Application Brief

Understanding Functional Isolation

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Introduction

As end equipment's move toward the reduction of overall product size, design engineers seek out small package options that can reduce board size without unnecessary over-design. The design used to isolate a system, for example, can require various certifications and isolation specifications, but not all applications share the same requirements. In the case of a system requiring isolation below 200 V, this can allow simpler forms of isolation with less or no certification, creepage, or clearance requirements. To aid in such applications, TI now offers a new family of digital isolators, the ISO65xx, which features functional isolation available in small packages.

What is functional isolation? There are varying levels or ratings of isolation, each with an additional layer of protection. Functional, basic, and reinforced isolation refer to the insulation rating level assigned to an electrical system, as listed in Table 1. Functional isolation refers to the minimum amount of isolation required for a system to function properly, without protecting against electrical shock. One example application for functional isolation is breaking a ground loop that can introduce a noise voltage that can cause errors in the data communication of a system. TI's new functional isolator (ISO6521) offers a lower level of protection while providing galvanic isolation between conductive parts and breaking potential ground loops.

Table 1. Isolation Rating Overview

Insulation Grade	Certification Description
Functional	Insulation needed for the correct operation of the equipment.
Basic	Insulation that provides basic protection against electric shock.
Supplementary	Independent insulation applied in addition to basic insulation to maintain protection against electric shock in the event of a failure of the basic insulation.
Double	Insulation comprising both basic and supplementary insulation.
Reinforced	A single insulation system which provides a degree of protection against electric shock equivalent to double insulation under the conditions specified by the standard.

Isolation is required in modern electrical systems for a variety of reasons. Some examples include protecting human operators and preventing damage to expensive processors in high voltage systems, breaking the ground loop in communication networks, and communicating to high-side devices in motor-drive or power-converter system. The requirements surrounding isolation ratings are backed by various standards committees such as IEC, UL, TUV, CQC, VDE, and so on through rigorous qualification tests to make sure the isolation device can be used in high-voltage systems where there is risk of electric shock. Though these qualifications are required for some systems, there are many applications where functional isolation is sufficient and isolation certifications are not required.

Certain applications demand isolation, but not for safety reasons. One example of an application where functional isolation is sufficient is controlling Gallium Nitride (GaN) FETs. Digital isolators enable level shifting to control signals while withstanding fast switching voltages across the barrier. In these types of applications, the isolators are used to maintain the proper functionality of the system. Functional isolators stand out as the most space-optimizing designs for this implementation.

This family of digital isolators is designed to provide a lower cost, small footprint design for applications that only require functional isolation (less than 200 V_{RMS}) and do not have a requirement for a certified digital isolator. The ISO65xx devices are the smallest digital isolators in the industry. For example, these devices can be used for compact designs that do not have high creepage or clearance requirements. See creepage and clearance values for reinforced, basic, and functional isolation in Table 2. The small footprint of the ISO6521 provides an 80% package reduction when compared to the basic isolation package designs. Table 2 lists and compares the sizes of TI's digital isolator packages.

Table 2. Creepage and Clearance

	Reinforced Isolation	Basic Isolation	Functional Isolation
Creepage	4 mm, 8 mm, 14.5 mm	3.7 mm, 4 mm, 8 mm	2.2 mm
Clearance	4 mm, 8 mm, 14.5 mm	3.7 mm, 4 mm, 8 mm	2.2 mm

Table 3. Packaging

Insulation Grade	Packaging		
Reinforced			
Basic			
Functional	 (1)		

(1) DFN package (ISO6521)

When using isolators, understand the safety-limiting values and make decisions in the design to meet these values. This application brief serves as an introduction to some of the key applications and considerations of functional isolation. 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, see the related technical documents listed in Isolation Technical Documents. Video series covering both these and similar isolation topics can be found on TI's Isolation Overview page and in the Precision Labs training center.

Isolation Technical Documents

- *Why are Digital Isolators Certified to Meet Electrical Equipment Standards?*
- *Distance Through Insulation: How Digital Isolators Meet Certification Requirements*
- *Considerations for Selecting Digital Isolators*
- *Top 9 design questions about digital isolators*
- *Isolating SPI Signals*
- *Isolating UART Signals*
- *Part Recommendations and Technical Training [FAQ]*
- *Top Isolation Question - All Time [FAQ]*

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