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DIGITAL ISOLATION

A digital isolator passes bits across an insulating barrier with no shared ground, for safety or to break a noise loop. How it works and how to isolate a bus.

ONE THOUSAND DRONES ENGINEERING TEAM · VERIFIED 2026-07

Sometimes two parts of a system have to trade digital signals without sharing a ground wire, for safety or to stop a noise loop. A digital isolator does exactly that: it carries the bits across an insulating barrier, so the two sides pass data with no direct electrical connection between them.

WHY ISOLATE AT ALL

There are two reasons. Safety: keep a person, or a delicate circuit, on one side clear of any fault current on the other, which matters whenever mains power or a human body is in the loop. Noise: when two grounds sit at slightly different voltages, current flows in the ground itself, a ground loop, and isolation breaks that loop by cutting the shared connection.

- Texas Instruments. Digital Isolator Design Guide (SLLA284): what isolation is and how it works. ti.com

HOW IT CROSSES THE BARRIER

An isolator has a transmitter on one side, a receiver on the other, and an insulating barrier between them that blocks direct current while letting the signal across. The barrier is often a tiny capacitor or transformer built into the chip; an older optocoupler uses light across a gap. What never crosses is a direct electrical or ground connection.

DEEP DIVE · ISOLATORS VS OPTOCOUPLERS, AND ISOLATING THE POWER

An optocoupler sends the signal as light: an LED on one side, a photo-transistor on the other, with an air or resin gap between them. It works, but it is slow and it ages as the LED dims. A modern digital isolator sends the signal across a capacitive or magnetic barrier instead, which is faster, more stable, and packs several channels into one chip (TI SLLA284). Isolating the signal is only half the job. The far side still needs power, so a fully isolated link adds an isolated DC-DC converter to carry energy across the same barrier, again with no shared ground.

ISOLATING A WHOLE BUS

To isolate a bus like SPI or UART, you pass each of its signals through its own isolator channel, matching the direction of each line. A four-wire SPI link needs four channels routed the right way. The controller then talks to the peripheral exactly as before, with the barrier invisible in the middle.

A BUS CROSSING AN ISOLATION BARRIER: TWO SEPARATE GROUNDS, AND NO DIRECT ELECTRICAL CONNECTION.

A One Thousand Drones isolated bridge board does this on purpose: a full SPI bus crosses a digital isolator so the sensor side and the computer side never share a ground, which is what keeps a person safe when the sensor sits on skin.

CHECKPOINT

1. What does a digital isolator NOT carry across its barrier?

a. The data bits

b. A direct electrical or ground connection

c. The clock signal

ANSWER · B

The point of the barrier is that no direct electrical or ground path crosses it; the bits still get through.

2. One reason to isolate two parts of a board is which of these?

a. To break a ground loop and cut noise

b. To share a single ground

c. To raise the bus speed

ANSWER · A

Cutting the shared ground breaks the loop current, and it also protects a person from fault current on the other side.

3. To isolate a four-wire SPI bus, you need what?

a. One isolator channel for the whole bus

b. No isolation, SPI is already isolated

c. A channel for each of the four signals

ANSWER · C

Each SPI line crosses on its own channel, routed to match that line's direction.

- See it on a real board: the isolated SPI-bridge build
- Prerequisite: grounds and power rails
- Next: debugging a bus