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Why Screened Cable is a Good Idea in the Industrial Environment

B Elliott C.Eng

'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 levels of electrical noise will be encountered, screened cable should be used. For severe environments, 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 environments require special consideration.

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 cable put into harsher environments.

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

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

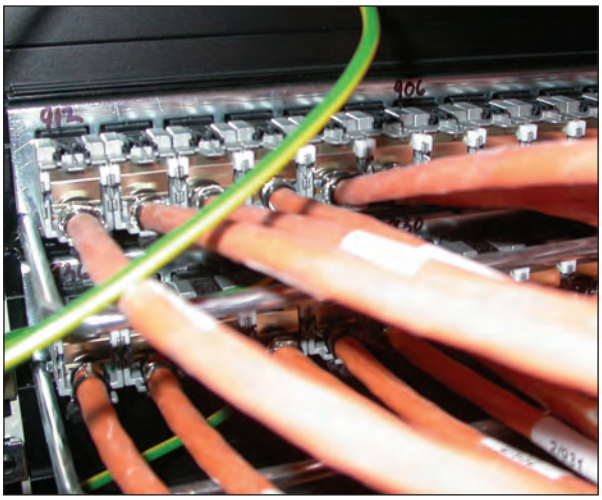
ISO/IEC 24702:2006 Information technology -- Generic cabling -- Industrial premises, specifies the design of a generic cabling infrastructure for industrial premises that stretches from the building entrance points to and including the Telecommunications Outlet.

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.

Full EMC protection to the floor outlet.



Fully screened keystone outlets give maximum EMC protection.

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). 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

		CLASS		
Mechanical		Low Severity	Medium Severity	High Severity
	Shock/bump	M_1	M_2	M_3
	Vibration			
	Tensile Force			
	Crush			
	Impact			
Ingress		Low Severity	Medium Severity	High Severity
	Particulate ingress	I_1	I_2	I_3
	Immersion			
Climatic		Low Severity	Medium Severity	High Severity
	Temperature ambient	C_1	C_2	C_3
	Thermal shock			
	Humidity			
	UV Solar Radiation			
	Liquid Pollution			
	Gaseous Pollution			
Electromagnetic		Low Severity	Medium Severity	High Severity
	Electrostatic discharge (ESD) contact and air	E_1	E_2	E_3
	Radiated radio frequency (RF-AM)			
	Conducted radio frequency (RF)			
	Electrical fast transient / Burst (EFT/B)			
	Surge Transient ground potential difference			
	Magnetic Field (50/60Hz and 60 to 20,000Hz)			

Table 1: MICE levels are degrees of environmental severity from BS EN 50173-1

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 (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, tensile force, crush.
- Ingress – particulate ingress and immersion.
- Climatic – temperature, thermal shock, humidity, UV (solar radiation), chemical pollution (liquid and gaseous).
- Electromagnetic – ESD, conducted and radiated 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.

From Table 2 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 BS EN 50174-2 where a figure of 200mm 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 3 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. From the cable classification we can derive the separation required. For unscreened cable we can see that the separation requirement **has gone up to 300mm** 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. Although there is a reduction for 1 to 5 small power circuits, for large three phase circuits the multiplication factor increases to 6.

There could then be a requirement to maintain 6 x 300mm, or 1.8 metres separation between data and power cables to guarantee safe operation of unscreened data circuits.

Electromagnetic	E_1	E_2	E_3
Electrostatic discharge - Contact (0,667 μC)	4kV	4kV	4kV
Electrostatic discharge - Air (0,132 μC)	8kV	8kV	8kV
Radiated radio frequency, amplitude modulated (RF-AM)	3V/m at (80 to 1,000) MHz 3V/m at (1,400 to 2,000) MHz	3V/m at (80 to 1,000) MHz 3V/m at (1,400 to 2,000) MHz	10V/m at (80 to 1,000) MHz 3V/m at (1,400 to 2,000) MHz
Conducted radio frequency (RF)	3V at 150kHz to 80MHz	3V at 150kHz to 80MHz	10V at 150kHz to 80MHz
Electrical fast transient/Burst (EFT/B)	AC 500V	AC 1,000V	AC 2,000V
Surge (transient ground potential difference) - signal, line to earth	500V	1,000V	2,000V
Magnetic field (50/60Hz)	1A/m	3A/m	30A/m
Magnetic field (60Hz to 20,000Hz))	ffs*	ffs*	ffs*

Table 2: More detail of the Electromagnetic environments from BS EN 50173-1 (ffs *For further study)

	Information Technology Cable		
	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	≥ 85	ffs	≥ 85
B	≥ 55	ffs	≥ 55
C	≥ 40	≥ 60,4 - 20 x lg f	≥ 40
D	< 40	< 60,4 - 20 x lg f	< 40

Table 3: Extract from Table 2 of the draft BS EN 50174-2 (Classification of information technology cables).

		Containment Applied to Information Technology or Mains Power Cabling		
Segregation Classification (from Table 2)	Separation without Electromagnetic Barrier	Open Metallic Containment A (basket)	Open Metallic Containment B (tray)	Open Metallic Containment C (conduit)
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

Table 4: Extract from Table 3 of the draft BS EN 50174-2

Electrical Circuit Type (see Notes 1, 2 and 3)	Quantity of Circuits	Power Cabling Factor "P" (see Note 4)
20A 230V 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 of 1-phase cables.
3. More than 20A shall be treated as multiples of 20A.
4. Lower voltage AC or DC power supply cables shall be treated based upon their current ratings i.e. a 100A 50 VDC cable = 5 of 20A cables (P=1).

Table 5: Extract from Table 4 of the draft BS EN 50174-2 (Power Cabling Factor).

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

Connectix has engineered the components of their cabling systems to precisely match each other and can thus guarantee a bit error performance rate better than 10^{-12} and thus exceeds the most demanding requirements of all Ethernet and industrial automation protocols.

To ensure external noise does not become a negative factor Connectix recommends the following:

- **Use unscreened cable** up to 1000Mb/s and when the ambient field strength is less than 3V/m from zero to 250MHz. 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 10V/m over 500MHz. This would be considered as an electrically noisy industrial environment.

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

UK Head Office:
Connectix Limited
33 Broomhills Industrial Estate
Braintree, Essex CM7 2RW