Long reach issues

IEEE P802.3 10SPE SG AdHoc

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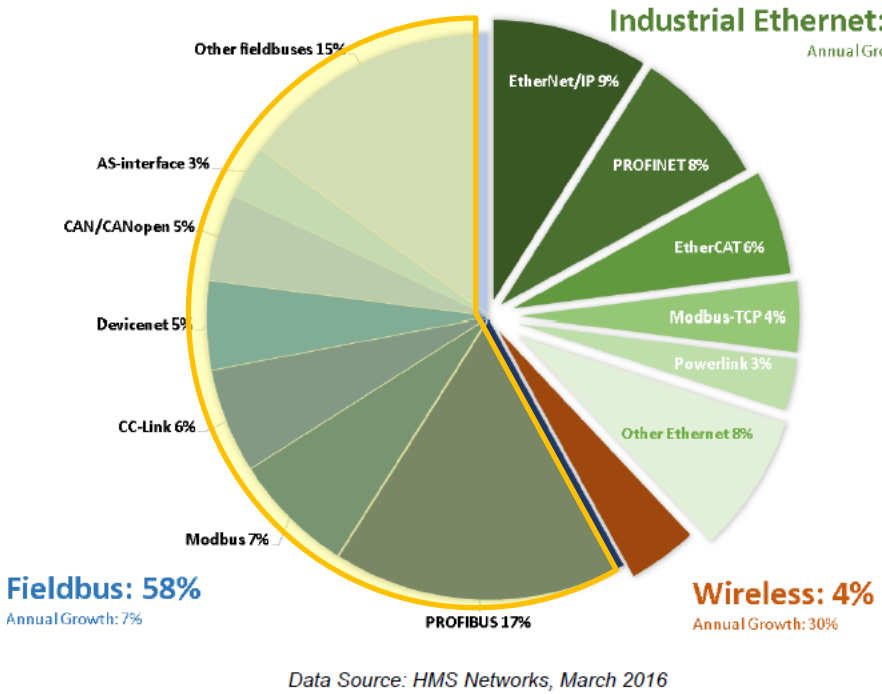
Long reach

Page 34 from CFI:

Current Industrial Network Share



Data Source: HMS Networks, March 2016

- Entire market is growing
  - Fieldbus (58%), 7% growth
  - Ethernet (38%), **20% growth**
  - Limited wireless adoption
- Despite greater growth rate today, Ethernet will hit a roadblock
  - Without this CFI, existing Ethernet cannot match key Fieldbus capabilities
- Significant number of protocols
  - Ethernet protocols can share common hardware
  - Fieldbuses have unique hardware

10Base-T1 must run for industrial applications over the big range of installed bus cables.
→ We must analyze this range of used and installed bus cables.

Long reach

- One of the important issues for the industrial people were the extended reach
  - In the CFI it was said 1200m
  - That why the speed was fixed to only 10Mb
- Of course it would mean special , probably thicker cables than the one usually used in 100 m technology.
- Also more than one cable type to be specified, each group would have same insertion loss; one possibility could be:
  - Normal reach (up to 250m)
  - Medium reach (up to 500 m)
  - long reach (up to 1000 m)
- As a factor of 4 cannot be done just by the cable the PHY should contribute with higher output power (or similar) for the long reach.

Long reach

→ We must analyze the range of the used and installed bus cables. 1st example PROFIBUS cable:

Profibus PA cable:

- Already only one pair.
- Used extensively in Europe and Asia
- Manufactured by a lot of vendors.
- wire diameter AWG 23/22 up to AWG 18 for long distances
- …

Long reach, existing cable example

Profibus PA cable:

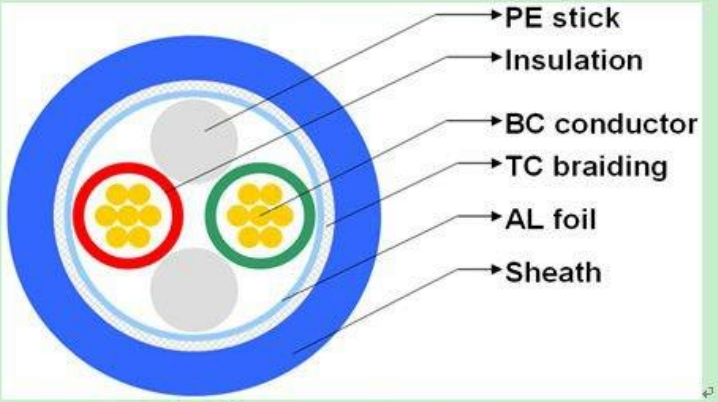
- Typical PROFIBUS cable manufactured by a lot of vendors

Complete family of cable exist

PROFIBUS PA CABLE

PRODUCT SPECIFICATION:	1 x 2 x 7/0.4mm BC PA Cable

Cross Section



PA CABLE DATASHEET

ITEMS	DATA
Insulation	2 cores (Green & Red)
Conductor dia.	≥ 1.212mm (7/0.40BC)
Area of conductor cross-section	≥ 0.8973mm²
Insulation tube	2 Pcs (F-PE)
Shielding	AL foil (thickness: 0.08mm) & 0.16mm TC braiding (Coverage rate: ≥90%)
Sheath	PVC
Color of Sheath	Blue
Sheath Dia.	> 9.0 mm

Long reach

- Such bus cable type are already installed, mainly specified according to IEC 61158-2 A and used for:
  - PROFINET / PROFINET PA
  - Modbus
  - Foundation Fieldbus
  - CC-Link
  - Devicenet / CAN
- There are a variety of layouts
  - 0.042 dB/m is specified by one vendor at 16 MHz for a thin 8mm diameter cable with 0.65 mm Wire diameter.
- The 0.8 and 1.212 mm type will have much lower attenuation.
- Is it possible to get an approximated frequency needed for 10Mb?
- We would then start to qualify this cables for “high frequency”. The industrial needs are covered.

Note –Times listed are subject to change.

Long reach

- IEC 61158-2 details – page 169:

12.8 Medium specifications

12.8.1 Connector

Cable connectors, if used, shall be in accordance with this standard (see Annex A for Type 1, and Annex I for Type 3 synchronous transmission). Field termination techniques such as screw or blade terminals and permanent termination may also be used.

12.8.2 Standard test cable

The cable used for testing fieldbus devices which claim conformance to this clause shall be a single twisted-pair cable with overall shield meeting the following minimum requirements at 25 °C:

a) impedance at f_r (31,25 kHz) = 100 Ω ± 20 %;

b) maximum attenuation at 1,25 f_r (39 kHz) = 3,0 dB/km;

c) maximum capacitive unbalance to shield = 4 nF/km, tested using a 30 m or longer sample;

d) maximum d.c. resistance (per conductor) = 24 Ω/km;

e) maximum propagation delay change 0,25 f_r to 1,25 f_r = 1,7 μs/km;

f) conductor cross-sectional area (wire size) = nominal 0,8 mm^2;

g) minimum shield coverage shall be 90 %.

Long reach

- IEC 61158-2 details – page 250/1:

DIN EN 61158-2:2011-09
EN 61158-2:2010

22.1.2.2 Cable

The bus medium is a shielded twisted-pair cable. The shield helps to improve the electromagnetic compatibility (EMC). Unshielded twisted-pair may be used, if there is no severe electromagnetic interference (EMI).

The characteristic impedance of the cable shall be in the range between 100 and 220 Ω, the cable capacity (conductor - conductor) should be less than 60 pF/m and the conductor cross-sectional area should be equal or greater than 0,22 mm^2. Cable selection criteria are included in the appendix of the ANSI TIA/EIA RS-485-A.

Two types of cables are defined, as specified in Table 107.

Table 107 – Cable specifications

Cable parameter	Type A	Type B
Impedance	135 to 165 Ω (f = 3 to 20 MHz)	100 to 130 Ω (f > 100 kHz)
Capacity	< 30 pF/m	< 60 pF/m
Resistance	< 110 Ω/km	not specified
Conductor cross-sectional area	≥ 0,34 mm^2	≥ 0,22 mm^2
Colour of sheath non-IS	Violet	Not specified
Colour of inner cable conductor A (RxD/TxD-N)	Green	Not specified
Colour inner cable conductor B (RxD/TxD-P)	Red	Not specified

Table 108 shows the maximum length of cable type A and cable type B for the different transmission speeds.

Long reach

- IEC 61158-2 details – page 250/2:

Table 108 – Maximum cable length for the different transmission speeds

Item	Unit	Value								
Data rate	kbit/s	9,6	19,2	93,75	187,5	500	1 500	3 000	6 000	12 000
Cable type A	m	1 200	1 200	1 200	1 000	400	200	100	100	100
Cable type B	m	1 200	1 200	1 200	600	200	70	Not permissible		

For data rates equal or less 1 500 kbit/s the sum of the stub lengths (total of the capacities of all stubs (Cstges)) is specified in 22.1. For example at 1 500 kbit/s the maximum stub length for cable type A is 6,6 m.

At 3 Mbit/s and higher data rates the total capacities of all stubs shall be less than 0,05 nF. For cable type A the total stub length is therefore 1,6 m. At this data rate it is necessary to integrate impedance into the wiring to avoid reflections.

The following example, Figure 100, shows the integration of inductances L1 to L4 in the connector.