Considerations for Selecting Digital Isolators

Luke Trowbridge, Product Marketing Engineer, Isolation, Interface Group

Introduction

Isolation is a means of preventing DC and uncontrolled AC currents between two parts of a system, while allowing signal and power transfer between those two parts. This isolation can be required in order to protect human operators and prevent damage to expensive processors in high voltage systems, break ground loops in communication networks, and to communicate to high-side devices. Digital isolators are a common choice when looking to achieve galvanic isolation for interfaces such as SPI, UART, I2C, RS-485, and RS-232 in many different system applications, including industrial automation systems, motor drives, medical equipment, solar inverters, power supplies, and hybrid electric vehicles. This application brief identifies key considerations when selecting the right digital isolator for a given application and provides a guide for understanding the different choices from Texas Instruments (TI) broad portfolio of digital isolators.

TI Isolation Technology

TI isolators use silicon-dioxide (SiO_2) based, high-voltage capacitors to serve as the signal insulation and dielectric in digital isolators. The digital isolator product families later discussed use two thick SiO_2 capacitors in series - one on each side of the isolation barrier to achieve high-voltage isolation. A graphical representation of this barrier technique can be seen in Figure 1. Compared to inductor based (polyimide) insulators and traditional optocouplers, SiO_2 provides the highest dielectric strength, does not degrade with exposure to ambient moisture, and can offer an isolation barrier lifetime >100 years. For a deeper explanation of TI's isolation technology refer to Enabling high voltage signal isolation quality and reliability.

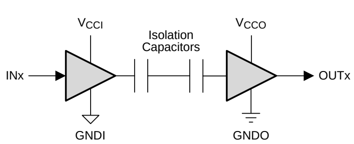

Figure 1. Series Capacitor Isolation

Key Isolation Specifications

Before choosing the right digital isolator, it is important for designers to know the isolation specification requirements for their given system application. Once this is known, how does a designer know how much protection a device can provide, and what are the maximum voltages an isolator can withstand?

High-voltage isolation performance of a digital isolator is quantified at the component level by parameters such as maximum transient isolation voltage (V_{IOTM}), isolation withstand voltage (V_{ISO}), maximum surge isolation voltage (V_{IOSM}), maximum repetitive peak voltage (V_{IORM}), working voltage (V_{IOWM}), and common-mode transient immunity (CMTI). These parameters represent a digital isolator's capability to handle high-voltage stresses of different magnitude and transient profiles and are key to selecting the right digital isolator for specific system requirements.

- **Maximum transient isolation voltage (V_{IOTM}):** Defined by IEC 60747-5-5 and VDE 0884-11 as the peak transient voltage that the isolator can handle for up to 60 seconds without breaking down. Arcing or load changes on a system power supply can cause disturbances where the voltage could briefly become several times that of the line voltage. An isolator must be able to handle these over voltages without damage.
- **Isolation withstand voltage (V_{ISO}):** Similar to the V_{IOTM}, isolation withstand voltage is defined per UL 1577 as the root mean square (rms) value of voltage that the isolator can handle without breakdown for 60 seconds. The difference is the value is given in an rms instead of a peak voltage.
- **Maximum surge isolation voltage (V_{IOSM}):** Quantifies the ability of the isolator to withstand very high voltage impulses of a certain transient profile. This waveform is shown in Figure 2. This parameter represents direct and indirect lighting strikes. As per IEC 60747-5-5 and VDE 0884-11, an isolator claiming a certain V_{IOSM} must pass the surge test at a peak voltage of 1.3 times V_{IOSM} for basic isolation, and 1.6 times V_{IOSM} for reinforced isolation. A digital isolator can be called reinforced at the component level, only if it passes the surge test at a level greater than 10kV.

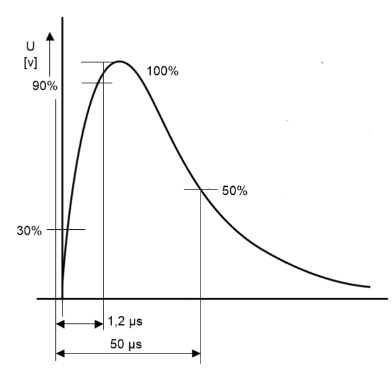

Figure 2. Surge Transient Waveform

Copyright © 2018, Texas Instruments Incorporated

- **Maximum repetitive peak voltage (V_{IORM}):** Defined in IEC 60747-5-5 and VDE 0884-11 as the maximum repetitive peak voltage that the isolator can withstand. This specification is intended to qualify the ability of an isolator to handle high voltage across its barrier on a continuous, day-to-day basis.
- **Working Voltage (V_{IOWM}):** Similar to the V_{IORM}, working voltage is the maximum rms, or equivalent dc voltage, that the isolator can withstand over a specified long lifetime. Again, the difference is the value is given in an rms instead of a peak voltage.
- **CMTI:** Common-mode transient immunity is the ability of an isolator to tolerate high-slew-rate voltage transients between its two grounds without corrupting signals passing through it, which could potentially cause bit errors. In some applications, these bit errors caused by the transients can result in dangerous short-circuit events. Higher CMTI indicates a more robust isolation channel.

Additional explanation on each of these isolation parameters can be found in High-voltage reinforced isolation: Definitions and test methodologies. The isolation certifications that have been mentioned ensure that your applications meet worldwide industry standards. Use these tables to check which TI devices meet each certification requirement.

Package Options

Creepage and clearance are the distance along the surface of the package and through the air between pins on one side of the isolator to the pins on the other side. This distance is mandated by system level standards based on parameters such as isolation voltage requirements, material group of the isolator's package mold compound, comparative tracking index (CTI) and altitude. CTI indicates the ability of the package mold compound to handle steady high voltage without surface degradation. A higher CTI allows the use of smaller packages for the same working voltage. TI offers package options with creepage distances of up to 14.5-mm and the isolator families shown in Table 3 both guarantee a CTI of >600 V.

Packages also dictate the isolation channel counts and solution size of a digital isolator. Drawn to scale images of TI's digital isolator package options can be seen in Figure 3 and the measurements, creepage, and channel counts of each package can be found in Table 1.

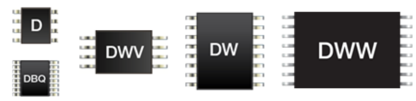

Figure 3. Packages

Table 1. Package Properties

Package	Identifier	Length (mm)	Width (mm)	Creepage (mm)	Channels
8-pin SOIC	D	4.90	3.91	4	1,2
16-pin SSOP	DBQ	4.90	3.90	3.7	3,4,6
8-pin SOIC	DWV	5.85	7.50	8.5	2
16-pin SOIC	DW	10.30	7.50	8	1,2,3,4,6
16-pin SOIC	DWW	10.30	14.00	14.5	1,2,3,4

Since the package of a digital isolator has a direct effect on the isolation performance of an isolator, packaging specifications must be considered when selecting the right device for a given application. The isolation capabilities of each product family and package can be found in Table 3.

Conclusion

This application brief serves as an introduction to some of the key considerations important to selecting and narrowing down TI's portfolio of digital isolators for use in industrial and automotive designs. These considerations are also useful when evaluating TI's additional portfolio of isolated interface devices. For a deeper explanation and analysis of the topics covered, consider the related technical documents in Table 2. Video series covering both these and similar isolation topics can be found on TI's isolation overview page and also in the Precision Labs training center.

Table 2. Related Technical Documents

Literature Number	Document Title
SSZY028	Enabling high voltage signal isolation quality and reliability
SLYY063	High-voltage reinforced isolation: Definitions and test methodologies
SLLA284A	Digital Isolator Design Guide
SLYT649	Pushing the envelope with high-performance, digital-isolation technology

Table 3. Digital Isolator Families

Device Family	V_{IOTM} (V_{PK})	V_{ISO} (V_{RMS})	V_{IOSM} (V_{PK})	V_{IORM} (V_{PK})	V_{IOWM} (V_{RMS})	Min CMTI (kV/µs)	CTI (V)	Package Options
ISO77xx	4242, 7071, 8000	3000, 5000	4000, 5000, 8000	566, 637, 1414	400, 450, 1000	85	>600	DBQ, D, DWV, DW
ISO78xx	8000	5700	8000	2121, 2828	1500, 2000	100	>600	DW, DWW

Copyright © 2018, Texas Instruments Incorporated

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2018, Texas Instruments Incorporated