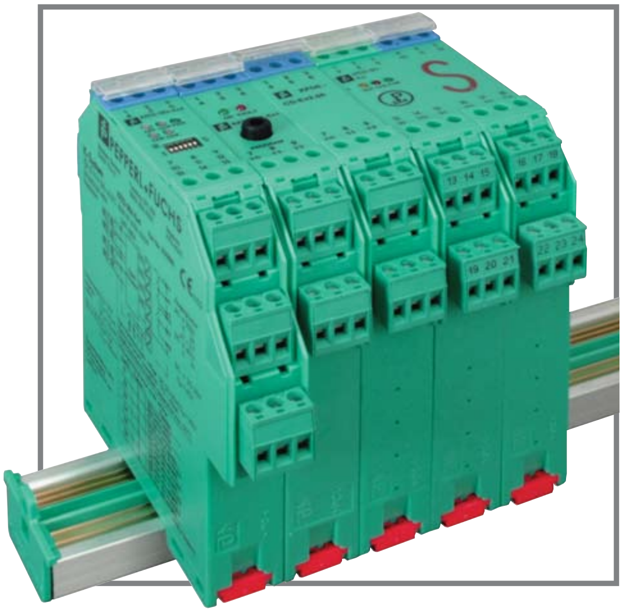
PROCESS AUTOMATION

K-System

Specification Guide

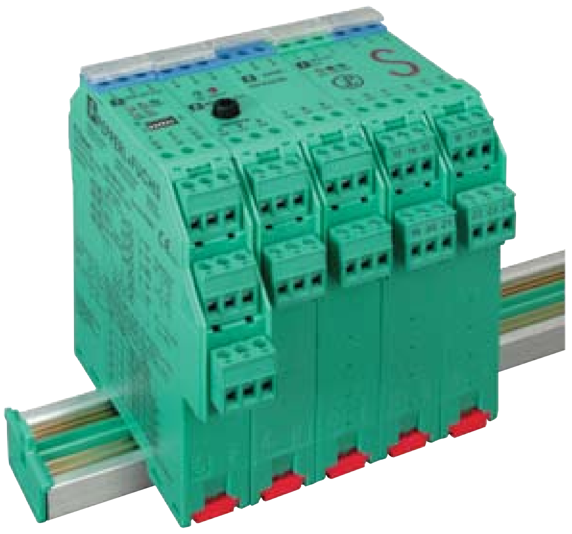


PEPPERL+FUCHS

K-System Isolators

Specification Guide
K-System Isolators
Installation & Operation

Specification Guide
K-System Isolators
Installation and Operation



Introduction

These devices are used in the automation industry for the galvanic isolation of automation signals, such as 20 mA and 10 V unit signals and also for the adaptation and/or standardization of signals. Devices that have intrinsically safe control circuits are used to operate field devices within hazardous areas. The data sheets issued by the manufacturer should be observed.

K-system devices are not suitable for the isolation of signals in power engineering, unless this is specifically referred to in the respective data sheet.

The respective statutory regulations and directives governing the application or intended use should be observed.

Installation and Commissioning in the Safe Area

Installation in the safe area and Div 2/Zone 2

The devices are constructed to satisfy the IP20 protection classification and must be protected accordingly from adverse environmental conditions such as water spray or dirt exceeding the pollution severity level 2.

Only devices with the relevant statement of conformity from an approved test center or covered by the manufacturer's declaration of conformity can be installed in Div. 2/Zone 2.

The individual data sheets indicate whether these conditions are met.

The devices should be installed in a suitable Type or IP rated switch or junction box.

For devices with intrinsically safe circuits, the protected circuit (light blue identification on the device) can be located in the hazardous area. It is especially important to ensure that all nonintrinsically safe circuits are safely isolated. The installation of the intrinsically safe circuits is to be conducted in accordance with the relevant installation regulations.

The respective peak values of the field device and the associated device with regard to explosion protection should be considered when connecting intrinsically safe field devices with the intrinsically safe circuits of K-system devices (demonstration of intrinsic safety).

When intrinsically safe circuits are used in areas made hazardous by dust only appropriately certified field devices must be used.

The certificates of conformity or test certificates should be observed. It is especially important to observe the "special conditions" where these are contained in the certificates.

For More Information . . .

Please refer to Pepperl+Fuchs ***2006 Engineer's Guide*** for additional information about intrinsic safety technology. It includes an applications guide, specific product specifications, and offers detailed technical information about our process automation products.

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Section 1
Installation of Intrinsically Safe and Associated Apparatus

In the United States installation of intrinsically safe and associated apparatus must conform to Article 504 of the National Electrical Code and ANSI/ISA-RP12.06.01. For Canada the Canadian Electrical Code, Part I, C22.1 applies. These standards require that intrinsically safe wiring be separated from non intrinsically safe wiring, and that intrinsically safe wiring, terminals and raceways be clearly labeled. Other considerations such as grounding and shielding requirements are also considered.

The installation of intrinsically safe and associated apparatus must be handled with particular care in order to prevent any intrusion in the intrinsically safe circuits from apparatus and conductors that are not intrinsically safe circuits, if these intrusions could reduce or eliminate the intrinsic safety of the system. To achieve this, it is important to understand the concepts of segregation, separation and clear identification of the intrinsically safe components. In particular:

1. The terminals of the intrinsically safe circuits must be placed at a distance of at least 2 inches (50 mm) from the terminals of the non intrinsically safe circuits, or adequate separators (e.g. grounded metal partitions) must be used.
2. The different types of intrinsically safe circuits do not have to be electrically connected, unless such connection has been specified in the control drawing.
3. The intrinsically safe circuits cannot be metallically connected to apparatus which may have an overvoltage that has been transmitted from power lines or any source of electrical energy. Such a connection is permitted only if it is specified in the control drawing. When different types of intrinsically safe circuits end at the same marshaling terminal, it is advisable to maintain a distance between the relative terminals that is much greater than the 6 mm required by the standard, unless it can be demononstrated that the interconnection between the different types of circuits will not introduce a dangerous energy situation.
4. The properties of intrinsically safe circuits are different if the circuits:
   - Operate at different voltages or polarities
   - Have different barrier grounding points
   - Are certified for different categories or for different gas groups

For the intrinsically safe circuit, installation must be performed so that the maximum allowed value for current and voltage can never be exceeded because of external electric or magnetic fields. For example, proper installation in this case requires the use of cables that are adequately shielded and are separated from the cables of other circuits.

The connection elements—terminal block housing, protective enclosures for cables, the external enclosures for single conductors, and the wiring between intrinsically safe apparatus and associated apparatus—must be clearly marked and easily identified. If a color is used for this purpose, the color must be light blue.

The types of information that must appear, clearly and permanently marked, on the required label for each of the intrinsically safe components are: (1) the identification of the apparatus and (2) all the requirements necessary to maintain the intrinsic safety of the system (or the essential elements of the design document containing such requirements must be clearly marked).

For devices such as terminal blocks and switches, additional certification or specific marking is not required.

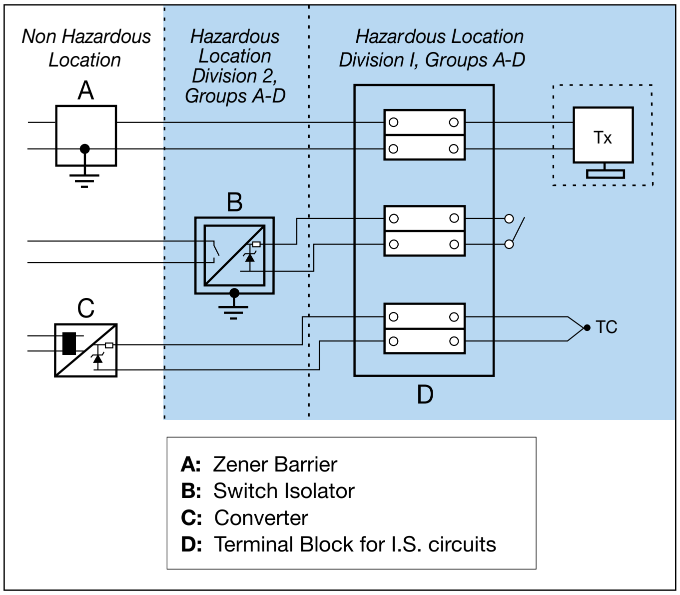


Figure 1.1

Example of different types of intrinsically safe circuits

Protection Ratings for Enclosures

Indoor enclosures

Required by the standards for enclosures of intrinsically safe and associated apparatus, Type 1 is the minimum degree of protection for enclosures that are installed in indoor and/or protected areas. (refer to the *Additional Information* section for a detailed presentation of Type protection ratings).

Outdoor enclosures

For outdoor enclosures, a protection degree of Type 4 or 4X is required. It is important to consider protection ratings of enclosures for intrinsically safe and associated apparatus in the context of the overall functionality and safety of the plant.

The *Additional Information* section presents the European enclosure protection rating system.

Cable Capacitance and Inductance

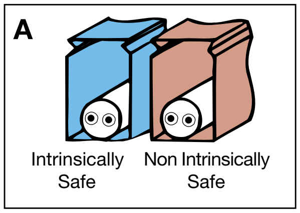
When designing and installing intrinsically safe systems, keep in mind that capacitance and inductance parameters of the connecting cables are important factors, even if they are not always determining factors.

The capacitance and inductance values of the cable (generally, given in pF/m and µH/m) should be easily available from the cable manufacturer. However, if there are difficulties in obtaining this data, the following values can be hypothesized (but only in an extreme situation).

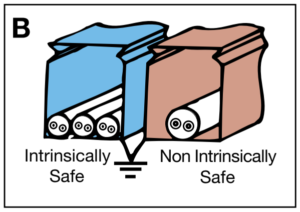
Capacitance: 60 pF/ft (200 pF/m) - Inductance: 0.2 µH/ft (1 µH/m)

As an alternative to the inductance, another characteristic of the cable, the inductance/resistance ratio (L/R), can be used and is normally given in μH/Ω This parameter permits more flexibility in the cable installation process.

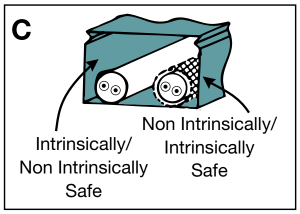
Refer to Figure 1.2 for examples of cable installation and to Figure 1.3 for examples of wiring in small enclosures containing associated apparatus.



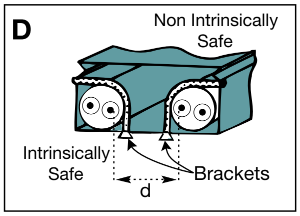
The cable of the intrinsically safe circuits and the cable of the non intrinsically safe circuits are installed in two different isolated trays.



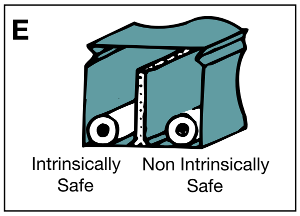
The cable of the intrinsically safe circuits and the cable of the non intrinsically safe circuits are installed in two different metallic grounded trays.



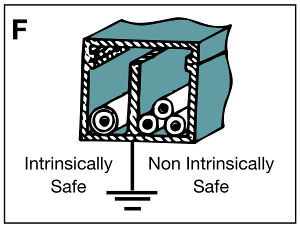
The cable of the intrinsically safe circuits and the cable of the non intrinsically safe circuits are installed in the same tray; one of the cables is protected by a grounded shield capable of carrying fault current to ground.



Installation as above, but the cables are separated by anchor brackets. The distance "d" must conform to the standards with a minimum of 50 mm.



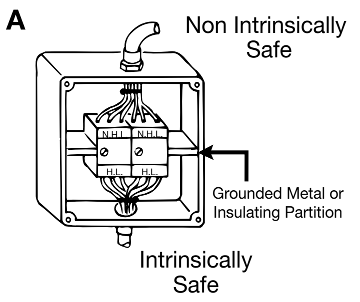
Installation as above, but the tray must have an isolated intermediate separator.



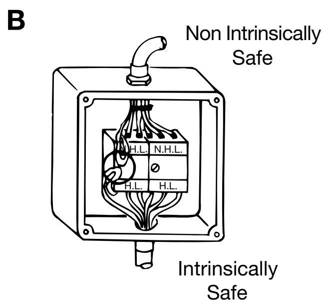
Installation as above, but the tray and the separator are metallic and grounded.

Figure 1.2

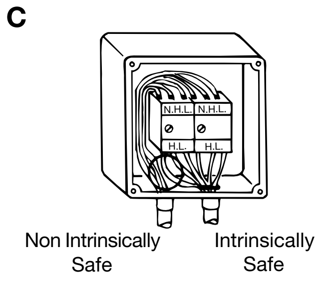
Examples of cable installation



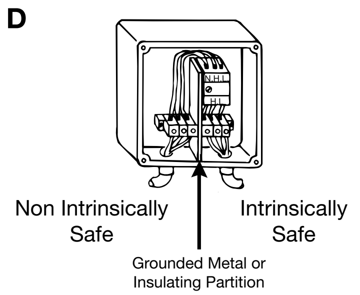
Correct:
When installing the wiring as shown, the minimum required distance between intrinsically safe and non intrinsically safe conductors is guaranteed.



Incorrect:
Several conductors are of excessive length.



Incorrect:
A separation does not exist between intrinsically safe and non intrinsically safe conductors.



Correct:
The maximum distance between the lid and the separator must be less than 1.5 mm; or the separator must guarantee a distance in air around the lid of at least 50 mm between the terminals of the intrinsically safe circuit and the non intrinsically safe circuit.

Figure 1.3

Examples of wiring in small enclosures containing associated apparatus

Grounding of Intrinsically Safe Plants

Intrinsic safety standards require that certain points of the system must be grounded and others must be isolated from ground. Generally, the grounding of intrinsically safe circuits is required to prevent or even to reduce the probabilities that excessive energy levels can be generated in the hazardous location.

The isolation from ground of parts of the circuit is required to prevent the possibility of having two grounded points with a different potential and the possible circulation of a high current.

It is also a requirement of intrinsic safety that only one point can be grounded, while the rest of the circuit must be isolated from ground (500 V_{ac} min).

The grounding of intrinsically safe circuits must be accomplished with a conductor that is isolated from any other plant grounds and connected to the reference ground system.

ANSI/ISA-RP12.06.01 has become the authority in the United States on the installation of intrinsically safe equipment. Refer to the applicable standards for grounding practices in other countries.

Grounding of Passive Barriers

From an intrinsic safety point of view, the effective functioning of passive barriers is linked to their capability of diverting to ground the dangerous energy coming from the non hazardous instrumentation devices on which they are connected.

For this reason, it is very important that the ground connection of the passive barrier is made to an equipotential ground system (refer to Figure 1.4).

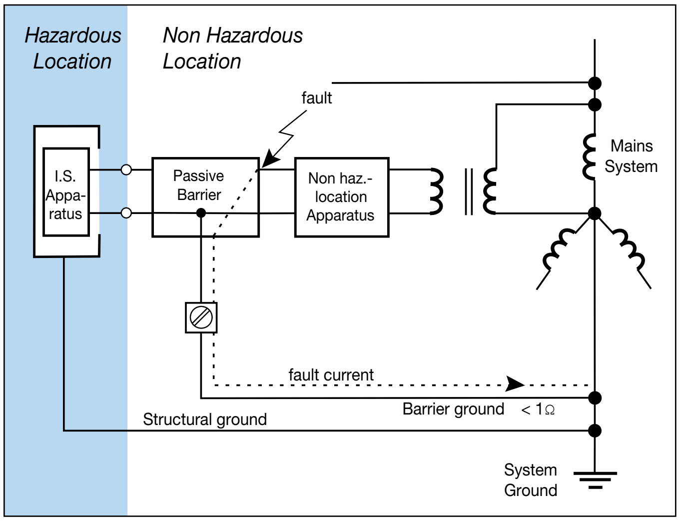


Figure 1.4

Schematic of a grounded passive barrier

The ground connector must be mechanically and electrically reliable and be able to reduce the fault current or the sum of the fault currents, if more barriers are connected to a single-ground bus.

The connecting cable used in grounding the barriers must be at least No. 12 AWG (American Wire Gauge).

The allowed resistance between the ground terminal of the most distant barrier and the isopotential ground point must be less than 1Ω

Barrier ground connections must be separated from any other plant grounds and must be connected to a ground system at only one point.

The required condition of the only ground point implies that a passive barrier cannot be used on interfacing sensors or hazardous location apparatus containing grounded or poorly isolated circuits (i.e., thermocouples with grounded junctions or non isolated transmitters).

The generally accepted practice differs, however, because an equalization conductor (bonding) of the ground potential is usually found in a hazardous location, as shown in Figure 1.5.

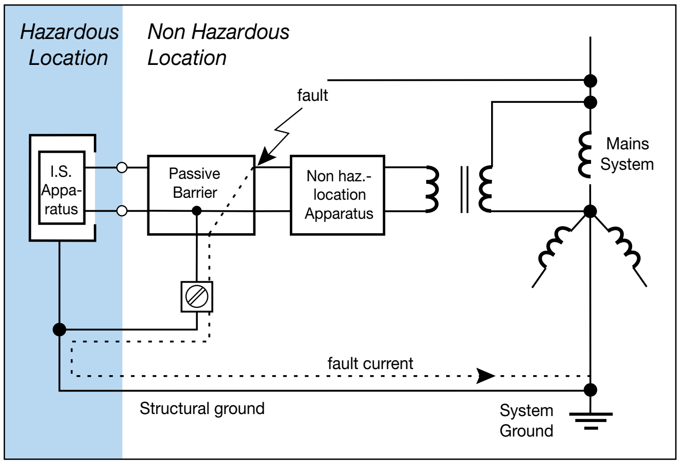


Figure 1.5

Schematic of a ground connector for a passive barrier (used only in Germany)

The fault current, following the route shown, can increase the ground potential of the hazardous location circuits in comparison to the one of the reference ground system. This does not represent a dangerous situation because all of the metallic structures in a hazardous location are connected to the equalization conductor, resulting in an isopotential state. This type of connection is permitted for Zones 1 and 2 in Germany. For Zone 0 applications, the use of galvanic separation, independent from the degree of isolation of the hazardous-location apparatus, is mandatory.

Grounding of Shielded Cables

The use of shielded cables for connecting the hazardous location sensors or transmitters with the non hazardous location control and measurement apparatus is widespread.

From a functional point of view, the shield's purpose is to create an equipotential zone around the conductor's capacitive coupling with that of other conductors. This is only true if the shield is connected to a grounded reference potential.

The shield should be grounded at only one point—preferably, at the system's ground point. If the shield is grounded at two non equipotential points, the current could circulate in the shield, preventing functionality. Therefore, a shielded cable must be provided with an extra isolating coat above the shield to prevent accidental ground contacts.

For intrinsically safe apparatus, the shield acts as another conductor between the hazardous and non hazardous locations and could become the fault current route if the cable is damaged. From this point of view, the principle of isolating the circuit in hazardous locations and grounding it in non hazardous locations can also be applied to the shield.

For passive-barrier applications, the shield can be locally grounded if the galvanic isolation is not damaged by this connection. This means that the two shields at the two sides of the isolation device must not be interconnected.

For applications where shielding is part of the segregation technique between different types of intrinsically safe circuits (i.e., multipolar cables), the reference ground connection of the shields must be the same as the ground connection of passive barriers (refer to Figure 1.6).

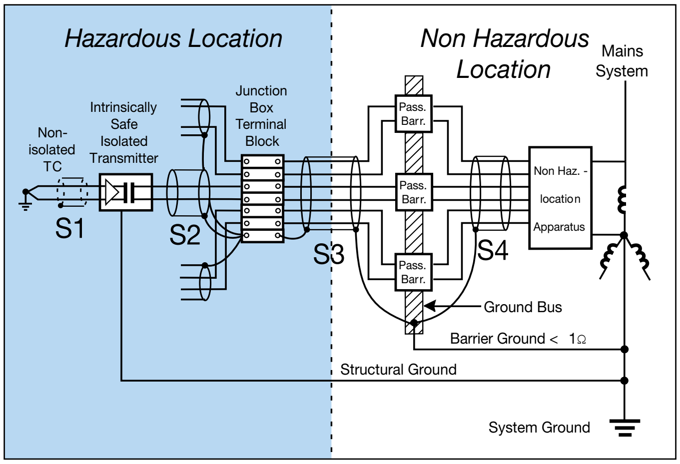


Figure 1.6

Example of shield ground connections

For functional reasons, the S1 shield is connected to the same grounding point as the measuring circuit. This must not be connected to the transmitter's metallic parts in order to prevent the second-circuit ground connection, which is not permitted by the intrinsic safety protection method.

Since the purpose of the field transmitter is to galvanically isolate the thermocouple's circuit from instrumentation in non hazardous locations, there must be no connection between shields S1 and S2.

Shields S2 and S3 provide the shielding of the connection between the transmitter and the barrier. They are interconnected in an isolated point of the junction box terminal block.

S3 is also connected to the barrier's ground bus that, by means of a separate conductor, is connected to the reference ground point.

Shield S4 completes the shielding of the system and is not very important from a safety point of view. It is connected to the shield's reference point, which is represented by the ground bus.

For this type of connection, it is necessary that Shield S2 be properly isolated from the transmitter's metallic structure; otherwise, a situation as shown in Figure 1.7 can occur.

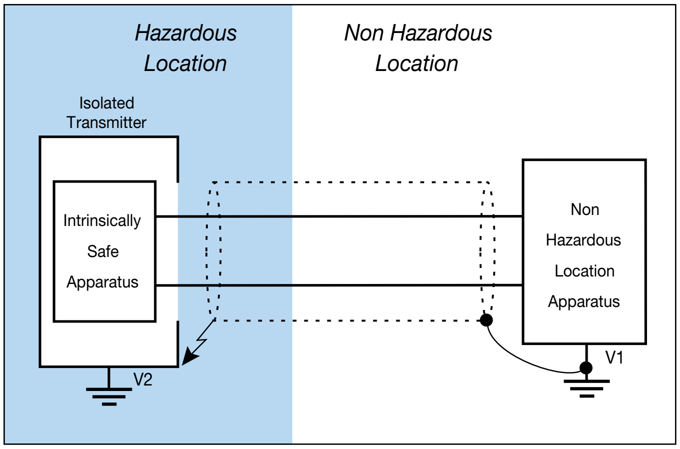


Figure 1.7

Possible dangerous situation for grounding of non hazardous-location shields

When isolation no longer exists between the shield and the transmitter's enclosure, an excessive energy level could be present in a hazardous location if ground potential V1 is different from V2. Since the fault current is limited only by the resistance of the shield and the one existing between V1 and V2, the generated spark could ignite the surrounding potentially dangerous atmosphere.

This situation can be prevented by grounding the shield in the hazardous location; therefore, a spark could occur in the non hazardous location without causing a fire or explosion.

Section 2
Maintenance of Safe Plants

No method of protection is completely safe and human-error proof. Proper maintenance that includes a rigorous initial inspection, verification, and subsequent periodic inspections and repairs is extremely important for the safety and economical management of any instrumentation plant, and becomes fundamental in plants where the danger of fire or explosion exists.

To reduce the risk of catastrophic human errors, it is also important to permit only authorized and competent personnel to repair explosionproof apparatus—as equipment must not be serviced under power. The following maintenance criteria are presented to give the reader a general understanding of what is involved in order to maintain an industrial facility relative to safety. This material is not intended to replace the applicable safety standards.

After the installation and completion of each plant, it is necessary to perform the following three types of inspection/maintenance activities:

1. Initial inspection
2. Programmed maintenance (periodic inspections and repairs)
3. Apparatus failure and repairs

Initial Inspection

Prior to acknowledging and classifying the presence of flammable mixtures and performing the startup of a newly completed, modified or expanded plant containinig hazardous locations, a complete inspection of the plant by qualified personnel must be carried out. An inspection must also be performed if the classification of the hazardous location has been modified. The inspection personnel must provide documentation that verifies the following:

- The adequacy of the entire plant
- The adequacy of all the field elements
- The adequacy of all the associated apparatus
- The agreement between safety parameters and the inter-connected apparatus

Adequacy of the Entire Plant

It is necessary to verify that the protection methods used, in their entirety, are compatible with the hazardous locations and the gas groups present and that the technical rules of each protection method have been strictly followed.

Explosion-proof installations

Specifically, for an explosion-proof installation, verify that:

1. All of the plant's components and electrical lines located in a hazardous location are of an explosion-proof type, with continuity, up to the exit point of the hazardous location or are directly protected with other authorized methods that are properly installed.
2. The apparatus are correctly anchored and do not exert force on the connecting pipes, causing cracks or deformation near the connection points.
3. The locking joints conform to the standard and are properly tightened and sealed.
4. The conductors leading into the junction boxes are firmly anchored but do not risk abrasion or cuts in the isolation.
5. There is no formation or accumulation of condensation in the pipes and/or the enclosure of the apparatus.
6. The explosion-proof enclosures have a reliable external ground connection.
7. If mixed protection methods are used, these methods must be authorized for the specific type of hazardous location and groups of gases and must be properly installed.
8. Adequate space has been allowed for easy removal of the lid during maintenance activities.

Intrinsically safe installations

For intrinsically safe installations, verify that:

1. All of the electrical conductors that route, even marginally, into a hazardous location and are not protected with explosion-proof pipes, and pertain exclusively to intrinsically safe circuits (or, where permitted, increased safety), are properly protected for the respective hazardous locations and gas groups and are installed in conformity with the installation standard.
2. None of the intrinsically safe circuit conductors are mixed with the non intrinsically safe circuit conductors (e.g., multiconductor cables) without respecting, along the entire route, the safety distance and segregation from other conductors and/or terminal blocks, and also its identification as an intrinsically safe circuit.
3. Conductors of different types of intrinsically safe circuits (especially ones with different safety parameters) are properly separated and isolated from each other.
4. If diode safety barriers (passive or non isolated) are used, there exists an isopotential system with plant grounds conforming to the applicable standard, and that the continuity toward ground is guaranteed for each apparatus.
5. Non hazardous-location apparatus that are directly powered with voltages larger than 250 V are not present, unless they are protected and certified for that use.
6. Shields of conductors associated with diode safety barriers are connected to the isopotential ground.
7. The reciprocal and toward-ground isolation, where required, of all intrinsically safe circuits conform to the standard. (Use a test instrument that does not generate more than 1.2 V and 0.1 A, or 25 mW if there is a presence of flammable mixtures in the plant, or shut down the plant and be sure that flammable mixtures are not present.)
8. The markings that specifying different measuring and/or regulation loops are clear and avoid confusion between different types of barriers with different parameters.
9. The barrier input terminals are not confused with the output terminals.
10. Installation conforms to the manufacturer's control drawing.

Adequacy of all the Field Elements

Demonstrate that all of the apparatus installed in hazardous locations are free from the risk of fire or explosion by:
(1) verifying that the apparatus are connected with simple devices (V_{max} Ω1.2 V; I_{max} Ω0.1 A; P_{max} Ω25 mW), or (2) verifying that a protection method is being used that is authorized for the specific installation zone and compatible with the gas groups and temperature class.

Explosion-proof apparatus

Specifically, for explosion-proof apparatus, verify that:

1. All of the apparatus are installed in Division 2, or Division 1 with certain restrictions. (In Europe Zone 1 or Zone 2; Zone 0 does not permit the installation of electrical apparatus using only the explosion-proof protection method.)
2. Certification is compatible with the gas group and surface temperature class of the flammable mixture present.
3. None of the explosion-proof points have been damaged during transport or installation.
4. All of the openings toward the outside of the enclosure have been used (flame break joint, conduit [pipe] joint) or properly sealed with explosion-proof caps that are properly tightened.
5. All of the removable lids are integral, closed and tight (lid bolts all present and tight; screw-type lids tightened completely and equipped with devices against accidental unscrewing).
6. All of the threaded junctions are integral and protected against corrosion.
7. Each enclosure has an external ground connection properly tightened and efficient.

8. Warnings stating that the power should be shut down before opening are always present on the lids and/or the labels.

Intrinsically safe apparatus

For intrinsically safe apparatus or for simple electrical devices, verify that:

1. They have, where required, a type of certification that is suitable for their hazardous location and the gas groups corresponding to the flammable mixtures present.
2. They have, where applicable, a surface temperature classification compatible with the flammable mixture present (e.g., T6).
3. They are exclusively connected to intrinsically safe circuits, in the manner specified by the certification documents, especially for the eventual connection to alarm safety apparatus, and that the safety parameters of the connecting cables have been respected.
4. They are, where applicable, powered or interconnected with associated apparatus having safety parameters compatible with the apparatus and the proper protection method.
5. They have a grounded enclosure, or if a plastic enclosure is used, that the risk of electrostatic discharge is not present (warning labels, etc.) and, if required, that they are installed with the proper environmental protection.
6. They do not have points of the circuit grounded or poorly isolated toward ground, only if connected with diode safety barriers without galvanic isolation, with the exception of the equipotential ground connection on the barrier.
7. The eventual loosening of cable clamps or conductor input joints does not jeopardize the tightness of the enclosure against water and corrosive atmospheric elements.

Adequacy of all Associated Apparatus

For the adequacy of the associated apparatus, verify that:

1. They have been exclusively installed in a protected non hazardous location, unless other protection methods that are suitable for the hazardous location have been used.
2. The type of certification is compatible with the intrinsically safe circuit to which they are connected, according to the hazardous location and the gas group.
3. They have safety parameters that are compatible with both the connection cable and the intrinsically safe apparatus to which they are connected.
4. Separation and identification of the intrinsically safe circuit exists along the entire connection route, as required by the standards.
5. They have correctly rated and installed internal fuses and that an external protection device (i.e., isolator breaker) is present on the main power line.

Agreement between the Safety Parameters and the Associated Apparatus

Any apparatus that is certified or recognized as safe can become unsafe if they are used in connection with other apparatus, even if these apparatus are certified as safe. Therefore, use the interconnected apparatus documentation to verify that the entire connections are specified and permitted by the certification, and that parameters derived by the interconnection, remain compatible with values that are characteristic of the cable and the field elements connected.

Section 3
Programmed Maintenance

Programmed maintenance prevents the deterioration of apparatus, both functionally and from a safety point of view. It includes the periodic inspection and the repairs (if any) which are made as a result of the inspection. A record must be kept of the type of maintenance performed, the date and the results.

Periodic Inspection for Explosion-proof Apparatus

To perform a periodic inspection to determine the safety of explosion-proof apparatus, verify that:

1. All of the explosion-proof lids are tightly screwed or bolted, depending on the type. If bolted, all of the bolts must be fitted properly and tightened.
2. Signs of deformations, cracks or corrosion in the flanged joint, tightening lid thread and pipe union are not present.
3. The enclosure's external grounding terminals are tightened, and that the grounding conductor is integral and guarantees a good ground connection.

Calibration Verification: Prior to performing calibration verification on an explosion-proof enclosure, the power supply must be turned off, or ensure that there are no flammable mixtures present around the enclosure. Turning off the power supply makes it impossible to verify the proper functioning of the apparatus; therefore, it is preferable to eliminate the presence of flammable mixtures and perform the calibration with the power on. (This can be determined by on-site testing with a combustible gas detector.)

1. During all of the subsequent operations, continuously verify with the gas detector the absence of flammable mixtures.
2. Turn off the power to the apparatus, and open the cover to access the input/output connection and calibration regulations.
3. Connect the calibration instrument to the input/output connection, according to the instructions on the apparatus. With the combustible gas detector, verify the absence of flammable mixtures and restore the power.
4. Following the manufacturer's instructions, verify the calibration and adjust it if necessary.
5. Turn off the power and reconnect the original connections.
6. Close the lid and verify its tightness.
7. Restore the power for normal functioning.

Periodic Inspection for Intrinsically Safe Apparatus

For intrinsically safe apparatus, certain inspections can be performed without a plant shutdown. For each inspection, however, verify that situations of real or potential dangers are not generated for the following reasons:

1. The instruments or verification connections do not cross the hazardous (I.S.) and non-hazardous terminals of the

barriers.

2. The ground connections are not interrupted while the intrinsically safe circuits are powered or are connected to other powered circuits.
3. The apparatus, used for the test, are certified and suitable to operate in a hazardous location with explosive mixtures present.
4. The apparatus used for the test do not introduce dangerous voltages or currents in the circuit. This is not necessary in order to test apparatus according to the standard.
5. The conductors, temporarily disconnected for the test, do not remain free to cause unwanted contacts, but are clearly identified and firmly anchored to an electrically safe point (e.g., isopotential grounded system).

When possible, verification of apparatus should be performed by removing them from the plant (substitution is advisable if spares are available) and safely testing them in a lab that is located in a non hazardous location. This procedure is greatly simplified if the apparatus are equipped with plug-in type connectors that allow removal of the card without touching the cable connections.

Hazardous locations

Generally, the maintenance procedure in a hazardous location should be limited to the following:

1. The disconnection and removal (or substitution) of apparatus and part of the connections
2. Calibration adjustment of the apparatus
3. The use of permitted and specified test apparatus
4. Other permitted or specified maintenance activities

Non hazardous locations

Although it may appear that there is less danger when inspecting or repairing apparatus in a non hazardous location, this is not the case. In fact, a more dangerous situation could develop due to the fact that often, less care is taken because of the non hazardous classification. It is difficult to realize that an erroneous operation in a non hazardous location can generate an explosion in a hazardous location by means of the interconnected circuit.

Passive barriers in non hazardous locations

Therefore, for circuits protected by diode safety barriers, verify that:

1. The ground conductor of each barrier is properly tightened and maintains a total resistance up to the isopotential ground point less than or equal to 1Ω
2. The safety circuits (measured by non repetitive samples) are isolated from other ground points, and the isopotential point to which they are connected is according to the standard.
3. The separating distances of safety terminal blocks and conductors are respected.

Active barriers in non hazardous locations

For circuits protected by galvanic isolation barriers, verify that:

1. The separating distances of safety terminal blocks and conductors are respected.

Calibration Verification: As previously stated, intrinsically safe circuits have the advantage of permitting maintenance activities to be performed while the power is on (usually the maximum voltage present is 28 V). However, with circuits protected by barriers, the possibility always exists that the barrier could be permanently short-circuited. This could cause the fuse to blow, rendering the barrier useless. In other apparatus, the risk of accidental improper contact remains. Therefore, when possible, it is advisable to remove the apparatus (this is particularly easy with instruments with plug-in type connectors) and proceed with verification in a lab. Where it is impossible to remove the apparatus from the installation, the following must be performed:

1. Disconnect the input/output conductors and, after identifying them, connect them temporarily to the isopotential ground; or, if already grounded, keep them isolated and anchored to the free terminals of a supporting terminal block.
2. Connect a calibrator to the input and a calibration indicator to the output. Both must be certified for the division and gas group in which they are used.
3. After completing the verifications and calibrations, restore both the input and output conductors with extreme care.

Apparatus Failure and Repairs

Repair of Explosion-proof Apparatus

When there are functioning abnormalities in an explosion-proof instrumentation plant, the following must be performed in the shortest time possible:

1. Determine the cause of the apparatus failure, or abnormality.
2. Isolate and determine the anomalous part of the plant.
3. Substitute, if possible, the malfunctioning components with spares.
4. Repair the malfunctioning components in order to regain proper functioning.

Reducing the time that a plant is shut down for repairs is the key to reducing maintenance costs. Quick and precise determination of the causes and identification of the malfunctioning apparatus become very important when viewed in this way. This can be made easier if precautionary measures that render safe and quick substitution of the components were taken during the design phase.

Using this concept, the best solution can be obtained from the use of:

1. Field and control room instrumentation of the modular and plug-in type, making it easier to remove the instrument without altering the wiring
2. Adequate inventory of spare components that permit immediate substitution

The determination of the causes of malfunction or failure and the identification of the failed apparatus in explosion-proof plants follow the same general rules as trouble-shooting in standard instrumentation plants. In this case, however, there is a danger of fire or explosion; therefore:

1. Do not perform connections that are not shown in the plant's schematic, unless the risks relative to safety have been analyzed.
2. Do not use test instruments that are not certified for use in the same hazardous location and gas group that the circuits to be analyzed are.
3. Isolate the part of the plant in which the repairs must be performed, and consider the effect of the performed tests on the interconnected circuits.
4. Most importantly, do not cross or eliminate the safety protections that are present in the safety barriers and in other parts of the plant.

The block substitution of the malfunctioning apparatus can be performed without a great deal of risk if the certainty of the correct apparatus insertion in its enclosure exists and eventual polarization keys, purposely placed on the insertion elements to prevent insertion of erroneous modules on a given apparatus, are not altered or forced.

Repair of Intrinsically Safe Apparatus

The repair of defective intrinsically safe apparatus, besides restoring the operative functionality, does not have to compromise in any way the characteristics of intrinsic safety. The most frequently used ways of ensuring that apparatus are intrinsically safe are:

1. Surface distances between the main line and the intrinsically safe circuit
2. Surface distances between two different types of intrinsically safe circuits
3. Protective coats which increase the isolations that are unobtainable with distances only
4. Protective fuses on main and signal transformers, and output circuit barriers
5. Signal and main transformers with dielectric rigidity that has been individually tested, and with distances and isolating materials that are guaranteed
6. Barrier resistors with construction techniques, nominal powers, values and tolerance as per the certification documentation
7. Diode or zener barriers with nominal voltage, tolerance, nominal power and assembly polarity well-defined
8. Optoelectronic coupler that has been certified as a component having surface and internal distances and approved construction techniques
9. Electromagnetic relays that have been certified with guaranteed surface distances between the coil circuits and the contacts and/or terminals for armor ground connections
10. Functional modules, encapsulated or not, that have been certified as components which are compatible with the concept of intrinsic safety

There are many other items that could be added to this list, but they are used less frequently and are too numerous for purposes of this discussion.

None of these protection characteristics can be substituted indiscriminately without having complete documentation and a great deal of knowledge about the concept and possible problems of intrinsic safety and the way in which intrinsic safety has been used in any particular apparatus.

For the manufacturer of the apparatus, however, it is often impossible to supply all of the documentation necessary for an average maintenance technician to perform, without risk, repairs on intrinsically safe apparatus.

The safer and sometimes less costly solution is to keep a series of spare cards or modules that permit an immediate substitution of the faulty unit. The faulty unit can then be sent to the authorized service dealer where it can be repaired or replaced.

Repair of intrinsically safe apparatus in emergency apparatus

If an intrinsically safe apparatus must be repaired in an emergency situation, give particular care:

1. Not to modify the air and surface distances of the barriers and their components
2. Not to substitute any component that determines its intrinsic safety (usually, these components are marked with shading on the silk screen of the printed circuit boards and on the schematics)
3. Not to substitute the fuses, unless they are substituted with others of identical type (rapid, medium lag, etc.) and nominal current
4. Not to substitute main or signal transformers, unless the substitution is made with identical components that are supplied by the manufacturer of the apparatus
5. Not to substitute certified modules, unless the substitution is made with identical modules that are supplied by the manufacturer
6. In reciprocal positioning of the components and in repositioning eventual isolators or spacing collars that are placed on the component terminals in order to distance them from the printed circuit board
7. In verifying the repaired card or component, to be certain of the complete efficiency of all the intrinsically safe protection
8. In performing an accurate washing of the printed circuit board and restoring eventual protective coatings

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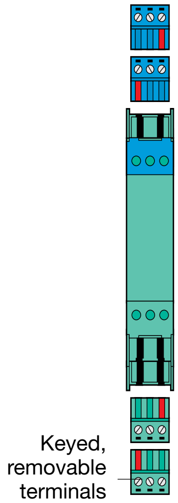
Section 4
Power Supplies and Connections

Removable Terminals

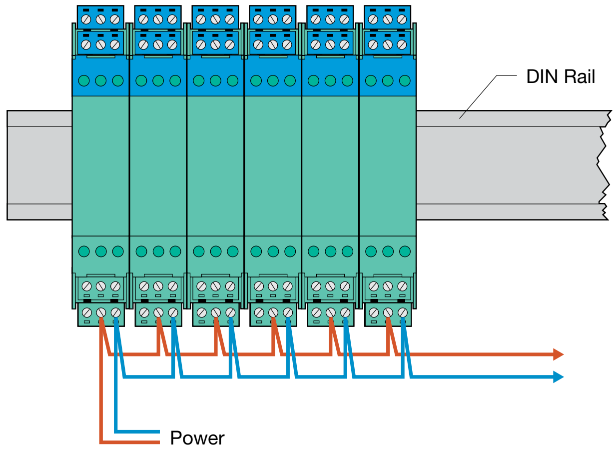
The removable terminals simplify control cabinet construction and allow the units to be replaced while under power. These screwed, cage clamp terminals allow space for the connection of leads with core cross-sections of up to 14 AWG (2.5 mm²). The connectors are coded, so that it is not possible to make an incorrect connection. With the KF-CP terminal block coding inserts, separately available connectors with test sockets or cage spring release terminals can be easily replaced.



Power Supply

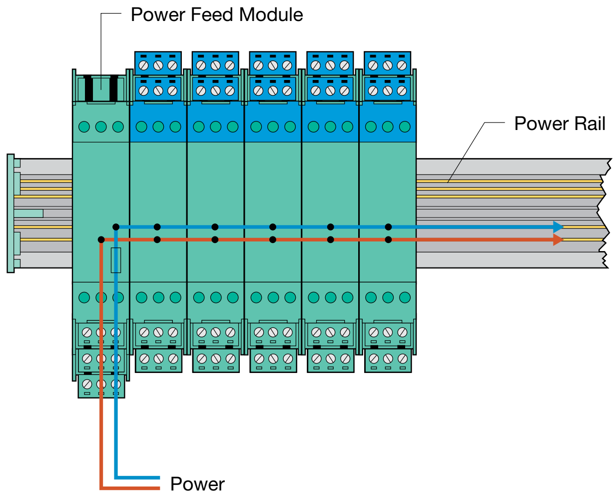
Conventional Power Supply without Power Rail

Conventional power supplies create complicated and expensive wiring systems because after all isolators are connected, more wiring must be added for features such as lead breakage and short-circuit monitoring.



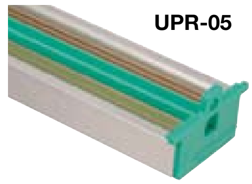
Power Supply with Power Rail

The Pepperl+Fuchs Power Rail eliminates wiring hassles and reduces expenses because two conductors power all isolators connected to the rail. P+F offers a three-conductor version for lead breakage and short-circuit monitoring.



Power Rail

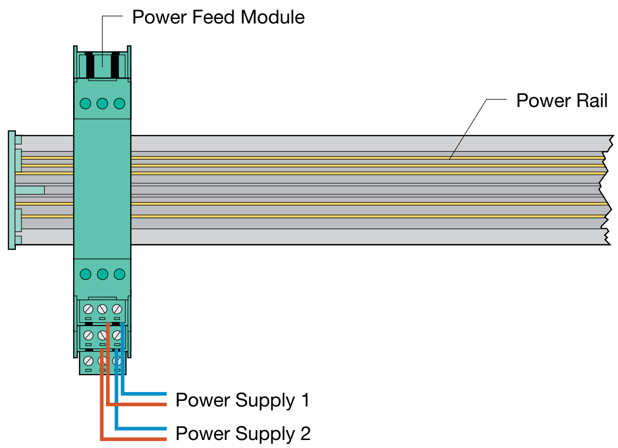
Power Rail snaps directly into a standard DIN rail and contains two conductors that deliver power to the modules. Power is sent through the rail by a power feed module which delivers 24 VDC at 4 A. The module uses a 4 A fuse to protect the barriers. The Power Rail virtually eliminates lead breakage and short circuit, and provides for easy expansion. Power Rail is available in two versions:



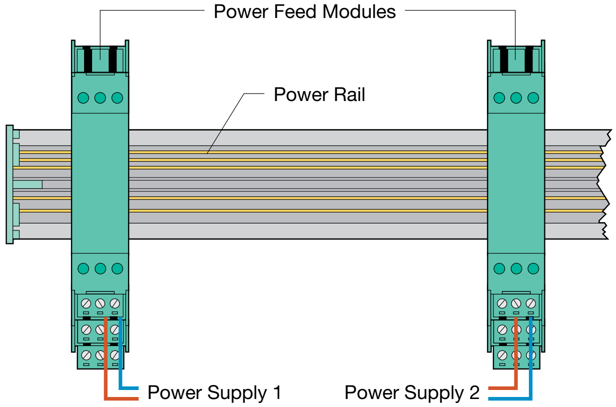
- UPR-03 and PR-03 These 3-conductor versions supply power and error signals.
- UPR-05 and PR-05 These models feature 5-conductors, two for power and three for serial data exchange.

Redundant Power Supplies

Two power supplies with one power feed module can be used for redundancy on Power Rail. See Power Feed Modules for 2 A and 4 A options.

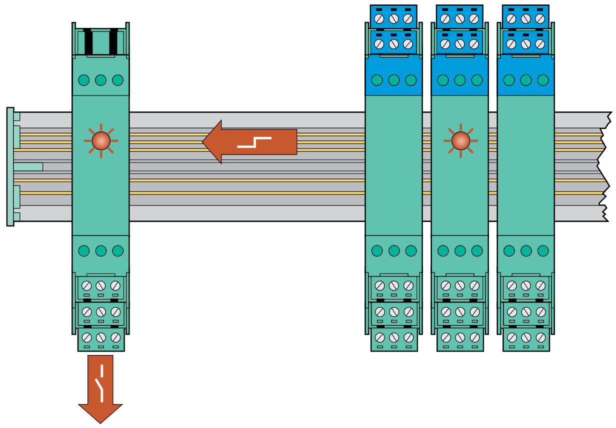


A redundant power supply with two power feed modules offers an even higher degree of safety. If a fuse opens in one power feed module, the second module continues to energize Power Rail. See Power Feed Modules for 2 A and 4 A options.



Collective Error Messaging

Collective error messaging enables lead breakage and short-circuit monitoring for isolator modules without additional wiring expenses. During fault conditions, an interrupt signal from an isolator module such as the KFD2-SR2-Ex2.W transfers to the Power Rail. The power feed module evaluates the signal and processes the interruption to the control system via a relay contact.



Mechanical Data for K-System

Design

Housing sizes:

1. Width 20 mm, height 115 mm
2. Width 40 mm, height 115 mm
3. Width 140 mm, height 103.5 mm (power supply KFA6-STR-1.24.4)

Mounting

1. Panel mounted. The tabs on the bottom of the modules must be extended and anchored to the panel with screws.
2. Power Rail or 35 mm standard DIN rail to EN 50022. Modules snap on for horizontal or vertical mounting.

Housing Material

Makrolon

Flame Resistance Classification

UL 94V - 0

Connection Options

KF-series:
Removable connector with integrated cage clamp terminals for maximum wire size of 14 AWG (2.5 mm^2).Torque rating: 4.4 to 5.3 in lbs (0.5 to 0.6 N-m)

KH-series:
Cage clamp connection terminals for maximum wire size of 14 AWG (2.5 mm^2).
Torque rating: 4.4 to 5.3 in lbs (0.5 to 0.6 N-m)

Special Features

Removable, mechanically-keyed connectors (KF-Series) ensure proper connection

Ambient Conditions

Climatic specifications according to DIN IEC 721 Class 3K3

Ambient Temperature

Normally -20°C to +60°C (-4°F to +140°F). See individual data sheets.

Storage Temperature

-40°C to +90°C (-40°F to +194°F)

Humidity

Maximum 75% relative humidity, 95% for many modules

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Electrical Standards for K-System

Isolators are designed for connection to circuits in Class I, Division 1, Groups A-D and EEx ia IIC Zone 0 unless otherwise noted.

- DC power supply 20-30 V
- AC power supply 120/240 V ±10%
- DC Power Rail compatible
- Intrinsic safety isolation in accordance to EN 50020
- Electrical isolation in accordance to EN 50178
- EMC in accordance with EN 50 081-2, EN 50 082-2 and NAMUR NE 21
- LED in accordance with NAMUR NE 44
- Software in accordance with NAMUR NE53
- Switch-on pulse suppression
- Fault signals via Power Rail
- Human/machine interface (HMI) software to VDE/VDI 2187
- Safety devices in accordance with IEC 61508, VDE 0660 Part 209, EN 954, AKs to DIN 19250

Discrete inputs/outputs in accordance with NAMUR

The standard references for these interface have changed many times:

German standard (old): DIN 19234: Electrical distance sensors — DC interface for distance sensors and switch amplifiers; 1990-06.

European standard (old): EN 50227: Low voltage switchgear and control gear — control devices and switching elements — proximity switches, DC interface for proximity sensors and switch amplifiers (NAMUR), 1996-10.

German version (old): DIN EN 50227: Low voltage switchgear — control devices and switching elements — proximity switches, DC interface for proximity sensors and switch amplifiers (NAMUR), 1997, German nomenclature VDE 0660 part 212.

Current designation: DIN EN 60947-5-6: Low voltage switchgear — control devices and switching elements — proximity switches, DC interface for proximity sensors and switch amplifiers (NAMUR), 2000, German nomenclature. VDE 0660 part 212.

Current IEC designation: IEC 60947-5-6: Low voltage switchgear and control gear — part 5-6: control circuit devices and switching elements — DC interface for proximity sensors and switch amplifiers (NAMUR), 1999.

Insulation coordination for using galvanic isolation in accordance with DIN EN 50178 and DIN/VDE 0106

The K-series devices are built-in devices and electronic apparatus for use in closed electrical operating areas to which only qualified electrical specialists and technicians have access.

The units are rated for use in pollution severity level 2 environments and overvoltage category II, in accordance with DIN EN 50178.

Insulation coordination for devices with Ex-certification

The units are rated for use in pollution severity level 2 environments, in accordance with DIN EN 50178.

The Pepperl+Fuchs KF-ExDuct

The KF-ExDuct from Pepperl+Fuchs has an overall length of 1.8 m and can be used to provide space-saving mounting for up to 90 KF-modules and accommodate the associated wiring. The system and field cables for Ex- and nonEx-signals are easily installed in the integral cable ducts of the KF-rail. No additional cable guides are necessary.

The power supply to the individual modules is normally provided via the Power Rail and can be integrated into the system. The power supply can be connected in two different ways:

1. If a 24 VDC supply is available, the supply to the modules can be by means of a KFD2-EB… power feed module. It is also possible to build up various function groups and to supply these separately via power supply modules. If required, a redundant power supply to the KF-modules can also be provided.
2. If 115/230 VAC is available, one of Pepperl+Fuchs‘ power supplies can be used to convert the AC voltage to 24 VDC. See "Power Supplies", page 401.

Advantages of the KF-ExDuct

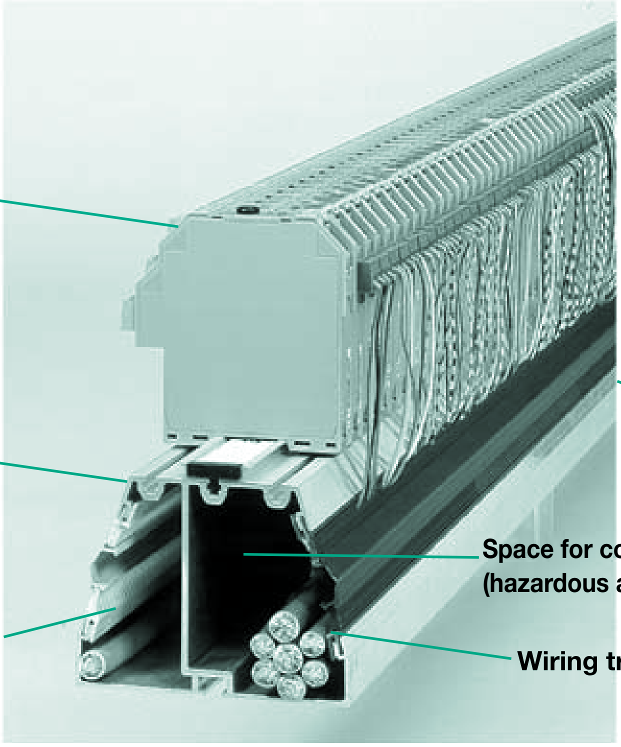
1. Very tight packing density in control cabinet assemblies because the wire duct is integrated into the mounting profile.
2. By using preconfigured system cables, an extremely short commissioning/start-up time is possible.
3. The prefabricated cables are equipped with the appropriate system connector. Thus, the number of connectors from the interface module to the control system is reduced to a minimum.

Optional Label Holder

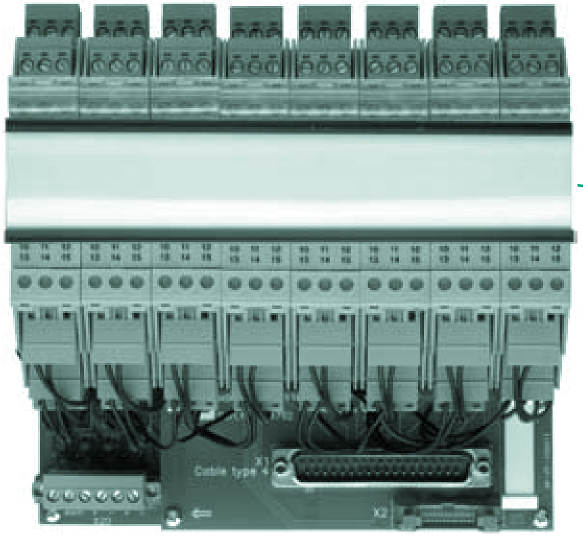
(KFD0-LC-0.5, KFD0-LC-1)

In addition to the integrated documentation holder on the module, Pepperl+Fuchs offers additional labeling for the KF-modules in the control cabinet. The labeling strips are available in 0.5 m or 1.0 m lengths. A labeling surface area of 20 x 30 mm is available per KF-module. See “Accessories” for more information.

Pepperl+Fuchs KF ExDuct



Optional label holder



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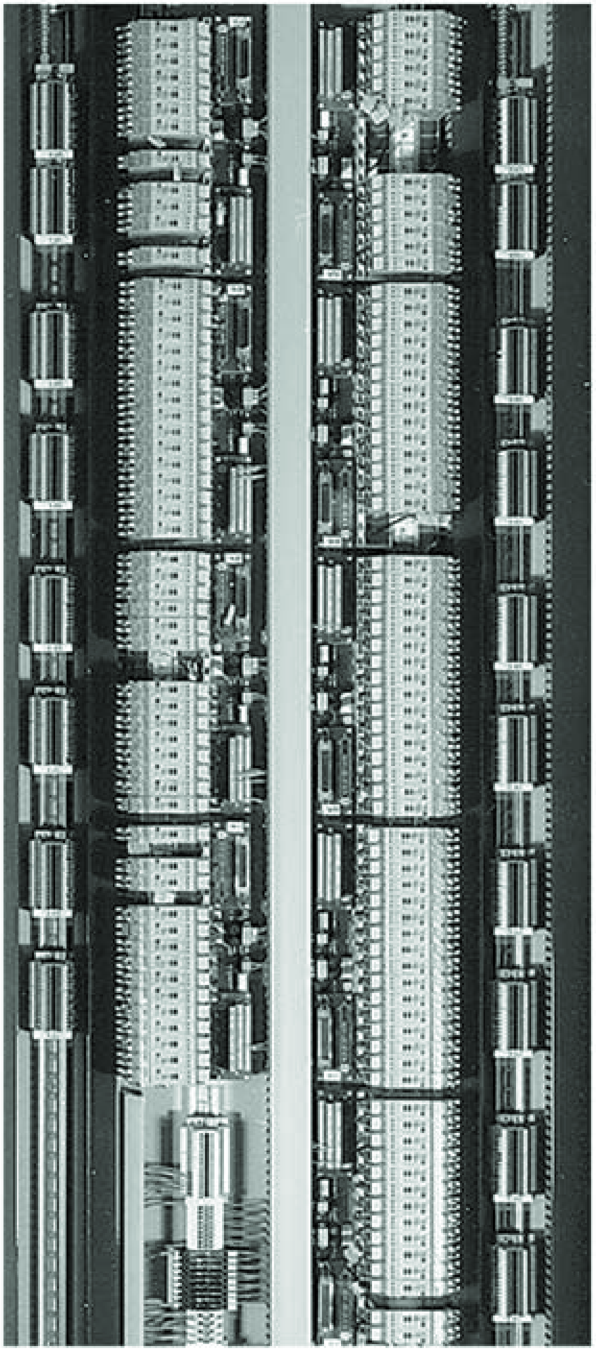
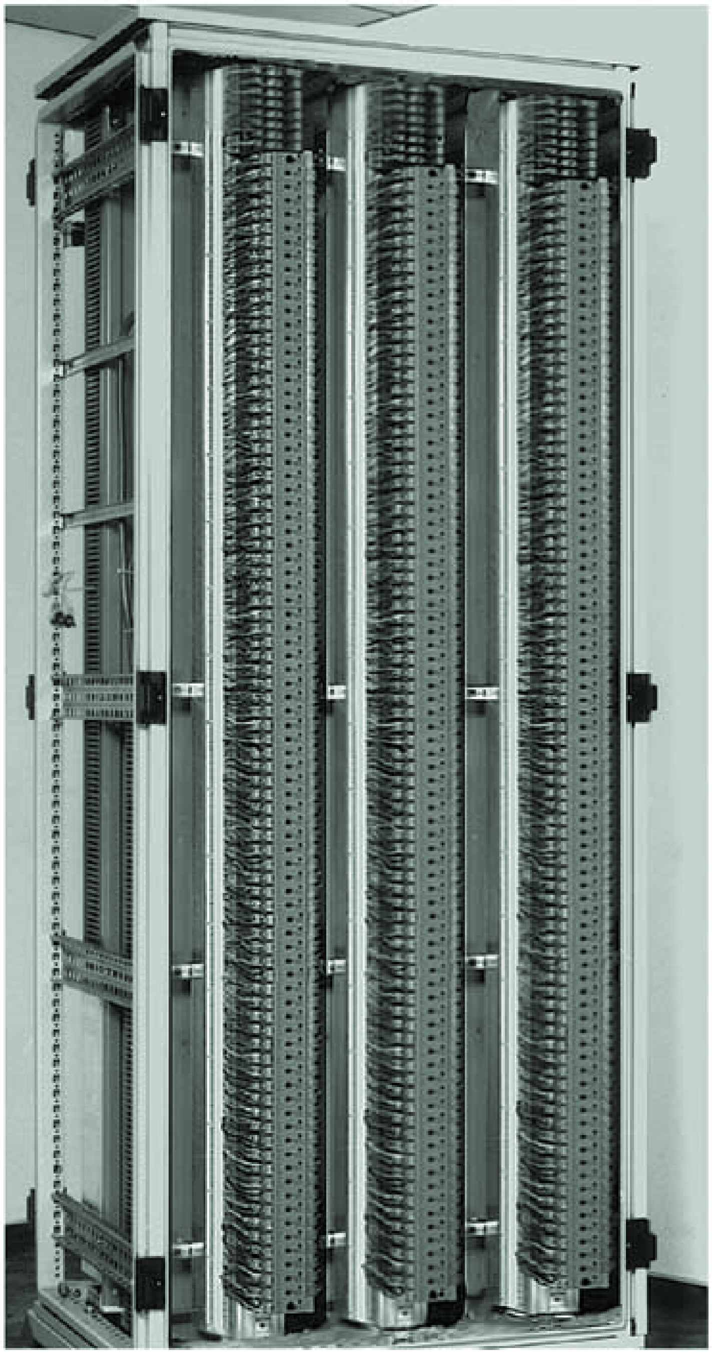
Switch cabinet layout



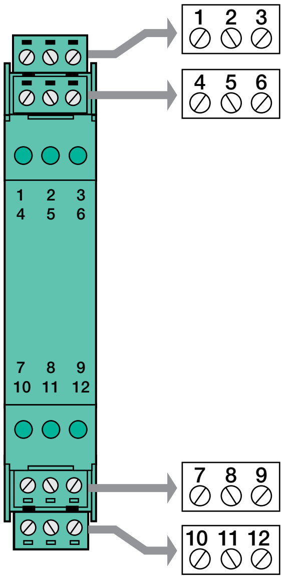
Control cabinet with marshalling

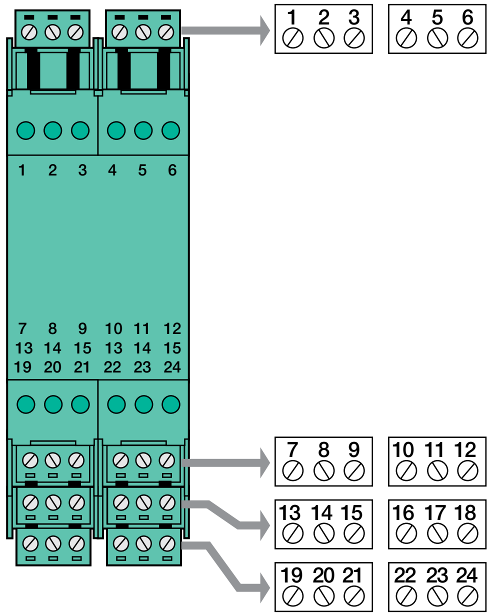


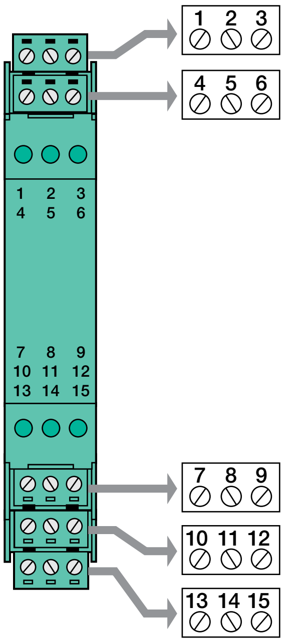
Control cabinet without marshalling

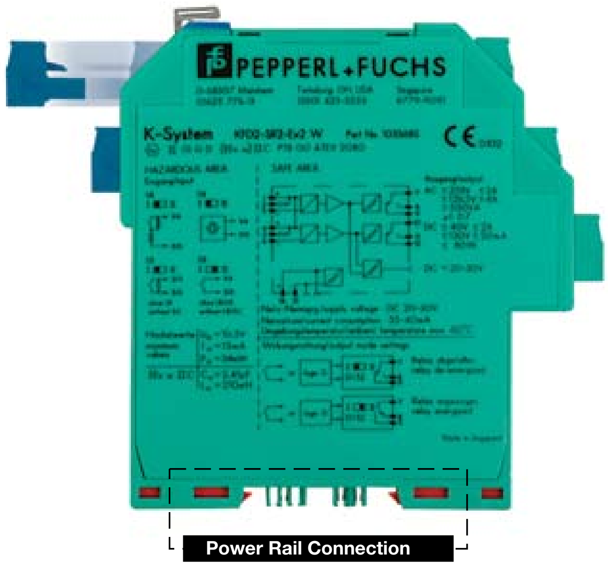
Terminal Designation

Please reference appropriate model for terminal designation.









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