

ISOW7821 High-Performance, 5000-V_{RMS} Reinforced Dual-Channel Digital Isolator With Integrated High-Efficiency, Low-Emissions DC-DC Converter

1 Features

- Integrated High-Efficiency DC-DC Converter With On-Chip Transformer
- 100 Mbps data rate
- Robust isolation barrier:
 - >100-Year projected lifetime at 1 kV_{RMS} working voltage
 - Up to 5000 V_{RMS} isolation rating
 - Up to 10 kV_{PK} surge capability
 - $\pm 100 \text{ kV}/\mu\text{s}$ minimum CMTI
- 3-V to 5.5-V Wide Input Supply Range
- Regulated 5-V or 3.3-V Output
- Up to 0.65-W Output Power
- 5 V to 5 V; 5 V to 3.3 V: Available Load Current $\geq 130 \text{ mA}$
- 3.3 V to 3.3 V: Available Load Current $\geq 75 \text{ mA}$
- Soft-Start to Limit Inrush Current
- Overload and Short-Circuit Protection
- Thermal Shutdown
- Default Output: High and Low Options
- Low Propagation Delay: 13 ns Typ (5-V Supply)
- Robust Electromagnetic Compatibility (EMC)
 - System-Level ESD, EFT, and Surge Immunity
 - $\pm 8 \text{ kV}$ IEC 61000-4-2 contact discharge protection across isolation barrier
 - Low Emissions
- 16-pin Wide SOIC Package
- Extended Temperature Range: -40°C to $+125^\circ\text{C}$
- Safety-Related Certifications:
 - 7071-V_{PK} Reinforced Isolation per DIN VDE V 0884-11:2017-01
 - 5000-V_{RMS} Isolation for 1 Minute per UL 1577
 - CSA Certification per IEC 60950-1, IEC 62368-1, and IEC 60601-1 End Equipment Standards
 - CQC Approval per GB4943.1-2011
 - TUV Certification According to EN 60950-1, EN62368-1 and EN 61010-1

2 Applications

- Industrial Automation
- Motor Control
- Grid Infrastructure
- Medical Equipment
- Test and Measurement

3 Description

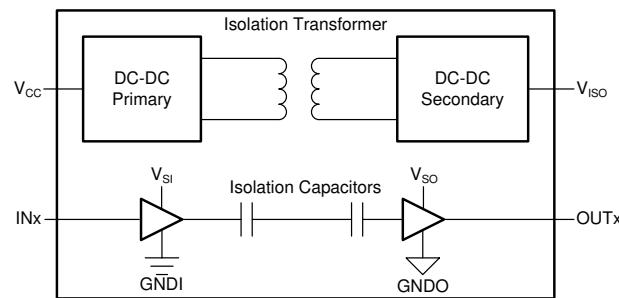
The ISOW7821 device is a high-performance, dual-channel reinforced digital isolators with an integrated high-efficiency power converter. The integrated DC-DC converter provides up to 650 mW of isolated power at high efficiency and can be configured for various input and output voltage configurations. Therefore this device eliminates the need for a separate isolated power supply in space-constrained isolated designs.

Device Information⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
ISOW7821	SOIC (16)	10.30 mm x 7.50 mm

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

Simplified Schematic



V_{CC} is the primary supply voltage referenced to GND1. V_{ISO} is the isolated supply voltage referenced to GND2.

V_{SI} and V_{SO} can be either V_{CC} or V_{ISO} depending on the channel direction.

V_{SI} is the input-side supply voltage referenced to GND1 and V_{SO} is the output-side supply voltage referenced to GND2.



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4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision A (March 2018) to Revision B	Page
• Made editorial and cosmetic changes throughout the document	1
• Added "Robust Isolation Barrier" bullet in Features	1
• Added ">100-Year Projected Lifetime at 1 kV _{RMS} Working Voltage" bullet in Features	1
• Added "Up to 5000 V _{RMS} Isolation Rating" bullet in Features	1
• Added "Up to 10 kV _{PK} Surge Capability" bullet in Features	1
• Added " ± 8 kV IEC 61000-4-2 Contact Discharge Protection across Isolation Barrier" bullet in Features	1
• Changed VDE standard name From: DIN V VDE V 0884-11:2017-01 To: DIN VDE V 0884-11:2017-01 in Features and Insulation Specifications table	1
• Added "EN 62368-1" standard in TUV certification bullet in Features	1
• Deleted "All Agency Certifications are Planned" bullet in Features	1
• Updated Simplified Schematic to show two isolation capacitors in series instead of a single capacitor for signal isolation channels	1
• Added "Contact discharge per IEC 61000-4-2; Isolation barrier withstand test" specification of ± 8000 in ESD Ratings table	6
• Added table note "IEC ESD strike is applied across the barrier with all pins on each side tied together creating a two-terminal device" to ESD Ratings table	6
• Deleted "TJ or Junction temperature" parameter from Recommended Operating Conditions table as it is already specified in Absolute Maximum Ratings table	6

Revision History (continued)

• Added "See Figure 34 " to TEST CONDITIONS of V_{IOWM} specification.....	8
• Updated Safety-Related Certifications table	9
• Added the following note to Figure 25 : "Optional 100 μ F capacitor can be added between V_{CC} and GND1; refer to Power Supply Recommendations "	22
• Added the following note to Figure 30 : "Optional 100 μ F capacitor can be added between V_{CC} and GND1; refer to Power Supply Recommendations "	28
• Added the following text to Design Requirements : "Optional 100 μ F decoupling capacitor can be added between V_{CC} and GND1 pins; refer to Power Supply Recommendations for more details"	29
• Added text to Power Supply Recommendations section to emphasise that input decoupling capacitor should be larger than output capacitor by at least 100 μ F	31
• Added the following note to Figure 35 : "Optional 100 μ F capacitor can be added between V_{CC} and GND1; refer to Power Supply Recommendations "	33

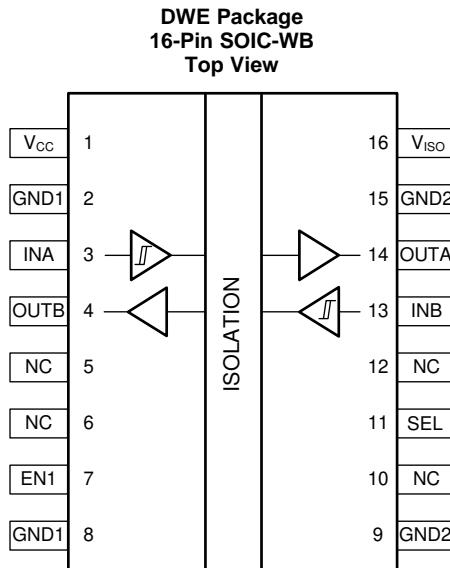
Changes from Original (November 2017) to Revision A	Page
• Changed OUTB to pin 4 and INB to pin 13 in the <i>Pin Functions</i> table	5

5 Description (continued)

The ISOW7821 device provides high electromagnetic immunity and low emissions while isolating CMOS or LVC MOS digital I/Os. The signal-isolation channel has a logic input and output buffer separated by a silicon dioxide (SiO_2) insulation barrier, whereas, power isolation uses on-chip transformers separated by thin film polymer as insulating material. Various configurations of forward and reverse channels are available. If the input signal is lost, the default output is high for the ISOW7821 device and low for the device with the F suffix (see the *Device Features*).

These devices help prevent noise currents on a data bus or other circuits from entering the local ground and interfering with or damaging sensitive circuitry. Through innovative chip design and layout techniques, electromagnetic compatibility of the ISOW7821 device has been significantly enhanced to ease system-level ESD, EFT, surge and emissions compliance. The high-efficiency of the power converter allows operation at a higher ambient temperature. The ISOW7821 device is available in a 16-pin SOIC wide-body (SOIC-WB) DWE package.

6 Pin Configuration and Functions



Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
EN1	7	—	Output enable for side 1. Output pins on side 1 are enabled when EN1 is high or open. Output pins on side 1 are high impedance when EN1 is low.
GND1	2, 8	—	Ground connection for V _{CC}
GND2	9, 15	—	Ground connection for V _{ISO}
INA	3	I	Input channel A
OUTB	4	I	Output channel B
NC	5	—	Not connected
NC	6	—	Not connected
NC	10	—	Not connected
NC	12	—	Not connected
OUTA	14	O	Output channel A
INB	13	O	Input channel B
SEL	11	I	V _{ISO} selection pin. V _{ISO} = 5 V when SEL is connected to V _{ISO} . V _{ISO} = 3.3 V, when SEL is connected to GND2 or left floating. For more information see the Device Functional Modes .
V _{CC}	1	—	Supply voltage
V _{ISO}	16	—	Isolated supply voltage determined by SEL pin

7 Specifications

7.1 Absolute Maximum Ratings

See ⁽¹⁾⁽²⁾

		MIN	MAX	UNIT
V_{CC}	Supply voltage	-0.5	6	V
V_{ISO}	Isolated supply voltage	-0.5	6	V
V_{IO}	Voltage at INx, OUTx, SEL pins	-0.5	$V_{CC} + 0.5$, $V_{ISO} + 0.5$ ⁽³⁾	V
I_O	Maximum output current through data channels	-15	15	mA
T_J	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 local ground pin (GND1 or GND2) and are peak voltage values.
- (3) This value depends on whether the pin is located on the V_{CC} or V_{ISO} side. The maximum voltage at the I/O pins should not exceed 6 V.

7.2 ESD Ratings

		VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	
		Contact discharge per IEC 61000-4-2; Isolation barrier withstand test ⁽³⁾	

- (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.
- (3) IEC ESD strike is applied across the barrier with all pins on each side tied together creating a two-terminal device.

7.3 Recommended Operating Conditions

		MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage	3		5.5	V
I_{OH}	High level output current ⁽²⁾	$V_{SO}^{(1)} = 5$ V	-4		mA
		$V_{SO} = 3.3$ V	-2		
I_{OL}	Low level output current ⁽²⁾	$V_{SO} = 5$ V		4	mA
		$V_{SO} = 3.3$ V		2	
V_{IH}	High-level input voltage		$0.7 \times V_{SI}$	V_{SI}	V
V_{IL}	Low-level input voltage	0		$0.3 \times V_{SI}$	V
DR	Data rate			100	Mbps
T_A	Ambient temperature	-40		125	°C

- (1) V_{SI} is the input side supply, V_{SO} is the output side supply.
- (2) This current is for data output channel.

7.4 Thermal Information

THERMAL METRIC ⁽¹⁾	ISOW7821	UNIT
	DWE (SOIC)	
	16 PINS	
R _{θJA} Junction-to-ambient thermal resistance	56.8	°C/W
R _{θJC(top)} Junction-to-case (top) thermal resistance	15.6	°C/W
R _{θJB} Junction-to-board thermal resistance	28.5	°C/W
Ψ _{JT} Junction-to-top characterization parameter	2.4	°C/W
Ψ _{JB} Junction-to-board characterization parameter	28.5	°C/W
R _{θJC(bot)} Junction-to-case (bottom) thermal resistance	—	°C/W

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

7.5 Power Ratings

V_{CC} = 5.5 V, I_{ISO} = 110 mA, T_J = 150°C, T_A ≤ 80°C, C_L = 15 pF, input a 50-MHz 50% duty-cycle square wave

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
P _D Maximum power dissipation (both sides)				1.16	W
P _{D1} Maximum power dissipation (side-1)				0.58	W
P _{D2} Maximum power dissipation (side-2)				0.58	W

7.6 Insulation Specifications

PARAMETER		TEST CONDITIONS	VALUE	UNIT
GENERAL				
CLR	External clearance ⁽¹⁾	Shortest terminal-to-terminal distance through air	>8	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 – capacitive signal isolation)	> 21	μm
		Minimum internal gap (internal clearance – transformer power isolation)	>120	
CTI	Comparative tracking index	DIN EN 60112 (VDE 0303-11); IEC 60112	> 600	V
	Material group	According to IEC 60664-1	I	
Overvoltage category per IEC 60664-1		Rated mains voltage $\leq 300 \text{ V}_{\text{RMS}}$	I-IV	
		Rated mains voltage $\leq 600 \text{ V}_{\text{RMS}}$	I-IV	
		Rated mains voltage $\leq 1000 \text{ V}_{\text{RMS}}$	I-III	
DIN VDE V 0884-11:2017-01⁽²⁾				
V_{IORM}	Maximum repetitive peak isolation voltage	AC voltage (bipolar)	1414	V_{PK}
V_{IOWM}	Maximum working isolation voltage	AC voltage; Time dependent dielectric breakdown (TDDB) Test; See Figure 34	1000	V_{RMS}
		DC voltage	1414	V_{DC}
V_{IOTM}	Maximum transient isolation voltage	$V_{\text{TEST}} = V_{\text{IOTM}}$; $t = 60 \text{ s}$ (qualification); $V_{\text{TEST}} = 1.2 \times V_{\text{IOTM}}$; $t = 1 \text{ s}$ (100% production)	7071	V_{PK}
V_{IOSM}	Maximum surge isolation voltage ⁽³⁾	Test method per IEC 62368-1, 1.2/50 μs waveform, $V_{\text{TEST}} = 1.6 \times V_{\text{IOSM}} = 10000 \text{ V}_{\text{PK}}$ (qualification)	6250	V_{PK}
q_{pd}	Apparent charge ⁽⁴⁾	Method a, after input/output safety test subgroup 2/3, $V_{\text{ini}} = V_{\text{IOTM}}$, $t_{\text{ini}} = 60 \text{ s}$; $V_{\text{pd(m)}} = 1.2 \times V_{\text{IORM}} = 1697 \text{ V}_{\text{PK}}$, $t_{\text{m}} = 10 \text{ s}$	≤ 5	pC
		Method a, after environmental tests subgroup 1, $V_{\text{ini}} = V_{\text{IOTM}}$, $t_{\text{ini}} = 60 \text{ s}$; $V_{\text{pd(m)}} = 1.6 \times V_{\text{IORM}} = 2263 \text{ V}_{\text{PK}}$, $t_{\text{m}} = 10 \text{ s}$	≤ 5	
		Method b1, at routine test (100% production) and preconditioning (type test), $V_{\text{ini}} = 1.2 \times V_{\text{IOTM}}$, $t_{\text{ini}} = 1 \text{ s}$; $V_{\text{pd(m)}} = 1.875 \times V_{\text{IORM}} = 2652 \text{ V}_{\text{PK}}$, $t_{\text{m}} = 1 \text{ s}$	≤ 5	
C_{IO}	Barrier capacitance, input to output ⁽⁵⁾	$V_{\text{IO}} = 0.4 \times \sin(2\pi ft)$, $f = 1 \text{ MHz}$	~ 3.5	pF
R_{IO}	Insulation resistance ⁽⁵⁾	$V_{\text{IO}} = 500 \text{ V}$, $T_A = 25^\circ\text{C}$	$> 10^{12}$	Ω
		$V_{\text{IO}} = 500 \text{ V}$, $100^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$	$> 10^{11}$	
		$V_{\text{IO}} = 500 \text{ V}$, $T_S = 150^\circ\text{C}$	$> 10^9$	
	Pollution degree		2	
	Climatic category		40/125/21	
UL 1577				
$V_{\text{ISO(UL)}}$	Withstand isolation voltage	$V_{\text{TEST}} = V_{\text{ISO(UL)}}$, $t = 60 \text{ s}$ (qualification), $V_{\text{TEST}} = 1.2 \times V_{\text{ISO(UL)}} = 6000 \text{ V}_{\text{RMS}}$, $t = 1 \text{ s}$ (100% production)	5000	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, ribs, or both on a printed circuit board are used to help increase these specifications.
- (2) This coupler is suitable for safe electrical insulation only within the safety ratings. Compliance with the safety ratings shall be ensured by means of suitable protective circuits.
- (3) Testing is carried out in air or oil to determine the intrinsic surge immunity of the isolation barrier.
- (4) Apparent charge is electrical discharge caused by a partial discharge (pd).
- (5) All pins on each side of the barrier tied together creating a two-terminal device.

7.7 Safety-Related Certifications

VDE	CSA	UL	CQC	TUV
Certified according to DIN VDE V 0884-11:2017-01	Certified according to IEC 60950-1, IEC 62368-1, and IEC 60601-1	Recognized under UL 1577 Component Recognition Program	Certified according to GB 4943.1-2011	Certified according to EN 61010-1:2010/A1:2019, EN 60950-1:2006/A2:2013 and EN 62368-1:2014
Reinforced insulation; Maximum transient isolation voltage, 7071 V_{PK} ; Maximum repetitive peak isolation voltage, 1414 V_{PK} ; Maximum surge isolation voltage, 6250 V_{PK}	Reinforced insulation per CSA 60950-1-07+A1+A2, IEC 60950-1 2nd Ed.+A1+A2, CSA 62368-1-14 and IEC 62368-1 2nd Ed., 800 V_{RMS} maximum working voltage (pollution degree 2, material group I); 2 MOPP (Means of Patient Protection) per CSA 60601-1:14 and IEC 60601-1 Ed. 3+A1, 250 V_{RMS} maximum working voltage; Temperature rating is 90°C for reinforced insulation and 125°C for basic insulation; see certificate for details.	Single protection, 5000 V_{RMS}	Reinforced Insulation, Altitude \leq 5000 m, Tropical Climate, 700 V_{RMS} maximum working voltage;	5000 V_{RMS} Reinforced insulation per EN 61010-1:2010/A1:2019 up to working voltage of 600 V_{RMS} ; 5000 V_{RMS} Reinforced insulation per EN 60950-1:2006/A2:2013 and EN 62368-1:2014 up to working voltage of 800 V_{RMS}
Certificate number: 40040142	Master contract number: 220991	File number: E181974	Certificate number: CQC15001121716	Client ID number: 77311

7.8 Safety Limiting Values

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

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_S Safety input, output, or supply current ⁽¹⁾	$R_{\theta JA} = 56.8^\circ\text{C}/\text{W}$, $V_I = 5.5 \text{ V}$, $T_J = 150^\circ\text{C}$, $T_A = 25^\circ\text{C}$, see Figure 1			400	mA
	$R_{\theta JA} = 56.8^\circ\text{C}/\text{W}$, $V_I = 3.6 \text{ V}$, $T_J = 150^\circ\text{C}$, $T_A = 25^\circ\text{C}$, see Figure 1			611	
P_S Safety input, output, or total power ⁽¹⁾	$R_{\theta JA} = 56.8^\circ\text{C}/\text{W}$, $T_J = 150^\circ\text{C}$, $T_A = 25^\circ\text{C}$, see Figure 2			2200	mW
T_S Maximum safety temperature ⁽¹⁾				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, T_A .

The junction-to-air thermal resistance, $R_{\theta JA}$, in the [Thermal Information](#) 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:

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

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

$$P_S = I_S \times V_I, \text{ where } V_I \text{ is the maximum input voltage.}$$

7.9 Electrical Characteristics—5-V Input, 5-V Output

$V_{CC} = 5 \text{ V} \pm 10\%$, SEL shorted to V_{ISO} (over recommended operating conditions, unless otherwise specified)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{ISO} Isolated supply voltage	External $I_{ISO} = 0$ to 50 mA	4.75	5.07	5.43	V
	External $I_{ISO} = 0$ to 130 mA	4.5	5.07	5.43	
$V_{ISO(LINE)}$ DC line regulation	$I_{ISO} = 50 \text{ mA}$, $V_{CC} = 4.5 \text{ V}$ to 5.5 V		2		mV/V
$V_{ISO(LOAD)}$ DC load regulation	$I_{ISO} = 0$ to 130 mA		1%		
EFF Efficiency at maximum load current	$I_{ISO} = 130 \text{ mA}$, $C_{LOAD} = 0.1 \mu\text{F} \parallel 10 \mu\text{F}$; $V_I = V_{SI}$ (ISOW7821); $V_I = 0 \text{ V}$ (ISOW7821 with F suffix)		53%		
$V_{CC+(UVLO)}$ Positive-going UVLO threshold on V_{CC} , V_{ISO}				2.7	V
$V_{CC-(UVLO)}$ Negative-going UVLO threshold on V_{CC} , V_{ISO}			2.1		V
V_{HYS} (UVLO) UVLO threshold hysteresis on V_{CC} , V_{ISO}			0.2		V
V_{ITH} Input pin rising threshold				0.7	V_{SI}
V_{ITL} Input pin falling threshold			0.3		V_{SI}
$V_{I(HYS)}$ Input pin threshold hysteresis (INx)			0.1		V_{SI}
I_{IL} Low level input current	$V_{IL} = 0$ at INx or SEL				μA
I_{IH} High level input current	$V_{IH} = V_{SI}^{(1)}$ at INx or SEL			10	μA
V_{OH} High level output voltage	$I_O = -4 \text{ mA}$, see Figure 24	$V_{SO}^{(1)} - 0.4$	$V_{SO} - 0.2$		V
V_{OL} Low level output voltage	$I_O = 4 \text{ mA}$, see Figure 24		0.2	0.4	V
$ CM_{H }$ High-level common-mode transient immunity	$V_I = V_{SI}$, $V_{CM} = 1000 \text{ V}$; see Figure 25		100		kV/ μs
$ CM_{L }$ Low-level common-mode transient immunity	$V_I = 0 \text{ V}$, $V_{CM} = 1000 \text{ V}$; see Figure 25		100		kV/ μs
I_{CC_SC} DC current from supply under short circuit on V_{ISO}	V_{ISO} shorted to GND2		137		mA
$V_{ISO(RIP)}$ Output ripple on isolated supply (pk-pk)	20-MHz bandwidth, $C_{LOAD} = 0.1 \mu\text{F} \parallel 20 \mu\text{F}$, $I_{ISO} = 130 \text{ mA}$		100		mV

(1) V_{SI} = input side supply; V_{SO} = output side supply

7.10 Supply Current Characteristics—5-V Input, 5-V Output

$V_{CC} = 5 \text{ V} \pm 10\%$, SEL shorted to V_{ISO} (over recommended operating conditions, unless otherwise specified)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
I _{CC}	No external I_{LOAD} ; $V_I = 0 \text{ V}$ (ISOW7821); $V_I = V_{SI}^{(1)}$ (ISOW7821 with F suffix)		21		mA
	No external I_{LOAD} ; $V_I = V_{SI}$ (ISOW7821); $V_I = 0 \text{ V}$ (ISOW7821 with F suffix)		17		
	All channels switching with square wave clock input of 1 Mbps; $C_L = 15 \text{ pF}$, No external I_{LOAD}		19		
	All channels switching with square wave clock input of 10 Mbps; $C_L = 15 \text{ pF}$, No external I_{LOAD}		20		
	All channels switching with square wave clock input of 100 Mbps; $C_L = 15 \text{ pF}$, No external I_{LOAD}		33		
I _{ISO(OUT)} ⁽²⁾	$V_I = 0 \text{ V}$ (ISOW7821); $V_I = V_{SI}$ (ISOW7821 with F suffix)	127			mA
	$V_I = V_{SI}$ (ISOW7821); $V_I = 0 \text{ V}$ (ISOW7821 with F suffix)	130			
	All channels switching with square wave clock input of 1 Mbps; $C_L = 15 \text{ pF}$	128			
	All channels switching with square wave clock input of 10 Mbps; $C_L = 15 \text{ pF}$	128			
	All channels switching with square wave clock input of 100 Mbps; $C_L = 15 \text{ pF}$	125			

(1) V_{SI} = input side supply; V_{SO} = output side supply

(2) Current available to load should be derated by 2 mA/°C for $T_A > 80^\circ\text{C}$.

7.11 Electrical Characteristics—5-V Input, 3.3-V Output

$V_{CC} = 5 \text{ V} \pm 10\%$, SEL shorted to GND2 (over recommended operating conditions, unless otherwise specified)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{ISO} Isolated supply voltage	$I_{ISO} = 0 \text{ to } 50 \text{ mA}$	3.13	3.34	3.56	V
	$I_{ISO} = 0 \text{ to } 130 \text{ mA}$	3	3.34	3.56	
$V_{ISO(LINE)}$ DC line regulation	$I_{ISO} = 50 \text{ mA}, V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$		2		mV/V
$V_{ISO(LOAD)}$ DC load regulation	$I_{ISO} = 10 \text{ to } 130 \text{ mA}$		1%		
EFF Efficiency at maximum load current	$I_{ISO} = 130 \text{ mA}, C_{LOAD} = 0.1 \mu\text{F} \parallel 10 \mu\text{F}; V_I = V_{SI} (\text{ISOW7821}); V_I = 0 \text{ V} (\text{ISOW7821 with F suffix})$		48%		
$V_{CC+(UVLO)}$ Positive-going UVLO threshold on V_{CC}, V_{ISO}				2.7	V
$V_{CC-(UVLO)}$ Negative-going UVLO threshold on V_{CC}, V_{ISO}			2.1		V
$V_{HYS (UVLO)}$ UVLO threshold hysteresis on V_{CC}, V_{ISO}			0.2		V
V_{ITH} Input pin rising threshold				0.7	V_{SI}
V_{ITL} Input pin falling threshold			0.3		V_{SI}
$V_{I(HYS)}$ Input pin threshold hysteresis (INx)			0.1		V_{SI}
I_{IL} Low level input current	$V_{IL} = 0 \text{ at } INx \text{ or } SEL$		-10		μA
I_{IH} High level input current	$V_{IH} = V_{SI}^{(1)}$ at $INx \text{ or } SEL$			10	μA
V_{OH} High level output voltage	$I_O = -2 \text{ mA, see Figure 24}$	$V_{SO}^{(1)} - 0.3$	$V_{SO} - 0.1$		V
V_{OL} Low level output voltage	$I_O = 2 \text{ mA, see Figure 24}$		0.1	0.3	V
$ CM_{H }$ High-level common-mode transient immunity	$V_I = V_{SI}, V_{CM} = 1000 \text{ V; see Figure 25}$	100			$\text{kV}/\mu\text{s}$
$ CM_{L }$ Low-level common-mode transient immunity	$V_I = 0 \text{ V}, V_{CM} = 1000 \text{ V; see Figure 25}$	100			$\text{kV}/\mu\text{s}$
I_{CC_SC} DC current from supply under short circuit on V_{ISO}	V_{ISO} shorted to GND2		137		mA
$V_{ISO(RIP)}$ Output ripple on isolated supply (pk-pk)	20-MHz bandwidth, $C_{LOAD} = 0.1 \mu\text{F} \parallel 20 \mu\text{F}$, $I_{ISO} = 130 \text{ mA}$		100		mV

(1) V_{SI} = input side supply; V_{SO} = output side supply

7.12 Supply Current Characteristics—5-V Input, 3.3-V Output

$V_{CC} = 5 \text{ V} \pm 10\%$, SEL shorted to GND2 (over recommended operating conditions, unless otherwise specified)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{CC} Current drawn from supply	No external I_{LOAD} ; $V_I = 0 \text{ V}$ (ISOW7821); $V_I = V_S^{(1)}$ (ISOW7821 with F suffix)		17		mA
	No external I_{LOAD} ; $V_I = V_{SI}$ (ISOW7821); $V_I = 0 \text{ V}$ (ISOW7821 with F suffix)		14		
	All channels switching with square wave clock input of 1 Mbps; $C_L = 15 \text{ pF}$, No external I_{LOAD}		16		
	All channels switching with square wave clock input of 10 Mbps; $C_L = 15 \text{ pF}$, No external I_{LOAD}		17		
	All channels switching with square wave clock input of 100 Mbps; $C_L = 15 \text{ pF}$, No external I_{LOAD}		27		
$I_{ISO(OUT)}^{(2)}$ Current available on isolated supply	$V_I = 0 \text{ V}$ (ISOW7821); $V_I = V_{SI}$ (ISOW7821 with F suffix)	127			mA
	$V_I = V_{SI}$ (ISOW7821); $V_I = 0 \text{ V}$ (ISOW7821 with F suffix)	130			
	All channels switching with square wave clock input of 1 Mbps; $C_L = 15 \text{ pF}$	128			
	All channels switching with square wave clock input of 10 Mbps; $C_L = 15 \text{ pF}$	128			
	All channels switching with square wave clock input of 100 Mbps; $C_L = 15 \text{ pF}$	126			

(1) V_{SI} = input side supply; V_{SO} = output side supply

(2) Current available to load should be derated by $2 \text{ mA}/^\circ\text{C}$ for $T_A > 105^\circ\text{C}$.

7.13 Electrical Characteristics—3.3-V Input, 3.3-V Output

$V_{CC} = 3.3\text{ V} \pm 10\%$, SEL shorted to GND2 (over recommended operating conditions, unless otherwise specified)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{ISO} Isolated supply voltage	External $I_{ISO} = 0$ to 30 mA	3.13	3.34	3.58	V
	External $I_{ISO} = 0$ to 75 mA	3	3.34	3.58	
$V_{ISO(LINE)}$ DC line regulation	$I_{ISO} = 30\text{ mA}$, $V_{CC} = 3\text{ V}$ to 3.6 V		2		mV/V
$V_{ISO(LOAD)}$ DC load regulation	$I_{ISO} = 0$ to 75 mA		1%		
EFF Efficiency at maximum load current	$I_{ISO} = 75\text{ mA}$, $C_{LOAD} = 0.1\text{ }\mu\text{F} \parallel 10\text{ }\mu\text{F}$; $V_I = V_{SI}$ (ISOW7821); $V_I = 0\text{ V}$ (ISOW7821 with F suffix)		47%		
$V_{CC+(UVLO)}$ Positive-going UVLO threshold on V_{CC} , V_{ISO}				2.7	V
$V_{CC-(UVLO)}$ Negative-going UVLO threshold on V_{CC} , V_{ISO}			2.1		V
$V_{HYS (UVLO)}$ UVLO threshold hysteresis on V_{CC} , V_{ISO}			0.2		V
V_{ITH} Input pin rising threshold				0.7	V_{SI}
V_{ITL} Input pin falling threshold			0.3		V_{SI}
$V_{I(HYS)}$ Input pin threshold hysteresis (INx)			0.1		V_{SI}
I_{IL} Low level input current	$V_{IL} = 0$ at INx or SEL		-10		μA
I_{IH} High level input current	$V_{IH} = V_{SI}^{(1)}$ at INx or SEL			10	μA
V_{OH} High level output voltage	$I_O = -2\text{ mA}$, see Figure 24	$V_{SO}^{(1)} - 0.3$	$V_{SO} - 0.1$		V
V_{OL} Low level output voltage	$I_O = 2\text{ mA}$, see Figure 24		0.1	0.3	V
$ ICM_H $ High-level common-mode transient immunity	$V_I = V_{SI}$, $V_{CM} = 1000\text{ V}$; see Figure 25		100		kV/ μs
$ ICM_L $ Low-level common-mode transient immunity	$V_I = 0\text{ V}$, $V_{CM} = 1000\text{ V}$; see Figure 25		100		kV/ μs
I_{CC_SC} DC current from supply under short circuit on V_{ISO}	V_{ISO} shorted to GND2		143		mA
$V_{ISO(RIP)}$ Output ripple on isolated supply (pk-pk)	20-MHz bandwidth, $C_{LOAD} = 0.1\text{ }\mu\text{F} \parallel 20\text{ }\mu\text{F}$, $I_{ISO} = 75\text{ mA}$		90		mV

(1) V_{SI} = input side supply; V_{SO} = output side supply

7.14 Supply Current Characteristics—3.3-V Input, 3.3-V Output

$V_{CC} = 3.3\text{ V} \pm 10\%$, SEL shorted to GND2 (over recommended operating conditions, unless otherwise specified)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{CC} Current drawn from supply	No external I_{LOAD} ; $V_I = 0\text{ V}$ (ISOW7821); $V_I = V_S$ ⁽¹⁾ (ISOW7821 with F suffix)		24		mA
	No external I_{LOAD} ; $V_I = V_{SI}$ (ISOW7821); $V_I = 0\text{ V}$ (ISOW7821 with F suffix)		19		
	All channels switching with square wave clock input of 1 Mbps; $C_L = 15\text{ pF}$, No external I_{LOAD}		22		
	All channels switching with square wave clock input of 10 Mbps; $C_L = 15\text{ pF}$, No external I_{LOAD}		22		
	All channels switching with square wave clock input of 100 Mbps; $C_L = 15\text{ pF}$, No external I_{LOAD}		32		
$I_{ISO(OUT)}^{(2)}$ Current available on isolated supply	$V_I = 0\text{ V}$ (ISOW7821); $V_I = V_{SI}$ (ISOW7821 with F suffix)		72		mA
	$V_I = V_{SI}$ (ISOW7821); $V_I = 0\text{ V}$ (ISOW7821 with F suffix)		75		
	All channels switching with square wave clock input of 1 Mbps; $C_L = 15\text{ pF}$		75		
	All channels switching with square wave clock input of 10 Mbps; $C_L = 15\text{ pF}$		73		
	All channels switching with square wave clock input of 100 Mbps; $C_L = 15\text{ pF}$		71		

(1) V_{SI} = input side supply; V_{SO} = output side supply

(2) Current available to load should be derated by 2 mA/°C for $T_A > 115^\circ\text{C}$.

7.15 Switching Characteristics—5-V Input, 5-V Output

$V_{CC} = 5 \text{ V} \pm 10\%$, SEL shorted to V_{ISO} (over recommended operating conditions, unless otherwise specified)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}, t_{PHL} Propagation delay time	See Figure 24		13	17.6	ns
PWD Pulse width distortion ⁽¹⁾ $ t_{PHL} - t_{PLH} $			0.6	4.7	ns
$t_{SK(o)}$ Channel-channel output skew time ⁽²⁾	Same-direction channels		4		ns
$t_{SK(p-p)}$ Part-part skew time ⁽³⁾			4.5		ns
t_r, t_f Output signal rise and fall times		2	4		ns

(1) Also known as pulse skew.

(2) $t_{SK(o)}$ is the skew between outputs of a single device with all driving inputs connected together and the outputs switching in the same direction while driving identical loads.

(3) $t_{SK(p-p)}$ is the magnitude of the difference in propagation delay times between any terminals of different devices switching in the same direction while operating at identical supply voltages, temperature, input signals and loads.

7.16 Switching Characteristics—5-V Input, 3.3-V Output

$V_{CC} = 5 \text{ V} \pm 10\%$, SEL shorted to GND2 (over recommended operating conditions, unless otherwise specified)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}, t_{PHL} Propagation delay time	See Figure 24		14	19.7	ns
PWD Pulse width distortion ⁽¹⁾ $ t_{PHL} - t_{PLH} $			0.6	4.4	ns
$t_{SK(o)}$ Channel-channel output skew time ⁽²⁾	Same-direction channels		4		ns
$t_{SK(p-p)}$ Part-part skew time ⁽³⁾			4.5		ns
t_r, t_f Output signal rise and fall times		1	4		ns

(1) Also known as pulse skew.

(2) $t_{SK(o)}$ is the skew between outputs of a single device with all driving inputs connected together and the outputs switching in the same direction while driving identical loads.

(3) $t_{SK(p-p)}$ is the magnitude of the difference in propagation delay times between any terminals of different devices switching in the same direction while operating at identical supply voltages, temperature, input signals and loads.

7.17 Switching Characteristics—3.3-V Input, 3.3-V Output

$V_{CC} = 3.3 \text{ V} \pm 10\%$, SEL shorted to GND2 (over recommended operating conditions, unless otherwise specified)

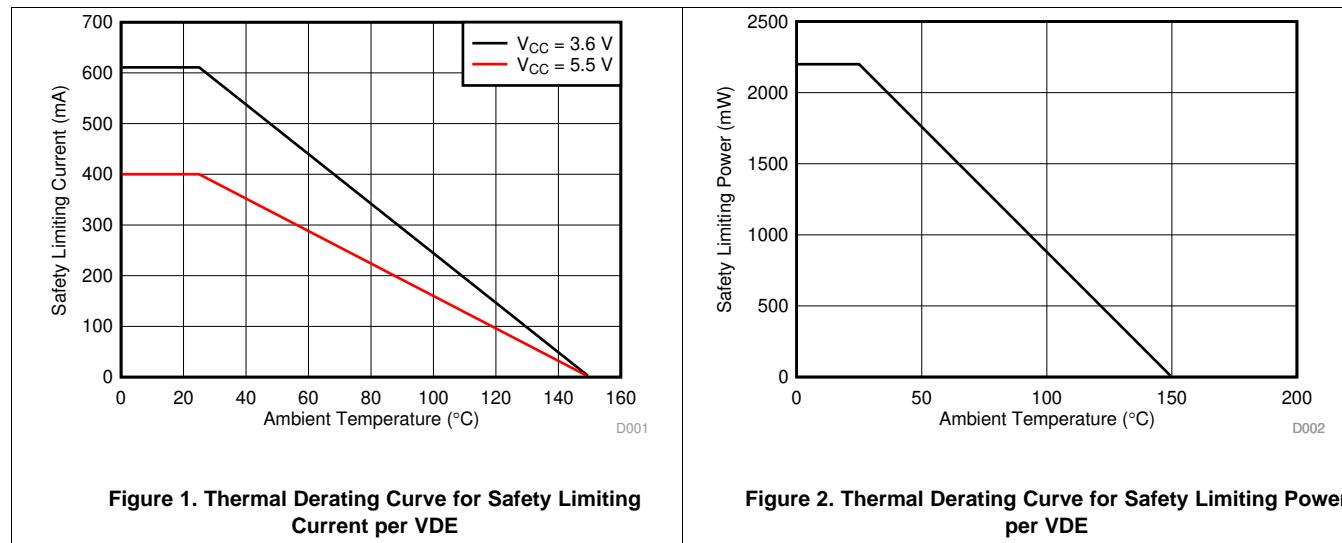
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}, t_{PHL} Propagation delay time	See Figure 24		14.5	20.2	ns
PWD Pulse width distortion ⁽¹⁾ $ t_{PHL} - t_{PLH} $			0.6	4.4	ns
$t_{SK(o)}$ Channel-channel output skew time ⁽²⁾	Same-direction channels		4		ns
$t_{SK(p-p)}$ Part-part skew time ⁽³⁾			4.5		ns
t_r, t_f Output signal rise and fall times		1	3		ns

(1) Also known as pulse skew.

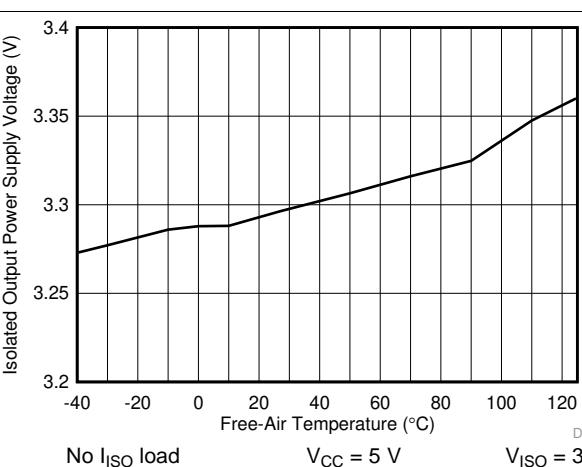
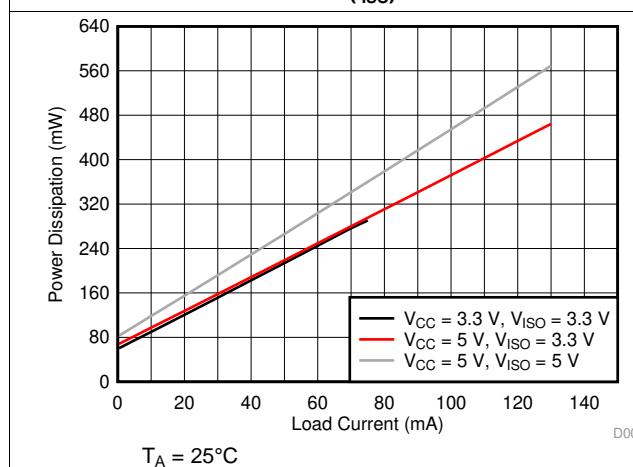
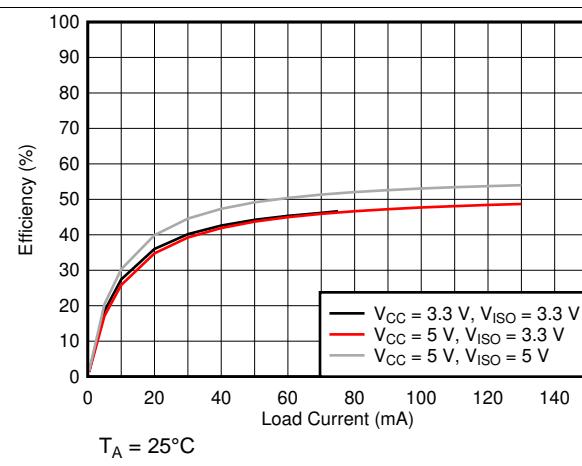
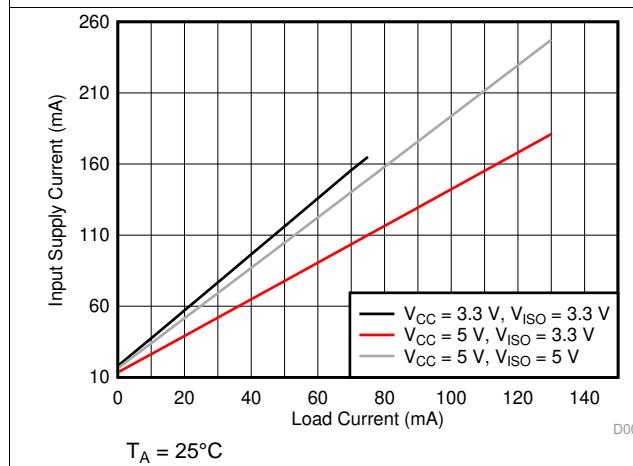
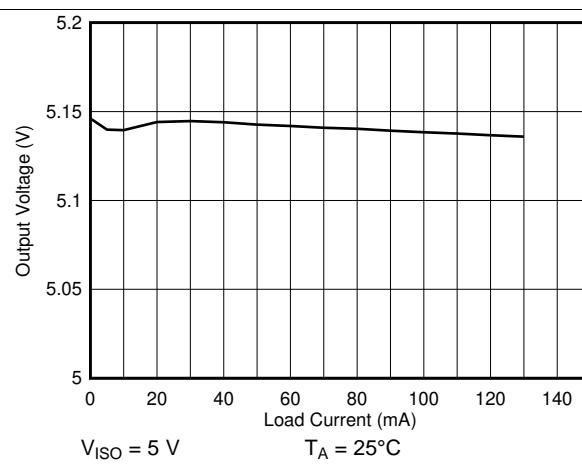
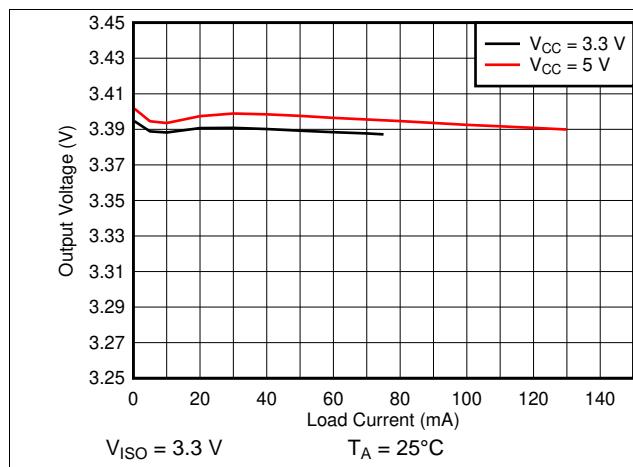
(2) $t_{SK(o)}$ is the skew between outputs of a single device with all driving inputs connected together and the outputs switching in the same direction while driving identical loads.

(3) $t_{SK(p-p)}$ is the magnitude of the difference in propagation delay times between any terminals of different devices switching in the same direction while operating at identical supply voltages, temperature, input signals and loads.

7.18 Insulation Characteristics Curves



7.19 Typical Characteristics



Typical Characteristics (continued)

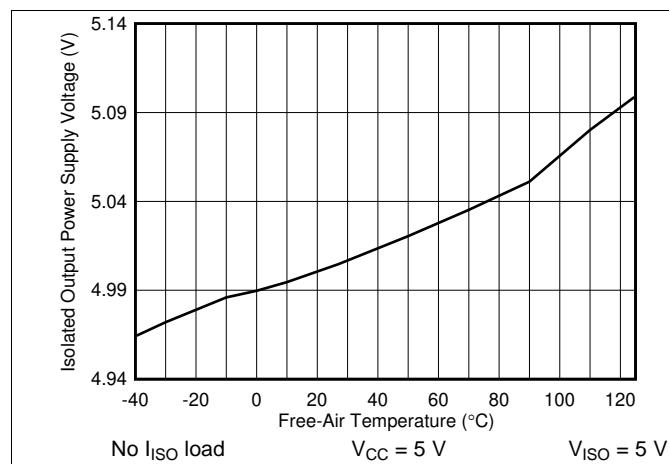


Figure 9. 5-V Isolated Supply Voltage (V_{ISO}) vs Free-Air Temperature

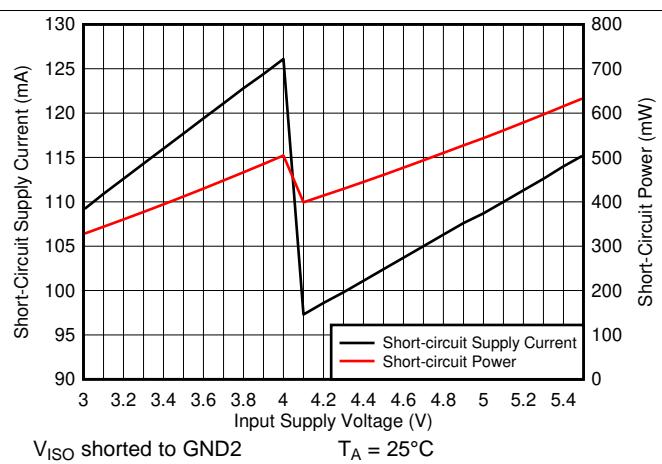


Figure 10. Short-Circuit Supply Current (I_{CC}) and Power (P) vs Supply Voltage (V_{CC})

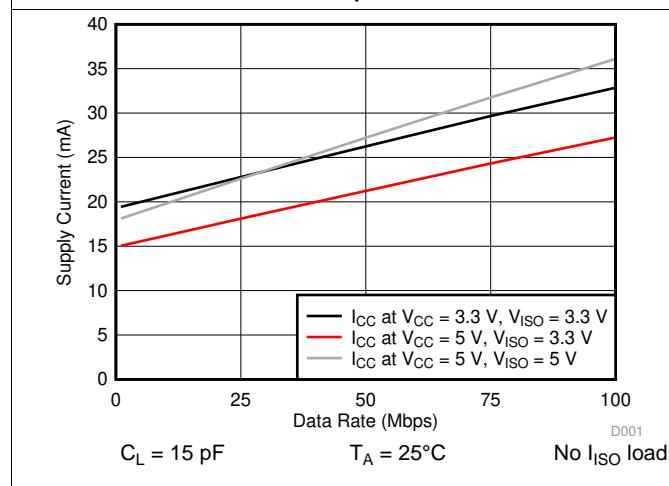


Figure 11. Supply Current vs Data Rate

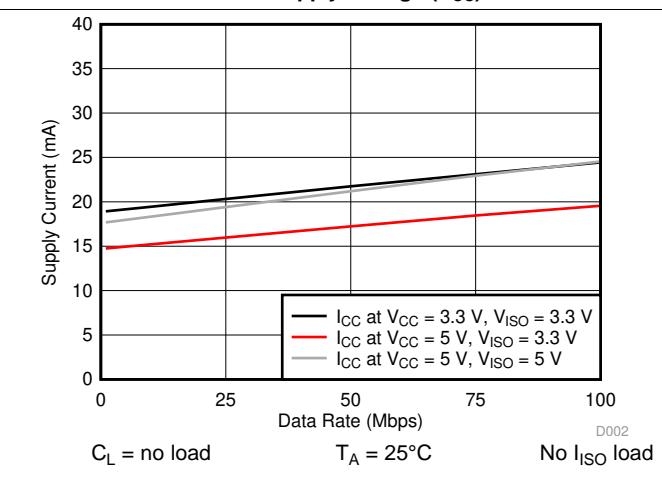


Figure 12. Supply Current vs Data Rate

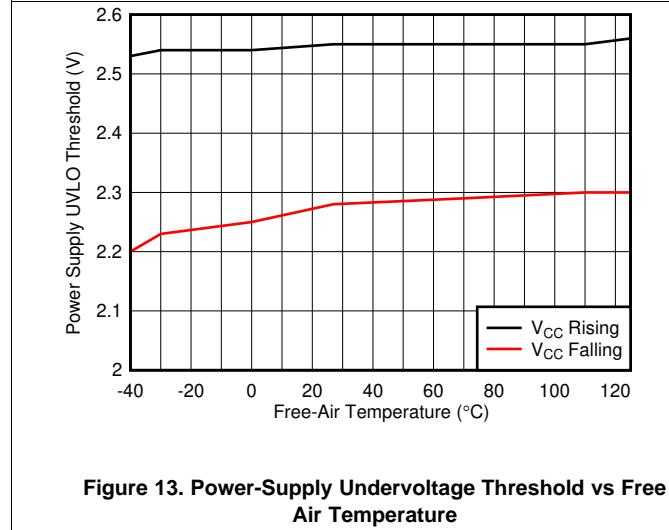


Figure 13. Power-Supply Undervoltage Threshold vs Free Air Temperature

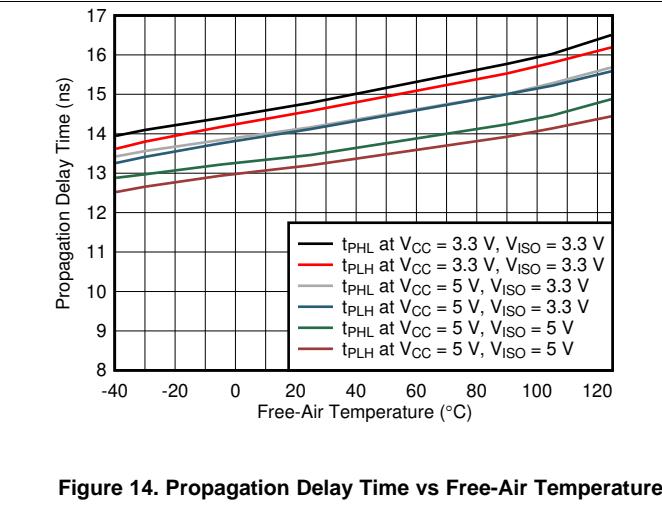


Figure 14. Propagation Delay Time vs Free-Air Temperature

Typical Characteristics (continued)

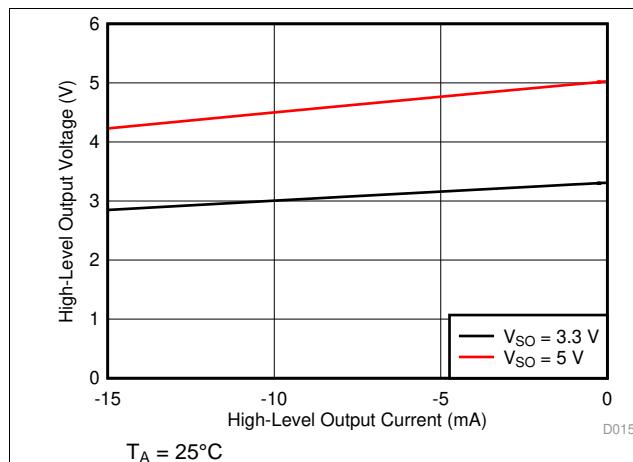


Figure 15. High-Level Output Voltage vs High-Level Output Current

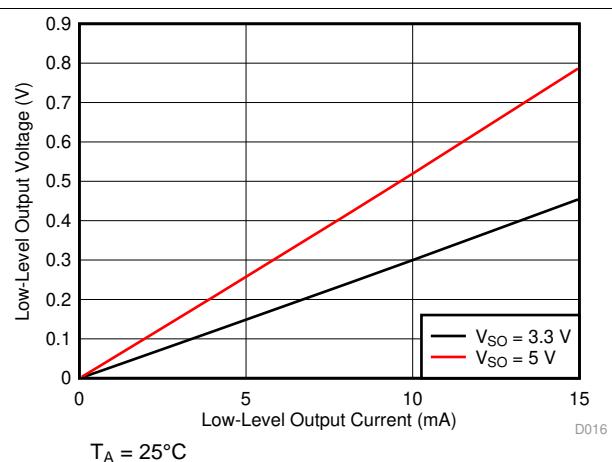
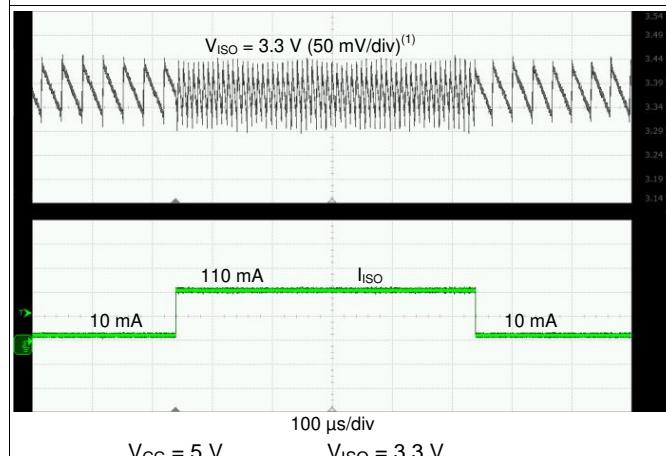
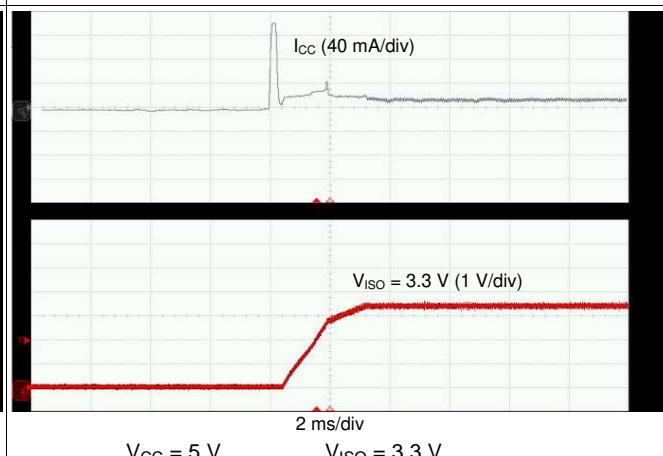


Figure 16. Low-Level Output Voltage vs Low-Level Output Current



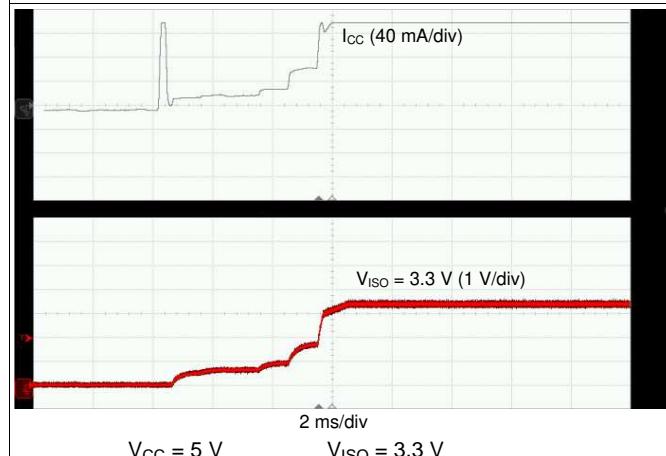
1. Negligible undershoot and overshoot because of load transient

Figure 17. 10-mA to 110-mA Load Transient Response



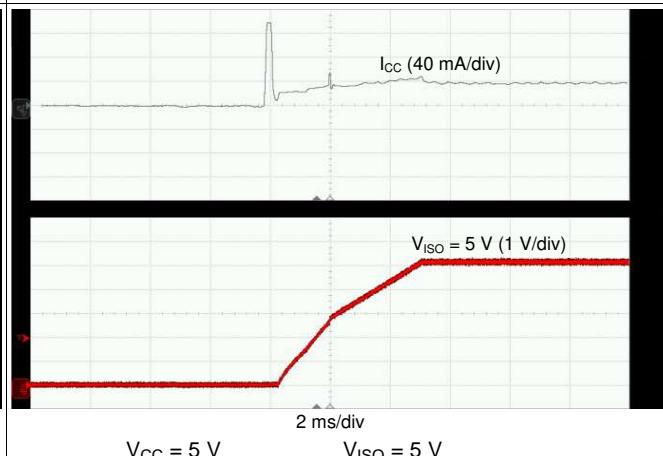
Current spike is because of charging the input supply capacitor

Figure 18. Soft Start at 10-mA Load



Input current spike is because of charging the input supply decoupling capacitor

Figure 19. Soft Start at 120-mA Load



Input current spike is because of charging the input supply decoupling capacitor

Figure 20. Soft Start at 10-mA Load

Typical Characteristics (continued)

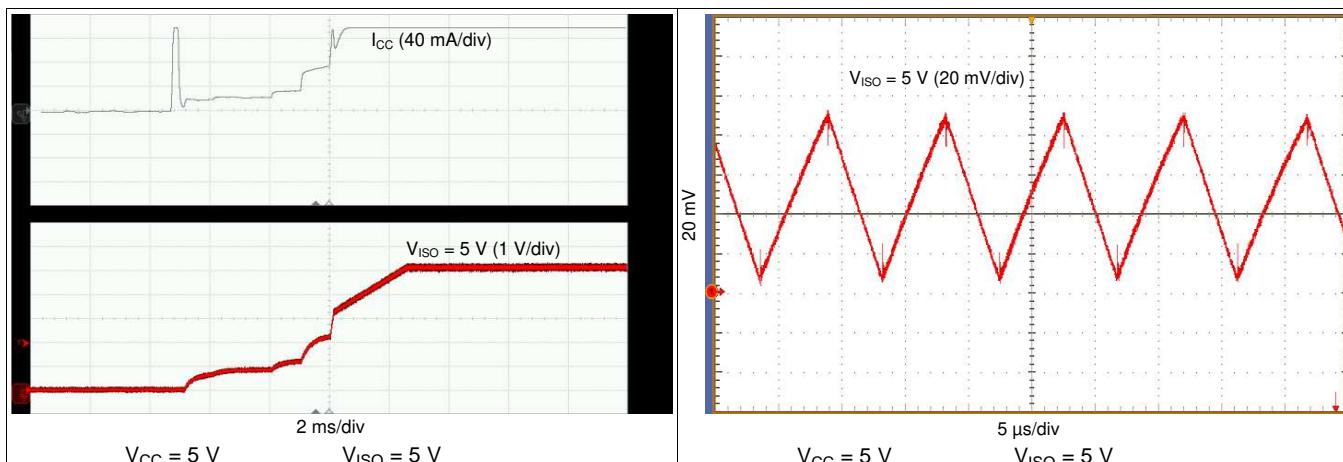


Figure 21. Soft Start at 130-mA Load

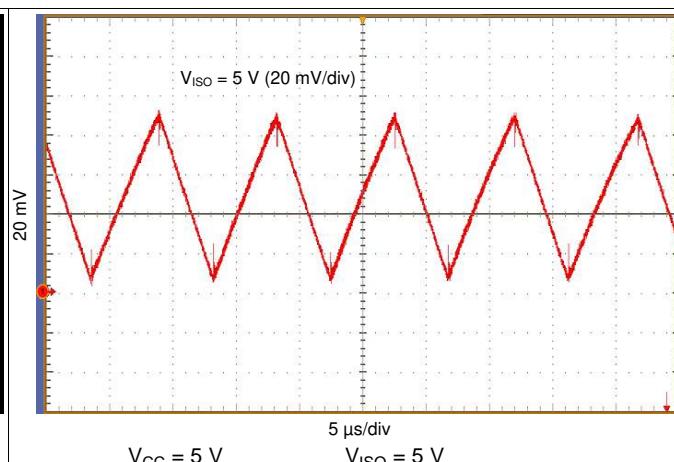


Figure 22. V_{ISO} Ripple Voltage at 130 mA

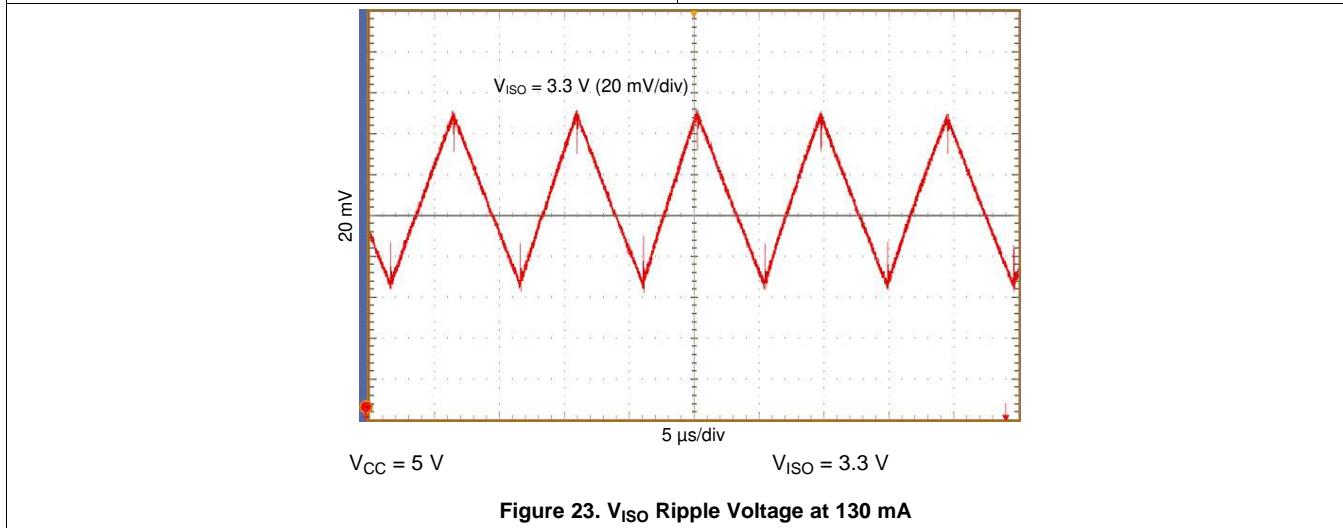
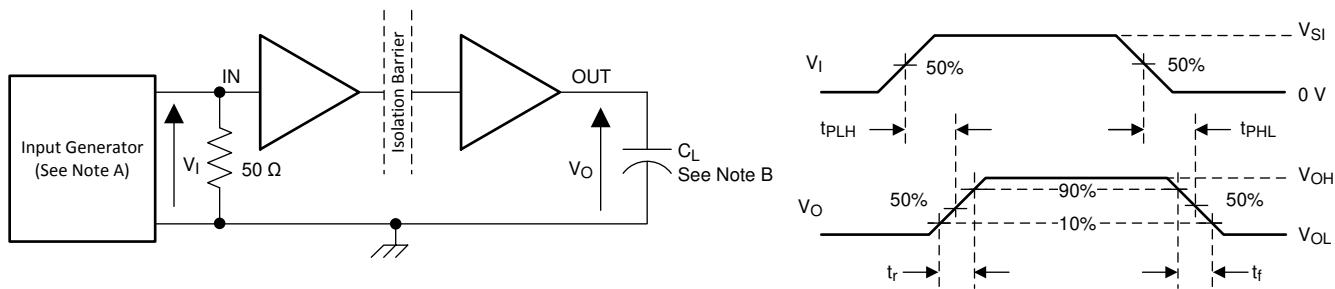


Figure 23. V_{ISO} Ripple Voltage at 130 mA

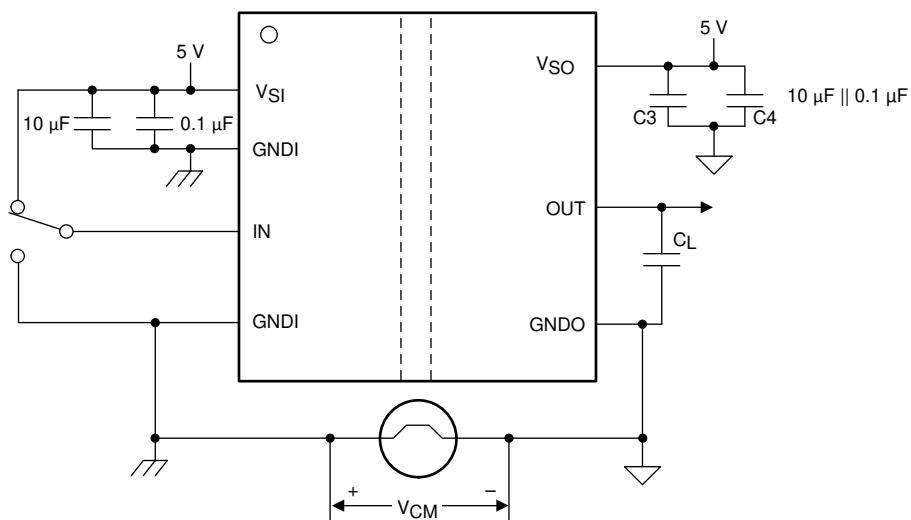
8 Parameter Measurement Information



The input pulse is supplied by a generator having the following characteristics: PRR \leq 50 kHz, 50% duty cycle, $t_r \leq 3$ ns, $t_f \leq 3$ ns, $Z_O = 50 \Omega$. At the input, 50- Ω resistor is required to terminate the input generator signal. The resistor is not required in the actual application.

$C_L = 15 \text{ pF}$ and includes instrumentation and fixture capacitance within $\pm 20\%$.

Figure 24. Switching Characteristics Test Circuit and Voltage Waveforms



$C_L = 15 \text{ pF}$ and includes instrumentation and fixture capacitance within $\pm 20\%$.

Optional 100 μF capacitor can be added between V_{CC} and $GND1$; refer to [Power Supply Recommendations](#).

Pass-fail criteria: Outputs must remain stable.

Figure 25. Common-Mode Transient Immunity Test Circuit

9 Detailed Description

9.1 Overview

The ISOW7821 device comprises a high-efficiency, low-emissions isolated DC-DC converter and two high-speed isolated data channels. [Figure 26](#) shows the functional block diagram of the ISOW7821 device.

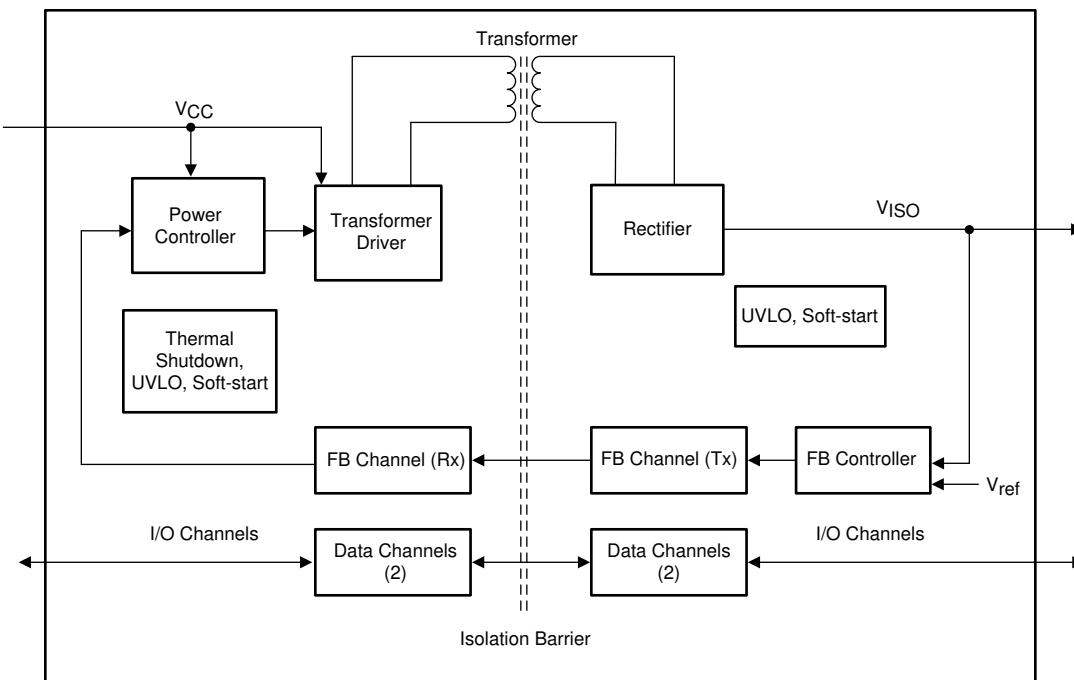
The integrated DC-DC converter uses switched mode operation and proprietary circuit techniques to reduce power losses and boost efficiency. Specialized control mechanisms, clocking schemes, and the use of a high-Q on-chip transformer provide high efficiency and low radiated emissions. The integrated transformer uses thin film polymer as the insulation barrier.

The V_{CC} supply is provided to the primary power controller that switches the power stage connected to the integrated transformer. Power is transferred to the secondary side, rectified and regulated to either 3.3 V or 5 V, depending on the SEL pin. The output voltage, V_{ISO} , is monitored and feedback information is conveyed to the primary side through a dedicated isolation channel. The duty cycle of the primary switching stage is adjusted accordingly. The fast feedback control loop of the power converter ensures low overshoots and undershoots during load transients. Undervoltage lockout (UVLO) with hysteresis is integrated on the V_{CC} and V_{ISO} supplies which ensures robust system performance under noisy conditions. An integrated soft-start mechanism ensures controlled inrush current and avoids any overshoot on the output during power up.

The integrated signal-isolation channels employ an ON-OFF keying (OOK) modulation scheme to transmit the digital data across a silicon-dioxide based isolation barrier. The transmitter sends a high-frequency carrier across the barrier to represent one state and sends no signal to represent the other state. The receiver demodulates the signal after signal conditioning and produces the output through a buffer stage. The signal-isolation channels incorporate advanced circuit techniques to maximize the CMTI performance and minimize the radiated emissions from the high frequency carrier and IO buffer switching. [Figure 27](#) shows a functional block diagram of a typical signal isolation channel.

The ISOW7821 device is suitable for applications that have limited board space and require more integration. These devices are also suitable for very-high voltage applications, where power transformers meeting the required isolation specifications are bulky and expensive.

9.2 Functional Block Diagram



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Figure 26. ISOW7821 Block Diagram

Functional Block Diagram (continued)

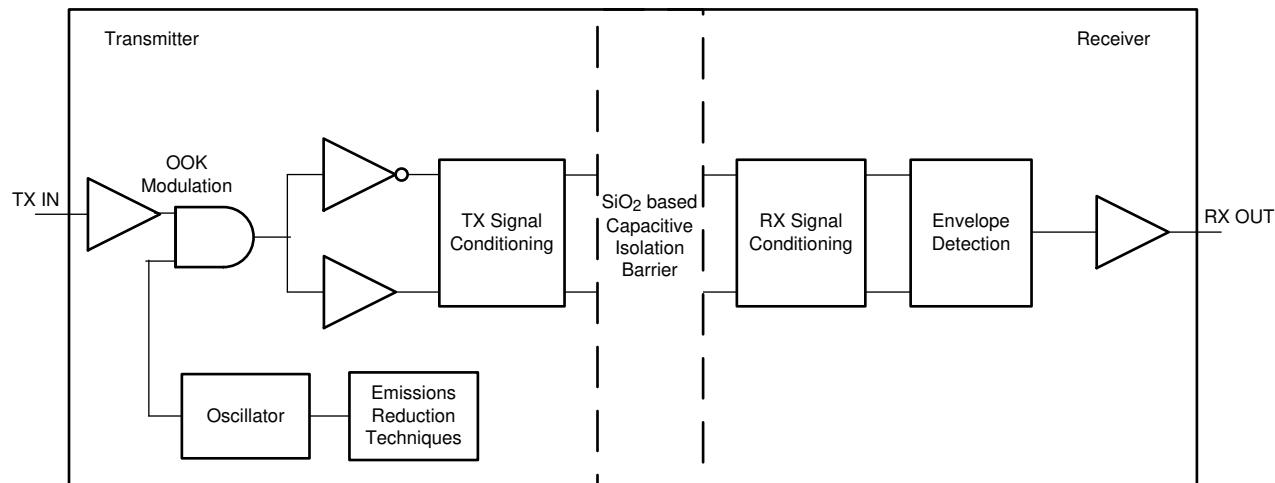


Figure 27. Conceptual Block Diagram of a Capacitive Data Channel

Figure 28 shows a conceptual detail of how the OOK scheme works.

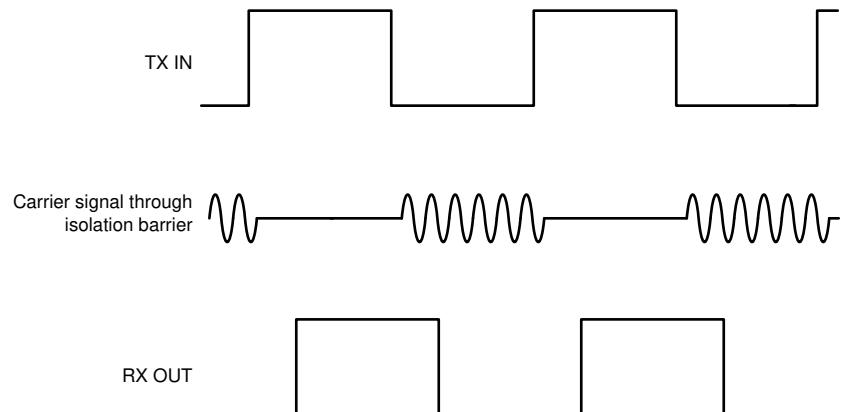


Figure 28. On-Off Keying (OOK) Based Modulation Scheme

9.3 Feature Description

Table 1 provides an overview of the device features.

Table 1. Device Features

PART NUMBER ⁽¹⁾	CHANNEL DIRECTION	MAXIMUM DATA RATE	DEFAULT OUTPUT STATE	RATED ISOLATION ⁽²⁾
ISOW7821	1 forward, 1 reverse	100 Mbps	High	5000 V _{RMS} / 7071 V _{PK}
ISOW7821F			Low	

(1) The F suffix is part of the orderable part number. See the [Mechanical, Packaging, and Orderable Information](#) section for the full orderable part number.

(2) For detailed isolation ratings, see the [Safety-Related Certifications](#) table.

9.3.1 Electromagnetic Compatibility (EMC) Considerations

The ISOW7821 device uses emissions reduction schemes for the internal oscillator and advanced internal layout scheme to minimize radiated emissions at the system level.

Many applications in harsh industrial environment are sensitive to disturbances such as electrostatic discharge (ESD), electrical fast transient (EFT), surge and electromagnetic emissions. These electromagnetic disturbances are regulated by international standards such as IEC 61000-4-x and CISPR 22. Although system-level performance and reliability depends, to a large extent, on the application board design and layout, the ISOW7821 device incorporates many chip-level design improvements for overall system robustness. Some of these improvements include:

- Robust ESD protection cells for input and output signal pins and inter-chip bond pads.
- Low-resistance connectivity of ESD cells to supply and ground pins.
- Enhanced performance of high voltage isolation capacitor for better tolerance of ESD, EFT and surge events.
- Bigger on-chip decoupling capacitors to bypass undesirable high energy signals through a low impedance path.
- PMOS and NMOS devices isolated from each other by using guard rings to avoid triggering of parasitic SCRs.
- Reduced common mode currents across the isolation barrier by ensuring purely differential internal operation.

9.3.2 Power-Up and Power-Down Behavior

The ISOW7821 device has built-in UVLO on the V_{CC} and V_{ISO} supplies with positive-going and negative-going thresholds and hysteresis. When the V_{CC} voltage crosses the positive-going UVLO threshold during power-up, the DC-DC converter initializes and the power converter duty cycle is increased in a controlled manner. This soft-start scheme limits primary peak currents drawn from the V_{CC} supply and charges the V_{ISO} output in a controlled manner, avoiding overshoots. Outputs of the isolated data channels are in an indeterminate state until the V_{CC} or V_{ISO} voltage crosses the positive-going UVLO threshold. When the UVLO positive-going threshold is crossed on the secondary side V_{ISO} pin, the feedback data channel starts providing feedback to the primary controller. The regulation loop takes over and the isolated data channels go to the normal state defined by the respective input channels or their default states. Design should consider a sufficient time margin (typically 10 ms with 10- μ F load capacitance) to allow this power up sequence before valid data channels are accounted for system functionality.

When V_{CC} power is lost, the primary side DC-DC controller turns off when the UVLO lower threshold is reached. The V_{ISO} capacitor then discharges depending on the external load. The isolated data outputs on the V_{ISO} side are returned to the default state for the brief time that the V_{ISO} voltage takes to discharge to zero.

9.3.3 Current Limit, Thermal Overload Protection

The ISOW7821 device is protected against output overload and short circuit. Output voltage starts dropping when the power converter is not able to deliver the current demanded during overload conditions. For a V_{ISO} short-circuit to ground, the duty cycle of the converter is limited to help protect against any damage.

Thermal protection is also integrated to help prevent the device from getting damaged during overload and short-circuit conditions on the isolated output. Under these conditions, the device temperature starts to increase. When the temperature goes above 180°C, thermal shutdown activates and the primary controller turns off which removes the energy supplied to the V_{ISO} load, which causes the device to cool off. When the junction temperature goes below 150°C, the device starts to function normally. If an overload or output short-circuit condition prevails, this protection cycle is repeated. Care should be taken in the design to prevent the device junction temperatures from reaching such high values.

9.4 Device Functional Modes

Table 2 lists the supply configurations for these devices.

Table 2. Supply Configurations

SEL INPUT	V_{CC}	V_{ISO}
Shorted to V_{ISO}	5 V	5 V
Shorted to GND2 or floating	5 V	3.3 V
Shorted to GND2 or floating	3.3 V ⁽¹⁾	3.3 V ⁽²⁾

(1) $V_{CC} = 3.3$ V, SEL shorted to V_{ISO} (essentially $V_{ISO} = 5$ V) is not recommended mode of configuration.

(2) The SEL pin has a weak pulldown internally. Therefore for $V_{ISO} = 3.3$ V, the SEL pin should be strongly connected to the GND2 pin in noisy system scenarios.

Table 3 lists the functional modes for ISOW7821 device.

Table 3. Function Table⁽¹⁾

INPUT SUPPLY (V_{CC})	INPUT (INx)	OUTPUT (OUTx)	COMMENTS
PU	H	H	Output channel assumes the logic state of its input
	L	L	
	Open	Default	Default mode ⁽²⁾ : When INx is open, the corresponding output channel assumes logic based on default output mode of selected version
PD	x	Undetermined ⁽³⁾	

(1) PU = Powered up ($V_{CC} \geq 2.7$ V); PD = Powered down ($V_{CC} < 2.1$ V); X = Irrelevant; H = High level; L = Low level, V_{CC} = Input-side supply

(2) In the default condition, the output is high for ISOW7821 and low for ISOW7821 with the F suffix.

(3) The outputs are in an undetermined state when $V_{CC} < 2.1$ V.

9.4.1 Device I/O Schematics

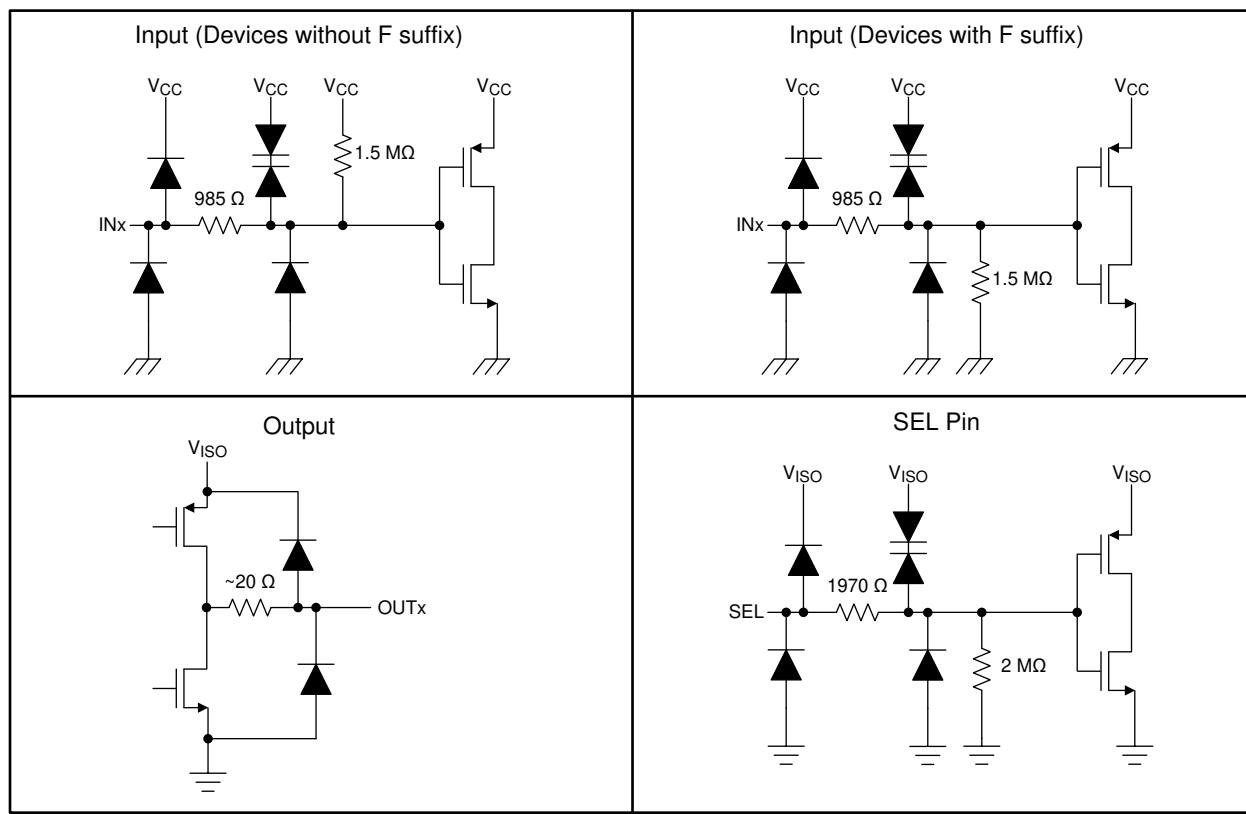


Figure 29. Device I/O Schematics

10 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. Customers should validate and test their design implementation to confirm system functionality.

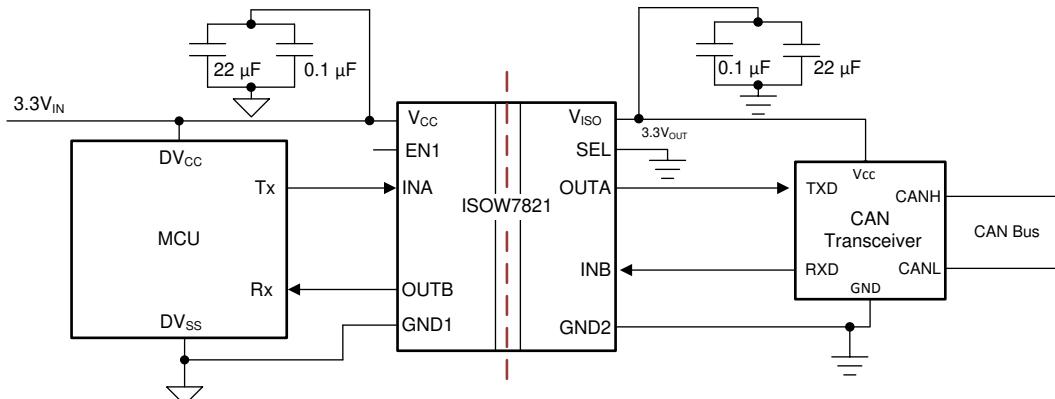
10.1 Application Information

The ISOW7821 high-performance, dual channel digital isolator with integrated DC-DC converter. Typically digital isolators require two power supplies isolated from each other to power up both sides of device. Due to the integrated DC-DC converter in the ISOW7821 device, the isolated supply is generated inside the device that can be used to power isolated side of the device and peripherals on isolated side, thus saving board space. The ISOW7821 device uses single-ended CMOS-logic switching technology. When designing with digital isolators, keep in mind that because of the single-ended design structure, digital isolators do not conform to any specific interface standard and are only intended for isolating single-ended CMOS or TTL digital signal lines. The isolator is typically placed between the data controller (that is a microcontroller or UART), and a data converter or a line transceiver, regardless of the interface type or standard.

The ISOW7821 device is suitable for applications that have limited board space and desire more integration. These devices are also suitable for very high voltage applications, where power transformers meeting the required isolation specifications are bulky and expensive.

10.2 Typical Application

Figure 30 shows the typical schematic for CAN isolation.



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Optional 100 μ F capacitor can be added between V_{CC} and $GND1$; refer to [Power Supply Recommendations](#).

Figure 30. Isolating CAN Bus and Generating Isolated Power for CAN Transceiver

10.2.1 Design Requirements

To design with this device, use the parameters listed in [Table 4](#).

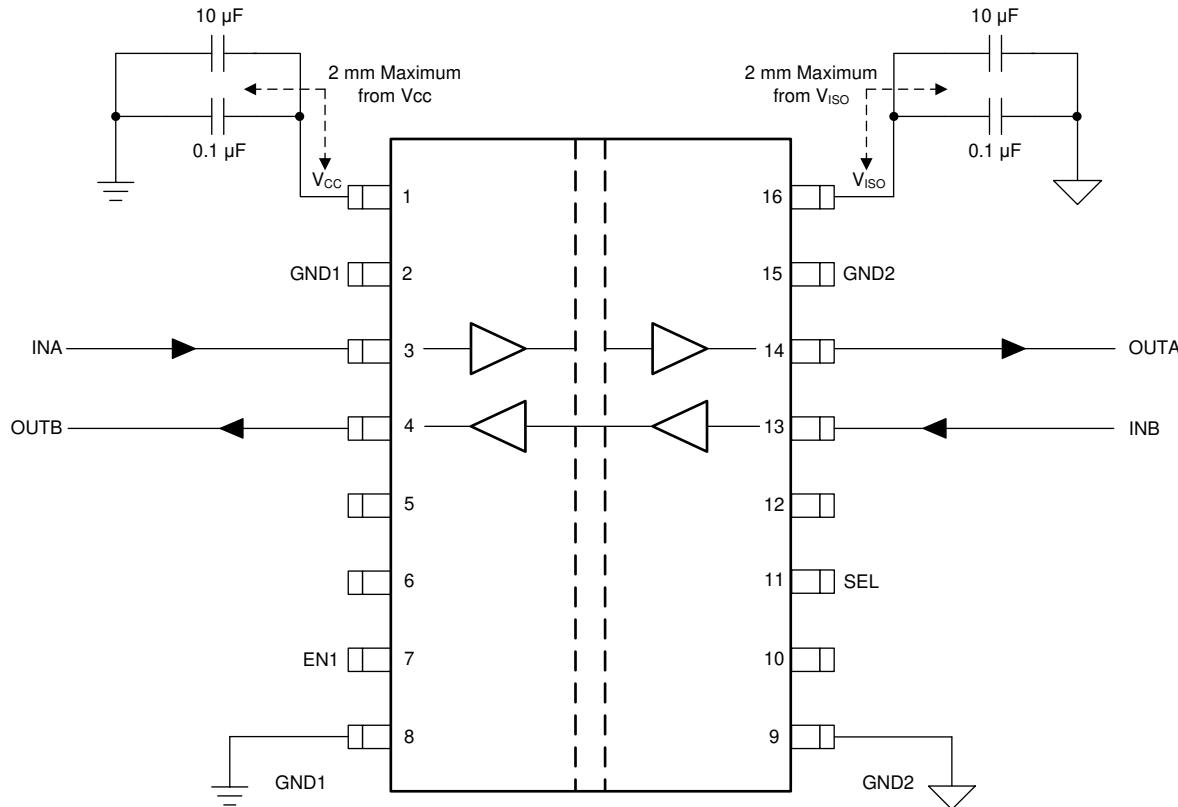
Table 4. Design Parameters

PARAMETER	VALUE
Input voltage	3 V to 5.5 V
Decoupling capacitor between V_{CC} and $GND1$	0.1 μ F to 10 μ F
Decoupling capacitor between V_{ISO} and $GND2$	0.1 μ F to 10 μ F

Because of very-high current flowing through the ISOW7821 V_{CC} and V_{ISO} supplies, higher decoupling capacitors typically provide better noise and ripple performance. Although a 10- μ F capacitor is adequate, higher decoupling capacitors (such as 47 μ F) on both the V_{CC} and V_{ISO} pins to the respective grounds are strongly recommended to achieve the best performance. Optional 100 μ F decoupling capacitor can be added between V_{CC} and GND1 pins; refer to [Power Supply Recommendations](#) for more details.

10.2.2 Detailed Design Procedure

The ISOW7821 device only requires external bypass capacitors to operate. These low-ESR ceramic bypass capacitors must be placed as close to the chip pads as possible.



Optional 100 μ F capacitor can be added between V_{CC} and GND1; refer to [Power Supply Recommendations](#).

Figure 31. Typical Circuit Hook-Up

The V_{CC} power-supply input provides power to isolated data channels and to the isolated DC-DC converter. Use [Equation 1](#) to calculate the total power budget on the primary side.

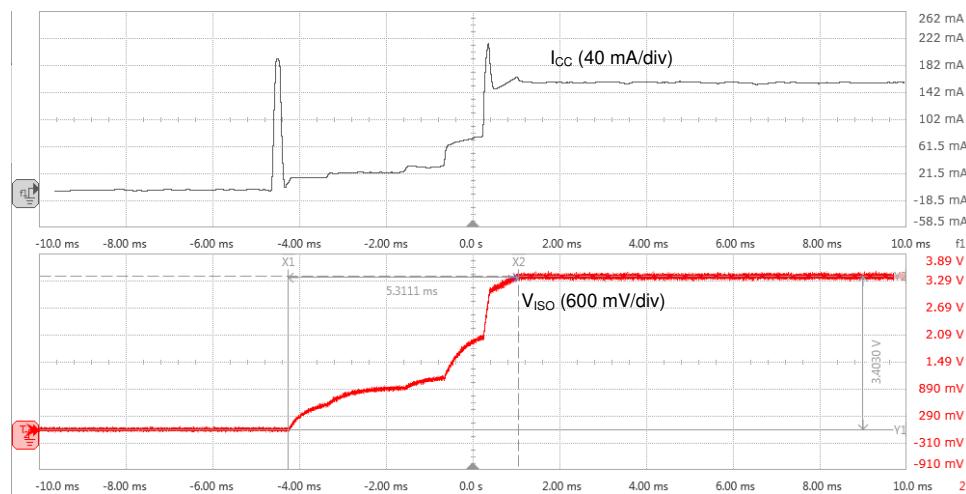
$$I_{CC} = (V_{ISO} \times I_{ISO}) / (\eta \times V_{CC}) + I_{inpx}$$

where

- I_{CC} is the total current required by the primary supply.
- V_{ISO} is the isolated supply voltage.
- I_{ISO} is the external load on the isolated supply voltage.
- η is the efficiency.
- V_{CC} is the supply voltage.
- I_{inpx} is the total current drawn for the isolated data channels and power converter when data channels are toggling at a specific data rate. This data is shown in the [Electrical Characteristics—5-V Input, 5-V Output](#) table.

(1)

10.2.3 Application Curve



$$V_{CC} = 3.3 \text{ V}$$

$$I_{ISO} = 70 \text{ mA}$$

Input current spike is because of charging the input supply decoupling capacitor

Figure 32. Soft-Start Waveform

10.2.3.1 Insulation Lifetime

Insulation lifetime projection data is collected by using industry-standard Time Dependent Dielectric Breakdown (TDDB) test method. In this test, all pins on each side of the barrier are tied together creating a two-terminal device and high voltage applied between the two sides; See [Figure 33](#) for TDDB test setup. The insulation breakdown data is collected at various high voltages switching at 60 Hz over temperature. For reinforced insulation, VDE standard requires the use of TDDB projection line with failure rate of less than 1 part per million (ppm). Even though the expected minimum insulation lifetime is 20 years at the specified working isolation voltage, VDE reinforced certification requires additional safety margin of 20% for working voltage and 87.5% for lifetime which translates into minimum required insulation lifetime of 37.5 years at a working voltage that's 20% higher than the specified value.

[Figure 34](#) shows the intrinsic capability of the isolation barrier to withstand high voltage stress over its lifetime. Based on the TDDB data, the intrinsic capability of the insulation is 1000 V_{RMS} with a lifetime of 1184 years.

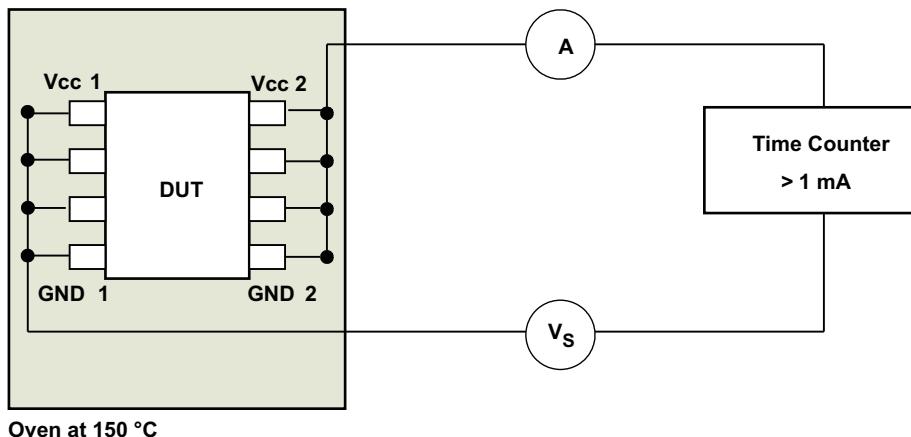


Figure 33. Test Setup for Insulation Lifetime Measurement

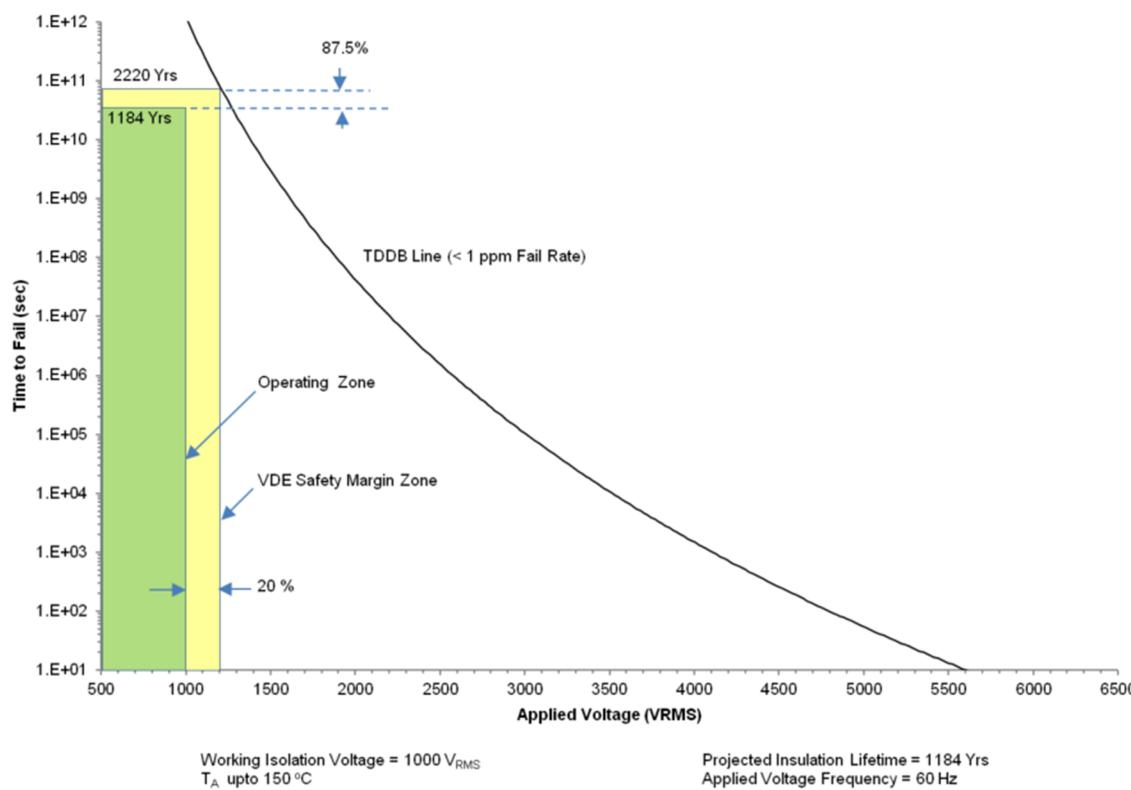


Figure 34. Insulation Lifetime Projection Data

11 Power Supply Recommendations

To help ensure reliable operation at data rates and supply voltages, adequate decoupling capacitors must be located as close to supply pins as possible. The input supply must have an appropriate current rating to support output load and switching at the maximum data rate required by the end application. For more information, refer to the [Detailed Design Procedure](#) section.

ISOW7821 integrates a synchronous, isolated DC/DC converter along with isolated data channels. Due to finite efficiency of the integrated micro-transformer, for any given output load current, the input current will be proportionally higher. Thus, the input supply (V_{CC}) decoupling capacitor also needs to be sufficiently larger than the output supply (V_{ISO}) decoupling capacitor. It is recommended to have an input capacitor that is larger than the output capacitor by at least 100 μ F. It is also recommended to have an input power supply to ISOW7821 with sufficient current limit to support output load current requirements. For an output load current of 130 mA, it is recommended to have >600 mA of input current limit and for lower output load currents, the input current limit can be proportionally lower. When the input supply is lower than 2.7 V, the device can go into a protected under-voltage lock out (UVLO) state per the UVLO thresholds specified in datasheet. Under UVLO state, it is recommended that the output voltage also be discharged to less than 2.1 V. This can be accomplished by having an input capacitor that is 100 μ F larger compared to the output capacitor. It also helps to have a small load (~10 mA) at the output capacitor to bleed off any unwanted, residual charge. To make sure ISOW7821 quickly transitions from UVLO state to powered state, it is recommended to have an input supply rise time of less than 10 ms.

If it is not possible to follow the aforementioned recommendations and frequent brownouts are expected on the input supply, then simple secondary side monitoring, protection and reset components can help improve the robustness of overall system and power-up or reset mechanisms. More details on output monitoring, protection and an example of reset mechanism can be found in [Overvoltage protection for isolated DC/DC converter](#).

12 Layout

12.1 Layout Guidelines

A minimum of four layers is required to accomplish a low-EMI PCB design (see [Figure 35](#)). Layer stacking should be in the following order (top-to-bottom): high-speed signal layer, ground plane, power plane, and low-frequency signal layer.

- 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.
- 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.
- Keep decoupling capacitors as close as possible to the V_{CC} and V_{ISO} pins.

If an additional supply voltage plane or signal layer is needed, add a second power or 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.

Because the device has no thermal pad to dissipate heat, the device dissipates heat through the respective GND pins. Ensure that enough copper is present on both GND pins to prevent the internal junction temperature of the device from rising to unacceptable levels.

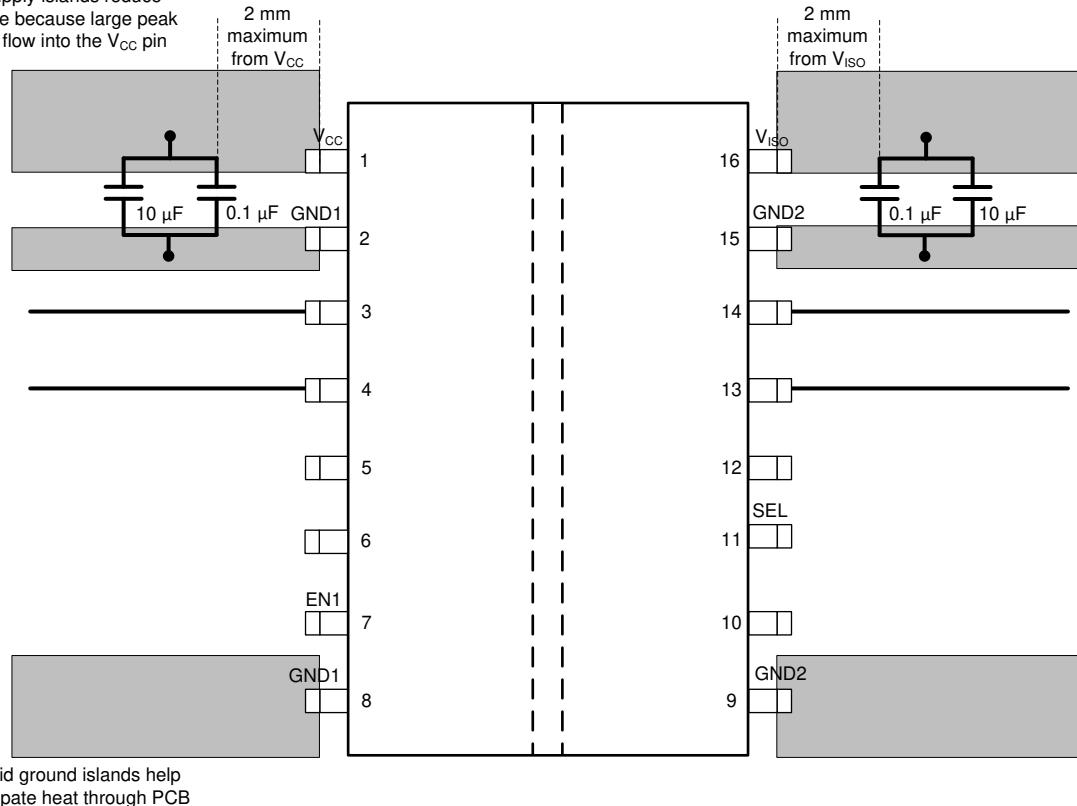
The ISOW7821 integrated signal and power isolation device simplifies system design and reduces board area. The use of low-inductance micro-transformers in the ISOW7821 device necessitates the use of high frequency switching, resulting in higher radiated emissions compared to discrete solutions. The ISOW7821 device uses on-chip circuit techniques to reduce emissions compared to competing solutions. For further reduction in radiated emissions at system level, refer to the [Low-Emission Designs With ISOW7841 Integrated Signal and Power Isolator](#) application report.

12.1.1 PCB Material

For digital circuit boards operating at less than 150 Mbps, (or rise and fall times greater than 1 ns), and trace lengths of up to 10 inches, use standard FR-4 UL94V-0 printed circuit board. This PCB is preferred over cheaper alternatives because of lower dielectric losses at high frequencies, less moisture absorption, greater strength and stiffness, and the self-extinguishing flammability-characteristics.

12.2 Layout Example

Solid supply islands reduce inductance because large peak currents flow into the V_{CC} pin



Optional 100 μ F capacitor can be added between V_{CC} and GND1; refer to [Power Supply Recommendations](#).

Figure 35. Layout Example

13 Device and Documentation Support

13.1 Device Support

13.1.1 Development Support

For development support, refer to the [Size and Cost Optimized Binary Module Reference Design Using Digital Isolator with Integrated Power TI Design](#)

13.2 Documentation Support

13.2.1 Related Documentation

For related documentation see the following:

- Texas Instruments, [Digital Isolator Design Guide](#)
- Texas Instruments, [Isolation Glossary](#)
- Texas Instruments, [ISOW784x Quad-Channel Digital Isolator With Integrated DC-DC Converter Evaluation Module user's guide](#)

13.3 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

13.4 Community Resources

[TI E2ETM 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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13.5 Trademarks

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13.6 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.

13.7 Glossary

[SLYZ022 — TI Glossary](#).

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

14 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.

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
ISOW7821DWE	Active	Production	SOIC (DWE) 16	40 TUBE	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	ISOW7821
ISOW7821DWE.A	Active	Production	SOIC (DWE) 16	40 TUBE	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	ISOW7821
ISOW7821DWER	Active	Production	SOIC (DWE) 16	2000 LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	ISOW7821
ISOW7821DWER.A	Active	Production	SOIC (DWE) 16	2000 LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	ISOW7821
ISOW7821FDWE	Active	Production	SOIC (DWE) 16	40 TUBE	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	ISOW7821F
ISOW7821FDWE.A	Active	Production	SOIC (DWE) 16	40 TUBE	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	ISOW7821F
ISOW7821FDWER	Active	Production	SOIC (DWE) 16	2000 LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	ISOW7821F
ISOW7821FDWER.A	Active	Production	SOIC (DWE) 16	2000 LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	ISOW7821F

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

⁽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.

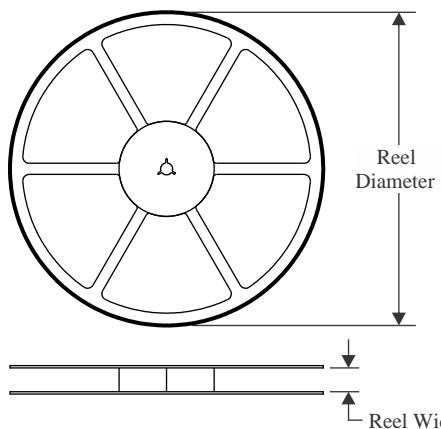
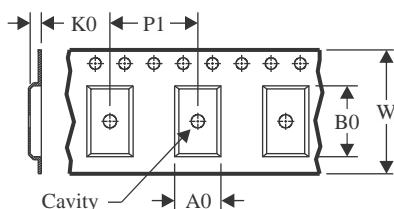
⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will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

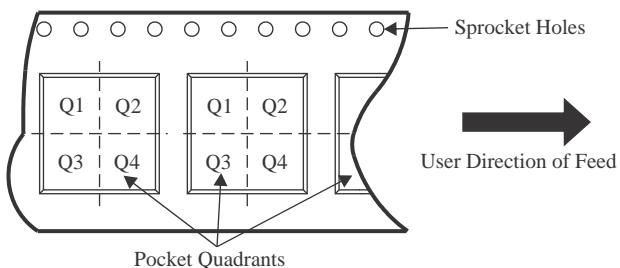
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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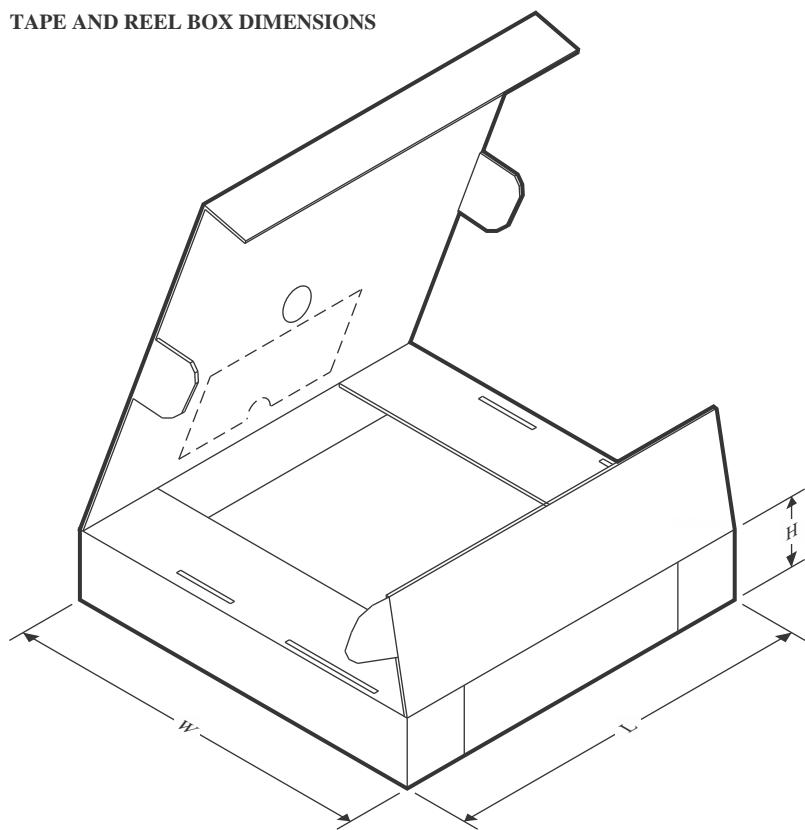
TAPE AND REEL INFORMATION
REEL DIMENSIONS

TAPE DIMENSIONS


A0	Dimension designed to accommodate the component width
B0	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


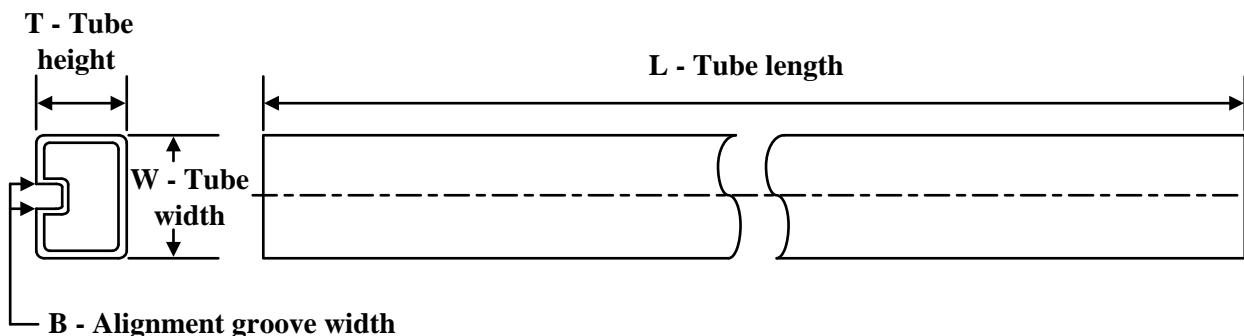
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
ISOW7821DWER	SOIC	DWE	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1
ISOW7821FDWER	SOIC	DWE	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)
ISOW7821DWER	SOIC	DWE	16	2000	350.0	350.0	43.0
ISOW7821FDWER	SOIC	DWE	16	2000	350.0	350.0	43.0

TUBE


*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μ m)	B (mm)
ISOW7821DWE	DWE	SO-MOD	16	40	506.98	12.7	4826	6.6
ISOW7821DWE.A	DWE	SO-MOD	16	40	506.98	12.7	4826	6.6
ISOW7821FDWE	DWE	SO-MOD	16	40	506.98	12.7	4826	6.6
ISOW7821FDWE.A	DWE	SO-MOD	16	40	506.98	12.7	4826	6.6

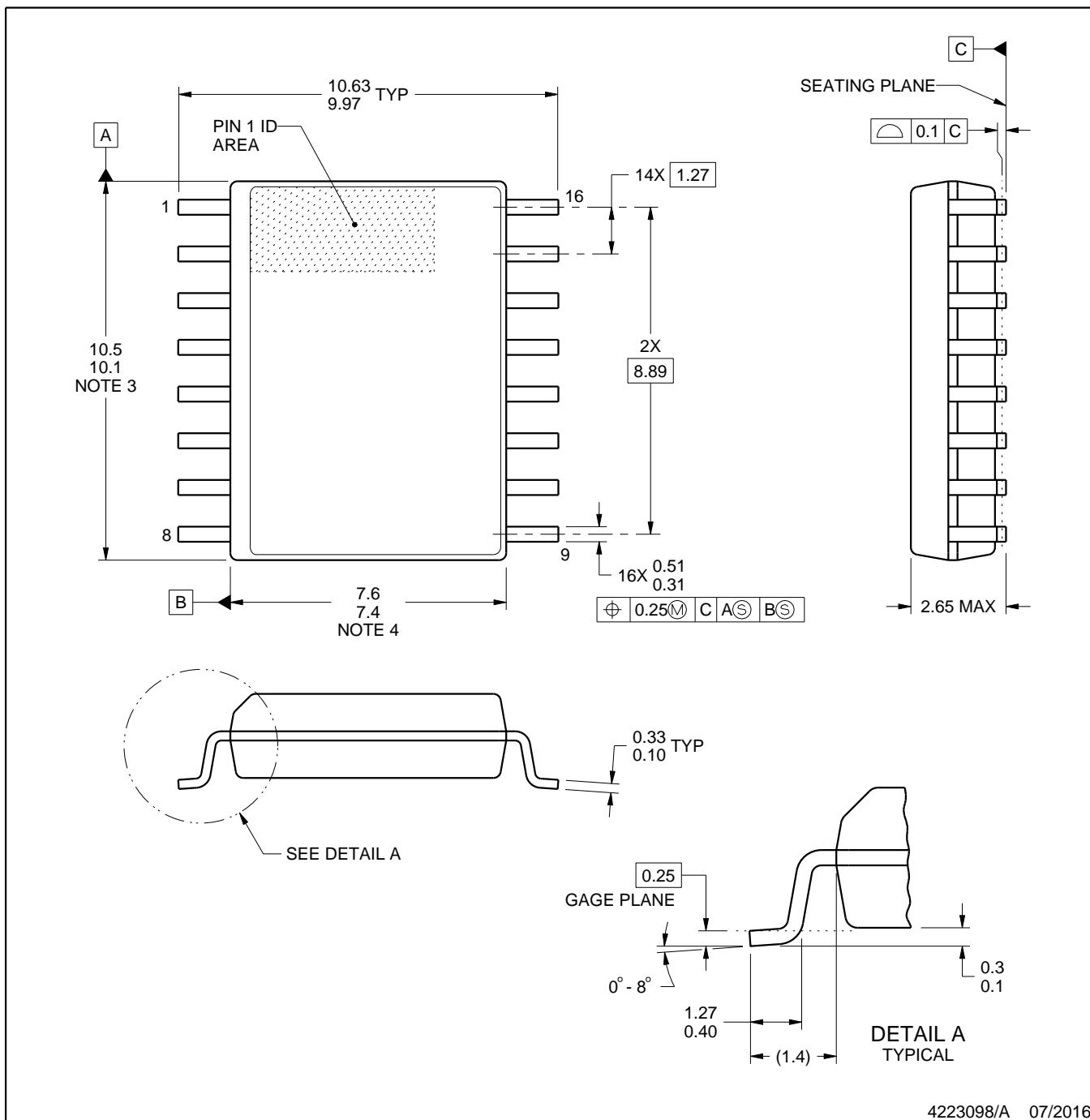


PACKAGE OUTLINE

DWE0016A

SOIC - 2.65 mm max height

SOIC



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NOTES:

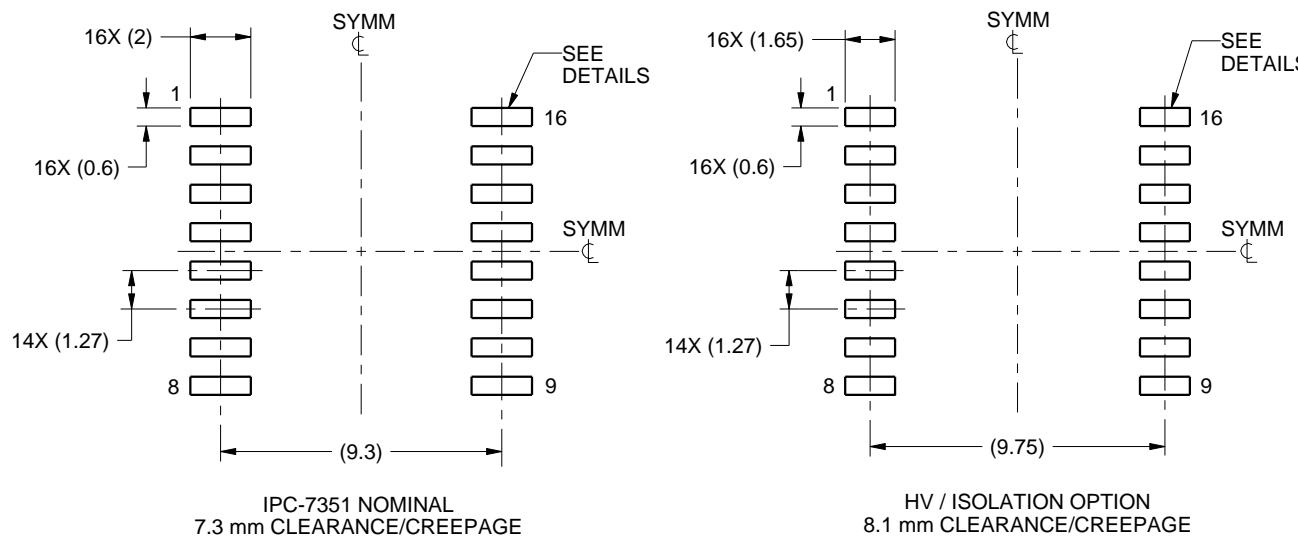
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm, per side.
5. Reference JEDEC registration MS-013.

EXAMPLE BOARD LAYOUT

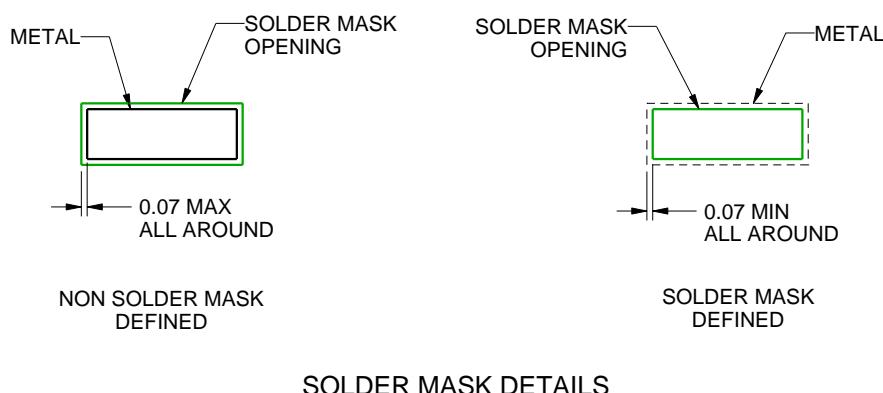
DWE0016A

SOIC - 2.65 mm max height

SOIC



LAND PATTERN EXAMPLE
SCALE:4X



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NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

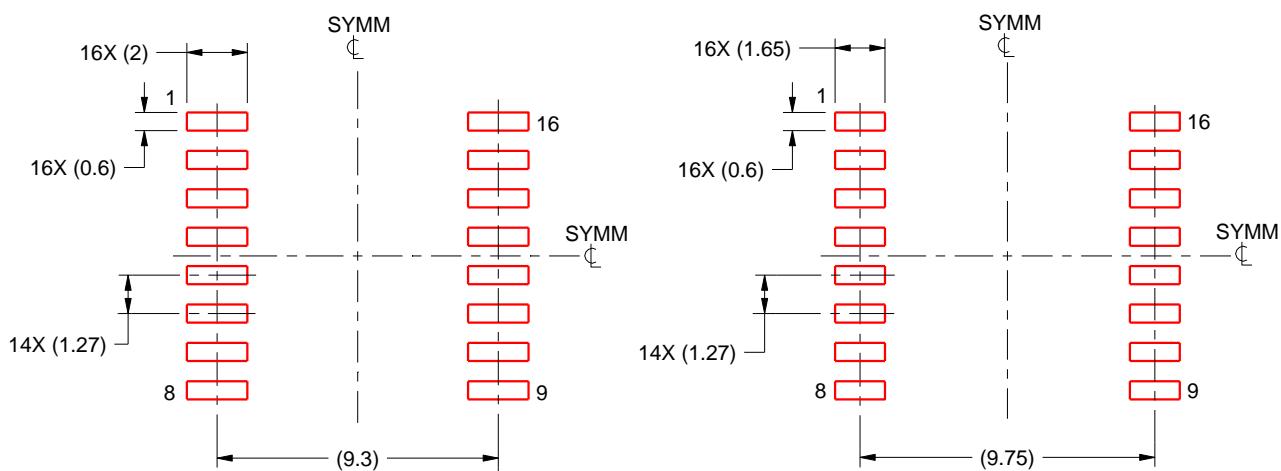
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DWE0016A

SOIC - 2.65 mm max height

SOIC



IPC-7351 NOMINAL
7.3 mm CLEARANCE/CREEPAGE

HV / ISOLATION OPTION
8.1 mm CLEARANCE/CREEPAGE

SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:4X

4223098/A 07/2016

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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