

**Oncore Remote GPS
Engineering Notes**



Advantages Of Oncore Remote GPS

The Remote GPS has been designed specifically for timing applications that require long cable lengths that are not practical with expensive low-loss RF cable. Cable lengths up to 2000 feet can be achieved with standard twisted pair shielded wire (22 AWG) that provides the user a cost-effective solution to system installation. In some systems, the site installation dictates the equipment be installed in the basement of a multistory building to obtain a better rental rate for the installed equipment. This type of installation could require several hundred feet of cable, dependent on the number of floors in the building, to allow for installation of the Remote GPS on top of the building. Previously, timing systems that had the GPS receiver installed at the user equipment with a long distance of separation of the antenna would require additional RF signal amplification and also the possibility of purchase of an expensive heliax low loss cable (1/2" diameter). Now with the use of the Remote GPS, the system can be implemented without adding amplification or expensive RF cable, thus reducing the total system cost.

Advantages:

- elimination of expensive low-loss heliax RF cable
- elimination of in-line amplifiers
- elimination of additional power supplies for the amplifiers
- ease of installation due to smaller and more flexible twisted pair cables

Oncore Remote GPS Product Description

It makes use of Motorola's T-RAIM (time receiver autonomous integrity monitoring) algorithm to ensure the validity and reliability of the GPS measurements. The Remote GPS is a complete GPS receiver and antenna combined into an environmentally sealed package capable of being mounted on top of a building or on any antenna mast. This new technology has been designed specifically for timing applications requiring long cable lengths, as is common in many paging and cellular base station sites. The Remote GPS utilizes RS-422/485 compatible transceivers, capable of driving very long twisted pair cables, to provide for Remote commands, timing status and the 1 pulse-per-second signal interface.

The Remote GPS incorporates an Oncore GPS receiver that includes Motorola GPS custom ICs (integrated circuits) and Motorola MPUs (Microprocessor Units). Motorola GPS receiver software, a patch antenna, and a power supply with RS422/RS485 driver/receivers all in an environmentally sealed plastic top housing and aluminum bottom housing. The power supply allows for operation over a voltage range of 8 to 36 VDC and also provides the RS422 line drivers and receivers. These devices provide the user with a highly reliable wired data link for long cable runs, since they provide common mode error rejection, thus canceling common noise on the differential twisted pair cable.

The Remote GPS offers the following features:

- Motorola Oncore 8 parallel channel C/A code timing receiver
- Timing accuracy (1 Pulse Per Second) of 130 ns (1 sigma) with SA on and less than 50 ns (1 sigma) in position hold mode
- Time RAIM (Receiver Autonomous Integrity Monitoring) to allow detection and isolation of satellites that could introduce timing errors
- User selectable position hold mode for improved timing accuracy
- Search for, acquire and track satellites on 8 parallel channels; receiver will always attempt to track the 8 satellites with the highest elevation angles
- Input/Output using the Motorola Binary Oncore format
- Position, velocity and time solution (height referenced to WGS-84 ellipsoid only and heading to true North only)
- Acquisition times:

Hot Start (w/ ephemeris):	< 15 s typical
Warm Start (w/o ephemeris):	< 45 s typical
Cold Start (w/o almanac, time, date):	< 90 s typical
- Reacquisition times after view of satellites obstructed: < 1 sec internally
- Indication of whether the active antenna is powered as part of self-test
- Optimized signal processing for operation in foliage environments and urban canyons

Oncore Remote GPS Product Specifications

POSITION AND
NAVIGATION
SYSTEMS
BUSINESS

Oncore Remote GPS Receiver Technical Characteristics

General Characteristics	Receiver Architecture	<ul style="list-style-type: none"> • 8 parallel channel • L1 1575.42 MHz • C/A code (1.023 MHz chip rate) • Code plus carrier tracking (carrier aided tracking)
	Tracking Capability	8 simultaneous satellite vehicles
Performance Characteristics	Dynamics	<ul style="list-style-type: none"> • Velocity: 1000 knots (515 m/s); > 1000 knots at altitudes < 60,000 ft. • Acceleration: 4 g • Jerk: 5 m/s³
	Acquisition Time (Time To First Fix, TTFF) (Tested at -30 to +85°C)	<ul style="list-style-type: none"> • <15 s typical TTFF - hot (with current almanac, position, time and ephemeris) • <45 s typical TTFF - warm (with current almanac, position and time) • <90 s typical TTFF - cold • <1.0 s internal reacquisition (typical)
	Positioning Accuracy	<ul style="list-style-type: none"> • 100 meters 2dRMS with SA as per DoD specification • Less than 25 meters SEP without SA
	Timing Accuracy (1 Pulse Per Second, 1 PPS)	<ul style="list-style-type: none"> • Time RAIM protection software • 130 ns observed (1 sigma) with SA on • In position hold mode, < 50 ns observed (1 sigma) with SA on
	Antenna	• Active micro strip patch antenna module
	Datum	• WGS-84
Serial Communication	Data Message	<ul style="list-style-type: none"> • Latitude, longitude, height, velocity, heading, time (Motorola binary protocol) • Software selectable output rate (continuous or poll)
	Input/Output (Receive port, Xmit port, 1PPS port)	<ul style="list-style-type: none"> • 9600 baud (N81) • RS-422/485
Electrical Characteristics	Power Requirements	<ul style="list-style-type: none"> • 8 to 36 Vdc multiple power lines for long cable lengths • Reverse voltage protection
	Power Consumption	• 1.9 W (maximum)
Physical Characteristics	Dimensions	• Receiver: 4.125 x 3.25 x 3.5 in [104.6 x 87.9 x 82.0 mm] (LWH)
	Mounting	• 3/4" Standard Pipe Thread (protected cable through pipe)
	Weight	• Receiver: 13 oz. [350 g]
	Cable (recommended)	• 6 twisted pairs, 22 gage, drain/shield, UV protected
	Connectors	<ul style="list-style-type: none"> • 12 pin Deutsch MMP 21C-2212P1 (equipment) • 12 pin Deutsch MMP 26C-2212S1 (cable extension)
	Operating Temperature	• -40°C to +75°C
Environmental Characteristics	Storage	• -55°C to +85°C
	Humidity	• MIL STD 810E, Method 507.3 (95%)
	Shock	• MIL STD 810E, Method 516.4, Procedure I, IV (100 g 10 ms, 30 g 18 ms)
	Weatherproof	• MIL STD 810E, Method 512.3, Procedure 1 (Submersion to 1 m for 15 minutes)
	Ultraviolet Light Protection	• ASTM G53-88
	Vibration	• SAE J1211, Section 5.3.7 (10 Hz, 100 Hz, 1000 Hz, accel. 2.6 g rms)
	Salt Fog	• MIL STD 810E, Method 509.3 (48 hours)
	ESD	• IEC 1000-4-2 Level 4 (-8,000 V to +8,000 V)
	EMI	• FCC Class B, European CE, 89/EEC EN55022 class B, EN50082-1
	Transient protection	• Transient protected data and power lines (600 watts, 1 ms)
Miscellaneous	Altitude	• -400 m to 8,000 m
	Optional Features (see Appendix I)	• Hardware mounting kit (pipe and brackets)

Supported Commands

This section defines which of the existing messages supported by the Remote GPS. For a complete description of the messages, refer to Chapter 6. The serial I/O can be referenced to the identical existing Oncore commands.

<u>ID</u>	<u>Message</u>
Aa	Time of Day
Ab	GMT offset
Ac	Date
Ad	Latitude
Ae	Longitude
Af	Height
As	Position-Hold Position
At	Position-Hold Mode
Aw	Time Mode
Az	1PPS Cable Delay
Be	Almanac Data Output
Bj	Leap Second Pending Status
Cb	Almanac Data Input
Cf	Set-To-Defaults
Cj	Receiver ID
Ea	Position/Status/Data Message
En	Time RAIM Setup and Status Message
Fa	Self-Test
Sz	System Power-on Failure Message

Antenna Sense Circuit

The Oncore Remote GPS is capable of detecting if the internal antenna is operational. The receiver utilizes an antenna sense circuit which can detect under current (open condition) and over current (shorted or exceeding maximum receiver limits) or a valid antenna connection.

The above information is output in two of the I/O messages, @@Ea (Position/Status/Data Message) and @@Fa (Self-Test message). Upon detecting an over current situation the receiver will automatically shut down the RF section until the fault is cleared. Upon detecting an under current situation, the receiver will continue to operate as normal, but will flag the fault mode in the two I/O messages.

RTC (Real Time Clock)

The RTC is a feature on the Remote GPS. The user has two options regarding time initialization:

- Set the time **BEFORE** the Remote GPS acquires any satellites, OR,
- Let the Remote GPS receiver automatically set the time **AFTER** the receiver acquires the first satellites.
- **Note:** Time cannot be set while the Remote GPS receiver is tracking satellites.

Since the RTC has no battery backup, the Remote GPS receiver will have an incorrect time on start up. To obtain a faster time to first fix, the time, date and GMT offset should be initialized if the main power has been disconnected.

1 PPS Signal Definition

The 1 PPS signal is output at the rate of 1 pulse per second every 1 second and is synchronized to the UTC time. Below is a set of

- Accuracy: 130 nanoseconds observed (1s) with SA on. In position hold mode, < 50 nanoseconds observed (1s) with SA, specified at output of the UT Oncore prior to the RS 422/RS485 driver, see FIGURE 1.
- Pulse width is approx. 200 milliseconds (± 1 millisecond); i.e. the falling edge will occur approximately 200 milliseconds after rising edge
- 0 to 5 V level pulse at the output of the user equipment RS422 receiver, delayed by t_1 , t_2 , t_3 , see FIGURE 1.
- 1 PPS time mark is synchronous with rising edge of pulse output at the Oncore receiver contained within the Remote GPS. The following are typical delays for systems with 1000 feet of cable; $t_1 = 30\text{ns}$, $t_2 = 1,620\text{ns}$, $t_3 = 30\text{ns}$, therefore the total delay = 1680ns, a constant offset which can be factored out of the solution. All measurements are typical. Long cable lengths effect the leading edge of the differential signal, thus increasing the uncertainty in the exact cable due to the level at which the receiver switches. Note, at cable lengths of more than a 1000 feet, the accuracy of the delay measurement is reduced.

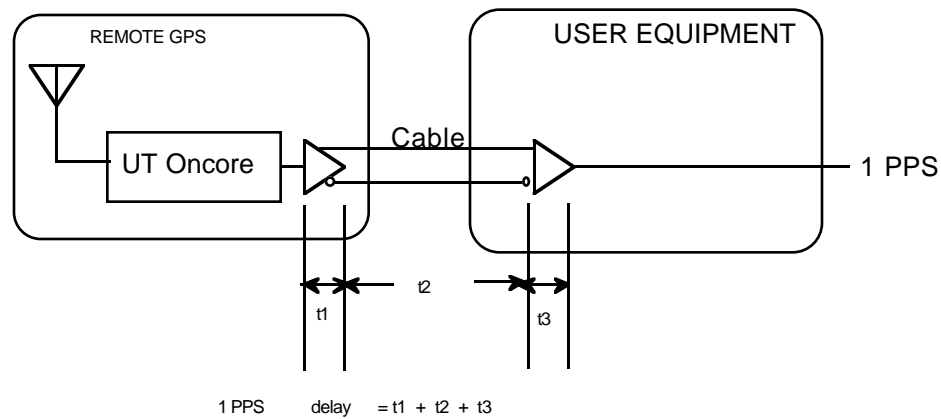


Figure 1 1PPS Delay

RS422/RS485 Serial Interface

The software interface for the Oncore Remote GPS is identical to the UT Oncore. Therefore, refer to the GT/UT Oncore users guide for a complete description of all of the user commands.

The serial interface signals are available at the receive port and the transmit port via RS422/RS485 differential bus transceivers.

Remote GPS Interface

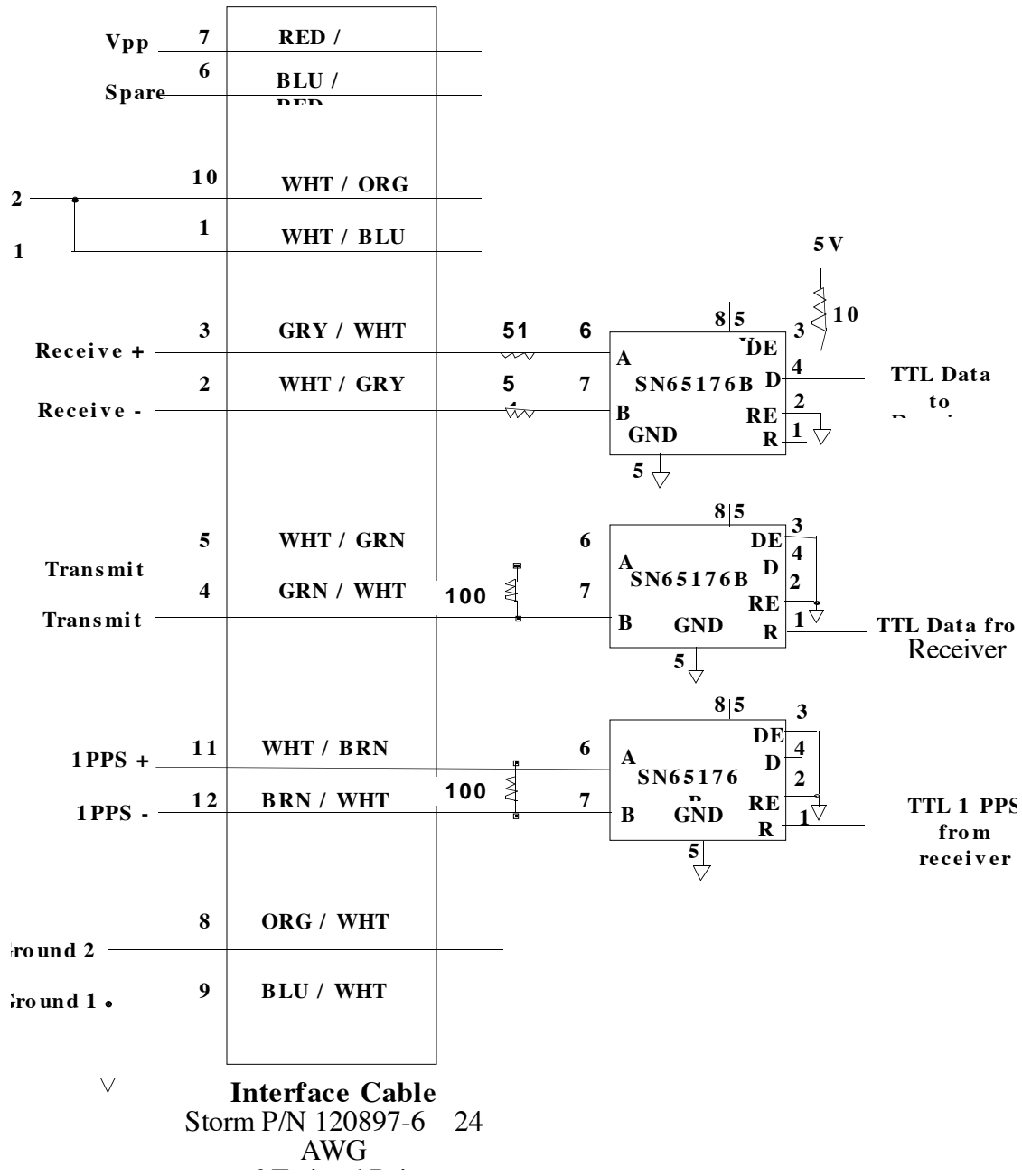


Figure 2 Recommended User Interface

Connector I/O Pinouts

The Remote GPS utilizes a 12 pin connector with two power and ground lines. Only one set of lines is required unless long cable lengths are installed and the voltage drop cannot be tolerated. The voltage applied at the cable will be dropped dependent on the length of cable in the system based on the cable resistance, load and voltage. Therefore, if a long cable is being installed, one must insure there is at least 8 volts available at the input of the Remote GPS. The Vpp pin is a re-programming voltage that should not be connected in the system. The typical installation will use the following connections 1,2,3,4,8,9,10,11, 12 drain wire and shield. Note short cable lengths that do not cause significant voltage drop, do not need to use both sets of power and ground. The foil shield (drain wire) on the extension cable should be tied to ground at the receiver end.

Remote GPS Pinouts

1	Power 1	White/Blue
2	Receive Port(-)	White/Gray
3	Receive Port (+)	Gray/White
4	Transmit Port (-)	Green/White
5	Transmit Port (+)	White/Green
6	Spare	Blue/Red
7	Vpp	Red/Blue
8	DC ground 2	Orange/White
9	DC ground 1	Blue/White
10	Power 2	White/Orange
11	1 PPS Timing (+)	White/Brown
12	1 PPS Timing (-)	Brown/White
	Drain wire	N/A
	Foil Shield	

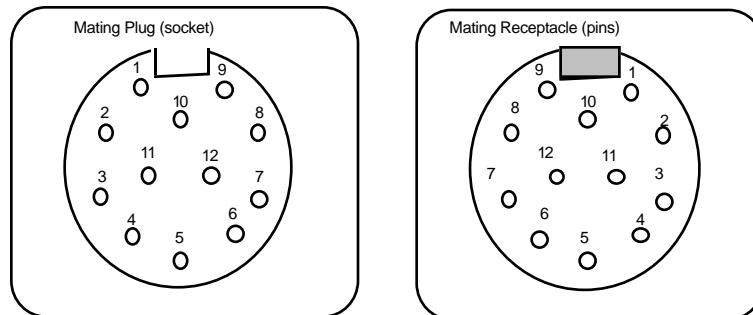


Figure 3 Connector Pinouts

Storm cable (6 twisted pairs with foil shield) P/N 12397-6 22 AWG

The part numbers for the Deutsch connectors are as follows:

On the receiver end:	Plastic housing (receptacle)	MMP21C-2212P1
	Contact Pins	6860-201-22278
For mating cords:	Plastic housing (plug)	MMP26C-2212S1
	Contact Sockets	6862-201-22278

Both plastic housings will utilize a 6810-204-2001 Backshell from Deutsch. However, for better performance a 1 1/2-inch section of heat shrink tubing with internal adhesive would be better. The one used on the receiver pigtail is from Sigmaform. It is their SST-07 type tubing .

Installation Recommendation

Location:

Most installations of the Remote GPS require placement of the precise timing device next to a cellular or paging base station, which implies the Remote GPS is mounted somewhere in the vicinity of the base station transmitter antennas. A careful installation will place the Remote GPS equipment in an area with minimum effect of RF interference. This can be accomplished by obtaining the radiation patterns of the transmitting antenna and installing the Remote GPS where the signal strength is at a minimum. A path loss chart is provided, see figure 5, to assist in calculating the separation needed from an interfering source at 1575 MHz. The GPS receiver RF front end that includes, the antenna, amplifiers and filters receives the GPS signal at 1575.42 MHz. The receiver is designed to filter out unwanted frequencies, however it is still prudent to install the Remote GPS as far as possible from any transmitting antennas, to minimize the effect of possible harmonics that may be within the pass band of the GPS receiver.

Lighting Considerations:

Several industry standards exist for lightning protection, which are not addressed in this document. However, it is recommended the Remote GPS be installed in an area that is not the highest point to minimize the possibility of a direct strike. Therefore, some other structure or lightning rod should be installed at a higher point than the Remote GPS. Although it is not possible for the Remote GPS to survive a direct strike, it is possible for the unit to survive the secondary effects of lightning due the internal protection that is present on each the interface lines (600 watt transient suppressers).

Remote GPS Placement:

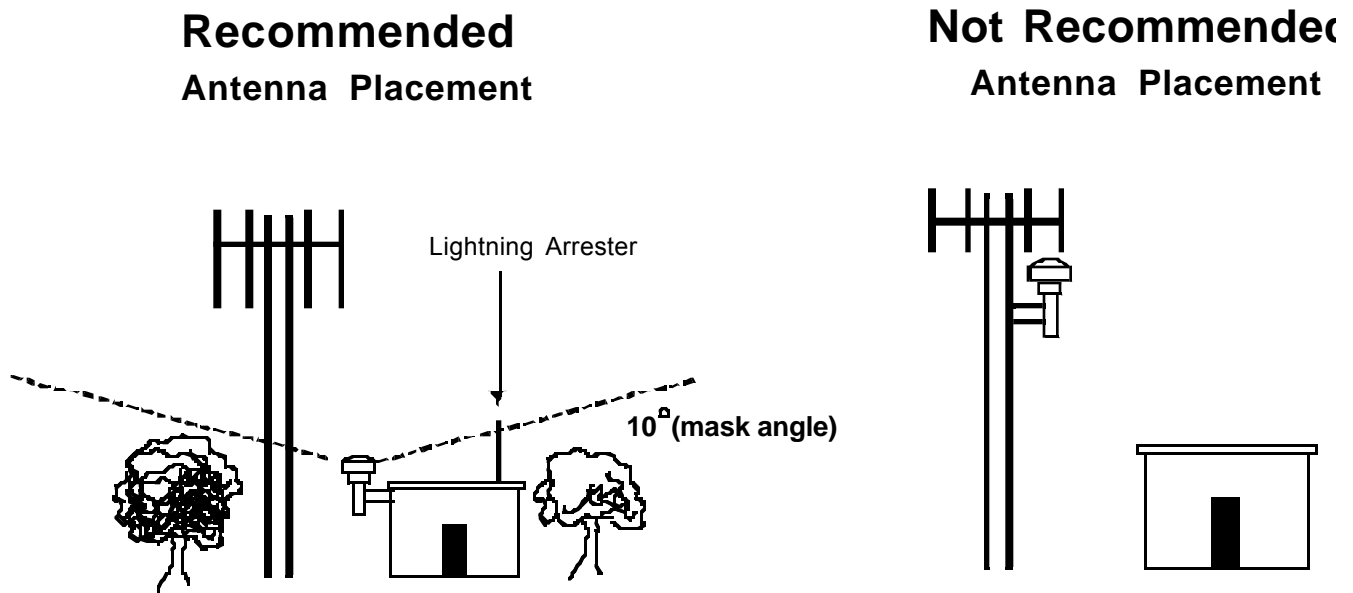
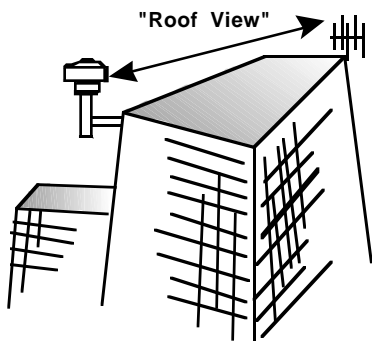
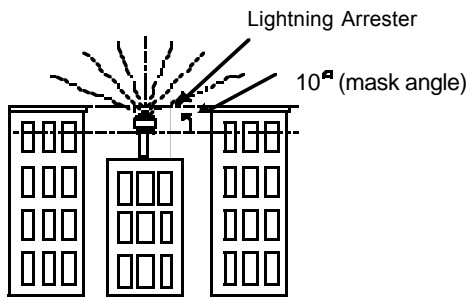
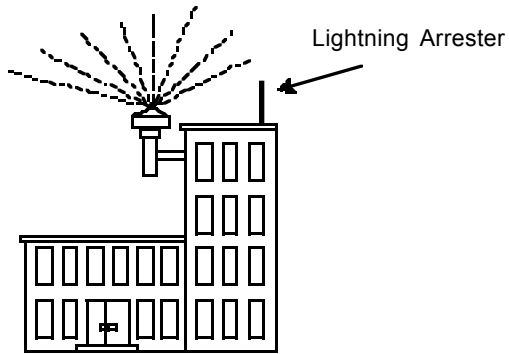
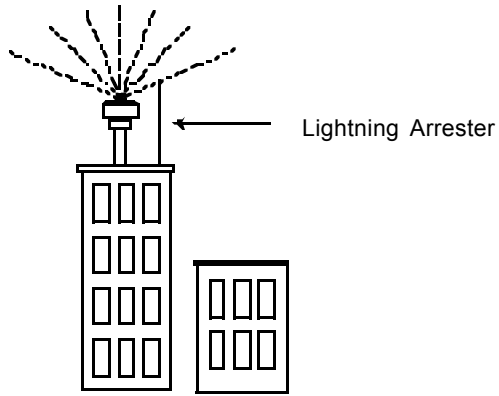
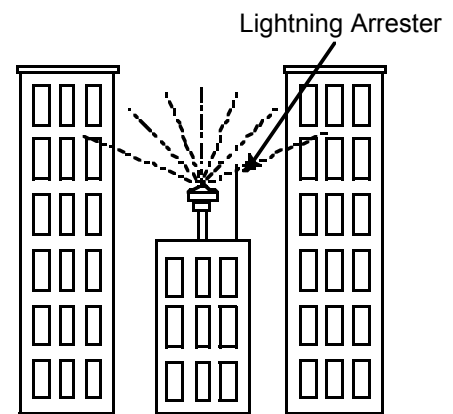
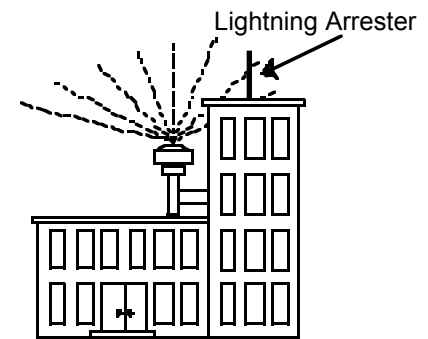
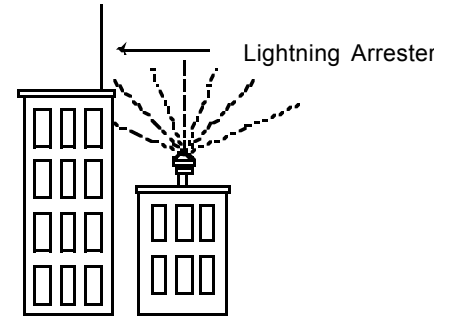


Figure 4 Remote GPS Placement

Recommended Antenna Placement



Not Recommended Antenna Placement



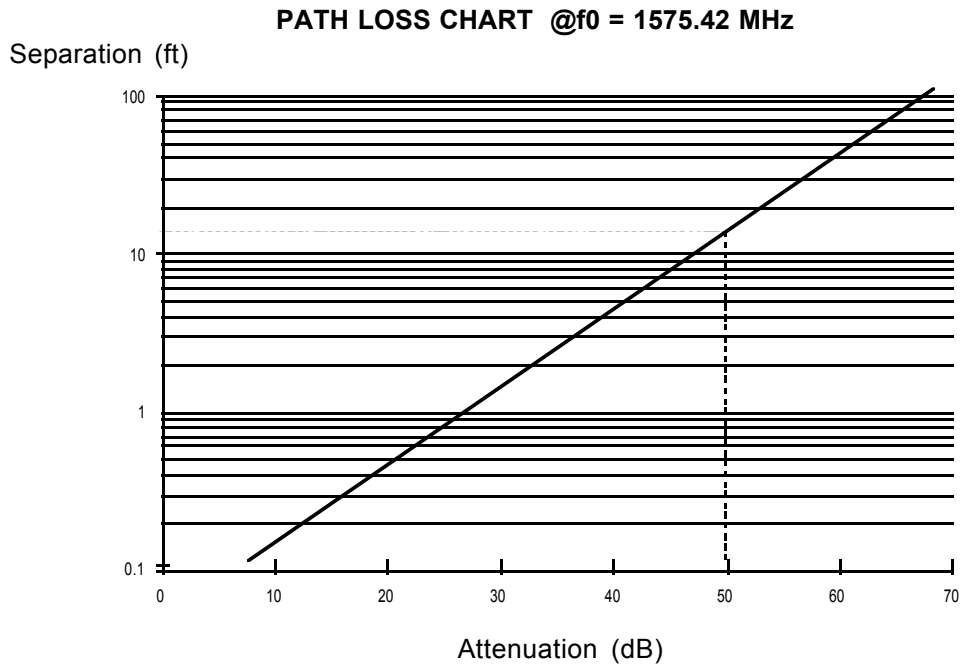


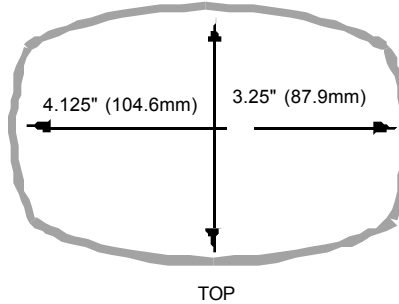
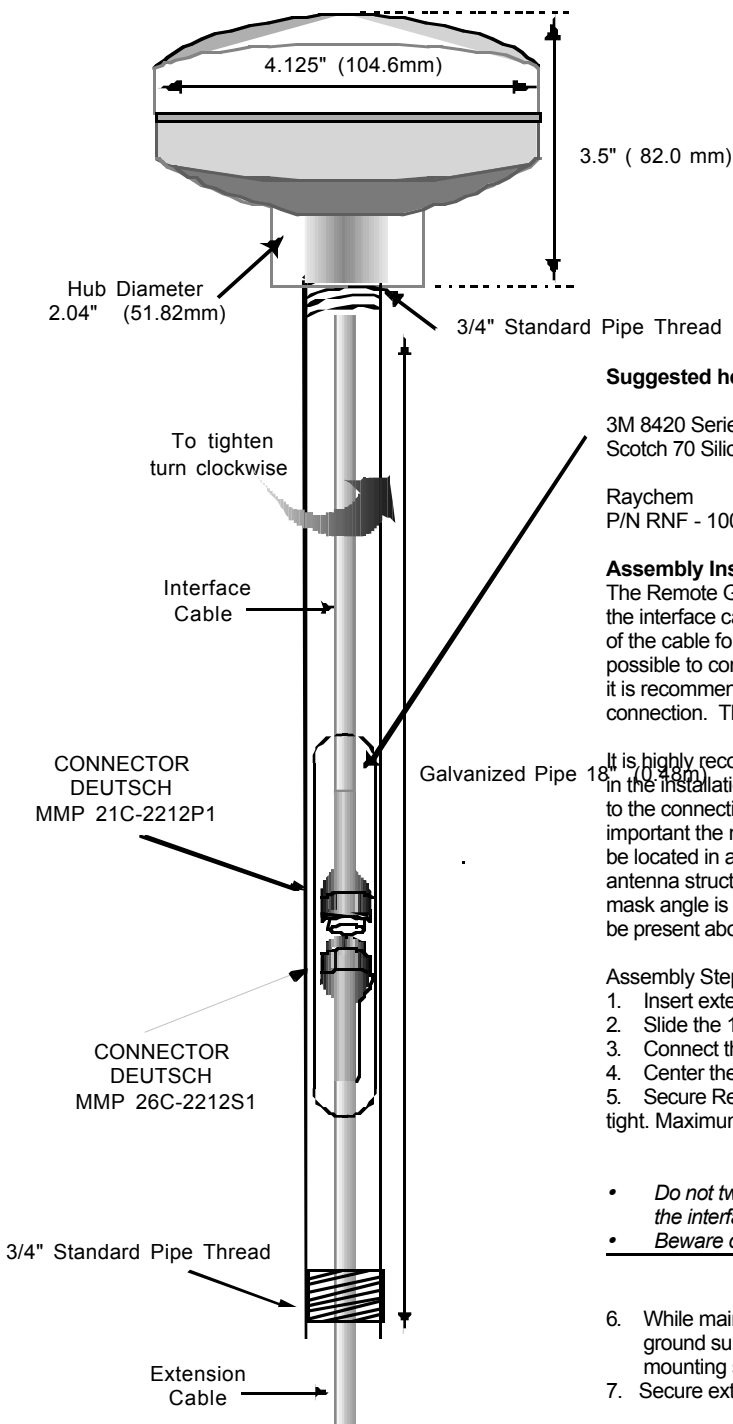
Figure 5 Attenuation Vs Distance at 1575 MHz

The following example explains Figure 5:

Assume that there is a -60 dB GPS interference signal source. The maximum allowed power level of that signal before it jams the GPS receiver is -110 dB. That means that the minimum separation between the interference signal source and the GPS receiver must be 15 feet, which provides 50 dB of attenuation.

Assembly Instructions

Remote GPS



Suggested heat shrink sleeving (12 in. with a 2:1 shrink) to cover the mating connectors

3M 8420 Series Cold Shrink connector insulator overwrapped with Scotch Super 33+ Vinyl Tape or Scotch 70 Silicone Tape.

Raychem
P/N RNF - 100 - 3/4 - BK

Assembly Instructions:

The Remote GPS is designed to allow for easy installation and protection of the interface cable. Note the interface cable protrudes out of the bottom of the Remote GPS, which allows for total encasement of the cable for severe requirements and many installations where exposed cable is not desired. It is possible to completely in-case the cable in a conduit if desired. If this type of installation is required, it is recommended conduit unions be installed with a breakout box to keep from twisting the cable connection. The break out box should be of adequate size to allow for a service loop of the cable.

It is highly recommended that an 18 inch galvanize pipe with 3/4 inch standard pipe threads be used in the installation process. The 18-inch pipe will afford both physical and weather resistant protection to the connection between the interface and extension cable. When mounting the Remote GPS, it is important the mounting pipe is placed in a vertical position (90°) without any tilt. The antenna should be located in an area that has clear view of the sky, since any obstructions such as building and tower antenna structures or heavy tree foliage will block the satellite signal. Note that the GPS receiver mask angle is defaulted to 10° above horizon line. Therefore, no obstruction to the GPS signal should be present above this angle.

Assembly Steps:

1. Insert extension cable through 18" galvanized pipe
2. Slide the 12" shrink tubing over extension cable.
3. Connect the two Deutsch connectors.
4. Center the 12" shrink tubing over the connectors and shrink.
5. Secure Remote GPS head with one hand and rotate the galvanized pipe clockwise until tight. Maximum allowable torque is 3 ft/lbs.

WARNING

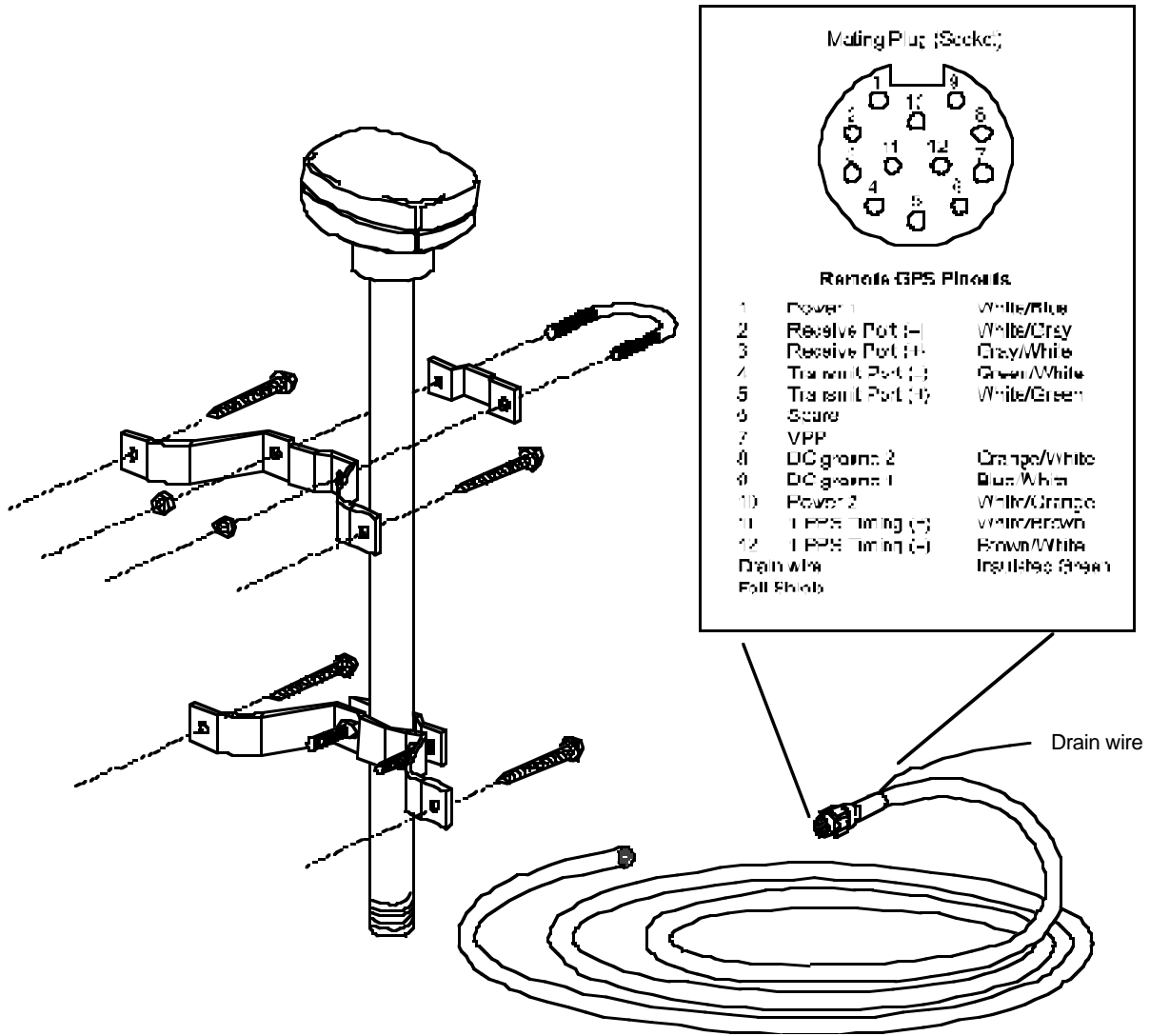
- Do not twist the Remote GPS head onto the galvanized pipe. This action could cause damage to the interface cable.
- Beware of Power Lines when installing the Remote GPS

6. While maintaining the assembly in a 90 degree angle in relation to the plane of the ground surface, attach the Remote GPS head and galvanized pipe assembly to the mounting structure using the hardware provided in the GCNOKT0002 hardware kit.
7. Secure extension cable with cable ties as it exits the 3/4" pipe.

Figure 6 Remote GPS

APPENDIX I

Optional Remote GPS Mounting Kit



(NOTE: Remote GPS UNIT NOT INCLUDED IN OPTION MOUNTING KITS)

Model Numbers:

GCNCBL0002 (Special Order):

- 1 50 foot Storm 120897-6 22 AWG6 twisted pair cable with one female 12 pin Deutsch connector (Deutsch part number MMP26C-2212S1) on one end and non-terminated on the other end

GCNOKT0002:

- 1 0.48 meter galvanized steel pipe with 3/4" National Standard pipe thread
- 2 Wall standoff mounting brackets with U bolt hardware and lag bolts

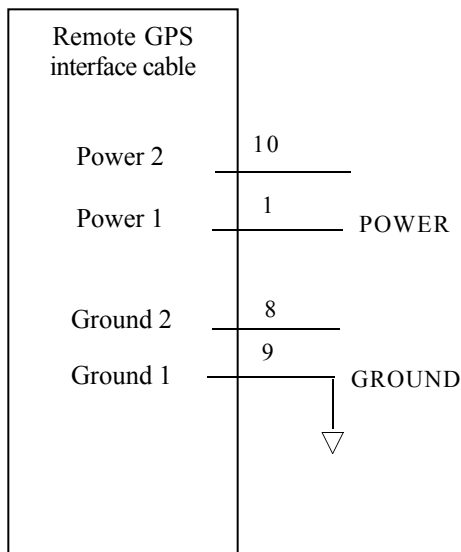
APPENDIX II

Power Supply Connections

The Remote GPS offers a wide operating voltage range, which allows for the same operating voltage to be used even though different cable lengths may be installed at the various site locations. For example the long cable lengths, assuming a conductor resistance of $22 \Omega/1000 \text{ ft}$ could drop the voltage level several volts, dependent on the resistance in the cable, the load and the initial voltage. An additional power and ground line are built into the Remote GPS that can be used to reduce the voltage drop inherent in long cables. If long cable lengths are installed, one should insure the cable voltage drop does not go below the minimum operating voltage of 8 VDC.

Voltage: 8 to 36 VDC
Power: < 1.9 watts (maximum)

Short Cable Runs



Long Cable Runs

