EMERSON
Process Management

PlantWeb University

Fieldbus 203

Intrinsic safety

Overview

Is intrinsic safety handled the same way with fieldbus as with analog devices?

In the analog world, intrinsic safety is based on well-known practices.

- Each input and output has a dedicated barrier
- Intrinsically safe points and conventional points are on separate field wires.

In the fieldbus world, intrinsic safety brings some new practices -- and some new advantages.

- Several devices may be on a single barrier, and several barriers may be on a single fieldbus segment
- Both intrinsically safe points and conventional points may coexist on the same segment
- Fieldbus intrinsic safety may be more flexible and more cost effective.

This course looks in more detail at how intrinsic safety works in a fieldbus-based architecture.

Hint: As you go through the topics in this course, watch for answers to these questions:

- *What is the ignition point?*
- *What is the maximum current draw for an intrinsically safe barrier?*
- *How can multivariable devices reduce the number of barriers required?*

Intrinsic safety models

Devices and barriers for intrinsically safe areas are designed so that the energy released by an electrical fault is not enough to cause ignition, even in a single or double failure condition. The ignition point is a function of power, determined by voltage and current.

How much current is allowed on an intrinsically safe segment -- as well as segment voltage, choice of barriers, and device count on each barrier -- depends not only on the type of hazardous atmosphere in which the devices are located, but also on which intrinsic safety model you use.

For fieldbuses, there are two models:

- The **Entity** model assumes the electrical parameters that represent the characteristics of the wire are all concentrated at the point of a fault. In this model, the wire is considered a source of stored energy. This conservative approach leads to a maximum DC current of 83 mA permitted in the wire and a maximum voltage of 18.4 V.

This model is well known and recognized worldwide.

- The Fieldbus Intrinsically Safe Concept or FISCO model considers the electrical wiring parameters to be distributed along its entire length. This reduces the energy available at a fault, resulting in a maximum current of 110 mA. This model permits more devices on a wire pair in a hazardous area.

  FISCO is not a worldwide standard. It is, however, a Euronorm and part of the FOUNDATION fieldbus specifications (Physical Layer Profile).

Intrinsic safety barriers are certified on the basis of one model or the other. Field devices can be certified for both.

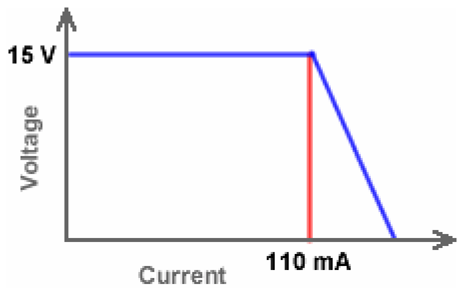
Despite the differences between the two models, the basic concepts for designing an intrinsically safe segment are similar. The remaining sections of this course describe those concepts using the FISCO model.

The ignition curve

Each type of atmosphere requires a certain minimum power for ignition. The plot of the voltage and current points that provide that power is called the ignition curve.

Because power is voltage times current, as voltage increases, the maximum amount of current required for ignition decreases. And, conversely, as voltage decreases, the maximum amount of current required for ignition increases.

In a segment using the FISCO model, the maximum current allowed is 110 mA in a Class IIC environment. This means that the **total current draw** for ALL devices on this barrier is 110 mA.

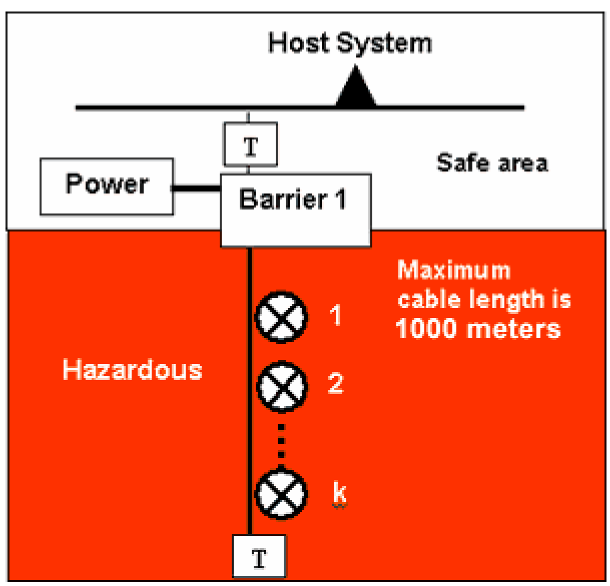


Designing an intrinsically safe segment

To calculate how many devices a single barrier can support, you add the individual current draws of each device — since each device type has a potentially different current draw.

For the FISCO model, as long as the total current draw is under 110 mA for gas groups A and B, and under 235 mA for gas groups C and D, the segment on the hazardous side of a barrier is intrinsically safe. You must also consider the electrical parameters of each device and be below the amounts permitted for the hazardous area classification.

In the example shown in the diagram, a single barrier is placed on a segment between the segment power conditioner and the field devices. There is a terminator in the safe area and in the hazardous area.



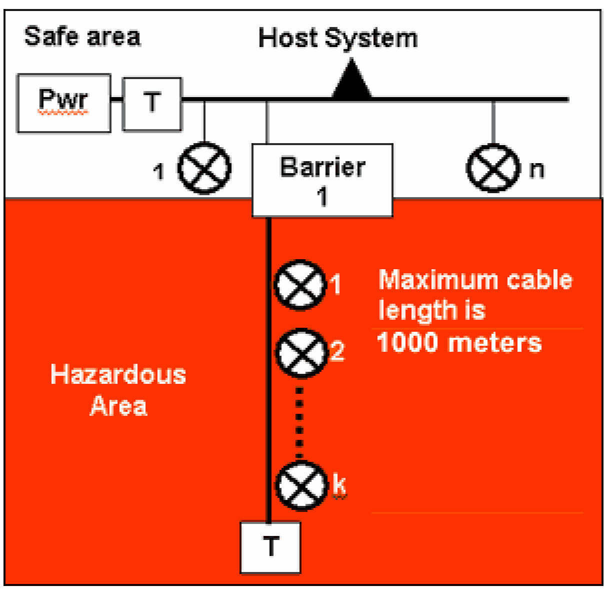
Here are some example calculations to determine the number of field devices allowable in this example. The current consumptions listed are for illustration purposes only and do not reflect the actual current consumption of specific devices or device types:

Temperature monitoring.
If a temperature transmitter uses 16 mA of current, a maximum of six (6 x 16 = 96) transmitters could be placed in a hazardous environment on a single barrier. For Class IIB gases, the maximum current is 240 mA, allowing 15 devices per barrier.

Temperature and pressure compensated mass flow.
In this case, the temperature transmitter uses 16 mA, a pressure and DP transmitter each use 20 mA, and a control valve uses 25 mA. All four of these devices could be placed on the same barrier in a Class IIC hazardous environment (16+20+20+25=81).

Combining safe and hazardous areas

There may be occasions when it's desirable to have both safe and hazardous areas on the same fieldbus segment. This isn't a problem as long as you follow the simple rules illustrated by the example below.



In this example, there are ***n*** devices in the safe area and ***k*** devices in the hazardous area. The maximum number of devices on a segment is 32. Experience demonstrates that up to 16 devices are acceptable. So ***k+n*** must be less than or equal to 32 or 16, depending on the type of devices being used.

In addition, ***k*** must equal the total number of devices with a combined power consumption of 110 mA or less (remember the ignition curve) with FISCO safety barriers.

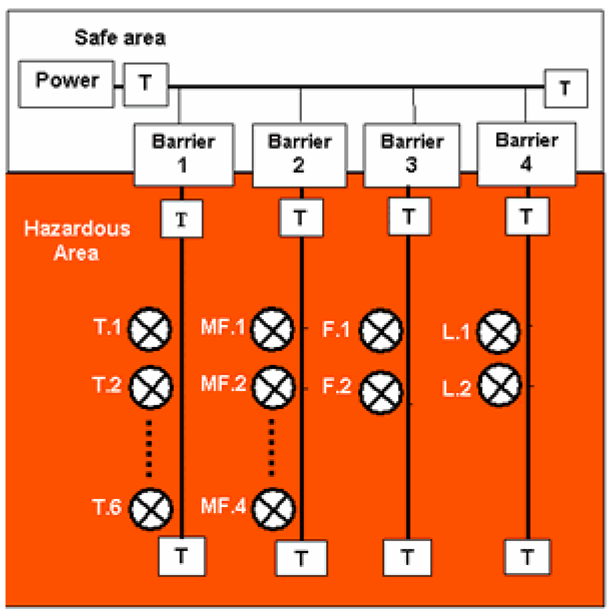
If more devices are desired in the hazardous area, you can use multiple segments, multiple barriers on one segment, or devices with lower power consumption.

Multiple barriers: one approach

Since FOUNDATION fieldbus is a multi-drop bus, there can be multiple barriers on a segment — each on a separate drop. However, if there are more than two barriers on a single segment, galvanically isolated barriers must be used.

Standard isolating barriers tend to distort the fieldbus signal. If more than two barriers are used, it is advisable to use a repeater type barrier. The repeater barrier corrects the signal back to its original shape.

The diagram shows an example of a multiple-barrier configuration using repeating barriers for one fieldbus segment. In the example, the process requires six temperature measurements, a mass flow loop, a liquid flow loop, and a level loop.



As shown, one possible solution is to put each of the four processes on a separate barrier.

Notice in the diagram that there are ten terminators — two on each barrier in the hazardous area, and two in the safe area. This is because with galvanic barriers the part of the segment in the safe area, and each drop in the hazardous area, are considered separate electrical segments. Each electrical segment must have a terminator at each end.

Each barrier powers the devices attached to it.

Note: Each of the four barriers also acts as a repeater. There is currently a limit of four repeater barriers per segment.

From a software addressing and segment communications perspective, all fourteen devices are on a single segment.

Although this is an acceptable configuration, it's not very cost efficient. In the next section, you'll see how to substitute and rearrange devices on barriers to reduce the cost of the segment.

Multiple barriers: a better approach

The digital advantage. One of the advantages of FOUNDATION fieldbus devices is that, being digital, they can have multiple parameters. As such, the previous example can be redesigned by placing all six temperature measurements into a single 8-point temperature multiplexer — thus reducing power consumption from 96 mA to 22mA.

Next, a 4-wire coriolis meter can be substituted for two pressure transmitters and one temperature transmitter — again reducing power consumption, this time from 56 mA to 10 mA.

It's a good idea to have all components associated with a loop on a single barrier. So the new design looks like:

- Barrier 1 - one 6-point temperature mux (22 mA), one liquid flow transmitter (20 mA), and one valve (25 mA). The total current draw is a safe 67 mA.
- Barrier 2 - one 4-wire coriolis flow meter (10 mA), one level transmitter (20 mA), and two valves (50 mA). The total current draw is 80 mA.

Careful selection of intrinsic safety devices can significantly reduce engineering time and complexity, and component cost.

Maximum current draws

The maximum current draw for a segment depends in part on the **physical-layer type** of each device. The Fieldbus Foundation classifies devices as one of two types depending on whether they're self-powered or externally powered, and whether their current consumption is constant or variable:

- **Physical-layer device types 111 and 112** have a constant current draw while transmitting and receiving.
- **Physical-layer device types 121 and 122** have different current draws for receiving (lower) and transmitting (higher).

The Foundation's list of registered devices (available on their website at www.fieldbus.org) shows the physical-layer type for each device.

The maximum current draw for an entire segment is equal to the total current draw for all devices on the segment that have a constant current draw, ***plus*** the transmitting current draw for the device with the LARGEST incremental current draw while transmitting.

Other loads. In addition to current draws for installed devices, temporary current loads may be imposed on the segment. These added loads may include the current draw for bus analyzers or for configuration and maintenance tools.

These additional devices will tend to have their own power — but intrinsic safety requires that these devices NOT inject power to the bus. To ensure this happens, any device MUST draw a minimum of 8 mA from the segment while communicating. It's wise to leave 10 mA of extra available current to allow for connection of temporary devices.

Other intrinsic safety considerations

Even equipment on the safe side of an intrinsically safe environment is subject to rules and regulations.

One device can make the difference. One such rule is that no equipment supplying or sourcing over 250 V RMS AC or DC power can be connected to any part of the safe segment.

In addition, the entire system on the hazardous side of a intrinsic safety barrier is certified at the lowest certification category and gas group of any apparatus in the system. For example, if a single piece of equipment on a category IIC segment is classified as IIB, then the entire system is classified as IIB.

Power supplies. Different types of power supplies can be used for intrinsic safety.

- A **type 133** power supply uses galvanic isolation. It provides a nominal 80 mA to the hazardous area and can connect directly to devices in a hazardous area.
- A **type 131** supply provides a nominal 400 mA for the segment. An intrinsic safety barrier MUST be used between a type 131 power supply and the hazardous area.