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What is a Digital Isolator? Digital Isolation Techniques and Uses

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Some circuits may be damaged if they try to talk to each other, and digital isolators are devices that make it possible for them to communicate without blowing each other up. In this Q&A, Rudye McGlothlin answers a few questions about these devices and techniques for balancing safety and performance.

What is driving the Industrial market to use isolation components in the first place?

There are many needs that drive the use of isolation components. System requirements for component protection, user safety, signal level shifting, and adherence to safety regulations are primary drivers. In all cases the isolation components add value to the system by enabling additional functionality and ensuring safe operation of the system.

When I add isolation devices, what affects does that have on my circuitry?

Improved performance in many cases and, in all cases, additional component safety is achieved. Isolation devices allow for multiple power domains to coexist and communicate, which means that sensitive circuits are protected from switching circuits. Modern, digital isolation allows for massive integration, which means that circuit component count can decrease. Performance, efficiency, size, and cost are all things that can be affected when adding isolation devices.

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So, what are my options when considering isolation components for my application?

Up until the last ten years, designers used optocouplers for their isolation needs, but digital isolation has come a long way since that time. Now, digital, CMOS-based isolation is the technology of choice for isolation tasks in the system.

What is the difference between an optocoupler and a digital isolation device?

Simply put, an optocoupler is a hybrid device that uses LED light to transmit data across an isolation barrier to a light detector. The LED turns on for logic High and off for logic Low. Optocouplers consume high levels of power, are prone to aging and temperature effects, and provide limited data rates, often below 1Mbps.

Digital isolation devices, on the other hand, were created to meet safety regulations while maximizing the benefits of modern CMOS technology. To do this, digital isolation devices use semiconductor process technology to create either transformers, or capacitors to transfer data instead of light. With this technology, performance and feature integration are both improved.

What is the best advice to give someone who is hesitant to make the switch from optocouplers to digital isolators?

Optocouplers, although incorporated in many designs, are based on outdated LED-technology that provides significant output variation over input current, temperature, and age. This reduces performance over the device's lifetime. Digital isolation components easily provide multichannel isolation solutions with a much smaller footprint, increases system reliability due to a lower failure rate, offer twice the electrical noise immunity, operate over a wider temperature range (-40oC to 125oC), and do not age or degrade over time. In general, the use of a high-frequency carrier instead of light enables low operating power and high-speed operation, which allows for precise timing specifications.

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I'm convinced, now what factors go into selecting a particular digital isolator for my application?

Feature set and isolation performance are both factors to consider with selecting a digital isolator. On the feature set side, consider the number of isolation channels and the channel configurations. Timing specifications, such as propagation delay, should be appropriate for your system. On the isolation performance side, it is important to gain an understanding of the isolation rating your system needs. Transient noise immunity, and electromagnetic emission profile are other considerations related to the isolation structure. With the isolation rating, there maybe be package options to consider given the system environment.

What is the biggest challenge a designer has after they've decided to make the switch?

The first challenge is to select the correct digital isolator for each application. As mentioned before, each component has its own specifications just as each application has particular needs. Once an appropriate device is identified and designed in, the system designer can proceed with their system evaluation in their typical fashion.

What safety requirements do I have to consider for my application?

Once you've nailed down your application's needs, you'll want to be sure that the devices meet appropriate Safety Standards as required by end safety agencies such as UL, CSA, VDE, and CQC. These safety agencies use their component safety standards to qualify and either specify a safety component's one-minute voltage withstand rating, which is typically 2.5 kVrms, 3.75kVrms, or 5 kVrms, or its life-time working voltage, which is typically between 125 Vrms to 1000 Vrms. All of component safety certificates from Skyworks can be requested online at skyworksinc.com.

What is the typical life expectancy of a digital isolator's isolation barrier?

This depends on the material used as well as its thickness. Standard materials used include polymer-based, polyimide-based, or SiO2-based insulators. In general, though, the life span of the barrier can easily be over 25 years.

What are some of the standard rated voltages I can expect to find?

Depending on the device manufacturer, common one-minute rated voltages are 1 kVrms, 2.5 kVrms, 3750 kVrms, or 5 kVrms. For surge protection, some devices can reach 10 kVpk.

What creepage and clearance do your products support?

The two most common creepage and clearance requirements that are required by end systems for basic and reinforced insulation needing up to 250Vrms working insulation are 3.2mm and 6.4 mm respectively. In general, narrow body SOIC packages from Skyworks support ~4mm of creepage/clearance and the wide body SOIC packages support ~8mm.

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