Isolated SPI Communication Made Easy

Thomas Brand, Field Applications Engineer.

Monitoring and controlling diverse systems requires direct access to the sensors and actuators, preferably from a central location and by means of a standardized communication method such as the serial peripheral interface (SPI). SPI is a synchronous serial data bus that facilitates data exchange between the devices and the central control unit over long distances. The communication takes place according to the master-slave principle and is full duplex. The SPI interface is made up of three lines: SDI, SDO, and SCK.

While the SPI communication method is generally suitable for distances up to approximately 10 m, to bridge longer distances, a repeater is often needed because of attenuation due to the increased line resistance of long cables. These signals must be amplified again. This also allows a larger signal-to-noise ratio (SNR) to be achieved at the same time. A device such as the isoSPI communication interface IC LTC6820 from Analog Devices, Inc. (ADI) can be used to read the signals.

Thanks to its innovative design, SPI communication can be maximized relatively easily by adding galvanic isolation using a twisted pair cable and appropriate transformers.

Because of harsh conditions frequently found in industrial environments, galvanically isolated communication components are often required to protect users from dangerous voltages as well as to ensure system reliability. Furthermore, isolation enables exact measurements despite occasional common-mode voltages. The isolation barrier is thereby key in separating the input stage from the rest of the system while still enabling a connection.

Figure 1 shows how all slaves are controlled by a single master. Masters and slaves can be microcontrollers or ADCs with an SPI interface to which the sensors, or microcontrollers, are usually connected. The LTC6820 thus enables bidirectional data transmission required for SPI communication between two completely galvanically isolated devices. It encodes the SPI signals from the master into differential signals with up to 1 Mbps, which are then transmitted through the galvanic isolation barrier and the twisted pair cables. At the opposite end of the cable, the differential signals are received again by an LTC6820 and decoded into SPI signals, which are then routed to the slave bus. The LTC6820 additionally supplies the required currents needed to drive the signals across the isolation barrier. Through an external resistor, these currents can be adapted to system requirements such as desired cable length, SNR, and immunity.

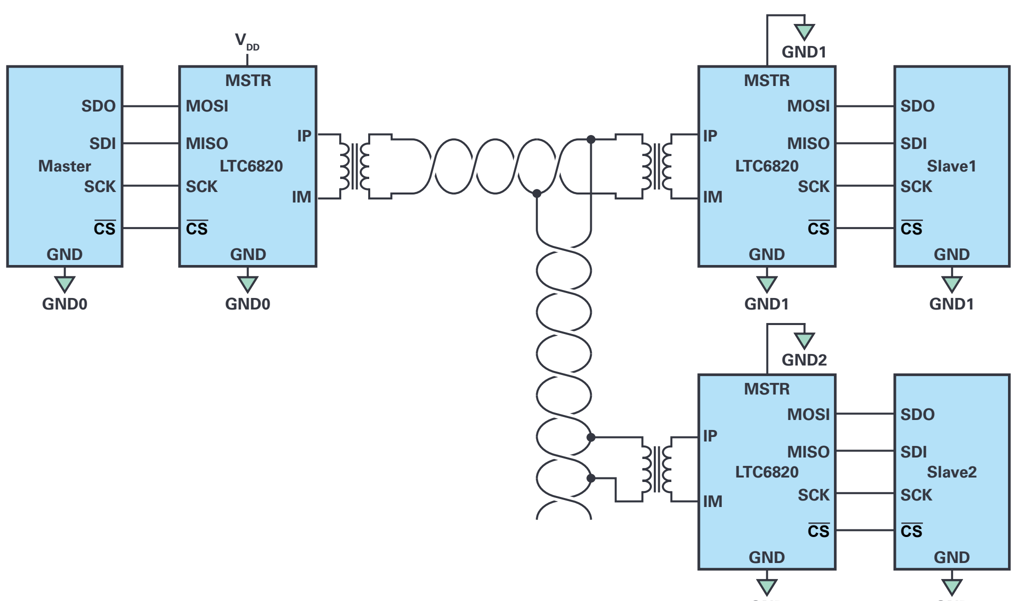

Figure 1. Isolated SPI interface for control of multiple boards (slaves) via a common master.

However, note that despite the use of SPI repeaters, the data rate is limited and dependent on cable length. For example, the data rate for the circuit shown in Figure 1 with a 100 m CAT5 cable is only about 0.5 Mbps, which is half of the maximum possible value of 1 Mbps the LTC6820 could provide (see Figure 2).

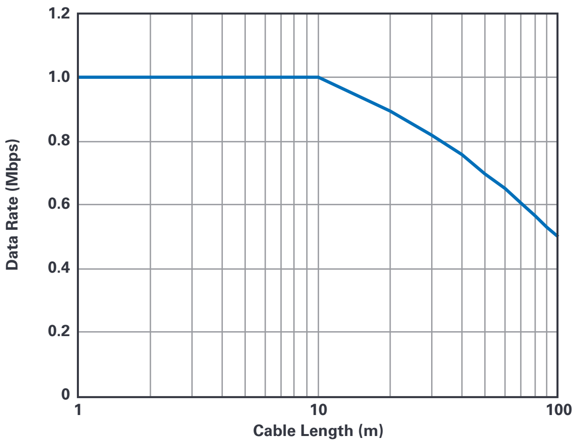

Figure 2. Data rate in relation to cable length with use of a CAT5 cable.

By using isoSPI communication ICs, the complexity of circuits for isolated transmission of SPI communication signals over long distances can be simplified, as a significant number of components typically required in conventional circuits can be omitted. In addition, with the LTC6820, distances of up to 100 m, which are not rare in industrial settings, can be realized. The LTC6820 makes it easy to implement daisy-chained applications in which one master controls several slaves. Furthermore, it is an ideal device for battery monitoring systems as they require galvanically isolated communication due to their partially explosive charge units (for example, lithium-ion batteries).

About the Author

Thomas Brand began his career at Analog Devices in Munich in October 2015 as part of his master's thesis. From May 2016 to January 2017, he was part of a trainee program for field applications engineers at Analog Devices. In February 2017, he moved into the role as field applications engineer. Within this role, he is mainly responsible for large industrial customers. Furthermore, he specializes in the subject area of industrial Ethernet and supports appropriate matters in central Europe.

He studied electrical engineering at the University of Cooperative Education in Mosbach before completing his postgraduate studies in international sales with a master's degree at the University of Applied Sciences in Constance. He can be reached at *thomas.brand@analog.com*.

TA21420-7/19