Installation and Environmental Considerations For Motion Control Systems

The following environmental and safety considerations must be observed during all phases of operation, service and repair of a motion control system. Failure to comply with these precautions violates safety standards of design, manufacture and intended use of motors, drivers, controllers, actuators, and any other electronic or mechanical component.

Please note that even with a well designed and soundly-built motion control system, if the components within the system are operated and installed improperly, it will create a hazardous situation. The customer is ultimately responsible for the proper selection, installation, and operation of the motion control system. Therefore, precaution must be observed by the integrator and/or user with respect to the load and operating environment at all times.

The atmosphere in which motion control components are used must be conducive to good general practices of electrical/electronic equipment. Follow these simple guidelines to help protect yourself and others, as well as the equipment in the system:

- Do not operate a motion control system in the presence of flammable gases, dust, debris, oil, vapor or moisture/condensation. For outdoor use, motors, drivers and controllers, and other electronic and mechanical components must be protected from the elements by an adequate cover, *while still providing adequate air flow and cooling*.

- Moisture may cause an electrical shock hazard and/or induce system breakdown. Due consideration should be given to the avoidance of liquids, moisture and vapors of any kind. Contact the factory should your application require specific IP ratings.

- It is wise to install motors, drivers and controllers, as well as other electronic and mechanical components, in an environment which is free from electrical noise, vibration and shock. Additionally, it is preferable to work with these products in a non-static, protective environment. Please refer to the details discussion of EMI in the installation section.

- Exposed circuitry should always be properly guarded and/or enclosed to prevent unauthorized human contact with live circuitry.

- No work should be performed while power is applied. Don’t plug in or unplug any connectors when power is ON. Wait for at least 5 minutes before doing inspection work on the motion control system after turning power OFF, because even after the power is turned off, there will still be some electrical energy remaining in the capacitors of the internal circuit of drivers and controllers.

- Plan the installation of the motion control system in an environment that is free from debris, such as metal debris from cutting, drilling, tapping, and welding, or any other foreign material that could come in contact with circuitry. Failure to do so can result in damage and/or shock.

Installation

Mounting - Introduction

Proper installation of electronic and mechanical components will achieve the best results from the production capability of the motion control system. This can only be accomplished if several important steps are implemented and some precautions are taken. ***Note:*** *Local city/county codes may suggest different requirements, but those given in this section must be satisfied as much as possible.*

CAUTION - Only qualified personnel should be allowed to open and work on motion control systems, as well as components inside electrical enclosures. Equipment and machinery should never be run unless the electrical enclosure door is closed and locked. The electronics in electrical enclosures and throughout a motion control system are sensitive to metal chips and filings. During the installation and use, great care must be given to make sure metal chips or filings cannot fall onto or into any of the electrical or electronic devices.

- **Plan Ahead**
  Before attempting any electrical installations, gather all drawings, instructions, or procedural documents you have on the components that will be used within your motion control system. Reading and studying the product documentation before starting the project will alert you to any special situations, such as the need for specific tools and protective measures. Also, you will know where to begin and where to go from there. Always keep the specific product documentation with you while completing the installation, as you should regularly refer to them, rechecking as you move along.

NOTE: Documentation among manufacturers will vary greatly, as their design, layout, and connections are not the same. Match the part numbers to the documentation before attempting the installation. Even seasoned professionals need guidance and advice while performing complicated electrical installations. This ensures the safest results for everyone.

- **Electrical Installation**
  Safety should be the number one concern when performing any task related to the electrical connection of motors, driver and controllers, as well as all other motion control products and electrical equipment. Therefore, check every step at least once after it has been taken. During the installation of motors, drivers and controllers, and HMIs, it is important to minimize the possibility of electrical noise

entering critical sensitive circuits. This is best accomplished by following the electrical installation procedures precisely. Considerable attention has been given to noise immunity in the basic design and manufacture of these components. However, it is essential that considerable care and attention be given during the installation in machinery or in a facility.

- **Safety**

  Human safety and equipment safety must be the first considerations when executing the installation procedures for a motion control system. When it comes to electronics in your factory or workplace, you want to make sure both your facility and the employees in it are safe at all times. The following is a partial electrical safety checklist, courtesy of the National Electric Safety Foundation:

  General Electrical Safety Checklist:

  Cords and Cables: Make sure cords and cables are in good condition. Routinely check cords, cables and other wiring for frays and cracks. Make sure that all wiring and cabling is placed out of reach, and out of traffic areas. Cords/cables should never be nailed or stapled to the wall, baseboard or to another object. Do not place cords under carpets or rugs. Anaheim Automation recommends using product-specific cables for motors, drivers, and controllers, and extreme care should be taken if the installer decides to use his/her own cabling system.

  Plugs and Terminals: Make sure that all plugs fit the outlets, and that the terminals of motors, drivers, controllers, and HMIs are correctly matched and fit snug. Never remove the ground pin (the third prong) to make a three-prong fit a two-conductor outlet, because it could lead to an electrical shock. Avoid overloading outlets with too many electronic components. Never force a plug into an outlet if it doesn't fit, nor should you ever modify terminal blocks or cables for motors, drivers, controllers, or HMIs.

  Electrical Outlet Safety: Routinely check for loose-fitting plugs, which can overheat and lead to fire. Replace broken or missing wall plates

  Ground Fault Circuit Interrupters (GFCIs): These can help prevent electrocution and are used in any areas where water and electricity may come into contact. When a CFCI senses leakage in an electrical circuit, it assumes a ground fault has occurred. It then interrupts power fast enough to help prevent serious injury from electrical shock. Test GFCIs regularly, according to the manufacturer's instructions to make sure they are working properly.

  Circuit Breakers/Fuses: Should be the correct size current rating for their circuit. If you do not know the correct size, have an electrician identify and label the size to be used. *Always replace a fuse with the same size fuse.*

Computer, Controller, HMI, PLC and Drive Products: Check to see that the equipment is in good condition and working properly. Look for cracks or damage in wiring, terminals, plugs and connectors. Use a surge protector bearing the seal of a nationally recognized certification agency. To prevent damage during an electrical storm, make sure you use surge protectors on all electronic devices.

- **Mounting, Bonding and Grounding**

  After establishing all of the layouts for your motion control system, you can begin mounting, bonding, and grounding each chassis/enclosure/heatsink. Bonding is the connecting together of metal parts of chassis, assemblies, frames, shields, and enclosures to reduce the effects of EMI and ground noise. Grounding is the connection to the grounding-electrode system to place equipment at earth ground potential.

  IMPORTANT NOTE: These guidelines assume that you follow surge-suppression guidelines. While these guidelines apply to the majority of motor, drive and controller installations, as well as other motion control applications, certain electrically harsh environments may require additional precautions.

  Grounding of equipment and machinery is required for two reasons.
  1. To prevent hazards to personnel in case of a breakdown between current electrical components and the exposed metal surfaces.
  2. To minimize the effects of electrical noise on the control system.

  Mounting and Bonding the Enclosure – General Practices

  Generally speaking, you can mount the chassis with either bolts or welded stud:

  • Stud-mounting a ground bus or chassis to the back panel of the enclosure
  • Stud-mounting a back panel to the enclosure
  • Bolt-mounting a ground bus or enclosure to the back panel of the enclosure

  If the mounting brackets of a chassis do not lay flat before the nuts are tightened, use additional washers as shims so that the chassis does not bend when you tighten the nuts.

  Important Note: Do not bend the chassis or heat sink material. Bending the chassis might damage the backplane and result in poor connections. Make good electrical connection between each chassis, back-panel, heat sink and enclosure through each mounting bolt or stud. Wherever contact is made, carefully remove paint and any other non-conductive finish from around studs or tapped holes.

  With motors, drives and controls, proper bonding and grounding helps reduce the effects of EMI and ground noise. Also, since bonding and grounding are important for safety in electrical installations, local codes and ordinances dictate which bonding and grounding methods are permissible. *Anaheim Automation supplies motion control components only, therefore, it is imperative that the integrator and user know all pertinent safety practices and local codes and*

ordinances for where the machinery or system is built, and/or their machinery is shipped.

For example, for U.S. installations, the **National Electrical Code (NEC)** will provide the requirements for safe bonding and grounding, such as information about the size and types of conductors and methods of safely grounding electrical components. Use such resources whenever in doubt about proper procedures.

Use a steel enclosure to guard against EMI. If the enclosure door has a viewing window, it should be a laminated screen or a conductive optical substrate to block EMI.

Important Note: *Do not rely on the hinge for electrical contact between the door and the enclosure; install a bonding wire.*

How Good Is Your Earth Grounding System?

The existing factory earth and power systems of the plant, into which a new machine or motion control system is to be installed, should be checked for at least 24 hours before the machine/system arrives. This should be done as soon as the location is known to allow as much time as possible to make any changes that may be required. A good and reliable system that has been used for this purpose for many years is a Dranetz line analyzer. The power line disturbances should not exceed + or - 15% of the machine, or motion control components specification power requirements. This includes all forms of noise, voltage drop out or voltage spikes. While most machinery and motion control systems can usually tolerate more deviation than this, it is best to maintain these limits to protect people and the machine/system performance. For U.S. installations, the **National Electrical Code (NEC)** will provide the requirements for safe bonding and grounding procedures. It may also be helpful to check local ordinances as well.

- **Water Pipes May Not work -** Although a utility ground, such as a cold water pipe or the metal frame of a building, is generally an adequate ground for safety purposes, IT IS NOT usually recommended for minimizing the effects of electrical noise.
- **Sources of Noise -** Normally, other electrical equipment is connected to water pipe grounds or building steel and, therefore, carries the transient electrical noise currents associated with all of the attached equipment. These combined electrical noise currents cause a voltage gradient to be developed within the pipe or structural member because of its inherent resistance and reactance. Therefore, a function of the total noise current flowing at any one instant may cause a disturbance. This transient ground shift voltage disturbances are set up which may be coupled into the electronics and cause the drives and controllers to malfunction.

- **What Is An Earth Rod?** - A separate earth ground should always be used to ground a computer-controlled machine tool, or motion control system that uses drives, controllers, PLCs and/or HMIs. It may consist of a driven rod, driven pipe, buried plate, or any other device approved for this purpose. However, they should be kept out of any oily areas.

  It is preferred that Earth Rods are located where saltwater can periodically be poured down the side of the rod. If a parallel water pipe is provided, the rod should be located where it can easily be filled. This type of ground usually provides the low-impedance, stable, noise-free ground required for minimizing the effects of electrical noise on the control system and will also provide personnel safeguards. At no time should more than one machine be connected to one ground rod. The cable connecting the control panels' ground point to the earth rod should be continuous, as short as practical, and of at least the size of the conductors used to connect the electrical power to the machine tool or process line.
- **Installation of Earth Ground Rod -** The length and diameter of the ground rod is dependent upon the soil in the area of machine site. A good starting point would be to use a ten foot long by 5/8" diameter rod. The actual length and diameter of the earth ground rod should be determined by the length, and hence the diameter, required to reach the water, or moisture table in the subsoil. However, the local grounding conditions should be well-known by the plant electrical engineers and local electric company or electrical authority engineers; Anaheim Automation recommends consulting with them. It is best to weld a steel spike or cone to the end of the rod to help it penetrate the soil.

Sizing the Transformer - General Practices

To determine the required rating of the transformer, add the external transformer load of the power supply and all other power requirements (input circuits, output circuits). The power requirements must take into consideration the surge currents of devices controlled by the processor. Choose a transformer with the closest standard transformer rating above the calculated requirements. For example, a 500VA transformer should be used if there were 360VA of load.

- **Isolation Transformer** — For applications near excessive electrical noise generators, an isolation transformer (for the second transformer) provides further suppression of electromagnetic interference (EMI) from other equipment.
- **Constant-Voltage Transformer** — In applications where the AC power source is especially "soft" and subject to unusual variations, a constant-voltage transformer can stabilize the AC power source to the processor and minimize shutdowns. The constant-voltage transformer must be of the harmonic neutralizing type. If the power supply receives its AC power through a constant-voltage transformer, the input sensors connected to the I/O chassis should also receive their AC power from the same constant-voltage transformer. If the inputs receive their AC power through another transformer,

the AC source voltage could go low enough that erroneous input data enters memory while the constant-voltage transformer prevents the power supply from shutting down the processor. The output actuators being controlled should draw power form the same AC sources as the constant-voltage transformer, but not from the secondary of the constant-voltage transformer.

The following information is intended as a general guideline for the installation and mounting of Motion Control Products.

WARNING *- Dangerous voltages capable of causing injury or death may be present in the system. Use extreme caution when handling, testing, adjusting during installation, set-up, tuning, troubleshooting and operation. It is very important that the wiring of the motion control system be taken into consideration upon installation and mounting.*

Subpanels - Subpanels installed inside the enclosure for mounting motion control system components, must be a flat, rigid surface that will be free from shock, vibration, moisture, oil, vapors, debris or dust. Here are some other subpanel guidelines:

- Remember that motors, drivers and controllers will produce heat during work. Therefore, heat dissipation should be considered in designing the system layout. Size the enclosure so as not to exceed the maximum ambient temperature rating. It is recommended that the drivers and controllers be mounted in an upright position whenever possible, providing adequate airflow at all times.
- Add a fan or fans to help dissipate heat wherever it is practical to do so.
- All components should be mounted in a stable fashion, secured tightly.
- There should be a minimum of 10mm between the drivers and controller, and any other devices mounted in the system/electric panel or cabinet. For example: There should be at least 10mm space in the lateral direction and 50mm space in the longitudinal direction, between a servo motor drive/controller, and other electronic/electrical devices.
- For multi-axis systems, mount in the panel left to right according to power utilization (highest to lowest). If power utilization is unknown, mount from left to right based on Amp ratings.
- In order to comply with UL and CE requirements, most drivers and controllers must be grounded in a grounded-conducive enclosure offering protection as defined in standard EN 60529 (IEC 529) to IP55 such that they are not accessible to the operator or unskilled person. As with any moving part in a system, motors and actuators should be kept out of the reach of the operator.
- A NEMA 4X enclosure exceeds those requirements providing protection to IP66. To improve the bond between the power rail and the subpanel, construct your subpanel out of zinc-plated (paint-free) steel.

- It is strongly recommended that the motors, drivers, controllers and HMIs should be protected against electrical noise interferences. Noise from signal wires can cause mechanical vibration and malfunctions.

PLEASE NOTE: *Technical assistance regarding its motion control product line, as well as all the products manufactured or distributed by Anaheim Automation, is available at no charge. This assistance is offered to help the customer in choosing Anaheim Automation products for a specific application. However, any selection, quotation, or application suggestion, offered from Anaheim Automation's staff, its' representatives or distributors, are only to assist the customer. In all cases, determination of fitness of a product in a specific system design is solely the customers' responsibility. While every effort is made to offer solid advice, and to produce technical data and illustrations accurately, such advice and documents are for reference only, and subject to change without notice.*