LOW-VOLTAGE CABLE SHIELDING

WHY ARE SHIELDS USED?

Low-voltage cable shielding provides an efficient way to manage electromagnetic interference (EMI). All cables that carry electrical signals radiate, or leak, electromagnetic energy into their surroundings. Likewise, cables located in an area where electromagnetic energy is present can also "pick up" unwanted energy just as an antenna picks up radio signals. If the electromagnetic energy is not properly managed problems can arise. For example, process control circuits can malfunction or computers may lock up.

Shields protect the cable from EMI and help contain any EMI generated by the cable. Shield effectiveness depends on the type of signal being carried by the cable and the shield type.

WHAT ARE THE BASIC TYPES?

Many types of shields have been developed to meet the electrical and mechanical requirements of thousands of different cable applications. The most common types include the following.

- Copper braid shield – a braid shield consists of small gauge copper wires braided into a mesh around the cable core. Typical coverage ranges from 65 percent to 98 percent.
- Foil shield – foil shields are constructed of a metallic (typically aluminum) foil with a 1/2-mil thick polyester backing to increase mechanical strength. The shield can be overlapped with the foil facing in or the foil facing out. A drain wire is placed in contact with the foil side of the shield to provide easier grounding of the shield at cable terminations.
- Spiral (serve) shield – these shields are typically constructed with bare or tinned small gauge copper wires that are helically applied in a flat or ribbon configuration. Spiral shields range in coverage from 80 percent to about 97 percent. These shields are used primarily in audio, microphone and retractile cord cables where extreme flexibility and a long flex-life are required.
- Foil and braid combination – foil and braid shields are used together to provide shielding at both high and low frequencies while maintaining mechanical strength.
- Corrugated metallic tubes – copper or aluminum that is thicker than foil but thinner than armor is formed into a corrugated tube around the cable core. It is typically used in applications such as electrical substations where large fault currents and induced noise are possible.
- Armor – mechanical protection is the primary function of armor, although it does provide some level of shielding.

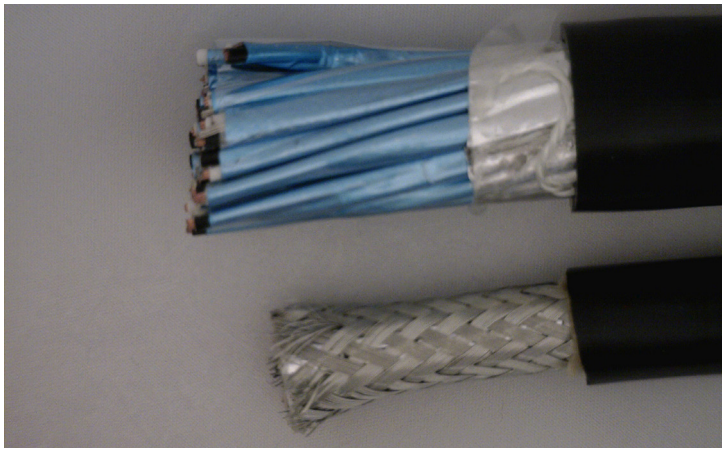

Figure 1: Foil and braid shield types

WHICH TYPES ARE MOST EFFECTIVE?

Shield effectiveness depends on the type of signal being carried by the cable. It also usually involves some compromises with regard to cable flexibility and mechanical protection. See Table 1 for an overview.

For low-frequency applications (up to about 1 MHz), braid or spiral wire shields are often used. At low frequencies, end-to-end electrical resistance of the shield is an important factor in shield effectiveness. Microphone cables are often made with a spiral wire shield because this type of shield is effective at audio frequencies, it has a low cost and has the desired flexibility and flex-life.

For medium-frequency applications (1 MHz to about 100 MHz), braid shields are often used. Braid shield effectiveness depends on the "coverage," i.e., the tightness of the weave. Coverage generally ranges from a low of about 65 percent to 98 percent. Higher braid coverage results in better shield performance, but also higher cost.

For high-frequency applications (above 100 MHz), braid shields are often used in combination with foil. This is because the little "windows" in a braid shield begin to "leak" energy at high frequencies. The addition of an aluminum foil shield under the braid effectively blocks this leakage.

	Braid	Spiral	Foil
Percent Coverage	65–98%	80–95%	100%
Low-Frequency Effectiveness	Excellent	Good	Fair
High-Frequency Effectiveness	Good	Fair	Excellent
Mechanical Strength	Excellent	Good	Fair
Flexibility	Good	Excellent	Good
Flex-Life	Good	Excellent	Fair

Table 1: Common Shield Type Characteristics

HOW DO YOU PROPERLY GROUND A SHIELD?

Proper grounding of a shield can have as much affect on performance as the choice of shield type. A few recommendations for maximum EMI control are as follows:

- At terminations, strip the shield back as little as possible to keep unshielded areas to a minimum.
- Carefully follow the recommendations of the manufacturer of the attached equipment regarding where and how to connect the shield.
- The shield should not be used as an electrical conductor. It is designed only to provide shielding (coaxial cable is an exception to this rule).
- The shield of each cable should be covered with an insulating jacket to prevent unintentional multiple grounding of the shield.
- The shields of grounded junction thermocouple circuits should be grounded at or near the thermocouple well.

More information is available in IEEE Standard 1143 Guide on Shielding Practice for Low Voltage Cables.

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