Why screened cable is a good idea in the industrial environment

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> *'Careful design of the cable interface may allow you to use unscreened cables and still meet EMC requirements, but this isn't always so.'* Radio Communications Agency/Ofcom

An unscreened balanced twisted pair data cable, when correctly installed, will keep out electromagnetic interference, but only up to a point. In mission critical systems and especially where high level of electrical noise will be encountered then screened cable should be used. For severe environments then optical fibre links should be used.

Factories, hospitals, laboratories airports and even office environments that contain dense amounts of equipment, can be classified as severe environments.

There is a range of European standards available spanning 2007 and 2008 which give guidance on the correct selection of data cables and their installation requirements in different environments.

BS EN 50173-1: 2007 *Information technology, generic cabling systems, Part 1; general requirements*
BS EN 50173-3: 2007 *Information technology, generic cabling systems, Industrial Premises*
BS EN 50174-2: 2008 (Draft) *Information technology - Cabling installation - Part 3: Installation planning and practices internal to buildings*

Industrial Ethernet is the name given to the use of Ethernet protocol to a range of industrial and process control network applications. Until recently automation and control systems have tended to use manufacturers' proprietary protocols and cabling. The advance and lower cost of TCP/IP interfaces means that more and more control, data and voice applications are being integrated together, and this means an integrated cable platform to support them.

But cables destined for benign office environments aren't ideal for harsh industrial and outdoor environments. Several other standards are in the pipeline to define the requirements of harsher environment cabling.

TIA 1005, *Industrial Cabling*, is due out in 2008

TIA/EIA-862 *Building Automation Systems Cabling Standard For Commercial Buildings* has been published

ISO/IEC 24702:2006 *Information technology -- Generic cabling -- Industrial premises* specifies the design of a generic cabling infrastructure for industrial premises that stretches from the building entrance points to and including the Telecommunications Outlet

IEC 61918 specifies profiles covering installation for Fieldbus communications media within and between the Automation Islands of industrial sites. It covers copper and optical media.

Where the media includes options for power transfer to communications entities the power options are also specified. It also covers the Automation Outlet (AO) that is the interface between the industrial automation network and a corporate network defined according to generic cabling specified in ISO/IEC 24702. This International Standard is a companion standard to the

communication systems specified in IEC 61158 and IEC 61784. It provides guidelines that cope with the critical aspects of the industrial automation area (climatic conditions, vibrations, chemical pollution, EMC, safety, etc.). It complements existing standards (IEC61158, IEC61784; IEEE 802.3; IEC11801; EN50174, EN50173, etc.). In particular, it complements defined generic industrial wiring specifications for enhanced shielding and armouring standards.

IEC 61918 addresses:

- Installation planning
- Installation implementation
- Installation verification
- Installation administration and maintenance
- Installation troubleshooting.

The actual list of profiles to be addressed in the first Committee Draft (CD) is: DeviceNet – ControlNet – EtherNet/IP – PROFIBUS – PROFIBUS-PA – PROFINET–INTERBUS REMOTE-BUS – INTERBUS RTE

EN 50173-1:2007 *Information technology – Generic cabling systems* introduces the concept of the 'MICE' classification. Typical of the new industrial Ethernet and automation standards is the concept of MICE, or Mechanical, Ingress, Climatic and EMC specifications for differing severities of environment.

The acronym MICE is being adopted by many industrial cabling standards committees as a means of describing levels of harsh environments.

- Mechanical – shock, impact, vibration, bending & flexing, crush.
- Ingress – particulate ingress and immersion.
- Climatic – temperature, thermal shock, humidity, UV (solar radiation), chemical pollution.
- Electromagnetic – ESD, conducted RF, EFT, transient ground potential, magnetic field.

MICE levels are degrees of environmental severity within an industrial premise.

MICE 1 – Essentially a description of the commercial office environment.
MICE 2 – Light industrial: assembly, food processing, health care, wash-down, etc
MICE 3 – Industrial: petro/chemical, foundry, automotive, machining, etc.

However any industrial facility may contain one, two or all three levels, or may exceed all three.

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 radio frequency, amplitude modulated (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 radio frequency (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
Electrical fast transient/Burst (EFT/B)	AC 500 V	AC 1 000 V	AC 2 000 V
Surge (transient ground potential difference) - signal, line to earth	500 V	1 000 V	2 000 V
Magnetic Field (50/60 Hz)	1 A/m	3 A/m	30 A/m
Magnetic Field (60 Hz to 20 000 Hz)	ffs	ffs	ffs

Figure 1: Electromagnetic environments from BS EN 50173-1

From Figure 1 we can see the electromagnetic environment predicted. Environments described as E2 and E3 are industrial levels.

One strategy to use if installing unscreened cable is to maintain a very large separation between data and power cables. This is described currently in BE EN 50174-2 where a figure of 200 mm is given as the separation between unscreened power and data cables. This figure will be increased by the forthcoming edition BS EN 50174-2: 2008. It should be noted that most cable manufacturers will only guarantee their cabling product performance if they have been installed to the BS EN 50174-2 standard.

Table 2 - Classification of information technology cables

	Information technology cable (see Note 1)		
	Screened	**Unscreened**	**Coaxial/twinaxial**
Segregation Classification (for use in Table 3 only)	**Coupling attenuation at 30- 100MHz (dB)**	**TCL at 30- 100MHz (dB)**	**Screening attenuation at 30- 100MHz (dB)**
A (see Note 2)	≥ 85	ffs	≥ 85
B (see Note 3)	≥ 55	ffs	≥ 55
C (see Note 4)	≥ 40	≥ 60,4 − 20 × lg *f*	≥ 40
D	< 40	< 60,4 − 20 × lg *f*	< 40

Figure 2: Extract from Table 2 of the draft BS EN 50174-2

Figure 2 is an extract from the draft EN 50174-2 showing how cable will be classified from A to D in their capacity for rejecting outside electrical interference. Only screened cable would qualify as Class A or B.

Table 3 - Minimum separation S

		Containment applied to information technology or mains power cabling		
Segregation Classification (from Table 2)	**Separation without electromagnetic barrier**	**Open metallic containment A[1]**	**Open metallic containment B[2, 3]**	**Solid metallic containment[4]**
A	55 mm	35 (ffs) mm	28 mm	0 mm
B	80 mm	50 (ffs) mm	40 mm	0 mm
C	100 mm	80 (ffs) mm	50 mm	0 mm
D	300 mm	300 mm	150 mm	0 mm

Figure 3: Extract from Table 3 of the draft BS EN 50174-2

From the cable classification we can derive the separation required. For unscreened cable we can see that the separation requirement **has gone up to 300 mm** if no other screening effect is supplied by the cable containment.

However the story does not end there. The distance undergoes a multiplication effect if the size or quantity of power cables increases.

Table 4 - Power cabling factor

Electrical circuit type (see Notes 1,2 and 3)	Quantity of circuits	Power cabling factor "P" (See Note 4)
20A 230 V 1-phase	1-5	0.4
	6-15	1
	16-30	2
	31-45	3
	45-60	4
	61-75	5
	> 75	6

1. The power cabling factor shall be used as a multiplier for the calculation of the distance A from Table 3.
2. 3-phase cables shall be treated as 3 off 1-phase cables.
3. More than 20 A shall be treated as multiples of 20A.
4. Lower voltage AC or DC power supply cables shall be treated based upon the their current ratings i.e. a 100 A 50 VDC cable = 5 off 20 A cables (P = 1).

Figure 4: Extract from Table 4 of the draft BS EN 50174-2

Although there is a reduction for 1 to 5 small power circuits for large three phase circuits the multiplication factor increases to 6; i.e. there could be a requirement to maintain 6 x 300 mm, or 1.8 metres separation between data and power cables to guarantee safe operation of unscreened data circuits.

The use of screened cable makes more practical sense when the application is in an electrically noisy environment.

To ensure external noise does not become a negative factor Capitoline recommends the following;

- **Use unscreened cable** up to 1000 Mb/s and when the ambient field strength is less than 3 V/m from zero to 250 MHz. This is the general expectation of the ordinary office environment.

- **Use screened cable** up to 10,000 Mb/s and when the ambient field strength is between 3 and 10 V/m over 500 MHz. This would be considered as an electrically noisy industrial environment.

- **Use optical fibre** if the ambient field strength exceeds 10 V/m, e.g. close to airport radars, radio transmitters and high voltage equipment such as x-ray sources.

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