DIGITAL CLOCK DISTRIBUTOR

INTEGRATED LOCAL PRIMARY REFERENCE

ENGINEERING GUIDELINES

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1. GENERAL

1.01 This practice provides the following information about the Digital Clock Distributor - Integrated Local Primary Reference (DCD-ILPR) System:

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

1.02 Whenever this practice is reissued, the reason for reissue will be given in this paragraph.

1.03 The following abbreviations are used in this practice:

DCD	Digital Clock Distributor
GPS	Global Positioning System
GTI	GPS Timing Interface
GTR	GPS Timing Antenna/Receiver
ILPR	Integrated Local Primary Reference
pps	pulses per second
PRS	primary reference source
RAIM	Receiver Autonomous Integrity Monitoring

SPS	Standard Positioning Service
ST2	Stratum-2 Clock
ST2E	Enhanced Stratum-2 Clock
ST3E	Enhanced Stratum-3 Clock
UTC	Universal Coordinated Time

Note: Throughout this practice, information common to the ST2E and ST3E clock cards is referenced as "clock card".

2. INTRODUCTION

2.01 The DCD-ILPR System is a Primary Reference Source (PRS) as specified by industry standards. Using GPS radio navigation services, the DCD-ILPR System can provide independent and diverse timing sources for both network or office primary reference clock applications.

2.02 The DCD-ILPR shelf is a standalone system that provides Stratum-1 quality reference signals. It accepts up to two GPS Timing Interface (GTI) plug-in cards.

2.03 The management of multiple GPS primary reference sources is performed through the use of the GPS Timing Reference Interface (GTI) card and the GPS Timing Antenna/Receiver (GTR).

2.04 The GTI receives a 1 pulse per second (pps), a 4-kHz clock, and a 4-kb/s data channel signal from the GTR and converts these into a 4 kHz output synchronization reference for the TO cards which meets the MTIE mask for PRC as defined by ANSI standards and Bellcore TR-NWT-001244.

2.05 The stratum clocks within the DCD-ILPR provide long-term averaging of the input reference. If the input is disrupted or is out of tolerance, the stratum clock provides the necessary bridge in timing (holdover) and allows the network to continue to operate slip-free for several hours or days depending on the clock installed.

2.06 The DCD-ILPR provides system-wide synchronization via DS1 or CC output timing signals (depending on the TO card installed). The DCD-ILPR regenerates a clocking signal from its input reference and buffers short-term timing variations. The DCD-ILPR permits unrestricted DS0 cross-connection between equipment. The DS1 output timing signals use a framed, all-ones format. The output signals can act as the node clock within a BITS environment or as a free-running source.

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 10,000 nautical miles, are arranged in six orbits with four satellites in each orbit. Each orbit is inclined 55° from the equator and separated by 60° 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 24 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 that is used in conjunction with the users' local or external oscillators that enables the DCD-ILPR to generate a PRS compliant with ANSI T1.101 and CCITT G.811.

3.05 The DCD-ILPR System mediates the multiple GPS satellites available by using the GPS Timing Reference Interface (GTI) 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.

3.08 The GTI utilizes a 1 pulse per second (pps), a 4-kHz clock, and a 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.

3.09 The DCD-ILPR outputs time and frequency signals synchronized to within 10 nanoseconds of the GPS/UTC time received from the satellite(s). During times when satellites are not being tracked, the DCD-ILPR continues to output framed all-ones signals still compliant with the PRC specifications. These signals are derived from the oscillator feed 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.)

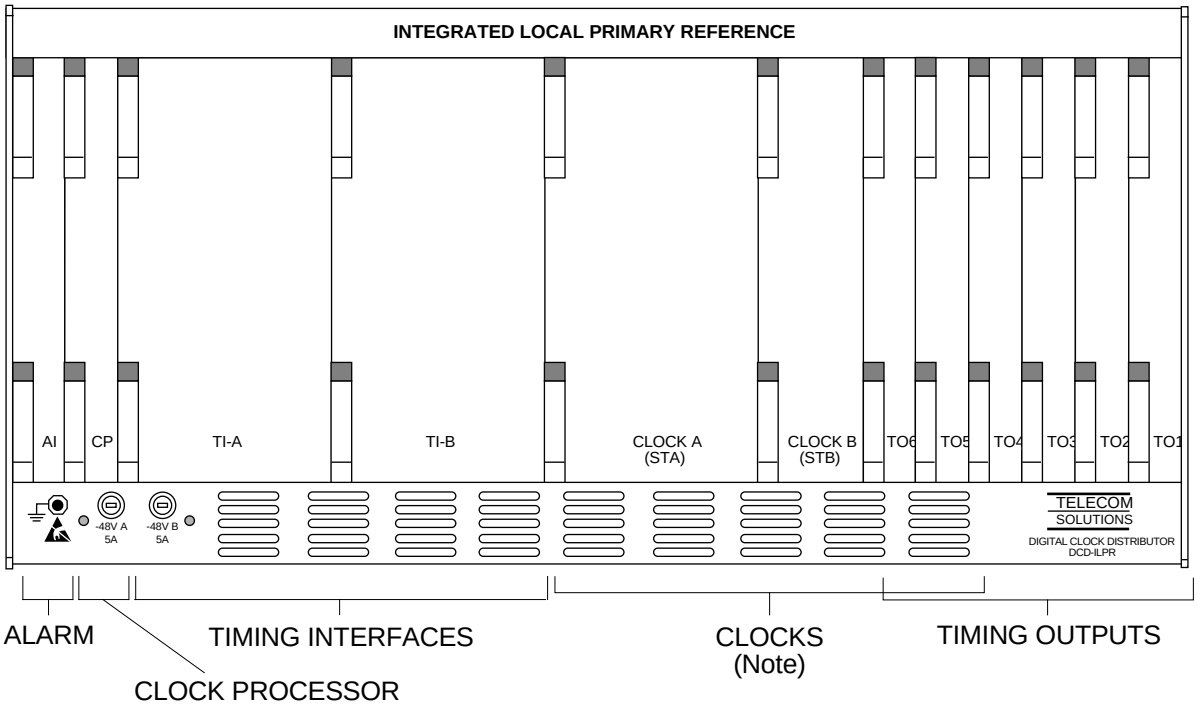
4. SYSTEM CONFIGURATION

A. Shelf

4.01 The DCD-ILPR (Figure 1) is designed to act as a standalone system, but can also be connected to a Telecom Solutions DCD shelf to provide timing and TL1 alarm reports. The DCD-ILPR shelf provides reference, contains the clocks, provides timing outputs, and provides the alarm and maintenance interface.

B. Card Quantities

4.02 Table A provides card quantities for the DCD-ILPR shelf.



Note: If two ST2E cards are installed, slots TO6 and TO5 will be used by the second ST2E.

Figure 1. DCD-ILPR Shelf

Table A. Card Quantities (Max. Number per Shelf)

CARDS	PART NUMBER	TWO ST2E CARDS	TWO ST3E CARDS	ONE ST2E/ONE ST3E CARD
AI	090-47010-01	1	1	1
CP (Note 1)	090-47011-01	1	1	1
GTI (Note 2)	090-47020-01	2	2	2
ST2E (Note 3)	090-47030-01	2	0	1
ST3E (Note 3)	090-47031-01	0	2	1
TOT (Note 4)	090-47040-01	Up to 4 in any combination	Up to 6 in any combination	Up to 6 in any combination
TOC (Note 4)	090-47041-01			

Notes:
1. The CP is an optional card; it is installed if intelligent alarm provisioning is desired. The unused CP slot may be filled with one single-wide blank panel, p/n 090-47098-01.
2. Up to two GTIs may be installed; if only one GTI card is installed, the unused slot may be filled with two single-wide panels (p/n 090-47098-01) and one double-wide blank panel (p/n 090-47098-02).
3. The following combinations of clock cards may be installed: one ST2E (the unused slot is filled with a double-wide blank panel, p/n 090-47098-02); two ST2E cards; one ST2E and one ST3E; or two ST3E (the unused slots are filled with two single-wide blank panels, p/n 090-47098-01).
4. Each unused TO slot may be filled with one single-wide blank panel, p/n 090-47098-01.

5. LIGHTNING PROTECTION PHILOSOPHY AND GROUNDING PRINCIPLES

5.01 Lightning is, typically, a thunderstorm-initiated discharge which is regional in nature in the United States. The Southwest experiences lightning storms only occasionally, but they are common in the North, the Southeast, and the Midwest. A 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 local 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 Telecom Solutions 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, Telecom Solutions recommends installing two lightning protectors, one installed outside the building, and the other installed inside the building.

5.05 Telecom Solutions offers separate lightning protector systems for the GPS systems.

GPS Lightning Protectors

5.06 The lightning protectors for the GPS system consists of two protectors; one designated for installation outside the building, and the other for inside the building.

5.07 The outside lightning protector is a 3-terminal spark gap that fires or shorts when the differential voltage on the power leads exceeds its breakdown threshold. The plus and minus terminals short to ground. Grounding of the outside protector is a very important issue in lightning protection. The ground wire should be as short and straight as possible, and grounded to outside building (ring) ground if using nonmetallic conduit for cable runs; if ring ground is not available, the best alternative is to ground the lightning protector to building steel, or other metallic items known to be well grounded per national or local code (e.g., metal conduits, air conditioner ducts, etc.). If using metallic conduit for cable runs, then ground the outside protector to the metal conduit, if possible.

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

5.08 The inside lightning protector provides an additional level of protection for equipment and personnel. The inside protector has a 3-terminal spark gap, but 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 10 feet). The inside protector should be grounded to building steel, metal conduits, air conditioner ducts, or other metallic items known to be well grounded per national or local code. If improperly installed, it may arc to some building structural ground and result in hazardous consequences.

B. Grounding Principles and Lightning Protector Placement

5.09 The following principles highlight general grounding rules for the GTR to minimize damage from lightning strikes:

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

- 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 run on the roof.
- 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 local 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. If the lightning protector is installed outside the mast, place it inside a junction box. The inside lightning protector should be installed as close as possible to the point where the cables from the GTR enter the building.

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

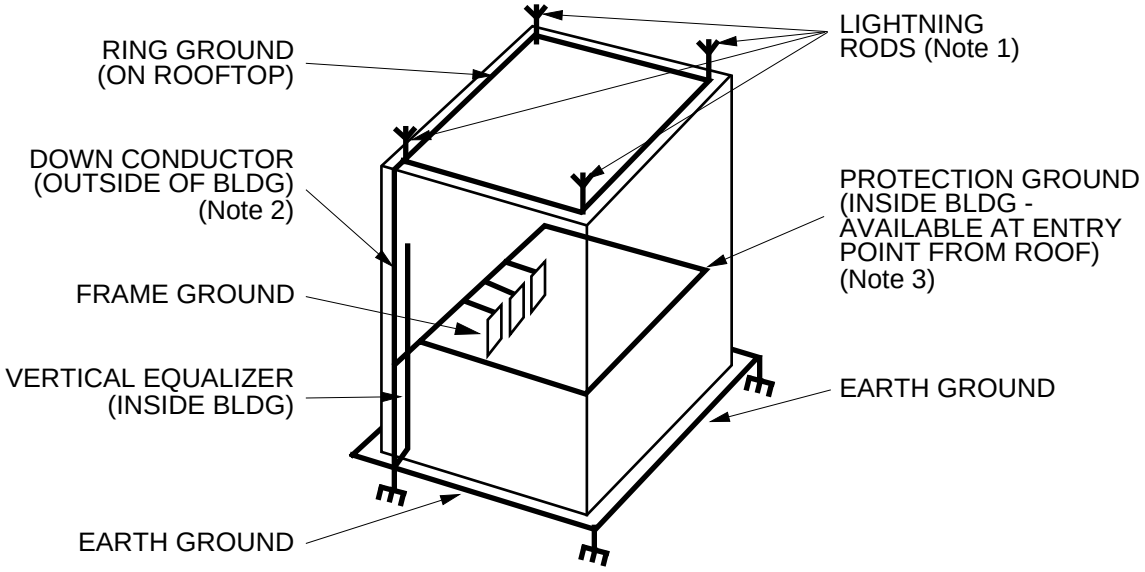
- The DCD-ILPR should be connected to frame ground per the installation procedure.
- The inside lightning protector must be connected to protection ground (the building steel or other suitable ground point) at the point of entry into the building. *Keep the ground wire as short and straight as possible (6 AWG minimum solid copper is recommended). Do not undersize this grounding wire.; the grounding wire should not exceed 15 feet.*
- The outside lightning protector must be contained in a weather-resistant junction box, and the lightning protector connected to outside building (ring) ground if possible, or a grounding rod if nothing else is available. If PVC mast and conduit are used, then ground at point of entry into the building. If metal conduit for cable runs is used, grounding to the conduit is preferred. *Keep the ground wire as short and straight as possible (6 AWG minimum solid copper is recommended). Do not undersize this grounding wire.; the grounding wire should not exceed 15 feet.*

- Do not ground both protectors together with one common wire; the outside and inside protectors must have separate ground points.
- DIG GND to battery RTN (on the DCD-ILPR backplane) is factory-strapped at TB1 only.
- Make sure that all connections are tight to avoid arcing, corrosion, and intermittent operation.
- Avoid 90° turns and *do not loop* the ground or power wires. If ground wires cross or are adjacent, they must be bonded at that point.
- 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.

C. Central Office Grounds

5.10 The GTR is provided with two solid-state lightning protectors that must be placed in-line with the power cable from the GTR to the DCD-ILPR shelf. The lightning protectors are effective only if installed correctly.

5.11 Refer to Figure 2 for an illustration of the basic central office grounding scheme.



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, on connection path to Earth at each corner of the building.
3. Multiple path connections to Earth ground.

Figure 2. Central Office Grounds

5.12 Generally, four types of central office grounds are available. The 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 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 return conductor from the equipment to the office battery and should not be considered a ground.

5.13 Figure 3 shows how the GTR uses the various grounds available at a central office.

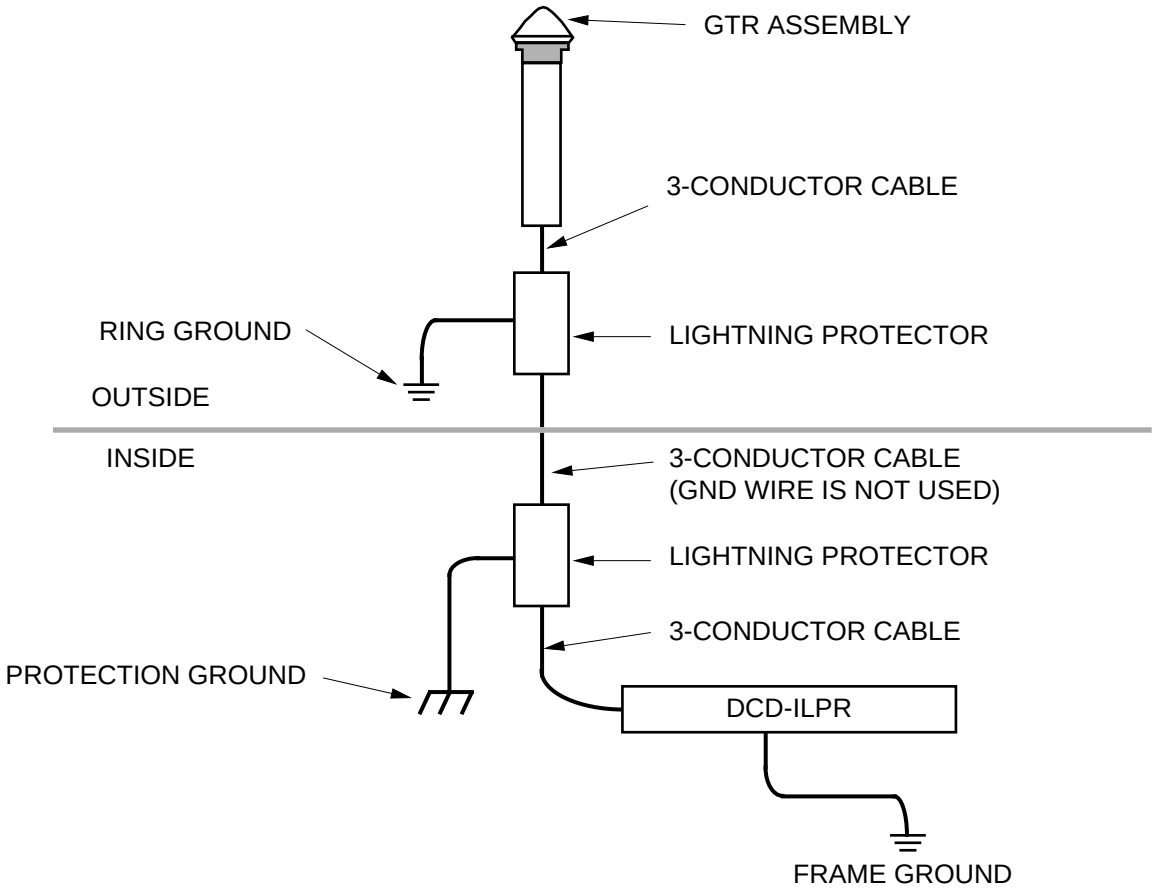


Figure 3. GPS Antenna Grounding Scheme

6. GPS ANTENNA INSTALLATION CONSIDERATIONS

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

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

6.02 Installation procedures are to follow local company procedures.

Note: Throughout this practice, the "xx" noted in a cable part number, specifies the cable length in 100-foot increments. For example, the part number for a 400-foot section of fiber optic cable (p/n 060-45100-xx), is 060-45100-04, a 300-foot section is 060-45100-03, etc.

A. Cabling Considerations

6.03 The GTR antenna assembly uses both 3-conductor (for power) and 2-strand fiber optic (for GTI to GTR communication) cables. The fiber optic cable distance allowable between the GTR and the DCD-ILPR is 4,000 feet.

6.04 The power cables are 18 AWG, stranded, 3-conductor cables. Cabling restraints for the GTR exist; if the internal power supply is used, the distance allowable between the GTR and the DCD-ILPR is 2,000 feet. If an external power source is used, the distance between the GTR and the DCD-ILPR is increased to 4,000 feet (maximum fiber cable distance).

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

- Current: 200 milliamps at 32 volts
- Voltage: 16 volts minimum, 32 volts maximum

Note: A linear power supply is preferred.

Note: If an external power supply is desired, the Telecom Solutions' Standalone Power Supply (p/n 990-40031-01) or an equivalent is recommended; for information regarding the Telecom Solutions power supply, contact Telecom Solutions Customer Service Department at 408-433-0910.

6.06 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, that a minimum 2-inch UL listed #651 PVC conduit (Schedule 40 minimum) be used to contain the cables.

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

6.07 Cables must be run as straight as possible; the fiber optic cable can have no less than a 2-inch bending radius; stripped (unsheathed) fiber cable can have no less than a 1-inch bending radius (Figure 4). All cables should be run in accordance with local company practices.

Caution: Less than a 2-inch bending radius; 1-inch 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.

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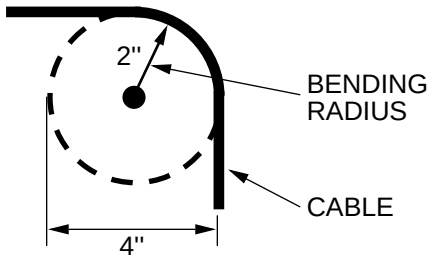


Figure 4. Bending Radius

B. Cabling Material

6.08 The following cable materials are required for installation:

- 3-conductor 18 AWG stranded cable for GTR power connection; the cable 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-ILPR. The cable may be purchased from Belden (p/n 9493), or Telecom Solutions (p/n 060-45120-xx). The Telecom Solutions' cable comes terminated with a GTR power connector on one end and unterminated on the other end.

  Note: If the cable is not purchased from Telecom Solutions, the GTR power connector will have to be ordered separately from Telecom Solutions (p/n 121-00805-01). Contact Telecom Solutions' Inside Sales Department (at 408-433-0910) to order.

  Note: The 3-conductor cable used to connect the inside and outside lightning protectors does not use its ground wire. Do not ground both protectors together with one common wire; the outside and inside protectors must have separate ground points. This is to prevent lightning current from entering the building and/or creating ground loops.

  Note: The GTR power cables can be purchased from Telecom Solutions in increments of 100 feet only; for lengths greater than 350 feet, cable is only available in 100-foot increments. The minimum length is 100 feet, maximum is 1500 feet. Contact Telecom Solutions' Inside Sales Department (at 408-433-0910) for ordering information. For cable lengths greater than 1500 feet, contact Telecom Solutions' Inside Sales Department for Special Order instructions.

- One 200-micron, 850 nanometer wavelength multimode fiber optic Riser-rated cable to connect the GTR to the DCD-ILPR. Fiber optic cables may be purchased from Telecom Solutions or SpecTran Specialty Optics Co. Telecom Solutions 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 200-micron, 850 nanometer wavelength multimode fiber optic Riser-rated cable from Telecom Solutions contains two different colored cables, a fiberglass strengthener, and two filler cables (Figure 5); other manufacturers may differentiate each cable by texture (smooth or ribbed).

  Note: The connectorized fiber optic cables can be purchased from Telecom Solutions in increments of 100, 150, 200, 250, 300, and 350 feet; for lengths greater than 350 feet, cable is only available in 100-foot increments. The minimum length is 100 feet, maximum is 1500 feet. Contact Telecom Solutions' Inside Sales Department (at 408-433-0910) for ordering information. For cable lengths greater than 1500 feet, contact Telecom Solutions' Inside Sales Department for Special Order instructions.

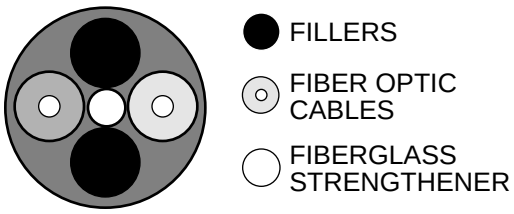


Figure 5. Fiber Optic Cable

- If unconnectorized fiber cables are ordered, four fiber optic compound cleave crimp-on ST-style connectors (200-micron multimode fiber) are needed. A package of six may be ordered from Telecom Solutions (p/n 093-42100-20). A fiber ST terminator connector tool will be needed for crimping on the connectors. The fiber ST terminator connector tool may be ordered from SpecTran Specialty Optics Co. at 203-678-0371 (p/n TK6-230-ST).

- 6 AWG grounding wires (or larger for longer runs)

- Spade lug connectors to fit an 18 AWG wire, 0.25-inch wide, and fit a #6 stud

- Weather-resistant conduit, metal or PVC; it is recommended that a minimum 2-inch UL listed #651 PVC conduit (Schedule 40 minimum) if PVC is chosen for cable runs

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

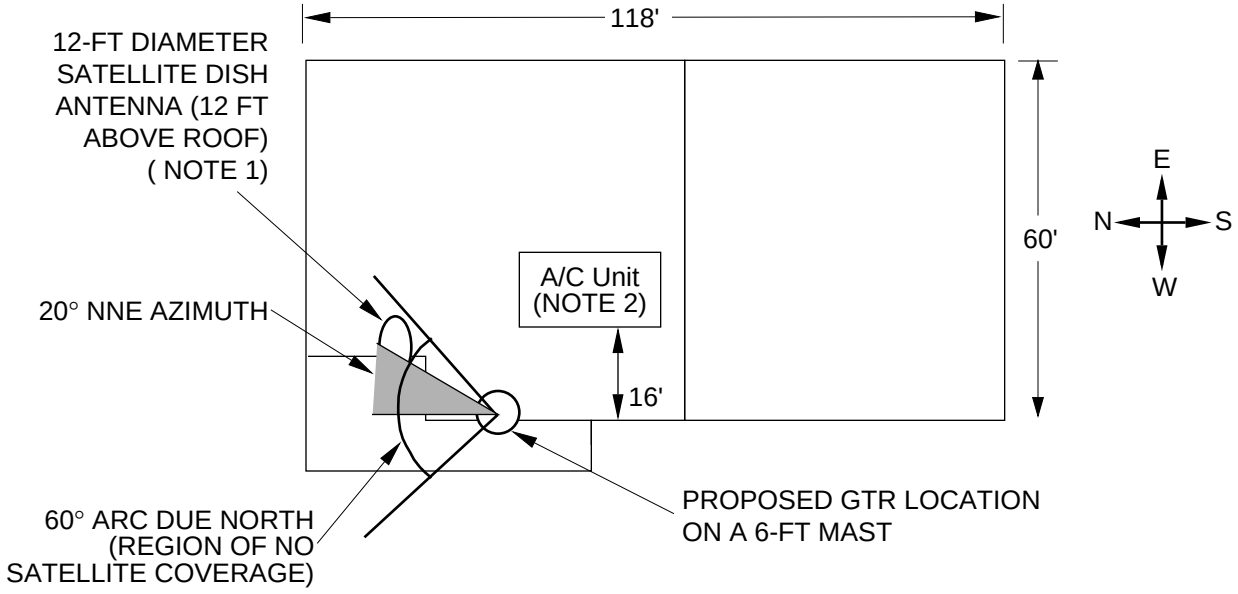
- Expansion joint sleeves to prevent breaks in the conduit due to expansions and contractions

Note: If metal conduit is used, conduit joints must be bonded 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.

6.09 Figure 6 through Figure 8 are examples of side view and top view drawings of a hypothetical DCD-ILPR site. The building has three roof line levels, a large air conditioning unit, a transmit and receive dish antenna on the higher roof line.



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: 24 ft length x 12 ft width x 5 ft height.

Figure 6. Aerial View of Building Rooftop

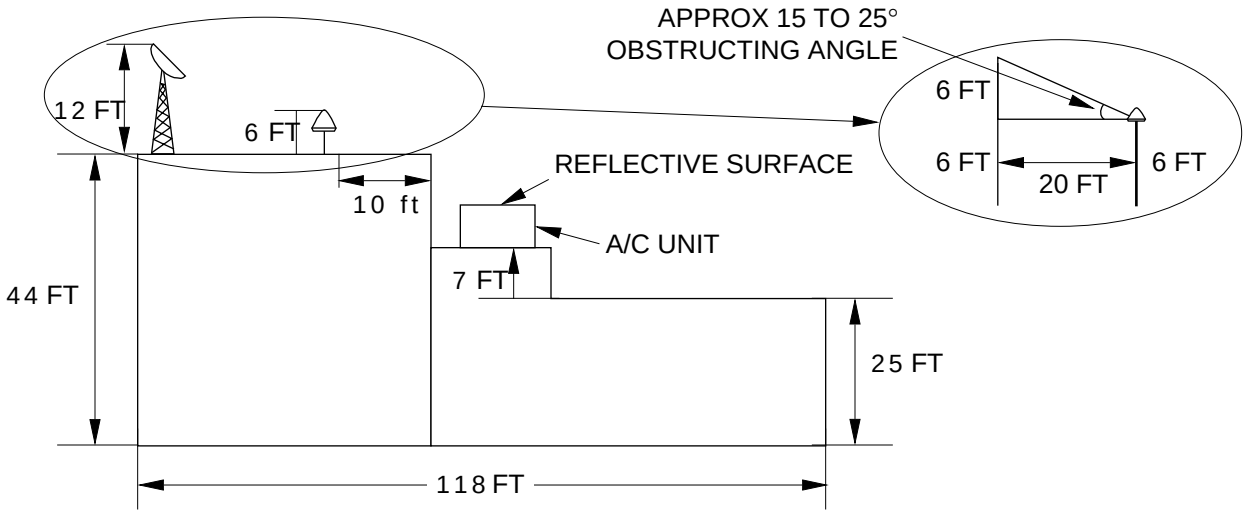
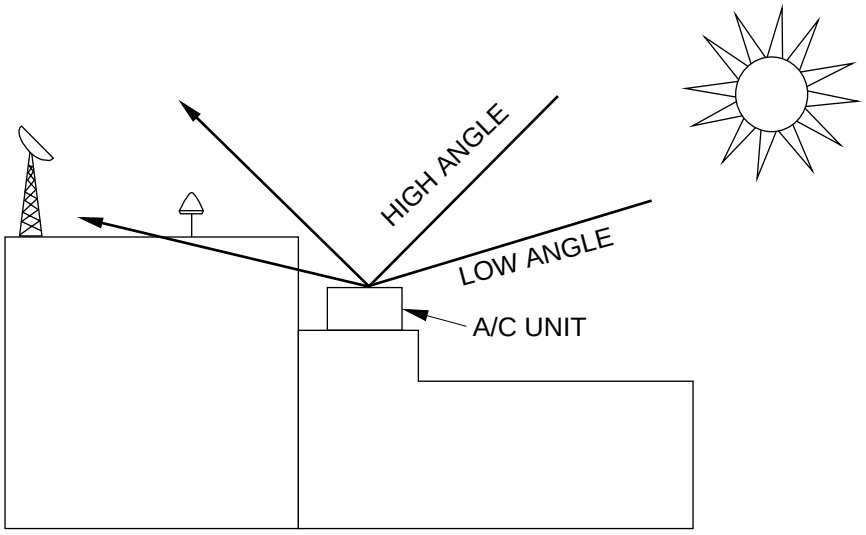


Figure 7. Side View of Antenna Obstructions



- Horizontal distance from vertical reflective structure (e.g., heating ducts, equipment housings, etc.) is recommended to be twice the height of the structure, minimum 10 ft.
- Vertical distance above metallic reflective object minimum 4 ft.

Figure 8. Side View of Placement with Respect to Reflective Surface

Location

6.10 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 needed. 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.

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

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

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

6.13 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.

6.14 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, then a detailed study using test equipment may be required.

6.15 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 6). 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° altitude, NNE azimuth-15° 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 1/8 of a mile (200 yds) around the building; check for the following:
   - The height and distance of taller objects, such as extremely high buildings up to 1/4 mile away.
   - The height, width, and distance to objects, such as towers, buildings, dense tall trees, etc., that may exceed 10° 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 7 and Figure 8).
7. Locate the GTR on the rooftop in a position which meets the following requirements:
   - **Is not** within 30° 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 10 to 20 feet of a corner of the building

- **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 8 and Figure 9). Typically this requires the GTR to be elevated on a mast of roughly 4 feet (independent of proximity to horizontal reflective surface).

   - Horizontal distance from vertical reflective objects (e.g., tower) is recommended to be twice the height of metallic reflective object; minimum 10 feet (Figure 10).

   - If GTR placement cannot be achieved without violating the 10° altitude guideline, or there happens to be another obstruction (either on the building roof or removed from it, e.g., water tower, skyscraper, etc.) then 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.

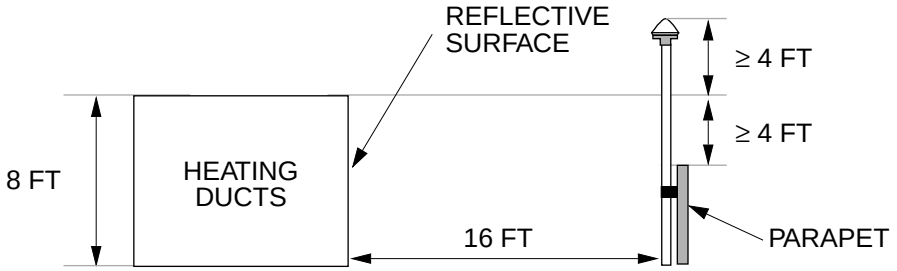
   Note: When the site is near or at the Equator, it does not matter where the obstructing object is with respect to the GTR, it will still obstruct the view of the GTR.

   - 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° altitude above the horizon with respect to the height of the GTR.

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

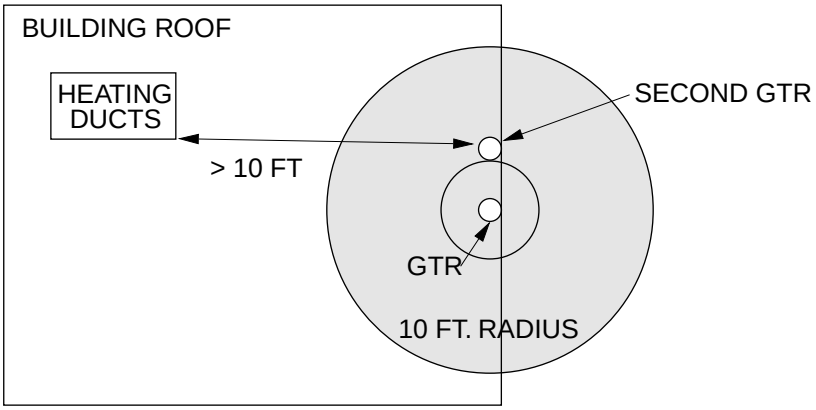
   Note: If guy wires are required to support the mast, each wire must be connected to rooftop ring ground.

10. From the information obtained previously, determine the type of mounting hardware needed (e.g., 0.75-inch U-bolts or masonry bolts, Romex-type conduit plug, etc.) (see Figure 11).



- Horizontal distance from vertical reflective structure (e.g., heating ducts, equipment housings, etc.) is recommended to be twice the height of the structure, minimum 10 ft.
- Vertical distance above metallic reflective object minimum 4 ft.

Figure 9. GTR Location—Distance from Reflective Objects



- Horizontal distance from any other GTR antennas 3 ft minimum
- Vertical distance above parapet, obstructions, horizontal metallic reflective surfaces 4 ft minimum

Figure 10. GTR Location—Field of View

11. Determine the location of the following:
    - The DCD-ILPR shelf
    - The inside and outside lightning protectors
    - The grounding points for lightning protectors and DCD-ILPR shelf (per the guidelines set previously)
12. For cable length, 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-ILPR shelf (for power cable)
    - The GTR and the DCD-ILPR (for fiber optic cable)
    - The DCD-ILPR and the DCD master shelf (not necessary if configuring for standalone) (ribbon cable)
13. For conduit length (for cable runs), determine the distance between the GTR and the cable entry point.

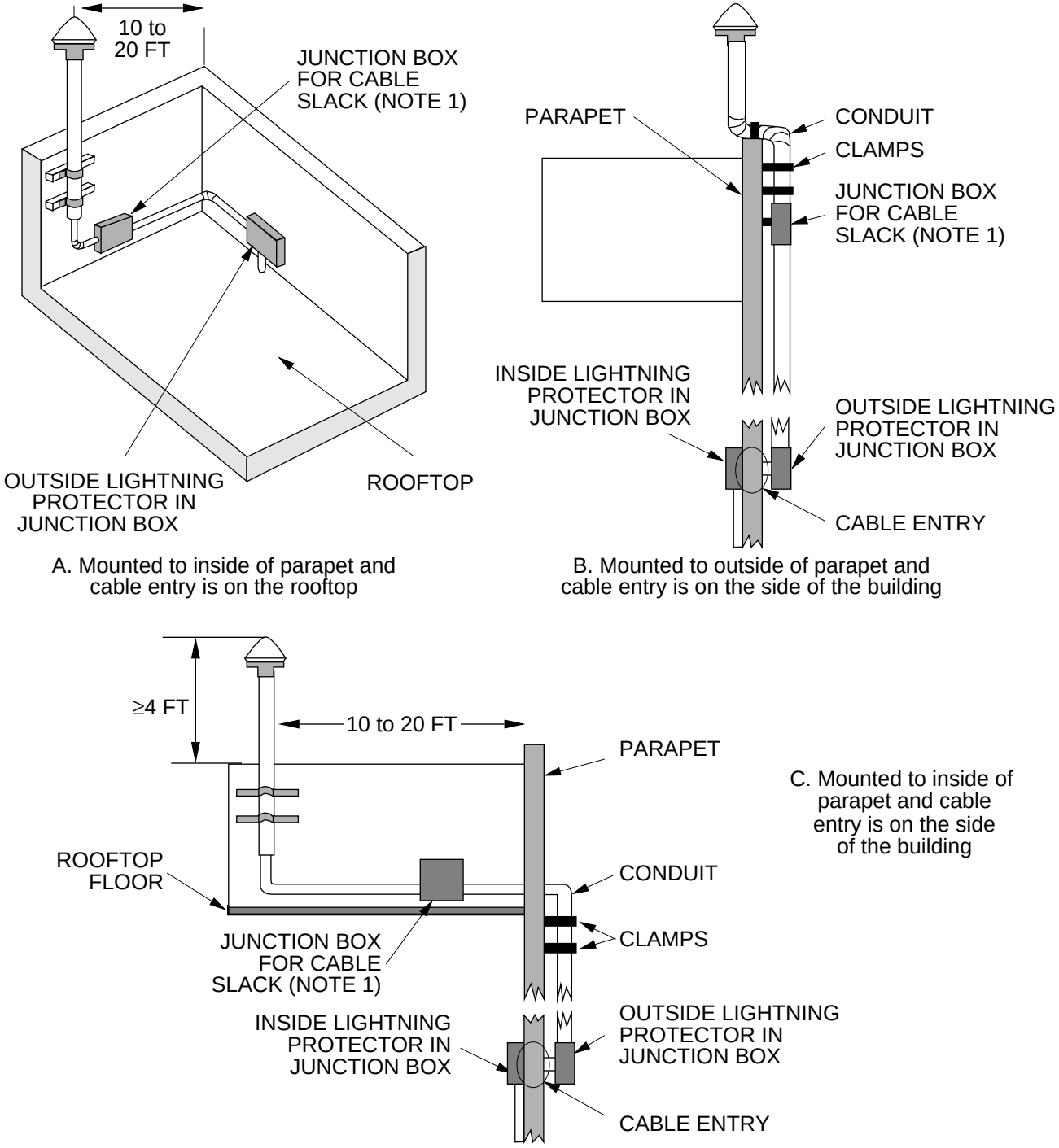
Mounting

6.16 It is recommended that the GTR be mounted on the rooftop, inside the parapet for connection to outside building (ring) ground. Refer to Figure 11 for examples of different GTR mountings.

> ***Note:*** A rooftop mounting platform is available from Prodelin Corp. (Figure 12) . Contact Prodelin Corp. (704-464-4141) for additional information; reference the Rectangular Block Mast Mount, p/n 0800-182.

6.17 When mounting the GTR, observe the following guidelines:

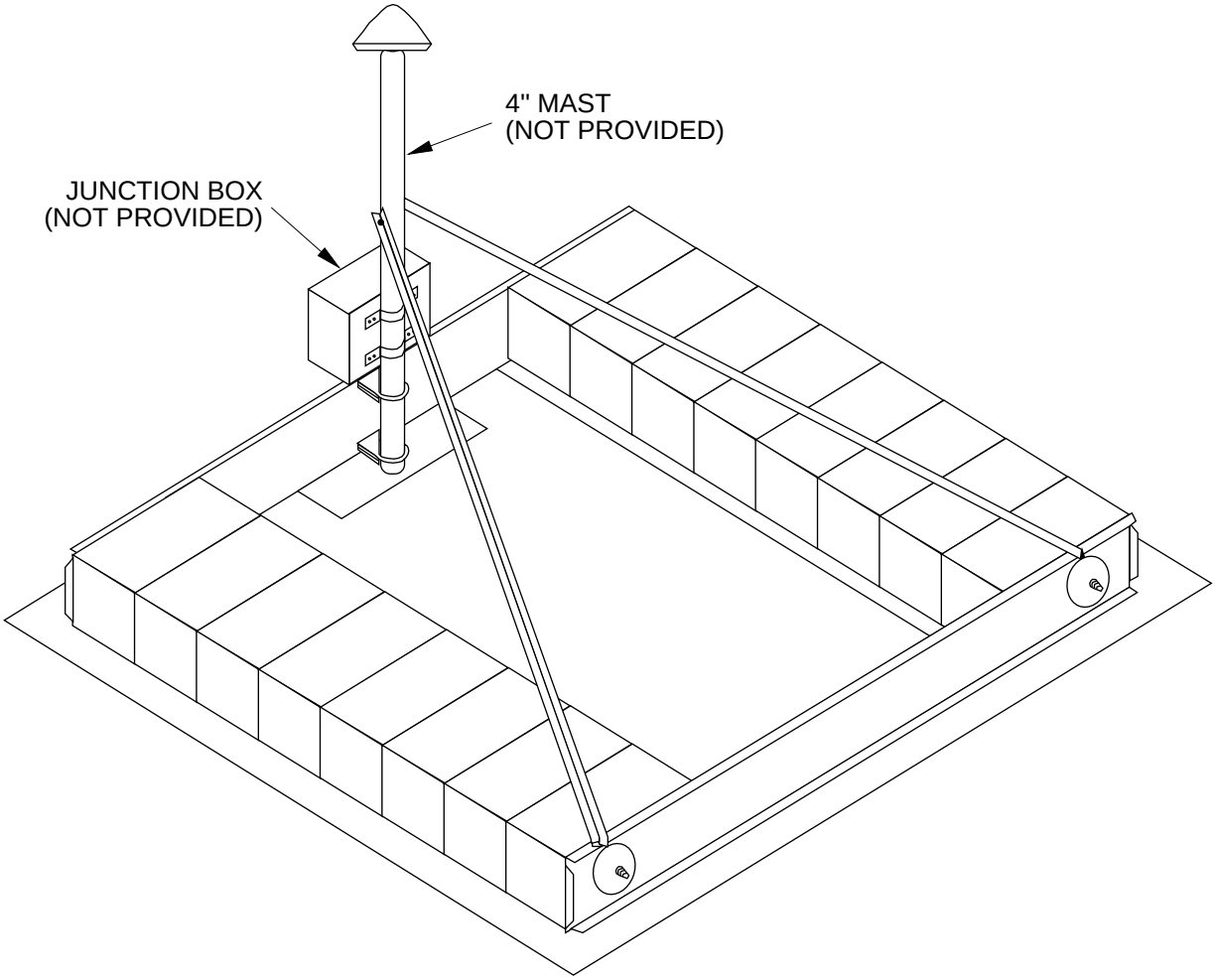
- Mount the GTR in such a way that the top of the GTR is at least four feet above the parapet.
- Mount the GTR in a location with easy access for future maintenance purposes.
- Mount the GTR on either 4-inch or 2-inch PVC or metal conduit for the mast. If PVC is used, rigid UL listed #651 PVC conduit (Schedule 40 minimum) is recommended.



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 Telecom Solutions.

Figure 11. Basic GTR Mountings



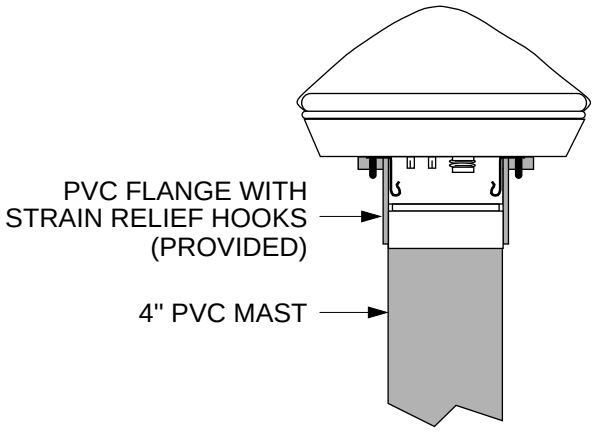
Notes:

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. for available configurations.
2. A 4" mast is shown in this figure; a 2.88" mast is provided by Prodelin Corp. and must be adapted to fit the 4" flange provided by Telecom Solutions; a 4" to 2.88" mast adaptor is available from Prodelin (p/n 0800-101). The junction box shown is not provided.

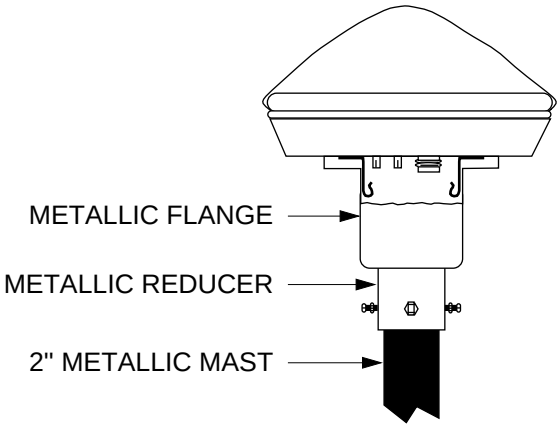
Figure 12. Prodelin Corp. Rectangular Block Mast Mount

Note: If PVC is used, the Schedule type used and the diameter of the mast (4-inch or 2-inch) depends on the conditions at each installation site. If the installation site is a high wind location, it may be advantageous to use 4-inch Schedule 80 conduit. If in a low wind location, the mast is under four feet, and guy wires are used to stabilize the mast, 2-inch Schedule 40 may suffice. Contact Telecom Solutions CTAC for assistance in determining the Schedule type and mast diameter best suited for your location.

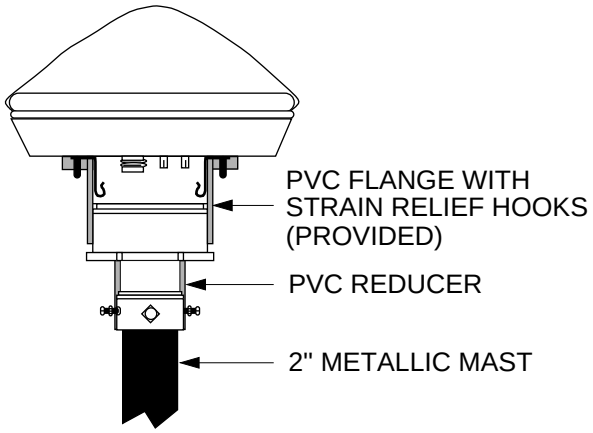
- If using a 2-inch mast, a pipe reducer must be user-provided; PVC or metal may be used. If PVC is used, rigid UL listed #651 PVC conduit (Schedule 40 minimum) is recommended. Refer to Figure 13 for examples of GTR mast configurations.
- If using the 2.88-inch mast from Prodelin Corp., a 4-inch to 2.88-inch mast adaptor is available from Prodelin (p/n 0800-101).



A. PVC flange with 4" PVC mast
(Preferred configuration)



B. Metal flange with 2" metal mast



C. PVC flange with 2" metal mast

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

Figure 13. Examples of GTR Mast Configurations

- All openings around the conduit hub/nonconductive conduit connection, and where the conduit enters the building must be waterproofed per local company practices.

- It is recommended that all exposed connections be treated with an electrically conductive anticorrosion 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.

- 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.

7. DCD-ILPR SHELF INSTALLATION CONSIDERATIONS

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

- 16 AWG stranded wire (red) to run from a battery source to the DCD-ILPR shelf

- 16 AWG stranded wire (black) to run from a battery return source to the DCD-ILPR shelf

- 16 AWG stranded wire (green) to run from the frame ground to frame ground on the DCD-ILPR