SPECIALCAVI

WE BRIDGE PEOPLE

INTERFERENCE AND SHIELDING

Technical information: INTERFERENCE AND SHIELDING

INTRODUCTION

One of the biggest problems faced by those who design or install transmission systems is preserving signal integrity as much as possible from interference and noise, both internal and, in particular, external to the transmission line.

The term “shield” (or “screen”) refers to a metal enclosure that completely encloses electronic equipment. A shield has two purposes:

- to prevent emissions from the equipment from radiating outside the enclosure, so as not to compromise compliance with radiated emissions standards and to prevent the equipment from causing interference with other devices;
- to prevent emissions radiated outside the equipment from coupling with internal electronic devices, thus causing interference with their operation.

Technological trends have led to the high complexity and sophistication of electronics applied to automation. Unfortunately, this has made the entire automated industrial system susceptible to disturbances present both on the power supply network and in the space near the plant.
The presence of these interferences has given rise to the acronym EMI (Electromagnetic Interference), which encompasses all phenomena of magnetic/electric field coupling (humming), electrostatic discharges (ESD), conducted disturbances on the network, emissions radiated by cables and electronic objects, immunity to electromagnetic fields and radio frequency interference (RFI), etc. The rapid evolution of electronic technology, the convergence of audio, video, and data signals, increasing regulations, and the need for low-cost installations, often near power lines, have made it necessary to create cables with more sophisticated shielding.

Specialcavi adopts different shielding solutions for its cables, illustrated below, which can be chosen based on the type of interference expected, its intensity, its frequency, the length of the cable, the permissible loss tolerances, and, last but not least, the costs.

ESI - ELECTROSTATIC NOISE

The source of the noise is external to the cable.
The interference is caused by the coupling of the external electric field with the circuit in the interconnection cable.
In this case, capacitive coupling is hindered by the high coverage of the shield, while its electrical resistance is not significant.
Grounding is important.
For “ESI” type disturbances, aluminum/polyester tape shielding is very suitable, with noise levels around 0.1 mV. Copper braid or copper spiral shielding is not recommended, as it can reach values of up to 5 mV.

EMI - INDUCTIVE NOISE

The source of the noise is still external to the cable and is caused by power lines, motors, transformers, etc.
In this case, the interconnect cable is located in a variable magnetic field: currents and voltages are induced on the shield, causing distortions in the cable circuit.
The effectiveness of the shielding is normally measured (see IEC standards) by means of the transfer impedance, defined, in an elementary length of cable, as the ratio between the voltage measured along the shielding and the current flowing through the disturbing system.
Experience shows that:

- For frequencies up to 100 KHz, the impedance remains almost constant and the value is determined by the type of shield used, taking into account its electrical resistance;
- For frequencies from 100 KHz to 10 MHz, there is an increase in transfer impedance, passing through a minimum (obviously with the same shields);
- For frequencies from 10 MHz to 300 MHz, the transfer impedance value is always influenced by the type of screen, as well as by the frequency.

Technical information: INTERFERENCE AND SHIELDING

ESD - ELECTROSTATIC DISCHARGES

The source of the noise is external to the cable. The disturbance causes a current pulse with a low rise time on the cable screen, with components up to 100 MHz.
The most suitable shields are those made of aluminum/polyester + copper braid, repeated several times in critical cases.

CROSS-TALK

The source of the disturbance is inside the cable.
The cause is capacitive/inductive coupling caused by low transverse impedance between two adjacent pairs.
The extent of the disturbance is determined by the type of cable construction (multipolar, pairs, shielded pairs, coaxial), the frequency, and, of course, the length.
Crosstalk in multipolar cables is insignificant, having very high values at any frequency and therefore limiting their use for current transmission.
In twisted pair cables, on the other hand, in order to obtain acceptable crosstalk, it is necessary to adopt systems that are appropriate for the frequency of use.
Different twist rates for the pairs have proven to be effective for medium frequencies (50 KHz - 500 KHz), while for high frequencies (500 KHz - 30 MHz), shielding of the pairs is advisable, if not essential.
Extremely low crosstalk values (>100 dB/300 m) can be achieved by using coaxial cables.
This type of circuit is normally used for frequencies from 0.5 MHz to 50 MHz.
Another important component for reducing crosstalk is the choice of dielectric material.
However, more than one type of interference and noise described above may be present at the same time, and therefore add up.
It is obviously not possible to establish a remedy in advance, and each case must be analyzed individually.

COMMON MODE

The source of the noise is both internal and external to the cable. The causes of the disturbance are essentially:
Different ground potentials at various points in the circuit;
Capacitance between the wires of the pair and any metal structure, both internal and external to the cable;
Excessive imbalance of electrical resistance within the transmission pair.
The first cause is clearly the most important, and it is obviously the type of installation and the measures taken that determine its effect.
The effects of the other two are effectively counteracted by good engineering and cable manufacturing by the manufacturer.

Technical information: INTERFERENCE AND SHIELDING

TYPES OF SCREENS

ALUMINUM STRIP SCREEN

It consists of a laminated aluminum strip coupled with a polyester strip, which acts as a support, electrical and thermal insulator, and makes the shield mechanically more robust.
It is placed on the cable both longitudinally and helically wound, depending on the application.
In both cases, a certain percentage of overlap is required to ensure 100% coverage, and a drainage wire to facilitate termination and therefore grounding.
Specialcavi Baldassari normally uses different shielding solutions with different types of tape.
Aluminum/polyester shields not only offer 100% coverage but also take up less space, are lighter, and are less expensive than copper shielding.
However, they have several disadvantages, such as high electrical resistance and poor mechanical resistance and, in particular, a rather short life when used in harsh conditions of flexibility.

SPIRAL SCREEN

This consists of a spiral-wound copper wire band wrapped around the cable.
It offers good shielding in audio applications and when flexibility and durability are the most important parameters.
It is practically useless in data transmission because at high frequencies the spiral winding causes an inductive effect.

COPPER BRAID SCREEN

This consists of groups of copper wires braided together to form a metal mesh around the cable body with a coverage that normally ranges from 80% to 95%.
100% coverage cannot be achieved with braiding.
Other manufacturing parameters, such as the number and diameter of the wires, the number of groups, and the braiding angle, must be considered in relation to the required performance.
Braided shielding is widely used because it offers very low electrical resistance and excellent mechanical resistance.
However, its greater weight and volume and the difficulty of connection sometimes limit its use.

MIXED SCREEN

The different types of shielding described above can be combined in various ways to achieve optimal shielding effectiveness across the entire frequency spectrum.
The most commonly used combination is aluminum tape with copper braid, which combines the advantages of 100% coverage with low electrical resistance.
Other combinations are: aluminum/braid/aluminum or double aluminum/braid, as in some LAN cables.
The different shielding layers can be insulated from each other or not, using the aluminum/polyester combinations already described.
Mixed screen is the best that can be achieved in the field of flexible shielding.

Technical information: INTERFERENCE AND SHIELDING

CHOOSING THE RIGHT SCREEN

The criteria to consider when choosing the most suitable type of screen to solve problems without incurring excessive costs are as follows:

- Identification of interference;
- Determination of the frequencies of disturbances present in the environment and on the system;
- Exact knowledge of the movements that the cable must withstand.

Specialcavi offers suggestions for choosing the most suitable shielded cable for various types of applications:

CABLES WITH TAPE SCREENING
Where interference is generated by: TV signals, crosstalk with other circuits, radio signals, fluorescent lamps
In industrial environments with low EMI levels
Where there are electrostatic charges (ESD) generated by synthetic materials (yarns, fabrics, textiles, etc.)

SPIRAL-SHIELDED CABLES
Where interference is at low frequencies
Where extremely high durability under continuous bending and twisting is essential

BRAIDED SCREEN CABLES
Where interference has a low impedance characteristic: motor power supplies from inverters or converters, intermittent power supply to inductive loads.
Where interference includes both low and high frequencies: signal cables for position sensors, computer cables, instrumentation and control cables, etc.

CABLES WITH TAPE + BRAID SCREENING
In all cases where there is multiple interference at low frequencies + high frequencies charged with ESD, an environment significantly disturbed by intense electromagnetic fields, high background noise, etc.