Industrial Applications Link Segment Electromagnetic Noise Environment IEEE 802.3 10 Mb/s Single Twisted Pair Ethernet Task Force

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Chris DiMinico
MC Communications/Cu-Test/PHY-SI/Panduit
cdiminico@ieee.org

Contributors

- **Ronald Nordin, Masud Bolouri-Saransar– Panduit**

Purpose

- **Scope**
  - **Consideration for industrial applications Link Segment noise environment**

IEEE 802.3cg: Adopted Objectives

Objectives (2)

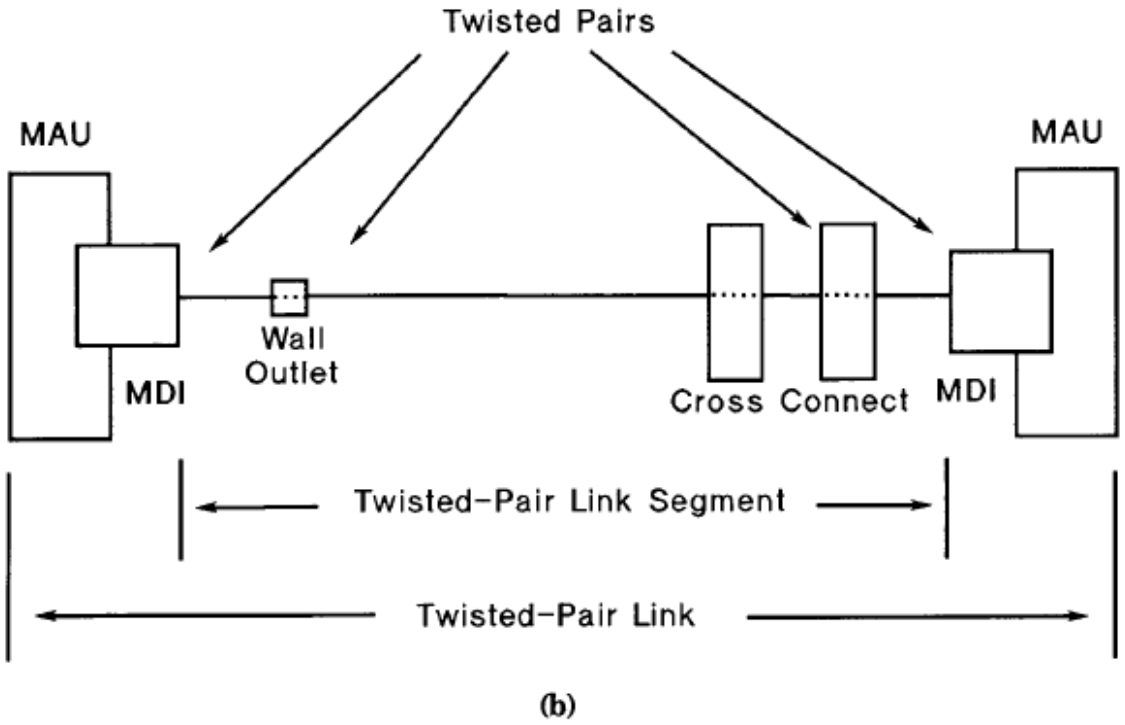
11. Define the performance characteristics of a link segment and a PHY to support operation over this link segment with single twisted pair supporting up to four inline connectors using balanced cabling for up to at least 15 m reach
12. Define the performance characteristics of a link segment and a PHY to support point-to-point operation over this link segment with single twisted pair supporting up to 10 inline connectors using balanced cabling for up to at least 1 km reach
13. Support fast-startup operation using predetermined configurations which enables the time from power_on**=FALSE to a state capable of transmitting and receiving valid data to be less than 100ms
14. Maintain a bit error ratio (BER) at the MAC/PLS service interface of less than or equal to 10^{-10} on link segments up to at least 15m, and 10^{-9} on link segments up to at least 1km
15. Specify one or more optional power distribution techniques for use over the 10 Mb/s single balanced twisted-pair link segments, in conjunction with 10 Mb/s single balanced twisted-pair PHYs, in the automotive and industrial environments

Source: http://www.ieee802.org/3/10SPE/objectives_10SPE_111016.pdf

Link Segment

1.4.242 link segment: The point-to-point full-duplex medium connection between two and only two Medium Dependent Interfaces (MDIs).

- **Example 10BASE-T**



(b)

Figure 14–2—Twisted-pair link

4 INDUSTRIAL AREAS

4.1 General

Industrial premises cabling may traverse from the front office through the factory floor area. The factory floor area (see figure 3) may include work areas and automation island areas.

Industrial premises cabling is installed in areas with a wider range of environments. These environments, that may be localized along a cabling channel, are generally expressed by "MICE" (M mechanical; I ingress; C climatic/chemical; and, E electromagnetic) as described in ANSI/TIA-568-C.0. The MICE environmental classification is stated with the use of subscripts ($M_aI_bC_cE_d$) where a, b, c and d are sub-classifications. These sub-classifications are numbered 1, 2 or 3 which relate to the severity of the environmental parameter. For example, the most benign environmental classification is described as $M_1I_1C_1E_1$ whereas the harshest environmental classification is described as $M_3I_3C_3E_3$. See TIA TSB-185 for tutorial information on the MICE classification system.

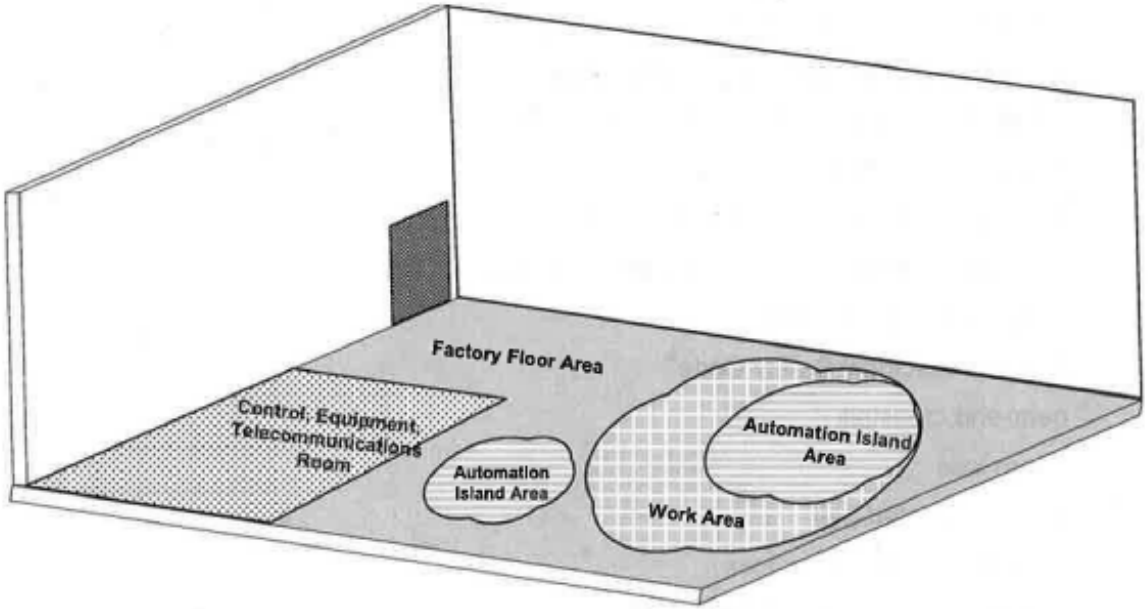


Figure 3 - Example of industrial areas

ANSI/TIA-568-C.0 ANNEX F (INFORMATIVE) ENVIRONMENTAL CLASSIFICATIONS

Table 8 (Concluded)

Electromagnetic	E_1	E_2	E_3
Electrostatic discharge – Contact (0,667 µC)	4 kV	4 kV	4 kV
Electrostatic discharge – Air (0,132 µC)	8 kV	8 kV	8 kV
Radiated RF - AM	3 V/m at (80 to 1 000 MHz) 3 V/m at (1 400 to 2 000 MHz) 1 V/m at (2 000 to 2 700 MHz)	3 V/m at (80 to 1 000 MHz) 3 V/m at (1 400 to 2 000 MHz) 1 V/m at (2 000 to 2 700 MHz)	10 V/m at (80 to 1 000 MHz) 3 V/m at (1 400 to 2 000 MHz) 1 V/m at (2 000 to 2 700 MHz)
Conducted RF	3 V at 150kHz to 80MHz	3 V at 150kHz to 80MHz	10 V at 150kHz to 80MHz
EFT/B (comms)	500 V	1 kV	1 kV
Surge (transient ground potential difference) - signal, line to earth	500 V	1 kV	1 kV
Magnetic Field (50/60 Hz)	1 Am^{-1}	3 Am^{-1}	30 Am^{-1}
Magnetic Field (60 Hz to 20 000 Hz)	ffs	ffs	ffs

NOTES

1 – Bump: the repetitive nature of the shock experienced by the channel shall be taken into account.

2 – This aspect of environmental classification is installation-specific and should be considered in association with IEC 61918 and the appropriate component specification.

3 – A single dimensional characteristic, i.e. Concentration x 10^{-6}, was chosen to unify limits from different standards.

802.3bp Type B link segment

Two link segments are specified:

a) A link segment optimized for use in automotive applications that supports up to four in-line connectors using a single twisted-pair copper cable for up to at least 15 m. This link segment is referred to as *link segment type A*.

b) An optional link segment supporting up to four in-line connectors using a single twisted-pair copper cable for up to at least 40 m to support applications requiring additional physical reach, such as industrial and automation controls and transportation (aircraft, railway, bus and heavy trucks). This link segment is referred to as *link segment type B*.

Table 97–15—Electromagnetic classifications Type B link segment

Electromagnetic	Minimum (dB)		
	E_1	E_2	E_3
Radiated RF – AM	3 V/m at (80 MHz to 1000 MHz) 3 V/m at (1400 MHz to 2000 MHz) 1 V/m at (2000 MHz to 2700 MHz)	3 V/m at (80 MHz to 1000 MHz) 3 V/m at (1400 MHz to 2000 MHz) 1 V/m at (2000 MHz to 2700 MHz)	10 V/m at (80 MHz to 1000 MHz) 3 V/m at (1400 MHz to 2000 MHz) 1 V/m at (2000 MHz to 2700 MHz)
Conducted RF	3 V at 150 kHz to 80 MHz	3 V at 150 kHz to 80 MHz	10 V at 150 kHz to 80 MHz

- ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises

802.3bp Type B link segment link segment parameters

97.6.2.5 Coupling attenuation

The coupling attenuation requirements of the type B link segment depend on the electromagnetic noise environment. The requirements in Table 97–14 shall be met based on the local environment as described by the electromagnetic classifications given in Table 97–15, E_1, E_2, or E_3. The coupling attenuation is tested as specified in IEC 62153-4–14.

Table 97–14—Coupling attenuation Type B link segment

Frequency (MHz)	Minimum (dB)		
	E_1	E_2	E_3
$30 \le f \le 600$	$80 - 20\log_{10}(f)$ (Max 40 dB)	$90 - 20\log_{10}(f)$ (Max 50 dB)	$100 - 20\log_{10}(f)$ (Max 60 dB)

- ANSI/TIA-1005-A-2013 – Telecommunications Infrastructure Standard for Industrial Premises

97.6.4 Coupling parameters between type B link segments
97.6.4.2 Multiple disturber power sum alien near-end crosstalk (PSANEXT) loss
97.6.4.4 Multiple disturber power sum alien attenuation crosstalk ratio far-end (PSAACRF)

BS EN 50174-2:2009+A2:2014, EN 50174-2:2009+A2:2014 (E)

〈AC1〉 Table 3 – Classification of information technology cables

Information technology cable			
Screened	**Unscreened**	**Coaxial/twinaxial**	
Coupling attenuation at 30 MHz to 100 MHz dB	**TCL at 30 MHz to 100 MHz** dB	**Screening attenuation at 30 MHz to 100 MHz** dB	**Segregation classification**
≥ 80 [a]	≥ 70 − 10 × lg f	≥ 85 [d]	d
≥ 55 [b]	≥ 60 − 10 × lg f	≥ 55	c
≥ 40	≥ 50 − 10 × lg f [c]	≥ 40	b
< 40	< 50 − 10 × lg f	< 40	a

[a] Cables meeting EN 50288-4-1 (EN 50173-1:2011, Category 7) meet Segregation Classification "d".

[b] Cables meeting EN 50288-2-1 (EN 50173-1:2011, Category 5) and EN 50288-5-1 (EN 50173-1:2011, Category 6) meet Segregation Classification "c". These cables may deliver performance of Segregation Classification "d" provided that the relevant coupling attenuation requirements are also met.

[c] Cables meeting EN 50288-3-1 (EN 50173-1:2011, Category 5) and EN 50288-6-1 (EN 50173-1:2011, Category 6) meet Segregation Classification "b". These cables may deliver performance of Segregation Classification "c" or "d" provided that the relevant TCL requirements are also met.

[d] Cables meeting EN 50117-4-1 (EN 50173-1:2011, Category BCT-C) meet Classification "d".

Profibus Reference

BS EN 50174-2:2009+A2:2014, EN 50174-2:2009+A2:2014 (E)

[A1] Table 4 – Minimum separation *S*

		Containment applied to information technology or power supply cabling		
Segregation classification (from Table 3)	**Separation without electromagnetic barrier**	**Open metallic containment [a]**	**Perforated metallic containment [b, c]**	**Solid metallic containment [d]**
d	10 mm	8 mm	5 mm	0 mm
c	50 mm	38 mm	25 mm	0 mm
b	100 mm	75 mm	50 mm	0 mm
a	300 mm	225 mm	150 mm	0 mm

[a] Screening performance (0 MHz to 100 MHz) equivalent to welded mesh steel basket of mesh size 50 mm × 100 mm (excluding ladders). This screening performance is also achieved with steel tray (trunking without cover) of less than 1,0 mm wall thickness and/or more than 20 % equally distributed perforated area.

[b] Screening performance (0 MHz to 100 MHz) equivalent to steel tray (trunking without cover) of at least 1,0 mm wall thickness and no more than 20 % equally distributed perforated area. This screening performance is also achieved with screened power cables that do not meet the performance defined in footnote d.

[c] The upper surface of installed cables shall be at least 10 mm below the top of the barrier.

[d] Screening performance (0 MHz to 100 MHz) equivalent to a steel conduit of 1,5 mm wall thickness. Separation specified is in addition to that provided by any divider/barrier. [A2] The assumption underlying the material performance of the conduit is that the product of the permeability and conductivity is greater than 38 H•S/m^2. This performance is not provided by stainless steel, aluminium and non-magnetic materials. [A2]

Profibus Reference

BS EN 50174-2:2009+A2:2014, EN 50174-2:2009+A2:2014 (E)

Table 6 – Separation requirements between metallic cabling and specific EMI sources

Source of disturbance	Minimum separation mm
Fluorescent lamps	130 [a]
Neon lamps	130 [a]
Mercury vapour lamps	130 [a]
High-intensity discharge lamps	130 [a]
Arc welders	800 [a]
Frequency induction heating	1 000 [a]
Hospital equipment	[b]
Radio transmitter	[b]
Television transmitter	[b]
Radar	[b]

[a] The minimum separations may be reduced provided that appropriate cable management systems are used or product suppliers guarantees are provided.

[b] Where product suppliers guarantees do not exist, analysis shall be performed regarding possible disturbances. e.g. frequency range, harmonics, transients, bursts, transmitted power, etc.

Profibus Reference

Recommendation

- **Adopt Table 97-15 electromagnetic classifications for 802.3cg baseline link segments**

Table 97–15—Electromagnetic classifications Type B link segment

Electromagnetic	Minimum (dB)		
	E_1	E_2	E_3
Radiated RF – AM	3 V/m at (80 MHz to 1000 MHz) 3 V/m at (1400 MHz to 2000 MHz) 1 V/m at (2000 MHz to 2700 MHz)	3 V/m at (80 MHz to 1000 MHz) 3 V/m at (1400 MHz to 2000 MHz) 1 V/m at (2000 MHz to 2700 MHz)	10 V/m at (80 MHz to 1000 MHz) 3 V/m at (1400 MHz to 2000 MHz) 1 V/m at (2000 MHz to 2700 MHz)
Conducted RF	3 V at 150 kHz to 80 MHz	3 V at 150 kHz to 80 MHz	10 V at 150 kHz to 80 MHz

- **Use electromagnetic environments and separation requirements between EMI sources and metallic cabling to characterize electromagnetic noise.**