Industrial Automation

MULTIBARRIER
MBD48-T415/Ex
MBD49-T415/Ex

USER MANUAL

F794/01

Prior to installation

- Verify that there is no explosion hazardous atmosphere
- Disconnect the device from the power supply
- Protect against an accidental restart
- Verify safe isolation from the supply
- Observe mounting instructions
- Only appropriately qualified personnel according to EN 50110-1/2- (VDC 0105 part 100) is permitted to work with the device/ system.
- Verify static discharge prior to installation and touching the device.
- The functional earth (FE) must be connected to the protective earth (PE) or the equipotential bond. The installer is responsible for establishing this connection.
- Safe electrical isolation of the low voltage for the 24 V supply must be ensured. Use power supply units compliant with IEC 60 364-4-41 or HD 384.4.41 S2 (VDE 0100 part 410) only.
- Fluctuations or deviations of the mains supply from the rated value may not exceed the tolerance limits specified in the technical data. Otherwise device malfunction or dangerous conditions cannot be excluded.
- The electrical installation has to be carried out in compliance with the applicable regulations (e.g. concerning cable cross sections, fuses, PE connection etc.)
- Transport, installation, set-up and maintenance may only be carried out by qualified staff (IEC 60 364 or HD 384 or DIN VDE 0100 and national accident prevention regulations must be observed).

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How to work with this manual

Meaning of the symbols used

Warning

This sign is placed next to a warning indicating the presence of a hazard. This can relate to personal injury as well as to system damage (hardware and software).

The user should interpret this symbol as follows: exercise extreme caution.

Attention

This sign is placed next to a warning indicating a potential hazard.

This can relate to personal injury as well as to system (hardware and software) and equipment damage.

Note

This sign is located next to general hints providing important information on individual or stepwise work procedures.

These hints may facilitate work and possibly help to avoid excess work resulting from faulty proceedings.

Attention
It is indispensable to read this section because the safety in dealing with electrical equipment should not be left to chance.

This manual contains all information pertaining to safe and proper operation of the TURCK products. It specifically addresses trained and qualified staff disposing of the appropriate technical knowledge.

Correct usage to the intended purpose

Warning
The devices described in this manual may only be used in such applications described in the technical sections of the manual and only in conjunction with certified external devices and components.

Correct and safe operation of the devices relies on appropriate transport and storage, correct installation and set-up as well as careful operation and maintenance.

Configuration guidelines/Product installation

Warning
It is indispensable to observe the applicable safety and accident prevention regulations of the specific application.

1 Introduction

The multibarriers MBD48-T415/Ex and MBD49-T415/Ex (in the following also referred to as MBD) from TURCK are 4-channel fieldbus junctions for explosion hazardous and safe areas.

The multibarrier is designed to increase the number of bus devices, to provide more flexibility, to enhance operational safety and to reduce power supply and cabling expenses.

If the multibarrier is connected to an H1 fieldbus segment, it can be used to power at least 4 fieldbus devices.

As the barriers can be cascaded via additional terminals, up to 32 field devices can be operated via a single segment coupler/power conditioner in the explosion hazardous area. The multibarrier does not require an extra power supply for this purpose since it is powered via the fieldbus cable.

According to the Directive 94/9/EC (ATEX 100a) the multibarrier may be mounted in Zone 1 (II 2 G). Within Zone 1 the device is connected via connections featuring protection type “Increased Safety” (EEx e) to the trunk line (main line) of a fieldbus according to IEC 61158-2.

Another characteristic is the selectable internal fieldbus terminating resistor (switch-in). The terminating resistor should be activated, if the multibarrier is physically the last device connected to the trunk line.

In order to avoid potential transfer and unwanted potential compensating currents, the MBD features galvanic isolation between the trunk line and the outputs and between individual the outputs. Per output there are 40 mA available for the supply of the fieldbus devices.

The outputs are short-circuit protected and accord to the requirements of PTB report W-53 and thus to the FISCO model. If there is a short-circuit at one of the fieldbus nodes, only the affected output is turned off, while the trunk line of the fieldbus segment and the other outputs remain operational.

This manual will help you plan your fieldbus application. It provides detailed technical information on the multibarrier as well as important details on the topic of explosion protection.

2 Basics of explosion protection

2 Basics of explosion protection

The multibarriers MBD48-T415/Ex and MBD49-T415/Ex are electrical equipment suited both for explosion hazardous and safe areas.

Explosion hazardous areas in process automation occur there where an explosive atmosphere of flammable gases, vapours and mists prevails. In the chemical, petro-chemical and pharmaceutical industries these substances occur in various concentrations.

Gas filling systems, oil pipe-lines or installations for the storage of flammable liquids are only a few examples of installations requiring permanent monitoring. In the explosion hazardous area, the manufacturer of machines and systems and his suppliers are required to assume a high level of responsibility. A single spark may suffice to trigger an explosion, which can cause significant harm to man, machine and the environment.

2.1 Zone classification and device categories

In Europe, explosion hazardous areas are divided into zones according to their danger potential. According to the Directive 94/9/EC (ATEX 100a), the areas of usage of the electrical equipment in the various zones are divided into categories according to their intended purpose. The category indicates in which zone the respective electrical apparatus may be used.

The following table (table 2.1) lists the zones according to IEC/CENELEC for gases, vapours and dusts:

Substances	Zones	Equipment categories
Gases, vapours	Zone 0 Areas in which dangerous concentrations of flammable gases/vapours are present continuously or over longer periods.	1G
	Zone 1 Areas in which dangerous concentrations of flammable gases/vapours are present occasionally	2G, 1G
	Zone 2, Areas in which dangerous concentrations of flammable gases/vapours are rarely present and if, then only for a short time	3G, 2G, 1G
Dusts	Zone 20 Areas in which dangerous concentrations of flammable dusts are present continuously or over longer periods	1D
	Zone 21 Areas in which dangerous concentrations of flammable dusts are present occasionally	2D, 1D
	Zone 22 Areas in which dangerous concentrations of flammable dusts are rarely present and if, then only for a short time	3D, 2D, 1D

Tab. 2.1 Zone classification acc. to IEC/CENELEC for gases, vapours and dusts

In order to prevent explosions, various different types of protection are applied to protect machines, systems and devices.

The TURCK multibarrier features protection types intrinsic safety, increased safety and encapsulation. The specific connection techniques associated with protection types "Intrinsic Safety" (EEx i) and "Increased Safety" (EEx e) are described in detail on the next pages.

2.1.1 Temperature classes

The ignition temperature of a combustible gas is defined as the lowest temperature of a hot surface at which the gas/air or vapour/air mixture can ignite. The highest surface temperature of electrical equipment must thus always be lower than the ignition temperature of the surrounding atmosphere. Temperature classes T1 to T6 are relevant for electrical equipment according to explosion group II. Electrical equipment is assigned to a temperature class according to its maximum surface temperature. Equipment, which accords to a higher temperature class can, of course, be used for lower temperature class applications. The temperature class of the TURCK multibarrier is T4.

Temperature class	T1	T2	T3	T4	T5	T6
Ignition temperature in °C	> 450	> 300	> 200	> 135	> 100	> 85
Max. surface temperature in °C	450	300	200	135	100	85
Example	Propane Methane Ammoniac	Ethylene Alcohol, Acethylene	Benzines	Ethylether Acetaldehyde	–	Carbon disulfide

Tab. 2.2 Temperature classes of explosion group II

2.2 Protection type "Intrinsic Safety (EEx i)"

Protection type "Intrinsic Safety" limits the electrical energy in an electric circuit needed to ignite an explosive atmosphere during normal and faulty operation. This is achieved by integrating current and voltage-limiting components in these circuits (see Fig. 2.1).

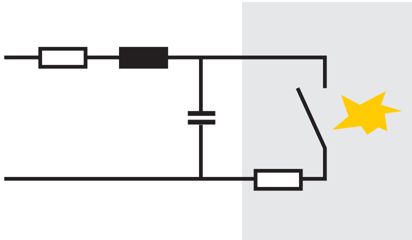

Fig 2.1 Function schematic - protection type "Intrinsic safety (EEx i)"

In contrast to other methods of explosion protection, protection type "Intrinsic Safety“ permits opening and operating the device, for instance, during maintenance, even in explosion hazardous areas, i.e. the intrinsically safe circuits according to category ia can be operated in zone 0.

Intrinsic safety is verified and approved by certified bodies such as the PTB or the TÜV. Whether a circuit is intrinsically safe, is tested by a spark test apparatus, which was introduced as an international standard test device according to IEC publication 79-3. It is connected to that point in the circuit at which an error is to be simulated. To assess the level of protection of the entire device one distinguishes two categories: **Category ia** und **Category ib**.

Category ia

The circuits may not lead to an ignition if the max. voltage is applied during normal operation and in the event of **two** errors - in addition to the non-countable errors (see Fig. 2.2).

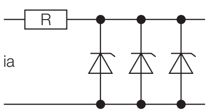

Fig. 2.2 Error possibilities in category ia

- Countable errors are errors, which can occur at the components of the electrical equipment complying with construction standard EN50020.
- Non-countable errors are errors, which can occur at the components of the electrical equipment non-compliant with EN 50020.

Category ib

The circuits may not lead to an ignition if the max. voltage is applied during normal operation and in the event of a **single** error - in addition to the non-countable errors (see Fig. 2.3).

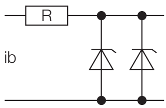

Fig. 2.3 Error possibilities in category ib

The four outputs of the multibarrier for the field devices feature protection type EEx ia.

Devices compliant with protection type EEx ia are suited for use in Zone 0, while devices with protection type EEx ib are approved for use in Zone 1.

Explosion protection type "Intrinsic Safety“ is described in standard EN50020 of the Directive 94/9/EC. The **Directive 94/9/EC** is a harmonising directive for the various legal regulations of the EU member states, covering devices and protective systems intended for use in explosion hazardous areas; it is also called the **ATEX Directive** .

2.3 Explosion protection type "Increased Safety (EEx e)"

The explosion protection type "Increased Safety" (Fig. 2.4) was developed in Germany with the aim to prevent the development of ignition sources (sparks, hot surface, arcs, sources of radiation) by applying an increased level of safety.

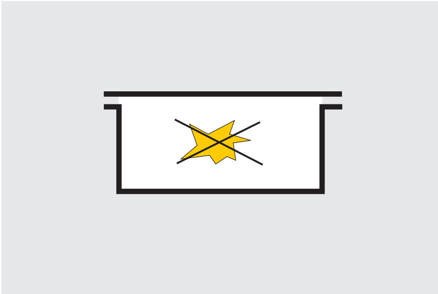

Fig 2.4 Function schematic - protection type "Increased Safety (EEx e)"

With electrical equipment of this protection type, particular importance is attached to the following factors:

- a safe construction according to EN 50014
- a re-inforced operational and basic insulation
- terminals protected against accidental loosening
- sufficient mechanical protection
- a safe connection of the incoming lines

The multibarrier features safe mechanical protection due to its EEx e base housing and EEx e cable glands; the incoming lines are safely connected via EEx e terminals.

2.4 Intrinsic safety and fieldbus systems

Fieldbus systems are gaining more and more acceptance also in the explosion hazardous area as a cost-effective solution for automation technology. When employing such systems, the according explosion protection guidelines must be observed and explosion protection measures must be taken (see Fig. 2.5).

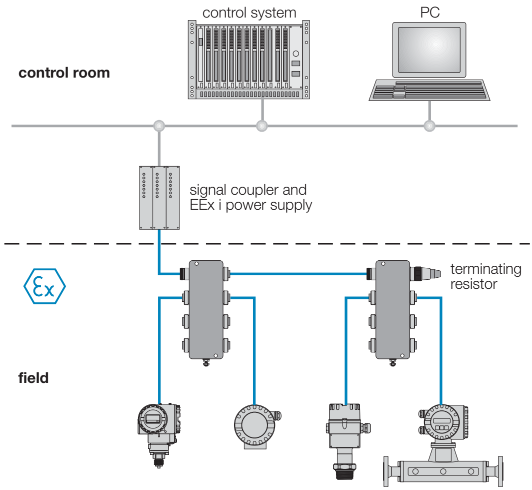

Fig. 2.5 Fieldbus model

The following requirements generally apply to intrinsically safe fieldbus systems (according to a PTB report, Johannsmeyer):

- Protection type "Intrinsic Safety" EEx ia or EEx ib according to EN 50020 (CENELEC) or IEC 79-11 (Class 1, Division 1, according to US standard) must be fulfilled.
- There is only a single active source in the system (voltage supply).
- The fieldbus nodes act as passive current sink devices with a current consumption of min. 10 mA.
- All fieldbus nodes have negligible internal inductances and capacitances.
- The cables used accord to the fieldbus standard.
- The bus is terminated at both ends;
  applying the following values: (R = 90...100 Ω, C ≤ 2.2 µF).

Protection type "Intrinsic Safety - EEx i“ has the advantage that bus nodes can be connected and disconnected during operation without igniting an explosive atmosphere.

If a fieldbus system is planned and installed in the explosion hazardous area, it is required to provide a means of "Verification of Intrinsic Safety" according to the explosion protection directive.

In order to simplify this procedure, the PTB has developed the FISCO model (**F**ieldbus **I**ntrinsically **S**afe **CO**ncept) in cooperation with renowned manufacturers (topic of research: intrinsic safety and fieldbus systems). The further development of the FISCO model for zone 2 installations is the FNICO model. Another model, mainly used in the United States, is the so-called Entity model. Following please find a short description of all models.

2.5 The FISCO model

In the FISCO model, typically only a single "active" device, i.e. the bus power supply, is conected to the fieldbus. All other devices do not supply any energy via the line and are thus defined as "passive". Consequently only a single device can supply power via the bus line in the event of an error, which always has to be assumed. Thus the number of connectable devices is maximised. Since the bus power supply unit is the only device that provides energy, it is the only equipment that must be equipped with an according current and voltage-limiting safety circuitry.

Tables 2.3 and 2.4 list the limits of the parameter areas for application of the FISCO model for EEx ib IIC/IIB or EEx ia IIC. These areas are derived from the results of previous studies as well as from extrapolations acceptable from the safety-technical aspect.

It must be stated, that the limit values of the bus power supply circuit usually specified, i.e. the max. admissible external inductance L_o and capacitance C_o, are not indicated. With these generally specified values it is assumed that L_o and C_o affect the intrinsically safe circuit in form of *lumped inductances and capacitances*, which is not the case with the FISCO model for the bus line considered here.

The following regulations apply in addition:

- Intrinsic Safety (category "ib“ or "ia“ to EN 50020)
- Only a single active source in terms of intrinsic safety; during data transfer of a node no power is supplied

- In a steady-state condition, each node consumes a constant basic current (direct current).
- The nodes (transmitter, hand-held, bus master and repeater) act as a passive "current sink" device.
- The effective internal inductances and capacitances of the nodes
  are negligible in terms of intrinsic safety.
- Various cable types are suitable
- Termination of both ends of the bus trunk line.

EEx ib IIC/IIB
Power supply unit: approx. rectangular output curve U_S = 14...24 V (max. safety value) I_k = short-circuit current according to PTB report W-39, e. g. up to 128 mA at U_S = 15 V (group IIC) up to 280 mA at U_S = 15 V (group IIB)
Cable (values per km): R' = 15...150 Ω (loop resistance) L' = 0.4...1 mH C' = 80...200 nF (incl. an existing shield) $C' = C'_{conductor / conductor} + 0.5\ C'_{conductor / shield}$ (if the bus circuit is potential-free, or: $C' = C'_{conductor / conductor} + C'_{conductor / shield}$ (if the shield is connected to a pole of the power supply unit) Up to a line length of 5000 m there are no safety restrictions.
Line termination: RC elements with R = 90...100 Ω, C = 0...2.2 µF Line termination is admissible at each end of the bus trunk line. The terminating resistor must be "interference immune" according to EN50020.

Tab. 2.3 Valid parameter area of the FISCO model for applications according to EEX ib IIC/IIB

EEx ia IIC
Power supply unit: trapezoidal output curve U_S = 14...20 V (max. safety value) $U_0 \geq 2 \times U_S$ (see chapter 2) I_k = short-circuit current according to PTB report W-39, e. g. up to 215 mA at U_S = 15 V (group IIC)
Cable (values per km): R' = 15...150 Ω (loop resistance) L' = 0.4...1 mH C' = 80...200 nF (incl. an existing shield) $C' = C'_{conductor\ /\ conductor} + 0.5\ C'_{conductor\ /\ shield}$ (if the bus circuit is potential-free, or: $C' = C'_{conductor\ /\ conductor} + C'_{conductor\ /\ shield}$ (if the shield is connected to a pole of the power supply unit) Up to a line length of 1000 m there are no safety restrictions.
Line termination: RC elements with R = 90...100 Ω, C = 0...2.2 µF Line termination is admissible at each end of the bus trunk line. The terminating resistor must be "interference immune" according to EN50020.

Tab. 2.4 Valid parameter area of the FISCO model for applications according to EEX ia IIC

These specifications result in the follwing basic construction of a fieldbus model as shown in Fig. 2.5. The power supply unit for the bus and the bus master for connection to the field devices are (usually) located in the control room (non-explosion hazardous area). The power supply unit integrates means for secure limitation of the power and voltage on the bus.

The technical requirements resulting from the FISCO model cannot be fulfilled by PROFIBUS-DP, as described in EN 50170. In contrast to PROFIBUS-DP, via which data are transferred via the UART protocol according to EIA standard RS485, PROFIBUS-PA and FOUNDATION™ fieldbus use the bit-synchronous line protocol and DC-free signal transmission according to the standard IEC 61158-2 (voltage mode, wire medium, 31.25 kbps, also called "H1 Bus“).

This standard fulfils the specific requirements of the chemical and petro-chemical industries and is compatible with the FISCO model described above.

2.6 The FNICO model

FNICO stands for **F**ieldbus **N**on **I**ncendive **Co**ncept. This concept is the further development of the FISCO model for zone 2 installations. With FNICO zone 2 installations are just as easily accomplished as zone 1 installations according to the FISCO standard. A main difference compared to the FISCO standard is the higher power that may be lead into the field.

Fieldbus devices to FNICO usually have an "Ex n" type approval. Electrical equipment of category 3G with Ex n approval is usually constructed in such a way, that an ignition of the explosive atmosphere during normal operation and under certain abnormal conditions is excluded.

The development of this type of protection was aimed at finding a compromise between normal industrial standards and the high requirements of the protection types for electrical equipment of device category 2G (zone 1).

2.7 The Entity model

The main difference between the Entity and the FISCO model regards the cable specifications. With Entity, these are considered as lumped inductances and capacitance, whereas FISCO sees these as distributed values.

With the Entity model, the cable values must be included in the calculation, which is very complex as a result. Even if the fieldbus segment is only expanded by a single device, the Entity model requires complete re-calculation of the intrinsic safety values.

Due to this fact less electrical energy can be transferred to the explosion hazardous area. The number of connectable bus nodes sinks.

The guidelines provided in chapter 2.3 concerning intrinsically safe fieldbus sytems apply both to the FISCO and to the Entity model.

When planning according to the Entity module it is rquired to meet the following criteria to obtain verification of intrinsic safety:

- The currents, voltages and power specs of all bus nodes must be higher than or identical to the according values of the fieldbus barrier.
- The capacitances and inductances of the nodes and the cables must be identical to or lower than the values of the fieldbus barrier.

In table 2.6 these requirements are summarised:

Intrinsically safe fieldbus node	Operator	Associated apparatus (multibarrier)
U_{max}	$\geq$	U_0
I_{max}	$\geq$	I_0
P_{max}	$\geq$	P_0
$L_{cable} + \Sigma L_i$	$\leq$	L_0
$C_{cable} + \Sigma C_i$	$\leq$	C_0

Tab. 2.6 Comparison of the Entity parameters

2.8 Shielding and earthing

To ensure optimum electro-magnetic capability of systems it is of great importance that all system components, in particular the cables connecting the components, are shielded. If possible, these shields must form an electrical sheath without any interruption. In terms of fieldbuses this means, that - in an ideal case - the cable shields are connected to the (mainly) metal housings (or according protective enclosures) of the connected field devices.

Earthing the metal housing with the equipotential bonding system must only be effected at one end of the fieldbus system. Preferably, this should be done at the end in the non-explosion hazardous area.

Thus the flow of ignitable compensating currents, due to different potentials between the two ends of the shield, is to be avoided.

In the following cases it is admissible to deviate from this rule:

- If the line shield has a high resistance or it is required to implement shielding against inductive interference. In this case the shield may be connected various times to the earth in its course.

- The installation itself reliably ensures potential equalisation between both ends of the cable. In this case the cable shield may be mechanically connected to the earth at both ends of the cable, as well as at intermediate positions, if necesssary. This procedure, which is an excellent means of establishing a high level of EMC and personnel safety, can be applied without any restrictions, provided optimum potential equalisation is ensured. The equipotential bond must extend over the entire length of the fieldbus in the explosion hazardous and the safe area (e. g. to DIN 57165, chapter 5.3.3)
- Multiple earthing via low capacitances (e.g. 1 nF, 1500 V, ceramics) is effected. The total capacitance, however, may not exceed the max. value of 10 nF (according to EN 60079-14 this is defined as a non-conductive connection).

Fig. 2.7 to 2.9 show various installation schematics for the protective conductor and the equipotential bonding connection in measuring and control systems. Fig. 2.7 shows a schematic which should be applied, if the equipotential bond extends from the associated apparatus in the safe area to the node in the explosion hazardous area. In Fig. 2.8, the equipotential bond is only present in the explosion hazardous area.

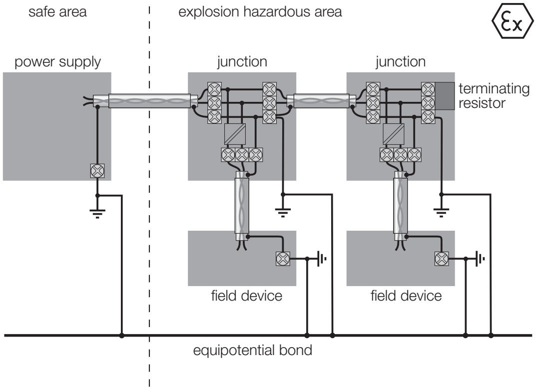

Fig. 2.7 Equipotential bond from the associated apparatus in the safe area to the node in the explosion hazardous area

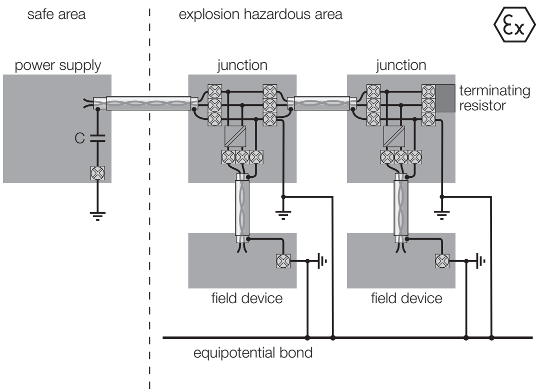

Fig. 2.8 Sufficient equipotential bonding only in the explosion hazardous area.

In Fig. 2.9, the cable shield in the safe area is coupled on one side directly to the station earth. In the explosion hazardous area, the cable shield is coupled capacitively to all further earthing points.

This variant is frequently used in practice. The capacitances to earth will only let high-frequency interference pass and may not exceed a total capacity of 10 nF.

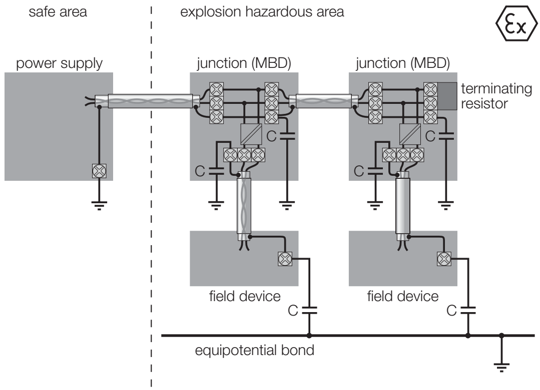

Fig. 2.9 Equipotential bond in the safe area connected to station earth at one end and in the explosion hazardous area capacitively to the earth.

2.9 Installation of cables and conductors

Feed-through openings from the explosion hazardous to the safe area must be sealed sufficiently. This is accomplished by a sand seal box, mortar closure or other suited commonly available sealing materials.

Unused openings for cables and conductors of electrical equipment (e. g. junction modules) must be terminated with approved closure caps. Within the housing, the ends of finely-stranded conductors or multi-wire cables must be protected against splicing via cable lugs, wire sleeves or suitable terminals; loosely attached terminals may not be used.

Outside the electrical equipment, conductor connections may only be established via compression connections, apart from the intrinsically safe circuits.

Cables and conductors may generally not be installed in closed pipe systems, unless these cable conduit systems are suited for explosion hazardous areas in terms of construction and installation. Via such a suited cable conduit system connections to explosion-proof housings may be established directly or a tested and approved adapter must be used for the transition of cable and conductor systems.

Increased requirements apply to the use of cables and conductors in zone 0. Here the cables and conductors for permanent routing must be equipped with a metal jacket, a braided copper or a metal shield and additionally feature an outer jacket made of plastic or rubber, featuring a flammability performance, that has been tested according to DIN VDE 0472 part 804, test type B.

2.9.1 Cables and conductors in intrinsically safe circuits

Cables and conductors in intrinsically safe circuits must meet various special additional requirements. However, the standard cable materials commonly available generally meet these demands.

For example, the test voltage from conductor to conductor and conductor to earth must be at least 500 VAC.

Routing more than one intrinsically safe circuit in a cable is permitted under the following conditions:

- The thickness of the conductor insulation must match the conductor diameter under consideration of the type of insulation material.
- The test voltage for the insulation of all connected conductors and the shields or earth must be at least 500 VAC, and at least 1000 VAC between a bundle of half the conductors and the other half of the conductors.
- In case of permanent and protected wiring, the peak voltage of each circuit may not exceed 60 V, or each circuit must have a conductive shield of its own, not matter whether permanently or flexibly connected.

If only one of the above mentioned three conditions is not fulfilled, then an error assessment according to EN 50039 or VDE 0170/0171 part 10/04.82, section 5.3, must be carried out.

Cables and conductors of intrinsically safe circuits must be marked clearly; if a colour is used for this purpose, then the colour light-blue must be used. If there is a risk of interchange errors between intrinsically safe and non-safe circuits, e.g. because there are blue neutral conductors, then the intrinsically safe cabling should be bundled, routed in a separate conduit or be clearly arranged and separated, so that interchange errors are excluded.

2.10 Selection of admissible cable types

Cables and conductors should be selected to resist the mechanical, chemical and thermal strain, which is expected to occur at the operating location.

It must thus first be clarified, which type of strain will occur mainly at the operating location, in order to then select the individual cable types according the following standards:

- DIN VDE 0298, part 1
- DIN VDE 0298, part 3
- DIN VDE 0891, part 1
- DIN VDE 0891, part 6.

These standards contain individual regulations for cables and conductors concerning the construction type, the area of use, the installation conditions, mounting, etc.

Fieldbus cables, type FB..., from TURCK are suited for use in explosion hazardous areas.

3 Operating manual for multibarriers

3 Operating manual for multibarriers

3.1 Usage and functions

The multibarrier enables connection of an increased number of field devices to a fieldbus compliant with transmission physics according to IEC 61158-2, either in the explosion hazardous or the safe area. The specific transmission technology applies both to FOUNDATION™ fieldbus and to PROFIBUS-PA.

Depending on the type of fieldbus model, (see chapter 3.4 to 3.6) only a limited number of field devices per segment can be operated via an intrinsically safe fieldbus (in practice quite often not more than 10 field devices).

When using the multibarrier, this limited number can be increased to 32 field devices. The increased number of connectable nodes is achieved by an "EEx e" rated fieldbus supply, which can be fed through from multibarrier to multibarrier (see Fig. 3.1). The outputs of the multibarrier are intrinsically safe.

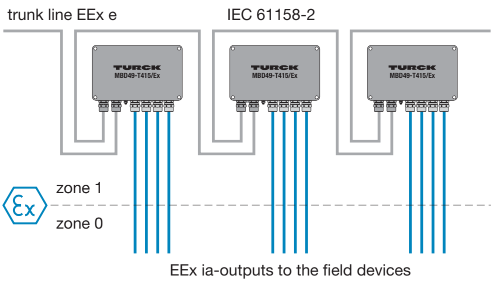

Fig. 3.1 Increasing the number of field devices

Due to the galvanic isolation between the trunk line and the outputs, and between the individual outputs, compensating currents and potential transfer are prevented.

Attention

Multibarriers operated in the safe area may subsequently not be used in explosion hazardous areas.

Attention

The multibarriers are exclusively approved for the applications listed in this document. Should this regulation be violated, the manufacturer is exempt from his liability and responsibility.

3.2 Marking and ident. numbers

The following indications are printed on the top of the multibarrier housing:

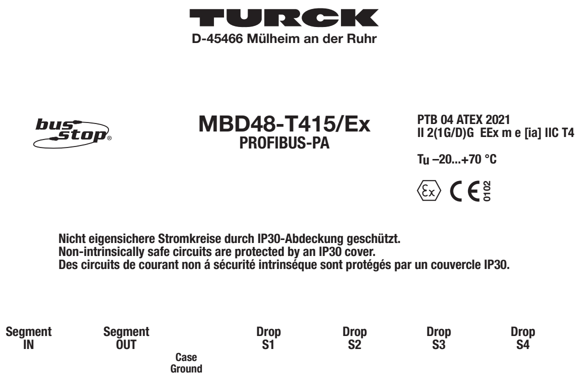

Fig. 3.2 Imprint on the top of the housing

Type codes and ident. numbers:

Multibarrier for PROFIBUS-PA:

- MBD48-T415/Ex, ident. number: 6611270

Multibarrier for FOUNDATION™ fieldbus:

- MBD49-T415/Ex, ident. number: 6611247

3.3 Electrical data

Operating voltage U_B.	16...32 VDC
Max. current consumption (at a load of 40 mA per output)	280 mA (at 16 VDC) up to 138 mA (at 32 VDC)
Galvanic isolation (to EN 50020) – Trunk line (EEX e) to output (EEx i) – Trunk line (EEX e) to supply voltage – Between individual outputs	 253 VDC 253 VDC 60 VDC
Output voltage Output current Short-circuit current limitation	≥ 10.5 V (at 40 mA) ≤ 40 mA ≤ 45 mA
Ex approval according to EC type test examination certificate Max. values – No-load voltage U_0 – Short-circuit current I_0 – Power P_0 Max. safety voltage I_m Internal inductances/capacitances L_i/C_i	PTB 04 ATEX 2021 14.3 V 268 mA 958 mW 253 VAC negligible

Tab. 3.1 Electrical data

3.4 Transmission physics

The multibarrier is suited for fieldbus system with transmission physics acc. to IEC 61158-2. FOUNDATION™ fieldbus and PROFIBUS-PA work in compliance with the specifications of the IEC fieldbus model. The MBD... – T415/Ex is thus compatible with both fieldbus types.

The fieldbus model according to IEC 61158-2 is described in more detail in chapter 4.1.

3.5 Area of application according to ATEX

The area of application according to ATEX is:

II 2 (1 GD) G EEx m e [ia] IIC T4

3.6 Mechanical dimensions

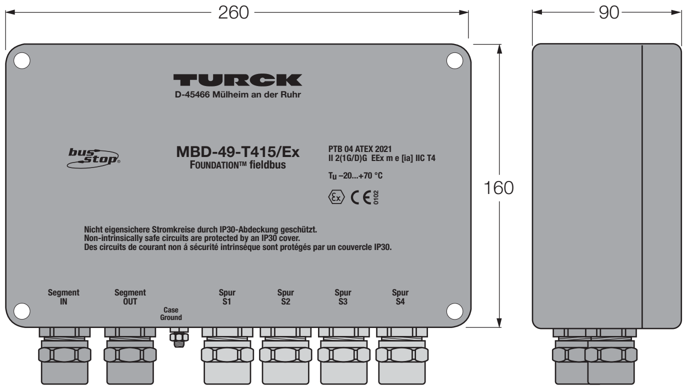

Fig. 3.3 Mechanical dimensions of MBD49-T415/Ex (identical to MBD48-T415/Ex)

3.7 Installation and disassembly

The installation, resp. the disassembly, of the multibarrier may only be carried out by specially trained and qualified staff. During installation, the applicable technical regulations and installer regulations must be observed.

3.7.1 Electrical installation

The multibarrier housing is suited for wall mounting and features protection degree IP66 acc. to IEC/EN 60529. For mounting use 4 screws with a diameter of approx. 5...6 mm (see Fig. 3.4). For mounting the housing cover must be removed.

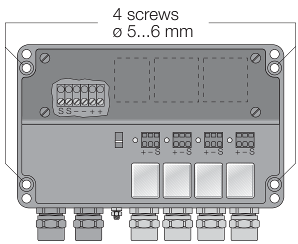

Fig. 3.4 Mounting of the fixing screws

Attention
Always take care that the housing is mounted correctly and safely during installation. The cable glands should be protected against the impact of mechanical hazards.

3.7.2 Electrical installation

Warning
The electrical connection may not be established if voltage applies.

The trunk line is connected via screw terminals; the outputs via cage clamp terminals.

To connect the trunk line, first the housing cover and then the IP30 cover must be removed. The connections of the intrinsically safe outputs can be freely accessed after opening the top cover.

The cables must be fully inserted into the cable glands.

Fig. 3.5 shows the position of the cable glands and the electrical connections:

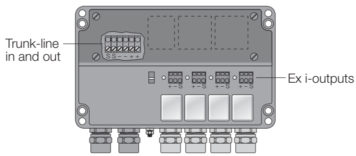

Fig. 3.5 Position of the cable glands and the electrical connections

Cable diameters and conductor cross sections

Trunk line – Cable diameter – Conductor cross section	10...14 mm ≤ 2.5 mm^2 with flexible conductors/ ≤ 4 mm^2 with rigid conductors/
Outputs – Cable diameter – Conductor cross section	5...9 mm ≤ 2.5 mm^2

Tab. 3.2 Admissible cable diameters and conductor cross sections

Attention

The fixing torque of the screw terminals may not be exceeded.

The cable glands may be used for permanent cabling only. For the trunk line (EEx e bus-in and bus-out) EEx e type cable glands are used.

To connect the conductors, the cable jacket should be stripped by 10...15 cm. The electrical pin configuration accords to the following tables, i.e. table 3.3 and table 3.4:

EEx e terminals	Function
S	Shield connection of EEx e cable
S	Shield connection of EEx e cable
–	EEx e cable (trunk line) –
–	EEx e cable (trunk line) –
+	EEx e cable (trunk line) +
+	EEx e cable (trunk line) +

Tab. 3.3 Connection of EEx e terminals

EEx i terminals	Function
+	EEx i cable (output) +
–	EEx i cable (output) –
S	Shield connection of EEx i cable

Tab. 3.4 Connection of EEx i terminals

Outputs	Function
S1	Output 1
S2	Output 2
S3	Output 3
S4	Output 4

Tab. 3.5 Connection of the outputs

3.8 Shielding and earthing

Shielding

The cable shields of the EEx e trunk line are connected via screw terminals; whereas the shields of the EEx i cables are connected via cage clamp terminals (see table 3.3 and table 3.4).

The cable shields are connected capacitively with the functional earth of the housing. The capacity is specified with 1 nF.

Note

In order to provide optimum EMC protection, we recommend the use of EMC-grade cable glands for multibarrier operation.

Earthing

Attention

Please ensure sufficient equipotential bonding of the installation. The device must be connected to the equipotential bond via the M5 x 1 bolt on the bottom of the housing. Potential equalisation must accord to EN 60079-14 specifications. It is not permitted to establish the equipotential bond via the shielding conductor.

3.9 Selectable terminating resistor

The multibarrier is equipped with a switch-in bus terminating resistor acc. to IEC 61158-2. The terminating resistor (also called terminator) prevents reflections at the end of the bus segment. The bus terminating resistor is described in more detail in chapter 4.4.

Fig. 3.7 shows the position of the switch:

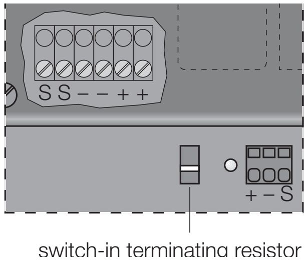

Fig. 3.7 Position of switch to enable/disable the terminating resistor

3.10 Short-circuit performance

The multibarrier outputs feature channel-specific short-circuit protection. The max. current is limited to 40 mA. This prevents a short-circuit from affecting the trunk line and other drop lines. The fieldbus remains operational.

Note

In order to check the LED indications in the event of a short-circuit, the housing cover of the multibarrier must be removed.

The short-circuit is indicated separately for each channel via a red LED inside the housing (see Fig.3.8). The LEDs are marked with "Fault".

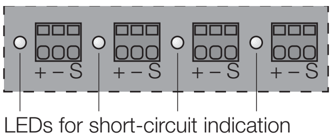

Fig. 3.8 Position of LED indicators

3.11 Potential isolation

The multibarrier features galvanic isolation between the EEx i outputs and the EEx e trunk line and between the individual EEx i outputs.

This has the advantage, that potential transfer and compensating currents between outputs cannot occur. Overvoltages are isolated.

3.12 Climatic withstand capability

In regions subject to high temperature fluctuations and variable humidity it can happen that condensation water builds up inside the device.

In order to prevent condensation water build-up, the MBD..-T415/Ex is equipped with a pressure compensation element (breather) on the cable connection side.

The pressure compensation element ensures continuous and reliable ventilation of the multibarrier. The ePTFE membrane inside the breather features a high water entry pressure and is oil-resistant. Salt crystals are also fully retained.

3.13 Maintenance

The multibarrier does not require maintenance, configuration or special settings.

3.14 Errors and error handling

Warning

Trouble-shooting and error elimination may only be carried out by specially trained qualified staff. Devices, which have once been used in the non-explosion hazardous area, may not be used subsequently in the explosion hazardous area.

If a malfunction of the multibarrier occurs due to inappropriate handling or other reasons, then the device must be replaced.

Defect device components may only be replaced with genuine TURCK spare parts.

3.15 Disposal

Disposal of the multibarrier and its packaging must comply with the regulations of the respective country, in which the device is used.

The multibarrier contains electronic components, such as semiconductors, and must possibly be treated as hazardous waste.

4 Planning a fieldbus application

4 Planning a fieldbus application

4.1 The fieldbus according to IEC 61158

FOUNDATION™fieldbus and PROFIBUS-PA are flexibly applicable fieldbuses for process automation The physical layer and data transfer of these bus systems are defined in IEC 61158.

This standard fulfils important requirements of the chemical and petro-chemical industries and has the title "Digital data communication for measurement and control – Fieldbus for use in industrial control systems". It is divided into 6 parts.

These parts are designated with 61158-1, 61158-2 etc. and comprise the following issues. Part 1 deals with introductory topics, while parts 2 to 6 are oriented at the OSI layer model. Table 4.1 and table 4.2 clearly indicate the contents of the standard and its context.

IEC 61158 Document	Contents	OSI layer
IEC 61158-1	Introductory guidelines	–
IEC 61158-2	Specification of the bit transmission layer (physical layer) and definition of its services	1
IEC 61158-3	Definition of the services of the safety layer (Data link layer)	2
IEC 61158-4	Specification of the protocol of the safety layer (Data link layer)	2
IEC 61158-5	Definition of the services of the application layer (application layer)	7
IEC 61158-6	Specification of the protocol of the application layer (application layer)	7

Tab.4.1 The structure of the IEC 61158

OSI layer	Designation of the layer	Function of the layer
7	Application layer	Interface to the user program with application-related commands (read, write)
6	Presentation layer	Presentation (coding) of the data for processing and interpretation in the next layer
5	Session layer	Connection and disconnection of temporary node connections; synchronisation of communicative processes
4	Transport layer	Control of data transfer for layer 5 (transport errors, division into data packets)
3	Network layer	Connection and disconnection of connections, prevention of network "traffic jams"
2	Data link layer	Description of the bus access method (Medium Access Control, MAC) including data back-up
1	Bit transmission layer (physical layer)	Definition of the medium (hardware, coding, the speed of data transmission etc.

Tab. 4.2 The OSI layer model

The IEC 61158-2 relates to the OSI layer 1 (physical layer) and defines the transmission medium, data coding and data transmission speed. For operation of a FOUNDATION™ fieldbus or PROFIBUS PA network it is required that all components used comply with this standard.

For use in the explosion hazardous area it is additionally required that the components are approved and certified by an authorised body, such as the PTB in Germany or the UL in the USA.

The multibarrier MBD..–T415/Ex operates in compliance with the specifications of the IEC 61158-2.

Table 4.3. shows the characteristics of the transmission technology according to IEC61158-2

Data transfer	Digital, bit-synchronous, Manchester coding
Transmission speed	31.25 kbps, voltage mode
Data back-up	Preamble, fail-safe start and end delimiter
Cable	Twisted and shielded 2-wire cable
Remote powering and nodes	Optionally possible via the signal wires
Explosion protection types	Intrinsic safety (EEx ia/ib) and encapsulation (EEx d/m/p/q)
Topology	Line and tree topology; also in combination
Number of bus nodes	Up to 32 nodes per line segment, max. 126 in total
Repeater	Extendable via max. 4 repeaters

Tab. 4.3 Characteristics of IEC 61158-2 transmission technology

4.2 Construction of a fieldbus segment

Starting from the control room, in which the process control system is usually located, it is possible to set-up a fieldbus segment according to IEC 61158-2 via a segment coupler or a power conditioner directly in the field.

4.2.1 Construction of a PROFIBUS-PA segment

A PROFIBUS-PA network with transmission physics according to IEC 61158-2 is usually set-up via a segment coupler or link between a PROFIBUS-DP segment with RS485 physics and the PROFIBUS-PA network.

The segment coupler is a signal converter, which adapts the RS485 signals to the IEC 61158-2 signal level. The bus protocol, in this case DP or DP/V1, retains its transparency. When using a segment coupler, the transmission rate is limited to max. 93.75 kbps (Pepperl & Fuchs-Koppler) or 45.45 kbps (SIEMENS coupler).

Both couplers are not monitored by the DP master, so that they do not require parameterisation. In short: the coupler converts the asynchronous DP protocol with 11 bit/byte into the synchronous PA protocol with 8 bit/byte.

The link is an intelligent signal converter. It reproduces all field devices connected in an
IEC 61158-2 segment as a single slave in the RS485 segment. When using links, the baud rate in the RS485 segment is not limited. Thus it also possible to use fast networks and field devices within a connection acc. to IEC61158-2, for instance, also for control engineering tasks.

A link attains only a single address in the DP branch and is treated like a slave. However, in a PROFIBUS-PA branch the link has master functionality. All PA devices of a link, also over several PA branches, have to be considered as a logical bus.

With PROFIBUS-PA, system integration is established via a DP/PA segment coupler or DP/PA link, branched off from the PROFIBUS-DP fieldbus.

The following figure (Fig. 4.1.) shows the construction of a PA segment with the multibarrier MBD48-T415/Ex.

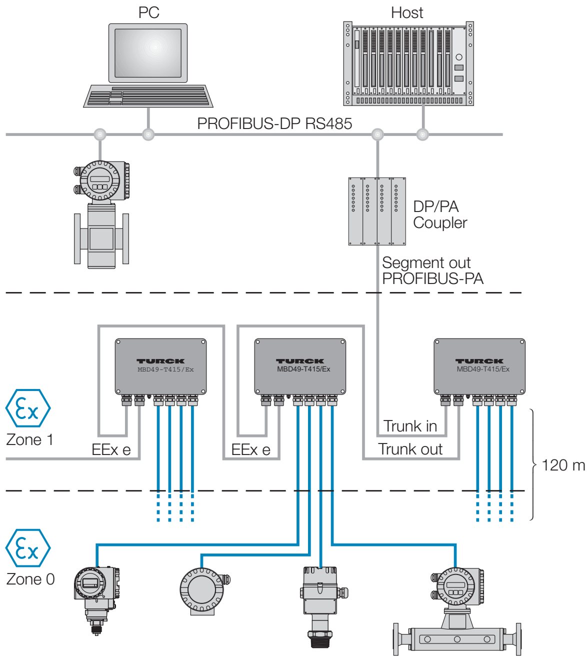

Fig. 4.1 Example of a PROFIBUS-PA fieldbus application

4.2.2 Construction of a FOUNDATION™ fieldbus segment

With FOUNDATION™ fieldbus, the segment is branched off from a High Speed Ethernet (HSE) segment via a so-called bridge (HSE-H1) or from the control system via a power conditioner.

Fig 4.2 shows a fieldbus segment with an HSE-H1 bridge.

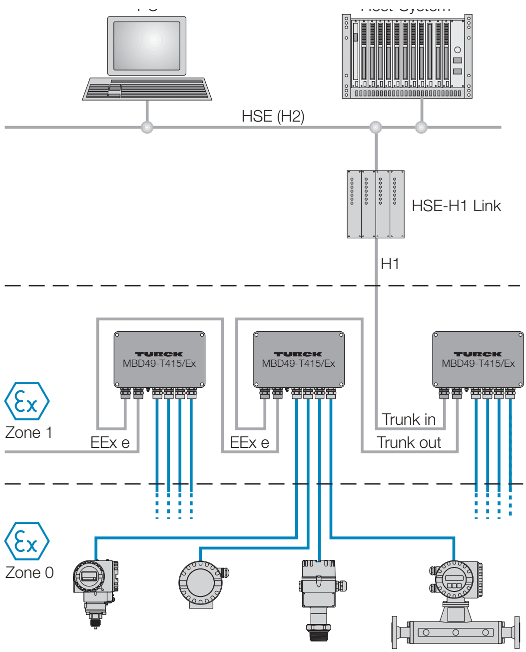

Fig. 4.2 Example of a FOUNDATION™ fieldbus application with an HSE-H1 link

In our example, the FOUNDATION™ fieldbus network is directly branched off from the process control system via a FOUNDATION™ fieldbus segment card and enabled via a "Linking-Device" by the fast High-Speed-Ethernet (HSE- stands for High Speed Ethernet which transfers the FOUNDATION™ fieldbus signals to Ethernet and provides significantly faster data communication for the higher cell levels).

In the following figure (Fig. 4.3) the segment is branched off directly from the control system via the power conditioner RPC49-205.

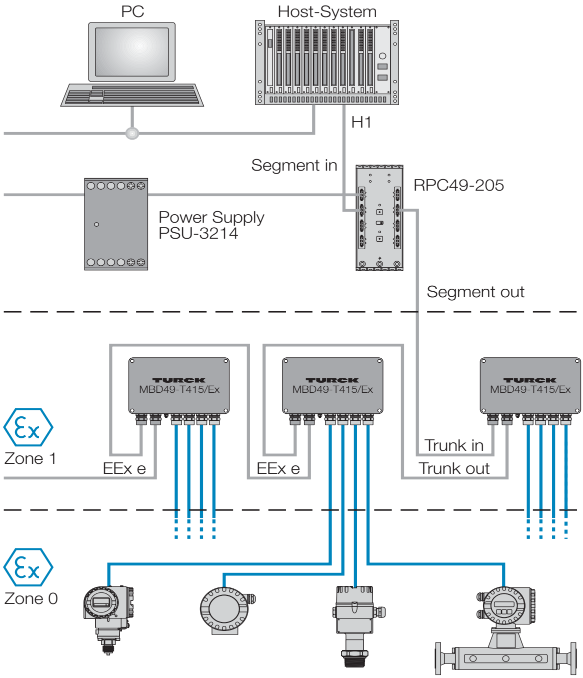

Fig. 4.3 Example of a FOUNDATION™ fieldbus application with a power conditioner

In our example, the FOUNDATION™ fieldbus network is branched off directly from the process control system via a FOUNDATION™ fieldbus segment card and powered via a power conditioner with integral power supply. Then the multibarrier is directly connected to the H1 bus. Depending on the number of nodes, it is possible to interconnect several multibarriers.

Alongside the devices shown, i.e. the PSU3214 and RPC49-205, TURCK provides all components needed to construct a FF-network, i.e. for installation of the physical layer.

4.3 Assessing the number of multibarriers needed

The number of multibarriers needed depends on the number of fieldbus nodes and their current consumption. The number is calculated as follows:

- Add up the number of fieldbus nodes.
- Divide the result by 4.
- Round up the result to the next whole number.

This result indicates the minimum number of multibarriers needed.

Example:

4 temperature transmitters

3 pressure transmitters

2 flow transmitters

2 level controls

4 rotational speed meters

This results in: (4 + 3 + 2 + 2 + 4) / 4 = 3,75

Therefore, the minimum number of multibarriers is 4!

A configuration tool for planning a segment, e.g. with a selection guide for cable types etc., can be downloaded from the TURCK homepage **www.turck.com** free of charge.

4.4 Termination of a fieldbus segment with a terminating resistor

To ensure correct communication, the bus line must be terminated at both ends with a terminating resistor in order to avoid reflections on the cable and thus to optimise the transmission quality. The bus terminator is usually integrated in the segment coupler/link or power conditioner und must thus only be added to the other end of the bus line.

If the multibarrier is physically the last device connected to the segment, then the internal terminating resistor must be activated. The terminating resistors are located on the printed circuit board of the multibarrier. (see chapter 3.9)

A model bus termination is shown in fig. 4.4.

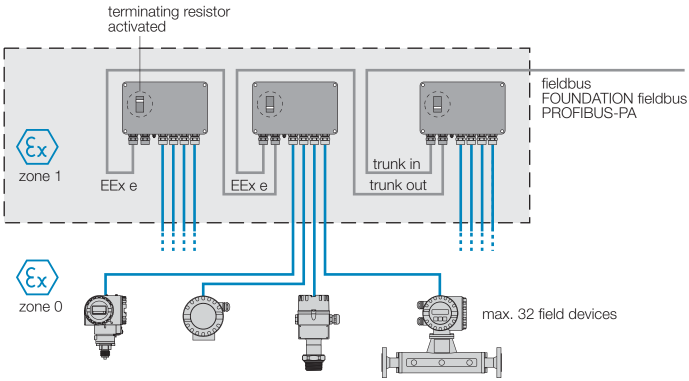

Fig. 4.4 Model bus termination (valid for FOUNDATION™ fieldbus and PROFIBUS-PA)

5 Set-up of the multibarrier

5 Set-up of the multibarrier

5.1 Mounting of the multibarrier

The multibarrier should be mounted according to the installation guidelines provided in chapter 3.7.

5.2 Electrical installation

The electric connection of the multibarrier must be carried out according to the installation guidelines provided in chapter 3.8.

5.3 Earthing of the housing

Attention

The equipotential bond is established via an M5 x 1 earthing bolt attached to the housing. Potential equalisation must accord to EN 60079-14 specifications. It is not permitted to establish the equipotential bond via the shielding conductor.

Note

Please observe the details provided in chapters 3.7 and 3.8

5.4 Termination of a fieldbus segment

If the multibarrier is physically the last device connected to the fieldbus, then the internal terminating resistor must be activated.

Note

Further information is provided in chapters 3.9 and 4.4.

5.5 LED indications

The multibarrier is equipped with 4 LEDs inside the housing on the printed circuit board. The channel-related LEDs 1...4 will illuminate red in the event of a short-circuit of the associated output.

Note

See also chapter 3.10

6 Glossary of terms

A

Applied Directives

Directive 94/9/EC

The directive 94/9/EC, better known under the name ATEX (ATEX 100a), regulates the manufacture and placing on the market of electrical equipment and protective systems for use in explosion hazardous areas.

The safety-technical aspects are based on the "Basic safety and health requirements for the conception and construction of devices and protective systems intended for use in explosion hazardous areas", acc. to Annex II.

The directives prescribes an EC type test examination certificate for electrical devices, category 1 and 2, together with the according test certificate (Ex certificate).

Devices of category 3 must have a manufacturer's declaration (EC conformity declaration), stating compliance with the directive, and if necessary, under application of specific standards.

DIN EN 60079-14

Electrical equipment for explosion hazardous areas, part 14: Electrical systems in explosion hazardous areas (except mining)

DIN EN 50 014

Electrical equipment for explosion hazardous areas: General regulations

DIN EN 50 019

increased safety "e"

DIN EN 50 020

intrinsic safety "i"

DIN EN 50 028

encapsulation "m"

C

CENELEC

Comité Européen de Normalisation Électrotechnique (European Community for Electrotechnical Standardisation).

Category "ia"

Category "ia" indicates that the electrical equipment should not be able to cause an ignition under normal operating conditions in the event of a single fault or any combination of two faults. Intrinsic safety must be ensured even when two independent faults occur at the same time.
For this reason, components used to limit the electrical energy or protective parts of an apparatus of category "ia" must be present in triplicate.

Category "ib"

An electrical apparatus, category "ib" should not be capable of causing ignition under normal operating conditions in the event of a single fault. Intrinsic safety must be ensured even when a fault occurs.
Any apparatus in category "ib" must have all components used to limit the electrical energy and protective parts in duplicate.

EEx m

Encapsulation

EEx n

Type of protection for devices of category 3G (non-sparking apparatus)

Explosive atmosphere

An explosive atmosphere contains flammable mixtures of gases, vapours, mist and dusts with air under atmospheric conditions.

Explosive atmosphere (dangerous)

A dangerous explosive atmosphere is a mixture containing concentrations of flammable gases or vapours that, when ignited, can cause damage to persons directly or indirectly through an explosion.

Explosive mixture (general term)

A combustible (flammable) mixture is a mixture of gases or vapours, or a mixture of gases and vapours with mists and dusts, capable of propelling a reaction after ignition.

Explosion hazardous area

An explosion hazardous area is a location where a potentially explosive atmosphere may exist due to local operating conditions.

Explosion hazard

An explosion hazard exists in locations:

- in which ignitable concentrations of flammable gases or vapours can exist under normal operating conditions, or because of repair or leakage, and when these conditions provide the probability that a dangerous fuel to air mixture will occur;
- where the explosive or ignitable mixtures can come in contact with a source of ignition and continue to burn after ignition.

Explosion protection, primary

The primary method of explosion protection comprises measures which prevent formation of a dangerous atmosphere

- avoiding the use of flammable liquids
- increase of flash point
- limiting the concentration to safe levels
- through natural and technical ventilation
- monitoring the concentration

The primary method of protection is not described in this brochure. Please refer to the explosion protection regulations of the professional association of the chemical industry (Ex-RL) and the EN 1127-1.

Explosion protection, secondary

The secondary method of explosion protection comprises measures which prevent ignition of a dangerous atmosphere. Here, constructive or electrical techniques are used to:

- segregate the electrical equipment, which could ignite a dangerous mixture, by keeping the explosive atmosphere away from the ignition source
- prevent an explosion by impeding the propagation to the surrounding explosive atmosphere.

F

FISCO

Fieldbus Intrinsically Safe Concept

In the FISCO model, typically only a single "active" device, i.e. the bus power supply, is conected to the fieldbus. All other devices do not supply any energy via the line and are thus specified as "passive".

FNICO

Fieldbus Non Incendive Concept

With FNICO zone 2 installations are just as easily accomplished as zone 1 installations according to the FISCO standard. A main difference compared to the FISCO standard is the higher power that may be lead into the field.

I

Intrinsic safety EEx i – explosion protection type (i) [EN 50020]

All other protection types except "intrinsic safety" attempt to contain the explosion to the inside of the housing and to prevent penetration of an ignitable gaseous mixture.
The method of "intrinsic safety" is based on a different approach. It limits the electrical energy of a circuit to such an extent, that excessive temperatures cannot occur, or arcs and sparcs are incapable of generating the energy needed to ignite an explosive atmosphere.
Due to the limited energy, these circuits are mainly suited to application in the field of measuring, control and instrumentation. "Intrinsic Safety" has some inherent advantages over other protection types, for example, wiring and maintenance of live circuits.

Intrinsically safe electrical equipment

Intrinsically safe electrical equipment is any apparatus in which all circuits are intrinsically safe. Direct installation in hazardous locations is permitted, provided that all related requirements are met. An example is a NAMUR sensor approved according to EN 60947 or a transmitter.

Increased safety EEx e – protection type (e) [EN50019]

Protection type (e) applies to electrical equipment or components of electrical equipment which do not generate sparcs or arcs under normal conditions, do not adopt excessive temperatures and whose nominal voltage does not exceed the value of 1 kV.

M

MBD

Multibarrier

MBP

Manchester Bus Powered: stands for a transmission technology with the attributes:

- Manchester Coding and
- powering via the bus

Industrial Automation

P

PTB

Physikalisch Technische Bundesanstalt

T

Temperature classes

The temperature class specifies the maximum allowable surface temperature of an apparatus. Here, the explosion protected apparatus can be approved for different temperature classes - a decision which depends on technical and financial considerations. Thus, the lowest possible temperature classification in dependence on the type of protection is usually related with challenging techniques and accordingly high expenses. "Intrinsically safe" products are, in comparison, more efficient and cheaper. Temperature classification is only required for intrinsically safe equipment which is directly installed in explosion hazardous areas. For associated apparatus this classification is not needed.

TÜV

Technischer Überwachungsverein

V

Verification of intrinsic safety

According to EN60079-14 it is required to document and confirm that intrinsic safety is maintained when interconnecting intrinsically safe apparatus and associated equipment.

Z

Zone 0

Zone 0 comprises locations in which a dangerous explosive atmosphere is present continuously or frequently.
Likelyhood of the occurrence of an ignitable mixture: constantly, for long periods or frequently (guide value: >1000 h/a).

Zone 1

Zone 1 are locations in which an explosive or dangerous explosive atmosphere is likely to occur.
Likelyhood of the occurrence of an ignitable mixture: occasionally during normal operation (guide value: 10...1000 h/a).

Zone 2

Zone 2 are locations in which an explosive or dangerous explosive atmosphere is likely to occur only rarely and if, only for a short time.
Likelyhood of the occurrence of an ignitable mixture: unlikely or rarely and then only for a short time (guide value: <10 h/a).

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