By using the right signal interface instruments, in the right ways, potential problems can be easily avoided well before they boil over... quite literally in some cases.

Whether you call them signal isolators, signal converters or signal interfaces, these useful process instruments solve important ground loop and signal conversion challenges everyday. Just as important, they are called upon to do a whole lot more. They can be used to share, split, boost, protect, step down, linearize and even digitize process signals. This guide will tell you many of the important ways signal isolators, converters and interfaces can be used, and what to look for when specifying one.

Signal Isolation

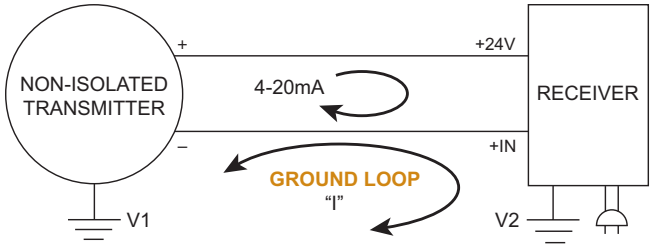
The need for signal isolation began to flourish in the 1960s and continues today. Electronic transmitters were quickly replacing their pneumatic predecessors because of cost, installation, maintenance and performance advantages. However, it was soon discovered that when 4-20mA (or other DC) signal wires have paths to ground at both ends of the loop, problems are likely to occur.

The loop in question may be as simple as a differential pressure (DP) transmitter sending a 4-20mA measurement to a receiver, such as a recorder. But when the voltages (V) at the two ground points are different, a circulating, closed current (I) path is formed by the copper wires used for the 4-20mA signal and the ground (Figure 1). When this happens, an additional and unpredictable amount of current is introduced into the loop, which distorts the true measurement. This current path, known as a ground loop, is a very common source of signal inaccuracies.

A ground loop forms when three conditions are present:

1. There are two grounds;
2. The grounds are at different potentials;
3. There is a galvanic path between the grounds.

Figure 1. *A ground loop forms when the voltages at two ground points in a loop are at different potentials.*

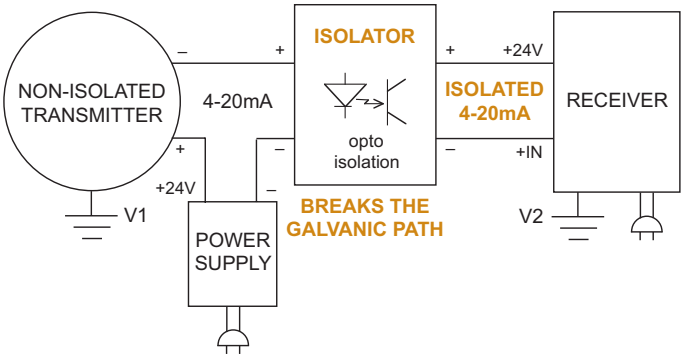


In addition to simple signal isolation and conversion, signal interface instruments can be used to share, split, boost, protect, step down, linearize and even digitize process signals.

To remove the ground loop, any one of these three conditions must be eliminated. The challenge is, the first and second conditions are not plausible candidates for elimination. Why? Because you cannot always control the number of grounds, and it is often impossible to just "lift" a ground.

The ground may be required for the safe operation of an electronic device. It's also possible that the ground exists because the instrument is in physical contact with the process which, in turn, is in physical contact with the ground. From a practical standpoint, you cannot reach into the earth and regulate the voltage at these permanent ground points.

Figure 2. *A signal isolator "breaks" the galvanic path between two grounds.*



So what can be done? Use a signal isolator to "break" the galvanic path between the two grounds (Figure 2). When the conductive path between the differential voltages is broken, a current cannot form. So even though there are two grounds and different voltages at each ground, there is no current flow. The ground loop has been eliminated.

Breaking the Galvanic Path

The first and foremost duty of an isolator is to break the galvanic path between circuits that are tied or "grounded" to different potentials. A galvanic path is defined as a path in which there is a direct electrical connection between two or more electrical circuits that allow current to flow. Breaking this galvanic path can be accomplished by any number of means including electromagnetic, optic, capacitive, inductive and even acoustic methods.

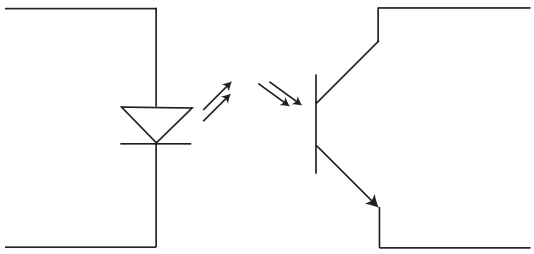
With most industrial measuring equipment, the two prevalent methods chosen for galvanic isolation are optical and transformer.

Optical Isolation—Optical isolation (Figure 3) uses light to transfer a signal between elements of a circuit. The opto-coupler or opto-isolator is usually self-contained in a small compact module that can be easily mounted on a circuit board.

An optical isolation circuit is comprised of two basic parts: a light source (usually a LED- Light Emitting Diode, acting as the transmitter) and a photo-sensitive detector (usually a phototransistor, acting as the receiver). The output signal of the opto-coupler is proportional to the light intensity of the source. The insulating air gap between the LED and the phototransistor serves as the galvanic separation between the circuits, thus providing the desired isolation between two circuits at different potentials.

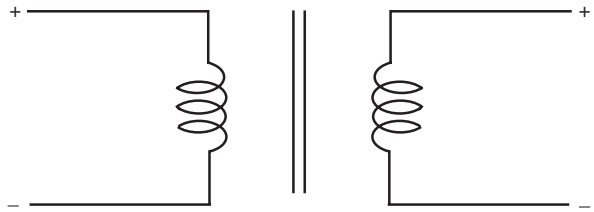
Optical isolation has better common-mode noise rejection, is usually seen in digital circuits, is not frequency sensitive, is smaller, and can sometimes provide higher levels of isolation than transformer isolation.

Figure 3. *Galvanic Signal Isolation via an Opto-Coupler.*



Transformer Isolation—Transformer isolation (Figure 4), often referred to as electromagnetic isolation, uses a transformer to electromagnetically couple the desired signal across an air gap or non-conductive isolation gap. The electromagnetic field intensity is proportional to the input signal applied to the transformer. Transformers are very efficient and fast at transferring AC (alternating current) signals. Since many process control signals are DC, they must be electrically "chopped" into an AC signal so they can pass across the transformer. Once passed, they have to be rectified and amplified back into the desired DC signal output.

Figure 4. *Galvanic Signal Isolation via a Transformer.*



Two-Way vs. Three-Way Isolation

Two common terms used within the process control industry with respect to isolation are two-way and three-way isolation. Isolation specifications often detail what the isolation levels are from input to output. This is often referred to as two-way (input-to-output) isolation, and is the appropriate specification for a 2-wire transmitter since it is powered from either its input or output terminals.

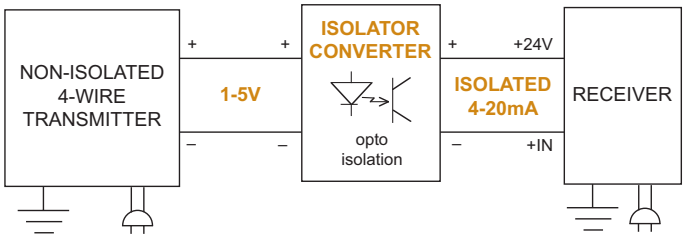
However, many manufacturers fail to mention or outline the isolation details when their isolators are 4-wire (line/mains-powered) and require 24Vdc, 110Vac or 220Vac to operate its circuits. In these instances, you want to ensure that you have an isolator that has full three-way isolation.

Three-way isolation is defined as input-to-output, power-to-input and power-to-output isolation. If the isolator is powered by a DC supply, many manufacturers use common signal wires between the output and the power input. In these situations you could have problems with common mode noise, or a failing switching power supply that could create unwanted output signal errors.

Signal Conversion

Signal converters are used to get legacy signal types, such as 10-50mA, converted to a standard 4-20mA or some other signal type that is compatible with a particular receiving device (Figure 5).

Figure 5. *Signal converters convert one signal type to another that is compatible with a particular receiving device.*



Fixed Range or Configurable Signal Converters?

There are three approaches to performing signal conversion:

1. One is to use fixed-ranged signal converters designed and built specifically for the conversion need, such as 0-10V in and 4-20mA out. The advantage is simplicity, as there is nothing to configure. Just mount and wire the device, and you're up and running. The disadvantage is lack of flexibility. If the application changes, the fixed-range signal converter is not easily, or simply can't, be modified to accommodate signal types other than what was originally specified.

2. Another solution is to use a signal converter that has switches or jumpers to select or re-range the input and/or output. There's a little more work to make the instrument suitable to the application, but a configurable signal interface is more flexible in addressing multiple applications or changing signal conversion needs. Fewer instruments need to be kept in stock.

3. The third approach is to use a signal converter that is PC-configurable to provide similar application flexibility, plus some performance enhancements. Usually the rangeability has more resolution, and there are no potentiometers, jumpers or switches that can be easily changed without authorization.

Step Down Dangerous AC Signals

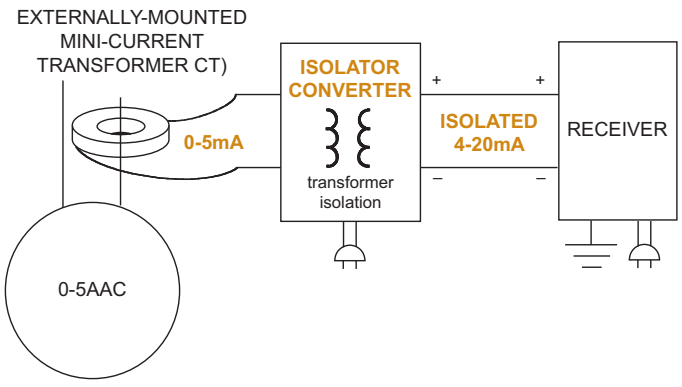
Normally when you think of isolators, you think of solving a problem at the instrument control level layer, typically dealing with DC signals. However, very common applications use a signal converter to monitor, trend or alarm on AC signals. With preventative maintenance budgets shrinking, companies are closely monitoring expensive and critical equipment purchases. Pumps, motors and fans are quick to fall into this category.

Since much of this equipment is powered with AC voltage, and high levels of current, a current transformer (CT) is installed. The role of a CT is two-fold. First, a CT is used to step down the current to a level that can easily be monitored. Second, safety is always a large concern. No one, especially a plant safety manager, wants technicians used to working with 24Vdc grabbing hold of 5 amps AC.

A signal converter with an AC current input is utilized in these situations to convert and isolate a "high level" AC signal to a lower level 4-20mA DC signal (Figure 6). Now the secondary of the CT, which is most always 0-5 amps, can be directly wired into the input of the signal converter. As an added measure of protection, some manufacturers offer an externally-mounted CT option that makes use of a "mini-CT" to step the 0-5 amps AC down to 0-5mA AC. This signal interface with the much lower AC signal is now very safe to wire and handle.

Moore Industries Instrument Recommendations:
ECT 2-Wire (Output Loop-Powered) or
ECT 4-Wire (Line/Mains-Powered) Signal Isolator/Converter with 0-5AAC input and -EM (Externally-Mounted CT) Option

Figure 6. *An externally-mounted mini-CT steps down a dangerous 0-5 amps AC to a safe 0-5mA AC signal.*



Digital Signal Conversion

A new emerging method of converting signals ignores all the previous rules laid down by analog isolators and converters. This new "digital signal conversion" is becoming especially popular in locations where power is sparse and wires are few. A common application deals with digitally converting or "mapping" HART® digital signals to the popular MODBUS RTU serial communications protocol (Figure 7).

Many PLCs and DCSs, new and old, accept MODBUS RTU, so this becomes a quick and efficient way to get HART data into a control system that doesn't natively accept HART. HART devices and HART signals contain multiple pieces of data per instrument. Therefore, a HART-to-MODBUS converter can be an effective tool when additional process variable and diagnostic data from field instruments is desired.

On the data acquisition side, you usually find an RTU or SCADA system that supports MODBUS RTU. A HART-to-MODBUS converter (Figure 7), represents a new trend in digital signal conversion. Not only does the converter gather all of the HART data from the HART transmitters and convert it to MODBUS, but it also powers the HART bus using its 9-24Vdc power input. This allows any MODBUS RTU enabled RTU or SCADA system to monitor any HART variable from any of the up to 16 HART field devices on a multidrop HART network.

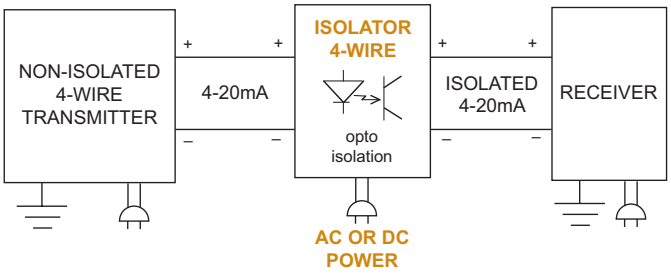
Moore Industries Instrument Recommendations:
HCS HART-to MODBUS RTU Converter
HIM Smart HART Loop Interface and Monitor

Powering an Isolator/Converter

A signal isolator/converter can be 4-wire (line/mains-powered) or 2-wire (loop-powered). Selecting the correct type of isolator and power configuration depends on the application.

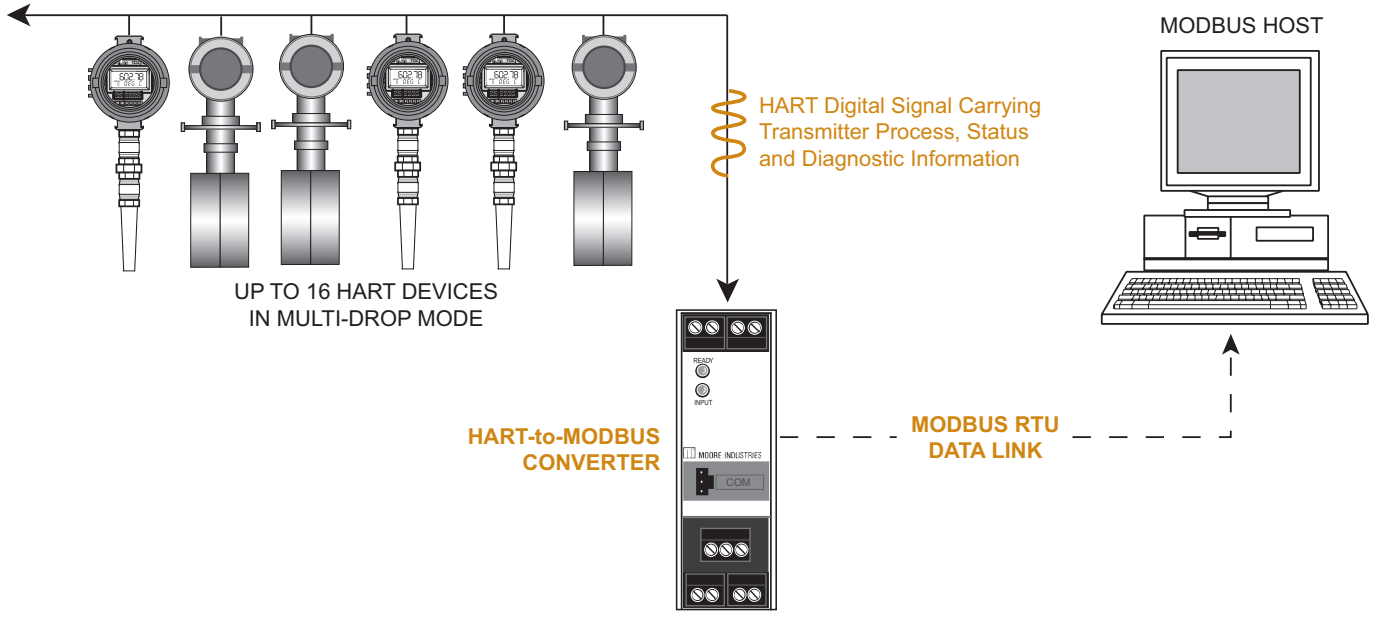
4-Wire (Line/Mains-Powered) Signal Isolators—A 4-wire isolator/converter (Figure 8) is used when the instrument output has to be voltage (i.e., 0-10V) or zero-based (i.e., 0-20mA) or bipolar (i.e., –10V to +10V). A 4-wire isolator usually sources its current output, and typically has a drive capacity of around 1000 to 1200 ohms. Some isolators will drive up to 1800 ohms.

Figure 8. *4-Wire (Line/Mains-Powered) Signal Isolator/Converter.*



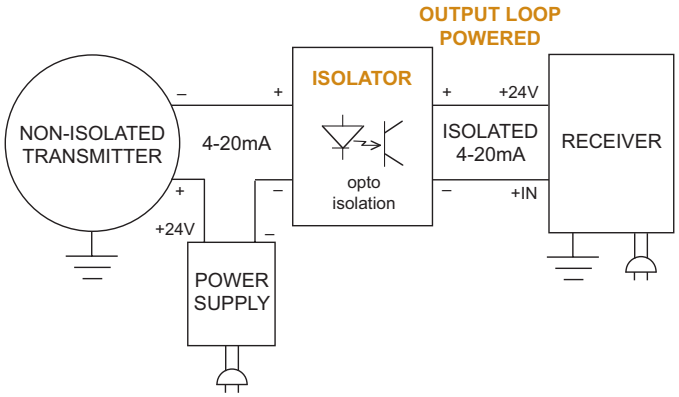
2-Wire (Loop-Powered) Signal Isolators—A 2-wire isolator/converter typically costs less to install than a 4-wire unit because power wires don't have to be run to the unit. Loop-powered instruments can be powered from the loop either on their output side or their input side.

Figure 7. *Digital signal conversion is becoming a popular strategy where power is sparse and wires are few.*



Isolators/converters that are output loop-powered are powered just like any other 2-wire dP, pressure or temperature transmitter (Figure 9). The output always has to be some form of 4-20mA, but signal conversion (such as 1-5V to 4-20mA) and split ranging, like a 4-12mA range, can still be performed. When powered with 24V, these isolators typically drive into 600 ohms.

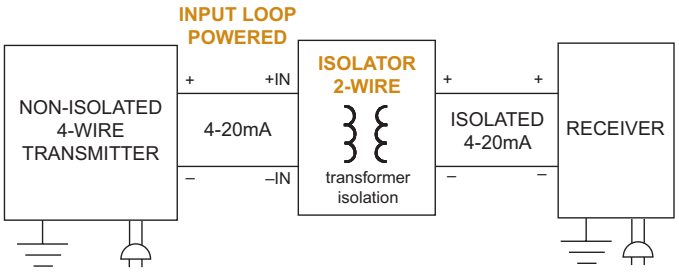
Figure 9. *2-Wire, Output Loop-Powered Signal Isolator/Converter.*



A 2-wire, input loop-powered isolator is a great solution when applied correctly. The beauty of this isolator is its overall simplicity, with integration into the loop nearly seamless. For example, look at Figure 10 and imagine that the isolator was not originally implemented. Soon after startup, it was discovered that isolation was required for the process. The good news is that to install this type of isolator, you just break your loop where convenient and insert the isolator. A simple solution, wiring changes and installation costs are minimal.

However, its also simple to misapply a input loop-powered isolator. Certain "rules" must be followed. An input loop-powered isolator is powered from the 4-wire transmitter in the field. The transmitter's 4-20mA output and its compliance voltage must power the isolator electronics and the isolator's output. Because loop-power is limited, the isolator's output load is held to 250 ohms. The receiver's input impedance can be anywhere from 0-250 ohms, and it should be a fixed load. In addition, there can be no voltage on the output of the isolator.

Figure 10. *2-Wire, Input Loop-Powered Signal Isolator/Converter.*



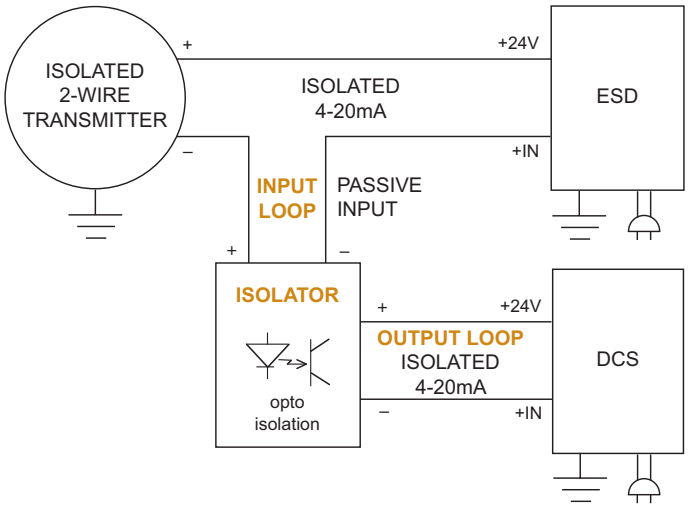
To run the isolator electronics, the isolator consumes 5.5V from the loop or, to put it another way, the isolator itself looks like a 275 ohm load on the transmitter. To calculate the total burden on the transmitter, you have to add the isolator load to the 275 ohm load. The total load could then be as high as 525 ohms plus wire resistance. That is not usually a challenge for a 4-wire transmitter, but it can be for a loop-powered transmitter limited to 600 ohms.

Beyond the Basics

Area Isolation (Divert and Protect Signals)

It is quite commonplace to share process signals between two different systems. It could be two control systems, one Emergency Shutdown System (ESD) and one control system, one DCS and a data acquisition system, and other numerous combinations. Generally it is unacceptable to create one series loop between the transmitter and two systems. Why? You would not want a series loop if you had to disconnect the input at one system for maintenance purposes, because both systems would lose the signal. One solution to sharing a variable with two systems is to use a single signal isolator (Figure 11). One system is declared the primary system, and it powers the transmitter. In Figure 11, the primary system is an ESD. The output loop-powered isolator

Figure 11. *A signal isolator can be used to share a process variable with two different systems.*



(with a Passive Input) isolates the primary loop from the secondary loop. The DCS is the secondary loop. Maintenance can disconnect the input to the DCS without impacting the signal going to the ESD.

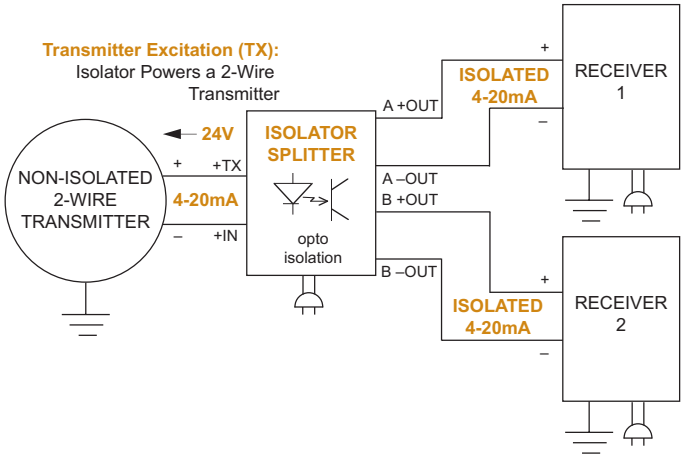
This architecture is very common, but there is a weakness to this design: if you had to disconnect the input to the ESD, then the DCS also loses the signal. Disconnecting the ESD input removes power from the transmitter. Fortunately, there is an alternative solution using a "Splitter."

Moore Industries Instrument Recommendations:
MIX 2-Wire Multi-Channel Signal Isolator/Converter
ECT 2-Wire (Output Loop-Powered) Signal Isolator/Converter
SIY 2-Wire PC-Programmable Signal Isolator/Converter
SDY 2-Wire PC-Programmable Signal Isolator/Converter with Display
SSX 2-Wire SIL 3 Capable Functional Safety Isolator/Converter

Split a Signal

A signal splitter is a 4-wire signal isolator/converter that takes one signal input and provides two or more identical outputs proportional to the input. All inputs and outputs, and power, are isolated from one another. In Figure 12, the transmitter is provided a 24V power supply, called

Figure 12. *A signal splitter takes one signal input and provides two or more identical outputs proportional to the input.*



"Transmitter Excitation", by the splitter. The advantage of the splitter (versus Area Isolation) approach is that you can disconnect either control system for maintenance without affecting the signal going to the other system. Some of the popular splitter applications (other than area isolation) include custody transfer and isolating validated systems from non-validated systems in the bio-pharmaceutical market.

Moore Industries Instrument Recommendations:
MIT 4-Wire Multi-Channel Signal Isolator/Converter
MIX 2-Wire 2-Channel Signal Isolators/Converters
MIX 2-Wire 4-Channel Signal Isolator
ECT 4-Wire Signal Isolator/Converter with the 2X4-20MA, 2X1-5V or 2X0-10V Output Type
SST 4-Wire SIL 3 Capable Functional Safety Isolator/Converter

What is a Passive Input?

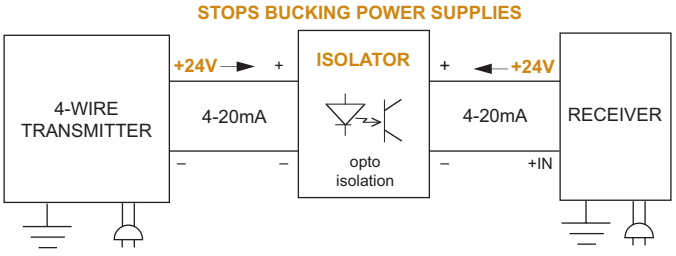
A common question is, "What happens to my input loop if I lose power to my isolator?" The good news is that nothing will happen to the input loop, assuming the isolator is not powering the input transmitter. An instrument with a **Passive Input** resembles a resistive load that is typically 20 or 50 ohms. This concern commonly arises when output loop-powered isolators/converters are used in conjunction with a critical input loop (Figure 11), such as a loop going to an Emergency Shutdown Device (ESD).

Solve "Bucking Power Supplies"

Some DCS manufacturers offer lower cost 4-20mA input cards. However, there is a significant tradeoff—the card must power all the loops. This is not a problem when all inputs are from loop-powered transmitters. But if you have 4-wire magmeters, or other line/mains-powered transmitters, both sides of the loop are trying to source the 4-20mA. The result is either too little current or no current at all. A simple output loop-powered isolator solves this problem. It can operate with powered inputs from both sides, thus restoring normal operations to the loop (Figure 13).

Moore Industries Instrument Recommendations:
MIX 2-Wire Multi-Channel Signal Isolator/Converter
ECT 2-Wire (Output Loop-Powered) Signal Isolator/Converter
SIY 2-Wire PC-Programmable Signal Isolator/Converter
SDY 2-Wire PC-Programmable Signal Isolator/Converter with Display

Figure 13. *A output loop-powered signal isolator eliminates "Bucking Power Supplies."*



Provide Power to a 2-Wire Transmitter

Transmitter Excitation—It is often convenient, and cost-effective, to power a 2-wire transmitter from a 4-wire signal isolator/converter installed on the loop (Figure 12). Called "Transmitter Excitation" (TX), the isolator/converter provides 24V power supply which eliminates the need to install an additional instrument power supply.

Compliance Voltage

The term "compliance voltage" describes the internal voltage source driving the output current of a signal isolator/converter. Compliance voltage is related to drive capacity (in ohms) through Ohm's Law. Isolator outputs are often expressed in terms of drive capacity; like "4-20mA into 1000 ohms." To determine the compliance voltage from this specification, use the equation: **V = 20mA x 1000 ohms = 20V**

Boost a Signal

Loops rarely start out overburdened, but over time, devices get added to the point where the drive capacity of the transmitter is exceeded. Nominally, a 2-wire (loop-powered) transmitter, powered with 24V, will drive into 600 ohms. If your receiving device is still using a 250 ohm input impedance, it does not take much to overburden the loop. A signal isolator solves the problem by providing a way to add more power—called drive capability—to an overburdened loop. In Figure 14, if you exclude the isolator from the loop there is an overall impedance of 615 ohms, plus wire impedance. That exceeds the 600 ohms drive of a loop-powered transmitter. With the isolator added to the loop, the input loop is satisfied with only 415 ohms plus wire. The output loop is also satisfied with only 250 ohms of load. The PLC's 24V powers the isolator, which in turn provides another 600 ohms of load capacity.

Moore Industries Instrument Recommendations:
MIX 2-Wire Multi-Channel Signal Isolator/Converter
ECT 2-Wire (Output Loop-Powered) Signal Isolator/Converter
SIY 2-Wire PC-Programmable Signal Isolator/Converter
SDY 2-Wire PC-Programmable Signal Isolator/Converter with Display

Figure 14. *A signal isolator adds more power, or drive capability, to an overburdened loop.*

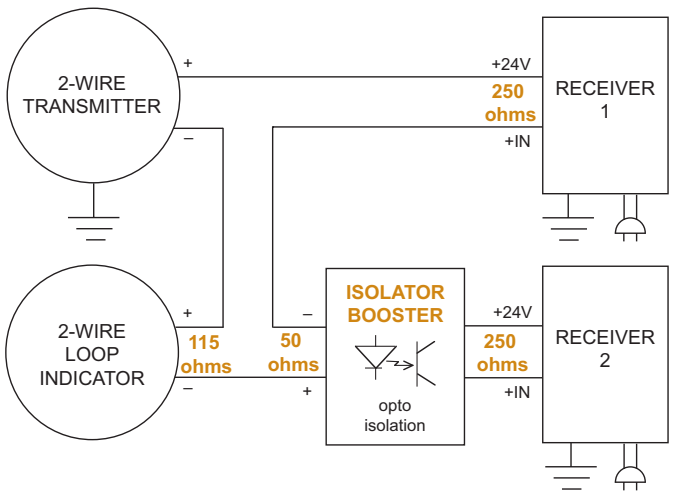
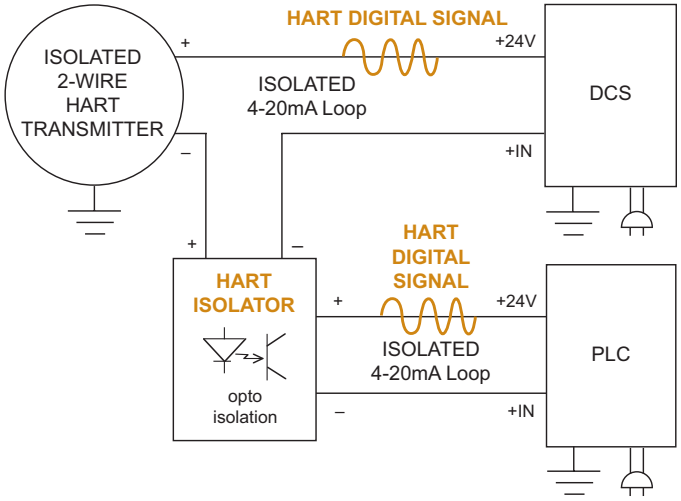


Figure 15. *A HART isolator allows the HART digital signal to pass through the isolator.*



Pass or Block a HART Signal

By choosing the proper isolator, you can allow the HART signal to "pass" to the output side of the isolator and on to the receiving device. Alternatively, you can block the HART signal from going beyond the primary loop to the receiving device.

Passing the HART Signal—Select a signal isolator that allows the HART signal to pass when you want a technician to be able to access a transmitter's process and diagnostic information via the HART signal, using a HART hand-held, from any termination point on the loop (Figure 15). To pass the HART signal you need an isolator specifically designed for that purpose. A "hole" has to be created in the filtering to allow 1200Hz and 2200Hz to pass through.

Moore Industries Instrument Recommendations:
HIX 2-Wire HART Signal Isolator
HIT 4-Wire HART Signal Isolator

Blocking the HART Signal—There are a couple of reasons why you may not want to pass the HART signal to the isolator output. For one, you might have an older receiving device with insufficient noise rejection on its inputs, and the HART signal causes interference with the analog measurement. Another reason might be that you have a process signal that has to go to a DCS and also to a PLC and you do not want the instrument technicians reconfiguring the field transmitter. Furthermore, blocking the HART signal makes it impossible for a technician to make unauthorized changes to the HART transmitter using a hand-held communicator or from a HART-based control system. An isolator with good common mode rejection is generally all you need to block the HART from the output loop.

Multi-Channel Instruments Save Costs

Multi-channel signal isolators/converters combine multiple analog signal channels into a single instrument to substantially save panel space and instrument costs (Figure 16).

Multi-channel instruments can be used in most all of the applications of traditional signal isolators and converters at a very low cost per point. This would include taking one signal and, in the case of a 4-channel unit, split one signal into four, and send it to four different receivers (Figure 17).

Moore Industries Instrument Recommendations:
MIX 2-Wire Multi-Channel Isolator/Converter (2- and 4-Channels)
MIT 4-Wire Multi-Channel Signal Isolator/Converter (2-Channels)

Figure 16. *Multi-channel signal isolators and converters substantially reduce hardware and installation cost per point.*

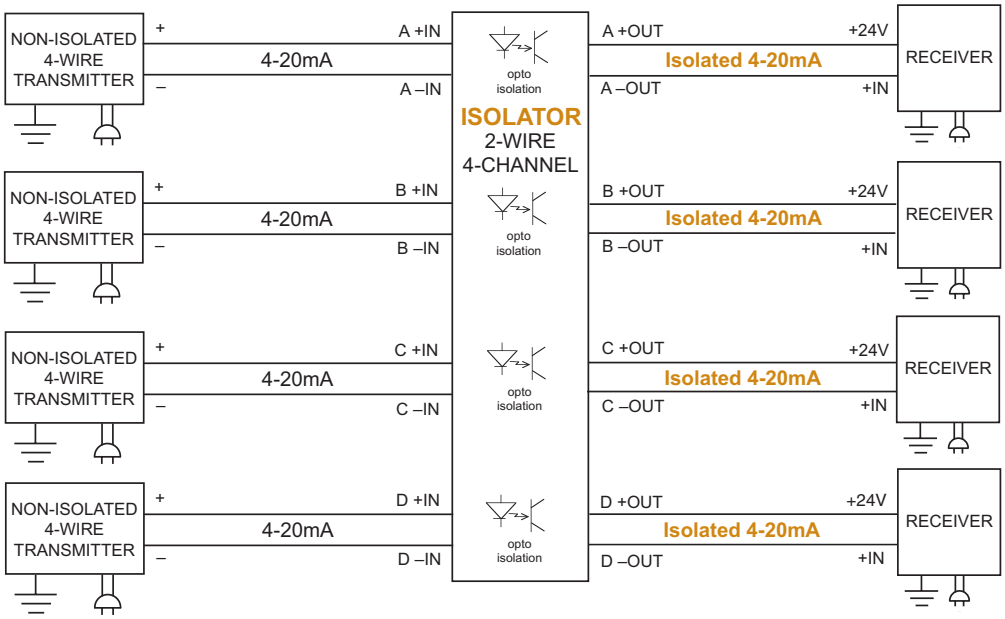
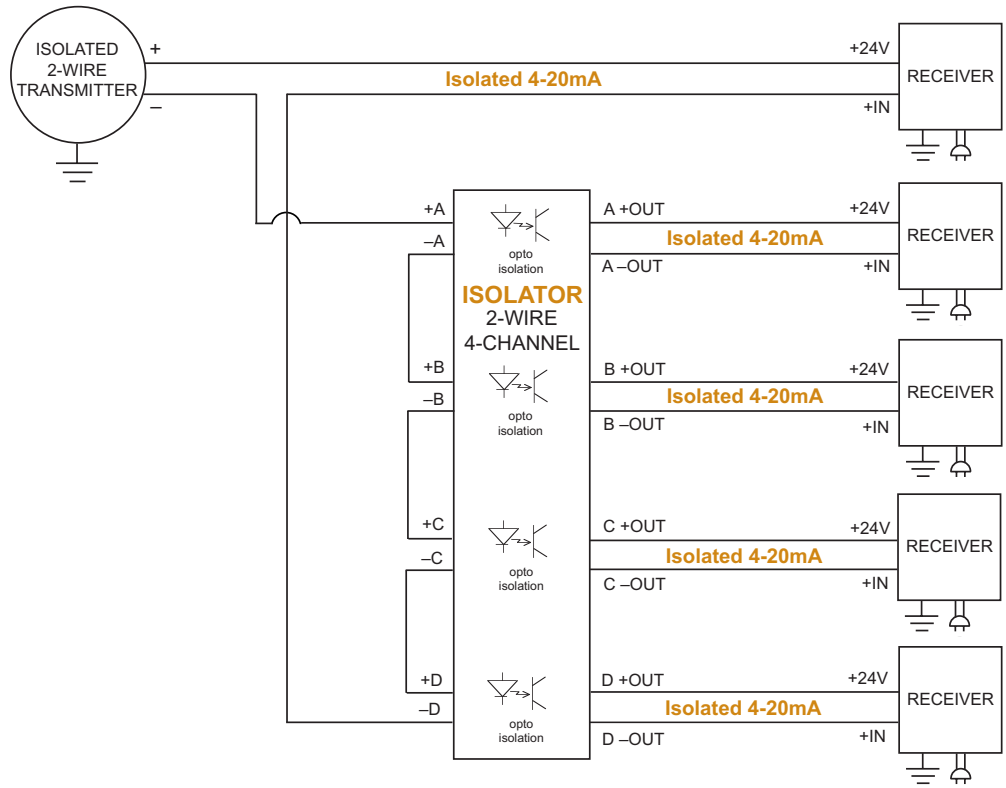


Figure 17. *Multi-channel signal isolators can be used as a "splitter" to send one signal to multiple receiving devices.*



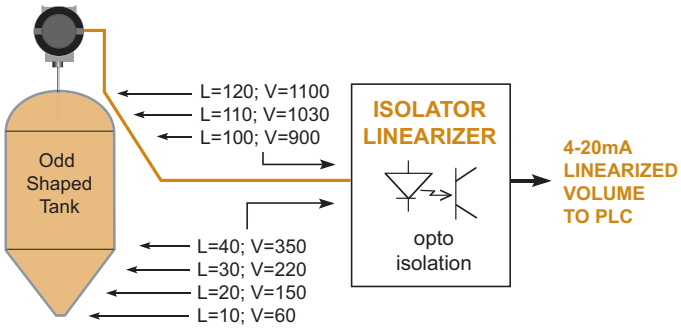
Custom Linearization

Microprocessor-based isolators/converters offer some solutions that are not found in analog isolators. Custom linearization is one. This provides the ability to plot custom curves that can very simply address applications like linearizing tank level to volume in a non-linear tank, square root extraction, signal limiting, characterizing pH to reagent demand and valve linearization. Some manufacturers offer curve capabilities of up to 128 points.

For example, because of an odd shaped storage tank, the output from a level transmitter doesn't correspond to volume because of the non-linear relationship. The strapping data is available for the tank, but the PLC is overloaded and can't perform the linearization function. The solution: a microprocessor-based PC-programmable isolator/converter (Figure 18). Simply enter the strapping data into the instrument's PC configuration software custom linearization table, and the output will be linearized and scaled to provide a 4-20mA output proportional to tank volume.

Moore Industries Instrument Recommendation:
SIY 2-Wire PC-Programmable Signal Isolator/Converter
SDY 2-Wire PC-Programmable Signal Isolator/Converter with Display

Figure 18. *Microprocessor-based isolators/converters provide the ability to plot custom linearization curves.*



Input Quality Alarms and Isolators

If your transmitter is connected to a control system, you probably have quality alarms on the 4-20mA input to let operations know if the transmitter fails. If you then have to install an isolator between the transmitter and the control system, you want to make sure to select an isolator that will not negate your input alarm strategy. This is an important consideration because not all isolator manufacturers offer the same functionality.

For this application, an isolator with a 4-20mA input and a 4-20mA output is recommended. Some isolators do not permit the output to drop below 4mA when the input goes to 0mA, which is exactly what you want to avoid if you are using quality alarms. Why? Because the way an isolator reacts will determine if the alarm will trip on the conditions you require.

Premium isolators have outputs that try to follow the input as it goes to 0mA. Just how far an isolator output can go depends upon how it is powered. The output of a premium 4-wire (line/mains-powered) isolator will go all the way to 0mA because loop-power is not required to power the isolator.

The output of a 2-wire (output loop-powered isolator) can not go to 0mA, because loop power—Power (P) = Voltage (V) * Current (I)—is needed to run the isolator electronics.

The output of a 2-wire input loop-powered isolator does go to 0mA when the input goes to 0mA, because you have effectively cut power to the isolator. The isolator output will follow the input down to 3mA, at which point the isolator loses power and the output goes to 0mA.

If the isolator is analog, then the output can go to 3.0mA before power is lost. It is also important to note that microprocessor-based isolators are more power hungry, and the output typically cannot go below 3.8mA. If your DCS is an older system that has a quality alarm with a fixed setpoint of 3.2mA, you need to use an analog isolator that will allow the output to go below this threshold.

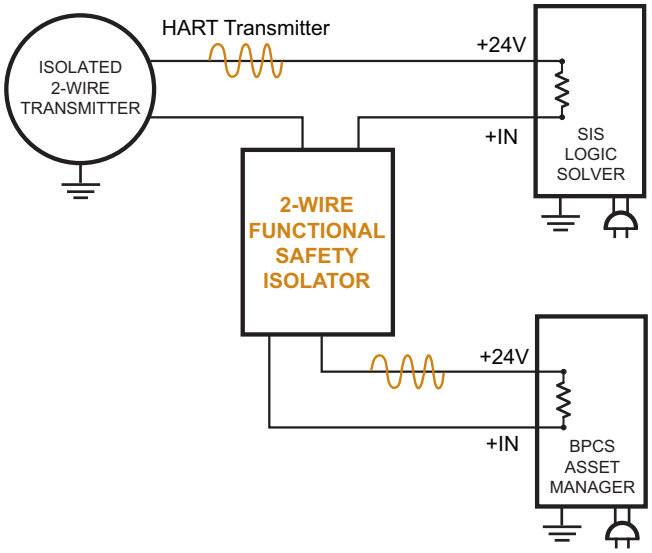
Isolation in a Safety Instrumented System

Safety Isolators and Splitters used in a Safety Instrumented System (SIS) provide isolation and signal conversion for your most critical loops. These units protect and enhance loops and if they feature HART pass-through technology, they can also pass valuable HART® data from the field transmitter to host systems and vice-versa. Most often these devices are used to isolate your SIS from your Basic Process Control System or monitoring system so disconnections or failures to these secondary systems don't affect your safety system (Figure 19).

A third-party approved isolator designed and built from the ground up to IEC 61508 specifications is the best choice. FMEDA (Failure Mode Effects and Diagnostic Analysis) reports, which are available from the manufacturer, provide the required safety data to ensure that risk reduction requirements are met when implementing SIFs (Safety Instrumented Functions).

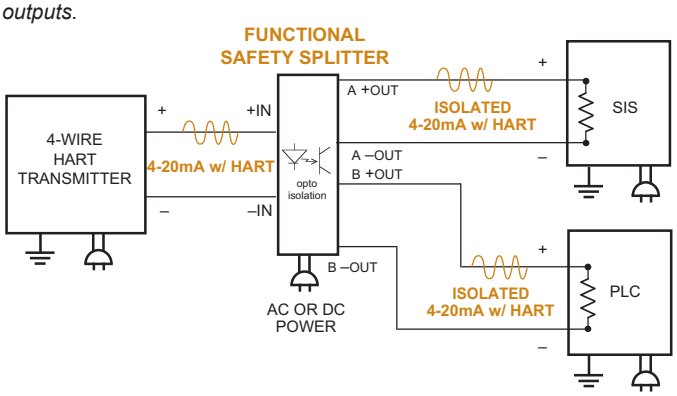
A common question that is often asked is: "What happens to my primary or SIS loop if power is completely lost to the isolator?" If your isolator is not powering the input transmitter the critical SIS portion of the loop will remain uninterrupted and continue to operate normally.

Figure 19. *A Functional Safety isolator protects the critical SIS portion of the loop from the BPCS or monitoring system. HART data is passed along when the isolator features that capability.*



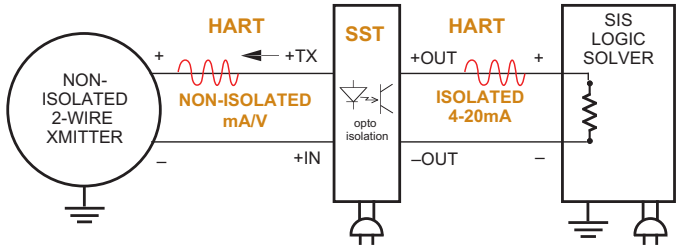
Functional Safety isolators come in three varieties previously discussed throughout this white paper: 4-Wire (Line/Mains-Powered), 2-Wire (Loop-Powered), and a 4-Wire (Line/Mains-Powered) Splitter that supports two separate isolated outputs (Figure 20). The Splitter takes the input from one of your process signals and creates two identical, completely isolated outputs to two separate monitoring or control devices.

Figure 20. *Functional Safety Splitter takes the input from one of your process transmitters and creates two identical, completely isolated outputs.*



Functional Safety isolators equipped with built-in HART pass-through technology ensure that when your safety loops use HART transmitters, critical and valuable HART diagnostic, process, and calibration information can be read on either side of the isolator (Figure 21). This makes it very convenient when using HART handhelds, modems or programming devices to configure remote field transmitters from control rooms. Many other safety isolators block and "strip off" the HART signal.

Figure 21. *When the isolator features Transmitter Excitation it can supply loop power to a 2-Wire transmitter.*



Moore Industries Instrument Recommendations:
SSX 2-Wire SIL 3 Capable Functional Safety Isolator/Converter with HART pass-through technology
SST 4-Wire SIL 3 Capable Functional Safety Isolator/Converter and Splitter with HART pass-through technology

Environmental Considerations

Hazardous Area Isolators

There are times when isolators and signal converters cannot be installed in "back-of-panel" service or safe areas. Equipment location, lack of wiring, and process flammables may be reasons that necessitate isolators/converters be installed in hazardous areas within a plant. When such needs arise, technicians have to determine whether the area is classified as NEC Class I, Division 1 (IEC Zone 0/1) or Division 2 (IEC Zone 2). Today, isolators come in all flavors to accommodate such installations. Intrinsically-safe, non-incendive and explosion proof are all options that one can now choose. One requirement that often arises is the need for an explosion proof signal converter/isolator with a local indication for remote operators.

Figure 22. *Signal isolators/converters are available in a variety of hazardous area mounting configurations.*

RFI/EMI Protection

The effects of Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI) can cause unpredictable and non-repeatable degradation in instrument performance and accuracy, and may even lead to complete instrument malfunction or failure. When this unwanted noise finds its way into your measurement circuits it can result in off-spec product, reduced process efficiency, plant shutdowns and sometimes dangerous safety hazards.

Some common sources of interference are: mobile and stationary radios and handhelds, static discharge, large solenoids or relays, AC and DC motors and welders. Because RFI can "squeeze" through even the smallest of cracks, a isolator housing should be designed so there are no openings, uncovered mounting holes, or exposed PCB (Printed Circuit Board) areas. In addition, the use of solid aluminum cases that help block stray RFI/EMI is a recommended feature (Figure 23).

Figure 23. *Solid aluminum housings designed with no openings, covered mounting holes and no exposed circuit boards help block RFI/EMI noise.*

To further mitigate the effects of noise, PCB's are carefully designed with noise in mind. To harden the designs, look to instruments that utilize low pass filters, terminal strip common ground plane to the low side of the filters, strategically placed capacitors and inductance filters (LC), and the use of full spectrum ceramic RFI/EMI. In fact, some of the filtering guarantees less than 0.1 percent error at radiated noise levels of 50V/m between 20MHz and 1000MHz.

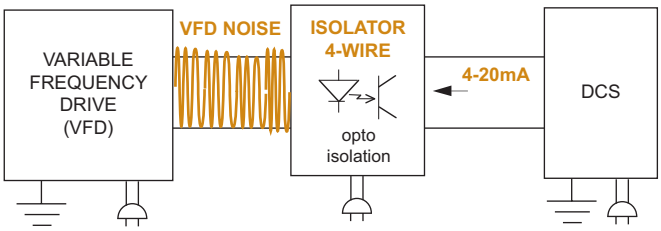
Output Damping "Hides" Noisy Process Signals

In ideal control environments, input signals to isolators/converters would be clean and flat, with no extraneous process or plant noise. Such environments don't exist, unless your plant is in a lab. There will always be unwanted noise accompanying your desired control or monitoring signal. Often these fluctuations are part of the process and searching for ways to soften or eradicate them could sometimes be detrimental to the process. In other instances, recently installed equipment, grounding problems, or unknown entities conduct noise onto your input signals. A microprocessor-based isolator can quickly and easily remedy these situations. Output damping is an option on many isolators. By adjusting the output damping feature on any isolator, you can prevent the receiver from seeing this erratic process noise or extraneous conducted noise. In processes that cannot deal with spurious trips, output damping may save hundreds of hours of downtime and nuisance process resets.

VFD Noise: A New Problem

A new problem that has cropped up in the last ten years or so is noise from VFDs (Variable Frequency Drives). Before the days of VFDs, output signals from PLCs or DCSs fed directly into AC or DC driven motors. However, after discovering the inefficiencies of AC and DC motors as compared to VFDs, plants everywhere started replacing traditional motors in plants. Shortly thereafter engineers and operators at these plants starting seeing a new set of problems: Noise on the output cards going to the VFDs. The issue of common mode noise resurfaces in regards to VFDs. VFDs, by their very nature, are a terrific source of common mode noise. A VFD usually receives an AC input source of 240/480Vac. In order to control the output and torque of the motors, the frequency of this input is varied over a large range. This changing of motor load and input frequency creates and conducts a lot of extraneous noise that can be directly coupled onto surrounding electronics and even onto its own input signal coming from the control system.

Figure 24. *A 4-wire (line/mains-powered) signal isolator prevents unwanted VFD noise from disturbing the output signal from the control system.*



How do you solve this problem? Install a 4-wire (line/mains-powered) isolator to filter out the unwanted common mode noise (Figure 24). Rather than the input to the isolator originating in the field, the control system now supplies the input to the isolator, and it drives the output to the VFD. Now the isolator simultaneously isolates and shields the control system from the noise.

Ambient Temperature Effects

One of the many considerations that must be examined when choosing instrumentation is the amount of heat the electronics will be exposed to over its installation lifetime. Though field instruments often possess sufficient ambient temperature operating specifications, many DIN-rail mounted instrument suppliers assume that their equipment will be installed in a climate-controlled environment. As such, you will often see DIN-rail instruments with a top end ambient operating temperature rating of 60°C (140°F). While heat is the major culprit of failure of electronic components, colder climates can also present a myriad of challenges. Some isolators and converters are suitable for installation in areas that see low temperatures of –40°C (–40°F) and high temperatures of 85°C (185°F).

Versatile Workhorses

The ability to depend on accurate monitoring and control signals is literally priceless. Inaccuracies can lead to process inefficiencies, process upsets and even very costly plant shutdowns. Much worse, inaccuracies can lead to dangerous safety conditions for plant personnel.

Isolators and signal conditioners are indispensable tools that enhance measurement accuracy and protect signals from damaging conditions, thereby saving money.

With the extensive array of isolators available, selecting the correct isolator or the right combination of isolator features might be a bit daunting at first. However, if you take the time to add the right instruments to your process, signal isolators, converters and interfaces can help improve the efficiency and throughput of your process

When you need to isolate, convert, share, split, boost, protect, step down, linearize or digitize process signals, look to the versatile workhorses of the process instrumentation world... signal isolators, converters and interfaces.

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