Standards-based comms cabling for hard networks

Automation and control systems have tended to use manufacturers' proprietary protocols and cabling. But cables destined for the benign office environment aren't ideal for harsh industrial and outdoor use. There are several standards in the pipeline to define a hardened cable infrastructure. Barry Elliott

A complex automated industrial system – say a manufacturing assembly line – usually needs an organised hierarchy of controller systems to function. The EU has promoted EN 50173-3 as an industrial cabling standard while IEC61918 specifies profiles covers fieldbus communications mediainstallation for within and between the automation islands of industrial sites for both copper and optical media.

Where the media includes options for power transfer to end devices, the power options are also specified. It also covers the Automation Outlet (AO). This last item is the interface between IA and enterprise networks defined according to generic cabling specified in ISO/IEC 24702.

This is a companion standard to the communication systems specified in IEC 61158 and 61784. It provides guidelines that cope with the critical aspects of the industrial automation area (climatic conditions, vibration, chemical pollution, EMC, safety, etc.). It complements existing standards, in particular defined generic industrial wiring specifications for enhanced shield and armouring standards.

US-based organisations are also working on industrial infrastructure standardisation. TIA-1005 will address test methods to qualify cabling, cables and connectors for MICE based on the EIA/TIA-568 channel model, with additional guidelines and specifications for industrial environments such as longer patch cords – shorter horizontal length, more than four connections and sealed copper and fibre connectors. Industrialised pathway systems will also be considered such as chemical and oil resistance, mechanical strength and EMI protection. This is a similar position to that being taken by CENELEC with their EN 50173-3 draft standard for industrial cabling and also ISO/IEC 24702. TIA 1005, Industrial Cabling, is due out this year. Other applicable standards include:

TIA/EIA-862 Building Automation Systems cabling standard for commercial buildings has been published.

ISO/IEC 24702 will specify the design of a generic cabling infrastructure for industrial premises that stretch from the building entrance points to and including the Telecommunications Outlet.

All about MICE

Typical of the new industrial Ethernet and automation standards is the concept of MICE. This acronym expands to Mechanical, Ingress, Climatic and EMC specifications for differing severities of environment. The MICE concept is being adopted by many industrial cabling standards committees as a means of describing levels of harsh environments. The environmental components break down into:

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

MICE levels are degrees of environmental severity within an industrial premise and possess the following hierarchy:

- 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. There are generally three ways to protect a cabling system from an aggressive environment: mechanical isolation, separation and the use of cabling with intrinsic mechanical/electrical performance. The table on the next page shows some of the early work, still in draft stage, by the IEC, to define the climatic requirements for the three classes.

Industrial Ethernet standards

The cables defined for industrial Ethernet will be close cousins to the Category 5, 6 and 7 and optical cables defined in the current, office based, structured cabling stan-

dards such as ISO 11801:2002 and EN 50173. There will be a greater emphasis on screened cabling and probably optical fibre cable as well. Optical cables are much better at going long distances and fending off unwanted and potentially damaging electromagnetic interference.

Basic Ethernet, working at 10Mbps – 10Base-T can use the relatively low standard Category 3 cable. This is no longer recognised as a first choice cable by the Standards which see Category 5 as the minimum requirement. All of these cable categories are based on four twisted pairs within one sheath and presenting a 100 ohm characteristic impedance to the transmitting and receiving electronics. Cat 5 provides a 100MHz bandwidth channel over 100 metres, and will support up to 1000Mbps, i.e. Gigabit Ethernet over the same distance. The Standards recognise shielded and unshielded cables but offer little advice to the user about actual choice. Most office-based applications opt for unshielded cabling because it is cheaper. However, this is unlikely to satisfy the Industrial Ethernet environment. Leaving aside the screening requirement, cables will be exposed to wider temperature variations, sunlight, water and sea water and a huge range of contaminants and solvents.

Climatic	C1	C2	C3
Ambient temperature	-10 to +50°C	-25 to +70°C	-40 to +70°C
Rate of change of temperature	0.1°C/minute	1°C/minute	3°C/minute
Humidity	5 to 85% (non-condensing)	5 to 95% (condensing)	5% to 95% (condensing)
Ultraviolet radiation	ffs	ffs	ffs
Solar radiation	700W/m²	1120W/m²	1120W/m²
Sodium chloride	None	ffs	ffs
Sodium stearate	None	ffs	ffs
Detergent	None	ffs	ffs
Oil	None	ffs	ffs
Conductive materials in solution	None	Temporary (condensation)	Present
Gaseous pollution contaminants (ppm)	Mean /Peak	Mean /Peak	Mean /Peak
Hydrogen sulphide	0.003/0.01	0.005/0.05	10/50
Sulphur dioxide	0.01/0.03	0.1/0.3	5/10
Sulphur trioxide	0.01/0.03	0.1/0.3	5/10
Chlorine wet	0.0005/0.001	0.005/0.03	0.05/0.3
Chlorine dry	0.002/0.01	0.02/0.1	0.2/1.0
Hydrogen fluoride	0.001/0.005	0.01/0.05	0.1/1.0
Ammonia	1/5	10/50	50/250
Oxides of Nitrogen	0.05/0.1	0.5/1	5/10
Ozone	0.002/0.005	0.025/0.05	0.1/1.0

Labelling standards

Whatever the cables have to survive then so must the labelling method that identifies those cables, patch panels and outlets. Labels also have to survive the outdoor environment as well as benign indoor areas. The European standard for data cable installation EN 50174-3 Information Technology – external cabling, recognises this and states that cables, jointing chambers and cabinets shall be labelled with a unique identifier to enable tracing in both directions. Labels shall be chosen allowing for the environments in which they will be used in order to ensure adequate lifetimes.

When it comes to testing labels for their ability to survive these extremes of temperature, solar radiation and chemicals, there are a range of suitable standards that may be invoked including UL 969 Marking and Labelling Systems 4th Ed. 2001, and SAE J 1960 – Simulated External Weathering. This last definition provides the test method used by the North American Automotive Industry for the evaluation of the of component weathering when used on the exterior of an automobile.

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