

ISL32450E, ISL32452E, ISL32453E, ISL32455E, ISL32457E, ISL32458E, ISL32459E  
 ±60V Fault Protected, 3.3V to 5V, ±20V Common-Mode Range, RS-485/RS-422  
 Transceivers with Cable Invert and ±15kV ESD

FN7921  
 Rev.3.00  
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The [ISL32450E](#), [ISL32452E](#), [ISL32453E](#), [ISL32455E](#), [ISL32457E](#), [ISL32458E](#), and [ISL32459E](#) are 3.3V to 5V powered, fault protected, extended Common-Mode Range (CMR) differential transceivers for balanced communication. The RS-485 bus pins (driver outputs and receiver inputs) are protected against overvoltages up to ±60V, and against ±15kV ESD strikes. These transceivers operate in environments with common-mode voltages up to ±20V (exceeds the RS-485 requirement), making this RS-485 family one of the most robust on the market.

The transmitters are RS-485 compliant with  $V_{CC} \geq 4.5V$  and deliver a 1.1V differential output voltage into the RS-485 specified 54Ω load even with  $V_{CC} = 3V$ . The receiver (Rx) inputs feature a full fail-safe design that ensures a logic-high Rx output if the Rx inputs are floating, shorted, or on a terminated but undriven (idle) bus. The Rx full fail-safe operation is maintained even when the Rx input polarity is switched (cable invert function on ISL32457E and ISL32459E).

The ISL32457E and ISL32459E include a cable invert function that reverses the polarity of the Rx and Tx bus pins in case the cable is misconnected during installation.

See [Table 1 on page 4](#) for key features and configurations by device number.

## Related Literature

- [ISL32450E](#), [ISL32452E](#), [ISL32453E](#), [ISL32455E](#), [ISL32457E](#), [ISL32458E](#), and [ISL32459E](#) device pages

## Features

- Fault protected RS-485 bus pins . . . . . up to ±60V
- Extended common-mode range. . . . . ±20V larger than required for RS-485
- ±15kV HBM ESD protection on RS-485 bus pins
- Wide supply range . . . . . 3V to 5.5V
- Cable invert pin (ISL32457E and ISL32459E only) corrects for reversed cable connections while maintaining Rx full fail-safe functionality
- 1/4 unit load for up to 128 devices on the bus
- High transient overvoltage tolerance. . . . . ±80V
- Full fail-safe (open, short, terminated) RS-485 receivers
- Choice of RS-485 data rates . . . . . up to 20Mbps
- Low quiescent supply current. . . . . 2.1mA

## Applications

- Utility meters and automated meter reading systems
- Air conditioning systems
- Security camera networks
- Building lighting and environmental control systems
- Industrial and process control networks

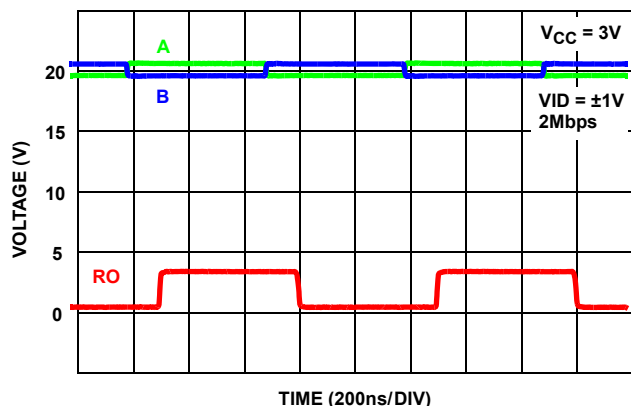


FIGURE 1. EXCEPTIONAL ISL32453E RX OPERATES AT >1Mbps EVEN WITH ±20V COMMON-MODE VOLTAGE

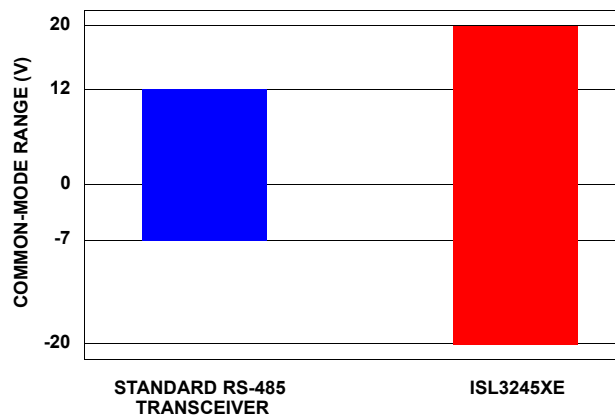


FIGURE 2. TRANSCEIVERS DELIVER SUPERIOR COMMON-MODE RANGE vs STANDARD RS-485 DEVICES

## Typical Operating Circuits

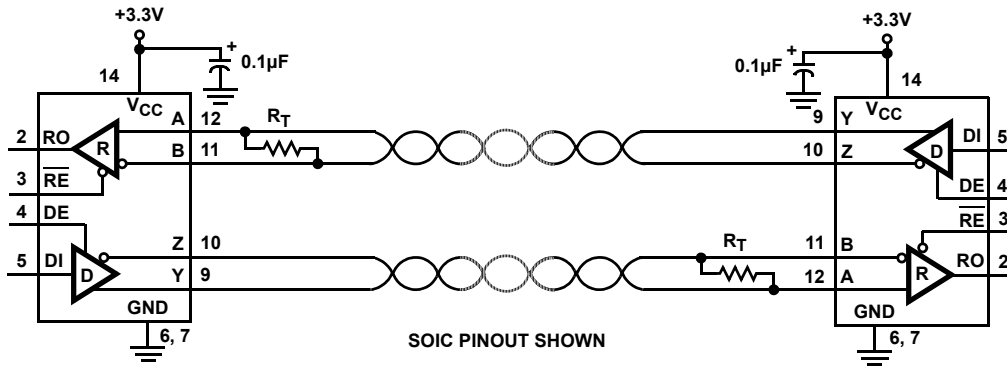


FIGURE 3. ISL32450E, ISL32453E FULL DUPLEX NETWORK

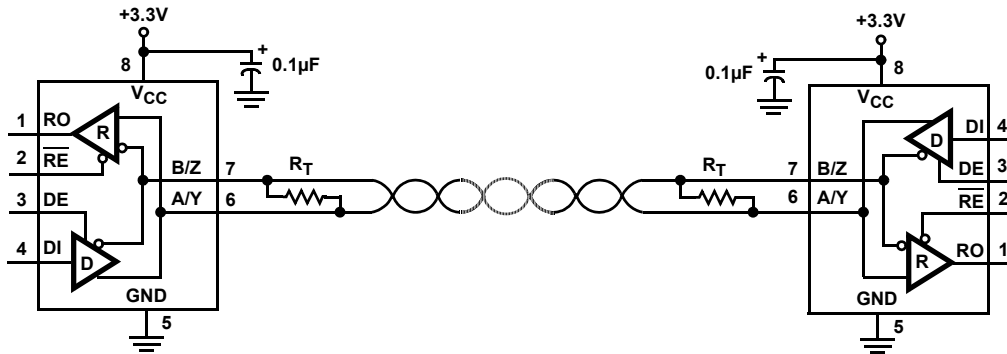


FIGURE 4. ISL32452E, ISL32455E, ISL32458E HALF DUPLEX NETWORK

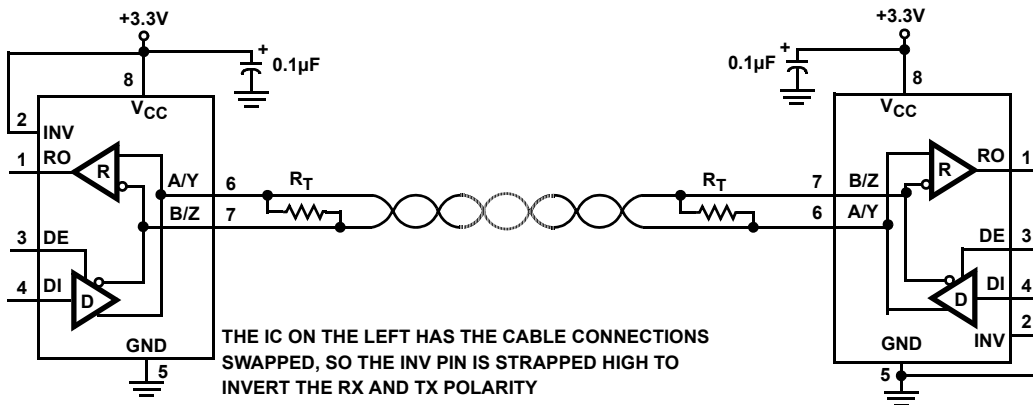


FIGURE 5. ISL32457E, ISL32459E HALF DUPLEX NETWORK USING CABLE INVERT FUNCTION

## Ordering Information

| PART NUMBER<br>(Notes 2, 3) | PART<br>MARKING | TEMP. RANGE<br>(°C) | TAPE AND REEL<br>(Units) (Note 1) | PACKAGE<br>(RoHS Compliant) | PKG.<br>DWG. # |
|-----------------------------|-----------------|---------------------|-----------------------------------|-----------------------------|----------------|
| ISL32450EIBZ                | ISL32450 EIBZ   | -40 to +85          | -                                 | 14 Ld SOIC                  | M14.15         |
| ISL32450EIBZ-T              | ISL32450 EIBZ   | -40 to +85          | 2.5k                              | 14 Ld SOIC                  | M14.15         |
| ISL32450EIBZ-T7A            | ISL32450 EIBZ   | -40 to +85          | 250                               | 14 Ld SOIC                  | M14.15         |
| ISL32450EIUZ                | 2450E           | -40 to +85          | -                                 | 10 Ld MSOP                  | M10.118        |
| ISL32450EIUZ-T              | 2450E           | -40 to +85          | 2.5k                              | 10 Ld MSOP                  | M10.118        |
| ISL32450EIUZ-T7A            | 2450E           | -40 to +85          | 250                               | 10 Ld MSOP                  | M10.118        |
| ISL32452EIBZ                | 32452 EIBZ      | -40 to +85          | -                                 | 8 Ld SOIC                   | M8.15          |
| ISL32452EIBZ-T              | 32452 EIBZ      | -40 to +85          | 2.5k                              | 8 Ld SOIC                   | M8.15          |
| ISL32452EIBZ-T7A            | 32452 EIBZ      | -40 to +85          | 250                               | 8 Ld SOIC                   | M8.15          |
| ISL32452EIUZ                | 2452E           | -40 to +85          | -                                 | 8 Ld MSOP                   | M8.118         |
| ISL32452EIUZ-T              | 2452E           | -40 to +85          | 2.5k                              | 8 Ld MSOP                   | M8.118         |
| ISL32452EIUZ-T7A            | 2452E           | -40 to +85          | 250                               | 8 Ld MSOP                   | M8.118         |
| ISL32453EIBZ                | ISL32453 EIBZ   | -40 to +85          | -                                 | 14 Ld SOIC                  | M14.15         |
| ISL32453EIBZ-T              | ISL32453 EIBZ   | -40 to +85          | 2.5k                              | 14 Ld SOIC                  | M14.15         |
| ISL32453EIBZ-T7A            | ISL32453 EIBZ   | -40 to +85          | 250                               | 14 Ld SOIC                  | M14.15         |
| ISL32453EIUZ                | 2453E           | -40 to +85          | -                                 | 10 Ld MSOP                  | M10.118        |
| ISL32453EIUZ-T              | 2453E           | -40 to +85          | 2.5k                              | 10 Ld MSOP                  | M10.118        |
| ISL32453EIUZ-T7A            | 2453E           | -40 to +85          | 250                               | 10 Ld MSOP                  | M10.118        |
| ISL32455EIBZ                | 32455 EIBZ      | -40 to +85          | -                                 | 8 Ld SOIC                   | M8.15          |
| ISL32455EIBZ-T              | 32455 EIBZ      | -40 to +85          | 2.5k                              | 8 Ld SOIC                   | M8.15          |
| ISL32455EIBZ-T7A            | 32455 EIBZ      | -40 to +85          | 250                               | 8 Ld SOIC                   | M8.15          |
| ISL32455EIUZ                | 2455E           | -40 to +85          | -                                 | 8 Ld MSOP                   | M8.118         |
| ISL32455EIUZ-T              | 2455E           | -40 to +85          | 2.5k                              | 8 Ld MSOP                   | M8.118         |
| ISL32455EIUZ-T7A            | 2455E           | -40 to +85          | 250                               | 8 Ld MSOP                   | M8.118         |
| ISL32457EIBZ                | 32457 EIBZ      | -40 to +85          | -                                 | 8 Ld SOIC                   | M8.15          |
| ISL32457EIBZ-T              | 32457 EIBZ      | -40 to +85          | 2.5k                              | 8 Ld SOIC                   | M8.15          |
| ISL32457EIBZ-T7A            | 32457 EIBZ      | -40 to +85          | 250                               | 8 Ld SOIC                   | M8.15          |
| ISL32457EIUZ                | 2457E           | -40 to +85          | -                                 | 8 Ld MSOP                   | M8.118         |
| ISL32457EIUZ-T              | 2457E           | -40 to +85          | 2.5k                              | 8 Ld MSOP                   | M8.118         |
| ISL32457EIUZ-T7A            | 2457E           | -40 to +85          | 250                               | 8 Ld MSOP                   | M8.118         |
| ISL32458EIBZ                | 32458 EIBZ      | -40 to +85          | -                                 | 8 Ld SOIC                   | M8.15          |
| ISL32458EIBZ-T              | 32458 EIBZ      | -40 to +85          | 2.5k                              | 8 Ld SOIC                   | M8.15          |
| ISL32458EIBZ-T7A            | 32458 EIBZ      | -40 to +85          | 250                               | 8 Ld SOIC                   | M8.15          |

## Ordering Information (Continued)

| PART NUMBER<br>(Notes 2, 3) | PART MARKING | TEMP. RANGE<br>(°C) | TAPE AND REEL<br>(Units) (Note 1) | PACKAGE<br>(RoHS Compliant) | PKG.<br>DWG. # |
|-----------------------------|--------------|---------------------|-----------------------------------|-----------------------------|----------------|
| ISL32459EIBZ                | 32459 EIBZ   | -40 to +85          | -                                 | 8 Ld SOIC                   | M8.15          |
| ISL32459EIBZ-T              | 32459 EIBZ   | -40 to +85          | 2.5k                              | 8 Ld SOIC                   | M8.15          |
| ISL32459EIBZ-T7A            | 32459 EIBZ   | -40 to +85          | 250                               | 8 Ld SOIC                   | M8.15          |

NOTES:

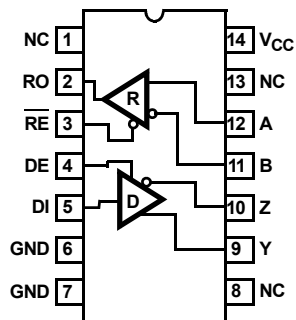
- See [TB347](#) for details about reel specifications.
- These Pb-free plastic packaged products employ special Pb-free material sets, molding compounds/die attach materials, and 100% matte tin plate plus anneal (e3 termination finish, which is RoHS compliant and compatible with both SnPb and Pb-free soldering operations). 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.
- For Moisture Sensitivity Level (MSL), see the [ISL32450E](#), [ISL32452E](#), [ISL32453E](#), [ISL32455E](#), [ISL32457E](#), [ISL32458E](#), [ISL32459E](#) device pages. For more information about MSL, see [TB363](#).

TABLE 1. SUMMARY OF FEATURES

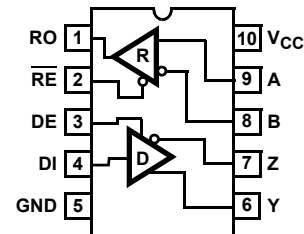
| PART NUMBER | HALF/FULL DUPLEX | DATA RATE (Mbps) | SLEW-RATE LIMITED? | EN PINS? | HOT PLUG | CABLE INVERT (INV) PIN? | QUIESCENT I <sub>CC</sub> (mA) | LOW POWER SHUTDOWN? | PIN COUNT |
|-------------|------------------|------------------|--------------------|----------|----------|-------------------------|--------------------------------|---------------------|-----------|
| ISL32450E   | Full             | 0.25             | Yes                | Yes      | No       | No                      | 2.1                            | Yes                 | 10, 14    |
| ISL32452E   | Half             | 0.25             | Yes                | Yes      | No       | No                      | 2.1                            | Yes                 | 8         |
| ISL32453E   | Full             | 1                | Yes                | Yes      | No       | No                      | 2.1                            | Yes                 | 10, 14    |
| ISL32455E   | Half             | 1                | Yes                | Yes      | No       | No                      | 2.1                            | Yes                 | 8         |
| ISL32457E   | Half             | 0.25             | Yes                | Tx Only  | No       | Yes                     | 2.1                            | No                  | 8         |
| ISL32458E   | Half             | 20               | No                 | Yes      | No       | No                      | 2.1                            | Yes                 | 8         |
| ISL32459E   | Half             | 20               | No                 | Tx Only  | No       | Yes                     | 2.1                            | No                  | 8         |

## Pin Configurations

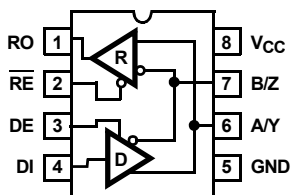
ISL32450E, ISL32453E  
(14 LD SOIC)  
TOP VIEW



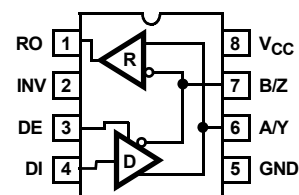
ISL32450E, ISL32453E  
(10 LD MSOP)  
TOP VIEW



ISL32452E, ISL32455E, ISL32458E  
(8 LD SOIC, 8 LD MSOP)  
TOP VIEW



ISL32457E, ISL32459E  
(8 LD SOIC, 8 LD MSOP)  
TOP VIEW



NOTE: Evaluate creepage and clearance requirements at your maximum fault voltage before using small pitch packages, such as MSOP.

## Pin Descriptions

| PIN NAME        | ISL32450E,<br>ISL32453E,<br>(14 LD SOIC)<br>PIN # | ISL32450E,<br>ISL32453E,<br>(10 LD MSOP)<br>PIN # | ISL32452E,<br>ISL32455E,<br>ISL32458E<br>(8 LD SOIC,<br>8 LD MSOP)<br>PIN # | ISL32457E,<br>ISL32459E<br>(8 LD SOIC,<br>8 LD MSOP)<br>PIN # | FUNCTION  |
|-----------------|---|---|---|---|---|
| RO              | 2   | 1   | 1   | 1   | Receiver output. For parts without the cable invert function - or if INV is low - then: If A - B $\geq$ -10mV, RO is high; if A - B $\leq$ -200mV, RO is low. If INV is high, then: If B - A $\geq$ -10mV, RO is high; if B - A $\leq$ -200mV, RO is low. In all cases, RO = High if A and B are unconnected (floating), or shorted together, or connected to an undriven, terminated bus (that is, Rx is always fail-safe open, shorted and idle, even if polarity is inverted). |
| $\overline{RE}$ | 3   | 2   | 2   | N/A   | Receiver output enable. RO is enabled when $\overline{RE}$ is low; RO is high impedance when $\overline{RE}$ is high. Internally pulled low.  |
| DE              | 4   | 3   | 3   | 3   | Driver output enable. The driver outputs, Y and Z, are enabled by bringing DE high and they are high impedance when DE is low. Internally pulled high.  |
| DI              | 5   | 4   | 4   | 4   | Driver input. For parts without the cable invert function - or if INV is low - a low on DI forces output Y low and output Z high, while a high on DI forces output Y high and output Z low. The output states, relative to DI, invert if INV is high.   |
| GND             | 6, 7  | 5   | 5   | 5   | Ground connection.  |
| A/Y             | N/A   | N/A   | 6   | 6   | $\pm$ 60V fault protected and $\pm$ 16.5kV ESD protected RS-485/RS-422 I/O pin. For parts without the cable invert function - or if INV is low - A/Y is the noninverting receiver input and noninverting driver output. If INV is high, A/Y is the inverting receiver input and the inverting driver output. Pin is an input if DE = 0; pin is an output if DE = 1.   |
| B/Z             | N/A   | N/A   | 7   | 7   | $\pm$ 60V fault protected and $\pm$ 16.5kV ESD protected RS-485/RS-422 I/O pin. For parts without the cable invert function - or if INV is low - B/Z is the inverting receiver input and inverting driver output. If INV is high, B/Z is the noninverting receiver input and the noninverting driver output. Pin is an input if DE = 0; pin is an output if DE = 1.   |
| A               | 12  | 9   | N/A   | N/A   | $\pm$ 60V fault protected and $\pm$ 15kV ESD protected RS-485/RS-422 noninverting receiver input.   |
| B               | 11  | 8   | N/A   | N/A   | $\pm$ 60V fault protected and $\pm$ 15kV ESD protected RS-485/RS-422 inverting receiver input.  |
| Y               | 9   | 6   | N/A   | N/A   | $\pm$ 60V fault protected and $\pm$ 15kV ESD protected RS-485/RS-422 noninverting driver output.  |
| Z               | 10  | 7   | N/A   | N/A   | $\pm$ 60V fault protected and $\pm$ 15kV ESD protected RS-485/RS-422 inverting driver output.   |
| V <sub>CC</sub> | 14  | 10  | 8   | 8   | System power supply input (3V to 5.5V).   |
| INV             | N/A   | N/A   | N/A   | 2   | Receiver and driver cable invert (polarity selection) input. When driven high this pin swaps the polarity of the driver output and receiver input pins. If unconnected (floating) or connected low, normal RS-485 polarity conventions apply. Internally pulled low.  |
| NC              | 1, 8, 13  | N/A   | N/A   | N/A   | No internal connection.   |

## Truth Tables

| TRANSMITTING    |    |    |              |                 |                 |
|-----------------|----|----|--------------|-----------------|-----------------|
| INPUTS          |    |    |              | OUTPUTS         |                 |
| $\overline{RE}$ | DE | DI | INV (Note 4) | Y               | Z               |
| X               | 1  | 1  | 0            | 1               | 0               |
| X               | 1  | 0  | 0            | 0               | 1               |
| X               | 1  | 1  | 1            | 0               | 1               |
| X               | 1  | 0  | 1            | 1               | 0               |
| 0               | 0  | X  | X            | High-Z          | High-Z          |
| 1               | 0  | X  | X            | High-Z (Note 5) | High-Z (Note 5) |

NOTES:

- Parts without the INV pin follow the rows with INV = "0" and "X".
- Low Power Shutdown mode (see [Notes 14](#) and [19](#)).

| RECEIVING                 |                |                |                           |              |                 |
|---------------------------|----------------|----------------|---------------------------|--------------|-----------------|
| INPUTS                    |                |                |                           |              | OUTPUT          |
| $\overline{RE}$ (Note 19) | DE Half Duplex | DE Full Duplex | A-B                       | INV (Note 4) | RO              |
| 0                         | 0              | X              | $V_{AB} \geq -0.01V$      | 0            | 1               |
| 0                         | 0              | X              | $-0.01V > V_{AB} > -0.2V$ | 0            | Undetermined    |
| 0                         | 0              | X              | $V_{AB} \leq -0.2V$       | 0            | 0               |
| 0                         | 0              | X              | $V_{AB} \leq 0.01V$       | 1            | 1               |
| 0                         | 0              | X              | $0.01V < V_{AB} < 0.2V$   | 1            | Undetermined    |
| 0                         | 0              | X              | $\geq 0.2V$               | 1            | 0               |
| 0                         | 0              | X              | Inputs Open or Shorted    | X            | 1               |
| 1                         | 0              | 0              | X                         | X            | High-Z (Note 5) |
| 1                         | 1              | 1              | X                         | X            | High-Z          |

## Absolute Maximum Ratings

|   |   |
|---|---|
| V <sub>CC</sub> to Ground                               | 7V  |
| Input Voltages  |   |
| DI, DE, RE, INV   | -0.3V to V <sub>CC</sub> + 0.3V                                   |
| Input/Output Voltages                                   |   |
| A/Y, B/Z, A, B, Y, Z                                    | ±60V  |
| A/Y, B/Z, A, B, Y, Z                                    |   |
| (Transient Pulse Through 100Ω, <a href="#">Note 6</a> ) | ±80V  |
| RO  | -0.3V to (V <sub>CC</sub> + 0.3V)                                 |
| Short-Circuit Duration                                  |   |
| Y, Z  | Indefinite  |
| ESD Rating  | see " <a href="#">ESD PERFORMANCE</a> " on <a href="#">page 8</a> |
| Latch-Up (per JESD78, Level 2, Class A)                 | +125°C  |

## Thermal Information

|   |                           |                        |
|---|---------------------------|------------------------|
| Thermal Resistance (Typical)                      | θ <sub>JA</sub> (°C/W)    | θ <sub>JC</sub> (°C/W) |
| 8 Ld SOIC Package ( <a href="#">Notes 7, 8</a> )  | 108                       | 47                     |
| 8 Ld MSOP Package ( <a href="#">Notes 7, 8</a> )  | 140                       | 40                     |
| 10 Ld MSOP Package ( <a href="#">Notes 7, 8</a> ) | 135                       | 50                     |
| 14 Ld SOIC Package ( <a href="#">Notes 7, 8</a> ) | 88                        | 39                     |
| Maximum Junction Temperature (Plastic Package)    | +150°C                    |                        |
| Maximum Storage Temperature Range                 | -65°C to +150°C           |                        |
| Pb-Free Reflow Profile                            | see <a href="#">TB493</a> |                        |

## Recommended Operating Conditions

|                                   |                |
|-----------------------------------|----------------|
| Supply Voltage (V <sub>CC</sub> ) | 3.3V or 5V     |
| Temperature Range                 | -40°C to +85°C |
| Bus Pin Common-Mode Voltage Range | -20V to +20V   |

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

### NOTES:

- Tested according to TIA/EIA-485-A, Section 4.2.6 (±80V for 15μs at a 1% duty cycle).
- θ<sub>JA</sub> is measured with the component mounted on a high-effective thermal conductivity test board in free air. See [TB379](#) for details.
- For θ<sub>JC</sub>, the "case temp" location is taken at the package top center.

**Electrical Specifications** Test Conditions: V<sub>CC</sub> = 3V to 3.6V and 4.5V to 5.5V, unless otherwise specified. Typical values are at the worst case of V<sub>CC</sub> = 5V or V<sub>CC</sub> = 3.3V, T<sub>A</sub> = +25°C ([Note 9](#)). **Boldface limits apply across the operating temperature range, -40°C to +85°C.**

| PARAMETER   | SYMBOL            | TEST CONDITIONS  | TEMP (°C)              | MIN ( <a href="#">Note 17</a> ) | TYP        | MAX ( <a href="#">Note 17</a> ) | UNIT                  |   |
|---|-------------------|--|------------------------|---------------------------------|------------|---------------------------------|-----------------------|---|
| <b>DC CHARACTERISTICS</b>   |                   |  |                        |                                 |            |                                 |                       |   |
| Driver Differential V <sub>OUT</sub> (No load)  | V <sub>OD1</sub>  |  | Full                   | -                               | -          | <b>V<sub>CC</sub></b>           | V                     |   |
| Driver Differential V <sub>OUT</sub> (Loaded, <a href="#">Figure 6A</a> )                   | V <sub>OD2</sub>  | R <sub>L</sub> = 100Ω (RS-422), V <sub>CC</sub> ≥ 4.5V                         | Full                   | <b>2</b>                        | 3          | -                               | V                     |   |
|   |                   | R <sub>L</sub> = 54Ω (RS-485)  | V <sub>CC</sub> ≥ 4.5V | Full                            | <b>1.7</b> | 2.3                             | <b>V<sub>CC</sub></b> | V |
|   |                   |  | V <sub>CC</sub> ≥ 3V   | Full                            | <b>1.1</b> | 1.3                             | <b>V<sub>CC</sub></b> | V |
| Change in Magnitude of Driver Differential V <sub>OUT</sub> for Complementary Output States | ΔV <sub>OD</sub>  | R <sub>L</sub> = 54Ω or 100Ω ( <a href="#">Figure 6A</a> )                     | Full                   | -                               | -          | <b>0.2</b>                      | V                     |   |
| Driver Differential V <sub>OUT</sub> with Common-Mode Load ( <a href="#">Figure 6B</a> )    | V <sub>OD3</sub>  | R <sub>L</sub> = 60Ω, -20V ≤ V <sub>CM</sub> ≤ 20V, V <sub>CC</sub> ≥ 4.5V     | Full                   | <b>1.5</b>                      | -          | -                               | V                     |   |
| Driver Common-Mode V <sub>OUT</sub> ( <a href="#">Figure 6A</a> )                           | V <sub>OC</sub>   | R <sub>L</sub> = 54Ω or 100Ω   | Full                   | <b>-1</b>                       | -          | <b>3</b>                        | V                     |   |
| Change in Magnitude of Driver Common-Mode V <sub>OUT</sub> for Complementary Output States  | ΔV <sub>OC</sub>  | R <sub>L</sub> = 54Ω or 100Ω ( <a href="#">Figure 6A</a> )                     | Full                   | -                               | -          | <b>0.2</b>                      | V                     |   |
| Driver Short-Circuit Current  | I <sub>OSD</sub>  | DE = V <sub>CC</sub> , -20V ≤ V <sub>O</sub> ≤ 20V ( <a href="#">Note 11</a> ) | Full                   | <b>-250</b>                     | -          | <b>250</b>                      | mA                    |   |
|   | I <sub>OSD1</sub> | At first foldback, 24V ≤ V <sub>O</sub> ≤ -24V                                 | Full                   | <b>-83</b>                      | -          | <b>83</b>                       | mA                    |   |
|   | I <sub>OSD2</sub> | At second foldback, 35V ≤ V <sub>O</sub> ≤ -35V                                | Full                   | <b>-13</b>                      | -          | <b>13</b>                       | mA                    |   |
| Logic Input High Voltage  | V <sub>IH</sub>   | DE, DI, RE, INV (See <a href="#">Figure 33</a> )                               | Full                   | <b>2.35</b>                     | -          | -                               | V                     |   |
| Logic Input Low Voltage   | V <sub>IL</sub>   | DE, DI, RE, INV  | Full                   | -                               | -          | <b>0.8</b>                      | V                     |   |
| Logic Input Current   | I <sub>IN1</sub>  | DI   | Full                   | <b>-1</b>                       | -          | <b>1</b>                        | μA                    |   |
|   |                   | DE, RE, INV  | Full                   | <b>-15</b>                      | 6          | <b>15</b>                       | μA                    |   |

**Electrical Specifications** Test Conditions:  $V_{CC} = 3V$  to  $3.6V$  and  $4.5V$  to  $5.5V$ , unless otherwise specified. Typicals are at the worst case of  $V_{CC} = 5V$  or  $V_{CC} = 3.3V$ ,  $T_A = +25^\circ C$  (Note 9). **Boldface limits apply across the operating temperature range,  $-40^\circ C$  to  $+85^\circ C$ .** (Continued)

| PARAMETER   | SYMBOL          | TEST CONDITIONS  | TEMP (°C)  | MIN (Note 17) | TYP         | MAX (Note 17)               | UNIT       |         |
|---|-----------------|--|--|---------------|-------------|-----------------------------|------------|---------|
| Input/Output Current (A/Y, B/Z)                                   | $I_{IN2}$       | DE = 0V, $V_{CC} = 0V$ or $3.6V$ or $5.5V$   | $V_{IN} = 12V$                                       | Full          | -           | -                           | <b>250</b> | $\mu A$ |
|   |                 |  | $V_{IN} = -7V$                                       | Full          | <b>-200</b> | -                           | -          | $\mu A$ |
|   |                 |  | $V_{IN} = \pm 20V$                                   | Full          | <b>-800</b> | -                           | <b>850</b> | $\mu A$ |
|   |                 |  | $V_{IN} = \pm 60V$ , (Note 18)                       | Full          | <b>-6</b>   | -                           | <b>6</b>   | mA      |
| Input Current (A, B)<br>(Full Duplex Versions Only)               | $I_{IN3}$       | $V_{CC} = 0V$ or $3.6V$ or $5.5V$  | $V_{IN} = 12V$                                       | Full          | -           | -                           | <b>125</b> | $\mu A$ |
|   |                 |  | $V_{IN} = -7V$                                       | Full          | <b>-100</b> | -                           | -          | $\mu A$ |
|   |                 |  | $V_{IN} = \pm 20V$                                   | Full          | <b>-500</b> | -                           | <b>500</b> | $\mu A$ |
|   |                 |  | $V_{IN} = \pm 60V$ , (Note 18)                       | Full          | <b>-3</b>   | -                           | <b>3</b>   | mA      |
| Output Leakage Current (Y, Z)<br>(Full Duplex Versions Only)      | $I_{OZD}$       | $\overline{RE} = 0V$ , DE = 0V, $V_{CC} = 0V$ or $3.6V$ or $5.5V$  | $V_{IN} = 12V$                                       | Full          | -           | -                           | <b>200</b> | $\mu A$ |
|   |                 |  | $V_{IN} = -7V$                                       | Full          | <b>-100</b> | -                           | -          | $\mu A$ |
|   |                 |  | $V_{IN} = \pm 20V$                                   | Full          | <b>-500</b> | -                           | <b>500</b> | $\mu A$ |
|   |                 |  | $V_{IN} = \pm 60V$ , (Note 18)                       | Full          | <b>-3</b>   | -                           | <b>3</b>   | mA      |
| Receiver Differential Threshold Voltage                           | $V_{TH}$        | $-20V \leq V_{CM} \leq 20V$ ,<br>(For ISL32457E and ISL32459E only, A-B if INV = 0; B-A if INV = 1)        | $V_{CC} \leq 3.6V$                                   | Full          | <b>-200</b> | -120                        | <b>-10</b> | mV      |
|   |                 |  | $V_{CC} \geq 4.5V$                                   | Full          | <b>-250</b> | -180                        | <b>-10</b> | mV      |
| Receiver Input Hysteresis   | $\Delta V_{TH}$ | $-20V \leq V_{CM} \leq 20V$  | +25  | -             | 30          | -                           | mV         |         |
| Receiver Output High Voltage                                      | $V_{OH1}$       | $V_{ID} = -10mV$   | $I_O = -4mA$ , $V_{CC} \geq 3V$                      | Full          | <b>2.4</b>  | -                           | -          | V       |
|   | $V_{OH2}$       |  | $I_O = -8mA$ , $V_{CC} \geq 4.5V$                    | Full          | <b>2.4</b>  | -                           | -          | V       |
| Receiver Output Low Voltage                                       | $V_{OL}$        | $I_O = 4mA$ , $V_{CC} \geq 3V$ , $V_{ID} = -200mV$   |  | Full          | -           | -                           | <b>0.4</b> | V       |
|   |                 |  | $I_O = 5mA$ , $V_{CC} \geq 4.5V$ , $V_{ID} = -250mV$ | Full          | -           | -                           | <b>0.4</b> | V       |
| Three-State (High Impedance)<br>Receiver Output Current (Note 19) | $I_{OZR}$       | $0V \leq V_O \leq V_{CC}$  | Full   | <b>-1</b>     | 0.01        | <b>1</b>                    | $\mu A$    |         |
| Receiver Short-Circuit Current                                    | $I_{OSR}$       | $0V \leq V_O \leq V_{CC}$  | Full   | -             | -           | <b><math>\pm 115</math></b> | mA         |         |
| <b>SUPPLY CURRENT</b>   |                 |  |  |               |             |                             |            |         |
| No-Load Supply Current (Note 10)                                  | $I_{CC}$        | DE = $V_{CC}$ , $\overline{RE} = 0V$ or $V_{CC}$ , DI = 0V or $V_{CC}$                                     | Full   | -             | 2.1         | <b>4.5</b>                  | mA         |         |
| Shutdown Supply Current (Note 19)                                 | $I_{SHDN}$      | DE = 0V, $\overline{RE} = V_{CC}$ , DI = 0V or $V_{CC}$  | Full   | -             | 10          | <b>35</b>                   | $\mu A$    |         |
| <b>ESD PERFORMANCE</b>  |                 |  |  |               |             |                             |            |         |
| All Pins  |                 | Human Body Model<br>(ISL32450E, ISL32452E, ISL32453E,<br>ISL32455E, ISL32457E; Tested per<br>JESD22-A114E) | +25  | -             | $\pm 8$     | -                           | kV         |         |
|   |                 |  | +25  | -             | $\pm 3$     | -                           | kV         |         |
|   |                 |  | +25  | -             | $\pm 700$   | -                           | V          |         |
| RS-485 Pins (A, B, Y, Z,<br>A/Y, B/Z)                             |                 | Human Body Model,<br>from Bus Pins to GND  | Full Duplex  | +25           | -           | $\pm 15$                    | -          | kV      |
|   |                 |  | Half Duplex  | +25           | -           | $\pm 16.5$                  | -          | kV      |



**Electrical Specifications** Test Conditions:  $V_{CC} = 3V$  to  $3.6V$  and  $4.5V$  to  $5.5V$ , unless otherwise specified. Typicals are at the worst case of  $V_{CC} = 5V$  or  $V_{CC} = 3.3V$ ,  $T_A = +25^\circ C$  (Note 9). **Boldface limits apply across the operating temperature range,  $-40^\circ C$  to  $+85^\circ C$ .** (Continued)

| PARAMETER   | SYMBOL             | TEST CONDITIONS                              | TEMP<br>( $^\circ C$ ) | MIN<br>(Note 17) | TYP | MAX<br>(Note 17) | UNIT |
|---|--------------------|--|------------------------|------------------|-----|------------------|------|
| <b>DRIVER SWITCHING CHARACTERISTICS (250kbps VERSIONS; ISL32450E, ISL32452E, ISL32457E)</b> |                    |  |                        |                  |     |                  |      |
| Driver Differential Output Delay  | $t_{PLH}, t_{PHL}$ | $R_D = 54\Omega, C_D = 50pF$ (Figure 7)      | Full                   | -                | 280 | <b>1000</b>      | ns   |
| Driver Differential Output Skew   | $t_{SKEW}$         | $R_D = 54\Omega, C_D = 50pF$ (Figure 7)      | Full                   | -                | 4   | <b>100</b>       | ns   |
| Driver Differential Rise or Fall Time   | $t_R, t_F$         | $R_D = 54\Omega, C_D = 50pF$ (Figure 7)      | Full                   | <b>250</b>       | 650 | <b>1500</b>      | ns   |
| Maximum Data Rate   | $f_{MAX}$          | $C_D = 820pF$ (Figure 9)                     | Full                   | <b>250</b>       | -   | -                | kbps |
| Driver Enable to Output High  | $t_{ZH}$           | SW = GND (Figure 8), (Note 12)               | Full                   | -                | -   | <b>1600</b>      | ns   |
| Driver Enable to Output Low   | $t_{ZL}$           | SW = $V_{CC}$ (Figure 8), (Note 12)          | Full                   | -                | -   | <b>1600</b>      | ns   |
| Driver Disable from Output Low  | $t_{LZ}$           | SW = $V_{CC}$ (Figure 8)                     | Full                   | -                | -   | <b>300</b>       | ns   |
| Driver Disable from Output High   | $t_{HZ}$           | SW = GND (Figure 8)                          | Full                   | -                | -   | <b>300</b>       | ns   |
| Time to Shutdown  | $t_{SHDN}$         | (Notes 14, 19)                               | Full                   | <b>60</b>        | 160 | <b>600</b>       | ns   |
| Driver Enable from Shutdown to Output High  | $t_{ZH(SHDN)}$     | SW = GND (Figure 8), (Notes 14, 15, 19)      | Full                   | -                | -   | <b>3000</b>      | ns   |
| Driver Enable from Shutdown to Output Low   | $t_{ZL(SHDN)}$     | SW = $V_{CC}$ (Figure 8), (Notes 14, 15, 19) | Full                   | -                | -   | <b>3000</b>      | ns   |
| <b>DRIVER SWITCHING CHARACTERISTICS (1Mbps VERSIONS; ISL32453E, ISL32455E)</b>              |                    |  |                        |                  |     |                  |      |
| Driver Differential Output Delay  | $t_{PLH}, t_{PHL}$ | $R_D = 54\Omega, C_D = 50pF$ (Figure 7)      | Full                   | -                | 70  | <b>200</b>       | ns   |
| Driver Differential Output Skew   | $t_{SKEW}$         | $R_D = 54\Omega, C_D = 50pF$ (Figure 7)      | Full                   | -                | 4   | <b>25</b>        | ns   |
| Driver Differential Rise or Fall Time   | $t_R, t_F$         | $R_D = 54\Omega, C_D = 50pF$ (Figure 7)      | Full                   | <b>50</b>        | 130 | <b>300</b>       | ns   |
| Maximum Data Rate   | $f_{MAX}$          | $C_D = 820pF$ (Figure 9)                     | Full                   | <b>1</b>         | -   | -                | Mbps |
| Driver Enable to Output High  | $t_{ZH}$           | SW = GND (Figure 8), (Note 12)               | Full                   | -                | -   | <b>300</b>       | ns   |
| Driver Enable to Output Low   | $t_{ZL}$           | SW = $V_{CC}$ (Figure 8), (Note 12)          | Full                   | -                | -   | <b>300</b>       | ns   |
| Driver Disable from Output Low  | $t_{LZ}$           | SW = $V_{CC}$ (Figure 8)                     | Full                   | -                | -   | <b>300</b>       | ns   |
| Driver Disable from Output High   | $t_{HZ}$           | SW = GND (Figure 8)                          | Full                   | -                | -   | <b>300</b>       | ns   |
| Time to Shutdown  | $t_{SHDN}$         | (Note 14)                                    | Full                   | <b>60</b>        | 160 | <b>600</b>       | ns   |
| Driver Enable from Shutdown to Output High  | $t_{ZH(SHDN)}$     | SW = GND (Figure 8), (Notes 14, 15)          | Full                   | -                | -   | <b>3000</b>      | ns   |
| Driver Enable from Shutdown to Output Low   | $t_{ZL(SHDN)}$     | SW = $V_{CC}$ (Figure 8), (Notes 14, 15)     | Full                   | -                | -   | <b>3000</b>      | ns   |
| <b>DRIVER SWITCHING CHARACTERISTICS (20Mbps VERSIONS; ISL32458E, ISL32459E)</b>             |                    |  |                        |                  |     |                  |      |
| Driver Differential Output Delay  | $t_{PLH}, t_{PHL}$ | $R_D = 54\Omega, C_D = 50pF$ (Figure 7)      | Full                   | -                | 28  | <b>45</b>        | ns   |
| Driver Differential Output Skew   | $t_{SKEW}$         | $R_D = 54\Omega, C_D = 50pF$ (Figure 7)      | Full                   | -                | 3   | <b>9</b>         | ns   |
| Driver Differential Rise or Fall Time   | $t_R, t_F$         | $R_D = 54\Omega, C_D = 50pF$ (Figure 7)      | Full                   | -                | 17  | <b>35</b>        | ns   |
| Maximum Data Rate   | $f_{MAX}$          | $C_D = 470pF$ (Figure 9)                     | Full                   | <b>20</b>        | -   | -                | Mbps |
| Driver Enable to Output High  | $t_{ZH}$           | SW = GND (Figure 8), (Note 12)               | Full                   | -                | -   | <b>180</b>       | ns   |
| Driver Enable to Output Low   | $t_{ZL}$           | SW = $V_{CC}$ (Figure 8), (Note 12)          | Full                   | -                | -   | <b>180</b>       | ns   |
| Driver Disable from Output Low  | $t_{LZ}$           | SW = $V_{CC}$ (Figure 8)                     | Full                   | -                | -   | <b>300</b>       | ns   |
| Driver Disable from Output High   | $t_{HZ}$           | SW = GND (Figure 8)                          | Full                   | -                | -   | <b>300</b>       | ns   |
| Time to Shutdown  | $t_{SHDN}$         | (Notes 14, 19)                               | Full                   | <b>60</b>        | 160 | <b>600</b>       | ns   |
| Driver Enable from Shutdown to Output High  | $t_{ZH(SHDN)}$     | SW = GND (Figure 8), (Notes 14, 15, 19)      | Full                   | -                | -   | <b>3000</b>      | ns   |

**Electrical Specifications** Test Conditions:  $V_{CC} = 3V$  to  $3.6V$  and  $4.5V$  to  $5.5V$ , unless otherwise specified. Typical values are at the worst case of  $V_{CC} = 5V$  or  $V_{CC} = 3.3V$ ,  $T_A = +25^\circ C$  (Note 9). **Boldface limits apply across the operating temperature range,  $-40^\circ C$  to  $+85^\circ C$ .** (Continued)

| PARAMETER   | SYMBOL             | TEST CONDITIONS   | TEMP<br>( $^\circ C$ ) | MIN<br>(Note 17) | TYP | MAX<br>(Note 17) | UNIT |
|---|--------------------|---|------------------------|------------------|-----|------------------|------|
| Driver Enable from Shutdown to Output Low   | $t_{ZL}(SHDN)$     | $SW = V_{CC}$ (Figure 8), (Notes 14, 15, 19)                              | Full                   | -                | -   | <b>3000</b>      | ns   |
| <b>RECEIVER SWITCHING CHARACTERISTICS (250kbps VERSIONS; ISL32450E, ISL32452E, ISL32457E)</b> |                    |   |                        |                  |     |                  |      |
| Maximum Data Rate   | $f_{MAX}$          | (Figure 10)   | Full                   | <b>250</b>       | -   | -                | kbps |
| Receiver Input to Output Delay  | $t_{PLH}, t_{PHL}$ | (Figure 10)   | Full                   | -                | 240 | <b>325</b>       | ns   |
| Receiver Skew   $t_{PLH} - t_{PHL}$   | $t_{SKD}$          | (Figure 10)   | Full                   | -                | 6   | <b>25</b>        | ns   |
| Receiver Enable to Output Low   | $t_{ZL}$           | $R_L = 1k\Omega, C_L = 15pF, SW = V_{CC}$ (Figure 11), (Notes 13, 19)     | Full                   | -                | -   | <b>80</b>        | ns   |
| Receiver Enable to Output High  | $t_{ZH}$           | $R_L = 1k\Omega, C_L = 15pF, SW = GND$ (Figure 11), (Notes 13, 19)        | Full                   | -                | -   | <b>80</b>        | ns   |
| Receiver Disable from Output Low  | $t_{LZ}$           | $R_L = 1k\Omega, C_L = 15pF, SW = V_{CC}$ (Figure 11), (Note 19)          | Full                   | -                | -   | <b>80</b>        | ns   |
| Receiver Disable from Output High   | $t_{HZ}$           | $R_L = 1k\Omega, C_L = 15pF, SW = GND$ (Figure 11), (Note 19)             | Full                   | -                | -   | <b>80</b>        | ns   |
| Time to Shutdown  | $t_{SHDN}$         | (Notes 14, 19)  | Full                   | <b>60</b>        | 160 | <b>600</b>       | ns   |
| Receiver Enable from Shutdown to Output High  | $t_{ZH}(SHDN)$     | $R_L = 1k\Omega, C_L = 15pF, SW = GND$ (Figure 11), (Notes 14, 16, 19)    | Full                   | -                | -   | <b>2500</b>      | ns   |
| Receiver Enable from Shutdown to Output Low   | $t_{ZL}(SHDN)$     | $R_L = 1k\Omega, C_L = 15pF, SW = V_{CC}$ (Figure 11), (Notes 14, 16, 19) | Full                   | -                | -   | <b>2500</b>      | ns   |
| <b>RECEIVER SWITCHING CHARACTERISTICS (1Mbps VERSIONS; ISL32453E, ISL32455E)</b>              |                    |   |                        |                  |     |                  |      |
| Maximum Data Rate   | $f_{MAX}$          | (Figure 10)   | Full                   | <b>1</b>         | -   | -                | Mbps |
| Receiver Input to Output Delay  | $t_{PLH}, t_{PHL}$ | (Figure 10)   | Full                   | -                | 115 | <b>200</b>       | ns   |
| Receiver Skew   $t_{PLH} - t_{PHL}$   | $t_{SKD}$          | (Figure 10)   | Full                   | -                | 4   | <b>20</b>        | ns   |
| Receiver Enable to Output Low   | $t_{ZL}$           | $R_L = 1k\Omega, C_L = 15pF, SW = V_{CC}$ (Figure 11), (Note 13)          | Full                   | -                | -   | <b>80</b>        | ns   |
| Receiver Enable to Output High  | $t_{ZH}$           | $R_L = 1k\Omega, C_L = 15pF, SW = GND$ (Figure 11), (Note 13)             | Full                   | -                | -   | <b>80</b>        | ns   |
| Receiver Disable from Output Low  | $t_{LZ}$           | $R_L = 1k\Omega, C_L = 15pF, SW = V_{CC}$ (Figure 11)                     | Full                   | -                | -   | <b>80</b>        | ns   |
| Receiver Disable from Output High   | $t_{HZ}$           | $R_L = 1k\Omega, C_L = 15pF, SW = GND$ (Figure 11)                        | Full                   | -                | -   | <b>80</b>        | ns   |
| Time to Shutdown  | $t_{SHDN}$         | (Note 14)   | Full                   | <b>60</b>        | 160 | <b>600</b>       | ns   |
| Receiver Enable from Shutdown to Output High  | $t_{ZH}(SHDN)$     | $R_L = 1k\Omega, C_L = 15pF, SW = GND$ (Figure 11), (Notes 14, 16)        | Full                   | -                | -   | <b>2500</b>      | ns   |
| Receiver Enable from Shutdown to Output Low   | $t_{ZL}(SHDN)$     | $R_L = 1k\Omega, C_L = 15pF, SW = V_{CC}$ (Figure 11), (Notes 14, 16)     | Full                   | -                | -   | <b>2500</b>      | ns   |
| <b>RECEIVER SWITCHING CHARACTERISTICS (20Mbps VERSIONS; ISL32458E, ISL32459E)</b>             |                    |   |                        |                  |     |                  |      |
| Maximum Data Rate   | $f_{MAX}$          | (Figure 10)   | Full                   | <b>20</b>        | -   | -                | Mbps |
| Receiver Input to Output Delay  | $t_{PLH}, t_{PHL}$ | (Figure 10)   | Full                   | -                | 40  | <b>80</b>        | ns   |
| Receiver Skew   $t_{PLH} - t_{PHL}$   | $t_{SKD}$          | (Figure 10)   | Full                   | -                | 3   | <b>9</b>         | ns   |
| Receiver Enable to Output Low   | $t_{ZL}$           | $R_L = 1k\Omega, C_L = 15pF, SW = V_{CC}$ (Figure 11), (Notes 13, 19)     | Full                   | -                | -   | <b>80</b>        | ns   |
| Receiver Enable to Output High  | $t_{ZH}$           | $R_L = 1k\Omega, C_L = 15pF, SW = GND$ (Figure 11), (Notes 13, 19)        | Full                   | -                | -   | <b>80</b>        | ns   |
| Receiver Disable from Output Low  | $t_{LZ}$           | $R_L = 1k\Omega, C_L = 15pF, SW = V_{CC}$ (Figure 11), (Note 19)          | Full                   | -                | -   | <b>80</b>        | ns   |

**Electrical Specifications** Test Conditions:  $V_{CC} = 3V$  to  $3.6V$  and  $4.5V$  to  $5.5V$ , unless otherwise specified. Typicals are at the worst case of  $V_{CC} = 5V$  or  $V_{CC} = 3.3V$ ,  $T_A = +25^\circ C$  (Note 9). **Boldface limits apply across the operating temperature range,  $-40^\circ C$  to  $+85^\circ C$ .** (Continued)

| PARAMETER                                    | SYMBOL         | TEST CONDITIONS   | TEMP (°C) | MIN (Note 17) | TYP | MAX (Note 17) | UNIT |
|--|----------------|---|-----------|---------------|-----|---------------|------|
| Receiver Disable from Output High            | $t_{HZ}$       | $R_L = 1k\Omega$ , $C_L = 15pF$ , SW = GND (Figure 11), (Note 19)               | Full      | -             | -   | <b>80</b>     | ns   |
| Time to Shutdown                             | $t_{SHDN}$     | (Notes 14, 19)  | Full      | <b>60</b>     | 160 | <b>600</b>    | ns   |
| Receiver Enable from Shutdown to Output High | $t_{ZH(SHDN)}$ | $R_L = 1k\Omega$ , $C_L = 15pF$ , SW = GND (Figure 11), (Notes 14, 16, 19)      | Full      | -             | -   | <b>2500</b>   | ns   |
| Receiver Enable from Shutdown to Output Low  | $t_{ZL(SHDN)}$ | $R_L = 1k\Omega$ , $C_L = 15pF$ , SW = $V_{CC}$ (Figure 11), (Notes 14, 16, 19) | Full      | -             | -   | <b>2500</b>   | ns   |

**NOTES:**

9. 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.
10. Supply current specification is valid for loaded drivers when DE = 0V.
11. Applies to peak current. See “Typical Performance Curves” beginning on page 13 for more information.
12. Keep  $\overline{RE} = 0$  to prevent the device from entering shutdown (does not apply to the ISL32457E and ISL32459E).
13. The  $\overline{RE}$  signal high time must be short enough (typically <100ns) to prevent the device from entering shutdown.
14. Transceivers 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 ensured not to enter shutdown. If the inputs are in this state for at least 600ns, the parts are ensured to have entered shutdown. See “Low Power Shutdown Mode” on page 19
15. Keep  $\overline{RE} = V_{CC}$ , and set the DE signal low time >600ns to ensure that the device enters shutdown.
16. Set the  $\overline{RE}$  signal high time >600ns to ensure that the device enters shutdown.
17. Compliance to data sheet limits is assured by one or more methods: production test, characterization and/or design.
18. See “Caution” statement following “Absolute Maximum Ratings” on page 7.
19. Does not apply to the ISL32457E and ISL32459E. These transceivers have no Rx enable function, and thus no shutdown function.

## Test Circuits and Waveforms

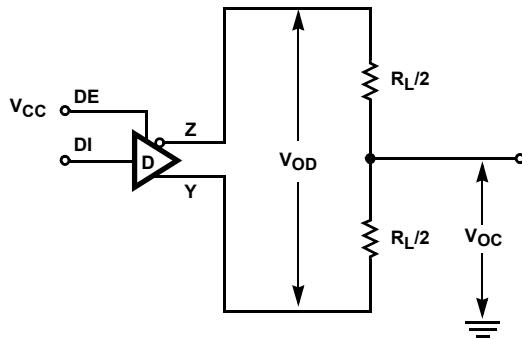


FIGURE 6A.  $V_{OD}$  AND  $V_{OC}$

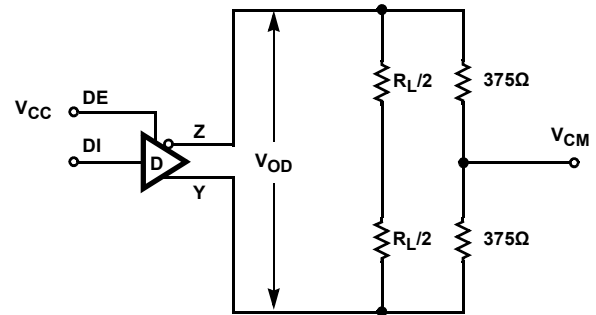


FIGURE 6B.  $V_{OD}$  WITH COMMON-MODE LOAD

FIGURE 6. DC DRIVER TEST CIRCUITS

## Test Circuits and Waveforms (Continued)

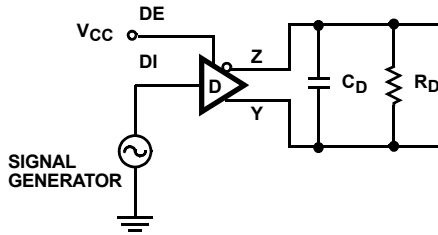


FIGURE 7A. TEST CIRCUIT

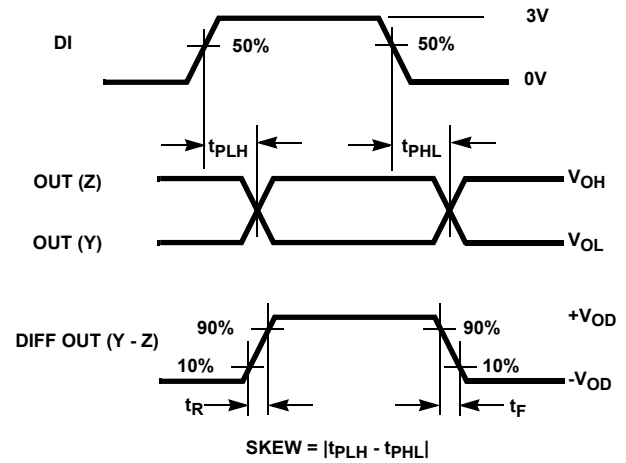


FIGURE 7B. MEASUREMENT POINTS

FIGURE 7. DRIVER PROPAGATION DELAY AND DIFFERENTIAL TRANSITION TIMES

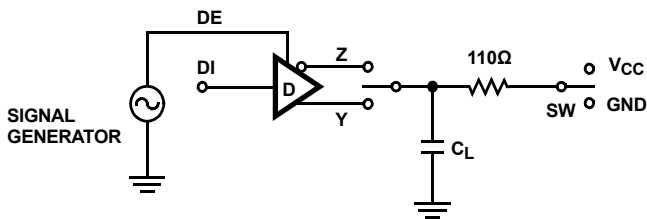


FIGURE 8A. TEST CIRCUIT

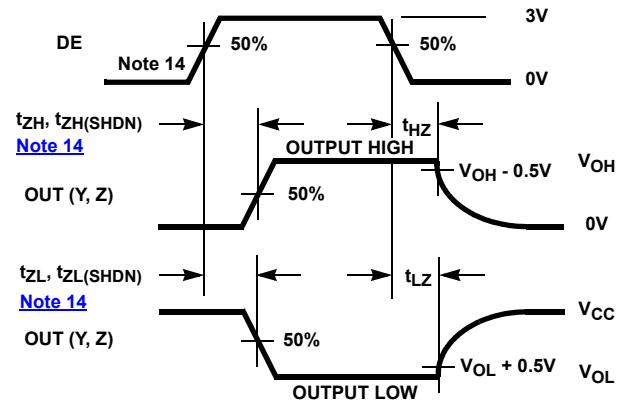


FIGURE 8B. MEASUREMENT POINTS

FIGURE 8. DRIVER ENABLE AND DISABLE TIMES

| PARAMETER      | OUTPUT | $\overline{RE}$ | DI  | SW       | $C_L$ (pF) |
|----------------|--------|-----------------|-----|----------|------------|
| $t_{HZ}$       | Y/Z    | X               | 1/0 | GND      | 50         |
| $t_{LZ}$       | Y/Z    | X               | 0/1 | $V_{CC}$ | 50         |
| $t_{ZH}$       | Y/Z    | 0 (Note 12)     | 1/0 | GND      | 100        |
| $t_{ZL}$       | Y/Z    | 0 (Note 12)     | 0/1 | $V_{CC}$ | 100        |
| $t_{ZH(SHDN)}$ | Y/Z    | 1 (Note 15)     | 1/0 | GND      | 100        |
| $t_{ZL(SHDN)}$ | Y/Z    | 1 (Note 15)     | 0/1 | $V_{CC}$ | 100        |

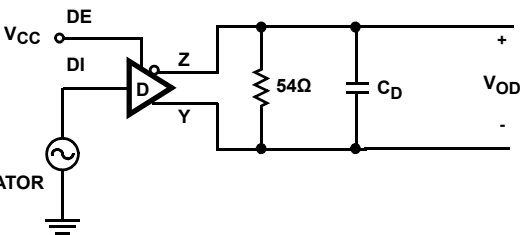


FIGURE 9A. TEST CIRCUIT

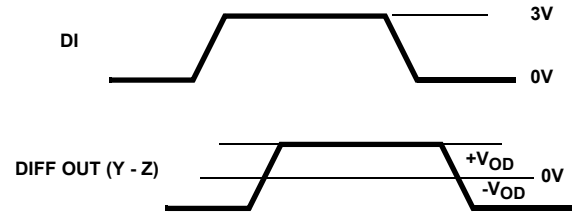


FIGURE 9B. MEASUREMENT POINTS

FIGURE 9. DRIVER DATA RATE

## Test Circuits and Waveforms (Continued)

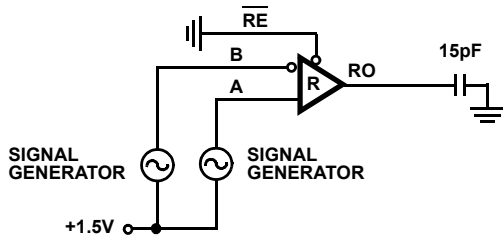


FIGURE 10A. TEST CIRCUIT

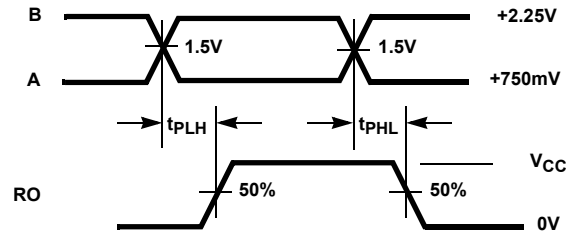
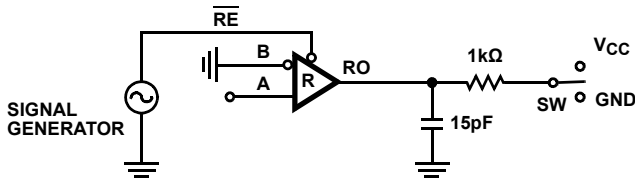


FIGURE 10B. MEASUREMENT POINTS

FIGURE 10. RECEIVER PROPAGATION DELAY AND DATA RATE



| PARAMETER                | DE | A     | SW       |
|--------------------------|----|-------|----------|
| $t_{HZ}$                 | 0  | +1.5V | GND      |
| $t_{LZ}$                 | 0  | -1.5V | $V_{CC}$ |
| $t_{ZH}$ (Note 13)       | 0  | +1.5V | GND      |
| $t_{ZL}$ (Note 13)       | 0  | -1.5V | $V_{CC}$ |
| $t_{ZH(SHDN)}$ (Note 16) | 0  | +1.5V | GND      |
| $t_{ZL(SHDN)}$ (Note 16) | 0  | -1.5V | $V_{CC}$ |

FIGURE 11A. TEST CIRCUIT

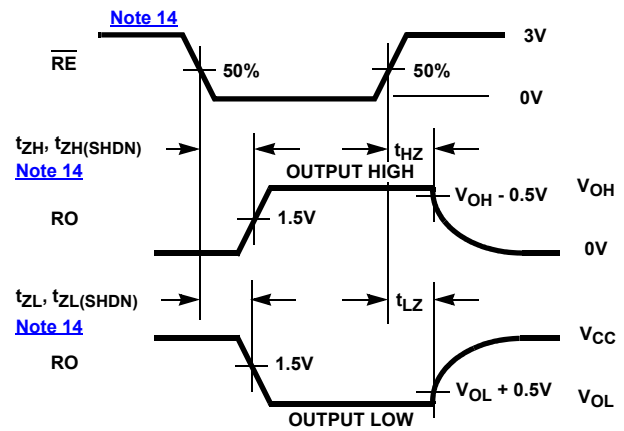


FIGURE 11B. MEASUREMENT POINTS

FIGURE 11. RECEIVER ENABLE AND DISABLE TIMES

## Typical Performance Curves

$T_A = +25^\circ\text{C}$ ; unless otherwise specified.

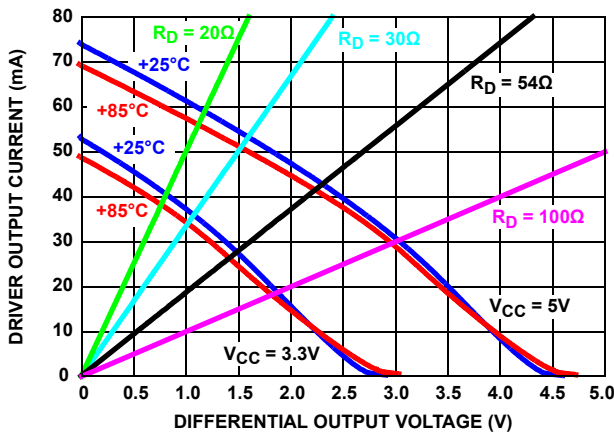


FIGURE 12. DRIVER OUTPUT CURRENT vs DIFFERENTIAL OUTPUT VOLTAGE

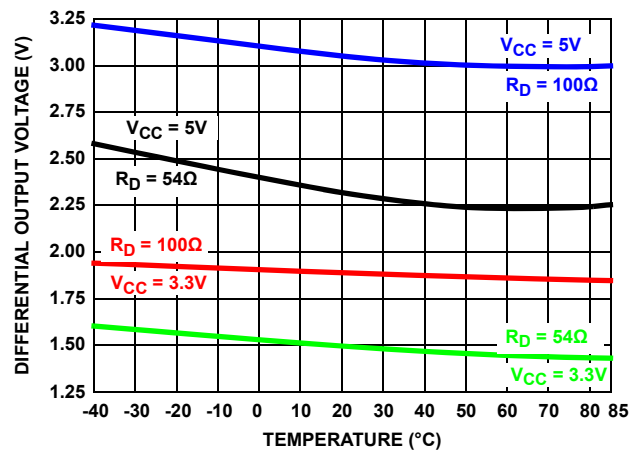


FIGURE 13. DRIVER DIFFERENTIAL OUTPUT VOLTAGE vs TEMPERATURE

**Typical Performance Curves**  $T_A = +25^\circ\text{C}$ ; unless otherwise specified. (Continued)

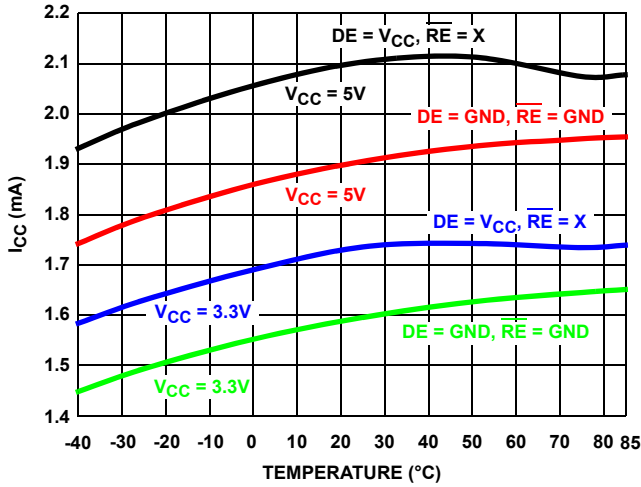


FIGURE 14. SUPPLY CURRENT vs TEMPERATURE

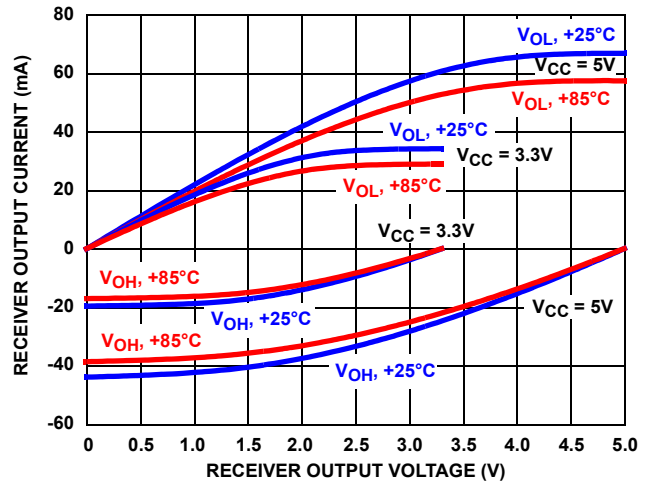


FIGURE 15. RECEIVER OUTPUT CURRENT vs RECEIVER OUTPUT VOLTAGE

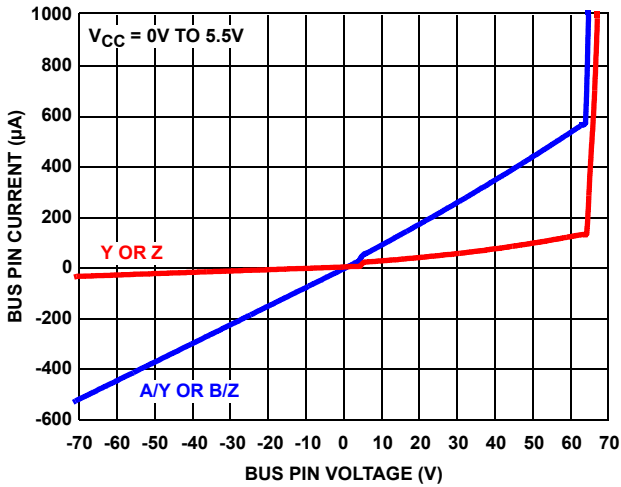


FIGURE 16. BUS PIN CURRENT vs BUS PIN VOLTAGE

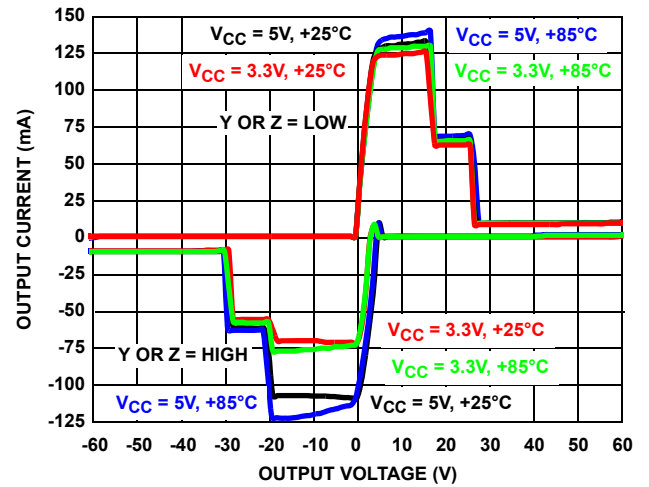


FIGURE 17. DRIVER OUTPUT CURRENT vs SHORT-CIRCUIT VOLTAGE

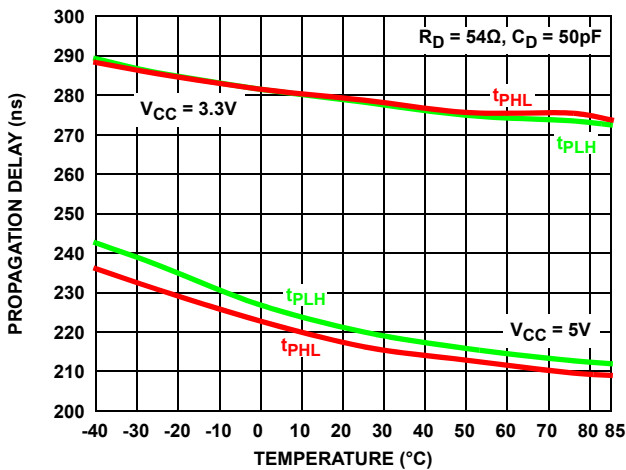


FIGURE 18. DRIVER DIFFERENTIAL PROPAGATION DELAY vs TEMPERATURE (ISL32450E, ISL32452E, ISL32457E)

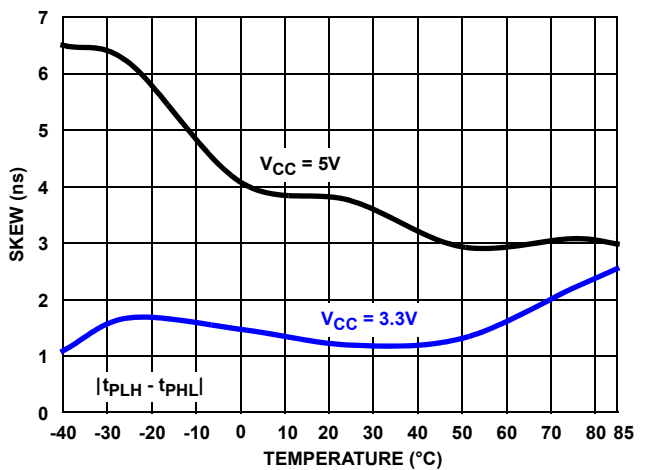


FIGURE 19. DRIVER DIFFERENTIAL SKEW vs TEMPERATURE (ISL32450E, ISL32452E, ISL32457E)

## Typical Performance Curves $T_A = +25^\circ\text{C}$ ; unless otherwise specified. (Continued)

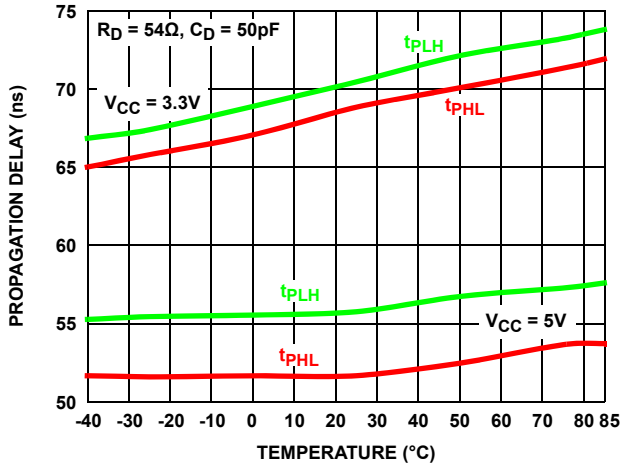


FIGURE 20. DRIVER DIFFERENTIAL PROPAGATION DELAY vs TEMPERATURE (ISL32453E, ISL32455E)

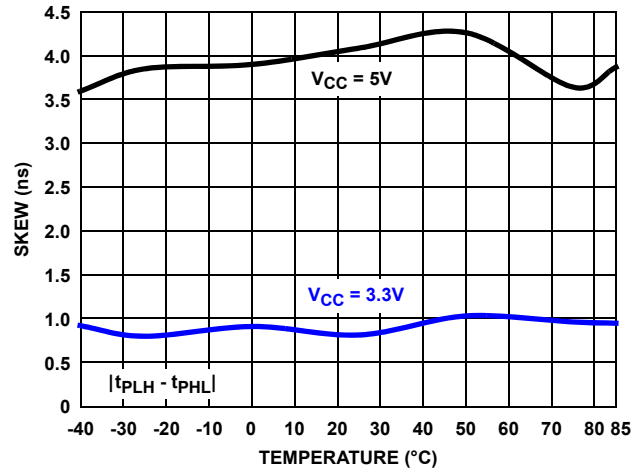


FIGURE 21. DRIVER DIFFERENTIAL SKEW vs TEMPERATURE (ISL32453E, ISL32455E)

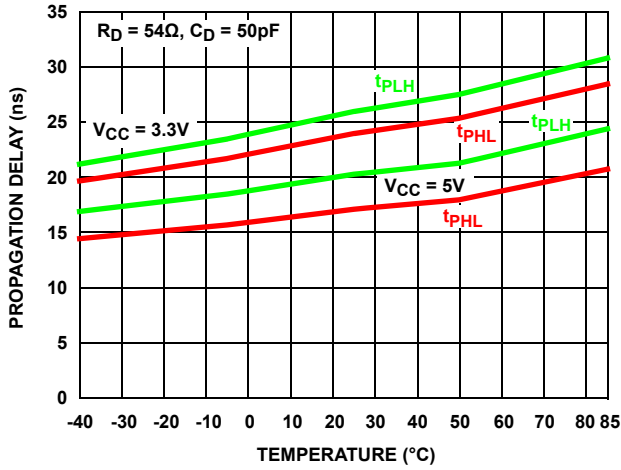


FIGURE 22. DRIVER DIFFERENTIAL PROPAGATION DELAY vs TEMPERATURE (ISL32458E, ISL32459E)

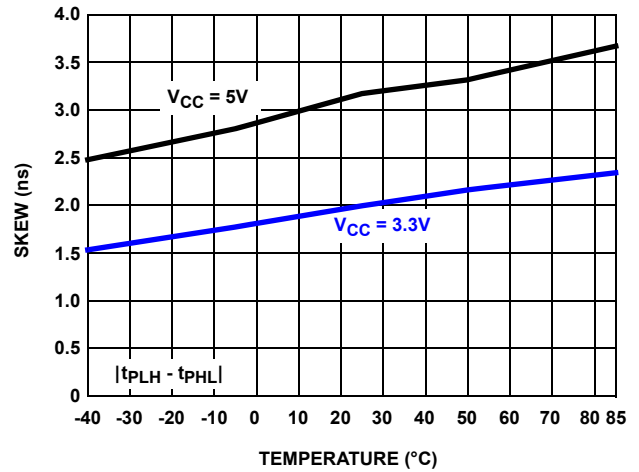


FIGURE 23. DRIVER DIFFERENTIAL SKEW vs TEMPERATURE (ISL32458E, ISL32459E)

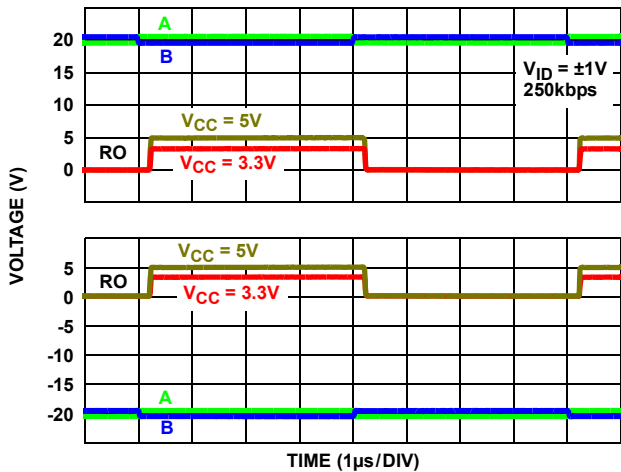


FIGURE 24.  $\pm 20\text{V}$  RECEIVER PERFORMANCE (ISL32450E, ISL32452E, ISL32457E)

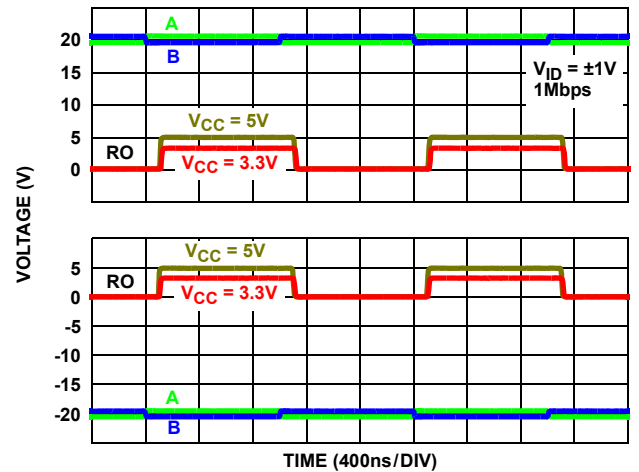


FIGURE 25.  $\pm 20\text{V}$  RECEIVER PERFORMANCE (ISL32453E, ISL32455E)

**Typical Performance Curves**  $T_A = +25^\circ\text{C}$ ; unless otherwise specified. (Continued)

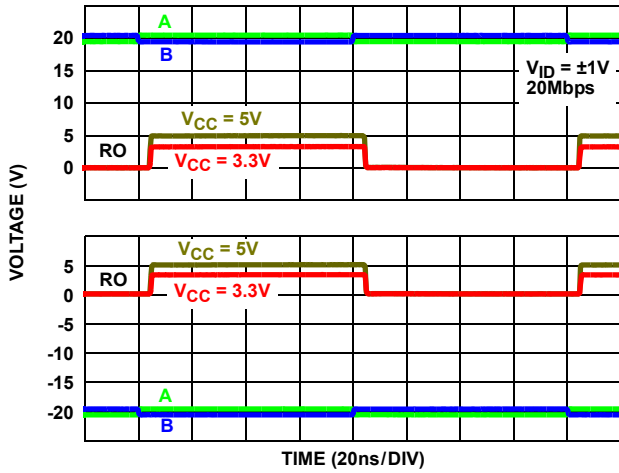


FIGURE 26.  $\pm 20\text{V}$  RECEIVER PERFORMANCE (ISL32458E, ISL32459E)

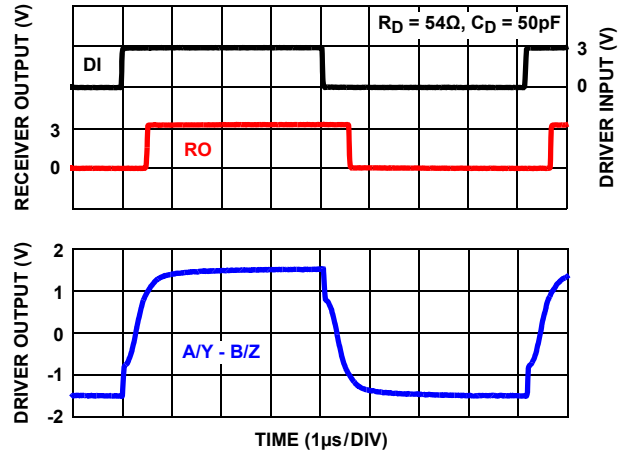


FIGURE 27.  $V_{CC} = 3.3\text{V}$ , DRIVER AND RECEIVER WAVEFORMS (ISL32450E, ISL32452E, ISL32457E)

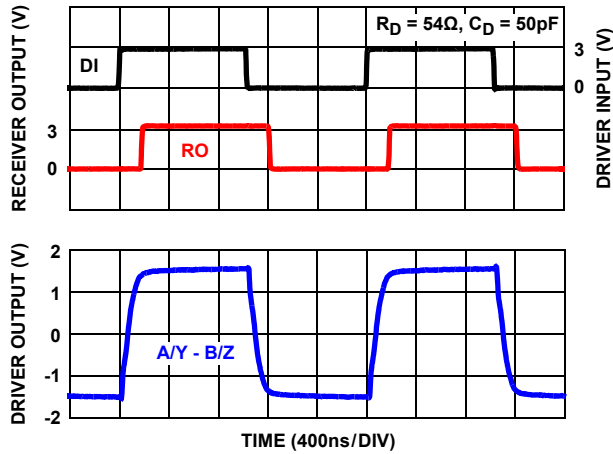


FIGURE 28.  $V_{CC} = 3.3\text{V}$ , DRIVER AND RECEIVER WAVEFORMS (ISL32453E, ISL32455E)

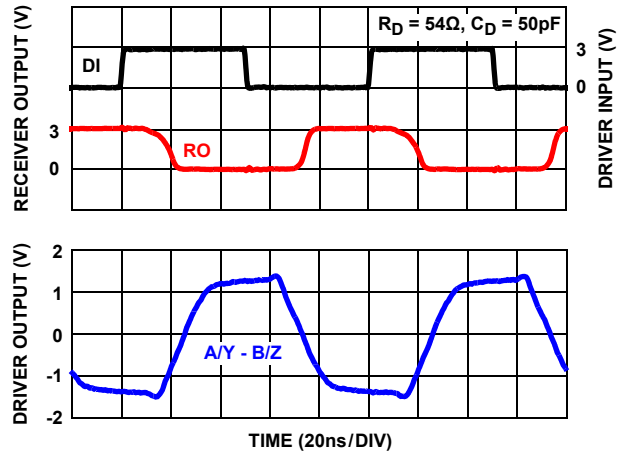


FIGURE 29.  $V_{CC} = 3.3\text{V}$ , DRIVER AND RECEIVER WAVEFORMS (ISL32458E, ISL32459E)

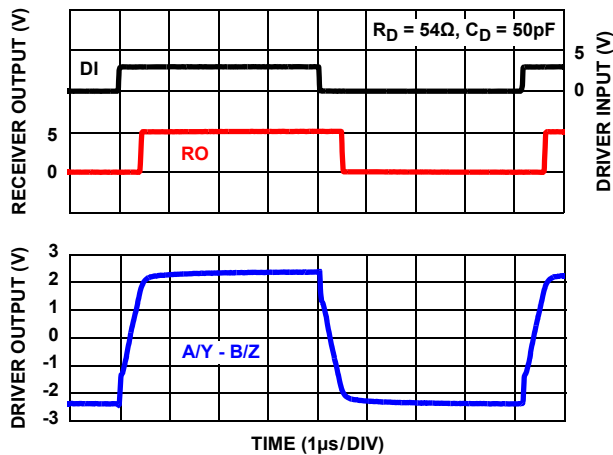


FIGURE 30.  $V_{CC} = 5\text{V}$ , DRIVER AND RECEIVER WAVEFORMS (ISL32450E, ISL32452E, ISL32457E)

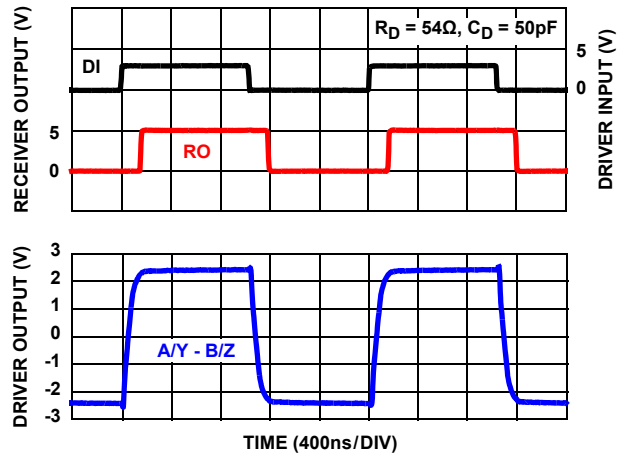


FIGURE 31.  $V_{CC} = 5\text{V}$ , DRIVER AND RECEIVER WAVEFORMS (ISL32453E, ISL32455E)



## Typical Performance Curves

$T_A = +25^\circ\text{C}$ ; unless otherwise specified. (Continued)

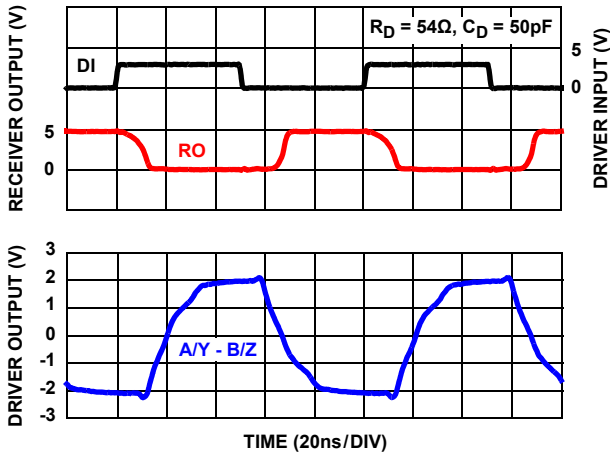


FIGURE 32.  $V_{CC} = 5\text{V}$ , DRIVER AND RECEIVER WAVEFORMS (ISL32458E, ISL32459E)

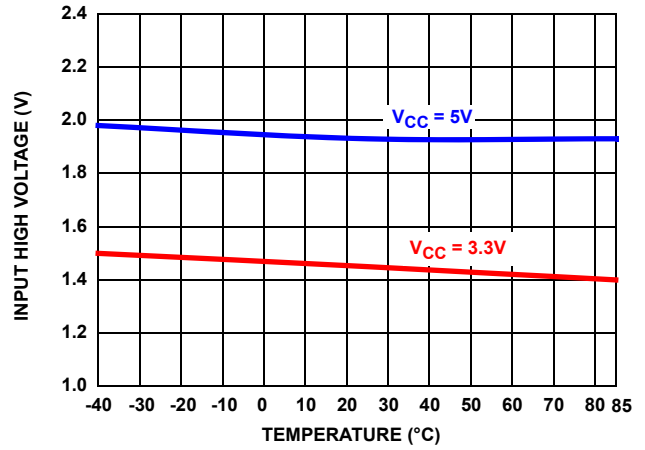


FIGURE 33. LOGIC INPUT HIGH VOLTAGE vs TEMPERATURE

## Application Information

RS-485 and RS-422 are differential (balanced) data transmission standards used for 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 that allows only one driver and up to 10 receivers (assuming one unit load devices) on each bus. RS-485 is a true multipoint standard that allows up to 32 one unit load devices (any combination of drivers and receivers) on each bus. To allow for multipoint operation, the RS-485 specification requires that drivers must handle bus contention without sustaining any damage.

An 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 4000ft, so the wide CMR is necessary to handle ground potential differences and voltages induced in the cable by external fields.

The ISL3245xE are a family of ruggedized RS-485 transceivers that improve on the RS-485 basic requirements and increases system reliability. The CMR increases to  $\pm 20V$  that the RS-485 bus pins (receiver inputs and driver outputs) include fault protection against voltages and transients up to  $\pm 60V$ . Additionally, the  $\pm 15kV$  to  $\pm 16.5kV$  built-in ESD protection complements the fault protection.

### Receiver (Rx) Features

These devices use a differential input receiver for maximum noise immunity and common-mode rejection. Input sensitivity is better than  $\pm 200mV$  (3.3V operation), as required by the RS-422 and RS-485 specifications.

The receiver input (load) current surpasses the RS-422 specification of 3mA and is four times lower than the RS-485 Unit Load (UL) requirement of 1mA maximum. Therefore, these products are known as one-quarter UL transceivers, and there can be up to 128 of these devices on a network while still complying with the RS-485 loading specification.

The receiver (Rx) functions, with common-mode voltages as great as  $\pm 20V$ , make them ideal for industrial or long networks where induced voltages are a realistic concern.

All the receivers include a full fail-safe function that ensures 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 (an idle bus).

Receivers easily meet the data rates supported by the corresponding driver, and most receiver outputs are tri-statable using the active low RE input.

The Rx in the 250kbps (ISL32450E, ISL32452E, and ISL32457E) and 1Mbps (ISL32453E and ISL32455E) versions include noise filtering circuitry to reject high frequency signals. The ISL32453E and ISL32455E typically reject pulses narrower than 50ns (equivalent to 20Mbps), while the ISL32450E, ISL32452E, and ISL32457E Rx reject pulses below 150ns (6.7Mbps). The ISL32450E, ISL32452E, and ISL32457E have no Rx noise filtering.

### Driver (Tx) Features

The RS-485/RS-422 driver is a differential output device that delivers at least 1.7V across a  $54\Omega$  load (RS-485), and at least 2V across a  $100\Omega$  load (RS-422) with  $V_{CC} \geq 4.5V$ . The drivers feature low propagation delay skew to maximize bit width and to minimize EMI. All drivers are tri-statable through the active high DE input.

The 250kbps and 1Mbps driver outputs are slew rate limited to minimize EMI and reflections in unterminated or improperly terminated networks. The ISL32458E and ISL32459E driver outputs are not limited, so faster output transition times allow data rates of at least 20Mbps.

### High Overvoltage (Fault) Protection Increases Ruggedness

Note: The available smaller pitch package (MSOP) may not meet the Creepage and Clearance (C&C) requirements for  $\pm 60V$  levels. Determine C&C requirements before selecting a package type.

The  $\pm 60V$  fault protection (referenced to the IC GND) on the RS-485 pins makes these transceivers some of the most rugged on the market. This level of protection makes the ISL3245xE family ideal for applications where power (such as 24V and 48V supplies) must be routed in the conduit with the data lines and for outdoor applications where large transients are likely to occur. When power is routed with the data lines, even a momentary short between the supply and data lines destroys an unprotected device. The  $\pm 60V$  fault levels of this family are at least four times higher than the levels specified for standard RS-485 ICs. The ISL3245xE's protection is active whether the Tx is enabled or disabled, and even if the IC is powered down or VCC and Ground are floating.

If transients or voltages (including overshoots and ringing) greater than  $\pm 60V$  are possible, additional external protection is required. Use a protection device with the lowest clamping voltage acceptable for the application. Note, TVS type devices typically clamp 5V to 10V above the designated stand-off voltage (for example, a "54V TVS" clamps between 60V and 66V).

### Wide Common-Mode Voltage (CMV) Tolerance Improves Operating Range

RS-485 networks operating in industrial complexes or over long distances are susceptible to large CMV variations. Either of these operating environments can suffer from large node-to-node ground potential differences or CMV pickup from external electromagnetic sources, and devices with only the minimum required +12V to -7V CMR can malfunction. The ISL3245xE's extended  $\pm 20V$  CMR allows for operation in environments that would overwhelm lesser transceivers. Additionally, the Rx does not phase invert (erroneously change state) even with CMVs of  $\pm 25V$  or differential voltages as large as 40V.

## Cable Invert (Polarity Reversal) Function

Large node count RS-485 networks are commonly wired backwards during installation. When this happens, the node is unable to communicate over the network. When a technician finds the miswired node, they must then rewire the connector, which is time consuming.

The ISL32457E and ISL32459E simplify this task by including a cable invert pin (INV) that allows the technician to invert the polarity of the Rx input and the Tx output pins simply by moving a jumper to change the state of the invert pin. When the invert pin is low, the IC operates like any standard RS-485 transceiver, and the bus pins have their normal polarity definition of A and Y as noninverting and B and Z as inverting. With the invert pin high, the corresponding bus pins reverse their polarity, so B and Z become noninverting, and A and Y become inverting.

This unique cable invert function is superior to that found on competing devices, because the Rx full fail-safe function is maintained, even when the Rx polarity is reversed. Competitor devices implement the Rx invert function simply by inverting the Rx output. This means that with the Rx inputs floating or shorted together, the Rx appropriately delivers a logic 1 in normal polarity, but outputs a logic low when the IC is operated in the inverted mode. The innovative Renesas Rx design ensures that the Rx output remains high with the Rx inputs floating or shorted together ( $V_{ID} = 0V$ ), regardless of the state of the invert pin.

## Data Rate, Cables, and Terminations

RS-485/RS-422 are intended for network lengths up to 4000ft, but the maximum system data rate decreases as the transmission length increases. High speed versions operating at 20Mbps can be used at lengths up to 150ft (46m), but the distance can be increased to 328ft (100m) by operating them at 5Mbps. The ISL32453E and ISL32455E can operate at the full data rate of 1Mbps with lengths up to 800ft (244m). Jitter is the limiting parameter at faster data rates and may limit the network to shorter lengths, so employing encoded data streams (such as Manchester coded or Return-to-Zero) may allow increased transmission distances. The ISL32450E, ISL32452E, and ISL32457E can operate at 115kbps or less at the full 4000ft (1220m) distance, or at 250kbps for lengths up to 3000ft (915m). DC cable attenuation is the limiting parameter, so using better quality cables (such as 22 AWG) may allow increased transmission distance.

Use twisted pair cables for RS-485/RS-422 networks. Twisted pair cables tend to pick up noise and other electromagnetically induced voltages as common-mode signals that are effectively rejected by the differential receivers in these ICs.

Note: Proper termination is imperative to minimize reflections when using the 20Mbps ISL32458E and ISL32459E devices. Short networks using the 250kbps ISL32450E, ISL32452E, and ISL32457E versions do not need to be terminated; however, terminations are recommended unless power dissipation is an overriding concern.

In point-to-point or point-to-multireceiver networks (single driver on bus like RS-422), terminate the main cable in its characteristic impedance (typically 120Ω) at the end farthest from the driver. In multireceiver applications, keep stubs

connecting receivers to the main cable as short as possible. Multipoint (multidriver) systems require that the main cable is terminated in its characteristic impedance at both ends. Keep stubs connecting a transceiver to the main cable as short as possible.

## Built-In Driver Overload Protection

The RS-485 specification requires that drivers survive worst-case bus contentions undamaged. These transceivers meet this requirement through driver output short-circuit current limits and on-chip thermal shutdown circuitry.

The driver output stages incorporate a double foldback short-circuit current limiting scheme that ensures that the output current never exceeds the RS-485 specification, even at the common-mode and fault condition voltage range extremes. The first foldback current level ( $\approx 83mA$ ) is set to ensure that the driver never folds back when driving loads with common-mode voltages up to  $\pm 20V$ . The very low second foldback current setting ( $\approx 13mA$ ) minimizes power dissipation if the Tx is enabled when a fault occurs.

In the event of a major short-circuit condition, the ISL3245xE's thermal shutdown feature disables the drivers whenever the die temperature becomes excessive. Thermal shutdown eliminates the power dissipation allowing the die to cool. The drivers automatically re-enable after the die temperature drops about 15°C. If the contention persists, the thermal shutdown/re-enable cycle repeats until the fault is cleared. The receivers stay operational during thermal shutdown.

## Low Power Shutdown Mode

These BiCMOS transceivers all use a fraction of the power required by competitive devices, but they (excluding ISL32457E and ISL32459E) also include a shutdown feature that reduces the already low quiescent  $I_{CC}$  to a 10μA trickle. These devices enter 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 ensures that the transceiver does not enter shutdown.

Note: The receiver and driver enable times increase when the transceiver enables from shutdown. See [Notes 12](#) through [16](#) on [page 11](#) for more information.

## Die Characteristics

### SUBSTRATE POTENTIAL (POWERED UP):

GND

### PROCESS:

Si Gate BiCMOS

**Revision History** The revision history provided is for informational purposes only and is believed to be accurate, but not warranted. Please visit our website to make sure you have the latest revision.

| DATE              | REVISION | CHANGE   |
|-------------------|----------|--|
| Feb 14, 2019      | FN7921.3 | Updated links throughout document.<br>Updated ordering information table by adding all tape and reel information and updating notes.<br>Updated last sentence in second paragraph in "High Overvoltage (Fault) Protection Increases Ruggedness" on page 18<br>Removed About Intersil section.<br>Updated disclaimer. |
| August 31, 2017   | FN7921.2 | Updated the receiving truth table on page 3.   |
| December 1, 2015  | FN7921.1 | Added 20Mbps versions (ISL32458E and ISL32459E) to datasheet.<br>Replaced Products section with About Intersil verbiage.<br>Updated Package Outline Drawing M10.118 to the latest version. Changes are as follows:<br>-Updated to new POD template. Added land pattern.  |
| February 20, 2012 | FN7921.0 | Initial release  |

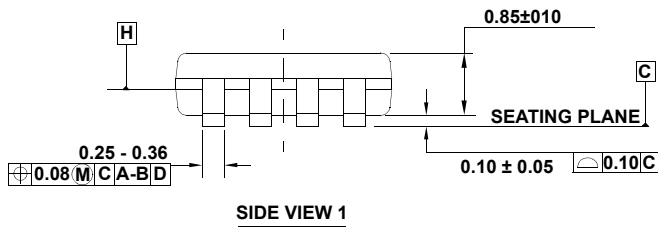
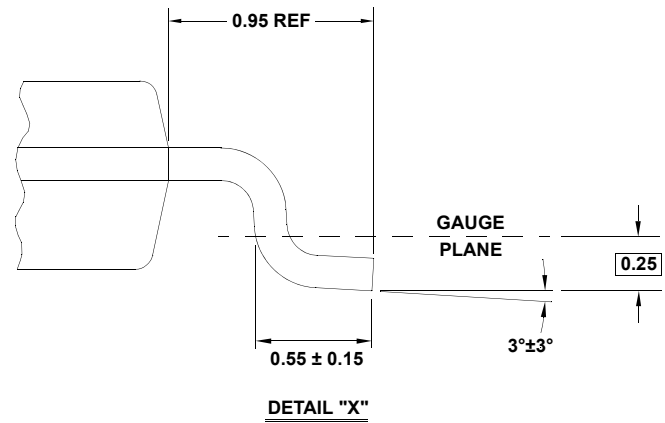
# Package Outline Drawings

For the most recent package outline drawing, see [M8.118](#).

## M8.118

8 LEAD MINI SMALL OUTLINE PLASTIC PACKAGE

Rev 4, 7/11



**NOTES:**

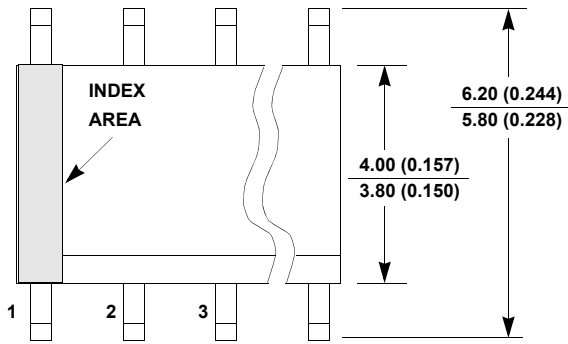
1. Dimensions are in millimeters.
2. Dimensioning and tolerancing conform to JEDEC MO-187-AA and AMSEY14.5m-1994.
3. Plastic or metal protrusions of 0.15mm max per side are not included.
4. Plastic interlead protrusions of 0.15mm max per side are not included.
5. Dimensions are measured at Datum Plane "H".
6. Dimensions in ( ) are for reference only.

**M8.15**

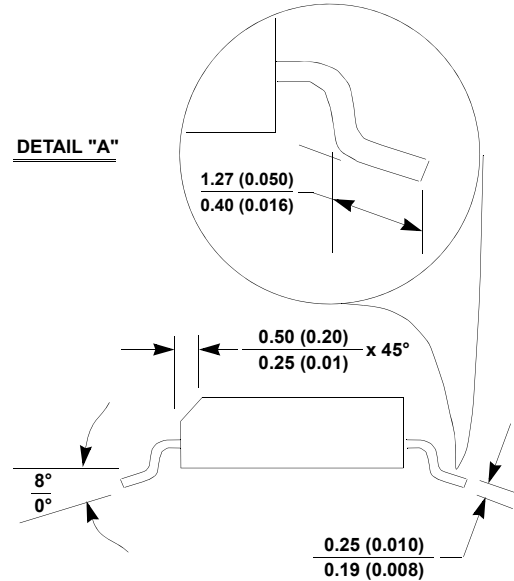
**8 LEAD NARROW BODY SMALL OUTLINE PLASTIC PACKAGE**

Rev 4, 1/12

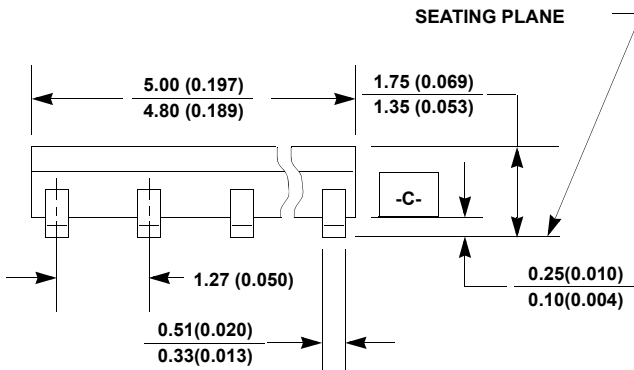
For the most recent package outline drawing, see [M8.15](#).



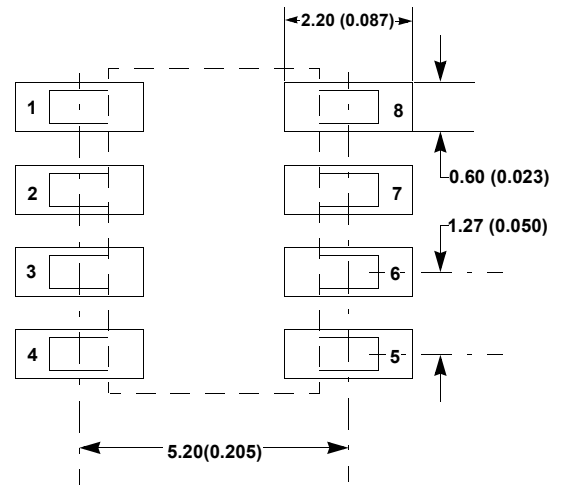
**TOP VIEW**



**SIDE VIEW "B"**



**SIDE VIEW "A"**



**TYPICAL RECOMMENDED LAND PATTERN**

**NOTES:**

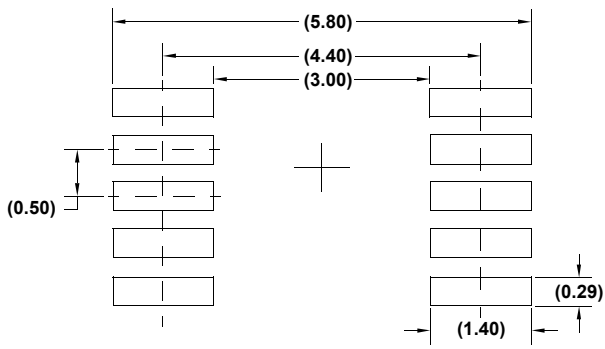
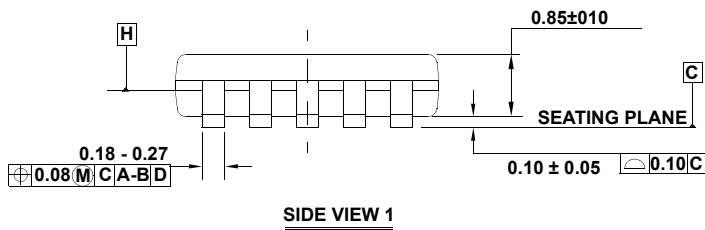
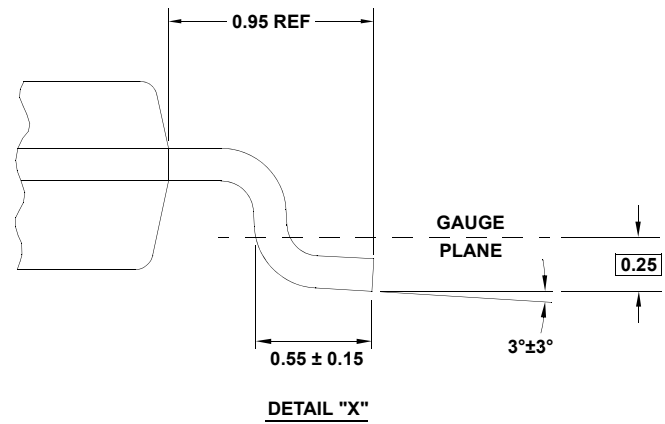
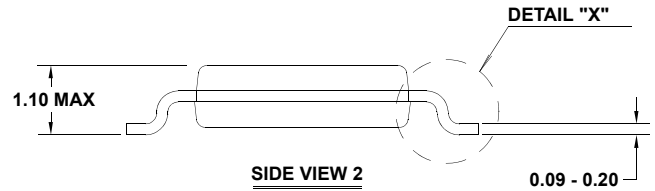
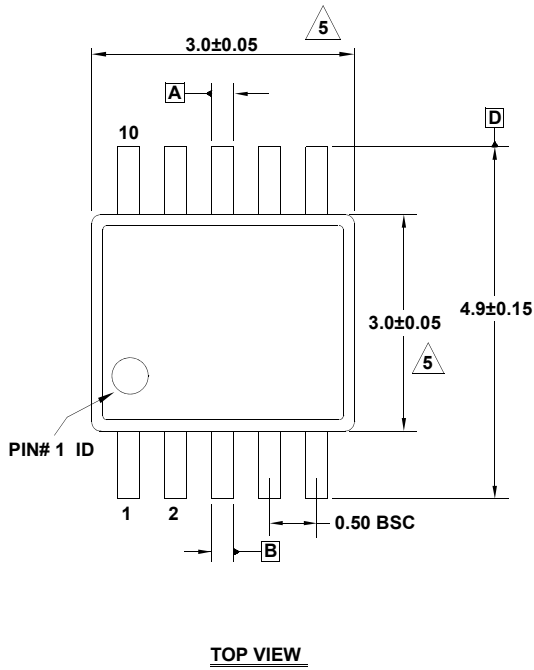
20. Dimensioning and tolerancing per ANSI Y14.5M-1994.
21. Package length does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
22. Package width does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.25mm (0.010 inch) per side.
23. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
24. Terminal numbers are shown for reference only.
25. The lead width 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).
26. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.
27. This outline conforms to JEDEC publication MS-012-AA ISSUE C.

**M10.118**

**10 LEAD MINI SMALL OUTLINE PLASTIC PACKAGE**

Rev 1, 4/12

For the most recent package outline drawing, see [M10.118](#).



**NOTES:**

1. Dimensions are in millimeters.
2. Dimensioning and tolerancing conform to JEDEC MO-187-BA and AMSEY14.5m-1994.
3. Plastic or metal protrusions of 0.15mm max per side are not included.
4. Plastic interlead protrusions of 0.15mm max per side are not included.

**5.** Dimensions are measured at Datum Plane "H".

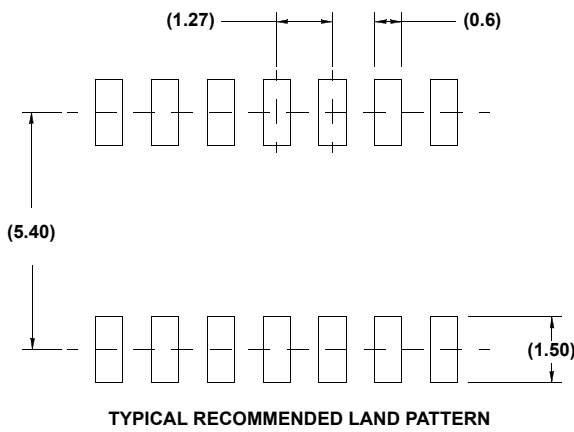
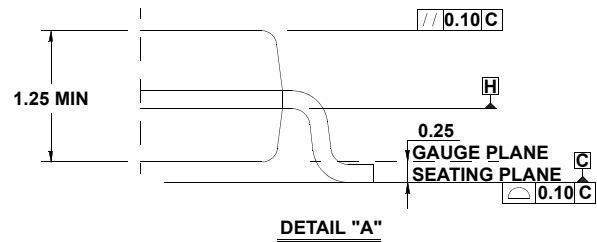
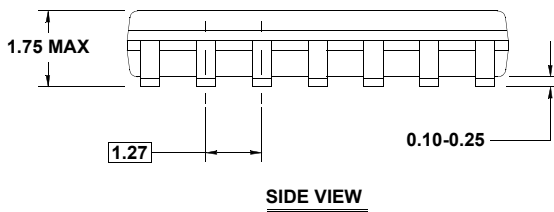
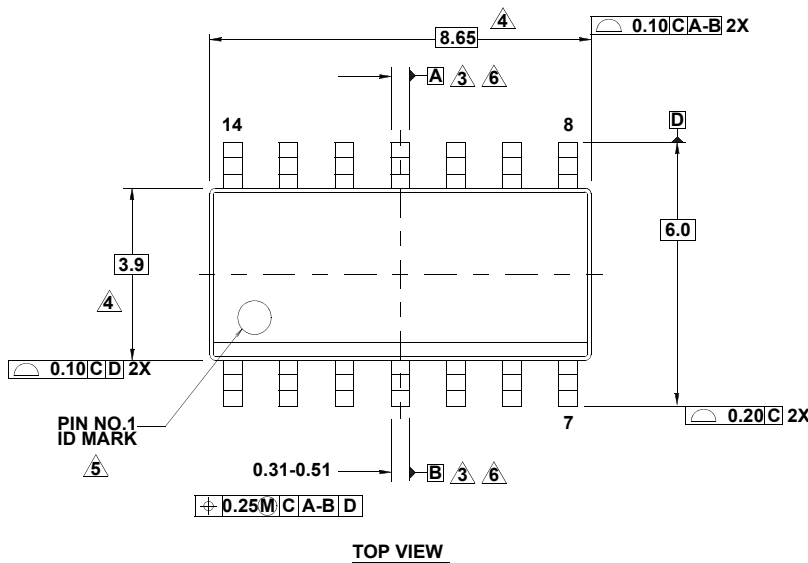
**6.** Dimensions in ( ) are for reference only.

**M14.15**

**14 LEAD NARROW BODY SMALL OUTLINE PLASTIC PACKAGE**

Rev 1, 10/09

For the most recent package outline drawing, see [M14.15](#).



**NOTES:**

1. Dimensions are in millimeters.  
Dimensions in ( ) for Reference Only.
2. Dimensioning and tolerancing conform to AMSEY14.5m-1994.
3. Datums A and B to be determined at Datum H.
4. Dimension does not include interlead flash or protrusions.  
Interlead flash or protrusions shall not exceed 0.25mm per side.
5. The pin #1 identifier may be either a mold or mark feature.
6. Does not include dambar protrusion. Allowable dambar protrusion shall be 0.10mm total in excess of lead width at maximum condition.
7. Reference to JEDEC MS-012-AB.



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