



# Isolated Profibus RS-485 Transceiver with Integrated Transformer Driver

Check for Samples: [ISO1176T](#)

## FEATURES

- 3000V<sub>RMS</sub> / 4242V<sub>PK</sub> Isolation
- Meets or Exceeds the Requirements of EN 50170 and TIA/EIA RS-485
- Signaling Rates up to 40 Mbps
- Easy Isolated Power Design with Integrated Transformer Driver
- Typical Efficiency > 60% (I<sub>LOAD</sub> = 100 mA) - see [sluu471](#)
- Differential Output exceeds 2.1V (54Ω Load)
- Low Bus Capacitance 10pF (MAX)
- 50kV/μs Typical Transient Immunity
- UL 1577, IEC 60747-5-2 (VDE 0884, Rev. 2) Approvals Pending
- Fail-safe Receiver for Bus Open, Short, or Idle

## APPLICATIONS

- Profibus®
- Factory Automation
- Networked Sensors
- Motor/motion Control
- HVAC and Building Automation Networks
- Networked Security Stations

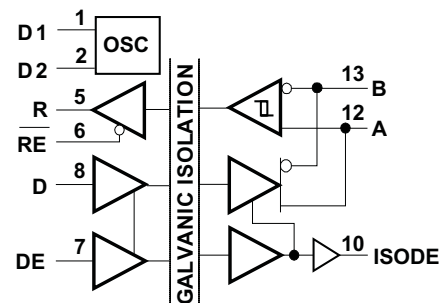
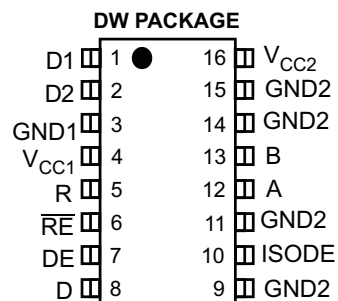
## DESCRIPTION

The ISO1176T is an isolated differential line transceiver with integrated oscillator outputs that provide the primary voltage for an isolation transformer. The device is ideal for long transmission lines because the ground loop is broken to allow the device to operate with a much larger common-mode voltage range. The symmetrical isolation barrier of each device is tested to provide 4242V<sub>PK</sub> of isolation per VDE for 60 seconds between the line transceiver and the logic-level interface.

The galvanically isolated differential bus transceiver is an integrated circuit designed for bi-directional data communication on multipoint bus-transmission lines. The transceiver combines a galvanically isolated differential line driver and differential input line receiver. The driver has an active-high enable with isolated enable-state output on the ISODE pin (pin 10) to facilitate direction control. The driver differential outputs and the receiver differential inputs connect internally to form a differential input/output (I/O) bus port that is designed to offer minimum loading to the bus whenever the driver is disabled or V<sub>CC2</sub> = 0.

Any cabled I/O can be subjected to electrical noise transients from various sources. These noise transients can cause damage to the transceiver and/or near-by sensitive circuitry if they are of sufficient magnitude and duration. The ISO1176T can significantly reduce the risk of data corruption and damage to expensive control circuits.

The device is characterized for operation over the ambient temperature range of –40°C to 85°C.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

Profibus is a registered trademark of Profibus International.



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

**DEVICE INFORMATION**

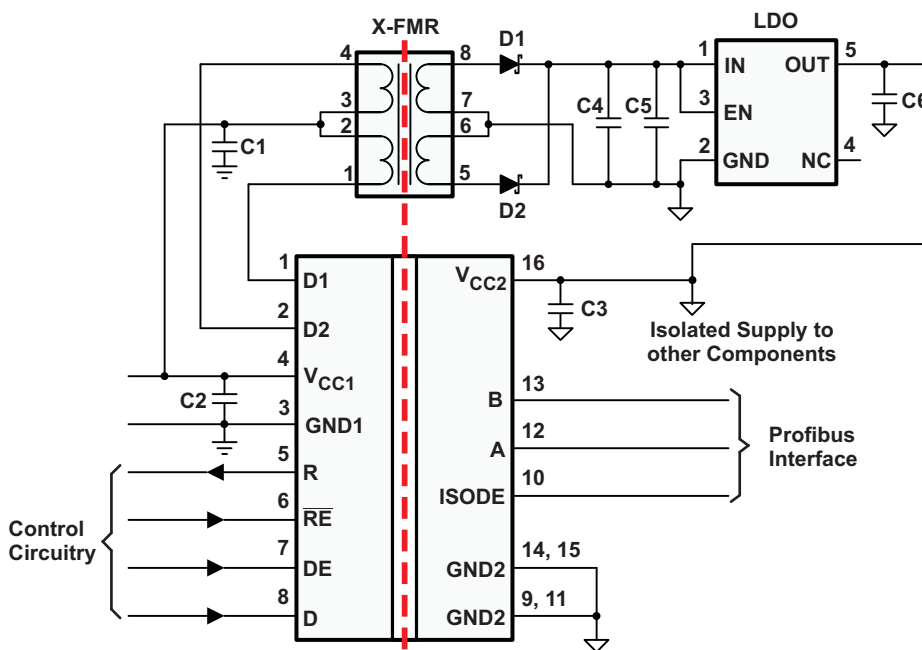


Figure 1. Typical Applications

**PIN DESCRIPTIONS**

NAME	PIN #	FUNCTION
D1	1	Transformer Driver Terminal 1, Open Drain Output
D2	2	Transformer Driver Terminal 2, Open Drain Output
GND1	3	Logic-side Ground
V <sub>CC1</sub>	4	Logic-side Power Supply
R	5	Receiver Output
$\overline{RE}$	6	Receiver Enable Input. This pin has complementary logic.
DE	7	Driver Enable Input
D	8	Driver Input
GND2	9, 11, 14, 15	Bus-side Ground. All pins are internally connected.
ISODE	10	Bus-side Driver Enable Output Status
A	12	Non-inverting Driver Output / Receiver Input
B	13	Inverting Driver Output / Receiver Input
V <sub>CC2</sub>	16	Bus-side Power Supply

**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

				VALUE	UNIT	
$V_{CC1}$ , $V_{CC2}$	Input supply voltage <sup>(2)</sup>			-0.5 to 7	V	
$V_O$	Voltage at any bus I/O terminal			-9 to 14	V	
	Voltage at D1, D2			14	V	
$V_I$	Voltage input at D, DE or $\overline{RE}$ terminal			-0.5 to 7	V	
$I_O$	Receiver output current			$\pm 10$	mA	
$I_{D1}$ , $I_{D2}$	Transformer Driver Output Current			450	mA	
ESD	Electrostatic Discharge	Human Body Model	JEDEC Standard 22, Test Method A114-C.01	Bus pins to GND1	$\pm 6$	kV
				Bus pins to GND2	$\pm 10$	
		all pins		$\pm 4$		
		Charged Device Model	JEDEC Standard 22, Test Method C101	all pins		$\pm 1.5$
Machine Model	ANSI/ESDS5.2-1996					$\pm 200$
$T_J$	Maximum junction temperature			170	$^{\circ}\text{C}$	
$T_{STG}$	Storage temperature			-65 to 150	$^{\circ}\text{C}$	

- (1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values except differential I/O bus voltages are with respect to the referenced network ground terminal and are peak voltage values.

**RECOMMENDED OPERATING CONDITIONS**

over operating free-air temperature range (unless otherwise noted)

			MIN	NOM	MAX	UNIT
$V_{CC}$	Logic side supply voltage, $V_{CC1}$ (with respect to GND1)		3		5.5	V
	Bus side supply voltage, $V_{CC2}$ (with respect to GND2)		4.75		5.25	
$V_{CM}$	Voltage at either bus I/O terminal		A, B		12	V
$V_{IH}$	High-level input voltage		$\overline{RE}$		$V_{CC1}$	V
			D, DE	$0.7 V_{CC1}$		
$V_{IL}$	Low-level input voltage		$\overline{RE}$	0	0.8	V
			D, DE		$0.3 V_{CC1}$	
$V_{ID}$	Differential input voltage		A with respect to B	-12	12	V
$I_O$	Output Current		RS-485 driver	-70	70	mA
			Receiver	-8	8	
$T_A$	Ambient temperature		-40		85	$^{\circ}\text{C}$
$T_J$	Operating junction temperature				150	$^{\circ}\text{C}$
$1 / t_{UI}$	Signaling Rate				40	Mbps

# ISO1176T

SLLSE28F – OCTOBER 2010 – REVISED OCTOBER 2012

www.ti.com

## SUPPLY CURRENT

over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$I_{CC1}^{(1)}$	Logic-side quiescent supply current	$V_{CC1} = 3.3\text{ V} \pm 10\%$ , DE, $\overline{RE} = 0\text{V}$ or $V_{CC1}$ , No load		4.5	8	mA
		$V_{CC1} = 5\text{ V} \pm 10\%$ , DE, $\overline{RE} = 0\text{V}$ or $V_{CC1}$ , No load		7	11	mA
$I_{CC2}^{(1)}$	Bus-side quiescent supply current	$V_{CC2} = 5\text{ V} \pm 5\%$ , DE, $\overline{RE} = 0\text{V}$ or $V_{CC1}$ , No load		13.5	18	mA

(1)  $I_{CC1}$  and  $I_{CC2}$  are measured when device is connected to external power supplies. D1 and D2 are disconnected from external transformer.

## ISODE-PIN ELECTRICAL CHARACTERISTICS

over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{OH}$	High-level output voltage	$I_{OH} = -8\text{mA}$	$V_{CC2} - 0.8$	4.6		V
		$I_{OH} = -20\mu\text{A}$	$V_{CC2} - 0.1$	5		
$V_{OL}$	Low-level output voltage	$I_{OL} = 8\text{mA}$		0.2	0.4	V
		$I_{OL} = 20\mu\text{A}$		0	0.1	

## RS-485 DRIVER ELECTRICAL CHARACTERISTICS

over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{OD}$	Open-circuit differential output voltage	$ V_A - V_B $ , See <a href="#">Figure 2</a>	1.5		$V_{CC2}$	V
$ V_{OD(SS)} $	Steady-state differential output voltage magnitude	See <a href="#">Figure 3</a> and <a href="#">Figure 7</a>	2.1			V
		See <a href="#">Figure 4</a> , Common-mode loading with $V_{test}$ from $-7\text{V}$ to $+12\text{V}$	2.1			
$ \Delta V_{OD(SS)} $	Change in steady-state differential output voltage between logic states	See <a href="#">Figure 5</a> and <a href="#">Figure 6</a> , $R_L = 54\Omega$	-0.2		0.2	V
$V_{OC(SS)}$	Steady-state common-mode output voltage	See <a href="#">Figure 5</a> and <a href="#">Figure 65</a> , $R_L = 54\Omega$	2		3	V
$\Delta V_{OC(SS)}$	Change in steady-state common-mode output voltage		-0.2		0.2	
$V_{OC(pp)}$	Peak-to-peak common-mode output voltage		0.5			
$V_{OD(ring)}$	Differential output voltage over and under shoot	See <a href="#">Figure 7</a> and <a href="#">Figure 10</a>			10%	$V_{OD(pp)}$
$I_I$	Input current	D, DE at 0V or $V_{CC1}$	-10		10	$\mu\text{A}$
$I_{O(OFF)}$	Power-off output current	$V_{CC2} = 0\text{ V}$	See receiver input current			
$I_{OZ}$	High-impedance output current	DE at 0V				
$I_{OS(P)}$	Peak short-circuit output current	See <a href="#">Figure 9</a> , DE at $V_{CC1}$	$V_{OS} = -7\text{V}$ to $12\text{V}$		250	mA
$I_{OS(SS)}$	Steady-state short-circuit output current		$V_{OS} = 12\text{V}$ , D at GND1		135	
			$V_{OS} = -7\text{V}$ , D at $V_{CC1}$	-135		
$C_{OD}$	Differential output capacitance		See receiver $C_{IN}$			
CMTI	Common-mode transient immunity	See <a href="#">Figure 20</a>	25			kV/ $\mu\text{s}$

## RS-485 DRIVER SWITCHING CHARACTERISTICS

over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{PLH}, t_{PHL}$	Prop delay time	$V_{CC1} = 5V \pm 10\%$ , $V_{CC2} = 5V \pm 5\%$		23	35	ns
$t_{sk(p)}$	Pulse skew ( $ t_{PHL} - t_{PLH} $ )			2	5	
$t_{PLH}, t_{PHL}$	Prop delay time	$V_{CC1} = 3.3V \pm 10\%$ , $V_{CC2} = 5V \pm 5\%$		25	40	ns
$t_{sk(p)}$	Pulse skew ( $ t_{PHL} - t_{PLH} $ )			2	5	
$t_r$	Differential output signal rise time	See Figure 10		2	3	ns
$t_f$	Differential output signal fall time			2	3	
$t_{pDE}$	DE to ISODE prop delay	See Figure 14			30	ns
$t_t(MLH), t_t(MHL)$	Output transition skew	See Figure 11			1	ns
$t_{p(AZH)}, t_{p(BZH)}, t_{p(AZL)}, t_{p(BZL)}$	Propagation delay, high-impedance-to-active output	See Figure 12 and Figure 13, $C_L = 50\text{pf}$ , $\overline{RE}$ at 0 V			80	ns
$t_{p(AHZ)}, t_{p(BHZ)}, t_{p(AZL)}, t_{p(BZL)}$	Propagation delay, active-to-high-impedance output				80	
$ t_{p(AZL)} - t_{p(BZH)} $ $ t_{p(AZH)} - t_{p(BZL)} $	Enable skew time			0.55	1.5	ns
$t_{(CFB)}$	Time from application of short-circuit to current fold back	See Figure 9		0.5		$\mu\text{s}$
$t_{(TSD)}$	Time from application of short-circuit to thermal shutdown	See Figure 9, $T_A = 25^\circ\text{C}$	100			$\mu\text{s}$

## RECEIVER ELECTRICAL CHARACTERISTICS

over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT	
$V_{IT(+)}$	Positive-going input threshold voltage	See Figure 16		-80	-10	mV	
$V_{IT(-)}$	Negative-going input threshold voltage			-200	-120		
$V_{hys}$	Hysteresis voltage ( $V_{IT+} - V_{IT-}$ )			25			
$V_{OH}$	High-level output voltage	$V_{CC1} = 3.3V \pm 10\%$ and $V_{CC2} = 5V \pm 5\%$	$V_{ID} = 200\text{ mV}$ , See Figure 16	$I_{OH} = -8\text{mA}$	$V_{CC1} - 0.4$	3	V
$V_{OL}$	Low-level output voltage			$I_{OH} = -20\mu\text{A}$	$V_{CC1} - 0.1$	3.3	
$V_{OH}$	High-level output voltage	$V_{CC1} = 5V \pm 10\%$ and $V_{CC2} = 5V \pm 5\%$	$V_{ID} = -200\text{ mV}$ , See Figure 16	$I_{OL} = 8\text{mA}$	$V_{CC1} - 0.8$	4.6	V
$V_{OL}$	Low-level output voltage			$I_{OL} = 20\mu\text{A}$	$V_{CC1} - 0.1$	5	
$V_{OH}$	High-level output voltage	$V_{CC1} = 5V \pm 10\%$ and $V_{CC2} = 5V \pm 5\%$	$V_{ID} = 200\text{ mV}$ , See Figure 16	$I_{OH} = -8\text{mA}$	$V_{CC1} - 0.8$	4.6	V
$V_{OL}$	Low-level output voltage			$I_{OH} = -20\mu\text{A}$	$V_{CC1} - 0.1$	5	
$I_A, I_B$	Bus pin input current	$V_I = -7$ or $12\text{V}$ , Other input = 0 V	$V_{CC2} = 4.75\text{V}$ or $5.25\text{V}$	-160	200	$\mu\text{A}$	
$I_{A(off)}, I_{B(off)}$							$V_{CC2} = 0\text{V}$
$I_I$	Receiver enable input current	$\overline{RE} = 0\text{ V}$		-50	50	$\mu\text{A}$	
$I_{OZ}$	High-impedance state output current	$\overline{RE} = V_{CC1}$		-1	1	$\mu\text{A}$	
$R_{ID}$	Differential input resistance	A, B		60		k $\Omega$	
$C_{ID}$	Differential input capacitance	Test input signal is a 1MHz sine wave with 1Vpp amplitude. CD is measured across A and B.		7	10	pF	
CMR	Common mode rejection	See Figure 19		4		V	

## RECEIVER SWITCHING CHARACTERISTICS

over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{PLH}$ , $t_{PHL}$	Propagation delay time	See <a href="#">Figure 16</a>		50	65	ns
$t_{sk(p)}$	Pulse skew ( $ t_{PHL} - t_{PLH} $ )			2	5	
$t_{PLH}$ , $t_{PHL}$	Propagation delay time			53	70	
$t_{sk(p)}$	Pulse skew ( $ t_{PHL} - t_{PLH} $ )			2	5	
$t_r$	Output signal rise time		2	4		
$t_f$	Output signal fall time		2	4		
$t_{PZH}$	Propagation delay, high-impedance-to-high-level output	DE at $V_{CC1}$ , See <a href="#">Figure 17</a>		13	25	
$t_{PHZ}$	Propagation delay, high-level-to-high-impedance output			13	25	
$t_{PZL}$	Propagation delay, high-impedance-to-low-level output	DE at $V_{CC1}$ , See <a href="#">Figure 18</a>		13	25	
$t_{PLZ}$	Propagation delay, low-level-to-high-impedance output			13	25	

## TRANSFORMER DRIVER CHARACTERISTICS

over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$f_{OSC}$	Oscillator frequency	$V_{CC1} = 5V \pm 10\%$ , D1 and D2 connected to Transformer	350	450	610	kHz
		$V_{CC1} = 3.3V \pm 10\%$ , D1 and D2 connected to Transformer	300	400	550	
$R_{ON}$	Switch on resistance	D1 and D2 connected to 50 $\Omega$ pull-up resistors		1	2.5	$\Omega$
$t_{r,D}$	D1, D2 output rise time	$V_{CC1} = 5V \pm 10\%$ , See <a href="#">Figure 21</a> , D1 and D2 connected to 50 $\Omega$ pull-up resistors		80		ns
		$V_{CC1} = 3.3V \pm 10\%$ , See <a href="#">Figure 21</a> , D1 and D2 connected to 50 $\Omega$ pull-up resistors		70		
$t_{f,D}$	D1, D2 output fall time	$V_{CC1} = 5V \pm 10\%$ , See <a href="#">Figure 21</a> , D1 and D2 connected to 50 $\Omega$ pull-up resistors		55		ns
		$V_{CC1} = 3.3V \pm 10\%$ , See <a href="#">Figure 21</a> , D1 and D2 connected to 50 $\Omega$ pull-up resistors		80		
$f_{St}$	Startup frequency	$V_{CC1} = 2.4V$ , D1 and D2 connected to Transformer		350		kHz
$t_{BBM}$	Break before make time delay	$V_{CC1} = 5V \pm 10\%$ , See <a href="#">Figure 21</a> , D1 and D2 connected to 50 $\Omega$ pull-up resistors		38		ns
		$V_{CC1} = 3.3V \pm 10\%$ , See <a href="#">Figure 21</a> , D1 and D2 connected to 50 $\Omega$ pull-up resistors		140		

PARAMETER MEASUREMENT INFORMATION

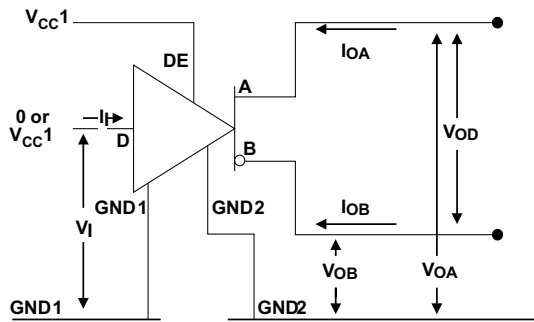


Figure 2. Open Circuit Voltage Test Circuit

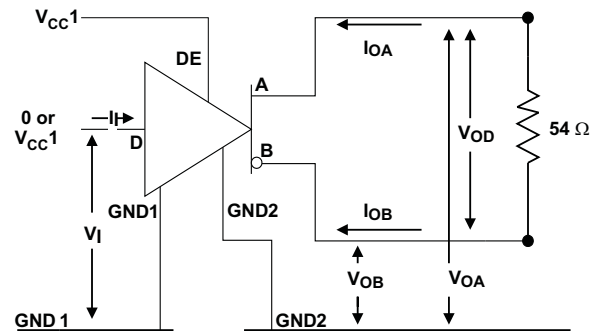


Figure 3.  $V_{OD}$  Test Circuit

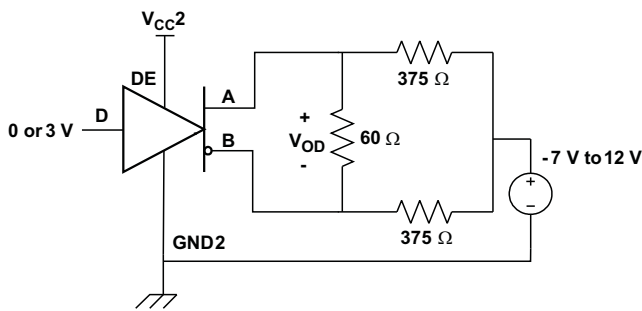


Figure 4. Driver  $V_{OD}$  with Common-mode Loading Test Circuit

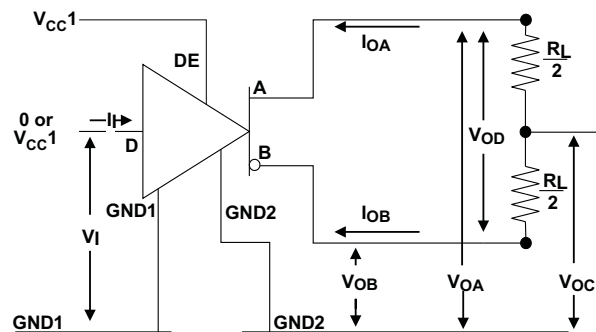


Figure 5. Driver  $V_{OD}$  and  $V_{OC}$  Without Common-Mode Loading Test Circuit

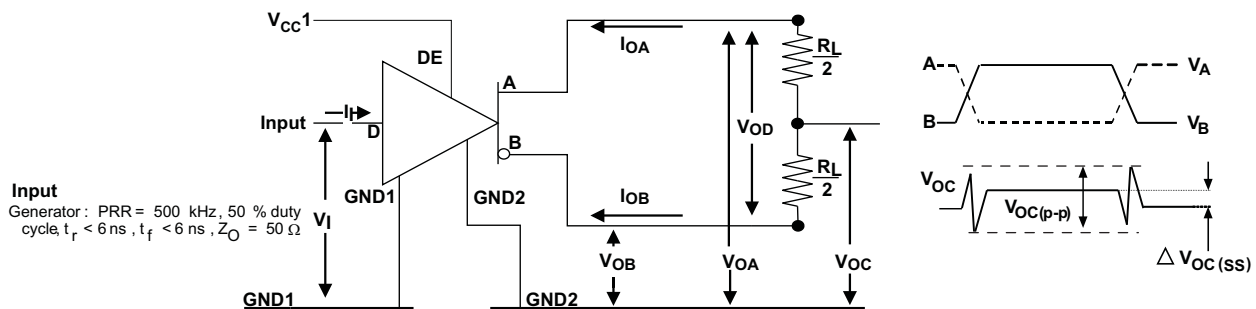


Figure 6. Steady-State Output Voltage Test Circuit and Voltage Waveforms

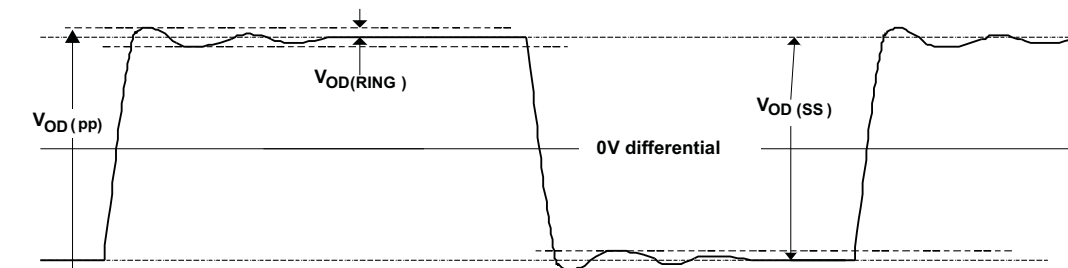
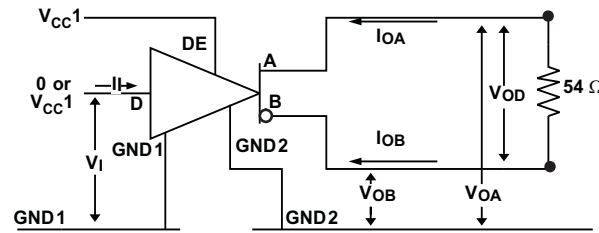
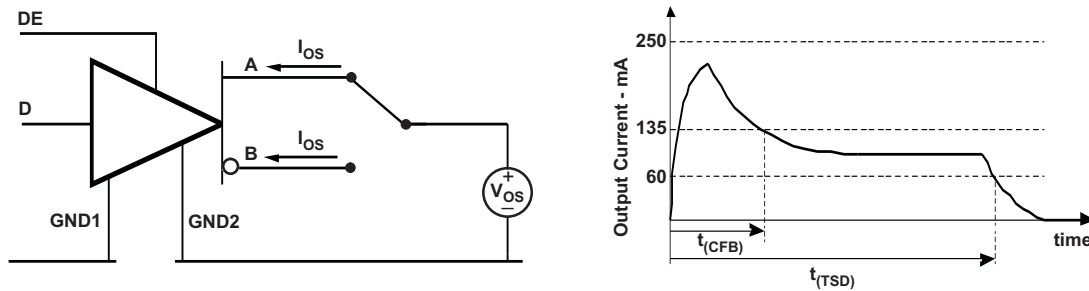


Figure 7.  $V_{OD(RING)}$  Waveform and Definitions

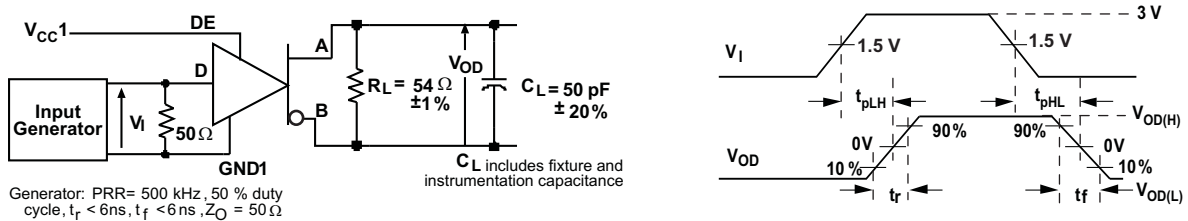
**PARAMETER MEASUREMENT INFORMATION (continued)**



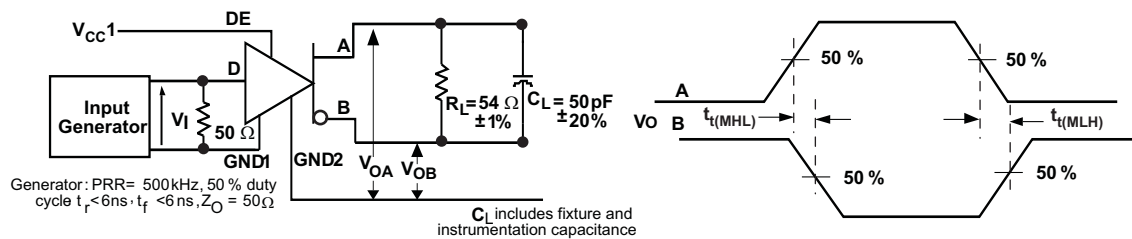
**Figure 8. Input Voltage Hysteresis Test Circuit**



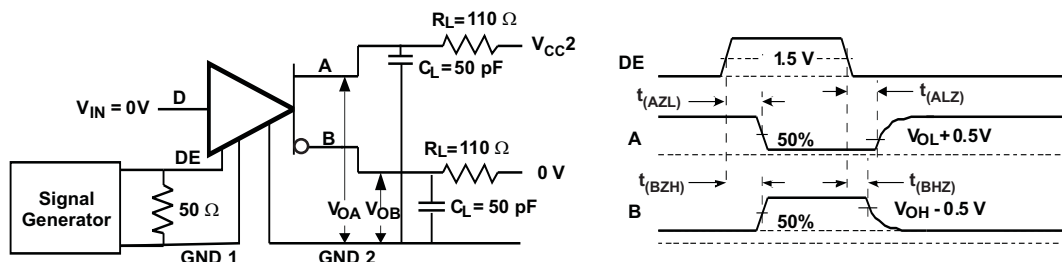
**Figure 9. Driver Short-Circuit Test Circuit and Waveforms (Short Circuit applied at Time t=0)**



**Figure 10. Driver Switching Test Circuit and Waveforms**



**Figure 11. Driver Output Transition Skew Test Circuit and Waveforms**



**Figure 12. Driver Enable/Disable Test, D at Logic Low Test Circuit and Waveforms**

PARAMETER MEASUREMENT INFORMATION (continued)

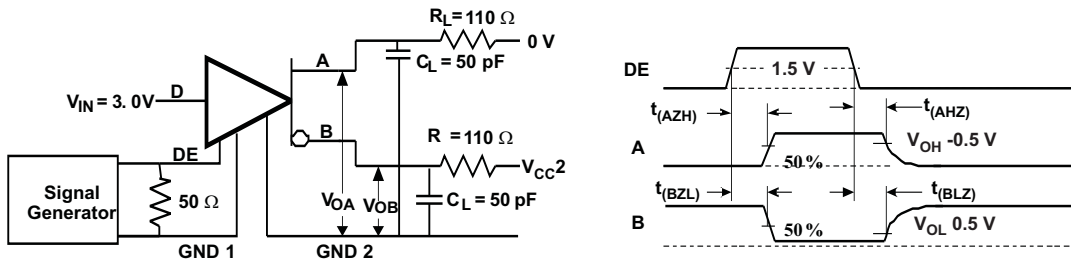


Figure 13. Driver Enable/Disable Test, D at Logic High Test Circuit and Waveforms

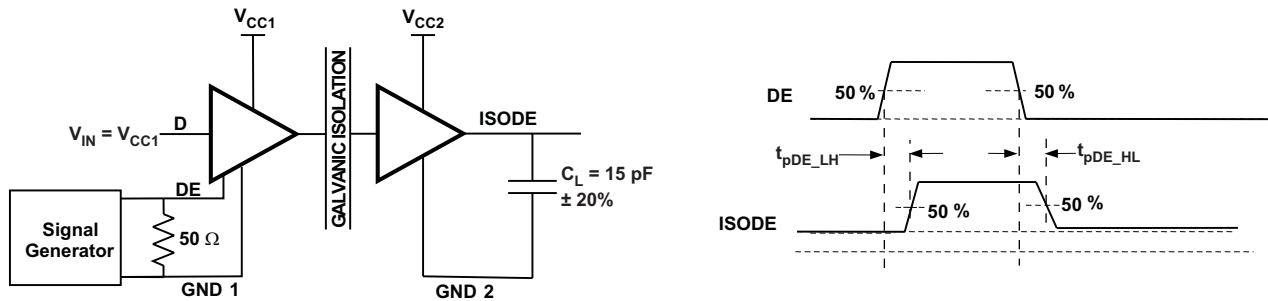


Figure 14. DE to ISODE Prop Delay Test Circuit and Waveforms

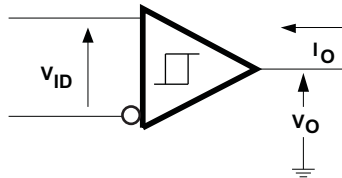


Figure 15. Receiver DC Parameter Definitions

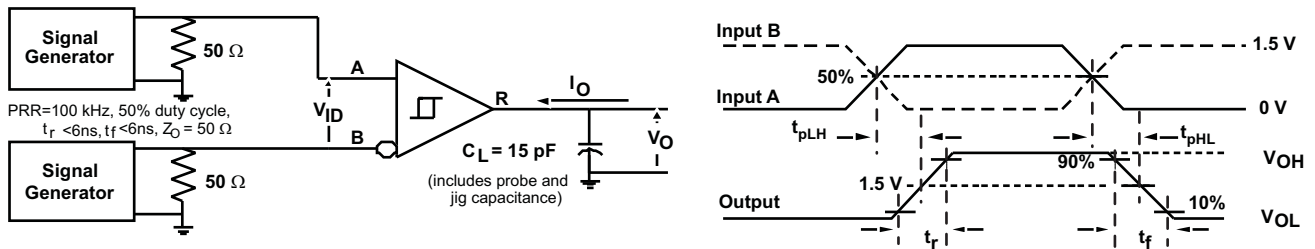


Figure 16. Receiver Switching Test Circuit and Waveforms

PARAMETER MEASUREMENT INFORMATION (continued)

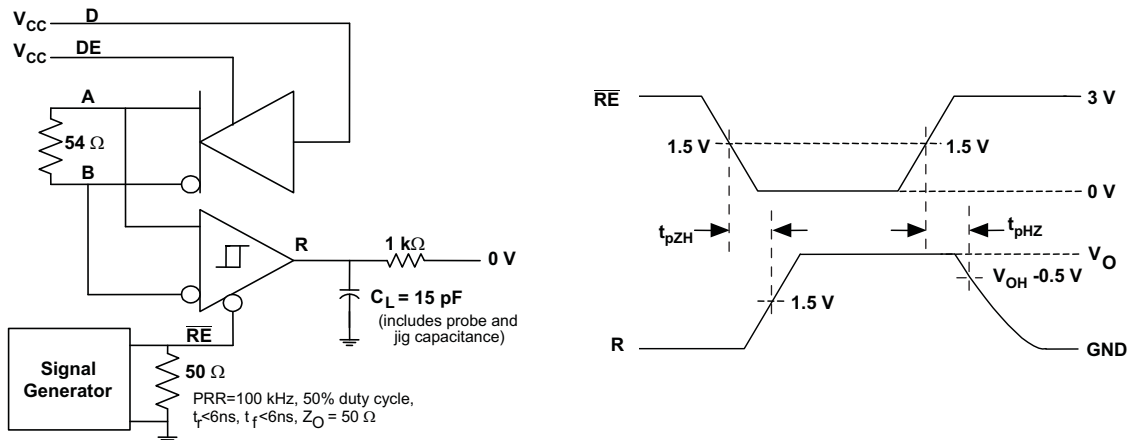


Figure 17. Receiver Enable Test Circuit and Waveforms, Data Output High

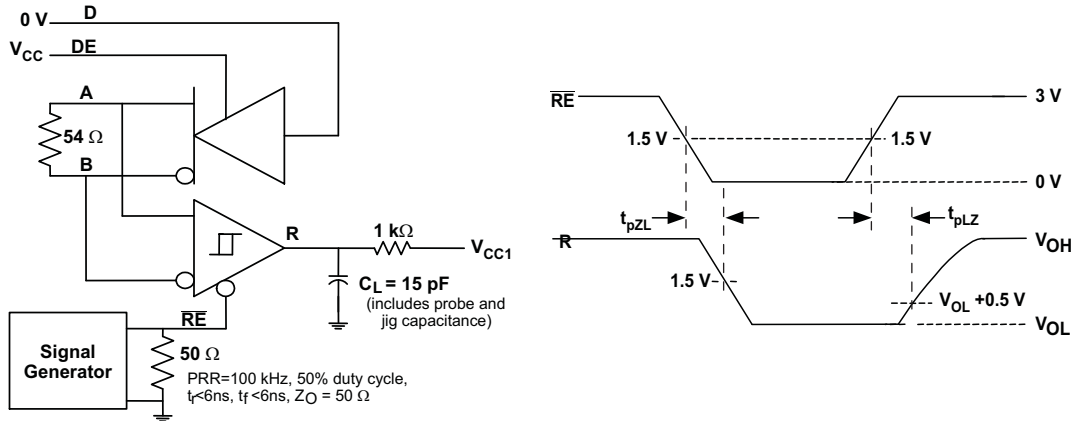


Figure 18. Receiver Enable Test Circuit and Waveforms, Data Output Low

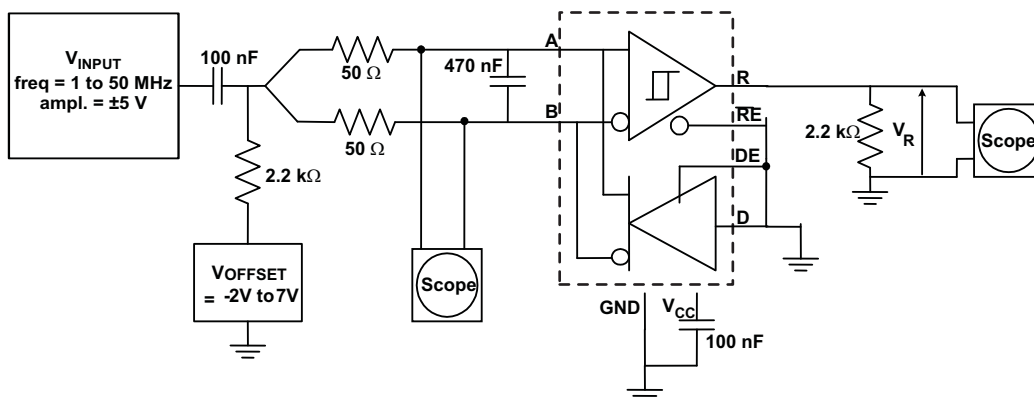


Figure 19. Common-Mode Rejection Test Circuit

PARAMETER MEASUREMENT INFORMATION (continued)

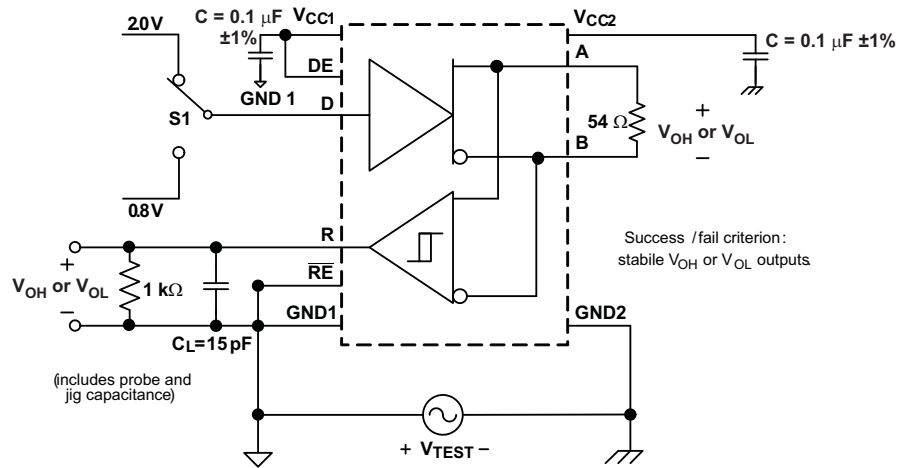


Figure 20. Common-Mode Transient Immunity Test Circuit

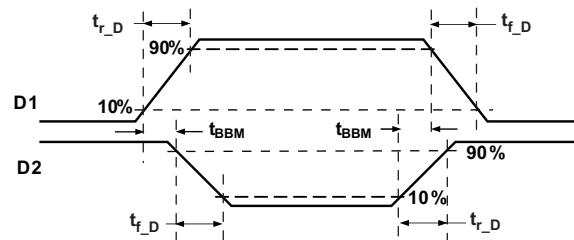


Figure 21. Transition Times and Break-Before-Make Time Delay for D1, D2 Outputs

**Table 1. DRIVER FUNCTION TABLE<sup>(1)</sup>**

V <sub>CC1</sub>	V <sub>CC2</sub>	INPUT (D)	ENABLE INPUT (DE)	ENABLE OUTPUT (ISODE)	OUTPUTS	
					A	B
PU	PU	H	H	H	H	L
PU	PU	L	H	H	L	H
PU	PU	X	L	L	Z	Z
PU	PU	X	open	L	Z	Z
PU	PU	open	H	H	H	L
PD	PU	X	X	L	Z	Z
PU	PD	X	X	L	Z	Z
PD	PD	X	X	L	Z	Z

(1) PU = Powered Up, PD = Powered Down, H = High Level, L = Low Level, X = Don't Care, Z = High Impedance (off)

**Table 2. RECEIVER FUNCTION TABLE<sup>(1)</sup>**

V <sub>CC1</sub>	V <sub>CC2</sub>	DIFFERENTIAL INPUT V <sub>ID</sub> = (V <sub>A</sub> – V <sub>B</sub> )	ENABLE ( $\overline{RE}$ )	OUTPUT (R)
PU	PU	$-0.01V \leq V_{ID}$	L	H
PU	PU	$-0.2V < V_{ID} < -0.01V$	L	?
PU	PU	$V_{ID} \leq -0.2V$	L	L
PU	PU	X	H	Z
PU	PU	X	open	Z
PU	PU	Open circuit	L	H
PU	PU	Short Circuit	L	H
PU	PU	Idle (terminated) bus	L	H
PD	PU	X	X	Z
PU	PD	X	L	H
PD	PD	X	X	Z

(1) PU = Powered Up, PD = Powered Down, H = High Level, L = Low Level, X = Don't Care, Z = High Impedance (off), ? = Indeterminate

## IEC INSULATION AND SAFETY RELATED SPECIFICATIONS FOR 16-DW PACKAGE

over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
L(I01)	Minimum air gap (Clearance) <sup>(1)</sup>	Shortest terminal to terminal distance through air	8.3			mm
L(I02)	Minimum external tracking (Creepage) <sup>(1)</sup>	Shortest terminal to terminal distance across the package surface	8.1			mm
CTI	Tracking resistance (Comparative Tracking Index)	DIN IEC 60112 / VDE 0303 Part 1	400			V
	Minimum Internal Gap (Internal Clearance)	Distance through the insulation	0.008			mm
R <sub>IO</sub>	Isolation resistance	Input to output, V <sub>IO</sub> = 500 V, all pins on each side of the barrier tied together creating a two-terminal device		>10 <sup>12</sup>		Ω
C <sub>IO</sub>	Barrier capacitance Input to output	V <sub>I</sub> = V <sub>CC</sub> /2 + 0.4 sin(2πft), f = 1MHz, V <sub>CC</sub> = 5 V		2		pF
C <sub>I</sub>	Input capacitance to ground	V <sub>I</sub> = 0.4 sin(2πft), f = 1MHz		2		pF
P <sub>D</sub>	Maximum device power dissipation	V <sub>CC1</sub> = 5.5V, V <sub>CC2</sub> = 5.25V, T <sub>J</sub> = 150°C, C <sub>L</sub> = 50pf, R <sub>L</sub> = 54Ω Input a 20MHz 50% duty cycle square wave			719	mW

- (1) Creepage and clearance requirements should be applied according to the specific equipment isolation standards of an application. Care should be taken to maintain the creepage and clearance distance of a board design to make sure that the mounting pads of the isolator on the printed circuit board do not reduce this distance.

Creepage and clearance on a printed circuit board become equal according to the measurement techniques shown in the Isolation Glossary. Techniques such as inserting grooves and/or ribs on a printed circuit board are used to help increase these specifications

### IEC 60664-1 RATINGS TABLE

PARAMETER	TEST CONDITIONS	SPECIFICATION
Basic isolation group	Material group	II
Installation classification	Rated mains voltage ≤ 150V <sub>rms</sub>	I-IV
	Rated mains voltage ≤ 300V <sub>rms</sub>	I-III
	Rated mains voltage ≤ 400V <sub>rms</sub>	I-II

### IEC 60747-5-2 INSULATION CHARACTERISTICS<sup>(1)</sup>

over recommended operating conditions (unless otherwise noted)

PARAMETER	TEST CONDITIONS	SPECIFICATION	UNIT
V <sub>IORM</sub>	Maximum working insulation voltage	566	V <sub>peak</sub>
V <sub>PR</sub>	Input to output test voltage	Method b1, V <sub>PR</sub> = V <sub>IORM</sub> × 1.875, 100% Production test with t = 1s, Partial discharge < 5pC	1062
		Method a, After environmental tests subgroup 1, V <sub>PR</sub> = V <sub>IORM</sub> × 1.6, t = 10s, Partial discharge < 5pC	906
		After Input/Output Safety Test Subgroup 2/3, V <sub>PR</sub> = V <sub>IORM</sub> × 1.2, t = 10s, Partial discharge < 5pC	680
V <sub>IOTM</sub>	Transient overvoltage	t = 60s (qualification), t = 1s (100% production)	4242
V <sub>IOSM</sub>	Maximum surge voltage	Tested per IEC 60065 (Qualification Test)	4242
R <sub>S</sub>	Insulation resistance	V <sub>IO</sub> = 500V at T <sub>S</sub> = 150°C	> 10 <sup>9</sup>
	Pollution degree		2

- (1) Climatic Classification 40/125/21

# ISO1176T

SLLSE28F – OCTOBER 2010 – REVISED OCTOBER 2012

[www.ti.com](http://www.ti.com)

## REGULATORY INFORMATION

VDE	UL
Certified according to DIN EN 60747-5-2 (VDE 0884 Part 2)	Recognized under 1577 Component Recognition Program
Basic Insulation Maximum Transient Overvoltage, 4242 V <sub>PK</sub> Maximum Surge Voltage, 4242 V <sub>PK</sub> Maximum Working Voltage, 566 V <sub>PK</sub>	Single / Basic Isolation Voltage, 2500 V <sub>RMS</sub> <sup>(1)</sup>
File Number: Pending	File Number: Pending

(1) Production tested  $\geq 3000 V_{rms}$  for 1 second in accordance with UL 1577.

## IEC SAFETY LIMITING VALUES

Safety limiting intends to prevent potential damage to the isolation barrier upon failure of input or output circuitry. A failure of the IO can allow low resistance to ground or the supply and, without current limiting, dissipate sufficient power to overheat the die and damage the isolation barrier potentially leading to secondary system failures.

PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT
I <sub>S</sub> Safety input, output, or supply current	DW-16	$\theta_{JA} = 76^{\circ}\text{C}/\text{W}$ , $V_I = 5.5 \text{ V}$ , $T_J = 170^{\circ}\text{C}$ , $T_A = 25^{\circ}\text{C}$			347	mA
T <sub>S</sub> Maximum case temperature	DW-16				150	°C

The safety-limiting constraint is the absolute maximum junction temperature specified in the absolute maximum ratings table. The power dissipation and junction-to-air thermal impedance of the device installed in the application hardware determines the junction temperature. The assumed junction-to-air thermal resistance in the Thermal Characteristics table is that of a device installed on a High-K Test Board for Leaded Surface Mount Packages. The power is the recommended maximum input voltage times the current. The junction temperature is then the ambient temperature plus the power times the junction-to-air thermal resistance.

## THERMAL INFORMATION

THERMAL METRIC <sup>(1)</sup>		ISO1176T	UNITS
		DW-16	
$\theta_{JA}$	Junction-to-ambient thermal resistance	76	°C/W
$\theta_{JC(top)}$	Junction-to-case(top) thermal resistance	37.9	
$\theta_{JB}$	Junction-to-board thermal resistance	44.6	
$\Psi_{JT}$	Junction-to-top characterization parameter	12.1	
$\Psi_{JB}$	Junction-to-board characterization parameter	37.9	
$\theta_{JC(bottom)}$	Junction-to-case(bottom) thermal resistance	n/a	

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](#).

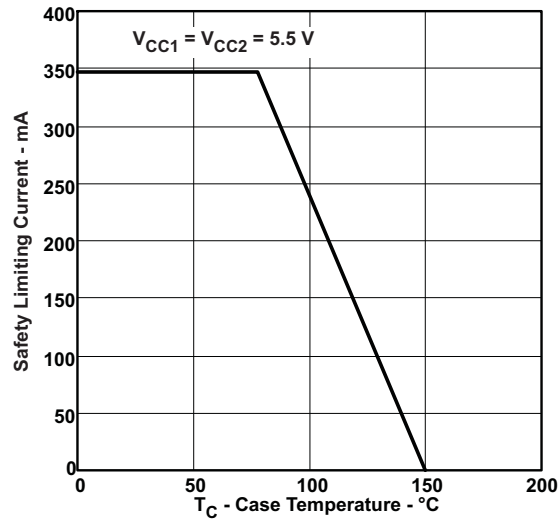
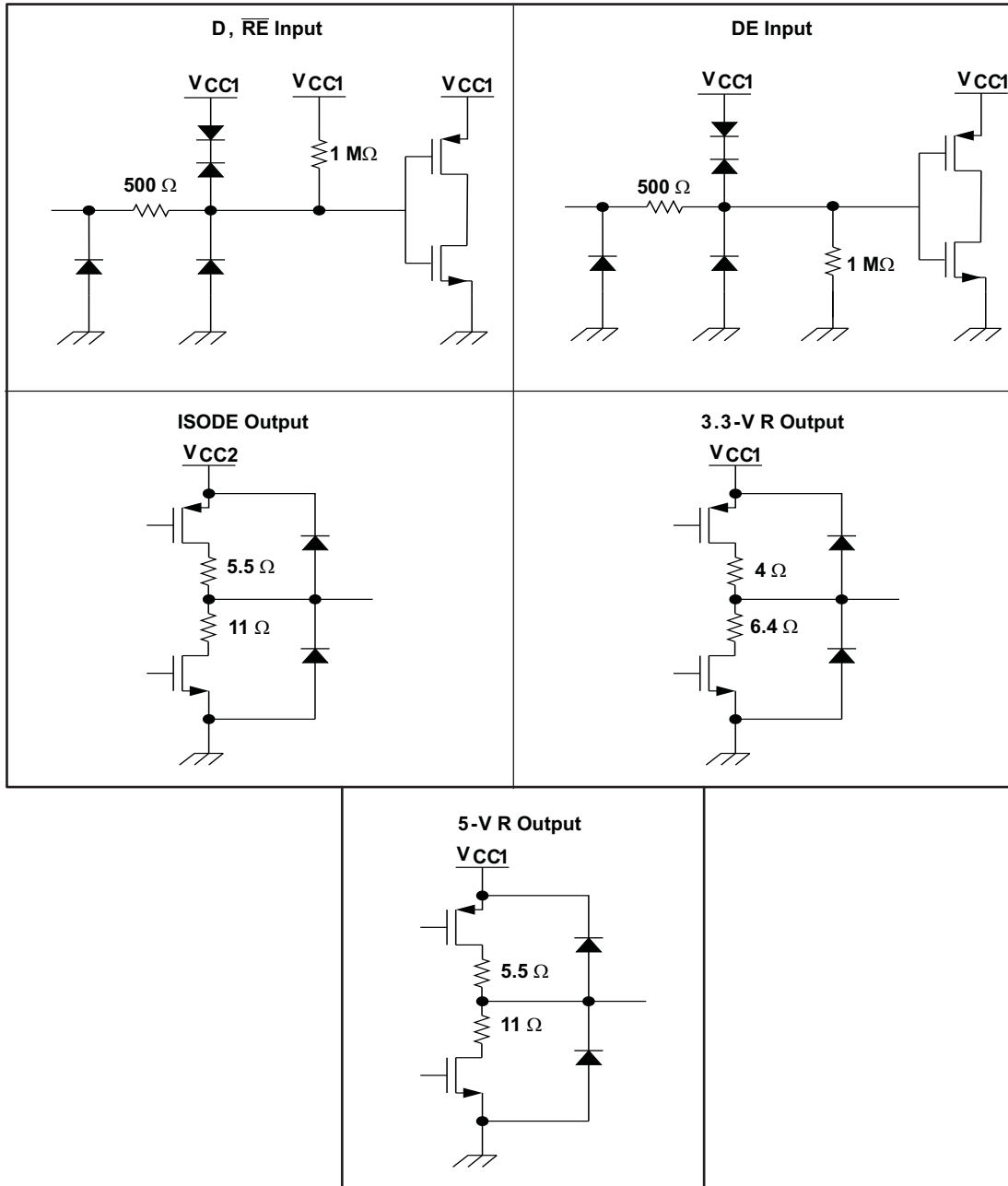
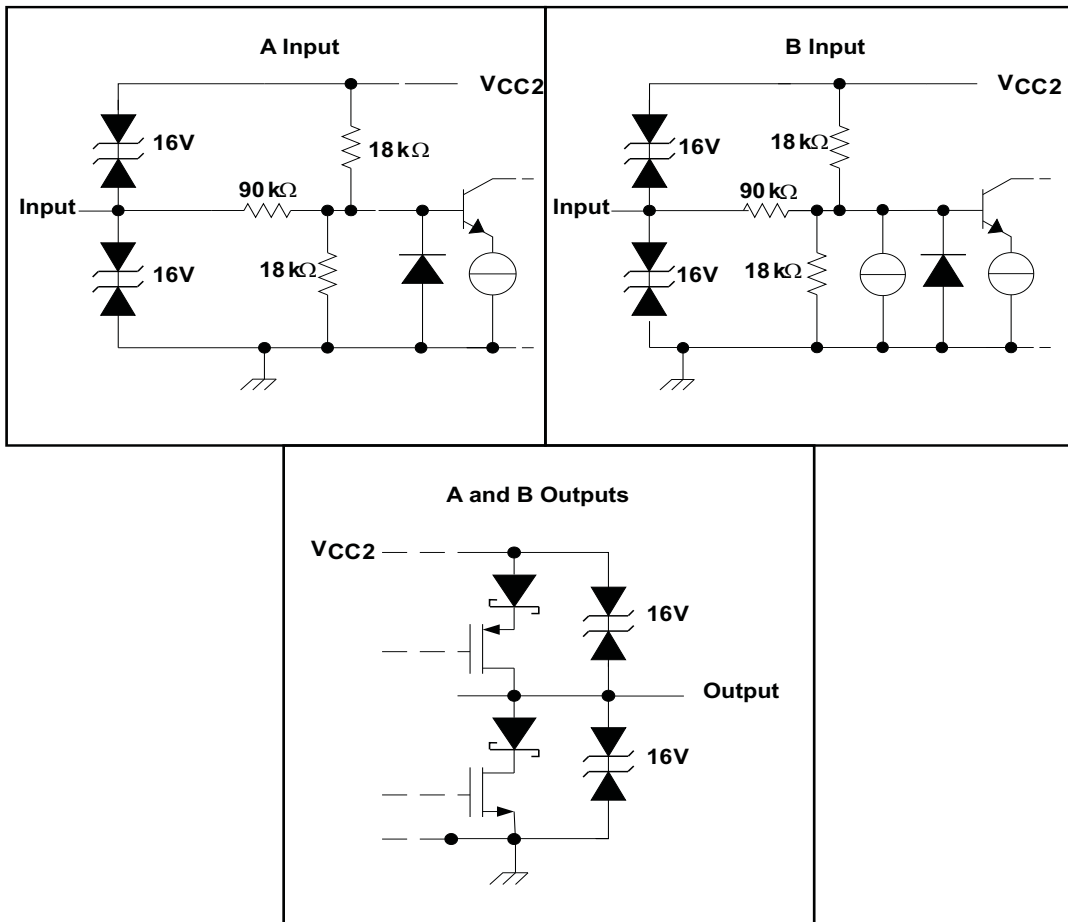


Figure 22. DW-16  $\theta_{JC}$  THERMAL DERATING CURVE per IEC 60747-5-2

**EQUIVALENT CIRCUIT SCHEMATICS**





TYPICAL CHARACTERISTICS

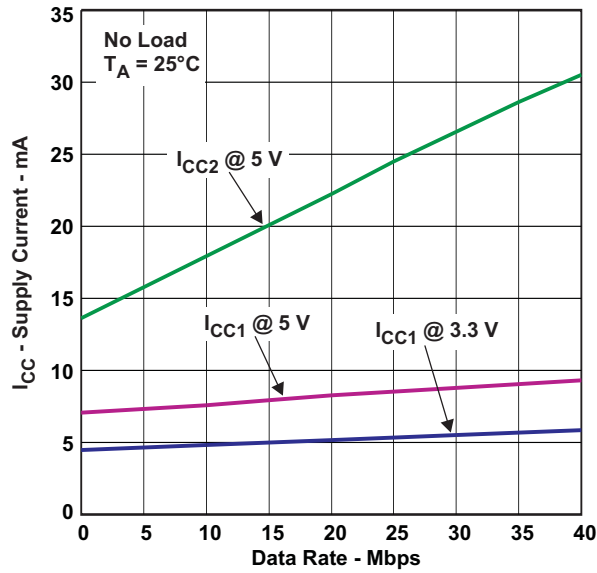


Figure 23. RMS SUPPLY CURRENT (I<sub>CC1</sub> and I<sub>CC2</sub>) vs SIGNALING RATE WITH NO LOAD

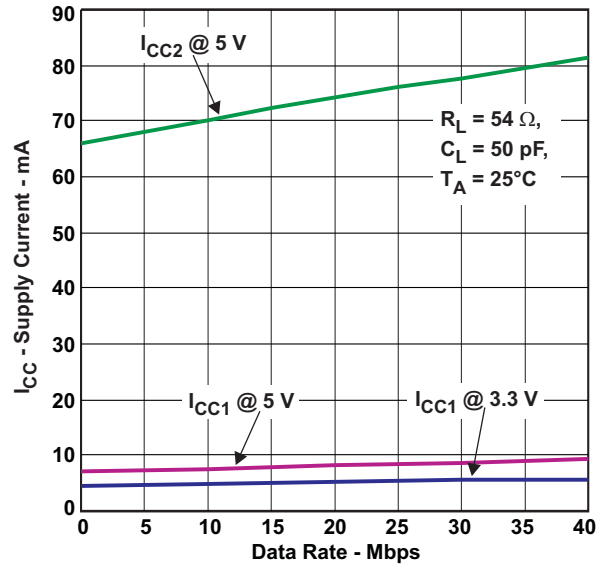


Figure 24. RMS SUPPLY CURRENT (I<sub>CC1</sub> and I<sub>CC2</sub>) vs SIGNALING RATE WITH LOAD

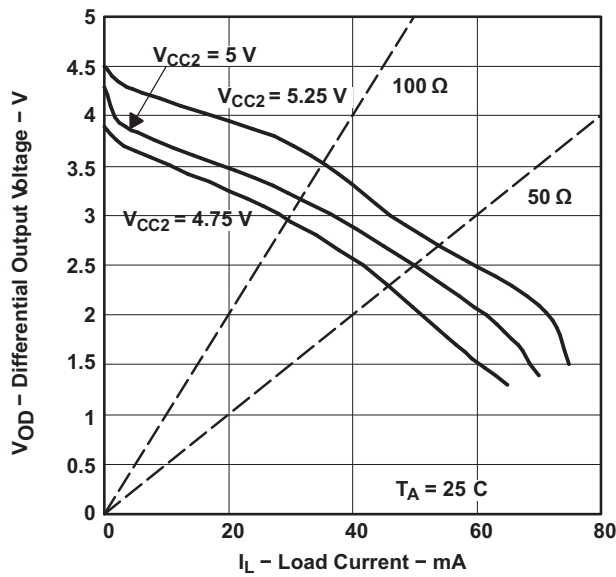


Figure 25. DIFFERENTIAL OUTPUT VOLTAGE vs LOAD CURRENT

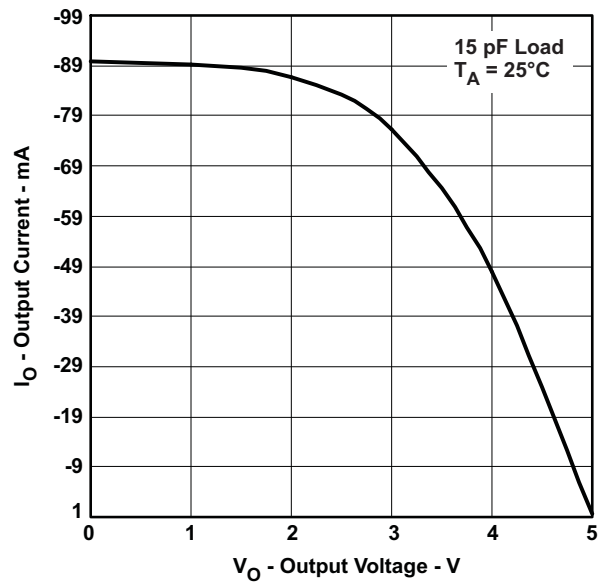


Figure 26. RECEIVER HIGH-LEVEL OUTPUT VOLTAGE vs HIGH-LEVEL OUTPUT CURRENT

TYPICAL CHARACTERISTICS (continued)

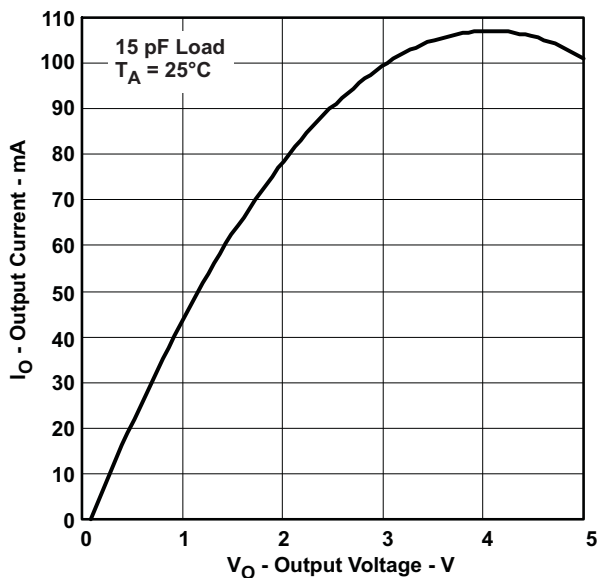


Figure 27. RECEIVER LOW-LEVEL OUTPUT VOLTAGE vs LOW-LEVEL OUTPUT CURRENT

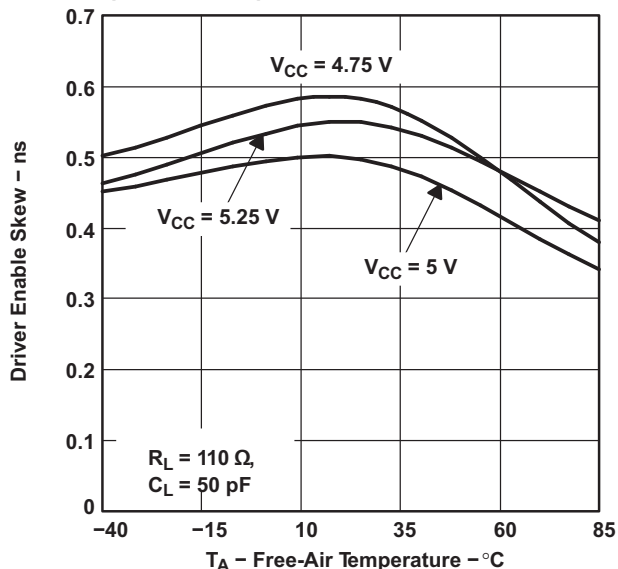


Figure 28. DRIVER ENABLE SKEW vs FREE-AIR TEMPERATURE

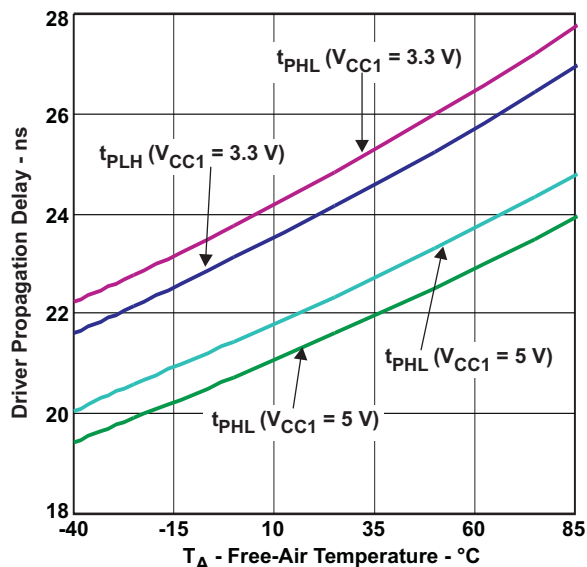


Figure 29. DRIVER PROPAGATION DELAY vs FREE-AIR TEMPERATURE

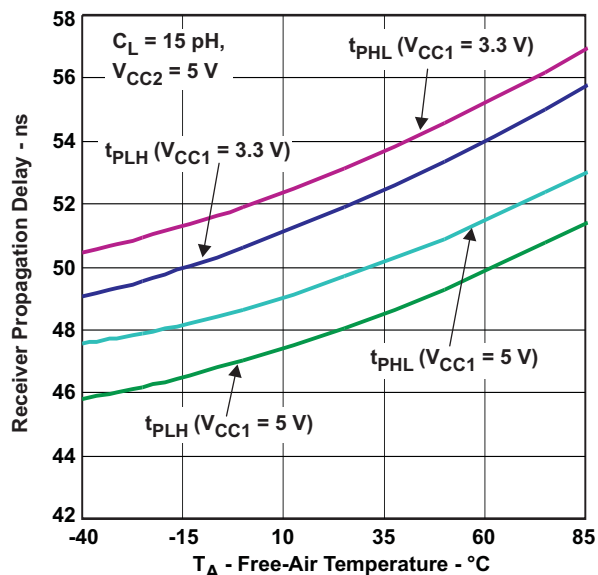


Figure 30. RECEIVER PROPAGATION DELAY vs FREE-AIR TEMPERATURE

## APPLICATION INFORMATION

### REFERENCE DESIGN

ISO1176T Reference Design ([SLUU471](#)) is available to provide complete isolated data and power solution.

### TRANSIENT VOLTAGES

Isolation of a circuit insulates it from other circuits and earth so that noise develops across the insulation rather than circuit components. The most common noise threat to data-line circuits is voltage surges or electrical fast transients that occur after installation and the transient ratings of ISO1176T are sufficient for all but the most severe installations. However, some equipment manufacturers use their ESD generators to test transient susceptibility of their equipment and can exceed insulation ratings. ESD generators simulate static discharges that may occur during device or equipment handling with low-energy but high voltage transients.

[Figure 31](#) models the ISO1176T bus IO connected to a noise generator.  $C_{IN}$  and  $R_{IN}$  is the device and any other stray or added capacitance or resistance across the A or B pin to GND2,  $C_{ISO}$  and  $R_{ISO}$  is the capacitance and resistance between GND1 and GND2 of ISO1176T plus those of any other insulation (transformer, etc.), and we assume stray inductance negligible. From this model, the voltage at the isolated bus return is

$$V_{GND2} = V_N \frac{Z_{ISO}}{Z_{ISO} + Z_{IN}}$$

and will always be less than 16 V from  $V_N$ . If ISO1176T is tested as a stand-alone device,  $R_{IN} = 6 \times 10^4 \Omega$ ,  $C_{IN} = 16 \times 10^{-12}$  F,  $R_{ISO} = 10^9 \Omega$  and  $C_{ISO} = 10^{-12}$  F.

Note from [Figure 31](#) that the resistor ratio determines the voltage ratio at low frequency and it is the inverse capacitance ratio at high frequency. In the stand-alone case and for low frequency,

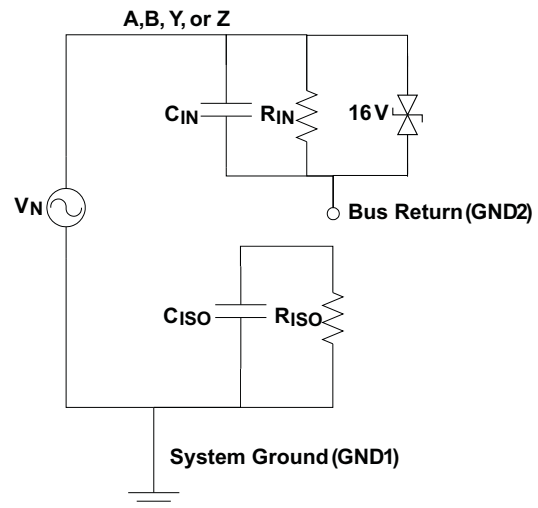
$$\frac{V_{GND2}}{V_N} = \frac{R_{ISO}}{R_{ISO} + R_{IN}} = \frac{10^9}{10^9 + 6 \times 10^4}$$

or essentially all of noise appears across the barrier. At high frequency,

$$\frac{V_{GND2}}{V_N} = \frac{\frac{1}{C_{ISO}}}{\frac{1}{C_{ISO}} + \frac{1}{C_{IN}}} = \frac{1}{1 + \frac{C_{ISO}}{C_{IN}}} = \frac{1}{1 + \frac{1}{16}} = 0.94$$

and 94% of  $V_N$  appears across the barrier. As long as  $R_{ISO}$  is greater than  $R_{IN}$  and  $C_{ISO}$  is less than  $C_{IN}$ , most of transient noise appears across the isolation barrier, as it should.

We recommend the reader not test equipment transient susceptibility with ESD generators or consider product claims of ESD ratings above the barrier transient ratings of an isolated interface. ESD is best managed through recessing or covering connector pins in a conductive connector shell and installer training.



**Figure 31. Noise Model**

## REVISION HISTORY

Changes from Revision initial (October 2010) to Revision A	Page
• Updated transformer driver characteristics .....	6
• Added Thermal Table data .....	14
<b>Changes from Revision A (December 2010) to Revision B</b>	
• Changed the Steady-state short-circuit output current - Test Conditions and values. ....	4
• Changed the Oscillator frequency values .....	6
• Changed the D1, D2 output rise time values .....	6
<b>Changes from Revision B (December 2010) to Revision C</b>	
• Added a Typ value of 23ns to Prop delay time for $V_{CC1} = 5V$ in the RS-485 DRIVER SWITCHING CHARACTERISTIC table .....	5
• Added a Typ value of 25ns to Prop delay time for $V_{CC1} = 3.3V$ in the RS-485 DRIVER SWITCHING CHARACTERISTIC table .....	5
• Deleted $R_{OFF}$ from the TRANSFORMER DRIVER CHARACTERISTICS table .....	6
• Changed $\theta_{JA} = 212^{\circ}C/W$ To: $\theta_{JA} = 76^{\circ}C/W$ , Changed the $I_S$ Max value From: 128mA To: 347mA, and changed paragraph two in the IEC SAFETY LIMITING VALUES section .....	14
• Changed <a href="#">Figure 22</a> .....	15
<b>Changes from Revision C (February 2011) to Revision D</b>	
• Added <a href="#">Figure 1</a> .....	2
• Moved the Pin Description closer to the Pin drawing .....	2
<b>Changes from Revision D (May 2011) to Revision E</b>	
• Deleted the MIN and MAX values for $t_{r,D}$ , $t_{f,D}$ and $t_{BDM}$ specifications in the Transformer Driver Characteristics table. ....	6
• Changed test conditions from 1.9 V to 2.4 V, and changed TYP value from 230 to 350 for $f_{St}$ specification in the Transformer Driver Characteristics table. ....	6
<b>Changes from Revision E (August 2011) to Revision F</b>	
• Changed From "ISO1176T Reference Design SLLU471" To: "ISO1176T Reference Design SLUU471" .....	20

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
ISO1176TDW	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	ISO1176T	<a href="#">Samples</a>
ISO1176TDWR	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	ISO1176T	<a href="#">Samples</a>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Only one of markings shown within the brackets will appear on the physical device.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## TAPE AND REEL INFORMATION



### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
ISO1176TDWR	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS

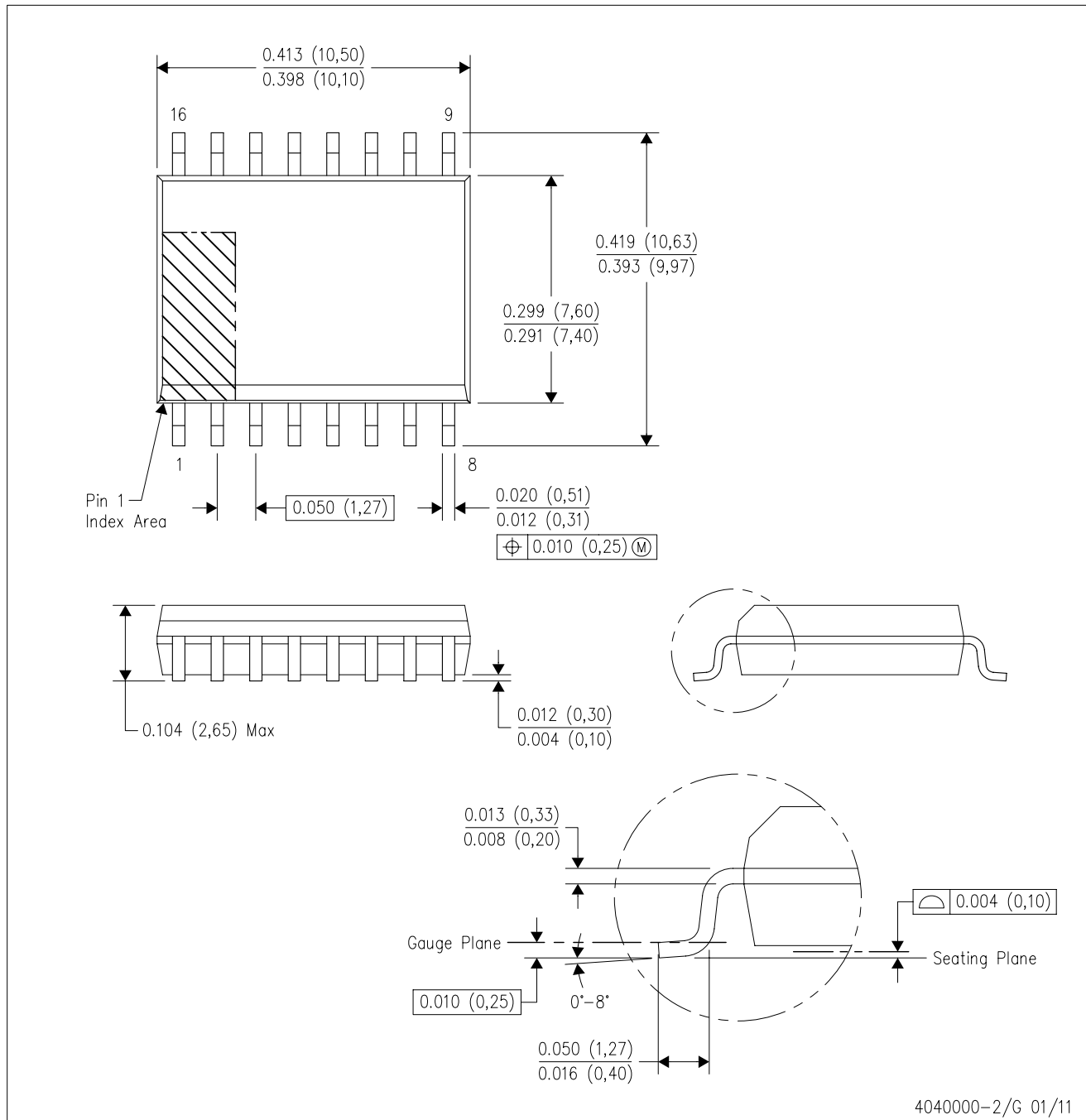


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
ISO1176TDWR	SOIC	DW	16	2000	367.0	367.0	38.0

DW (R-PDSO-G16)

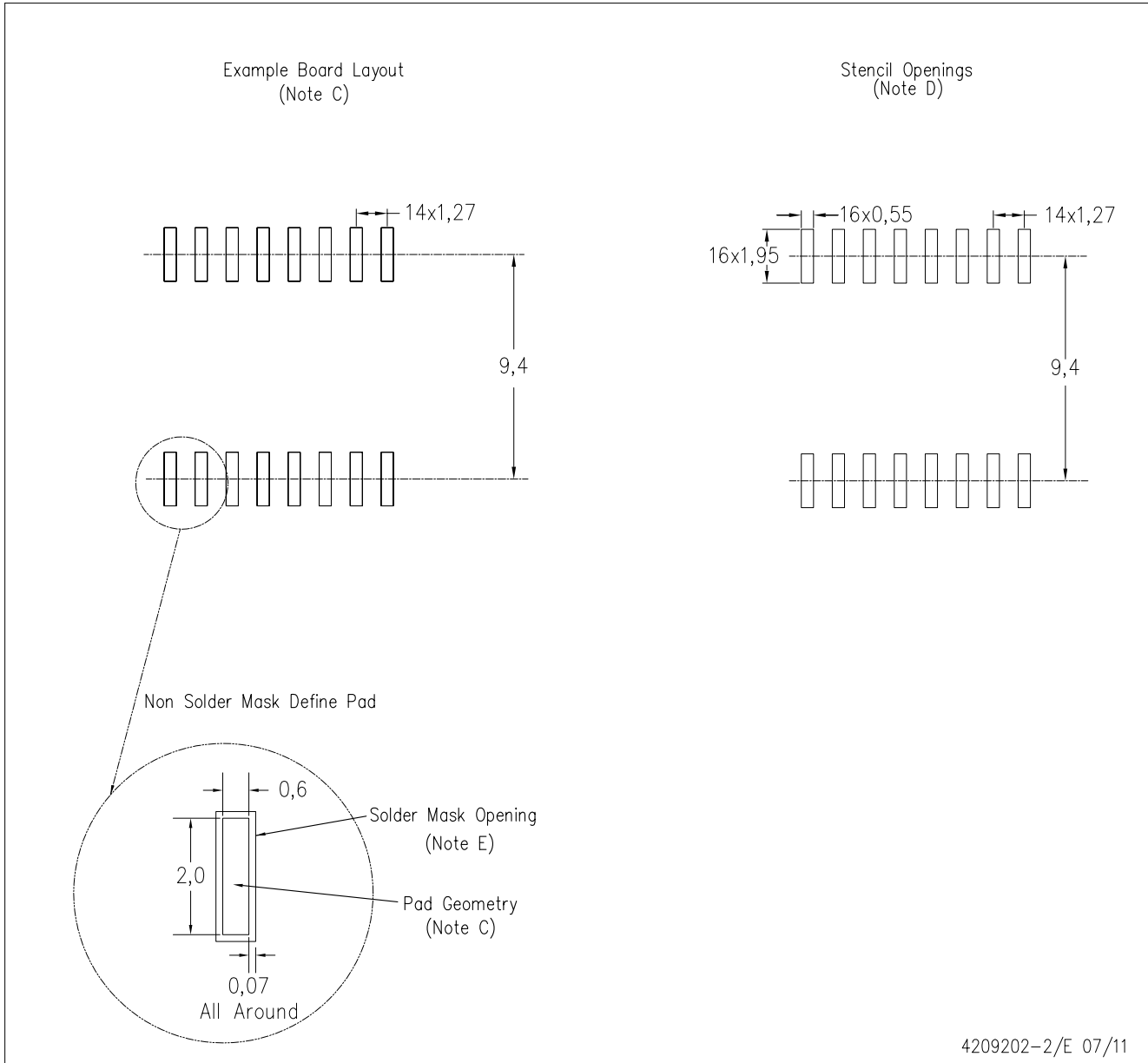
PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
  - D. Falls within JEDEC MS-013 variation AA.

DW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



4209202-2/E 07/11

- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Refer to IPC7351 for alternate board design.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)