IEEE 802.3dg Task Force

Possible Installation Changes for 100BASE-T1L

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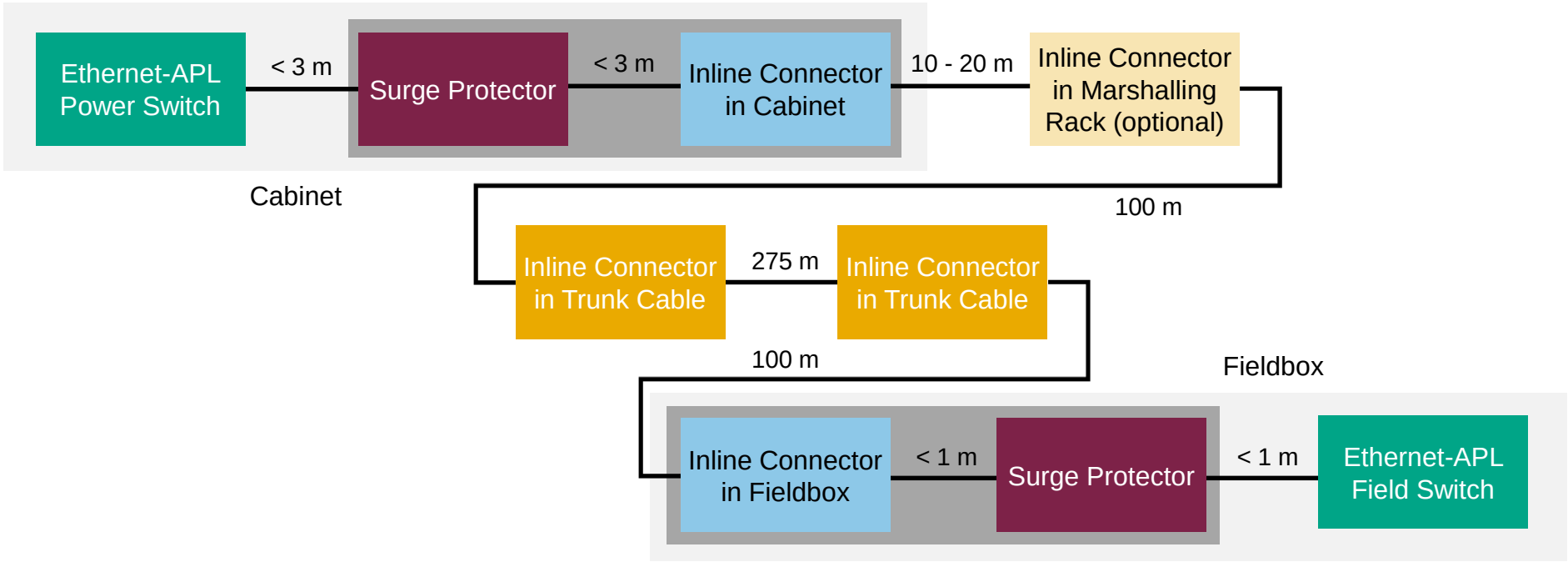
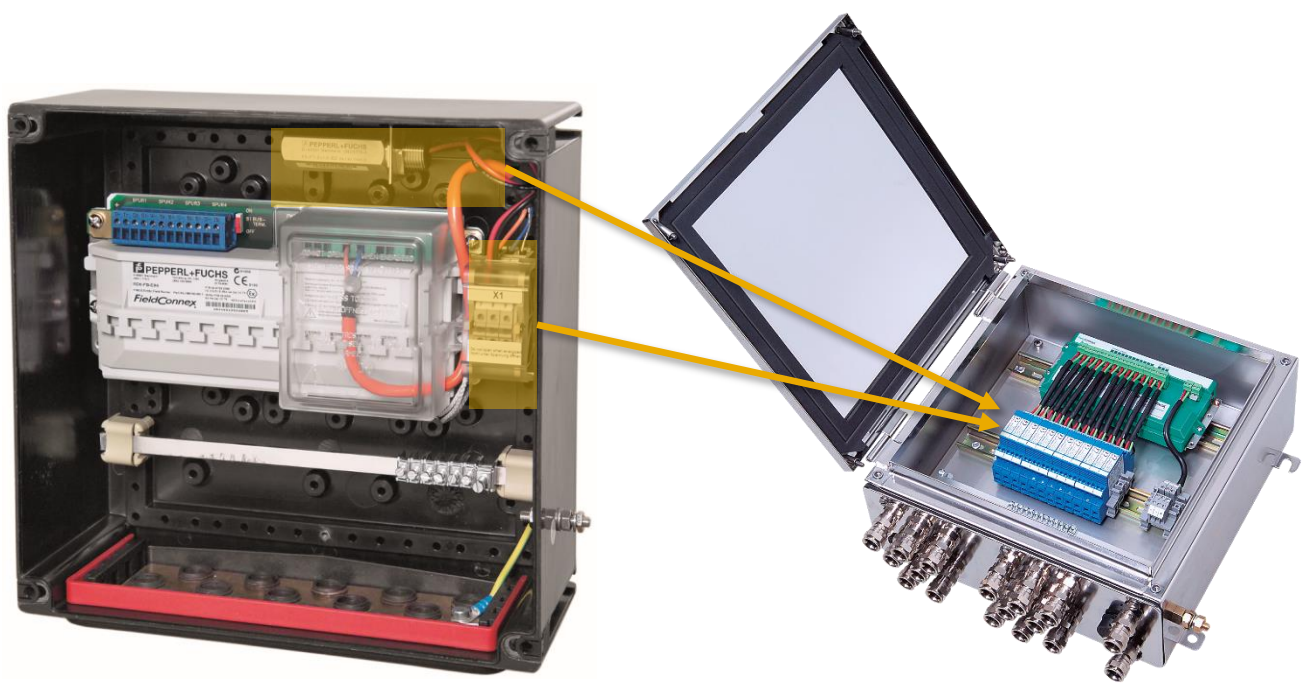
Ethernet-APL Segment Overview

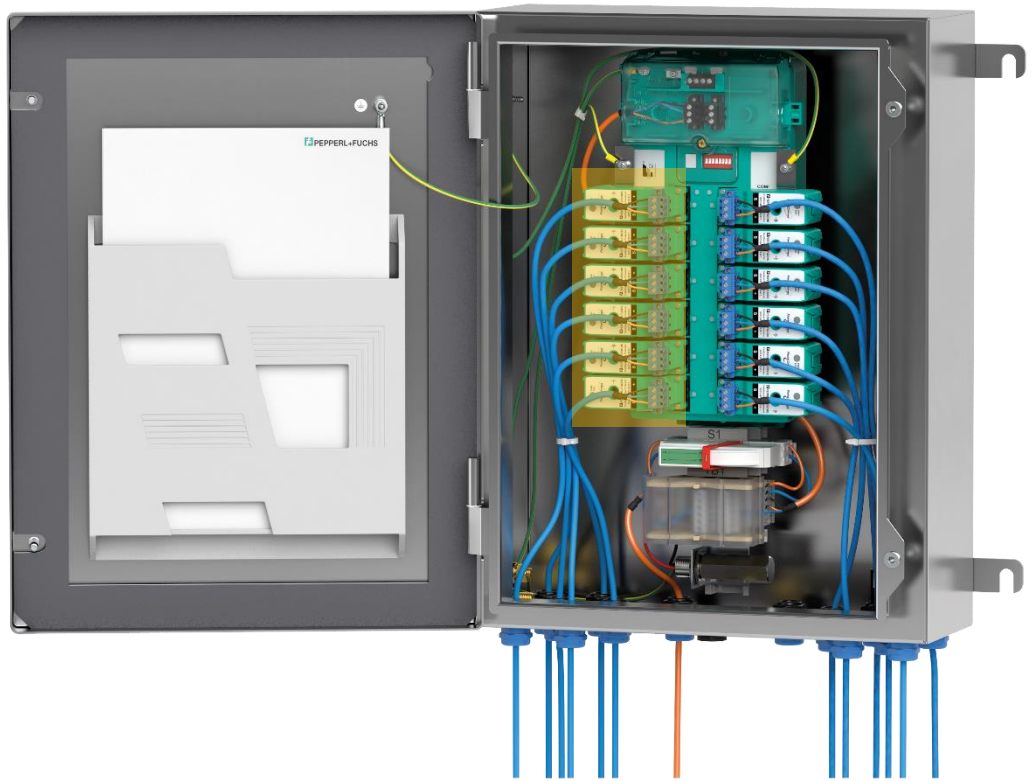
- Presentation https://www.ieee802.org/3/SPEP2P/public/graber_3SPEP2P_01_07212021.pdf shows a typical 500 m Ethernet-APL segment with surge protection and inline connectors:



- In most Ethernet-APL segments the **inline connectors will not be distributed equally**, but **concentrate at the beginning and end of the segments**, depending on the application also in combination with surge protection devices.
- Alien crosstalk at the connectors close to the device ports is likely the most critical parameter and thus it is beneficial to **limit the number of these connectors**; **surge protection** and **connectors/terminals** could be e.g. **integrated in one device**.

Integration of Surge Protection and Terminals





- Current installations (fieldbus and also Ethernet-APL 10 Mbit/s often use separate terminals and surge protection modules (e.g. connected using stubs).
- Due to the higher speed they would need to be integrated in a surge protection module, which can also be used as access point for connecting the external cables.

Installed Cable Base

- As the installation of the cables is by far the largest effort of the complete installation, it is important to be able to keep the 10BASE-T1L compliant cables as far as possible.
- Ethernet APL specifies the minimum cable requirements as provided in the table on the right side of this slide.
- The insertion loss is specified for 1000 m (trunk) or 200 m (spur) AWG18 cable.
- The expectation for 100BASE-T1L is to be suitable for up to 400 m AWG18 trunk cable or 500 m AWG16 trunk cable (similar insertion loss as 400 m AWG18) and 200 m AWG18 spur cable.
- For compatibility with 10 Mbit/s Ethernet-APL installations beside the reduced trunk cable length, the used topologies for 100BASE-T1L and also the installation (including hazardous area installations) and grounding practices need to be kept as close as possible to the existing and upcoming Ethernet-APL installations.

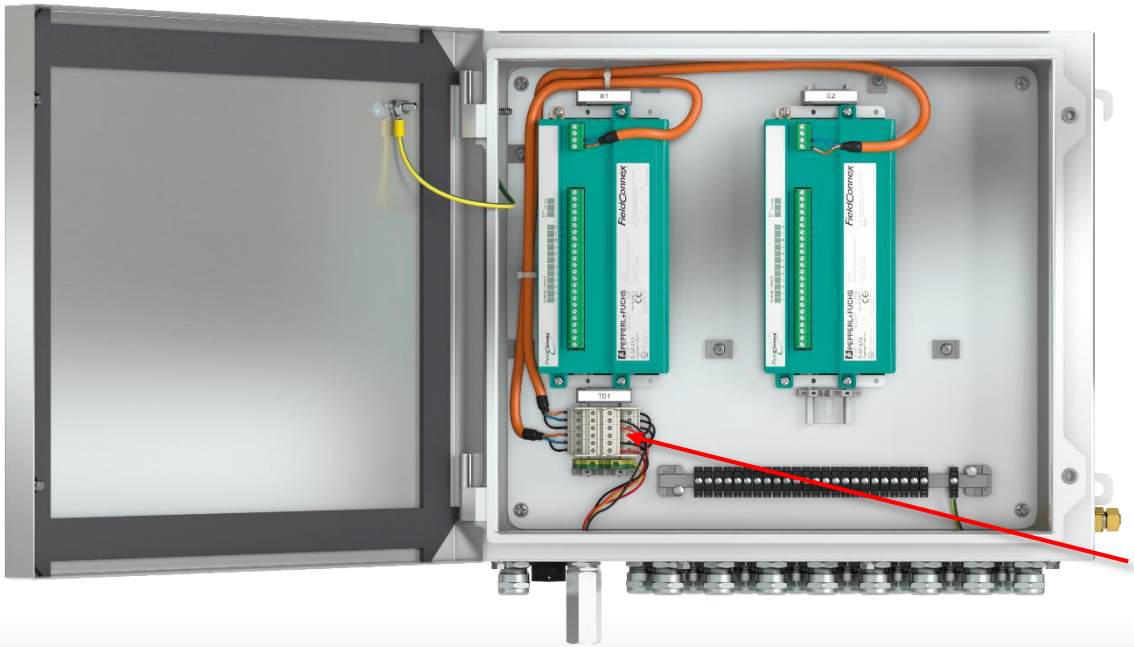
Parameter	APL cable category			
	I	II	III	IV
Maximum trunk cable length in m	250	500	750	1 000
Maximum spur cable length in m	50	100	150	200
Coupling attenuation in dB	≥ 60 (f is frequency in MHz; 0.1 ≤ f ≤ 20)			
Cable return loss in dB	≥ 15 + 8 × f (f is frequency in MHz; 0.1 ≤ f ≤ 0.5)			
	≥ 19 (f is frequency in MHz; 0.5 ≤ f ≤ 20)			
Trunk cable insertion loss in dB	≤ 10 × (1.23 × √f + 0,01 × f + 0.2/√f) (f is frequency in MHz; 0.1 ≤ f ≤ 20)			
Spur cable insertion loss in dB	≤ 2 × (1.23 × √f + 0,01 × f + 0.2/√f) (f is frequency in MHz; 0.1 ≤ f ≤ 20)			
Cross talk in dB, (PSANEXT/PSAFEXT wire pair to wire pair) for multi core cables	≥ 60 (f is frequency in MHz; 0.1 ≤ f ≤ 20)			
NOTE 1 The values in Table 4-3 apply to both single pair and multi pair cables. NOTE 2 Insertion loss and return loss shall be measured with a reference cable length of 500 m. NOTE 3 The AC link segment requirements may also be verified using TIA SP1-1000 and ISO/IEC T1-A-1000 channel definitions, which might exclude IEC 61158 type A fieldbus cables from being compliant to these definitions. NOTE 4 Depending on the APL cable category, the maximum cable length is limited. This allows the use of higher insertion loss cables, which, therefore, can only support a lower maximum APL segment length, while still fulfilling all requirements of this table. NOTE 5 The cable return loss limit curve is 6 dB above the IEEE802.3cg limit curve, taking into account multiple additive signal reflections occurring at short cable lengths. NOTE 6 For powered APL segments, the voltage drop over the cable has to be additionally taken into account in order to determine the maximum supported cable length.				

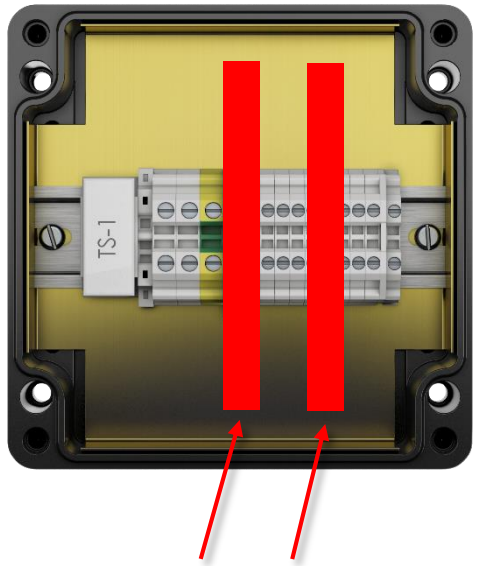
APL cable categories from APL Engineering Guideline

- Many details about segment planning, installation practice, wiring rules, grounding and shielding rules, cable/segment layout, power calculations and so on can be seen in the Ethernet-APL Engineering Guideline: https://www.ethernet-apl.org/wp-content/uploads/APL-Engineering-Guideline-V114_1.14.pdf.

Cable Installation and Junction Boxes

- Cables are typically laid out on cable trays and bundled using cable ties (so a 6 around 1 disturber model for the cables could be reasonable).
- As alien crosstalk at the intermediate-connectors is likely one of the dominant disturbers, separation or additional shielding measures need to be added to the field and junction boxes.
- The shielding elements can also cover the area of the cable close to the terminals, where the cable shield must be removed.

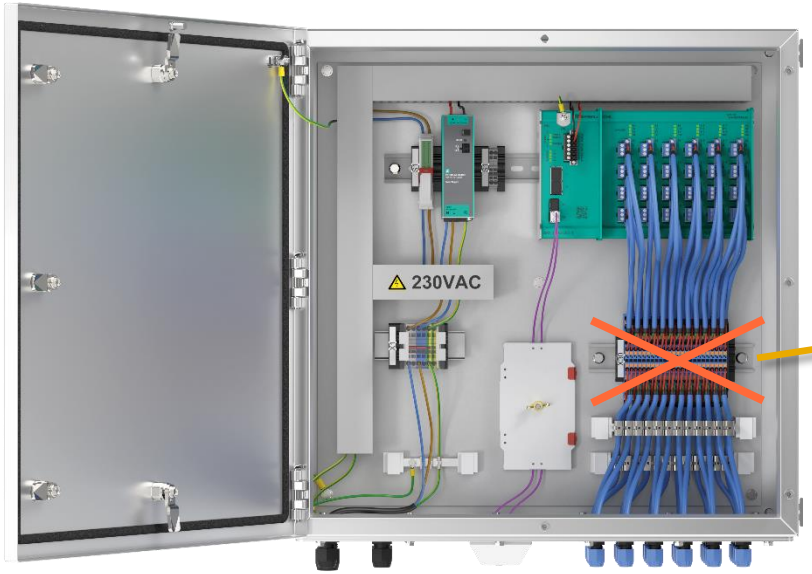




Separate the terminals of the different segments from each other by adding a spacer or shielding element.

Cable Installation and Junction Boxes

- Reduce the number of inline-terminal blocks.
- Design the devices so that the incoming/outgoing cables can be directly connected.



Summary

- While the **cables can only be changed with a high effort and significant cost**, **intermediate connectors/terminals** and the surge protection modules **can be exchanged relatively easy and at moderate cost**.
- It would also be possible to **add spacers or shielding plates in between the connectors/terminals**.

Upgrade 10BASE-T1L → 100BASE-T1L	**Modification**	**Remarks**
Use different cable type	No	A change of the cable causes a high effort/relative cost.
Use different cable diameter	No	A change of the cable causes a high effort/relative cost.
Change connector type (e.g. screw terminal)	Difficult	Requires new constructed connectors acc. to IEC 60079-7.
Increase distance between connector groups	Possible	For trunk applications easy, for spurs space constraints.
Add shielding plate between the connectors	Possible	For trunk applications easy, for spurs space constraints.
Modify grounding of devices/junction boxes	Possible	As long as safety requirements are kept.
Use in-line surge protection modules	Possible	Possible mechanical solutions are already available.
New power switch	Mandatory	Needs to be exchanged for higher speed upgrade.
New field switch	Mandatory	Needs to be exchanged for higher speed upgrade.
New field device (only if higher speed is needed)	Mandatory	Needs to be exchanged for higher speed upgrade.

Thank you!