IMPLEMENTATION OF ETHERNET SYSTEM IN INDUSTRY

White paper
by Multimedia Connect

INTRODUCTION

Since the 1980s, Ethernet has been the gold standard for office applications. Today, it attracts the business world thanks to its ease of configuration, and simple administration and maintenance.
It facilitates the development of distributed automation, the inclusion of existing equipment, and the operation of specialized applications in real time.
Ethernet is: cost effective - universal - fully understood - open source.

From now on, most BUS networks operate with TCP/IP communications.
This means that when technology converged and was standardized, Ethernet became the system of choice for machine management and optimization.

FIELDBUS/TCP-IP Equivalence: The right cables for the right application

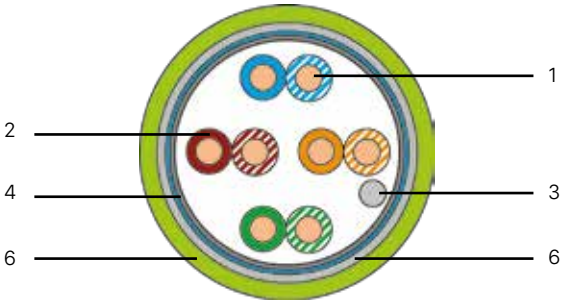
FIELDBUS	ETHERNET EQUIVALENT	CABLE SYSTEM PERFORMANCE
DeviceNet /ControlNe	Ethernet/IP	Minimum CLASS D
ModBus	ModBus TCP	Minimum CLASS D
ProfiBus	ProfiNet	Minimum CLASS D
Foundation	HSE	Minimum CLASS D

Having the same network in the office as for the machines simplifies IT management, but the Ethernet platform was not initially designed for a heavy industrial environment.
Until now, cabling was the poor cousin of communication infrastructures. It didn't deserve any particular attention until BUS communication simplified its implementation, and it became a key factor in INDUSTRIAL ETHERNET operations.
Indeed, using Ethernet in a sensitive environment along with electromagnetic interference, and environmental and energy network restrictions proved to be the heart of the challenge faced by the products themselves and those who installed them.

In order to do this, the new European standard EN 50173-3 (INFORMATIN TECHNOLOGY - GENERIC CABLING SYSTEMS - SECTION 3: INDUSTRIAL PREMISES), will provide the guidelines for the design, installation, and infrastructure requirements of industrial cabling.
This document will define the various installation topologies and connection performance levels through the electrical parameters that govern communication connection quality.

TRANSMISSION PERFORMANCE

A factory environment is overflowing with sources of interference such as synchronous and asynchronous motors, switching mode power supplies, transformers, etc.
To be protected against this, the cables used must be shielded with aluminium sheeting and a copper plate braid shield to act as a barrier (SF/UTP or S/FTP Structure). Thus, the coupling attenuation that defines the armour quality is extremely high, the system becomes immune to its external environment and is not itself a source of interference: perfect electromagnetic compatibility.



1. Stranded core: Single or multiple ductile copper strands
2. Insulation: Polyethylene Foam Skin
3. Earth strand: Single or multiple plated copper
4. Shielding 1: Aluminium/Polyester tape - Overlay 110%
5. Shielding 2: Tin plated copper braid shield - Min. 50% overlay
6. Casing: Polyurethane

Connectors must be shielded and have 360° earthing directly on the aluminium sheeting or the braiding so that the shielding is seamless between the cable and the connector. The contact quality is defined by the transfer impedance: the lower the value the higher the protection.

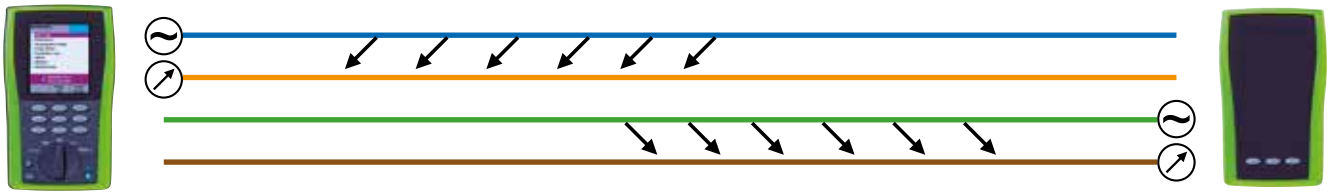
External electromagnetic interference is not the only phenomenon that can degrade the connection quality. It must also be verified that the products' intrinsic characteristics meet the desired level of quality. Information technology standards set the various electric parameters used to confirm correct network protocol operations.

ELECTRICAL PARAMETERS

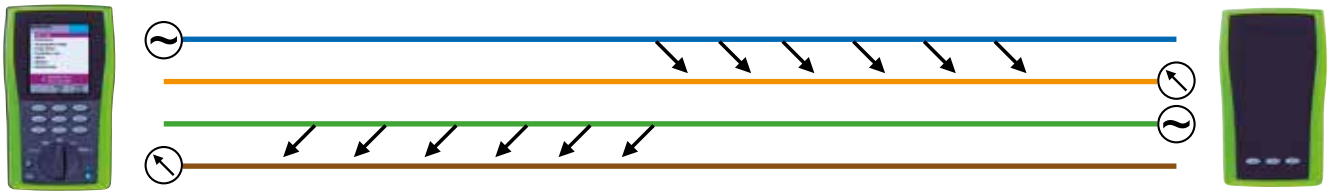
Ppropagation time
The signal propagation time for each pair between the two ends of the connection. Propagation time depends on the signal length and frequency.
The propagation time for a full connection (CHANNEL) should not exceed 555ns for reasons linked to data transmission and frame collision detection (CSMA/CD).

Insertion loss
The signal weakens along the connection in proportion to its frequency and length.
Insertion loss is a symptom of attenuation due to energy loss. It is a fundamental parameter and contributes to the signal-to-noise ratio.

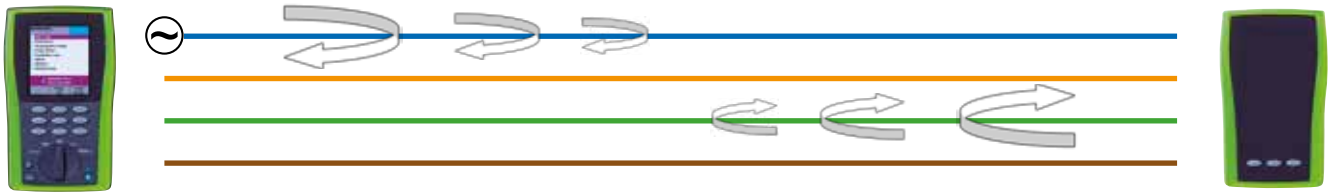
NEXT (Near End Cross Talk)
NEXT describes near-end crosstalk. NEXT is measured in order to check that the transmission lines do not pollute the receiver lines during FULL DUPLEX communications.
Sending a signal to one of the pairs, and receiving the signal on the other pair at the same end.



FEXT (Far End Cross Talk)
FEXT describes far end crosstalk, and is measured in order to check that the transmission lines do not pollute the opposing transmission lines during FULL DUPLEX communications.
Sending a signal to one of the pairs, and receiving the signal on the other pair at the opposite end.



Return loss
Return loss measures the power of reflected signal echoes caused by impedance failures along the cable. The echo is an additional source of noise that impedes data retrieval.



To make it easier to select components, products have been organized by category according to their performance for each of the electrical parameters described above, and the applications in operation:

COMPONENTS	CAT5e	CAT6	CAT6A	CAT7	CAT7A
BANDWIDTH	100 Mhz	250 Mhz	500 Mhz	600Mhz	1000 Mhz
System EN Standard	EN 50173-1(2007)	EN 50173-1(2007)	EN 50173-1(2009)	EN 50173-1(2007)	EN 50173-1(2009)
Ethernet 10 BASE T	X	X	X	X	X
Ethernet 100 BASE Tx	X	X	X	X	X
Ethernet 1000 BASE T	X	X	X	X	X
Ethernet 10G BASE T		X	X	X	X
PoE (Power Over Ethernet)	Aim to use a large diameter cables (AWG23/AWG22)				

When complete, installation technicians use field testers with a given sensitivity (Level III, IIIe, or IV) to check performance: this s the cable validation process.

MECHANICAL AND ENVIRONMENTAL PERFORMANCE

In addition to electromagnetic factors, a factory represents a hostile environment for products that were originally designed to operate in a calm office environment.
Cabling system manufacturers have therefore needed to modify their standard products for industrial use.

Physico-chemical restrictions

Depending on the business activity, various chemical compounds may cause damage to the installed products, thus weakening the network. To remedy this, Polyurethane cables must be used. This coating compound is the most offers the most versatility in terms of mechanical and chemical resistance.

Coating characteristics table

	PE	LSZH	PVC	PUR	PA
MECHANICAL BEHAVIOUR					
FLEXIBILITY	Average	Average	Good	Excellent	Poor
TENSILE STRENGTH	Average	Average	Average	Excellent	Excellent
RESISTANCE TO COMPRESSION AND IMPACT	Average	Average	Good	Excellent	Good
ABRASION RESISTANCE	Average	Poor	Good	Excellent	Good
TEAR RESISTANCE	Average	Average	Good	Excellent	Good
THERMAL BEHAVIOUR					
EXPANSION AND CONTRACTION	Average	Average	Average	Average	Very good
AGEING DUE TO COLD AND TEMP. CHANGES	Average	Average	Good	Average	Average
FRAGILITY AT LOW TEMP.	Average	Average	Good	Excellent	Good
CHEMICAL AND ENVIRONMENTAL PROPERTIES					
STABILITY WHEN EXPOSED TO OIL AND HYDROCARBON	Average	Average	Good	Excellent	Very good
STABILITY WHEN EXPOSED TO ACID	Good	Good	Good	Good	Poor
RRESISTANCE TO OZONE	Excellent	Excellent	Excellent	Excellent	Excellent
UV RESISTANCE	Good	Good	Good	Excellent	Poor
WATER RESISTANCE	Excellent	Average	Average	Good	Average

PE : Polyéthylene
LSZH : Low Smoke Zero Halog
PVC : Polyvinyl chloride
PUR : Polyurethane
PA : Polyamide

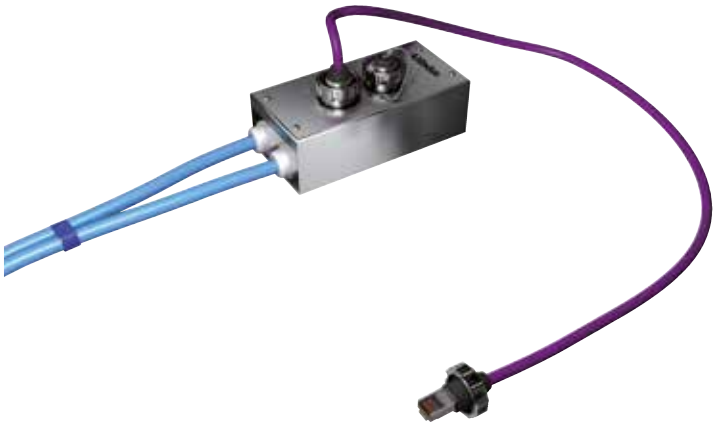
Standard connectivity systems are designed to last for many years in an ordinary office environment.

These same connections, when used in extreme conditions (dirt, temperature, humidity, vibrations, etc.), suffer from reduced performance and reliability over time.

In a “workshop” environment, the Ethernet connection may suffer corrosion, wear, and exposure to dust, and may cease to function adequately. Maintenance costs may prove to be significant over time.

Industrial connections are able to withstand the most extreme conditions. They may be used in environments with high humidity, or that are susceptible to leaks, or have toxic atmospheres and/or extreme temperatures.

An IP67 connector must be used in order to avoid malfunctions due to a degraded connector.



Recap of IEC 60529 on IP Codes

IP CLASSIFICATION

THE FIRST DIGIT

NAME	DESCRIPTION
0X	no protection
1X	protected against solid matter over 50mm
2X	protected against solid matter over 12mm
3X	protected against solid matter over 2.5mm
4X	protected against solid matter over 1mm
5X	protected against dust
6X	fully protected against dust

THE SECOND DIGIT

NAME	DESCRIPTION
X1	protected against dripping water
X2	protected against dripping water up to 15° from vertical
X3	protected against dripping water up to 60° from vertical
X4	protected against splashes from all angles
X5	protected against water jets from all angles
X6	protected against powerful water jets from all angles
X7	protected against immersion

Connectors must be approved in line with:

Corrosive environments H2S/SO2 under IEC 60068-2-60
Vibration testing IEC 60068-2-6
Temperature variation testing IEC 60068-2-14

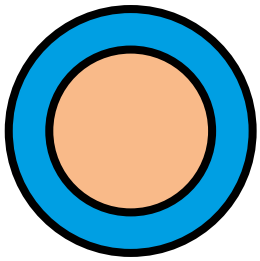
Pros: Information on anti-corrosion properties of the stainless steel 304 connector

Stainless steel is a Chrome/Nickel/Molybdenum alloy. Stainless steel is more resistant to corrosion the higher the molybdenum content. The stainless steel 304 connector has an anti-corrosion grade of A2.

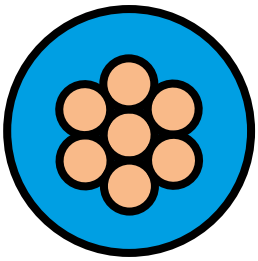
Mechanical restrictions

A significant number of situations require either fully or partially mobile installation, unlike in an “office” environment.
The cables used must therefore be able to withstand repeated movement.
The right cable with the right conductor must then be used.

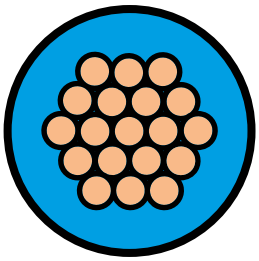
STATIC MONOFIL CORE AME



MULTI-STRANDED FLEXIBLE CORE



MULTI-STRANDED ULTRA- FLEXIBLE CORE



IK 10 Connector: Shock resistant up to impacts of 20 Joules

CONCLUSION

Implementing an Ethernet system entails certain difficulties:

- Lack of qualified personnel, able to manage both IT bases and automation networks.
  Maintenance personnel for automated chains and IT personnel must therefore work together to install and implement and Ethernet system.

- The second obstacle lies in network configuration.
  The planning stage of an automated industrial Ethernet is key to its success.
  For the network to meet expectations, a full and documented inventory must be taken of cable routes, available space, cables, devices and connections, and appropriate routers and switches must be chosen. A properly installed Ethernet network requires little maintenance. Migration will be completed without a hitch if the correct products and right personnel are used.

GLOSSAIRE

10 BASE T
10 Mb/s Ethernet on a twisted pair cable. Transmission over pairs 1/2 and 3/6.

100 BASE Tx
100 Mb/s Ethernet on a twisted pair cable. Transmission over pairs 1/2 and 3/6.

1000 BASE T
100 Mb/s Ethernet on a twisted pair cable. Transmission over 4 pairs simultaneously.

10 G BASE T
Ethernet 10 000 Mbits/s sur un câble à paires torsadées. Transmission sur les 4 paires en simultanées.

CHANNEL
10,000 Mb/s Ethernet on a twisted pair cable. Transmission over 4 pairs simultaneously.

CSMA/CD (IEEE 802.3)
Carrier Sense Multiple Access with collision detection, a basic Ethernet communication protocol, it defines access methods to communications, especially through collision detection.

PERMANENT LINK
Permanent link, excluding patch cable, and workstation cable.

FULL DUPLEX
Simultaneous transmission method: the signal is transmitted and received at the same time at both ends.

TCP
Transport Control Protocol

IP
Internet Protocol

Poe
Power Over Ethernet. Transmission of a power supply signal through a given cable.
Maximum capacity of 13.6 Watt.