

High ESD Protected, +125°C, 40Mbps, 3.3V, Full Fail-Safe, RS-485/RS-422 Transceivers

Intersil's ISL3179E and ISL3180E are high ESD Protected (see Table 1 below), 3.3V powered, single transceivers that meet both the RS-485 and RS-422 standards for balanced communication. Each device has low bus currents (+220µA/-150µA), so it presents a "1/5 unit load" to the RS-485 bus. This allows up to 160 transceivers on the network without violating the RS-485 specification's 32 unit load maximum, and without using repeaters.

Receiver (Rx) inputs feature a "Full Fail-Safe" design, which ensures a logic high Rx output if Rx inputs are floating, shorted, or terminated but undriven.

The ISL3180E is configured for full duplex applications. The ISL3179E half duplex version multiplexes the Rx inputs and Tx outputs to allow a transceiver with an output disable function in 8 Ld packages.

Hot Plug circuitry ensures that the Tx and Rx outputs remain in a high impedance state while the power supply stabilizes.

Ordering Information

| PART NUMBER (Note) | PART MARKING # | TEMP. RANGE (°C) | PACKAGE (Pb-Free) | PKG. DWG. # |
|--------------------|----------------|------------------|-------------------|-------------|
| ISL3179EFBZ* | 3179 EFBZ | -40 to +125 | 8 Ld SOIC | M8.15 |
| ISL3179EFUZ* | 179FZ | -40 to +125 | 8 Ld MSOP | M8.118 |
| ISL3179EFRZ* | 79FZ | -40 to +125 | 10 Ld DFN | L10.3x3C |
| ISL3179EIBZ* | 3179 EIBZ | -40 to +85 | 8 Ld SOIC | M8.15 |
| ISL3179EIUZ* | 179IZ | -40 to +85 | 8 Ld MSOP | M8.118 |
| ISL3179EIRZ* | 79IZ | -40 to +85 | 10 Ld DFN | L10.3x3C |
| ISL3180EIBZ* | ISL3180 EIBZ | -40 to +85 | 14 Ld SOIC | M14.15 |

*Add "-T" suffix for tape and reel. Please refer to TB347 for details on reel specifications

NOTE: These Intersil Pb-free plastic packaged products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate PLUS ANNEAL - e3 termination finish, which is RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.

Features

- High ESD Protection on RS-485 I/O Pins
 - ISL3179E ±16.5kV IEC61000
 - ISL3180E ±12kV HBM
 - Class 3 HBM ESD Level on all Other Pins >9kV
- Specified for +125°C Operation
- High Data Rates up to 40Mbps
- 5V Tolerant Logic Inputs
- 1/5 Unit Load Allows up to 160 Devices on the Bus
- Full Fail-Safe (Open, Shorted, Terminated/Undriven) Receiver
- Hot Plug - Tx and Rx Outputs Remain Three-State During Power-Up
- Low Quiescent Current 4mA (Max)
- Low Current Shutdown Mode 1µA (Max)
- -7V to +12V Common Mode Input Voltage Range
- Three-State Rx and Tx Outputs
- 16/16.5ns (Max) Tx/Rx Propagation Delays; 1.5ns (Max) Skew
- Operates from a Single +3.3V Supply (10% Tolerance)
- Current Limiting and Thermal Shutdown for driver Overload Protection
- Pb-Free (RoHS Compliant)

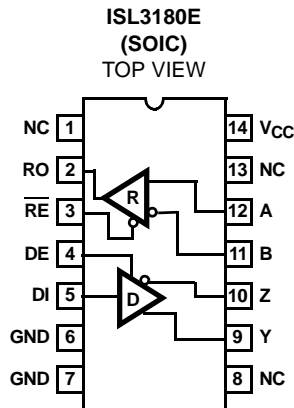
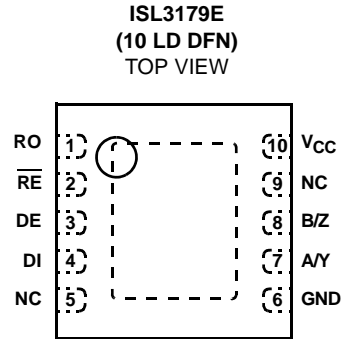
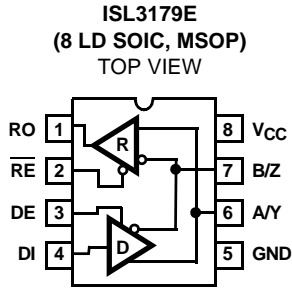
Applications

- Motor Controller/Position Encoder Systems
- Factory Automation
- Field Bus Networks
- Security Networks
- Building Environmental Control Systems
- Industrial/Process Control Networks

TABLE 1. SUMMARY OF FEATURES

| PART NUMBER | HALF/FULL DUPLEX | DATA RATE (Mbps) | RS-485 PIN ESD LEVEL | HOT PLUG? | RX/TX ENABLE? | QUIESCENT I _{CC} (mA) | LOW POWER SHUTDOWN? | PIN COUNT |
|-------------|------------------|------------------|----------------------|-----------|---------------|--------------------------------|---------------------|-----------|
| ISL3179E | HALF | 40 | 16.5kV IEC61000 | YES | YES | 2.6 | YES | 8, 10 |
| ISL3180E | FULL | 40 | 12kV HBM | YES | YES | 2.6 | YES | 14 |

Pinouts



Truth Table

| TRANSMITTING | | | | |
|-----------------|----|----|---------|---------|
| INPUTS | | | OUTPUTS | |
| \overline{RE} | DE | DI | B/Z | A/Y |
| X | 1 | 1 | 0 | 1 |
| X | 1 | 0 | 1 | 0 |
| 0 | 0 | X | High-Z | High-Z |
| 1 | 0 | X | High-Z* | High-Z* |

NOTE: *Shutdown Mode

Truth Table

| RECEIVING | | | |
|-----------------|----|---------------------|---------|
| INPUTS | | | OUTPUT |
| \overline{RE} | DE | A-B | RO |
| 0 | 0 | $\geq -0.05V$ | 1 |
| 0 | 0 | $\leq -0.2V$ | 0 |
| 0 | 0 | Inputs Open/Shorted | 1 |
| 1 | 1 | X | High-Z |
| 1 | 0 | X | High-Z* |

NOTE: *Shutdown Mode

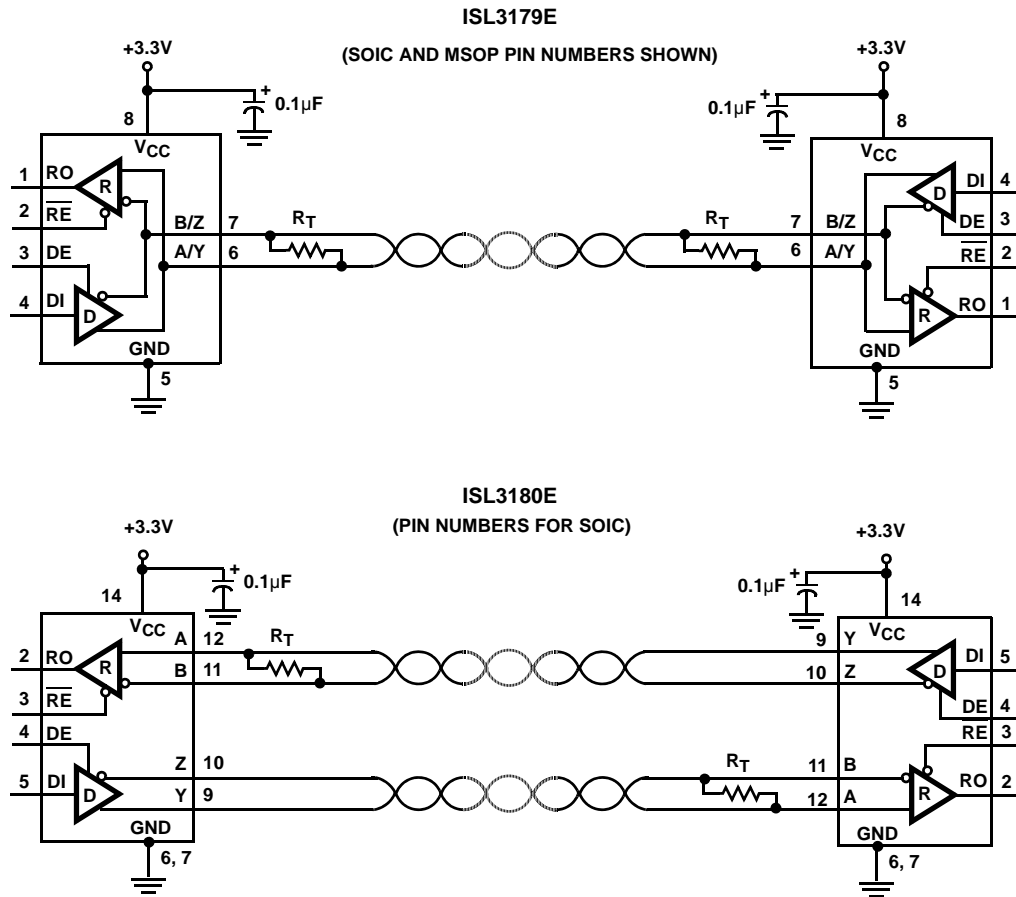
Pin Descriptions

| PIN | FUNCTION |
|-----------------|--|
| RO | Receiver output: If $A-B \geq -50mV$, RO is high; If $A-B \leq -200mV$, RO is low; RO = High if A and B are unconnected (floating) or shorted, or connected to a terminated bus that is undriven. |
| \overline{RE} | Receiver output enable. RO is enabled when \overline{RE} is low; RO is high impedance when \overline{RE} is high. If the Rx enable function isn't required, connect \overline{RE} directly to GND. |
| DE | Driver output enable. The driver outputs, Y and Z, are enabled by bringing DE high, and they are high impedance when DE is low. If the Tx enable function isn't required, connect DE to V_{CC} through a $1k\Omega$ or greater resistor. |
| DI | Driver input. A low on DI forces output Y low and output Z high. Similarly, a high on DI forces output Y high and output Z low. |

Pin Descriptions (Continued)

| PIN | FUNCTION |
|-----------------|--|
| GND | Ground connection. |
| A/Y | ±16.5kV IEC61000 ESD Protected RS-485/RS-422 level, non-inverting receiver input and non-inverting driver output. Pin is an input (A) if DE = 0; pin is an output (Y) if DE = 1. ISL3179E only |
| B/Z | ±16.5kV IEC61000 ESD Protected RS-485/RS-422 level, inverting receiver input and inverting driver output. Pin is an input (B) if DE = 0; pin is an output (Z) if DE = 1. ISL3179E only |
| A | ±12kV HBM ESD Protected RS-485/RS-422 level, non-inverting receiver input. ISL3180E only |
| B | ±12kV HBM ESD Protected RS-485/RS-422 level, inverting receiver input. ISL3180E only |
| Y | ±12kV HBM ESD Protected RS-485/RS-422 level, non-inverting driver output. ISL3180E only |
| Z | ±12kV HBM ESD Protected RS-485/RS-422 level, inverting driver output. ISL3180E only |
| V _{CC} | System power supply input (3.0V to 3.6V). |
| NC | No Connection. |

Typical Operating Circuit



ISL3179E, ISL3180E

Absolute Maximum Ratings

| | |
|---------------------------|-----------------------------------|
| V _{CC} to Ground | 7V |
| Input Voltages | |
| DI, DE, RE | -0.3V to 7V |
| Input/Output Voltages | |
| A, B, Y, Z, A/Y, B/Z | -9V to +13V |
| RO | -0.3V to (V _{CC} + 0.3V) |
| Short Circuit Duration | |
| Y, Z | Continuous |
| ESD Rating | See Specification Table |

Thermal Information

| | | |
|---|----------------------|----------------------|
| Thermal Resistance (Typical, Note 1, 2) | θ_{JA} (°C/W) | θ_{JC} (°C/W) |
| 8 Ld SOIC Package | 160 | N/A |
| 14 Ld SOIC Package | 128 | N/A |
| 8 Ld MSOP Package | 137 | N/A |
| 10 Ld DFN Package | 46 | 3.5 |
| Maximum Junction Temperature (Plastic Package) | +150°C | |
| Maximum Storage Temperature Range | -65°C to +150°C | |
| Pb-free reflow profile | see link below | |
| http://www.intersil.com/pbfree/Pb-FreeReflow.asp | | |

Operating Conditions

| | |
|----------------------|-----------------|
| Temperature Range | |
| ISL3179EF | -40°C to +125°C |
| ISL3179EI, ISL3180EI | -40°C to +85°C |

CAUTION: Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions may adversely impact product reliability and result in failures not covered by warranty.

NOTES:

- θ_{JA} is measured with the component mounted on a high effective thermal conductivity (with direct attach for DFN) test board in free air. See Tech Brief TB379 for details.
- For θ_{JC} , the "case temp" location is the center of the exposed metal pad on the package underside.

Electrical Specifications

Test Conditions: V_{CC} = 3.0V to 3.6V; Typicals are at V_{CC} = 3.3V, T_A = +25°C. (Note 3)

| PARAMETER | SYMBOL | TEST CONDITIONS | TEMP (°C) | MIN (Note 13) | TYP | MAX (Note 13) | UNITS | |
|---|-------------------|--|-----------------------|-----------------------|------|-----------------|-------|----|
| DC CHARACTERISTICS | | | | | | | | |
| Driver Differential V _{OUT} | V _{OD} | R _L = 100Ω (RS-422) (Figure 1A), (Note 12) | Full | 2 | 2.3 | - | V | |
| | | R _L = 54Ω (RS-485) (Figure 1A) | Full | 1.5 | 2.1 | V _{CC} | V | |
| | | No Load | Full | - | - | V _{CC} | | |
| | | R _L = 60Ω, -7V ≤ V _{CM} ≤ 12V (Figure 1B), (Note 12) | Full | 1.5 | 2 | - | V | |
| Change in Magnitude of Driver Differential V _{OUT} for Complementary Output States | ΔV _{OD} | R _L = 54Ω or 100Ω (Figure 1A) | Full | - | 0.01 | 0.2 | V | |
| Driver Common-Mode V _{OUT} | V _{OC} | R _L = 54Ω or 100Ω (Figure 1A) | Full | - | 2 | 2.5 | V | |
| Change in Magnitude of Driver Common-Mode V _{OUT} for Complementary Output States | ΔV _{OC} | R _L = 54Ω or 100Ω (Figure 1A) | Full | - | 0.02 | 0.2 | V | |
| Logic Input High Voltage | V _{IH} | DI, DE, RE | Full | 2 | - | - | V | |
| Logic Input Low Voltage | V _{IL} | DI, DE, RE | Full | - | - | 0.8 | V | |
| Logic Input Current | I _{IN1} | DI = DE = RE = 0V or V _{CC} | Full | -2 | - | 2 | μA | |
| Input Current (A, B, A/Y, B/Z) | I _{IN2} | DE = 0V, V _{CC} = 0V or 3.6V | V _{IN} = 12V | Full | - | - | 220 | μA |
| | | | V _{IN} = -7V | Full | -160 | - | - | μA |
| Y or Z Output Leakage Current | I _{OZ} | DE = 0V, -7V ≤ V _Y or V _Z ≤ 12V, ISL3180E Only | Full | -40 | - | 40 | μA | |
| Driver Short-Circuit Current, V _O = High or Low | I _{OSD1} | DE = V _{CC} , -7V ≤ V _Y or V _Z ≤ 12V (Note 5) | Full | - | - | ±250 | mA | |
| Receiver Differential Threshold Voltage | V _{TH} | -7V ≤ V _{CM} ≤ 12V | Full | -200 | - | -50 | mV | |
| Receiver Input Hysteresis | ΔV _{TH} | V _{CM} = 0V | 25 | - | 28 | - | mV | |
| Receiver Output High Voltage | V _{OH} | I _O = -12mA, V _{ID} = -50mV | Full | V _{CC} - 0.5 | - | - | V | |
| Receiver Output Low Voltage | V _{OL} | I _O = +10mA, V _{ID} = -200mV | Full | - | - | 0.4 | V | |

ISL3179E, ISL3180E

Electrical Specifications Test Conditions: $V_{CC} = 3.0V$ to $3.6V$; Typicals are at $V_{CC} = 3.3V$, $T_A = +25^\circ C$. (Note 3) (Continued)

| PARAMETER | SYMBOL | TEST CONDITIONS | TEMP (°C) | MIN (Note 13) | TYP | MAX (Note 13) | UNITS |
|--|-----------------------|---|-----------|---------------|-------------|---------------|------------|
| Receiver Output Low Current | I_{OL} | $V_{OL} = 1V$, $V_{ID} = -200mV$ | Full | 25 | - | - | mA |
| Three-State (high impedance) Receiver Output Current | I_{OZR} | $0.4V \leq V_O \leq 2.4V$ | Full | -1 | 0.015 | 1 | μA |
| Receiver Input Resistance | R_{IN} | $-7V \leq V_{CM} \leq 12V$ | Full | 54 | 80 | - | k Ω |
| Receiver Short-Circuit Current | I_{OSR} | $0V \leq V_O \leq V_{CC}$ | Full | ± 20 | - | ± 110 | mA |
| SUPPLY CURRENT | | | | | | | |
| No-Load Supply Current (Note 4) | I_{CC} | $DI = DE = 0V$ or V_{CC} | Full | - | 2.6 | 4 | mA |
| Shutdown Supply Current | I_{SHDN} | $DE = 0V$, $\overline{RE} = V_{CC}$, $DI = 0V$ or V_{CC} | Full | - | 0.05 | 1 | μA |
| ESD PERFORMANCE | | | | | | | |
| RS-485 Pins (A/Y, B/Z) ISL3179E Only | | IEC61000-4-2, Air-Gap Discharge Method | 25 | - | ± 16.5 | - | kV |
| | | IEC61000-4-2, Contact Discharge Method | 25 | - | ± 9 | - | kV |
| | | Human Body Model, From Bus Pins to GND | 25 | - | ± 16.5 | - | kV |
| RS-485 Pins (A, B, Y, Z) ISL3180E Only | | IEC61000-4-2, Air-Gap Discharge Method | 25 | - | ± 4 | - | kV |
| | | IEC61000-4-2, Contact Discharge Method | 25 | - | ± 5 | - | kV |
| | | Human Body Model, From Bus Pins to GND | 25 | - | ± 12 | - | kV |
| All Pins | | HBM, per MIL-STD-883 Method 3015 | 25 | - | $> \pm 9$ | - | kV |
| | | Machine Model | 25 | - | $> \pm 400$ | - | V |
| DRIVER SWITCHING CHARACTERISTICS | | | | | | | |
| Maximum Data Rate | f_{MAX} | $V_{OD} \geq \pm 1.5V$, $R_D = 54\Omega$, $C_L = 100pF$ (Figure 4) | -40 to 85 | 40 | 60 | - | Mbps |
| | | | 125 | 16 | 32 | - | Mbps |
| Driver Differential Output Delay | t_{DD} | $R_D = 54\Omega$, $C_D = 50pF$ (Figure 2) | Full | - | 11 | 16 | ns |
| Prop Delay Part-to-Part Skew | t_{SKP-P} | $R_D = 54\Omega$, $C_D = 50pF$ (Figure 2), (Note 11) | Full | - | - | 4 | ns |
| Driver Differential Output Skew | t_{SKEW} | $R_D = 54\Omega$, $C_D = 50pF$ (Figure 2) | Full | - | 0 | 1.5 | ns |
| Driver Differential Rise or Fall Time | t_R , t_F | $R_D = 54\Omega$, $C_D = 50pF$ (Figure 2) | Full | - | 4 | 7 | ns |
| Driver Enable to Output High | t_{ZH} | $R_L = 110\Omega$, $C_L = 50pF$, $SW = GND$ (Figure 3), (Note 6) | Full | - | 18 | 25 | ns |
| Driver Enable to Output Low | t_{ZL} | $R_L = 110\Omega$, $C_L = 50pF$, $SW = V_{CC}$ (Figure 3), (Note 6) | Full | - | 16 | 25 | ns |
| Driver Disable from Output High | t_{HZ} | $R_L = 110\Omega$, $C_L = 50pF$, $SW = GND$ (Figure 3), | Full | - | 15 | 25 | ns |
| Driver Disable from Output Low | t_{LZ} | $R_L = 110\Omega$, $C_L = 50pF$, $SW = V_{CC}$ (Figure 3), | Full | - | 18 | 25 | ns |
| Time to Shutdown | t_{SHDN} | (Note 8) | Full | 60 | - | 600 | ns |
| Driver Enable from Shutdown to Output High | $t_{ZH(SHDN)}$ | $R_L = 110\Omega$, $C_L = 50pF$, $SW = GND$ (Figure 3), (Notes 8, 9) | Full | - | - | 1000 | ns |
| Driver Enable from Shutdown to Output Low | $t_{ZL(SHDN)}$ | $R_L = 110\Omega$, $C_L = 50pF$, $SW = V_{CC}$ (Figure 3), (Notes 8, 9) | Full | - | - | 1000 | ns |
| RECEIVER SWITCHING CHARACTERISTICS | | | | | | | |
| Maximum Data Rate | f_{MAX} | $V_{ID} = \pm 1.5V$ | Full | 40 | 60 | - | Mbps |
| Receiver Input to Output Delay | t_{PLH} , t_{PHL} | (Figure 5) | Full | - | 10 | 16.5 | ns |
| Prop Delay Part-to-Part Skew | t_{SKP-P} | (Figure 5), (Note 11) | Full | - | - | 4 | ns |
| Receiver Skew $t_{PLH} - t_{PHL}$ | t_{SKD} | (Figure 5) | Full | - | 0 | 1.5 | ns |
| Receiver Enable to Output High | t_{ZH} | $R_L = 1k\Omega$, $C_L = 15pF$, $SW = GND$ (Figure 6), (Note 7) | Full | - | 10 | 15 | ns |

Electrical Specifications Test Conditions: $V_{CC} = 3.0V$ to $3.6V$; Typicals are at $V_{CC} = 3.3V$, $T_A = +25^\circ C$. (Note 3) (Continued)

| PARAMETER | SYMBOL | TEST CONDITIONS | TEMP (°C) | MIN (Note 13) | TYP | MAX (Note 13) | UNITS |
|--|----------------|---|-----------|---------------|-----|---------------|-------|
| Receiver Enable to Output Low | t_{ZL} | $R_L = 1k\Omega$, $C_L = 15pF$, $SW = V_{CC}$ (Figure 6), (Note 7) | Full | - | 11 | 15 | ns |
| Receiver Disable from Output High | t_{HZ} | $R_L = 1k\Omega$, $C_L = 15pF$, $SW = GND$ (Figure 6) | Full | - | 10 | 15 | ns |
| Receiver Disable from Output Low | t_{LZ} | $R_L = 1k\Omega$, $C_L = 15pF$, $SW = V_{CC}$ (Figure 6) | Full | - | 10 | 15 | ns |
| Time to Shutdown | t_{SHDN} | (Note 8) | Full | 60 | - | 600 | ns |
| Receiver Enable from Shutdown to Output High | $t_{ZH}(SHDN)$ | $R_L = 1k\Omega$, $C_L = 15pF$, $SW = GND$ (Figure 6), (Notes 8, 10) | Full | - | - | 1000 | ns |
| Receiver Enable from Shutdown to Output Low | $t_{ZL}(SHDN)$ | $R_L = 1k\Omega$, $C_L = 15pF$, $SW = V_{CC}$ (Figure 6), (Notes 8, 10) | Full | - | - | 1000 | ns |

NOTES:

- All currents into device pins are positive; all currents out of device pins are negative. All voltages are referenced to device ground unless otherwise specified.
- Supply current specification is valid for loaded drivers when $DE = 0V$.
- Applies to peak current. See "Typical Performance Curves" on page 11 for more information.
- Because of the shutdown feature, keep $\overline{RE} = 0$ to prevent the device from entering SHDN.
- Because of the shutdown feature, the \overline{RE} signal high time must be short enough (typically $<100ns$) to prevent the device from entering SHDN.
- These IC's are put into shutdown by bringing \overline{RE} high and DE low. If the inputs are in this state for less than 60ns, the parts are guaranteed not to enter shutdown. If the inputs are in this state for at least 700ns, the parts are guaranteed to have entered shutdown. See "Low Power Shutdown Mode" on page 10.
- Keep $\overline{RE} = V_{CC}$, and set the DE signal low time $>700ns$ to ensure that the device enters SHDN.
- Set the \overline{RE} signal high time $>700ns$ to ensure that the device enters SHDN.
- This is the part-to-part skew between any two units tested with identical test conditions (Temperature, V_{CC} , etc.).
- $V_{CC} = 3.3V \pm 5\%$
- Parameters with MIN and/or MAX limits are 100% tested at $+25^\circ C$, unless otherwise specified. Temperature limits established by characterization and are not production tested.

Test Circuits and Waveforms

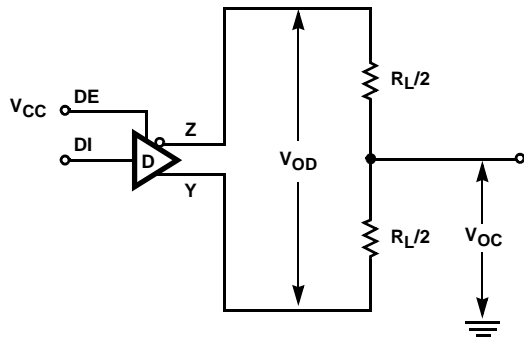


FIGURE 1A. V_{OD} AND V_{OC}

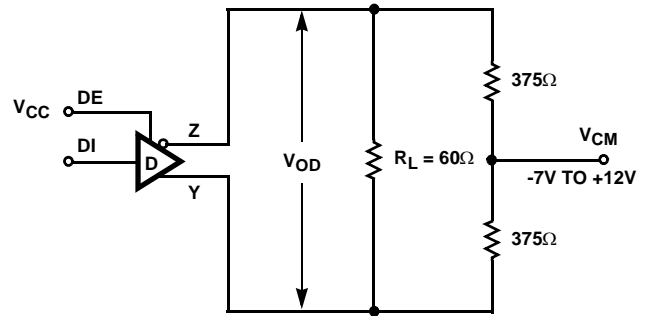


FIGURE 1B. V_{OD} WITH COMMON MODE LOAD

FIGURE 1. DC DRIVER TEST CIRCUITS

Test Circuits and Waveforms (Continued)

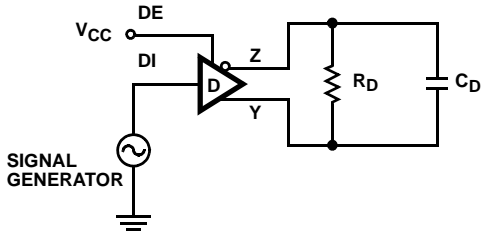


FIGURE 2A. TEST CIRCUIT

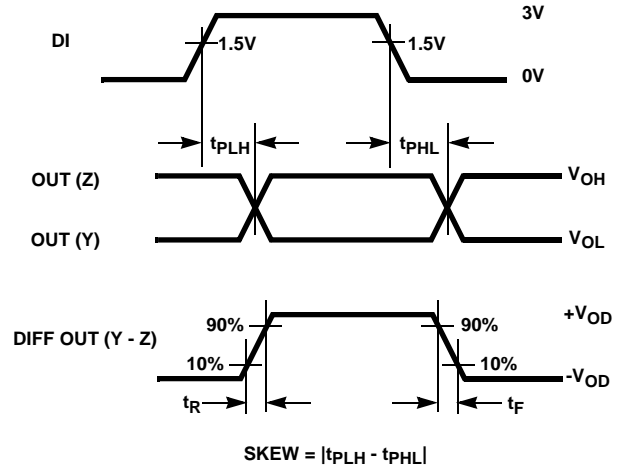


FIGURE 2B. MEASUREMENT POINTS

FIGURE 2. DRIVER PROPAGATION DELAY AND DIFFERENTIAL TRANSITION TIMES

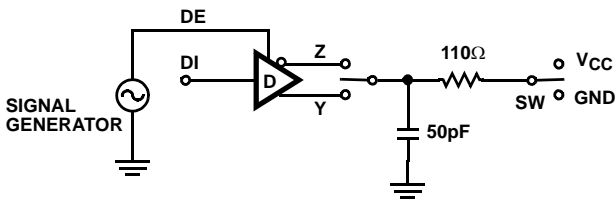


FIGURE 3A. TEST CIRCUIT

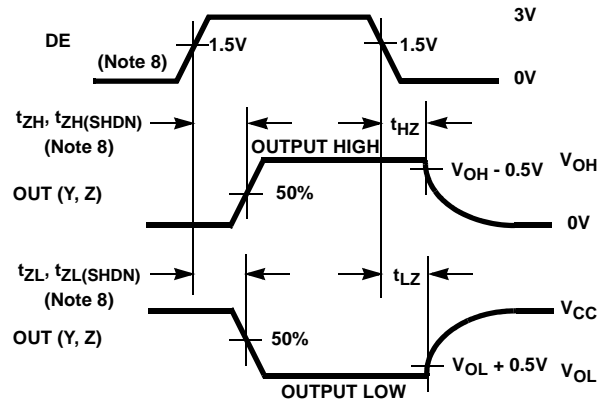


FIGURE 3B. MEASUREMENT POINTS

FIGURE 3. DRIVER ENABLE AND DISABLE TIMES

| PARAMETER | OUTPUT | RE | DI | SW |
|----------------|--------|------------|-----|----------|
| t_{HZ} | Y/Z | X | 1/0 | GND |
| t_{LZ} | Y/Z | X | 0/1 | V_{CC} |
| t_{ZH} | Y/Z | 0 (Note 6) | 1/0 | GND |
| t_{ZL} | Y/Z | 0 (Note 6) | 0/1 | V_{CC} |
| $t_{ZH(SHDN)}$ | Y/Z | 1 (Note 9) | 1/0 | GND |
| $t_{ZL(SHDN)}$ | Y/Z | 1 (Note 9) | 0/1 | V_{CC} |

FIGURE 4A. TEST CIRCUIT

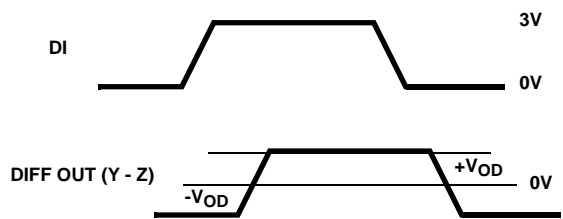
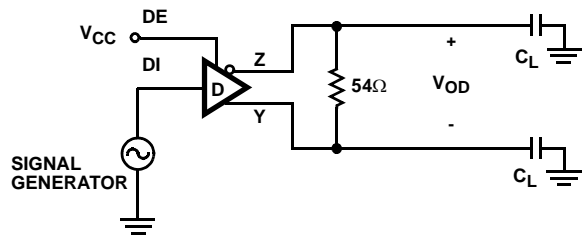


FIGURE 4B. MEASUREMENT POINTS

FIGURE 4. DRIVER DATA RATE

Test Circuits and Waveforms (Continued)

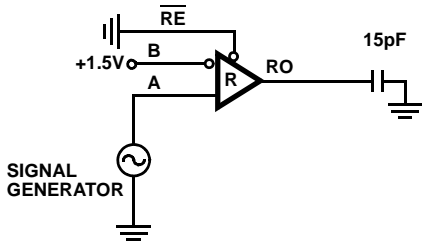


FIGURE 5A. TEST CIRCUIT

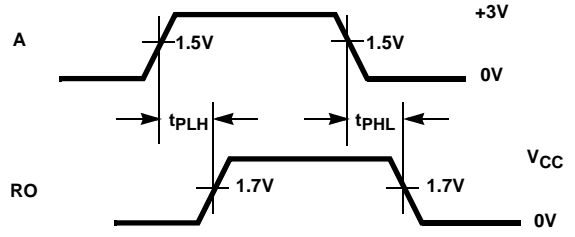
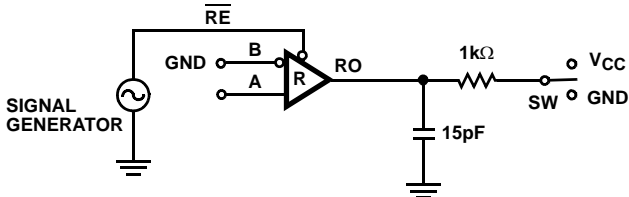


FIGURE 5B. MEASUREMENT POINTS

FIGURE 5. RECEIVER PROPAGATION DELAY



| PARAMETER | DE | A | SW |
|--------------------------|----|-------|----------|
| t_{HZ} | 0 | +1.5V | GND |
| t_{LZ} | 0 | -1.5V | V_{CC} |
| t_{ZH} (Note 7) | 0 | +1.5V | GND |
| t_{ZL} (Note 7) | 0 | -1.5V | V_{CC} |
| $t_{ZH(SHDN)}$ (Note 10) | 0 | +1.5V | GND |
| $t_{ZL(SHDN)}$ (Note 10) | 0 | -1.5V | V_{CC} |

FIGURE 6A. TEST CIRCUIT

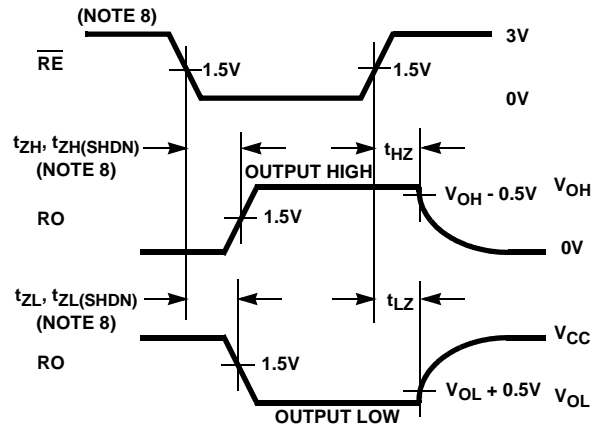


FIGURE 6B. MEASUREMENT POINTS

FIGURE 6. RECEIVER ENABLE AND DISABLE TIMES

Application Information

RS-485 and RS-422 are differential (balanced) data transmission standards for use in long haul or noisy environments. RS-422 is a subset of RS-485, so RS-485 transceivers are also RS-422 compliant. RS-422 is a point-to-multipoint (multidrop) standard, which allows only one driver and up to 10 (assuming one unit load devices) receivers on each bus. RS-485 is a true multipoint standard, which allows up to 32 one unit load devices (any mix of drivers and receivers) on each bus. To allow for multipoint operation, the RS-485 spec requires that drivers must handle bus contention without sustaining any damage.

Another important advantage of RS-485 is the extended common mode range (CMR), which specifies that the driver outputs and receiver inputs withstand signals that range from +12V to -7V. RS-422 and RS-485 are intended for runs as long as 4000' (~1200m), so the wide CMR is necessary to handle ground potential differences, as well as voltages induced in the cable by external fields.

Receiver (Rx) Features

This transceiver utilizes a differential input receiver for maximum noise immunity and common mode rejection. Input sensitivity is $\pm 200\text{mV}$, as required by the RS-422 and RS-485 specifications. Receiver inputs function with common mode voltages as great as +9/-7V outside the power supplies (i.e., +12V and -7V), making them ideal for long networks, or industrial environments, where induced voltages are a realistic concern.

The receiver input resistance of $50\text{k}\Omega$ surpasses the RS-422 specification of $4\text{k}\Omega$, and is 5x the RS-485 "Unit Load" (UL) requirement of $12\text{k}\Omega$ minimum. Thus, the ISL3179E is known as a "one-fifth UL" transceiver, and there can be up to 160 devices on the RS-485 bus while still complying with the RS-485 loading specification.

The receiver is a "Full Fail-Safe" version that guarantees a high level receiver output if the receiver inputs are unconnected (floating), shorted together, or connected to a terminated bus with all the transmitters disabled (terminated/undriven).

Rx outputs deliver large low state currents (typically 28mA at $V_{OL} = 1\text{V}$) to ease the design of optically coupled isolated networks.

Receivers easily meet the 40Mbps data rate supported by the driver, and the receiver output is tri-statable via the active low RE input.

Driver (Tx) Features

The RS-485/RS-422 driver is a differential output device that delivers at least 1.5V across a 54Ω load (RS-485), and at least 2V across a 100Ω load (RS-422). The drivers feature low propagation delay skew to maximize bit width, and to minimize EMI.

Outputs of the drivers are not slew rate limited, so faster output transition times allow data rates of at least 40Mbps. Driver outputs are tri-statable via the active high DE input.

For parallel applications, bit-to-bit skews between any two transmitter and receiver pairs are guaranteed to be no worse than 8ns (4ns max for any two Tx, 4ns max for any two Rx).

ESD Protection

All pins on the ISL3179E and ISL3180E include class 3 (>9kV) Human Body Model (HBM) ESD protection structures, but the RS-485 pins (driver outputs and receiver inputs) incorporate advanced structures allowing them to survive ESD events in excess of $\pm 16.5\text{kV}$ HBM (ISL3179E) or $\pm 12\text{kV}$ HBM (ISL3180E), and $\pm 16.5\text{kV}$ (ISL3179E) or $\pm 4\text{kV}$ (ISL3180E) IEC61000-4-2. The RS-485 pins are particularly vulnerable to ESD strikes because they typically connect to an exposed port on the exterior of the finished product. Simply touching the port pins, or connecting a cable, can cause an ESD event that might destroy unprotected ICs. These new ESD structures protect the device whether or not it is powered up, and without degrading the RS-485 common mode range of -7V to +12V. This built-in ESD protection eliminates the need for board level protection structures (e.g., transient suppression diodes), and the associated, undesirable capacitive load they present.

IEC61000-4-2 Testing

The IEC61000 test method applies to finished equipment, rather than to an individual IC. Therefore, the pins most likely to suffer an ESD event are those that are exposed to the outside world (the RS-485 pins in this case), and the IC is tested in its typical application configuration (power applied) rather than testing each pin-to-pin combination. The IEC61000 standard's lower current limiting resistor coupled with the larger charge storage capacitor yields a test that is much more severe than the HBM test. The extra ESD protection built into the ISL3179E's RS-485 pins allows the design of equipment meeting level 4 criteria without the need for additional board level protection on the RS-485 port.

AIR-GAP DISCHARGE TEST METHOD

For this test method, a charged probe tip moves toward the IC pin until the voltage arcs to it. The current waveform delivered to the IC pin depends on approach speed, humidity, temperature, etc., so it is more difficult to obtain repeatable results. The ISL3179E RS-485 pins withstand $\pm 16.5\text{kV}$ air-gap discharges, while the ISL3180E's RS-485 pins withstand $\pm 4\text{kV}$.

CONTACT DISCHARGE TEST METHOD

During the contact discharge test, the probe contacts the tested pin before the probe tip is energized, thereby eliminating the variables associated with the air-gap discharge. The result is a more repeatable and predictable test, but equipment limits prevent testing devices at voltages

higher than $\pm 9\text{kV}$. The RS-485 pins of the ISL3179E survive $\pm 9\text{kV}$ contact discharges, while the ISL3180E's RS-485 pins withstand $\pm 5\text{kV}$.

Hot Plug Function

When a piece of equipment powers up, there is a period of time where the processor or ASIC driving the RS-485 control lines (DE, RE) is unable to ensure that the RS-485 Tx and Rx outputs are kept disabled. If the equipment is connected to the bus, a driver activating prematurely during power up may crash the bus. To avoid this scenario, the ISL3179E and ISL3180E incorporate a "Hot Plug" function. Circuitry monitoring V_{CC} ensures that, during power up and power down, the Tx and Rx outputs remain disabled, regardless of the state of DE and RE, if V_{CC} is less than $\sim 2.4\text{V}$. This gives the processor/ASIC a chance to stabilize and drive the RS-485 control lines to the proper states.

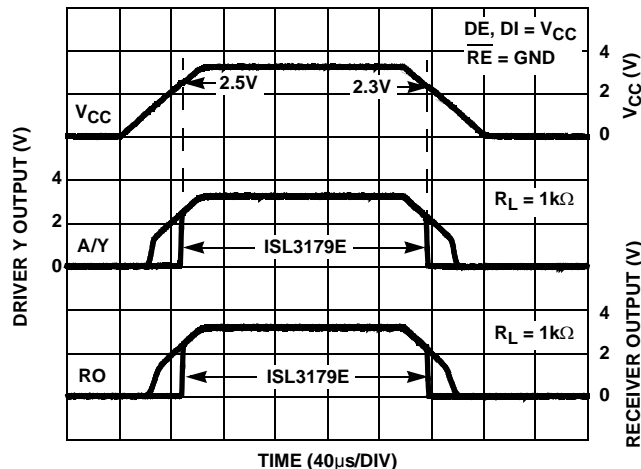


FIGURE 7. HOT PLUG PERFORMANCE (ISL3179E) vs ISL83485 WITHOUT HOT PLUG CIRCUITRY

Data Rate, Cables, and Terminations

RS-485/RS-422 are intended for network lengths up to 4000', but the maximum system data rate decreases as the transmission length increases. Devices operating at 40Mbps are limited to lengths less than 100'.

Twisted pair is the cable of choice for RS-485/RS-422 networks. Twisted pair cables tend to pick up noise and other electromagnetically induced voltages as common mode signals, which are effectively rejected by the differential receiver in this IC.

Proper termination is imperative to minimize reflections. In point-to-point, or point-to-multipoint (single driver on bus) networks, the main cable should be terminated in its characteristic impedance (typically 120Ω) at the end farthest from the driver. In multi-receiver applications, stubs connecting receivers to the main cable should be kept as short as possible. Multipoint (multi-driver) systems require that the main cable be terminated in its characteristic

impedance at both ends. Stubs connecting a transceiver to the main cable should be kept as short as possible.

The ISL3179E, and ISL3180E may also be used at slower data rates over longer cables, but there are some limitations. The Rx is optimized for high speed operation, so its output may glitch if the Rx input differential transition times are too slow. Keeping the transition times below 500ns, which equates to the Tx driving a 1000' (305m) CAT 5 cable, yields excellent performance over the full operating temperature range.

Built-In Driver Overload Protection

As stated previously, the RS-485 specification requires that drivers survive worst case bus contentions undamaged. These transmitters meet this requirement via driver output short circuit current limits, and on-chip thermal shutdown circuitry.

The driver output stages incorporate short circuit current limiting circuitry which ensures that the output current never exceeds the RS-485 specification, even at the common mode voltage range extremes. In the event of a major short circuit condition, the device also includes a thermal shutdown feature that disables the drivers whenever the die temperature becomes excessive. This eliminates the power dissipation, allowing the die to cool. The drivers automatically reenables after the die temperature drops about +15°C. If the contention persists, the thermal shutdown/reenable cycle repeats until the fault is cleared. Receivers stay operational during thermal shutdown.

Low Power Shutdown Mode

This BiCMOS transceiver uses a fraction of the power required by their bipolar counterparts, but it also includes a shutdown feature that reduces the already low quiescent I_{CC} to a 50nA trickle. It enters shutdown whenever the receiver and driver are **simultaneously** disabled ($\overline{RE} = V_{CC}$ and $DE = GND$) for a period of at least 600ns. Disabling both the driver and the receiver for less than 60ns guarantees that the transceiver will not enter shutdown.

Note that receiver and driver enable times increase when the transceiver enables from shutdown. Refer to Notes 6, 7, 8, 9 and 10, at the end of the "Electrical Specification" table on page 6, for more information.

Typical Performance Curves $V_{CC} = 3.3V$, $T_A = +25^\circ C$; Unless Otherwise Specified

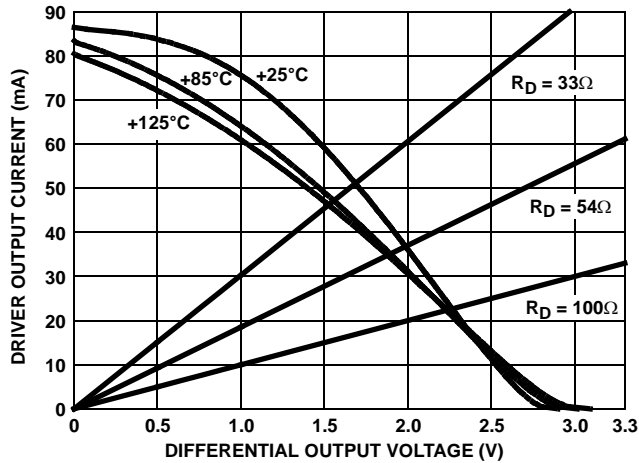


FIGURE 8. DRIVER OUTPUT CURRENT vs DIFFERENTIAL OUTPUT VOLTAGE

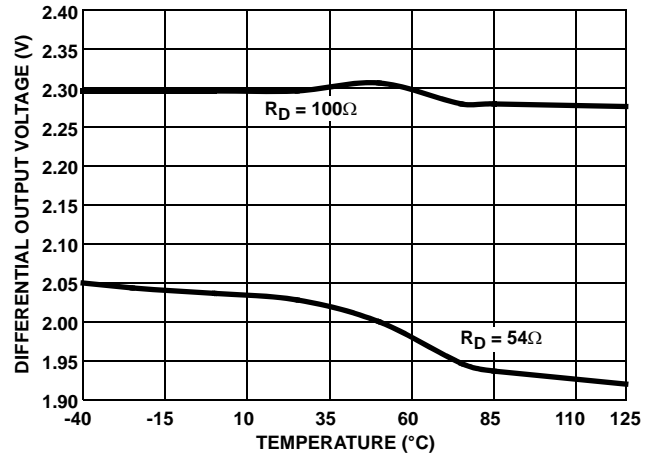


FIGURE 9. DRIVER DIFFERENTIAL OUTPUT VOLTAGE vs TEMPERATURE

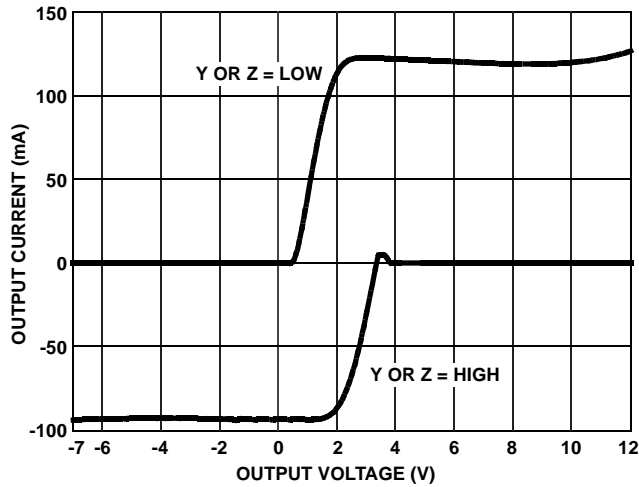


FIGURE 10. DRIVER OUTPUT CURRENT vs SHORT CIRCUIT VOLTAGE

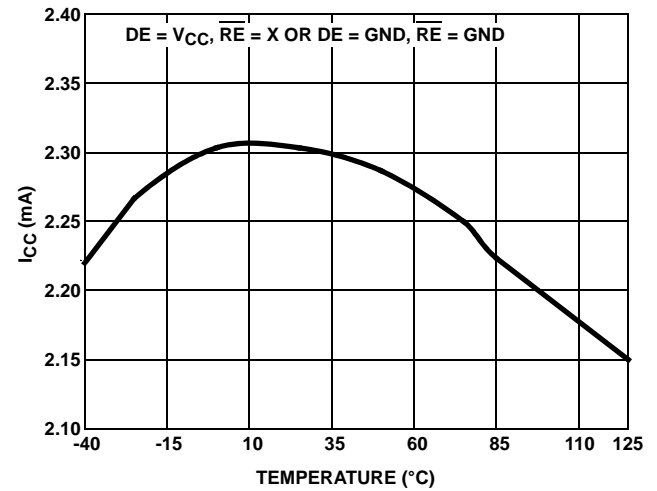


FIGURE 11. SUPPLY CURRENT vs TEMPERATURE

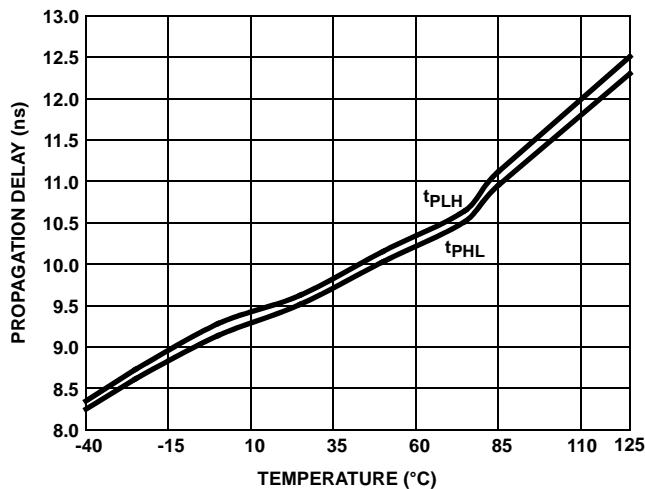


FIGURE 12. DRIVER DIFFERENTIAL PROPAGATION DELAY vs TEMPERATURE

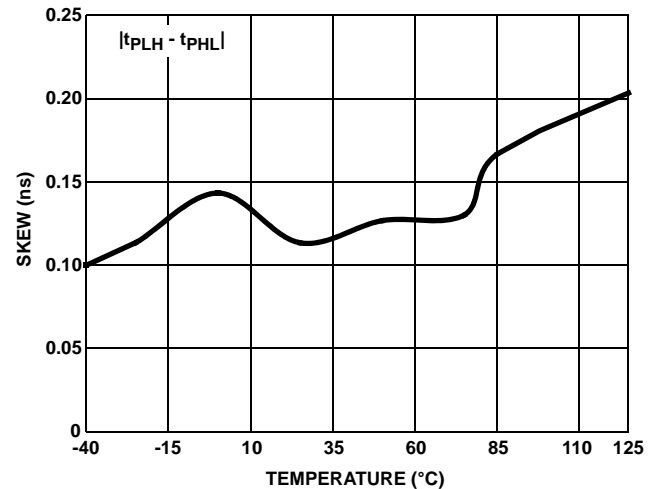


FIGURE 13. DRIVER DIFFERENTIAL SKEW vs TEMPERATURE

Typical Performance Curves $V_{CC} = 3.3V$, $T_A = +25^\circ C$; Unless Otherwise Specified (Continued)

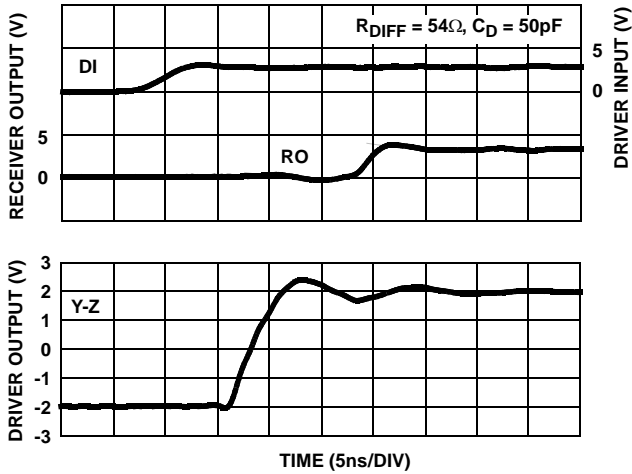


FIGURE 14. DRIVER AND RECEIVER WAVEFORMS

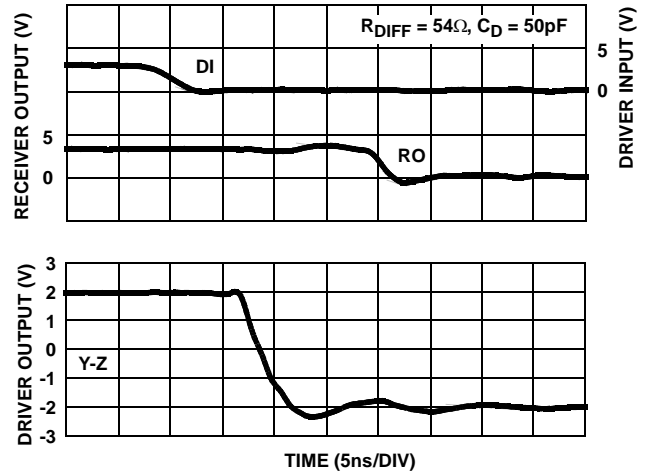


FIGURE 15. DRIVER AND RECEIVER WAVEFORMS

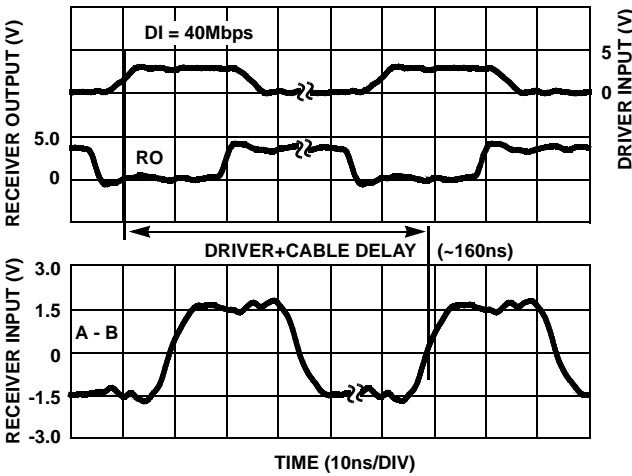


FIGURE 16. DRIVER AND RECEIVER WAVEFORMS DRIVING 100' (31m) OF CAT5 CABLE (DOUBLE TERMINATED WITH 120Ω)

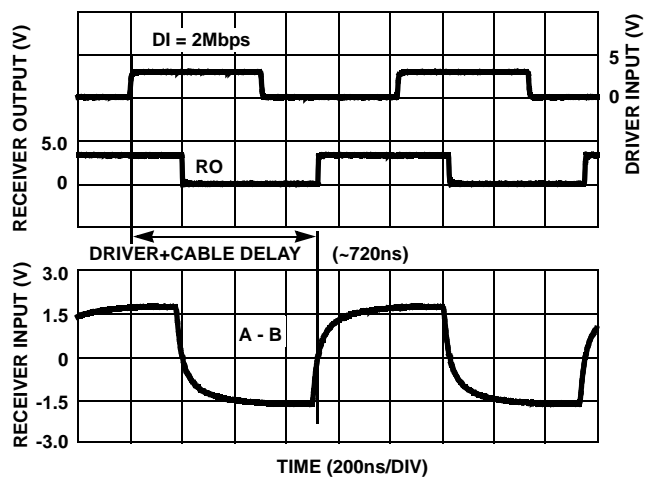


FIGURE 17. DRIVER AND RECEIVER WAVEFORMS DRIVING 500' (152m) OF CAT5 CABLE (DOUBLE TERMINATED WITH 120Ω)

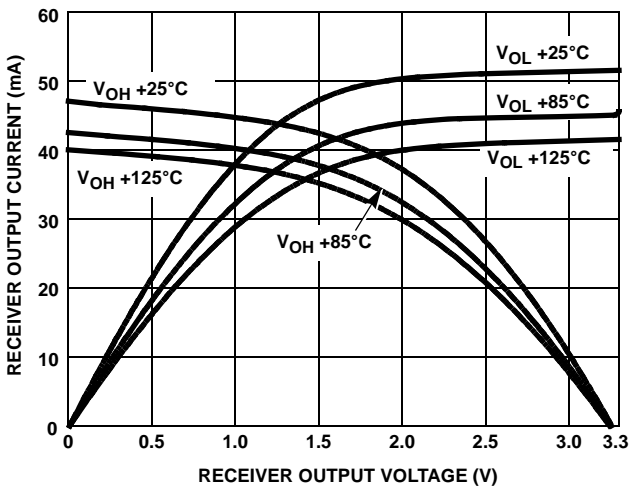


FIGURE 18. RECEIVER OUTPUT CURRENT vs RECEIVER OUTPUT VOLTAGE

Die Characteristics

**SUBSTRATE AND DFN THERMAL PAD POTENTIAL
(POWERED UP):**

GND

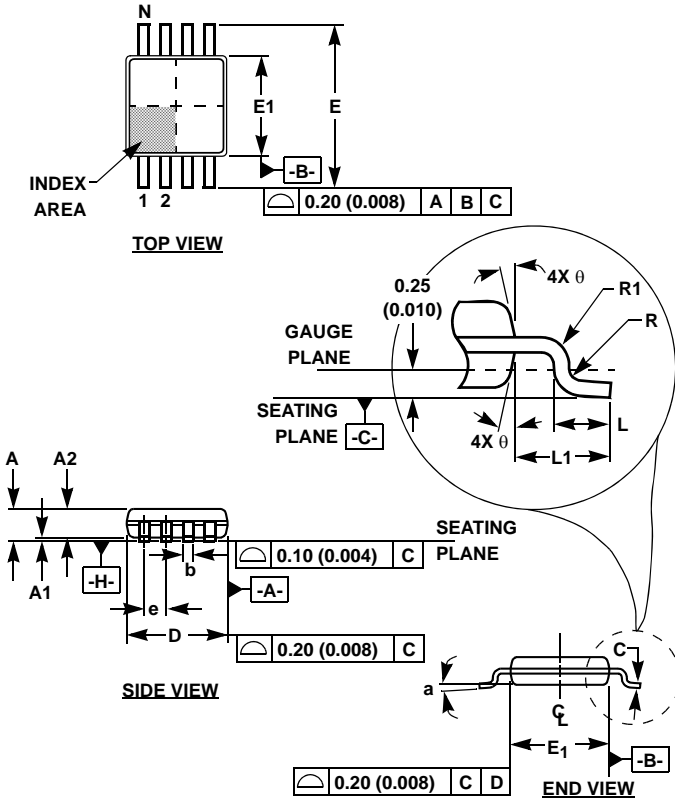
TRANSISTOR COUNT:

768

PROCESS:

Si Gate BiCMOS

Mini Small Outline Plastic Packages (MSOP)



M8.118 (JEDEC MO-187AA)
8 LEAD MINI SMALL OUTLINE PLASTIC PACKAGE

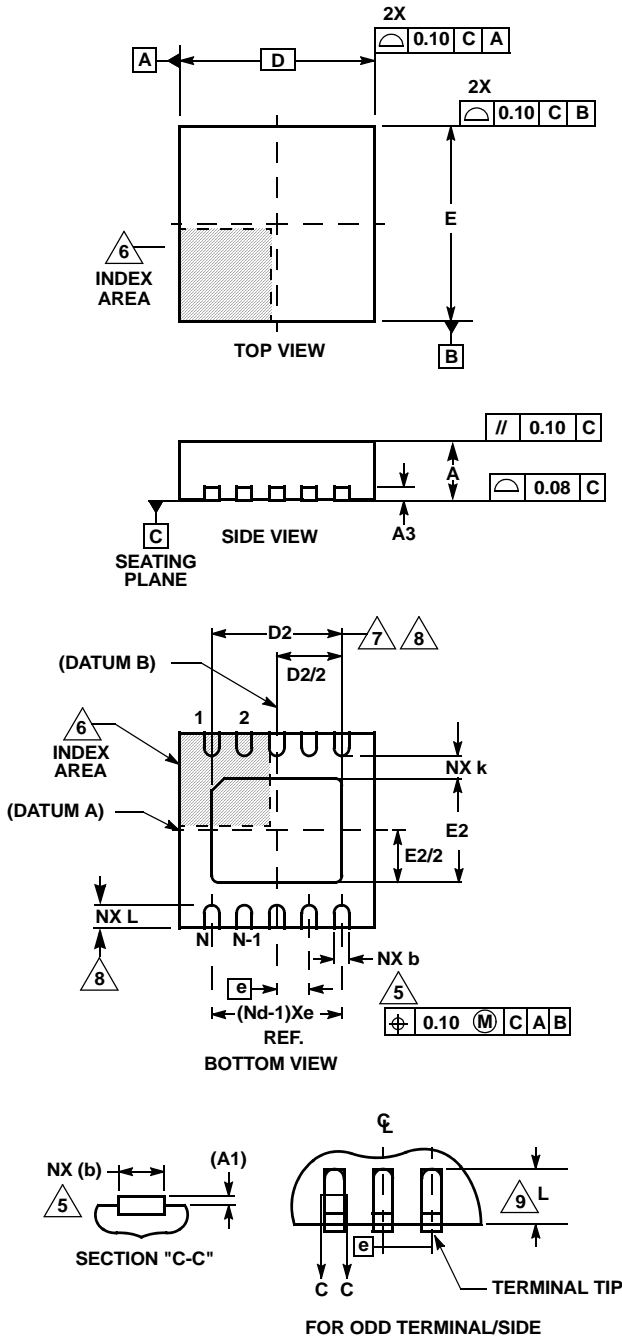
| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|--------|-----------|-------|-------------|------|-------|
| | MIN | MAX | MIN | MAX | |
| A | 0.037 | 0.043 | 0.94 | 1.10 | - |
| A1 | 0.002 | 0.006 | 0.05 | 0.15 | - |
| A2 | 0.030 | 0.037 | 0.75 | 0.95 | - |
| b | 0.010 | 0.014 | 0.25 | 0.36 | 9 |
| c | 0.004 | 0.008 | 0.09 | 0.20 | - |
| D | 0.116 | 0.120 | 2.95 | 3.05 | 3 |
| E1 | 0.116 | 0.120 | 2.95 | 3.05 | 4 |
| e | 0.026 BSC | | 0.65 BSC | | - |
| E | 0.187 | 0.199 | 4.75 | 5.05 | - |
| L | 0.016 | 0.028 | 0.40 | 0.70 | 6 |
| L1 | 0.037 REF | | 0.95 REF | | - |
| N | 8 | | 8 | | 7 |
| R | 0.003 | - | 0.07 | - | - |
| R1 | 0.003 | - | 0.07 | - | - |
| θ | 5° | 15° | 5° | 15° | - |
| α | 0° | 6° | 0° | 6° | - |

Rev. 2 01/03

NOTES:

1. These package dimensions are within allowable dimensions of JEDEC MO-187BA.
2. Dimensioning and tolerancing per ANSI Y14.5M-1994.
3. Dimension "D" does not include mold flash, protrusions or gate burrs and are measured at Datum Plane. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
4. Dimension "E1" does not include interlead flash or protrusions and are measured at Datum Plane. [-H-] Interlead flash and protrusions shall not exceed 0.15mm (0.006 inch) per side.
5. Formed leads shall be planar with respect to one another within 0.10mm (0.004) at seating Plane.
6. "L" is the length of terminal for soldering to a substrate.
7. "N" is the number of terminal positions.
8. Terminal numbers are shown for reference only.
9. Dimension "b" does not include dambar protrusion. Allowable dambar protrusion shall be 0.08mm (0.003 inch) total in excess of "b" dimension at maximum material condition. Minimum space between protrusion and adjacent lead is 0.07mm (0.0027 inch).
10. Datums [-A-] and [-B-] to be determined at Datum plane [-H-].
11. Controlling dimension: MILLIMETER. Converted inch dimensions are for reference only.

Dual Flat No-Lead Plastic Package (DFN)



L10.3x3C

10 LEAD DUAL FLAT NO-LEAD PLASTIC PACKAGE

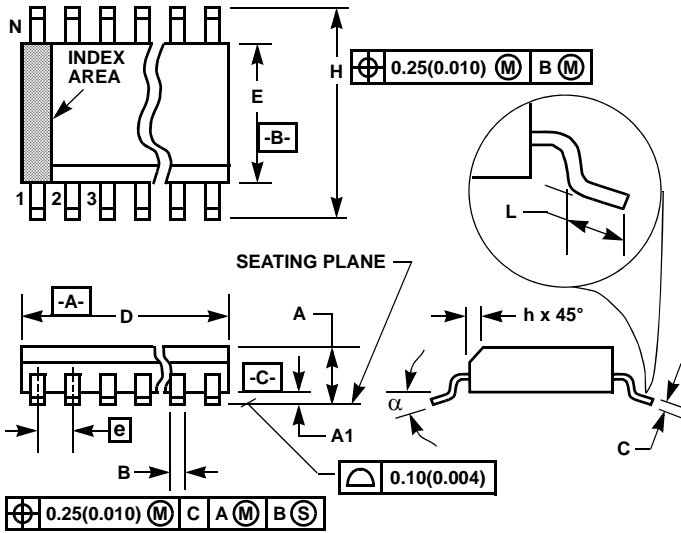
| SYMBOL | MILLIMETERS | | | NOTES |
|--------|-------------|---------|------|-------|
| | MIN | NOMINAL | MAX | |
| A | 0.85 | 0.90 | 0.95 | - |
| A1 | - | - | 0.05 | - |
| A3 | 0.20 REF | | | - |
| b | 0.20 | 0.25 | 0.30 | 5, 8 |
| D | 3.00 BSC | | | - |
| D2 | 2.33 | 2.38 | 2.43 | 7, 8 |
| E | 3.00 BSC | | | - |
| E2 | 1.59 | 1.64 | 1.69 | 7, 8 |
| e | 0.50 BSC | | | - |
| k | 0.20 | - | - | - |
| L | 0.35 | 0.40 | 0.45 | 8 |
| N | 10 | | | 2 |
| Nd | 5 | | | 3 |

Rev. 1 4/06

NOTES:

1. Dimensioning and tolerancing conform to ASME Y14.5-1994.
2. N is the number of terminals.
3. Nd refers to the number of terminals on D.
4. All dimensions are in millimeters. Angles are in degrees.
5. Dimension b applies to the metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip.
6. The configuration of the pin #1 identifier is optional, but must be located within the zone indicated. The pin #1 identifier may be either a mold or mark feature.
7. Dimensions D2 and E2 are for the exposed pads which provide improved electrical and thermal performance.
8. Nominal dimensions are provided to assist with PCB Land Pattern Design efforts, see Intersil Technical Brief TB389.
9. COMPLIANT TO JEDEC MO-229-WEED-3 except for dimensions E2 & D2.

Small Outline Plastic Packages (SOIC)



M8.15 (JEDEC MS-012-AA ISSUE C)
8 LEAD NARROW BODY SMALL OUTLINE PLASTIC PACKAGE

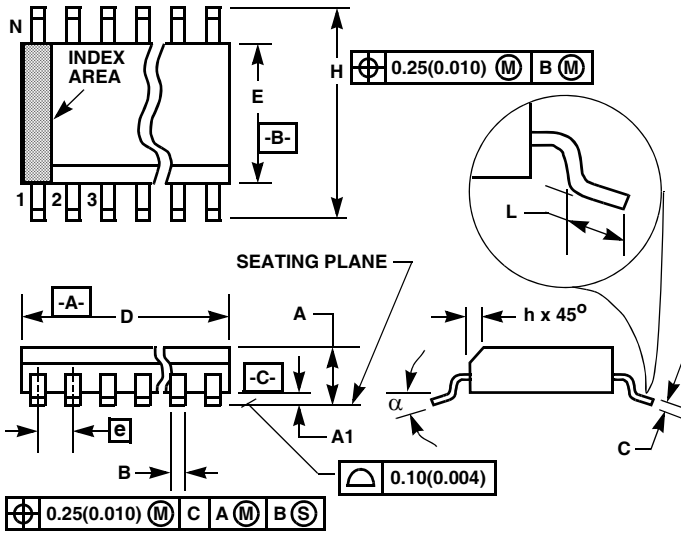
| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|--------|-----------|--------|-------------|------|-------|
| | MIN | MAX | MIN | MAX | |
| A | 0.0532 | 0.0688 | 1.35 | 1.75 | - |
| A1 | 0.0040 | 0.0098 | 0.10 | 0.25 | - |
| B | 0.013 | 0.020 | 0.33 | 0.51 | 9 |
| C | 0.0075 | 0.0098 | 0.19 | 0.25 | - |
| D | 0.1890 | 0.1968 | 4.80 | 5.00 | 3 |
| E | 0.1497 | 0.1574 | 3.80 | 4.00 | 4 |
| e | 0.050 BSC | | 1.27 BSC | | - |
| H | 0.2284 | 0.2440 | 5.80 | 6.20 | - |
| h | 0.0099 | 0.0196 | 0.25 | 0.50 | 5 |
| L | 0.016 | 0.050 | 0.40 | 1.27 | 6 |
| N | 8 | | 8 | | 7 |
| α | 0° | 8° | 0° | 8° | - |

NOTES:

1. Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication Number 95.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
4. Dimension "E" does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.25mm (0.010 inch) per side.
5. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
6. "L" is the length of terminal for soldering to a substrate.
7. "N" is the number of terminal positions.
8. Terminal numbers are shown for reference only.
9. The lead width "B", as measured 0.36mm (0.014 inch) or greater above the seating plane, shall not exceed a maximum value of 0.61mm (0.024 inch).
10. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.

Rev. 1 6/05

Small Outline Plastic Packages (SOIC)



M14.15 (JEDEC MS-012-AB ISSUE C)
14 LEAD NARROW BODY SMALL OUTLINE PLASTIC PACKAGE

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|--------|-----------|--------|-------------|------|-------|
| | MIN | MAX | MIN | MAX | |
| A | 0.0532 | 0.0688 | 1.35 | 1.75 | - |
| A1 | 0.0040 | 0.0098 | 0.10 | 0.25 | - |
| B | 0.013 | 0.020 | 0.33 | 0.51 | 9 |
| C | 0.0075 | 0.0098 | 0.19 | 0.25 | - |
| D | 0.3367 | 0.3444 | 8.55 | 8.75 | 3 |
| E | 0.1497 | 0.1574 | 3.80 | 4.00 | 4 |
| e | 0.050 BSC | | 1.27 BSC | | - |
| H | 0.2284 | 0.2440 | 5.80 | 6.20 | - |
| h | 0.0099 | 0.0196 | 0.25 | 0.50 | 5 |
| L | 0.016 | 0.050 | 0.40 | 1.27 | 6 |
| N | 14 | | 14 | | 7 |
| alpha | 0° | 8° | 0° | 8° | - |

NOTES:

1. Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication Number 95.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
4. Dimension "E" does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.25mm (0.010 inch) per side.
5. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
6. "L" is the length of terminal for soldering to a substrate.
7. "N" is the number of terminal positions.
8. Terminal numbers are shown for reference only.
9. The lead width "B", as measured 0.36mm (0.014 inch) or greater above the seating plane, shall not exceed a maximum value of 0.61mm (0.024 inch).
10. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.

Rev. 0 12/93

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