DIGITAL CLOCK DISTRIBUTOR

LOCAL PRIMARY REFERENCE CE MARK COMPLIANT

ENGINEERING GUIDELINES

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1. GENERAL

1.01 This section provides the following information about the Digital Clock Distributor - Local Primary Reference CE Mark Compliant (DCD-LPR/C) System:

- A brief explanation of Global Positioning System (GPS) transmissions
- Engineering considerations, including Symmetricom philosophy on lightning protection
- Antenna site selection information
- System configuration and mounting information

1.02 This section was reissued for the reasons listed below. Changes and additions are marked by change bars.

- Added a GTI/C card, part number 090-44140-18.
- Added Table A, DCD-LPR Cards.

1.03 All product names, service marks, trademarks, and registered trademarks used in this document are the property of their respective owners.

1.04 The following abbreviations are used in this section:

DCD	Digital Clock Distributor
GPS	Global Positioning System
GTI/C	GPS Timing Interface
GTR	GPS Timing Antenna/Receiver
LOU/C	LPR Oscillator Unit
LPR	Local Primary Reference
MIS/C	Maintenance Interface, System
MRC/C	Multi-reference Controller (MRC-EA/C, MRC-T/C)
OPGP	office principal ground point
pps	pulses per second
PRC	primary reference clock
PRS	primary reference source
RAIM	Receiver Autonomous Integrity Monitoring
SSM	Synchronization Status Messaging
TNC/C	Transit Node Clock
TNC-E/C	Enhanced Transit Node Clock
TOD	Time-of-Day
UTC	Universal Coordinated Time

1.05 The DCD-LPR/C conforms to the European Standards EN55022, EN50082-1, and EN60950, and carries the CE Mark certification.

2. DCD-LPR/C SYSTEM

2.01 The DCD-LPR/C System provides management of signals received from the GPS primary reference source (PRS). The DCD-LPR/C is a system designed to provide a primary timing signal for the DCD System. Components of the system may include the following:

- DCD-LPR/C Shelf
- GPS Timing Interface (GTI/C) card
- LPR Oscillator Unit (LOU/C) card

2.02 Cards which may be included in the DCD-LPR/C System are listed in Table A.

Table A. DCD-LPR/C Cards

CARD	NAME USED IN THIS SECTION	PART NUMBER	REVISION	FEATURES
GTI/C	GTI/C -12	090-44140-12	–	Input: 5 MHz or 10 MHz, rubidium or better quality clocks, TNC-E cards only Output: 2.048 Mb/s (E1) Framing format: CCS/CAS with or without CCS4
GTI/C	GTI/C -14	090-44140-14	D or earlier	Input: 5 MHz or 10 MHz, quartz, rubidium, or better quality clocks, any combination of two quartz, rubidium, or better quality clocks, or LOU card Output: 2.048 Mb/s (E1) Framing format: CCS/CAS with or without CCS4
GTI/C *V5*	GTI/C -14	090-44140-14	E or later	
GTI/C *V5*	GTI/C -16	090-44140-16	–	Input: 5 MHz or 10 MHz, quartz, rubidium, or better quality clocks, any combination of two quartz, rubidium, or better quality clocks, or LOU card Output: 2.048 Mb/s (E1) Framing format: CCS/CAS with or without CCS4 Time-of-Day

Table A. DCD-LPR/C Cards (Contd)

CARD	NAME USED IN THIS SECTION	PART NUMBER	REVISION	FEATURES
GTI/C[V5]	GTI/C-18	090-44140-18	–	Input: 5 MHz or 10 MHz, quartz, rubidium, or better quality clocks, any combination of two quartz, rubidium, or better quality clocks, or LOU card Output: 2.048 Mb/s (E1) or 2.048 MHz (analog) Framing format: CCS/CAS with or without CCS4 Time-of-Day SSM capable
LOU/C	LOU-1/C	090-44145-01	–	Source: one oven-controlled crystal oscillator with two parallel outputs
LOU/C	LOU-2/C	090-44145-02	–	Source: two independent oven-controlled crystal oscillators, each with one output

Notes:
1. The [V5] indicates that this is a Version 5 card.
2. Where information is common to all GTI/C cards, these cards are collectively referred to as GTI/C cards.
3. Where information is common to both LOU/C cards, these cards are collectively referred to as LOU/C cards.

3. GLOBAL POSITIONING SYSTEM

3.01 The United States Government has developed a navigation system called the Global Positioning System (GPS). It is a satellite-based, radio navigation aid designed to provide global, all-weather, precise navigation and timing capability to users 24 hours a day.

3.02 The satellites, circling the earth at approximately 20,200 km, are arranged in six orbits with four satellites in each orbit. Each orbit is inclined 55 degrees from the equator, and separated by 60 degrees longitude from the adjacent orbit. One additional satellite in the GPS constellation, number 12, has its own orbit. Each satellite has an orbital period of approximately 12 hours. The position of the constellation repeats every 12 hours ±4 minutes.

3.03 The geometry of the satellite constellation is oriented such that it furnishes direct line-of-sight timing signals from at least four satellites (and usually more) to any monitor station on or near the earth's surface at all times.

3.04 It is the UTC traceable signal transmitted by the GPS satellites used in conjunction with the users' local or external oscillators that enables the DCD-LPR/C to generate a PRS compliant with ANSI T1.101 and CCITT G.811.

3.05 The DCD-LPR/C System mediates the multiple GPS satellites available by using the GPS Timing Interface (GTI/C) card together with the GPS Timing Antenna/Receiver (GTR). The GTR manages the received signal from all the satellites in view and qualifies the performance of each, using the Receiver Autonomous Integrity Monitoring (RAIM) algorithm.

3.06 The performance of each tracked satellite is observed and compared to the others. Unacceptable performance data results in the suspect satellite being dropped from the timing solution and replaced by the next best satellite, if one exists. A maximum of eight satellites can be tracked at any one time.

3.07 The GTR automatically examines all visible satellites, and a maximum of six satellites (the best satellites in view) are processed simultaneously to derive the timing solution for the GTI/C.

3.08 The GTI/C utilizes a 1 pps, 4 kHz clock, and 4 kb/s data channel signal from the GTR, and converts these into two primary rate T1 timing output signals which comply with the MTIE mask for PRC, as defined in ANSI T1.101, Bellcore TR-2830, and ITU Recommendation G.811. These two signals are supplied as inputs to the DCD System, where they are groomed for distribution.

3.09 The DCD-LPR/C, when coupled with the clocks in the DCD Shelf, or the LOU/C card in the DCD-LPR/C Shelf, outputs time and frequency signals synchronized to within 10 ns of the GPS/UTC time received from the satellite(s). During times when satellites are not being tracked, the DCD-LPR/C continues to output framed all-ones signals still compliant with the PRC specifications. These signals are derived from the oscillator for 24 hours, then the output is either squelched or outputs an AIS signal. (The number of hours, as well as defining whether the signal is squelched or AIS, is user-selectable.)

4. SYSTEM CONFIGURATIONS

4.01 The DCD-LPR/C Shelf is available in several configurations, including: basic, enhanced, and stand-alone.

4.02 The basic configuration (Figure 1) provides the necessary signal conditioning for the GPS derived primary rate signals by ensemble-averaging the selected oscillator to meet (or exceed) industry standard requirements for PRS under normal conditions.

> ***Note:*** A DCD-500 series shelf provides the GTI/C with 5 MHz or 10 MHz inputs, and accepts the E1 PRS outputs.

4.03 The basic configuration consists of the DCD-LPR/C Shelf equipped with up to two GTI/C cards. Figure 1 depicts a basic configuration equipped with two GTI/C cards.

4.04 The enhanced configuration (Figure 2) includes Maintenance Interface System (MIS/C), Multi-reference Controller (MRC/C), and Precision Synchronization Monitoring (PSM/C) cards installed in the DCD master shelf.

4.05 The enhanced configuration provides the same necessary signal conditioning for the GPS derived primary rate signals by ensemble averaging the oscillator to exceed industry standard requirements for PRS/Stratum-1 under normal conditions. In addition, the enhanced configuration, using the MRC/C card, provides complete fault tolerance operation to detect and remove a reference that is not within normal operating limits.

4.06 For more information regarding the DCD-LPR/C configurations, refer to the Functional Description section of this manual.

4.07 The stand-alone configuration provides the necessary signal conditioning for the GPS derived primary rate signals by using the signal from the oscillator on the LOU/C card to meet industry standard requirements for PRS/Stratum-1 under normal conditions.

4.08 The stand-alone configuration consists of the DCD-LPR/C Shelf equipped with one GTI/C card and one LOU/C card (Figure 3).

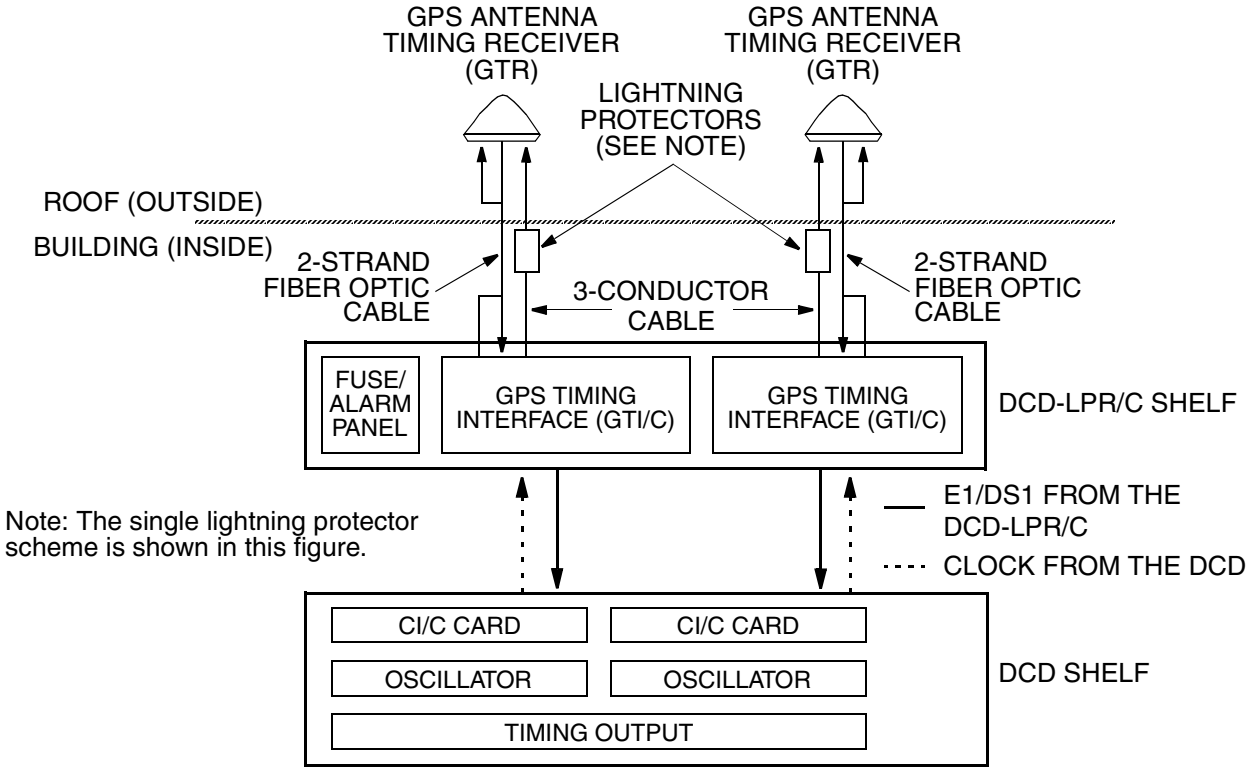
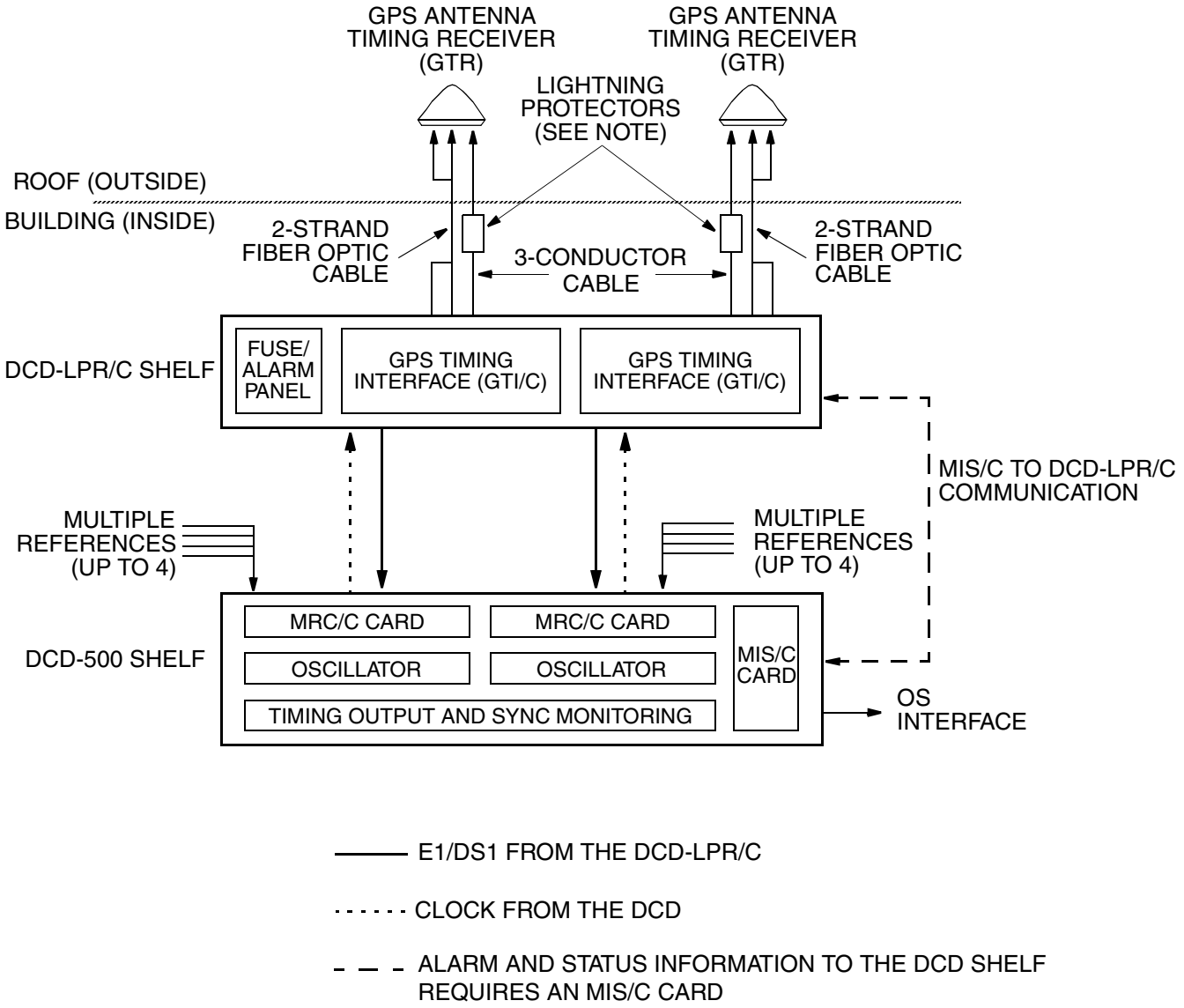
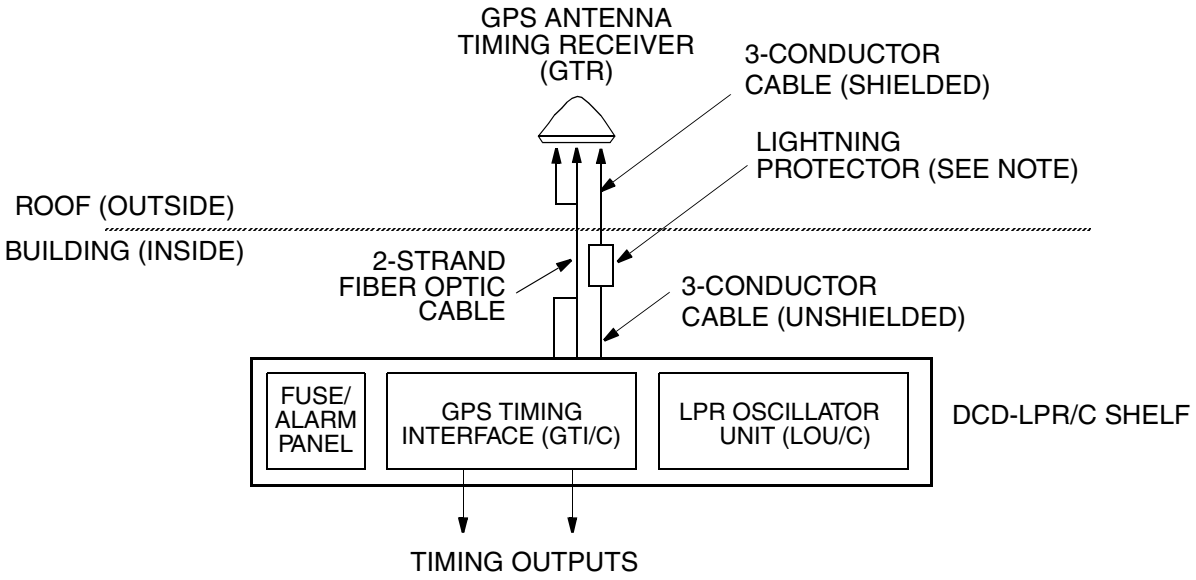


Figure 1. Basic DCD-LPR/C System Configuration



Note: The single lightning protector scheme is shown in this figure.

Figure 2. Enhanced DCD-LPR/C System



Note: The single lightning protector scheme is shown in this figure.

Figure 3. Stand-alone Configuration

5. LIGHTNING PROTECTION PHILOSOPHY AND GROUNDING PRINCIPLES

5.01 Lightning is, typically, a thunderstorm-initiated discharge. A lightning flash may be comprised of multiple return strokes with consequent slow decay, static potentials, producing radio noise analogous to precipitation static in its ability to degrade reliable radio signal reception.

5.02 The information contained in this section describes considerations for lightning protection, and the types of grounds available at a central office and some general principles that may be employed. Follow the approved company practices regarding grounding and lightning protection.

A. Lightning Protection Philosophy

5.03 From the early development phase of this product, the primary concern of Symmetricom was to protect personnel and equipment inside the building wherever the GPS antenna (GTR) was deployed.

5.04 The most important feature of any lightning protection approach is the building grounding system. To augment local building grounding practices, Symmetricom currently uses two lightning protector schemes:

- The installation of a single lightning protector installed inside the building
- The installation of two lightning protectors, one installed outside the building, and the other installed inside the building

5.05 The single lightning protector scheme is the recommended scheme for GTR lightning protection. In this application, the lightning protector is grounded to a C.O. ground bar that is bonded to the office principal ground point (OPGP). The OPGP is a bus bar normally located near the entrance switchgear. It functions as:

- The central connection point for all main grounding connectors and earth electrodes
- The point of origin for the vertical equalizer
- The C.O. ground bus bar for the floor where it is located (typically the basement)

5.06 The single lightning protector scheme should be used in sites where the following items are true:

- The inside and outside grounds are not bonded to building steel, or the OPGP.
- The GTR is located in a high lightning area.

5.07 Other acceptable alternatives are to ground it to building steel, metal conduits, air conditioner ducts, or other metallic items known to be well-grounded per national or local code. (Lightning discharge does not discriminate between any of these various alternatives.)

5.08 The lightning protector scheme whereby two lightning protectors are used is considered a secondary method. In this application, the outside lightning protector is grounded to either a metal conduit (if applicable) or ring ground, and the inside lightning protector is connected to the building ground. In existing installations located in low-lightning areas, or in sites where the C.O. ground bar is not bonded to the OPGP, the dual lightning protector scheme will suffice, but the single lightning protector scheme is the preferred and recommended lightning protection method for all installations.

5.09 Both methods are covered in this document.

B. Single Lightning Protector Scheme

Grounding Principles and Lightning Protector Placement

5.10 In GTR applications, a shielded 1.47 mm (16 AWG) three-conductor power cable with a built-in 1.47 mm (16 AWG) drain wire is used for the connection between the GTR and the lightning protector. Unshielded 1.47 mm (16 AWG) three-conductor cabling is used for connection between the lightning protector and the DCD-LPR/C Shelf.

5.11 The shield of the GTR power cable is open at the GTR and the lightning protector; the built-in drain wire (on the lightning protector end) is connected to the grounding plate on the lightning protector.

5.12 The shield allows the three conductors inside the lightning protector to rise to the same potential (with minimal difference of potential between them) during a near-lightning strike. The common (CMN) leads from both the DCD-LPR/C Shelf and the GTR are also connected to the grounding plate on the lightning protector. The CMN lead between the DCD-LPR/C Shelf and the GTR is required to ensure proper balance between the power supplies.

5.13 The shield keeps the three leads at the same potential, and because the shield is grounded at the lightning protector, they (including the CMN lead) will be kept at the building ground potential. If they rise sufficiently above ground, the lightning protector will fire and bring the power leads (and the CMN lead) back to ground potential.

5.14 The following principles highlight general grounding rules for GPS antennas to minimize damage from lightning strikes:

Note: Do not substitute other lightning protectors for those supplied with the GTR; the warranty will be voided.

a. The ground wire should be as short (less than 4.5 meters is recommended) and straight as possible, and grounded to a C.O. ground bar bonded to the OPGP. Solid copper is recommended; 4.115 mm [6 AWG] wire should be used if the cable length is less than 30 meters, and 5.189 mm [4 AWG] if more than 30 meters).

Note: Lightning discharge will not travel around right-angle bends; it will find the shortest and straightest path possible.

b. The length of the antenna cable run on the roof should be encased in weather-resistant conduit. Minimize the length of the exposed antenna cable runs on the roof.

c. The lightning protector should be located within 15 meters of the point where the cables from the GTR enter the building (per company practice); Symmetricom recommends that the inside lightning protector be located within 3 meters of the cable entry point.

d. Under no circumstances should the shielded cable run inside the building be more than 15 meters before the shield is grounded to a C.O. ground bar that is bonded to the OPGP.

e. The DCD-LPR/C should be connected to frame ground per the installation procedure.

f. The lightning protector should be grounded to a C.O. ground bar that is bonded to the OPGP. Other acceptable alternatives are to ground it to building steel, metal conduits, air conditioner ducts, or other metallic items known to be well grounded per national or local code.

g. DIG GND to battery RTN (on the DCD-LPR/C backplane) is factory-strapped at TB1 only.

h. Make sure that all connections are tight to avoid arcing, corrosion, and intermittent operation.

i. Avoid 90 degree turns, and *do not loop* the ground or power wires. If ground wires cross or are adjacent, they must be bonded at that point.

j. Have an office grounding specialist verify the quality of ground and grounding protection methods. Deviations or omissions to grounding and protection principles may cause serious damage to equipment and/or personnel.

Lightning Protectors

5.15 The GPS lightning protector has a three-terminal spark gap inductance, and is designed with semiconductor devices that limit the maximum voltage to 60 volts.

C. Dual Lightning Protector Scheme

5.16 Symmetricom offers separate dual lightning protector schemes for the GPS. This dual lightning protector scheme should be used only at sites that have a valid roof ring ground system. If in doubt about the ring ground system, it is recommended that the single lightning protector scheme be used.

Grounding Principles and Lightning Protector Placement

5.17 The following principles highlight general grounding rules to minimize damage from lightning strikes:

Caution: To prevent hazardous consequences, do not install the outside GPS lightning protector inside, or vice versa.

Note: Do not substitute other lightning protectors for those supplied with the GTR; the warranty will be voided.

a. The length of the antenna cable run on the roof should be encased in weather-resistant conduit. Minimize the length of the exposed antenna cable runs on the roof.

b. When considering placement of the lightning protectors, use the following guidelines:

- If installing either a PVC mast and PVC conduit for the cable run, or a metal mast and metal conduit, one lightning protector should be installed inside the building, and the other installed outside the building, as close as possible to the point where the cables from the GTR enter the building (per company practice).

- If installing either a PVC mast and metal conduit for the cable run, or a metal mast and PVC conduit, the outside lightning protector should be installed at the closest point of transition from PVC to metal. The outside lightning protector must be installed inside a junction box, and grounded to the metal conduit or roof ring ground. The inside lightning protector should be installed as close as possible to the point where the cables from the GTR enter the building.

c. The DCD-LPR/C should be connected to frame ground per the installation procedure.

d. The ground wire for the outside lightning protector must be as short (less than 4.5 meters is recommended) and straight as possible, and grounded to outside building (ring) ground. If using metallic conduit for cable runs, ground the outside protector to the metal conduit, if possible. All joints of metallic conduit must be bonded together, and both ends of the conduit run must be connected to the ring ground.

Note: Lightning discharge will not travel around right angle bends; it will find the shortest and straightest path possible to ground. If improperly installed, it may arc to some building frame ground, and result in hazardous consequences.

e. The inside lightning protector should be grounded to a C.O. ground bar that is bonded to the OPGP. Keep the ground wire as short (less than 4.5 meters is recommended) and straight as possible. Do not undersize this grounding wire.

f. The inside lightning protector should be located as close to the point of cable entry into the building as possible; Symmetricom recommends 3 meters; not to exceed 15 meters.

g. The outside lightning protector must be contained in a weather-resistant junction box, and the lightning protector connected to outside building (ring) ground. If PVC mast and conduit are used, ground at the point of entry into the building. If metal conduit for cable runs is used, grounding to the conduit is preferred, and the conduit bonded to ring ground. *Keep the ground wire as short and straight as possible. Do not undersize this grounding wire.*

h. Do not ground both protectors together with one common wire; the outside and inside protectors must have separate ground points.

i. Make sure that all connections are tight to avoid arcing, corrosion, and intermittent operation.

j. Avoid 90 degree turns, and *do not loop* the ground or power wires. If ground wires cross or are adjacent, they must be bonded at that point.

k. Have an office grounding specialist verify the quality of ground and grounding protection methods. Deviations or omissions to grounding and protection principles may cause serious damage to equipment and/or personnel.

GPS Lightning Protectors

5.18 The lightning protectors for the dual lightning protector scheme consist of one lightning protector designated for installation outside the building, and the other for inside the building.

5.19 The outside lightning protector is a three-terminal spark gap inductance that fires or shorts when the differential voltage on the power leads exceeds its breakdown threshold. The plus and minus terminals short to ground.

5.20 The inside protector has a three-terminal spark gap inductance, and is designed with semiconductor devices that limit the maximum voltage to 60 volts. The inside lightning protector is considered backup protection when the cable length from the outside to inside lightning protector is short (less than 3 meters).

D. Central Office Grounds

5.21 Generally, several types of central office grounds are available. Typical grounding types are:

a. Ring Ground: ring ground is located around the rooftop of a structure with a low-resistance conductor (copper bar) directly to earth at multiple points. The function of this ground is to ensure that all exposed conductive surfaces are at the same potential, and to provide a low reactive (inductive) resistance path to earth through which direct lightning strike currents can flow.

b. Protection Ground: protection ground is used to ground lightning-protection devices to earth ground by means of a low-resistance conductor to earth.

c. Frame Ground: frame ground is primarily an electromagnetic interference (EMI) drain at the equipment level, and is not designed to dissipate high current from sources such as lightning.

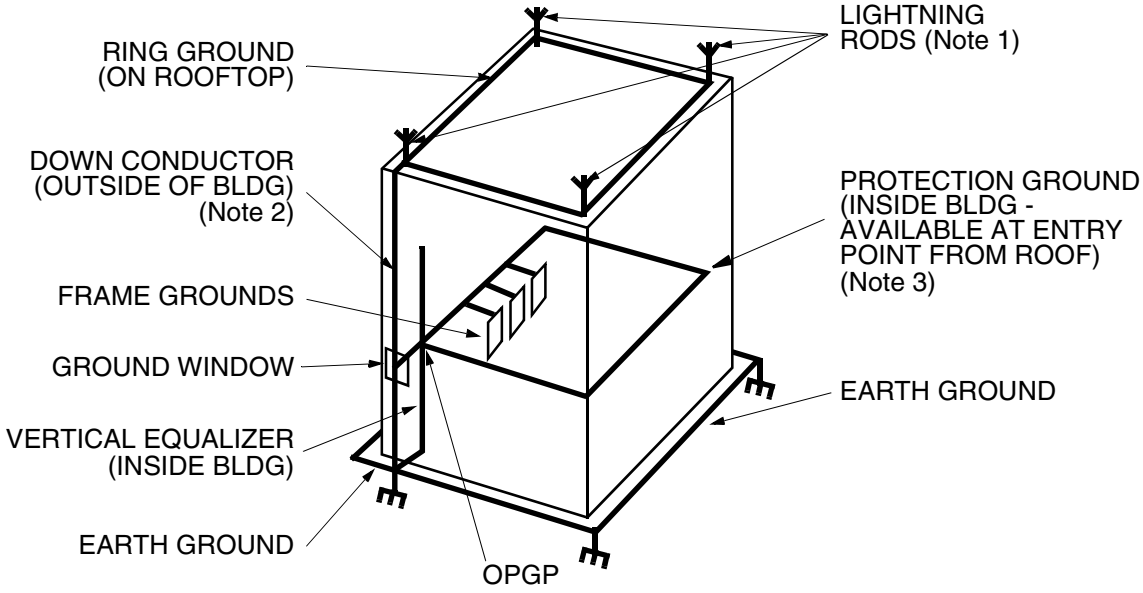
d. Earth Ground: this is the earth itself. All other grounds are ultimately connected to earth ground.

Note: Battery return is a conductor from the equipment to the office battery, and should not be considered a ground.

e. The OPGP is a bus bar normally located near the entrance switchgear. It functions as:

- The central connection point for all main grounding connectors and earth electrodes
- The point of origin for the vertical equalizer
- The C.O. ground bus bar for the floor where it is located (typically the basement)

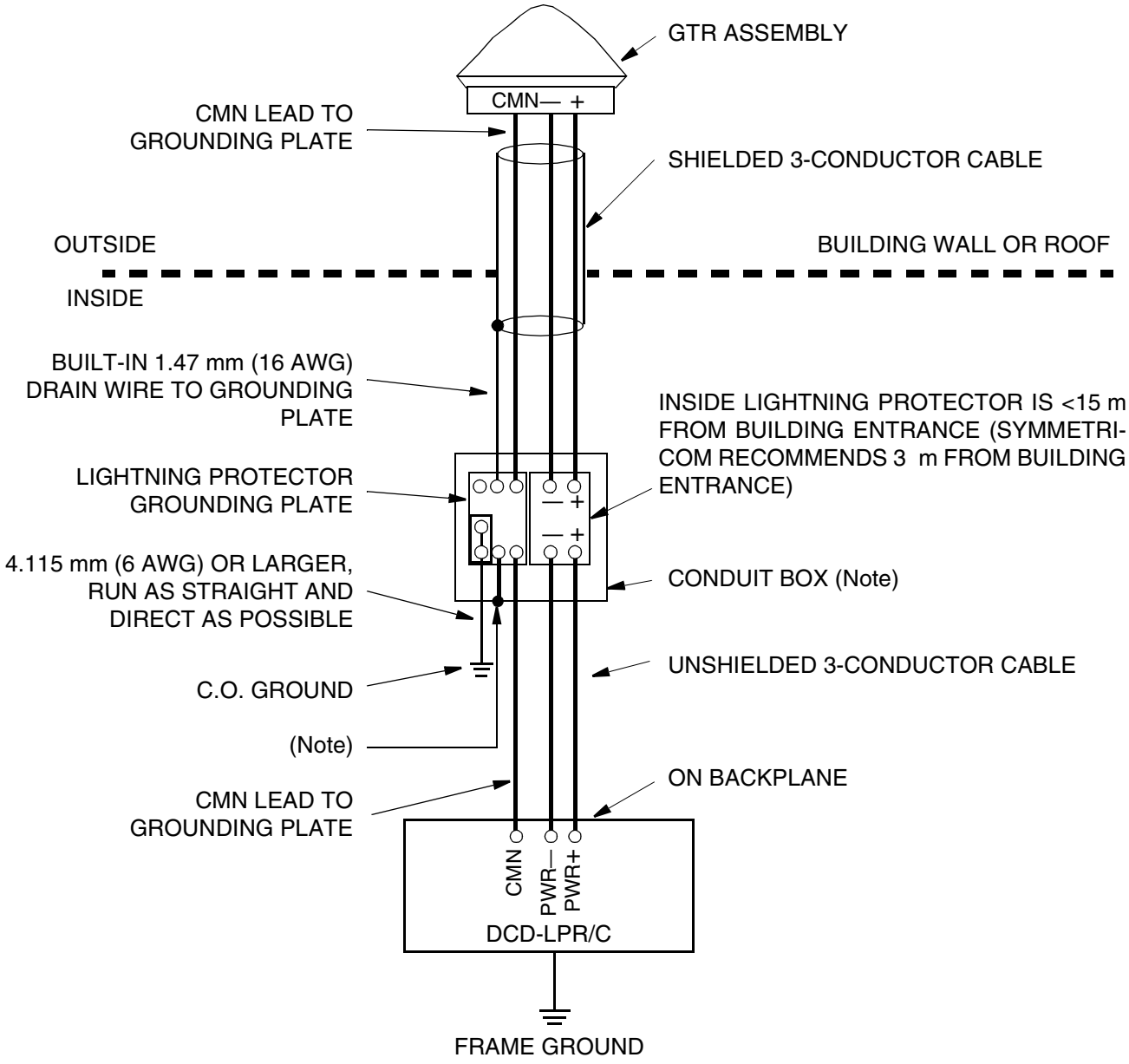
5.22 Figure 4 shows the various grounds available at a central office, and Figure 5 and Figure 6 show how the GTR uses these grounds.



Notes:

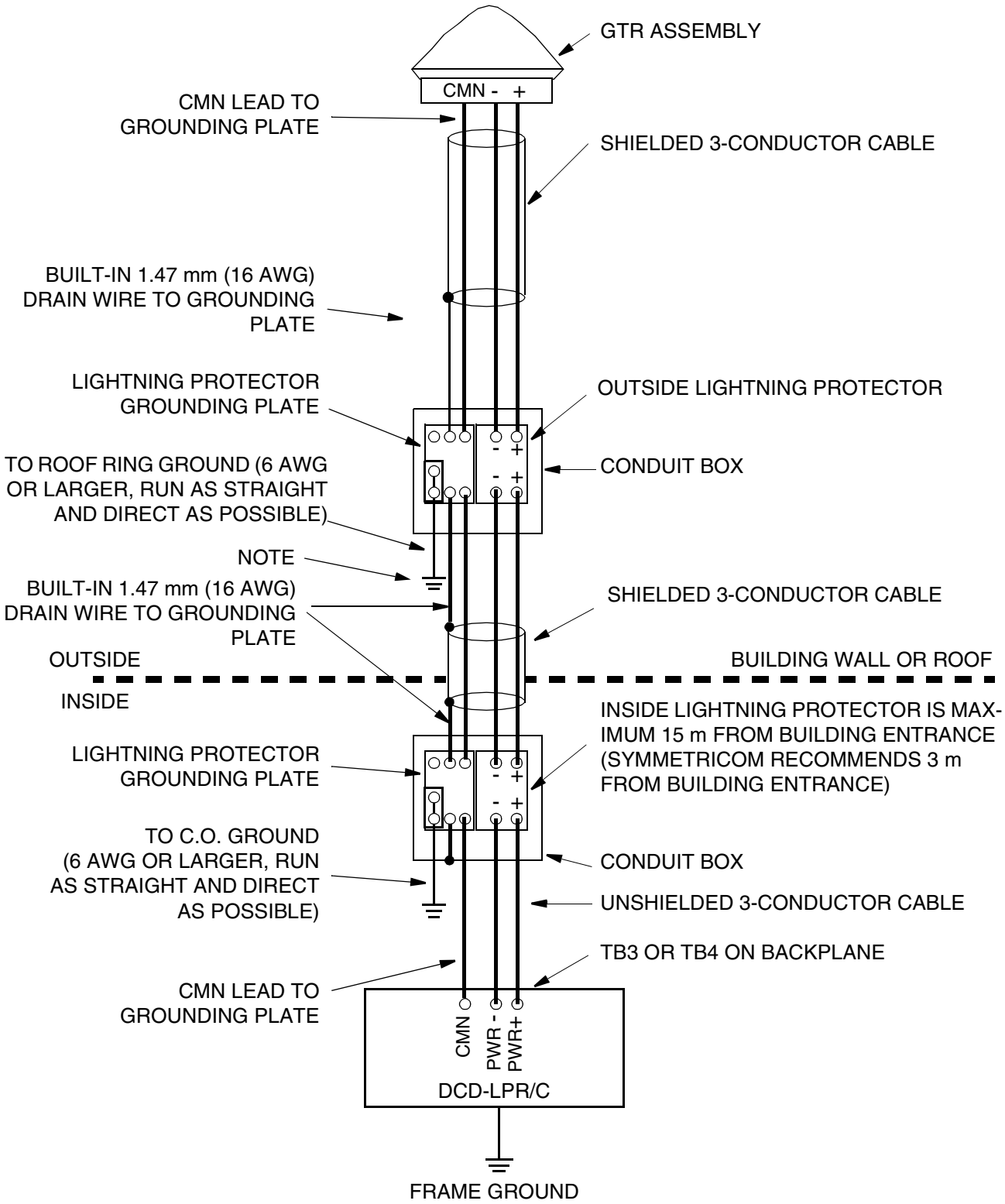
1. Lightning rods are connected to ring ground or to building structural steel.
2. There is only one down conductor path shown; multiple paths are recommended. At minimum, one connection path to Earth at each corner of the building.
3. Multiple path connections to Earth ground.

Figure 4. Central Office Grounds



Note: If the conduit (junction) box is metal, ground the box to the spare #6 stud on the grounding plate.

Figure 5. GTR Single Lightning Protector Grounding Scheme



Note: Ground the outside protector to a valid roof ring ground system or building structure steel. Ground wire should be maximum 4.5 m.

Figure 6. GTR Dual Lightning Protector Grounding Scheme

6. GPS ANTENNA INSTALLATION CONSIDERATIONS

6.01 This section describes guidelines to consider when installing the GTR, including:

- Cabling considerations and materials required
- Antenna location
- Lightning protection

6.02 Installation procedures are to follow company procedures.

Note: Throughout this section, the "xx" noted in a cable part number is used in place of the number indicating the length. For example, the part number for the fiber optic cable is seen as "060-45100-xx"; the part number for a 121.3 meter section of fiber optic cable is 060-45100-04, a 91 meter section is 060-45100-03, etc. Contact Symmetricom Inside Sales Department at +44 1483 510300 (U.K.) for available cable lengths and part numbers.

A. Cabling Considerations

6.03 The GTR antenna assembly uses two-strand fiber optic (for GTI to GTR communication) cables. For power, depending on the lightning protection scheme, shielded and/or unshielded three-conductor cables are used. The fiber optic cable distance allowable between the GTR and the DCD-LPR/C is 1213 meters.

6.04 For single lightning protection schemes, the power cables are shielded, 1.47 mm (16 AWG), stranded, three-conductor cable with a 1.47 mm (16 AWG) drain wire for connection between the GTR and the lightning protector; and unshielded 1.47 mm (16 AWG), stranded, three-conductor cable for connection between the lightning protector and the DCD-LPR/C Shelf. For dual schemes, the same cabling materials are required as for the single lightning protector installation, plus an additional shielded cable is required to connect the inside lightning protector to the outside lightning protector.

6.05 Regardless whether an internal power supply or an external power source is used, the maximum cable distance between the GTR and the power supply that can be supported using 1.47 mm (16 AWG) wire is 243 meters.

6.06 Specifications for the external power source at the GTR interface are:

- Maximum 1.16 amps in-rush current
- Nominal operation: 6.4 watts continuous (200 mA at 32 volts)

Note: If an external power supply is desired, the Symmetricom Stand-alone Power Supply (p/n 990-40031-01) or an equivalent is recommended; for information regarding the Symmetricom power supply, contact Symmetricom Customer Assistance Center (CTAC) at one of the following numbers:

- +44 1483 510300 (U.K.)
- +1 888 367 7966 (U.S.A.)

6.07 All cable runs outside the building must have the cables encased in weather-resistant conduit. The conduit should be large enough to accommodate the fiber optic cables and connectors, power cables and connectors, as well as pulling wires. Either metal or PVC conduit may be used; it is recommended that if PVC conduit is used, a minimum 50.8 mm UL listed #651 PVC conduit (minimum Schedule 40) be used to contain the cables.

Warning: Avoid hard (tight) corner small radius turns and any unnecessary turns.

6.08 Cables must be run as straight as possible; the fiber optic cable can have a minimum 50.8 mm bending radius; stripped (unsheathed) fiber cable can have a minimum 25.4 mm bending radius (Figure 7). All cables should be run in accordance with company practices.

Caution: Less than a 50.8 mm bending radius; 25.4 mm for stripped (unsheathed) fiber cable could cause fiber breakage or excessive fiber loss.

Warning: Do not attempt to coil excess GTR power cable into the junction box. Failure to observe this caution may result in increased damage if a lightning strike occurs.

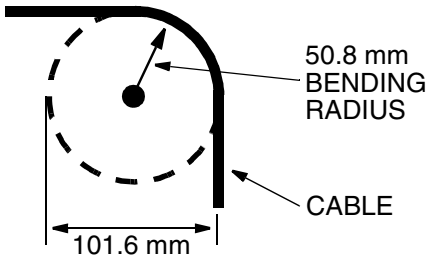


Figure 7. Bending Radius

B. Cabling Material

6.09 The following cable materials are required for installation:

> ***Note:*** Contact Symmetricom Inside Sales Department at +44 1483 510300 (U.K.) for ordering information.

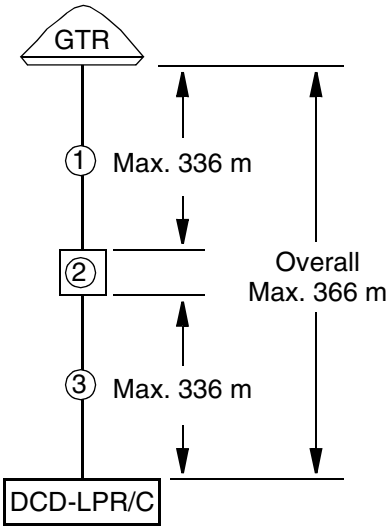
- For the recommended single lightning protector installation, a shielded three-conductor 1.47 mm (16 AWG) stranded cable with a built-in 1.47 mm (16 AWG) drain wire for GTR power connections between the GTR and the lightning protector is required; the cable must be long enough to allow for the connections from the GTR to the lightning protector (Figure 8). The cable may be purchased from Belden (p/n 9366), or Symmetricom (p/n 060-45125-xx). A 30 meter length of power cable is available in the GTR Grounding Upgrade Kit (p/n 093-45125-01), terminated with a GTR power connector on one end, and unterminated on the other end.

  > ***Note:*** The GTR connectorized shielded power cables can be purchased from Symmetricom in increments of 30 meters only; the length is minimum 30 meters, maximum 366 meters.

- An unshielded three-conductor 1.47 mm (16 AWG) stranded cable for GTR power connections between the lightning protector and the DCD-LPR/C Shelf is required; the cable must be long enough to allow for the connection from the lightning protector to the DCD-LPR/C. The cable may be purchased from Belden (p/n 9494), or Symmetricom (p/n 060-45140-xx).

  > ***Note:*** Unshielded three-conductor 1.47 mm (16 AWG) stranded cable for connection between the inside lightning protector and the DCD-LPR/C Shelf can be purchased from Symmetricom in 15 meter lengths, and 30 meter to 366 meter lengths, in 30 meter increments.

- For the dual lightning protector installation, the same cabling materials are required as for the single lightning protector installation, plus an additional shielded cable is required to connect the inside lightning protector to the outside lightning protector.



① Shielded 3-conductor power cable (connectorized: p/n 060-45125-xx or unconnectorized: Belden p/n 9366)

② Lightning protector

③ Unshielded 3-conductor power cable (unconnectorized: p/n 060-45140-xx or Belden 9494)

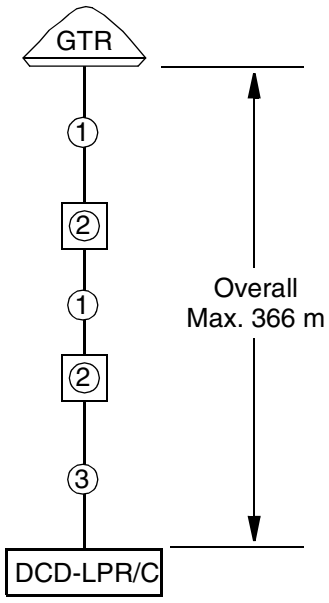
Figure 8. GTR Power Cable Limits (Single Lightning Protector)

The cables should be long enough to allow for the following connections: one to connect the outside lightning protector to the GTR, the second to connect the outside lightning protector to the inside lighting protector, and the third to connect the inside lighting protector to the DCD-LPR/C (Figure 9). The cable may be purchased from Belden (p/n 9494), or Symmetricom (p/n 060-45140-xx). The Symmetricom cable comes terminated with a GTR power connector on one end, and unterminated on the other end.

Notes:

1. If the cable is not purchased from Symmetricom, the GTR power connector will have to be ordered separately from Symmetricom (p/n 121-00805-01).

2. The 1.47 mm (16 AWG) GTR connectorized unshielded power cables can be purchased from Symmetricom in increments of 30 meters only; the length is minimum 30 meters, maximum 366 meters.



① Shielded 3-conductor power cable (connectorized: p/n 060-45125-xx or unconnectorized: Belden p/n 9366)

② Lightning protector

③ Unshielded 3-conductor power cable (unconnectorized: p/n 060-45140-xx or Belden 9494)

Figure 9. GTR Power Cable Limits (Dual Lightning Protectors)

- One 200 micron, 850 nm wavelength multimode fiber optic Riser-rated cable to connect the GTR to the DCD-LPR/C. Fiber optic cables may be purchased from Symmetricom or SpecTran Specialty Optics Co. (in the U.S.A.) at +1 860 678 0371. Symmetricom offers the cable in two configurations:

  - Riser-rated fiber cable with connectors and pulling mechanism (p/n 060-45110-xx)

  - Riser-rated fiber cable only (p/n 060-45100-xx)

  SpecTran Specialty Optics Co. offers the cable in two configurations:

  - Riser-rated fiber cable with connectors and pulling mechanism (p/n BP04344-xx)

  - Riser-rated fiber cable only (p/n BP04343-xx)

Note: The fiber optic cable from Symmetricom contains two different colored cables, a fiberglass strengthener, and two filler cables (Figure 10); other manufacturers may differentiate each cable by texture (smooth or ribbed).

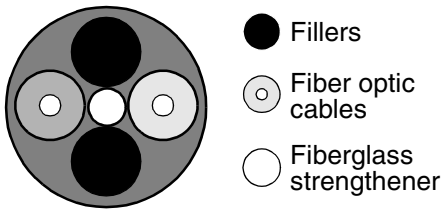


Figure 10. Fiber Optic Cable

Note: The connectorized fiber optic cables can be purchased from Symmetricom in increments of 30.3 meters, 45.5 meters, 60.7 meters, 75.8 meters, 91.0 meters, and 106.2 meters; for lengths over 106.2 meters, cable is only available in 30.3 meter increments. Contact your local Symmetricom distributor or Symmetricom Inside Sales Department at +44 1483 510300 (U.K.) for ordering information. For cable lengths over 455 meters, contact your local Symmetricom distributor or Symmetricom Inside Sales Department for Special Order instructions.

- Four fiber optic compound cleave crimp-on ST-style connectors (200 micron multimode fiber). A package of six may be ordered from Symmetricom (p/n 093-42100-20). A fiber ST terminator connector tool will be required for crimping on the connectors. The fiber ST terminator connector tool may be ordered from SpecTran Specialty Optics Co. (in the U.S.A.) at +1 860 678 0371 (p/n TK7-230-ST).

- 4.67 mm (6 AWG) grounding wires (or larger for long runs)

- Spade lug connectors to fit a 1.47 mm (16 AWG) wire, 6.4 mm wide, and fit a #6 stud

- Weather-resistant conduit, metal or PVC; it is recommended that a minimum 50.8 mm UL listed #651 PVC conduit (minimum Schedule 40) if PVC is chosen for cable runs

  Note: Metal conduit should be used if the conduit is to be used for ground.

- Expansion joint sleeves to prevent breaks in the conduit due to expansions and contractions

  Note: If metal conduit is used, conduit joints must be bonded (generally, threading the pipe is adequate) and, at minimum, both ends of the

conduit run must be connected to building structural ground via the ring ground, metal conduits, air conditioning ducts, etc. It is recommended that an intermediate point along the conduit be also grounded.

C. Location and Mounting

Warning: Do not select an antenna location that could be an electrical or physical hazard to work persons or equipment. Avoid proximity to all high-voltage sources. Mount in an easily maintainable location.

6.10 Figure 11 through Figure 13 are examples of side view and top view drawings of a hypothetical DCD-LPR/C site. The building has three roof line levels, with a large air conditioning unit, and a transmit and receive dish antenna on the higher roof line.

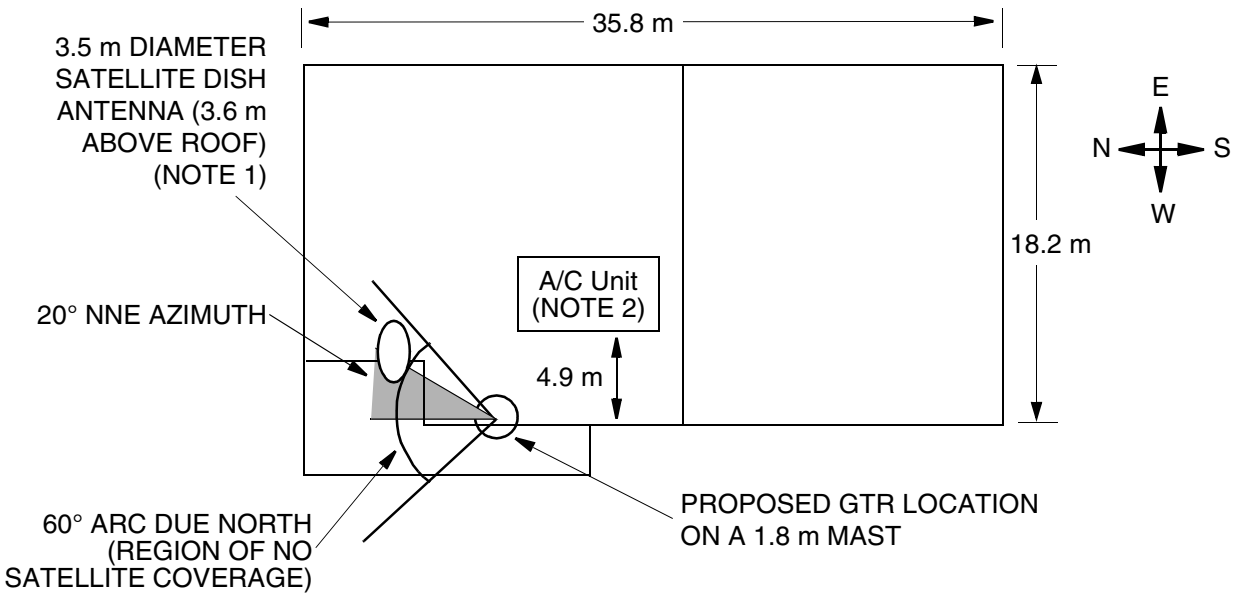
Location

6.11 It is recommended that a site survey be performed to determine the best rooftop location for the GTR, as well as determine what materials are required. While performing the site survey, keep in mind the selection of possible mounting locations in relation to the cable entry point in the building, accessibility, and proximity to suitable ground points.

6.12 The ideal mounting location for the GTR provides an unobstructed (360 degrees) view of the sky above the horizon. If this is the case, proceed to instructions for mounting the GTR.

6.13 If the ideal location is not available, the following minimum requirements must be met:

- 300 degree azimuth view of the sky
- No vertical obstructions
- 10 degrees altitude above the horizon line
- Any azimuthal (horizontal) obstruction in the same horizontal plane as the GTR should be confined within a 60 degree arc due north of the GTR if in the Northern Hemisphere, and due south in the Southern Hemisphere



Notes:

1. Receive only—C band (4 GHz) and KU band (12 GHz)—south direction azimuth, 45° altitude.
2. The dimensions of the air conditioning unit shown in this figure are: 7.3 m length x 3.6 m width x 1.5 m height.

Figure 11. Aerial View of Building Rooftop

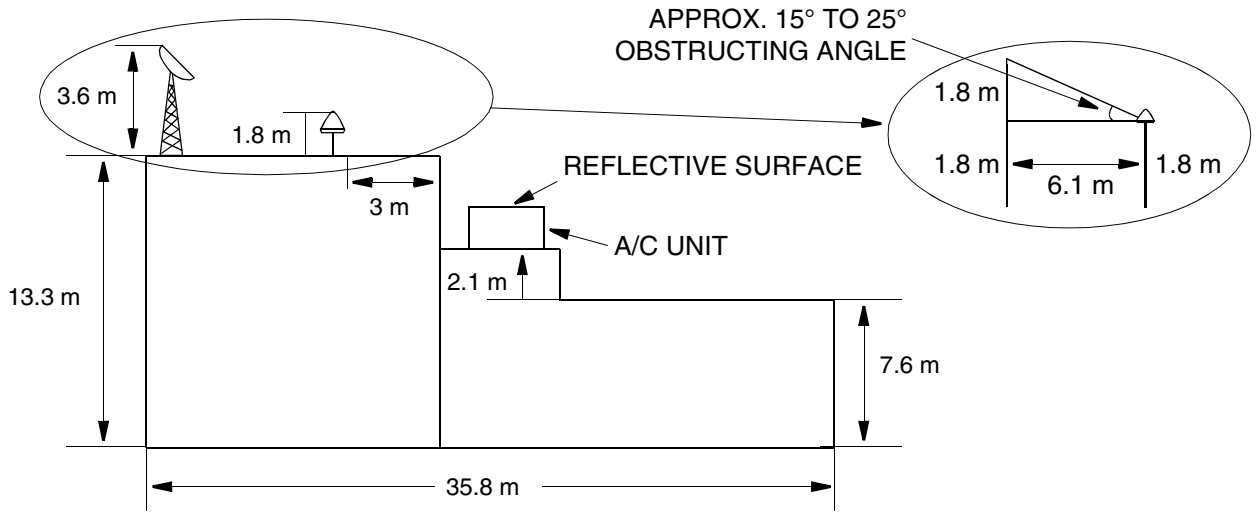
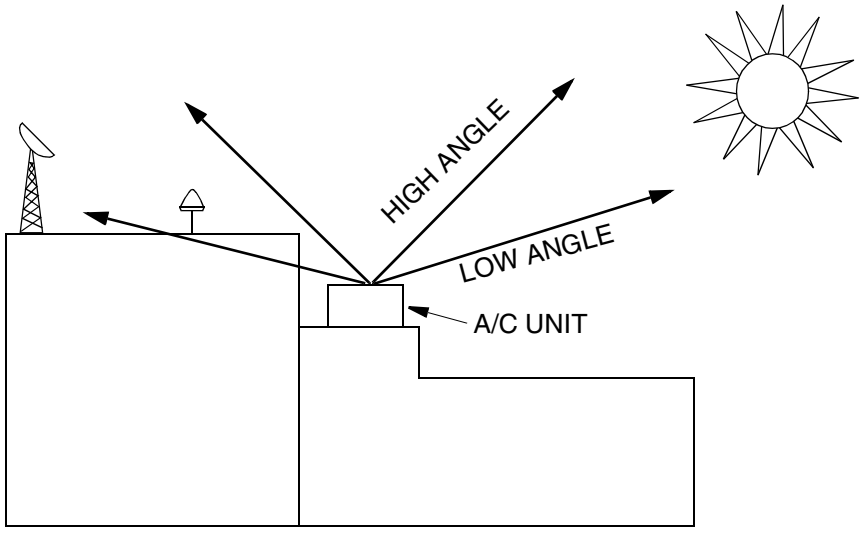


Figure 12. Side View of Antenna Obstructions



- Horizontal distance from the vertical reflective structure (e.g., heating ducts, equipment housings, etc.) is recommended to be twice the height of the structure, minimum 3.0 m.
- Vertical distance above the metallic reflective object minimum 1.4 m.

Figure 13. Side View of Placement with Respect to Reflective Surface

6.14 If the minimum requirements cannot be met, a compromise must be made between performance and satellite coverage. The less coverage you have, the fewer the number of satellites being used in the timing solution for GPS derived time. The consequence of this is the DCD clocks may experience holdover more often than if the minimum requirements had been met. This fact may influence the network engineer to select rubidium over quartz clocks.

6.15 The following procedures provide an engineering methodology to perform a physical site survey without the need for test equipment. Different GTR locations and mast heights on the roof may be required during the survey before the best GTR location is found. If the parameters cannot be met, a detailed study using test equipment may be required.

6.16 To perform a site survey, use the steps listed in the proposed site selection at the beginning of this section, and complete the following:

1. Make an aerial view drawing of the building rooftop to approximate scale (Figure 11). A hand sketch will suffice if engineering drawings are not available.

2. Mark the locations of reflective and obstructing objects on the roof, e.g., air conditioning units, motor/generators, other antennas, towers, metal capped parapets, etc.

3. Mark the dimensions (height, width, and length) and distances from walls and other objects on the roof for each obstructing object on the drawing. For antennas, mark the type, e.g., dish, horn, whip, etc., whether it is transmit only, receive only, or transmit and receive on the drawing.

4. Mark the drawing with other information about the antennas, e.g., azimuth direction and altitude angle above horizon it is pointing, such as N azimuth-10 degree altitude, NNE azimuth-15 degree altitude, etc., its operating frequencies (transmit and receive), and its output power in watts or decibels (dBm).

5. Do a visual azimuth survey of objects within 0.2 km around the building; check for the following:

   - The height and distance of taller objects, such as extremely high buildings up to 0.4 km away.
   - The height, width, and distance to objects, such as towers, buildings, dense tall trees, etc., that may exceed 10 degrees altitude above the horizon with respect to the roof line.
   - The approximate height, width, and distance of these objects from the building.
   - The proximity and height of any high-voltage power lines with respect to the building.

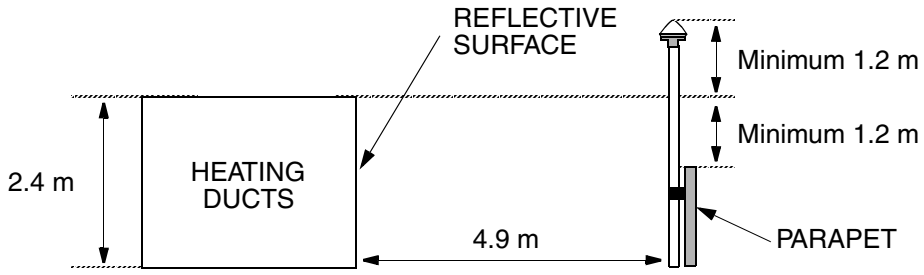
6. Make a side view drawing of the building, showing the height of the roof line and any obstructing objects (Figure 12 and Figure 13).

7. Locate the GTR on the rooftop in a position which meets the following requirements:

   - **Is not** within 30 degrees azimuth of the transmission direction of transmitting antennas (to avoid overpowering the front end of the GTR, even though it is at a different frequency)
   - **Is not** underneath high power lines — if it cannot be avoided, ensure that the GTR is placed at least twice as far from the power line as the power line is high (to avoid blockage and multipath effects) (if possible)
   - **Is not** within 3 meters of a corner of the building
   - **Is not** more than 243 meters from the GTR power supply (DCD-LPR/C Shelf or external source)
   - **Is** at least twice as far from obstructing objects as the obstructing object is high (if possible)

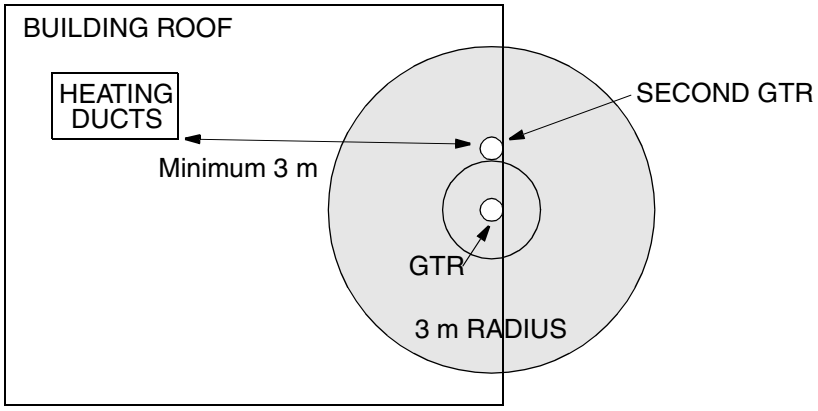
8. Choose the mast height for the GTR, using the following guidelines:

   - Placement with respect to a horizontal reflective surface (e.g., air conditioning unit) should be such that only high reflected wave angles strike the GTR (Figure 13 and Figure 14). Typically, this requires the GTR to be elevated on a mast of roughly 1.2 meters (independent of proximity to a horizontal reflective surface).
   - Horizontal distance from vertical reflective objects (e.g., tower) is recommended to be twice the height of metallic reflective object, minimum 3 meters (Figure 15).



- Horizontal distance from the vertical reflective structure (e.g., heating ducts, equipment housings, etc.) is recommended to be twice the height of the structure, minimum 3.0 m.
- Vertical distance above the metallic reflective object minimum 1.2 m.

Figure 14. GTR Location—Distance from Reflective Objects



- Horizontal distance from any other GTR antennas minimum 0.91 m
- Vertical distance above the parapet, obstructions, horizontal metallic reflective surfaces minimum 1.2 m

Figure 15. GTR Location—Field of View

- If GTR placement cannot be achieved without violating the 10 degree altitude guideline, or there happens to be another obstruction (either on the building roof or removed from it, e.g., water tower, skyscraper, etc.), choose a GTR location that places the obstruction due north of the GTR (if in the Northern Hemisphere), or due south (if in the Southern Hemisphere). The reason for this is that there are holes in the GPS satellite coverage over the North and South Poles. Thus, by locating the obstruction in the "hole" region, the obstruction is effectively removed because there are no satellites in this region to be blocked.

Note: When the site is near or at the Equator, it does not matter where the obstructing object is with respect to the GTR; it will still obstruct the view of the GTR.

- The GTR is above any local reflective or obstructing object, or high enough that the height of the view obstructing object is not higher than 10 degrees altitude above the horizon with respect to the height of the GTR.

9. Determine if guy wire requirements for the mast are required.

Note: If guy wires are required to support the mast, each wire must be connected to rooftop ring ground.

10. From the information obtained previously, determine the type of mounting hardware needed (e.g., 19.1 mm U-bolts or masonry bolts, Romex-type conduit plug, etc.) (see Figure 17).

11. Determine the location of the following:

- The DCD-LPR/C Shelf
- The inside and outside lightning protectors
- The grounding points for lightning protectors and DCD-LPR/C Shelf (per the guidelines set previously)

12. To determine the cable lengths required for single lightning protector installations, determine the distance between the following:

- The GTR and the lightning protector (for shielded power cable)
- The lightning protector and the DCD-LPR/C Shelf (for unshielded power cable)
- The GTR and the DCD-LPR/C (for fiber optic cable)
- The lightning protector and the C.O ground bar (grounding wire)
- The DCD-LPR/C and the DCD master shelf (not necessary if configuring for stand-alone) (ribbon cable)

13. To determine the cable lengths required for dual lightning protector installations, determine the distance between the following:

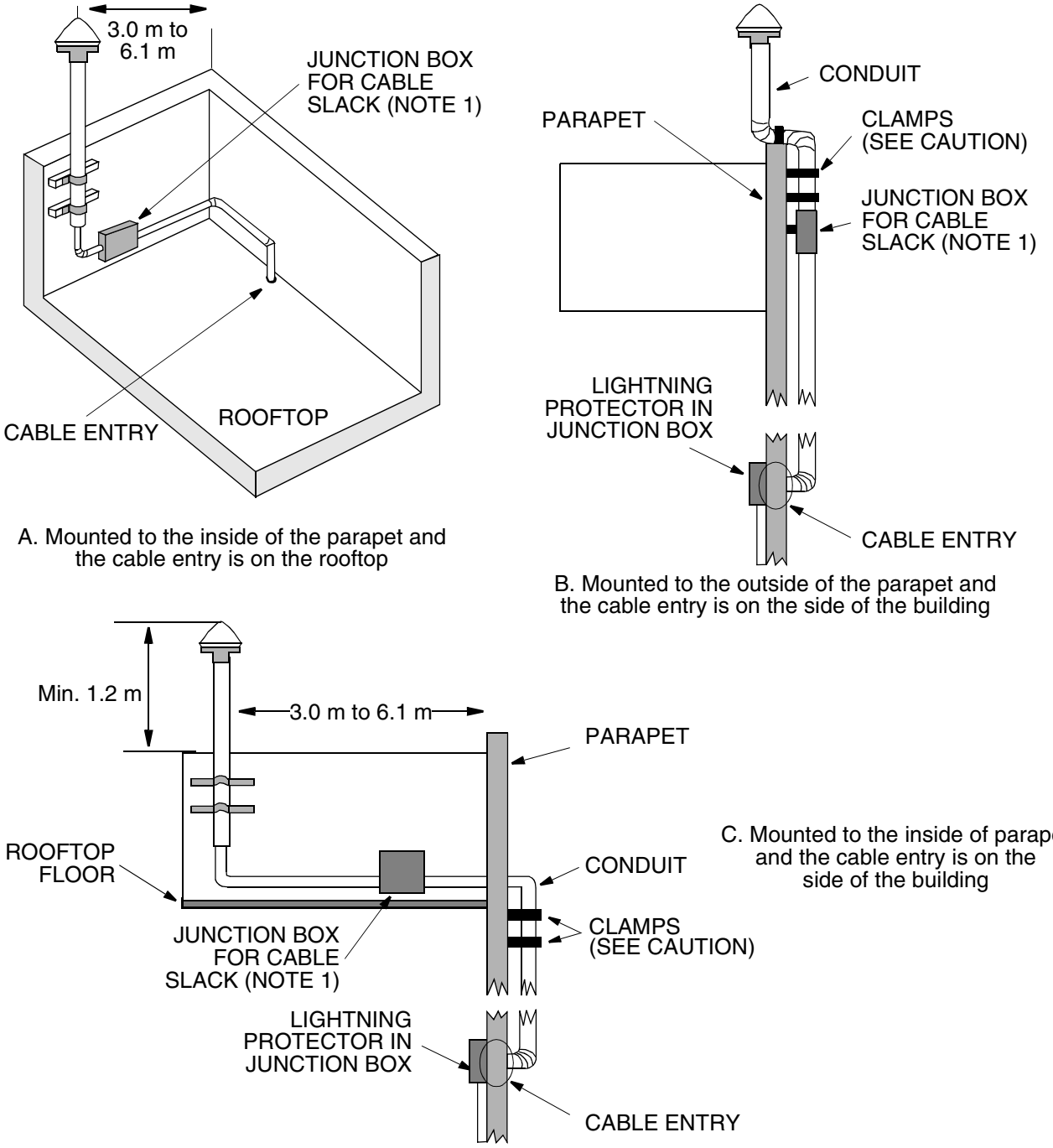
- The GTR and the outside lightning protector (for power cable)
- The outside lightning protector and the inside lightning protector (for power cable)
- The inside lightning protector and the DCD-LPR/C Shelf (for power cable)
- The GTR and the DCD-LPR/C (for fiber optic cable)
- The lightning protector and the building ground (grounding wire)
- The DCD-LPR/C and the DCD master shelf (not necessary if configuring for stand-alone) (ribbon cable)

14. For conduit length (for cable runs), determine the distance between the GTR and the cable entry point.

Mounting

6.17 It is recommended that the GTR be mounted on the rooftop, inside the parapet for connection to outside building (ring) ground. Refer to Figure 16 or Figure 17 for examples of different GTR mountings.

Note: A rooftop mounting platform is available from Prodelin Corp. (Figure 18). Contact Prodelin Corp. (in the U.S.A.) at +1 704 464 4141 for additional information; reference the Rectangular Block Mast Mount, p/n 0800-182.

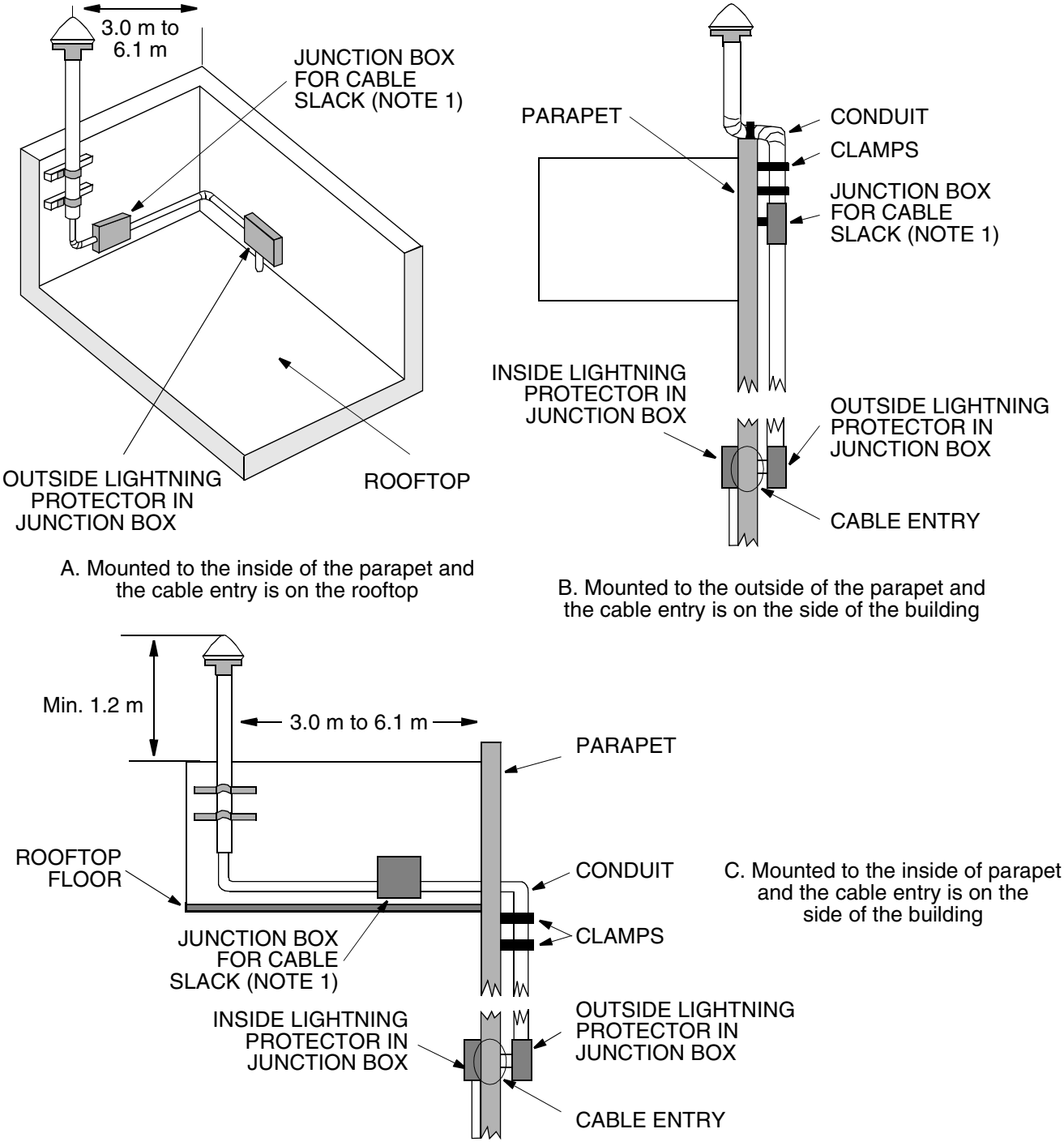


Caution: Clamps that form a complete circle around the power cable or the cable conduit are not allowed. The ring clamp acts like a choke coil to induced currents which resists current flow and hampers proper lightning protection.

Notes:

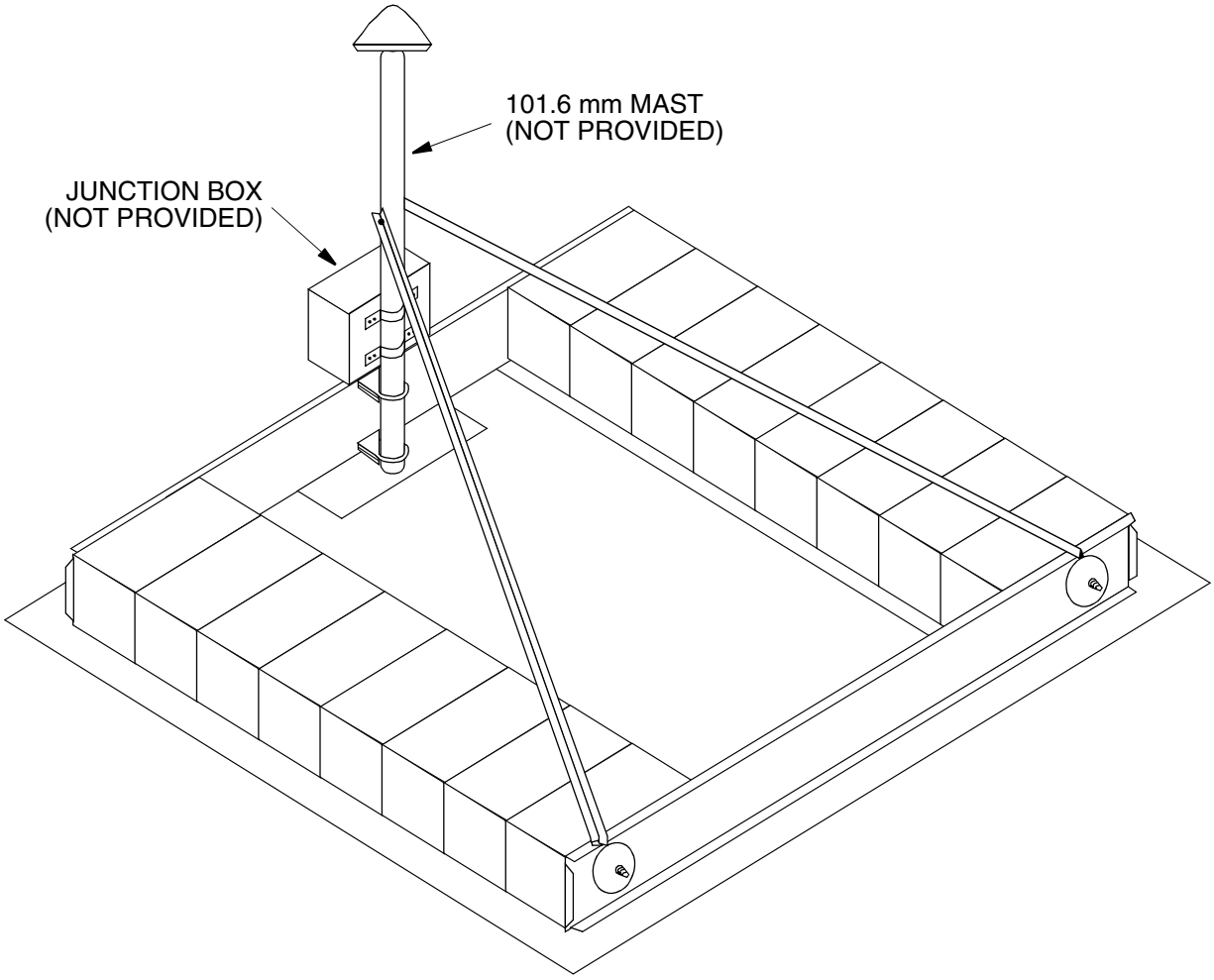
1. A weather-resistant junction box can be used to hold the excess fiber cable.
2. These are example installations only. Not all parts are available from Symmetricom.

Figure 16. Basic GTR Mountings (Single Lightning Protector)



Notes:
1. If excess fiber cable is a problem, a weather-resistant junction box can be used to hold the excess fiber cable.
2. These are example installations only. Not all parts are available from Symmetricom.

Figure 17. Basic GTR Mountings (Dual Lightning Protectors)



Notes:

1. This is an example configuration only; the Prodelin part number for the platform shown is 0800-182. The actual installation may have to be modified from that shown. Consult Prodelin Corp. (in the U.S.A. at +1 704 464 4141) for available configurations.
2. A 101.6 mm mast is shown in this figure; a 73.2 mm mast is provided by Prodelin Corp., and must be adapted to fit the 101.6 mm flange provided by Symmetricom; a 101.6 mm to 73.2 mm mast adaptor is available from Prodelin Corp. (reference the Rectangular Block Mast Mount, p/n 0800-182).

Figure 18. Prodelin Corp. Rectangular Block Mast Mount

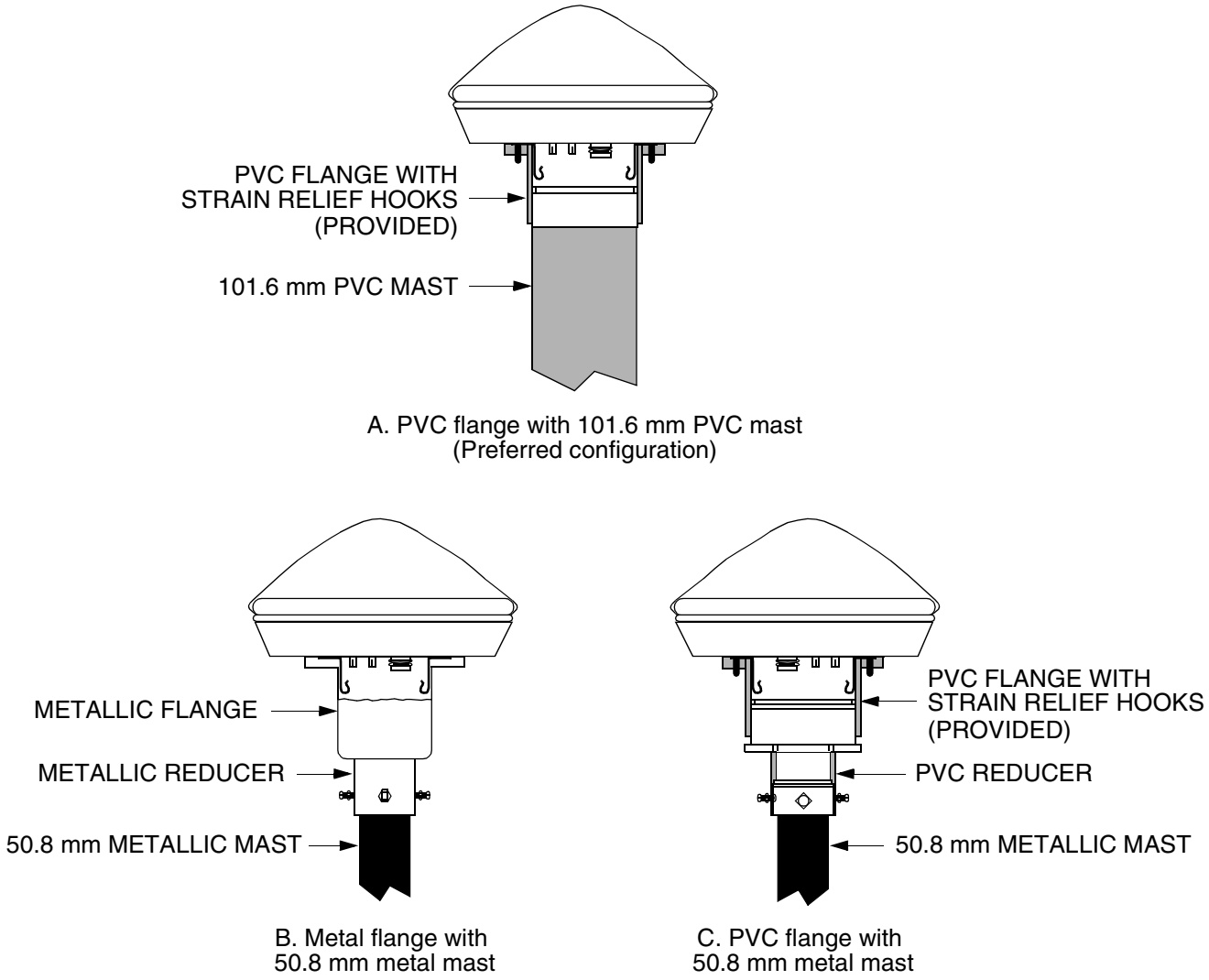
6.18 When mounting the GTR, observe the following guidelines:

- Mount the GTR in such a way that the top of the GTR is at least 1.2 meters above the parapet.
- Mount the GTR in a location with easy access for future maintenance purposes.
- Mount the GTR on either 50.8 mm or 101.6 mm PVC or metal conduit for the mast. If PVC is used, rigid UL listed #651 PVC conduit (minimum Schedule 40) is recommended.

Note: If PVC is used, the Schedule type used and the diameter of the mast (50.8 mm or 101.6 mm) depends on the conditions at each installation site. If the installation site is a high-wind location, it may be advantageous to use 101.6 mm of Schedule 80 conduit. If in a low-wind location, the mast is under 1.2 meters, and guy wires are used to stabilize the mast, 50.8 mm Schedule 40 may suffice. Contact Symmetricom's CTAC for assistance in determining the Schedule type and mast diameter best suited for your location.

- If using a 50.8 mm mast, a pipe reducer must be user-provided; PVC or metal may be used. If PVC is used, rigid UL listed #651 PVC conduit (minimum Schedule 40) is recommended. Refer to Figure 19 for examples of GTR mast configurations.
- If using the 73.2 mm mast from Prodelin Corp., a 101.6 mm to 73.2 mm mast adaptor is available from Prodelin (p/n 0800-101).
- All openings around the conduit hub/nonconductive conduit connection, and where the conduit enters the building, must be waterproofed per company practices.
- It is recommended that all exposed connections be treated with an electrically conductive anti-corrosion compound (Kopr-Shield or equivalent).
- When selecting a cable entry location, as well as the location to mount the lightning protectors, consideration must be given to the grounding connections for the lightning protectors. The ground connections on the lightning protectors must be as short and straight as possible, and not near any other equipment. This connection may have to carry large currents in the event of a lightning strike.
- When selecting a cable entry location, keep in mind that Symmetricom recommends the lightning protector be installed within 3 meters of the cable entry location.
- It is recommended that for fiber optic cable slack, a weather-resistant junction box be installed as required. The weather-resistant junction box should be large enough to hold the excess fiber cable. Within the junction box, attempt to provide sufficient cable slack without coiling the fiber cables.

Warning: Do not attempt to coil excess GTR power cable into the junction box. Failure to observe this caution may result in increased damage if a lightning strike occurs.



Note: These are examples only. Not all parts are available from Symmetricom.

Figure 19. Examples of GTR Mast Configurations

7. DCD-LPR/C SHELF INSTALLATION CONSIDERATIONS

Ground and Power Cabling

7.01 For grounding and power, the following must be user-provided:

- 1.47 mm (16 AWG) stranded wire (red) to run from a battery source to the DCD-LPR/C Shelf
- 1.47 mm (16 AWG) stranded wire (black) to run from a battery return source to the DCD-LPR/C Shelf
- 1.47 mm (16 AWG) stranded wire (green) to run from the frame ground to frame ground on the DCD-LPR/C

Output Cabling

7.02 The 0.642 mm (22 AWG) solid shielded twisted pair cable for E1/DS1 output connections from the DCD-LPR/C Shelf to the DCD Shelf are user-provided.

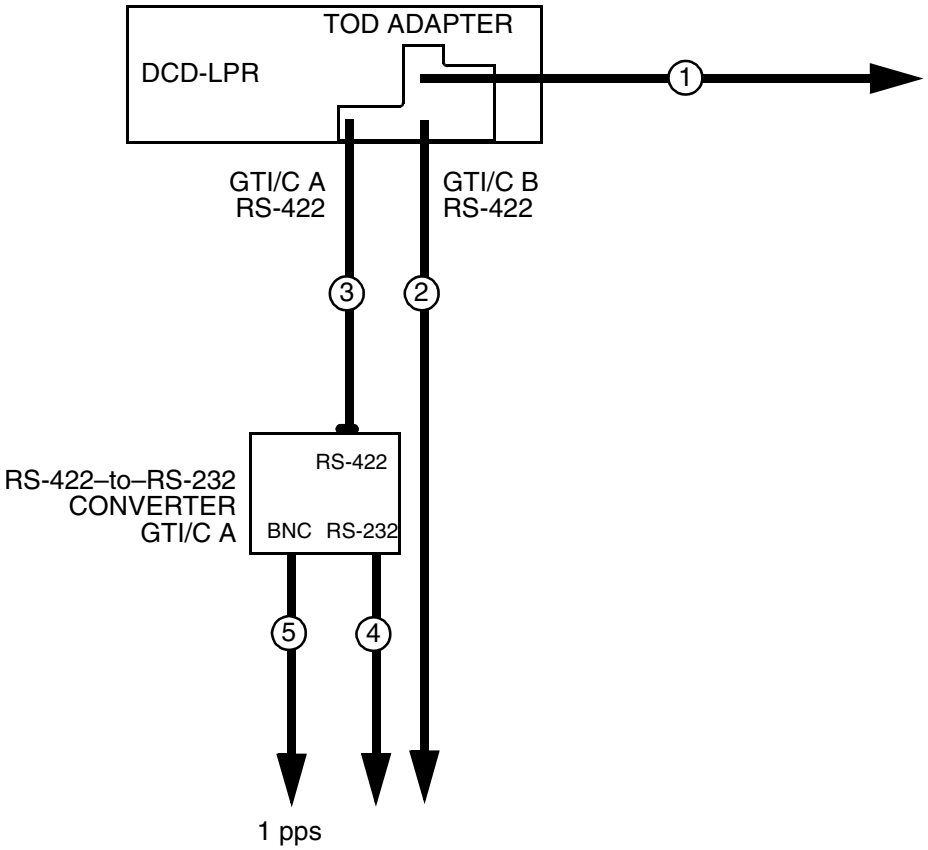
Time-of-Day Cabling

7.03 If configuring the DCD-LPR/C Shelf for Time-of-Day applications, see Figure 20 for cabling. Any of the following combinations are possible:

- One GTI/C card with or without an RS-422–to–RS-232 converter
- Two GTI/C cards with or without RS-422–to–RS-232 converters
- One GTI/C card with an RS-422–to–RS-232 converter and one GTI/C card without an RS-422–to–RS-232 converter

Thermal Insulator

7.04 In DCD Systems equipped with LNC/C cards, a thermal insulator must be installed on the oscillator of the LNC/C card to better regulate the temperature of the oscillator. The thermal insulator is included in the GTR hardware kit. For information regarding the insulator, refer to the instructions included in the Thermal Insulator Installation kit.



① Factory-provided 25-pin shielded cable for connection to the LPRS connector on the DCD Shelf (p/n 060-44210-04). *To be used with the MIS/C card.*

② User-provided 0.511 mm (24 AWG) 3 twisted-pair shielded cable (Belden 9680 or equivalent) with a DB9 male connector to provide one RS-422 signal; one cable per GTI/C card.

③ User-provided 0.511 mm (24 AWG) 3 twisted-pair shielded cable (Belden 9680 or equivalent) with DB9 (male) to DB9 (female) connectors (max. 15 m if using 1 pps, if not, max. 305 m); one cable per GTI/C card.

④ User-provided standard shielded data cable with a DB25 male connector to provide one RS-232 signal; one cable required for each GTI/C card installed.

⑤ User-provided coaxial cable with a BNC connector to provide 1 pps TTL output.

Figure 20. GPS Time-of-Day Cabling