

# Fieldbus Intrinsically Safe Barrier and Repeater SB312-LP Datasheet



## Features

- H1 Isolated Barrier and I.S. Power Supply
- Built-in H1 Fieldbus Signal Repeater
- Bus termination on Hazardous side
- Provides up to 80mA at 14V to the Hazardous Network for field devices
- Can be installed in safe area (Div. 2/Zone 2 or Div. 1/Zone 1)
- Conforms to IEC 1158-2, 31.25 Kbit/s standard for Foundation Fieldbus and PROFIBUS
- Complies with FISCO I.S. model
- FM & CENELEC Intrinsic Safety standards certified
- Based on PTB Report W-53, "Investigations into Intrinsic Safety of Fieldbus Systems"

## General Description

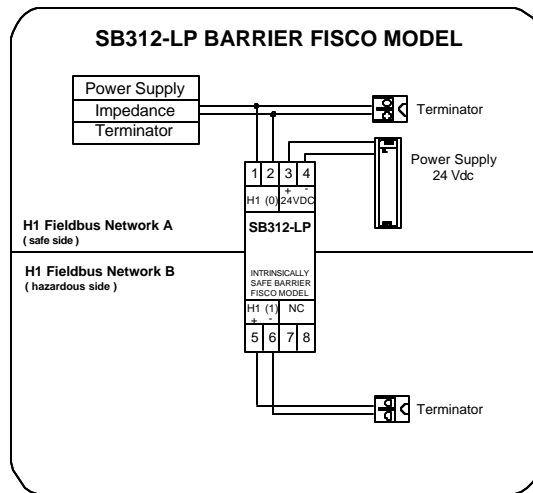
The SB312-LP uses Intrinsically Safe (I.S.) technology to completely isolate the control network on the hazardous side of the barrier. It supplies up to 80mA to field devices located in the hazardous area in accordance with the FISCO model.

The incorporated repeater (operating in compliance with IEC 1158-2 specifications at 31.25 Kbits/s) cleans and boosts the incoming communication signal, transmitting it to instruments

inside the hazardous environment without compromising the safety requirements of explosion proof wiring. The networks on the hazardous and safe sides of the SB312-LP are completely independent of each other.

The SB312-LP also incorporates bus termination for the hazardous network in its design so that only one far terminator is required and up to a 2.5 mm<sup>2</sup> (12 AWG) conductor can be used.

## Design Techniques



### Mechanical Isolation

Mechanical Isolation is the most important technique to preventing intrinsically safe circuits and non-intrinsically safe circuits from contacting each other. The SB312-LP uses spacing and partitions to achieve mechanical isolation.

### Electrical Isolation

Electrical Isolation of the SB312-LP uses protective transformers to create electrical isolation between the hazard and non-hazard circuits.

One transformer is placed at the power supply and two are placed between the safe and hazardous area for communication signal isolation.

### Current and Voltage Limiting

Voltage limiting is accomplished in the SB312-LP by using redundant zener diodes. Current limiting is accomplished through the use of metal film or wire wound resistors of high reliability.

## Technical Characteristics

### Power

**Power Supply Input** Rated Input Voltage: 24 VDC  $\pm$  5 %

### Hazardous Area

**Power Supply** Maximum Voltage available at the barrier terminals at maximum  
Maximum current: 80 mA @ 14V  
Short Circuit Electronic Protection: Trigger @ 100 mA  
Steady State @ 45 mA

**Safety Parameters (Hazardous Area)** Open Circuit Voltage (Voc): 15 VDC and Power: 1887 mW  
Short Circuit Current (Isc): 221.7 mA, Is=125.8 mA at 15V  
Max. Allowed Capacitance: Refer to FISCO standard  
Max. Allowed Inductance: Refer to FISCO standard

**Internal Dissipation** 3W maximum at 24V input, nominal Conditions

**Cable Length Parameters\*** 15 Ohm/km  $= <R' <= 150$  Ohm/km  
0,1 mH/km  $= <L' <= 1$  mH/Km  
80 nF/km  $= <C' <= 200$  nF/km

**Digital Signal Transmission** Compatible with 31.25kbit/sec – Fieldbus systems

**Fuse** Safe area Power Supply: 400mA  
Hazardous area: 125mA  
Safe Area Fieldbus: 100mA

**Terminals** Accommodate conductors up to 2.5 mm<sup>2</sup> (12AWG)

**Isolation** 2500V galvanic isolation between input, output, and power supply terminals. Tested at 1500Vrms minimum between hazardous and safe area terminals.

### Physical

**Ambient Temperature** -20° to + 60°C (Continuous operation)  
-40° to + 80°C (storage - off line)

**Humidity** -5% to 95% relative humidity

**Marking** Ex II (1)G [Eex ia] IIB/IIC  
Ex I M2 [Eex ia] I  
SB312 – I.S. Barrier: It should be physically located in a safe area

\* Refer to FISCO standard to see other restrictions applied.

## Installation

Installation should always be performed by competent, trained personnel. Contact SmarResearch or your local representative for further information.

The installer of an intrinsically safe system must install the system in compliance with all local codes and intrinsic safety requirements. In the United States reference should be made to Article 504 of the National Electrical Code, the ISA RP 12.6 and to SmarResearch's control drawing.

### Location

The barrier is normally installed in a dust-free and moisture-free NEMA 4 or 12 enclosure located in the non-hazardous area. The enclosure should be located as close as possible to the hazardous area to reduce cable runs and increased capacitance. If the barrier is installed in a hazardous area, it must be in a proper enclosure suited for the intended area. The only intrinsically safe terminals are at the barrier output.

**IMPORTANT**  
**BEFORE PROCEEDING TO INSTALL**  
**AND WIRE THE SB312-LP, READ AND**  
**THOROUGHLY UNDERSTAND THESE**  
**INSTRUCTIONS.**

### Wiring

Intrinsically safe circuits may be wired in the same manner as conventional circuits installed for unclassified locations with two exceptions:

- The intrinsically safe conductors must be separated from all other wiring by placing them in separate conduits or by a separation of 2 inches of air space.
- The raceways, cable trays, open wiring, and terminal boxes must be labeled "Intrinsically Safe Wiring" to prevent interference with the other circuits.

### ***Installation Principles defined by the ISA***

- 1 Ensure that there is positive separation of intrinsically safe and non-intrinsically safe circuits so that ignition capable energy from non-intrinsically safe circuit does not intrude into the intrinsically safe circuit.
- 2 Ensure that the limiting parameters of system design, total inductance and capacitance for example, upon which approval of the system is based are not exceeded.
- 3 Ensure that power system faults and ground potential differences do not make the system ignition capable.

## Intrinsic Safety

In industrial processes where flammable or explosive materials are handled any leak or spill can cause an explosive, dangerous atmosphere. These conditions occur in many industrial environments, most typically those involving petroleum and other chemicals, process gases, metal and carbon dust, alcohol, grain, starch, flour, and fibers. To protect both personnel and plant, precautions must be taken inside these hazardous areas to protect both personnel and plant. In the past pneumatic controls were used in these environments to avoid the risk of electrical spark. Today, while pneumatic equipment is still used, new technologies and engineering advances have created a wide range of electrical controls which allow far greater functionality, and still maintain a safe operating environment.

Many of these new technologies and advances as they apply to process measurement and control fall into a category of engineering know as Intrinsic Safety.

Intrinsic Safety methodology inserts an energy-limiting interface in the wiring between safe and hazardous areas. This restricts the electrical energy in the hazardous-area circuits so that potential electrical sparks or hot spots are too weak to cause ignition. The interface passes signals in both directions but limits the voltage and current that can reach the hazardous area under fault conditions. Intrinsic Safety became popular for many applications in the early 1960s with the introduction of the 'shunt-diode safety barrier' based on the Zener diode, and is now the preferred solution

in most applications for several reasons:

- Advances in semiconductors allow increasingly complex electrical operations to be carried out in hazardous areas at very low (typically 1 watt) power levels.
- Hazardous-area equipment can be calibrated and serviced 'live'.
- Ordinary instrument wiring can be used in hazardous areas.
- It is Inherently safe for personnel due to the low voltages employed.
- International standards governing the design of Intrinsically Safe equipment allow the same product to be sold and used in many countries.
- With a certified IS interface, safe-area equipment needs no certification and the user can choose or change the hazardous-area equipment within wide limits.

Regulations governing the installation of electrical equipment in a hazardous area are issued on national, regional, and local levels. In the United States specific regulations from Federal, State, and local agencies must be observed; In Canada regulations from the national, provincial, and city governments must be followed. In Europe European Union regulations define the general specifications and methods of protection against explosion, while national requirements primarily cover installation criteria. **IT IS ESSENTIAL TO DETERMINE ALL OF THE APPROPRIATE REGULATORY REQUIREMENTS PRIOR TO ELECTRICAL DEVICES IN HAZARDOUS AREAS.**

## Instrument Classifications

DIN EN 50014.

Electrical instruments for explosion groups I and II and temperature classifications T1 - T6

DIN EN 50020.

Design and test specifications and model identifications for intrinsically safe instruments.

Approvals for electrical instruments that are used in explosive environments are regulated by EG-Ex-Framework Guidelines 76/117/EEG and Guideline 94/9/EEG.

## Intrinsic Safety Circuit

An Intrinsically Safe Circuit is one that does not create electrical or heat effects which might compromise the safety of the area or materials being handled. The regulation defining Intrinsic Safety, EN 50020 [2] defines Intrinsic Safety as follows:

*“A circuit in which any spark and any thermal effect produced in the conditions specified in this standard, which include normal operation and specified fault conditions, is not capable of causing ignition of a given explosive gas atmosphere.”*

Intrinsically safe circuits or equipment are classified in two categories, “ia” or

“ib”, with “ia” providing the greater safety level. The primary difference between the two levels involves fault analysis. Devices in category “ia” can have two faults as defined by the standard without impairing the Intrinsic Safety of the circuit. Devices in category “ib” will only protect the circuit after suffering from one fault..

## Intrinsic Safety Barrier

*(Associated Apparatus)*


An Intrinsic Safety Barrier (Associated Apparatus) is a device typically placed in a non-hazardous or safe location that permits the electrical connection of devices located in a hazardous area. The barrier limits the power that can be introduced into the hazardous location to energy levels which are safe for the material being handled or process being performed in that area by protecting against the following faults:

- 1 - Shorting of the wires connected to the hazardous area side of the barrier.
- 2 - Grounding of the wires connected to the hazardous area side of the barrier.
- 3 - Misconnection or failure of the power supply allowing an unsafe voltage to be applied to the safe area side of the barrier.

**SB312 - BARRIER FISCO MODEL**  
**Smar Research Corporation**

Safety Parameters:


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APPROVED

Intrinsically Safe Connections for,  
CL I, DIV 1, GP ABCD and CL I,  
ZONE 0, GP IIC [AEx ia] IIC

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DMT 01 ATEX E 0005X  
II (1)G [EEx ia] IIB / IIC  
I M2 [EEx ia] I

Non intrinsically Safe Fieldbus Signal Circuits.  
Voltage Um 250V AC - Max. Tamb. 60 C

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Intrinsically Safe Fieldbus Supply - and Signal Circuit (FISCO)			
Voltage	Uo	DC	15.0V
Short circuit current	Io		221,7mA
Supply current at 15V	Is		125.8mA
Power	Po		1887mW
Current limiting resistor	Ri	>=	156.42 ohm
Characteristics	Trapezoidal		

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## Barrier Safety Parameters

A Barrier is evaluated for the maximum energy levels capable of being discharged through its circuit under the defined fault conditions, including the opening, shorting and grounding of the intrinsically safe leads. Voltage and current determine the maximum capacitance and inductance that can be “seen” by the barrier on the hazardous side, and are represented in the form of Safety Parameters consisting of some combination of the following values:

**Voc or Vt** - Maximum open-circuit voltage

**Isc or It** - Short circuit current if the terminals on the hazardous area side are shorted:  $I_{sc} = V_{oc}/R$

**Pt** - Power transfer

**Rmin** - Minimum resistance value for the shunt resistor

## Intrinsically Safe Devices (Intrinsically Safe Apparatus)

Intrinsically Safe Devices are products such as transmitters and positioners designed to be connected to an intrinsically safe circuit. Intrinsically

Safe Devices are evaluated for the maximum voltage and current they are able to withstand before internal component failures begin, resulting in an excessive buildup of heat and subsequent ignition of the surrounding hazardous material (usually a fuel-air mixture). They are also evaluated for the amount of stored capacitance and inductance that may be discharged under predefined fault conditions. Circuit modifications may be required to either limit or prevent such a condition.

Devices that have energy storing or generation characteristics of > 1.2 V, 0.1 A, 25 mW or 20 mJ require evaluation for use in Intrinsically Safe circuits. Approved devices will receive one of the following approval ratings:

## Loop Approval

The device has been evaluated in combination with Associated Apparatus (barrier, isolator, etc.) and is approved for installation in the approved combination only. Any changes to the device, Associated Apparatus, or wiring require re-approval.

### Entity Approval

The intrinsically safe apparatus and associated devices are independently evaluated, according to a consistent standard. The devices are combined in a loop on Entity and tested to meet the safety parameters (also called Entity Parameters) shown in the “Comparison of Entity Parameters” table.

Loop and Entity approvals are issued by agencies such as Underwriters Laboratories, Inc. and Factory Mutual Insurance in the United States, CSA in Canada, several European laboratories following CENELEC standards, and in other countries by national laboratories or testing agencies following the specific requirements of those countries.

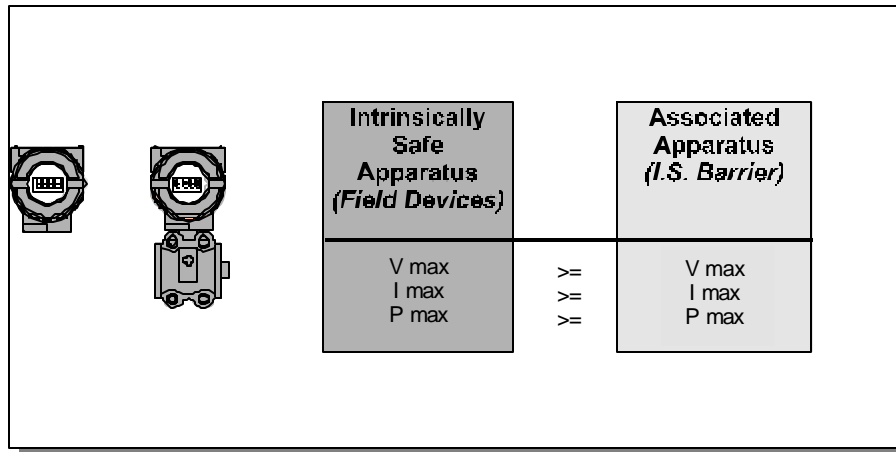
### Intrinsically Safe Devices (Intrinsically Safe Apparatus)

Under the Fieldbus Intrinsic Safe Concept (FISCO), intrinsically safe apparatus will be assigned Entity Parameters which, when properly matched to those of associated apparatus, will constitute an intrinsically safe system. Overall cable capacitance and inductance are added to the intrinsically safe apparatus capacitance and inductance, respectively.

These values include:

- V<sub>max</sub>** - Maximum voltage
- I<sub>max</sub>** - Maximum current
- P<sub>max</sub>** - Maximum power

### Comparison of Entity Parameters





## *Fisco Model - Fieldbus Intrinsic Safe Concept*

- Based on IEC 1158-2 - Physical Layer
- Intrinsic Safe (ib or ia) according to EN50020 and IEC 79-11; Division 1 according to U.S. Standards
- Only one active source (power supply) per system
- Nodes (devices) act as passive current sinks and have negligible inner inductance and capacitance. The maximum internal values of every device is  $L_i \leq 10\mu\text{H}$  and  $C_i \leq 5\text{nF}$
- The network bus line is terminated at both ends

These characteristics permit the optimization of:

- Supply voltage and power for field devices
- Number of field devices
- Length of bus cable
- Variation of cable parameters ( $R'$ ,  $L'$  and  $C'$ )
- Line Terminators
- Gas groups and categories
- Simple I.S. evaluation of installations

The result is more power for field devices as the cable length and two of the terminators have no negative influence on ignition.

### ***FISCO - Ex ia IIC Parameters:***

#### **Power Supply:**

Trapezoidal or rectangular output characteristic only.

$U_o = 14 \dots 24$  V (I.S. maximum value)

$I_o$  according to standards such as to PTB Report W-39 (Ex. up to 215 mA for  $U_o = 15$  V, group IIC)

#### **Cable:**

There is no specification of  $L_o$  and  $C_o$  in the certificate and on the label of the device. There is no safety restrictions on cable length up to 1000m ( $R'$ : 15.....150/km,  $L'$ : 0.4.....1 mH/km,  $C'$ : 80.....200 nF/km)

#### **Terminators:**

RC Elements,  $R = 90 \dots 100$  Ohms and  $C = 0 \dots 2.2$   $\mu\text{F}$

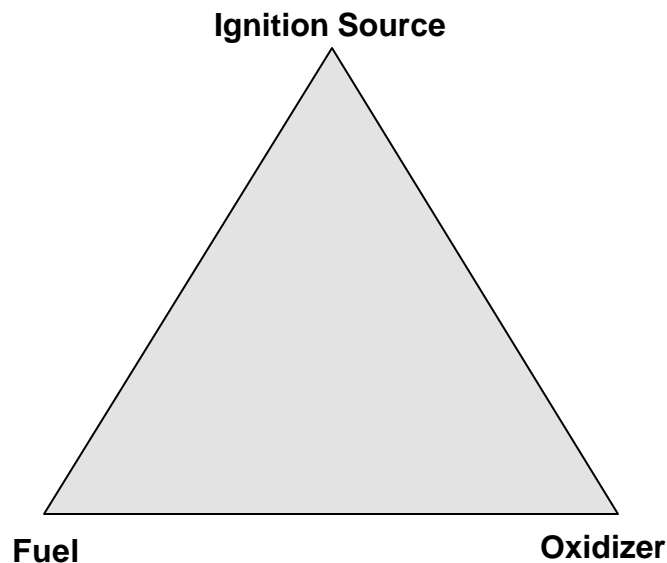
## Hazardous Area Classification

The United States National Electrical Code defines Hazardous atmospheres and designates them by degree of hazard. Class, Division and Group are used to categorize the general form of hazardous material (vapor, dust, fibers), the degree of hazard, and the specific material in the atmosphere. A barrier must be selected that is suitable for use as defined by these classifications. (Detailed information is available in the United States National Electrical Code, Chapter 5, Article 500.)

A certified Barrier is able to safely deliver limited electrical energy to a device located in specifically classified areas and can safely accept signals from

associated elements of the same device, eliminating the risk of an explosion and/or excessive temperature of these devices.

Area classification methods provide a precise description of the hazardous material that may be present and the probability that it is present, so that appropriate equipment is selected and installed properly. Every area classification specifies in some way what kind of flammable material may be present and the probability that it will be present.



## Selected Safety Terminology

**The ignition capability of an electrical circuit** is determined by the electrical energy available and the manner in which such energy is released. Energy may be released in the form of a spark, by resistive heating effects or a combination of the two.

There are three basic mechanisms by which electrical energy may be released in the form of spark discharge:

- Discharge of a capacitive circuit
- Interruption of current in an inductive circuit
- Make-break of a resistive circuit

The minimum ignition energy for any flammable mixture is the smallest amount of energy released as a spark and sufficient to ignite the mixture at 0 psi.

**The most easily ignited air mixture** is that mixture of a flammable material in air that requires the minimum amount of energy for ignition. The flammables are usually designated in % by volume in air.

**Normal operating conditions** include maximum supply voltage and the extreme environmental conditions that fall within the rating given for the specific equipment under investigation.

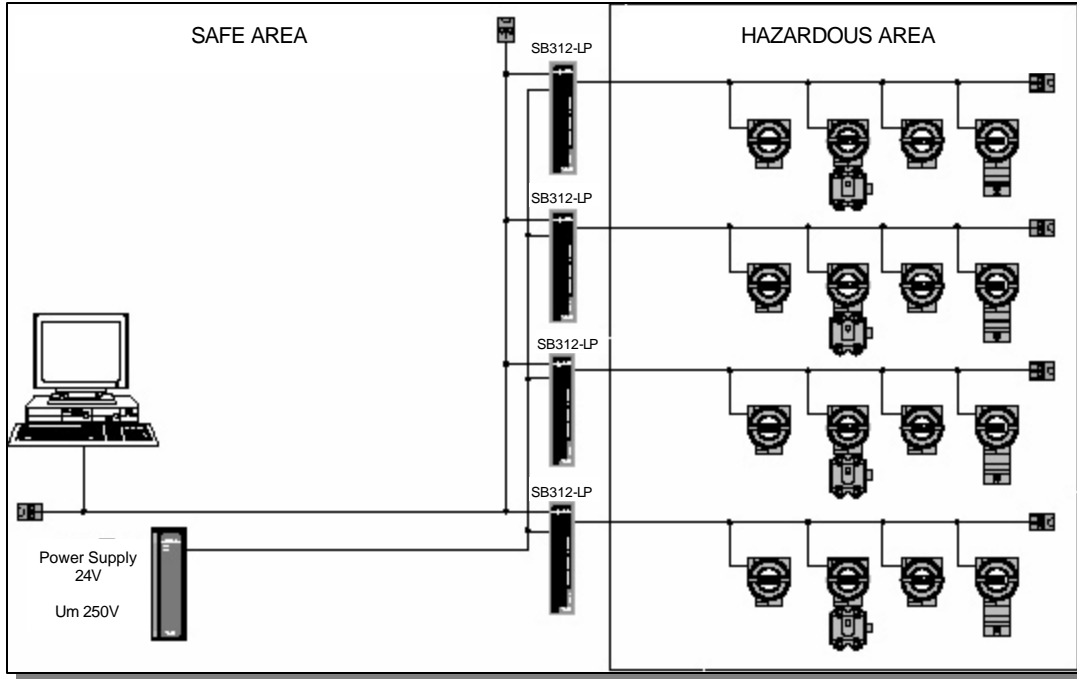
**Abnormal operating conditions** usually refer to any two mechanical or electrical faults occurring in combination. The faults are independent and include accidental damage to, and failure of, components or wiring.

**Intrinsically Safe electrical equipment** and associated wiring are incapable of releasing sufficient electrical or thermal energy under normal or abnormal operating conditions to cause ignition of a specific hazardous mixture in its most easily ignited concentration in air. The flammable material may be a gas or vapor.

**Independent testing laboratory approval** is based on examination and tests of samples of production quality equipment, and inspection of manufacturing and quality control facilities. Of particular consideration are the adequacy of design and workmanship, uniformity and dependability of production, effectiveness of quality control, functional suitability, assurance of availability of service and replacement of parts.

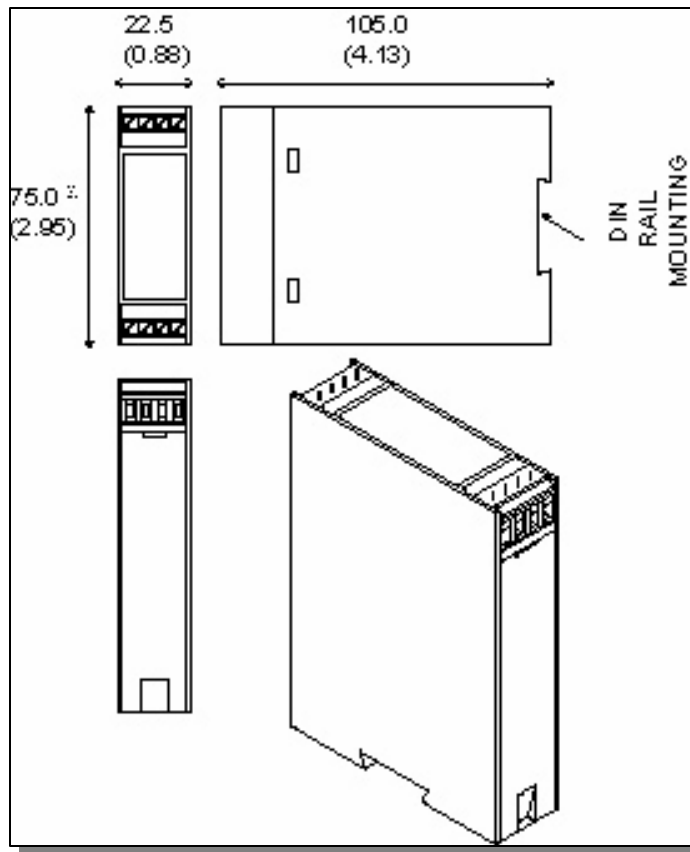
To be completely assured of an Intrinsically Safe installation, all equipment used must be approved; and the installation, including the wiring plus all of the inputs, must meet the requirements of isolation to avoid any failures that may occur in its system.

# Typical Topology



Intrinsic Safety

## Mechanical Dimensions



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