System Grounding

Section 5

Introduction

This section discusses grounding practices for ABB control systems. Good grounding practices prevent problems and reduce system downtime. A complete and properly grounded electrical system is vital for personnel safety, equipment protection, and normal process system operation. Digital process control systems require a single point grounding system. For more information on grounding power systems refer to IEEE Standard 142-1991, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book).

It is important to realize that proper grounding is critical for the successful operation of a digital control system. Failure to observe good grounding practices or taking shortcuts during the installation of a grounding system may result in costly problems with the control system. The information given in this document serves as a general guideline to installation engineers and contractors. It is not exhaustive of all possible situations. Refer any problems or situations not covered by this document to ABB technical support personnel. They have been trained and equipped to give advice on proper installation techniques and to help troubleshoot problems that relate to system grounding.

AC Ground (Safety Ground)

Grounding Symphony system equipment, associated control or test equipment, and all exposed conductive materials is not the responsibility of ABB. All grounding must be according to local regulations and must not be a hazard to operation and service personnel. Symphony system equipment design allows safety grounds to be installed in accordance with NFPA 70, NEC 1999, Article 250 and C22.1-1998, CEC Part 1, Section 10.

Harmony system equipment provides terminals for an equipment grounding conductor (not provided) at the equipment power input terminals. In addition to these terminals, all
control, driver, and workstation enclosures have two ¼-inch bolts for supplemental grounding. These supplemental connections allow for larger equipment grounding conductors. They also can be used to connect and bond enclosures that do not have power input connections, such as enclosures used only for I/O connections, to an adjacent grounded enclosure. Ground all unpowered control system equipment by connecting an insulated equipment grounding conductor from the unpowered enclosure to the powered enclosure. Connect the equipment grounding conductor to the enclosure at either the power input grounding terminals or the supplemental grounding connections (but not both). The powered enclosure must have an equipment grounding conductor that connects it to the installation site electrical system ground at the AC power source.

Minimum safety requirements dictate that the equipment grounding conductor run with the line conductor and grounded conductor (neutral) through the same cable, cord, conduit, or raceway from the AC power source to the load (powered enclosure). The purpose of the equipment grounding conductor is to maintain a low impedance path for ground fault currents from the load to the applicable overcurrent protection device within the service equipment. A low impedance path for fault current does not exist if only the line conductor and grounded conductor (neutral) run from the AC power source to the load. Connecting the grounding terminals of a PEP (load) solely to a grounding electrode creates a condition that could restrict fault current in the event of a line conductor to enclosure fault.

**WARNING**

The equipment grounding conductor must be installed properly. Improper installation creates a safety hazard. Electrocution may result.

**NOTE:** Do not use the structural metal frame of a building as the equipment grounding conductor for the control system equipment.

**Do not** mount the control system equipment to structural members that have a potential unequal to the ground circuit of the installation location electrical system. If mounting the control system equipment to structural members cannot be avoided, connect the structural members to the grounding circuit of the installation location electrical system. This equalizes any electrical potential that exists between the control system equipment.
equipment and the building. All conduit, raceways, and cable trays must be effectively grounded.

**Power Supply Common**

There are three types of system configurations:

- Harmony block systems - systems with enclosures containing Harmony block components only.
- Harmony rack systems - systems with enclosures containing Harmony rack components only.
- Systems with enclosures containing Harmony rack components and Harmony block components.

**WARNING**

Do not connect the I/O common bus to an electrically isolated grounding electrode. Using an isolated grounding electrode can create hazardous electrical potentials between AC and DC systems. These electrical potentials can lead to electrocution.

**NOTE:** Refer to Figures 6-1 and 6-2 for graphical representations of the power supply common connections in the three Harmony system configurations.

Harmony systems have the power supply common connected internally to the enclosure chassis. In all configurations, the enclosure chassis is also connected to the equipment grounding conductor.

**Other Grounding Considerations**

A large control system installation has many conductors and circuits installed in conduit, wireways, or cable trays. Although a control system is properly installed and grounded, unintentional ground connections can easily exist because of the way an industrial building is constructed. There may be refrigerant pipes, chilled water pipes, sprinkler system pipes, halon systems, compressed air tubing for thermostat and other controls, and air ducts. These are hung by wire or straps from the ceiling, usually above a drop ceiling. Others may rest upon or mount above the subfloor. Many of these conductive conduits, pipes, ducts, and structural members will be electrically interconnected at multiple points shared by the same hangers and clamp tiedown straps.
Wiring and Shielding

If many foreign conductive members penetrate an installation location, a room designed as a Faraday shielded room may no longer meet design criteria. Often refrigerant cooling pipes or copper tubes are connected to roof mounted condensers or heat exchangers. This arrangement is like running lightning rod downwires through the installation location because the roof mounted equipment are in effect lightning rods.

Electrical noise voltages and currents on conduit couple with the conductors inside that conduit. Nevertheless, it is possible to reduce the effects of noise on conducting members that penetrate an installation location by routing all conducting members through a single entry point ground window. A single entry point eliminates the voltage differences between equipment and the potential ground loop currents.

The isolation transformer for incoming power should be on the load side of the single entry point ground window. It may be possible to retain single point ground characteristics for shielded conductors by using double shielded signal conductors. Another method is running shielded cable with an outside insulating jacket through conduit. However, the outer shield or conduit may become a multipoint ground.

Wiring and Shielding

Wires that connect field devices to the control system may be subject to RFI and EMI. Using twisted pair wires helps reduce the effects of this interference. By using twisted pairs, the induced interference in each wire (from magnetic fields around those wires) is nominally equal and in the opposite direction, causing it to cancel. For information on the common mode rejection characteristics of a particular module or product, refer to the appropriate document for that device.

Shields should be grounded at one end only. Connecting the shield at one end eliminates circulating currents (and the resulting noise) by eliminating differences in potential between the two ends. A shield may be more effective in eliminating interference in cases where there is high frequency interference and short runs of wire. It is permissible to ground the shield at the field end if a good ground can be established. If a good ground cannot be established at the field end, ground the shield at the enclosure end where a good ground is certain if properly connected. Shield drain wires must be as short as
possible (preferably 25 millimeters (one inch) or less). They should be insulated from each other and metallic objects except at the point of connection. Figure 6-6 provides a graphical representation of shield connections for Harmony systems.

If the cable is sufficiently long, the shield may exhibit a high potential at its open (unterminated) end. Where this may occur, terminate the normally open end to ground using an X or Y-type 0.01 microfarad capacitor and a 150-volt MOV in parallel.

If magnetic induced noise is present, it may be necessary to connect the shield at both ends to reduce the effects. A better way to deal with magnetic induced noise is to use double shielded cable. Ground the inner shield at one end, ground the outer shield on the other end.

Connect wiring shields to the vertical common bus bar inside the field enclosure or cabinet. The vertical common bus bar used for shield grounding connects to the AC safety ground inside the enclosure. Tests have proven that shields connected to AC safety ground exhibit better transient immunity than those connected in some other manner.

Devices such as workstations, a host computer, or foreign device interfaces that communicate to the system through an RS-232-C port must be isolated.

**Verification and Testing**

When installing any AC distribution and grounding system, faults may exist in the system.

**NOTE:** Verification and testing of the AC power distribution system and the grounding system is mandatory at the time of installation and before power is applied to the control system.

In addition to the initial testing of the power and grounding systems, establish and maintain a power and grounding system preventive maintenance program. Contact ABB technical support for assistance in developing an AC power distribution and grounding system verification, testing, and preventive maintenance program.