ISL4489E, ISL4491E

±15kV ESD Protected, 1/8 Unit Load, 5V, Low Power, High Speed and Slew Rate Limited, Full Duplex, RS-485/RS-422 Transceivers

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The ISL4489E and ISL4491E are ESD protected, “fractional” Unit Load (UL), BiCMOS, 5V powered, single transceivers that meet both the RS-485 and RS-422 standards for balanced communication. Each driver output and receiver input is protected against ±15kV ESD strikes without latch-up. Unlike competitive versions, these devices are specified for 10% tolerance supplies (4.5V to 5.5V).

The Rx inputs and Tx outputs present a 1/8 unit load to the RS-485 bus, which allows a total of 256 transmitters and receivers on the network for large node count systems.

These devices are configured for full duplex (separate Rx input and Tx output pins) applications, so they are ideal for RS-422 networks requiring high ESD tolerance on the bus pins.

The ISL4489E uses a slew rate limited driver that reduces EMI and minimizes reflections from improperly terminated transmission lines, or unterminated stubs in multidrop and multipoint applications.

Data rates up to 15Mbps are achievable using the ISL4491E, which features higher slew rates.

The receiver (Rx) inputs feature a “fail-safe if open” design, which ensures a logic high Rx output if Rx inputs are floating.

The driver (Tx) outputs are short-circuit protected, even for voltages exceeding the power supply voltage. Additionally, on-chip thermal shutdown circuitry disables the Tx outputs to prevent damage if power dissipation becomes excessive.

Related Literature

For a full list of related documents, visit our website:

- ISL4489E, ISL4491E product pages

Features

- Pb-free (RoHS compliant)
- RS-485 I/O pin ESD protection . . . . ±15kV HBM
  - Class 3 ESD level on all other pins . . . . >7kV HBM
- 1/8 unit load allows up to 256 devices on the bus
- High data rates (ISL4491E) . . . . up to 15Mbps
- Slew rate limited version for error free data transmission (ISL4489E)
- Very low quiescent current:
  - 140µA (ISL4489E)
  - 370µA (ISL4491E)
- -7V to +12V common-mode input voltage range
- Tri-statable Rx and Tx outputs
- Full duplex pinout
- Operates from a single +5V supply (10% tolerance)
- Current limiting and thermal shutdown for driver overload protection

Applications

- Factory automation
- Security networks
- Building environmental control systems
- Industrial/process control networks
- Level translators (for example, RS-232 to RS-422)
- RS-232 “extension cords”

TABLE 1. SUMMARY OF FEATURES

PART NUMBER	HALF/FULL DUPLEX	HIGH ESD?	NO. OF DEVICES ALLOWED ON BUS	DATA RATE (Mbps)	SLEW-RATE LIMITED?	RECEIVER/ DRIVER ENABLE?	QUIESCENT I_{CC} (µA)	PIN COUNT
ISL4489E	Full	Yes	256	0.25	Yes	Yes	140	14
ISL4491E	Full	Yes	256	15	No	Yes	370	14

Ordering Information

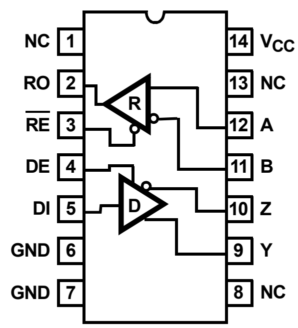
PART NUMBER (Notes 2, 3)	PART MARKING	TEMP. RANGE (°C)	TAPE AND REEL (UNITS) (Note 1)	PACKAGE (RoHS Compliant)	PKG. DWG. #
ISL4489EIBZ	4489EIBZ	-40 to +85	-	14 Ld SOIC	M14.15
ISL4489EIBZ-T	4489EIBZ	-40 to +85	2.5k	14 Ld SOIC	M14.15
ISL4491EIBZ	4491EIBZ	-40 to +85	-	14 Ld SOIC	M14.15
ISL4491EIBZ-T	4491EIBZ	-40 to +85	2.5k	14 Ld SOIC	M14.15

NOTES:

1. Refer to TB347 for details about reel specifications.
2. Pb-free plus anneal products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate termination finish, which are 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.
3. For Moisture Sensitivity Level (MSL), see the ISL4489E and ISL4491E product information pages. For more information on MSL, see TB363.

Pinout

14 LD SOIC
TOP VIEW



Pin Descriptions

PIN	FUNCTION
RO	Receiver output.RO is high if A > B by at least 0.2V; RO is low if A < B by 0.2V or more; RO = High if A and B are unconnected (floating).
$\overline{RE}$	Receiver output enable. RO is enabled when $\overline{RE}$ is low; RO is high impedance when $\overline{RE}$ is high.
DE	Driver output enable. The driver outputs Y and Z are enabled by bringing DE high. They are high impedance when DE is low.
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.
GND	Ground connection.
A	±15kV HBM ESD protected, noninverting receiver input.
B	±15kV HBM ESD protected, inverting receiver input.
Y	±15kV HBM ESD protected, noninverting driver output.
Z	±15kV HBM ESD protected, inverting driver output.
V_{CC}	System power supply input (4.5V to 5.5V).
NC	No connection.

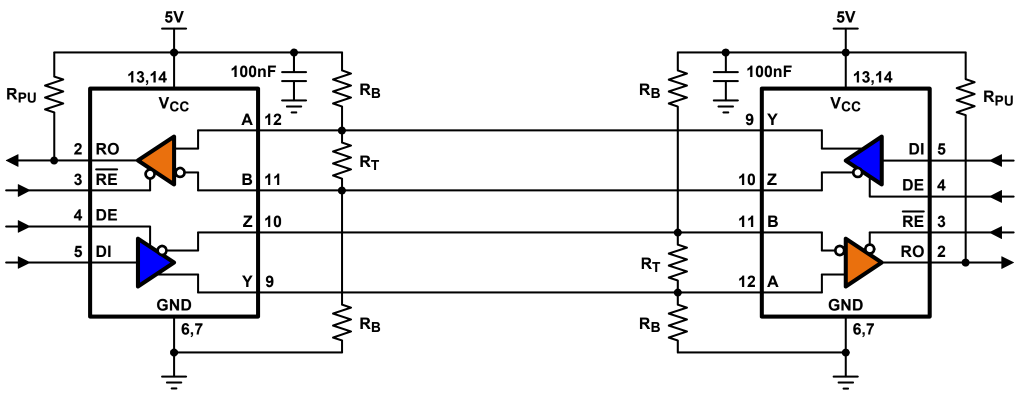
Truth Tables

TRANSMITTING				
INPUTS			OUTPUTS	
$\overline{RE}$	DE	DI	Z	Y
X	1	1	0	1
X	1	0	1	0
X	0	X	High-Z	High-Z

RECEIVING			
INPUTS			OUTPUT
$\overline{RE}$	DE	A-B	RO
0	X	≥ +0.2V	1
0	X	≤ -0.2V	0
0	X	Inputs Open	1
1	X	X	High-Z

Typical Operating Circuit

ISL4489E, ISL4491E



To calculate the resistor values, refer to TB509

Absolute Maximum Ratings

V_{CC} to Ground 7V
Input Voltages
DI, DE, $\overline{RE}$ . . . . -0.5V to (V_{CC} +0.5V)
Input/Output Voltages
A, B, Y, Z . . . . -8V to +12.5V
RO . . . . -0.5V to (V_{CC} +0.5V)
Short-Circuit Duration
Y, Z . . . . Continuous
ESD Rating . . . . See "ESD PERFORMANCE" on page 5

Thermal Information

Thermal Resistance (Typical, Note 4) θ_{JA} (°C/W)
14 Ld SOIC Package 128
Maximum Junction Temperature (Plastic Package) . . . . . . +150°C
Maximum Storage Temperature Range . . . . -65°C to +150°C
Maximum Lead Temperature (Soldering 10s) . . . . +300°C
(Lead Tips Only)

Operating Conditions

Temperature Range . . . . -40°C to +85°C

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" can permanently damage the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTE:

4. θ_{JA} is measured with the component mounted on a low-effective thermal conductivity test board in free air. See TB379 for details.

Electrical Specifications

Test Conditions: V_{CC} = 4.5V to 5.5V; Unless Otherwise Specified. Typicals are at V_{CC} = 5V, T_A = +25°C, Note 5

PARAMETER	SYMBOL	TEST CONDITIONS		TEMP (°C)	MIN	TYP	MAX	UNIT
DC CHARACTERISTICS								
Driver Differential V_{OUT} (no load)	V_{OD1}			Full	-	-	V_{CC}	V
Driver Differential V_{OUT} (with load)	V_{OD2}	R = 50Ω (RS-422) (Figure 1)		Full	2	3	-	V
		R = 27Ω (RS-485) (Figure 1)		Full	1.5	2.3	5	V
Change in Magnitude of Driver Differential V_{OUT} for Complementary Output States	ΔV_{OD}	R = 27Ω or 50Ω (Figure 1)		Full	-	0.01	0.2	V
Driver Common-Mode V_{OUT}	V_{OC}	R = 27Ω or 50Ω (Figure 1)		Full	-	-	3	V
Change in Magnitude of Driver Common-Mode V_{OUT} for Complementary Output States	ΔV_{OC}	R = 27Ω or 50Ω (Figure 1)		Full	-	0.01	0.2	V
Logic Input High Voltage	V_{IH}	DE, DI, $\overline{RE}$		Full	2	-	-	V
Logic Input Low Voltage	V_{IL}	DE, DI, $\overline{RE}$		Full	0.8	-	-	V
Logic Input Current	I_{IN1}	DI		Full	-2	-	2	µA
		DE, $\overline{RE}$		Full	-40	-	40	µA
Input Current (A, B) (Note 8)	I_{IN2}	DE = 0V, V_{CC} = 0V or 4.5 to 5.5V	V_{IN} = 12V	Full	-	-	130	µA
			V_{IN} = -7V	Full	-100	-	-	µA
Driver Tri-State (High Impedance) Output Current (Y, Z)	I_{OZD}	-7V ≤ V_O ≤ 12V		Full	-100	-	100	µA
Receiver Differential Threshold Voltage	V_{TH}	-7V ≤ V_{CM} ≤ 12V		Full	-0.2	-	0.2	V
Receiver Input Hysteresis	ΔV_{TH}	V_{CM} = 0V		+25	-	70	-	mV
Receiver Output High Voltage	V_{OH}	I_O = -4mA, V_{ID} = 200mV		Full	3.5	-	-	V
Receiver Output Low Voltage	V_{OL}	I_O = -4mA, V_{ID} = 200mV		Full	-	-	0.4	V
Tri-State (high impedance) Receiver Output Current	I_{OZR}	0.4V ≤ V_O ≤ 2.4V		Full	-	-	±1	µA
Receiver Input Resistance	R_{IN}	-7V ≤ V_{CM} ≤ 12V		Full	92	120	-	kΩ
No-Load Supply Current (Note 6)	I_{CC}	ISL4489E, DE, DI, $\overline{RE}$ = 0V or V_{CC}		Full	-	140	190	µA
		ISL4491E, DE, DI, $\overline{RE}$ = 0V or V_{CC}		Full	-	370	460	µA
Driver Short-Circuit Current, V_O = High or Low	I_{OSD1}	DE = V_{CC}, -7V ≤ V_Y or V_Z ≤ 12V (Note 7)		Full	35	-	250	mA
Receiver Short-Circuit Current	I_{OSR}	0V ≤ V_O ≤ V_{CC}		Full	7	-	85	mA

Electrical Specifications Test Conditions: V_{CC} = 4.5V to 5.5V; Unless Otherwise Specified. Typicals are at V_{CC} = 5V, T_A = +25°C, Note 5 **(Continued)**

PARAMETER	SYMBOL	TEST CONDITIONS	TEMP (°C)	MIN	TYP	MAX	UNIT
SWITCHING CHARACTERISTICS (ISL4489E)							
Driver Input to Output Delay	t_{PLH}, t_{PHL}	R_{DIFF} = 54Ω, C_L = 100pF (Figure 2)	Full	250	400	2000	ns
Driver Output Skew	t_{SKEW}	R_{DIFF} = 54Ω, C_L = 100pF (Figure 2)	Full	-	160	800	ns
Driver Differential Rise or Fall Time	t_R, t_F	R_{DIFF} = 54Ω, C_L = 100pF (Figure 2)	Full	250	600	2000	ns
Driver Enable to Output High	t_{ZH}	C_L = 100pF, SW = GND (Figure 3)	Full	250	1000	2000	ns
Driver Enable to Output Low	t_{ZL}	C_L = 100pF, SW = V_{CC} (Figure 3)	Full	250	860	2000	ns
Driver Disable from Output High	t_{HZ}	C_L = 15pF, SW = GND (Figure 3)	Full	300	660	3000	ns
Driver Disable from Output Low	t_{LZ}	C_L = 15pF, SW = V_{CC} (Figure 3)	Full	300	640	3000	ns
Receiver Input to Output Delay	t_{PLH}, t_{PHL}	Figure 4	Full	250	500	2000	ns
Receiver Skew | t_{PLH} - t_{PHL} |	t_{SKD}	Figure 4	+25	-	60	-	ns
Receiver Enable to Output High	t_{ZH}	C_L = 15pF, SW = GND (Figure 5)	Full	-	10	50	ns
Receiver Enable to Output Low	t_{ZL}	C_L = 15pF, SW = V_{CC} (Figure 5)	Full	-	10	50	ns
Receiver Disable from Output High	t_{HZ}	C_L = 15pF, SW = GND (Figure 5)	Full	-	10	50	ns
Receiver Disable from Output Low	t_{LZ}	C_L = 15pF, SW = V_{CC} (Figure 5)	Full	-	10	50	ns
Maximum Data Rate	f_{MAX}		Full	250	-	-	kbps
SWITCHING CHARACTERISTICS (ISL4491E)							
Driver Input to Output Delay	t_{PLH}, t_{PHL}	R_{DIFF} = 54Ω, C_L = 100pF (Figure 2)	Full	13	24	40	ns
Driver Output Skew	t_{SKEW}	R_{DIFF} = 54Ω, C_L = 100pF (Figure 2)	Full	-	3	10	ns
Driver Differential Rise or Fall Time	t_R, t_F	R_{DIFF} = 54Ω, C_L = 100pF (Figure 2)	Full	5	12	20	ns
Driver Enable to Output High	t_{ZH}	C_L = 100pF, SW = GND (Figure 3)	Full	-	14	70	ns
Driver Enable to Output Low	t_{ZL}	C_L = 100pF, SW = V_{CC} (Figure 3)	Full	-	14	70	ns
Driver Disable from Output High	t_{HZ}	C_L = 15pF, SW = GND (Figure 3)	Full	-	44	70	ns
Driver Disable from Output Low	t_{LZ}	C_L = 15pF, SW = V_{CC} (Figure 3)	Full	-	21	70	ns
Receiver Input to Output Delay	t_{PLH}, t_{PHL}	(Figure 4)	Full	30	90	150	ns
Receiver Skew | t_{PLH} - t_{PHL} |	t_{SKD}	(Figure 4)	+25	-	5	-	ns
Receiver Enable to Output High	t_{ZH}	C_L = 15pF, SW = GND (Figure 5)	Full	-	9	50	ns
Receiver Enable to Output Low	t_{ZL}	C_L = 15pF, SW = V_{CC} (Figure 5)	Full	-	9	50	ns
Receiver Disable from Output High	t_{HZ}	C_L = 15pF, SW = GND (Figure 5)	Full	-	9	50	ns
Receiver Disable from Output Low	t_{LZ}	C_L = 15pF, SW = V_{CC} (Figure 5)	Full	-	9	50	ns
Maximum Data Rate	f_{MAX}		Full	15	-	-	Mbps
ESD PERFORMANCE							
RS-485 Pins (A, B, Y, Z)		Human Body Model	+25	-	±15	-	kV
All Other Pins			+25	-	>±7	-	kV

NOTES:

5. 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.
6. Supply current specification is valid for loaded drivers when DE = 0V.
7. Applies to peak current. See "Typical Performance Curves" on page 9 for more information.
8. Devices meeting these limits are denoted as "1/8 unit load (1/8 UL)" transceivers. The RS-485 standard allows up to 32 UL on the bus, so there can be 256 1/8 UL devices on a bus.

Test Circuits and Waveforms

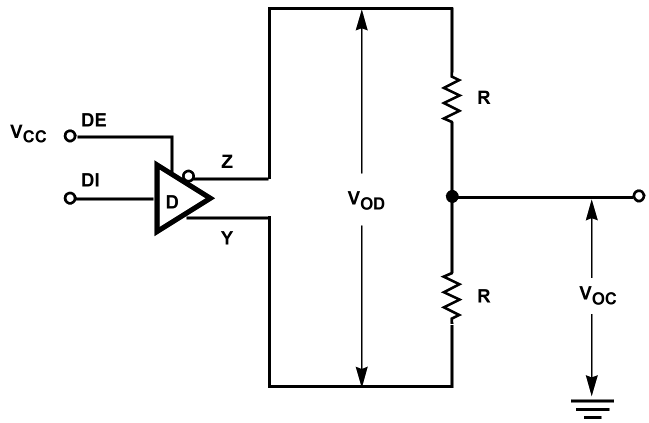
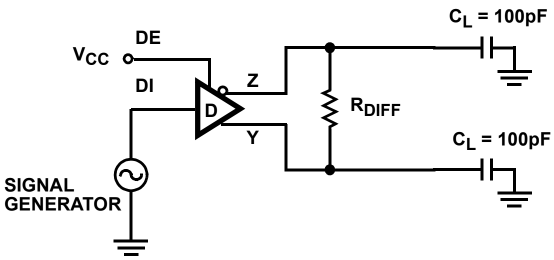


FIGURE 1. DRIVER V_{OD} AND V_{OC}



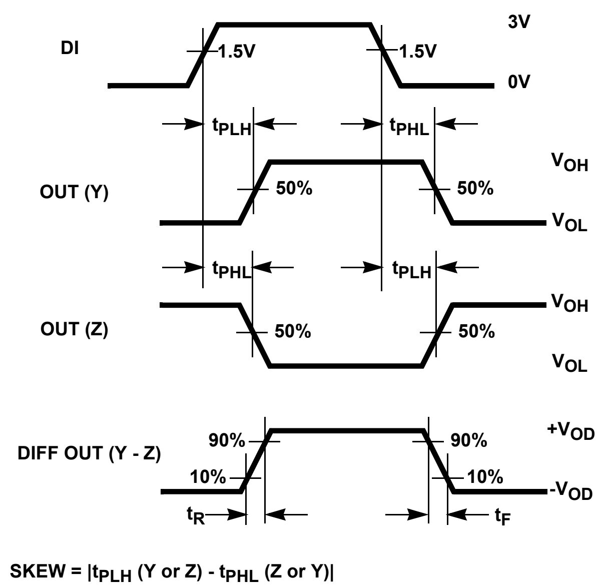
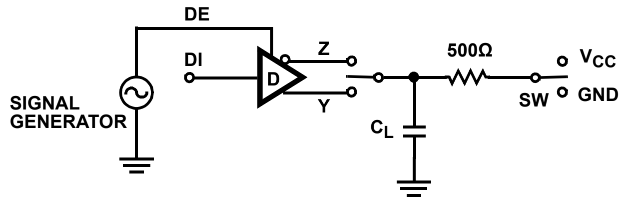


FIGURE 2A. TEST CIRCUIT

FIGURE 2B. MEASUREMENT POINTS

FIGURE 2. DRIVER PROPAGATION DELAY AND DIFFERENTIAL TRANSITION TIMES

Test Circuits and Waveforms (Continued)



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

FIGURE 3A. TEST CIRCUIT

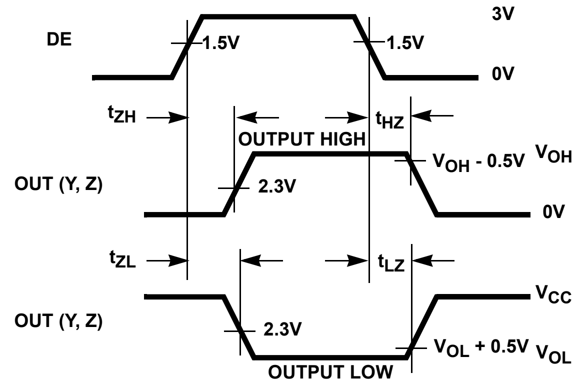


FIGURE 3B. MEASUREMENT POINTS

FIGURE 3. DRIVER ENABLE AND DISABLE TIMES

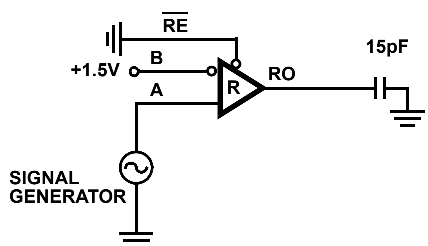


FIGURE 4A. TEST CIRCUIT

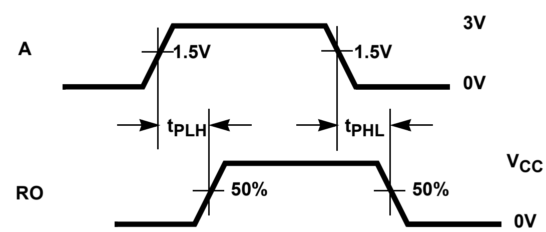
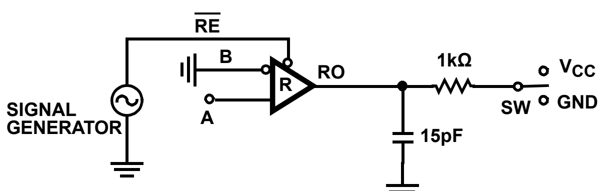


FIGURE 4B. MEASUREMENT POINTS

FIGURE 4. RECEIVER PROPAGATION DELAY



PARAMETER	DE	A	SW
t_{HZ}	X	+1.5V	GND
t_{LZ}	X	-1.5V	V_{CC}
t_{ZH}	X	+1.5V	GND
t_{ZL}	X	-1.5V	V_{CC}

FIGURE 5A. TEST CIRCUIT

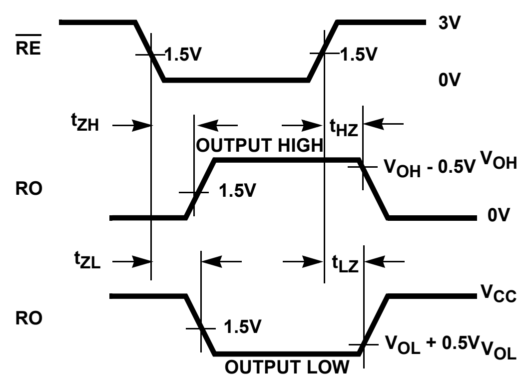


FIGURE 5B. MEASUREMENT POINTS

FIGURE 5. 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 that allows only one driver and up to 10 receivers on each bus, assuming one unit load devices. RS-485 is a true multipoint standard, which 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.

Receiver Features

These devices use a differential input receiver for maximum noise immunity and common-mode rejection. Input sensitivity is ±200mV as required by the RS-422 and RS-485 specifications.

The receiver input resistance of 120kΩ surpasses the RS-422 specification of 4kΩ, and is more than eight times the RS-485 “UL” requirement of 12kΩ. Thus, these products are known as “one-eighth UL” transceivers. There can be up to 256 of these devices on a network while still complying with the RS-485 loading specification.

Receiver inputs function with common-mode voltages as great as ±7V outside the power supplies (such as +12V and -7V), making them ideal for long networks in which induced voltages are a realistic concern.

All the receivers include a “fail-safe if open” function that ensures a high level receiver output if the receiver inputs are unconnected (floating).

Receivers easily meet the data rate supported by the corresponding driver, and the receiver outputs are tri-statable using the active low $\overline{\text{RE}}$ input.

Driver Features

The RS-485/422 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. The driver outputs are tri-statable using the active high DE input.

The ISL4489E driver outputs are slew rate limited to further reduce EMI and to minimize reflections in unterminated or improperly terminated networks. Data rates on these slew rate limited versions are a maximum of 250kbps. The ISL4491E driver outputs are not limited, so faster output transition times allow data rates of at least 15Mbps.

Data Rate, Cables, and Terminations

Twisted pair cable is the cable of choice for RS-485/422 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 receivers in these ICs.

RS-485/422 are intended for network lengths up to 4000ft, but the maximum system data rate decreases as the transmission length increases. Devices operating at 15Mbps are limited to lengths of a few hundred feet, while the 250kbps versions can operate at full data rates with lengths in excess of 1000ft.

Proper termination is imperative to minimize reflections when using the 15Mbps devices. Short networks using the 250kbps versions do not need to be terminated, but terminations are recommended unless power dissipation is an overriding concern. In point-to-point or point-to-multipoint (single driver on bus) networks, terminate the main cable in its characteristic impedance (typically 120Ω) at the end farthest from the driver. In multi-receiver applications, keep stubs connecting receivers to the main cable as short as possible. In multipoint (multi-driver) systems, terminate the main cable 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

As stated previously, the RS-485 specification requires that drivers survive worst case bus contentions undamaged. The ISL44xxE devices meet this requirement through 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. Additionally, these devices use a foldback circuit that reduces the short-circuit current, and thus the power dissipation, when the contending voltage exceeds either supply.

In the event of a major short-circuit condition, the ISL44xxE devices’ thermal shutdown feature disables the drivers when the die temperature becomes excessive. This eliminates the power dissipation, allowing the die to cool. The drivers automatically reenable 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.

ESD Protection

All pins on these devices include Class 3 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 ±15kV HBM. The RS-485 pins are particularly vulnerable to ESD damage 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. The ESD structures protect the device whether or not it is powered up, protect without allowing any latchup mechanism to activate, 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 (for example, transient suppression diodes), and the associated undesirable capacitive load they present.

Typical Performance Curves V_{CC} = 5V, T_A = 25°C; Unless Otherwise Specified

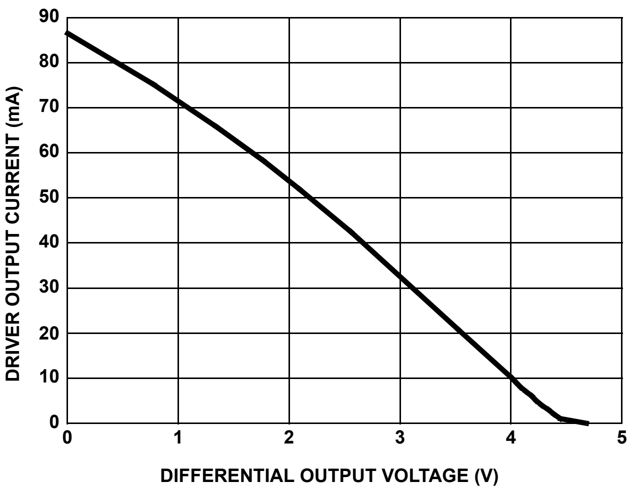


FIGURE 6. DRIVER OUTPUT CURRENT vs DIFFERENTIAL OUTPUT VOLTAGE

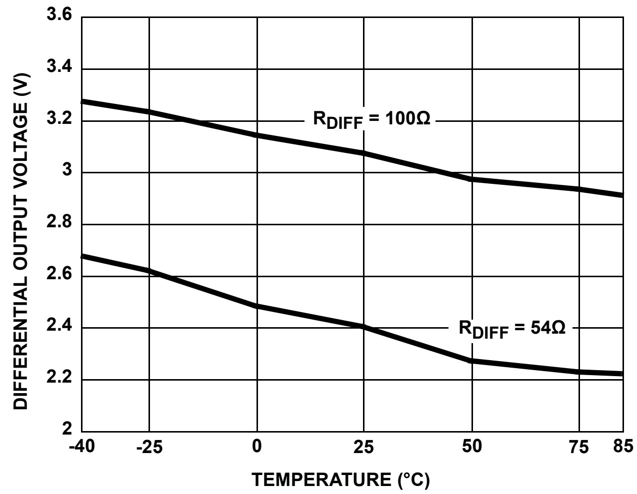


FIGURE 7. DRIVER DIFFERENTIAL OUTPUT VOLTAGE vs TEMPERATURE

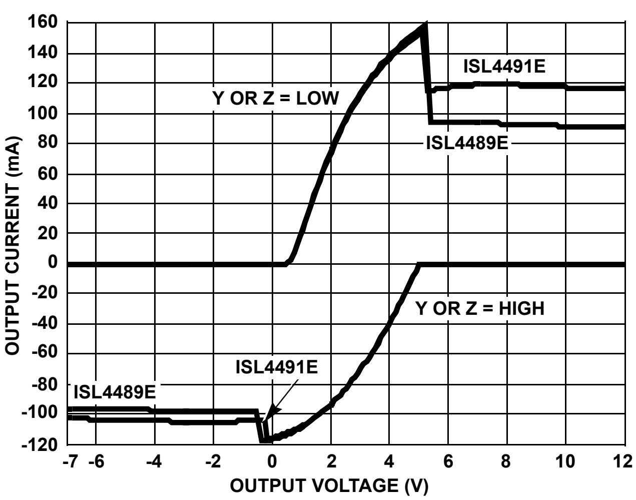


FIGURE 8. DRIVER OUTPUT CURRENT vs SHORT-CIRCUIT VOLTAGE

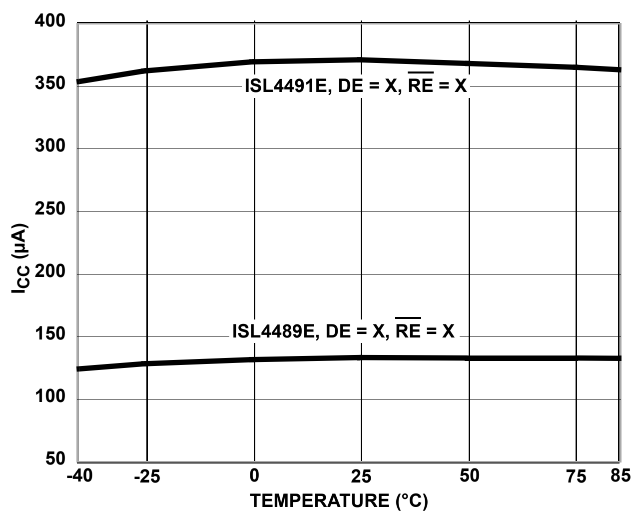


FIGURE 9. SUPPLY CURRENT vs TEMPERATURE

Typical Performance Curves V_{CC} = 5V, T_A = 25°C; Unless Otherwise Specified **(Continued)**

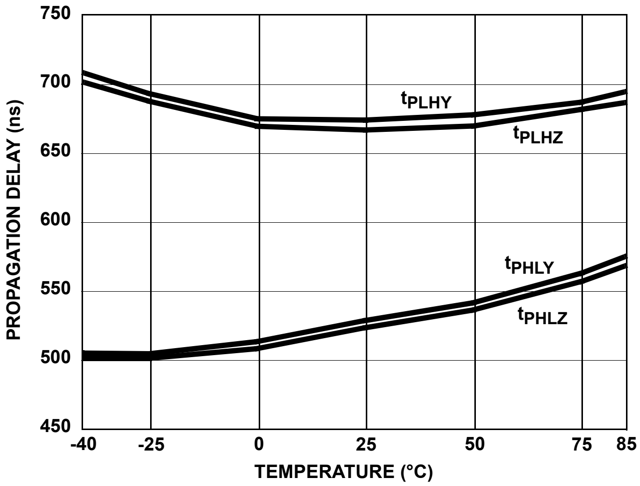


FIGURE 10. DRIVER PROPAGATION DELAY vs TEMPERATURE (ISL4489E)

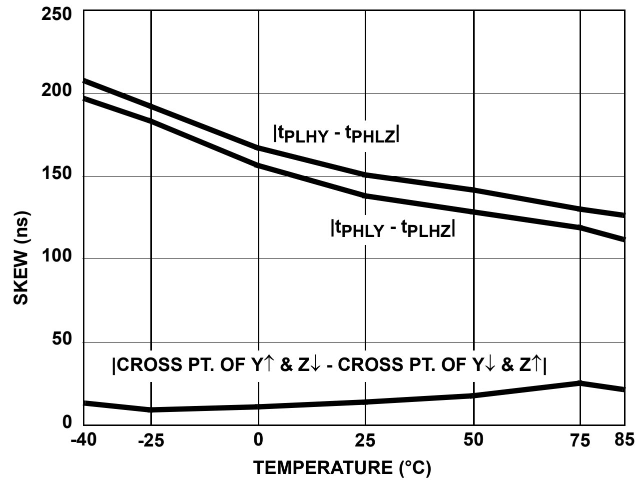


FIGURE 11. DRIVER SKEW vs TEMPERATURE (ISL4489E)

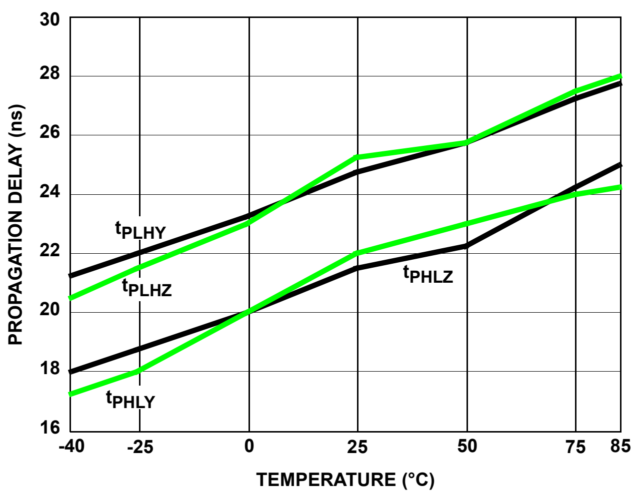


FIGURE 12. DRIVER PROPAGATION DELAY vs TEMPERATURE (ISL4491E)

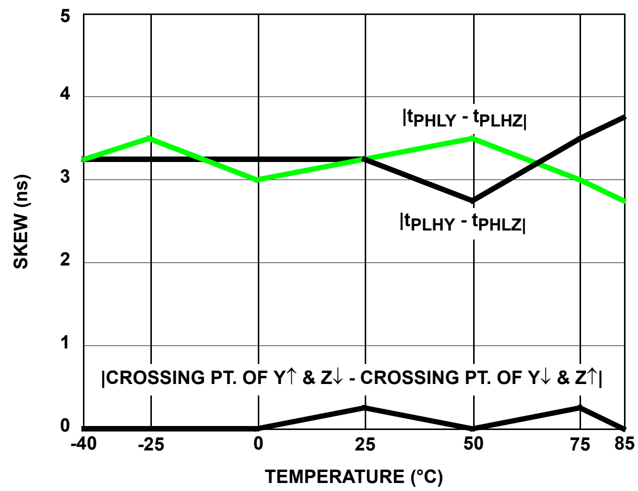


FIGURE 13. DRIVER SKEW vs TEMPERATURE (ISL4491E)

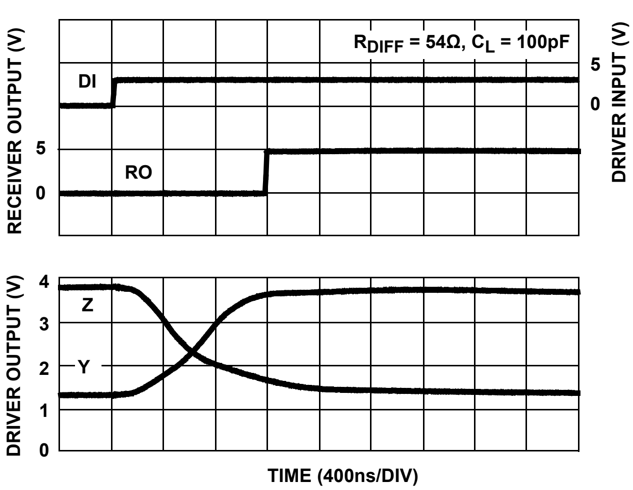


FIGURE 14. DRIVER AND RECEIVER WAVEFORMS, LOW TO HIGH (ISL4489E)

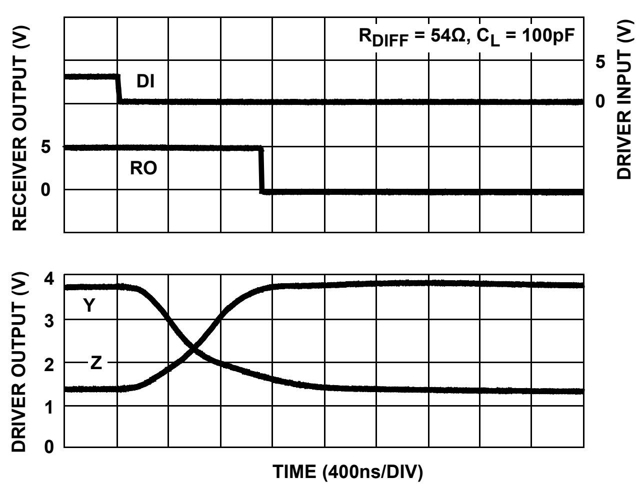


FIGURE 15. DRIVER AND RECEIVER WAVEFORMS, HIGH TO LOW (ISL4489E)

Typical Performance Curves V_{CC} = 5V, T_A = 25°C; Unless Otherwise Specified **(Continued)**

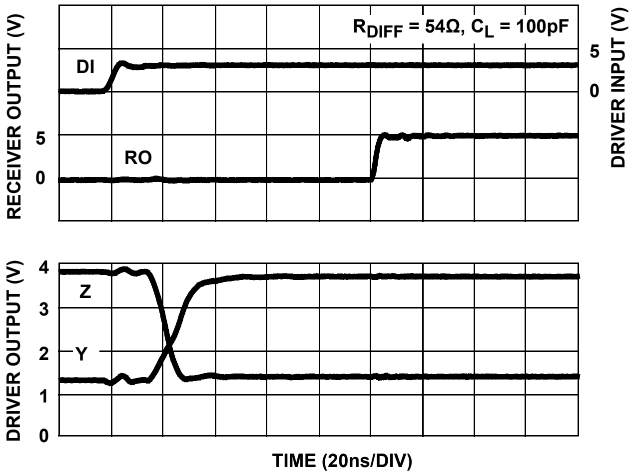


FIGURE 16. DRIVER AND RECEIVER WAVEFORMS, LOW TO HIGH (ISL4491E)

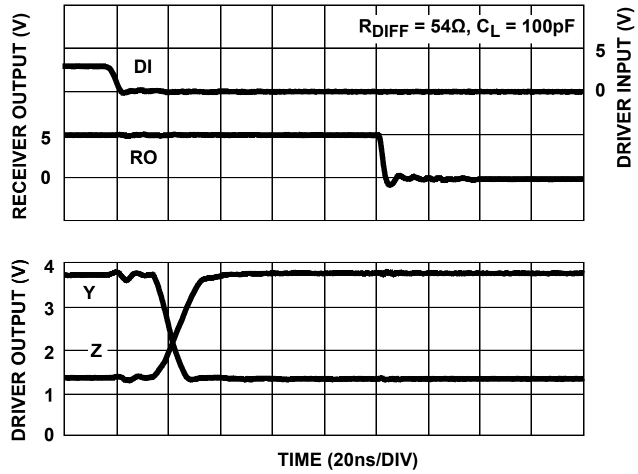


FIGURE 17. DRIVER AND RECEIVER WAVEFORMS, HIGH TO LOW (ISL4491E)

Die Characteristics

SUBSTRATE POTENTIAL (POWERED UP):

GND

TRANSISTOR COUNT:

518

PROCESS:

Si Gate BiCMOS

Revision History

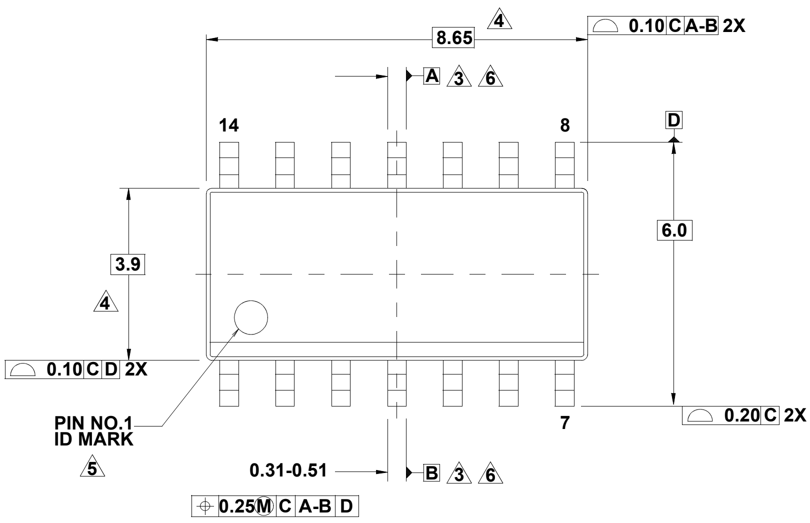
The revision history provided is for informational purposes only and is believed to be accurate, but not warranted. Please visit our website to make sure you have the latest revision.

DATE	REVISION	CHANGE
Sep 14, 2018	FN6074.4	Added Related Literature section. Updated first features bullet. Updated Ordering Information table by removing retired parts, adding Notes 1 and 3, added tape and reel parts and column. Updated the Typical Operating Circuit diagram on page 3. Added Revision History section. Updated POD M14.15 to the latest revision. Changes are as follows: - Add land pattern and moved dimensions from table onto drawing

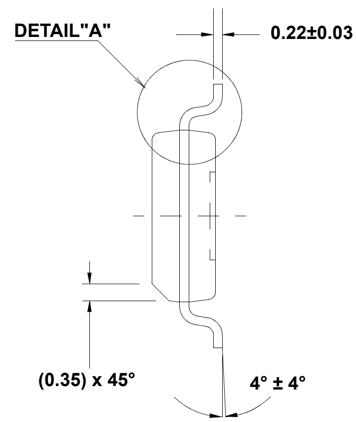
Package Outline Drawing

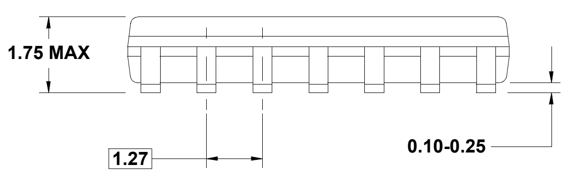
For the most recent package outline drawing, see M14.15.

M14.15
14 LEAD NARROW BODY SMALL OUTLINE PLASTIC PACKAGE
Rev 1, 10/09

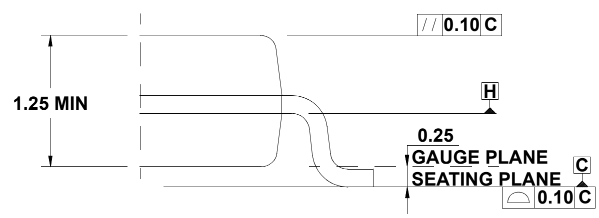


TOP VIEW

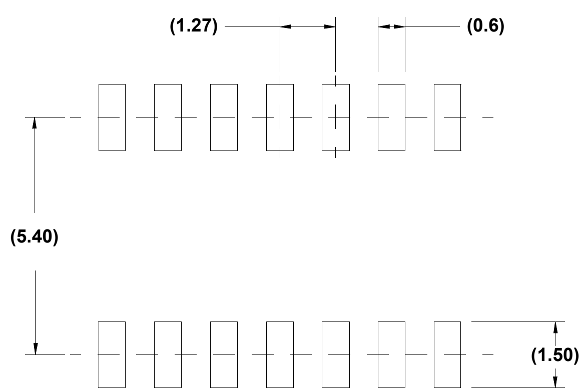




SIDE VIEW



DETAIL "A"



TYPICAL RECOMMENDED LAND PATTERN

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 indentifier 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.

SALES OFFICES Renesas Electronics Corporation http://www.renesas.com

Refer to "http://www.renesas.com/" for the latest and detailed information.

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Colophon 7.1