PROFIBUS

Design and

Good Practices

PROFIBUS • PROFINET

Introduction

PROFIBUS-DP

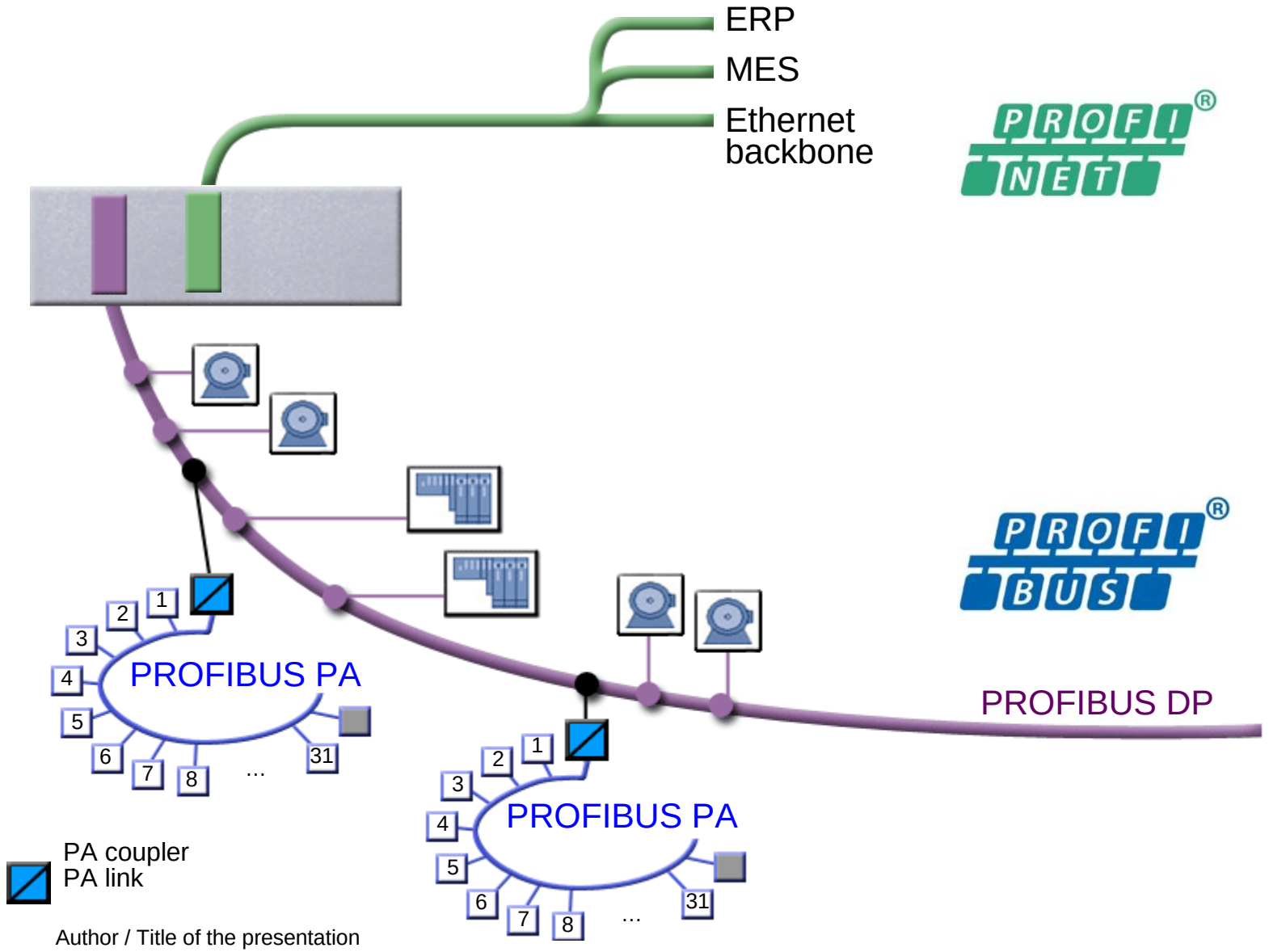
PROFIBUS-PA

Installations and Best practise

PROFIBUS Family

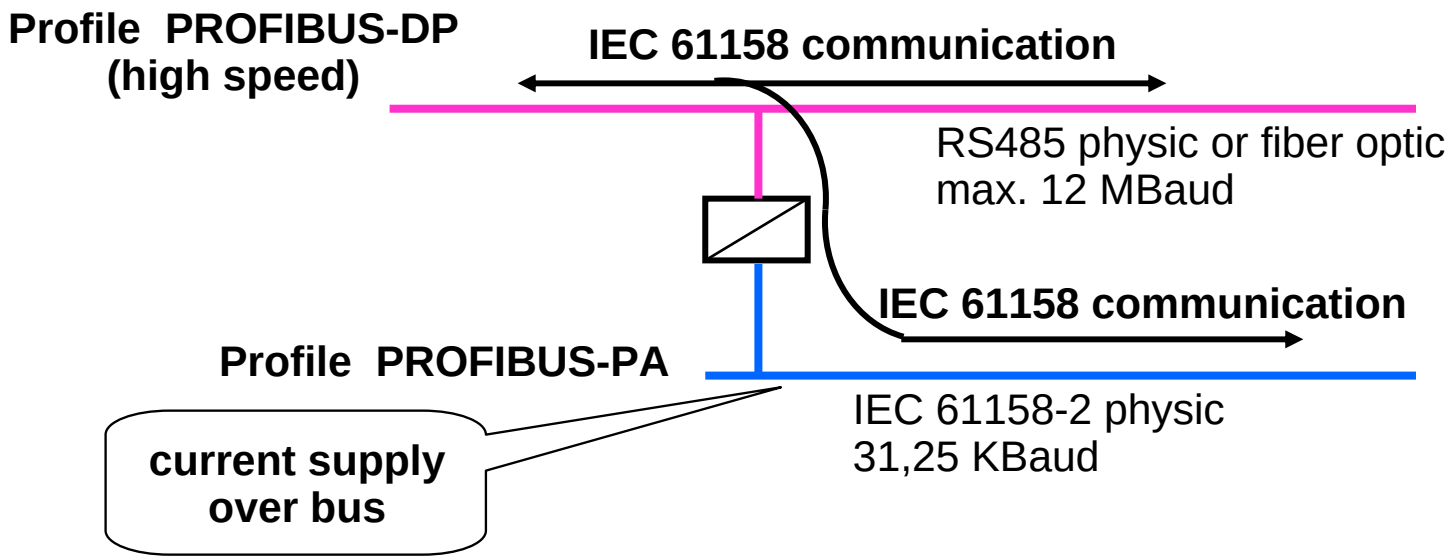
Agenda

- PROFIBUS Family
- Communication Medias
- Topologies
- Cable length
- Devices Rules
- Installation Rules
- Troubleshooting
- Training



PROFIBUS-DP/PA

- Specification by 13 industrial firms and 5 university institutes
- 1988 German DIN Standard 19245
- 1996 European Fieldbus Standard EN 50170
- 2000 International Standard IEC 61158



PROFIBUS - Transmission Technologies

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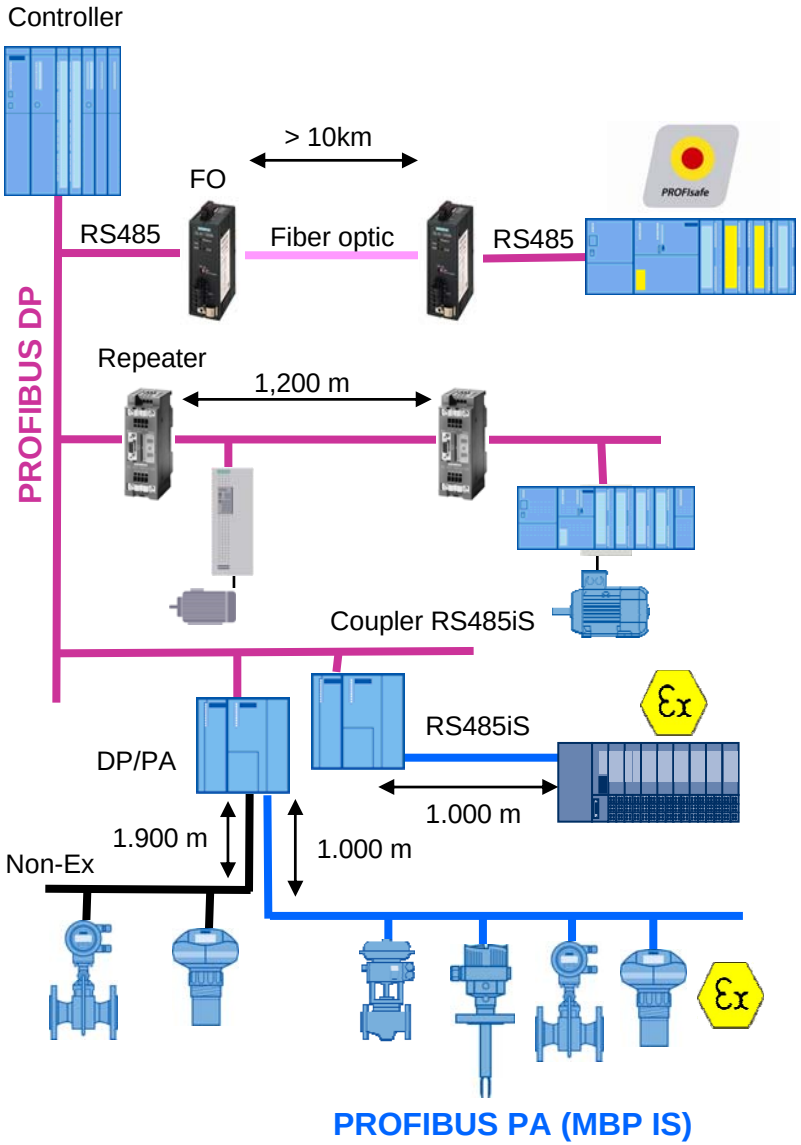

- **Per PROFIBUS DP Master system max. 125 DP slaves**
- **OLM's (Optical Link Module) for wide distances with high EMC stability**
- **Electrical networks can be extended by means of repeaters (segments)**
  - **max. 32 DP slaves per segment**
- **RS485iS couplers for intrinsically safe PROFIBUS DP in EX areas**
- **PROFIBUS PA for direct connection of field devices with power supply via bus**

PROFIBUS - Functional levels

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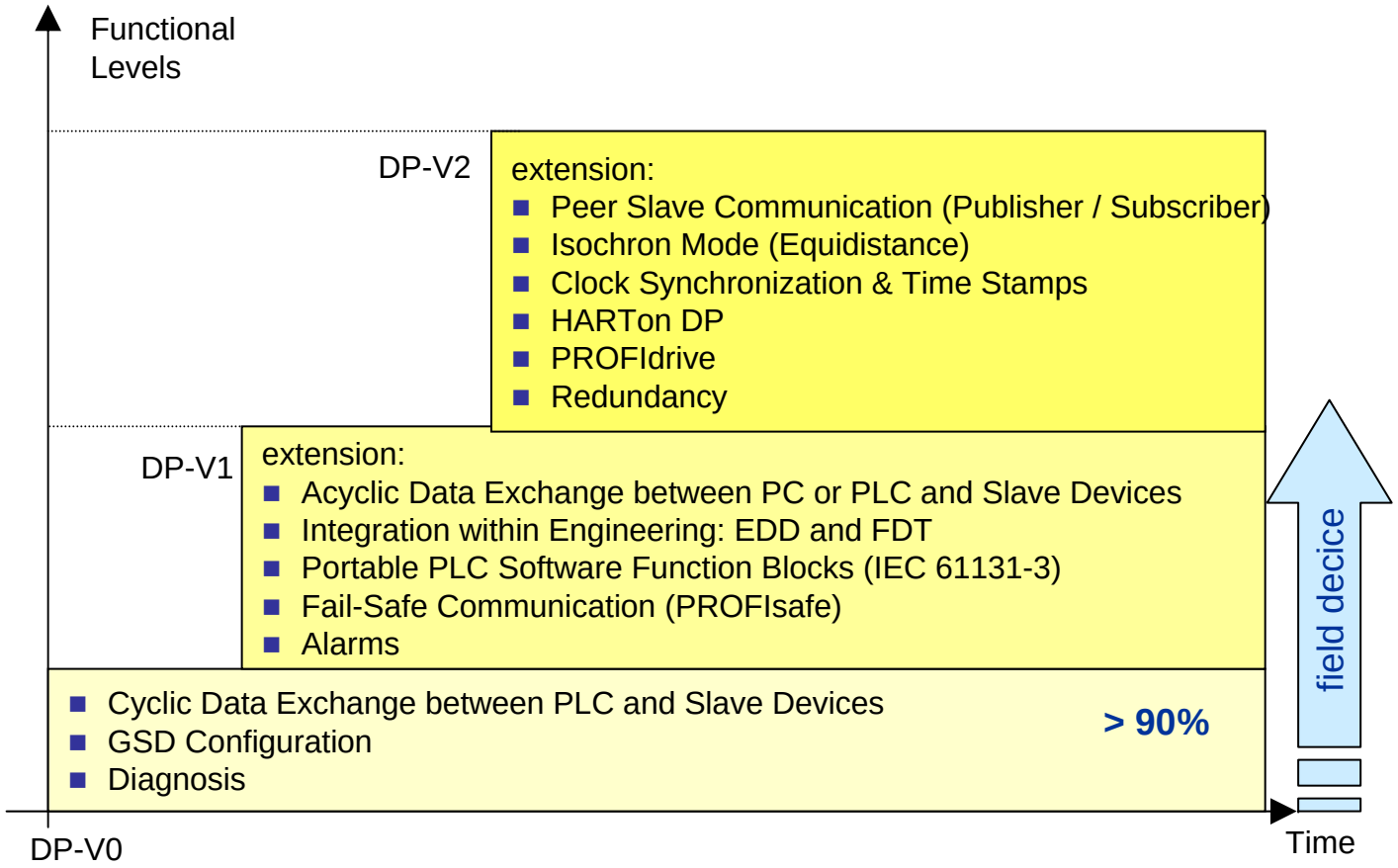
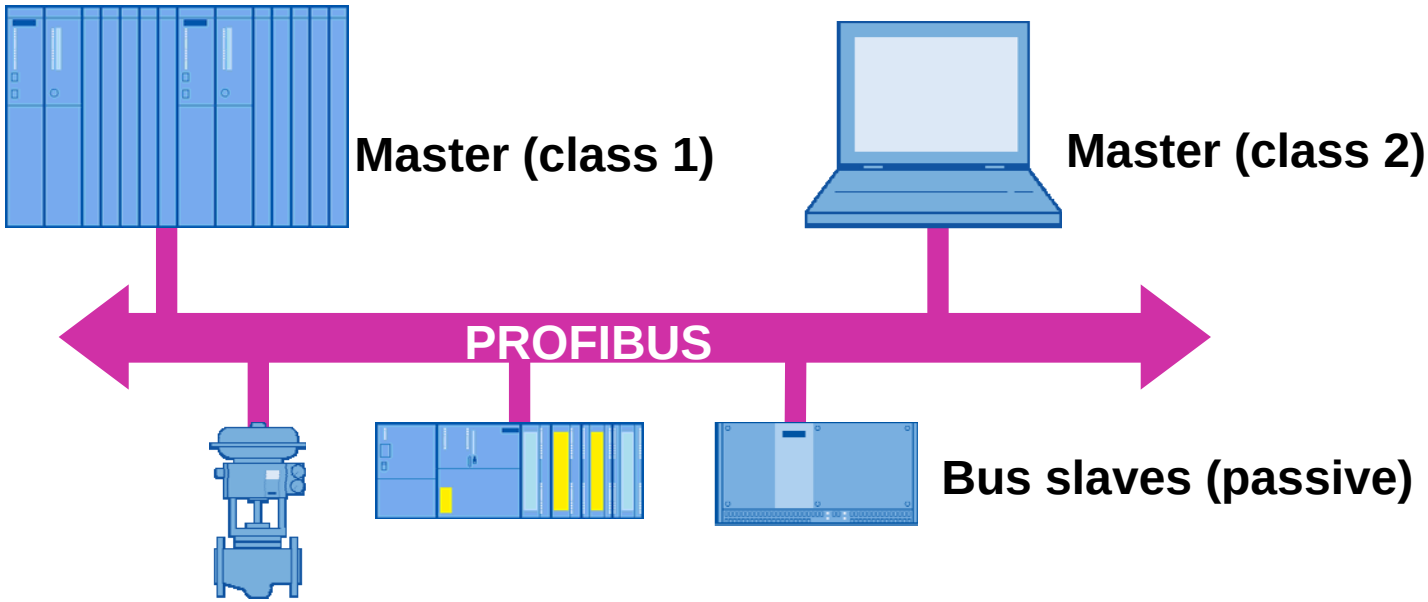


PROFIBUS - Master - Slave

- Master (class 1)
  - Central control
  - Cyclical data exchange with the slaves
  - Acyclical data exchange with the slaves
  - Active with a high priority
- Master (class 2)
  - Engineering tool for commis-sioning and parameter settings of the slaves
  - Acyclical data exchange with the slaves
  - Active with a low priority



PROFIBUS DP/PA - Deterministic communication

Agenda

PROFIBUS Family

Communication Medias

Topologies

Cable length

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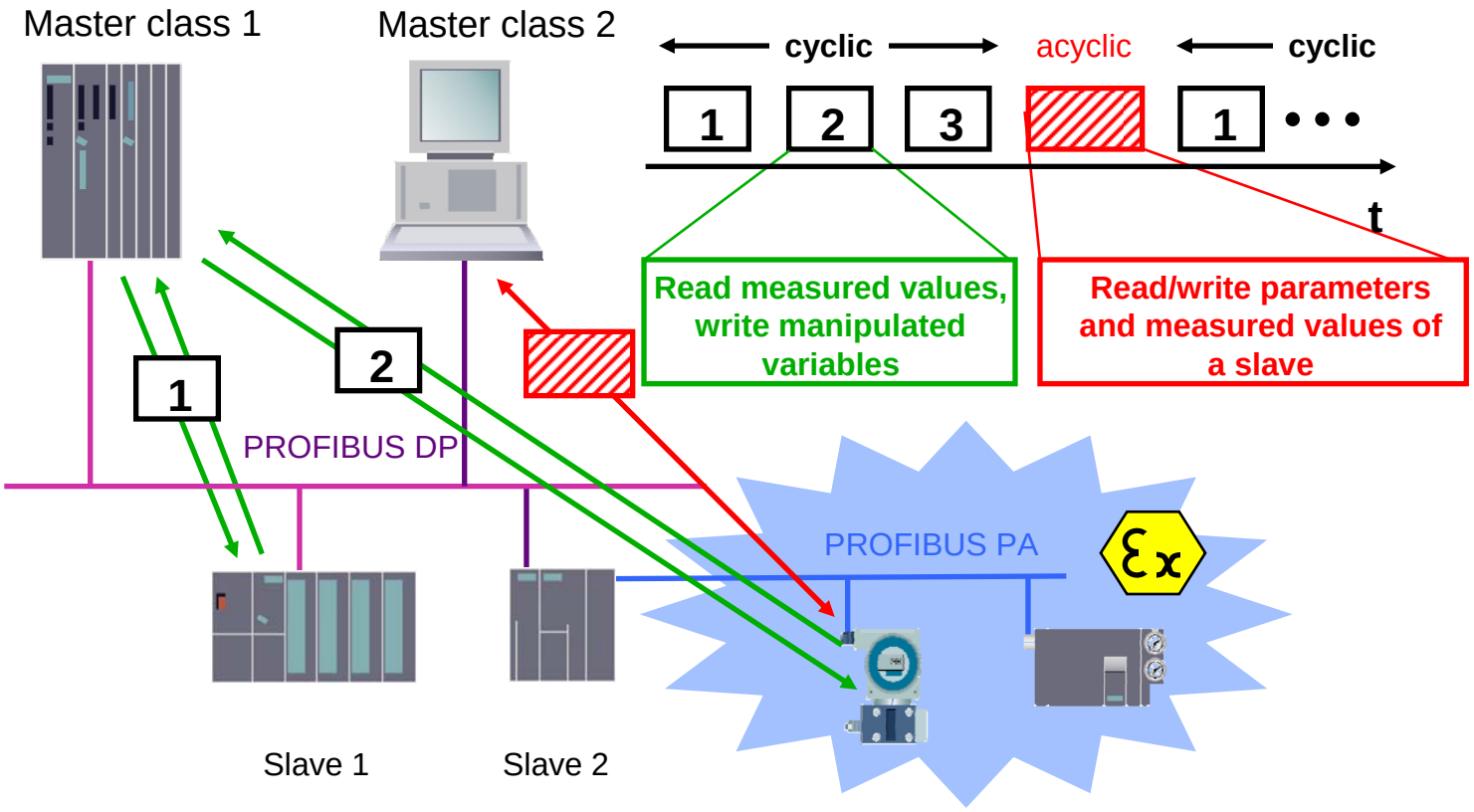
Training

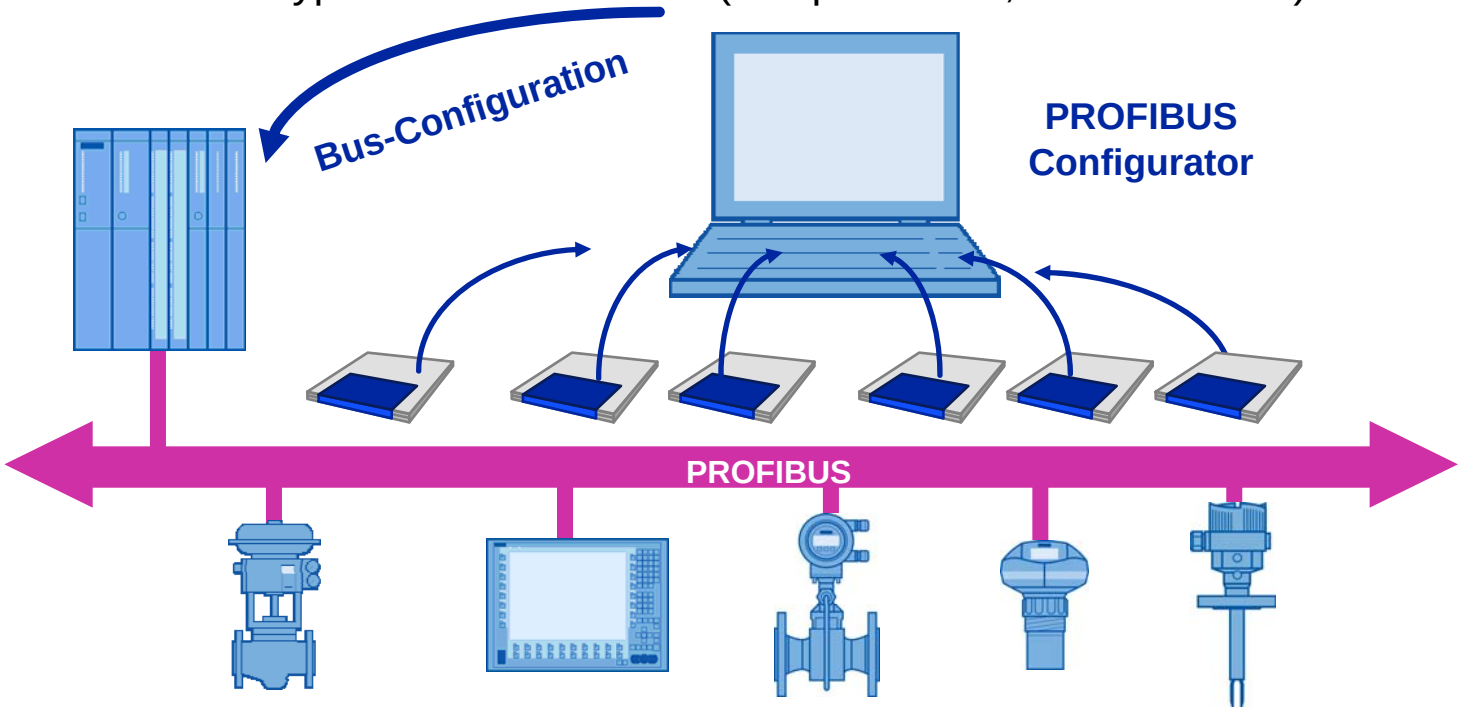
Deterministic communication according Master/Slave principle:

- **Parameterized time behaviour of the bus and defined reaction times of the slaves are permanently guaranteed!**



Configuration of the bus (GSD file)

- Bus master (Class 1 Master) needs the technical data of the attached field device.
  - The GSD file describes the general and device specific communication characteristic of a PROFIBUS device: sheet
    - Supported transmission rates
    - Length of the transferred I/O data
    - Type of the field device (compact slave, modular slave)



Introduction

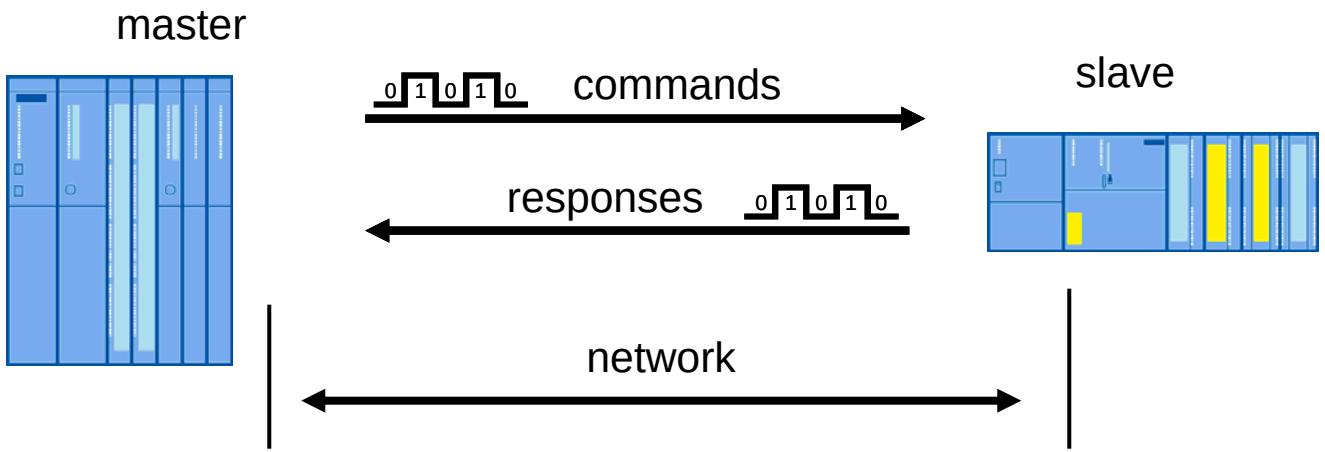
PROFIBUS-DP

PROFIBUS-PA

Installations and Best practise

PROFIBUS Family - Principle

- To create hierarchy in the network, PROFIBUS defines 2 types of stations: active (**masters**) and passive (**slaves**).



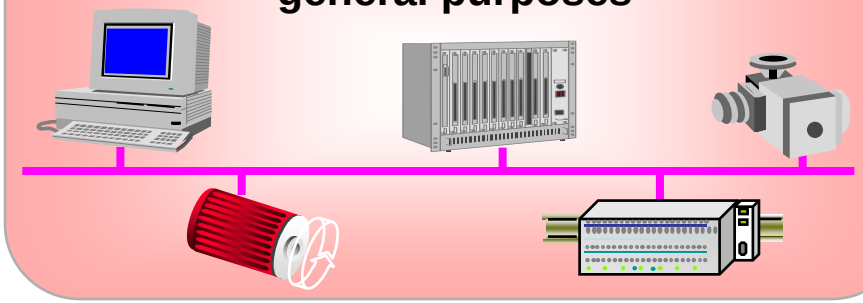
- At least **1 master** is mandatory.
- PROFIBUS networks allow **multiple masters**.
- In total **127 stations** can be addressed (masters + slaves).

Communication Medias

- PROFIBUS Supports 3 transmission media

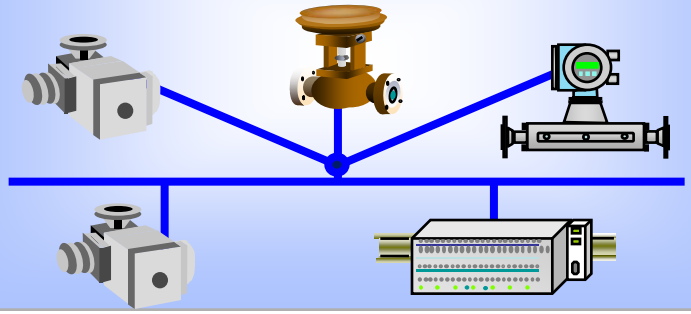
RS 485

2-wire CU-cable for general purposes



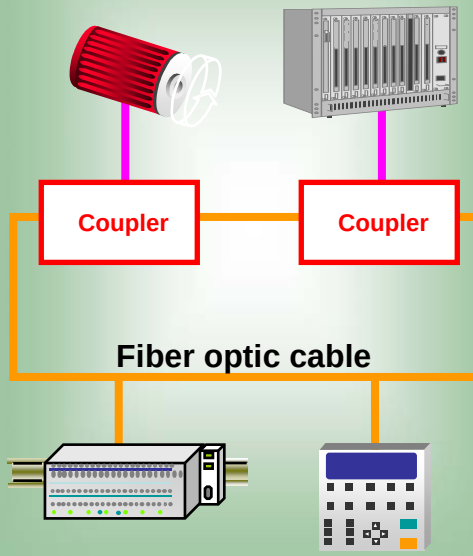
MBP-IS

2-wire CU-cable with the option for power over the bus and Ex-protection



Fiber Optic

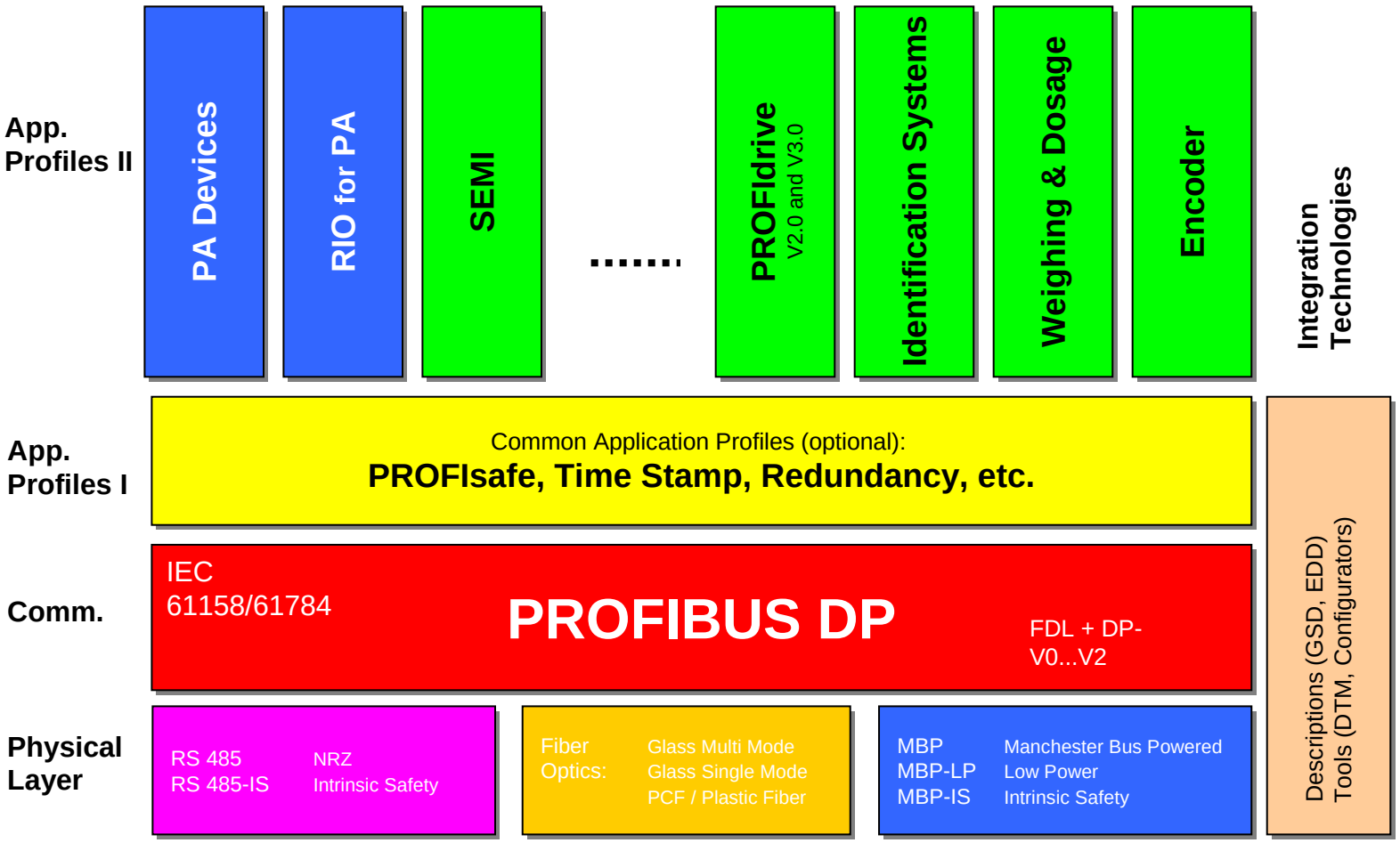
Highest EMC protection and wide distances



Total Overview of the Technology

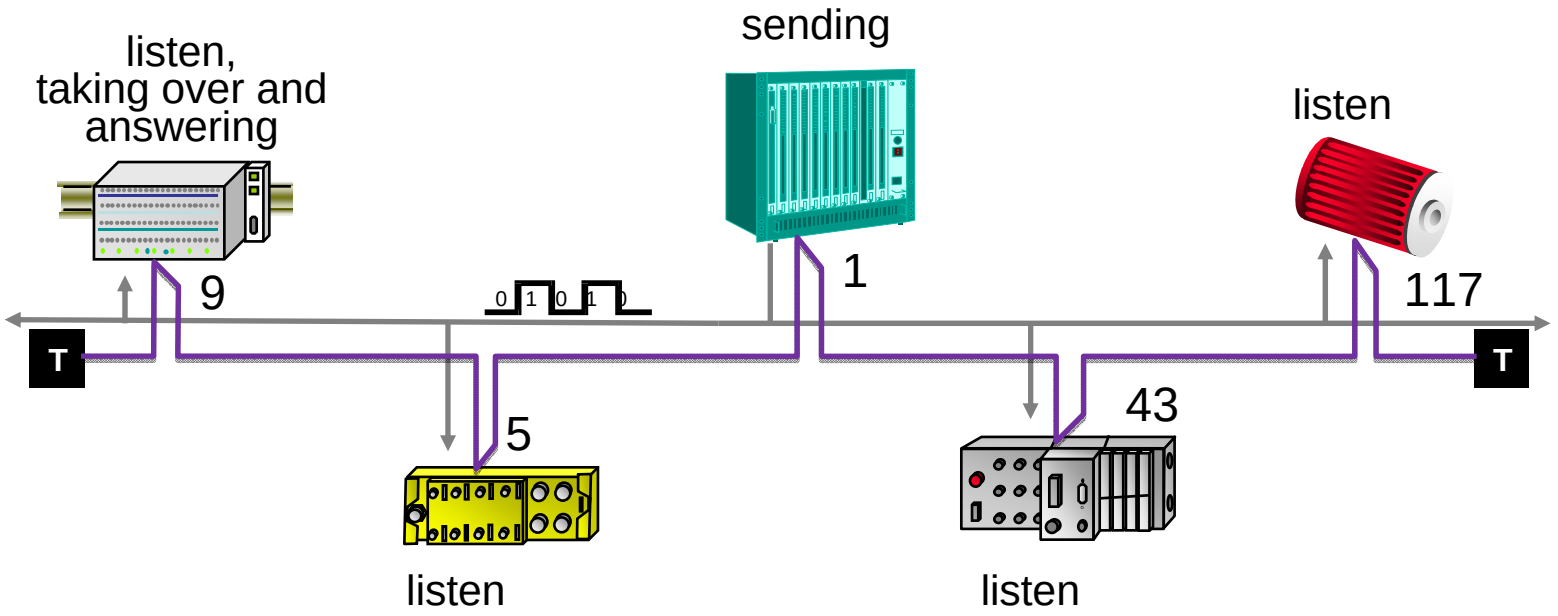
Agenda

- PROFIBUS Family
- Communication Medias
- Topologies
- Cable length
- Devices Rules
- Installation Rules
- Troubleshooting
- Training



PROFIBUS DP Topologies - General

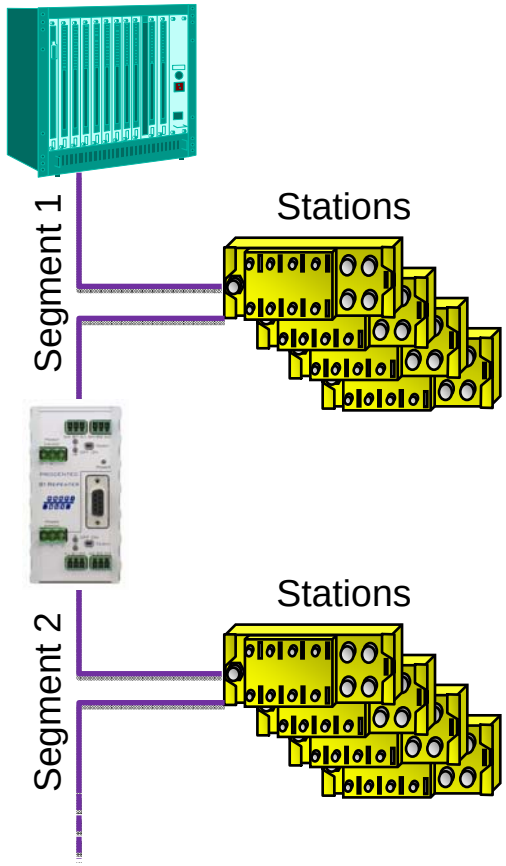
PROFIBUS communicates over a two wire bus structure.



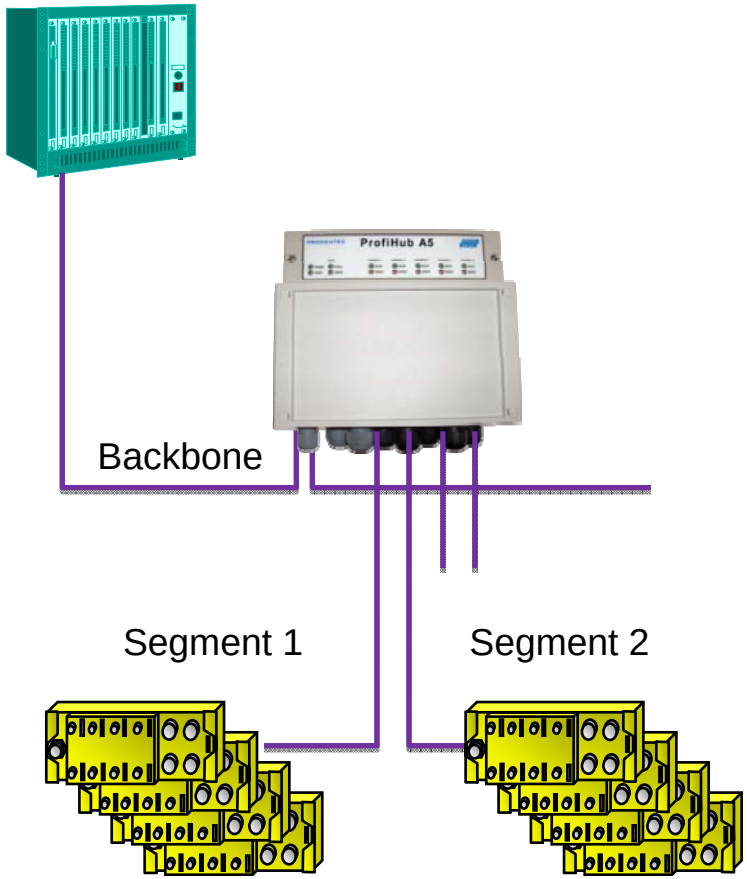
- Devices are addressed through a network address (0..126).
- Devices are coupled in parallel to the bus.
- Devices can be hot swapped and position does not matter.
- Each segment is terminated at both end with an active termination
- Spurs should be avoided as length is very limited

PROFIBUS DP Topologies - Repeaters

Single Repeaters



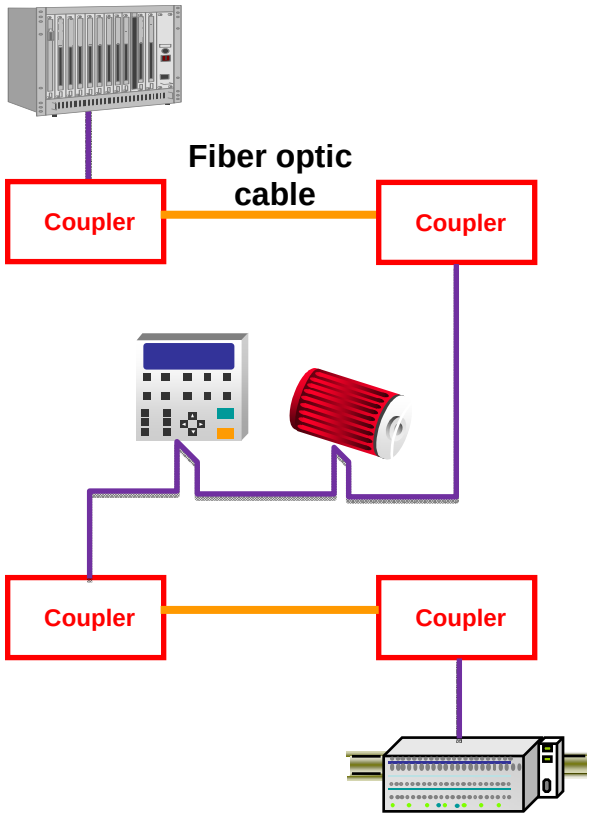
PROFIBUS Hubs



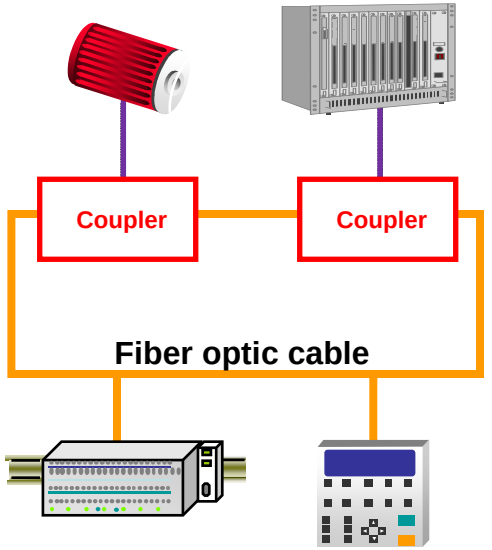
Benefit: Isolate part of your network from EMC/Noise

PROFIBUS DP Topologies – Fiber Optic

Classic Topology



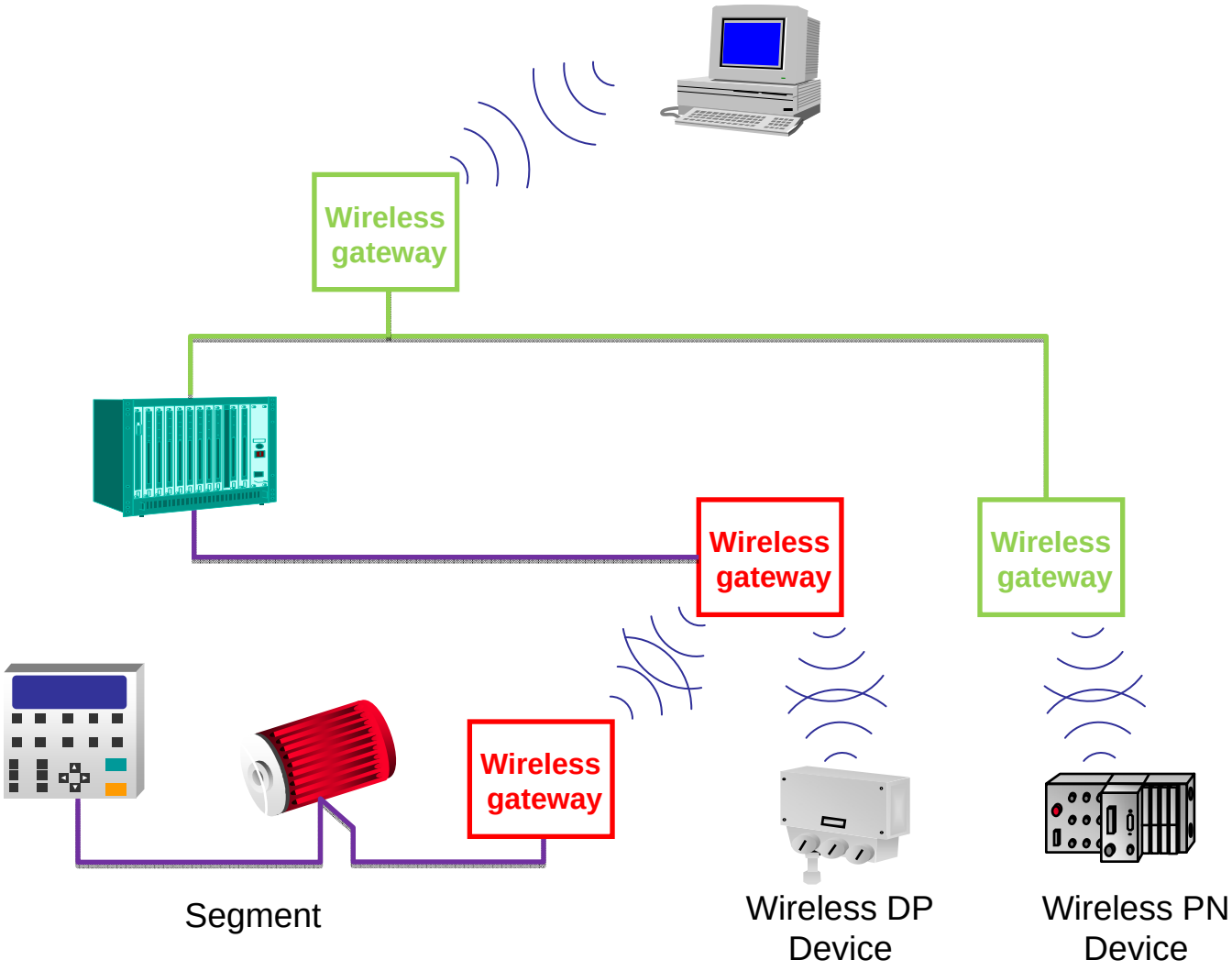
Ring Topology



Benefits: Long distances and EMC/Noise isolation

PROFIBUS DP Topologies - Wireless

Connect your slaves through wireless couplers



PROFIBUS DP Topologies - Redundancy

Agenda

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- Devices Rules
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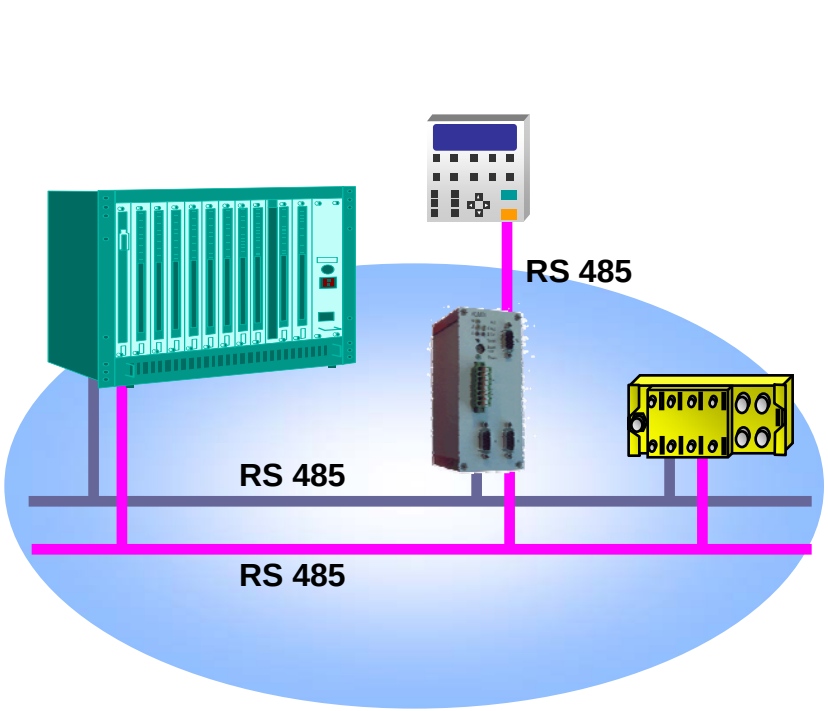
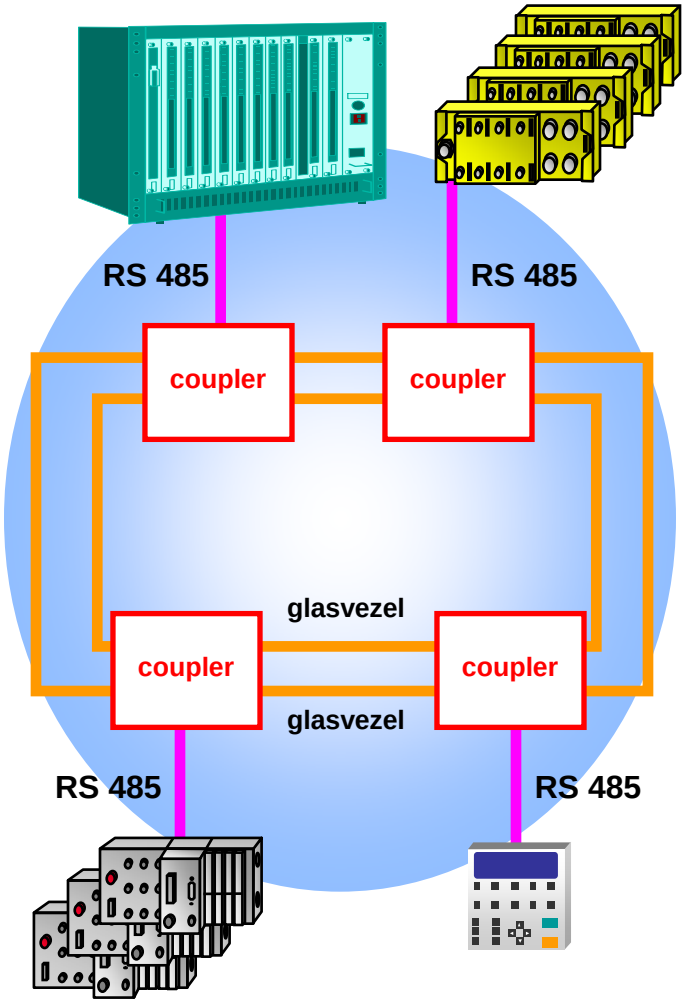
- Training





Transmission speed (baudrate)

PROFIBUS offers the user the possibility to choose from 10 transmission speeds (RS 485).

9,6	**19,2**	**45,45**	**93,75**	**187,5**	**500**	**1500**	**3000**	**6000**	**12000 kbps**

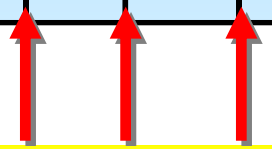
Remarks:

- The transmission speed determines the maximum cable length and vice versa.
- The transmission speed has to be set identically at all the masters on the same bus.
- Most slaves detect the baudrate automatically.
- Because of economic and technical reasons some products do not support all transmission speeds.
- Some older products do not support 45,45 kbps.

PROFIBUS DP – Cable Length

Baudrate vs Cable Length

Baudrate (kbit/s)	9.6	19.2	45.45	93.75	187.5	500	1500	3000	6000	12000
Segment length (m)	1200	1200	1200	1200	1000	400	200	100	100	100
Segment length (feet)	3940	3940	3940	3940	3280	1310	656	328	328	328



3 baudrate transitions in which the cable length reduces with more than 50 %.

These lengths are defined for 1 segment with 32 bus loads!

Device Rules - Network

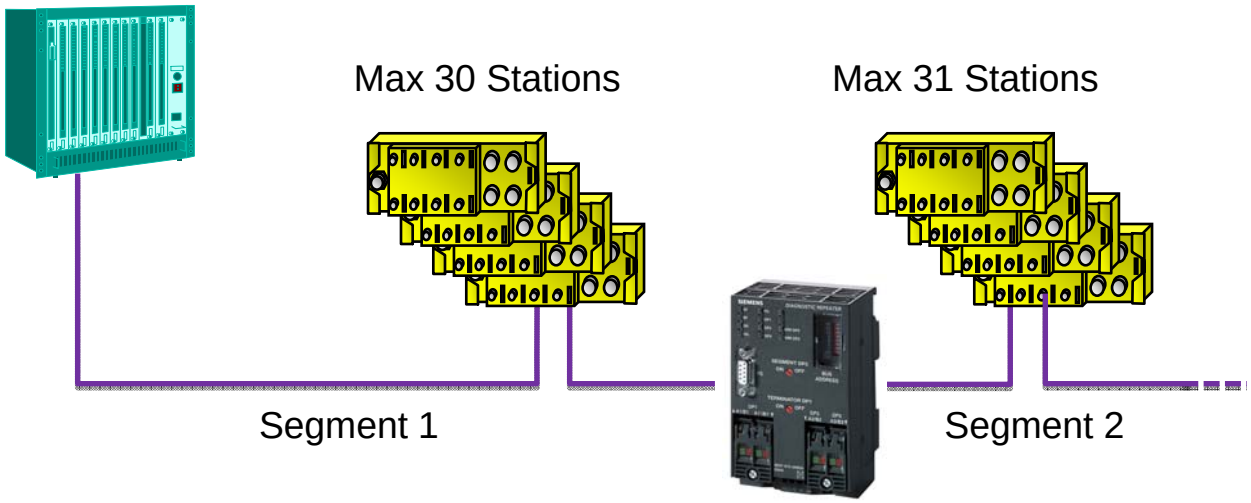
PROFIBUS Address Map

0	Service-, diagnosis- and programming tool
1..**2**	Masters (class 1)
3..125	Slaves (total **123** or 124)
126	Address for: “Set Slave Address”
127	Broadcast address

- Most configuration tools block address 0 and 126 for slaves.
- Address 126 is a default address for slaves with software address settings.
- Address 127 is a broadcast address (only visible with a busmonitor).
- Maximum 124 DP slaves per bus!!!!!!!

Device Rules - DP Segments

- Maximum 32 loads per RS485 segments



- Devices that generate new segments:
  - Repeaters
  - Fiber Optic Couplers
  - Wireless gateways
- After these devices, PROFIBUS segment rules are the same.

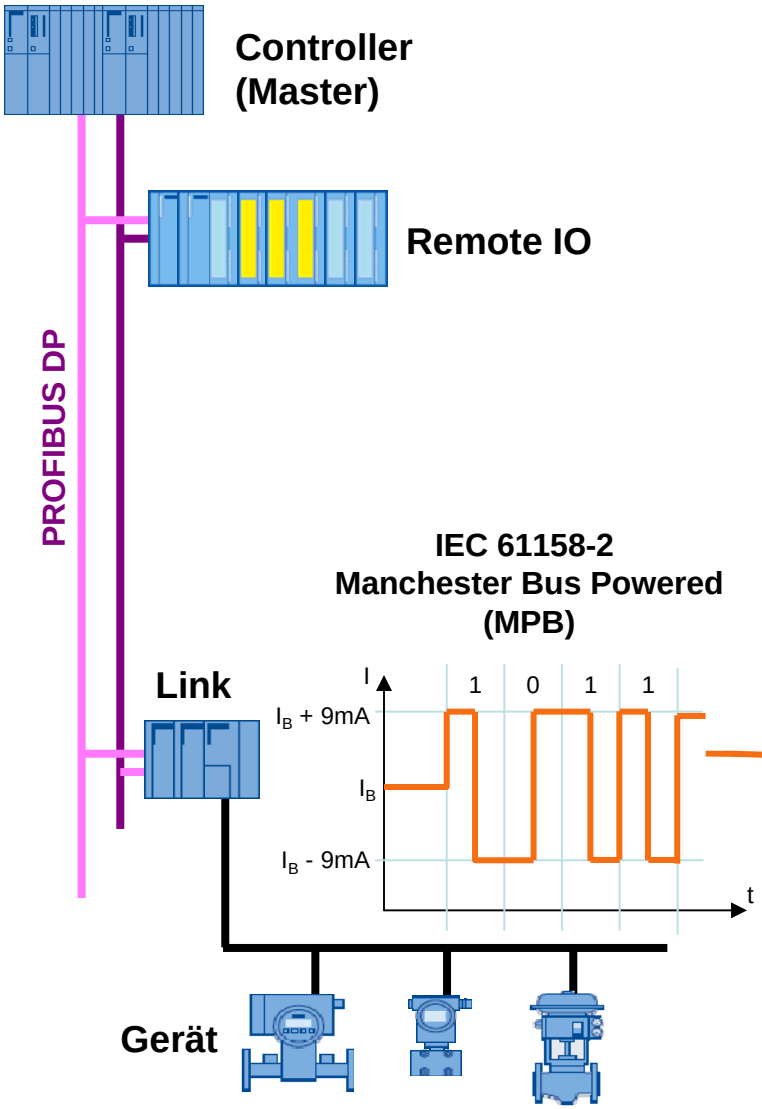
Introduction

PROFIBUS-DP

PROFIBUS-PA

Installations and Best practise

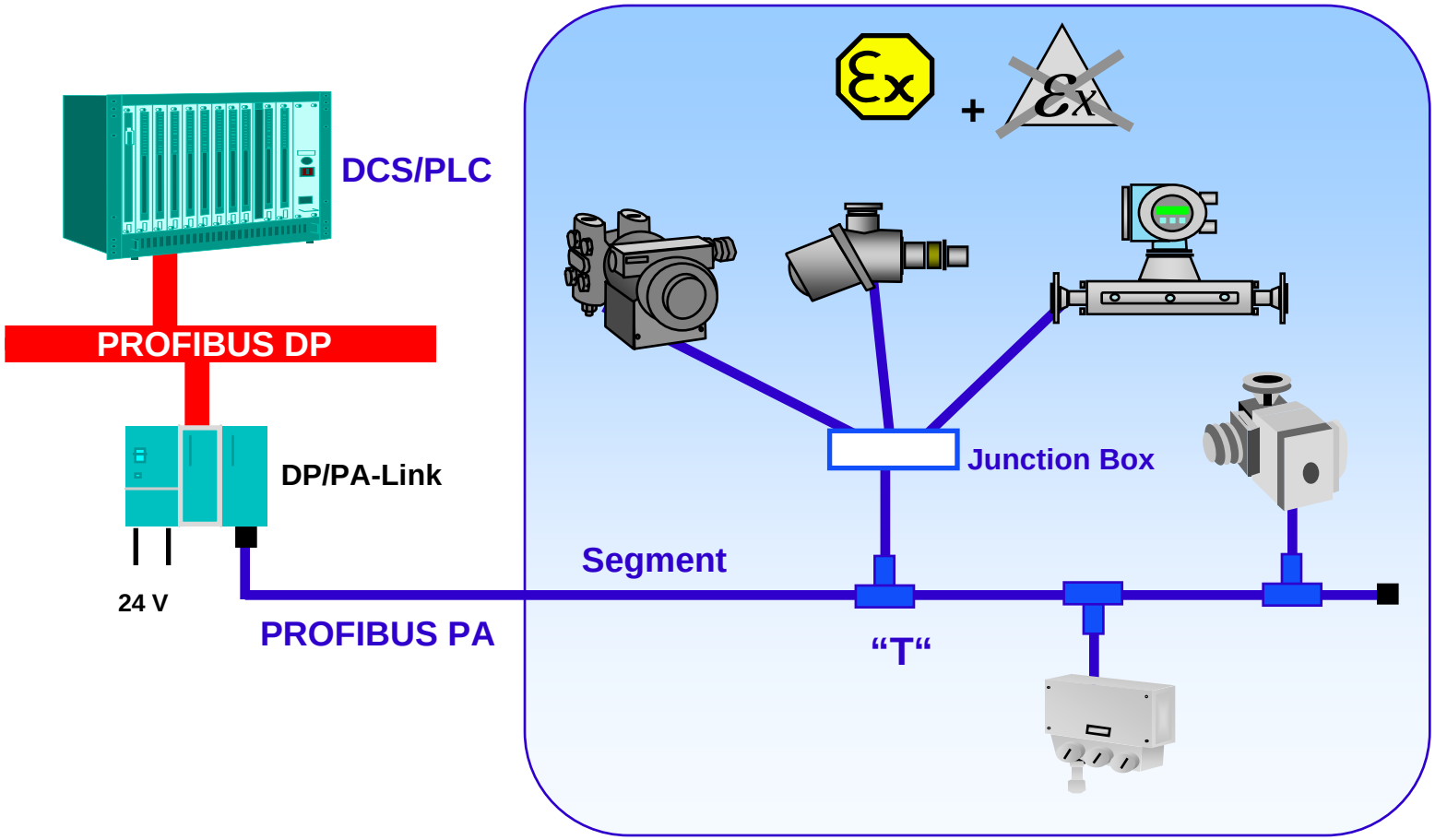
PROFIBUS-PA Network layout



	Layer Model (ISO Standard since 1983)
7	*Application* — DPV0 .. 2
6	*Presentation*
5	*Session*
4	*Transport*
3	*Network*
2	*Data Link* — FDL
1	*Physical* — MBP

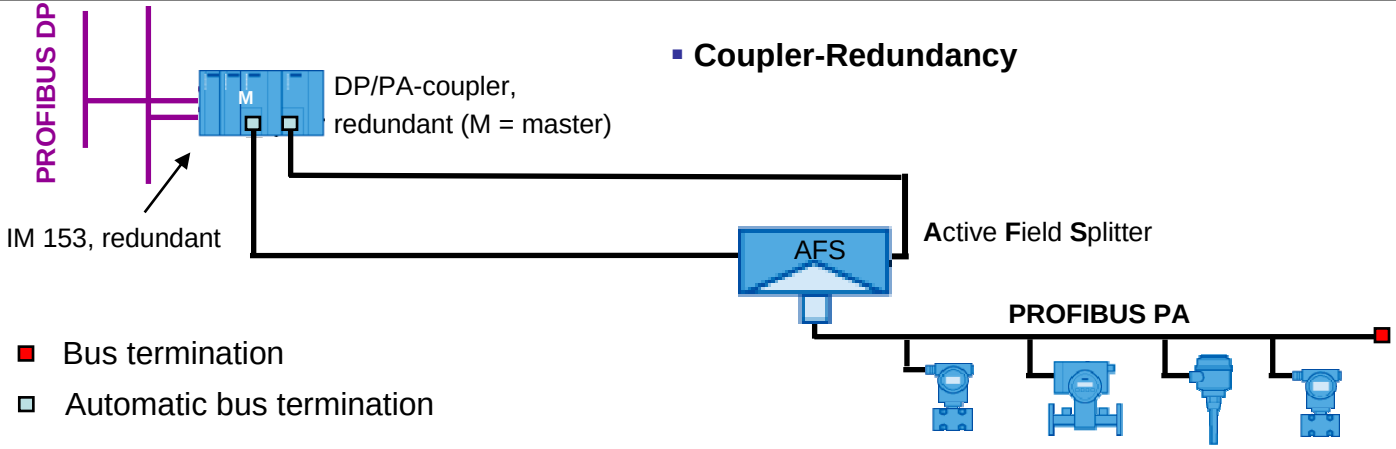
PROFIBUS PA

PROFIBUS PA Topologies - Overview



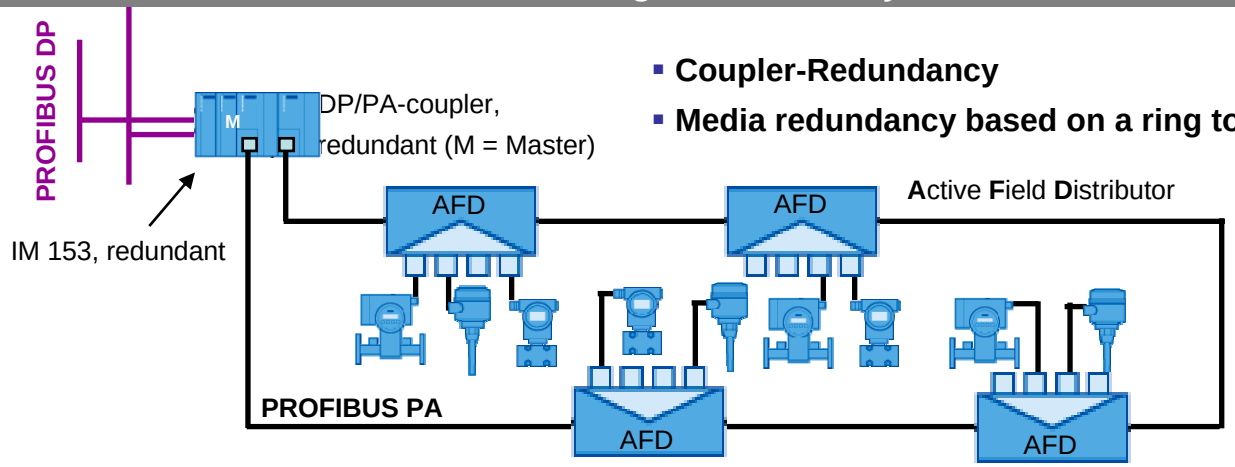
PROFIBUS PA Topologies - Redundancy

Coupler Redundancy



- **Coupler-Redundancy**

PA Ring Redundancy



- **Coupler-Redundancy**
- **Media redundancy based on a ring topology**

Higher availability with Redundancy

Agenda

PROFIBUS Family

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Devices Rules

Installation Rules

Troubleshooting

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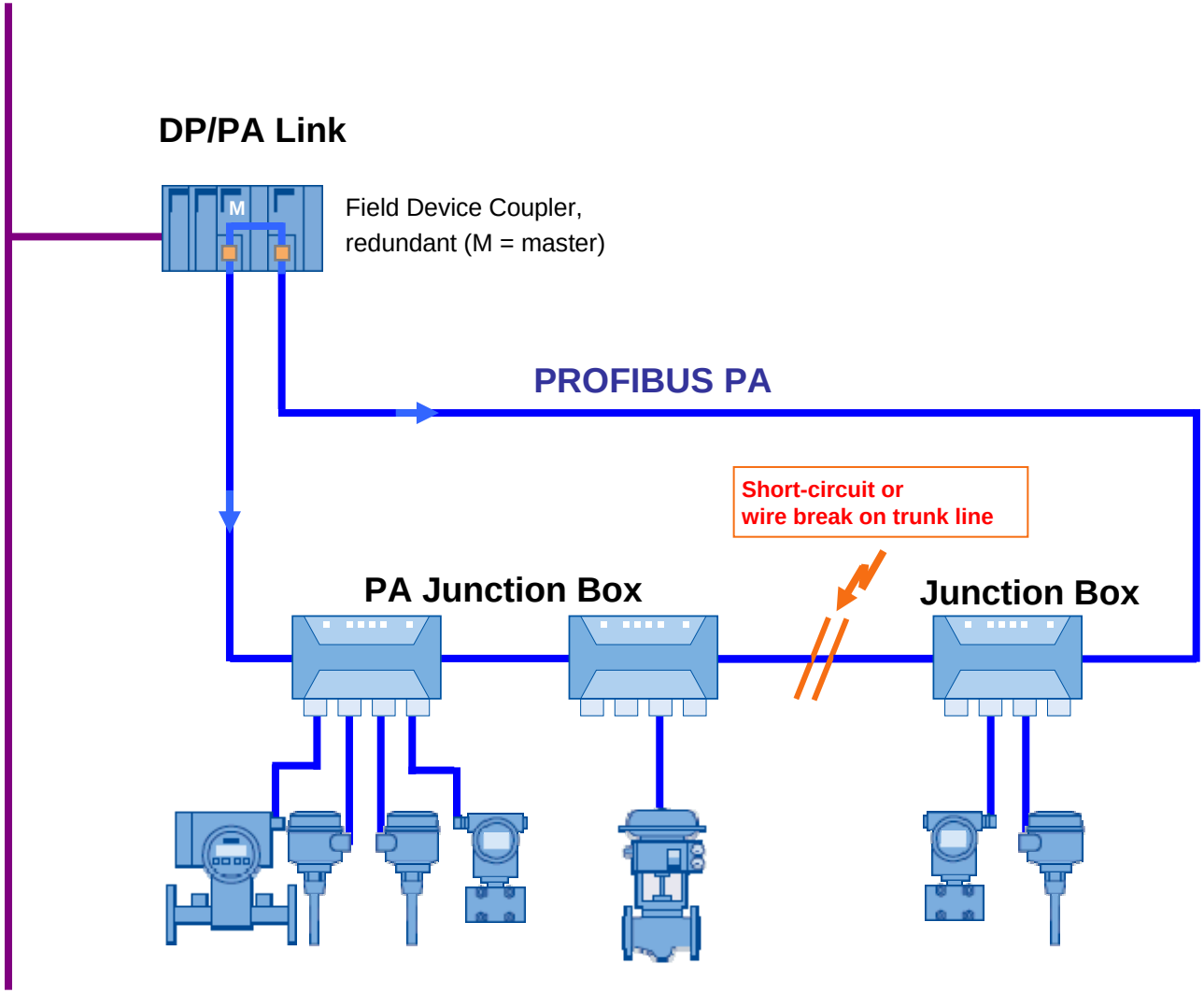
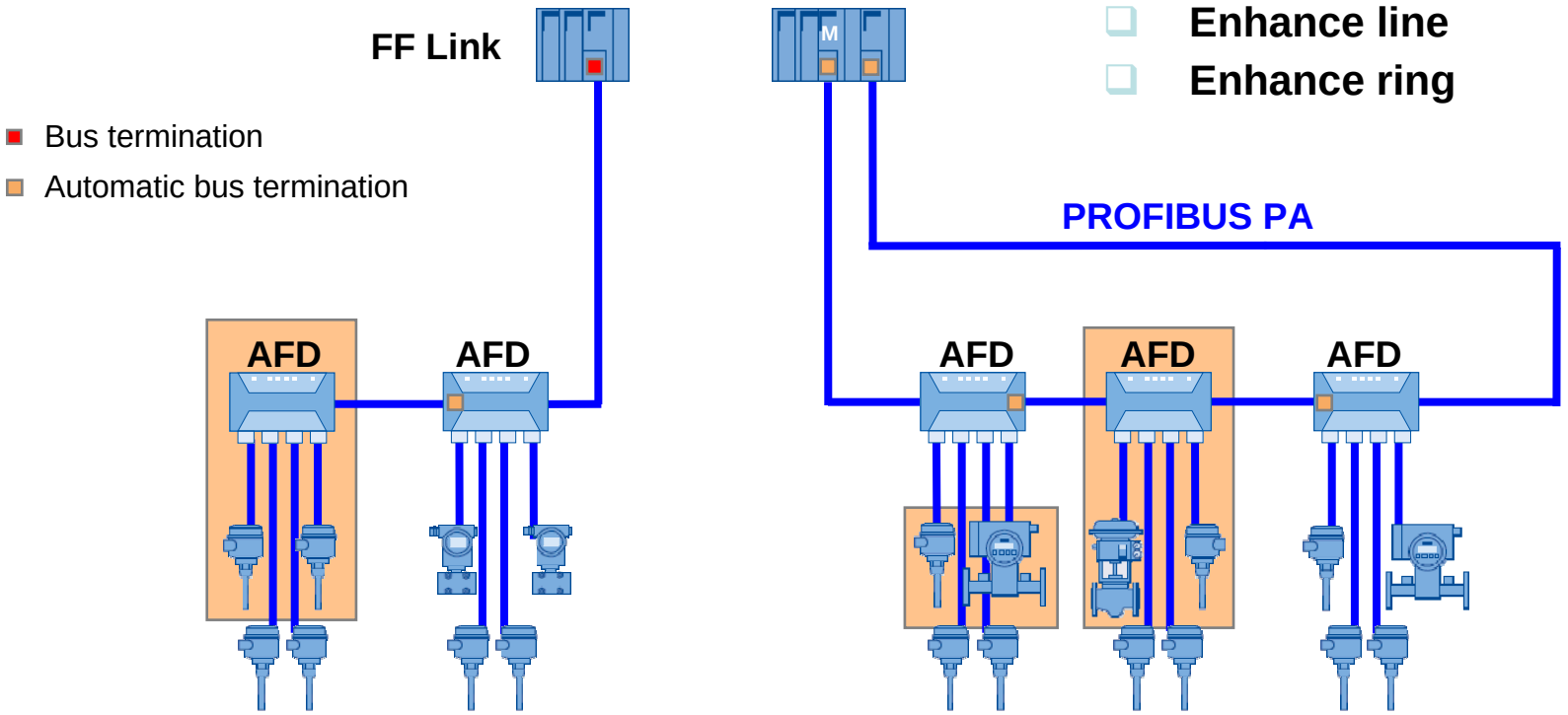


- Automatic bus termination

Automatic Termination

Automatic bus termination enables unique online changeability

- **Add new devices**
- **Enhance line**
- **Enhance ring**



There is no need to reserve spare ports of the AFDs !

Introduction

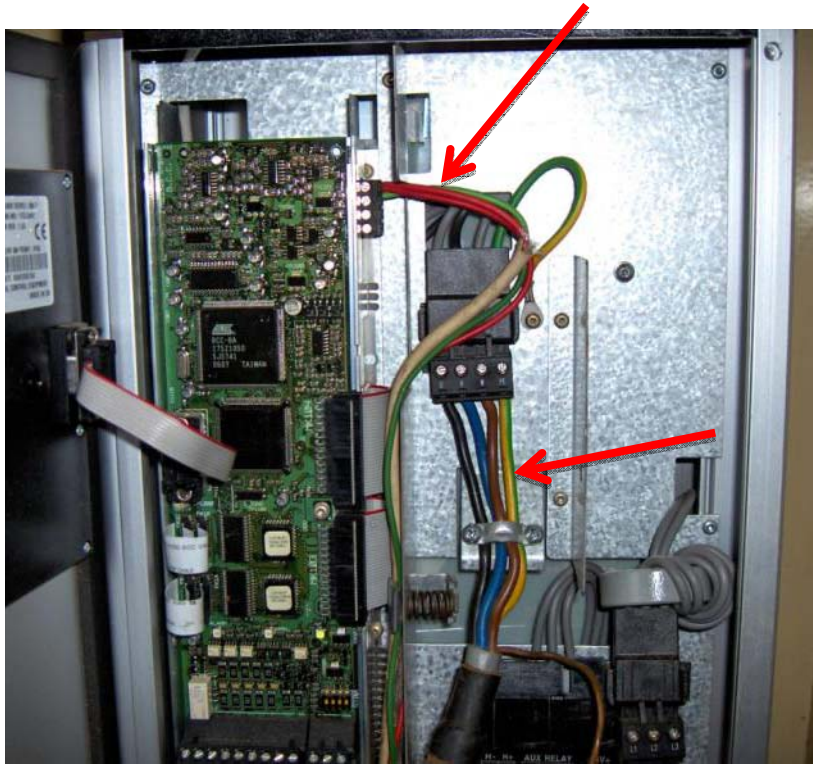
PROFIBUS-DP

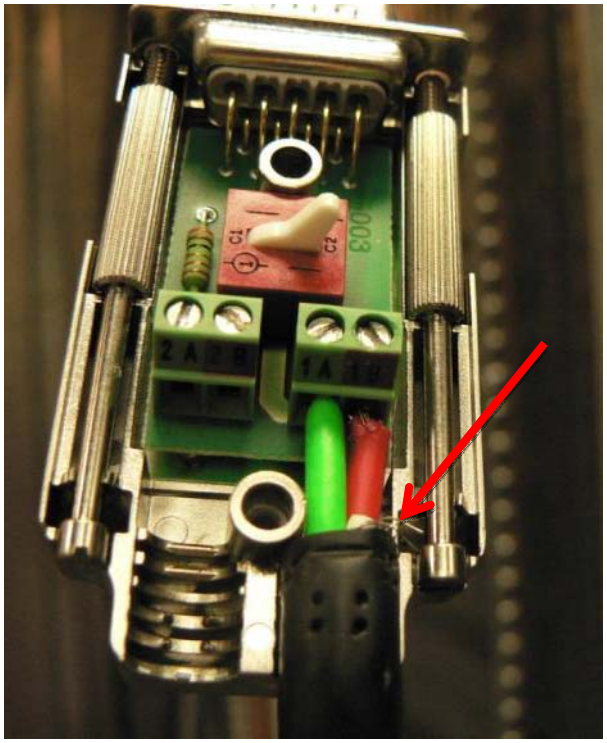
PROFIBUS-PA

Installations and Best practise

Installation rules

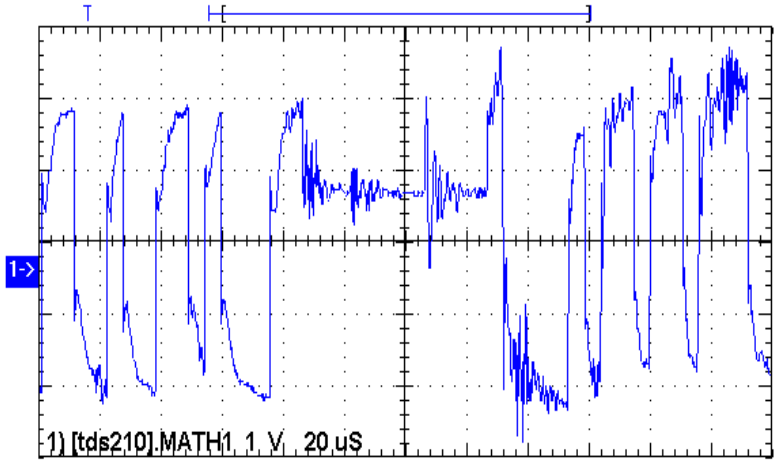
- Grounding & Shielding
  - PROFIBUS is digital communication, not 4-20mA
  - Ground at both end
  - Ungrounded shield has no effect



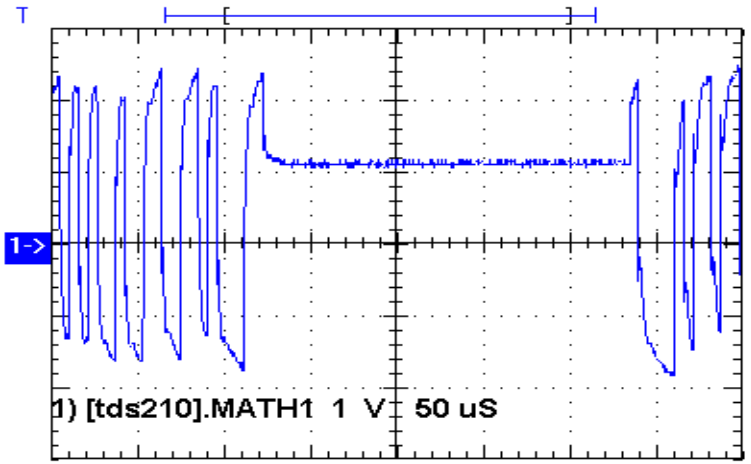


Installation rules

- Power Lines
  - Digital communication is sensitive to power lines
  - Watch out for cable runs in trays
  - Respect distances for air separation



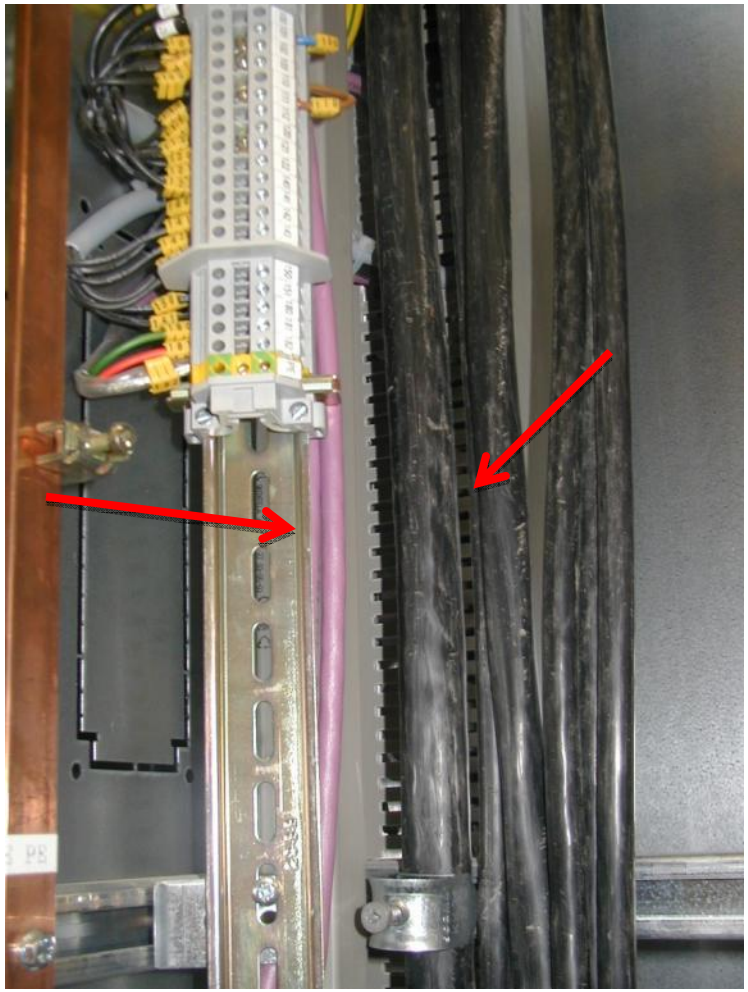
Power line too close

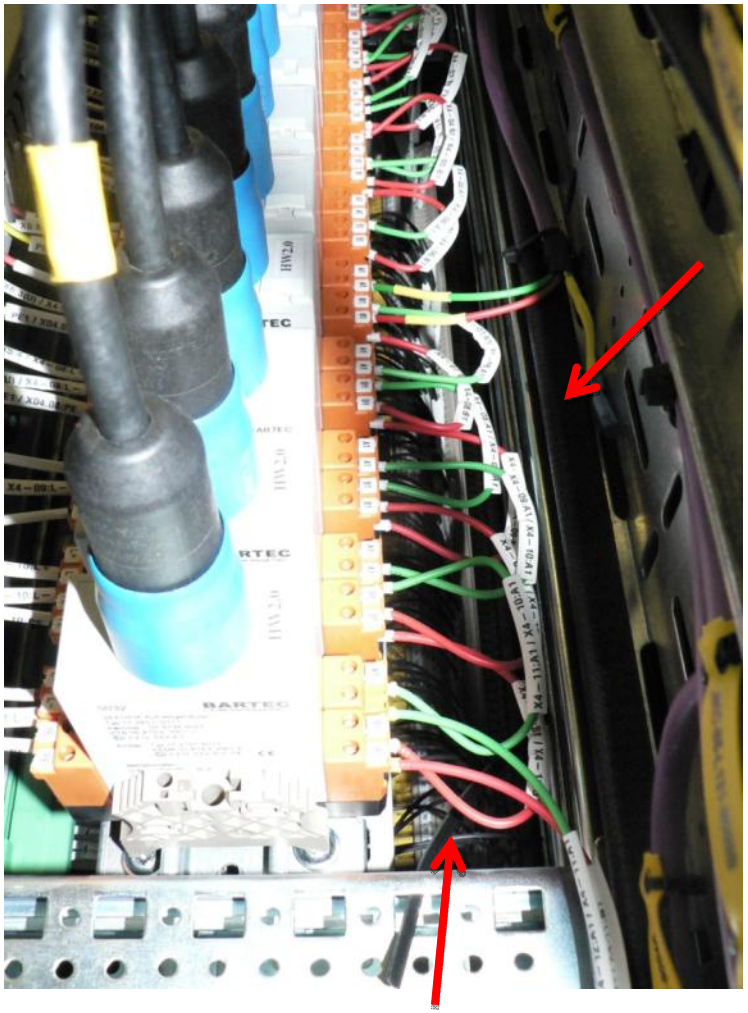


Power line are removed

Installation rules

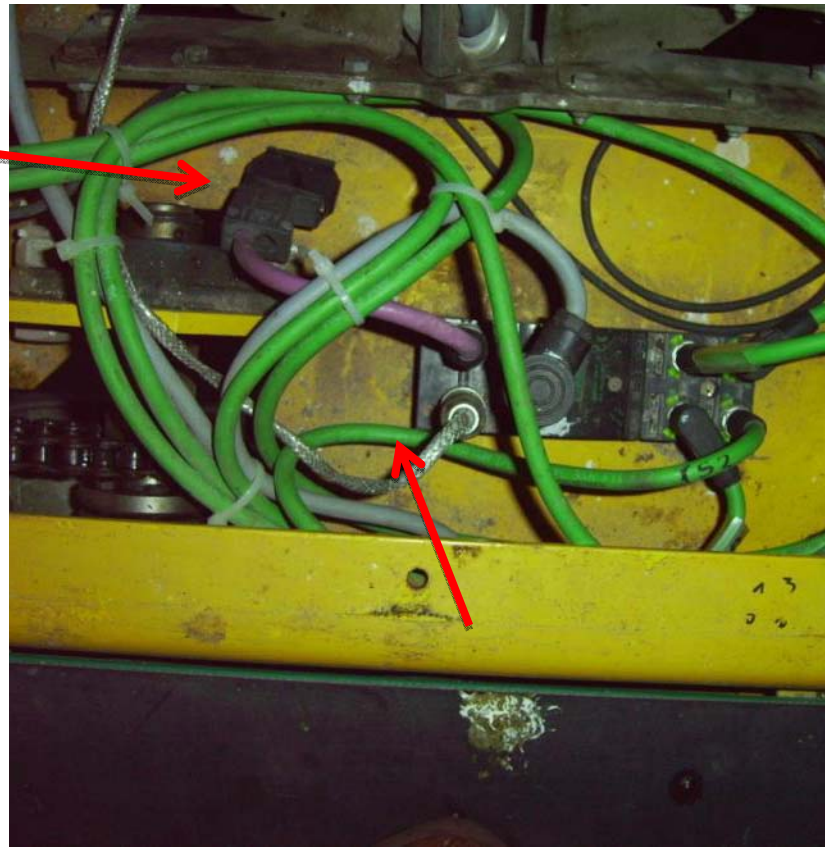
Some examples with Power Lines





Installation rules

- Proper wiring and component selection
  - Wiring and cable termination is critical
  - Wrong component selection leads to bad installation
  - Take environment in account (humidity, sunlight…)

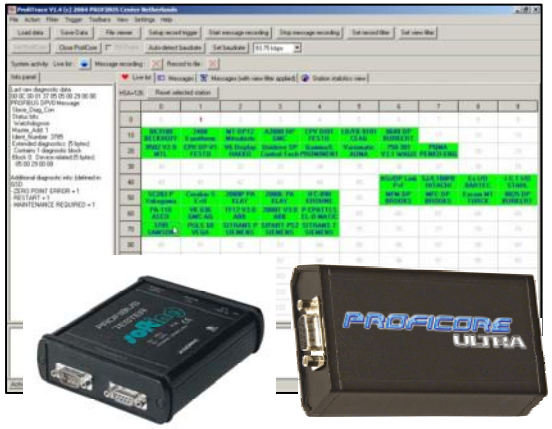


Troubleshooting

- Recognizing bad installations
  - You cannot use the multimeter, this is digital comm.
  - Specific tools are required

Cable Tester

Oscilloscope

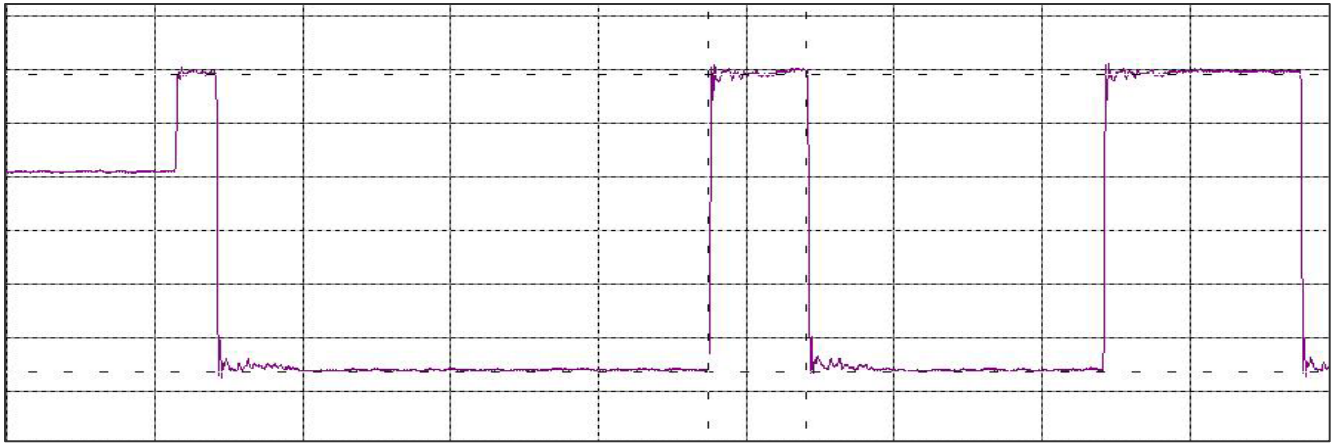


Analyzer

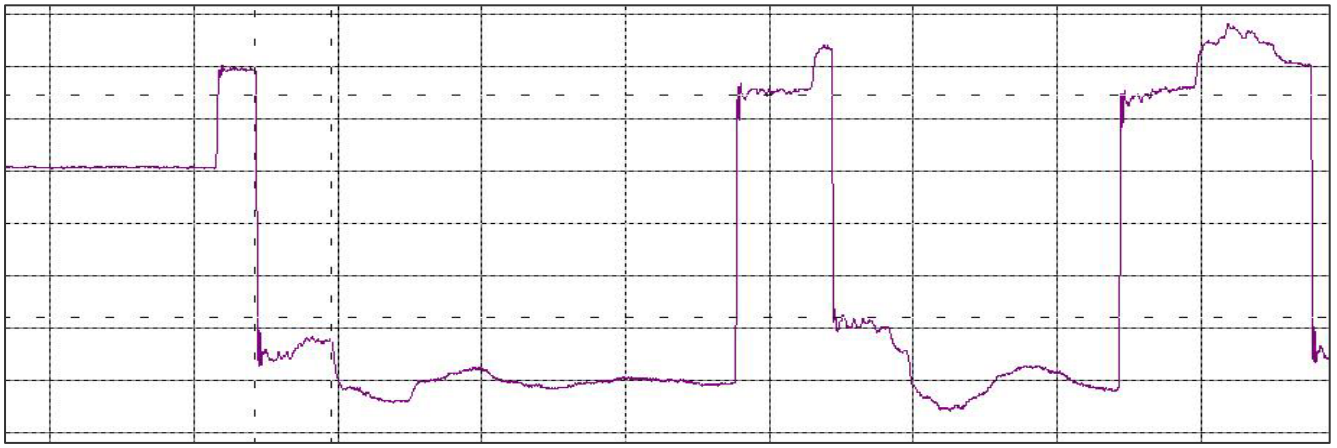
- Find wiring errors such as short circuit
- Identify missing termination and EMC
- Capture error messages and find the source of your system shutdown
- Cost and time saving by using the right tools!

Troubleshooting - Oscilloscope

Good signal



Missing termination



Troubleshooting - Analyzer

- Capture all PROFIBUS messages
  - Useful for random errors
  - Shows underlying conditions
  - Device diagnostic

FrameNr	Timestamp	Idle time	Attention	Frame	Addr	Service	Msg type	Req/Re
3664497	22-May-2...	43 Bit		SD4	0->2	Token pass	Pass token	
3664498	22-May-2...	40 Bit		SD2	2->10	SRD_HIGH	Data Exchange	Req
3664499	22-May-2...	16 Bit		SD2	2<-10	DL	Data Exchange	Res
3664500	22-May-2...	39 Bit		SD2	2->12	SRD_HIGH	Data Exchange	Req
3664501	22-May-2...	18 Bit		SD2	2<-12	DL	Data Exchange	Res
3664502	22-May-2...	39 Bit		SD2	2->14	SRD_HIGH	Data Exchange	Req
3664503	22-May-2...	17 Bit		SD2	2<-14	DL	Data Exchange	Res
3664504	22-May-2...	39 Bit		SD2	2->20	SRD_HIGH	Data Exchange	Req
3664505	22-May-2...	36 Bit	Parity error	Illegal				
3664506	22-May-2...	172 Bit		SD2	2->20	SRD_HIGH	Data Exchange	Req
3664507	22-May-2...	316 Bit		SD2	2->21	SRD_HIGH	Data Exchange	Req
3664508	22-May-2...	307 Bit	Repeat(lost)	SD2	2->21	SRD_HIGH	Data Exchange	Req
3664509	22-May-2...	316 Bit		SD2	2->22	SRD_HIGH	Data Exchange	Req
3664510	22-May-2...	307 Bit	Repeat(lost)	SD2	2->22	SRD_HIGH	Data Exchange	Req
3664511	22-May-2...	316 Bit		SD2	2->23	SRD_HIGH	Data Exchange	Req
3664512	22-May-2...	307 Bit	Repeat	SD2	2->23	SRD_HIGH	Data Exchange	Req
3664513	22-May-2...	36 Bit		SD2	2<-23	DL	Data Exchange	Res
3664514	22-May-2...	39 Bit		SD2	2->24	SRD_HIGH	Data Exchange	Req
3664515	22-May-2...	35 Bit		SD2	2<-24	DL	Data Exchange	Res
3664516	22-May-2...	40 Bit		SD2	2->25	SRD_HIGH	Data Exchange	Req
3664517	22-May-2...	49 Bit		SD2	2<-25	DL	Data Exchange	Res
3664518	22-May-2...	40 Bit		SD2	2->26	SRD_HIGH	Data Exchange	Req
3664519	22-May-2...	54 Bit		SD2	2<-26	DL	Data Exchange	Res
3664520	22-May-2...	40 Bit		SD2	2->27	SRD_HIGH	Data Exchange	Req
3664521	22-May-2...	62 Bit		SD2	2<-27	DL	Data Exchange	Res

Training

- Certified Training by PROFIBUS International

Benefits

- Avoid basic errors that cost time and money
- Quality assurance for design and commissioning
- Faster project delivery
- Better installation, longer operation

Various courses available

- PROFIBUS Certified Engineer
- PROFIBUS Certified PA Module
- PROFIBUS Certified Installer

- PROFINET Certified Engineer

Certified by

The end

Thank you for listening