MultiGain Wireless

System Manual - Part III

Radio Port System

Installation and Operation

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ECI TELECOM

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SAFETY WARNINGS

Potentially hazardous voltages exist on the DSL lines, within the RPU and RPC units, and on the line interface card installed in the RPU and RPC. Always observe standard safety precautions during installation, operation, and maintenance of these products. To avoid the possibility of electrical shock, be sure to disconnect the power from the remote power source before you perform any line connections or repairs.

Always disconnect all the cables connected to the system before disconnecting the grounding connection.

After disconnecting the power from the appropriate RPCU line interface card and disconnecting the cables connected to the line interface card, wait a few seconds for internal capacitors to discharge before removing the card.

WARNING

The installation procedures described in this Manual must be performed by qualified personnel aware of the hazards involved. The personnel involved in equipment installation must be trained in the installation of MGW systems, and must strictly observe all the safety precautions related to the installation of communication equipment.

Never install, remove or adjust antennas, and associated cables, and do not work on masts or towers during a lightning storm.

ATTENTION! STATIC SENSITIVE DEVICES

PROPER HANDLING AND GROUNDING PRECAUTIONS REQUIRED

The MGW system contains components sensitive to electrostatic discharge (ESD). To prevent ESD damage, avoid touching the internal components, and removing cards, touch the frame of an grounded equipment. Keep parts and cards in their antistatic packaging material until you are ready to install.

The use of an antistatic wrist strap, connected to the grounded equipment frame or chassis, is recommended when handling cards during installation, removal, or setting of on-board option switches. Do not use a conductive tool, such as a screwdriver or paper clip, to set the position of internal DIP switches.

UL INSTALLATION SAFETY INSTRUCTIONS

a. Never install telephone wiring during a lightning storm.

b. Never install telephone jacks in a wet location unless the jack is specifically designed for wet locations.

c. Never touch telephone wires or terminals unless the telephone line has been disconnected at the network interface.

Four. Use caution when installing or modifying telephone lines.

FEDERAL COMMUNICATIONS COMMISSION (FCC) STATEMENT

The RPC and RPU equipment have been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-Reorient or relocate the receiving antenna.
-Increase the separation between the equipment and receiver.
-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
-Consult the dealer or an experienced radio/TV technician for help.

Abbreviations

AIU-120	Analog Interface Unit
DIU	Digital Interface Unit
DSL	Digital Subscriber Line
FAU	Fixed Access Unit
GOS	Grade of Service
GSS	Global Synchronization System
GPS	Global Positioning System
GTU	Global Timing Unit
kbps	Kilobits per second
Mbps	Megabits per second
MCX	MGW Coverage Extender System
MCX-L	MGW Coverage Extender Local Multiplexer Unit
MCX-R	MGW Coverage Extender Remote Multiplexer Unit
MGW	MultiGain Wireless
LOS	Line of Sight
PCM	Pulse Code Modulation
PRM	Port Radio Module
RPC	Radio Port Coupler Unit
RPCU	Radio Port Control Unit
RPU	Radio Port Unit
RRU	Radio Repeater Unit
RS-232C	EIA standard for Interface between Data Terminal Equipment and Data Communication Equipment employing serial binary data interchange using an unbalance interface
SSFH	Spread Spectrum Frequency Hopping
TDD	Time Division Duplexing
TDM	Time Division Multiplexing
TDMA	Time Division Multiple Access
WLL	Wireless Local Loop

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Chapter 1

INTRODUCTION

Scope

This manual provides the information required for the installation, configuration, and field maintenance of the radio port system used in the MultiGain Wireless (MGW) system. The equipment covered by this manual includes the Radio Port Unit (RPU), and the Radio Port Coupler (RPC).
The manual is organized as follows:

- **Chapter 1 - INTRODUCTION** - presents the scope of this manual and related publications, and provides a general description of the equipment.
- **Chapter 2 - INSTALLATION PLANNING GUIDELINES** - presents the information needed for planning the installation of the RPU and RPC, including site preparation, mechanical data, grounding and lightning protection requirements, power requirements, cabling requirements, and ambient requirements.
- **Chapter 3 - RPU INSTALLATION PROCEDURES** - presents a list of tools equipment and materials needed for the installation of the RPU and antennas, mounting methods, installation procedures for the RPU and the various antenna types, and instructions for cable connections.
- **Chapter 4 - RPC INSTALLATION PROCEDURES** - presents a list of tools equipment and materials needed for the installation of the RPC and antennas, installation procedures for the RPC and antennas, and instructions for cable connections.
- **Chapter 5 - CONFIGURATION INSTRUCTIONS** - presents RPU/RPC configuration procedures, post-installation operation and testing instructions, and provides procedures for correcting the most frequent problems encountered when operating for the first time an RPU/RPC unit.
- **Chapter 6 - MAINTENANCE** - presents RPU and RPC maintenance and troubleshooting procedures, including testing of the RPU and of the RPC in conjunction with other system components and repair instructions for the RPU, RPC, and antenna equipment.

This manual assumes familiarity with the characteristics, configuration, and operating procedures of the MultiGain Wireless System. If necessary, refer to the applicable manuals listed in para. 0.

Related Publications

This manual is Part III of the MultiGain Wireless System Manual. The MultiGain Wireless System Manual includes three additional Parts:

Part I **MultiGain Wireless System Overview** - provides a concise description of system capabilities and its various components, integration with CO equipment, general configuration options, optional equipment (MCX, RRU, etc.), and a general description of management and provisioning options. This Part also includes functional and technical descriptions of the MultiGain Wireless System.

Part II **MultiGain Wireless Central Office/Exchange Interface System Installation and Operation Manual** - provides a general description of the RPCU, GSS, AIU-120, and DIU units, physical and functional descriptions, site requirements, data related to installation planning, installation procedures for each equipment item, cable connections, first-time operation, configuration and provisioning procedures, commissioning procedures, troubleshooting instructions and field maintenance procedures.

Part III **MultiGain Wireless Subscriber System Installation and Operation Manual** - provides a general description of the FAU, PCU and PDC/4 units, physical and functional descriptions, site requirements and installation planning, installation

procedures for each equipment item, cable connections, first-time operation, configuration and provisioning procedures, commissioning procedures, troubleshooting instructions and field maintenance procedures.

Additional information regarding the MGW system is provided in the following manuals:

- **CraftMap CMAP 8000 Installation and Operation Manual,** P/N 7438-71401-02, provides the information required for the installation and operation of the CMAP 8000 management tool.
- **SuperOfficeMap Installation and Operation Manual,** P/N 8638-71407-00, provides the information required for the installation and operation of the SuperOfficeMap tool.
- **AIU-120 Concentrator Option Installation and Operation Manual,** P/N 5726-71436-00, provides the information required for the installation operation and maintenance of the AIU-120.
- **DIU Installation and Operation Manual,** P/N 8674-71135-00, provides the information required for the installation, operation and maintenance of the DIU.
- **MCX Installation and Operation Manual,** P/N 8619-71006-00, provides the information required for the installation, operation and maintenance of the MGW Coverage eXtender (MCX) system equipment.
- **HHT Installation and Operation Manual,** P/N 8626-09104-90, provides the information required for the installation and operation of the Handheld Terminal (HHT).
- **HFIT-2000 User's Manual,** P/N 8626-71470-00, provides instructions for the operation of the Handy FAU Installation Terminal, HFIT-2000.
- **HFIT Super User Manual,** P/N 8626-71471-00, provides super-user operating instructions for the Handy FAU Installation Terminal, HFIT-2000.
- **HFIT-100 User's Manual,** P/N 8626-71140-00, provides instructions for the operation of the Handheld FAU Installation Terminal, HFIT-100.

EQUIPMENT DESCRIPTION

Equipment Versions

This manual covers the following radio port equipment versions:

- Radio Port Unit, RPU, and the associated antennas and mounting accessories. The RPU can be ordered for operation in the following frequency bands: 800 MHz, 1.5 GHz, 1.9 GHz, 2.4 GHz and 3.5 GHz.
- Radio Port Coupler, RPC, performs the RPU functions with an internal antenna. The RPC can be ordered for operation in the following frequency bands: 1.5, 1.9, 2.4 and 3.5 GHz.

Figure 1-1 shows a general view of typical basic RPU and RPC units.

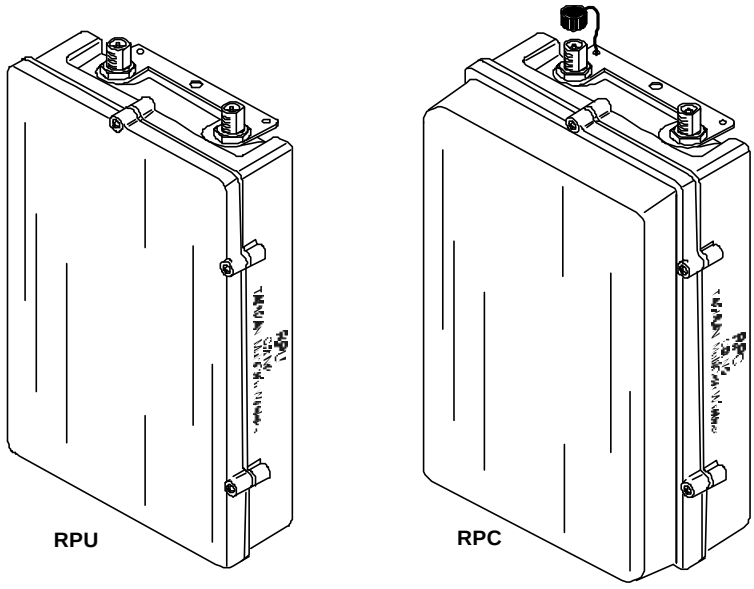


Figure 1-1. Typical RPU and RPC Units, General View

RPU Description

RPU Functional Description

The RPU is a compact, weatherproof unit intended for outdoor installation on poles, masts or towers, that provides radio links between one of the RPI modules installed in the RPCU unit located at the exchange or at a remote sites, and FAU's installed on the subscriber's premises. One RPU can simultaneously carry eight calls to independent subscribers.

The RF links between the RPU and the FAU's are supported by two external antennas, so that an RPU-based radio station includes one RPU and two antennas. By connecting two antennas to the RPU, space diversity is used to improve communication reliability. Either omni-directional or sectorized antennas can be used, for flexible radio coverage and optimal deployment.

The connection to the RPU is made by means of two DSL lines (regular twisted-pairs of the type usually found in the local subscriber's plant, having a typical gage of 0.4 to 0.6 mm (22 AWG to 26 AWG)), which carry both data and power. The RPU can be either connected directly to a radio port interface of the RPCU, or indirectly, by means of an MGW Coverage eXtender (MCX) link (see Part I of the manual for system planning considerations):

- The direct connection can be made when the RPU is located on the exchange building, or at a remote site within a few kilometers of the RPCU. The actual range depends on the twisted pair gage (thicker pairs support longer ranges).
- RPU's connected by means of an MCX link can be located at distances of tens of kilometers from the RPCU. This is made possible by the use of transmission equipment (microwave link, fiber-optic line etc.).

Figure 1-2 illustrates both connection methods.

The two DSL lines are operated as a single logical link with a data rate of 288 kbps. The link is used to carry the eight 32 kbps payload channels, and two 8 kbps channels that carry the management

communication link between the RPCU and the RPU, and subscriber signaling. The payload channels usually carry ADPCM-encoded voice of toll quality, however the channels can also be programmed for data transmission, with the option of combining two channels to obtain one 64 kbps clear channel for data transmission.
The RPU is remotely fed through the DSL lines. Its operation is remotely controlled from the RPCU through the management channel.

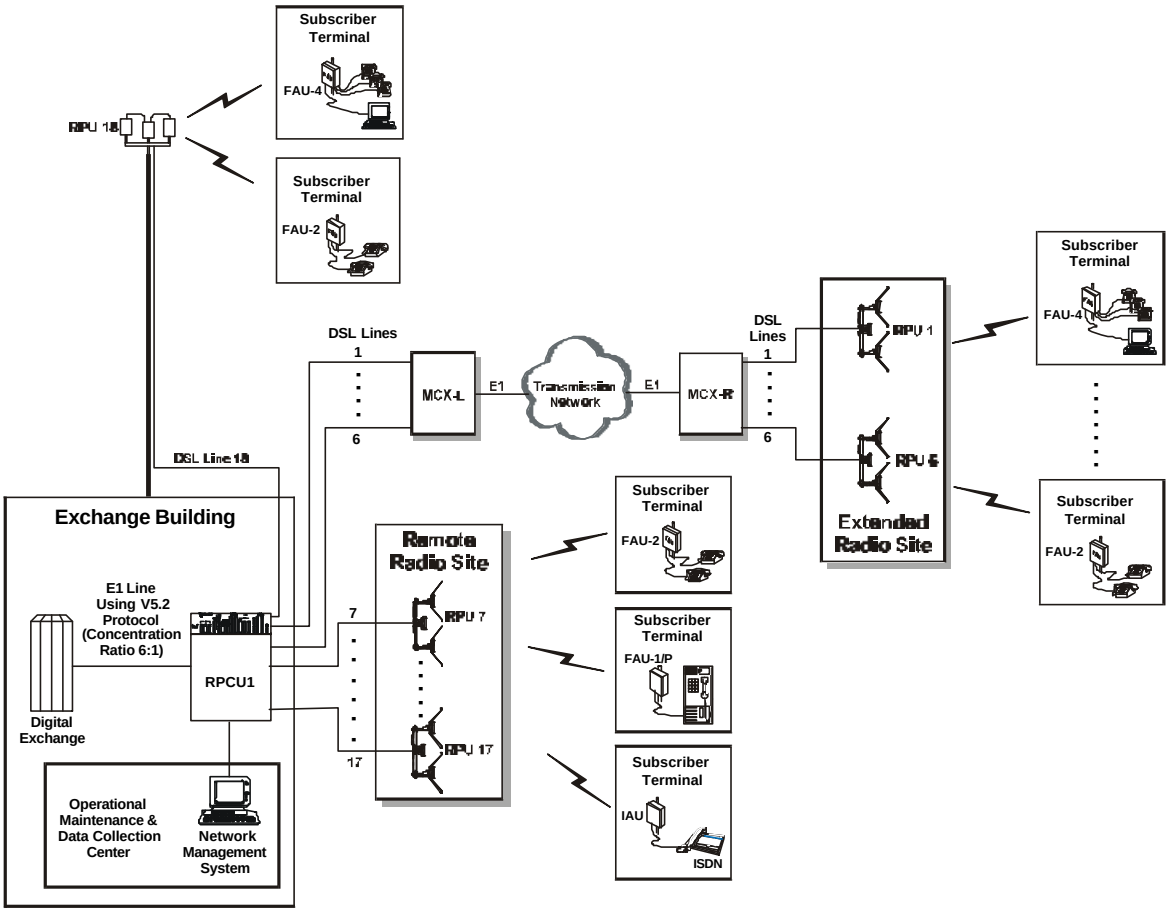


Figure 1-2. Typical RPU Connection Methods

RPU Functional Block Diagram

Figure 1-3 shows the functional diagram of the RPU. The RPU comprises the following modules:

One. Port Line Interface (PLI) Module - includes the interface for the two DSL lines arriving from the RPCU or from the MCX-R, control and data processing circuits.

The PLI module also includes the power supply. The power supply receives the supply voltage provided through the DSL lines and converts this voltage to regulated voltages used to power the RPU modules.

Two. Port Radio Control (PRC) Module - comprises interfaces and microcontroller-based control circuits. The PRC module includes two microcontrollers that perform all the central processing functions:

- One microcontroller controls the digital line interface and the HDLC communication link to the RPCU, via the PLI module.
- The other microcontroller controls the digital radio interface and the operation of the transceiver in the PRM module. The digital radio interface is also used to obtain status information and control the operating mode of the FAU units communicating with the RPU:

The PRC module also includes an RS-232 synchronous communication interface that enables monitoring of RPU operation, and includes a management interface that enables management via the RPCU, using Supper OfficeMap, OfficeMap or CMAP 8000 network management systems.

Three. Port Radio Module (PRM) - Contains a frequency-hoping transceiver. The transceiver comprises the following main functions:

- Transmitter, modulates the carrier with the baseband signal provided by the radio interface, using digital wideband modulation.
- Two receivers, which demodulate the signals received by two antennas, using FM quadrature discrimination, and recover the baseband signal.
- Synthesizer, generates the carrier frequency for the transmitter, and the local oscillator signals for the receivers.
- RF switches which control the routing of RF signals between the transmit and receive paths and perform antenna selection.
- Reference clock synchronized to GPS receiver or exchange master clock.

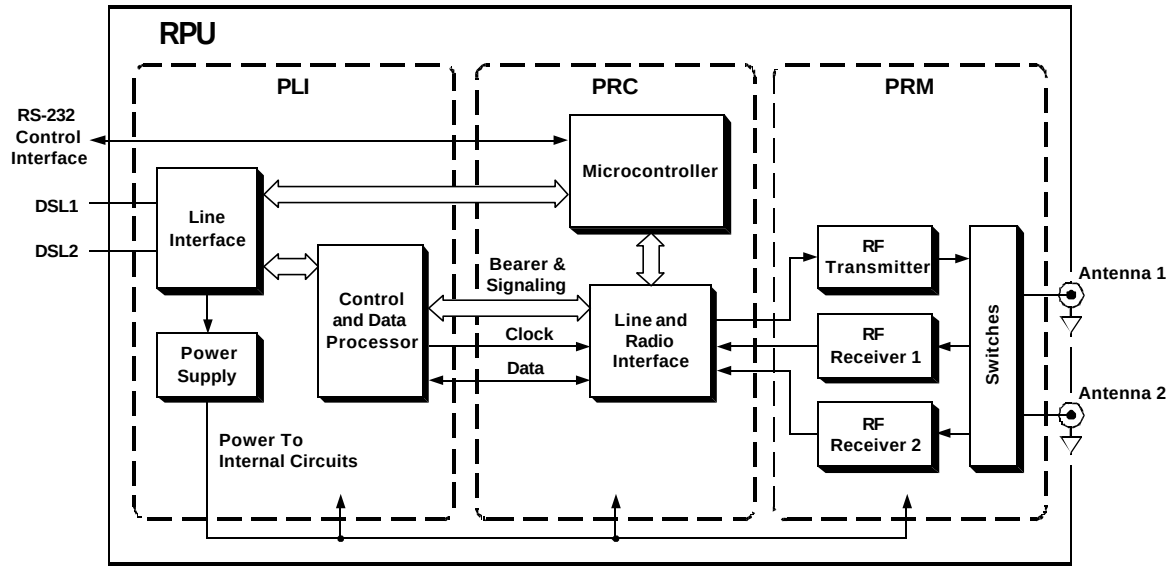


Figure 1-3. RPU Functional Diagram

RPU Antennas

The RPU can be ordered with two basic types of antennas:

One. Omni-directional Antennas. Figure 1-4 shows an RPU radio station with two omni-directional antennas.

Two. Sectorized Antennas. The following sectorized antenna types are offered:

- 60° sector antennas with reflectors, which improve the isolation among antennas mounted at the same level on a common mast or tower. This type of antenna is used for operation in the 800 MHz, 1.5 GHz and 1.9 GHz frequency bands.
- 60° sector antennas without reflectors, for use in the 2.4 and 3.5 GHz frequency bands.

Figure 1-5 shows typical RPU sectorized antennas, with and without reflectors.

The antennas must be ordered in accordance with type and frequency band.

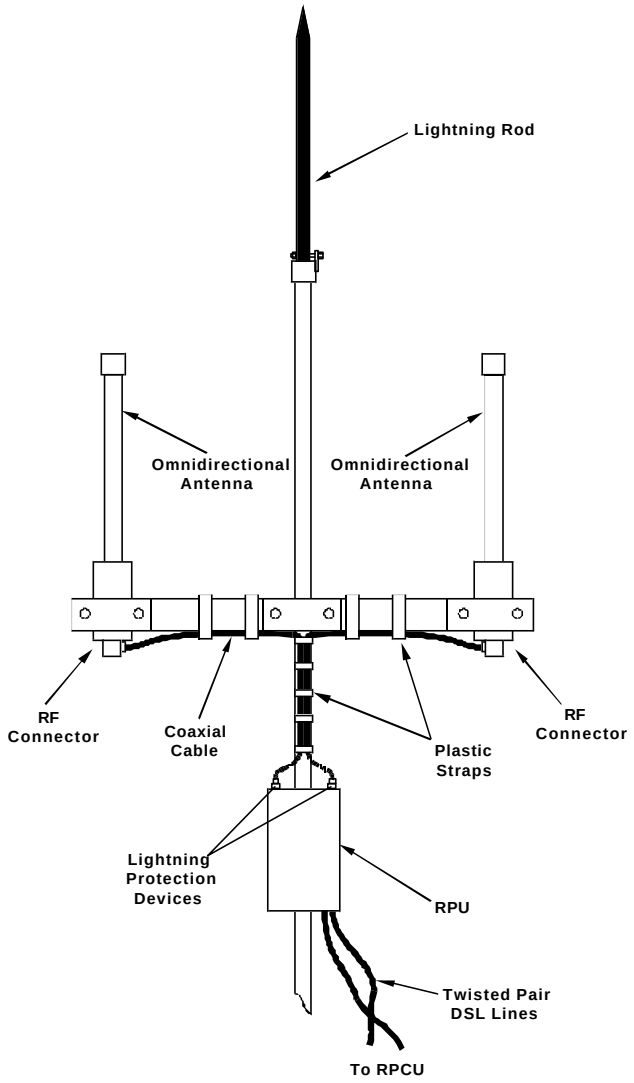


Figure 1-4. Typical RPU Radio Station with two Omni-directional Antennas

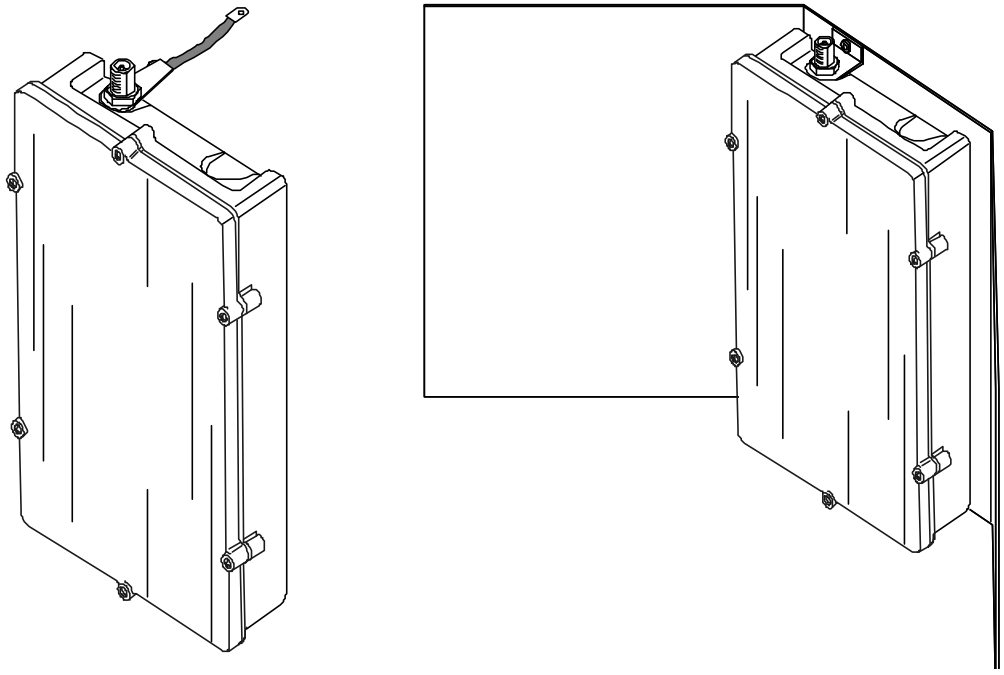


Figure 1-5. Typical Sectorized Antennas with and without Reflector

RPU and Antenna Mounting

Accessories

InnoWave offers a diversity of mounting accessories for the RPU and the associated antennas:

- Pole mounting accessories with or without lighting rod, including H-support.
- Mast or tower mounting accessories, including H-support.

Figure 1-4 shows an RPU station with two omni-directional antennas and a lightning rod mounted on a pole, and Figure 1-6 shows a top view of an RPU radio station with two sectorized antennas mounted on an H-support. One H-support allows mounting of two RPU-based radio stations, including two RPU's and four sectorized antennas.

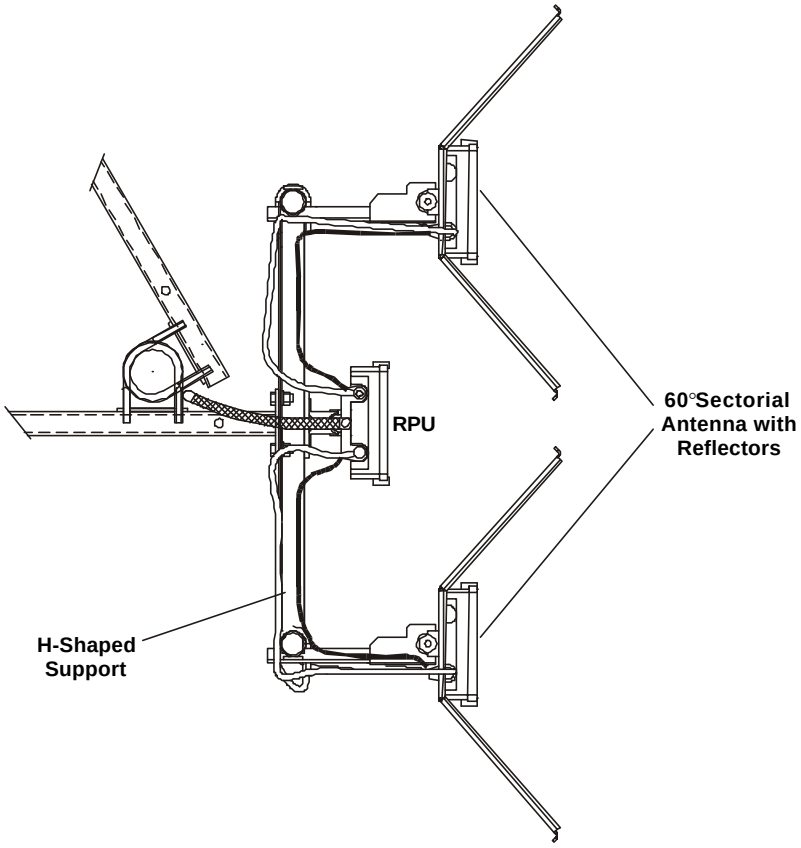


Figure 1-6. RPU Radio Station Mounted on H-Support

The RPU sectorized antennas are attached to the H-support by means of a special tilt assembly, which enables the user to direct the main beam of the antenna below the horizontal, in six steps, up to -18° (see Figure 1-7).

Tilting is recommended when the RPU is located at an elevation significantly higher than the subscribers sites, and is more effective in the higher frequency bands (2.4 GHz and 3.5 GHz), at which the RPU antennas have particularly narrow vertical beamwidth patterns.

Tilting the beam down has two effects:

- Enables antennas installed on high towers or buildings within urban areas to provide better coverage of the area near the antenna.
- For closely spaced cells, reduces the energy radiated toward remote cells, thereby minimizing the intercell interference.

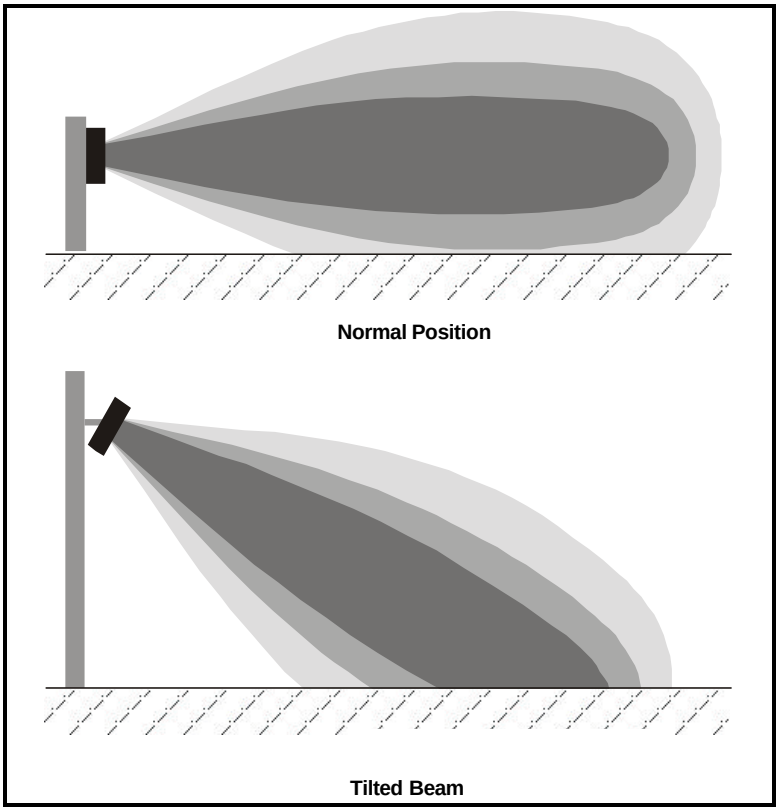


Figure 1-7. Effect of Beam Tilting

RPC Description

RPC Functional Description

The RPC is a complete radio port subsystem, which contains the RPU hardware, an internal 60° sectorized antenna and an antenna coupler, that enables connection to another RPC or to an external antenna, for space diversity.

Therefore, the RPC simplifies the installation process, reduces the resources and environmental impact relative to typical RPU-based installations, and improves the appearance of the radio base station.

The RPC is offered in the following versions:

- RPC with external reflectors for the 1.5 GHz frequency band.
- RPC without reflectors for the 2.4 and 3.5 GHz frequency bands.

RPC Functional Block Diagram

The functional diagram of the RPC is shown in Figure 1-8. The RPC uses PLI and PRC modules whose functionality is similar to that of the corresponding RPU modules, an internal antenna, and a PC module that includes the transceiver functions of the PRM module used in the RPU, with the addition of a coupler.

The coupler is used only in the dual-RPC base station configuration (see para. 0), in which the RPC2 connectors of two RPC units heading in the same direction are cross-connected using two coaxial cables. Space diversity is obtained for each RPC by coupling the internal antenna of the other RPC. The dual RPC configuration supports up to 16 simultaneous calls.

NOTE

3.5 GHz RPC units connected in a dual-RPC configuration, support antenna diversity only in the receive mode. When transmitting, each of these RPC units uses only its internal antenna.

In the single RPC base station, and also when using special external antennas configurations, the coupler is bypassed.

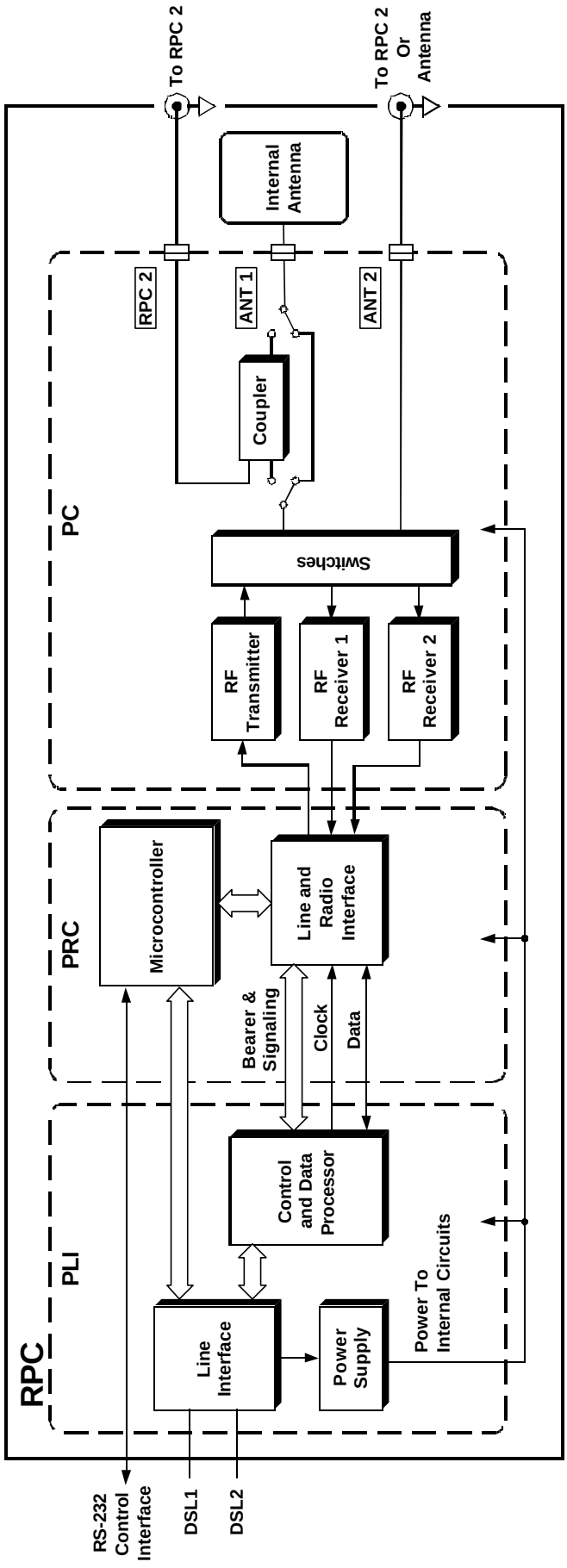


Figure 1-8. RPC Functional Diagram

In addition, the RPC can be used with external antennas:

- An additional (standard) RPU antenna can be connected to the second connector of the RPC.
- For special applications, e.g., for omni-directional coverage or when special antennas are needed, or to support antenna diversity when transmitting on a 3.5 GHz RPC, two external antennas shall be used. In this case, the internal antenna of the RPC can be disconnected in the field and the internal connector can be directly connected to one of the external RF connectors.

RPC Configurations

This section presents basic configurations using the RPC capabilities.

Dual-RPC Radio Base Station

This configuration, shown in Figure 1-9, includes two radio base stations, heading in the same direction (Figure 1-9 shows units without external reflectors: such reflectors are used only with the 1.5 GHz units). The internal antenna of each RPC is used as the second antenna for the other RPC, so that space diversity is obtained for both RPC's.
This configuration, which requires only two units, replaces six units (two RPU's and four antennas). As a result, it is possible to install four RPC-based radio stations on one H-support. Eventually, installation costs are reduced and environmental and aesthetic impact is minimized.
Every installation including multiple radio base stations, heading in the same direction, will include pairs of RPC's connected according to Figure 1-9.

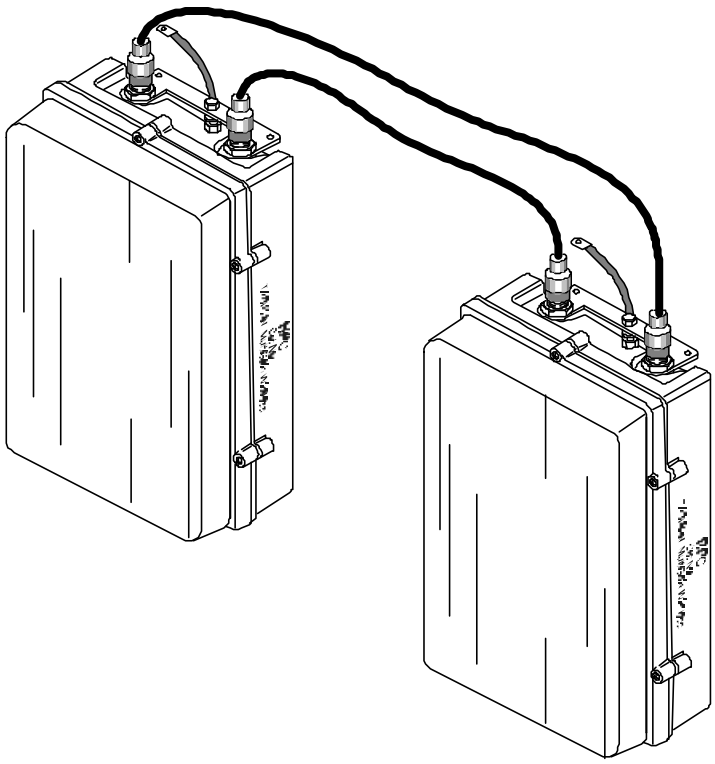


Figure 1-9. Dual RPC Configuration

Single RPC Radio Base Station with Space Diversity

A single radio base station with space diversity comprises an RPC and a sectorized antenna. A single cable connects the two units. Both the internal and external antennas are connected via the antenna coupler in the RPC.

Figure 1-10 shows a typical RPC radio station. This configuration is used for the installation of a single radio base station, and for the single radio base station left at a location that includes an odd number of radio base stations, heading in the same direction.

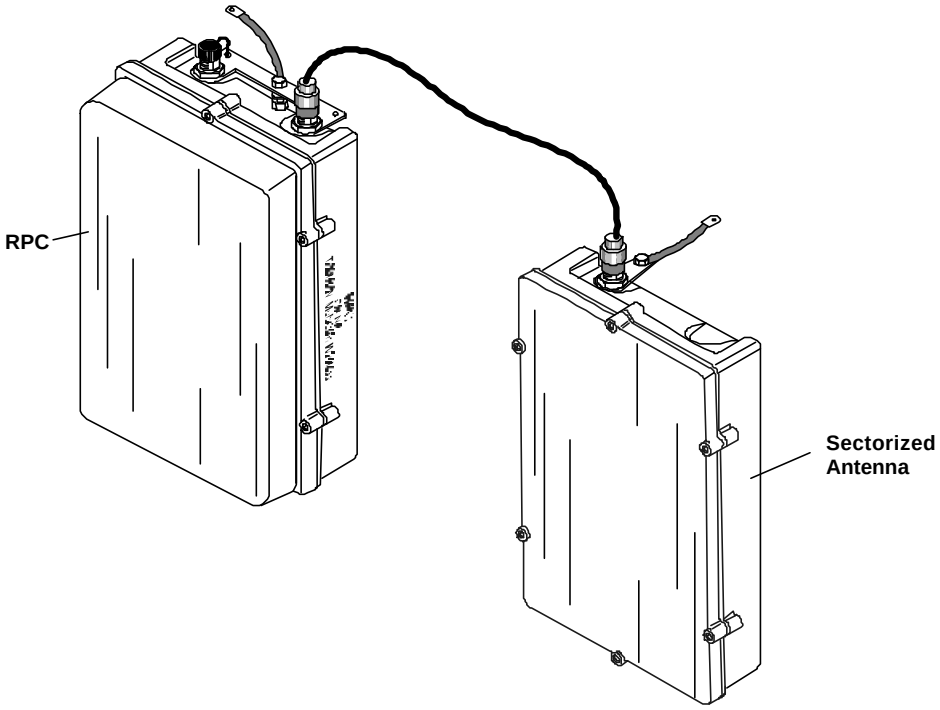


Figure 1-10. Single RPC Radio Station

External Antenna Options

The RPC enables the connection of a pair of external antenna pairs (e.g., omni-directional or wider beam-width antennas), whenever needed. To use this option, it is necessary to change internal connections in the RPC.

External antennas must always be used on a 3.5 GHz RPC, when it is necessary to use antenna diversity in the transmit mode.

Technical Characteristics

DSL Line Interface (RPCU Interface)	
Number of DSL Interfaces	two
Line Interface Type	Based on ANSI T1.600
Basic Line Bit Rate	144 kbps per DSL line
Line Code	2B1Q
Transmit Signal Level	5V peak
Line Nominal Impedance	135 ohm @ 40 kHz
Transmission Media	Unloaded twisted wire pairs
Air Interface	
Frequency Range	a. 800 MHz bands: 806-812 MHz; 851-857 MHz b. 1.5 GHz band: 1.428 - 1.525 GHz c. 1.9 GHz band: 1.850 - 1.930 GHz d. 2.4 GHz bands: 2.400 - 2.499 GHz or 2.401 - 2.479 GHz (ETS 300-328 version) e. 3.5 GHz band: 3.405 - 3.520 GHz
Spectrum Spreading Method	Frequency Hopping
Channel Access	TDMA/TDM
Duplex Method	TDD
Number of Full Duplex TDMA Slots	Eight per channel
Number of Hopping Frequencies	80 maximum
Channel Spacing	1 MHz
Bit Rate	875 kbps
Dwell Time (hopping rate)	2 msec (500 hops/sec)
Diversity Techniques	– ATD (Adaptive Time Diversity) – AD (Antenna Diversity) for the uplink
Error Detection Technique	CRC (85, 73)
Modulation Method	3-Level Synthesized Response FSK
Frequency Deviation of RF Channel	Maximum 230 kHz
-20 dB Bandwidth of RF Channel	1000 kHz
RF Transmit Power Level	
Typical RF Output Power	f. +25 dBm g. +8 dBm (ETS 300-328 version)

RPU Antenna Gain (typical)	h. 800 MHz bands: i. 1.5 GHz band: j. 1.9 GHz band: k. 2.4 GHz band: (ETS 300-328) l. 3.5 GHz band:	7 dBi 10 dBi 10.5 dBi 11 dBi 13 dBi
RPC Antenna Gain (typical built-in antenna)	m. 1.5 GHz band: n. 1.9 GHz band: o. 2.4 GHz band: (ETS 300-328) 3.5 GHz band:	10 dBi 10.5 dBi 11 dBi 13 dBi
RF Receiver		
Receiver Subsystem	Two receivers with diversity switching	
Adjacent Channel Selectivity	-14 dB	
Sensitivity	– -90 dBm @ WER=10^{-2} (BER=10^{-4}) – -87 dBm @ WER=10^{-4} (BER=10^{-6})	
Second Channel Selectivity	-40 dB at ± 2 MHz	
Power Supply	–	
Source	Remote feeding through the DSL from the RPCU or MCX-R	
Nominal Supply Voltage	±60 V DC, ±80 V DC, ±90 V DC, or ±120 V DC	
Typical Feed Range	6 km on 0.5 mm pairs for ±90 V DC feed voltage	
Connectors		
DSL Lines	Terminal strip	
Control Connector	9-pin D-type	
RF Connectors	N-type	
Software Downloading	Remote software download through the radio link	
Physical Characteristics	**RPU**	**RPC**
Dimensions (H × W × D)	320 × 210 × 65 mm	320 × 210 × 103 mm
Weight	1.9 kg	2.6 kg

Environmental	
Operating Conditions	
Temperature	-25 to +60°C
Relative Humidity	10 to 95%
Storage and Transportation Conditions	
Temperature	-40 to +70°C
Relative Humidity	Up to 95%
Rain	IEC specification 68-2-18, test Rb, impacting water, method 1

Chapter 2

INSTALLATION PLANNING GUIDELINES

General Considerations

The RPU and RPC are weatherproof units, intended for outdoor installation on poles, masts or towers. A MultiGain Wireless system contains a number of RPU's and/or RPC's, where each unit or group of RPU's or RPC's provide radio link coverage to a predetermined subscriber area.

TadiPlan

InnoWave offers the TadiPlan dynamic software utility that designs, evaluates and upgrades new or existing radio coverage systems. TadiPlan addresses all planning and development issues. The user need enter the basic geographical information as topographical maps or standard Digital Terrain Maps files, customer requirements, etc. TadiPlan processes all the planning and development issues and all the information provided by the user and creates a recommended optional system plan which answers and meets the customer requirements.

It is recommended to use this planning tool in order to achieve the optional system plan. However, the following paragraph presents additional information regarding the physical planing of the system installation and the selected configuration parameters. Contact InnoWave technical support for additional information.

Radio Link Characteristics

The MultiGain Wireless system operates in the 0.8 to 3.5 GHz range, using orthogonal frequency hopping with time and code division multiple access (FH-CDMA).

The maximum number of RF frequencies supported by the system in each frequency band is 80, and the channel spacing is 1 MHz. The occupied RF bandwidth is such that two collocated RPU's can use RF frequencies differing by 2 MHz.

The hopping set (i.e., the frequencies in actual use) can be selected by the system planning tools. This tool allows avoiding occupied frequency bands, or "noisy" frequencies, and ensures that the MultiGain Wireless system can efficiently use the frequencies available at any particular location, even when the available spectrum is not continuous. System frequency allocation is controlled by means of the RPCU. All the RPU's connected to an RPCU hop synchronously at a rate of 500 hops per second, using a common pseudorandom sequence. Collocated RPU's are assigned different sequence numbers to ensure that two neighboring RPU's are never working on the same frequency at the same time.

The propagation of radio waves in the frequency range used by the MultiGain Wireless system requires a free line of sight.

- Obstruction of the line of sight between the transmitter and receiver adds a significant

amount of attenuation.

- Reflections from large buildings and large nearby objects have significant amplitudes, and can cause large variations in the local signal amplitude (selective fading, in addition to the regular fading).

As a result, providing accurate estimates of the attenuation (a prerequisite for the calculation of the system coverage areas), in this frequency range needs an accurate planning method. To improve accuracy, it is recommended to use the TadiPlan system.
By connecting two antennas to the RPU, space diversity is used to improve communication reliability.
With omni-directional antennas, the range of the RPU/RPC-to-FAU radio links is 3 km with free line-of-sight. When the RPU/RPC uses 60° sectorized antennas directed towards the target area, the line-of-sight range is up to 30 km.
Since an RPU/RPC can be located at a large distance from the RPCU to which it is connected (using either long DSL lines, or by means of an MCX link), and it is remotely powered and managed, RPU/RPC units can be conveniently distributed throughout the service area, so that every potential subscriber is within reach of at least one radio port.
In densely populated areas, the RPU/RPC's may be mounted on street lamp posts; in other areas, RPU/RPC's can be mounted on masts or towers on roofs of tall buildings, to extend the potential coverage.

Site Preparation

Mounting Accessories

When planning the installation, first evaluate installation on existing poles, masts, or towers. If the available options are not satisfactory, design and install dedicated masts or towers in accordance with the applicable regulations.

InnoWave has designed a wide range of accessories that enable efficient mounting of equipment on many types of poles, masts, towers, etc. In particular several types of multi-unit supports, called ***H-supports*** are available. An H-support has a capacity of two RPU's (including the associated antennas), or four RPC's, or two RPC's (and the associated antennas).
When planning the installation, refer to Chapter 3 for description of the available mounting accessories.

Connection Accessories

Prepare at a convenient location a distribution box for the connection of the cable(s) arriving from the RPCU or MCX system, and the lines to the RPU's/RPC's.

Antenna/RPC Spacing

Antennas, or RPC and antennas, mounted on a common tower, mast, or pole should be arranged in accordance with Figure 2-11. The spacing among antennas or RPC units must comply with the minimum spacing given in Table 2-1 or Table 2-2, respectively.

Table 2-1. Minimum Antenna Spacing

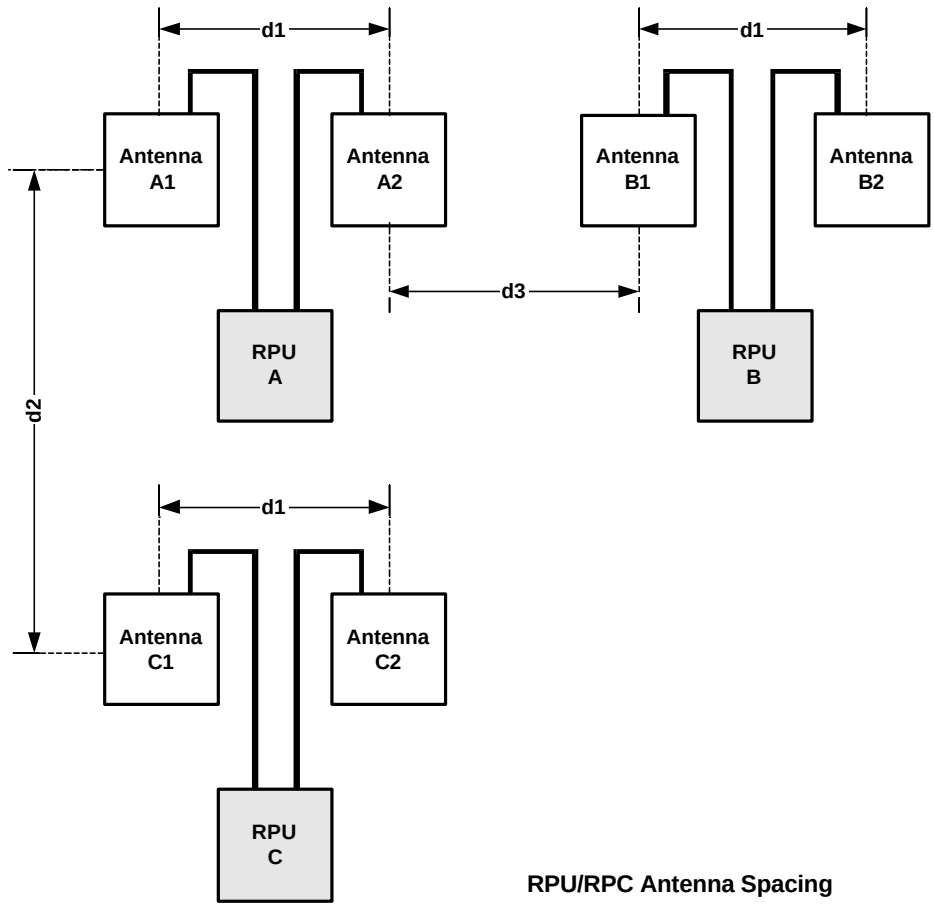
Dimension	Frequency Band				
	0.8 GHz	1.5 GHz	1.9 GHz	2.4 GHz	3.5 GHz
d1	75 cm	75 cm	75 cm	40 cm	35 cm
d2	60 cm	60 cm	60 cm	60 cm	60 cm
d3	75 cm	75 cm	75 cm	40 cm	35 cm

Table 2-2. Minimum RPC Spacing

Dimension	Frequency Band			
	1.5 GHz	1.9 GHz	2.4 GHz	3.5 GHz
d1	50 cm	50 cm	40 cm	35 cm
d2	60 cm	60 cm	60 cm	60 cm
d3	50 cm	50 cm	40 cm	35 cm

Figure 2-11 identifies the dimensions d1, d2, and d3, as follows:

- d1- minimum distance, in centimeters, between the vertical center lines of two antennas connected to the same RPU, between the vertical center lines of two interconnected RPC units, or between the vertical center lines of an RPC and its associated external antenna.
- d2 - minimum distance, in centimeters, between the horizontal center lines of two antennas connected to neighboring RPU/RPC's, or between the horizontal center lines of two RPC units, installed at different heights.
- d3- minimum distance, in centimeters, between the vertical center lines of two antennas connected to neighboring RPU/RPC's, or between the vertical center lines of neighboring RPC units, installed at the same height.



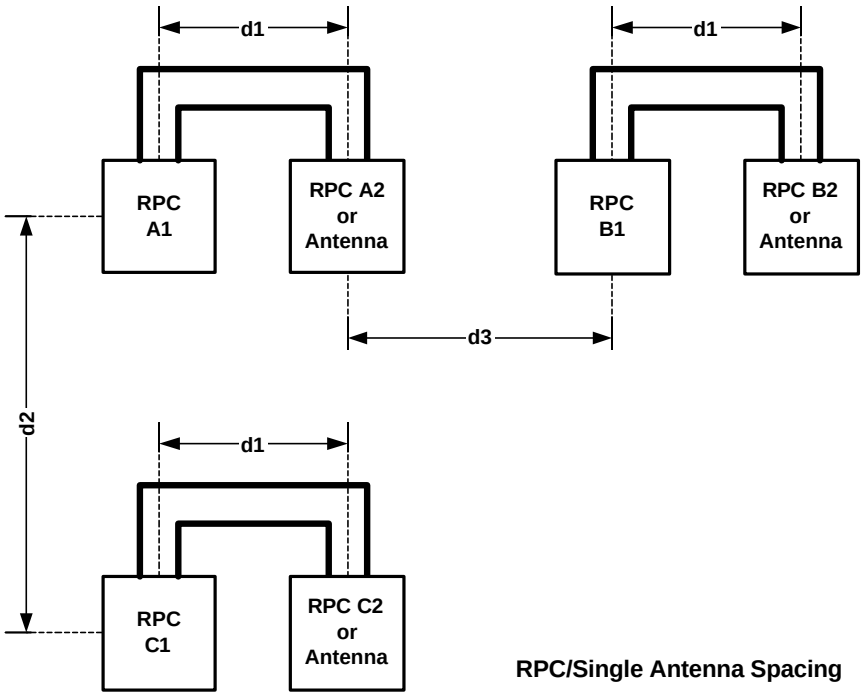


Figure 2-11. RPU/RPC Antenna Spacing

Achieving 360° Radio Coverage

When 360° radio coverage is required, it is recommended to use at least six H-supports, arranged either in one or two levels.

Three. Option 1 - six narrow H-supports, arranged in pairs at one level. This option can be used for mounting RPU's and sectorized antennas without external reflectors, i.e., that operate in the 2.4 and 3.5 GHz bands, or RPC's without external reflectors.

Each pair of H-supports is attached to the tower by means of an additional T-shaped support, as shown in Figure 2-13. The antenna spacing specified in para. 0 must be observed. Each T-shaped support is directed at 120° from the other two supports.

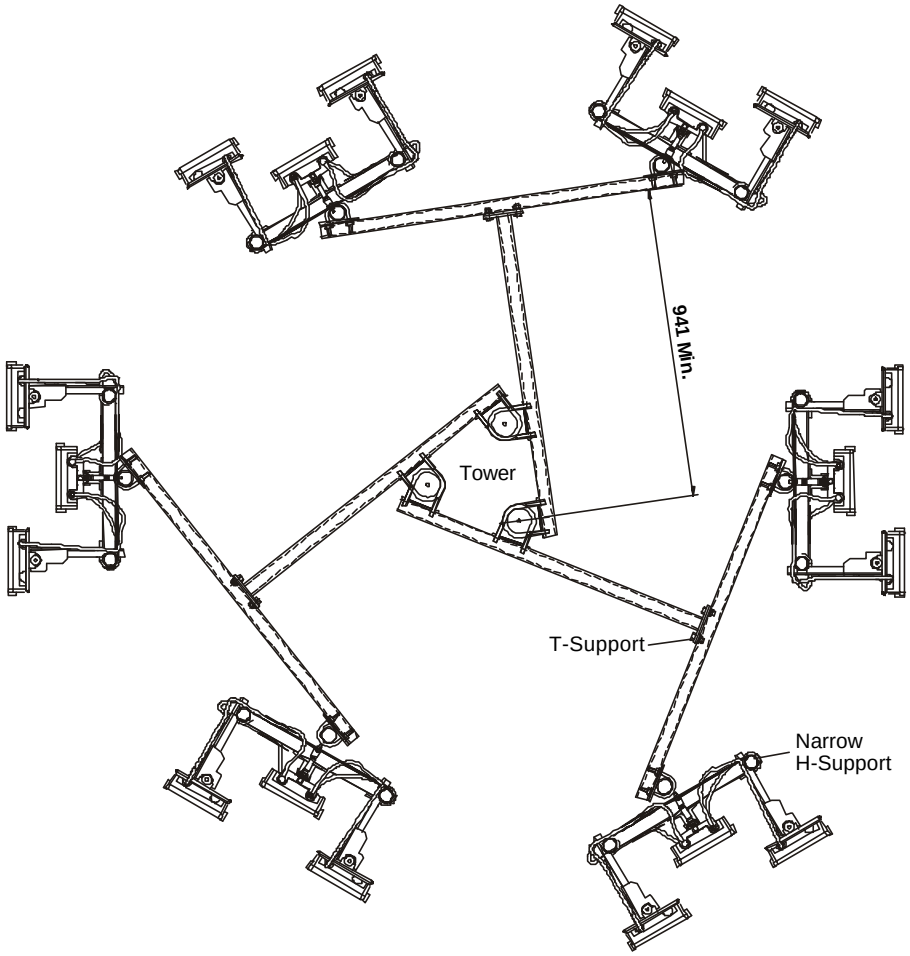


Figure 2-13. RPU and Antenna Installation for 360° Coverage in One Level

Four. Option 2 - six H-supports arranged in two levels and offset in direction as shown in Figure 2-13. This option can be used for mounting all types of RPU's and sectorized antennas or RPC's. The antenna spacing specified in para. 0 must be observed.

Each level includes a group of three standard width H-supports, where support is directed at 120° from the other two supports. The vertical distance between the two groups of H-supports is 2 meters. The H-supports shall be oriented so that the upper antenna array is shifted by 60° with respect to the lower antenna array, as shown in Figure 2-14.

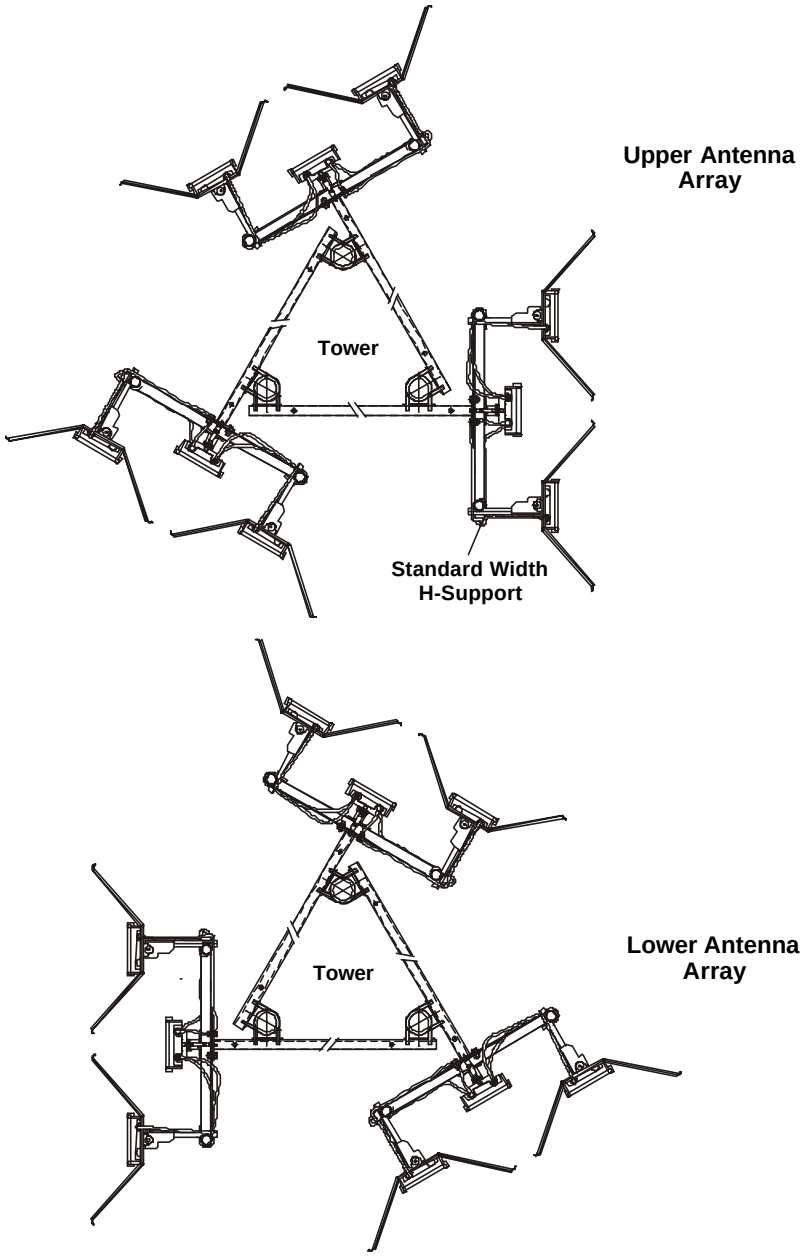


Figure 2-14. RPU and Antenna Installation for 360° Coverage in Two Levels

Grounding and Lightning Protection

General

The possibility of antennas, RPU/RPC units, and supporting mast being subjected to lightning strokes or accidental contact with power lines and the possibility of disturbances caused by surges must be taken into consideration during equipment installation. Suitable protection, including proper mast grounding, must be provided by the customer, in accordance with the applicable national standards and regulations (American Standard NFPA78, British Standard BS6651, Israeli Standard IS1173, etc) taking into consideration the requirements presented in the following paragraphs.
The lightning protection system is composed of the following parts:

- Lightning rod (para. 0).
- Lightning discharge conductor (para. 0).
- Protective ground cable and connections (para. 0).
- Ground connection (para. 0).
- Protection of cables entry to buildings (para. 0).

Lightning Rod

The customer shall provide a lightning rod at the top of the pole or mast that will support the RPU/RPC and the antennas. The rod must be connected to an appropriate grounding (lightning discharge) conductor as specified below. Alternately, InnoWave offers a lightning rod that can be installed on H-supports.

Figure 2-16 shows a typical H-support with lightning rod offered by InnoWave.

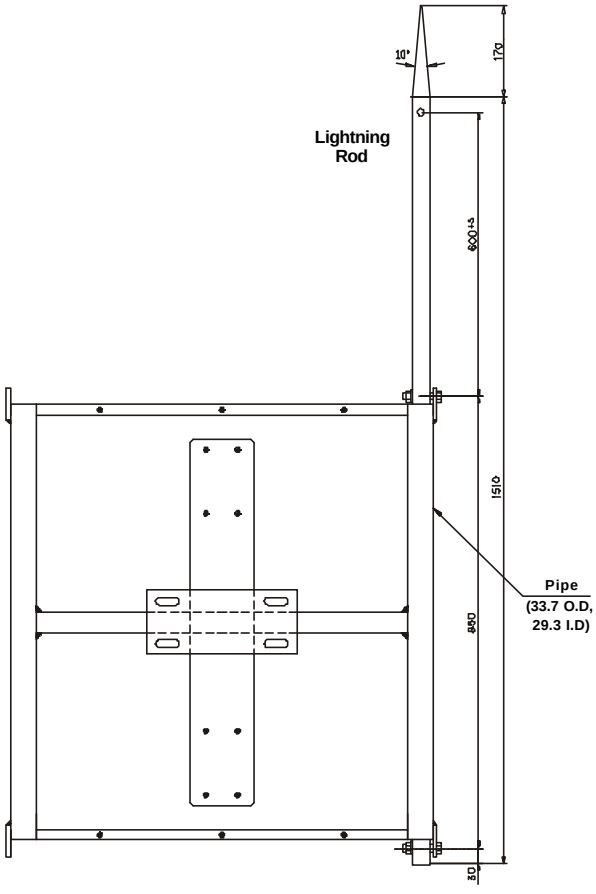


Figure 2-16. Typical H-Support with Lightning Rod

An effective lightning protection can be achieved by locating the equipment within the 30° cone formed by the rod top and the upper edge of the equipment, as shown in Figure 2-18.

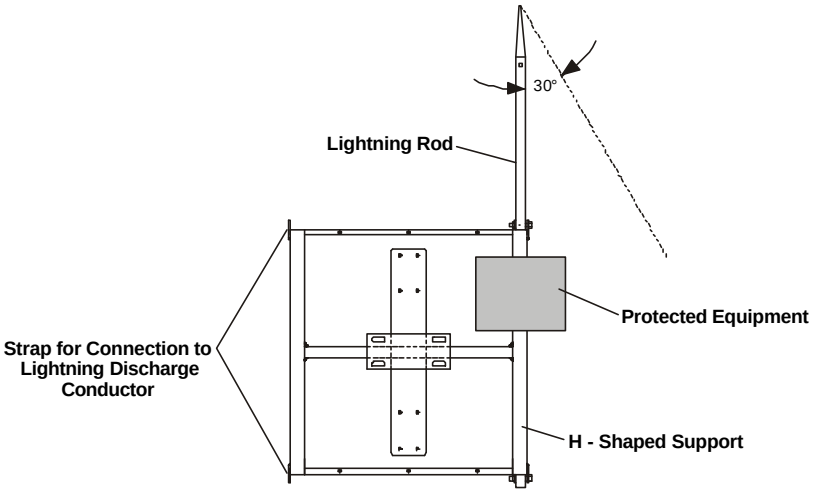


Figure 2-18. Lightning Protection Cone

The lightning rod must be mounted inside one of the H-support pipes, and the pipe itself must be connected to a lightning discharge conductor that is connected to the ground at the base of the pole.
The lightning rod must be tightly secured to the pipe of the H-support. The resulting contact resistance, measured between the rod and the H-support pipe, must be less than 2.5 milliohm. Grounding connection instructions for the H-support are given in para. 0.
In installations where the distance between the top of the lightning rod and the antenna exceeds 50 m, an additional lightning rod must be installed on an H-support, to protect the lower antennas.

Lightning Discharge Conductor

The lightning discharge grounding conductor must be able to handle short pulses of up to 100 kA. Therefore, copper or brass straps, or thick cables, with a cross area of 50 mm^2 built of strands having a minimum thickness of 3 mm shall be used. Rectangular cross section is preferred.
In order to withstand climate conditions, the bars shall be 90 µm zinc plated. The bars can be also made of stainless steel having a minimum cross section of 70 mm^2 with a galvanized outer surface.
When a wooden pole is used, two or more grounding conductors must be provided. The conductors must be bonded together every 5 meters. Special care must be paid to the grounding connection (para. 0).
Suggested grounding conductor products are CRC8000 or CRRC2716 manufactured by HELITA (France), or RD800-0088 manufactured by DEHN (Germany).
To prevent corrosion, it is recommended to use the same material for the conductor and the material to which it will be connected.
Always route the grounding conductor to the base of the pole along the shortest path, without loops or bends. When this is not feasible, the bending angle must be less than 90°, and the bending radius must exceed 200 mm.
To prevent breakdown between the lightning discharge conductor and a metallic pole or mast, the grounding conductor must be bonded to the metallic pole or the mast every 5 meters. The resistance of the connection must be less than 1 milliohm.

Grounding of H-Support

A grounding strap must be tightly connected between the H-support and the lightning discharge conductor. The contact area at both ends must be cleaned of paint and coated with conductive paint after assembly. The contact resistance between the grounding strap and the H-support, and between the grounding strap and the lightning discharge conductor, must be less than 2.5 milliohm.

The H-support must be tightly attached to the metallic mast structure, to achieve a contact resistance less than 5 milliohm (as measured between the H-support and the metallic mast structure).

Protective Ground Connections

In addition to the lightning discharge system, it is necessary to use a protective grounding system, which is used to connect equipment with insulating cases (e.g., RPU's, RPC's, and sectorized antennas) to protective ground.

The protective grounding system uses a separate grounding conductor, that contacts the lightning discharge conductor only at the common grounding point, e.g., at the mast or tower base.

RPU/RPC Grounding

The RPU and the RPC are supplied with a dedicated grounding plate, that is used to connect the N-type connector shells to the protective ground cable of the antenna tower or mast.
Figure 2-20 shows the method used to connect the RPU/RPC to the protective ground conductor and to the antenna grounding wires.

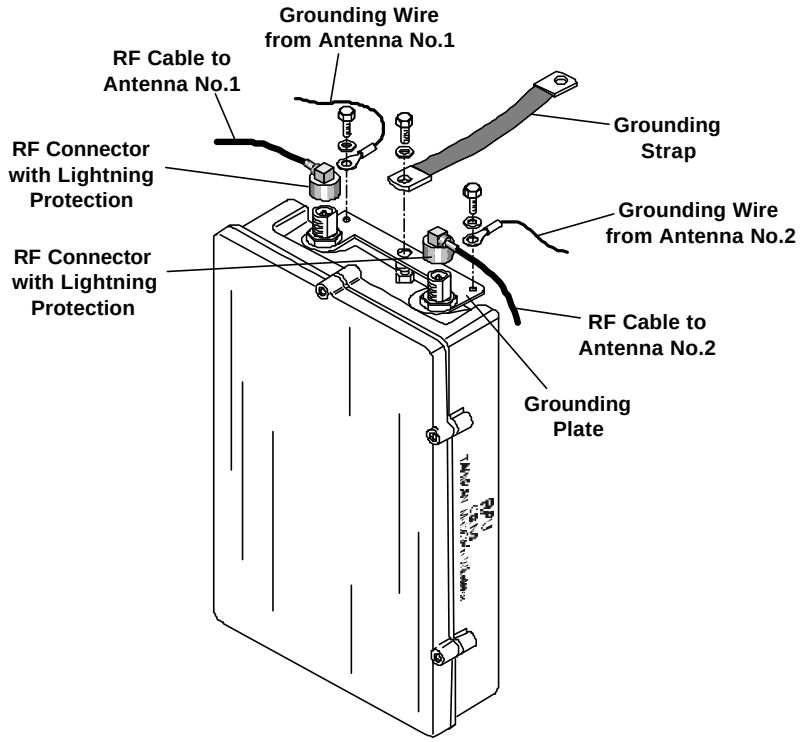


Figure 2-20. Ground Connection to RPU/RPC

Sectorized Antenna Grounding

The RPU antennas for the 0.8, 1.5 and 1.9 GHz bands must be connected to the RPU grounding plate using a special grounding plate, assembled under the nut of the N-type connector as shown in Figure 2-22. The external reflector is connected to ground via the tilting assembly, the H-support, and the lightning discharge cable.
The RPU antennas and the RPC's for the 2.4 and 3.5 GHz bands have no external reflectors. These antennas must be connected to the ground using a special grounding plate, assembled under the nut of the N-type connector as shown in Figure 2-24. The plate has an 8.3 mm diameter hole for the connection of a grounding wire. One end of the grounding wire is connected to the hole on the antenna ground plate, and the other end must be connected to the grounding plate.
The recommended grounding cable is 15×2 mm tin-plated braid, capable of handling a minimum current of 120 A. Each wire shall be made of 0.15 mm electrolytic copper.

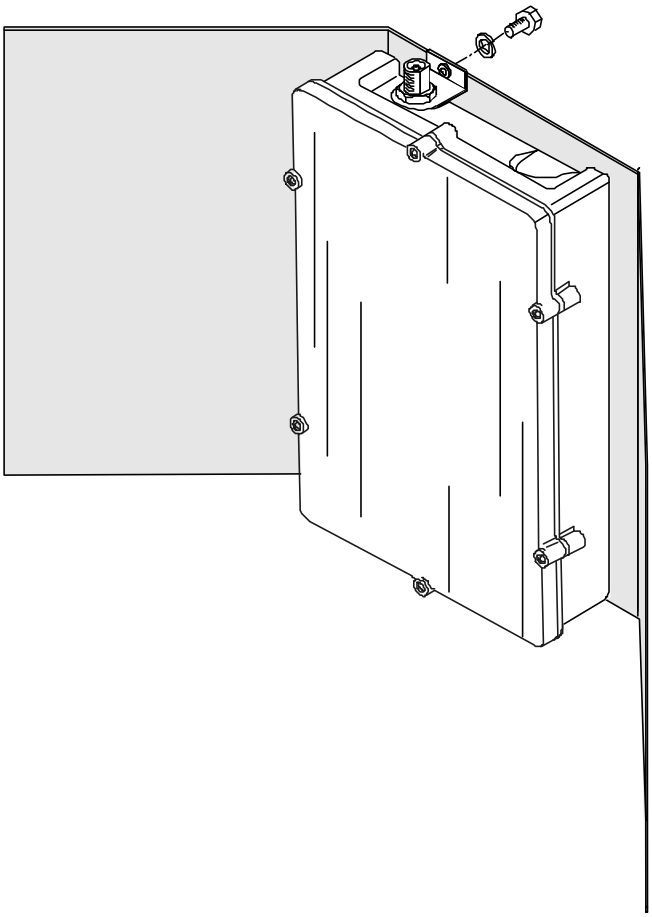


Figure 2-22. Ground Connection to Sectorized Antennas for 0.8, 1.5 and 1.9 GHz Bands

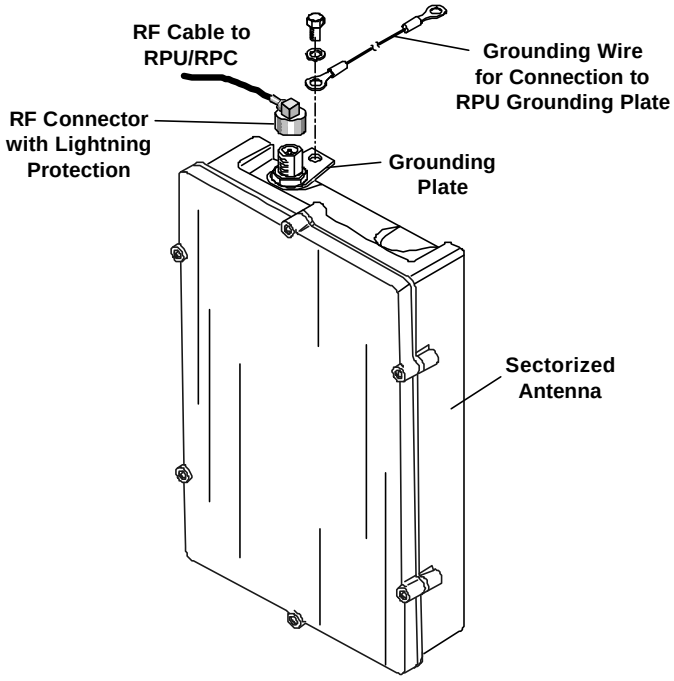


Figure 2-24. Ground Connection to Sectorized Antennas for 2.4 and 3.5 GHz Bands

Grounding Connection

The customer must prepare a grounded pole or tower in compliance with the applicable standards and regulations (para. 0).

Grounding anchors made of stainless steel with a minimum cross section of 300 mm^2 must be used.

Recommended ground anchors: PHH3020 made by HELITA, or 635-200 made by DEHN.

The parallel connection between the grounding anchors shall be made by conductors similar to those

used for grounding conductors.

Protection of Cable Entry to Buildings

General

This paragraph provides technical information regarding lightning protection on the MGW radio port equipment.

Lightning Protection Scheme

General

The lightning protection scheme includes several stages of protection, distributed along the signal paths within the radio port system.

Primary Protection

The radio port system requires a primary protection system at the entrance of the DSL cables to the exchange building and to the radio port sites, in accordance with the applicable international and national standards and regulations. The standard practice is to use gas discharge tubes, or similar components, e.g., carbon blocks. These components must be provided and installed by the customer.

Typically, this protection, that is installed as a feed-through, has a trip delay on the order of one microsecond, and clamps high voltage pulses to a maximum voltage of 2 to 3 kV.

The body of the protection components, e.g., IS-DPTL for one RPU/RPC, or IS-GPTL for three RPU's/RPC's (made by POLYPHSER) shall be mounted on a metal panel attached to the outside wall of the building, before the connection to the MDF. The metal panel shall be properly grounded. Inside the building, the DSL cables shall be routed to the MDF through plastic pipes.

To reduce interference, the DSL cable must be shielded, at least along the segment from the RPU/RPC to the pole base. Since the shield cross-section shall be at least 6 mm^2, the easiest way is to route the DSL cable inside a metal pipe or a special U profile parallel to the pole, and as close as possible to it. The pipe or U profile shall be bonded to the pole every 5 meters, and shall be connected to ground at both sides.

Secondary Protection

The first stage of secondary protection provided in radio port equipment is located inside the RPU/RPC and can handle pulses up to 4 kV.

NOTES