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DATASHEET

ISL32470E, ISL32472E, ISL32475E, ISL32478E

Fault Protected, Extended Common-Mode Range, RS-485/RS-422 Transceivers with ±16.5kV ESD

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The ISL32470E, ISL32472E, ISL32475E, and ISL32478E are fault-protected, extended common-mode range differential transceivers that exceed the RS-485 and RS-422 standards for balanced communication. The RS-485 bus pins (driver outputs and receiver inputs) are fault protected against overvoltages up to ±60V and are protected against ±16.5kV ESD strikes without latch-up. Additionally, these transceivers operate in environments with common-mode voltages up to ±15V (exceeds the RS-485 requirement), making this fault-protected RS-485 family one of the most robust on the market.

The transmitters (Tx) deliver an exceptional 2.5V (typical) differential output voltage into the RS-485 specified 54Ω load. This yields better noise immunity than standard RS-485 ICs or allows up to six 120Ω terminations in star topologies.

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 outputs feature high drive levels; typically, 15mA at V_{OL} = 1V (to ease the design of opto-coupled isolated interfaces).

Half duplex (Rx inputs and Tx outputs multiplexed together) and full duplex pinouts are available. See Table 1 on page 2 for key features and configurations by device number.

For a fault-protected RS-485 transceiver with a ±25V extended common-mode range, see the ISL32490E and ISL32483E datasheets.

Related Literature

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

- ISL32470E, ISL32472E, ISL32475E, and ISL32478E device pages

Features

- Fault protected RS-485 bus pins . . . . . Up to ±60V
- Extended common-mode range. . . . . ±15V larger than required for RS-485
- 1/4 unit load for up to 128 devices on the bus
- ±16.5kV HBM ESD protection on RS-485 bus pins
- High transient over-voltage tolerance . . . . . ±80V
- Full fail-safe (open, short, terminated) RS-485 receivers
- High Rx I_{OL} for opto-couplers in isolated designs
- Hot plug circuitry: Tx and Rx outputs remain three-state during power-up/power-down
- RS-485 data rates. . . . . .250kbps to 15Mbps
- Low quiescent supply current. 2.3mA
- Ultra low shutdown supply current. 10µA

Applications

- Utility meters and automated meter reading systems
- High node count RS-485 systems
- PROFIBUS and RS-485 based field bus networks, factory automation
- Security camera networks
- Building lighting and environmental control systems
- Industrial/process control networks

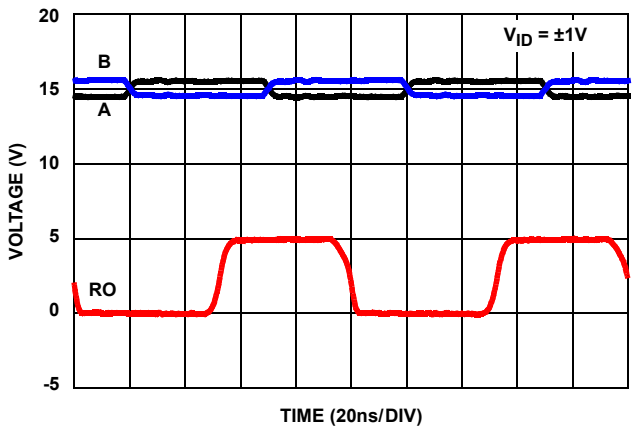


FIGURE 1. EXCEPTIONAL Rx OPERATES AT >15Mbps EVEN WITH ±15V COMMON-MODE VOLTAGE

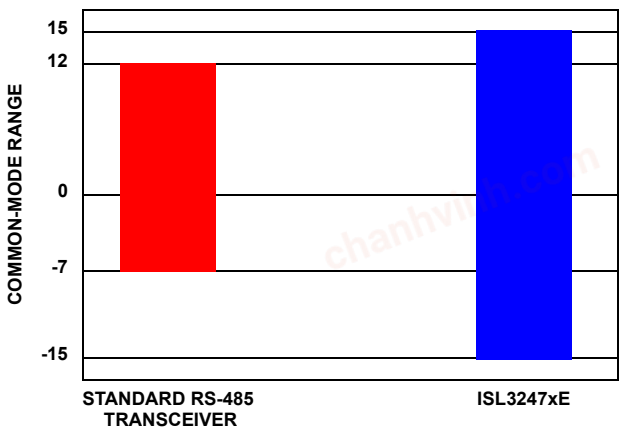


FIGURE 2. TRANSCEIVERS DELIVER SUPERIOR COMMON-MODE RANGE vs STANDARD RS-485 DEVICES

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TABLE 1. SUMMARY OF FEATURES

PART NUMBER	HALF/FULL DUPLEX	DATA RATE (Mbps)	SLEW-RATE LIMITED?	EN PINS?	HOT PLUG?	QUIESCENT I_{CC} (mA)	LOW POWER SHUTDOWN?	PIN COUNT
ISL32470E	Full	0.25	Yes	Yes	Yes	2.3	Yes	14
ISL32472E	Half	0.25	Yes	Yes	Yes	2.3	Yes	8
ISL32475E	Half	1	Yes	Yes	Yes	2.3	Yes	8
ISL32478E	Half	15	No	Yes	Yes	2.3	Yes	8

Typical Operating Circuits

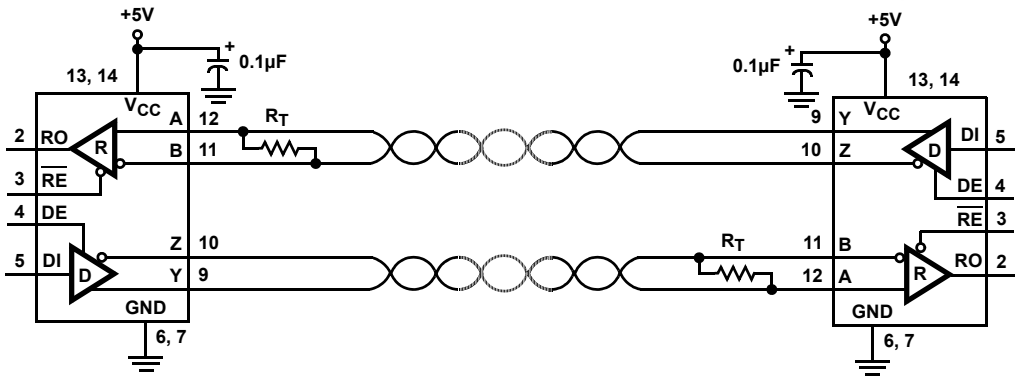


FIGURE 3. ISL32470E FULL DUPLEX EXAMPLE

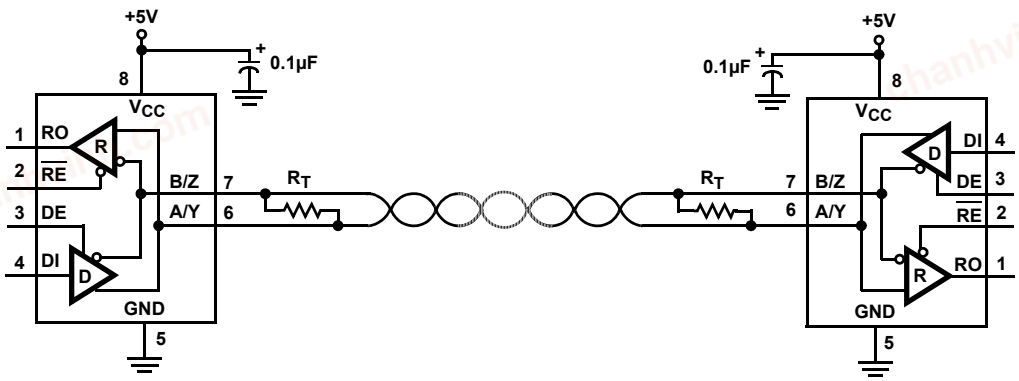


FIGURE 4. ISL32472E, ISL32475E, ISL32478E HALF DUPLEX EXAMPLE

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Ordering Information

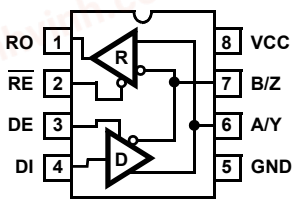
PART NUMBER (Notes 2, 3)	PART MARKING	TEMP. RANGE (°C)	TAPE AND REEL (Units) (Note 1)	PACKAGE (RoHS Compliant)	PKG. DWG. #
ISL32470EIBZ	ISL32470 EIBZ	-40 to +85	-	14 Ld SOIC	M14.15
ISL32470EIBZ -T	ISL32470 EIBZ	-40 to +85	2.5k	14 Ld SOIC	M14.15
ISL32470EIBZ -T7A	ISL32470 EIBZ	-40 to +85	250	14 Ld SOIC	M14.15
ISL32472EIBZ	32472 EIBZ	-40 to +85	-	8 Ld SOIC	M8.15
ISL32472EIBZ -T	32472 EIBZ	-40 to +85	2.5k	8 Ld SOIC	M8.15
ISL32472EIBZ-T7A	32472 EIBZ	-40 to +85	250	8 Ld SOIC	M8.15
ISL32475EIBZ	32475 EIBZ	-40 to +85	-	8 Ld SOIC	M8.15
ISL32475EIBZ-T	32475 EIBZ	-40 to +85	2.5k	8 Ld SOIC	M8.15
ISL32475EIBZ-T7A	32475 EIBZ	-40 to +85	250	8 Ld SOIC	M8.15
ISL32478EIBZ	32478 EIBZ	-40 to +85	-	8 Ld SOIC	M8.15
ISL32478EIBZ-T	32478 EIBZ	-40 to +85	2.5k	8 Ld SOIC	M8.15
ISL32478EIBZ-T7A	32478 EIBZ	-40 to +85	250	8 Ld SOIC	M8.15

NOTES:

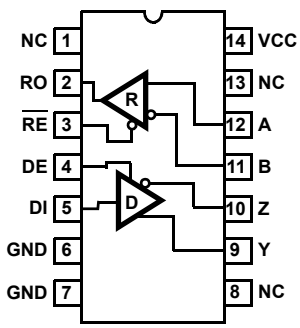
1. See TB347 for details about reel specifications.
2. These Pb-free plastic packaged products employ special Pb-free material sets, molding compounds/die attach materials, and 100% matte tin plate plus anneal (e3 termination finish, which is RoHS compliant and compatible with both SnPb and Pb-free soldering 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.
3. For Moisture Sensitivity Level (MSL), see the ISL32470E, ISL32472E, ISL32475E, ISL32478E device pages. For more information about MSL, see TB363.

Pin Configurations

ISL32472E, ISL32475E, ISL32478E
(8 LD SOIC)
TOP VIEW



ISL32470E
(14 LD SOIC)
TOP VIEW



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Pin Descriptions

PIN NAME	8 LD PIN #	14 LD PIN #	FUNCTION
RO	1	2	Receiver output. If A-B ≥ 10mV, RO is high; if A-B ≤ 200mV, RO is low; RO = high if A and B are unconnected (floating), shorted together, or connected to an undriven, terminated bus.
$\overline{RE}$	2	3	Receiver output enable. RO is enabled when $\overline{RE}$ is low; RO is high impedance when $\overline{RE}$ is high. Internally pulled low.
DE	3	4	Driver output enable. The driver outputs, Y and Z, are enabled by bringing DE high. They are high impedance when DE is low. Internally pulled high.
DI	4	5	Driver input. A low on DI forces output Y low and output Z high. A high on DI forces output Y high and output Z low.
GND	5	6, 7	Ground connection.
A/Y	6	-	±60V fault and ±16.5kV HBM ESD protected, RS-485/RS-422 level, non-inverting receiver input and non-inverting driver output. Pin is an input if DE = 0; pin is an output if DE = 1.
B/Z	7	-	±60V fault and ±16.5kV HBM ESD protected, RS-485/RS-422 level, inverting receiver input and inverting driver output. Pin is an input if DE = 0; pin is an output if DE = 1.
A	-	12	±60V fault and ±15kV HBM ESD protected, RS-485/RS-422 level, non-inverting receiver input.
B	-	11	±60V fault and ±15kV HBM ESD protected, RS-485/RS-422 level, inverting receiver input.
Y	-	9	±60V fault and ±15kV HBM ESD protected, RS-485/RS-422 level, non-inverting driver output.
Z	-	10	±60V fault and ±15kV HBM ESD protected, RS-485/RS-422 level, inverting driver output.
VCC	8	14	System power supply input (4.5V to 5.5V).
NC	-	1, 8, 13	No internal connection.

Truth Tables

TRANSMITTING				
INPUTS			OUTPUTS	
RE	DE	DI	Z	Y
X	1	1	0	1
X	1	0	1	0
0	0	X	High-Z	High-Z
1	0	X	High-Z (Note 4)	High-Z (Note 4)

NOTE:
4. Low Power Shutdown Mode (see Note 13 on page 9).

RECEIVING				
INPUTS				OUTPUT
RE	DE Half Duplex	DE Full Duplex	A-B	RO
0	0	X	≥ -0.01V	1
0	0	X	≤ -0.2V	0
0	0	X	Inputs Open/Shorted	1
1	0	0	X	High-Z (see Note 5)
1	1	1	X	High-Z

NOTE:
5. Low Power Shutdown Mode (see Note 13 on page 9).

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Absolute Maximum Ratings

V_{CC} to Ground 7V
Input Voltages
DI, DE, $\overline{RE}$. . . . . -0.3V to (V_{CC} + 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, Note 17). . . . . ±80V
RO . . . . . -0.3V to (V_{CC} +0.3V)
Short-Circuit Duration
Y, Z . . . . . Indefinite
ESD Rating . . . . . see "ESD PERFORMANCE" on page 6
Latch-Up (per JESD78, Level 2, Class A) . . . . . +125°C

Thermal Information

Thermal Resistance (Typical)	θ_{JA} (°C/W)	θ_{JC} (°C/W)
8 Ld SOIC Package (Notes 6, 7)	108	47
14 Ld SOIC Package (Notes 6, 7)	88	39

Maximum Junction Temperature (Plastic Package). . . . . +150°C
Maximum Storage Temperature Range . . . . . -65°C to +150°C
Pb-Free Reflow Profile . . . . . see TB493

Recommended Operating Conditions

Supply Voltage (V_{CC}). 5V
Temperature Range . . . . . -40°C to +85°C
Bus Pin Common-Mode Voltage Range. . . . . -15V to +15V

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:

6. θ_{JA} is measured with the component mounted on a high-effective thermal conductivity test board in free air. See TB379 for details.
7. For θ_{JC}, the "case temp" location is taken at the package top center.

Electrical Specifications

Test Conditions: V_{CC} = 4.5V to 5.5V; unless otherwise specified. Typical values are V_{CC} = 5V, T_A = +25°C (Note 8). **Boldface limits apply over the operating temperature range, -40°C to +85°C.**

PARAMETER	SYMBOL	TEST CONDITIONS	TEMP (°C)	MIN (Note 16)	TYP	MAX (Note 16)	UNIT
DC CHARACTERISTICS							
Driver Differential V_{OUT} (No load)	V_{OD1}		Full	-	-	V_{CC}	V
Driver Differential V_{OUT} (Loaded, Figure 5A)	V_{OD2}	R_L = 100Ω (RS-422)	Full	2.4	3.2	-	V
		R_L = 54Ω (RS-485)	Full	1.5	2.5	V_{CC}	V
		R_L = 54Ω (PROFIBUS, V_{CC} ≥ 5V)	Full	2.0	2.5	-	V
		R_L = 21Ω (six 120Ω terminations for star configurations, V_{CC} ≥ 4.75V)	Full	0.8	1.3	-	V
Change in Magnitude of Driver Differential V_{OUT} for Complementary Output States	ΔV_{OD}	R_L = 54Ω or 100Ω (Figure 5A)	Full	-	-	0.2	V
Driver Differential V_{OUT} with Common-Mode Load (Figure 5B)	V_{OD3}	R_L = 60Ω, -7V ≤ V_{CM} ≤ 12V	Full	1.5	2.1	V_{CC}	V
		R_L = 60Ω, -15V ≤ V_{CM} ≤ 15V (V_{CC} ≥ 4.75V)	Full	1.7	2.3	-	V
Driver Common-Mode V_{OUT} (Figure 5A)	V_{OC}	R_L = 54Ω or 100Ω	Full	-1	-	3	V
Change in Magnitude of Driver Common-Mode V_{OUT} for Complementary Output States	ΔV_{OC}	R_L = 54Ω or 100Ω (Figure 5A)	Full	-	-	0.2	V
Driver Short-Circuit Current	I_{OSD}	DE = V_{CC}, -15V ≤ V_O ≤ 15V (Note 10)	Full	-250	-	250	mA
	I_{OSD1}	At first foldback, 22V ≤ V_O ≤ -22V	Full	-83	-	83	mA
	I_{OSD2}	At second foldback, 35V ≤ V_O ≤ -35V	Full	-13	-	13	mA
Logic Input High Voltage	V_{IH}	DE, DI, $\overline{RE}$	Full	2.5	-	-	V
Logic Input Low Voltage	V_{IL}	DE, DI, $\overline{RE}$	Full	-	-	0.8	V
Logic Input Current	I_{IN1}	DI	Full	-1	-	1	µA
		DE, $\overline{RE}$	Full	-15	6	15	µA

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Electrical Specifications Test Conditions: V_{CC} = 4.5V to 5.5V; unless otherwise specified. Typical values are V_{CC} = 5V, T_A = +25°C (Note 8). **Boldface limits apply over the operating temperature range, -40°C to +85°C.** (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS		TEMP (°C)	MIN (Note 16)	TYP	MAX (Note 16)	UNIT
Input/Output Current (A/Y, B/Z)	I_{IN2}	DE = 0V, V_{CC} = 0V or 5.5V	V_{IN} = 12V	Full	-	110	**250**	µA
			V_{IN} = -7V	Full	**-200**	-75	-	µA
			V_{IN} = ±15V	Full	**-800**	±240	**800**	µA
			V_{IN} = ±60V (Note 18)	Full	**-6**	±0.5	**6**	mA
Input Current (A, B) (Full Duplex Versions Only)	I_{IN3}	V_{CC} = 0V or 5.5V	V_{IN} = 12V	Full	-	90	**125**	µA
			V_{IN} = -7V	Full	**-100**	-70	-	µA
			V_{IN} = ±15V	Full	**-500**	±200	**500**	µA
			V_{IN} = ±60V (Note 18)	Full	**-3**	±0.4	**3**	mA
Output Leakage Current (Y, Z) (Full Duplex Versions Only)	I_{OZD}	$\overline{RE}$ = 0V, DE = 0V, V_{CC} = 0V or 5.5V	V_{IN} = 12V	Full	-	20	**200**	µA
			V_{IN} = -7V	Full	**-100**	-5	-	µA
			V_{IN} = ±15V	Full	**-500**	±40	**500**	µA
			V_{IN} = ±60V (Note 18)	Full	**-3**	±0.1	**3**	mA
Receiver Differential Threshold Voltage	V_{TH}	-15V ≤ V_{CM} ≤ 15V		Full	**-200**	-100	**-10**	mV
Receiver Input Hysteresis	ΔV_{TH}	-15V ≤ V_{CM} ≤ 15V		25	-	25	-	mV
Receiver Output High Voltage	V_{OH}	I_O = -2mA, V_{ID} = -10mV		Full	**V_{CC} - 0.5**	4.75	-	V
		I_O = -8mA, V_{ID} = -10mV		Full	**2.8**	4.2	-	V
Receiver Output Low Voltage	V_{OL}	I_O = 6mA, V_{ID} = -200mV		Full	-	0.27	**0.4**	V
Receiver Output Low Current	I_{OL}	V_O = 1V, V_{ID} = -200mV		Full	**15**	22	-	mA
Three-State (High Impedance) Receiver Output Current	I_{OZR}	0V ≤ V_O ≤ V_{CC}		Full	**-1**	0.01	**1**	µA
Receiver Short-Circuit Current	I_{OSR}	0V ≤ V_O ≤ V_{CC}		Full	**±12**	-	**±110**	mA
SUPPLY CURRENT								
No-Load Supply Current (Note 9)	I_{CC}	DE = V_{CC}, $\overline{RE}$ = 0V or V_{CC}, DI = 0V or V_{CC}		Full	-	2.3	**4.5**	mA
Shutdown Supply Current	I_{SHDN}	DE = 0V, $\overline{RE}$ = V_{CC}, DI = 0V or V_{CC}		Full	-	10	**50**	µA
ESD PERFORMANCE								
RS-485 Pins (A, Y, B, Z, A/Y, B/Z)		Human Body Model, from Bus Pins to GND	1/2 Duplex	25	-	±16.5	-	kV
			Full Duplex	25	-	±15	-	kV
All Pins		Human Body Model, per JEDEC		25	-	±8	-	kV
		Machine Model		25	-	±700	-	V
DRIVER SWITCHING CHARACTERISTICS (250kbps Versions; ISL32470E and ISL32472E)								
Driver Differential Output Delay	t_{PLH}, t_{PHL}	R_D = 54Ω, C_D = 50pF (Figure 6)		Full	-	320	**450**	ns
Driver Differential Output Skew	t_{SKEW}	R_D = 54Ω, C_D = 50pF (Figure 6)		Full	-	6	**30**	ns
Driver Differential Rise or Fall Time	t_R, t_F	R_D = 54Ω, C_D = 50pF (Figure 6)		Full	**400**	650	**1200**	ns

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Electrical Specifications Test Conditions: V_{CC} = 4.5V to 5.5V; unless otherwise specified. Typical values are V_{CC} = 5V, T_A = +25°C (Note 8). **Boldface limits apply over the operating temperature range, -40°C to +85°C.** (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS	TEMP (°C)	MIN (Note 16)	TYP	MAX (Note 16)	UNIT
Maximum Data Rate	f_{MAX}	C_D = 820pF (Figure 8)	Full	**0.25**	1.5	-	Mbps
Driver Enable to Output High	t_{ZH}	SW = GND (Figure 7), (Note 11)	Full	-	-	**1200**	ns
Driver Enable to Output Low	t_{ZL}	SW = V_{CC} (Figure 7), (Note 11)	Full	-	-	**1200**	ns
Driver Disable from Output Low	t_{LZ}	SW = V_{CC} (Figure 7)	Full	-	-	**120**	ns
Driver Disable from Output High	t_{HZ}	SW = GND (Figure 7)	Full	-	-	**120**	ns
Time to Shutdown	t_{SHDN}	(Note 13)	Full	**60**	160	**600**	ns
Driver Enable from Shutdown to Output High	$t_{ZH(SHDN)}$	SW = GND (Figure 7), (Notes 13, 14)	Full	-	-	**2500**	ns
Driver Enable from Shutdown to Output Low	$t_{ZL(SHDN)}$	SW = V_{CC} (Figure 7), (Notes 13, 14)	Full	-	-	**2500**	ns
DRIVER SWITCHING CHARACTERISTICS (1Mbps Versions; ISL32475E)							
Driver Differential Output Delay	t_{PLH}, t_{PHL}	R_D = 54Ω, C_D = 50pF (Figure 6)	Full	-	70	**125**	ns
Driver Differential Output Skew	t_{SKEW}	R_D = 54Ω, C_D = 50pF (Figure 6)	Full	-	4.5	**15**	ns
Driver Differential Rise or Fall Time	t_R, t_F	R_D = 54Ω, C_D = 50pF (Figure 6)	Full	**70**	170	**300**	ns
Maximum Data Rate	f_{MAX}	C_D = 820pF (Figure 8)	Full	**1**	4	-	Mbps
Driver Enable to Output High	t_{ZH}	SW = GND (Figure 7), (Note 11)	Full	-	-	**350**	ns
Driver Enable to Output Low	t_{ZL}	SW = V_{CC} (Figure 7), (Note 11)	Full	-	-	**300**	ns
Driver Disable from Output Low	t_{LZ}	SW = V_{CC} (Figure 7)	Full	-	-	**120**	ns
Driver Disable from Output High	t_{HZ}	SW = GND (Figure 7)	Full	-	-	**120**	ns
Time to Shutdown	t_{SHDN}	(Note 13)	Full	**60**	160	**600**	ns
Driver Enable from Shutdown to Output High	$t_{ZH(SHDN)}$	SW = GND (Figure 7), (Notes 13, 14)	Full	-	-	**2000**	ns
Driver Enable from Shutdown to Output Low	$t_{ZL(SHDN)}$	SW = V_{CC} (Figure 7), (Notes 13, 14)	Full	-	-	**2000**	ns
DRIVER SWITCHING CHARACTERISTICS (15Mbps Versions; ISL32478E)							
Driver Differential Output Delay	t_{PLH}, t_{PHL}	R_D = 54Ω, C_D = 50pF (Figure 6)	Full	-	21	**45**	ns
Driver Differential Output Skew	t_{SKEW}	R_D = 54Ω, C_D = 50pF (Figure 6)	Full	-	3	**6**	ns
Driver Differential Rise or Fall Time	t_R, t_F	R_D = 54Ω, C_D = 50pF (Figure 6)	Full	**5**	17	**30**	ns
Maximum Data Rate	f_{MAX}	C_D = 470pF (Figure 8)	Full	**15**	25	-	Mbps
Driver Enable to Output High	t_{ZH}	SW = GND (Figure 7), (Note 11)	Full	-	-	**100**	ns
Driver Enable to Output Low	t_{ZL}	SW = V_{CC} (Figure 7), (Note 11)	Full	-	-	**100**	ns
Driver Disable from Output Low	t_{LZ}	SW = V_{CC} (Figure 7)	Full	-	-	**120**	ns
Driver Disable from Output High	t_{HZ}	SW = GND (Figure 7)	Full	-	-	**120**	ns
Time to Shutdown	t_{SHDN}	(Note 13)	Full	**60**	160	**600**	ns
Driver Enable from Shutdown to Output High	$t_{ZH(SHDN)}$	SW = GND (Figure 7), (Notes 13, 14)	Full	-	-	**2000**	ns
Driver Enable from Shutdown to Output Low	$t_{ZL(SHDN)}$	SW = V_{CC} (Figure 7), (Notes 13, 14)	Full	-	-	**2000**	ns

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Electrical Specifications Test Conditions: V_{CC} = 4.5V to 5.5V; unless otherwise specified. Typical values are V_{CC} = 5V, T_A = +25°C (Note 8). **Boldface limits apply over the operating temperature range, -40°C to +85°C.** (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS	TEMP (°C)	MIN (Note 16)	TYP	MAX (Note 16)	UNIT
RECEIVER SWITCHING CHARACTERISTICS (250kbps Versions; ISL32470E and ISL32472E)							
Maximum Data Rate	f_{MAX}	(Figure 9)	Full	**0.25**	5	-	Mbps
Receiver Input to Output Delay	t_{PLH}, t_{PHL}	(Figure 9)	Full	-	200	**280**	ns
Receiver Skew | tPLH - tPHL |	t_{SKD}	(Figure 9)	Full	-	4	**10**	ns
Receiver Enable to Output Low	t_{ZL}	R_L = 1kΩ, C_L = 15pF, SW = V_{CC} (Figure 10), (Note 12)	Full	-	-	**50**	ns
Receiver Enable to Output High	t_{ZH}	R_L = 1kΩ, C_L = 15pF, SW = GND (Figure 10), (Note 12)	Full	-	-	**50**	ns
Receiver Disable from Output Low	t_{LZ}	R_L = 1kΩ, C_L = 15pF, SW = V_{CC} (Figure 10)	Full	-	-	**50**	ns
Receiver Disable from Output High	t_{HZ}	R_L = 1kΩ, C_L = 15pF, SW = GND (Figure 10)	Full	-	-	**50**	ns
Time to Shutdown	t_{SHDN}	(Note 13)	Full	**60**	160	**600**	ns
Receiver Enable from Shutdown to Output High	$t_{ZH(SHDN)}$	R_L = 1kΩ, C_L = 15pF, SW = GND (Figure 10), (Notes 13, 15)	Full	-	-	**2000**	ns
Receiver Enable from Shutdown to Output Low	$t_{ZL(SHDN)}$	R_L = 1kΩ, C_L = 15pF, SW = V_{CC} (Figure 10), (Notes 13, 15)	Full	-	-	**2000**	ns
RECEIVER SWITCHING CHARACTERISTICS (1Mbps Versions; ISL32475E)							
Maximum Data Rate	f_{MAX}	(Figure 9)	Full	**1**	15	-	Mbps
Receiver Input to Output Delay	t_{PLH}, t_{PHL}	(Figure 9)	Full	-	90	**150**	ns
Receiver Skew | t_{PLH} - tPH |	t_{SKD}	(Figure 9)	Full	-	4	**10**	ns
Receiver Enable to Output Low	t_{ZL}	R_L = 1kΩ, C_L = 15pF, SW = V_{CC} (Figure 10), (Note 12)	Full	-	-	**50**	ns
Receiver Enable to Output High	t_{ZH}	R_L = 1kΩ, C_L = 15pF, SW = GND (Figure 10), (Note 12)	Full	-	-	**50**	ns
Receiver Disable from Output Low	t_{LZ}	R_L = 1kΩ, C_L = 15pF, SW = V_{CC} (Figure 10)	Full	-	-	**50**	ns
Receiver Disable from Output High	t_{HZ}	R_L = 1kΩ, C_L = 15pF, SW = GND (Figure 10)	Full	-	-	**50**	ns
Time to Shutdown	t_{SHDN}	(Note 13)	Full	**60**	160	**600**	ns
Receiver Enable from Shutdown to Output High	$t_{ZH(SHDN)}$	R_L = 1kΩ, C_L = 15pF, SW = GND (Figure 10), (Notes 13, 15)	Full	-	-	**2000**	ns
Receiver Enable from Shutdown to Output Low	$t_{ZL(SHDN)}$	R_L = 1kΩ, C_L = 15pF, SW = V_{CC} (Figure 10), (Notes 13, 15)	Full	-	-	**2000**	ns
RECEIVER SWITCHING CHARACTERISTICS (15Mbps Versions; ISL32478E)							
Maximum Data Rate	f_{MAX}	(Figure 9)	Full	**15**	25	-	Mbps
Receiver Input to Output Delay	t_{PLH}, t_{PHL}	(Figure 9)	Full	-	35	**70**	ns
Receiver Skew | t_{PLH} - t_{PHL} |	t_{SKD}	(Figure 9)	Full	-	4	**10**	ns
Receiver Enable to Output Low	t_{ZL}	R_L = 1kΩ, C_L = 15pF, SW = V_{CC} (Figure 10), (Note 12)	Full	-	-	**50**	ns
Receiver Enable to Output High	t_{ZH}	R_L = 1kΩ, C_L = 15pF, SW = GND (Figure 10), (Note 12)	Full	-	-	**50**	ns
Receiver Disable from Output Low	t_{LZ}	R_L = 1kΩ, C_L = 15pF, SW = V_{CC} (Figure 10)	Full	-	-	**50**	ns
Receiver Disable from Output High	t_{HZ}	R_L = 1kΩ, C_L = 15pF, SW = GND (Figure 10)	Full	-	-	**50**	ns

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Electrical Specifications Test Conditions: V_{CC} = 4.5V to 5.5V; unless otherwise specified. Typical values are V_{CC} = 5V, T_A = +25°C (Note 8). **Boldface limits apply over the operating temperature range, -40°C to +85°C.** (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS	TEMP (°C)	MIN (Note 16)	TYP	MAX (Note 16)	UNIT
Time to Shutdown	t_{SHDN}	(Note 13)	Full	**60**	160	**600**	ns
Receiver Enable from Shutdown to Output High	$t_{ZH(SHDN)}$	R_L = 1kΩ, C_L = 15pF, SW = GND (Figure 10), (Notes 13, 15)	Full	-	-	**2000**	ns
Receiver Enable from Shutdown to Output Low	$t_{ZL(SHDN)}$	R_L = 1kΩ, C_L = 15pF, SW = V_{CC} (Figure 10), (Notes 13, 15)	Full	-	-	**2000**	ns

NOTES:

8. 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.
9. Supply current specification is valid for loaded drivers when DE = 0V.
10. Applies to peak current. See "Typical Performance Curves" beginning on page 5 for more information.
11. Keep $\overline{RE}$ = 0 to prevent the device from entering shutdown.
12. The $\overline{RE}$ signal high time must be short enough (typically <100ns) to prevent the device from entering shutdown.
13. 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 enter shutdown. See "Low Power Shutdown Mode" on page 17.
14. Keep $\overline{RE}$ = V_{CC} and set the DE signal low time >600ns to ensure that the device enters shutdown.
15. Set the $\overline{RE}$ signal high time >600ns to ensure that the device enters shutdown.
16. Compliance to datasheet limits is assured by one or more methods: production test, characterization, and/or design.
17. Tested according to TIA/EIA-485-A, Section 4.2.6 (±80V for 15µs at a 1% duty cycle).
18. See the Caution statement in "Absolute Maximum Ratings" on page 5.

Test Circuits and Waveforms

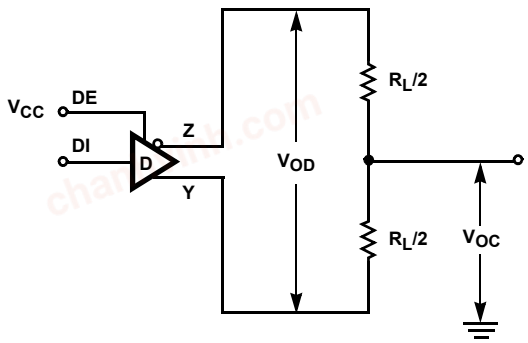


FIGURE 5A. V_{OD} AND V_{OC}

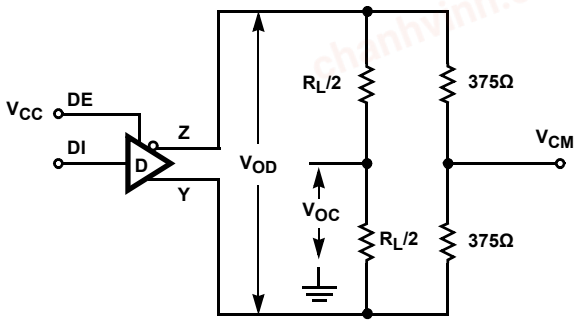


FIGURE 5B. V_{OD} AND V_{OC} WITH COMMON-MODE LOAD

FIGURE 5. DC DRIVER TEST CIRCUITS

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Test Circuits and Waveforms (Continued)

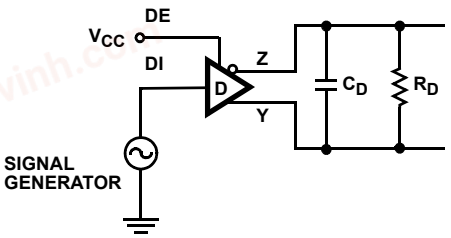


FIGURE 6A. TEST CIRCUIT

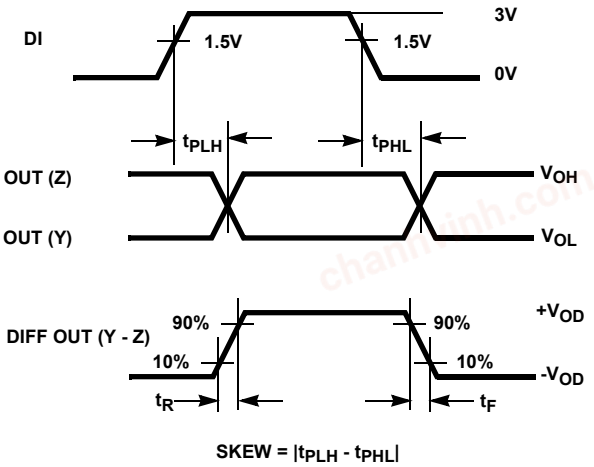
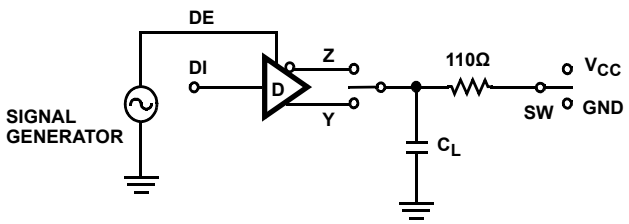


FIGURE 6B. MEASUREMENT POINTS

FIGURE 6. DRIVER PROPAGATION DELAY AND DIFFERENTIAL TRANSITION TIMES



PARAMETER	OUTPUT	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 11)	1/0	GND	100
t_{ZL}	Y/Z	0 (Note 11)	0/1	V_{CC}	100
$t_{ZH(SHDN)}$	Y/Z	1 (Note 14)	1/0	GND	100
$t_{ZL(SHDN)}$	Y/Z	1 (Note 14)	0/1	V_{CC}	100

FIGURE 7A. TEST CIRCUIT

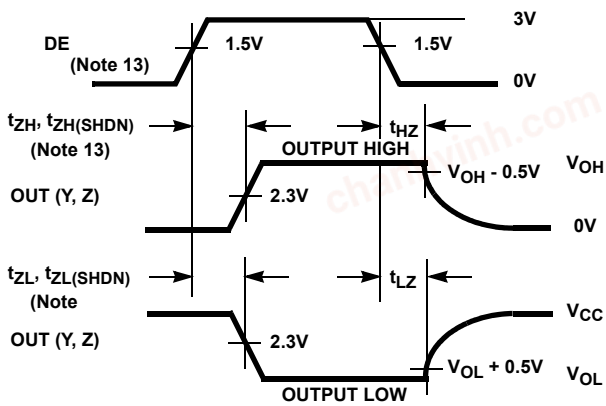


FIGURE 7B. MEASUREMENT POINTS

FIGURE 7. DRIVER ENABLE AND DISABLE TIMES

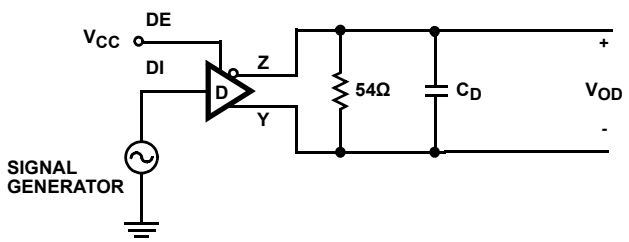


FIGURE 8A. TEST CIRCUIT

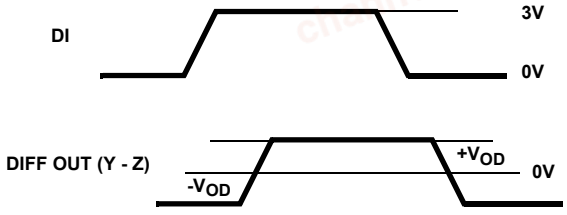


FIGURE 8B. MEASUREMENT POINTS

FIGURE 8. DRIVER DATA RATE

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Test Circuits and Waveforms (Continued)

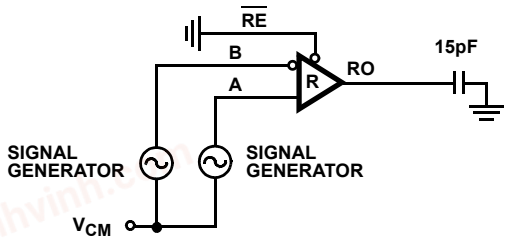


FIGURE 9A. TEST CIRCUIT

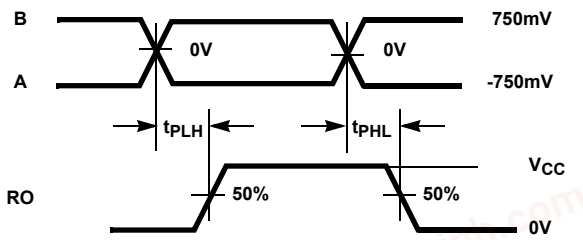
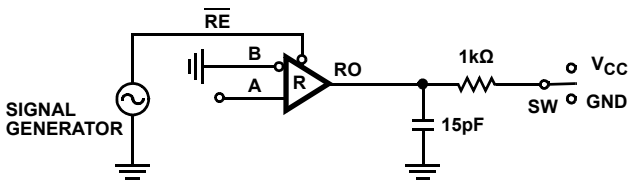


FIGURE 9B. MEASUREMENT POINTS

FIGURE 9. 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 12)	0	+1.5V	GND
t_{ZL} (Note 12)	0	-1.5V	V_{CC}
$t_{ZH(SHDN)}$ (Note 15)	0	+1.5V	GND
$t_{ZL(SHDN)}$ (Note 15)	0	-1.5V	V_{CC}

FIGURE 10A. TEST CIRCUIT

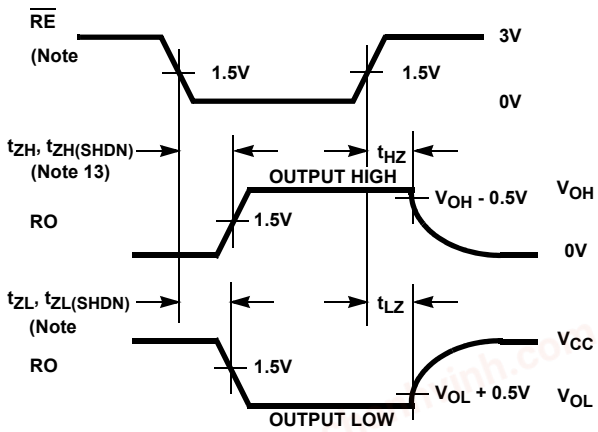


FIGURE 10B. MEASUREMENT POINTS

FIGURE 10. RECEIVER ENABLE AND DISABLE TIMES

Typical Performance Curves V_{CC} = 5V, T_A = +25°C; unless otherwise specified.

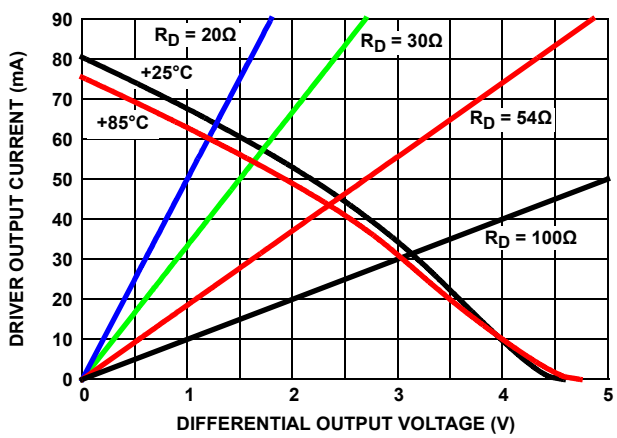


FIGURE 11. DRIVER OUTPUT CURRENT vs DIFFERENTIAL OUTPUT VOLTAGE

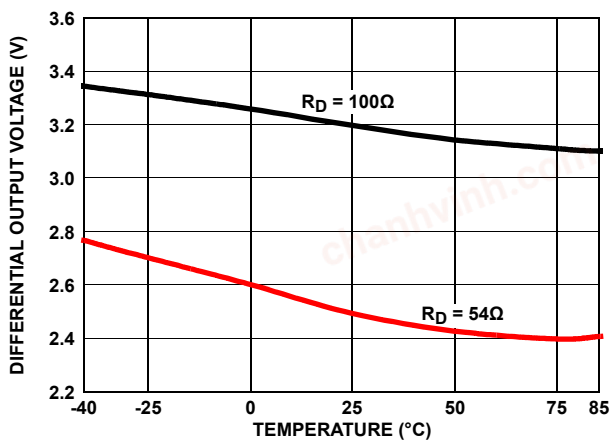


FIGURE 12. DRIVER DIFFERENTIAL OUTPUT VOLTAGE vs TEMPERATURE

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Typical Performance Curves V_{CC} = 5V, T_A = +25°C; unless otherwise specified. (Continued)

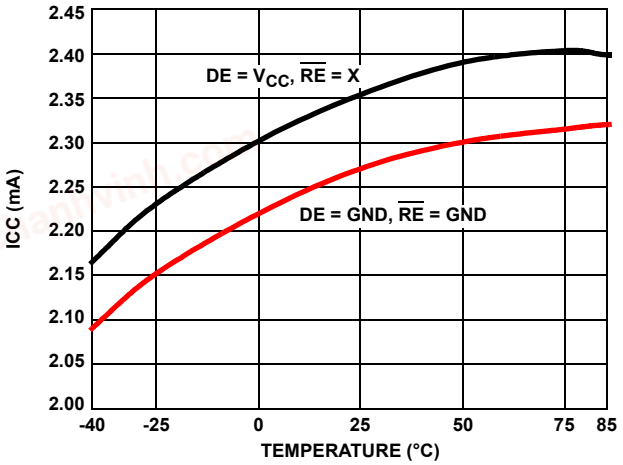


FIGURE 13. SUPPLY CURRENT vs TEMPERATURE

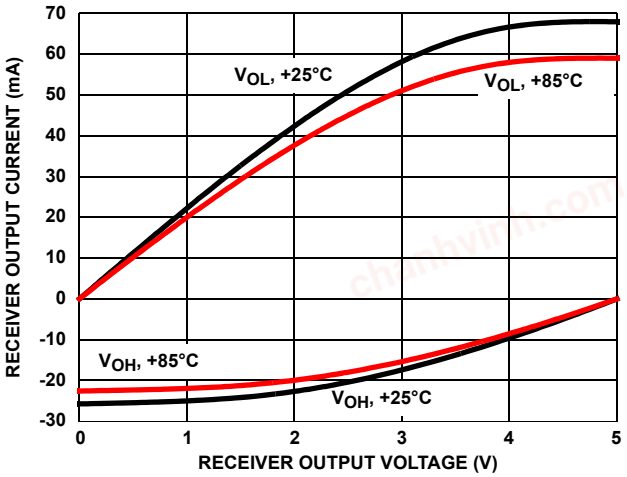


FIGURE 14. RECEIVER OUTPUT CURRENT vs RECEIVER OUTPUT VOLTAGE

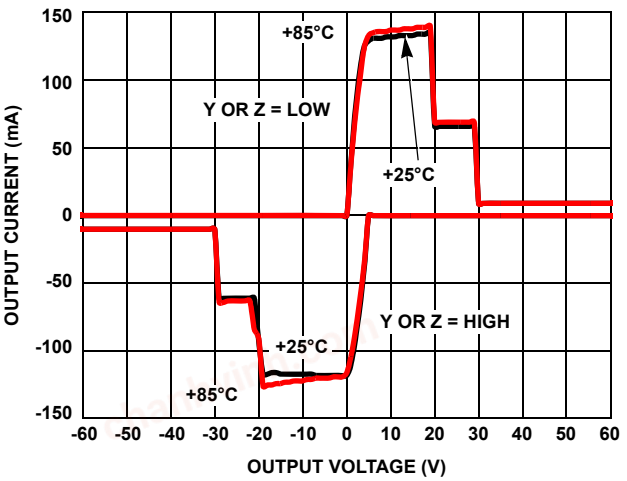


FIGURE 15. DRIVER OUTPUT CURRENT vs SHORT-CIRCUIT VOLTAGE

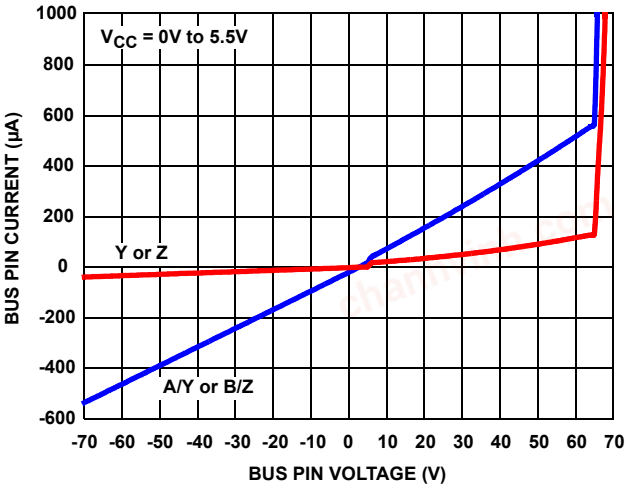


FIGURE 16. BUS PIN CURRENT vs BUS PIN VOLTAGE

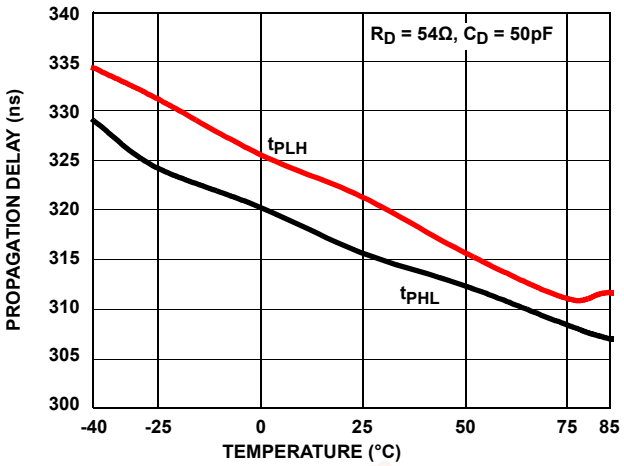


FIGURE 17. DRIVER DIFFERENTIAL PROPAGATION DELAY vs TEMPERATURE (ISL32470E, ISL32472E)

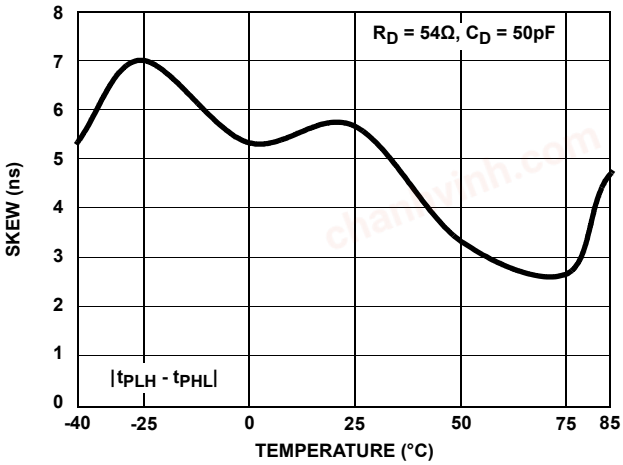


FIGURE 18. DRIVER DIFFERENTIAL SKEW vs TEMPERATURE (ISL32470E, ISL32472E)

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Typical Performance Curves V_{CC} = 5V, T_A = +25°C; unless otherwise specified. (Continued)

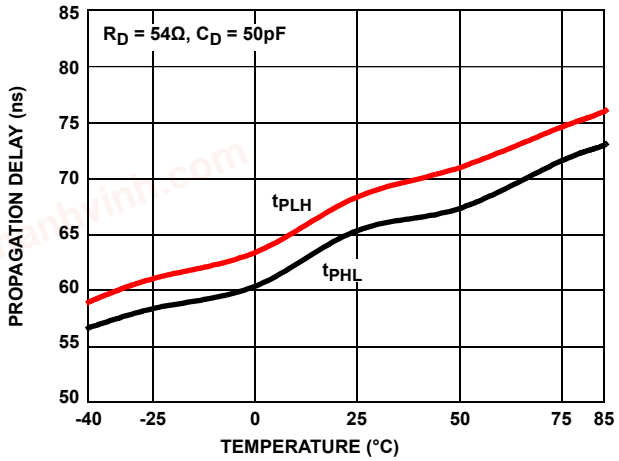


FIGURE 19. DRIVER DIFFERENTIAL PROPAGATION DELAY vs TEMPERATURE (ISL32475E)

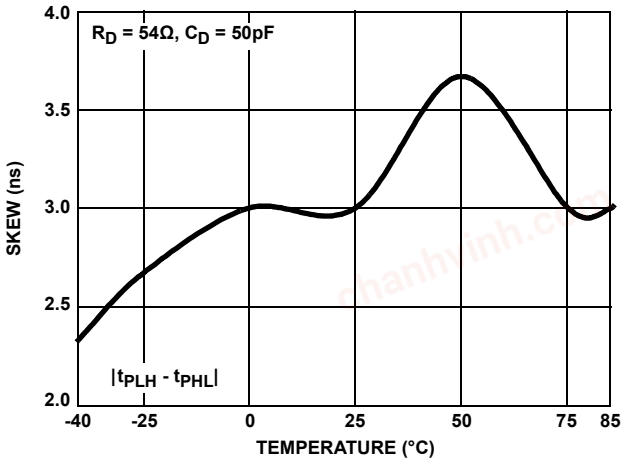


FIGURE 20. DRIVER DIFFERENTIAL SKEW vs TEMPERATURE (ISL32475E)

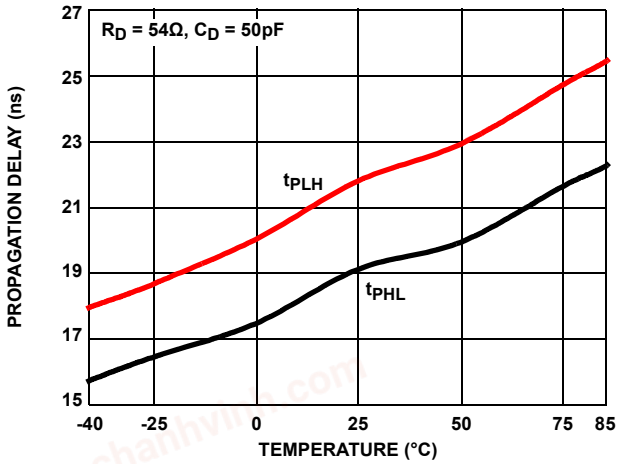


FIGURE 21. DRIVER DIFFERENTIAL PROPAGATION DELAY vs TEMPERATURE (ISL32478E)

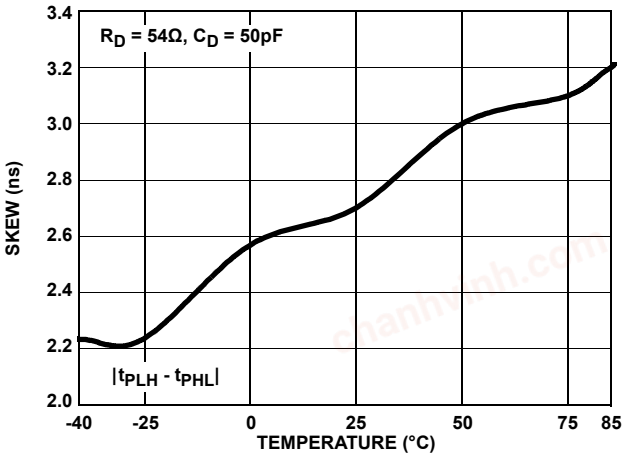


FIGURE 22. DRIVER DIFFERENTIAL SKEW vs TEMPERATURE (ISL32478E)

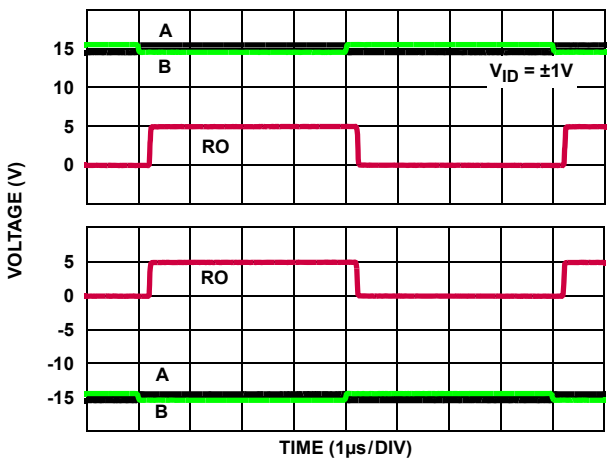


FIGURE 23. RECEIVER PERFORMANCE WITH ±15V CMV (ISL32470E, ISL32472E)

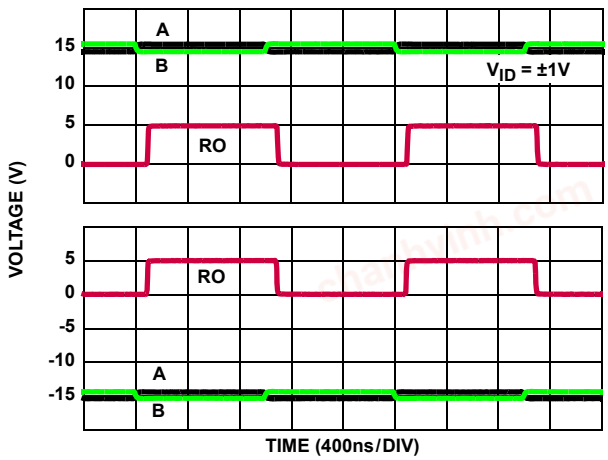


FIGURE 24. RECEIVER PERFORMANCE WITH ±15V CMV (ISL32475E)

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Typical Performance Curves V_{CC} = 5V, T_A = +25°C; unless otherwise specified. (Continued)

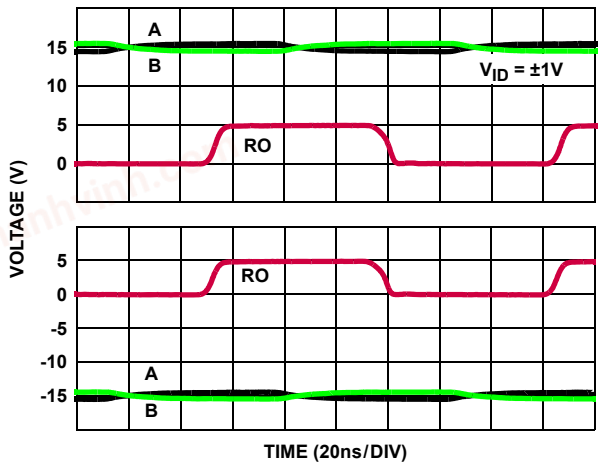


FIGURE 25. RECEIVER PERFORMANCE WITH ±15V CMV (ISL32478E)

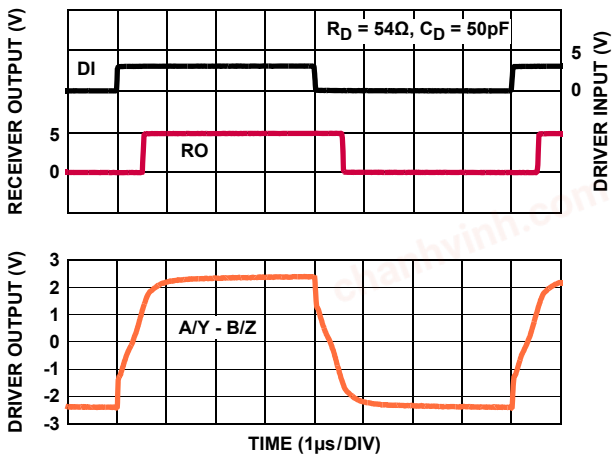


FIGURE 26. DRIVER AND RECEIVER WAVEFORMS (ISL32470E, ISL32472E)

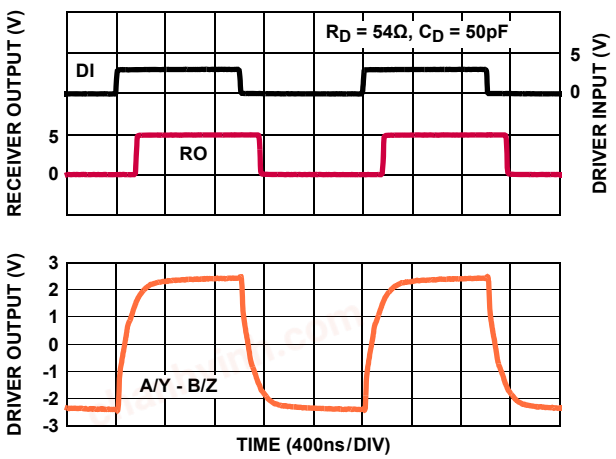


FIGURE 27. DRIVER AND RECEIVER WAVEFORMS (ISL32475E)

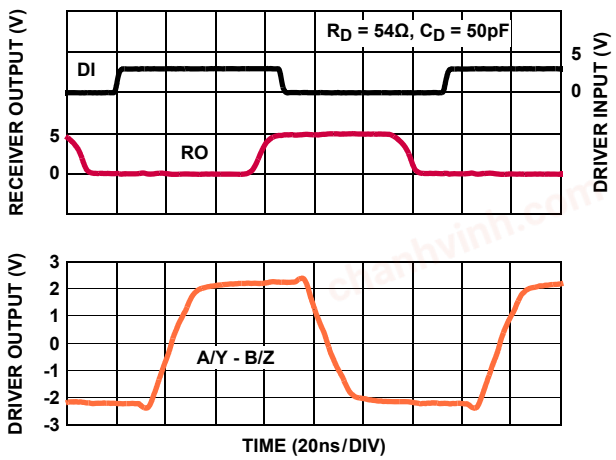


FIGURE 28. DRIVER AND RECEIVER WAVEFORMS (ISL32478E)

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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 (assuming one-unit load devices) receivers 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; thus, the wide CMR is necessary to handle ground potential differences and voltages induced in the cable by external fields.

The ISL3247xE devices are a family of ruggedized RS-485 transceivers that improves on the RS-485 basic requirements and increases system reliability. The CMR increases to ±15V and the RS-485 bus pins (receiver inputs and driver outputs) include fault protection against voltages and transients up to ±60V. Additionally, larger-than-required differential output voltages (V_{OD}) increase noise immunity, and the ±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 ±200mV, 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 receivers function with common-mode voltages as great as ±15V, making 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).

The receiver outputs feature high drive levels (typically 22mA at V_{OL} = 1V) to ease the design of optically coupled isolated interfaces.

The receivers easily meet the data rates supported by the corresponding driver, and all receiver outputs are three-statable using the active low $\overline{RE}$ input.

The receivers in the 250kbps versions (ISL32470E and ISL32472E) and 1Mbps versions (ISL32475E) include noise filtering circuitry to reject high-frequency signals. The ISL32475E version typically rejects pulses narrower than 50ns (equivalent to 20Mbps). The ISL32470E and ISL32472E reject pulses below 150ns (6.7Mbps).

Driver (Tx) Features

The RS-485/RS-422 driver is a differential output device that delivers at least 1.5V across a 54Ω load (RS-485) and at least 2.4V across a 100Ω load (RS-422). The drivers feature low propagation delay skew to maximize bit width and to minimize EMI, and all drivers are three-statable using 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 ISL32478E driver outputs are not limited, so faster output transition times allow data rates of at least 15Mbps.

High Overvoltage (Fault) Protection Increases Ruggedness

The ±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 ISL3247xE perfect for applications where power (for example 24V and 48V supplies) must be routed in the conduit with the data lines, or 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 ±60V fault levels of this family are at least five times higher than the levels specified for standard RS-485 ICs. The ISL3247xE protection is active whether the Tx is enabled or disabled, and even if the IC is powered down or if VCC and Ground are floating.

If transients or voltages (including overshoots and ringing) greater than ±60V are possible, additional external protection is required.

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 ISL3247xE's extended ±15V 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 ±40V or differential voltages as large as 40V.

High V_{OD} Improves Noise Immunity and Flexibility

The ISL3247xE driver design delivers larger differential output voltages (V_{OD}) than the RS-485 standard requires or than most RS-485 transmitters can deliver. The typical ±2.5V V_{OD} provides more noise immunity than networks built using many other transceivers.

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Another advantage of the large V_{OD} is the ability to drive more than two bus terminations, which allows use of the ISL3247xE in star topologies and other multi-terminated, nonstandard network topologies. Figure 11 on page 11 details the transmitter's V_{OD} vs I_{OUT} characteristic and includes load lines for four (30Ω) and six (20Ω) 120Ω terminations. Figure 11 shows that the driver typically delivers ±1.3V into six terminations, and the "Electrical Specifications" ensure a V_{OD} of ±0.8V at 21Ω across the full temperature range. The RS-485 standard requires a minimum 1.5V V_{OD} into two terminations, but the ISL3247xE delivers RS-485 voltage levels with two to three times the number of terminations.

Hot Plug Function

When a piece of equipment powers up, there is a period of time when the processor or ASIC driving the RS-485 control lines (DE, $\overline{RE}$) is unable to ensure that the RS-485 Tx and Rx outputs are kept disabled. If the equipment is connected to the bus, a driver activating prematurely during power-up can crash the bus. To avoid crashes, the ISL3247xE devices incorporate a hot plug function. Circuitry monitoring V_{CC} ensures that, the Tx and Rx outputs remain disabled during power-up and power-down if V_{CC} is less than ≈3.5V, regardless of the state of DE and $\overline{RE}$. The disabled Tx and Rx outputs allow the processor/ASIC to stabilize and drive the RS-485 control lines to the proper states. Figure 29 illustrates the power-up and power-down performance of the ISL3247xE compared to an RS-485 IC without the hot plug feature.

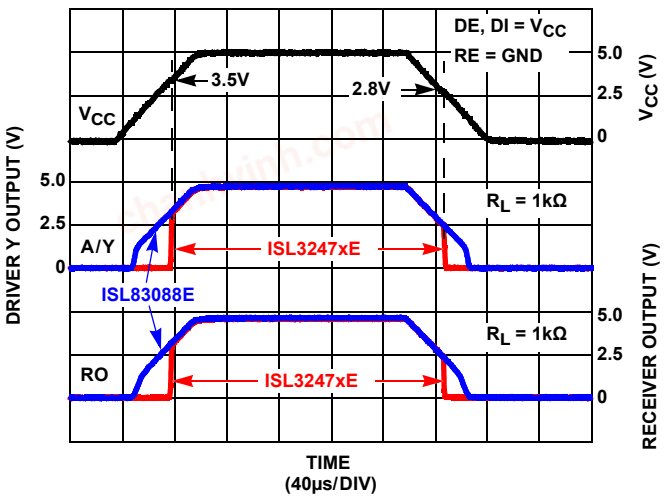


FIGURE 29. HOT PLUG PERFORMANCE (ISL3247xE) vs ISL83088E WITHOUT HOT PLUG CIRCUITRY

ESD Protection

All pins on these devices include Class 3 (>8kV) Human Body Model (HBM) ESD protection structures that can survive ESD events commonly seen during manufacturing. Even so, the RS-485 pins (driver outputs and receiver inputs) incorporate more advanced structures that allow them to survive ESD events in excess of ±16.5kV HBM (±15kV for the full-duplex versions). The RS-485 pins are particularly vulnerable to ESD strikes because they typically connect to an exposed port on the exterior of the finished product. Touching the port pins or connecting a cable can cause an ESD event that destroys unprotected ICs. The new ESD structures protect the device whether or not it is powered up, and without interfering with the exceptional ±15V CMR. The built-in ESD protection minimizes the need for board-level protection structures (such as transient suppression diodes) and the associated undesirable capacitive load they present.

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. The ISL32478E operating at 15Mbps can be used at lengths up to 150ft (46m), but the distance can be increased to 328ft (100m) by operating at 10Mbps. The ISL32475E can operate at full data rates (1Mbps) with lengths up to 800ft (244m). Jitter is the limiting parameter at these faster data rates, so using encoded data streams (for example, Manchester coded or Return-to-Zero) can allow increased transmission distances. The ISL32470E and ISL32472E can operate at 115kbps or less at the full 4000ft (1220m) distance, or at the full data rate of 250kbps for lengths up to 3000ft (915m). DC cable attenuation is the limiting parameter, so using better-quality cables such as 22 AWG can 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 ISL32478E. Short networks using the ISL32470E and ISL32472E do not need to be terminated; however, terminations are recommended unless power dissipation is an overriding concern.

In point-to-point or point-to-multipoint networks (single driver on the bus like RS-422), 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. Multipoint (multi-driver) systems require the main cable to terminate in its characteristic impedance at both ends. Stubs connecting a transceiver to the main cable should be 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 (≈70mA) is set to ensure that the driver never folds back when driving loads with common-mode voltages up to ±15V. The very low second foldback current setting (≈9mA) minimizes power dissipation if the Tx is enabled when a fault occurs.

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In the event of a major short-circuit condition, the ISL3247xE 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 by 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 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 11 through 15 for more information.

Die Characteristics

SUBSTRATE POTENTIAL (POWERED UP):

GND

PROCESS:

Si Gate BiCMOS

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Revision History

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

DATE	REVISION	CHANGE
Feb 14, 2019	FN7784.2	Added Related Literature section to page 1. Added tape and reel information and updated notes in ordering information table on page 3. Updated “High Overvoltage (Fault) Protection Increases Ruggedness” section on page 15. Removed Products section. Updated disclaimer.
Mar 9, 2012	FN7784.1	Page 5 - Thermal Information, Thermal Resistance: 8 Ld SOIC Package Theta JA changed from 116 to 108 Page 14 - Updated Figure 15 to show Pos breakdown between 60V and 70V. Page 19 - Updated Package Outline Drawing M8.15 to newest revision.
Jan 21, 2011	FN7784.0	Initial Release

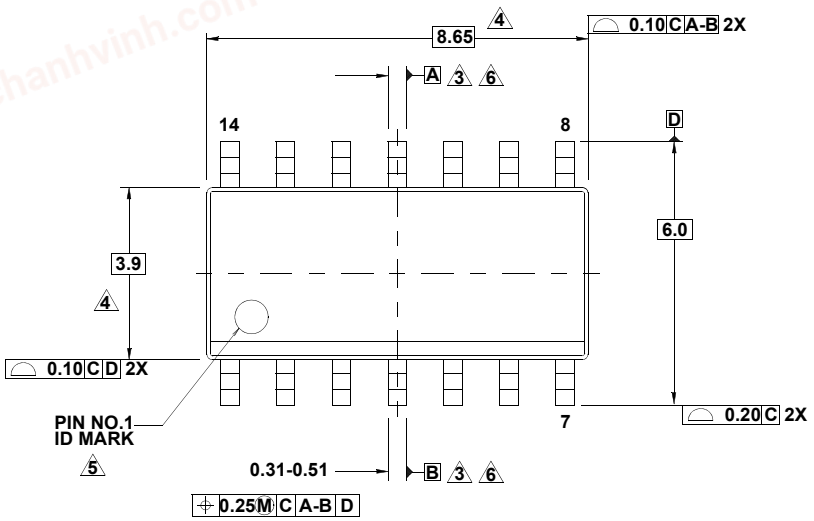
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Package Outline Drawings

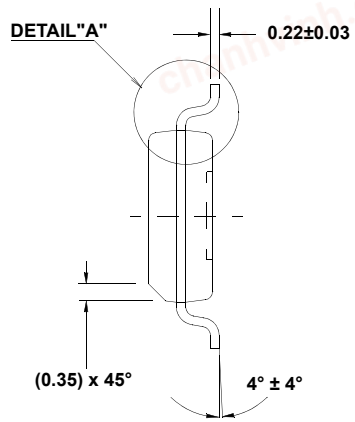
For the most recent package outline drawing, see M14.15.

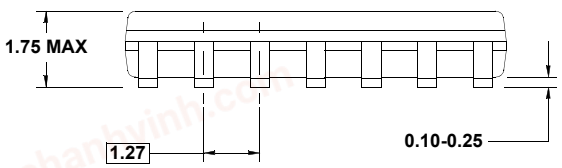
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14 LEAD NARROW BODY SMALL OUTLINE PLASTIC PACKAGE
Rev 1, 10/09

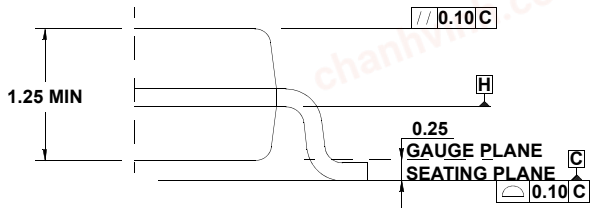


TOP VIEW

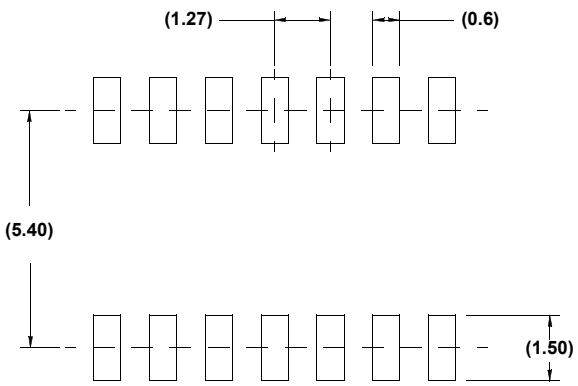




SIDE VIEW



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.

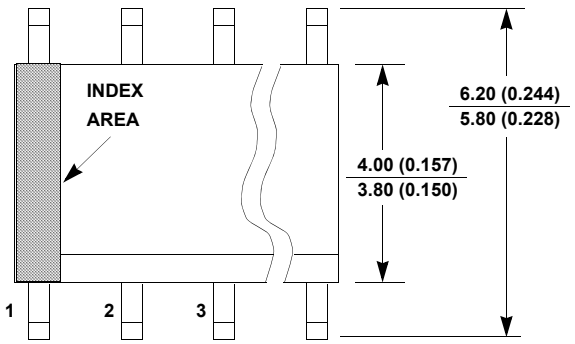
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M8.15

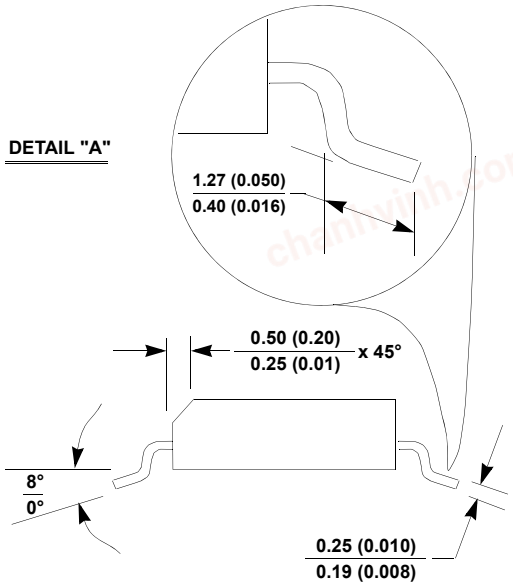
For the most recent package outline drawing, see M8.15.

8 LEAD NARROW BODY SMALL OUTLINE PLASTIC PACKAGE

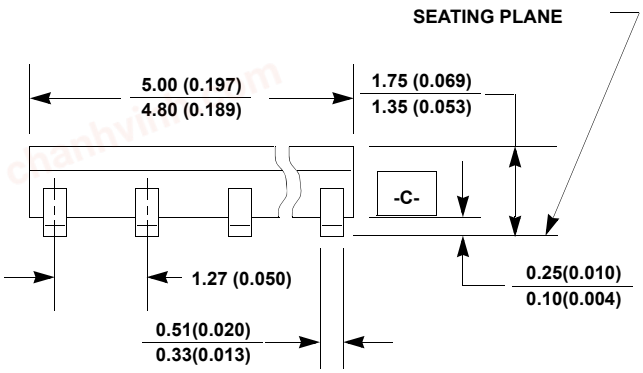
Rev 4, 1/12



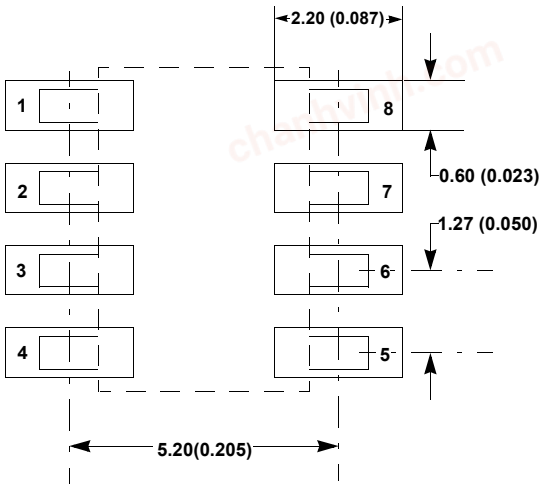
TOP VIEW



SIDE VIEW "B"



SIDE VIEW "A"



TYPICAL RECOMMENDED LAND PATTERN

NOTES:

1. Dimensioning and tolerancing per ANSI Y14.5M-1994.
2. 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.
3. Package width does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.25mm (0.010 inch) per side.
4. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
5. Terminal numbers are shown for reference only.
6. 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).
7. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.
8. This outline conforms to JEDEC publication MS-012-AA ISSUE C.

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