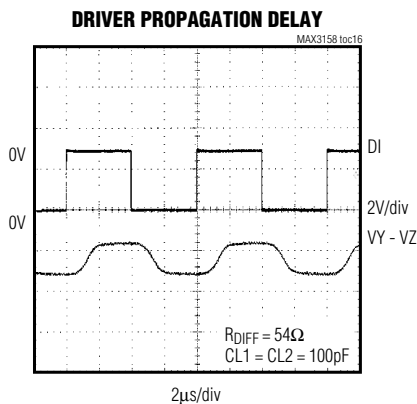
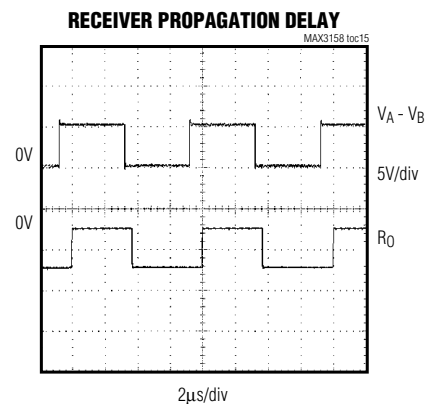
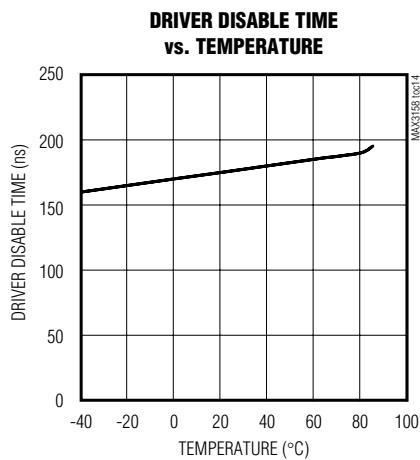
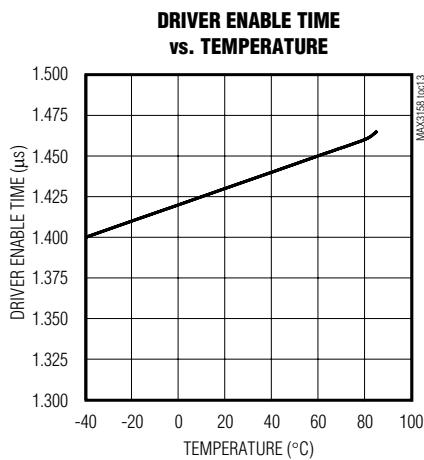
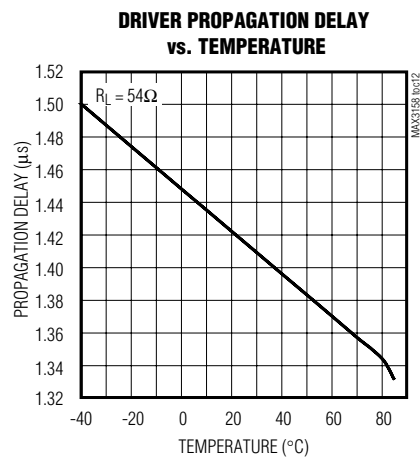
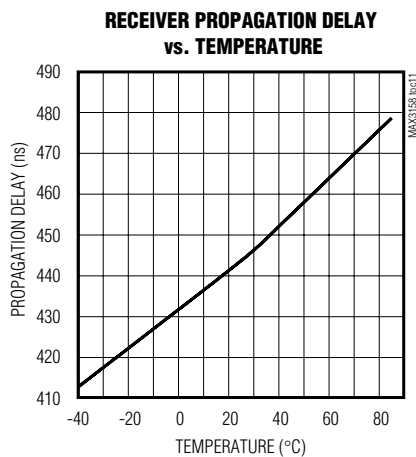
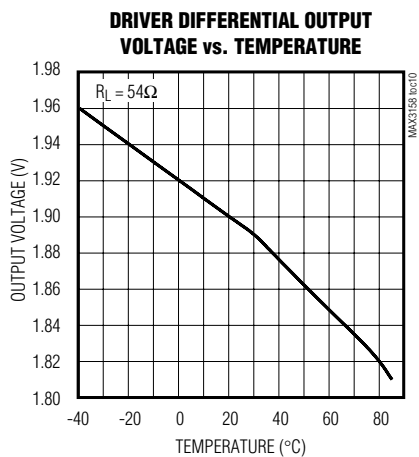
**DRIVER OUTPUT CURRENT vs. DIFFERENTIAL OUTPUT VOLTAGE**



# High CMRR RS-485 Transceiver with $\pm 60V$ Isolation

## Typical Operating Characteristics (continued)

( $V_{CC} = +5V$ ,  $YR = ZR = AR = BR = ISOCOM$ ,  $C1 = C2 = 0.047\mu F$ ,  $C3 = 1\mu F$ ,  $C4 = 10nF$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

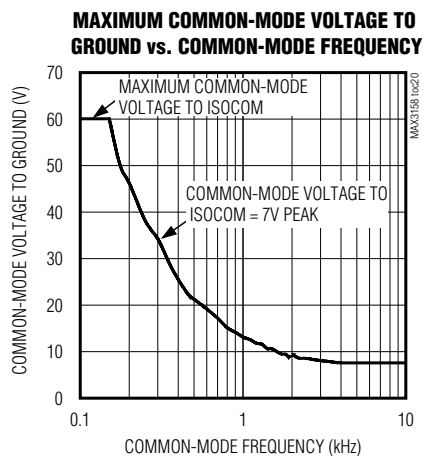
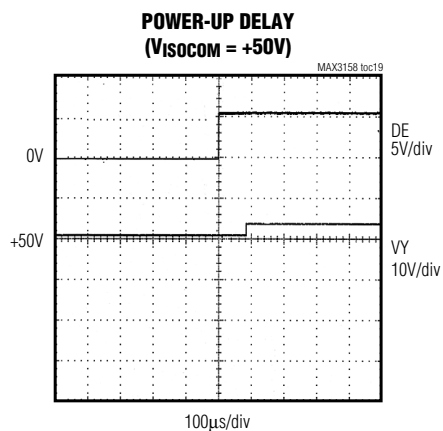


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## Typical Operating Characteristics (continued)

( $V_{CC} = +5V$ ,  $Y_R = Z_R = A_R = B_R = ISOCOM$ ,  $C_1 = C_2 = 0.047\mu F$ ,  $C_3 = 1\mu F$ ,  $C_4 = 10nF$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



## Test Circuits and Timing Diagrams

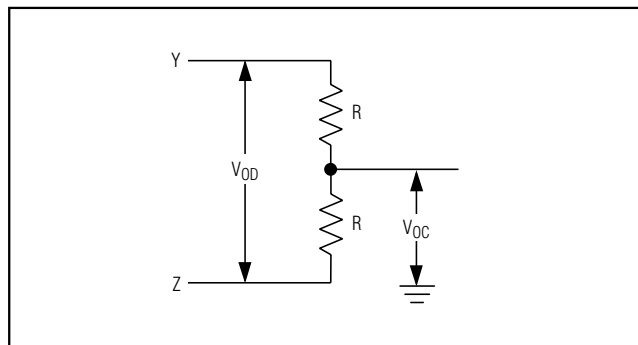


Figure 1. Driver DC Test Load

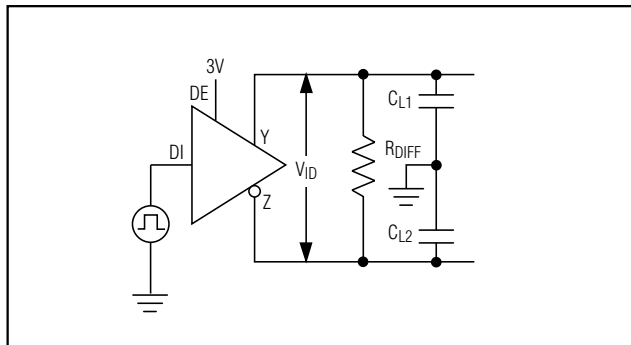


Figure 3. Driver Timing Test Circuit

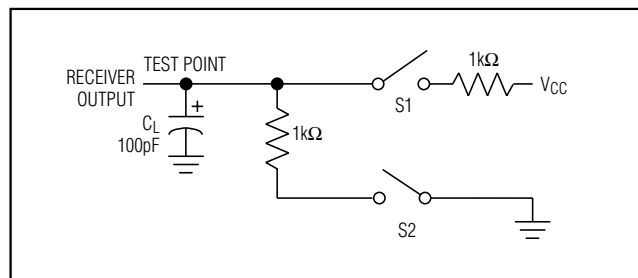


Figure 2. Receiver Enable/Disable Timing Test Load

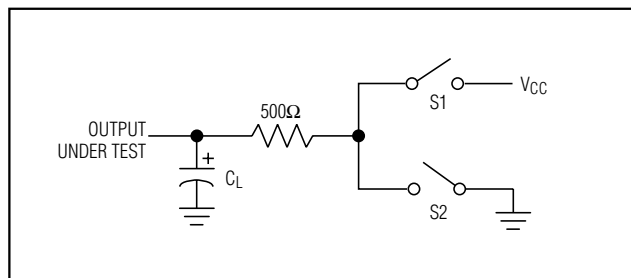


Figure 4. Driver Enable/Disable Timing Test Load

# High CMRR RS-485 Transceiver with $\pm 60V$ Isolation

## Test Circuits and Timing Diagrams (continued)

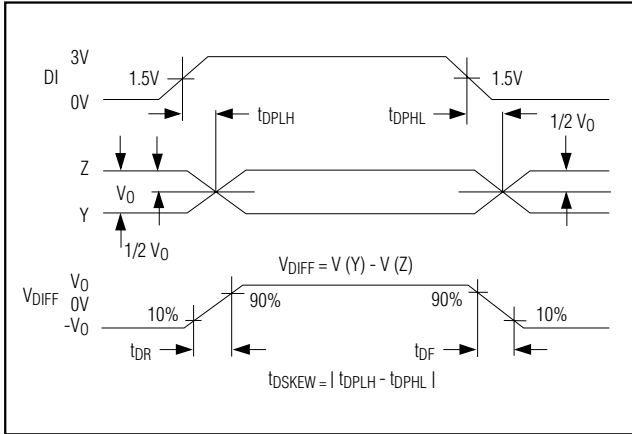


Figure 5. Driver Propagation Delays

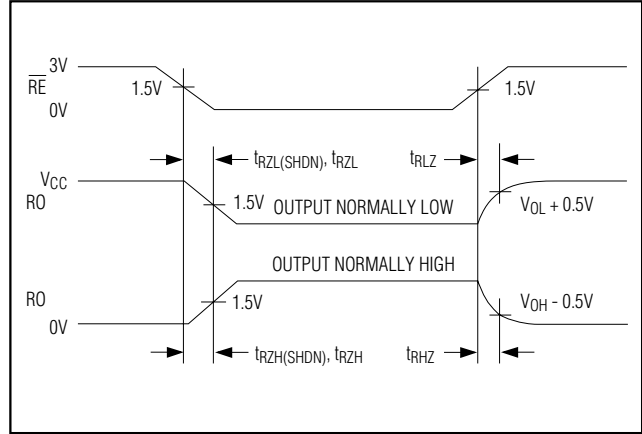


Figure 8. Receiver Enable and Disable Times

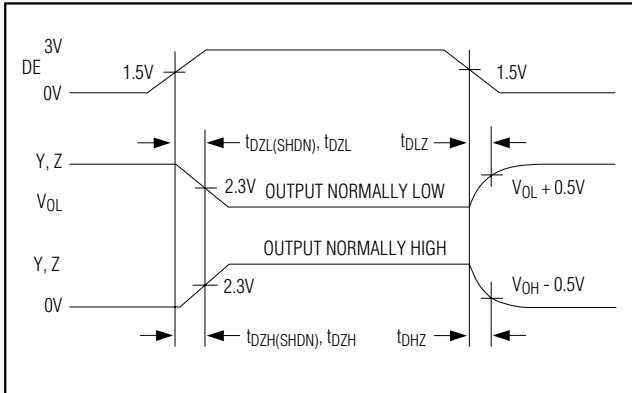


Figure 6. Driver Enable and Disable Times

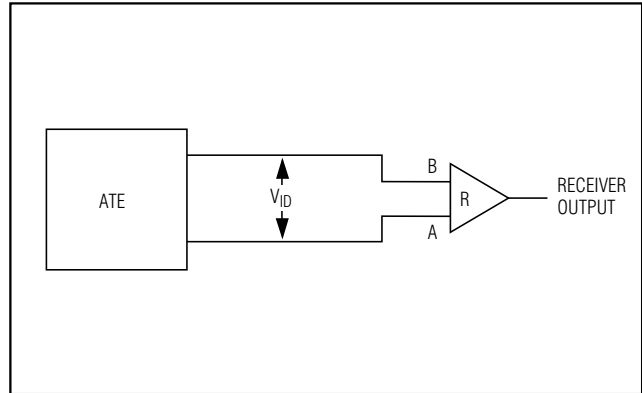


Figure 9. Receiver Propagation Delay Test Circuit

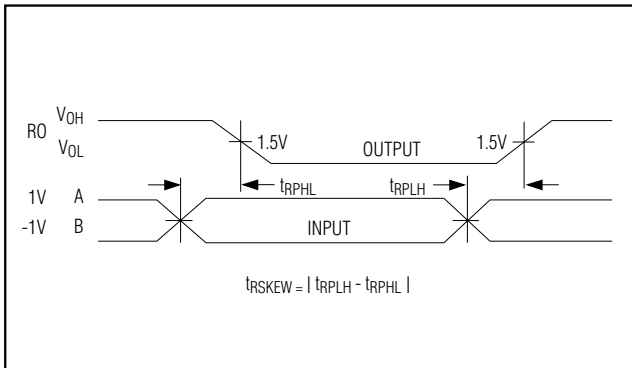


Figure 7. Receiver Propagation Delays

# High CMRR RS-485 Transceiver with $\pm 60V$ Isolation

## Pin Description

MAX3158

| PIN                    |                         | NAME              | FUNCTION                                                                                                                                            |
|------------------------|-------------------------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| SSOP                   | PDIP                    |                   |                                                                                                                                                     |
| 1                      | 2                       | RO                | Receiver Output. When $\overline{RE}$ is low and $A - B > -50mV$ , RO will be high; if $A - B \leq -200mV$ , RO will be low.                        |
| 2                      | 3                       | $\overline{RE}$   | Receiver Output Enable. Drive $\overline{RE}$ low to enable RO.                                                                                     |
| 3                      | 4                       | DE                | Driver Output Enable. Drive DE high to enable driver outputs.                                                                                       |
| 4                      | 5                       | DI                | Driver Input. With DE high, a low on DI forces the noninverting output low and the inverting output high; with DI high, outputs reverse.            |
| 5                      | 6                       | C1LO              | Connect to the negative terminal of C1 (0.047 $\mu$ F, 100V).                                                                                       |
| 6, 7,<br>12, 22,<br>23 | 1, 12,<br>14, 15,<br>28 | N.C.              | No Connection. Not internally connected.                                                                                                            |
| 8                      | 7                       | C1HI              | Connect to the positive terminal of C1 (0.047 $\mu$ F, 100V).                                                                                       |
| 9                      | 8                       | ISOVCC            | Internally generated power-supply voltage, referenced to the cable ground (ISOCOM). Connect a 1 $\mu$ F capacitor to ISOCOM.                        |
| 10                     | 9                       | H/ $\overline{F}$ | Half/Full-Duplex Selector Pin. Leave open, or connect to ISOCOM to select Full Duplex, or connect to ISOVCC to select Half Duplex.                  |
| 11                     | 10                      | ZR                | Connect to ISOCOM for a 1.5k $\Omega$ input impedance on Z. Leave open for a 12k $\Omega$ input impedance on Z.                                     |
| 13                     | 11                      | YR                | Connect to ISOCOM for a 1.5k $\Omega$ input impedance on Y. Leave open for a 12k $\Omega$ input impedance on Y.                                     |
| 14                     | 13                      | ISOCOM            | Cable Ground                                                                                                                                        |
| 15                     | 16                      | Z                 | Inverting Driver Output (and Inverting Receiver Input in Half-Duplex Mode)                                                                          |
| 16                     | 17                      | Y                 | Noninverting Driver Output (and Noninverting Receiver Input in Half-Duplex Mode)                                                                    |
| 17                     | 18                      | B                 | Inverting Receiver Input in Full-Duplex Mode                                                                                                        |
| 18                     | 19                      | A                 | Noninverting Receiver Input in Full-Duplex Mode                                                                                                     |
| 19                     | 20                      | BR                | Connect to ISOCOM for a 1.5k $\Omega$ input impedance on B. Leave open for a 12k $\Omega$ input impedance on B.                                     |
| 20                     | 21                      | AR                | Connect to ISOCOM for a 1.5k $\Omega$ input impedance on A. Leave open for a 12k $\Omega$ input impedance on A.                                     |
| 21                     | 22                      | C2HI              | Connect to the positive terminal of C2 (0.047 $\mu$ F, 100V).                                                                                       |
| 24                     | 23                      | C2LO              | Connect to the negative terminal of C2 (0.047 $\mu$ F, 100V).                                                                                       |
| 25                     | 24                      | GND               | Ground                                                                                                                                              |
| 26                     | 25                      | TXP               | Transmitter Phase. Leave open, or connect to GND for normal transmitter polarity, or connect to V <sub>CC</sub> to invert the transmitter polarity. |
| 27                     | 26                      | RXP               | Receiver Phase. Leave open, or connect to GND for normal receiver polarity, or connect to V <sub>CC</sub> to invert the receiver polarity.          |
| 28                     | 27                      | V <sub>CC</sub>   | +4.75V to +5.25V Positive Supply. Connect a 0.1 $\mu$ F capacitor to GND.                                                                           |

# High CMRR RS-485 Transceiver with $\pm 60V$ Isolation

## Detailed Description

The MAX3158 is a high CMRR RS-485/RS-422 data-communications interface providing  $\pm 60V$  isolation in a hybrid microcircuit. A single +5V supply on the logic side powers both sides of the interface, with external 100V capacitors transferring power from the logic side to the isolated side (see *Block Diagram*). The MAX3158 typically draws 25mA of supply current when unloaded or when fully loaded with the driver disabled. Supply current drops to 25 $\mu A$  when the device is placed in shutdown mode (see *Low-Power Shutdown Mode* section). The MAX3158 transceiver for RS-485/RS-422 communication contains one driver and one receiver.

This device features fail-safe circuitry, which guarantees a logic-high receiver output when the receiver inputs are open or shorted, or when they are connected to a terminated transmission line with all drivers disabled (see *Fail-Safe* section). The MAX3158 is selectable between half- and full-duplex communication by connecting a selector pin to ISOVCC or ISOCOM, respectively. Drivers are output short-circuit current limited. Thermal shutdown circuitry protects drivers against excessive power dissipation. When activated, the thermal shutdown circuitry places the driver outputs into a high-impedance state. The device also features independently programmable receiver and transmitter output phase through separate pins. The MAX3158 is a low-cost replacement for opto-isolated transceivers.

### Fail-Safe

The MAX3158 **guarantees** a logic-high receiver output when the receiver inputs are shorted or open, or when they are connected to a terminated transmission line with all drivers disabled. The receiver threshold is fixed between -50mV and -200mV. If the differential receiver input voltage (A - B) is greater than or equal to -50mV, RO is logic high. If A - B is less than or equal to -200mV, RO is logic low. In the case of a terminated bus with all transmitters disabled, the receiver's differential input voltage is pulled to 0V by the termination. With the receiver thresholds of the MAX3158, this results in a logic high with a 50mV minimum noise margin. Unlike competitor's fail-safe devices, the -50mV to -200mV threshold complies with the  $\pm 200mV$  EIA/TIA-485 standard.

### MAX3158 Programming

The MAX3158 has several programmable operating modes. Occasionally, twisted-pair lines are reversed. The MAX3158 has two pins that invert the phase of the driver and the receiver to correct for this problem. For normal operation, drive TXP and RXP low, connect them to ground, or leave them unconnected (internal pulldown). To invert the driver phase, drive TXP high or

connect it to VCC. To invert the receiver phase, drive RXP high or connect it to VCC. Note that the receiver threshold is positive when RXP is high.

The MAX3158 can operate in full- or half-duplex mode. Connect H/F to ISOCOM for full-duplex mode, and connect it to ISOVCC for half-duplex operation. In half-duplex mode, the receiver inputs are switched to the driver outputs, connecting outputs Y and Z to inputs A and B, respectively. In half-duplex mode, the internal full-duplex receiver input resistors are still connected to pins A and B.

### Low-Power Shutdown Mode

The low-power shutdown mode is initiated by bringing both RE high and DE low. In shutdown, this device typically draws only 25 $\mu A$  of supply current, and no power is transferred across the isolation capacitors in this mode. RE and DE may be driven simultaneously; the parts are guaranteed not to enter shutdown if RE is high and DE is low for less than 50ns. If the inputs are in this state for at least 700ns, the parts are guaranteed to enter shutdown. Enable times  $t_{ZH}$  and  $t_{ZL}$  in the *Switching Characteristics* table assume the part was not in a low-power shutdown state. Enable times  $t_{ZH}(SHDN)$  and  $t_{ZL}(SHDN)$  assume the parts were shut down. It takes drivers and receivers longer to become enabled from low-power shutdown mode  $t_{ZH}(SHDN)$ ,  $t_{ZL}(SHDN)$  than from driver/receiver-disable mode ( $t_{ZH}$ ,  $t_{ZL}$ ).

### Driver Output Protection

Two mechanisms prevent excessive output current and power dissipation caused by faults or by bus contention. The first, a foldback current limit on the output stage, provides immediate protection against short circuits over the whole common-mode voltage range (see *Typical Operating Characteristics*). The second, a thermal shutdown circuit, forces the driver outputs into a high-impedance state if the die temperature becomes excessive—typically around +150°C.

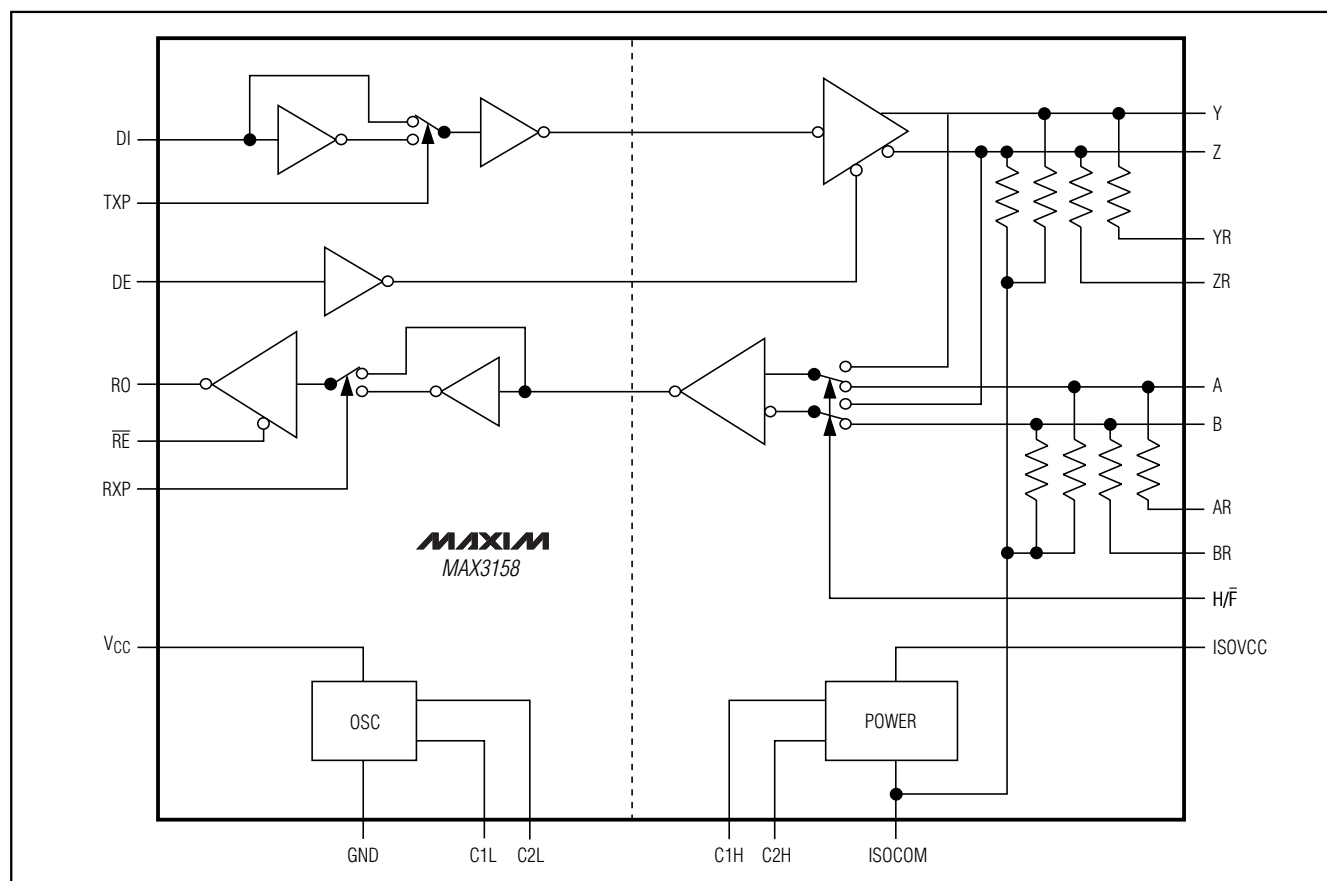
## Applications Information

### Capacitor and Grounding Resistor Selection

The value for the charge-pump capacitors C1 and C2 should be between 47nF and 100nF. Smaller values will result in insufficient supply voltage on the isolated side. Larger values are allowed but will not result in better charge-pump capacity. The values for C1 and C2, as well as that of C4, determine the maximum frequency and amplitude of the voltage difference (under operating conditions) between the local and isolated ground. Besides the capacitor values, this maximum frequency

# High CMRR RS-485 Transceiver with $\pm 60V$ Isolation

## Block Diagram



MAX3158

and amplitude are also determined by the resistance between the remote ground and the ISOCOM pin. The receiver input resistors will cause the isolated common voltage to go to the mean voltage of the receiver inputs, which will be a direct function of the remote ground potential. The receiver input resistance and the capacitors C1, C2, and C4 set up a time constant that limits how fast the ISOCOM pin can follow variations in the remote ground voltage. Connecting YR and ZR in half-duplex operation, or AR and BR in full-duplex operation, to ISOCOM results in a relatively low input impedance of the MAX3158 receiver inputs ( $2k\Omega$ ). This allows for a 60Hz sine wave with a 60V maximum amplitude (see *Typical Operating Characteristics*). If YR, ZR, AR, and BR are left open, the receiver input impedance is  $12k\Omega$  allowing up to 32 transceivers on the bus. To guarantee the same low time constant under those conditions, use a shielded cable with a  $1k\Omega$  resistor connected between

the shield and ISOCOM. Using a lower value for this resistor is not recommended because this could trigger a holding current in the internal ESD protection device if the  $\pm 75V$  isolation limit is exceeded.

A single point hard-ground connection for the shield is recommended.

### Communication Between Two MAX3158s

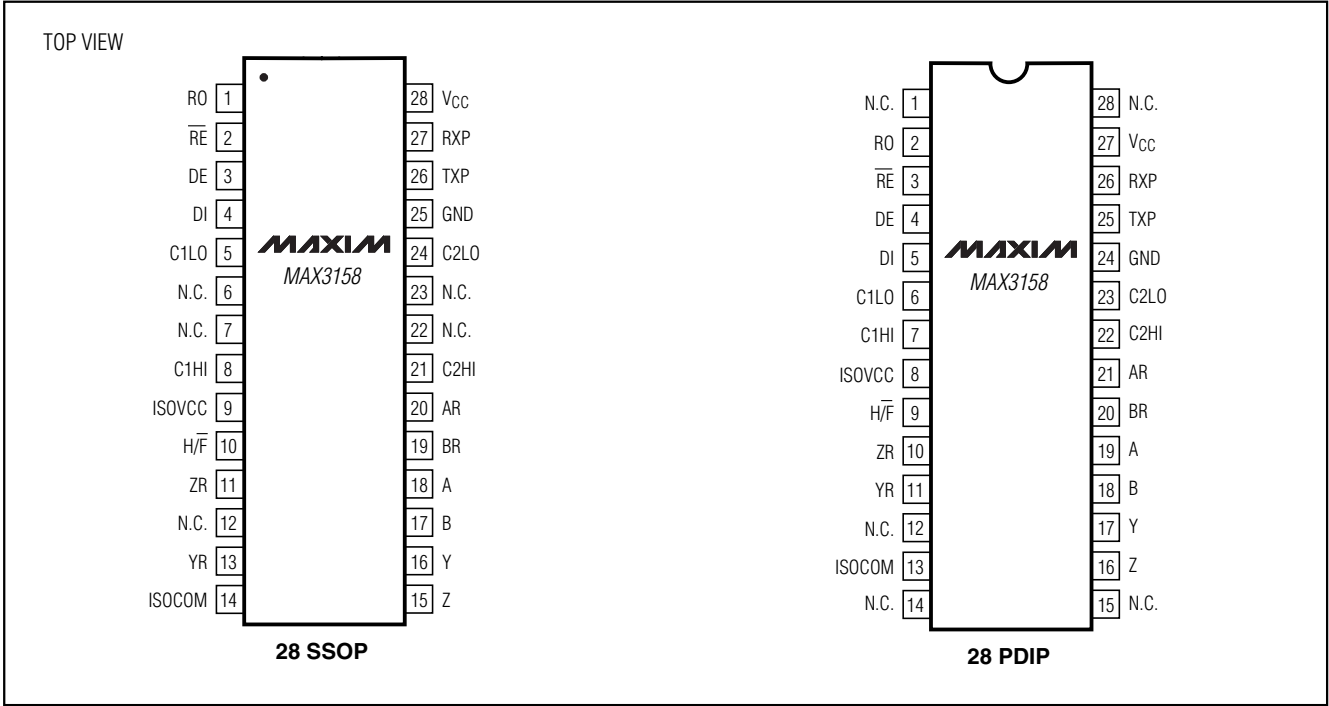
If two MAX3158 devices are used to communicate with each other, one of the devices must have ISOCOM connected to local ground. Failure to do so will result in floating ISOCOM pins, with both devices trying to adapt to the isolated ground of the other.

### Chip Information

TRANSISTOR COUNT: 1309

# High CMRR RS-485 Transceiver with ±60V Isolation

## Pin Configurations



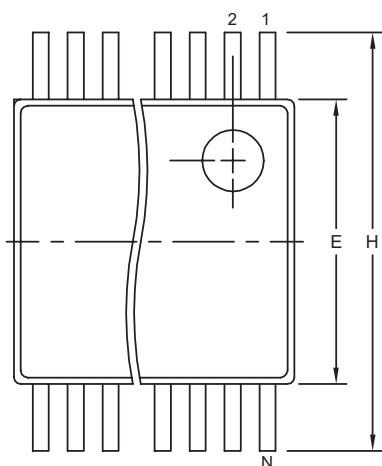
# High CMRR RS-485 Transceiver with $\pm 60V$ Isolation

## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)

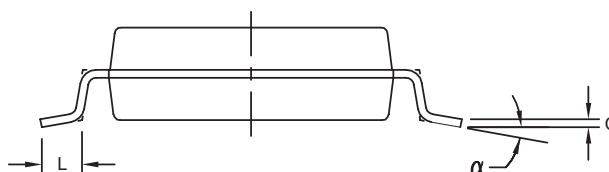
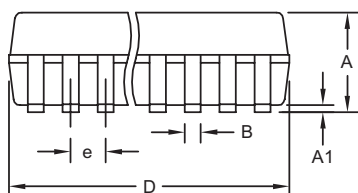
MAX3158

SSOP-EPS



| DIM      | INCHES         |       | MILLIMETERS |      |
|----------|----------------|-------|-------------|------|
|          | MIN            | MAX   | MIN         | MAX  |
| A        | 0.068          | 0.078 | 1.73        | 1.99 |
| A1       | 0.002          | 0.008 | 0.05        | 0.21 |
| B        | 0.010          | 0.015 | 0.25        | 0.38 |
| C        | 0.004          | 0.008 | 0.09        | 0.20 |
| D        | SEE VARIATIONS |       |             |      |
| E        | 0.205          | 0.212 | 5.20        | 5.38 |
| e        | 0.0256 BSC     |       | 0.65 BSC    |      |
| H        | 0.301          | 0.311 | 7.65        | 7.90 |
| L        | 0.025          | 0.037 | 0.63        | 0.95 |
| $\alpha$ | 0°             | 8°    | 0°          | 8°   |

|   | INCHES |       | MILLIMETERS |       | N   |
|---|--------|-------|-------------|-------|-----|
|   | MIN    | MAX   | MIN         | MAX   |     |
| D | 0.239  | 0.249 | 6.07        | 6.33  | 14L |
| D | 0.239  | 0.249 | 6.07        | 6.33  | 16L |
| D | 0.278  | 0.289 | 7.07        | 7.33  | 20L |
| D | 0.317  | 0.328 | 8.07        | 8.33  | 24L |
| D | 0.397  | 0.407 | 10.07       | 10.33 | 28L |



### NOTES:

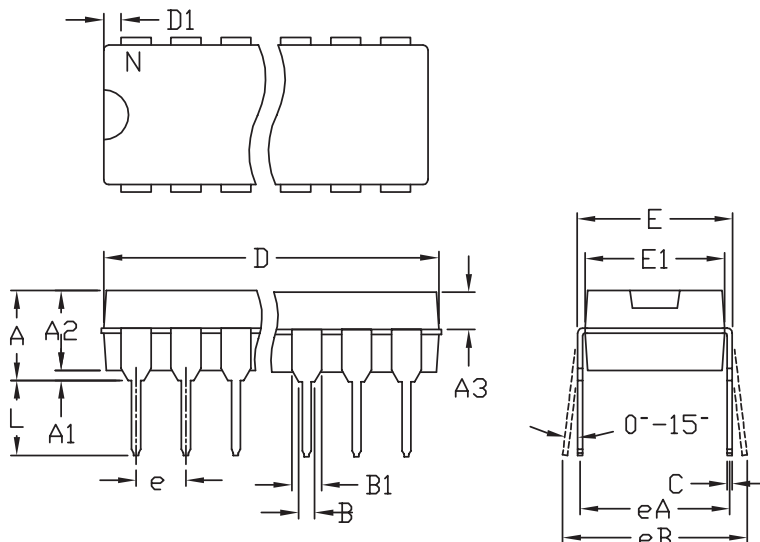
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15 MM (.006").
3. CONTROLLING DIMENSION: MILLIMETERS.
4. MEETS JEDEC MO150.
5. LEADS TO BE COPLANAR WITHIN 0.10 MM.

|                                                               |                                                       |                                     |
|---------------------------------------------------------------|-------------------------------------------------------|-------------------------------------|
|                                                               |                                                       |                                     |
| <small>PROPRIETARY INFORMATION</small>                        |                                                       |                                     |
| <small>TITLE:</small><br><b>PACKAGE OUTLINE, SSOP, 5.3 MM</b> |                                                       |                                     |
| <small>APPROVAL</small>                                       | <small>DOCUMENT CONTROL NO.</small><br><b>21-0056</b> | <small>REV.</small><br><b>C 1/1</b> |

# High CMRR RS-485 Transceiver with $\pm 60V$ Isolation

## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)



PDIPNEPS

|    | INCHES |       | MILLIMETERS |       |
|----|--------|-------|-------------|-------|
|    | MIN    | MAX   | MIN         | MAX   |
| A  | ---    | 0.180 | ---         | 4.572 |
| A1 | 0.015  | ---   | 0.38        | ---   |
| A2 | 0.125  | 0.175 | 3.18        | 4.45  |
| A3 | 0.055  | 0.080 | 1.40        | 2.03  |
| B  | 0.015  | 0.022 | 0.381       | 0.56  |
| B1 | 0.045  | 0.065 | 1.14        | 1.65  |
| C  | 0.008  | 0.014 | 0.2         | 0.355 |
| D1 | 0.005  | 0.080 | 0.13        | 2.03  |
| E  | 0.300  | 0.325 | 7.62        | 8.26  |
| E1 | 0.240  | 0.310 | 6.10        | 7.87  |
| e  | 0.100  | BSC.  | 2.54        | BSC.  |
| eA | 0.300  | BSC.  | 7.62        | BSC.  |
| eB | 0.400  | BSC.  | 10.16       | BSC.  |
| L  | 0.115  | 0.150 | 2.921       | 3.81  |

|   | INCHES |       | MILLIMETERS |       |    |       |
|---|--------|-------|-------------|-------|----|-------|
|   | MIN    | MAX   | MIN         | MAX   | N  | MS001 |
| D | 0.348  | 0.390 | 8.84        | 9.91  | 8  | AB    |
| D | 0.735  | 0.765 | 18.67       | 19.43 | 14 | AC    |
| D | 0.745  | 0.765 | 18.92       | 19.43 | 16 | AA    |
| D | 0.885  | 0.915 | 22.48       | 23.24 | 18 | AD    |
| D | 1.015  | 1.045 | 25.78       | 26.54 | 20 | AE    |
| D | 1.14   | 1.265 | 28.96       | 32.13 | 24 | AF    |
| D | 1.360  | 1.380 | 34.54       | 35.05 | 28 | *5    |

### NOTES:

1. D&E DO NOT INCLUDE MOLD FLASH
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. CONTROLLING DIMENSION: MILLIMETER
4. MEETS JEDEC MS001-XX AS SHOWN IN ABOVE TABLE
5. SIMILAR TO JEDEC MO-058AB
6. N = NUMBER OF PINS



PACKAGE FAMILY OUTLINE: PDIP .300" TITLE

1/1

21-0043 D DOCUMENT CONTROL NUMBER REV

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