AltiGen KB

Grounding an AltiGen Chassis

Introduction This document urges AltiGen PBX installers to provide a frame ground path to the AltiGen chassis as an independent ground for system fault currents, transients, surges, and small signaling currents. It provides a list of things to avoid and things to do to provide an adequately grounded system. It also recommends that the AltiGen system have its own dedicated power outlet. Detailed diagrams are included.

Nothing in this document should be construed to supercede the National Electric Code (NEC) requirements and recommendations.

Contents

General Requirements for Telecommunications Systems

The building electrical systems must be grounded per NEC. This is the responsibility of the building owner/leasor, who should ensure that this has been provided by a qualified electrician.

All metallic systems must be bonded. Bonding is the coupling with copper of the metallic grounded components. Bonding is always accomplished by welding or significant pressure provided by clamps and machine screws to provide a gas-tight, low resistance bond. This is very important for protection of people and equipment. Bonding is necessary to prevent excessively high voltages between system equipment and other metallic grounded items. The objective is to limit the voltage between components when power crosses, lightning hits, line surges occur, or induction from any of these occurs. Any metallic fixture containing electronic equipment must have a metallic path to ground. For small electrical equipment, this is provided by the safety green wire that is provided via the line cord.

Caveats

§ The green wire must never be isolated, either by cutting it or installing a line ground cheater.

§ Never attempt to power up any metallic cabinets without the green wire path to ground intact. This wire must always be attached and provide a drain path to ground. Without this ground, the chassis will go to a voltage mid-way between 120V and ground due to the voltage dividing action of the EMI caps in the power supply surge protection circuit. There will be NO ground reference and even the smallest surge or imbalance could cause hazards to personnel as well as equipment.

§ Always use a power cord to the chassis with a green wire at least as heavy in gauge as the power wires.

§ Never depend on solder wires or sheet metal screws to attach ground bonding wires. This violates the NEC and UL requirements. Always use machine screws, where proper torque can be applied to assure sufficient pressure for a high conductivity connection that won't loosen when equipment is moved.

§ A gas pipe or sprinkler system pipe is unacceptable for use as a ground. Do not use any black pipe for grounding,

§ Do not use a hot water pipe for ground. This includes steam pipes.

Requirements for a Ground System

Grounds: Keep in mind that all grounds, other than the multiple ground neutral (MGN) (white wire), are normally non-current carrying. The MGN carries the power imbalance. The green wire serves as an assured safety path to ground, and should always provide continuity whenever power is applied to the system. The frame ground provides for fault currents, transient surges and small signaling currents. Thus each ground provides a designated path for a particular purpose. In addition, collectively they assure that everything maintains a minimum mutual differential potential.

Water Pipe: A water pipe connection must be within 5 feet of a building entrance, or be a pipe that only authorized maintenance people would service, that is, a major feed pipe 4" or greater in diameter. Plumbers don't want to become part of a fault return path and expect to see the ground at the entrance. Note: To conform to NEC specifications the water pipe must be longer than 10 feet. A metallic water pipe system can be an excellent ground source.

Supplemental electrodes: A ground rod, ground field, or concrete-encased electrode or significant building structural steel must be part of the essential ground. The water pipe alone cannot be the ground. The water pipe must be continuous metal; water meters, and so on, do not count as continuity, but if encountered they must be bypassed with a bonding wire of at least #10 AWG. A supplementary electrode must be less than 25 Ohms, per NEC. For telecommunications products, the industry requirement is to be less than 5 Ohms. Remember, the purpose of a ground window and tying all parts to this reference is to provide for a safe building.

Concrete: If concrete is to be used as a supplemental ground, it must have a concrete-encased electrode and be identified as a ground conforming to NEC per article 250. Note: This is not the first choice for a ground, and can be used in parallel with the water pipe ground. Whether the concrete-encased electrode or ground bar is better, depends on which one has the lower resistivity. Neither is a sufficient ground by itself. Bonding all grounds together is imperative and is covered nicely in these Rural Utilities Service (RUS) documents:

§ RUS Bulletins 1751F-801, "Protection at Customer Locations."

§ RUS Bulletin 1751F-810, "Electrical Protection of Digital and Lightwave Telecommunications Equipment," is superb in illustrating grounding.

The MGN generally has the lowest resistance to ground. It can be used as a reference to verify the integrity of the other grounds, but it must never be directly attached to the equipment. Note: it will have a small AC voltage due to power load imbalances under normal conditions, thus making a simple Ohm measurement sometimes difficult. (Under error conditions it could be the phase lead.) Also, even if proper, it has a small possibility of being poorly bonded, and load imbalance would thus put severe stress on AltiGen equipment. So don't tie into it. Its sole purpose is reference power circuit to ground and it is common to all grounds at the main power circuit breaker box, or at the MGB master ground bar if an isolated ground zone (IGZ) is provided.

Recommendation for Altigen Equipment

A second ground path, frame ground, must be provided to the chassis. The supplemental ground wire to the AltiGen equipment is essential, even when equipped with only loop start trunks. This wire should be a minimum of #8 GA copper connected to a minimum #6. (Note the exception provision for Office 1, in the Bonding section, below.)

All electrical equipment in metallic cabinets associated with the AltiGen equipment should be bonded to this #6 copper wire. This #6 wire must not be run through any iron or steel conduit. Doing so increases the inductance of the return by orders of magnitude (iron pipe ur = 1200), thus increasing the transient voltages on the equipment by potentially thousands of volts.

The primary reason for the extra ground (frame ground), is to provide an independent ground for system transients and signaling. The green safety wire is too small a gauge for adequate protection from transients. It may be routed through steel conduit, and its sole purpose is to provide a no-current reference for the system and drain off small leakage currents. It is not intended as a ground for surges, nor a return path for DC signals, but rather for 60Hz leakage current that an internal fault may provide. It also provides a reference voltage to the chassis. (A note of clarification regarding the safety wire: When the return is through the steel conduit itself, then there is no inductance enhancement due to the steel.)

Bonding

Good bonding of grounds connections is very important. If proper bonding isn’t present, good performance or safety cannot be assured. This is a code issue as well as a technical performance issue.

§ All grounds should be properly bonded. They should have low resistance between them. For example #6AWG is 400uOhms/foot, #10 is 0.001 Ohm/ foot and #14 is 0.0025 Ohms/ft at 60Hz, 25C. Thus if you were checking an installation complying with recent code, the resistance between green wire and frame ground would be as follows (Note: for office 1, a 10AWG wire from Office 1 to the Demarc protection bar may be used satisfactorily):

§ Green wire is 100 feet long = 0.25 Ohms

§ The #6 Ground, if tied to the water pipe at the same point that the main panel is tied to the pipe, and is 25 feet long = .01 Ohms. The total resistance = 0.26 Ohms. Note: The Main Panel is the panel where green wire and MGN come together. At the main panel in the simplest of installations, the ground bus in the panel will have a ground wire going to a water pipe, the MGN will tie to this point, and the green wire will tie to this point.

§ In the above example if our system took a hit from a power line to our cabinet and a 500 A surge occurred from an AC contact, the voltage rise would be only 500* 0.01Ohms = 5 volts. If the extra wire was not present, the rise would be 500*.26 = 110 volts. This does not apply to the transient effect of a lightning hit, just the 60Hz voltage level.

§ If the current was a 50 Amp transient, due to induction from a lightning hit on the telephone line (our trunks), and good primary protection is present, one could reasonably expect to see a transient with a rise time of 1us. This pulse is due to our sidactors conducting; and if the 14Ga wire ran through steel conduit; which as mentioned above is highly probable, the voltage rise would be e=Ldi/dt. L.> 500uH. Thus the chassis voltage rise would be 25,000V. With the #6 wire from the chassis not in steel conduit, the rise would be 12uH. Or the voltage rise would be 600V, rather different from the 25,000V alternative.

§ All ground sources must be bonded together (see NEC article 250):

§ metallic cold water pipes

§ multiple ground neutral (MGN) – white wire

§ non-current carrying safety drain – green wire

§ communications system ground – frame ground, #6 AWG bus

§ metallic frame building

Use # 6 AWG, solid or stranded, as main ground bus for the AltiGen equipment chassis. If stranded is used, a solid block should be available at the end to attach ground wires to the chassis.

The source end should go to the main ground window of the building, or as a minimum go to a substantial conductor that feeds to this window. Note: Sometimes this window is not present. In that case, a suitable alternative must be determined. (See appendix for an example.)

Use #8 stranded to bond all associated chassis to the bus.

Dedicated Power Outlet

For reliability, is best if the AltiGen system has its own dedicated power outlet.

§ This minimizes the noise it will see from other sources, especially if it is not installed in an isolated ground zone (the computer rooms).

§ It assures that the system won’t go down because someone connects another competing load for power. You have direct control of the power demand on the dedicated branch circuit.

§ If the power feed is through steel conduit, the conduit will further aid in the attenuation of noise. It is a big inductor.

Make sure a good surge arrestor is installed in the power feed line. This can greatly help in protecting the equipment from metallic surges, as well as reduce the longitudinal surge.

Verify that the power leads are connected properly. Use a line tester, such as a Sure Test model ST-D1.

Appendix

Minimal Ground System

Major Telecom Installation. (For reference only)

Some arithmetic examples follow:

In the first example above, the power ground and telephone ground are not bonded; they have independent grounds. As shown in the example, with a surge on the power line of 500Amps to the power meter, with or without surge arresters, the surge goes to ground through a ground rod of 25 Ohms. The entire power to the building will rise 25,000 volts, but the telephone lines won't, since they aren't bonded. After the circuit breaker blows, everything else will be history.

However, if the 6AWG ground wire is installed, we can now keep this potential across the telephone equipment to about 8 volts. This shows the importance of bonding.

The third view shows a typical lightning induced surge on the telephone line. If we assume 20Ohms to ground through the sideactor and PTC, and a 10x1000us pulse of 1000 volts, we get 50 amps to ground. Even if the #6AWG wire is in place, but is run through steel conduit, we get at least 2500 volts; whereas, if the wire does not go through steel conduit, the voltage transient is 60 volts.

Definitions

bonded: Welded, or pressure coupled with clamps and machine screws, per NEC article 250. All ground sources must be bonded together. This means they should have low resistance between them.

building structural ground: A grounding source provided by the structural steel, contained within the building walls, roof, floors, footings and foundation.

cable entrance ground bar (CEGB): A copper ground bar to terminate incoming telephone cable shields on a common connection point. This bar is normally located close to the cable entrance location.

green wire ground: A normally non-current carrying conductor that protects personnel and equipment.

ground loop: Ground loops exist whenever there is more than one electrical path to ground. These parallel paths to ground are not normally a problem if associated with non-voltage sensitive circuits. Grounds are avoided with isolated ground zones (IGZ). If multiple telecom boxes are installed, an IGZ should be considered.

ground window bar (GWB): A copper bar for the common connection of all equipment within an IGZ. See green wire ground and master ground bar.

intermediate ground bar (IGB): A copper bar, insulated from its support, used to connect a ground wire from the master ground bar to several racks or pieces of metallic enclosed equipment, usually in a non-IGZ.

isolated ground zone (IGZ): A dedicated area within the office building where all equipment is electrically insulated from all external grounds, except through a single ground connection between the ground window bar and master ground bar.

master ground bar (MGB): A copper bar used as a single-point connection for surge producers, surge absorbers, non-IGZ equipment grounds and IGZ grounds. The MGB is normally non-current carrying, and isolated from the building structural ground.

MDF protector assembly: An assembly consisting of the protector module and a connector module. These modules connect an arrester between each conductor and ground. These arresters, commonly called primary protection, limit the voltage in the event of a inductive surge power cross, or induced surge due to power fault or lightning to typically < 1000 volts.

metallic water pipe: An outdoor section of metallic water pipe with at least 10 feet in length buried.

multi-ground neutral: A continuous electrical conductor on a power distribution system with multiple direct connections to ground at multiple points. At least four grounds must be provided per mile of distribution power line. This wire provides a very low impedance to ground for lightning hits and other power line surges. Since it also provides a return path for unbalance loads, it will have a voltage drop. Thus it is not directly tied to electronic equipment.

surge absorbers (A): Paths with a low impedance connection to a remote ground. A grounding element with a low impedance path to earth ground is considered a primary surge absorber. There are three primary surge absorbers:

§ The service system ground itself

§ The multi-grounded neutral (MGN)

§ A metallic water system

surge producers (P): Connections to metallic sources of lightning and /or power surges.

§ Telephone cable pairs

§ Telephone cable shields

§ Power system conductors.

§ Metal Cabinets connected to each other. Each should have its own frame ground.

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