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DMS-10 Family

600-Series Generics

Grounding System

06.01
For Generic 602.20 Standard August 2006

NORTEL

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Contents

Section 1: Introduction

Scope and purpose

This Nortel technical publication (NTP) summarizes the requirements for a DMS-10 central office (CO) ground network and its Isolated Ground Zone (IGZ) or Isolated Ground Plane.

Definitions

Terms used in this publication are defined as follows:

AC EQUIPMENT GROUND (ac/AC EG; alternating current equipment ground): A normally noncurrent-carrying conductor that is provided for the protection of personnel and equipment. Its green color distinguishes it from the current-carrying grounded conductors (neutrals) which are natural, gray, or white.

BUILDING/STRUCTURE GROUND: A ground bond connected to structural steel and/or reinforcement rods, such as found within the building's walls, roofs, floors, foundations, and footings.

CABLE ENTRANCE GROUND BAR (CEGB): A piece of electrical grade copper used to terminate incoming cable sheath grounds at a common point. The CEGB is normally located near the cable entrance, usually in a cable vault, if provided.

DISTRIBUTION FRAME GROUND BAR (DFGB; also called the MDFGB): A piece of electrical grade copper located on the Main Distribution Frame (MDF) and used as the common connection point for tip cable shields and MDF protector assemblies. The DFGB may or may not be isolated from the MDF, depending upon operating company guidelines.

FRAME GROUND BAR (FGB): A piece of electrical grade copper, located within the IGZ, to which all rows of equipment bays within the IGZ are radially linked by #6 AWG insulated cable. A single #2/0 AWG or larger cable connects the FGB to Section I (the IGZ section) of the Master Ground Bar (MGB). The FGB allows easy separation of the IGZ equipment frames from the MGB for maintenance and integrity testing of the IGZ. For offices subject to Rural Electrification Administration (REA) guidelines, consult REA tables for cable length and dc resistance. For offices subject to Independent Operating Company (IOC) guidelines, consult appropriate corporate documentation. For Bell Operating Companies (BOC) offices, the #2/0 AWG or larger FGB conductor will terminate on the Main Ground Bus located within the Ground Window as shown in TR-EOP-000295.

GROUND GRID: A series of buried interconnected ground rods which provide a low resistance connection to earth ground.

GROUND JUNCTION BAR (GND JUNCTION BAR): A piece of electrical grade copper that is isolated and located on top of the PE-1 bay or, for the Large Cluster Controller (LCC) feature, on top of the CE-1 bay (J1T30E). The GND Junction serves as the 48 V return junction for dc power distributed only to DMS-10 equipment bays.

GROUND WINDOW: A dimensioned spherical transition zone, of a maximum radius of three feet, that is the interface between the integrated ground plane of a CO and an IGZ. After passing through the Ground Window, all conductors associated with the IGZ are isolated from the CO integrated ground plane because they have become part of the IGZ.

GROUND WINDOW SPLICE PLATE (GWSP): A piece of electrical grade copper located on top of the Power Distribution bay (PD-1). The GWSP is the main dc-return conductor between the GND JUNCTION and the Master Ground Bar. It is isolated from equipment frame and building ground. The GWSP is connected to Section N of the Master Ground Bar by two #4/0 AWG insulated cables for redundancy and maintenance of the installation over its operating life. These cables are normally noncurrent-carrying and provide the earth ground connection for the DMS-10 system, either by way of the Master Ground Bar or, in a BOC office, by way of the Main Ground Bus.

INCIDENTAL GROUND: An unplanned grounding connection, such as might occur if the mechanical assembling and installing of frames, raceways, piping, ducts, and other conductive objects formed a path that connected to building/structure ground.

For a complete listing of NTPs, refer to the *Index to Nortel Technical Publications* (NTP 297-3501-000).

INTEGRATED COLLECTION BAR (ICB; Option S): An isolated piece of electrical grade copper to which all metallic objects within seven feet of the DMS-10 Isolated Ground Zone (IGZ) or Isolated Ground Plane (IGP) equipment must be connected if they are not connected to the central office's Master Ground Bar or Main Ground Bus.

These metallic objects may include lighting conduit; auxiliary framing; cable and relay racks; heating, ventilation, and air conditioning (HVAC) ducts; doors, door and window frames; water coolers; high pressure water radiators; steam lines; exit signs; air conditioning units; baseboard heaters; ac power branch panel enclosures; or any metal object that could, intentionally or unintentionally, be connected to, and cannot be insulated from, the building's integrated ground plane or non-isolated ground zone.

ISOLATED GROUND ZONE (IGZ; also called, in a BOC office, the Isolated Ground Plane): A dedicated area with specific boundaries within the CO. The DMS-10 switch must be located inside the IGZ and all circuits within the IGZ must be electrically isolated from all external grounds except for a single ground connection from the GND JUNCTION, through the GWSP, if provided, to the MGB or, in a BOC office, the Main Ground Bus. In this document, the abbreviation “IGZ” shall also refer to the Isolated Ground Plane of a BOC office.

MAIN DISTRIBUTION FRAME (MDF or DF): A frame containing terminal blocks where cables from outside plant and office equipment are protected and terminated. Outside plant is terminated on vertical rows of blocks and office equipment is terminated on horizontal rows. Cross-connection flexibility and organization are provided by jumper pairs between horizontal and vertical terminal blocks.

MAIN GROUND BUS: In a BOC office, a bus bar located within the ground window used to provide the electrical interface location for connections between the building's integrated ground plane and the isolated ground plane.

MASTER GROUND BAR (MGB): A piece of electrical grade copper, also called the CO-GND, that is isolated from building/structure ground and serves as the principal ground for all equipment associated with a CO, such as the MDF, cable sheath, battery rack, miscellaneous equipment bays, and the DMS-10 switch. The MGB is (under normal quiescent conditions) noncurrent-carrying and provides a single connection to earth ground. Connections to the MGB must be grouped and ordered as producers (P), absorbers (A), non-IGZ (N), and IGZ (I), according to accepted industry standards. The MGB must be labeled as such, and its four sections must be identified as P, A, N, and I.

MULTIGROUNDED NEUTRAL (MGN): The grounded conductor of the commercial ac distribution system.

PERSONAL HAZARD GROUND RIBBON/STRAP: A copper ribbon or strap that runs the length of each DMS-10 bay line-up, in the cable trough on top of the bay frames, for personal protection.

SURGE ABSORBERS (A): Surge-absorbing paths with a low resistance connection to earth ground. A grounding element which has a low resistance path to earth ground is considered a primary surge absorber, such as a CO ground field, a multigrounded neutral (MGN) connection, or a metallic water system.

SURGE PRODUCERS (P): Connections to metallic sources of lightning and/or power surges, such as indoor office cabinets or bays associated with radio and microwave equipment, the collective telephone cable shields by way of the Cable Entrance Ground Bar (CEGB), the Distribution Frame Ground Bar (DFGB), and the auxiliary ac power plant frame.

General

A structure housing telecommunications equipment must include an adequate grounding network for all equipment and systems. Deliberate or incidental interconnections may form a ground network which may cause serious problems in providing adequate ground for both normal operation and fault conditions. Ground paths that can create problems, if not properly connected in the total ground network, include ac conduits, high-voltage protection devices, building structural steel, heating and air conditioning ducts, and metallic water pipe systems. Building lightning grounds and antenna towers are surge producers and must not be brought into the building to either the MGB or the Main Ground Bus.

The DMS-10 switch is designed with the protection necessary to withstand normally-encountered transients and surge currents. External voltage transients or surge currents injected into the DMS-10 switch can damage the equipment or cause erroneous operation. To minimize disturbances caused by fault conditions and noise, the DMS-10 switch requires a single-point ground system within an IGZ. The grounding arrangement outlined in this NTP provides adequate integration of the DMS-10 IGZ into the building ground network and provides the necessary protection under most fault conditions.

Annual maintenance

An annual ground audit, consisting of tests identical to those used at initial installation, is strongly recommended to ensure that no adverse incidental grounds have been created since the previous inspection. The IGZ Integrity Test must consist of the following two steps:

1) Clamp an ac/dc amp meter around the conductor from the Frame Ground Bar (FGB) to the MGB. The preferred reading is less than 100 mA; the ideal reading of 0 mA is possible only by the use of non-conductive interface with input/output devices or with input/output devices that have internally isolated signal and chassis grounds.

2) Remove the FGB-to-MGB ground lead and measure the IGZ isolation with a digital multimeter. The minimum objective is 2 megaohms; the ideal measurement is infinite resistance.

Earth ground measurements are recommended biannually, after the initial installation measurement, to record any change in earth ground resistance from the time of installation.

A Ground Audit Service is available from Nortel Networks Corporation Additional information about this service may be obtained from the local Nortel Networks Corporation sales representative.

Compliance

The grounding procedures outlined in this NTP are intended to reflect the latest issues of the following Nortel Networks Corporation drawings: SD0T01-11 (DMS-10 System Application Schematic) and SD0T01-06 (DMS-10 400-Series Generics Remote System Application Schematic). Together they represent the most advanced information available. The latest issues of these drawings are required for the adequate installation, protection, maintenance, and performance of all DMS-10 equipment installed after this NTP's date of issue.

Deviations or exceptions to this NTP and the documents referenced above, in regard to any DMS-10 equipment installed after this NTP's date of issue, must be brought to the attention of DMS-10 Customer Engineering Department, Nortel Networks Corporation, as soon as the discrepancy is recognized. Approval of any deviations or exceptions to these requirements must be obtained in writing from Nortel Networks Corporation before power is applied to any equipment or the system.

The intent of this publication is to comply with recognized operating company grounding practices and the procedures outlined in the following documents:

- *Isolated Ground Planes: Definition and Application to Telephone Central Offices*, Technical Requirement TR-EOP-000295, Issue 1 (November, 1987), published by Bell Communications Research, Inc.
- "Electrical Protection Grounding Fundamentals," Section 802 of Telecommunications Engineering and Construction Manual, Issue 2 (September, 1984), published by the Rural Electrification Administration
- "Electrical Protection of Electronic Analog and Digital Central Office Equipment," Section 810 of Telecommunications Engineering and Construction Manual, Issue 6 (September, 1983), published by the Rural Electrification Administration
- *Electronic Analog and Digital Central Office Protection Design, Installation, and Maintenance*, Contel System Practice 540-100-11/400-700-025
- *Central Office Grounding Systems Engineering Applications*, GTE Telops Practice 795-805-071, Issue 7, August 1988
- *Electrical Protection of Digital Central Office Equipment*, ALLTEL System Practice ASP 540-100-011, Issue 3, August 1988

Upgrading existing systems

The increased protection provided by the grounding system enhancements outlined in this NTP can be accomplished with any existing DMS-10 system.

These enhancements include:

- elimination of commercial ac in the DMS-10 IGZ
- separate FGB
- isolation of DFGB and protector grounds
- organization of MGB connections

These enhancements can be accomplished by using compatible Miscellaneous Equipment bays equipped with inverters, by implementing the enhanced grounding connections, and by reconnecting frame grounds in accordance with the SD0T01-11 options.

In addition to enhanced protection, these improvements stress organization and visibility of the IGZ elements, reduce the risk of IGZ violations by equipment added by the operating company, and facilitate the recommended annual audit process.

References

For more specific details and additional information concerning the grounding of DMS-10 systems, refer to SD0T01-11 or SD0T01-06. These schematic drawings contain block diagrams of an entire CO and major sub-sections of a DMS-10 switch. The following documents are also referenced in this NTP:

- NTI SD2419-01, *Charge and Discharge Circuit*
- NTI ED0T03-10, *DMS-10 Specifications for Typical AC Wiring and Frame Ground*
- *National Electrical Code 1987 Handbook*. Peter J. Schram, Editor. Quincy, Massachusetts: National Fire Protection Association, 1986
- *National Fire Protection Association Manual*. NFPA-78. Quincy, Massachusetts: National Fire Protection Association, 1986
- *Canadian Electrical Code*, C22.1 (1986)

Nortel Networks Corporation documents are available from an operating company's Nortel Networks Corporation representative.

Section 2: Central office grounding

General

The central office (CO) grounding must use a single point to provide a uniform reference potential for an entire switching system. Although the voltage at this connection point may rise above zero volts-to-earth-ground under fault conditions, the entire switching system will also rise at the same rate to the same voltage. This characteristic helps minimize any voltage differential between switch components during a condition of lightning or other power surges.

Earth ground

Earth Ground is provided to the CO and the DMS-10 switch by a dedicated ground grid. When a ground grid is placed around the perimeter of a structure, it should be at least 3 feet (0.91 m) away from the foundations and 2 feet, 6 inches (0.76 m) below normal grade level (or below frost line, whichever is greater) to maintain wet-earth contact. In normally dry climate areas, ground rods should be driven approximately 10 feet (3.05 m) apart, depending upon their length, and permanently connected to the buried grid to assure wet-earth contact. Cadweld connections are recommended. The required rod length is determined by the type of subterrain and the normal water table level. For additional information on driven ground rods, refer to Section 802 of the REA manual identified in Section 1 of this NTP.

The cable connecting earth ground to Section A of the MGB must be of sufficient size to assure a low resistance (0.005-ohm) connection. This cable must enter the building through nonmetallic conduit ONLY and comply with the cable installation requirements listed below.

The earth ground resistance, including cable to the MGB, should be less than five ohms (and must be less than twenty-five ohms) for a single system when measured with the three-electrode “Fall-of-Potential” method at the MGB, but with cable disconnected from the MGB. (Refer to *Getting Down To Earth*, Biddle Instruments Co., Manual 25TA.)

To obtain less than five ohms for the earth ground resistance may be difficult in some instances. Reasonable grounding improvements may be necessary before any deviation above the five-ohms objective is considered. Some improvements that should be attempted are:

- Add additional ground rods to the existing electrode by means of permanent bonding with #6 AWG or larger copper cable. (Tinned dipped #2 AWG solid soft-drawn copper is recommended.) Four to eight 8-foot (2.45-m) rods, spaced 10 feet (3.05 m) apart, are recommended.
- Drive extended sectional ground rods to a depth of up to 32 feet (9.75 m).
- Treat soil around electrode(s) or grid area to lower earth resistivity. The preferred soil treatment method is the use of Bentonite as a backfill material in areas of extremely high soil resistivity. As a last alternative, chemical treatment may be used. Magnesium sulfate, copper sulfate, and ordinary rock salt are suitable materials. However, chemical treatment of soil is not permanent and must be replenished periodically, depending on the soil porosity and the amount of rain.
- A salt pond containing a buried grid may be considered at high elevations with rocky terrain or in a shallow subsoil layer area. A driven metallic well casing, or pipe contacting water-table level, or both, may be required in dry areas with sandy soil.

Water system ground

A commercial water pipe system should not be used for the primary CO earth ground electrode. Future modifications to an existing system, or the use of plastic pipe, could make a water pipe system useless as an earth ground electrode. When a water pipe ground or building/structure ground (that is, a footing electrode) is substituted for a ground grid, it must be approved by Nortel. If a water pipe system is used as the primary CO ground grid, it must meet the following requirements:

- A continuous length of buried metallic pipe of a minimum length of 40 feet (12.19 m) must be owned and controlled by the operating company.
- Connection to the water pipe must be made at the street/supply side of any water meter and/or valve, and all meters and valves must be jumpered with #6 AWG copper cable.
- The earth ground resistance, including cable to the MGB, must meet the less-than-five-ohms objective for a single system. A water pipe ground electrode is not allowed as the earth ground for a shared system.
- A metal well casing, 6 inches (152.4 mm) in diameter, owned and controlled by the operating company, that is deep enough to make contact with the water table, even under dry climate conditions, is also allowed. The CO ground conductor must be Cadwelded to the metal well casing. The less-than-five-ohms objective indicated above applies. The well casing should not take the place of the ground field.

Lightning protection

Building air terminals and antenna towers must have a separate, dedicated ground field or ground electrodes for primary earth ground terminations. The primary grounding electrodes for these devices should be referenced, outside the CO, to the dedicated CO earth grounding provided for the DMS-10 switch.

When a CO complex or building contains separate lightning rod and/or antenna tower ground fields or electrodes, these individual ground fields must be referenced to the CO ground field by connecting a cable of #6 AWG minimum size between them, outside the CO building (preferably underground). The 0.01-ohm objective shown in Figures 3-1 and 3-4 must be met. The lightning rod or tower grounds must not be connected directly to the MGB.

Over-voltage protection

Primary overvoltage protection is required at the MDF for all telephone cable pairs. This protection may be provided by 0.003-inch (0.076-mm) carbon 450 V protector modules (Cook Model 303-0350 or equivalent). Gas tube protectors (Cook Model 303-0750 or equivalent) are recommended for low maintenance protection. Gas tube protectors with a back-up gap (Cook Model 303-0755 or equivalent) provide low maintenance and extra reliability. Solid State Overvoltage Protector Units (Cook Model 12-A or equivalent) are also available.

Antenna towers require special protective considerations because of their high vulnerability to lightning strikes. Microwave systems must be protected with heavy-duty gas tube arrestors at the carrier interface. The arrestors must be grounded at the MGB. Grounding cable(s) must meet the installation requirements listed under "Cable Installation."

Suitable protectors are recommended on the ac electrical power secondary circuit to the operating company. Power company protectors are usually not adequate (9 to 10 kV) when provided to protect watt-hour meters at service entrances. Secondary power arrestors of less than 1800 V peak must be provided either at the power pole for underground entrance or at the conduit weather head for an aerial entrance. The installation of appropriately-rated ac surge arrestors (such as the Joslyn Model 1265/ 1455 or equivalent) within the CO building and as near as possible to the main disconnect switch is highly recommended. Units with alarm capabilities are preferred.

If an automatic transfer switch for emergency transfer of ac power is on site, the placement of the (Joslyn) ac surge arrestor before or after the transfer switch is at the discretion of the operating company.

Master Ground Bar

The Master Ground Bar (MGB) provides termination of the CO connections listed below:

- P (Producers): Telephone cable shields at the entrance to the cable vault or building, normally by way of the CEGB, the Distribution Frame Ground Bar (DFGB), any standby power generators, radio equipment grounds, and any other equipment that could be classified as a producer of surges
- A (Absorbers): CO earth ground field, metallic water pipe ground (service side of any shut-off valve and water meter), ac-bypass to MGN, and building/structure ground
- N (Non-IGZ): Ground Window Splice Plate (GWSP) and miscellaneous grounds (for example, heating and air conditioning ducts, battery rack, miscellaneous equipment frames, cable racks, and MDF ironwork if isolated from the DFGB)
- I (IGZ): The Frame Ground Bar (FGB)

For the exact placement of conductors, refer to the appropriate system schematic drawing.

Cable installation

All cables listed above, with the exception of the GWSP and FGB connections to the MGB, are normally supplied by the operating company and must be in place prior to applying power to the DMS-10 switch. The routes of all cables connected to Sections P and A of the MGB must be shown on building floorplans and related drawings provided by the operating company. All cables connected to the MGB must:

- have an insulating cover and not make intermittent contact with the building/structure ground
- have permanent terminations using a two-bolt crimping lug that result in a low-resistance connection
- be routed only through nonmetallic conduit (if passing through walls or floors)
- be noncurrent-carrying under normal conditions, except the CEGB, which usually has ac current from cable shields
- be routed in the shortest, most direct route that is practical, without passing through the IGZ
- be accessible (except when buried in earth or concrete) for inspection and maintenance
- be continuous with no splices or junctions

- not have sharp or right-angle bends of a radius less than 12 inches (304.8 mm), not be bundled with any signal or power cables, and not share the same rack with signal and power cables
- not be run adjacent to or through MDF framework (except those that originate at the MDF)
- In addition, the cable connecting the CO with the MGB must be tagged at both ends with the warning "DO NOT DISCONNECT," and be identified with labels at both ends.

Tower cable installation

Cables, such as coaxial, heliax, and waveguide cables, that are associated with towers and that also interface with Improved Mobile Telephone Service (IMTS), paging equipment, mobile radio, Cable Television (CATV), or microwave radio equipment, must meet or exceed the requirements given in REA Section 810, Appendix B. The use of surge arrestors located at the tower leg or cable entrance plate, sometimes referred to as a cable hatch, is also recommended for each cable. Contact Nortel DMS-10 Customer Engineering for additional information in regard to particular circumstances.

ac power panel ground

All ground conductors and conduit emanating from the ac service panel must comply with the National Electrical Code (NEC), Article 250 entitled Grounding, or the Canadian Electrical Code C22.1. All cables must be copper conductors without splices or joints between the panel and the ground electrodes. The wire gauge used must comply with NEC 250-94, this NTP, and installation specifications where applicable.

In an REA-based office, a buried metallic water pipe is referenced to the ac service neutral. The water pipe must be connected to the MGB with a separate #6 AWG or larger copper cable at the street/supply side of any water meter and/or valve. In a BOC office, the ac service is connected to the metallic water pipe with a #2 AWG or larger conductor. A #6 AWG or larger jumper cable across the meter and/or valve is also required to assure grounding of the building water pipe distribution system.

An insulated conductor that connects the ac service neutral at the ac service panel to Section A of the Master Ground Bar is required. This conductor is labeled the ac Bypass cable. The ac Bypass cable size is dependent on its length; see Table 2-A.

Conduit or armor on cable is not intended to provide the primary "equipment ground." The equipment ground (ac EG) must be provided by a separate insulated conductor that is the size specified in NEC Table 250-95, or the same size as the load-carrying conductor.

Table 2-A: Recommended sizes of ac bypass cable	
Cable Length	**Cable Size (AWG)**
0-50 feet (0-15.24 m)	00 (2/0)
50-75 feet (15.24-22.86 m)	000 (3/0)
75-100 feet (22.86-30.48 m)	0000 (4/0)

Note: *The ac Bypass cable is installed in accordance with the requirements outlined in the paragraphs entitled "Cable Installation" in this section of this NTP.*

Auxiliary ac power

Auxiliary ac power (standby motor generator) grounding should comply with the National Electrical Code. The commercial ac service neutral conductor and the generator neutral conductor are bonded within the transfer switch panel; consequently, a direct electrical connection between the grounded circuit conductor (neutral) and the generator exists. Therefore, the system supplied by the generator is not a separately derived system and grounding the neutral at the generator is not permitted. However, an equipment grounding conductor must be run from the commercial service equipment to the 3-pole transfer switch and from the 3-pole transfer switch to the generator. If the generator is outside the central office, the frame of the generator can also be grounded by means of a ground rod. If the generator is in another building, the frame of the generator can also be grounded to that building's steel.

Miscellaneous equipment

Non-DMS-10 switch equipment frames may be located within the IGZ if they are isolated from the building/structure ground, and if they contain no protectors, and if they have separate battery and frame grounds. These non-DMS-10 switch equipment frames may be bolted to DMS-10 frames and have a frame ground connection to the FGB.

The -48 Volt battery for all non-DMS-10 switch equipment bays within the IGZ must be supplied from the Power Distribution Panel (J0T75) within the DMS-10 switch. Battery return for this IGZ equipment must terminate on the DMS-10 switch Ground Junction Bar.

Non-DMS-10 switch equipment frames that are not isolated from building/structure ground and external metalwork (for example, ac conduit or cable racks) must not contact or be connected to DMS-10 switch frames. Non-isolated equipment frames must be connected directly to Section N of the MGB with separate ground cables. If the non-DMS-10 switch equipment contains isolated secondary protectors or arrestors mounted in the equipment bays, those protectors must also be connected directly to Section P of the MGB.

The -48 Volt battery for all non-DMS-10 switch equipment bays outside the IGZ must be supplied from the power distribution bay located outside the IGZ. Battery return for non-DMS-10, non-IGZ equipment must not terminate on the DMS-10 switch Ground Junction Bar.

Any equipment or metalwork that is grounded directly to the MGB must be mounted at least 7 feet (2.13 m) away from equipment grounded directly to the GWSP or to the FGB. This distance is adequate for reducing the chance of electrical shock hazard which can exist between various pieces of metalwork during local electrical storm activity. If the minimum distance cannot be met because of building restraints, then equipment should be placed, guarded, or screened so that operating company personnel cannot simultaneously contact two or more pieces of metalwork that are not grounded directly to a common ground bar. If the minimum distance cannot be met, and if protection cannot be provided to prevent operating company personnel from simultaneously contacting two or more pieces of equipment or metalwork not grounded directly to a common ground bar, Nortel recommends the installation of an Integrated Collection Bar (ICB; Option S), as shown on SD0T01-11, and also in Figures 3-1 and 3-2.

IOC Main Distribution Frame ground

The isolation of MDF protectors and the Distribution Frame Ground Bar (DFGB or MDFGB) is strongly recommended. Frames provided by Nortel Corporation's Cook Electric Division can be equipped with the isolated ground bar option. The isolation of the C-310, C-377, C-378, and C-388 families of main frame connectors can be done by using the installation hardware included with each connector.

Isolated protector blocks at the MDF must have separate grounding conductors connected to the DFGB and must not depend on their mechanical connection to the frame for this ground connection.

The DFGB is connected directly to Section P of the MGB with a #2/0 AWG or larger (depending on cable length) insulated conductor. One conductor for every 10 feet (3.05 m) of DFGB is required. The #2/0 AWG or larger cable should be connected to the DFGB with a two-bolt crimping lug.

If the main cable shields are not terminated at a Cable Entrance Ground Bar (CEGB), they must be grounded at the DFGB. If the main cable shields are terminated at the CEGB and the tip cable shields are grounded at the DFGB, the two shields must be separated from each other for a distance of at least 3 inches (76.2 mm) after the CEGB termination, and preferably 10 inches (255 mm). For personnel protection, the cable shields must not be separated if the CEGB and the DFGB can be simultaneously contacted by personnel.

BOC Main Distribution Frame ground

The telephone cable sheaths that enter the building must be bonded together and connected to the ground bus on the Main Distribution Frame (MDF). If the CO GND and the Main Ground Bus are on the same floor, the ground bus on the MDF must be bonded to both the CO GND and to the Main Ground Bus. The MDF must be multigrounded and treated as an integrated ground plane for personnel safety. Generally, the MDF is bonded to the cable sheaths, building steel, CO GND, and the Main Ground Bus.

Power bays

The required functions of the power system for the DMS-10 switch have been defined in the appropriate system schematic drawing. The power system must have the following:

- an isolated bar to serve as a GWSP
- main battery A and main battery B circuit breakers with low voltage disconnect for the DMS-10 switch
- one 15A circuit for alarm battery supply (ABS)
- the rectifier frames must be isolated from the positive battery leads
- alarm reporting by means of a dry loop closure(s)

The following feature is recommended:

- separate charge and discharge bus bars

The following features are optional:

- +48 V converter
- dc/ac inverters, each of which must have an isolated ground

The possibility of a shared power plant or multiple IGZs will be engineered on a case-by-case basis.

The connection of ac power and conduit, by the operating company, to the power bay(s) has also been defined in the appropriate system schematic drawing and complies with known electrical code requirements. A separate ac EG is required for each rectifier/inverter. The use of PVC or PVC-coated conduit is recommended if local codes permit.

Battery power cable connections are provided from the DMS-10 power plant and are kept as short as possible. Separate *charge* cables are provided from PD-1 to the battery terminals and *discharge* cables from the battery terminals to the DMS-10 load distribution (*A* and *B* bus) at PD-1. Providing separate *charge* and *discharge* cables minimizes potential rectifier noise in the DMS. Cable sizes are determined by the loop length (2^x distance) and load current as specified in the *DMS-10 Power Plant requirements* of SD2419-01, Notes 107 and 108.

Section 3: Digital switch grounding

General

This section provides an overview of the grounding connections between the DMS-10 system and the various grounding elements in the central office building. Two industry grounding schemes are recognized: the REA-based grounding scheme, used primarily in Independent Operating Company (IOC) office sites; and the BELLCORE-based grounding scheme, used primarily by office sites under the control of a Bell Operating Company (BOC). If it is determined that neither grounding scheme has been established by an operating company, then the REA-based grounding scheme will be engineered and installed; the BELLCORE-based grounding scheme is, however, an available option.

Grounding design documentation

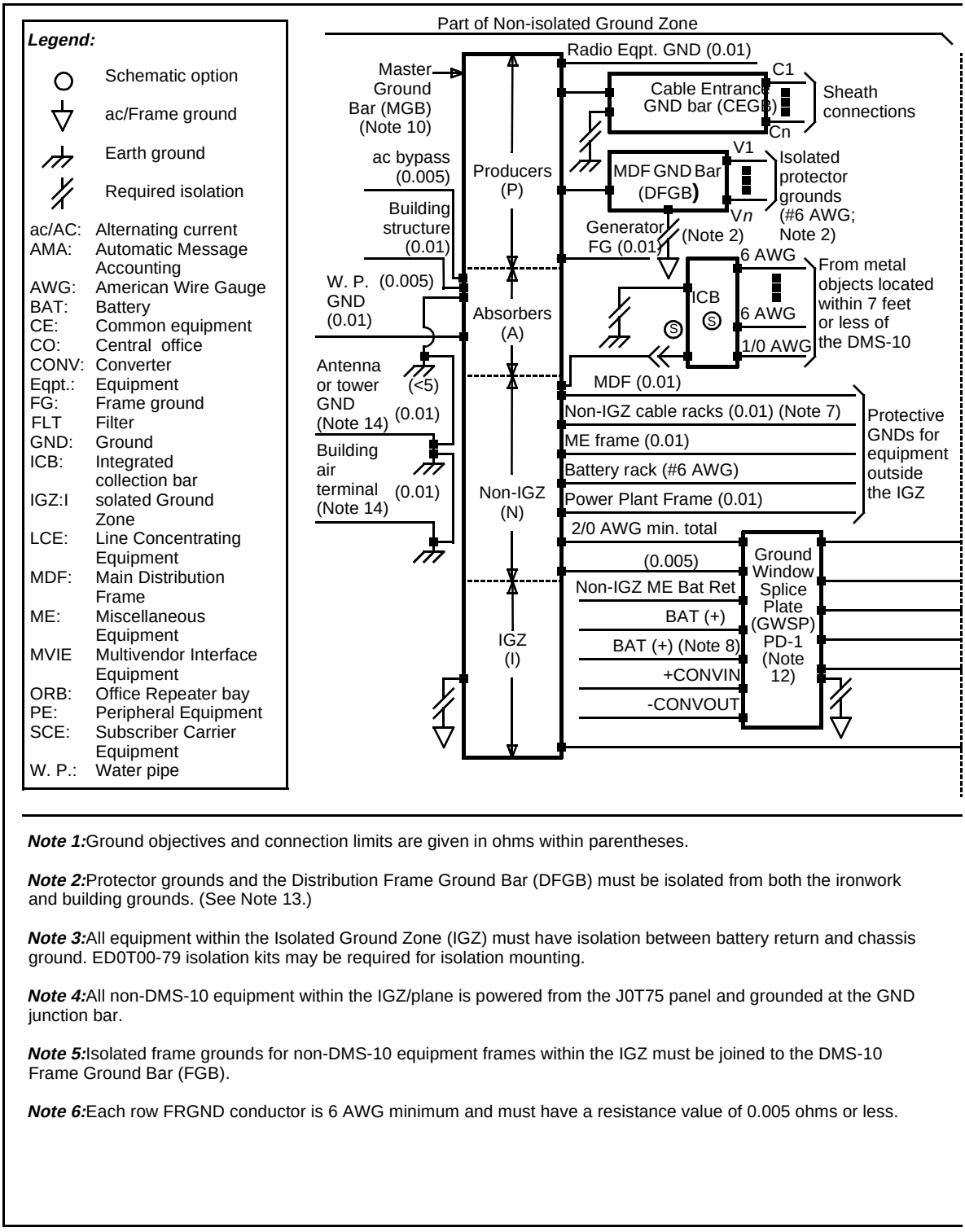
The latest issue of the following DMS-10 System Application Schematics must be consulted when evaluating grounding of a DMS-10 product in the building in which it resides:

- SD0T01-11 (for general system applications in North America)
- SD0T01-06 (for remote system applications in North America)

Figure 3-1 shows excerpts from the grounding section of SD0T01-11 applicable for IOC offices. Figure 3-2 shows excerpts from the grounding section of SD0T01-11 applicable for BOC offices. In these figures, system-level options that are relevant to grounding connections of the DMS-10 switch include:

Z: dc/ac inverter-driven ac outlets
Y: dual dc/ac inverter-driven ac outlets
X: dc-powered modems
W: isolation transformer-driven ac outlets
V: positive dc superimposed ringing
U: Large Cluster Controller with a co-located DMS-10 switch
T: Bellcore-based system grounding
S: Integrated Collection Bar (ICB)

Figure 3-1: DMS-10 System Grounding Configuration for IOC Offices



Note 1:Ground objectives and connection limits are given in ohms within parentheses.

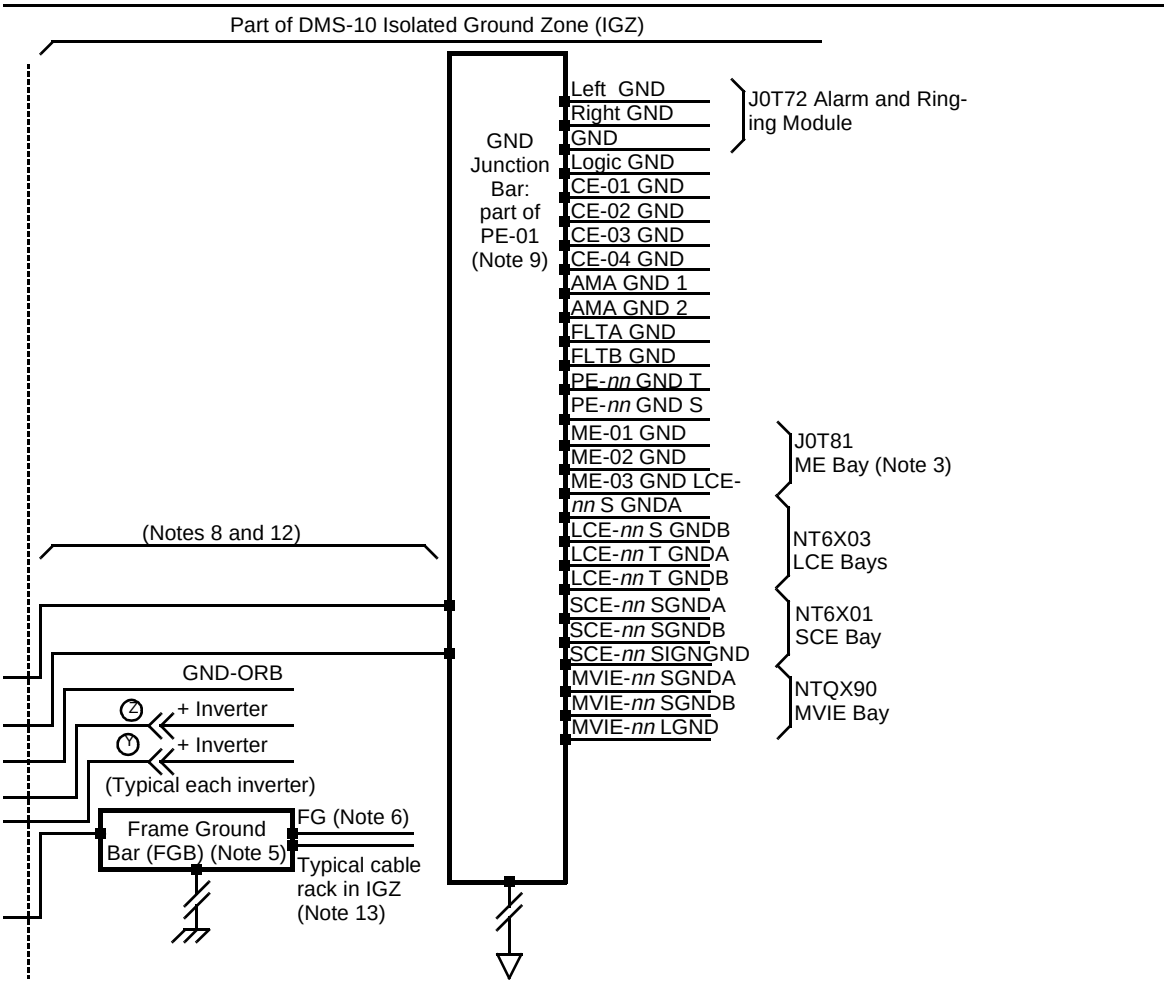
Note 2:Protector grounds and the Distribution Frame Ground Bar (DFGB) must be isolated from both the ironwork and building grounds. (See Note 13.)

Note 3:All equipment within the Isolated Ground Zone (IGZ) must have isolation between battery return and chassis ground. ED0T00-79 isolation kits may be required for isolation mounting.

Note 4:All non-DMS-10 equipment within the IGZ/plane is powered from the J0T75 panel and grounded at the GND junction bar.

Note 5:Isolated frame grounds for non-DMS-10 equipment frames within the IGZ must be joined to the DMS-10 Frame Ground Bar (FGB).

Note 6:Each row FRGND conductor is 6 AWG minimum and must have a resistance value of 0.005 ohms or less.



Note 7:Cable racks leaving or outside the IGZ must be insulated from all DMS-10 frames and grounded by a separate #6 AWG conductor to Section N of the MGB or to the ICB (Option S) if equipped. Cable racks must be bonded at each joint).

Note 8:Current-carrying conductors are engineered to voltage range requirements for powered systems.

Note 9:Use of specified terminal positions provides full capacity and ground audit capability.

Note 10:All MGB conductors must terminate in appropriate P/A/N/I sections of the MGB.

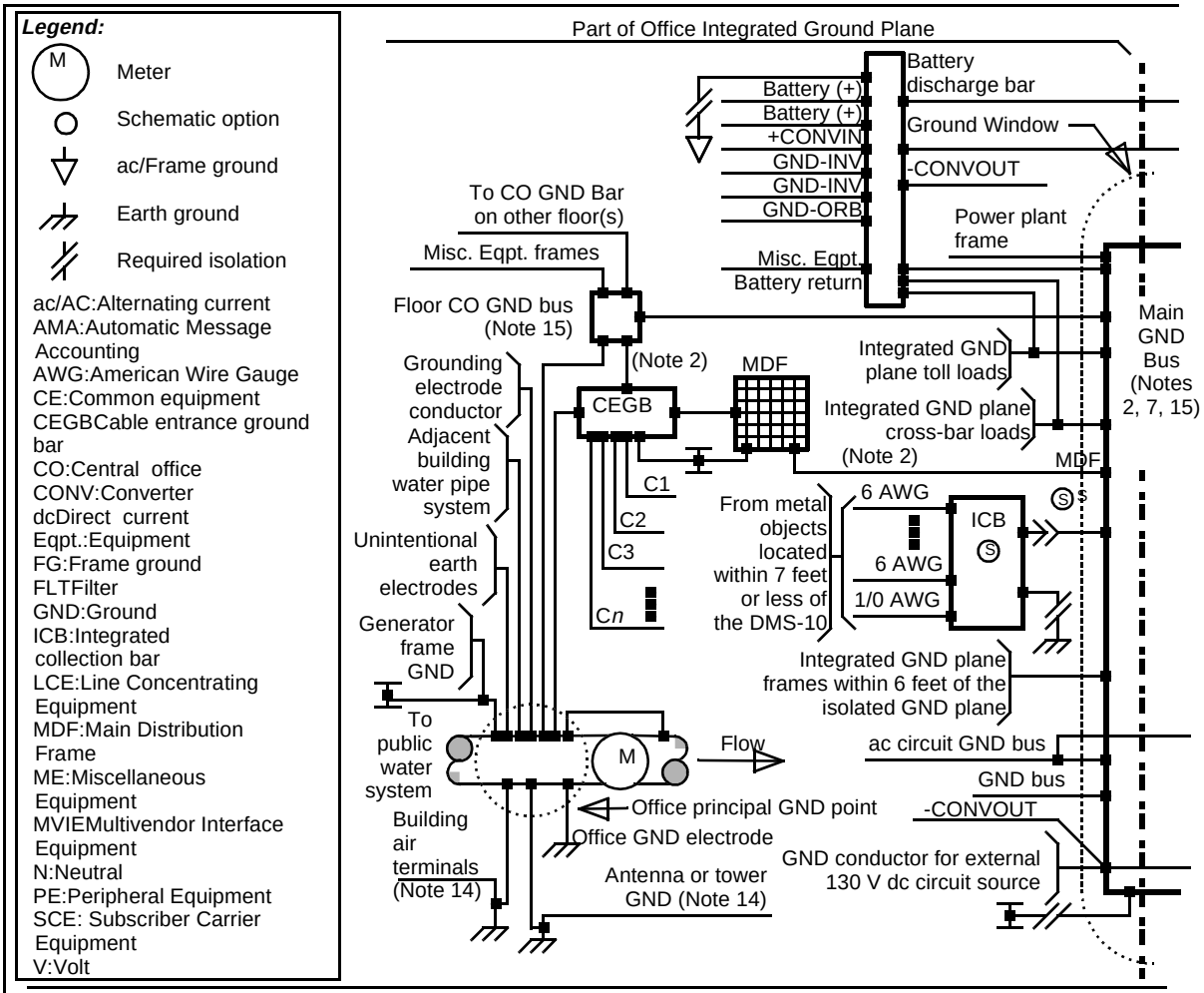
Note 11:Unassigned

Note 12:With the LCC feature, if a co-located DCM is used, the two offices must have a common power bay and the GND Junction Bar in the LCC should be tied to the GND Junction Bar in the co-located DMS-10 switch (Option U). This distance should be kept to a minimum.

Note 13:Cross-aisle cable rack within the Isolated Ground Plane must be physically isolated from the DMS-10 bays.

Note 14:These are reference ground conductors only and must be connected to different dedicated ground fields outside the Central Office (CO).

Figure 3-2: DMS-10 System Grounding Configuration (option "T") for BOC Offices



Note 1: Ground objectives and connection limits are given in ohms within parentheses.

Note 2: Refer to Bellcore document TR-EOP-000295, or later versions, for specific conductor AWG, routing, length limitations, and acceptable destination alternatives.

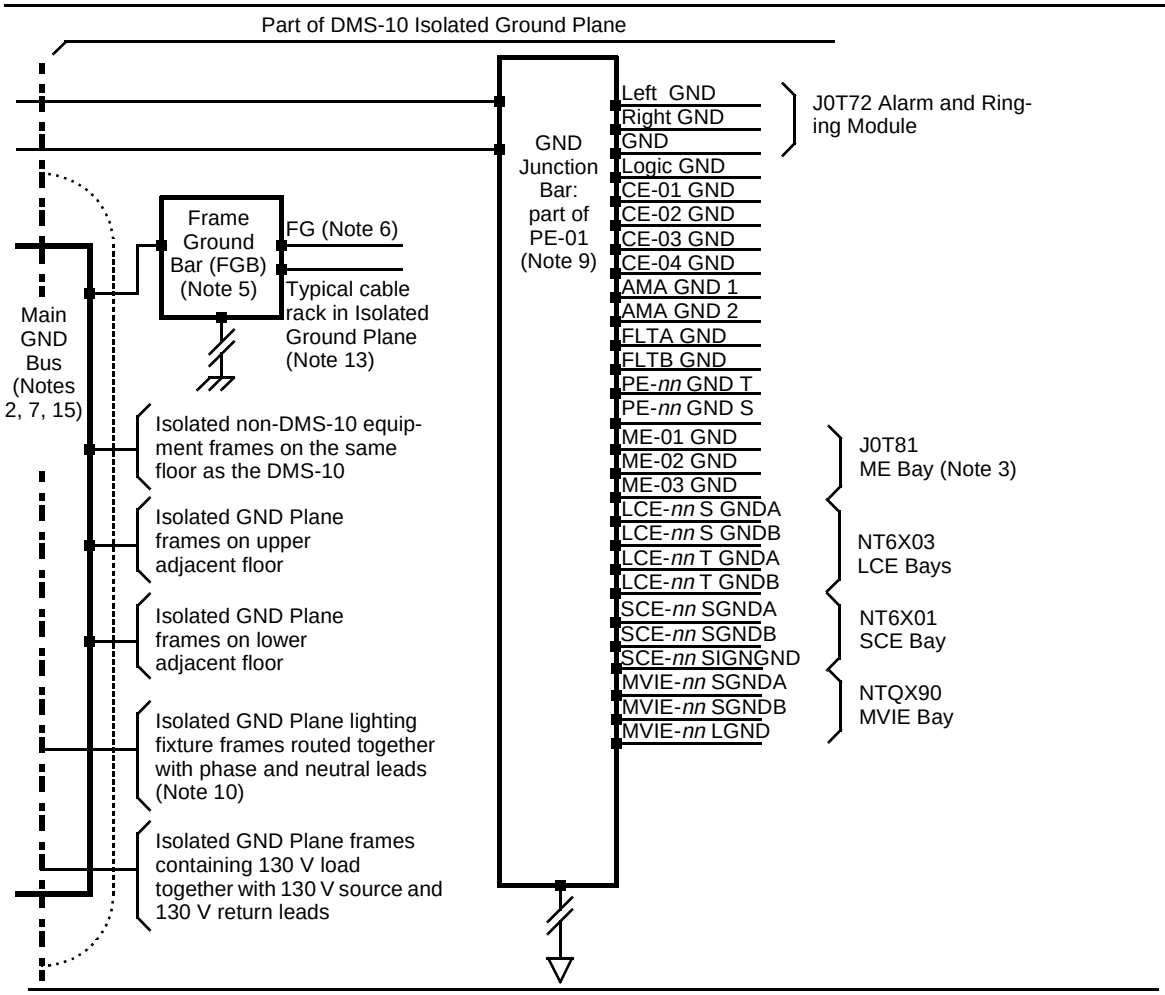
Note 3: All equipment within the Isolated Ground Plane must have isolation between battery return and chassis ground. ED0T00-79 isolation kits may be required for isolation mounting.

Note 4: All non-DMS-10 equipment within the IGZ/plane is powered from the J0T75 panel and grounded at the GND junction bar.

Note 5: Isolated frame grounds for non-DMS-10 equipment frames within the Isolated Ground Plane may be joined to the DMS-10 Frame Ground Bar (FGB).

Note 6: Each row FRGND conductor is 6 AWG minimum and must have a resistance value of 0.005 ohms or less.

Note 7: Only electrical relation and connectivity are depicted; physical equipment shape or placement is not implied.



Note 8:Current-carrying conductors are engineered to voltage range requirements for powered systems.

Note 9:Use of specified terminal positions provides full capacity and ground audit capability.

Note 10:Conduit, raceways, lighting fixtures, armored sheaths, and grounding wires in the Isolated GND Plane are to be insulated from building steel, super-structure supports, and Integrated GND Plane equipment.

Note 11:Unassigned

Note 12:With the LCC feature, if a co-located DCM is used, the two offices must have a common power bay and the GND Junction Bar in the LCC should be tied to the GND Junction Bar in the co-located DMS-10 (Option U). This distance should be kept to a minimum.

Note 13:Cross-aisle cable rack within the Isolated Ground Plane must be physically isolated from the DMS-10 bays.

Note 14:These are reference ground conductors only and must be connected to different dedicated ground fields outside the Central Office (CO).

Note 15:Provided by the operating company.

dc system grounding for the DMS-10 switch

Ground Junction Bar

As shown in Figure 3-1 and in Figure 3-2, the Ground Junction Bar is the collection point for all of the battery return conductors from each equipment bay of the DMS-10 switch. The Ground Junction Bar resides within the cable trough immediately above the PE-01 bay and, thus, is mechanically part of the DMS-10 switch. The location of the Ground Junction Bar adjacent to the J0T75 dc Power Distribution Panel(s) in the PE-01 bay helps to reduce possible EMI susceptibility and emissions. The Ground Junction Bar is electrically isolated from the DMS-10 framework. The bar has designated terminal assignments chosen in such a way as to provide for easy accommodation of conductors from additional bays during the normal course of system growth. Designated terminal assignments also provide for conductor connection uniformity among different offices which facilitates easier conductor identification during grounding audits.

Since the DMS-10 switch is the main equipment in an office containing IGZ equipment, the battery return conductors from various DMS-10 equipment bays constitute most of the battery return conductor terminations on the Ground Junction Bar; however, a non-DMS-10 miscellaneous equipment bay, such as an adjacent, mechanically isolated relay rack containing IGZ-compliant equipment, may be electrically powered like a J0T81 ME bay and frame grounded as a single bay equipment row. As such, it is powered from a J0T75 dc Power Distribution Panel and has battery return connection(s) only to the Ground Junction Bar. As shown in Figure 4-1, IGZ battery and IGZ battery returns must remain electrically within the IGZ. IGZ-grounded equipment must not be powered from a non-IGZ distribution source. Non-IGZ-grounded equipment must not be powered from an IGZ source.

Logic Ground Bar

The individual shelves residing in the Control Equipment (CE) bays of the DMS-10 switch depend on a common logic ground. In order to facilitate a common logic grounding point for these shelves, and in order for this grounding point to be relatively free from electrical transients which occur during the normal operation of the system, a Logic Ground Bar resides within one of the CE bays. Although the Logic Ground Bar is mechanically part of one of the CE bays, it is electrically isolated from the CE bay frame. This Logic Ground Bar is actually an extension of the Ground Junction Bar in that only a single conductor connects it to the Ground Junction Bar. (Other supplementary Logic Ground Bars may also exist in a system, but each of these supplementary bars connects directly to the main Logic Ground Bar). Provided that no foreign ground paths are introduced through hard-wired interface(s) to circuit packs located on the CE shelves (see Section 4 of this NTP for examples of such interface violations), the Logic Ground Bar functions ideally as a nested single-point ground within the DMS-10 system into which disruptive transients cannot flow.

Ground Window Splice Plate

The DMS-10 battery return current is cabled to a main battery return bar which serves as a collection point for all of the dc-powered equipment battery return conductors in the central office. This bar typically resides within the PD-1 bay of the power plant. In DMS-10 IOC offices, the bar is known as the Ground Window Splice Plate. In BOC offices, the bar is known as the Battery Discharge Bar. As shown in Figures 3-1 and 3-2, the battery return bar serves as the grounding connection point for the dc power plant itself. Some IOC office practices instead specify the positive battery post as the grounding connection point for the dc power plant.

Master Ground Bar

In an IOC office, the grounding point for the dc power plant is the Master Ground Bar. In a BOC office, the grounding point for the dc power plant is the Main Ground Bus. The Master Ground Bar is the final conductor collection bar in an IOC office before the connection to the buried earth ground grid. This bar also serves as a collection point for other types of grounding conductors in the central office including cable entrance ground cables, MDF protector ground cables, and frame ground cables. In a BOC office, the Main Ground Bus may cable to a Floor Ground Bar (if the office is located in a multi-floor building) or directly to the Office Principal Ground Point (which collects other building and site facility grounding conductors) to which the buried earth ground grid also connects.

Frame Ground Bar

Frame grounding network The frame grounding network provides two important functions. First, it provides an electrical connection of the IGZ metalwork to an electrical potential which is close to the electrical potential of the building floor. This reduces the likelihood of a step-and-touch shock hazard particularly during electrically dynamic conditions outside of the central office. Second, the frame grounding network provides an intentional low impedance path for any inadvertent dc, or ac, fault current so that the over-current protection device supplying the affected feed will activate and thereby remove the hazard presented by the feed conductor. The diameter of the frame grounding conductors are necessarily large so that even major, higher-current protection devices will activate if involved in a fault.

IGZ frame ground Conductors connecting the IGZ equipment rows and the IGZ cable racks to the Frame Ground Bar collection point do not carry current during normal operation of the system. If current can be measured on any of the conductors, then a violation of the IGZ exists somewhere within the installation and requires corrective action. Typical causes of frame current are: non-IGZ- compliant equipment mounted in a DMS-10 frame subsequent to the initial installation which is returning battery current through its chassis; or a pinched signal (or battery return) cable in which conductor(s) have come into contact with a mechanical item in the DMS-10 frame.

To help isolate the source of IGZ frame ground violations, each equipment row is equipped with a frame ground conductor to the Frame Ground Bar. Cross-aisle cable racks within the IGZ are also equipped with a frame ground conductor to the Frame Ground Bar and are electrically isolated from other structures and from the equipment rows themselves. Non-IGZ cable racks, which are mechanically mounted to (and incidentally connected electrically to) the building structure, must be electrically isolated from IGZ cable racks and IGZ equipment. (Non-IGZ cable racks are grounded to Section N of the MGB in an IOC office.)

ac System grounding for the DMS-10 switch

ac outlets serving IGZ equipment

Since the DMS-10 400 Series System itself does not require commercial ac power to operate, there is no need for commercial ac connections within the DMS-10 IGZ. One or more dc-to-ac inverters are typically used to provide power for normal support equipment for the DMS-10 switch such as maintenance terminals, computers, and stand-alone ac-powered modems. ac Courtesy outlets, which can be provisioned in the DMS-10 System, are inverter driven. The use of ac electrical outlets directly fed by an ac service panel is not permitted in an IOC office. (In a BOC office, any ACEG conductor from an ac service panel to outlets within the Isolated Ground Plane must pass through the Ground Window and must be bonded to the Main Ground Bus.)

Inverter grounding

As shown in Figure 3-3, the dc-to-ac inverter(s) are normally located in the Isolated Ground Zone, mounted in the J0T81 ME bay. A telecom-quality inverter of 500VA is most commonly used; rarely is there a need for the full-load capacity of a 1000VA inverter. Some inverter models may have built-in outlets in which case the neutral conductor and the ACEG are made common within the inverter unit. For inverters that do not have built-in outlets, the neutral conductor and the ACEG conductor feeding an ED0T03-10 outlet assembly are made common in a junction box through which the phase and neutral conductor pass. This junction box typically resides within the cable trough immediately above the bay in which the inverter resides. Within the junction box, a union is made between the junction box, the Frame Ground Ribbon, the inverter neutral conductor feed, the ED0T03-10 outlet assembly neutral conductor, and the ED0T01-10 outlet assembly ACEG conductor. An inverter that resides in a power plant bay can also provide power to IGZ outlets; however, in this case the inverter neutral and ACEG conductors are made common within the inverter unit, but are not grounded until they enter the junction box mounted on top of the IGZ equipment Frame Ground Ribbon. (This differs from an immediately grounded inverter output in an Integrated Ground Plane power plant bay of a BOC office -- grounding option T.)

Other ac grounding

Grounding of ac-powered equipment or ac-generating equipment located outside of the IGZ is based on national electrical codes or on other codes adopted by local governmental bodies exercising legal jurisdiction over electrical installations. Figure 3-3 shows ac connectivity aspects of the dc power plant excerpted from System Application Schematic, SD0T01-11, which reflect general compliance with the existing codes. Not included in the commercial ac codes is an additional conductor, known as the ac Bypass Conductor (or Grounding Electrode Conductor, in a BOC office), which connects from the commercial ac service neutral at a point within the Main Service Panel to the Master Ground Bar (or Office Principal Ground Point, in a BOC office). See Section 2 of this NTP under the paragraph entitled, “ac Power Panel Ground,” for more information about this conductor.

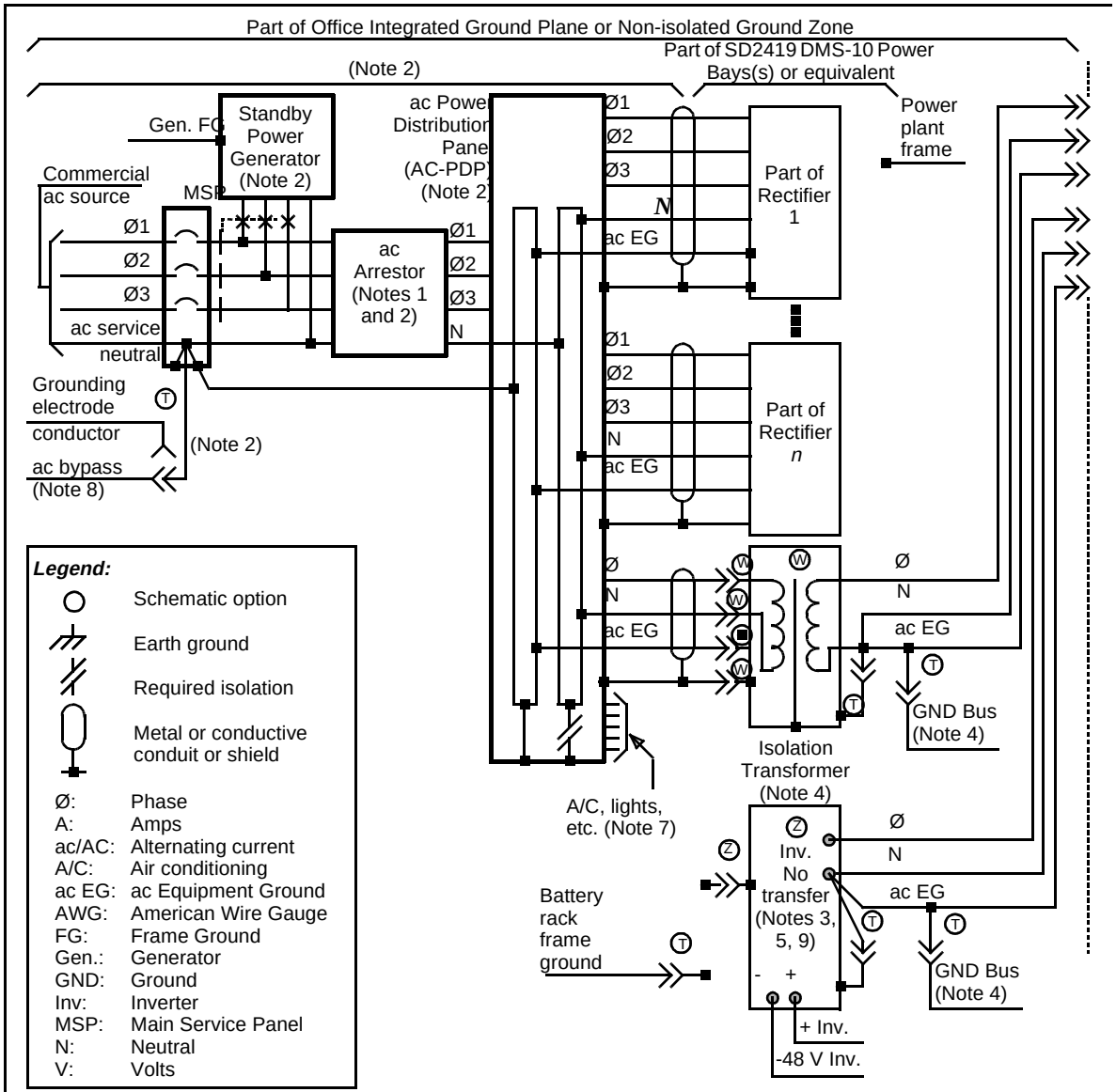
Grounding for electrostatic discharge

A flexible braided strap is recommended for connecting metal switchroom entrance doors to their door frames. From that point an electrostatic discharge (ESD) conductor is routed from the door frame to the “N” section of the Master Ground Bar. Personnel are expected to use ESD wrist straps when they remove and insert circuit packs or when they perform maintenance on DMS-10 equipment. Frame ground jacks containing a 1M ohm resistance to frame ground are provided on all DMS-10 400 Series IGZ bays to accommodate personnel ESD wrist strap grounding conductors.

Grounding for remote systems

DMS-10 remote systems conform to the same grounding principles and practices applicable to larger central offices. Grounding design documentation details for most of these remote systems, including Remote Line Concentrating Modules (RCLMs), Remote Subscriber Line Equipment (RSLE), and Remote Subscriber Line Modules (RSLMs) are provided in DMS-10 System Application Schematic, SD0T01-06. Excerpts from this schematic are provided in Figure 3-4 and in Figure 3-5.

Figure 3-3: DMS-10 ac protection and distribution

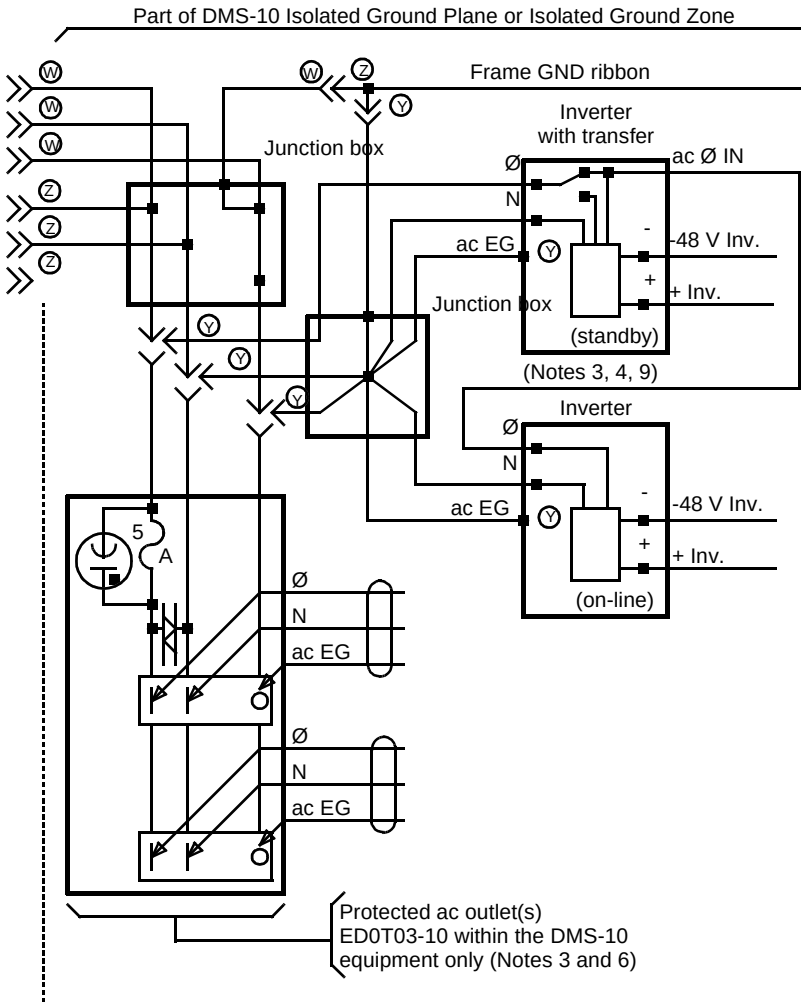


Note 1: Use of an appropriately-rated surge arrestor is recommended.

Note 2: Provided by the operating company; must meet all local and national electrical code requirements.

Note 3: Use of dual dc/ac inverters (Option Y) to provide all ac power within the IGZ is preferred. Options Z and W are intended for non-critical load circuits; that is, a dedicated outlet strip separate from Option Y.

Note 4: When Option Z, W, or Y equipment is used in conjunction with the grounding Option T and is located within the Integrated Ground Plane, then the associated ac output circuit must pass through the ground window and the circuit's ac EG must be connected to the Main Ground Bus. This creates the circuit's entry point into the Isolated Ground Plane.



***Note 5*:**When Option Z equipment is located within the Isolated Ground Zone or Isolated Ground Plane, its wiring must be like that depicted for the standby inverter of Option Y, except that the ac Ø IN conductor is deleted.

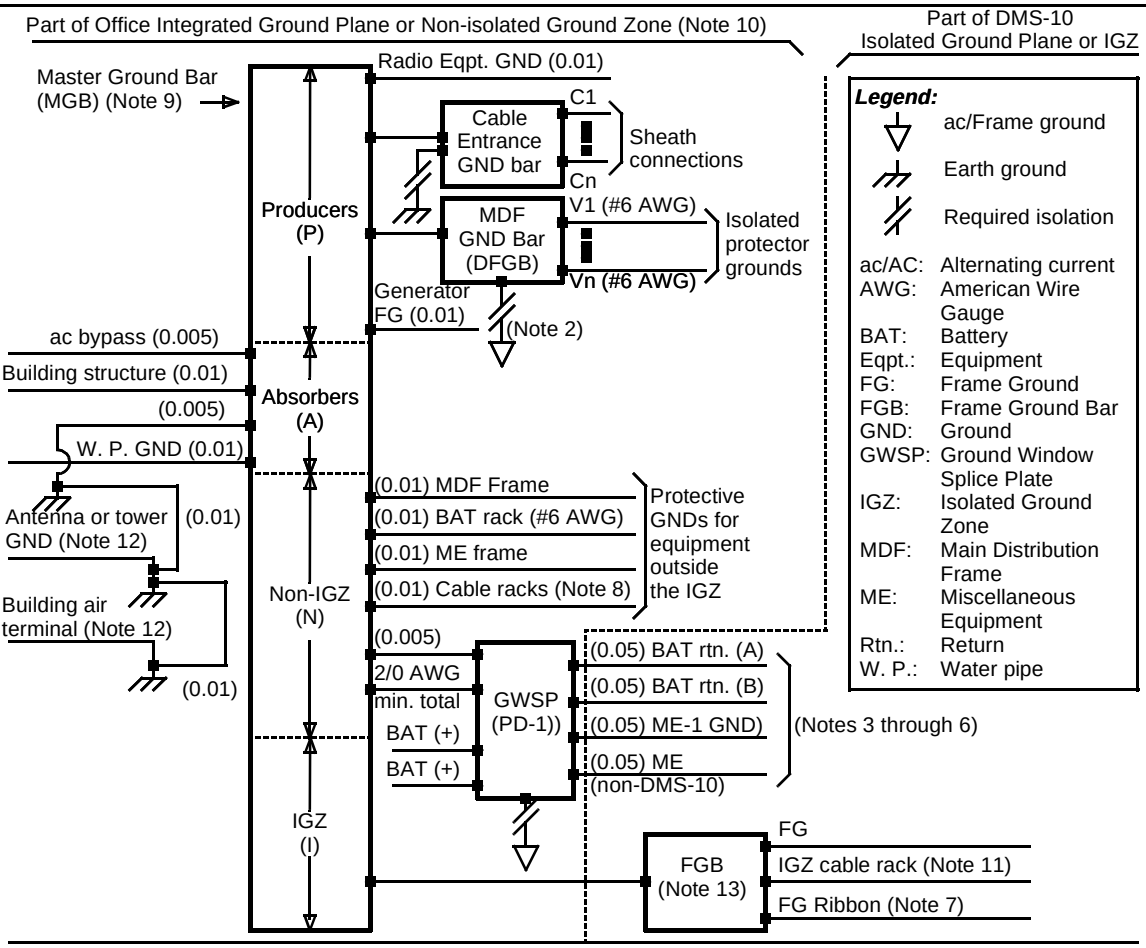
Note 6:The power Options Z, Y, and W are mutually exclusive for sourcing a given outlet circuit.

Note 7:Systems supporting the DMS-10 IGZ must be isolated and separated from the DMS-10 switch and its related cables and racks.

Note 8:This ac bypass conductor must be 2/0 AWG or larger and must not be smaller than the incoming commercial ac neutral conductor.

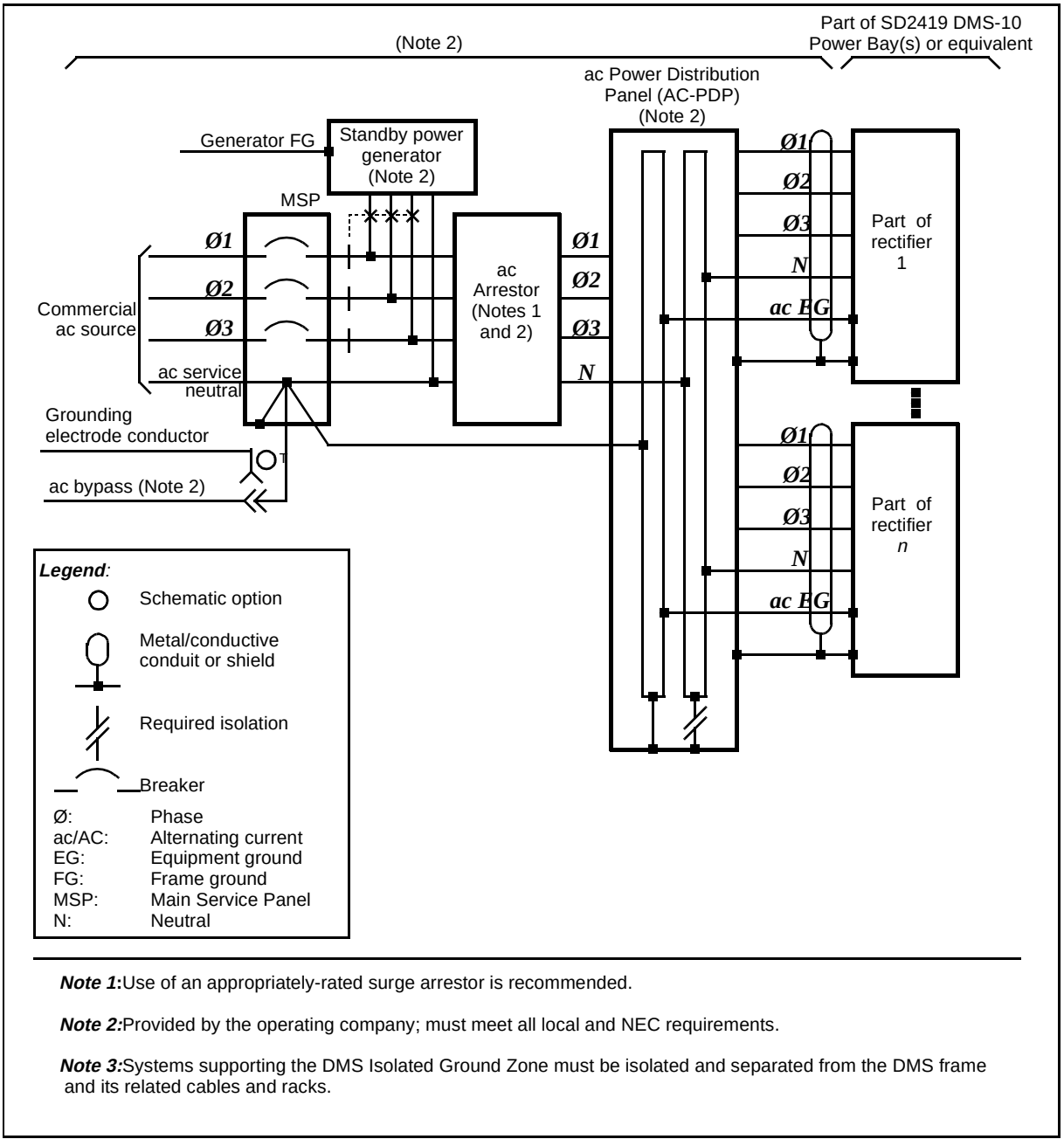
Note 9:Refer to the appropriate system schematic drawing for inverter alarm wiring requirements.

Figure 3-4: Remote Line Concentrating Module (RLCM), Remote Subscriber Line Equipment (RSLE), and Remote Subscriber Line Module (RSLM) grounding - block diagram



Note 1:Ground objectives and connection limits are given in ohms within parentheses.
Note 2:Protector grounds and the Distribution Frame Ground Bar (DFGB) must be isolated from both the ironwork and building grounds.
Note 3:All equipment within the IGZ must have isolation between battery return and chassis ground. ED0T00-79 isolation kits may be required for isolation mounting.
Note 4:Current-carrying conductors are engineered to voltage range requirements for powered systems.
Note 5:RSLM Type A shelves require only a single feed and a single return.
Note 6:All non-DMS equipment frames within the IGZ must be grounded to the Frame Ground Bar (FGB).
Note 7:Each row FRGND conductor is 6 AWG minimum and must have a resistance value of 0.005 ohms or less. The FGB may not be provisioned unless the remote location contains two or more bays in two or more lineups. The Power Distribution (PD) bay, because it is outside the IGZ, is grounded to Section N of the MGB.
Note 8:Cable racks leaving or outside the IGZ must be insulated from all IGZ equipment frames and grounded by a separate #6 AWG conductor to the MGB.
Note 9:All MGB conductors must terminate in appropriate P/A/N/I sections of the MGB.
Note 10:The Cable Entrance Ground Bar (CEGB), DFGB, and FGB can be eliminated if the sheath connections, DF protector grounds, and the frame grounds are connected directly to the appropriate sections of the MGB.
Note 11:Cross-aisle cable rack within the IGZ must be physically isolated from the IGZ equipment frames.
Note 12:These are reference ground conductors only and must be connected to different dedicated ground fields outside the CO.
Note 13:Some installations may not require the installation of an FGB. In those cases, a 2/0 AWG (minimum) conductor connects from the remote bay frame directly to the MGB, eliminating the #6 AWG conductor entirely.

Figure 3-5: Remote Line Concentrating Module (RLCM), Remote Subscriber Line Equipment (RSLE), and Remote Subscriber Line Module (RSLM) ac protection and distribution - block diagram



Note 1:Use of an appropriately-rated surge arrestor is recommended.

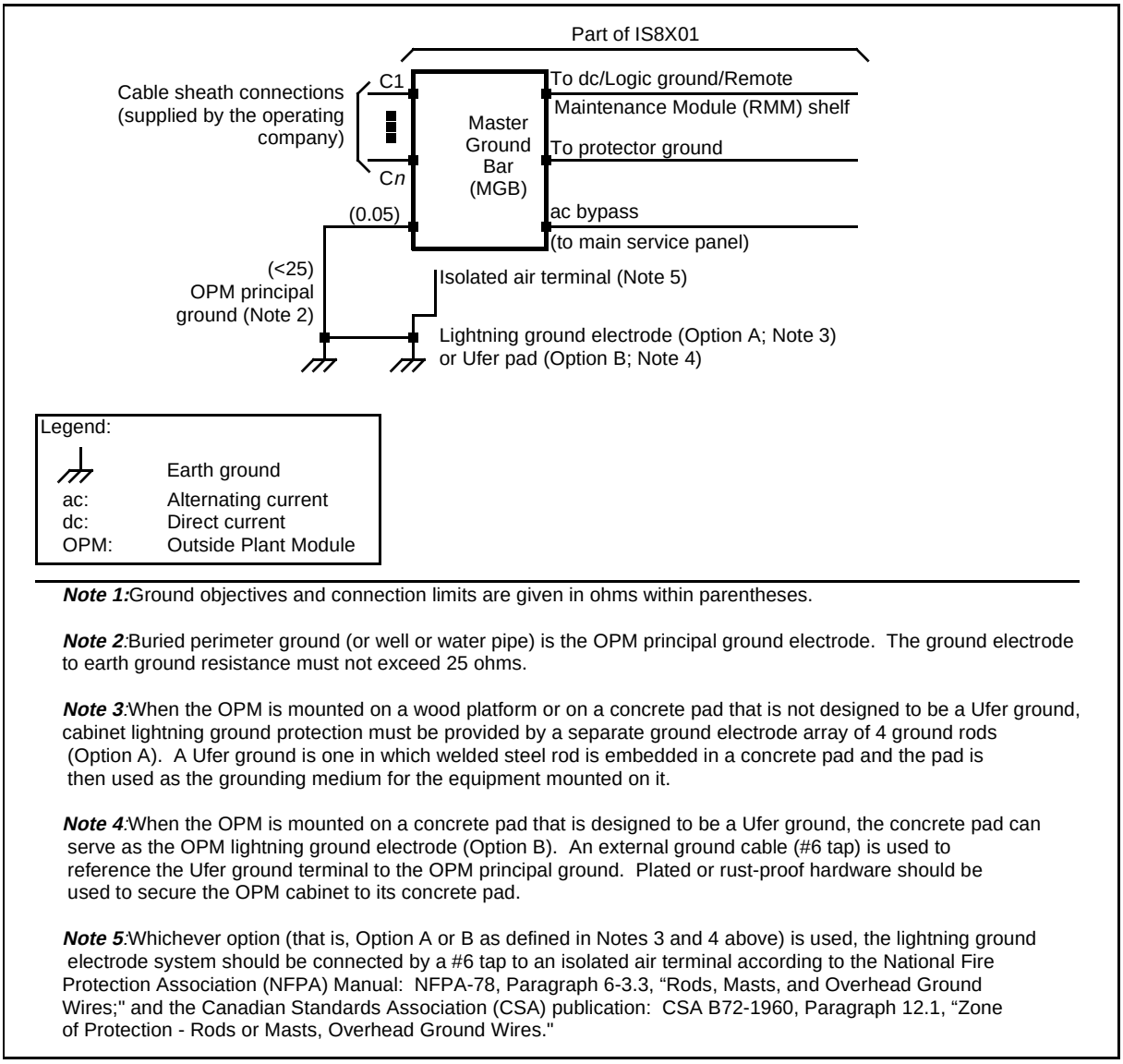
Note 2:Provided by the operating company; must meet all local and NEC requirements.

Note 3:Systems supporting the DMS Isolated Ground Zone must be isolated and separated from the DMS frame and its related cables and racks.

Outside Plant Module (OPM) grounding

Outside Plant Modules (OPMs) are grounded in accordance with SD0T01-06 and IS8X01. An excerpt from the drawing is shown in Figure 3-6. The OPM Master Ground Bar (MGB) is shown in Figure 3-7.

Figure 3-6: Outside Plant Module (OPM) grounding - block diagram



Note 1:Ground objectives and connection limits are given in ohms within parentheses.

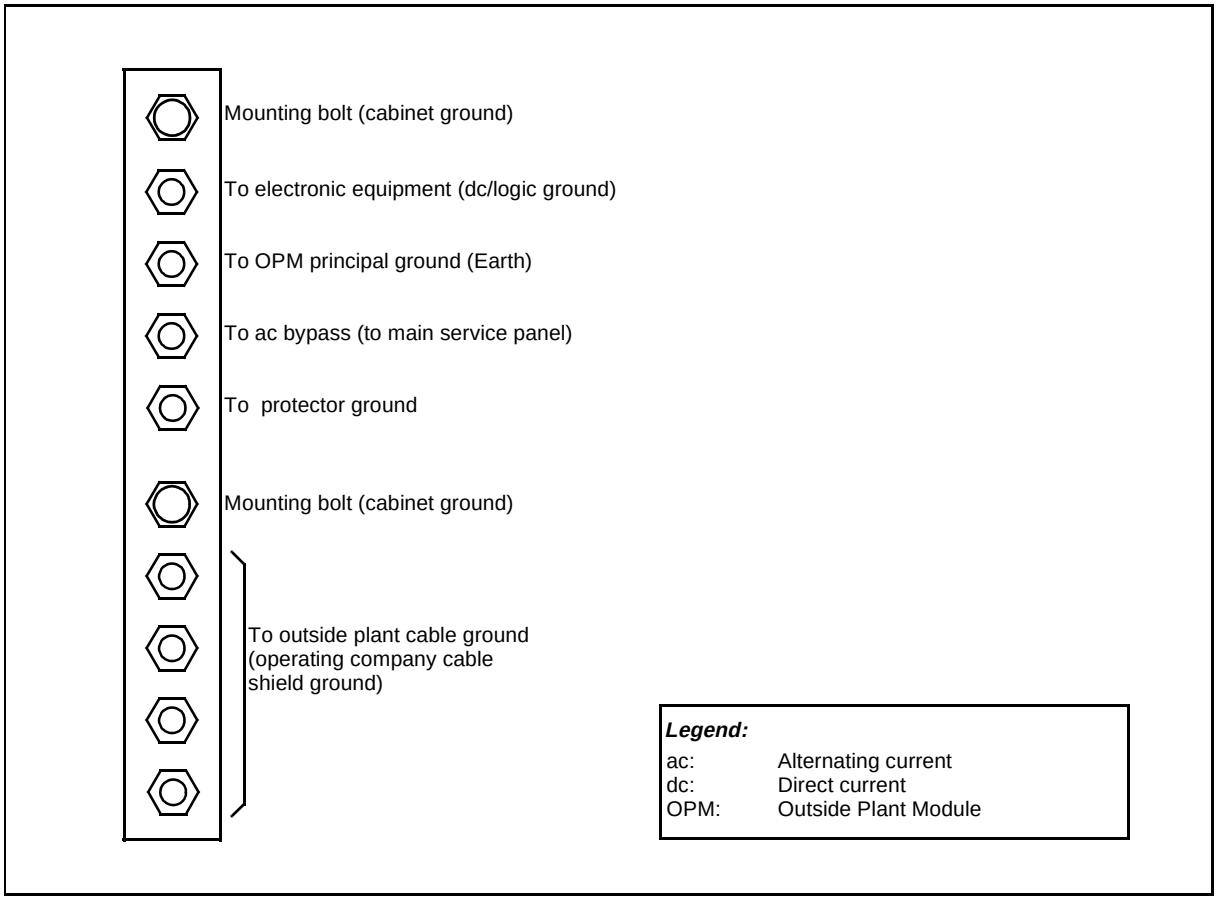
Note 2:Buried perimeter ground (or well or water pipe) is the OPM principal ground electrode. The ground electrode to earth ground resistance must not exceed 25 ohms.

Note 3:When the OPM is mounted on a wood platform or on a concrete pad that is not designed to be a Ufer ground, cabinet lightning ground protection must be provided by a separate ground electrode array of 4 ground rods (Option A). A Ufer ground is one in which welded steel rod is embedded in a concrete pad and the pad is then used as the grounding medium for the equipment mounted on it.

Note 4:When the OPM is mounted on a concrete pad that is designed to be a Ufer ground, the concrete pad can serve as the OPM lightning ground electrode (Option B). An external ground cable (#6 tap) is used to reference the Ufer ground terminal to the OPM principal ground. Plated or rust-proof hardware should be used to secure the OPM cabinet to its concrete pad.

Note 5:Whichever option (that is, Option A or B as defined in Notes 3 and 4 above) is used, the lightning ground electrode system should be connected by a #6 tap to an isolated air terminal according to the National Fire Protection Association (NFPA) Manual: NFPA-78, Paragraph 6-3.3, “Rods, Masts, and Overhead Ground Wires;" and the Canadian Standards Association (CSA) publication: CSA B72-1960, Paragraph 12.1, “Zone of Protection - Rods or Masts, Overhead Ground Wires."

Figure 3-7: Outside Plant Module (OPM) Master Ground Bar (MGB) terminations



Outside Plant Subscriber Module (OPSM) grounding

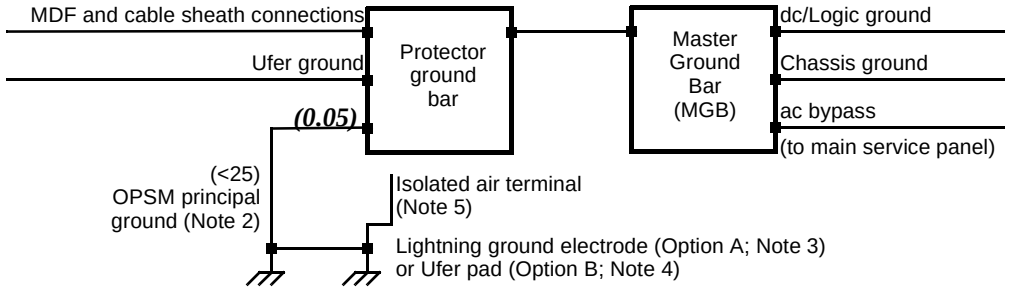
Outside Plant Subscriber Modules (OPSMs) must be grounded in accordance with SD0T01-06. A block diagram excerpt is shown in Figure 3-8.

The OPSM Master Ground Bar (MGB) is shown in Figure 3-9. The OPSM MGB consists of two sections, both isolated from the chassis and both located within the cabinet. One section of the bar is used for lightning ground; the other section carries all other earth currents. Normally, the two sections are strapped together. However, the option for a separate path for the lightning ground is available.

The equivalent of a Ground Window is located at the rear of the Frame Supervisory Panel (FSP). All -48 Volt battery return paths are wired to the Ground Window. This window provides ground for the battery strings, rectifiers, and all electronic equipment.

The OPSM MGB must be connected to a ground electrode provided by the operating company in accordance with local utility codes and operating company requirements. The ground electrode to earth ground resistance must not exceed 25 ohms.

Figure 3-8: Outside Plant Subscriber Module (OPSM) grounding - block diagram



Legend:

Earth ground

ac: Alternating current
dc: Direct current
MDF: Main Distribution Frame
OPSM: Outside Plant Subscriber Module

Note 1: Ground objectives and connection limits are given in ohms within parentheses.

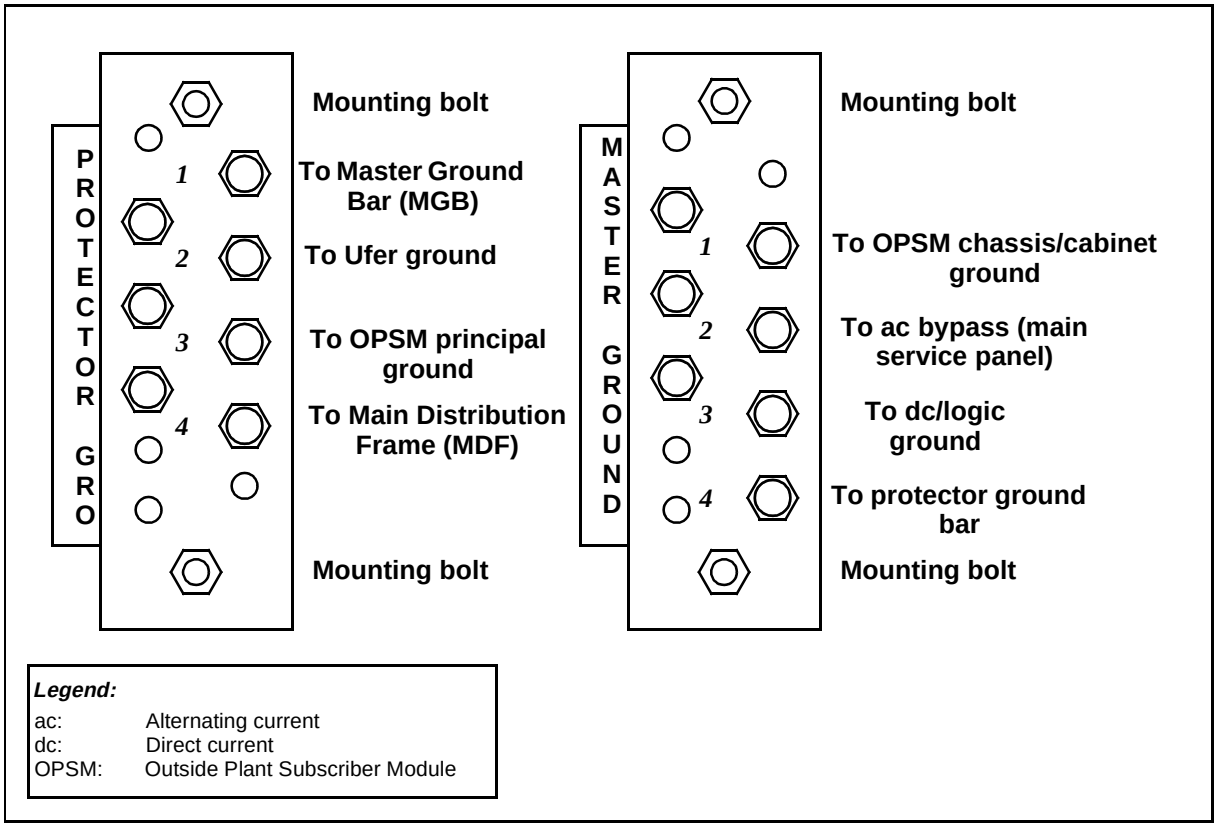
Note 2: Buried perimeter ground (or well or water pipe) is the OPSM principal ground electrode. The ground elec trode to earth ground resistance must not exceed 25 ohms.

Note 3: When the OPSM is mounted on a wood platform or on a concrete pad that is not designed to be a Ufer ground, cabinet lightning ground protection must be provided by a separate ground electrode array of 4 ground rods (Option A). A Ufer ground is one in which welded steel rod is embedded in a concrete pad and the pad is then used as the grounding medium for the equipment mounted on it.

Note 4: When the OPSM is mounted on a concrete pad that is designed to be a Ufer ground, the concrete pad can serve as the OPSM lightning ground electrode (Option B). An external ground cable (#6 tap) is used to reference the Ufer ground terminal to the OPSM principal ground. Plated or rust-proof hardware should be used to secure the OPSM cabinet to its concrete pad.

Note 5: Whichever option (that is, Option A or B as defined in Notes 3 and 4 above) is used, the lightning ground electrode system should be connected by a #6 tap to an isolated air terminal according to the National Fire Protection Association (NFPA) *Manual*: NFPA-78, Paragraph 6-3.3, “Rods, Masts, and Overhead Ground Wires;" and the Canadian Standards Association (CSA) publication: CSA B72-1960, Paragraph 12.1, “Zone of Protection - Rods or Masts, Overhead Ground Wires.”

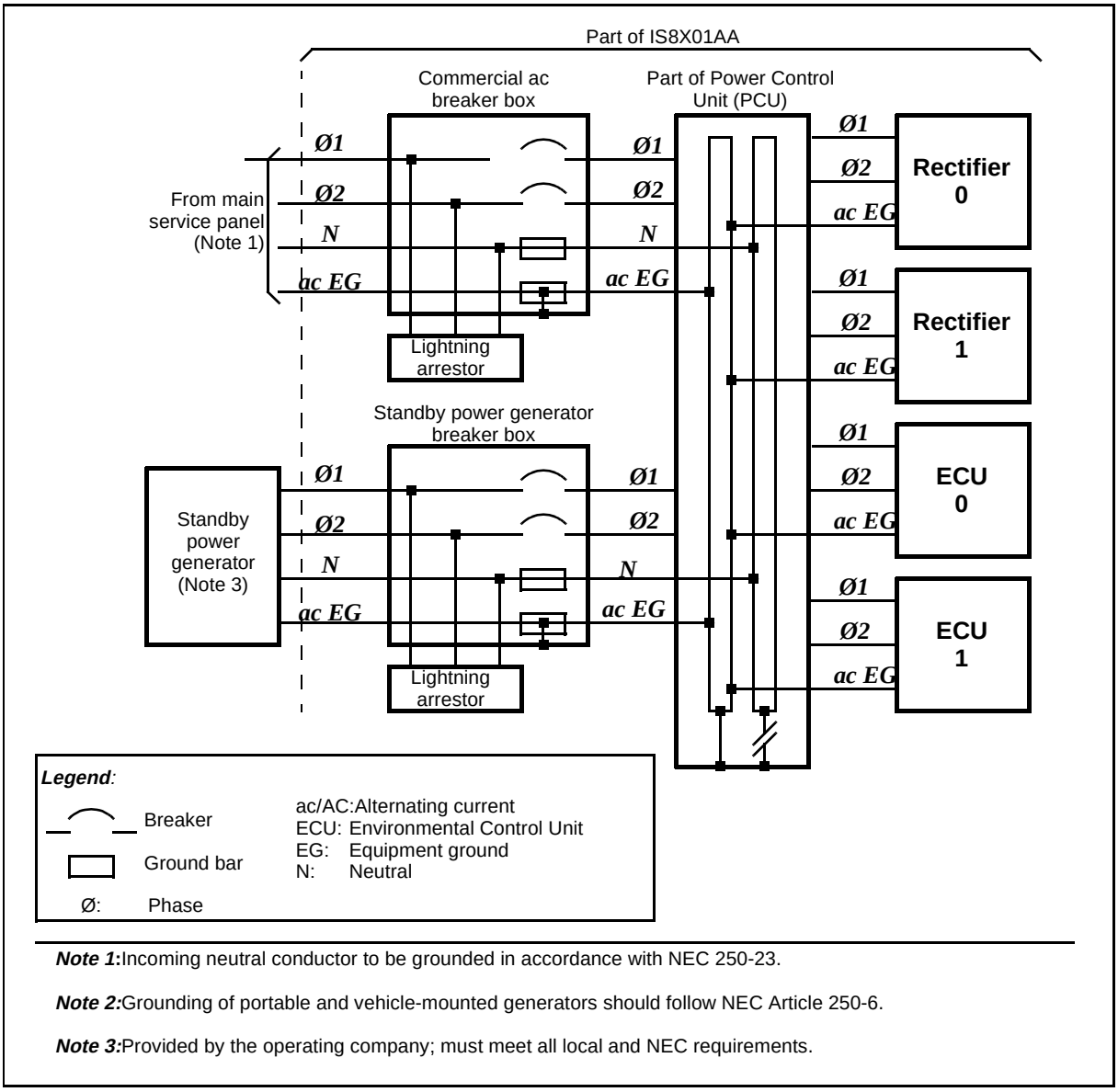
Figure 3-9: Outside Plant Subscriber Module (OPSM) Master Ground Bar (MGB) terminations



OPM power

The OPM electrical system consists of power distribution equipment, two rectifiers, and batteries. The cabinet requires a standard 30A single-phase 110 Volt or 220 Volt commercial ac supply. The power distribution equipment includes two ac circuit breaker boxes, a Power Control Unit (PCU), and a Frame Supervisory Panel (FSP). Each ac circuit breaker box is equipped with a 30A double-pole 220 Volt circuit breaker and a lightning arrestor. The PCU contains two 15A double-pole 240 Volt circuit breakers connected to the rectifiers; one 7A single-pole 120 Volt circuit breaker to feed the two heaters in each of the two Environmental Control Units (ECU); one 15A single-pole 120 Volt circuit breaker (to feed the duplex ground fault receptacle; a dual service receptacle; and a 30A 120/240 Volt 3PDT switch, which selects the source of input power from either the local utility or the standby power generator. (See Figure 3-10.)

Figure 3-10: Outside Plant Module (OPM) ac protection and distribution - block diagram



***Note 1*:** Incoming neutral conductor to be grounded in accordance with NEC 250-23.

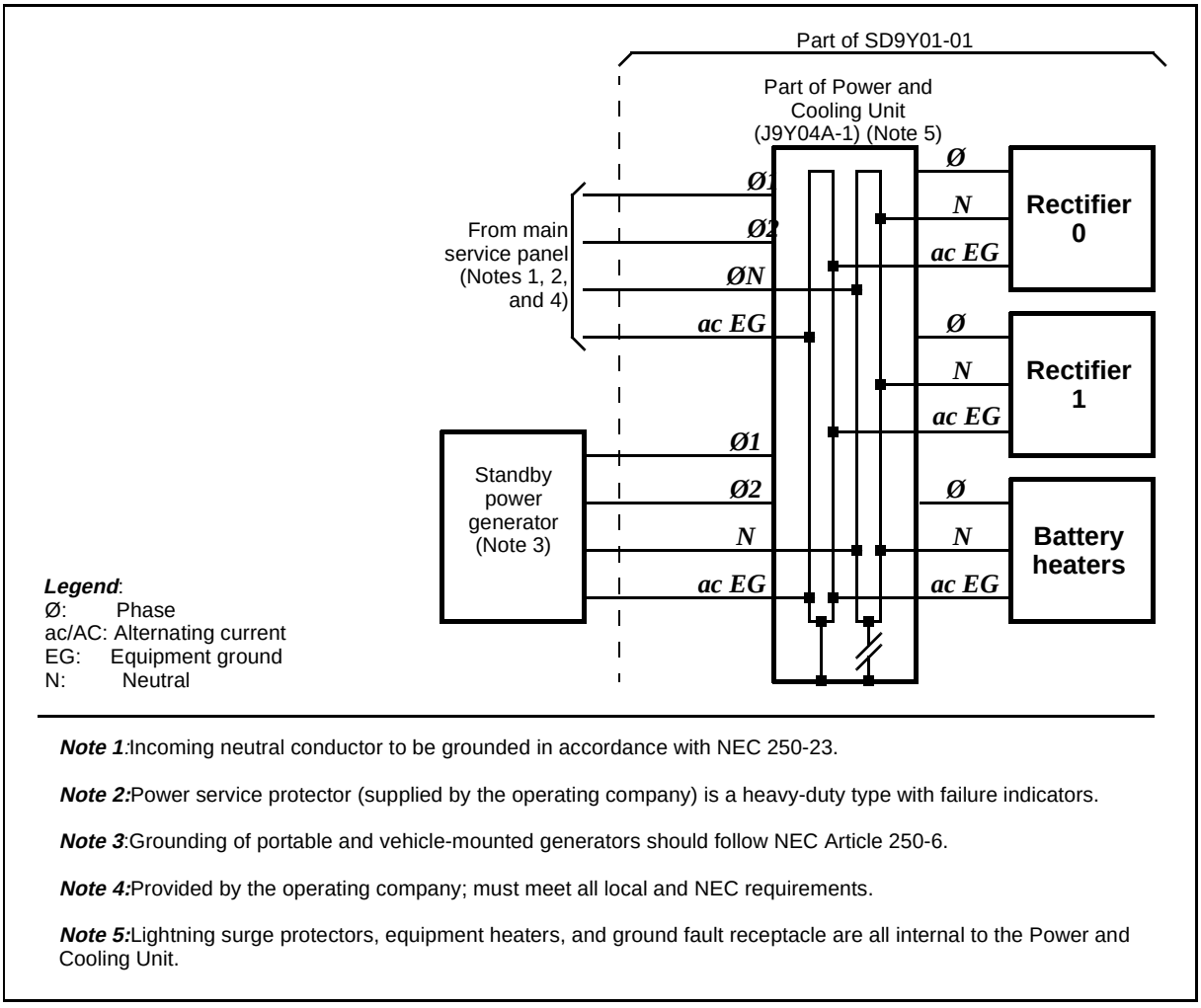
Note 2: Grounding of portable and vehicle-mounted generators should follow NEC Article 250-6.

Note 3: Provided by the operating company; must meet all local and NEC requirements.

OPSM power

The OPSM electrical system consists of power distribution equipment, two rectifiers, and batteries. The cabinet requires a standard 30A single-phase 110 Volt or 220 Volt commercial ac supply. A standby power generator socket is located at the rear of the cabinet. The transfer switch (SW1) is located on the front panel of the Power and Cooling Unit (PCU), which also includes a 120 Volt ac receptacle. The PCU contains a 15A double-pole 120 Volt circuit breaker for each rectifier, a 15A single-pole 120 Volt circuit breaker for the ac receptacle, and a 10A single-pole 120 Volt circuit breaker for the equipment heater. The operating company is responsible for connecting the grounding electrode conductor to the grounded service conductor (ac service neutral) in accordance with NEC 250-23. Secondary lightning protection is provided within the OPSM for both the commercial ac mains and for the standby power generator input. The Frame Supervisory Panel (FSP) provides dc power distribution. (See Figure 3-11.)

Figure 3-11: Outside Plant Subscriber Module (OPSM) ac protection and distribution - block diagram



Note 1:Incoming neutral conductor to be grounded in accordance with NEC 250-23.

Note 2:Power service protector (supplied by the operating company) is a heavy-duty type with failure indicators.

Note 3:Grounding of portable and vehicle-mounted generators should follow NEC Article 250-6.

Note 4:Provided by the operating company; must meet all local and NEC requirements.

Note 5:Lightning surge protectors, equipment heaters, and ground fault receptacle are all internal to the Power and Cooling Unit.

Outside Plant Access Cabinet (OPAC) grounding

The OPAC is serviced by a standard 60 A single phase, 3-wire, 230 V ac commercial supply.

OPAC grounding network

Two ground bars located on either wall of the electronics compartment and connected by a No. 6 AWG cable, collect the ground conductors from the doors and swing frames, the service protection center (mounted on the wall separating the electronics and termination compartments, the ac power supply, and the outside plant cables. Provision for connection to the customer-supplied ground rod is also included in the termination and ac compartments. The ground bars are shown in Figures 3-12 and 3-13.

The maximum ground-to-earth resistance target is 25 ohms. Outside plant cables must be grounded using QCM2A cable bond clamps or equivalent on the grounding bar located within the termination compartment.

Figure 3-12: Outside Plant Access Cabinet (OPAC) ground bar terminations - ac bulkhead

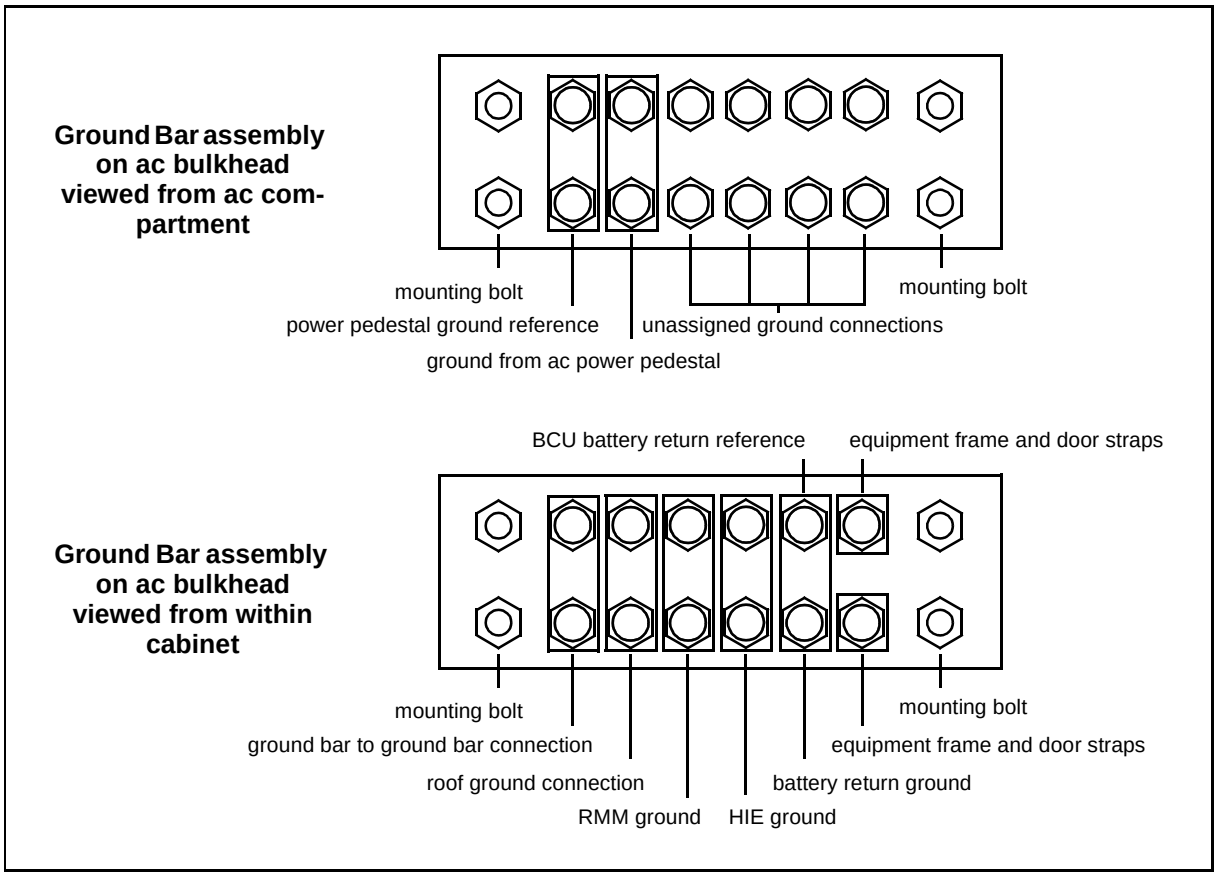
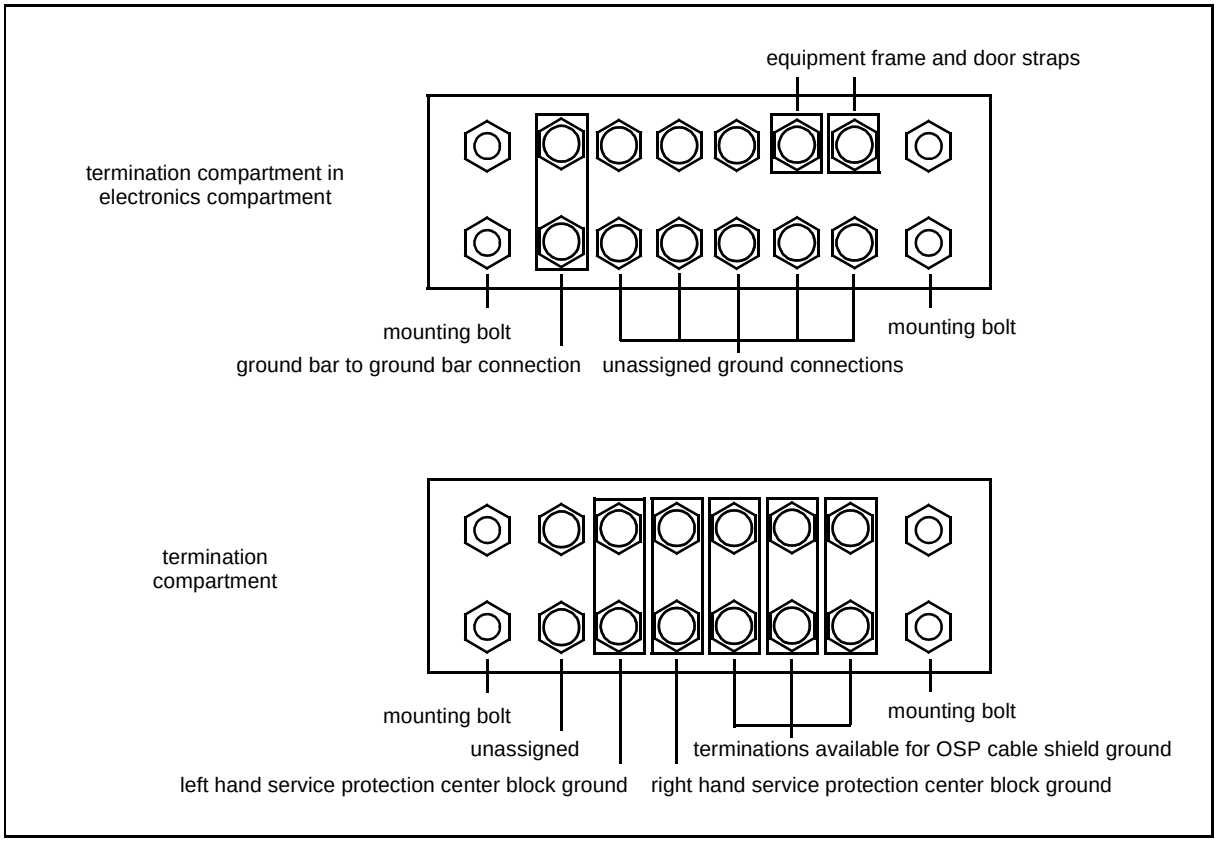


Figure 3-13: Outside Plant Access Cabinet (OPAC) ground bar terminations - termination compartment



Power and grounding requirements

The OPAC grounding network provides the necessary grounding protection required for the equipment in the cabinet.

- The pedestal ground (or ground rods) is the principal ground (that is, *MGN*) electrode. When the main ac disconnect panel is not at the same location as the transformer, the panel ac neutral conductor should be grounded in accordance with National Electrical Code (NEC) sections 250-23 and 250-25 (2).
- The buried perimeter ground, in accordance with NEC section 250-81 (a), is the OPAC principal ground electrode.
- When the OPAC is not mounted on a Ufer ground, cabinet lightning ground protection is provided by a separate ground electrode (that is, ground rod, as per NEC sections 250-83 and 250-86). A Ufer ground is one in which a welded steel rod embedded in the concrete pad contacts ground rods leaving the pad. The pad is a grounding medium for the equipment mounted on it.

- All three separate ground electrodes, MGN, OPAC, and lightning, must be tied together outside the cabinet with a tap that can be disconnected when each separate ground electrode impedance must be measured. The electrodes are accessible through a hand hole.
- When the concrete pad is designed to be a Ufer ground, it serves as the OPAC lightning ground electrode. Plated or rustproofed hardware should be used. An external ground cable (#6 tape) is used to reference the Ufer ground to the OPAC principal ground.
- If lightning protection is required, the lightning ground electrode system should be connected to an isolated air terminal according to the *National Fire Protection Association Manual* (NFPA-78), paragraph 6-3.3 Rods, Masts and Overhead Ground Wire and CSA B72-1960, paragraph 12.1 Zone of Protection-Rods or Masts, Overhead Ground Wires.
- The utility distribution transformer can be mounted on an aerial pole or on a concrete pad for underground service. In either case it can be located on the opposite side of the highway from the OPAC.
- The power service protector is a heavy-duty type, with failure indicators, normally supplied by the customer. Refer to *Specification for Gas Tube Arrestors*, REA/P-80(gg).

Section 4: Interface equipment grounding

General

This section provides grounding guidelines for signaling equipment that interfaces directly with the DMS-10 switch. Guideline emphasis is placed on direct-coupled interface equipment such as digital modems, video terminals, mini-computers, printers, TTYs, recorded announcement equipment, clock synchronization sources, alarm wiring, and some types of transmission equipment. Other ac-coupled interface equipment such as transformer-coupled DS-1 cable connection guidelines are also included. Figure 4-1 illustrates DMS-10 interface equipment grounding.

> ***Note:*** *Failure to comply with these guidelines has been demonstrated to result in damage within equipment at either or both ends of the signaling interface during electrically dynamic conditions external to the central office such as utility power interruptions, and local electrical storms. Preventive or corrective actions that are identified in any installation should be considered urgent, and should be safely completed at the earliest prepared opportunity.*

In addition to these guidelines, the latest issues of the following *DMS-10 System Application Schematic* must be consulted when evaluating the grounding compliance of an existing interface or when planning an equipment addition:

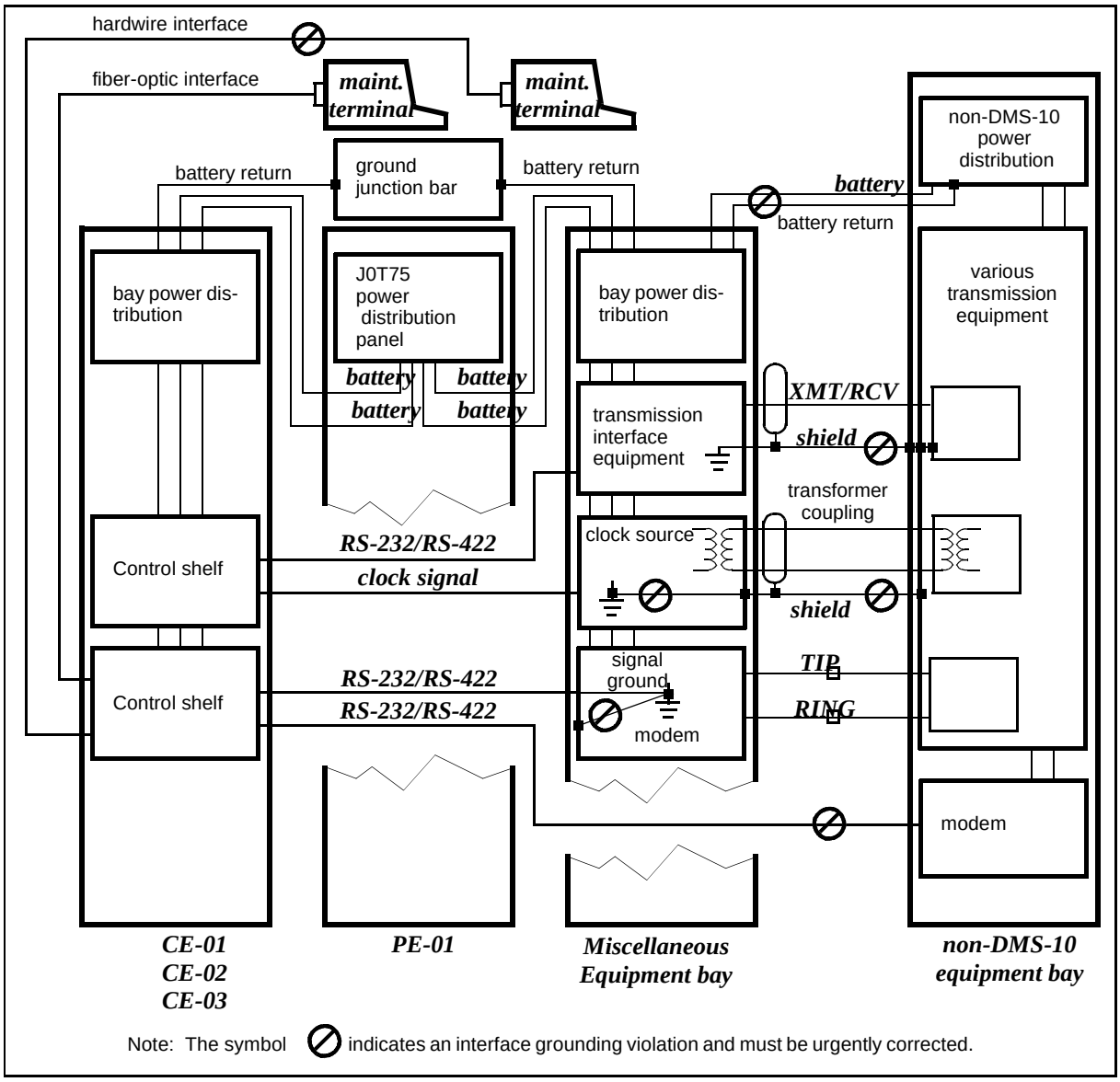
- SD0T01-11 (for general applications in North America)
- SD0T01-06 (for remote installations in North America)

The electrical location of interface equipment and the grounding requirements for this equipment will generally be depicted in these documents on schematic sheets dedicated to a given feature such as CCS7, SSO/HSO, LAMA, or SDI ports.

Selection of interface equipment

Before a specific model of interface equipment is selected for use with the DMS-10 switch, it should be evaluated for compliance with the guidelines in the following sections to determine which equipment powering options can be made available. It is strongly recommended that -48V dc-powered interface equipment be used within DMS-10 frames because of the simplicity of the interface to the DMS-10's power distribution structure and because the additional potential for grounding violations associated with the use of ac-powered interface equipment is eliminated. Equipment intended for dc-powered telecom use is often equipped with internal power and grounding option features that enable the equipment to operate in compliance with isolated grounding schemes recognized by the telecom industry.

Figure 4-1: Interface Equipment Grounding



Power and grounding guidelines for interface equipment

The selection of a power distribution source for interface equipment is governed by the type of interface circuitry employed rather than on the equipment's proximity to the intended power distribution panel. Interface equipment which connects directly to a DMS-10 communications port by way of RS-232/RS-422, or by any other hard-wire interface method (excluding DS-1 transformer-coupled interfaces to carrier equipment and excluding optical interfaces) must be powered from the J0T75 Power Distribution panel located within the DMS-10 switch, or from a downstream distribution panel within the DMS-10 switch lineup, such as a distribution panel in the J0T81 Miscellaneous bay. The J0T75 panel is a circuit breaker panel located in the top shelf position of the DMS-10 PE-01 (peripheral equipment) bay. The battery return(s) for equipment powered from the J0T75 panel must terminate on the DMS-10 ground junction bar (normally located within the cable trough on top of the PE-01 bay). If the power feeds for interface equipment originate at a downstream distribution panel, then the respective battery return(s) must connect to the designated ground collector bar or terminal strip associated with that panel (typically located adjacent to the panel's power distribution terminals). For additional information, see "Isolation of interface equipment frame and battery return," below.

> ***Note:*** *Under no circumstances should interface equipment battery returns be connected to the DMS-10 framework, or to ground points outside of the DMS-10 such as relay-rack/transmission equipment grounds.*

Some specific types of interface equipment that must be powered from a power distribution point within the DMS-10 switch and grounded to an isolated battery return point within the DMS-10 switch include:

- modems (or modem shelves) which serve the NT3T50 Data Link Controllers through RS-232 ports
- modems which connect to the Serial Data Interface packs (NT3T80, NT3T09, or NT3T71) through RS-232 ports
- modems which connect to a pollable billing device such as the Cook Billing Media Converter (BMC)
- modems which serve CCS7 links through connections into the J1T65 Messaging shelf's RS-422 ports
- channel banks, or channel drop-and-insert equipment, which serve CCS7 links through connections into the J1T65 Messaging shelf's RS-422 ports
- Building Integrated Timing Supply (BITS) clock reference sources which connect directly to the NT3T47 Synchronous Clock pack

When economic practicality or availability concerns dictate that ac-powered equipment be used, as in the case of video display terminals used for DMS-10 switch maintenance activity, it is recommended that the equipment be powered from a telecom-grade dc-to-ac inverter. A 500VA inverter (for example, Nortel A0367433) is normally sufficient to provide power for two or three maintenance terminals. Critical ac-powered equipment that has no dc-powered equivalent should be powered from a redundant dc-to-ac inverter arrangement. For dc-to-ac inverter connection depictions and guidelines, refer to the functional schematic "AC Protection and Distribution" in the applicable SD0T01 document. For additional information, see "Fiber-optic interfaces for DMS-10 maintenance terminals," below.

Ground option straps within interface equipment

Equipment which is designed specifically for use in a telecom environment typically has one or more grounding options in the form of electrical straps, rotating screws, jumpers, switches, or other contact means. The purpose of such options is to provide either an open circuit between the equipment's output signal ground return and its chassis (frame grounded), or a short circuit. Option points may also be present which connect or disconnect the equipment's chassis to battery return. For dc-powered interface equipment which connects directly to the DMS-10, such as that tabulated above under the heading "Power and grounding guidelines for interface equipment," the "OPEN" option (the option which disconnects the equipment's output signal ground from its chassis) must always be selected; the "OPEN" option for battery return-to-chassis, if available, must also be selected.

To obtain specific guidelines for locating connection option points, it is necessary to refer to the equipment manual, or in some cases, to consult with the equipment manufacturer. On modem shelves with multiple plug-in modem cards, *all* of the cards (including spare cards) must have the "OPEN" option(s) selected; a single card with this option selected differently can defeat the "OPEN" option(s) on the other cards when plugged into the shelf. On hard-wire transmission equipment interfaces, such as channel banks serving CCS7 links, an option strap connecting battery return and frame ground may be found on the interface equipment backplane. If the strap is found intact, it must be removed so that the reliable operation of the interface equipment is not jeopardized.

Isolation of interface equipment frame and battery return

When the interface equipment frame and battery return (and/or the interface signal ground) are common, and the equipment is to be mounted and powered from within the DMS-10 switch in order to comply with signaling interface requirements, but no option exists to completely disconnect the equipment's battery return/signal ground from its mounting chassis, then it is necessary to electrically isolate the equipment mounting chassis from the DMS-10 framework. At each mounting point, an ED0T00-79 Isolation Kit (or a functional equivalent) should be used. A single 6 AWG conductor must then be connected to the isolated equipment chassis, and the opposite end of this conductor must terminate on the DMS-10 ground junction bar which is typically located within the cable trough on top of the PE-01 bay.

Fiber-optic interfaces for DMS-10 maintenance terminals

To comply with the *DMS-10 System Application Schematic* documents, all data terminal equipment (DTE) such as TTY, video terminal, mini-computer, and printer interfaces connecting to the DMS-10 switch must have electrical isolation between their data port signal ground and chassis. The chassis for ac-powered equipment is connected directly to ac “green wire” ground (AC EG); consequently, isolation of the interfacing signal ground is needed so that the DMS-10 switch's logic ground is not corrupted by foreign AC EG activity through the interface cable. Since most interfacing ac-powered DTEs do not have internal option points to provide this isolation, a fiber-optic interface cable between the DTE and the DMS-10 switch provides the most practical interface solution. *(Interfacing DTEs powered by an inverter are not excluded from this signal-to-chassis ground isolation requirement. Adapting the 3-wire power plug to 2-wire does not make ac-powered DTEs compliant with the grounding requirements).*

An electrical continuity check will generally determine if an isolation means is necessary for the DTE. If continuity is detected between pins 1 and 7 of the DTE's DB-25 port (RS-232), or if electrical continuity is detected between pin 7 of the DTE's DB-25 port (RS-232) and the DTE's chassis (AC EG), and the DTE design has no internal provision specifically for separating signal ground and chassis, then isolation is necessary. Again, a fiber-optic interface provides the most practical interface solution; however, back-to-back modems may also be used to gain the necessary ground isolation *if the modem grounding is compliant with the guidelines in this NTP*.

A fiber-optic cable assembly available from Nortel for this application consists of three parts: the DCE modem-connector (this always connects to a DMS-10 SDI port provided by the NT3T09, NT3T71, or NT3T80; the DTE modem-connector (this always connects to the interfacing TTY, video terminal, printer); and the duplex fiber-optic connectorized cable which routes between the DCE modem-connector and the DTE modem-connector. No external power is needed by the modem-connectors since they are powered internally by the RS-232 signals themselves. These components can be ordered from Nortel using the following part numbers:

1) DCE modem-connector which connects to the DMS-10 switch:

Nortel part number: A0383090
Description: fiber optic modem, DCE 25-pin male, 19.2 Kbps, includes DB-25 securing screws and keepers

2) DTE modem-connector which connects to TTYs, video terminals, mini-computers, printers:
Nortel part number: A0383089
Description: fiber optic modem, DTE 25-pin male, 19.2 Kbps, includes DB-25 securing screws and keepers (mates to DTE having female DB-25 pin port such as the TI-820)

or

Nortel part number A0383088
Description: fiber optic modem, DTE 25-pin female, 19.2 Kbps, includes DB-25 securing screws and keepers (mates to DTE having male DB-25 pin port such as the LA-120, VT-220, or VT-320)

3) duplex fiber-optic connectorized cable for modem-connectors:

Nortel Part Number	Description
A0382242	30 ft. cable
A0382243	50 ft. cable
A0382244	75 ft. cable
A0382245	100 ft. cable
A0382246	125 ft. cable
A0382247	150 ft. cable
A0382248	200 ft. cable
A0382249	300 ft. cable

Alarm wiring for interface equipment

The DMS-10 switch alarm scanning circuity detects the presence or absence of electrical continuity in alarm wire loops; consequently, each assignable alarm detection circuit appears at the MDF connector block as a pin pair. One of the pins in each pair is an extension of a special dedicated ground within the DMS-10 alarm shelf; for example, IP34 (alarm input 34) is paired with IPG34 (alarm input ground 34). Equipment to be monitored by the DMS-10 switch such as dc-to-ac inverters, or doors to the central office, must connect to these IP and IPG alarm pins only by way of an isolated contact set which completes or breaks the alarm loop. A relay located in the monitored equipment typically provides a contact set for this purpose. A magnetic switch normally provides a contact set for a central office door alarm. Items which provide only a contact closure to a ground that is locally associated with the item, or within the item, is *not* acceptable to connect directly to the intended DMS-10 IP alarm pin. *Failure to comply defeats the self-testing capability of the alarm system and exposes the alarm and control equipment to possible electrical damage.* Un-isolated alarms of this type must first be used to drive a local relay coil so that an isolated contact can then be presented to the IP and IPG alarm pins.

In response to a recognized alarm condition, the programmed DMS-10 alarm reporting circuitry provides either a “CLOSURE” to signal distribution ground (SD Ground, within the DMS-10 alarm shelf), or an “OPEN” on the assigned alarm output point. The equipment receiving an output alarm signal, for example OP34M (alarm output 34 “make” to SD ground; OP34B also simultaneously “breaks” from SD ground), must either be powered from the J0T75 panel within the DMS-10 switch, or from a secondary panel supplied from the J0T75 panel. If the alarm receiving circuitry in the interfacing equipment is located and powered outside of the DMS-10 isolated ground zone, then an isolation relay, provided in the ED0T81-01 Alarm Isolation and Transfer Panel (described in NTP 297-3601-150, *Equipment Identification*), must be used so that the interfacing equipment receives the alarm signal as referenced to its own local ground through the contacts of the isolation relay. In this case, the assigned OP alarm point switches SD ground to the relay coil which is powered from -48ABS (alarm battery supply) available on the DMS-10 alarm shelf.

Interface cabling to transmission equipment

The cable shields in twisted-pair transmission cable (for DS-1) connecting from interface points within the DMS-10 (such as the J0T13 DCM shelf, the J1T80 DCI shelf, or other products) to the transmission facilities (such as the DSX field, office repeater bay) are grounded internally *within the DMS-10 end* of the cable only. The opposite end of each cable (for example, ED0T25-22) must be prepared so that the cable shields are cut back and insulated so they cannot make electrical contact with any foreign ground at the transmission facilities. Electrical grounds which are considered foreign to the DMS-10 switch include the MDF frame, patch panels, DSX frame, nearby equipment frames, their battery return, or connection terminals on interface equipment which may even be offered for the purpose of connecting to cable shields.

COAX transmission cables such as ED8T32-02 cables connecting between DMS-10 equipment, and transmission facilities, may connect to DMS-10 equipment only where interfaces are designed to accommodate this interface (for example, the J1T80 DCI shelf). The transmission facility may offer the option of a bond wire between the COAX cable shield and the transmission facility frame. If this option is present, then the bond wire must be removed so that the shield is not connected to the transmission facility frame.

Section 5: Index

DMS-10 Family

600-Series Generics

Grounding System

NTP number: NTP 297-3601-187
Release: 06.01
For Generic 602.20
Status: Standard
Date: August 2006

NORTEL