IsoLoop® magnetic couplers replace opto-couplers in industrial data communication.

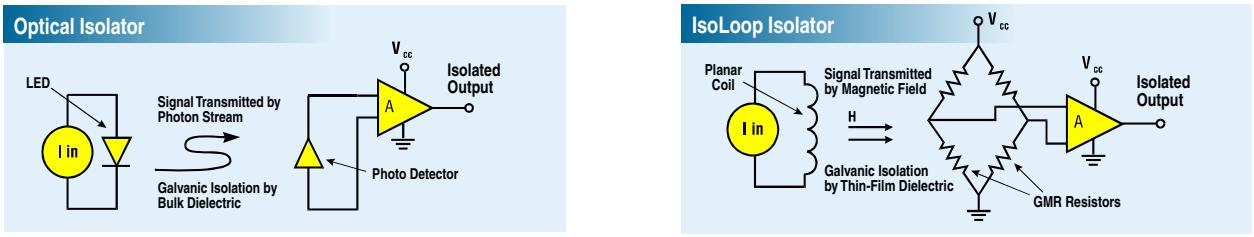
In many industrial control systems getting valuable data to its destination is often a headache. Factors such as ground loops, noise, temperature extremes, and speed bottlenecks can adversely affect data transmission.

Opto-isolators have been until recently the obvious solution, but their bulk, slow speed, high power consumption, and limited temperature range now presents serious shortcomings for the designer.

A new generation of solid-state couplers IsoLoop® magnetic couplers, has been introduced which overcomes many opto-coupler limitations.

IsoLoop® magnetic couplers

Opto-couplers transmit signals by light through a bulk dielectric that provides isolation (Figure 1a). The original spintronic couplers transmit signals via a magnetic field across a thin-film dielectric that provides the galvanic isolation (Figure 1a). New current-mode spintronic couplers use a precision thin-film coil as the direct input (Figure 1b).



Figures 1a and 1b: Optical couplers compared to magnetic couplers.

IsoLoop® coupler technology

At the heart of these couplers are giant magnetoresistance (GMR) resistors. The technology is also used in precision magnetic field sensors and ultra high-density hard-disk drives. The resistors exhibit a change in resistance when their electrons change spin orientation when subjected to a magnetic field.

A polymer dielectric layer provides several thousand volts of isolation between the input coil and the Wheatstone bridge made up of GMR resistors. A magnetic field proportional to the input current signal is generated by the coil winding. The resulting magnetic field flips the spin of electrons in the GMR resistors, changing their resistance.

The bridge output is fed to a comparator, which drives either a CMOS output stage or an open drain transistor output. Ground potential variations are common to both sides of the input coil, so they do not generate an input coil current. Thus ground potential variations are rejected yielding a very high common-mode rejection ratio (CMRR) and true galvanic isolation.

Advantages of IsoLoop® coupler technology

The advantages of IsoLoop® devices compared to opto-couplers include high speed, small footprint, excellent noise immunity, and unlimited life.

High Speed— IsoLoop® devices are faster than the fastest opto-couplers, and have correspondingly faster rise, fall, and propagation times. Faster rise and fall times also reduce power consumption in the device and system by minimizing time in active regions.

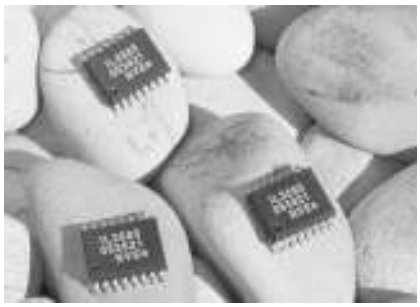
High Channel Density—Unlike opto-couplers, which are discrete devices, and transformers, which are inherently bulky, IsoLoop® devices are truly monolithic and can be fabricated in less than 1 mm^2 of die area per channel. This allows multi-channel devices in an 8-pin MSOP packages. Less board real estate means lower costs and more room for other functions. Furthermore, because of their small die size, Isoloop® devices cost no more than high-performance opto-couplers.

Excellent Noise immunity— IsoLoop® devices provide transient immunity up to 25 kV/µs, compared to 10 kV/µs for opto-couplers. This is especially important in harsh industrial and process control environments.

Unlimited Life—Opto-couplers degrade over time and have limited life, especially when used at high temperatures. IsoLoop® devices have no such wear-out mechanism; they last indefinitely with no performance degradation over time.

Integrated isolated transceivers
IsoLoop® devices can be combined with conventional integrated circuits to create single-package isolated transceivers. RS 485, RS 422, and Profibus isolated transceivers are available in single 16-pin SOIC packages. These devices support data rates as high as 40Mbps.

These devices represent not only a considerable speed advantage over an opto isolator based circuit, but also a considerable reduction in PCB space and number of components used.



RS485 single chip isolated tranceivers

Figure 1 shows a typical high-speed two-node RS-485 network with transmission line terminations of 110 Ω and failsafe biasing resistors to ensure the R output is high when no drivers are active. This circuit has many great features: up to 32 devices can be attached to the network; it can drive up to 1200 metres of twisted pair cable; and differential signals enable transient immunity of as much as 30 kV/µs. All of this comes with 2.5 kVrms input-to-output isolation.

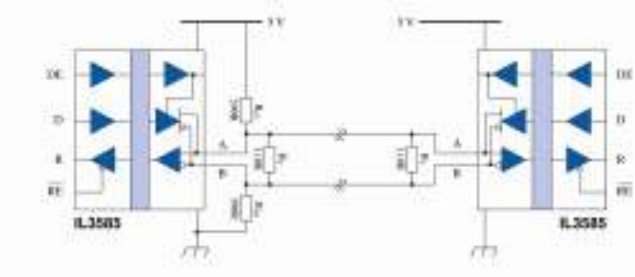


Figure 1

Unidirectional communication

The circuit in figure 1 is an excellent solution for transceiver applications. For unidirectional or “listen only” mode however only one third of the isolated transceiver capability is used. In this case discrete IsoLoop® devices still offer a cost effective solution.

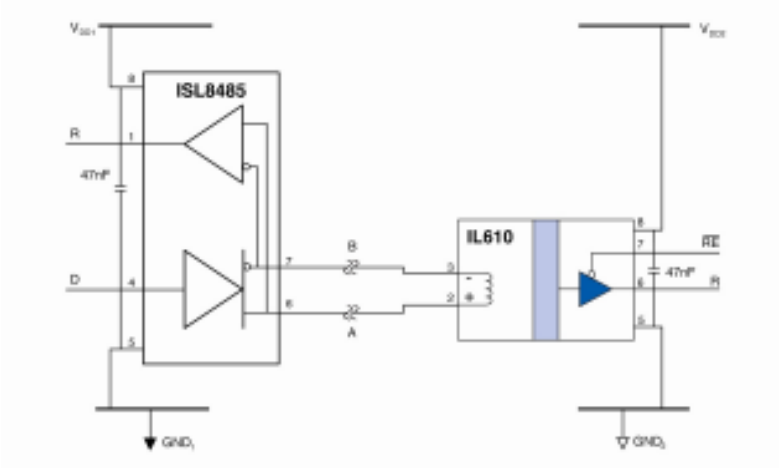


Figure 2

The first thing to note about the circuit in Figure 2 is the absence of external resistors. The IL610 single channel IsoLoop® isolator is guaranteed to switch to the high state when the coil input current is less than 500 µA. When the RS-485 bus is in high-impedance mode, the current through the coil approaches zero so the output will automatically go high, eliminating the need for external failsafe biasing and saving the 7 mA of bias current that would normally flow through these resistors.

In addition, there is no need for line termination resistors in most IL610 line receiver applications below a data rate of 10 Mbps. In a conventional RS-485 network pair, the bus impedance is the parallel combination of the two receivers plus the connecting cable. In the IL610 example, the line resistance is dictated by the IL610's low resistance coil. The coil resistance is approximately 85Ω, so signal reflections are close to their minimum value without external terminators. If the bus length is long and data rates are high, line terminations may still be needed to reduce reflections to an absolute minimum, but the IL610 will function well with data rates as high as 20 Mbps and twisted-pair cable lengths of 30M without terminations which is comparable to the performance of any conventional isolated transceiver.

The passive input of the IL610 also means that one layer of DC/DC converters is not needed.

Simple low cost RS422 repeater

A simple low cost repeater network can be made with a RS-422 transmitter /receiver pair and an IL610. Repeaters can extend the useful cable length and node count indefinitely, provided the network controller can tolerate the additional propagation delays.

Figure 3 shows an example of an RS-422 repeater network. In this mode, the IL610 can be used in un-terminated mode for maximum signal integrity, or an in line current limit resistor may used to reduce power dissipation.

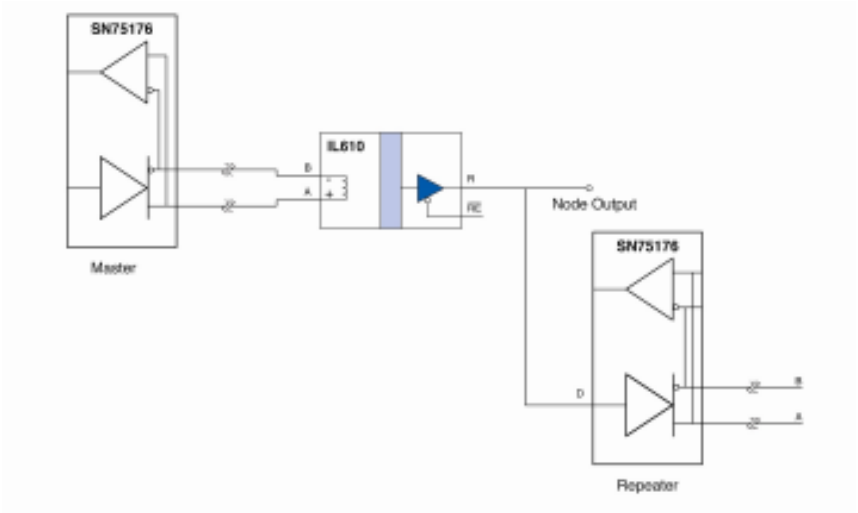


Figure 3 .

IsoLoop® devices are available via Rhopoint Components www.rhopointcomponents.com