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Cable Tray Grounding: Power, Instrumentation, and Telecommunications

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Grounding has always been a controversial topic. But, with the growth of digital high frequency systems the issues are more complex. Grounding means connected to earth or a conducting body that acts in place of earth. Some international standards refer to grounding as earthing. Bonding is the interconnection of metal parts to establish electrical continuity. These definitions are NEC terminology and apply to power system grounding.

The purpose of grounding is:

- Fire Protection
- Electrical Shock Protection
- Electrical system ground fault protection
- Lighting protection-building and electrical system
- Electrical Noise and EMI protection
- Voltage Stabilization

Power System Grounding
Power circuit grounding of cable trays is explained in CTI Technical Bulletins, Titles No. 8, 11, and 12, and the National Electrical Code Sections 318-3-© and 318-7. It is also covered in NEMA Standard VE-2.

The purpose of power grounding (Article 250) is to minimize the damage from wiring or equipment ground fault. Cable tray systems are in the path of ground fault currents. Cable tray systems are bonded together through their bolting, connectors splice plates, clamps, and bonding jumpers where there are gaps in the cable tray system. Cable tray systems are not required to be mechanically continuous, but shall be electrically continuous.

Cable trays are also bonded to conduit, cable channel or other wiring drops. They must also be bonded back to the power source. All bonding jumpers must be sized (as a minimum) to meet the requirements of equipment grounding conductors. Both side rails of the tray must be bonded together to the next section. Cable trays can be used as the only equipment grounding conductor (EGC), but they must meet certain criteria (only in qualifying facilities, minimum cross-sectional areas, U.L. classified as to suitability, etc., see NEC 318-7).

There are other alternatives-use EGC’s in the cable (U.L. listed cable can be supplied with EGC’s in certain conductor sizes) or a separate EGC in the cable tray that bonds the cable tray sections together and can also be used to tap EGC’s to individual drop-outs from the CT. These two alternatives can be used for non-metallic cable trays. Cables with equipment ground conductors within the cable are an accepted practice in industry. They provide a two-point connection from the power source to the load, however, any conduit, cable tray, or raceway must still be bonded back to the power source.

Some companies do not accept conduit as an EGC.

The EGC system is a critical safety system. Therefore, it is prudent to treat the cable tray system as an equipment grounding conductor in parallel with the ground conductors in the cables or an individual ground conductor.

Cable Tray Grounding-Signal and Communication Circuits
Where cable tray systems contain only signal and communication circuits that operate at low energy levels, power grounding per NEC Section 318-7 is not appropriate, but cable tray grounding for lightning protection, noise, and electromagnetic interference is necessary. For telecommunications circuits TIA/EIA standard 607, Commercial Building Grounding and Bonding Requirements for Telecommunications, provides grounding for these systems. Voltage disturbances, lightning induced voltages, and radiated EMI are the concern. Lightning protection is a concern if cable trays are located on the top of buildings, in an outdoor exposed area, or in the path of lightning currents. An overhead cable system can provide protection. NFPA780, Standard for the Installation of Lightning Protection Systems 1997 Edition, provides the criteria for building lightning protection.

Cable tray designs are also available that are EMI/RFI shielded. The tray is totally enclosed and the gaskets and covers are constructed and tested to meet EMI standards for the protection of the sensitive circuits in the cable tray against external electric and magnetic fields. Solid bottom cable trays also provide some degree shielding as do cable tray covers. Steel provides effective shielding at frequencies up to approximately 100 kilohertz however at higher frequencies, in the megahertz range, aluminum or copper shielding is more effective.

Cross Talk
Cable tray systems that contain signal and communication circuits should be grounded and, in some situations, shielded from external electrical and magnetic disturbances. In addition to these concepts, the CTI has received a number of questions concerning the coupling of electrical noise from power wiring into sensitive circuits because the wiring is within the same cable tray or close to the cable tray. The key question is how far apart does the power and signal cables have to be. The most desirable design is to separate power and signal cables in separate cable trays, or to separate wiring systems by a barrier.

The sensitivity of signal systems depends on a number of complex factors. Including electronic circuitry involved, isolation or coupling to ground, filtering, the signal type and logic, type of signal cable (untwisted pair, twisted pair, shielded twisted pair, coaxial cable double-shielded coaxial cable) and characteristic impedance of the circuit and cable. Some systems are quite tolerant to external noise. For instance, 4 to 20MA instrument signal systems and telecommunication circuits do quite well with respect to noise.

Some companies and organizations have published their own recommended practices and they should be followed. The national standard that includes separation distances is the Institute of Electrical Electronic Engineers (IEEE) Standard 518, IEEE Guide for the Installation of Electronic Equipment to Minimize Electrical Noise Inputs to External Sources. The cable spacing criteria found in this standard is large, based on industry experience. Many systems work quite well with lesser distances. Much depends on the particular installation. Typical spacing of cables in trays used in various industry standards varies from two inches to four feet. In some situations, two inches is probably adequate.

AC Drives

There have been a number of noise problems (and other problems) with the application of the newer IGBT AC Pulse Width Modulated Adjustable Speed Motor Drives. The new IGBT Drives produce fact rise time pulses that produce high voltage, high frequency pulses in the power wiring from the Inverter electronics to the motor. (The IGBT is a new type of power semiconductor.) This power wiring is essentially a radiator of high frequency power.

The noise frequency can be as high as 30MHZ. A number of IEEE papers have been presented on this topic. In particular, they provide detailed studies analysis and noise measurements using different types of motor power cable types. The conclusion is that one can manage this concern by proper grounding and power cable selection. At these frequencies, based on tests, the power cable should be shielded with a metal armor or foil either copper or aluminum. These studies and technical papers indicate that:

1. Shielded cable-either type TC or MC should be used
2. Nonferrous metal, such as aluminum, becomes the metal of choice at high frequencies for the cable shield
3. Additional high frequency bonding is required

Conclusion

Cable tray systems have been used extensively to support sensitive electronic circuitry. For many circuits shielding and separation requirements are minimal. Proper attention to the following can manage noise and EMI concerns:

- Signal cable
- Grounding of signal circuits and cable shields
- Cable selection
- Cable tray grounding

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