



Intrinsic safety

# 10 advantages to using intrinsic safety in hazardous locations

## Learn more about

- Why you should consider using intrinsic safety (IS)
- Key terminology related to IS
- Examples of applications where IS is appropriate



# Introduction

**In the following paper, I list ten reasons (in no particular order) to consider using intrinsic safety when feasible.**

**I highlight “when feasible” because, like most everything else in this world, there are limitations, and intrinsic safety is not an exception.**

**Again, there is no specific order, but depending upon your application and situation, the relevance and importance of these could change. One thing to note in this paper is the use of quotation marks. I’ve used these to signal a proper term according to UL. Because of time and space limitations, I will not be able to define them all.**

## 1. Use of standard, safe area devices

### **Intrinsic safety technology permits use of some “safe area” devices in lieu of explosion-proof devices as long as they meet certain requirements.**

U.S. and global requirements for hazardous location wiring practices allow two types of devices to be used in an “intrinsically safe circuit” (NEC article 504.2, 504.4, and 504.10(B)). The first type of device is an “intrinsically safe apparatus,” which must be tested, approved, and labeled as an “intrinsically safe apparatus” according to UL 913. The second is called a “simple apparatus.” A simple apparatus only needs to meet a few limitations of electrical parameters to qualify, and then does not have to be tested, approved, or labeled as an intrinsically safe or hazardous area device. The electrical parameter limitations are as follows: the device cannot be capable of generating more than 1.5V, 100 mA, or 1.5 W, or dissipate more than 2.5 W. Some examples of this type of device are: thermocouples, RTDs, switches, and LEDs.

What’s so great about being able to use a normal area (safe area) device? Typically, safe area/non-Ex devices cost less and are more readily available than hazardous area-rated devices. There’s also a good chance you’re already using them in your safe area applications. Why buy, stock, and maintain more parts than you have to?

When using explosion-proof technology for your hazardous-area wiring technology, there are no safe area options. A device designed to withstand the required “containment” (explosion-proof) requirements would be overkill, bulky, and cost more than the market would bear. ■

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## 2. Safest hazardous area technique

**The only technique allowed for zone 0, the continuous presence of hazardous material.**

Instead of two hazardous area divisions as defined by the NEC and CEC (Canadian Electrical Code), ATEX (European Union) and the International Electrotechnical Commission (IEC) use three (zones), zones 0, 1, and 2, with zone 0 being the most (considered continuously) hazardous. According to ATEX, IECEx, and the U.S. national standard NFPA (article 505.5), which addresses zones, only the power-limiting, electrical control technique of intrinsic safety (ia) is allowed to be used as an electrical signal medium into and out of a zone 0 area (similar but equal to N.A. Div 1). Compare this to Ex d (Flameproof) (global version of explosion-proof), which is based on containment only allowed into zone 1 and 2. So why is intrinsic safety considered safe for zone 0 (an area always considered hazardous) (similar but not equal to N.A. Div. 1)? See below, reason #3 (Figure 1). ■

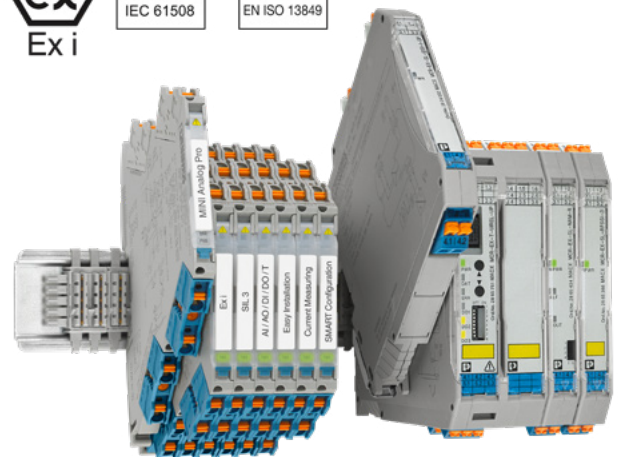


*Figure 1: Intrinsically safe I/O modules, like some in the AXL F family, can be used in Zone 1, Zone 0, or Division 1.*

## 3. Fault-tolerant

**Remains safe after faults develop in cables and faulty components.**

Because faults in electrical circuits and devices can cause hazardous voltage, current, and stored-energy levels, safeguards are part of the design requirements of “intrinsically safe apparatus” and “associated apparatus.” Some examples of these safeguards are fuses on any incoming signal termination to limit hazardous currents into the hazardous area (Figure 2). Transformer isolation is used to limit hazardous voltage spikes or wrong high-voltage terminations from reaching the hazardous area. Diodes are then used to limit the finer levels of voltage.



*Figure 2: Some versions of the MACX and MINI EX signal conditioners can minimize hazards to help protect people, machines, and the environment.*

continued →

### 3. Fault-tolerant **continued** →

The fault-tolerant part comes into play via the redundant protective circuits required. There are three types or levels of intrinsically safe Ex i devices: ia, ib, and ic (article 505.2 FPN). Type ia must be able to withstand two faults and retain its intrinsic safety to work in Div. 1 and zone 0. Type ib must be able to withstand one fault and maintain its intrinsic safety circuit to work in zone 1 areas (no N.A. equivalent). Type ic has no redundancy requirement and

is approved for use in circuits into the Div. 2 and zone 2 areas.

There are no fault-tolerant requirements for redundancy in explosion-proof and flame-proof technologies. If an accident happens, or human mistake reduces the containment properties of the devices, there are no back-up devices to automatically take over. ■

## 4. Live maintenance

### **Intrinsic safety is the only hazardous location wiring practice that permits live work on circuits without gas clearance certificates and with power applied.**

With live maintenance of an electrical circuit, one of the hazards is the creation of an arc or spark when shorting of a circuit occurs. But in a properly designed IS circuit, even if there is electrical energy present, there will not be enough energy to cause an arc or spark with enough energy behind it to ignite the hazardous material. The theory behind intrinsic safety is that the modules are designed to limit the amount of energy onto a circuit below the minimum ignition energy (MIE) of hazardous materials. If a

properly designed intrinsic safety barrier or isolator would fail, they are designed to fail safe (see reason #3).

Because the other common hazardous location wiring practices (explosion-proof, purged enclosures) do not limit energy below the MIE, but rely on physical containment and separation, opening one of these enclosures without shutting off power would expose their hazardous electrical energy to the hazardous atmosphere. ■

## 5. Least expensive

### **Big savings in explosion-proof enclosures, conduit, fittings, protected cable, special glands, seals, etc.**

Intrinsic safety relies upon electronic technology to prevent explosions by limiting the energy or ignition source in a hazardous location. This allows the use of safe area cabling, as long as it does not act like a conduit and transmit explosive gases from the hazardous areas to a safer area.

(Explosion) Containment technologies, which cover the explosion-proof and flame-proof practices, use mechanical containment techniques to contain an explosion within the special engineered, heavy-duty, cast metal electrical enclosures, conduit, and fittings. Main access to the

enclosure is either through a lid, in which both the lid and enclosure body surface are machined to tolerances engineered to allow the hot gases to escape in a design-controlled manner, or via a machine-threaded lid and enclosure body. These heavy-duty enclosures also require the entries into and out of the enclosure to be machine-threaded holes. Seal-offs are then used to keep hot gases from escaping via the conduit. The rigid conduit runs need to be cut, threaded, bent, fit, and secured into place, which adds to the project installation time, and cost. ■

## 6. Safe area wiring methods

### No need for added installation cost of explosion-proof conduit because the system is electrically protected at the source.

In a non-IS circuit, there is the possibility of the circuit conductors carrying hazardous voltage and current. This means there's the possibility that an accident or mistake could occur, short-circuiting the conductors and causing a spark with enough energy to ignite any hazardous substance.

With intrinsic safety, the current and voltage are limited in the circuit to such a point that an accident shorting the conductor would not cause a spark with enough energy to

ignite the hazardous substance. Of course, to help eliminate any downtime, one still might want to protect the conductors to a certain degree or point, but the need to do this to prevent an explosive situation is not necessary.

Another advantage to using safe area cabling is the flexibility of acceptable safe area wiring. This offers the advantage of quicker and easier installation and the possibility of reusing the flexible cabling and conduit if the installation is temporary. ■

## 7. Safe for personnel

### Extra-low voltages and currents, typically below 30 Volts, 100 mA maximum.

Compared to the larger voltages and currents typically used in circuits found in Ex d technologies, IS circuits are very safe for personnel and equipment. The heavier lifting or moving of objects typically done in non-combustible areas with electrical energy is accomplished with pneumatic or hydraulic energy, which is controlled by low-level, safe electrical energy. ■

*Figure 3: The flammable gases generated in power-to-X applications are a key safety issue, so intrinsically safe devices must be used in these environments.*



## 8. Safest method

### **Immune from improperly secured explosion-proof covers, sealed conduits, marred surfaces, etc.**

Explosion-proof enclosures are specially designed to withstand an internal explosion and exhaust the hot gases at a certain rate across the face of the enclosure or through the gap of a threaded enclosure, cooling the hot gases. If the lid is not secured properly (bolts missing or not tightened down), the machined face surface marred or

scratched, or a threaded lid not tightened, hot gases could be allowed to escape.

If the explosion-proof structures/devices are not properly installed or become insecure via accident or ambient conditions over time, they could leave an opening for hot vapors into a hazardous area or hazardous gas transmission to an area considered safe. ■

## 9. Loop isolation

### **Intrinsic safety isolators provide loop-to-loop isolation and eliminate ground loops.**

Sometimes simply referred to as galvanic isolators, these devices are not only designed to limit electrical energy in a circuit (the IS part), but most will also condition the analog signal according to its function. For example, a 4-20 mA analog repeater might provide loop isolation and add power to the signal. Or an IS-rated thermocouple

transducer might go a step further by filtering, isolating, and converting the signal.

If you find yourself having signal issues and determine certain circuits could require loop isolation, it might be worth the quality of your product to consider accomplishing the Ex circuit protection and signal conditioning in one step by using an intrinsically safe Isolator. ■

## 10. Global acceptance, one standard design

### **Intrinsic safety is a well-defined universal approach to safely installing instrumentation and control devices into hazardous locations, with virtually identical standards across the world and applicable to all industries.**

From the ATEX scheme, which most of the EU follows, to the IECEx scheme, which most of the rest of the world follows, there are very few, if any, changes. Even the NEC and CEC standards, which the U.S. and Canada follow, adopt most of IECEx and change very little. Because of this, manufacturers of devices using intrinsic safety

circuits can easily and cost-effectively design devices that fit approvals around the world. This, in turn, keeps design costs down for global engineering firms. From design staffing to data warehousing of technical documentation, the global acceptance of IS technology makes it the most cost-effective hazardous location technology to use. ■

# Admission

## Intrinsic safety does have its disadvantages

As stated at the beginning of this paper, there are limitations to intrinsic safety technology/applications. The biggest is probably the technology method itself, energy limitation. Due to this, the application of powering devices with electrical energy is regulated to smaller, low-power energy-consuming sensors, instruments, and regulating devices. With that said, it still can be used in conjunction (to monitor and control) with other forms of safer or possibly large-power energies (e.g., pneumatic and hydraulic) in hazardous locations.

The second most commonly stated disadvantage with intrinsic safety technology is that it requires more engineering time than the other technologies. From my perspective, it's probably not so much more time, but it's an unfamiliar technology, and engineers make it harder than it really is. With an explosion-proof design, you need to choose the proper hazardous area enclosure/instrument (housing), and the same with intrinsic safety. In addition, there are only two more pieces of information needed: the properly associated apparatus (intrinsic safety isolator), and then making sure the entity parameters of the field device, the intrinsic safety isolator, and the cabling make up an intrinsically safe circuit. ■

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**Derek Sackett**  
Senior Product Marketing Specialist,  
Phoenix Contact USA, Inc.  
[dsackett@phoenixcontact.com](mailto:dsackett@phoenixcontact.com)

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