IEEE 802.3 10 Mb/s single twisted pair Ethernet for Process Industry

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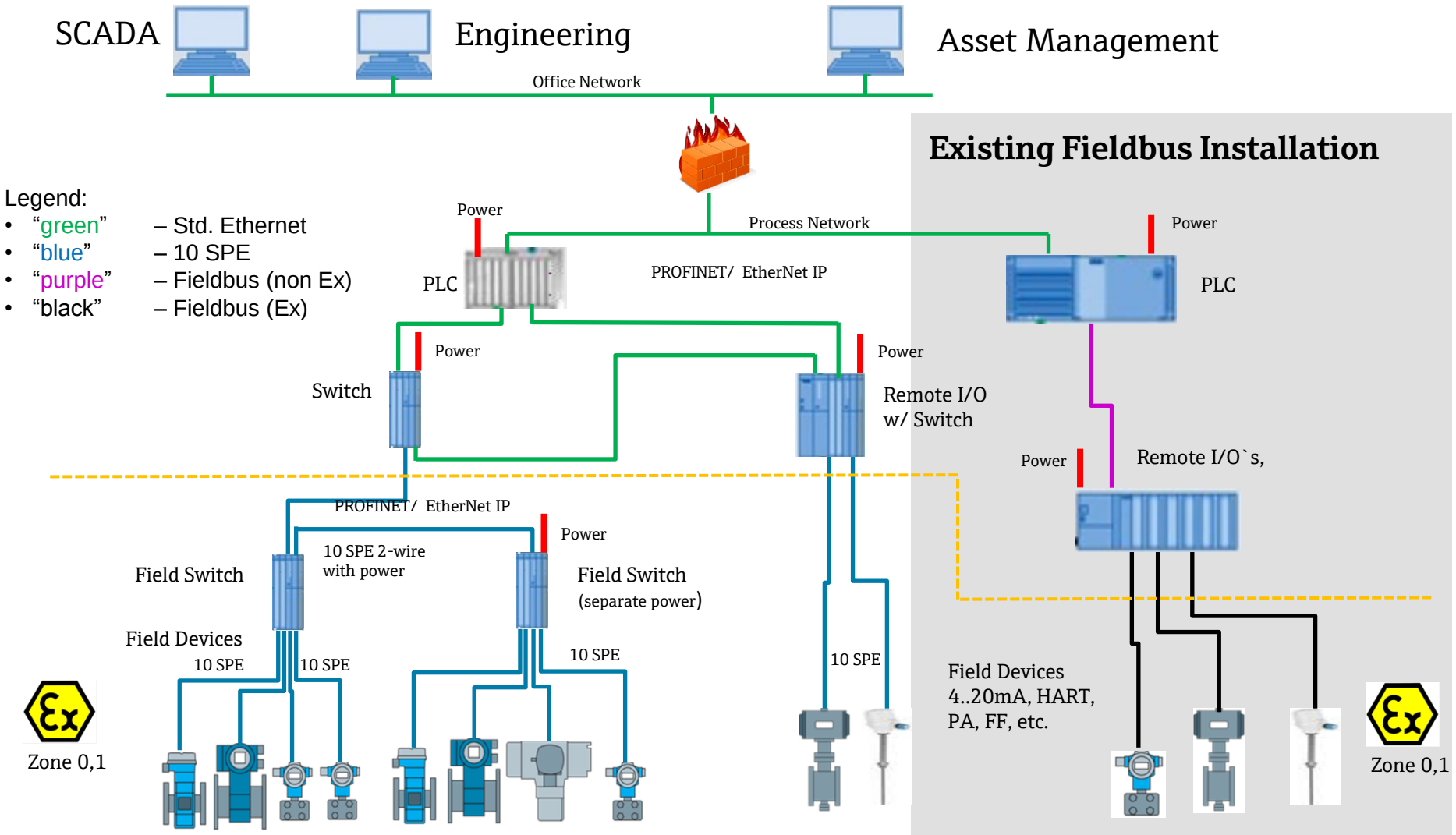
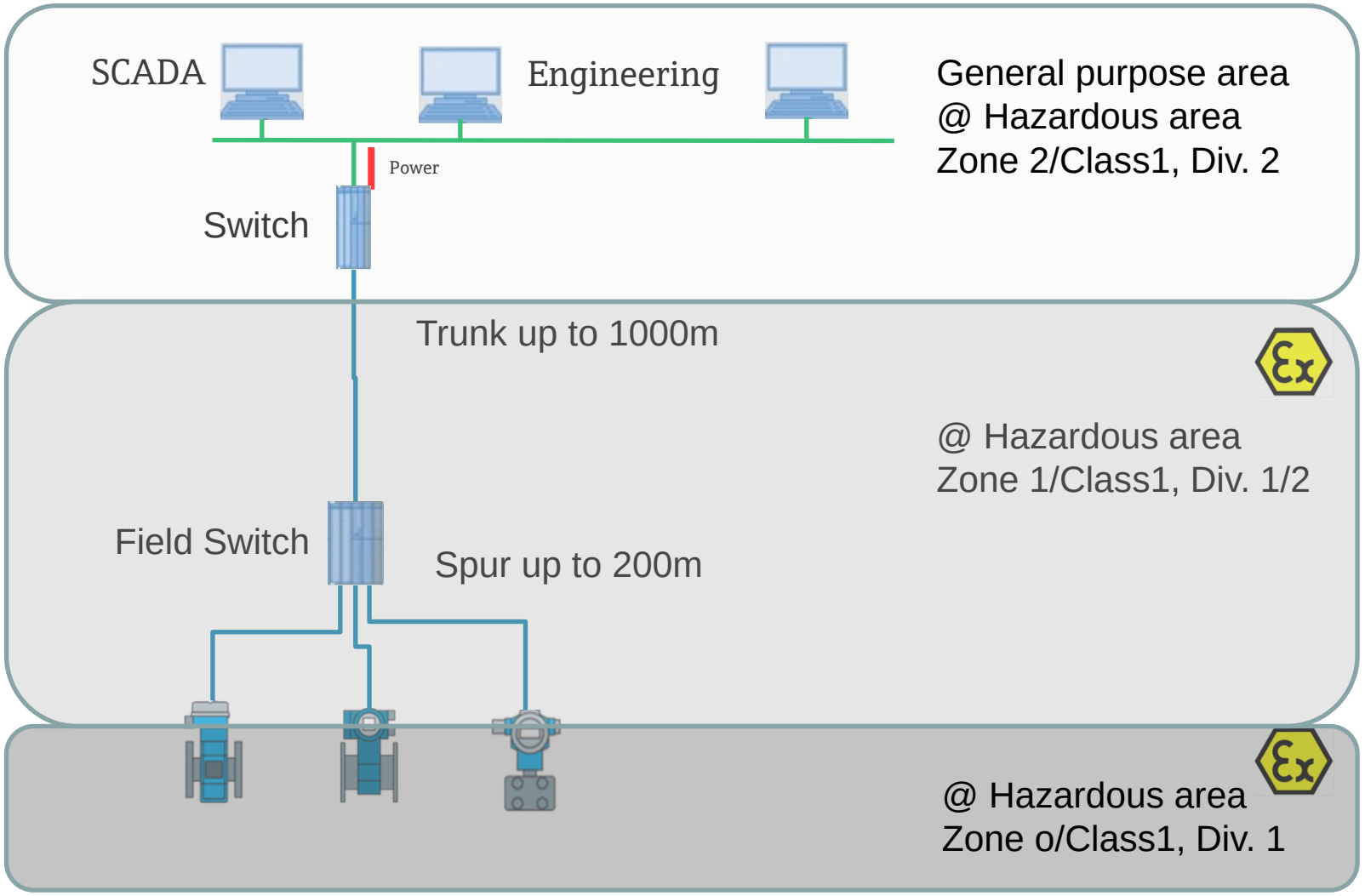
Purpose

- **Scope**
  - Initiate discussion/understanding on typical topologies and installations for industrial applications in Process Automation
    - Typical topology, length and components
    - Environmental conditions: Non-Ex and Ex
- **Rationale**
  - Understanding of the specific requirements on a Ethernet Phy for the Process Automation
  - Topology and resulting link segment characteristic enables specification on the Ethernet Phy
- **Objective**
  - The link segment and the Phy shall not preclude the ability to create intrinsically safe devices and systems
  - Ex requirements. The link segment current, voltage, power and stored energy shall comply with IEC 60079
  - Support extension to 100 Mb/s. The Phy shall not preclude the ability of future transmission speed extension (100 Mb/s)

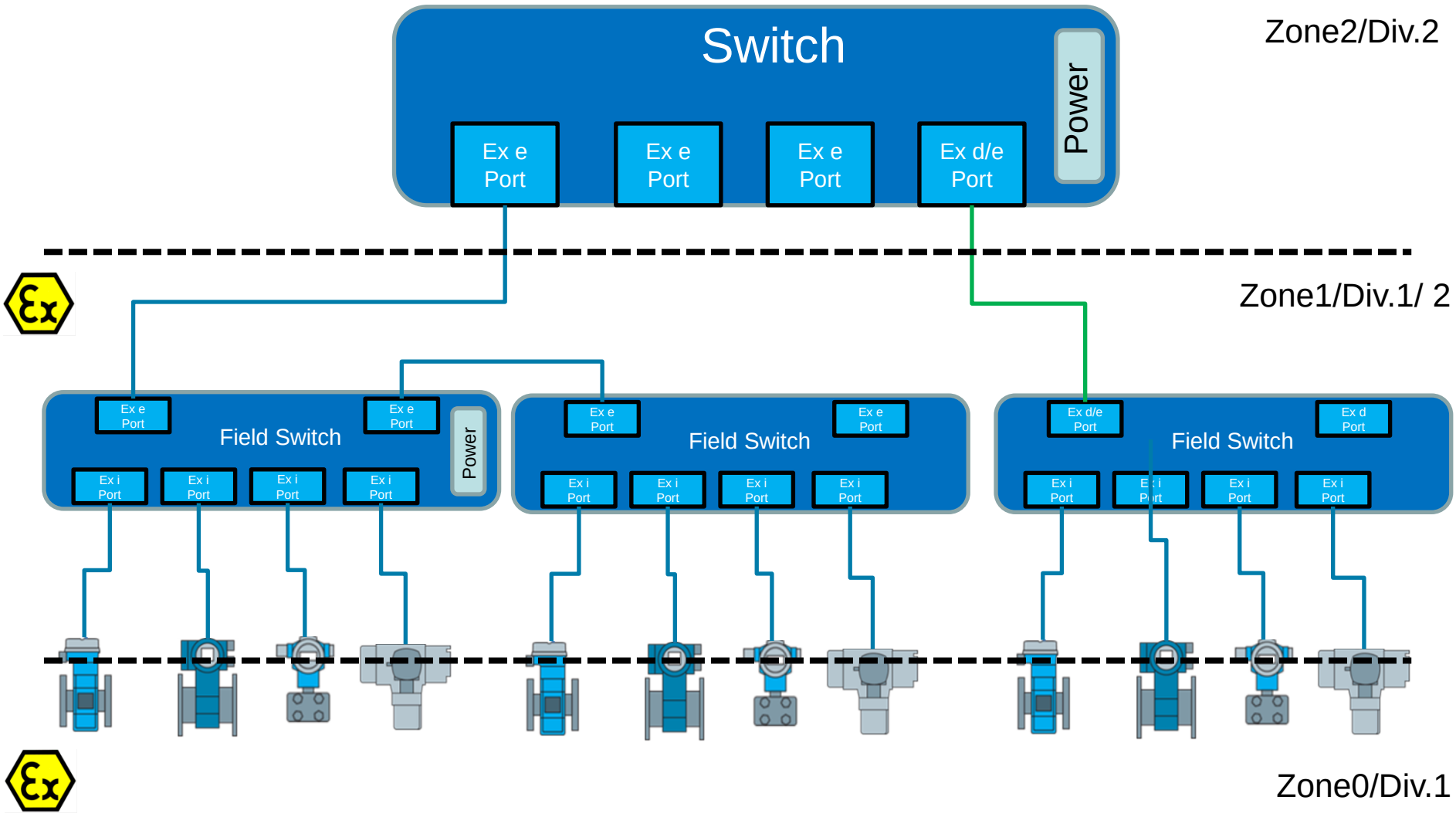
Overview Topology in Process Automation



Generalized Overview of the Topology



Switched Topology



Characteristics of the topology

- Components are installed within different environmental conditions – hazardous areas where different handling of flammable gases, vapors and dust are attributable to normal chemical and physical processes
- The process automation differentiates different zones with different requirements
  - **Zone 0,1,2:** The explosive characteristics of the air mixtures of gases, vapors, or dusts vary with the specific material involved. Materials have been placed in groups based on their ignition temperatures and explosion pressures
  - The zone defines the probability of hazardous material being present in an ignitable concentration in the surrounding atmosphere.

    Zone 0: Area in which an explosive gas-air mixture is continuously present or present for long periods.

    Zone 1: Combustible or conductive dusts are present. Area in which an explosive gas-air mixture is likely to occur for short periods in normal operation.

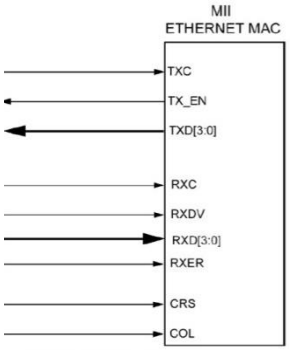
    Zone 2: Area in which an explosive gas-air mixture is not likely to occur, and if it occurs it will only exist for a very short time due to an abnormal condition.

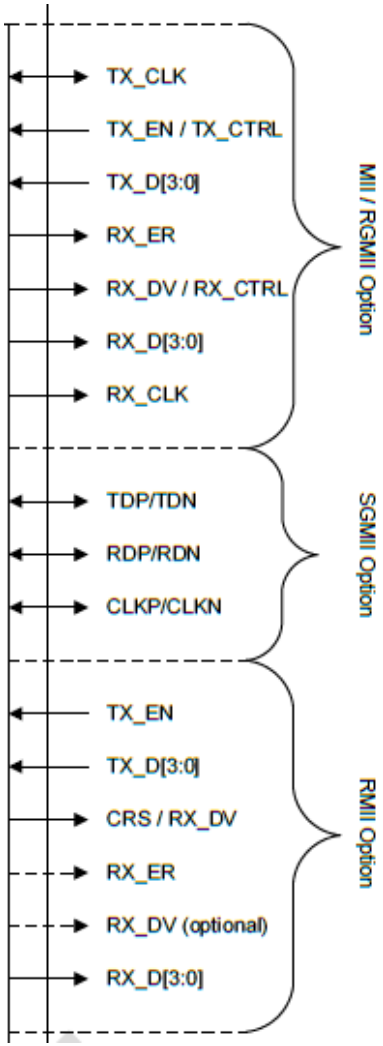
Protection types

		Zone
Ex d	Flameproof (Explosion proof) Enclosure	1, 2
Ex e	Increased Safety	1, 2
Ex ia	Intrinsically Safe	0, 1, 2
Ex ib	Intrinsically Safe	1, 2
Ex o	Oil Immersion	2
Ex p	Pressurized Apparatus (Purged Apparatus)	1, 2
Ex q	Powder Filling (Sand Filling)	2
Ex m	Encapsulation	1, 2
Ex n or Ex N	Non incentive or/and normally no sparking circuits	2

PHY – MCU Interface

- Support of standard PHY interfaces
  - MII => for standard devices standard MCU
  - SGMII => for switches
  - SPI, 3,4 pin => for low power devices and low speed MCU



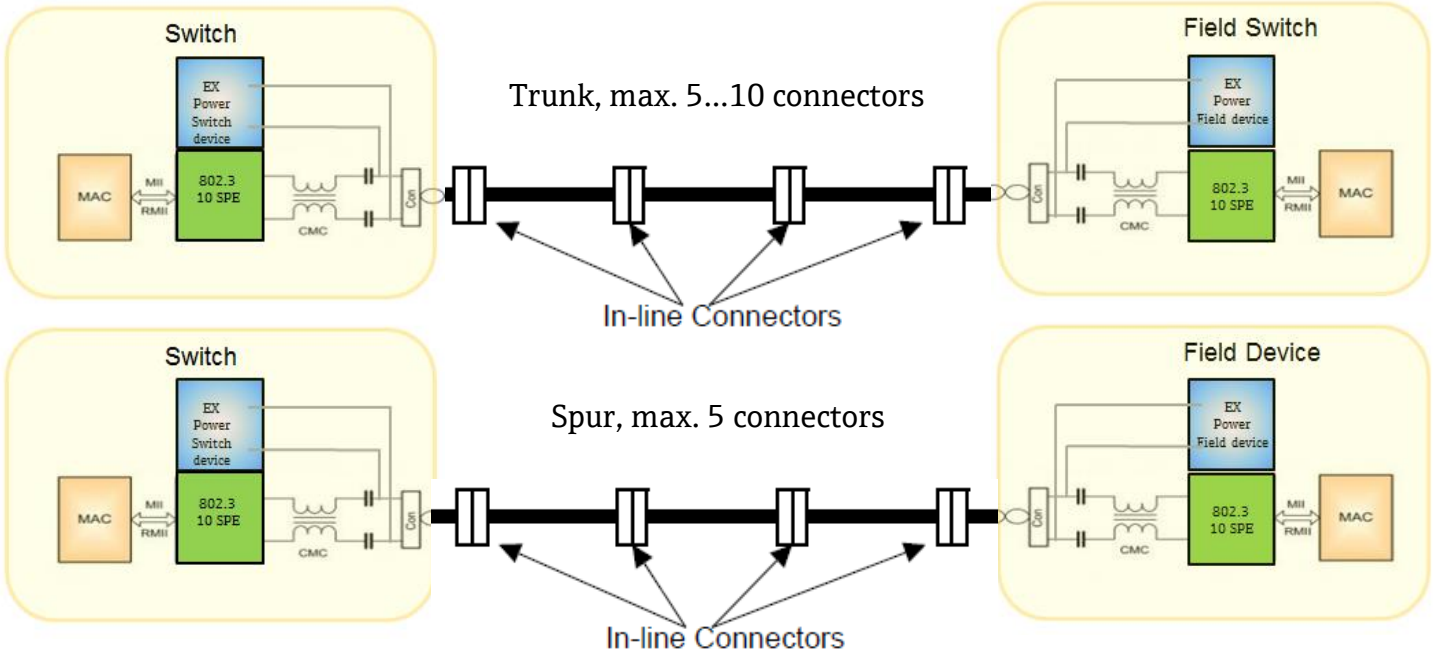


Typical requirements

- Long distances into the field: typically 1000 meters - called as Trunk with or without power supply into the field
- Shorter distance in the field to the different field devices: typically 200 meters - called Spur
- Powering of the field devices in the field by single twisted pair including communication
- Field devices operating in hazardous areas are intrinsic safe – limited energy in order to avoid release of sufficient electrical or thermal energy under normal or abnormal conditions
- Power consumption of the field device: typically 500mW to 5 W

Link segment consideration

- 2-wire concept supports with preferred cable: IEC61158 type A fieldbus cable with shield, other cables can be considered
- Power supply of the devices, low and high power devices 500mW up to 5 W
- Phy power consumption (less than 100mW @10Mb/s) adequate for low power field devices
- 10 Mbit, full-duplex via MII-Interface including auto negotiation (support for future extension of transmission speed 100 Mbit)
- Cable length 200 for Spur with max. 5 connectors , > 1000 m for Trunk with max. 5..10 connectors

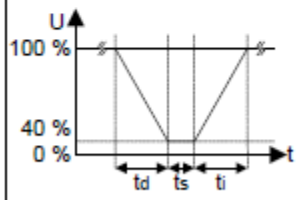


EMI requirement IEC 61326-1 and NE21 (I)

No.	Test	Test disturbance	Standards	Remarks
1.1	Magnetic field with power frequency	50 Hz 100 A/m	EN 61000-4-8	For magn. sensitive equip-ment only
1.2	Electromagnetic RF field	80-2000 MHz 10 V/m 2.0-2.7 GHz 3 V/m AM 1 kHz 80%	EN 61000-4-3	
1.3	Electrostatic discharge	Contact discharge 6 kV Air discharge 8 kV	EN 61000-4-2	

No.	Test	Test disturbance	Standards	Remarks
2.1	RFI asymmetrical	0.010 – 80 MHz 10 V AM 1 kHz 80%	EN 61000-4-6	
2.2	Fast transients (Burst)	Pulse groups 1 kV Frequency 5 kHz	EN 61000-4-4	Tests are also conducted with 100 kHz. The results are informative.
2.3	Surge	Surge 1.2/50 µs (Line to ground) 1 kV	EN 61000-4-5	Performance criterion B is permissible for the dura-tion of the disturbance.

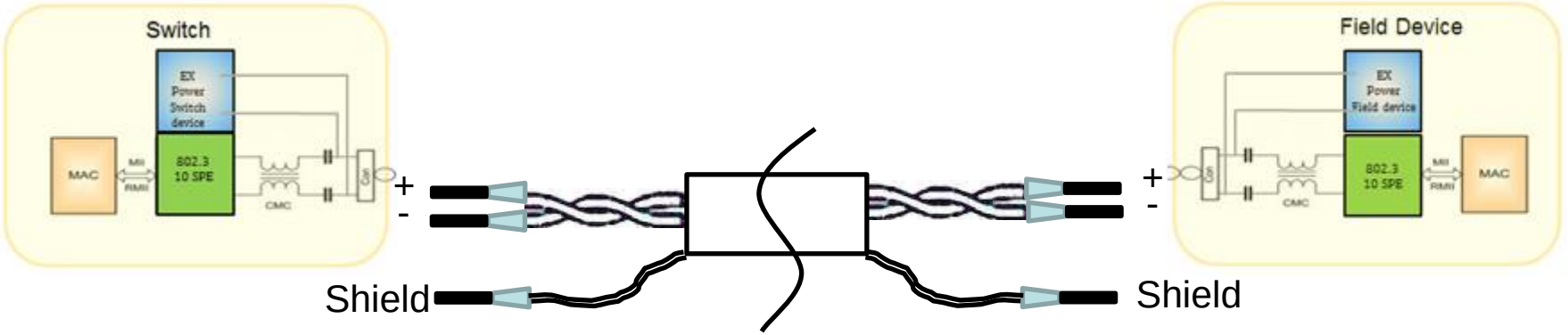
EMI requirement IEC 61326-1 and NE21 (II)

No.	Test	Test disturbance	Standards	Remarks
3.1	RFI asymmetrical	0.010 – 80 MHz 10 V AM 1 kHz 80%	EN 61000-4-6	
3.2	Fast transients (Burst)	Pulse groups 2 kV Frequency 5 kHz	EN 61000-4-4	Tests are also conducted with 100 kHz. The results are informative.
3.3	Surge	Surge 1.2/50 µs Line to Ground 1 kV Line to Line 0.5 kV	EN 61000-4-5	
3.4	Power supply toleranc-es	Power supply ± 20%	* see under 6 listed norms „note“	
3.5	Voltage variation	Cycle a) and b): a) 100% - 0 % - 100 % b) 100% - 40 % - 100 % t_d=t_i=2 s; t_s=1 s each with 10 Cycles		Performance criterion B permitted.
3.6	Voltage interruptions	Duration at 0% : 20ms	* see under 6 listed norms „note“	

cable shield - EMI

- 2-wire concept supports with preferred cable: IEC61158 type A fieldbus cable with shield, other cables can be considered
- Cable shield option

Switch	↔	Field device
Ground		Ground
Ground		capacitive to ground
Ground		open



Cable and Data rate for Process Industry

- Preferred cable: IEC61158 type A fieldbus cable, other cables can be considered
- Use for 10 Mb/s and future phase 100 Mb/s
- Insertion loss cable and connectors: TBD

3076F Multi-Conductor - DataBus® ISA/SP-50 FOUNDATION Fieldbus or PROFIBUS Cable

For more Information please call

1-800-Belden1

UNITRONIC® BUS PA 1 x 2 x 1	**DB2170234** gültig ab: 12.07.2013
UNITRONIC® BUS PA FC 1 x 2 x 0,8	**DB2170334** gültig ab: 12.07.2013

Verwendung

Feldbusleitung für PROFIBUS PA Feldnetzwerk gem. IEC 61158-2. Die Leitung ist zur festen Verlergung in trockenen und feuchten Räumen geeignet und mit dem schwarzen, UV-beständigen Mantel ebenfalls zur Verlegung im Freien.

BUS Cables

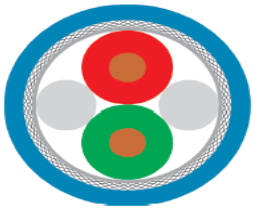
Profibus PA fixed installed armoured

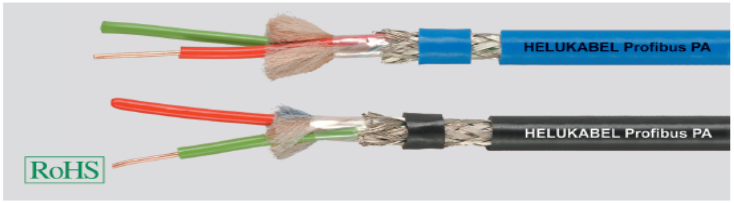
BUS Cables

Profibus PA fixed installed

HELUKABEL®

PVC





Type Cable structure	Hazardous areas 1x2x1.0/2.55 mm	Non-hazardous areas 1x2x1.0/2.55 mm
Inner conductor diameter:	Copper, bare (AWG 18/1)	Copper, bare (AWG 18/1)
Core insulation:	PE	PE
Core colours:	rd, gn	rd, gn
Stranding element:	2 cores + 2 fillers stranded together	2 cores + 2 fillers stranded together
Separator:	Polyester foil over stranded bundle	Polyester foil over stranded bundle
Shielding 1:	Al-Foil	Al-Foil
Total shielding:	Cu braid, tinned	Cu braid, tinned
Outer sheath material:	PVC	PVC
Cable external diameter:	app. 7,6 mm ± 0,2 mm	app. 7,6 mm ± 0,2 mm
Outer sheath colour:	Blue	Black

BER Bit Error Rate for Process Industry

- According to actual available Fieldbus protocols
  - Example Profinet with BER 10^{-9}
  - 100BASE-T1
- The BER shall be less than 10^{-9} ... 10^{-10}

Support extension of transmission speed

- According to APL Group Req. Specification an extension of transmission speed should be possible
  - APL shall support a two-phase approach. Phase 1 will provide solutions based on today available technology e.g. electronic components and intrinsically safe concepts and supports 2 and 10 Mbit/s. Phase 2 will expand the capabilities of APL based on new integrated electronic components and new intrinsically safe concepts to 100 Mbit/s which have to be developed.

Advanced Physical Layer Study Team

Steering Committee Minutes – 27 April 2016, Conference Call

Revision 1.0

Present: Stefan Lueder (Siemens), Juergen Spitzer (Siemens), Shinji Oda (Yokogawa), Martin Zielinski (Emerson), John Lewis (Rockwell), Michael Gienke (ABB), Frank Schewe (Phoenix Contact), Steve Armstrong (Emerson), Hans Endl (Softing), Jörg Hähniche (Endress+Hauser), Harald Mueller (Endress+Hauser), Gunther Rogoll (Pepperl+Fuchs), Gunther Kegel (Pepperl+Fuchs), Christian Brehm (Krohne), Dave Dogett (Schneider Electric), Stefan Erben (Samson), Gert Nahler (Samson), Holger Sack (Vega), Thomas Peter (Weidmueller), Merget Oliver (Turck), Peter Praske (Turck), Carsten Brenner (Stahl), Klaus-Peter Lindner (E+H), and Michael Kessler (P+F)

Go To Meeting: Paul McLaughlin (Honeywell) and Gregg Jack (Honeywell)

Summary – Take away

- Ethernet down to the field in Process Automation has to consider the specific requirements: length, hazardous atmosphere and more
  - The outcome of IEEE 802.3 10 Mb/s Single Twisted Pair shall not preclude the ability to create intrinsically safe devices and systems
- The typical Process Automation architecture differentiate Trunk with up to 1000m down to the field and Spur with up to 200m between field device and Field Switch
  - The IEEE 802.3 10 Mb/s Single Twisted Pair should have the ability to bring Ethernet down to the field considering the specific requirements
- Typical field devices are sensors and actuators that are powered via the network (power over single twisted pair 500mW… 5W)
  - The IEEE 802.3 10 Mb/s Single Twisted Pair shall not preclude IS compatible design
  - Especially for low power field devices the power consumption of the Phy has to be small
  - The IEEE 802.3 10 Mb/s Single Twisted Pair shall not preclude future extension of transmission speed 100 Mb/s.