





ISO1176

SLLS897F - MARCH 2008 - REVISED AUGUST 2023

ISO1176 Isolated RS-485 Profibus Transceiver

1 Features

- Meets or exceeds the requirements of EN 50170 and TIA/EIA-485-A
- Signaling rates up to 40 Mbps
- Differential output exceeds 2.1 V (54 Ω load)
- Low bus capacitance 10 pF (maximum)
- Up to 160 transceivers on a bus
- 50 kV/µs typical transient immunity
- Fail-safe receiver for bus open, short, idle
- 3.3 V inputs are 5 V tolerant
- Bus-pin ESD protection
 - 16 kV HBM between bus pins and GND2
 - 6 kV HBM between bus pins and GND1
- Safety and regulatory approvals
 - 4000 V_{PK} isolation, 560 V_{PK} V_{IORM} per DIN EN IEC 60747-17 (VDE 0884-17)
 - 2500 V_{RMS} isolation rating per UL 1577
 - 4000 V_{PK} isolation rating per CSA 62368-1

2 Applications

- **Profibus**
- Factory automation
- Networked sensors
- Motor and motion control
- HVA and building automation networks
- Networked security stations

3 Description

The ISO1176 device is an isolated differential line transceiver designed for use in PROFIBUS applications. The device is ideal for long transmission lines because the ground loop is broken to provide for operation with a much larger common-mode voltage range. The symmetrical isolation barrier of each device is tested to provide 2500 V_{RMS} of isolation per UL between the line transceiver and the logic level interface.

The galvanically isolated differential bus transceiver is an integrated circuit designed for bidirectional 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 allowing up to 160 nodes.

The PV pin (pin 7) is provided as a full-chip enable option. All device outputs become high impedance when a logic low is applied to the PV pin. For more information, see the function tables in Section 8.3.

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 nearby sensitive circuitry if they are of sufficient magnitude and duration. The ISO1176 can significantly reduce the risk of data corruption and damage to expensive control circuits.

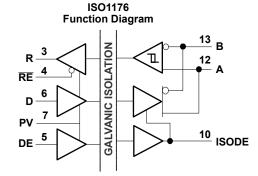
The device is characterized for operation over the ambient temperature range of -40°C to +85°C.

Device Information⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
ISO1176	SOIC (16)	10.30 mm × 7.50 mm

For all available packages, see the orderable addendum at the end of the data sheet.





Simplified Schematic



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 Changes from Revision E (June 2015) to Rev Updated the numbering format for tables, figure 1. Updated Thermal Characteristics, Safety Lim 	ıres, an	d cross-references throughout the document	
· Updated Thermal Characteristics, Safety Lim	iting Val	ues, and Thermal Derating Curves to provide	e more
accurate system-level thermal calculations			5
· Updated electrical and switching characterist	ics to m	atch device performance	7
Changes from Revision D (March 2010) to Re	vision l	E (June 2015)	Page
 Added Pin Configuration and Functions section Functional Modes, Application and Implement section, Device and Documentation Support section 	<i>itation</i> sestion,	ection, Power Supply Recommendations sec and Mechanical, Packaging, and Orderable	tion, Layout Information
VDE standard changed to DIN V VDE V 0884			
Changes from Revision C (October 2008) to F	Revisio	n D (March 2010)	Page
 Added 560-Vpeak V_{IORM} to the first Features 			
• Added UL 1577, IEC 60747-5-2 (VDE 0884,	Rev. 2),	to the Features List	1
• Changed the ISO1176 "Sticky Bit" Issue secti			
Changes from Revision B (June 2008) to Rev		·	Page
· Changed the text in the second paragraph of			
V_{CC2} = 0" To: "allowing up to 160 nodes."			1
Changes from Revision A (May 2008) to Revi	sion B		
		June 2008)	Page
Changes from Revision * (March 2008) to Rev		(May 2008)	
 Changes from Revision * (March 2008) to Rev Added 3.3-V Inputs are 5-V Tolerant to the Formula 	ision A	(May 2008)	Page
 Added 3.3-V Inputs are 5-V Tolerant to the Fe Added the Bus-Pin ESD Protection bullet and 	/ision A	(May 2008) List	Page 1

Added the APPLICATION INFORMATION section......24

5 Pin Configuration and Functions

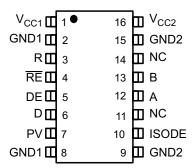


Figure 5-1. DW Package 16-Pin SOIC Top View

Table 5-1. Pin Functions

PI	PIN I/O		DESCRIPTION
NAME	NO.	1/0	DESCRIPTION
А	12	I/O	Noninverting bus output
В	13	I/O	Inverting bus output
D	6	I	Driver input
DE	5	I	Driver logic-high enable
GND1	2, 8	_	Logic-side ground; internally connected
GND2	9, 15	_	Bus-side ground; internally connected
ISODE	10	_	Bus-side driver enable output
NC	11, 14	_	Not connected internally; may be left floating
PV	7	I	ISO1176 chip enable, logic high applied immediately after power up for device operation. A logic low 3-states all outputs.
R	3	0	Receiver output
RE	4	I	Receiver logic-low enable
V _{CC1}	1	_	Logic side power supply
V _{CC2}	16	_	Bus side power supply



6 Specifications

6.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted)(1)

			MIN	MAX	UNIT
V _{CC}	Supply voltage ⁽²⁾	V _{CC1} , V _{CC2}	-0.5	6	V
V _O	Voltage at any bus I/O terminal		-9	14	V
VI	Voltage input	D, DE or RE	-0.5	6	V
Io	Receiver output current		-10	10	mA
TJ	Junction temperature			150	°C
T _{stg}	Storage temperature		-65	150	°C

- (1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. 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

6.2 ESD Ratings

			VALUE	UNIT
		Bus pins to 2, 8	±6000	V
	ESDA/JEDÉC JS-001(1)	Bus pins to 9, 15	±16000	V
V _(ESD) Electros tatic discharge		All pins	±4000	V
	Charged device model (CDM), per JEDEC	Specification JESD22-C101, all pins ⁽²⁾	±1000	V
	Machine model ANSI/ESDS5.2-1996		±200	V

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

			MIN	TYP MAX	UNIT
\/	Logic-side supply voltage, V _{CC1} (with respect to GND1)		3.15	5.5	V
V _{CC}	Bus-side supply voltage, V _{CC2} (with respect to GND2)		4.75	5.25	V
V _{CM}	Voltage at either bus I/O terminal	A or B	-7	12	V
V _{IH}	High-level input voltage	PV, RE	2	5.5	V
V _{IH}	High-level input voltage	D, DE	0.7*V _{CC1}		V
V _{IL}	Low-level input voltage	PV, RE	0	0.8	V
V _{IL}	Low-level input voltage	D, DE		0.3*V _{CC1}	V
V _{ID}	Differential input voltage	A with respect to B	-12	12	V
Io	Output current	Driver	-70	70	mA
Io	Output current	Receiver	-8	8	mA
	Input pulse width		10		ns
T _A	Ambient temperature		-40	25 85	°C

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6.4 Thermal Information

		ISO1176	
	THERMAL METRIC ⁽¹⁾	DW (SOIC)	UNIT
		16 PINS	
R _{θJA}	Junction-to-ambient thermal resistance	81.4	°C/W
R _{0JC(top)}	Junction-to-case (top) thermal resistance	41.4	°C/W
R _{θJB}	Junction-to-board thermal resistance	46.4	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	15.0	°C/W
ΨЈВ	Junction-to-board characterization parameter	45.8	°C/W
R _{0JC(bot)}	Junction-to-case (bottom) thermal resistance	n/a	°C/W

⁽¹⁾ For more information about traditional and new thermal metrics, see the Semiconductor and IC Package Thermal Metrics application report.

6.5 Power Ratings

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
P _D	Maximum power dissipation (both sides)	$V_{\rm CC1}$ = $V_{\rm CC2}$ = 5.25 V, $T_{\rm J}$ = 150°C, $C_{\rm L}$ = 15 pF, Input at 20 MHz 50% duty cycle square wave			283	mW

6.6 Insulation Specifications

	DADAMETED	TEST CONDITIONS	VALUE	LINUT
	PARAMETER	TEST CONDITIONS	DW-16	UNIT
CLR	External clearance ⁽¹⁾	Shortest terminal-to-terminal distance through air		mm
CPG	External creepage ⁽¹⁾	Shortest terminal-to-terminal distance across the package surface	8	mm
DTI	Distance through the insulation	Minimum internal gap (internal clearance)	8	um
CTI	Comparative tracking index	DIN EN 60112 (VDE 0303-11); IEC 60112	>400	V
	Material group	According to IEC 60664-1	II	
	Outs with the second se	Rated mains voltage ≤ 150 V _{RMS}	I-IV	
	Overvoltage category per IEC 60664-1	Rated mains voltage ≤ 300 V _{RMS}	1-111	1
DIN EN	IEC 60747-17 (VDE 0884-17) (2)		-	
V _{IORM}	Maximum repetitive peak isolation voltage	AC voltage (bipolar)	560	V _{PK}
V _{IOTM}	Maximum transient isolation voltage	$V_{TEST} = V_{IOTM}$, t = 60 s (qualification); $V_{TEST} = 1.2 \text{ x } V_{IOTM}$, t = 1 s (100% production)	4000	V _{PK}
q _{pd}	Apparent charge ⁽³⁾	Method b; At routine test (100% production) $V_{ini} = 1.2 \times V_{IOTM}$, $t_{ini} = 1 \text{ s}$; $V_{pd(m)} = 1.5 \times V_{IORM}$, $t_m = 1 \text{ s}$	≤5	pC
C _{IO}	Barrier capacitance, input to output ⁽⁴⁾	V _{IO} = 0.4 x sin (2πft), f = 1 MHz	2	pF
Cı	Input capacitance to ground	$V_I = VCC/2 + 0.4 \times \sin(2\pi ft), f = 1 \text{ MHz}, VCC = 5 \text{ V}$	2	pF
R _{IO}	Isolation resistance ⁽⁴⁾	V _{IO} = 500 V, T _A = 25°C	>10 ¹²	Ω
	Pollution degree		2	
	Climatic category		40/125/21	
UL 1577	,			
V _{ISO}	Maximum withstanding isolation voltage	$V_{TEST} = V_{ISO}$, t = 60 s (qualification), $V_{TEST} = 1.2 \text{ x } V_{ISO}$, t = 1 s (100% production)	2500	V _{RMS}

⁽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 ensure 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 in certain cases. Techniques such as inserting grooves and/or ribs on a printed-circuit board are used to help increase these specifications.
- This coupler is suitable for basic electrical insulation only within the safety ratings. Compliance with the safety ratings shall be ensured (2) by means of suitable protective circuits.
- Apparent charge is electrical discharge caused by a partial discharge (pd).
- All pins on each side of the barrier tied together creating a two-terminal device.

6.7 Safety-Related Certifications

VDE	CSA	UL
Certified according to DIN EN IEC 60747-17 (VDE 0884-17)	Certified according to IEC 60950-1 and IEC 62368-1	Certified according to UL 1577 Component Recognition Program
Basic insulation, 4000 V _{PK} Maximum transient isolation voltage, 560 V _{PK} Maximum repetitive peak isolation voltage	4000 VPK Isolation Rating; Reinforced insulation per CSA 60950-1 and IEC 60950-1 148 V _{RMS} working voltage; Basic insulation per CSA 62368-1 and IEC 62368-1 300V _{RMS} working voltage	Single protection, 2500 V _{RMS}
Certificate number: 40047657	Master contract number: 220991	File number: E181974

6.8 Safety Limiting Values

Safety limiting⁽¹⁾ intends to minimize potential damage to the isolation barrier upon failure of input or output circuitry.

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
DW-16 PA	ACKAGE					
Is	Safety input, output, or supply current	$R_{\theta JA} = 81.4$ °C/W, $V_I = 5.5$ V, $T_J = 150$ °C, $T_A = 25$ °C,			279	mA
Ts	Maximum case temperature				150	°C

(1) The maximum safety temperature, T_S, has the same value as the maximum junction temperature, T_J, specified for the device. The I_S and P_S parameters represent the safety current and safety power respectively. The maximum limits of I_S and P_S should not be exceeded. These limits vary with the ambient temperature, TA.

The junction-to-air thermal resistance, R_{BJA}, in the table is that of a device installed on a high-K test board for leaded surface-mount packages. Use these equations to calculate the value for each parameter:

 $T_J = T_A + R_{\theta,JA} \times P$, where P is the power dissipated in the device.

 $T_{J(max)} = T_S = T_A + R_{\theta JA} \times P_S$, where $T_{J(max)}$ is the maximum allowed junction temperature. $P_S = I_S \times V_I$, where V_I is the maximum input voltage.



6.9 Electrical Characteristics: Driver

All typical specs are at V_{CC1} =3.3V, V_{CC2} =5V, T_A =27°C, (Min/Max specs are 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 , Figure 8	1.8		V _{CC2}	V
	Steady state differential output voltage magnitude	See Figure 9 and Figure 13	2.1			V
V _{OD(SS)}	Steady state differential output voltage magnitude	Common mode loading with V _{test} from -7V to 12V, See figure 10	2.1			V
$\Delta V_{ODSS} $	Change in differential output voltage between two states	R _L = 54 ohms, See Figure 11 and Figure 12	-200		200	mV
V _{OC(SS)}	Steady state common-mode output voltage	R _L = 54 ohms, See Figure 11 and Figure 12	2		3	V
$\Delta V_{OC(SS)}$	change in steady-state common-mode output voltage between two states	R _L = 54 ohms, See Figure 11 and Figure 12	-200		200	mV
V _{OC(PP)}	Peak-to-peak common-mode output voltage	R _L = 54 ohms, See Figure 11 and Figure 12		0.5		V
V _{OD(RING)}	Differential output voltage over and undershoot	See Figure 13 and Figure 17			10	%V _{OD(PP)}
V _{I(HYS)}	Input voltage hysteresis	See Figure 14		150		mV
	lanut current	D, DE at 0 V or V _{CC1}	-10		10	μA
l _l	Input current	PV ⁽¹⁾ at 0 V or V _{CC1}			120	μA
I _{O(OFF)}	Output current with power off	Vcc ≤ 2.5V		ceiver input		
l _{OZ}	High-impedance state output current	DE at 0 V	current in Electr Re	ical Character eceiver	istics:	
I _{OS(P)}	Peak short circuit output current	DE at V _{CC} , See Figure 15 and Figure 16: V _{OS} = -7 to 12 V	-250		250	mA
	Steady state short-circuit output	DE at V_{CC} , See Figure 15 and Figure 16: V_{OS} = 12 V, D at GND1			150	
I _{OS(SS)}	current	DE at V_{CC} , See Figure 15 and Figure 16: V_{OS} = -7 V, D at V_{CC1}	-150			mA
C _{OD}	Differential output capacitance			7	10	pF
CMTI	Common-mode transient immunity	See Figure 27	25			kV/μs

⁽¹⁾ The PV pin has a $50-k\Omega$ pullup resistor and leakage current depends on supply voltage.

6.10 Electrical Characteristics: Receiver

All typical specs are at V_{CC1} =3.3V, V_{CC2} =5V, T_A =27°C, (Min/Max specs are over recommended operating conditions unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V _{IT+}	Positive-going input threshold voltage	Positive-going input threshold voltage I _O = -8 mA, See Figure 22				
V _{IT-}	Negative-going input threshold voltage	I _O = 8 mA, See Figure 22	-200	-120		mV
V _{hys}	Input hysteresis (V _{IT+} – V _{IT})			40		mV
V _{OH}	Output Voltage	$\rm V_{CC1}$ at 3.3 V and $\rm V_{CC2}$ at 5V, $\rm V_{ID}$ = 200mV, $\rm I_{O}$ = $\rm -8mA$	V _{CC1} -0.4	3		V
V _{OH}	Output Voltage	$\rm V_{CC1}$ at 3.3 V and $\rm V_{CC2}$ at 5V, $\rm V_{ID}$ = 200mV, $\rm I_{O}$ = $-20\rm uA$	V _{CC1} -0.1	3.3		V
V _{OL}	Output Voltage	$\rm V_{CC1}$ at 3.3 V and $\rm V_{CC2}$ at 5V, $\rm V_{ID}$ = -200mV, $\rm I_{O}$ = 8mA		0.2	0.4	V
V _{OL}	Output Voltage	V_{CC1} at 3.3 V and V_{CC2} at 5V, V_{ID} = -200mV, I_{O} = 20uA		0	0.1	V
V _{OH}	Output Voltage	$V_{\rm CC1}$ at 5 V and $V_{\rm CC2}$ at 5V, $V_{\rm ID}$ = 200mV, $I_{\rm O}$ = -8mA	V _{CC1} -0.8	4.6		V



All typical specs are at V_{CC1} =3.3V, V_{CC2} =5V, T_A =27°C, (Min/Max specs are over recommended operating conditions unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V _{OH} Output Voltage		$V_{\rm CC1}$ at 5 V and $V_{\rm CC2}$ at 5V, $V_{\rm ID}$ = 200mV, $I_{\rm O}$ = -20uA	V _{CC1} -0.1	5		٧
V _{OL}	Output Voltage	$V_{\rm CC1}$ at 5 V and $V_{\rm CC2}$ at 5V, $V_{\rm ID}$ = -200mV, $I_{\rm O}$ = 8mA		0.2	0.4	V
V _{OL}	Output Voltage	V_{CC1} at 5 V and V_{CC2} at 5V, V_{ID} = -200mV, I_{O} = 20uA		0	0.1	V
I _A or I _B	Due vie immed aument	V_1 = -7 V or 12 V, other input = 0V: V_{CC} = 4.75 V or 5.25 V			200	μA
I _{A(OFF)} or I _{B(OFF)}	Bus pin input current	V _I = -7 V or 12 V, other input = 0V: V _{CC2} = 0 V	-160			
II	Receiver enable input current	RE = 0 V or V _{CC1}	-50		50	μA
I _{OZ}	High impedance state output current	RE = V _{CC1}	-1		1	μΑ
R _{ID}	Differential input resistance	A, B	48			kohm
C _{ID}	Differential input capacitance	Test input signal is a 1.5MHz sine wave with 1V _{PP} amplitude, C _D is measured across A and B		7	10	pF
CMR	Common mode rejection	See Figure 26		4		V



6.11 Supply Current

Bus loaded or unloaded (over recommended operating conditions unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
DRIVER ENABLI	ED, RECEIVER DISABLED			'	
	3 V: DE at 0 V		4	6	mA
	3 V: DE at V _{CC1} , 2 Mbps		5		mA
	3 V: DE at _{VCC1} , 25 Mbps		6		mA
I _{CC1}	5.5 V: DE at 0 V		7	10	mA
	5.5 V: DE at V _{CC1} , 2 Mbps		8		mA
	5.5 V: DE at V _{CC1} , 25 Mbps		11		mA
	5.25 V: DE at 0 V		15	18	mA
I _{CC2}	5.25 V: DE at V _{CC1} , 2 Mbps, 54 ohm load		70		mA
	5.25 V: DE at V _{CC1} , 25 Mbps, 54 load ohm		75		mA

6.12 Electrical Characteristics: ISODE-Pin

All typical specs are at V_{CC1} =3.3V, V_{CC2} =5V, T_A =27°C, (Min/Max specs are over recommended operating conditions unless otherwise noted)

PARAMETER			TEST CONDITIONS	MIN	TYP	MAX	UNIT
V _{OH}	V	ligh-level output voltage	$I_{OH} = -8 \text{ mA}$	V _{CC2} - 0.4	4.6		V
	VOH I light-level output voltage		I _{OH} = -20 μA	V _{CC2} – 0.1	5		V
Ī	V	Low-level output voltage	$I_{OL} = -8 \text{ mA}$		0.2	0.4	V
	V _{OL}	Low-level output voltage	$I_{OL} = -20 \ \mu A$		0	0.1	V



6.13 Switching Characteristics: Driver

All typical specs are at V_{CC1} =3.3V, V_{CC2} =5V, T_A =27°C, (Min/Max specs are over recommended operating conditions unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
ISO1176						
t _{PHL} , t _{PLH}	Propagation delay				35	ns
tsk(p)	Pulse skew (t _{PHL} - t _{PLH})	V _{CC1} at 5 V, _{VCC2} at 5 V		2	7.5	ns
t _{PHL} , t _{PLH}	Propagation delay				40	ns
tsk(p)	Pulse skew (t _{PHL} - t _{PLH})	V _{CC1} at 3.3 V, V _{CC2} at 5 V		2	7.5	ns
t _r , t _f	Differential output rise time and fall time	See Figure 17	2	3	7.5	ns
t _{pDE}	DE to ISODE prop delay	See Figure 21			30	ns
$t_{t(MLH)}$, $t_{t(MHL)}$	Output transition skew	See Figure 18			1	ns
$t_{P(AZH)}$, $t_{P(BZH)}$, $t_{P(AZL)}$, $t_{P(BZL)}$	Propagation delay, high-impedance-to-active output				80	ns
$\begin{array}{l} t_{P(AHZ)},\\ t_{P(BHZ)},\ t\\ P(ALZ),\\ t_{P(BLZ)} \end{array}$	Propagation delay time, active-to-high-impedance output	C_L = 50 pF, \overline{RE} at 0 V, See Fgure 19 and Figure 20			80	ns
$\begin{aligned} t_{P(AZL)} - \\ t_{P(BZH)} , \\ t_{P(AZH)} - \\ t_{P(BZL)} \end{aligned}$	Enable skew time			0.55	1.5	ns
t _(CFB)	Time from application of short-circuit to current foldback	See Figure 16		0.5		μs
t _(TSD)	Time from application of short-circuit to thermal shutdown	T _A = 25°C, See Figure 16	100			μs

6.14 Switching Characteristics: Receiver

All typical specs are at V_{CC1} =3.3V, V_{CC2} =5V, T_A =27°C, (Min/Max specs are over recommended operating conditions unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
ISO1176					-	
t _{PHL} , t _{PLH}	Propagation delay	V _{CC1} at 5 V, V _{CC2} at 5 V			50	ns
tsk(p)	Pulse skew (t _{PHL} - t _{PLH})	V _{CC1} at 5 V, V _{CC2} at 5 V		2	7.5	ns
t _{PHL} , t _{PLH}	Propagation delay	V _{CC1} at 3.3 V, V _{CC2} at 5 V			55	ns
tsk(p)	Pulse skew (t _{PHL} - t _{PLH})	V _{CC1} at 3.3 V, V _{CC2} at 5 V		2	7.5	ns
t _r , t _f	Differential output rise time and fall time	See Figure 17		2	4	ns
t _{PZH}	Propagation delay time, high-impedance-to-high-level output	DE at V. See Figure 24		13	25	ns
t _{PHZ}	Propagation delay time, high-level-to- high-impedance output	DE at V _{CC1} , See Figure 24		13	25	ns
t _{PZL}	Propagation delay time, high-impedance-to-low-level output	DE at V. See Figure 25		13	25	ns
t _{PLZ}	Propagation delay time, low-level-to-high-impedance output	DE at V _{CC} , See Figure 25		13	25	ns

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6.15 Insulation Characteristics Curves

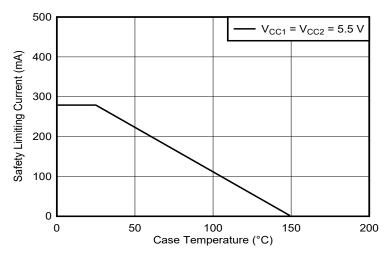
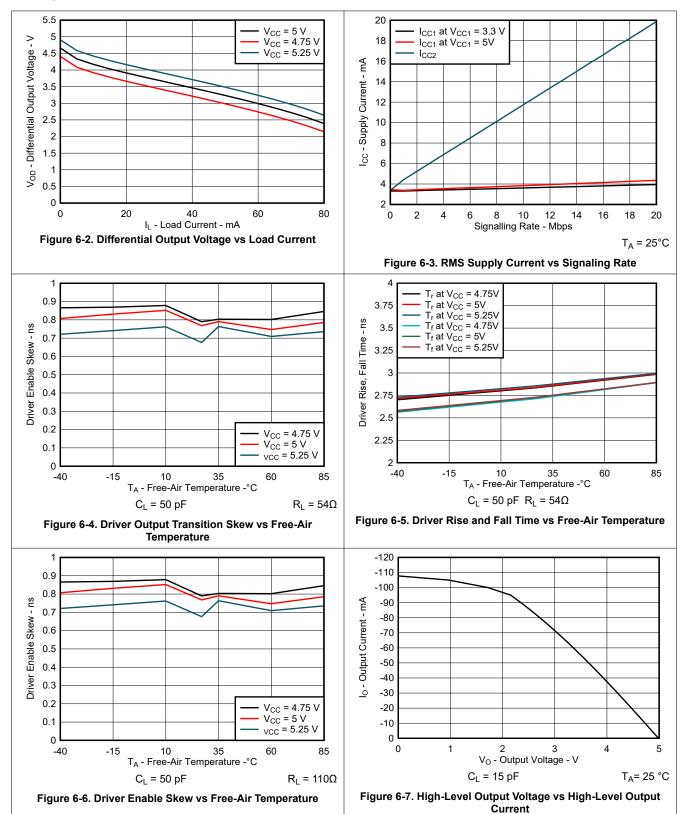


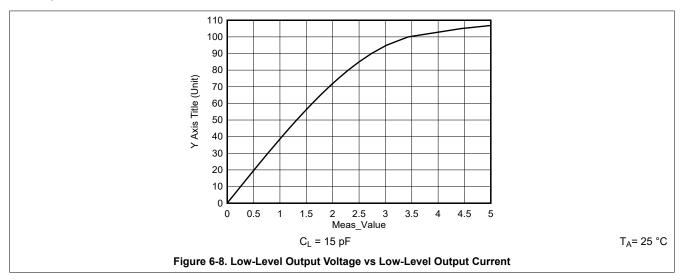
Figure 6-1. Thermal Derating Curve for Limiting Power per VDE



6.16 Typical Characteristics



6.16 Typical Characteristics (continued)





7 Parameter Measurement Information

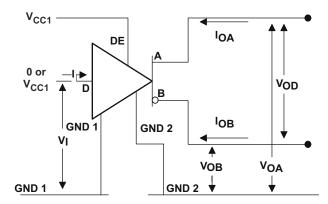


Figure 7-1. Open Circuit Voltage Test Circuit

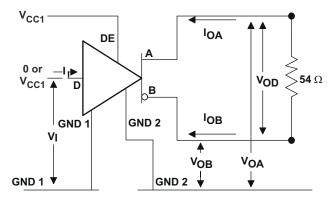


Figure 7-2. V_{OD} Test Circuit

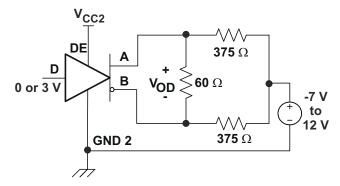


Figure 7-3. Driver V_{OD} With Common-Mode Loading Test Circuit

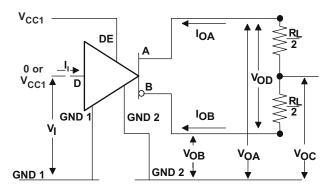


Figure 7-4. Driver V_{OD} and V_{OC} Without Common-Mode Loading Test Circuit

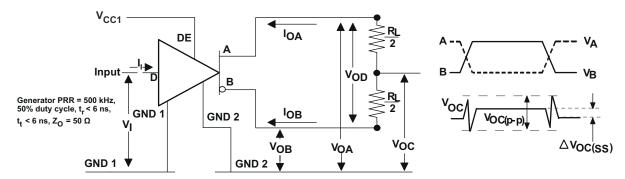


Figure 7-5. Steady-State Output Voltage Test Circuit and Voltage Waveforms

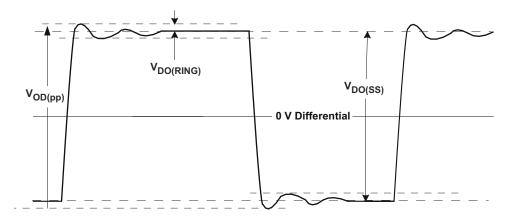


Figure 7-6. $V_{\text{OD(RING)}}$ Waveform and Definitions

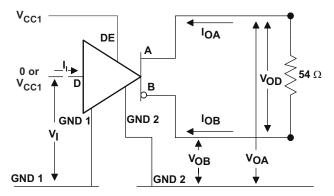


Figure 7-7. Input Voltage Hysteresis Test Circuit



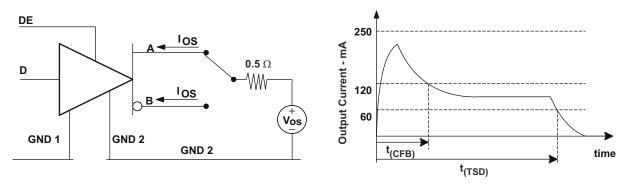


Figure 7-8. Driver Short-Circuit Test Circuit and Waveforms (Short-Circuit Applied at Time t=0)

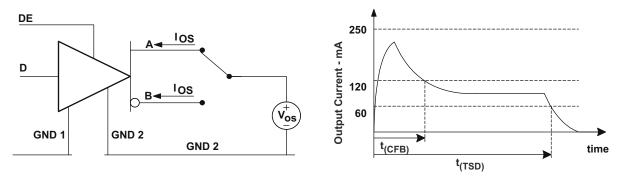


Figure 7-9. I_{OS(SS)} Steady State Short-Circuit Output Current Test Circuit

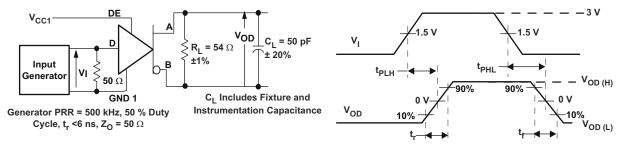


Figure 7-10. Driver Switching Test Circuit and Waveforms

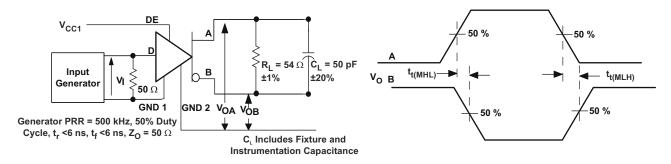


Figure 7-11. Driver Output Transition Skew Test Circuit and Waveforms

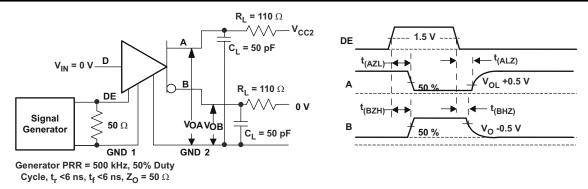


Figure 7-12. Driver Enable and Disable Test, D at Logic Low Test Circuit and Waveforms

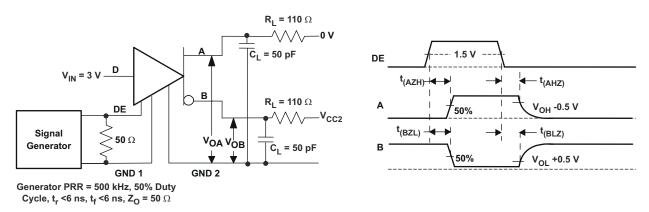


Figure 7-13. Driver Enable and Disable Test, D at Logic High Test Circuit and Waveforms

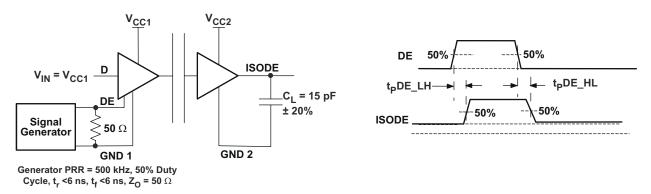


Figure 7-14. DE to ISODE Prop Delay Test Circuit and Waveforms

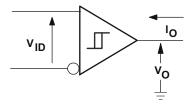


Figure 7-15. Receiver DC Parameter Definitions



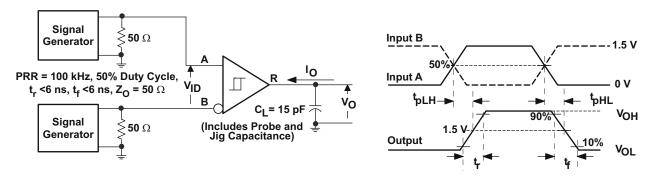


Figure 7-16. Receiver Switching Test Circuit and Waveforms

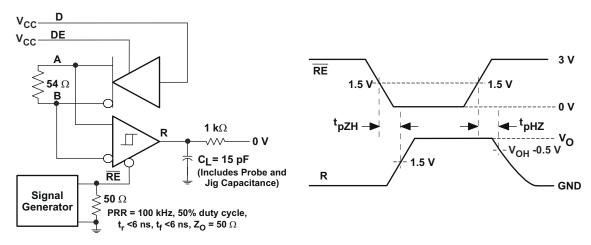


Figure 7-17. Receiver Enable Test Circuit and Waveforms, Data Output High

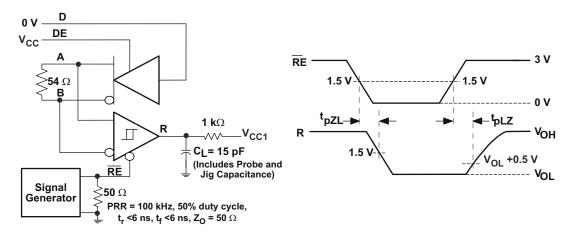


Figure 7-18. Receiver Enable Test Circuit and Waveforms, Data Output Low

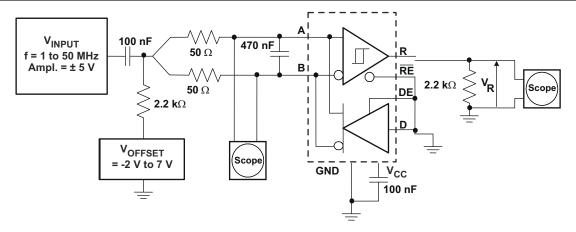


Figure 7-19. Common-Mode Rejection Test Circuit

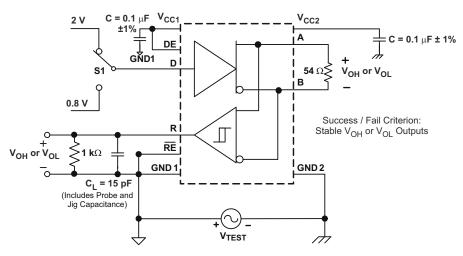


Figure 7-20. Common-Mode Transient Immunity Test Circuit



8 Detailed Description

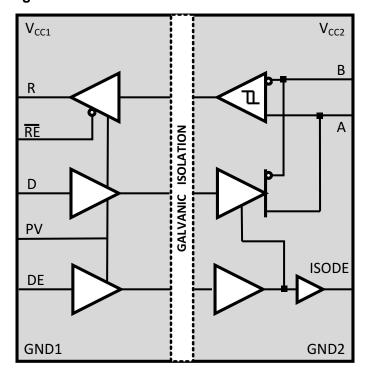
8.1 Overview

The ISO1176 is an isolated half-duplex differential line transceiver that meets the requirements of EN 50170 and TIA/EIA 485/422 applications. The device is rated to provide galvanic isolation of up to 2500 V_{RMS} for 60 s per UL 1577. The device has active-high driver enable and active-low receiver enable functions to control the data flow. The device has maximum data transmission speed of 40 Mbps.

When the driver enable pin, DE, is logic high, the differential outputs A and B follow the logic states at data input D. A logic high at D causes A to turn high and B to turn low. In this case, the differential output voltage defined as $V_{OD} = V_{(A)} - V_{(B)}$ is positive. When D is low, the output states reverse, B turns high, A becomes low, and V_{OD} is negative. When DE is low, both outputs turn high-impedance. In this condition, the logic state at D is irrelevant. The DE pin has an internal pulldown resistor to ground, thus when left open the driver is disabled (high-impedance) by default. The D pin has an internal pullup resistor to V_{CC} , thus, when left open while the driver is enabled, output A turns high and B turns low.

When the receiver enable pin, \overline{RE} , is logic low, the receiver is enabled. When the differential input voltage defined as $V_{ID} = V_{(A)} - V_{(B)}$ is positive and higher than the positive input threshold, V_{IT+} , the receiver output, R, turns high. When V_{ID} is negative and less than the negative and lower than the negative input threshold, V_{IT-} , the receiver output, R, turns low. If V_{ID} is between V_{IT+} and V_{IT-} the output is indeterminate. When \overline{RE} is logic high or left open, the receiver output is high-impedance and the magnitude and polarity of V_{ID} are irrelevant. Internal biasing of the receiver inputs causes the output to go failsafe-high when the transceiver is disconnected from the bus (open-circuit), the bus lines are shorted (short-circuit), or the bus is not actively driven (idle bus).

8.2 Functional Block Diagram





8.3 Device Functional Modes

Table 8-1. Driver Function Table

V _{CC1}	V _{CC2}	POWER VALID	INPUT	ENABLE	ENABLE OUTPUT	ОИТІ	PUTS
		(PV) (ISO1176)	(D)	INPUT (DE)	(ISODE)	A	В
PU	PU	H or open	Н	Н	Н	Н	L
PU	PU	H or open	L	Н	Н	L	Н
PU	PU	H or open	Х	L	L	Z	Z
PU	PU	H or open	Х	open	L	Z	Z
PU	PU	H or open	open	Н	Н	Н	L
PD	PU	Х	X	Х	L	Z	Z
PU	PD	Х	Х	X	L	Z	Z
PD	PD	Х	Х	Х	L	Z	Z
X	Х	L	X X		L	Z	Z

Table 8-2. Receiver Function Table

	Table 6 2. Receiver Falletter Table											
V _{CC1}	V _{CC2}	POWER VALID (PV) (ISO1176)	DIFFERENTIAL INPUT $V_{ID} = (V_A - V_B)$	ENABLE (RE)	OUTPUT (R)							
PU	PU	H or open	-0.01 V ≤ V _{ID}	L	Н							
PU	PU	H or open	-0.2 V < V _{ID} < -0.01 V	L	?							
PU	PU	H or open	V _{ID} ≤ -0.2 V	L	L							
PU	PU	PU H or open X		Н	Z							
PU	PU	H or open	Х	open	Z							
PU	PU	H or open	Open-circuit	L	Н							
PU	PU	H or open	Short-circuit	L	Н							
PU	PU	H or open	Idle (terminated) bus	L	Н							
PD	PU	X	Х	Х	Z							
PU	PD	H or open	Х	L	Н							
PD	PD	X	Х	Х	Z							
Х	Х	L	Х	Х	Z							



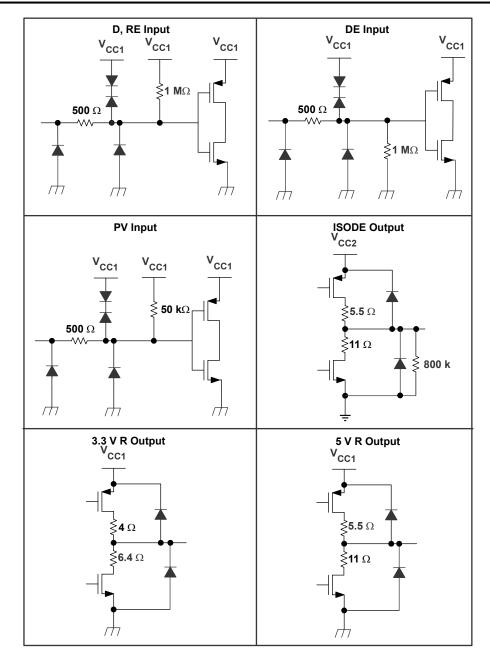


Figure 8-1. Equivalent I/O Schematics

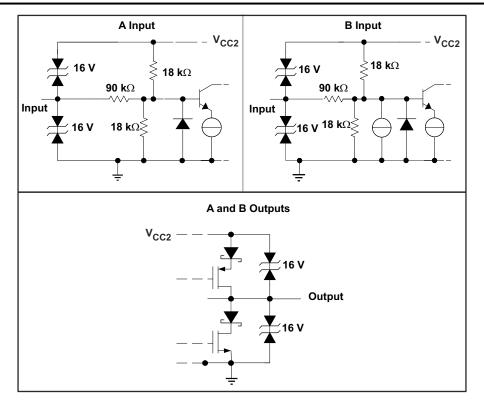


Figure 8-2. Equivalent I/O Schematics for A and B Inputs and Outputs

9 Application and Implementation

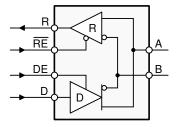
Note

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

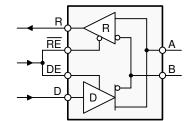
9.1 Application Information

The ISO1176 device consists of a RS-485 transceiver, commonly used for asynchronous data transmissions. For half-duplex transmission, only one pair is shared for both transmission and reception of data. To eliminate line reflections, each cable end is terminated with a termination resistor, R(T), whose value matches the characteristic impedance, Z0, of the cable. This method, known as parallel termination, allows for higher data rates over longer cable length.

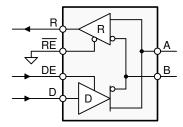
9.2 Typical Application



a) Independent driver and receiver enable signals



b) Combined enable signals for use as directional control pin



c) Receiver always on

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Figure 9-1. Half-Duplex Transceiver Configurations

9.2.1 Design Requirements

RS-485 is a robust electrical standard suitable for long-distance networking that may be used in a wide range of applications with varying requirements, such as distance, data rate, and number of nodes.

Table 9-1. Design Parameters

PARAMETER	VALUE
Pullup and Pulldown Resistors	1 kΩ to 10 kΩ
Decoupling Capacitors	100 nF

9.2.2 Detailed Design Procedure

Isolating of a circuit insulates it from other circuits and earth, so that noise voltage 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. The transient ratings of the ISO1176 standard are sufficient for all but the most severe installations. However, some equipment manufacturers use ESD generators to test equipment transient susceptibility. This practice can exceed insulation ratings. ESD generators simulate static discharges that may occur during device or equipment handling with low-energy but high-voltage transients.

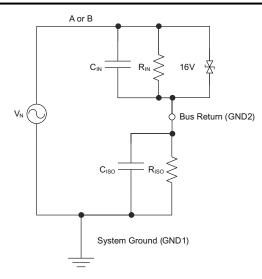


Figure 9-2. Device Model for Static Discharge Testing

Figure 9-2 models the ISO1176 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 the ISO1176, plus those of any other insulation (transformer, and so forth). Stray inductance is assumed to be negligible.

9.2.2.1 Transient Voltages

From this model, the voltage at the isolated bus return is

$$v_{GND2} = v_N \frac{Z_{ISO}}{Z_{ISO} + Z_{IN}} \tag{1}$$

and is always less than 16 V from V_N. If the ISO1176 is tested as a stand-alone device,

- R_{IN} = 6 x 10⁴ Ω ,
- C_{IN} = 16 x 10⁻¹² F,
- R_{ISO} = $10^9 \Omega$ and
- $C_{ISO} = 10^{-12} F.$

Notice from Figure 9-2 that the resistor ratio determines the voltage ratio at low frequencies, and that the inverse capacitance ratio determines the voltage ration at high frequencies. In the stand-alone case and for low frequencies,

$$\frac{v_{GND2}}{v_N} = \frac{R_{ISO}}{R_{ISO} + R_{IN}} = \frac{10^9}{10^9 + 6x10^4}$$
 (2)

or essentially all of the noise appears across the barrier.

At high frequencies,

$$\frac{v_{\text{GND2}}}{v_{\text{N}}} = \frac{\frac{1}{C_{\text{ISO}}}}{\frac{1}{C_{\text{ISO}}} + \frac{1}{C_{\text{IN}}}} = \frac{1}{1 + \frac{C_{\text{ISO}}}{C_{\text{IN}}}} = \frac{1}{1 + \frac{1}{16}} = 0.94$$
(3)

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 the transient noise appears across the isolation barrier, as it should.

Using ESD generators to test equipment transient susceptibility, or considering product claims of ESD ratings greater than the barrier transient ratings of an isolated interface is not recommended. ESD is best managed through recessing or covering connector pins in a conductive connector shell, and by proper installer training.

9.2.2.2 ISO1176 "Sticky Bit" Issue (Under Certain Conditions)

Summary: In applications with sufficient differential noise on the bus, the output of the ISO1176 receiver may "stick" at an incorrect state for up to 30 µs.

Description: The ISO1176 isolated Profibus (RS-485) transceiver is rated for signaling up to 40 Mbps on twisted-pair bus lines. The receiver thresholds comply with RS-485 and Profibus specifications; an input differential voltage $V_{ID} = V_A - V_B > 200$ mV causes a logic High on the R output, and $V_{ID} < -200$ mV causes a logic Low on the R output. To assure a known receiver output when the bus is shorted or idle, the upper threshold is set below zero, such that $V_{ID} = 0$ mV causes a logic High on the R output. The data sheet specifies a typical upper threshold (V_{IT+}) of -80 mV and a typical lower threshold (V_{IT-}) of -120 mV.

At a signaling rate of 40 Mbps, each valid data bit has a duration of 25 ns. At typical Profibus signaling rates of 12 Mbps or lower, each valid data bit has a duration of 83 ns or more. The ISO1176 correctly sets the R output for each of these valid data bits.

In applications with a high degree of differential noise on the bus lines, it is possible to get short periods when an invalid bus voltage triggers a change in state of the internal receiver circuits. An issue with the digital isolation channel in the ISO1176 may cause the invalid receiver state to "stick" rather than immediately transition back to the correct state. The receiver output will always transition to the correct state, but may stick in the incorrect state for up to $30~\mu s$. This can cause a temporary loss of data.

Figure 9-3 shows two cases which could result in temporary loss of data.

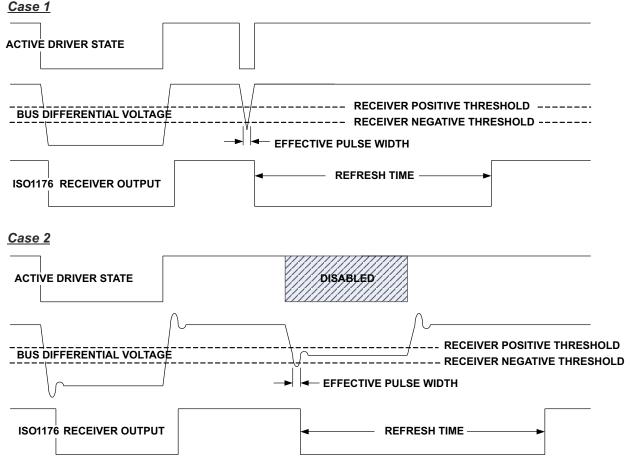


Figure 9-3. "Sticky Bit" Issue Waveforms

9.2.3 Application Curve

At maximum working voltage, ISO1176 isolation barrier has more than 28 years of life.

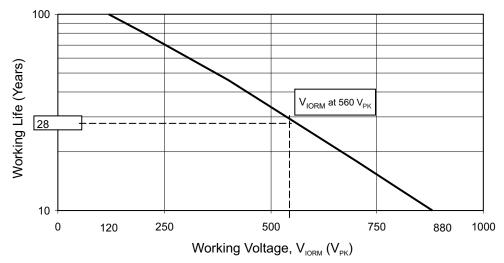


Figure 9-4. Time-Dependent Dielectric Breakdown Test Results

10 Power Supply Recommendations

To ensure reliable operation at all data rates and supply voltages, TI recommends a 0.1 μ F bypass capacitor at input and output supply pins (V_{CC1} and V_{CC2}). The capacitors should be placed as close to the supply pins as possible. If only a single primary-side power supply is available in an application, isolated power can be generated for the secondary-side with the help of a transformer driver such as TI's SN6501. For such applications, detailed power supply design and transformer selection recommendations are available in SN6501 data sheet (SLLSEA0).



11 Layout

11.1 Layout Guidelines

ON-chip IEC-ESD protection is good for laboratory and portable equipment but never sufficient for EFT and surge transients occurring in industrial environments. Therefore, robust and reliable bus node design requires the use of external transient protection devices. Because ESD and EFT transients have a wide frequency bandwidth from approximately 3-MHz to 3-GHz, high-frequency layout techniques must be applied during PCB design. A minimum of four layers is required to accomplish a low EMI PCB design (see Figure 11-1).

- Layer stacking should be in the following order (top-to-bottom): high-speed signal layer, ground plane, power plane, and low-frequency signal layer.
- Placing a solid ground plane next to the high-speed signal layer establishes controlled impedance for transmission line interconnects and provides an excellent low-inductance path for the return current flow.
- Placing the power plane next to the ground plane creates additional high-frequency bypass capacitance of approximately 100 pF/in².
- Routing the slower speed control signals on the bottom layer allows for greater flexibility as these signal links usually have margin to tolerate discontinuities such as vias.
- Place the protection circuitry close to the bus connector to prevent noise transients from penetrating your board.
- Use V_{CC} and ground planes to provide low-inductance. High-frequency currents might follow the path of least inductance and not necessarily the path of least resistance.
- Design the protection components into the direction of the signal path. Do not force the transient currents to divert from the signal path to reach the protection device.
- Apply 0.1-µF bypass capacitors as close as possible to the V_{CC}-pins of transceiver, UART, and controller ICs on the board.
- Use at least two vias for V_{CC} and ground connections of bypass capacitors and protection devices to minimize effective via-inductance.
- Use 1-kΩ to 10-kΩ pullup and pulldown resistors for enable lines to limit noise currents in theses lines during transient events.
- Insert pulse-proof resistors into the A and B bus lines if the TVS clamping voltage is higher than the specified maximum voltage of the transceiver bus pins. These resistors limit the residual clamping current into the transceiver and prevent it from latching up.
- While pure TVS protection is sufficient for surge transients up to 1 kV, higher transients require metal-oxide varistors (MOVs) which reduce the transients to a few hundred volts of clamping voltage, and transient blocking units (TBUs) that limit transient current to less than 1 mA.
- Routing the high-speed traces on the top layer avoids the use of vias (and the introduction of their inductances) and allows for clean interconnects between the isolator and the transmitter and receiver circuits of the data link.

If an additional supply voltage plane or signal layer is needed, add a second power and ground plane system to the stack to keep it symmetrical. This makes the stack mechanically stable and prevents it from warping. Also the power and ground plane of each power system can be placed closer together, thus increasing the high-frequency bypass capacitance significantly.

Note

For detailed layout recommendations, see Application Note *Digital Isolator Design Guide*, SLLA284.



11.2 Layout Example

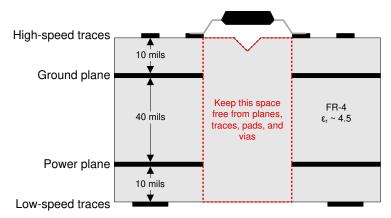


Figure 11-1. Recommended Layer Stack



12 Device and Documentation Support

12.1 Documentation Support

12.1.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, Digital Isolator Design Guide application report
- Texas Instruments, Transformer Driver for Isolated Power Supplies data sheet
- Texas Instruments, Isolation Glossary application report

12.2 Support Resources

TI E2E[™] support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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12.4 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

12.5 Glossary

TI Glossary

This glossary lists and explains terms, acronyms, and definitions.

13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

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PACKAGING INFORMATION

Orderable part number	Status	Material type	Package Pins	Package qty Carrier	RoHS	Lead finish/	MSL rating/	Op temp (°C)	Part marking
	(1)	(2)			(3)	Ball material	Peak reflow		(6)
						(4)	(5)		
ISO1176DW	Obsolete	Production	SOIC (DW) 16	-	-	Call TI	Call TI	-40 to 85	ISO1176
ISO1176DWR	Active	Production	SOIC (DW) 16	2000 LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	ISO1176
ISO1176DWR.A	Active	Production	SOIC (DW) 16	2000 LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	ISO1176
ISO1176DWR.B	Active	Production	SOIC (DW) 16	2000 LARGE T&R	-	Call TI	Call TI	-40 to 85	

⁽¹⁾ Status: For more details on status, see our product life cycle.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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⁽²⁾ Material type: When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ RoHS values: Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

⁽⁴⁾ Lead finish/Ball material: Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

⁽⁵⁾ MSL rating/Peak reflow: The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ Part marking: There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

PACKAGE MATERIALS INFORMATION

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TAPE AND REEL INFORMATION





A0	Dimension designed to accommodate the component width
В0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

	Device	Package Type	Package Drawing		SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	` '	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
ı	ISO1176DWR	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1

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*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
ISO1176DWR	SOIC	DW	16	2000	353.0	353.0	32.0

7.5 x 10.3, 1.27 mm pitch

SMALL OUTLINE INTEGRATED CIRCUIT

This image is a representation of the package family, actual package may vary. Refer to the product data sheet for package details.



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