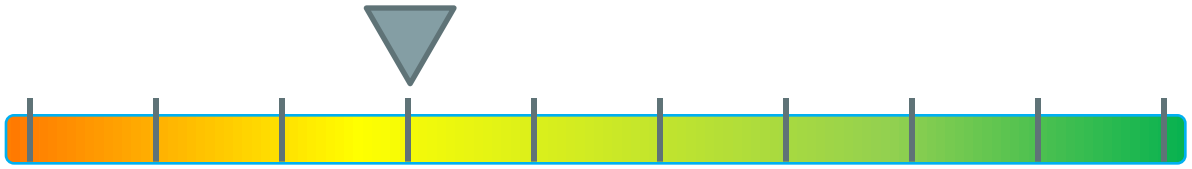
Fieldbus Engineering Basic

Agenda

Time	Topic
08:15	Topology & Hardware
08:30	FOUNDATION Fieldbus
08:45	POWERLINK
10:00	PROFIBUS DP + PA
13:00	HART
14:15	FDT/DTM
14:45	Modbus TCP
15:30	Live presentation, round of questions

Aimed level for the workshop



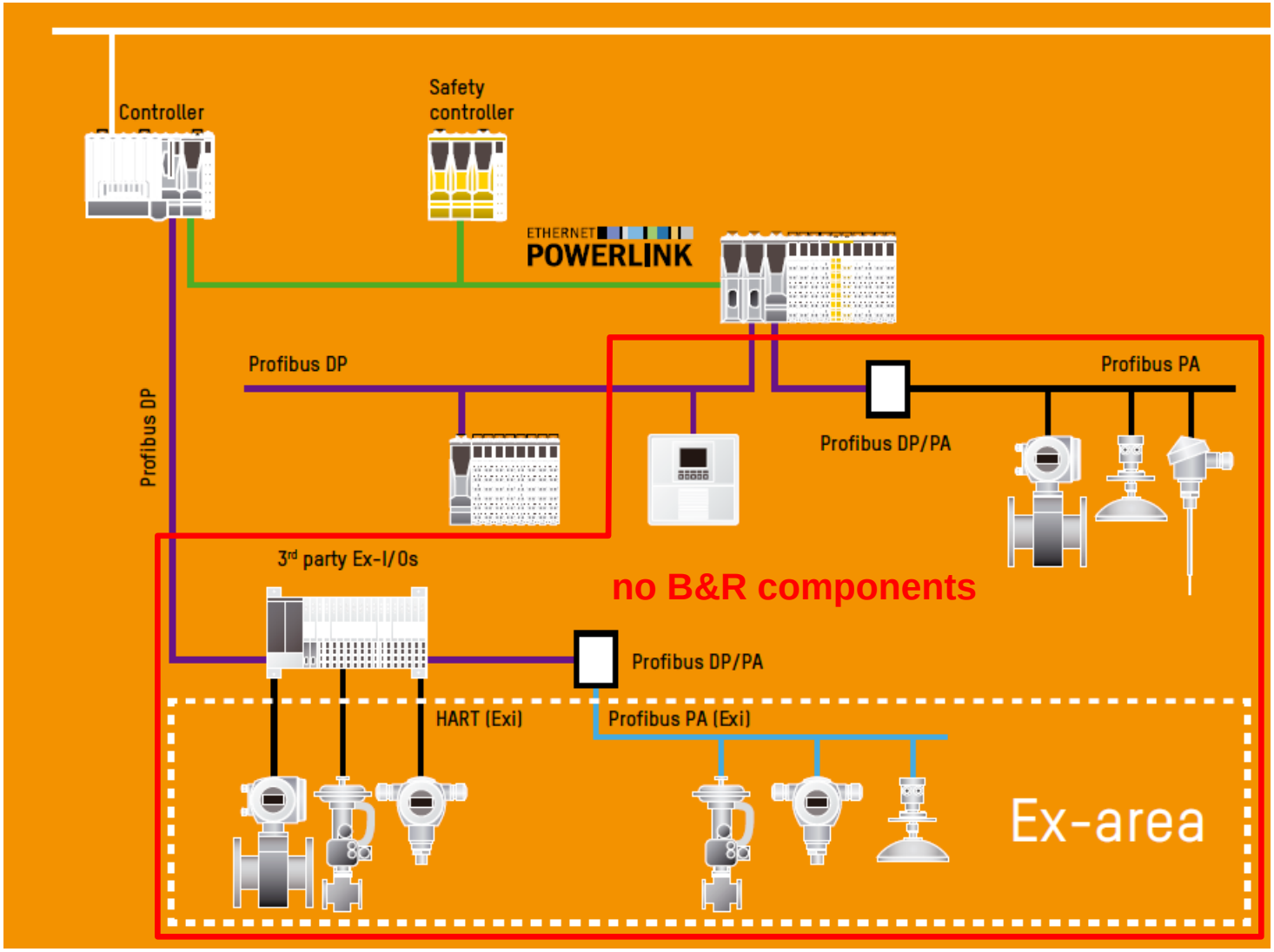
Beginner

Expert

Topics / Goals

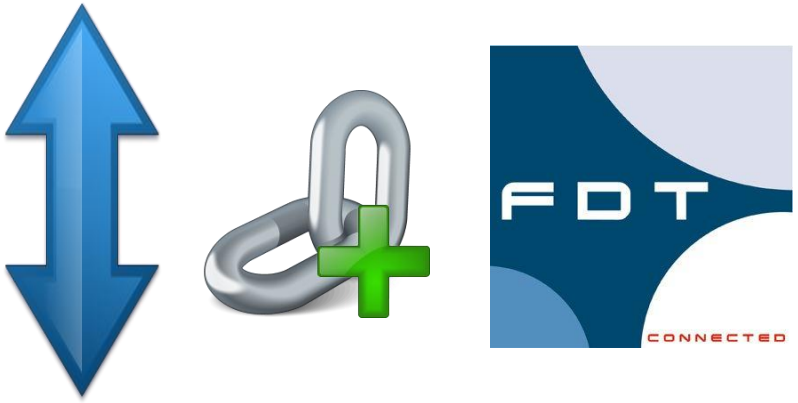
- Overview of common fieldbusses and communication protocols
- Typical topologies
- Technical fundamentals
- Restrictions, tips
- Use cases / live presentation

B&R topology example for Process Automation



Hardware components

- B&R provides
  - Controller
  - Network devices (interface modules, hubs, Cu/optical converter, …)
  - Bus controllers (X20/X67 at PLK, Profibus-DP, Modbus-TCP, …)
  - IO-modules (digital/analog, input/output, counter, serial, HART, …)

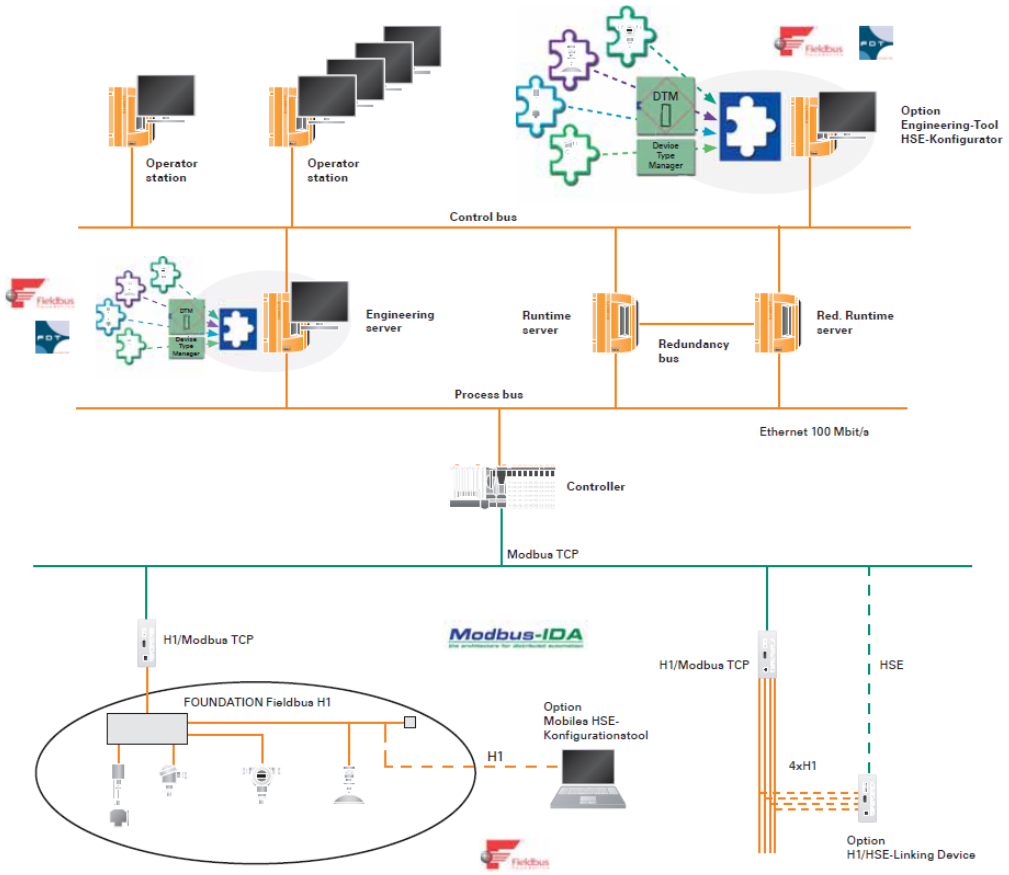


- Trade products and external devices
  - Media converters (DP/PA, Cu/optical)
  - Remote-IO systems (STAHL, TURCK, Pepperl+Fuchs)
  - Profibus-PA devices (E+H, VEGA, Siemens, ABB, …)
  - HART devices (E+H, VEGA, Siemens, ABB, …)

Relevant busses for Process Automation

Not integrated (but supported)

FOUNDATION Fieldbus



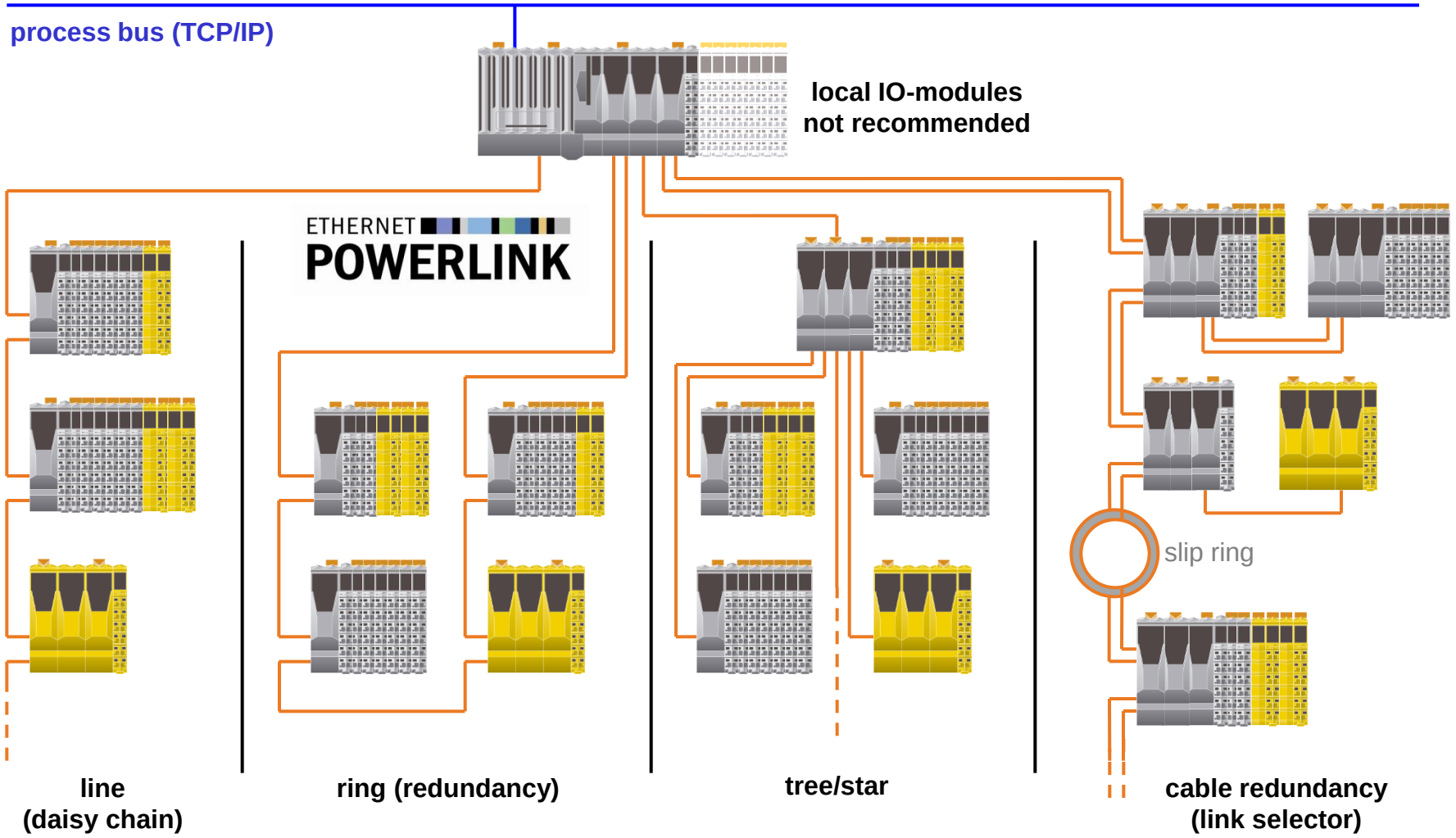
- No B&R hardware (IF) available
- Not integrated in APROL / AS
- HW-support via 3rd party ModbusTCP / FF H1 gateway
- SW-support via 3rd party DTM
- FDT communication is tunneled through B&R controller
- Read/write access to FF device via ModbusTCP configuration


ETHERNET
POWERLINK

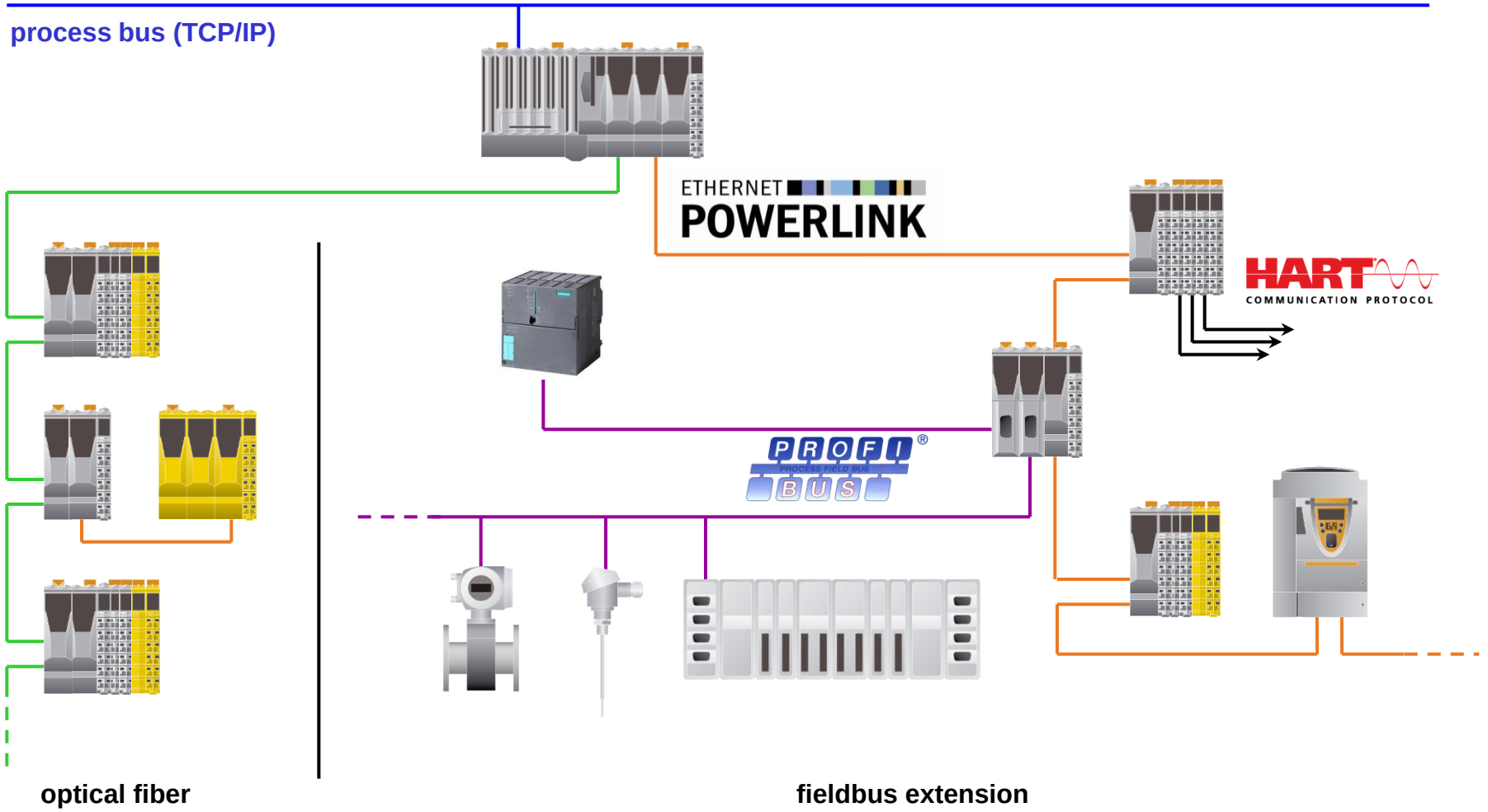
Basics POWERLINK I

POWERLINK is the standard B&R fieldbus

but no standard in Process Automation



Basics POWERLINK II



Basics POWERLINK III

- IF-modules
  - X20IF1082, X20IF1082-2 (PRC), X20IF1086-2 (FX), X20IF2181-2 (link selector, RMN)
- BC-modules
  - X20BC0083, X20BC1083 (IF ext.), X20BC8083 (hub ext.), X20BC8084 (link selector)
- HB-modules
  - X20HB8880 (base), X20HB2880 (ext. TX), X20HB1881 (ext., 1x FX), X20HB2881 (ext., 2x FX), X20HB2885 (redundant, TX), X20HB2886 (redundant, FX), X20HB8884 (link selector), X20HB8815 (TCP/IP gateway)

technical details → www.br-automation.com


PROFI
PROCESS FIELD BUS
BUS

Basics Profibus I

- 3 Variants
  - FMS – Fieldbus Message Specification (no longer supported)
  - DP – Decentralized Periphery
  - PA - Process Automation

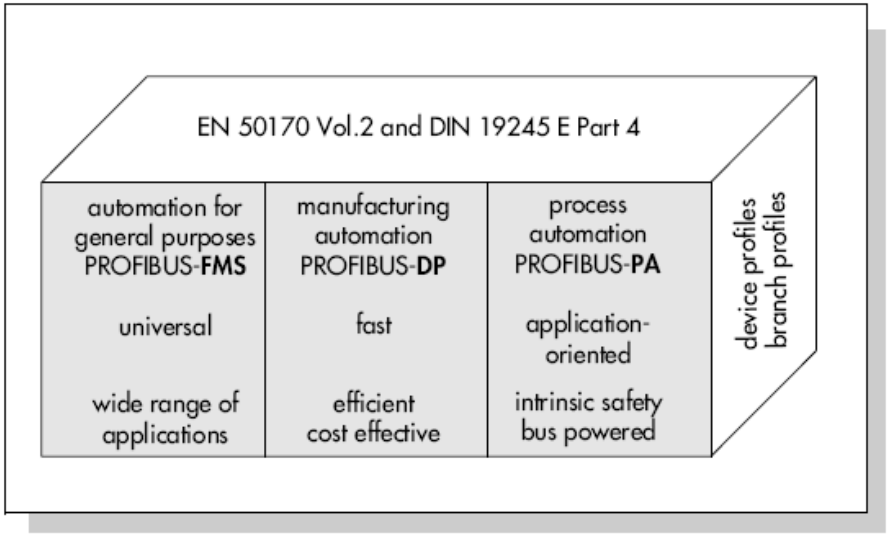
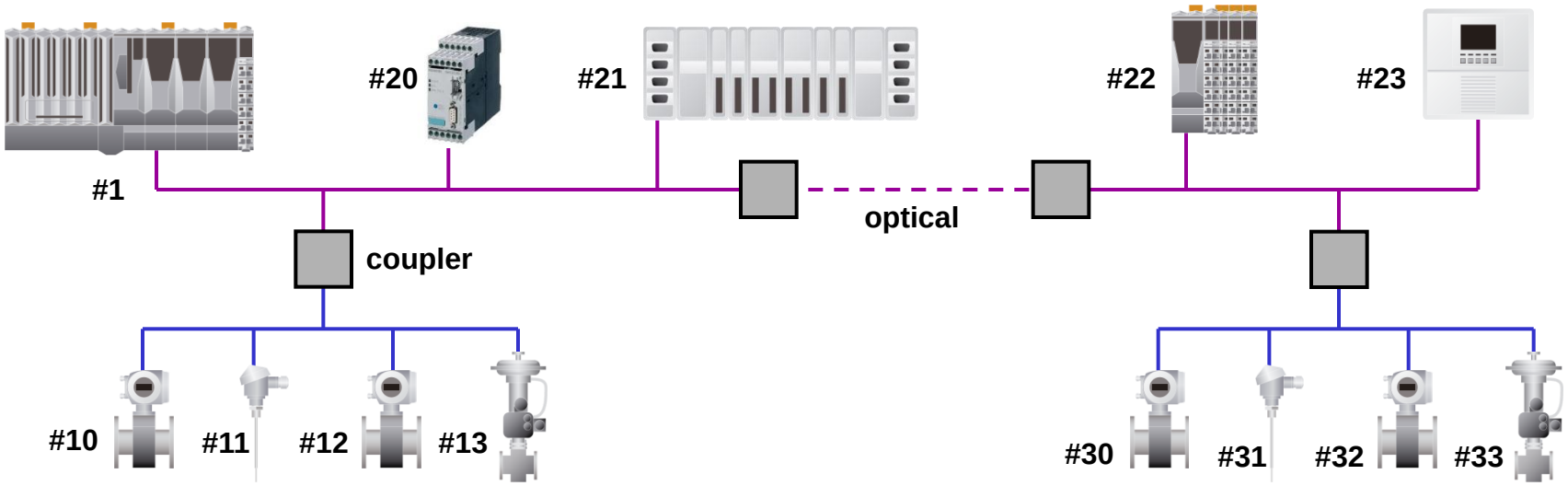


Fig. 1: PROFIBUS variants

- 3 Service levels
  - DPV0 – cyclic data exchange and diagnosis
  - DPV1 – DPV0 + acyclic data exchange and alarm handling
  - DPV2 – isochronous mode and slave to slave communication

Basics Profibus II

- Technical details
  - Master - Slave protocol
  - Baud rate 9.6kbit/s – 12Mbit/s
  - Cable distance up to 1200m (depends on baud rate), optical < 15km
  - Address range 0 – 127 (126 and 127 are reserved)
  - max. 32 devices per segment (repeater needed)
  - Profibus supports multi master (B&R supports only one master per network)
  - max. 244 bytes cyclic data per slave
  - max. 240 bytes acyclic data per slave (DPV1)



Basics Profibus III

- Profibus-PA features
  - 2 transmission types: RS485 and IEC 61158-2 (MBP – Manchester Bus Powered)
  - PA on RS485 can be operated with DP and FMS on a common bus line
  - IEC 61158-2 for intrinsic safety und bus supply (Ex area, max. 10/22 devices)
  - IEC 61158-2 has a fixed baud rate of 31,25kbit/s
  - Master of a PA-system is always Profibus-DP in safe area (segment coupler needed)

PROFIBUS-PA		
transmission technique	RS 485	IEC 61158-2
transmission rate	9.6 to 1200 kbit/s	31.25 kbit/s
intrinsic safety	–	optional
bus supply	–	optional

Fig. 6: Physical PROFIBUS-PA layer

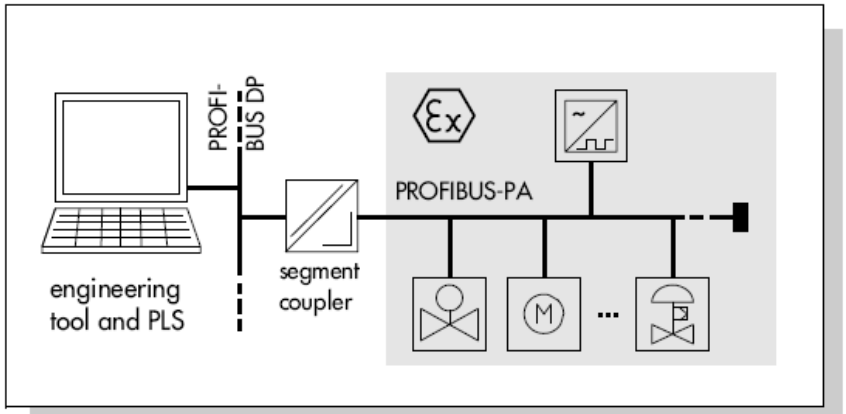


Fig. 7: PROFIBUS-PA segment coupled to a DP bus system

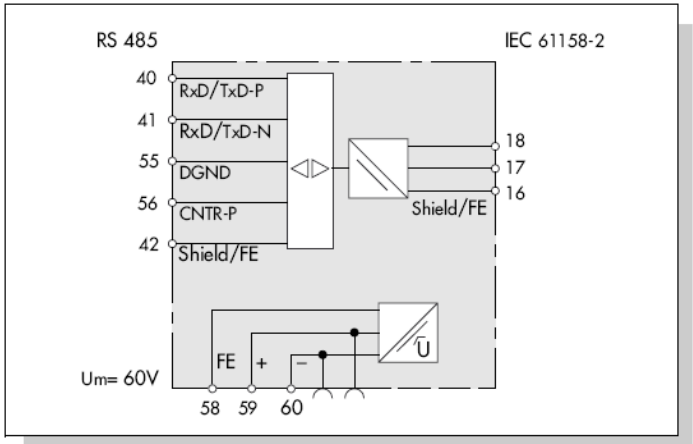


Fig. 8: Block diagram of a segment coupler (Pepperl+Fuchs)

	EEx ia IIC	EEx ia/ib IIB
max. power	1.8 W	4.2 W
max. current	110 mA	250 mA
max. device number*)	10	22
*) depends on the current consumption of the devices		

Fig. 9: Maximum power and number of devices per PA segment in hazardous areas

Basics Profibus IV

- Profibus-PA components

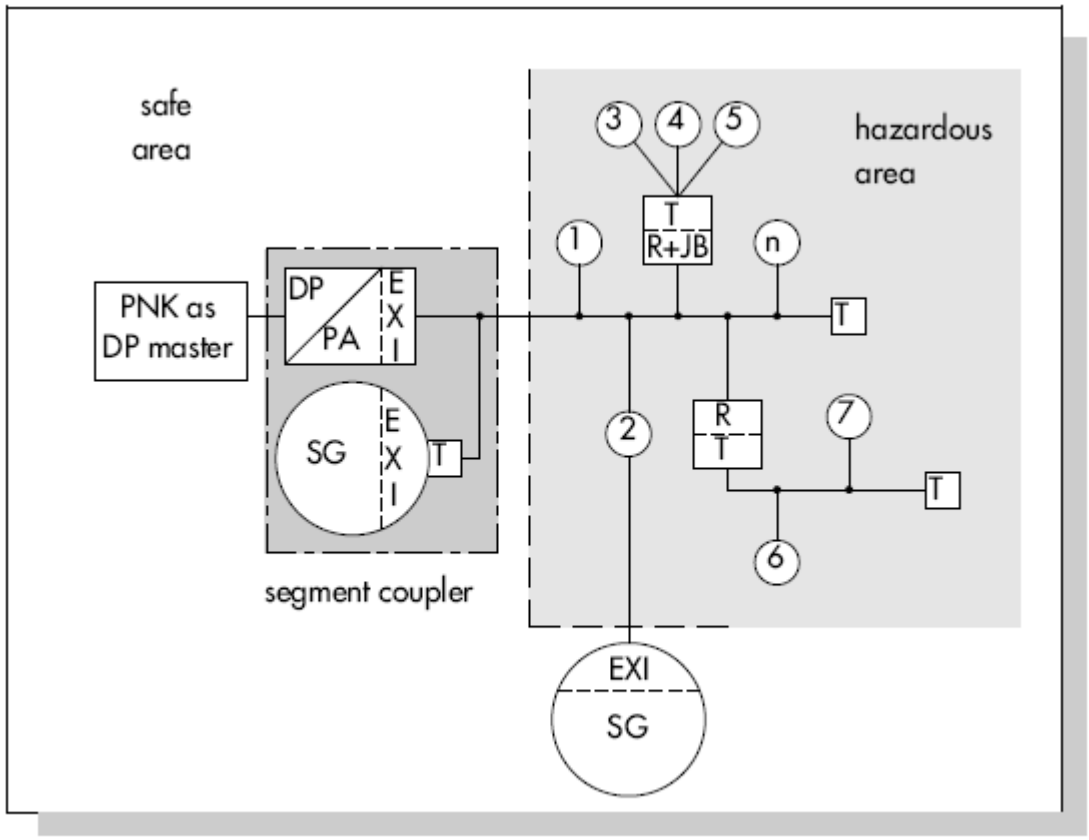


Fig. 16: Components of a PROFIBUS-PA system

PNK: process-near component
EXI: barrier (intrinsically safe))
SG: power supply unit
JB: distributor
R: repeater
T: bus termination
1... 7: field devices

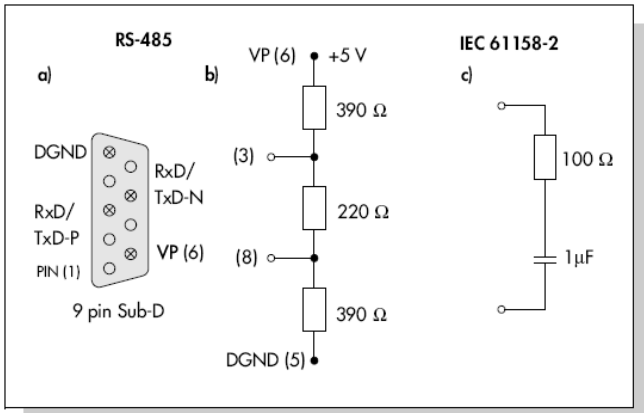


Fig. 14: Plug connector and bus termination


HART
COMMUNICATION PROTOCOL

Basics HART I

- Technical details
  - HART – Highway Addressable Remote Transducer
  - proven in practice, simply design, easy to maintain and operate
  - 2-wire bus for signal and sensor supply
  - 4-20mA analog signal with Bell 202 Frequency Shift Keying (digital)
  - devices for input and output signals (X20AI2438, X20AO2438)
  - Point-to-Point and Multidrop (up to 15 devices) mode
  - HART-PVs as REAL value with unitcode
  - Parameterization and diagnoses over the network (gateway driver needed)
  - Response time of approx. 500ms (1200 bit/s)

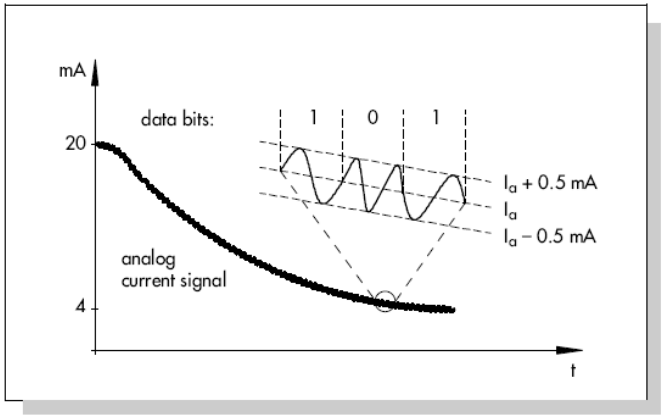
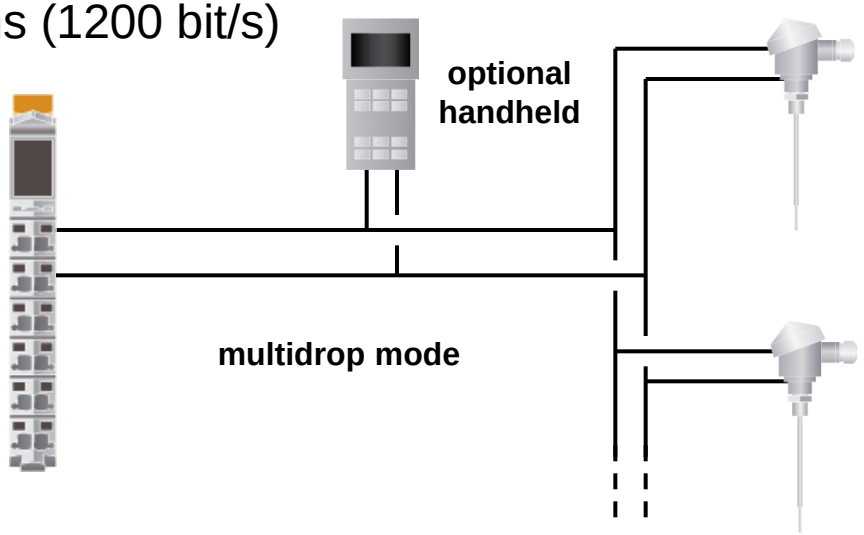
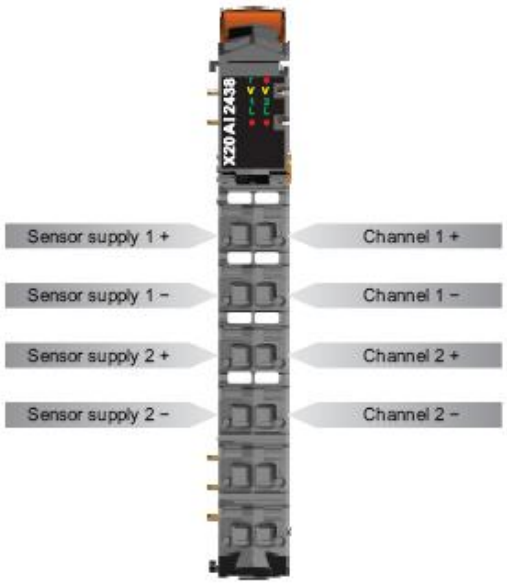


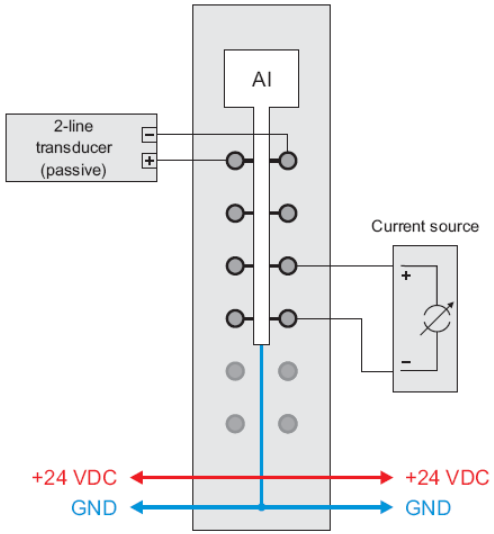
Fig. 10: Hart signal superimposed on the analog current signal

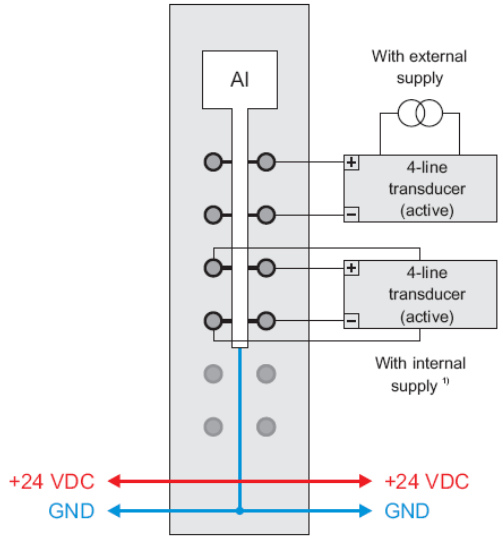


Basics HART II

- Technical details X20AI2438
  - 2 input channels, 15bit, electrically isolated
  - analog range 0-25mA (channel mode 0-32.767digits / 0-25.000digits)
  - integrated sensor supply (for each channel)
  - lower limit, upper limit and broken wire detection
  - substitution mode (hold last input value, error substitution values)
  - Point-to-Point and Multidrop mode
  - max. 4 HART PVs per channel in Point-to-Point mode







1) Max. load on internal supply = 30 mA

Basics HART III

- Technical details X20AO2438
  - 2 output channels, 15bit, electrically isolated
  - analog range 0-24mA (channel mode 0-32.767digits / 0-24.000digits)
  - DAC configuration for slewrate
  - Point-to-Point and Multidrop (with Split-Range) mode
  - HART PVs only in input direction

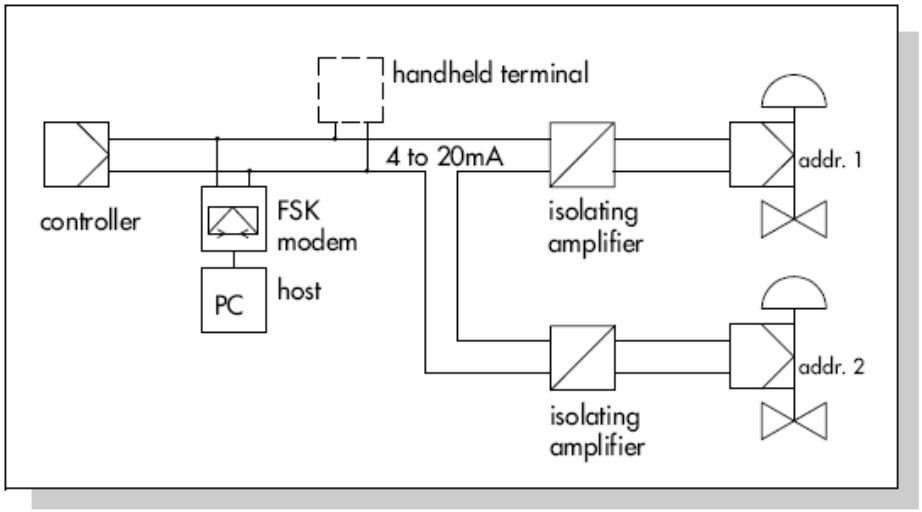
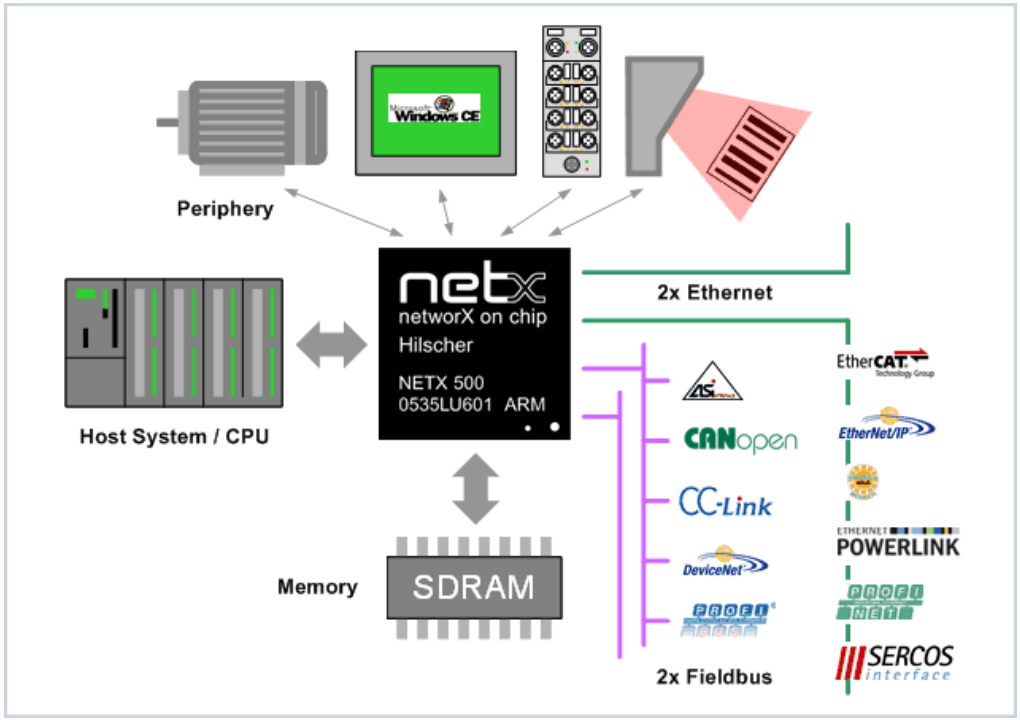


Fig. 5: Split-range operation with two HART positioners

FDT
CONNECTED

netX

- Features
  - networX on chip, provided by Hilscher
  - Classic + Real Time Ethernet fieldbusses (Master/Slave)
  - B&R Interface modules for X20 (X20IF10xx**-1**) and APC (PCI-card)
  - enables fieldbus support on PLK bus controller (X20BC1083)
  - no support for B&R 2005 system
  - FDT/DTM support starting from AS 3.0.81



e.g. Master: X20IF1061-1

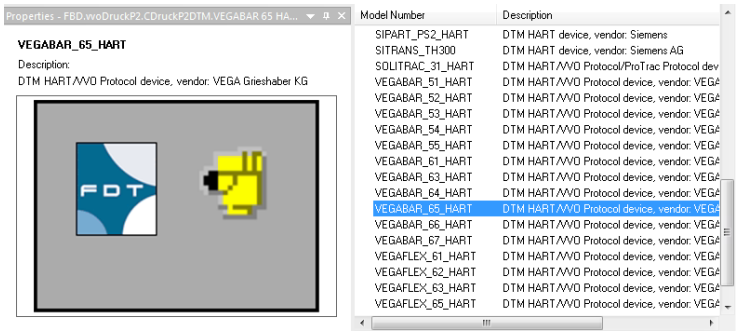
e.g. Slave: X20IF1063-1

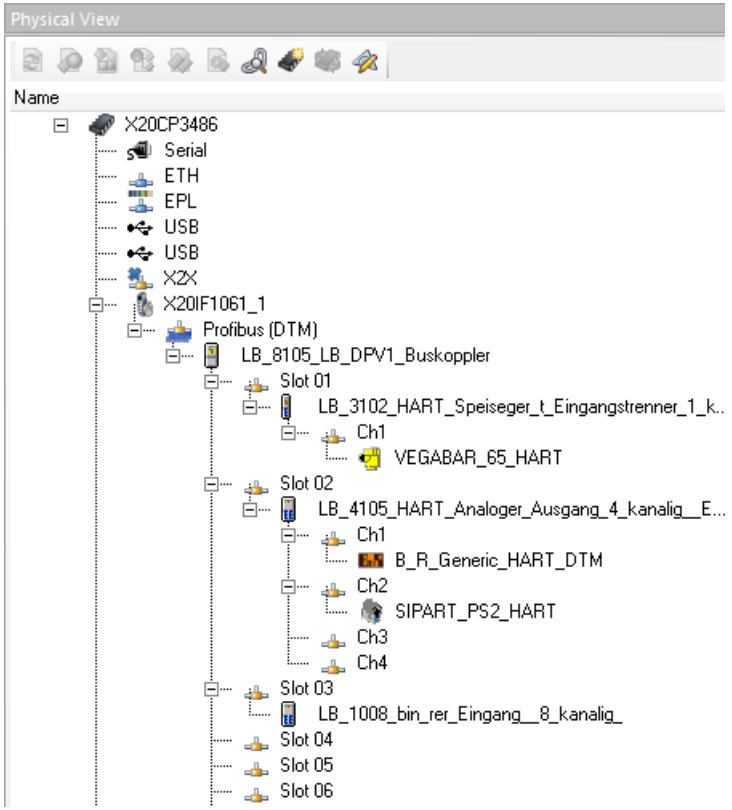
FDT/DTM

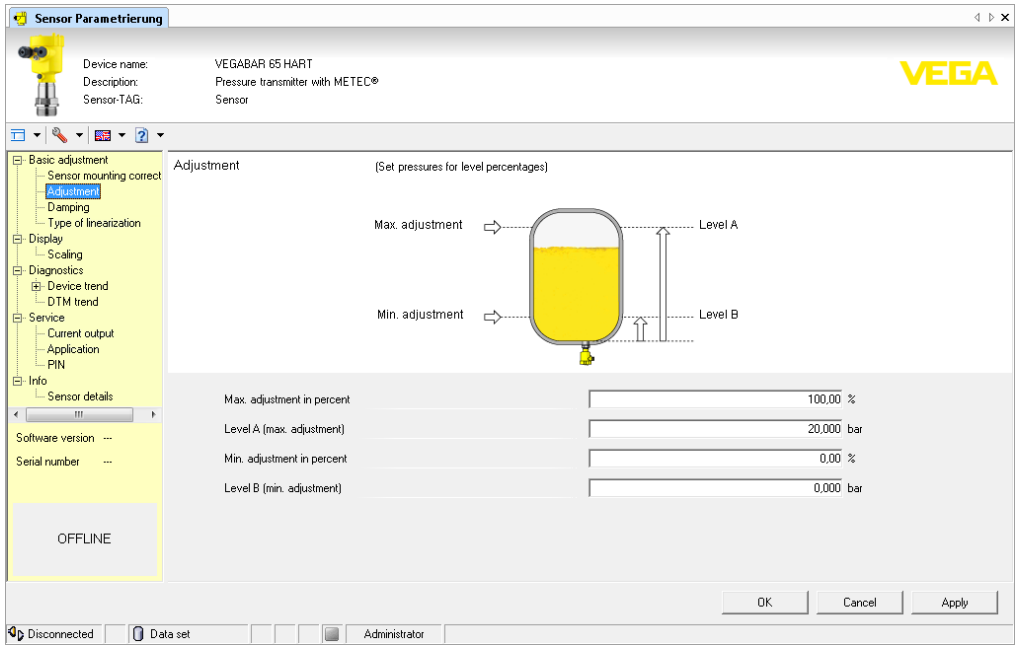
- FDT
  - Field Device Tool (Technology)
  - not a special program/software
  - definition of interface between container and DTM
  - FDT frame applications are e.g. PACTware, FieldCare, fdtCONTAINER, SmartVision

- DTM
  - Device Type Manager
  - is a driver (similar to a printer driver)
  - software has to be installed per device/manufacturer (.exe, .msi)
  - started out of container or application
  - contains functionality, parameterization, diagnoses, GUI, help, …
  - different types: device, communication and gateway DTMs

FDT/DTM – integrated in Automation Studio







General restrictions

- Profibus: max. 3.5kB input and 3.5kB output data when IF is in SS of CPU
- Profibus: max. 1.4kB input and 1.4kB output data when IF is in SS of BC
  - limitation per BC, limit = data IF SS1 + data IF SS2 (+ local IO data)
    → max. 1.4kB cyclic data per PLK node (frame size limitation)
- max. 30 Byte cyclic input/output data per X2X module
  - X20AI2438: 2 analog channels with status + max. 4 HART-PVs per module
  - new transfer mode for HART data, no limitation
- B&R HART DTM only useable starting from AS 4.0
  - with AS 3.0.90 (→ APROL R3.6) only useable in external FDT program (e.g. FieldCare, PACTware)


Modbus

Basics Modbus-TCP I

General

- Modbus protocol (serial) since 1979
- Modbus-TCP is Modbus over TCP/IP (port 502)
- Client(Master)/Server(Slave) communication, request - response
- Access via function code, start address and number of registers
- Nearly unlimited number of stations and data
- Qualified for building automation

Modbus TCP Frame Format		
Name	**Length**	**Function**
Transaction Identifier	2 bytes	*For synchronization between messages of server & client*
Protocol Identifier	2 bytes	*Zero for Modbus/TCP*
Length Field	2 bytes	*Number of remaining bytes in this frame*
Unit Identifier	1 byte	*Slave Address (255 if not used)*
Function code	1 byte	*Function codes as in other variants*
Data bytes	n bytes	*Data as response or commands*

Name	Type	Access	Visual
Discrete Input	single bit	read-only	
Discrete Output (Coils)	single bit	read-write	
Input Registers	16-bit word	read-only	
Holding Registers (Registers)	16-bit word	read-write	

Basics Modbus-TCP II

- B&R supports
  - Modbus-TCP master as software driver integrated in AS/AR
    Usable on every ETH interface (onboard IF and PLK IF-modules in SS)
  - X20BC0087 bus controller (slave) for remote I/Os
  - Modbus-TCP slave on controller

Modbus parameters	
Activate Modbus communication	on
Use as Modbus slave	off
Use as Modbus master	on
openSafety over TCP/IP	
Use as Modbus slave	off
Diagnostics	
Slave diagnostics	none

Protocol-specific description	Description
Read coils	Read back the digital outputs
Read discrete inputs	Read multiple digital inputs
Read holding registers	Read multiple registers
Read input registers	Read analog inputs
Write single coil	Write individual digital output
Write single register	Write analog output (register)
Write multiple coils	Write multiple digital outputs
Write multiple registers	Write multiple analog outputs (register)

IF2.ST1	
General	
Module supervised	off
Ethernet	
Mode	Internet address
IP address	10.43.180.97
Unit identifier	0
TCP port	502
Number of pending requests	1
Timeouts	
Refresh time violation [ms]	1500
Plug and play timer [s]	10
Channel configuration	
Reset outputs on fatal error	on
Block 1	
Function code	FC6: Write single register
Refresh time [ms]	100
Block send mode	once
Starting address (read)	0
Number of items (read)	1
Starting address (write)	4164
Number of items (write)	1
Channel 1	
Channel 2	
Block 2	
Block 3	

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