MOORE HAWKE
FIELDBUS WORLDWIDE

Bridging the Intrinsically-Safe Fieldbus Disconnect

At first glance, the concept of Intrinsically-Safe (I.S.) fieldbus is a study in opposing concepts. After all, fieldbus is about powering multiple devices, while the idea of I.S. is to limit energy flowing into hazardous areas. The fact that multiple devices can be powered from the same wire pair only adds to the design challenges that engineers face when developing their own systems. Typically, this can lead to complex installation schemes as users mix wiring methods such as Division 1 and Division 2 (Zones 0, 1 and 2) in order to accomplish their task.

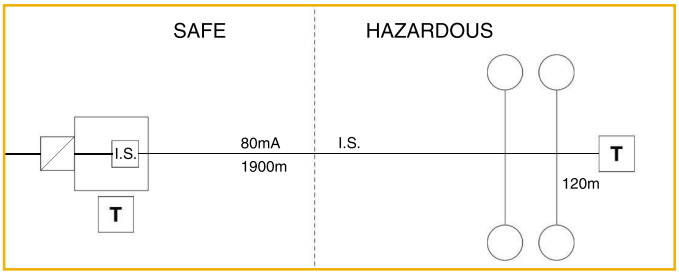
The ideal solution allows users to connect multiple devices (for PROFIBUS PA or FOUNDATION fieldbus™ H1 networks) without compromising area requirements or using expensive installation methods. Until recently, this was a pipe dream. But recent breakthroughs in design have brought together many of the best features of different I.S. techniques. Specifically the use of the "High Powered I. S. Trunk" concept greatly simplifies the installation and footprint for intrinsically-safe segments.

The sections below provide an overview of the existing technologies and methods that fieldbus users have at their disposal when they embark upon designing and installing fieldbus in hazardous areas. These sections assume that there is a general understanding of fieldbus segment topology and design.

Entity

Before discussing the latest wave of intrinsically-safe fieldbus methods, it's important to cover the traditional methods of dealing with intrinsically-safe wiring for fieldbus. Initial designs for fieldbus used barriers that had been successfully used in the 4-20mA world. These barriers use an infallible resistor (wire-wound), Zener diodes, a fuse and require a good intrinsically-safe ground. While this barrier limited energy sufficient for Class I, Div 1 all Gas Groups (Zone 0/1 all Gas Groups), it only provided 80mA for the fieldbus segment (see Figure 1).

Figure 1: The Entity barrier is a safe but low-power concept that eliminates many of the advantages inherent in fieldbus technology.

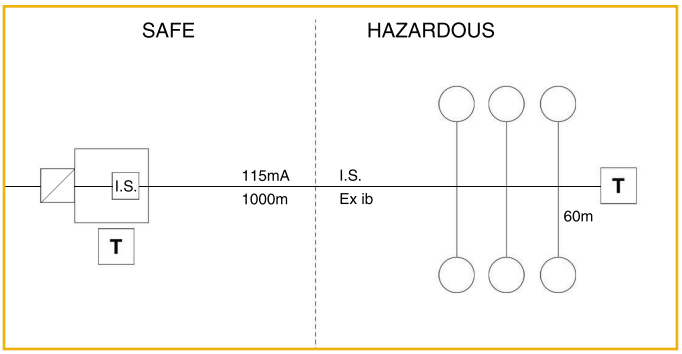


This optimistically could only power four fieldbus devices which typically take 15-26mA each. The Entity barrier concept is safe, but its low-power limitations and engineering requirements effectively eliminate many of the benefits of using bus technology.

FISCO

In response to the lack of bus power, several alternate designs were developed to simplify the process and allow more use of the fieldbus technology. One of the most popular is the Fieldbus Intrinsically Safe Concept (FISCO), which was first developed by PTB (Physikalisch-Technische Bundesanstalt, the national metrological institute of Germany) as a method to provide higher power to a fieldbus segment in hazardous settings.

Figure 2: FISCO provides more power than Entity barriers, but still lacks the ability to support eight to 12 devices per segment in Gas Groups AB and IIC.



The FISCO concept considers the entire circuit of the fieldbus segment. This solution requires that each part of the system including devices, cables and power conditioners are FISCO certified and that FISCO design and installation rules are strictly followed (IEC60079-27).

For instance, the maximum total cable length in a FISCO system is 1.0 km in Gas Groups A & B (IIC) and 1.9 km in Gas Groups C & D (IIA & IIB), while the maximum allowed spur length is 60 meters for Gas Groups A - D (IIC, IIB & IIA). Additional constraints are also placed on the power conditioners. For example, load sharing redundant power conditioners are not allowed in a FISCO power supply.

Certifying devices to a standard before implementation allows them to be integrated into systems without the engineering requirements necessitated by the Entity approach. This then allows FISCO power supplies to generate more power (and allow more devices per segment) than the Entity barrier solution.

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Up to 110mA can be generated for Class I, Div 1, Group A & B (Zone 1 Group IIC) applications and up to 250mA generated for Class I, Div 1, Group C & D (Zone 1 Group IIB & IIA) applications.

However, FISCO power supplies also have their limitations. Not using infallible components and the use of multiple current limiting designs restricts the power conditioner to Zone 1. Furthermore, the complexity of FISCO designs typically means a decrease in Mean Time Between Failures (MTBF) versus traditional fieldbus power conditioners.

While it does provide more power than the Entity barrier approach, a 110mA Class I, Div 1 Group A & B (Zone 0/1, Group IIC) system can only support four to five devices per segment using the FOUNDATION fieldbus method for segment load current (i.e., Segment Load Current = sum of device loads + device coupler + short circuit for one device + one handheld tester). This is still well short of the eight to 12 devices per segment typically required by most users. It can also be a very expensive system to implement when using repeaters and additional field based barriers for Zone 0 devices and non FISCO (Entity) devices.

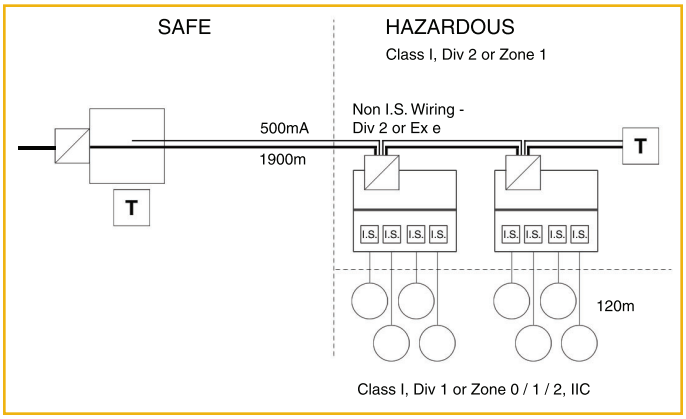
High Power Trunk Using Field Barriers

A more recent enhancement for intrinsically-safe applications is the High Power Trunk (HPT) with field-based field barriers (FB), which limits power at the spur rather than the trunk (see Figure 3). Since the trunk is not I.S., it and the field barriers must be installed in Class I, Div 2 or Zone 1 (Ex e wiring). Spurs can be intrinsically-safe and can be connected to a combination of Entity or FISCO devices located in either Division 1 or 2 (Zone 0/1 or 2) areas.

This method significantly changes the equation for end users of fieldbus in hazardous settings. It increases the amount of available power and therefore the number of connected devices on a segment. It also lets end users maximize the length of their trunk cables without the restrictions of FISCO.

While the HPT model does provide some significant improvements, it is not without its downsides. The field barrier is in essence a field-based isolated power conditioner. So even though the segment can be powered by load sharing redundant power conditioners at the host, the practical MTBF is still that of a single power conditioner, since most field barriers are not redundant. Also, the field barrier must have at least 16 volts to operate, so the minimum or threshold voltage is no longer

Figure 3: Utilizing a High Power Trunk with field barriers increases the amount of power and number of connected devices available for fieldbus applications in intrinsically safe settings. Drawbacks include a decrease in Mean Time Between Failures, an increased minimum threshold voltage and difficulty in making repairs while under power.



9 volts at the device, but 16 volts minimum at the field barrier. Furthermore, the field barrier itself is complex since the conversion from non-I.S. to I. S. must take place in the field barrier which is in the field enclosure. Since the enclosure uses both intrinsically-safe and non-intrinsically-safe wiring methods it can confuse field technicians and unfamiliar contractors.

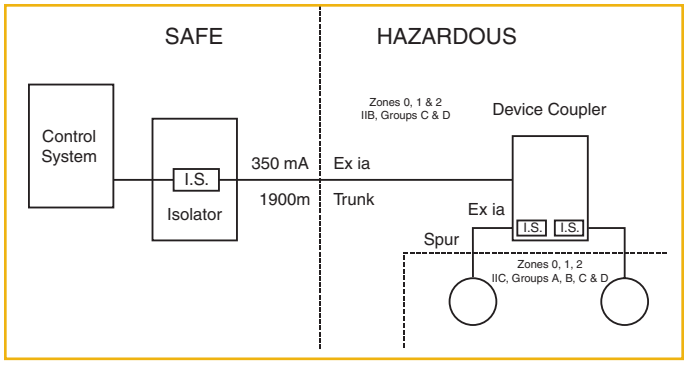
High Power Intrinsically-Safe Trunk

The HPT concept solves some problems associated with Entity and FISCO solutions, but it is far from perfect. There is one additional option in the evolution of hazardous area fieldbus installations that involves something tried and true and something new. The High Power I.S. Trunk (HPIST) technique provides an enhanced level of safety and simplicity in installation, along with the ability to use it for all devices (FISCO and Entity) and hazardous Divisions and Zones.

A prime example of this is the ROUTE-MASTER™ Fieldbus System from MooreHawke, a division of Moore Industries, which delivers 350mA of I.S. power to segments located in hazardous areas. This is the industry's highest segment current available for intrinsically-safe fieldbus installations.

The first question many ask is "How do you get 350mA into a hazardous area?" The ROUTE-MASTER does this by utilizing a patented split-architecture design that puts part of the barrier in an isolator card located in the safe area (power supply rack), with the other part in each of the spurs of field-mounted device couplers (see Figure 4). The barrier in the isolator allows 350mA to be run into IIB, Groups C & D. The additional barrier in each spur

Figure 4: The High Power Intrinsically-Safe Trunk concept delivers 350mA of I.S. power into hazardous areas for use with FISCO and Entity devices. This is made possible by ROUTE-MASTER's patented split architecture design.



is sufficient for IIC Groups A, B, C & D. Since infallible resistors are used, devices from Zone 0/1 or 2 can be direct connected.

Having 350mA now allows end users to power up to 16 fieldbus devices (20mA each) at 500m while retaining intrinsic-safety for hydrogen rich areas at the individual spur connections (See Figure 5).

This is a major improvement over the number of devices which can be connected via Entity barrier and FISCO systems, while allowing connections for all devices (FISCO and Entity) in all hazardous area Zones, and Gas Groups. Since the field enclosure now contains only a relatively simple I.S. 12-way device coupler, the size and complexity of the field enclosure is greatly reduced.

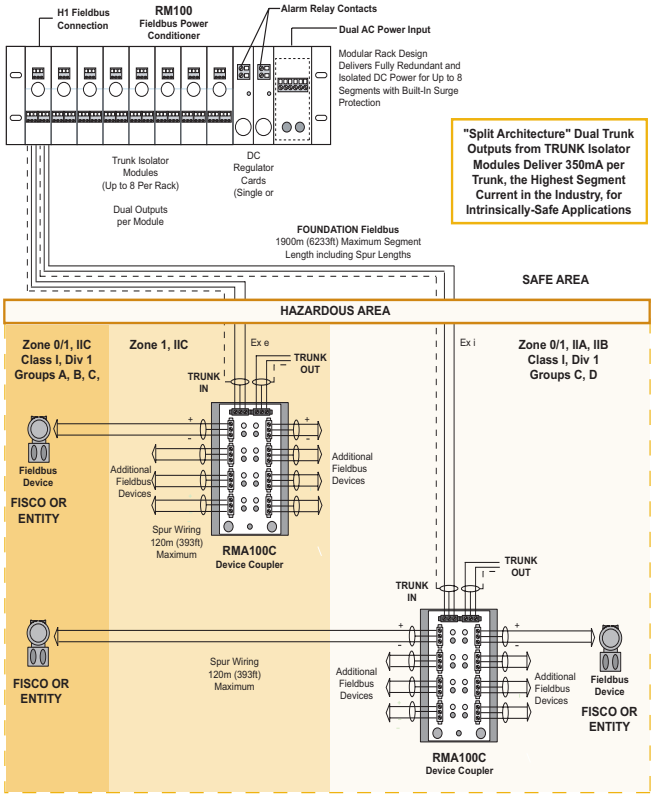
The HPIST does use an Entity based power supply, so Entity calculations are required to confirm the design does not exceed area Entity requirements. However, because of the unique split architecture design (part of the safety barrier in the isolator card and part in the spur of the field mounted device coupler), these calculations only need to be done once for the longest trunk and spur (If not FISCO), and will cover the entire plant installation.

The ROUTE-MASTER system includes a free and easy-to-use Segment Design Tool. It features a segment calculator that allows engineers to easily design and test ROUTE-MASTER segments that include FISCO or Entity devices. Also included is an Entity calculator that documents the single Entity calculation for the plant.

Conclusion

The increasing implementation of fieldbus shows that end users are realizing its value beyond the cost savings associated with having reduced and simplified wiring. Now they are using it in intrinsically-safe areas where fieldbus applications were once considered to be impractical. The comparison below shows the equipment required to implement a typical 12 Spur Segment connecting FISCO and Entity devices in Class I, Div 1 Groups ABCD, Zones 0/1/2 IIC with the different techniques. It is apparent that the High Power Intrinsically-Safe Trunk concept allows plenty of power for fieldbus installations and still retains all of the intended live working and safety features of intrinsic-safety, generally regarded as the safest of all Ex protection techniques.

Figure 5: The unique split architecture of the ROUTE-MASTER Fieldbus System allows for an industry-best 350mA for I.S. segments and supports 1900m total segment length and 120m spurs. Unlike other I.S. architectures, ROUTE-MASTER can easily support 16 Entity or FISCO Fieldbus devices on a 500m segment.



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Feature Comparison

Characteristic	Redundant FISCO	High Powered Trunk with Field Barrier	High Powered I.S. Trunk
Hardware required to support 12 intrinsically-safe (FISCO and Entity) devices on a segment in a Class I, Div 1 Groups A-D, IIC area	Control Room: • Four Redundant FISCO Repeating Fieldbus Power Supplies per segment • 10 terminators, four trunk cables • Complex wiring Field Enclosure: • Trunk/Spurs: Class I, Div 1, Groups A-D, Zone 1, IIC Ex ib • Four 4-Way device couplers with terminator on each coupler • Add Entity spur adapter DIN-Rail mount for each Entity device • Add Ex ia spur adapter DIN-Rail mount for each Zone 0 FISCO device	Control Room: • Redundant Fieldbus Power Supply Field Enclosure: • Trunk: Class I, Div 2, Ex e, Zone 1 & 2 • Spurs: Class I, Div 1, Groups A-D, Zone 0, IIC Ex ia FISCO or Entity devices • Two or three field barrier modules • Additional trunk terminals • Interconnecting wiring between additional field barriers • Isolating switches (if removal of field barrier modules is required)	Control Room: • Redundant Fieldbus Power Supply, rack or surface mounted with AC power Field Enclosure: • Trunk: Class I, Div 1, Groups C, D, Zone 0 IIB Ex ia • Spurs: Class I, Div 1, Groups A-D, Zone 0 IIC Ex ia FISCO or Entity • One 12-way device coupler for FISCO (all zones) or Entity devices OR • Trunk: Zone 1 IIC Ex e • Spurs: Zone 0 IIC Ex ia • One 12-way device coupler for FISCO (all zones) or Entity devices
Are all circuits in field enclosures live workable?	Yes	No	Yes
Typical field enclosure size (in mm)	300 x 300 x 160	300 x 600 x 160	150 x 260 x 90
Weight for 12 spurs in stainless steel enclosure	22 lbs	42 lbs	7 lbs
Control room footprint for eight redundant segments (in m^2)	0.163	0.097	0.062
System Mean Time Between Failures	Better	Good	Best
Field enclosure certification requirements	• Enclosure must be suitable for environment • In-service modifications permitted	• Enclosure must be suitable for environment. For ATEX areas: • Enclosure must be Ex Certified together with all internal components, and suitable for environment • No subsequent modification permitted • Ex e cable glands	• Enclosure must be suitable for environment • In-service modifications permitted

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