Technical Article

Why Capacitive Isolation: a Vital Building Block for Sensors in Smart Cities

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Other Parts Discussed in Post: ISO5852S UCC5390 UCC21220 UCC21521 ISO5452

With urbanization growing in every corner of the globe, the answer to this growth is smart cities. Building a smart city involves a paradigm shift in infrastructure, with sophisticated networks and controls for communications among key modules such as, community-based power grids, utilities, and weather monitoring.

The backbone for infrastructure networking is sensor technology. A sensor is a device, module or subsystem that detects events or changes in its environment and sends that information to other electronics such as a computer processor. You can imagine this sensor being connected to the actual system that could be an inverter from a rooftop solar that is part of a community-based grid; a heating, ventilation and air conditioning (HVAC) system; or an automation system for home or commercial buildings, automated laundromats or car-washing systems.

What is common among these systems? All these systems operate at high voltages and draw or supply a lot of current. The sensor data has to transmit to the controller side (the device translating the measurement for human readout). This controller could also be a human machine interface (HMI) such as a touch screen for monitoring the energy output of a solar inverter in your home. Therefore, any of the high voltages on the sensor side – if exposed to the controller side – could not only damage the controller, but also potentially act as a hazard to humans. The same risk is possible in a factory environment that heavily involves automation, process control and testing, or in medical equipment that comes into direct contact with patients.

Why Isolate

To prevent high voltage hazards, you need an isolator that acts as a barrier, blocking the common-mode voltage while still allowing signal voltages between the sensor and the controller. An isolator enables a robust overall system in harsh environments that involve high voltages and high power.

Another key criterion for smart cities is fast data rates. This can be realized only with telecom infrastructure that needs isolation due to the high power involved in transmitting data and signals. For example, citizens in a smart city will expect a drone to quickly deliver takeout food that they've ordered online. This expectation requires ultra-fast communications that need a telecommunications infrastructure transmitting data to mobile devices via base-stations and cellphone towers blasting data at high power levels.

How to Isolate

Galvanic isolation is a technique to isolate functional sections of electrical systems to prevent direct current or uncontrolled transient current flowing between them. Data and energy still need to get through a galvanic isolation barrier, however.

A galvanic isolation barrier is based on optical, magnetic or capacitive isolation technologies, as illustrated in Figure 1.

The medium of the barrier is different for each of the three technologies, but the end goal is the same. Optical isolation is the oldest among the three technologies and is simple to use. Optical technology is light-emitting diode (LED)-based, where the light transmitted by the diode transmits data. However, optical isolation suffers from low speeds (as it takes time for the LED to turn on), high power consumption, and performance degradation over its lifetime. It is difficult to reduce the size of the isolated devices (isolators, isolated gate drivers) due to the physical size limitation of the LED

In magnetic and capacitive isolation, data transmits through the barrier digitally. Magnetic isolation, also called inductive isolation, pulses current through the isolation barrier at speeds as high as 100Mbps. However, the power consumption increases along with the data rate. Magnetic isolation is also sensitive to electromagnetic interference, and high magnetic fields are strong and prevalent in environments such as HVAC systems and factory automation that involves motors.

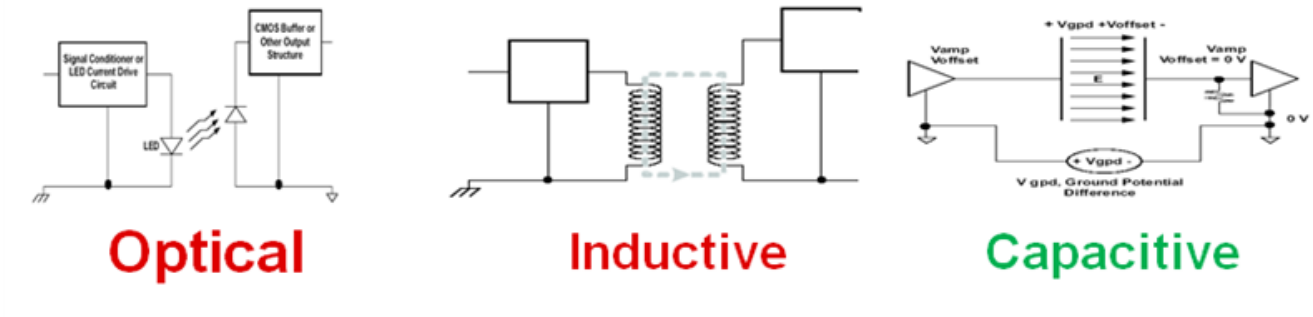

Figure 1. Isolation Technologies

Capacitive Isolation Is a Better Solution

Like magnetic isolation, capacitive isolation has digital circuits for encoding and decoding incoming AC signals (capacitors cannot pass DC signals) through the isolation barrier. A capacitive isolator's inability to pass DC signals makes them inherently the right choice for isolation. Capacitive isolators are not susceptible to magnetic noise, while maintaining high data rates and keeping power consumption low.

You can see the value of capacitive isolation over optical and magnetic isolation technologies across harsh environments and applications. It is particularly exciting to see the rapid growth in a smart city infrastructure, with isolation as an integral building block.

TI offers several isolated gate drivers for smart city infrastructure design, including the ISO5452, ISO5852S, UCC21521, UCC21220 and UCC5390. To browse all of our isolated gate driver products, please click here.

Additional Resources

- To learn more about isolation, read, "Why is the cloud isolated?"
- Watch the video, "What is an isolated gate driver?," to learn more about the value of isolation.
- Check out products based on capacitive isolation such as digital isolators, transceivers, gate drivers and isolated amplifiers.

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