EMC Installation Instructions

Electromagnetic Compatibility (EMC) Installation Guidelines

Introduction

The concept of Electromagnetic Compatibility (EMC), that an electrical device should operate as intended with out being disturbed by, or disturbing other electrical devices, has always been an implicit part of every successful industrial control installation. Recent regulation changes, particularly in the European Union, have explicitly and formally defined EMC. This appendix is intended to help professionally qualified OEMs, machine builders, and end users successfully install and operate Industrial Devices Corporation's single and dual axis servo drives and controls (Models: B8961 and B8962) in compliance with these EMC regulations.

There are two components to Electromagnetic Compatibility. The first, that an electrical device not disturb the operation of other electrical devices, is covered by limits on the power levels of both emitted and conducted electrical magnetic noise. The second component, the ability to operate in the presence of electromagnetic noise, is covered by specifications detailing required immunity levels from electromagnetic phenomena that would normally occur in an industrial environment.

The EMC emissions limits can be divided into two categories. The first, radiated noise, is primarily intended to protect nearby radio communication type equipment. These limits cover a frequency range from 30 MHz to 1GHz. Poorly grounded motor and power cables are usually the primary cause for high levels of noise in this frequency range. The grounding and cabling recommendations in this appendix give detailed instructions for limiting this radiated noise to safe levels. The second set of emission limits are placed on noise conducted back onto the AC power mains. High frequency switching power electronics, like those commonly found in industrial servo motor drives, can, if not properly filtered, conduct unacceptable limits of noise back onto the AC power lines. This noise could adversely affect other devices. It is worth noting that there is a two order of magnitude safety margin between the allowed noise limits and the required immunity limits. This means that a machine level, rather than component level, application of the following grounding and cabling practices is feasible with out compromising the operation of the individual components.

The EMC immunity standards cover a broad range of electromagnetic phenomena including:

- Electrostatic Discharges
- RF electromagnetic fields
- Fast transient and power surges into the AC power supply
- Fast transient bursts on the motor and encoder wiring.

Fundamentally robust electrical design is the best defense against this kind of unpredictable noise, but good grounding practices can help prevent intermittent, difficult to track down, noise related problems.

Since the electromagnetic immunity of the Smart Drive is almost exclusively a function of the design, the installation techniques followed will not positively or negatively impact this built-in immunity. The electromagnetic emissions of the machine, on the other hand, are almost completely a function of the installation methods used. There are only a few things a machine designer can do to minimize the chance of EMC conflicts between sub-systems in his final product, and between his product and other products. The first is to use products and components that have a sufficient level of EM immunity to assure that their operation will not be affected by other equipment. In some cases, such as sensitive measuring equipment, the very function of the device requires it to be sensitive to electromagnetic phenomena. A second method is to physically separate the sensitive components from the rest of the machine. In many cases, this is also impossible. A third method is to specify components that have an "acceptable" level of emissions. Properly installed, these components will not affect the operation of other components and machines. In the European Union, what constitutes "acceptable" has been formally defined.

The following pages contain information necessary to install and operate IDC brushless servo Smart Drives in compliance with European EMC regulations. (See the attached Declaration of Conformity for specific regulation details.) It is certainly NOT necessary to implement all of these procedures to get a IDC Smart Drive up and running. Though proactively addressing EMC concerns is always a good practice, unless the final machine needs to meet some kind of EMC standard, no special precautions are needed in most cases. The Smart Drives and the equipment they normally operate around, have sufficient levels of immunity to operate successfully. These installation guidelines were developed as a result of IDC's own testing process. They are meant only as recommendations. In some applications, EMC regulations may be met without implementing all these suggestions. In others, more extensive shielding and filtering may be needed. As always, it is the responsibility of the person taking the complete machine into service to make sure that it meets all applicable safety, and EMC specifications.

The recommendations are divided into 5 categories. The first, *Shielding and Separation*, covers basic control shielding and panel layout techniques. The second section, *Grounding*, covers some basic Radio Frequency (RF) grounding rules of thumb. The next section, Physical Layout, is intended to give a specific example of an EMC compliant panel layout. The fourth section covers AC line filtering. In order to meet the European Union conducted emissions specifications a line filter must be installed between the Smart Drive and power mains. The last section details some of the steps need to install the Smart Drive in compliance with the European Union radiated emissions specifications. Properly shielding and grounding the motor power cable is the most critical step in bringing a EMC compliant system into service.

Separation and Shielding

Since the power of electromagnetic radiation drops of as a square function of the distance from the source of the radiation, proper electrical panel layout can help prevent compatibility problems. Small changes in your panel layouts can make large differences in preventing compatibility problems. Care should be taken in keeping sensitive electrical components, especially sensitive measurement equipment as far away as possible from high voltage, high power electronics such as IDC Smart Drives. Though, before a machine builder goes to extraordinary lengths to separate power and control electronics, it should be noted that all IDC servo drives and controls have DSPs and microprocessors operating within an inch of the drive power electronics.

Another source of the “black magic” reputation of electrical noise abatement comes from the area of cable shielding. There are two objectives to cable shielding. The first is to shield the signals in the cable from outside interference. Traditionally, protecting sensitive, low voltage signals, such as encoder and resolver feedback signals, from corruption has been the main focus of industrial cable shielding. Preventing the high voltage, motor power signals from destroying the integrity of these feedback signals is obviously a key part of a functional machine.

The second objective of shielding is to protect the outside environment from unacceptable electromagnetic noise emissions. With the advent of formal electromagnetic noise emissions standards, this facet of shielding has become even more important. The high frequency (30 MHz to 1 GHz) spectrum covered by these regulations dictate using at least a quality, braided, shield on all cabling. The small cracks, and imperfections found in foil shields make them ineffective at these high frequencies. Even low power cables must be properly protected with a braided shield. These low voltage, signal or feedback wires often share a logic ground with the microprocessor and clock of the control. The clock ground is a significant contributor to the radiated noise in the frequency range in question.

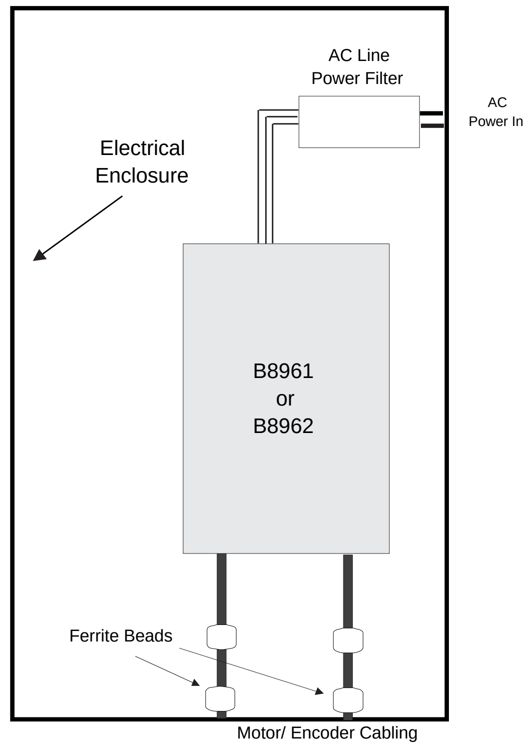
Another way in which EMC shielding differs from traditional shielding is in the connection of the shield to ground. A solid, 360° connection to ground rather than a single wire connections or even a braided strand connection can help prevent radiated noise problems. Connecting the cable shield to ground at BOTH ends of the shield can also help reduce the level of radiated noise. Please note there could be safety problems with this practice if the two grounds are at different potential levels. The shield could actually become a current carrying conductor. Safely connecting shields should always take precedents over any potential radiated emission reductions.

Grounding

Grounding is another topic that has a slightly different meaning in an EMC context that it has had traditionally. Local wiring safety codes generally thoroughly cover the subject of grounding, as it relates to personal safety, but they rarely address proper high frequency grounding practices. A good safety or DC ground can be made with a wire or small area contact. A high frequency ground connection requires a broad contact region or a wide braided strap to be effective. Simple wires can act like an open circuit at the radio frequencies under considerations. For this reason when mounting component chassises to a cabinet, it is important that the paint on both surfaces be scrapped away. A simple star washer grounding scheme may not be effective.

As always, the relevant local safety standards supersede any EMC precautions.

Physical Installation



The drawing at right shows an example of a EMC compliant IDC servo Smart Drive installation. It is assumed that the AC line filter and the Smart Drive have a good RF ground connection to the cabinet frame, and that the cables are shielded and grounded at both ends. The guidelines outlined above for grounding and cable separation should be followed when extending the concepts illustrated here to multiple component enclosure mounting.

As always, it is the responsibility of the machine builder to properly install the IDC servo drives and other electrical components making up the machine before taking the machine into service. When multiple electrical components are installed together on a machine, the radiated and conducted noise emissions levels can both be greater or less than the levels of the single component. The immunity levels of the individual components will not be affected.

AC Power Line Filtering

As mentioned above, one of the characteristics of the high power electronics used in servo drive amplifiers is the broadband noise their switching conducts back on to the AC input power line. There are a couple of ways to reduce the magnitude of the noise on the AC line. The first is to reduce the switching speed of the drive electronics, but this would increase the amount of heat the power transistors would need to dissipate. This in turn would increase the size and cost of the servo drive.

A second way would be to build an AC filter and/or isolation transformer into every drive. This solution also increases the size and cost of every drive. A third solution is to install an AC line filter at the point the where the AC power enters the protective enclosure where the servo drives and other machine control electronics are mounted. This is the method documented and used by IDC controls. The main advantage is that the cost and size of the filter can be specifically tailored to the application at hand, rather than being sized for a “worst case scenario” like an internal filter circuit. A second advantage is that the this externally mounted filter can be sized to supply multiple drives or other machine control electronics.

The proper installation and sizing of the AC line filter is critical in attaining acceptable attenuation of the broad band noise caused by the switching power electronics.

IDC has tested and documented the effectiveness of the Corcom EMI filters (part #: 6EQ8 F7264) but any filter with a similar power and high frequency impedance characteristics should provide similar results.

The proper installation of the line filter is at least as important as properly sizing it to the application. The following guidelines should be used:

1. Ground the line filter case to the enclosure cabinet ground. The case of the line filter is generally conductive and connected to the filter's ground. Insuring a good RF connection between the filter and the cabinet usually requires removing the paint where the filter is mounted to created a large surface area conduction path.
2. Minimize the AC cable run inside of the cabinet. The filtered side of the AC line filter can be contaminated by radiated noise from the unfiltered side of the filter and from other RF sources inside of the cabinet , thus completely negating the effect of the filtering. The best way to do this is to mount the filter at the point where the AC power enters the enclosure.

Motor Output Power Cable Shielding

Most of the radiated RF emissions come from the motor power cables. Use shielded motor cables. The shield needs to be connected at the motor AND the cabinet ground as close to the drive as possible for best results. Removing the paint around the bottom drive mounting tab, and using this bolt as the shield termination generally works very well.
To fully comply with the emission standards set forth in EN50081-1 (Residential, commercial, and light industrial environments) the motor power cables also need to be run inside of conductive conduit. The conduit should make good electrical contact with the motor case ground at the motor end, and the enclosure ground at the motor end. Please note that local electrical codes may have further rules and restrictions on high voltage and current cabling. These installation instructions are intended to supplement, not replace or supersede the local electrical, fire, and safety codes.

In addition to grounding both ends of the motor and encoder shield, to further reduce the radiated emissions from the drive, ferrite beads can be installed on the motor and encoder cables before they leave the electrical enclosure. (see the drawing above) IDC has tested and confirmed the effectiveness of the Fair-Rite model #0443164151. This is a removable "snap-on" style emission suppresser. These beads are necessary to meet the "residential and light industry" emission specifications. Other specification levels may or may not need the additional emission suppression provided by the beads. And in some cases, other measures may need to be taken.