

PROFIBUS Design and Good Practices





Introduction

PROFIBUS-DP

PROFIBUS-PA

Installations and Best practise

PROFIBUS Family

3

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

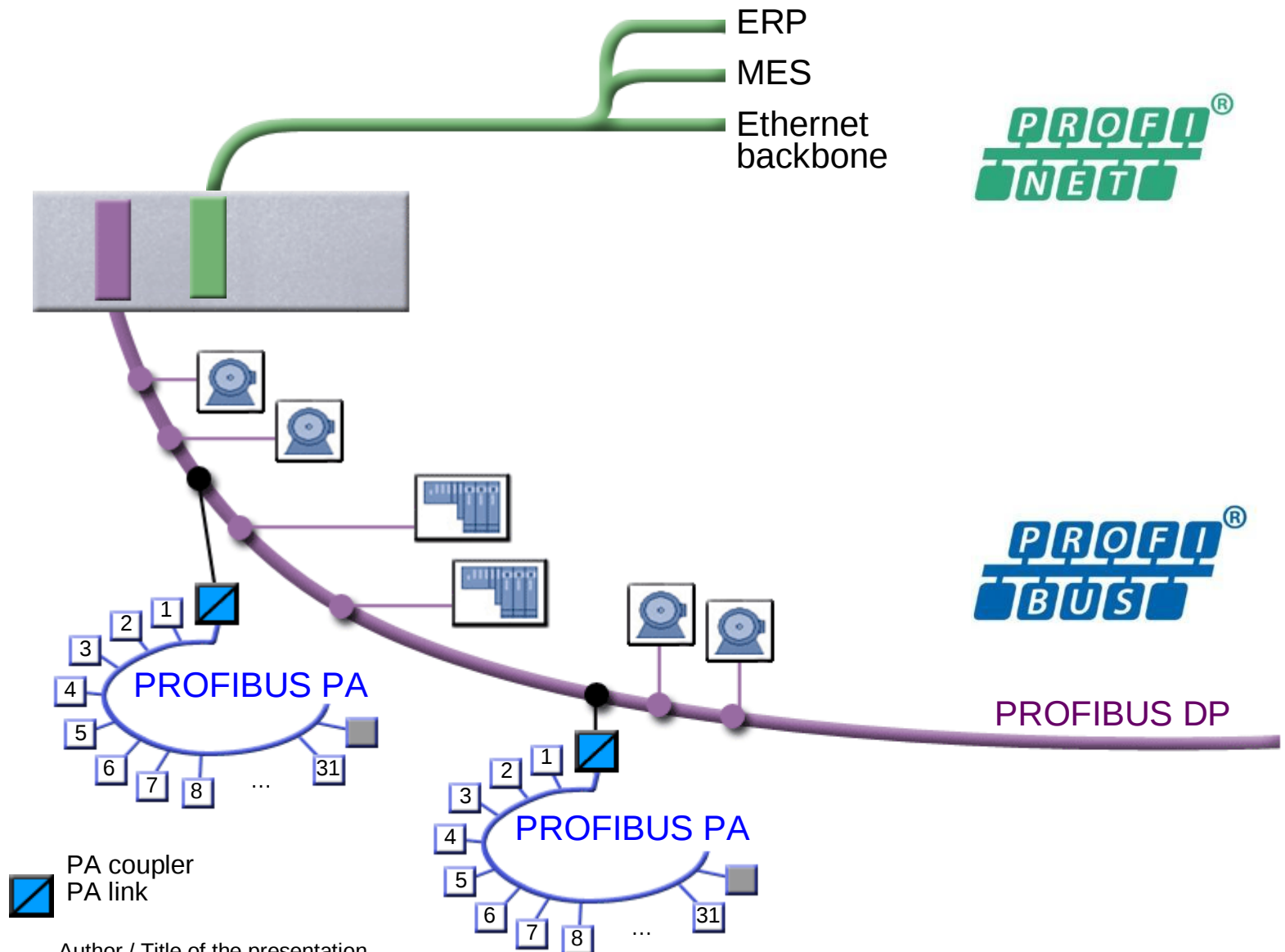
Cable length

Devices Rules

Installation
Rules

Troubleshooting

Training



Author / Title of the presentation

PROFIBUS-DP/PA

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

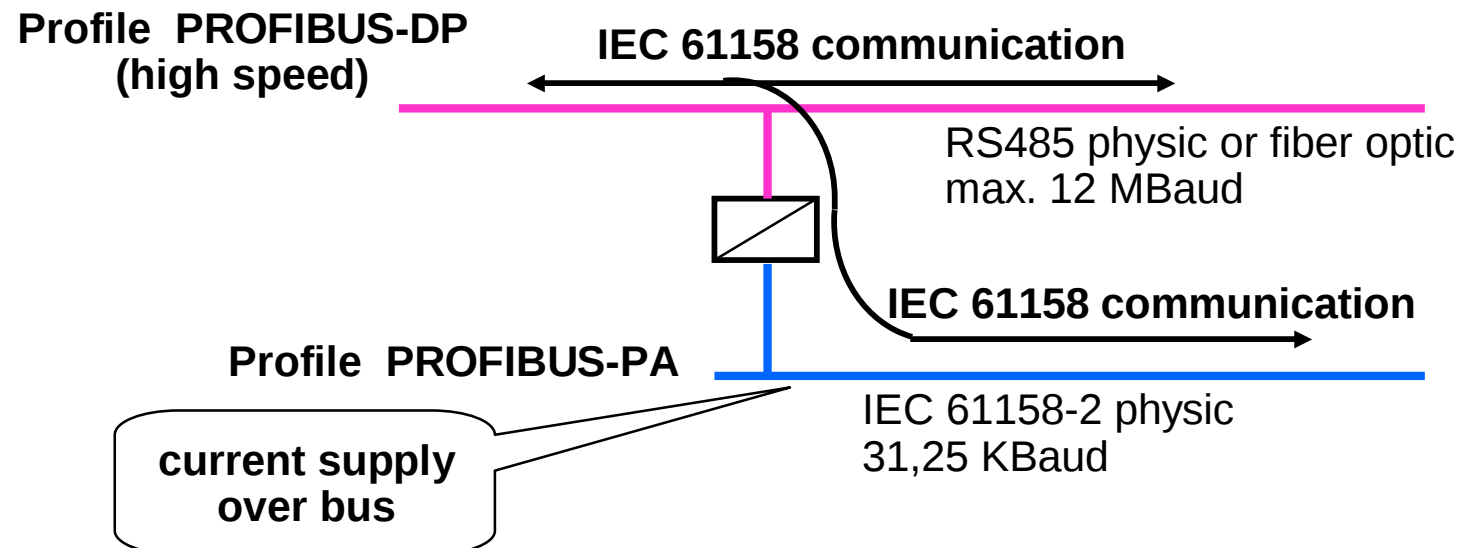
Devices Rules

Installation
Rules

Troubleshooting

Training

- 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

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

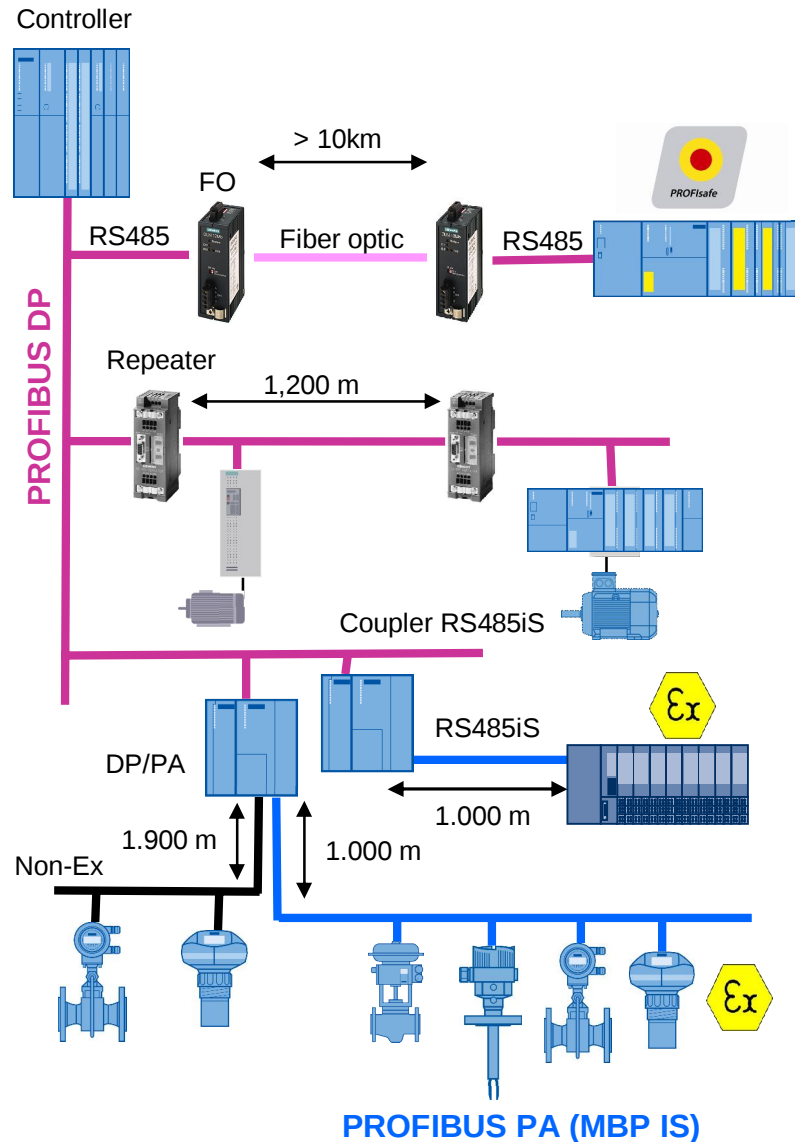
Cable length

Devices Rules

Installation
Rules

Troubleshooting

Training



- 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

Configuration of the bus (GSD file)

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

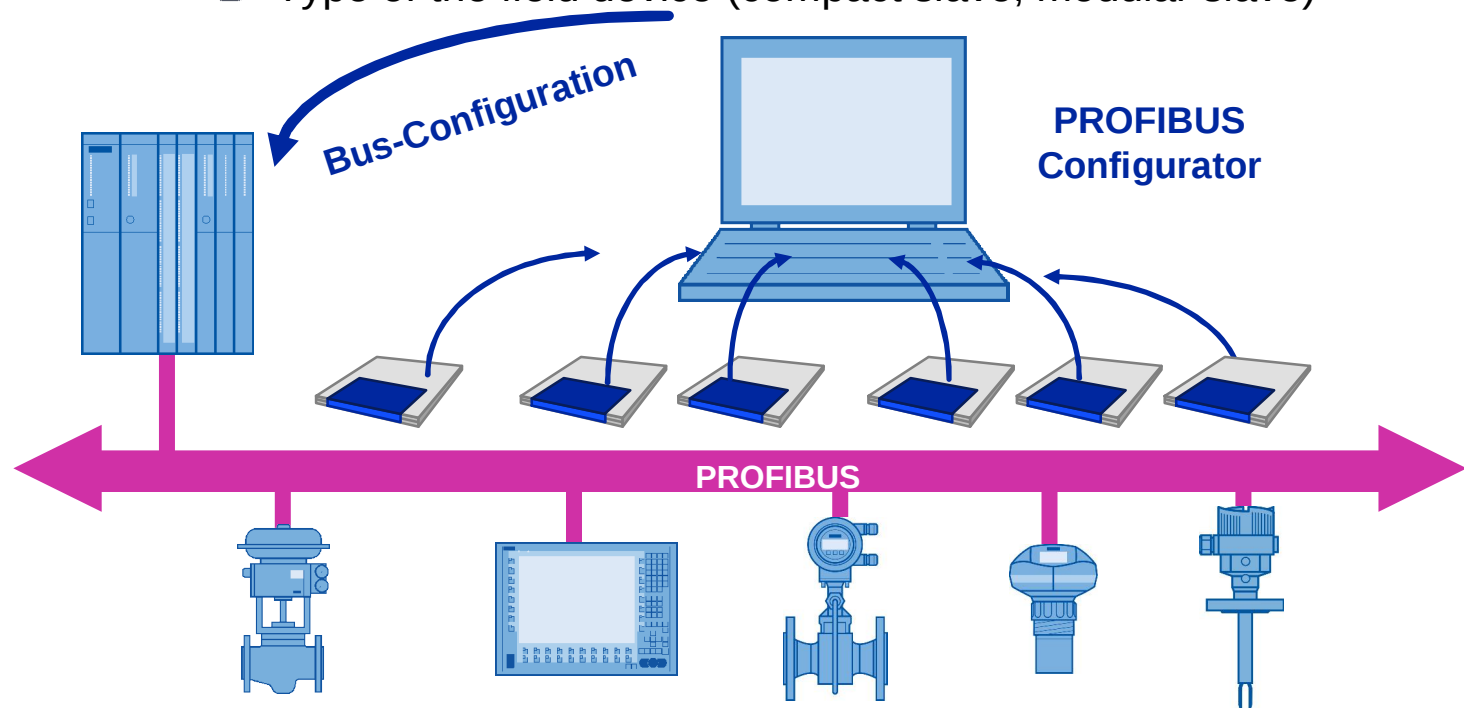
Devices Rules

Installation
Rules

Troubleshooting

Training

- 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

Network Setup/Debug

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

Devices Rules

Installation
Rules

Troubleshooting

Training

■ Set up your network

✓ cable Installation

- A-line green wire (RxD/TxD-N) , B-line red wire (RxD/TxD-P)

- Termination "ON" only at the beginning and end of segments

- Set station addresses

- Ensure proper connection of the shield

- do not exceed the max. segment length

✓ check proper installation

✓ Configure your system

- Select devices and station address

- Select specific functions (I/O configuration and device) parameters

- Select baud rate

✓ Load configuration file into master system

✓ Start up the network

✓ Trouble shoot and diagnose problems

Network Setup/Debug

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

Devices Rules

Installation
Rules

Troubleshooting

Training

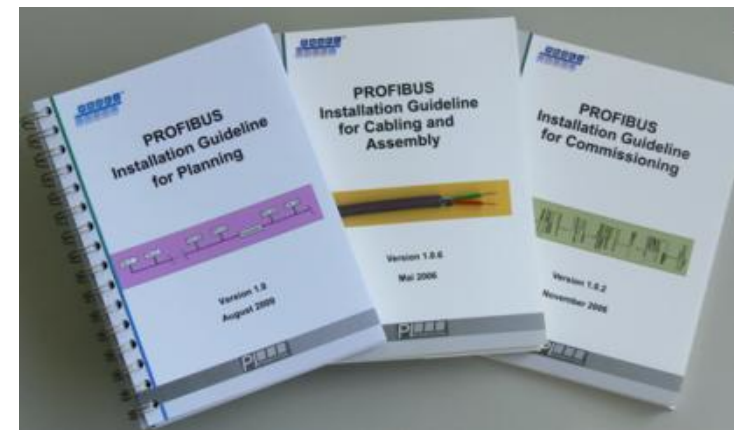
■ How to Wire?

■ PROFIBUS DP/FMS wiring can be done with:

- Fiber optic components (OLM, OBT,...)
- Twisted shielded pair copper cable (Repeater)
- Infrared components (ILM)

■ Wiring/Cabling Guides

- PI Installation Guides
- PROFIBUS Manual



Useful Links

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

Devices Rules

Installation
Rules

Troubleshooting
Training

- Siemens Customer Page, PROFIBUS Manual:
■ <http://support.automation.siemens.com/WW/view/en/35222591>
- PI Southeast Asia:
■ www.sea.profibus.com
■ www.sea.profinet.com
- Here you find information's on Seminars, Certified Training and Documentation.



Network Setup/Debug

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

Devices Rules

Installation
Rules

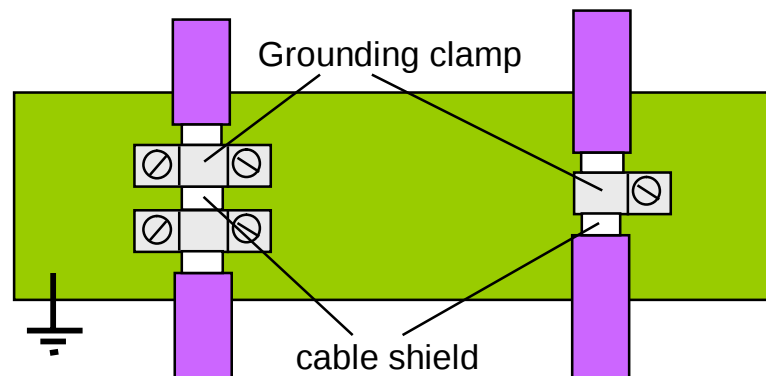
Troubleshooting

Training

■ Why grounding and shielding on both ends

- Helps to improve the EMC behavior
- Provides a low impedance (short) return path for noise and current
- Reduces the emission from the bus

☞ Shield is not always connected to protective GND within the devices; therefore, make sure the cable shield will be connected to GND before it leaves the cabinet.



Network Setup/Debug

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

Devices Rules

Installation
Rules

Troubleshooting

Training

■ Connectors

- One preferred connector type - 9 pin Sub-D
 - the pins for the Sub D connector are defined in the Profibus Standard
 - Connectors with integrated termination are available
 - For use at higher baud rates, inductance is built in
 - Easy plug and unplug without interrupting the communication to other devices
 - shield is connected with the Sub-D shell



It is highly recommended to use PROFIBUS Products (Connectors, Cables,..) to ensure a stable network

Cable construction and wire colors

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

Devices Rules

Installation
Rules

Troubleshooting

Training

The A and B line are **green** and **red**:

A-line	TXD-N	1	-	green
B-line	TXD-P	2	+	red

1. A-line (green) and B-line (red).

2. "Tubes" for a round cable.

3. Braid for frequencies up to 50 MHz.

4. Foil for frequencies above 50 MHz.

Cable types

All kinds of cables are available for areas in which the standard PROFIBUS cable cannot be used.

- Robust Cable
- Food Cable
- Underground Cable
- Trailing Cable
- Festoon Cable
- FRNC Cable
- Flexible Cable
- Shipboard Cable
- Hybrid Cable



Flexible cable



Trailing cable



Festoon cable



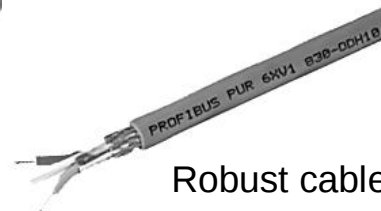
Food cable



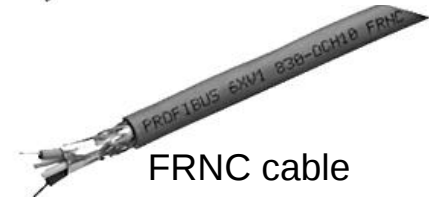
Shipboard cable



Hybrid cable



Robust cable



FRNC cable



PROFIBUS Family - Principle

15

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

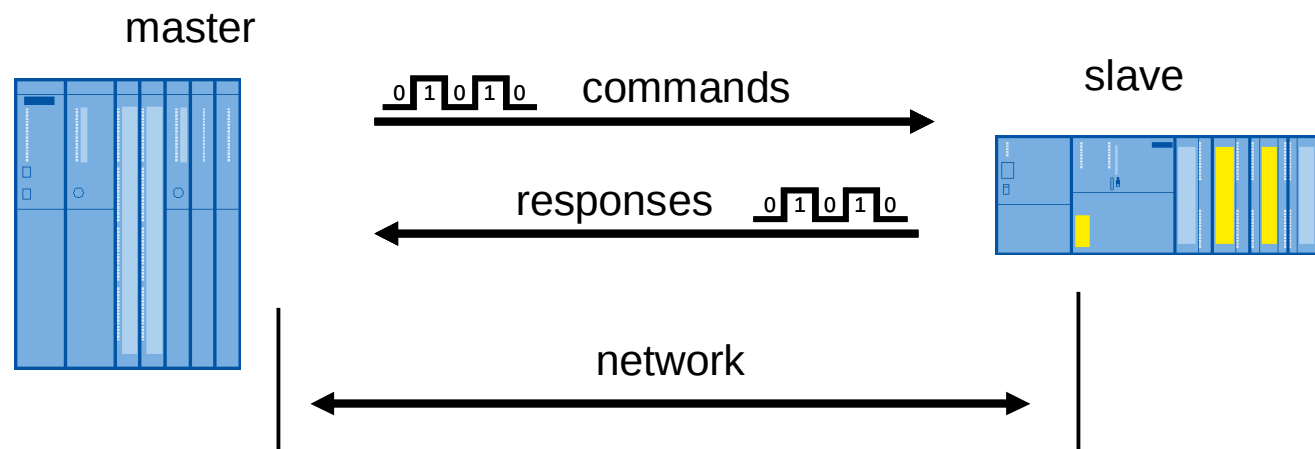
Devices Rules

Installation
Rules

Troubleshooting

Training

- 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).

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

Devices Rules

Installation
Rules

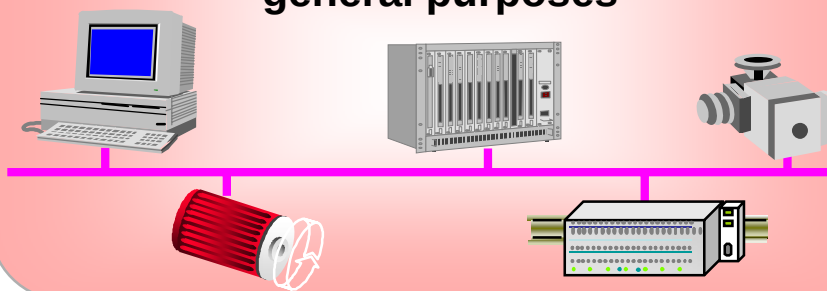
Troubleshooting

Training

PROFIBUS Supports 3 transmission media

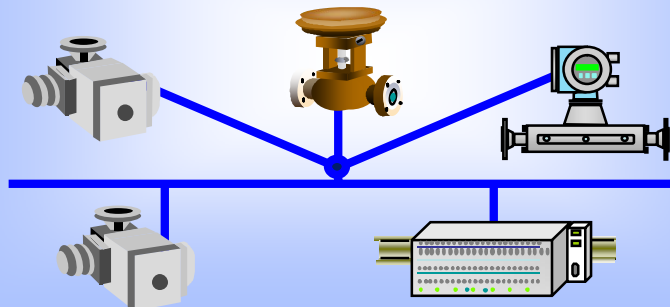
RS 485

2-wire CU-cable for
general purposes



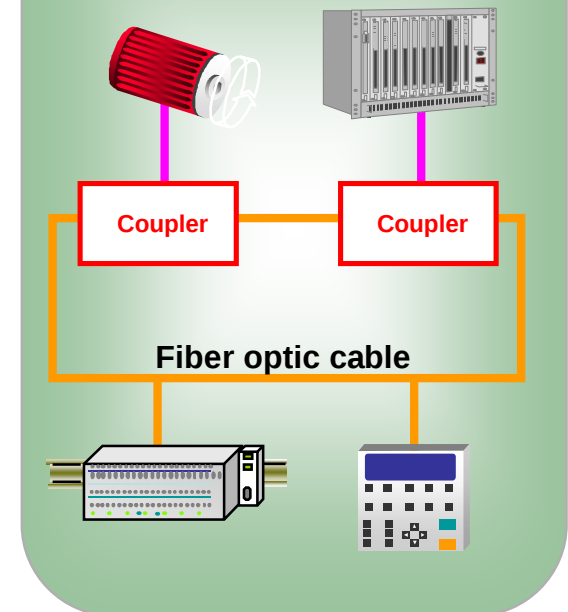
MBP-IS

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



Fiber Optic

Highest EMC protection
and wide distances



Termination

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

Devices Rules

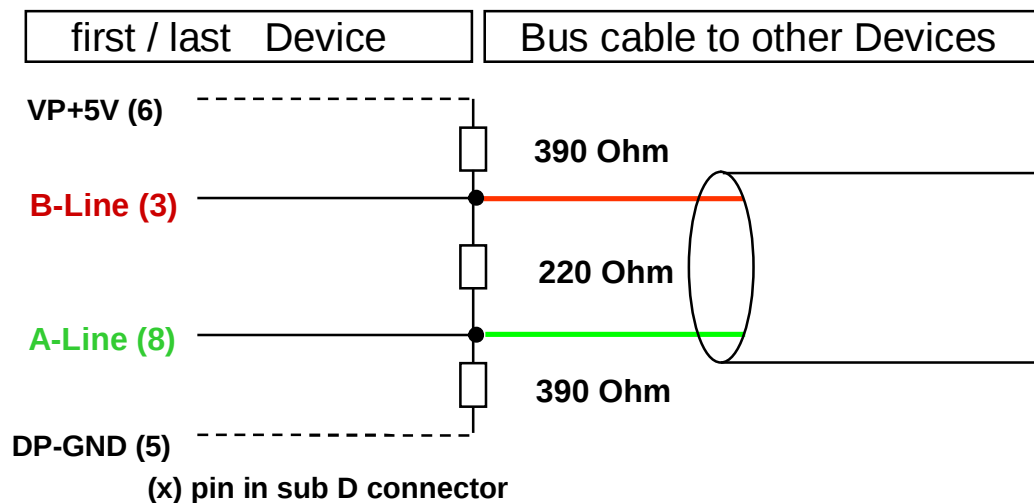
Installation
Rules

Troubleshooting

Training

■ Termination

- Each segment must be terminated at both ends
- Termination must be powered at all times
 - If necessary, connectors with power or active termination devices can be used at the ends of a segment
- If possible, use one termination at the master
- Power for termination or the termination itself needs to be provided by the device



PROFIBUS DP Topologies - General

18

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

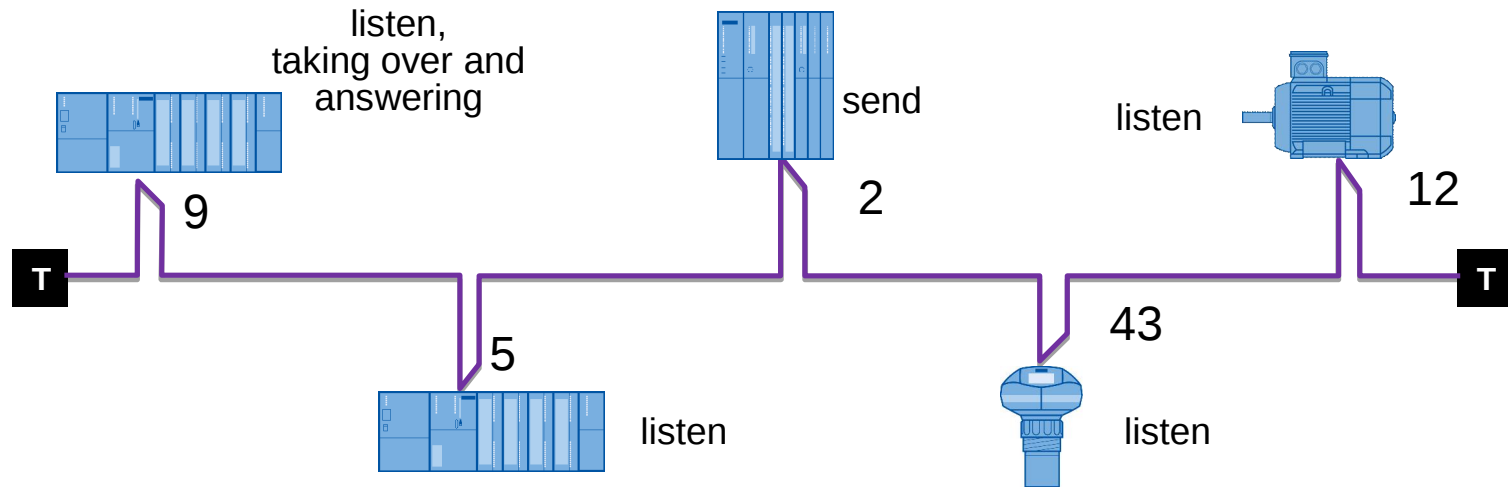
Devices Rules

Installation
Rules

Troubleshooting

Training

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.
- A segment is one complete connection between two terminators. More than one segment are possible per network (using repeaters)
- Each segment is terminated at both end with a termination
- Spurs should be avoided as length is very limited

T: Terminator is on

PROFIBUS DP Topologies - Repeaters

19

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

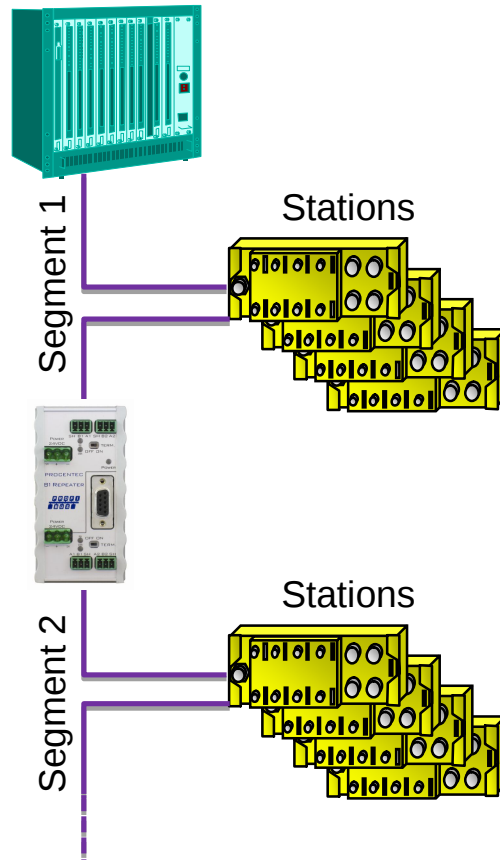
Devices Rules

Installation
Rules

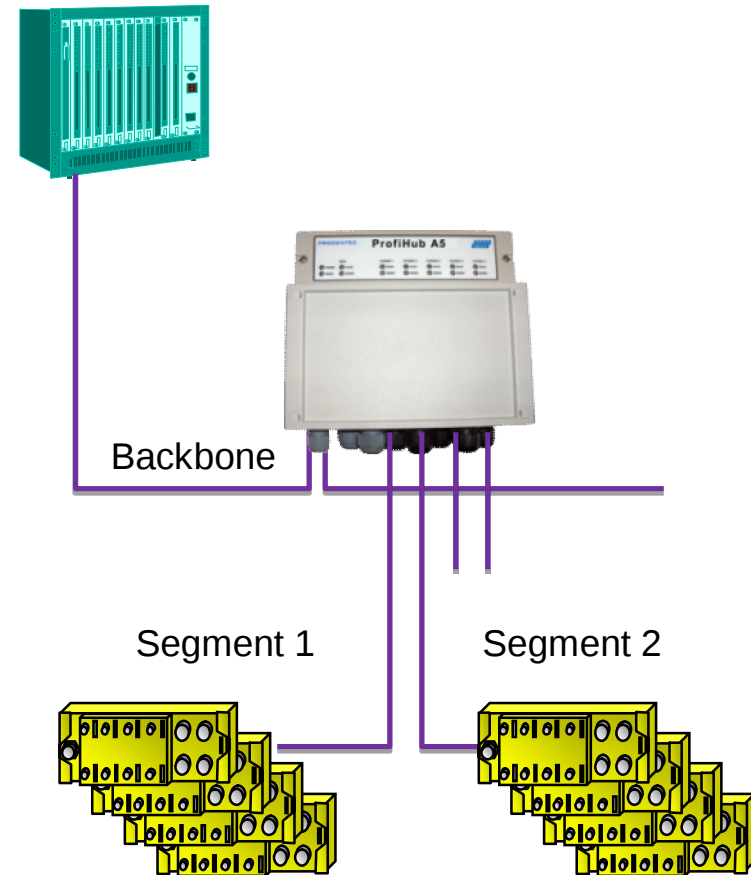
Troubleshooting

Training

Single Repeaters



PROFIBUS Hubs



Benefit: Isolate part of your network from EMC/Noise

PROFIBUS DP Topologies – Fiber Optic

20

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

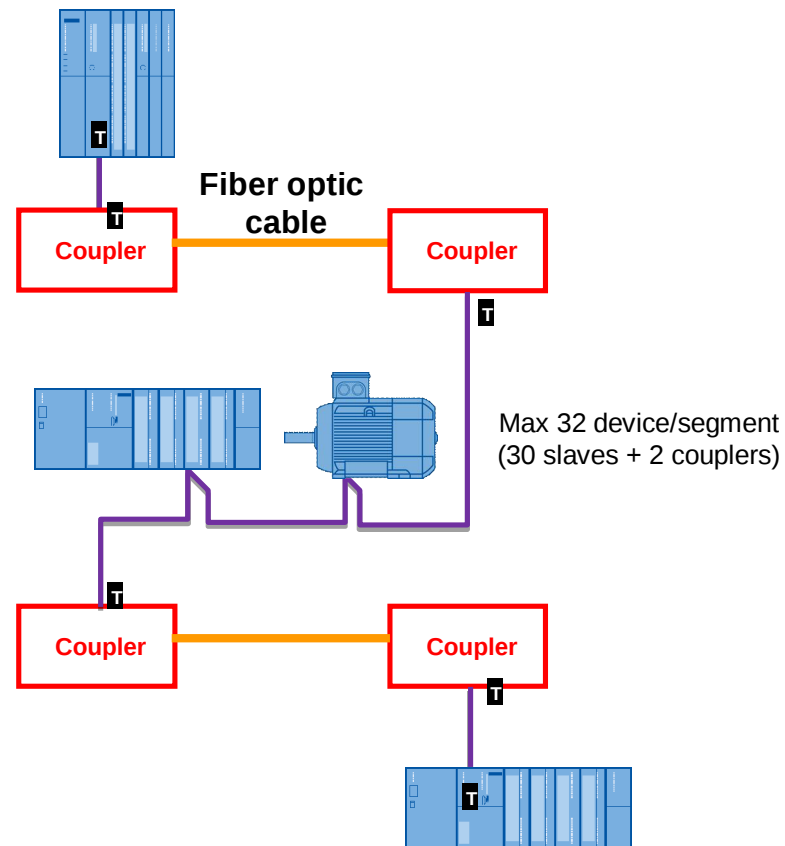
Devices Rules

Installation
Rules

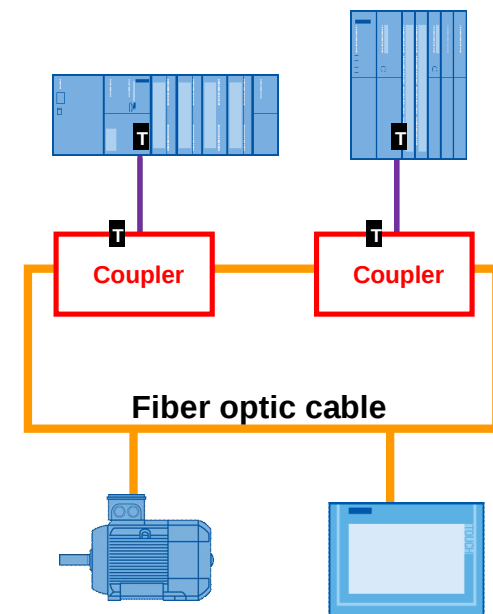
Troubleshooting

Training

Classic Topology Topology



Ring



Benefits: Long distances and EMC/Noise isolation

 : Terminator is on

PROFIBUS DP Topologies - Wireless

21

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

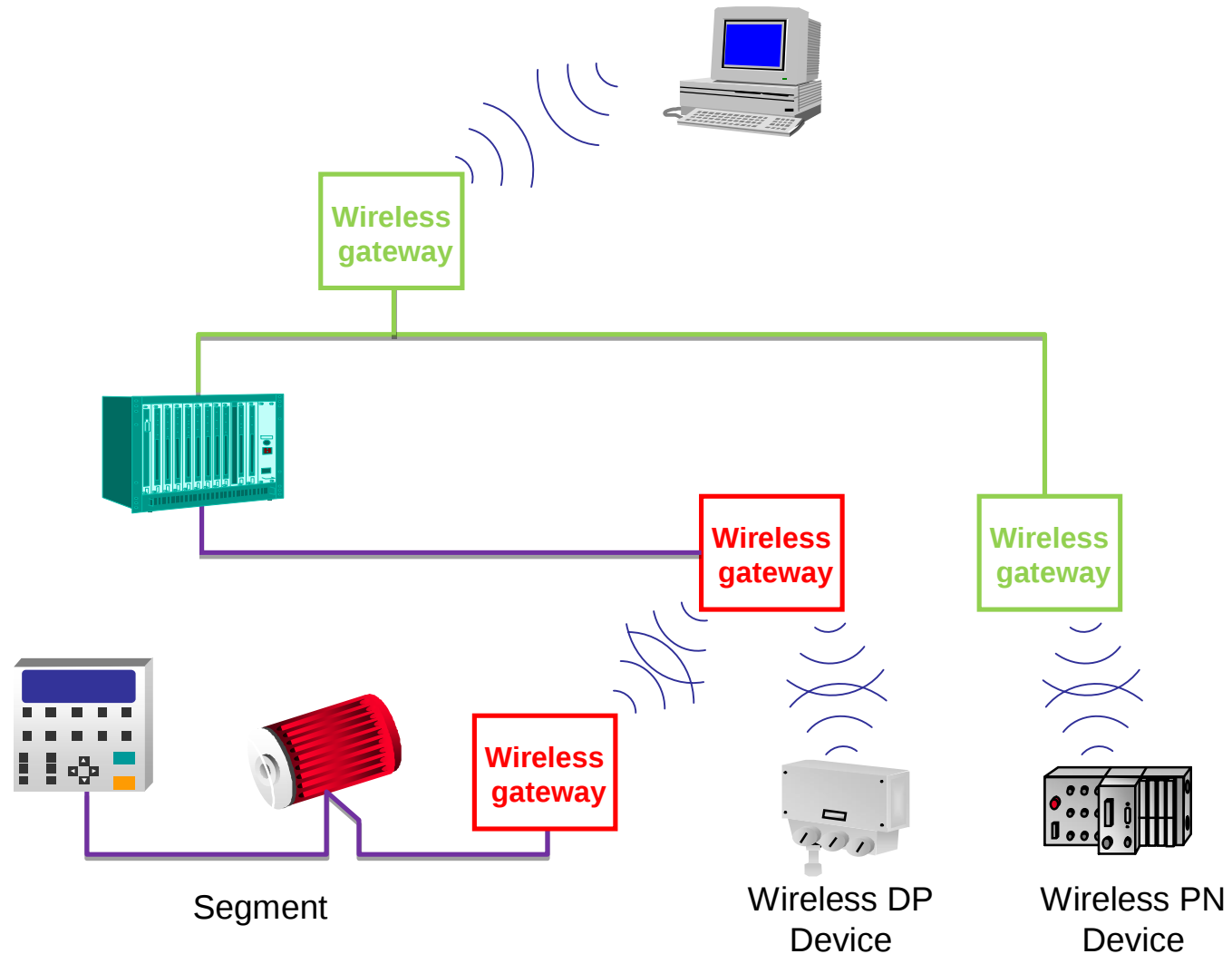
Devices Rules

Installation
Rules

Troubleshooting

Training

Connect your slaves through wireless couplers



PROFIBUS DP Topologies - Redundancy

22

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

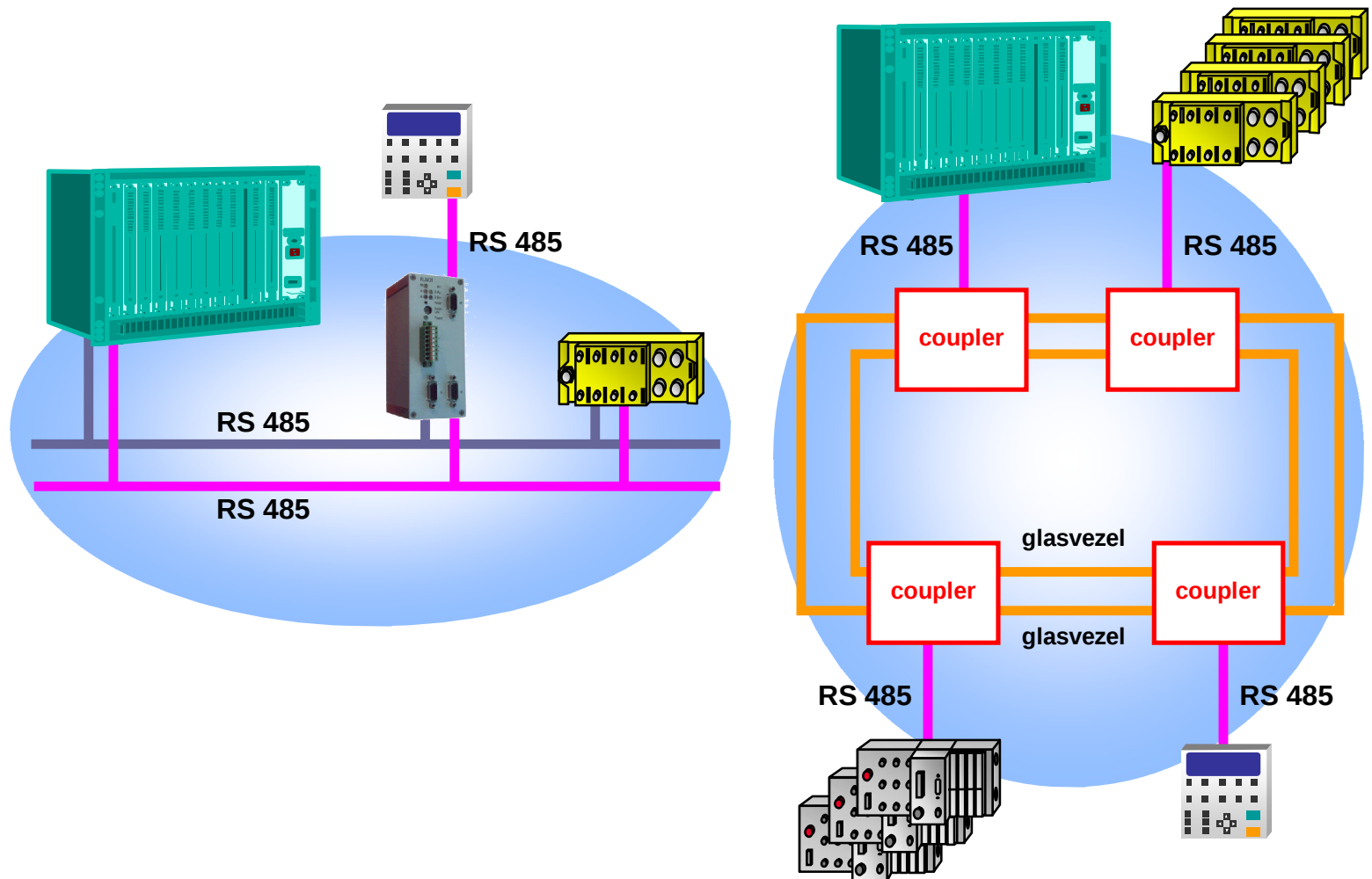
Cable length

Devices Rules

Installation
Rules

Troubleshooting

Training



Transmission speed (baudrate)

23

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

Devices Rules

Installation
Rules

Troubleshooting

Training

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
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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

24

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

Devices Rules

Installation
Rules

Troubleshooting

Training

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!

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

Devices Rules

Installation
Rules

Troubleshooting

Training

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!!!!!!

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

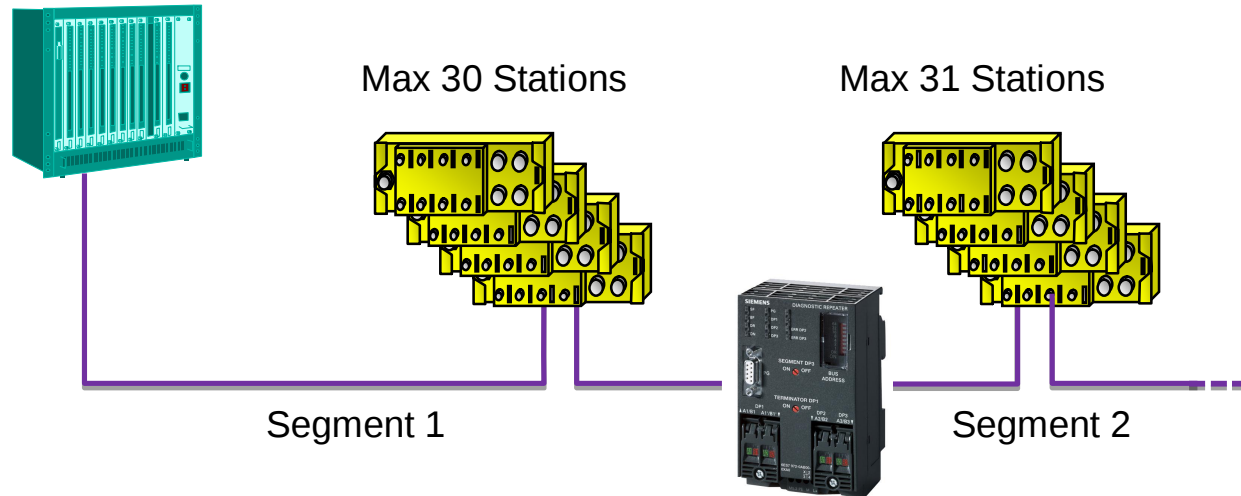
Devices Rules

Installation
Rules

Troubleshooting

Training

■ 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.

Summary

- 32 stations on one copper segment (RS 485), Repeater counts as device!
- Terminate each Segment (first and last node!)
- Notice Shielding on the connectors and when going in cabinet
- Use PROFIBUS Products
- 10cm distance between cables higher 110V if not isolate with i.e. grounded metal plate, if not possible use FO!
- High Baudrates, no Spurlines, no Cables shorter 1m
- Segment length depends on Baudrate!!
- Maximum 244 bytes input and 244 bytes output per slave.
- Slave configuration and parameters are set from the master side.
- GSD File needs to come with each PROFIBUS-DP Slave!!!!
- 124 slaves can be put in Data Exchange.



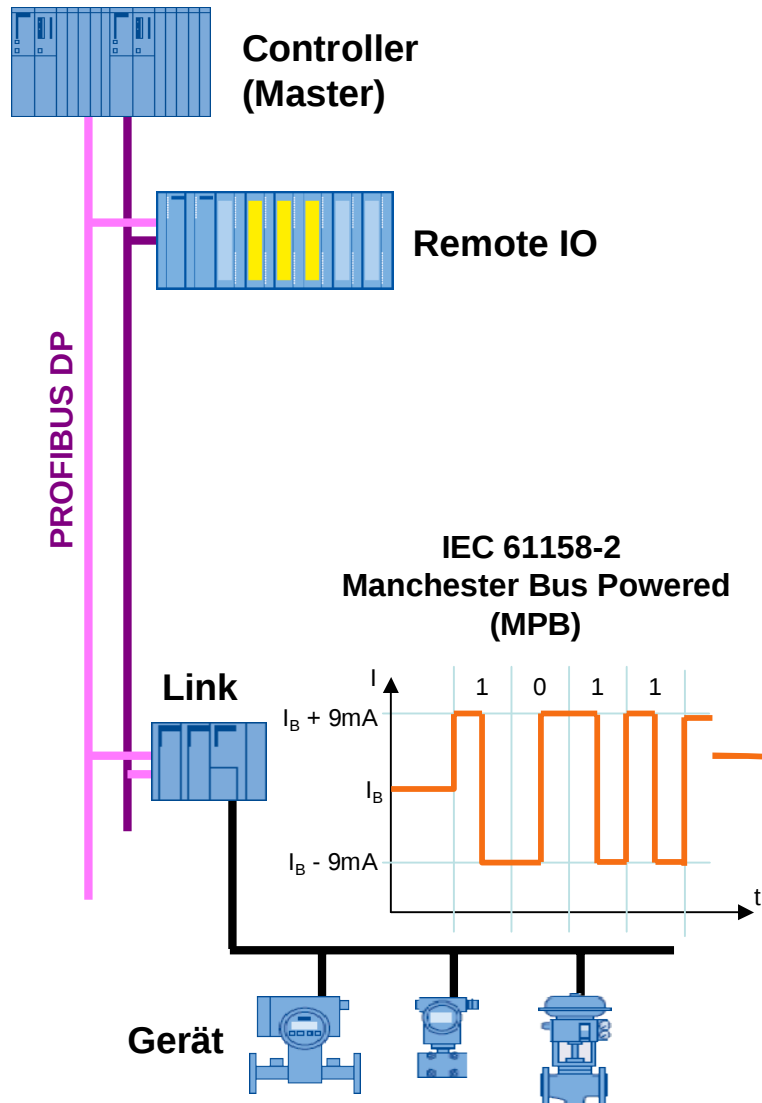
Introduction

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

30

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

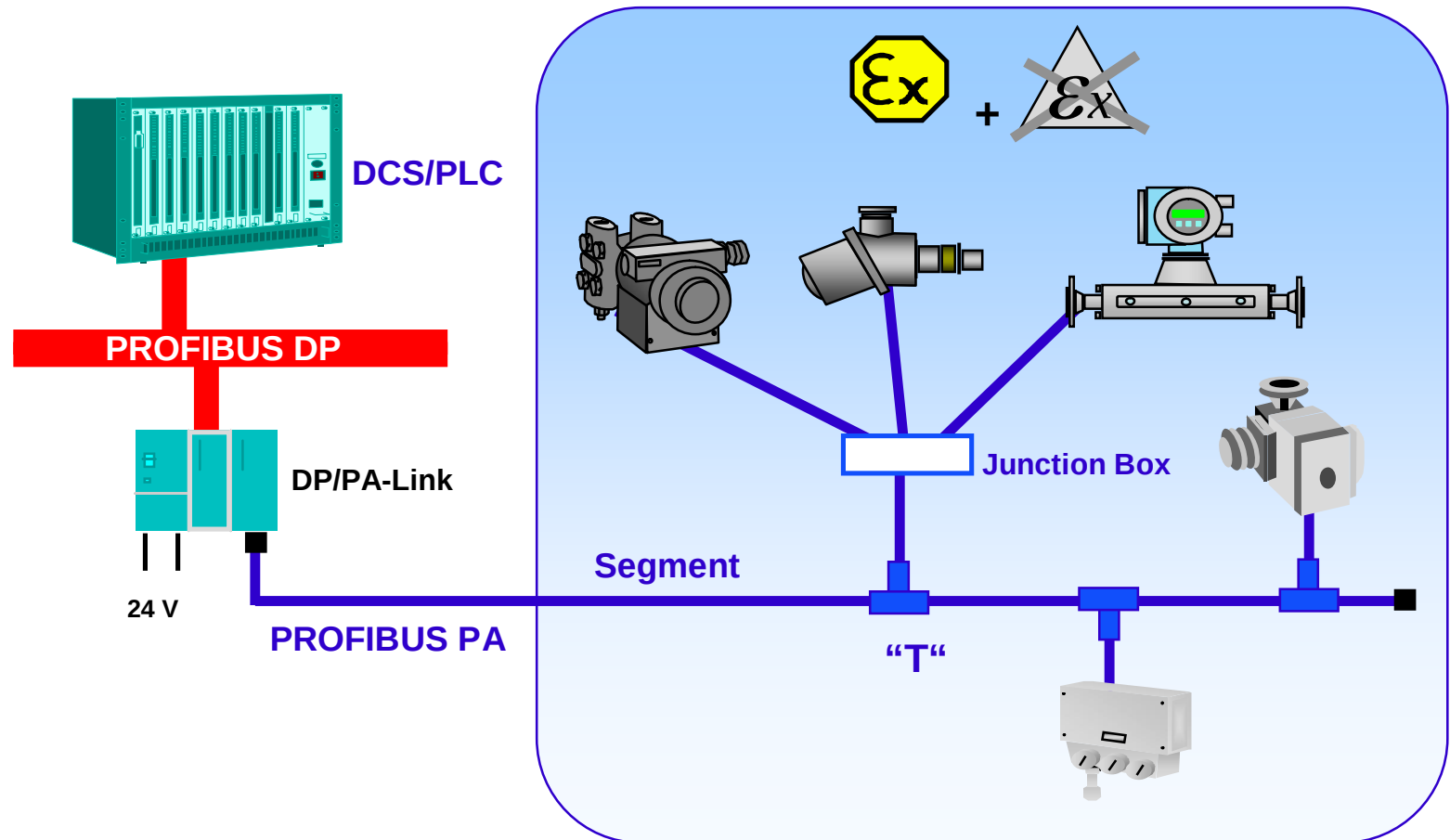
Cable length

Devices Rules

Installation
Rules

Troubleshooting

Training



PROFIBUS PA Topologies - Redundancy

31

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

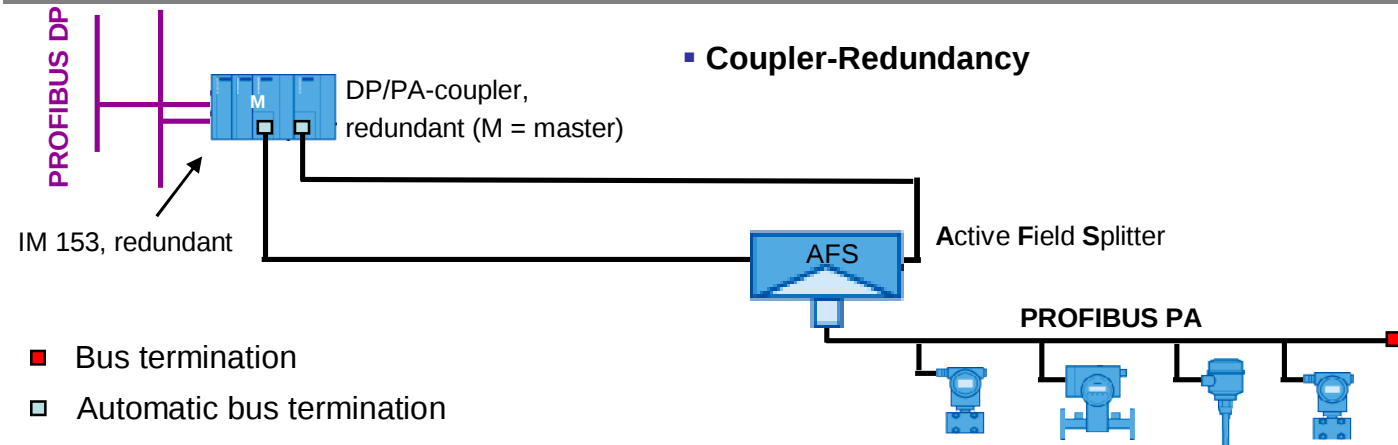
Devices Rules

Installation
Rules

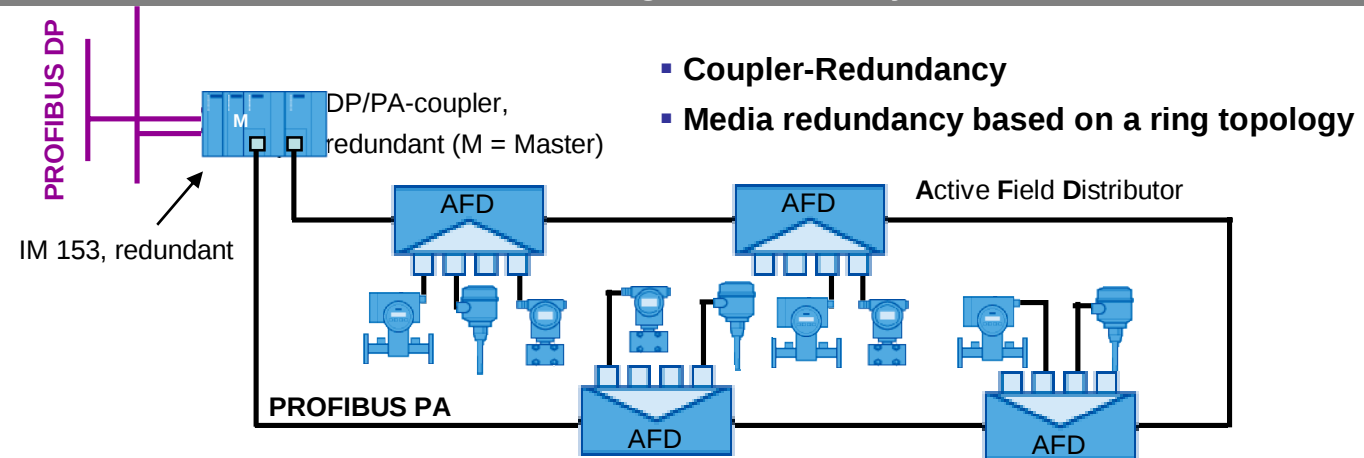
Troubleshooting

Training

Coupler Redundancy



PA Ring Redundancy



Higher availability with Redundancy

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

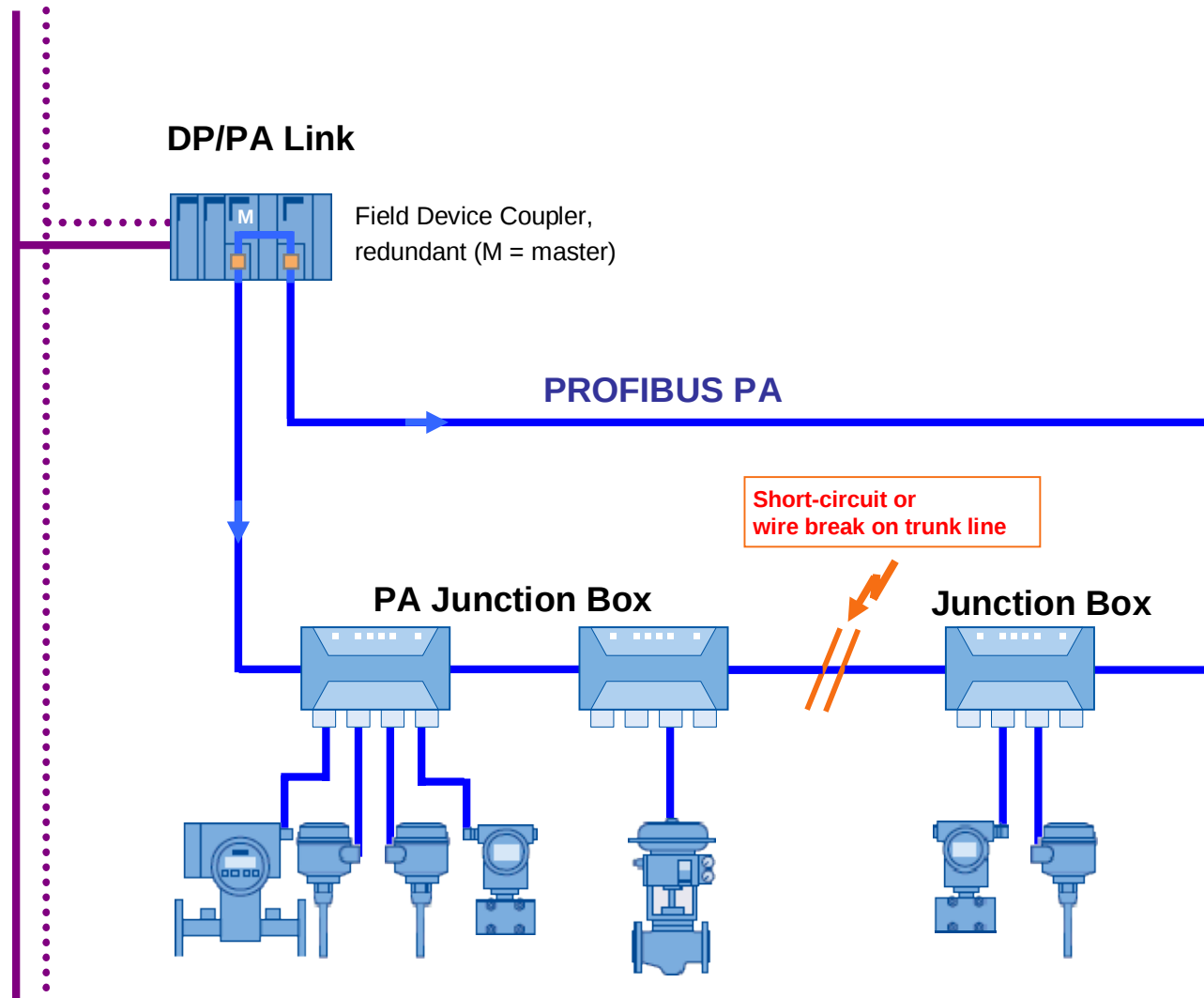
Cable length

Devices Rules

Installation
Rules

Troubleshooting

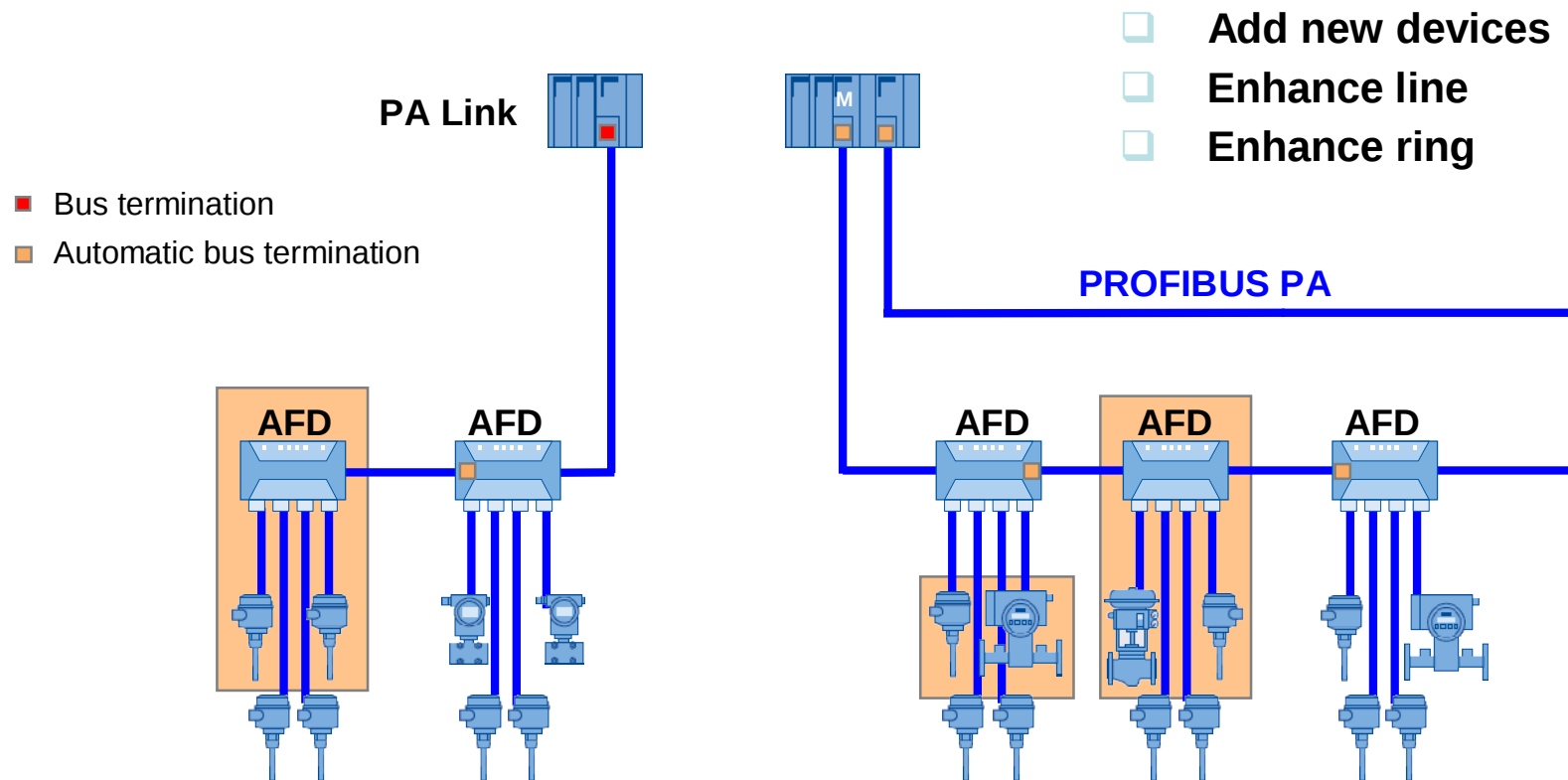
Training



■ Automatic bus termination

Automatic Termination

Automatic bus termination enables unique online changeability



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



Introduction

PROFIBUS-DP

PROFIBUS-PA

Installations and Best practise

Installation rules

35

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

Devices Rules

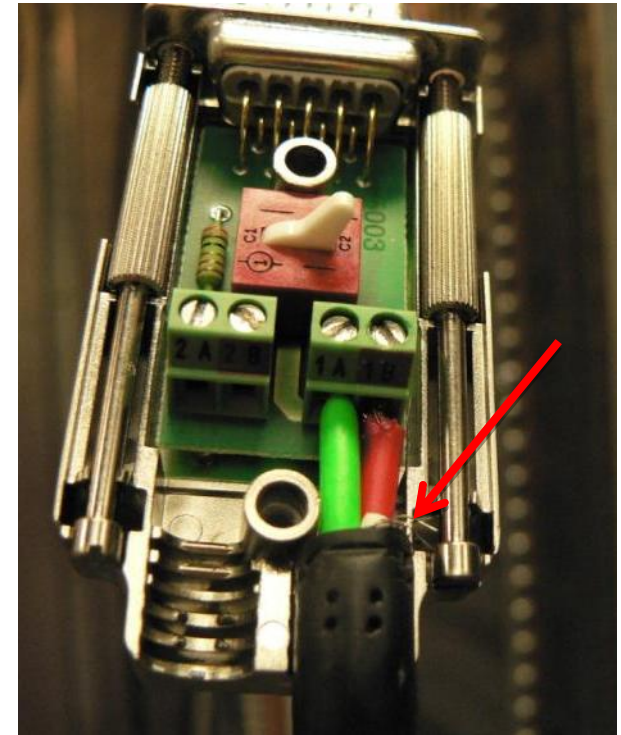
Installation
Rules

Troubleshooting

Training

■ Grounding & Shielding

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



Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

Devices Rules

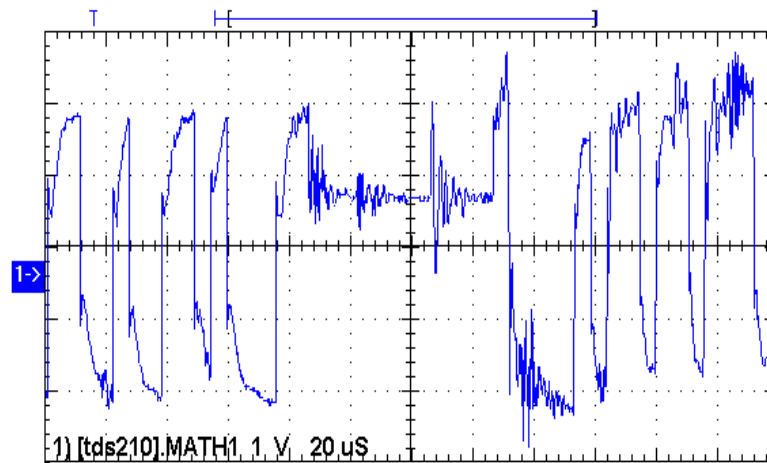
Installation
Rules

Troubleshooting

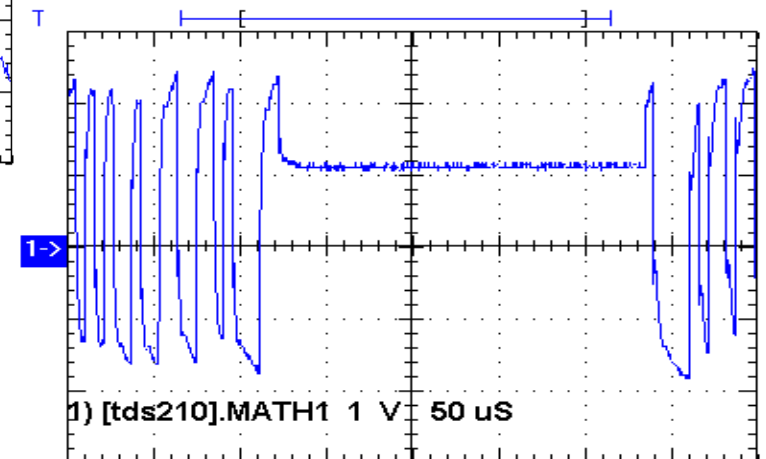
Training

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

37

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

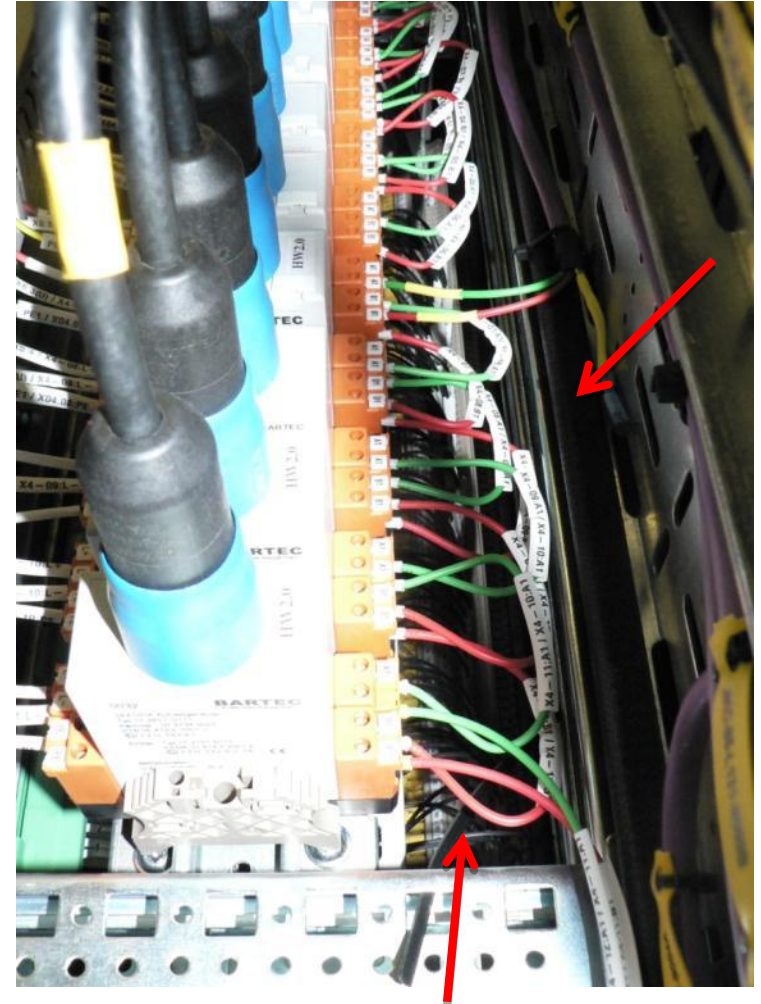
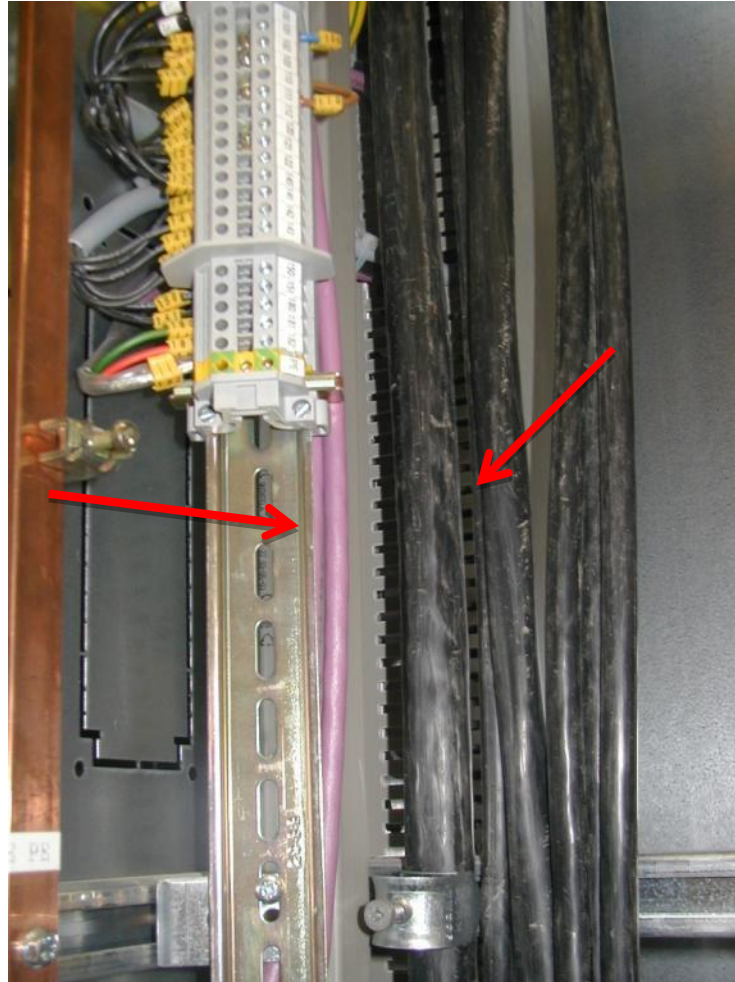
Devices Rules

Installation
Rules

Troubleshooting

Training

■ Some examples with Power Lines



Installation rules

38

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

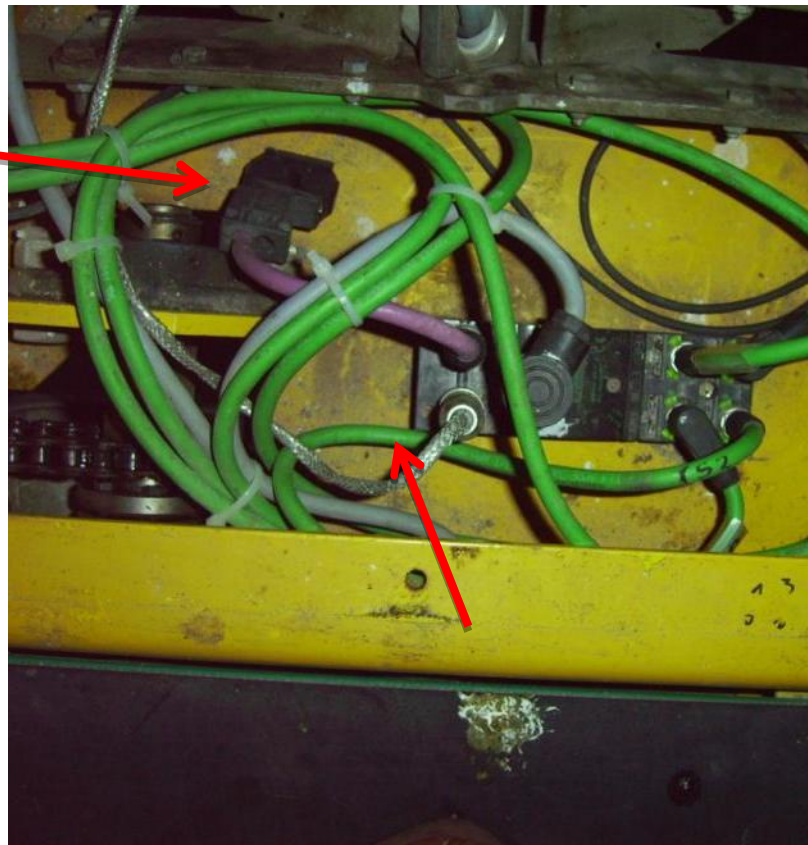
Devices Rules

Installation
Rules

Troubleshooting

Training

- 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

39

Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

Devices Rules

Installation
Rules

Troubleshooting

Training

■ Recognizing bad installations

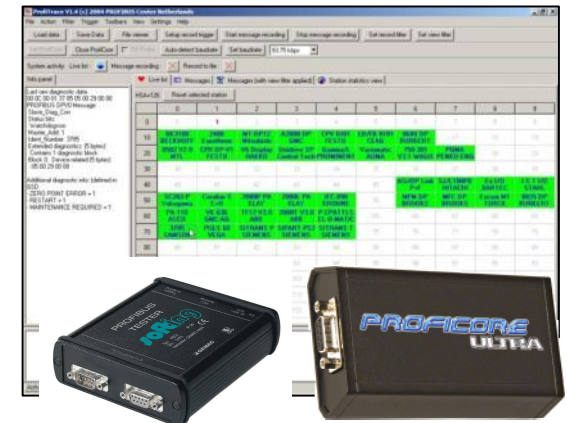
- You cannot use the multimeter, this is digital comm.
- Specific tools are required



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

40

Agenda

PROFIBUS

Family

Communication
Medias

Topologies

Cable length

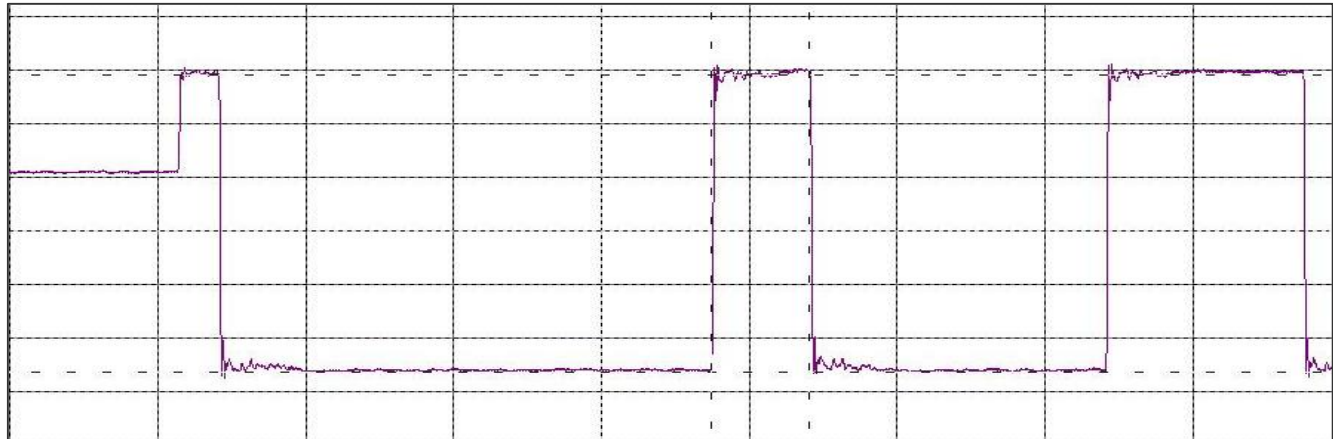
Devices Rules

Installation
Rules

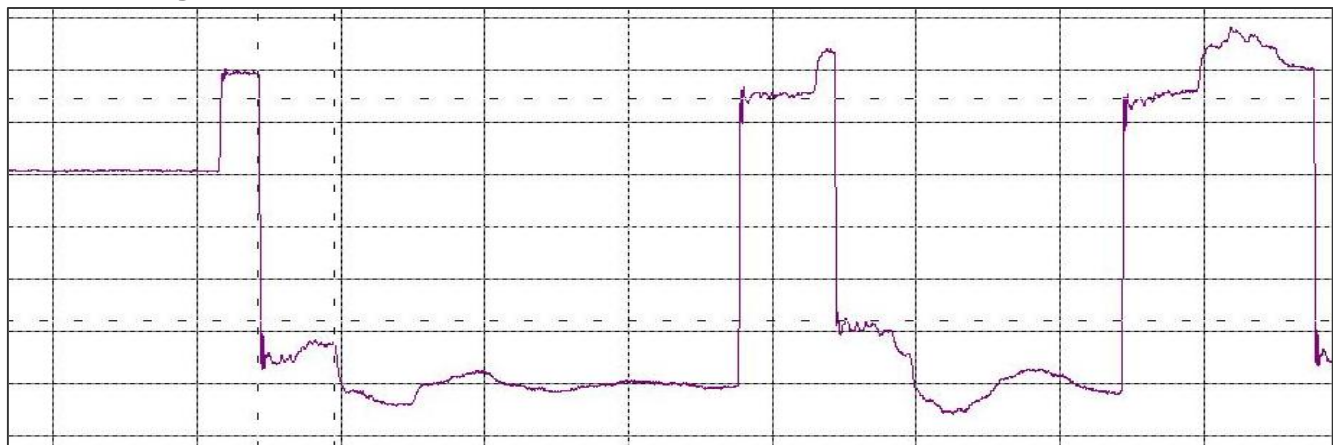
Troubleshooting

Training

■ Good signal



■ Missing termination



Agenda

PROFIBUS
Family

Communication
Medias

Topologies

Cable length

Devices Rules

Installation
Rules

Troubleshooting

Training

■ 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

Agenda

PROFIBUS

Family

Communication
Medias

Topologies

Cable length

Devices Rules

Installation
Rules

Troubleshooting

Training

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- Quality assurance for design and commissioning
- Faster project delivery
- Better installation, longer operation

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The end

Thank you for listening