Considerations for Selecting Digital Isolators
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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.

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 lightning 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 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?
• **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.

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>
<thead>
<tr>
<th>Literature Number</th>
<th>Document Title</th>
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<tbody>
<tr>
<td>SSZY028</td>
<td>Enabling high voltage signal isolation quality and reliability</td>
</tr>
<tr>
<td>SLYY063</td>
<td>High-voltage reinforced isolation: Definitions and test methodologies</td>
</tr>
<tr>
<td>SLLA284A</td>
<td>Digital Isolator Design Guide</td>
</tr>
<tr>
<td>SLYT649</td>
<td>Pushing the envelope with high-performance, digital-isolation technology</td>
</tr>
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**Table 2. Related Technical Documents**

<table>
<thead>
<tr>
<th>Device Family</th>
<th>( V_{IOTM} (V_{PK}) )</th>
<th>( V_{ISO} (V_{RMS}) )</th>
<th>( V_{IOSM} (V_{PK}) )</th>
<th>( V_{IORM} (V_{PK}) )</th>
<th>( V_{IOWM} (V_{RMS}) )</th>
<th>Min CMTI ( (kV/µs) )</th>
<th>CTI ( (V) )</th>
<th>Package Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO77xx</td>
<td>4242, 7071, 8000</td>
<td>3000, 5000</td>
<td>4000, 5000, 8000</td>
<td>566, 637, 1414</td>
<td>400, 450, 1000</td>
<td>85</td>
<td>&gt;600</td>
<td>DBQ, D, DWV, DW</td>
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<tr>
<td>ISO76xx</td>
<td>8000</td>
<td>5700</td>
<td>8000</td>
<td>2121, 2828</td>
<td>1500, 2000</td>
<td>100</td>
<td>&gt;600</td>
<td>DW, DWW</td>
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