

Solving Signal Problems

Effective shielding is key to enhancing the reliability and performance of broadcast cables.

by
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There is perhaps no other industry which values reliable cable performance as highly as broadcasting, for the failure of broadcast cable performance often produces immediate, far-reaching and embarrassing results. From outdoor news gathering, to studios and control rooms, to post production, the broadcast industry faces critical challenges from EMI/RF interference. Since broadcast systems were launched, system engineers have been in perennial pursuit of shielding that would effectively ensure signal integrity, prevent downtime, maintain sound and picture quality -- and provide a high level of confidence in audio and video transmissions.

Cable shielding has proven to be an effective strategy for dealing with problems of signal ingress and egress caused by electromagnetic interference (EMI). And, today, with the FCC's Cumulative Leakage Index (CLI) standard, maximizing cable shielding effectiveness is even more critical than ever before.

Signal Problems

EMI was first recognized in the early 1960's, as interference problems broadened to encompass the entire electromagnetic spectrum. Prior to that time, most interference problems were experienced with radio signals, and hence, were referred to as radio frequency interference (RFI). Today, EMI refers to electromagnetic interference in its broadest sense. Thus, within the non-ionizing portion of the electromagnetic spectrum, all emitters, receptors and frequency bands are part of the EMI definition. For this reason, such diverse problems as interference from ground loops, common impedance paths, direct magnetic/electric field coupling (AC Hum), electrostatic discharge (ESD), power line conducted emissions or radiated emissions from all sources fall under the umbrella category of EMI.

In broadcasting, there are mechanically-induced noise interference problems as well. Triboelectric noise is generated by movement in the cable's components, resulting in a static or piezoelectric effect. Mechanically-induced noise is a critical and frequent concern in the use of guitar cords, microphone cables, and other cables that may be flexed while in use.

Fortunately, both EMI/RFI and noise problems can be solved with the right cable shielding solution. Let's take a closer look at how cable shielding works and the different types available on the market for various applications.

Shielding Solutions

A cable shield is placed between the core or components of a cable and the outer jacket, or over individual components within a cable, to contain the RF signal or keep out unwanted interference. Cable shielding is offered in a wide range of designs and configurations. Each type of shielding has its own distinct advantages and disadvantages that need to be considered when selecting the best and most cost-effective option for a given application. Shields available on the market today include:

Braid Shields. Braid shields provide superior structural integrity while maintaining good flexibility and flex life. These shields are ideal for minimizing low frequency interference and have lower DC resistance than foil. Braid shields are effective at audio, as well as RF ranges. Generally, the higher the percentage of braid coverage, the more effective the shield.

Foil Shields. Foil shields consist of aluminum foil typically laminated to a polyester or polypropylene film. Foil shields provide 100 percent cable or component coverage, improving protection against radiated emission and ingress at audio and radio frequencies. Because of their small size, foil shields are commonly used to shield individual pairs of multi-pair cables to reduce crosstalk. Foil shields may also be bonded to a coaxial cable insulation or cable jacket with a layer of adhesive, allowing for faster, easier and more reliable termination. They have less weight, bulk, and cost less than braid shields and are generally more effective at higher frequencies. Foil shields are more flexible than braid but have a shorter flex life. Drain wires are generally used with foil shields to ease termination and ground electrostatic discharges.

The shorting fold construction technique in foil shield design helps improve high frequency performance by maintaining metal-to-metal contact, thereby increasing the foil shield's range of effectiveness to higher frequencies. This is achieved by folding one edge of the shield tape back upon itself. Thus when the tape is wrapped around the cable, there will be metal-to-metal contact along the seam or edge of the shield tape, better approximating the performance of a seamless tube. Without the shorting fold, a slot is created through which signals can leak and cause interference.

Combination Foil/Braid Shields. Combination shields consist of more than one layer of shielding and provide maximum shield efficiency across the frequency spectrum. The combination foil/braid combines the advantages of 100 percent foil coverage with the strength, flexibility, and low DC resistance of a braid. Typical braid coverages range from 60 to 95 percent. Other combination shields available include various braid/braid, foil/braid/foil, and foil/braid/foil/braid designs.

French Braid™ Shields. A relatively new development in cable shielding technology, especially suited to audio and RF cable applications, is an ultra-flexible double spiral shield. This design consists of dual spirals of bare or tinned copper conductors, with the two spirals tied together by one weave.

The French braid shield construction provides longer flex life than standard spiral shields, and greater flexibility than conventional braid shields. It produces a much lower level (up

to 50 percent less) of micro phonic and triboelectric noise than either spiral or conventional braid shields. In addition, since it is not fully woven, the double spiral shield is easier to terminate than a standard braid. It also provides for lower DC loop resistance than a single spiral, resulting in improved performance.

Testing Methods

Securing reliable and comprehensive test data is the surest and most effective way to select cable shielding which will protect against the kind of interference anticipated. Several questions need to be asked: What kind of interference is anticipated? What frequency range? Is ingress or egress the primary concern? Is triboelectric or other mechanical noise likely to occur?

Following is a description of several kinds of commonly conducted shield performance tests--their purpose, methodology, and the significance of their results.

Transfer Impedance Test. The transfer impedance test is the most widely accepted non-relative or absolute measure of a shield's performance. It is used to evaluate cable shield performance against ESD and radiated emissions coupling at a frequency range of DC to 1000 MHz. This testing method is recommended by the International Electrotechnical Commission as well as the military.

The transfer impedance value is dependent upon the sample cable's shield construction. *The lower the transfer impedance value, the more effective the shielding.* Theoretically, the absolute interference level of a cable can be determined using the transfer impedance value. Typically measured in a triaxial fixture, the transfer impedance takes into effect the relationship between the signal carrying regions of a coax cable and the surrounding detector. The shield separates these two regions. Therefore, the transfer impedance test is a true measure of the shield effectiveness of the cable.

Absorbing Clamp. The absorbing clamp is an accurate, portable testing device which is effective at detecting radiation directionally, as well as locally. It has a great capacity for electromagnetic compatibility cable measurements in the frequency range of 30 to 1000 MHz. It is also non-destructive to the sample. The test fixture clamps over the shielded sample cable and inductively detects signal leakage. The radiation values are then compared to those of an unshielded sample of the same length. Shielding effectiveness is defined as the difference between the two values.

GTEM Cell. The GTEM cell is a rectangular transmission line segment which operates in the Gigahertz Transverse Electromagnetic Mode (GTEM). Cables, cable/connector assemblies, and/or electronic devices are placed inside the chamber. The item under test can be subjected to a known field intensity provided by powering the cell or, alternately, the cell can be used as a detector to measure radiation emitted by the cable or device inside the cell. Frequency range covered by this method is DC to 1 GHz.

Flex Test. Shield performance during the life of the cable is an important consideration, especially in field or stage cables. Flex testing is performed on these cables because vibration, sway, continuous movement, coiling and uncoiling can cause degradation of shield performance over a prolonged period of time. Testing before and after flexing may be of value and concern for cables used in these types of applications.

Summary

Cable technology has become increasingly more complex since EMI problems were first discovered. The evolution of broadcast technology, and its resulting regulations, has created a growing need for more sophisticated cable shielding and reliable testing methods. For these reasons, it's more critical than ever for system designers to evaluate, right from the outset, the conditions of each application in order to specify the most appropriate shielding option.

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THE BOTTOM LINE:

EMI and RF interferences have a negative impact on broadcast cable performance and reliability. Effective shielding can protect cables from signal ingress or egress, as well as triboelectric or other mechanical noise. New shielding technologies and advanced cable testing procedures, such as those from Belden, are the keys to finding the right shielding solution for each application.