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Trouble-free!

Fieldbus segment planning made easy

As more than twenty years of PROFIBUS PA and FOUNDATION fieldbus H1 demonstrate: good planning (a different task to discrete installation technology) forms a solid foundation that simplifies speeds up and improves the quality of all subsequent steps. Installation, loop check and running operation all benefit. And this is how it's done…

Project Manager Jens Mueller (all characters and situations are purely fictional, similarities with true facts, however, are deliberate) was relieved when the first 50 field devices passed the loop check in the shortest possible time. For a moment, he dwelled on the project as it was a few years ago: Installed field devices that had worked perfectly in the testing laboratory either failed to respond, or temporarily stopped working. Many unplanned hours of troubleshooting revealed excessively low signal levels, faulty termination, or errors in shielding and earthing. These subsequently all had to be laboriously corrected.

Influenced by this experience, Mueller allowed himself to be convinced by his employee, Steffi Meier, to plan the fieldbus infrastructure in a structured manner at the outset of the project. During the planning stage, flaws were detected before the first cable was laid and it was also ensured that the fieldbus installation would comply with the basic requirements and that it would work.

Planning ensures reliability

Ms Meier explained that the fieldbus transmits power and data simultaneously via a common shielded twisted pair cable and that several field devices can be connected to a cable. Consequently, in comparison with conventional interface technology, the following requirements additionally must be determined during planning:

- Ambient conditions
- Cable lengths

- Number of nodes
- Voltage drop at the cable
- Bus cycle times
- Protection and earthing concept
- Explosion protection

Segment Checker (www.segmentchecker.com) or other planning tools that are available free of charge can be used to automate the calculations.

No wiring diagrams are required. These are replaced by clearly laid out spreadsheets in which the data relevant for planning is listed. Last-minute changes, as are often required when deploying instrumentation, measurement and control technology, are easier to implement during the planning stage. This is because:

- The connection technology is identical for all device types.
- The available power reserve is easy to determine.
- Less wiring and no I/O cards or remote I/O are required.
- Devices can be parameterized and calibrated remotely.

The technical data required for planning is based on the planning documents for instrumentation and control equipment, such as:

- Device data sheets
- Installation location in the field
- Cable tray planning
- Conditions in the control technology room

Planning procedure

The main steps for planning fieldbus segments are virtually identical in general and hazardous areas. The fieldbus installation is subject to the more stringent of constraints, which are defined in the IEC 61158-2 fieldbus standard and the IEC 60079 explosion protection standard respectively. The basic principle is as follows:

Topology: Although IEC 61158-2 permits numerous topologies, a standard topology with a trunk and one spur for each field device has become an established practice. The advantage of this so-called “trunk-and-spur” topology (Fig. 2) is its simplicity. It is easy to plan, install and maintain.

<< Fig. 2 >>

The segment protector prevents errors in the segment when working on the field device.

Ambient conditions: The maximum ambient temperature determines the voltage drop at the cable and the voltage available at the field device. Other ambient conditions have an effect upon the choice of cable material and field distributors.

Maximum cable length: The maximum required cable distance is determined during planning of the cable trays. This is verified taking the worst case into account for all following evaluations.

Selection of components: Planning software such as Segment Checker permits simple design of a segment using mouse clicks. The planner selects the power supply, the bus master, the field devices and segment protectors, adding them to the desired topology. At each mouse click, the software validates all the electrical values (Fig. 3) and indicates problem areas in the plan by means of plain text.

The protection concept for hazardous areas is also determined during this stage. These additional requirements are described in detail below.

<< Fig. 3 >>

Number of devices and achievable cable lengths: These two values are interdependent. For example, if the planning software indicates inadequate operating voltage for a field device, the length of the trunk or the number of nodes can be repeatedly changed as required in order to ensure compliance with the trip values. This represents the final stage of planning the fieldbus infrastructure.

The segments designed in this manner will operate correctly. During commissioning, only the typical installation errors can occur, which can be detected easily using physical layer diagnostic tools. The diagnostic tools automatically generate documentation regarding the physical layer, which can then additionally be compared with the plan values. A high-quality, reliable and tested infrastructure is available for the loop check.

Hazardous areas

In instrumentation, measurement and control technology, intrinsic safety is the preferred method of protection. It permits access to the devices and circuits in the hazardous area without requiring a hot work permit.

FISCO, the Fieldbus Intrinsically Safe COncept is defined in IEC 60079-27. It allows very simple use of fieldbus technology in hazardous areas from the point of view of planners and operators and is used throughout industry. The following must be taken into account during planning:

- Only one voltage source per segment
- Cables and devices must meet the FISCO requirements

The FISCO Standard specifies trip values for the safety voltage, current and power, as well as capacitances and inductances to ensure correct interoperability. Proof of intrinsic safety is simplified, no calculations are required.

High-Power Trunk

The greatest disadvantage of intrinsic safety is its limitation of power, which has almost fatal consequences in fieldbus practice: The cable lengths and/or number of connectable field devices is drastically limited. Here, the High-Power Trunk Concept provides a solution. It permits the maximization of cable length and the number of field devices.

A variety of types of protection are used for the trunk and the spurs. The trunk is installed “protected”. Here, the power is not limited for explosion protection purposes, enabling long cable runs and high supply currents.

The field devices are selected to comply with ignition protection “Intrinsic Safety” Ex i according to FISCO or the widely-used Entity concept. All the advantages of FISCO are maintained during the connection and operation of field devices. Connection to the spur is via a FieldBarrier (Fig. 4). This ensures short circuit protection, galvanic isolation between field devices and trunk, and intrinsic safety. Validation of intrinsic safety is only performed for FieldBarrier and field device outputs.

<< Fig. 4 >>

Features and advantages of the High-Power Trunk:

- Same topology for all areas
- Intrinsically safe field device installation technology
- Work on field device possible without hot work permit
- Short circuit protection at output

Planning steps for hazardous areas

In addition to planning for safe areas, the protection concept for hazardous areas must also be selected. The two methods most frequently used are:

- Fully intrinsically safe topology for short distances
- High-Power Trunk Concept, virtually without restrictions

The degree of protection is selected initially during selection of the topology and components. The subsequent steps are identical: Segment Checker calculates conformity with the fieldbus standard (IEC 61158-2) taking into account the reduced values with regard to the power supply, installation components and field devices.

Epilog

In the control room, Project Manager Mueller looks over his co-worker's shoulder: Ten further loop checks have already been completed. The go-live date won't be an issue; the other 700 devices should go into operation just as smoothly. And thanks to digital communication, the field devices can be parameterized from the control room. Jens Mueller is confident; he'll be able to cope with the forthcoming major expansion in two years without his two co-workers, who will have entered into retirement by then.

<< The following information is intended as a separate freely-configurable box >>

IEC standards for fieldbus and explosion protection

IEC 61158-2 specifies the framework that the fieldbus segment must meet for correct and reliable operation. IEC 60079 defines types of protection for explosion protection purposes. For operation in explosive areas, the constraints of both standards must be taken into account. The following tables compare these constraints:

Table 1: Boundary conditions according to IEC 61158-2 and IEC 60079-27

Boundary condition per segment	IEC 61158-2 Fieldbus	IEC 60079-27 FISCO
Maximum number of nodes	32	32
Sum of all cable lengths	1900 m	1000 m
Length of spurs	See table 2	See table 2
Minimum voltage at field device	9 V ±10%	9 V ±10%

The maximum permissible length for a spur is based on the number of nodes in the segment. All field devices and, where applicable, a bus master and in the case of redundant masters, two bus masters are regarded as nodes.

Table 2: Maximum spur length according to number of nodes, 1 field device per spur.

Nodes: field devices + bus masters	IEC 61158-2 Fieldbus	FISCO
1 – 12	120 m	60 m
13 – 14	90 m	60 m
15 – 18	60 m	60 m
19 – 24	30 m	30 m
25 – 32	1 m	1 m

About Pepperl+Fuchs

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One Company – Two Divisions

Pepperl+Fuchs – PROTECTING YOUR PROCESS

The **Process Automation Division** is a market leader in intrinsically safe explosion protection. We offer comprehensive, application-oriented system solutions, including customer-specific control cabinet solutions for the process industry. A large portfolio of components is available from our various product lines: isolated barriers, fieldbus infrastructure solutions, remote I/O systems, HART interface solutions, level measurement devices, purge and pressurization systems, industrial monitors and HMI solutions, power supplies, separator alarm systems for oil and petrol separators, signaling equipment, lighting as well as emergency shutdown equipment and accessories.

Pepperl+Fuchs – SENSING YOUR NEEDS

With the invention of the inductive proximity sensor in 1958, the company set an important milestone in the development of automation technology. Under the motto “Sensing your needs”, customers benefit from tailor-made sensor solutions for **factory automation.** The main target markets of the factory automation are machine and plant construction, the automotive industry, storage and material handling, printing and paper industry, packaging technology, process equipment, door, gate and elevator construction, mobile equipment, renewable energies.

The division offers a wide product range of industrial sensors whether it’s inductive, photoelectric or ultrasonic sensors, rotary encoders, identification systems, barcodes, code readers for data-matrix-codes and vision sensors.

Key words: Planning, fieldbus, FieldConnex, PROFIBUS PA, FOUNDATION fieldbus H1, explosion protection, High-Power Trunk, intrinsic safety, Segment Checker, software.

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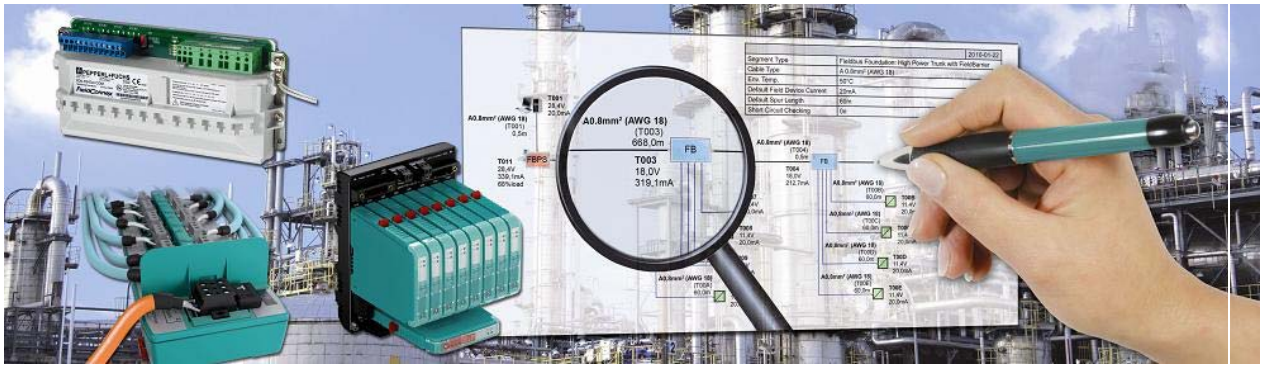

Fig. 1: Eye catcher

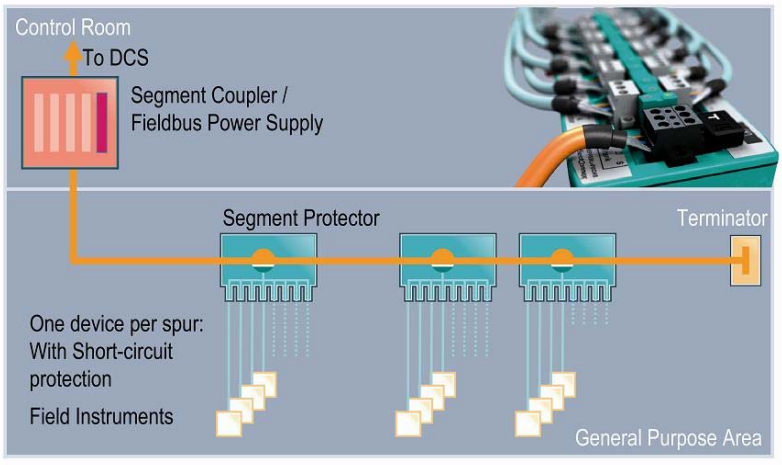

Fig. 2: Widely accepted: Trunk-and-spur topology. Simple to install and use. Work on the device during running operation possible due to short circuit protection.

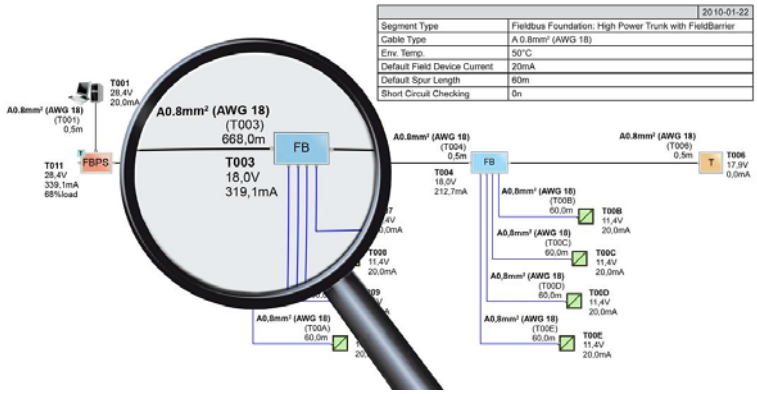

Fig. 3: Segment Checker – Reliable planning before the first cable is installed.

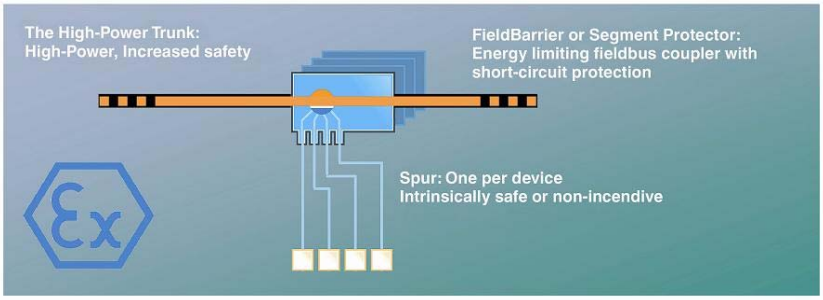

Fig. 4: High-Power Trunk for hazardous areas. Intrinsically-safe connection of field devices via FieldBarrier