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Recommended Practice

Wiring Practices for Hazardous (Classified) Locations Instrumentation Part I: Intrinsic Safety



ANSI/ISA-RP12.6, Wiring Practices for Hazardous (Classified) Locations Instrumentation,
Part I: Intrinsic Safety

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ISA
67 Alexander Drive
P.O. Box 12277
Research Triangle Park, North Carolina 27709

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This preface is included for informational purposes and is not part of ANSI/ISA-RP12.6.

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1 Purpose

1.1* This recommended practice is intended to promote the uniform installation of intrinsically safe systems for hazardous (classified) locations. Information is provided to clarify and explain the requirements of Article 504 of the National Electrical Code[®] (NEC[®]).

1.2 This recommended practice applies to the installation of intrinsically safe systems for use in hazardous (classified) locations.

2 Scope

2.1 This recommended practice provides guidance to those who design, install, and maintain intrinsically safe systems for hazardous (classified) locations.

2.2 This recommended practice should be used in conjunction with nationally recognized codes that cover wiring practices — such as the National Electrical Code[®] (NEC[®]), ANSI/NFPA 70; and the Canadian Electrical Code (CEC) Part I, CSA C22.1.

2.3 This recommended practice is not intended to:

- a) include guidance for designing, testing, or repairing intrinsically safe or associated apparatus, or
- b) apply to the use of portable equipment, except as shown on the control drawing.

3 Definitions

For purposes of this recommended practice, the following definitions apply:

3.1 approved: Acceptable to the authority having jurisdiction (NEC[®]).

3.2 associated apparatus: ([See Clause 4.](#))

3.3 authority having jurisdiction: The organization, office, or individual that has the responsibility and authority for approving equipment, installations, or procedures.

3.4 channel: An ungrounded conductor in a grounded intrinsically safe circuit, or a conductor and its reference in a galvanically isolated intrinsically safe circuit.

* Further information may be found in [Annex A](#).

3.5 control drawing: (See Clause 4.)

3.6 corrective maintenance: Any maintenance activity that is not normal in the operation of equipment and requires access to the equipment's interior. Such activities are expected to be performed by qualified personnel who are aware of the hazards involved. Such activities typically include locating causes of faulty performance, replacement of defective components,* adjustment of internal controls, and the like. Corrective maintenance is referred to simply as maintenance in Clause 6.

3.7 different intrinsically safe circuits: (See Clause 4.)

3.8 entity evaluation: A method used to determine acceptable combinations of intrinsically safe apparatus and connected associated apparatus that have not been investigated in such combination.

3.8.1 Entity parameters for intrinsically safe apparatus:

- C_i : The total equivalent internal capacitance that must be considered as appearing across the terminals of the intrinsically safe apparatus.
- I_{max} : The maximum dc or peak ac current that can be safely applied to the terminals of the intrinsically safe apparatus. The maximum input current may be different for different terminals.
- L_i : The total equivalent internal inductance that must be considered as appearing across the terminals of the intrinsically safe apparatus.
- V_{max} : The maximum dc or peak ac voltage that can be safely applied to the terminals of the intrinsically safe apparatus. The maximum input voltage may be different for different terminals.

3.8.2 Entity parameters for associated apparatus

- C_a : The maximum value of capacitance that may be connected to the intrinsically safe circuit of the associated apparatus.
- I_{sc} : The maximum dc or peak ac current that may be drawn from the intrinsically safe connections of the associated apparatus.
- L_a : The maximum value of inductance that may be connected to the intrinsically safe circuit of the associated apparatus.
- V_{oc} : The maximum dc or peak ac open circuit voltage that can appear across the intrinsically safe connections of the associated apparatus.

3.8.3 Additional entity parameters for associated apparatus with multiple channels may include the following:

- I_t : The maximum dc or peak ac current that can be drawn from any combination of terminals of a multiple-channel associated apparatus configuration.
- V_t : The maximum dc or peak ac open circuit voltage that can appear across any combination of terminals of a multiple-channel associated apparatus configuration.

*See Clause 6.2.1

3.9 galvanic isolation: The transfer of electrical power or signal from one circuit to another by means that do not include a direct electrical connection — e.g., through an isolating transformer or optical coupler.

3.10 hazardous (classified) location: A location where fire or explosion hazards may exist due to the presence of flammable gases or vapors, flammable liquids, combustible dust, or easily ignitable fibers or flyings.

3.11 intrinsic safety: A type of protection in which a portion of the electrical system contains only intrinsically safe equipment (apparatus, circuits, and wiring) that is incapable of causing ignition in the surrounding atmosphere. No single device or wiring is intrinsically safe by itself (except for battery-operated self-contained apparatus such as portable pagers, transceivers, gas detectors, etc., which are specifically designed as intrinsically safe self-contained devices) but is intrinsically safe only when employed in a properly designed intrinsically safe system. This type of protection is referred to by the International Electrotechnical Commission (IEC) as "Ex i." Also see "associated equipment (apparatus)."

3.12 intrinsic safety barrier: A network designed to limit the energy (voltage and current) available to the protected circuit in the hazardous (classified) location, under specified fault conditions.

3.13 intrinsic safety ground system: A grounding system that has a dedicated conductor isolated from the power system, except at one point, so that ground currents will not normally flow and is reliably connected to a grounding electrode in accordance with Article 250 of the NEC® or Section 10 of CEC Part I, CSA C22.1.

3.14 intrinsically safe apparatus: ([See Clause 4.](#))

3.15 intrinsically safe circuit: ([See Clause 4.](#))

3.16 intrinsically safe systems: ([See Clause 4.](#))

3.17 labeled: Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner. (See NEC® reference.)

3.18 listed: Equipment or materials included in a list published by an organization acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials, and by whose listing states that the equipment or material meets appropriate designated standards or has been tested and found suitable for use in a specified manner. (See NEC® reference.)

3.19 nonhazardous location: A location not designated as hazardous (classified). The term "unclassified location" is also used in the NEC®.

3.20 qualified person: One familiar with the construction and operation of the equipment and the hazards involved. (See NEC® reference.)

3.21 simple apparatus: A device that will neither generate nor store more than 1.2 V, 0.1 A, 25 mW, or 20 μ J; for example: switches, thermocouples, light-emitting diodes, connectors, and resistance temperature devices (RTDs).

3.22 wiring drawing: A drawing or other document created by the user based upon the relevant control drawings. The wiring drawing is used by the installer to determine the type, color, and size of the wire used to connect each terminal of the equipment used in the intrinsically safe circuit.

4 Article 504 of the NEC (ANSI/NFPA 70-1993) with explanation

NOTE: Throughout Clause 4, text that has been excerpted from the National Electrical Code[®] (NEC[®]) is distinguished from the main body of text as follows:

- NEC[®] Article 504 text is shaded and indented at the left and right margins.
- Other excerpted NEC[®] text (such as articles on sealing) is shaded but not indented.

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504-1. Scope. This article covers the installation of intrinsically safe (I.S.) apparatus, wiring, and systems for Class I, II, and III locations.

(FPN): For further information, see installation of Intrinsically Safe Instrument Systems in Class I Hazardous Locations, ANSI/ISA RP12.6-1987.

Prior to publication of the 1990 NEC[®], ANSI/ISA-RP12.6, Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations, was the recommended practice for the installation of intrinsically safe systems. The ISA SP12 committee proposed the addition of Article 504 to provide a more enforceable set of requirements for inspection authorities.

504-2. Definitions. For the purpose of this article:

Associated Apparatus: Apparatus in which the circuits are not necessarily intrinsically safe themselves, but that affect the energy in the intrinsically safe circuits and are relied upon to maintain intrinsic safety. Associated apparatus may be either:

1. electrical apparatus that has an alternative type of protection for use in the appropriate hazardous (classified) location, or
2. electrical apparatus not so protected that shall not be used within a hazardous (classified) location.

(FPN): Associated apparatus has identified intrinsically safe connections for intrinsically safe apparatus and also may have connections for nonintrinsically safe apparatus.

Intrinsic safety barriers are a common form of associated apparatus. These barriers are connected between the intrinsically safe apparatus and the control equipment. Their primary purpose is to limit the energy to the hazardous location under fault conditions. They may also provide isolation, signal conditioning, or both. There are also many types of associated apparatus that normally are not referred to as intrinsic safety barriers, but have energy-limiting circuits suitable for connection directly to intrinsically safe apparatus. An example of this type of associated apparatus is a controller that is not itself intrinsically safe, but has connections for intrinsically safe sensors.

Control Drawing: A drawing or other document provided by the manufacturer of the intrinsically safe or associated apparatus that details the allowed interconnections between the intrinsically safe and associated apparatus.

Different Intrinsically Safe Circuits: Different intrinsically safe circuits are intrinsically safe circuits in which the possible interconnections have not been evaluated and approved as intrinsically safe.

Intrinsically Safe Apparatus: Apparatus in which all the circuits are intrinsically safe.

Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under prescribed test conditions.

(FPN): Test conditions are described in Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations, ANSI/UL 913-1988.

Intrinsically Safe System: An assembly of interconnected intrinsically safe apparatus, associated apparatus, and interconnecting cables in that those parts of the system that may be used in hazardous (classified) locations are intrinsically safe circuits.

(FPN): An intrinsically safe system may include more than one intrinsically safe circuit.

504-3. Application of Other Articles. Except as modified by this article, all applicable articles of this Code shall apply.

Although intrinsically safe circuits are inherently low energy circuits, they may still be shock hazards because of the operating voltage.

Clause 500-2 provides an exception for intrinsically safe apparatus and wiring from the requirements of Articles 501 through 503 and 510 through 516. All other articles of the Code apply to intrinsically safe wiring, except as exempted by specific articles.

If the rated voltage of the circuit exceeds 60 volts dc or 30 volts ac, the wiring requirements for Class 3 circuits apply. (See NEC® Article 725.)

Other articles may apply, depending on the functional application — e.g., Article 760 for fire protective signaling systems, Article 800 for communications circuits, and Clause 725-49 for cables installed in ducts, plenums, risers, and other air-handling spaces.

504-4. Equipment Approval. All intrinsically safe apparatus and associated apparatus shall be approved.

Electrical equipment that is listed or labeled by a nationally recognized testing laboratory (NRTL) normally will be accepted by the authority having jurisdiction. The authority having jurisdiction may also accept specialized equipment not listed or labeled by a NRTL, with appropriate technical justification. A written report of the investigation and conclusion should be kept on file, and the markings on the equipment should identify the report.

504-10. Equipment Installation.

(a) Control Drawing. Intrinsically safe apparatus, associated apparatus, and other equipments shall be installed in accordance with the control drawing(s).

(FPN): The control drawing identification is marked on the apparatus.

There are three basic types of control drawings:

- a) Intrinsically safe apparatus and associated apparatus are specified by manufacturer and model number. See [Figure 4.1](#) for an example.
- b) Intrinsically safe apparatus is specified by manufacturer and model number for connection to associated apparatus specified by entity parameters. See [Figure 4.2](#) for an example.

- c) Associated apparatus is specified by manufacturer and model number for connection to intrinsically safe apparatus that is specified by entity parameters or to simple apparatus. See Figure 4.3 for an example.

Control drawings that are combinations of the above types are also possible. For example, control drawings for intrinsically safe apparatus often specify permissible connections to specific associated apparatus and also specify entity parameters to allow additional flexibility in selecting associated apparatus.

To ensure that a given interconnection forms an intrinsically safe system, it is necessary to obtain control drawings that specify each intrinsically safe apparatus and associated apparatus to be interconnected. If a control drawing of the type shown in Figure 4.1 that correctly describes the interconnection is available, only that control drawing is necessary.

If the intrinsic safety of the system is to be based on the comparison of entity parameters, it is necessary to obtain a control drawing for each intrinsically safe apparatus and associated apparatus. Care should be taken to ensure that the entity parameters used in the comparison apply to the specific set(s) of terminals to be interconnected.

If the system includes only simple apparatus connected to an associated apparatus, only the associated apparatus control drawing is necessary. Multiple channels of associated apparatus should not be connected to a single simple apparatus unless specifically permitted by the control drawing.

Frequently, the user creates a wiring drawing based on the control drawings provided by the manufacturers of the intrinsically safe apparatus and associated apparatus or other specification sheets that provide information such as terminal identification.

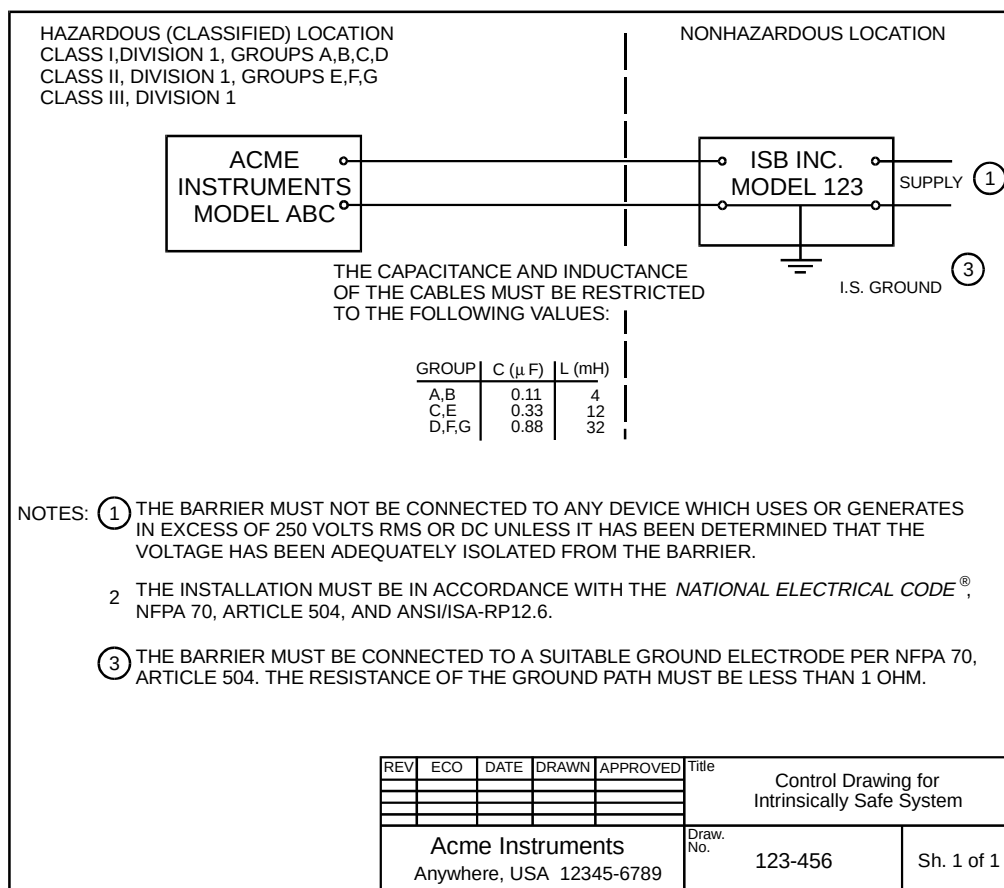


Figure 4.1 — Example of a control drawing for an intrinsically safe system