



**Alvarion®**

**Lightning Protection**

*White Paper*

**October 2005  
DN0855**

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# Contents

<b>Scope .....</b>	<b>1</b>
<b>Introduction.....</b>	<b>1</b>
<b>What is Lightning? .....</b>	<b>1</b>
<b>Lightning Protection Systems (LPS) .....</b>	<b>1</b>
<b>Lightning Protection Principles.....</b>	<b>2</b>
<b>LPS Components .....</b>	<b>4</b>
Air Terminal.....	4
Down Conductor.....	6
Outdoor Units' Grounding.....	7
Earth Termination System .....	7
Lightning Protectors (Surge Arrestors).....	8
<b>Installation Practices for an IF Type System.....</b>	<b>10</b>
<b>Lightning Protectors for an IF-Type System .....</b>	<b>14</b>
<b>Subscriber Unit Grounding and Lightning Protection.....</b>	<b>17</b>
<b>Subscriber Unit (CPE) IF Protection Practices.....</b>	<b>17</b>
<b>Indoor Unit Protection Practices.....</b>	<b>18</b>
<b>Baseband Protection Practices .....</b>	<b>19</b>
<b>References and Notes .....</b>	<b>21</b>
<b>References.....</b>	<b>21</b>

**Notes..... 21**

**Appendix A - Specifications.....22**

**Appendix B - Grounding Alvarion Units .....24**

**Grounding Outdoor Units..... 24**

**Grounding Indoor Units ..... 26**

# Figures

Figure 1: Air Terminal and Position Relative to Topmost Elements.....	5
Figure 2: Down Conductor and Earth Termination .....	6
Figure 3: Radio Equipment Mounted on a Tower .....	10
Figure 4: Mounting Blocks and Metal Grounding Plate .....	11
Figure 5: Metal Grounding Plate and Cable Entry to Facility Building.....	12
Figure 6: Radio Equipment Installed on a Pole .....	13
Figure 7: Radio Equipment and Lightning Protectors (Surge Arrestors).....	15
Figure 8: Lightning Protectors (Surge Arrestors) at Building Entrance .....	16
Figure 9: Integrated Radio and Antenna Unit Installed at CPE.....	18
Figure 10: Indoor Unit Protection .....	19
Figure 11: Baseband Protection.....	20
Figure B-1: Alvarion BreezeACCESS ODU Grounding Point.....	24
Figure B-2: Alvarion WALKair ODU Grounding Point.....	25
Figure B-3: Alvarion BreezeMAX (SU and AU) ODU Grounding Points .....	26
Figure B-4: IF MUX Rear Panel –WALKair System .....	27
Figure B-5: BS Rear Panel – WALKair System.....	27
Figure B-6: BS-SH Rear Panel – BreezeACCESS System.....	27
Figure B-7: BreezeMAX CAGE .....	28

## Scope

This guide provides information for the installation of an effective grounding and suppression system, for the protection of Alvarion products against lightning.

## Introduction

### What is Lightning?

Lightning is the visible discharge of static electricity within a cloud, between clouds, or between the earth and a cloud. Scientists still do not fully understand what causes lightning, but most experts believe that different kinds of ice interact in a cloud. Updrafts in the clouds separate charges, so that positive charges flow towards the top of the cloud and the negative charges flow to the bottom of the cloud. When the negative charge moves downwards, a "stepped leader" is created. The leader rushes towards the earth in 150-foot discrete steps, producing an ionized path in the air. The major part of the lightning discharge current is carried in the return stroke, which flows along the ionized path.

#### NOTE



A stepped leader of a lightning strike is the initial leader of a lightning discharge; an intermittently advancing column of high ionization and charge which establishes the channel for a first return stroke. The peculiar characteristic of this type of leader is its step-wise growth at intervals of approximately fifty to one hundred microseconds. The velocity of growth during the brief intervals of advance, each only about one microsecond in duration, is quite high (approximately  $5 \times 10^7$  m/s), but the long stationary phases reduce its effective speed to approximately  $5 \times 10^5$  m/s.

## Lightning Protection Systems (LPS)

A Lightning Protection System (LPS) provides a means by which a lightning discharge may enter or leave earth without passing through and damaging personnel, electrical equipment, and non-conducting structures such as buildings. A Lightning Protection System does not prevent lightning from striking; it provides a means for controlling it and prevents damage by providing a low resistance path for the discharge of the lightning energy.

Three types of Lightning Protection architecture are considered in this White Paper, as follows:

- IF type system, where the Indoor/Outdoor units are connected via coaxial cables, that carry the IF signals and DC supply voltages

- Subscriber Indoor Units connected to outdoor antennas
- Baseband type system, where Indoor/Outdoor connections are via shielded CAT5 cables that carry the baseband signals and a DC supply voltage.

The Lightning Protection System comprises grounding methods and Transient suppression techniques (TVS).

**A grounding system** constitutes a part of the safety network adapted to the electricity laws of the country, the terrain conditions, and the accepted and relevant standards for the country.

#### IMPORTANT



In the case of a contradiction between this White Paper and the standards requirements of the country in which the equipment is installed, the more stringent of the standards will always apply.

In the case of a contradiction between this White Paper and specific installation instructions given elsewhere by Alvarion, the former are in effect.

This White Paper is not primarily concerned with grounding against lightning or the grounding of buildings. It is concerned with the grounding of the equipment being installed. The Function of a Grounding System is to minimize lightning damage.

#### IMPORTANT



Alvarion does not provide any warranties as to the effectiveness of the suggested measures. The implementation of the suggested measures is at customer's own discretion. Under no circumstances will Alvarion be liable for any consequences resulting from the implementation or lack of implementation of the suggested measures.

The Grounding system must be maintained and checked periodically in accordance with local regulations.

## Lightning Protection Principles

Lightning protection for Alvarion Outdoor Units (ODU) installed outdoors on towers or poles, is provided by insuring minimum pickup of lightning induced transients, and by the suppression of transient voltages at the input and output terminals of both the Indoor and Outdoor units.

Minimizing the pickup of induced voltages is achieved by the isolation of the Outdoor Units and cables from the lightning down current, and by the use of shielded cables with peripheral shield grounding.

The outdoor Radio Units and Antennas are connected mechanically to the tower or pole, which is in turn grounded by the requirements of most safety standards, therefore the Outdoor Units are grounded too.

**NOTE**

Please refer to the installation instructions for each product.

Theoretically it is desirable to isolate the outdoor units from the tower that may carry the lightning down current, however in real life when the outdoor units are installed on conducting towers this is impractical, as any isolation will be rendered useless in rain time. Therefore the Outdoor Units, and the associated shield/signal grounds of the IF/RF cables, should be grounded to the tower or pole which in turn grounded by the requirements of most safety standards.

In order to limit the amount of lightning current flowing on the shields of the IF cables, only one grounding point for the shields to the tower or pole is allowed. This is the point where the Outdoor Units are grounded to the mast. In this way, the current from the lightning to the earth will prefer the down conductor from the lightning rod or the structure of the tower or pole, rather than the path along the shield, thus protecting the Alvarion equipment.

In this way, the current from the lightning to the earth will prefer the down conductor from the lightning rod or the structure of the tower or pole, rather than the path along the shield, thus protecting the Alvarion equipment.

In addition, the IF Cable shields must be grounded (at the other end) to the entry panel at the facility building.

To further protect the IF cables from lightning-induced voltages, the cables must be installed inside the tower or pole whenever possible, and must be isolated from the tower or pole structure and the down conductor. This insures some degree of shielding of the IF cables from the effects of electromagnetic fields associated with lightning strikes, and provides protection against direct strikes to the cables.



## LPS Components

The components of a typical Lightning Protection System (LPS) are as follows:

- Air Terminal
- Down Conductor
- Outdoor Units Grounding
- Earth Termination System
- Lightning Protectors

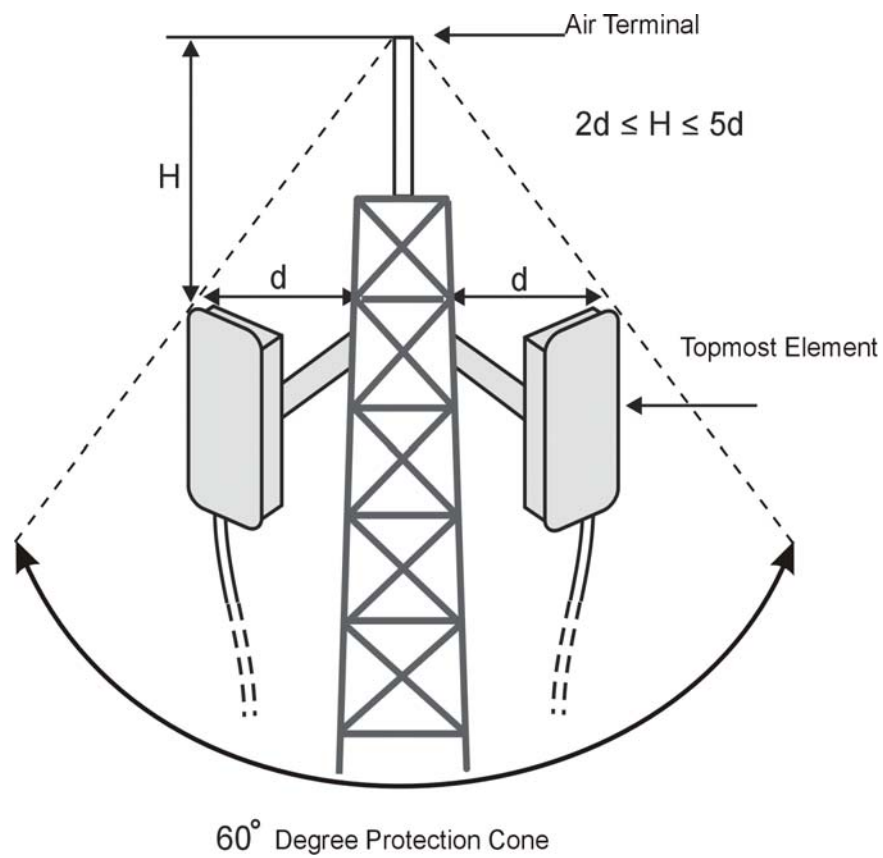
### Air Terminal

The **Air Terminal** is the part of the LPS that is intended to intercept lightning flashes.

The Air Terminal intercepts the downward-moving stepped leader of the lightning strike, by launching an upward-going attachment spark. Once the attachment is achieved, the bulk of the lightning current follows the ionized path. In this way, an Air Terminal diverts the lightning away from personnel and electronic equipment.

If an Air Terminal is not installed at the highest point of the tower or pole, the radio element connected to the highest point, usually the antenna, is the most likely attachment point.

The Air Terminal must be constructed of steel with a pointed tip. Referring to Figure 1 below, the height ("H") of the Air Terminal tip above the highest Alvarion element on the tower or pole, typically the antenna, must be at least twice the distance ("2 x d") between the outer surface of the antenna and the tower or pole. This will ensure a "protection cone" of 60° around the tower or pole. In areas of high lightning activity, the length ("H") should be increased to up to 5 times the distance.

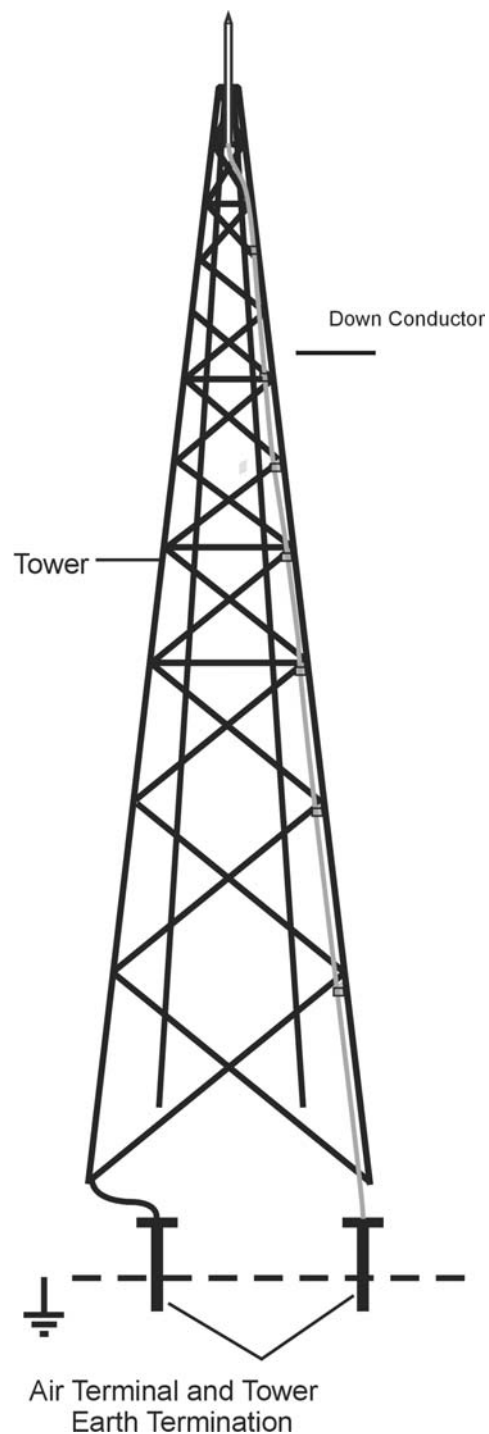


**Figure 1: Air Terminal and Position Relative to Topmost Elements**

The Air Terminal must be welded to the mast structure and connected to a Down Conductor.

## Down Conductor

The **Down-Conductor** is that part of the external Lightning Protection System (LPS) that conducts lightning current from the Air Terminal system to the Earth Termination system (see Figure 2).



**Figure 2: Down Conductor and Earth Termination**

The Down Conductor must be installed straight and vertically in order to provide the shortest and most direct path to earth. The formation of bends must be avoided.

The following table defines the minimum dimensions for down conductors according to IEC 1024-1:

Material	Down Conductor (mm <sup>2</sup> )
Cu	16
Al	25
Fe	30

We recommend that the Down-Conductor be at least 50 mm<sup>2</sup> or AWG 0 in all cases.

The grounding of the Down Conductor to earth must be of ground resistance no higher than 5  $\Omega$ . This is achieved by using **Earth Terminations** and wherever possible, grounding to the steel reinforcement bars of the concrete base of the tower.

## Outdoor Units' Grounding

The Alvarion **Outdoor Unit**, consisting of a Radio Frequency Unit and Antenna, includes a grounding point for connection to the grounding system. See *Appendix B – Grounding Alvarion Units*.

### NOTE



For standard communication sites where the mast (tower) is grounded, a standard Air Termination lightning rod is installed, coaxial (IF/RF) cables are grounded at the facility entrance, and the resistance between the Air Terminal and the Earth Termination is less than 5 Ohms: there is no need to ground the outdoor units (although such grounding will increase the level of protection).

## Earth Termination System

The **Earth Termination System** is that part of external LPS that is intended to conduct and disperse lightning current to earth.

See Figure 2.

## Lightning Protectors (Surge Arrestors)

**Lightning Protectors** provide an additional protection to the Alvarion equipment embedded protectors, in places where lightning occurs with a high probability.

Electrical surges are composed of two elements: voltage and quantity of charge. A very high voltage surge can damage electronic equipment by breaking down the insulating medium between the circuit elements, or between the circuit elements and ground. The current from the charge and/or the current from the power source, determine the amount of damage. In order to protect an electronic circuit from damage, a Lightning Protector (or Surge Arrestor) must conduct sufficient charge from the surge in order to lower the surge voltage to a safe level. It must also conduct fast enough in order to prevent the circuit insulation from breaking down.

Electrical circuits can withstand a high voltage for a short time period: The shorter the time period, the higher the voltage that can be withstood without causing damage. If, for example, a 50,000-volt surge is applied to a 220-volt piece of electrical equipment that has a surge arrestor is connected in parallel, the Surge Arrestor will bleed charge out of the circuit, reducing the surge voltage. When the charge decreases to zero, the surge voltage also decreases to zero. If the process occurs quickly enough, the equipment is protected.

The speed at which a Surge Arrestor can remove a surge from an electrical circuit depends on the following factors: the magnitude of the voltage, the quantity of the charge, the response speed, and the conductivity of the Surge Arrestor. A Surge Arrestor with high conductivity handles a surge faster than one with low conductivity. If two Surge Arrestors have exactly the same conductivity, the Surge Arrestor with the highest response speed eliminates the surge from a circuit more quickly.

The **Clamping Voltage** for a Surge Arrestor varies according to the amount of current conducted, the internal resistance of the Surge Arrestor, the response speed of the Surge Arrestor, and the point in time at which the Clamping Voltage is measured.

Whenever a Clamping Voltage is specified, the current being clamped must also be specified, for example, 500 volts at 1000 amps. For a negligible current, such as one milliamp, any Clamping Voltage can be achieved. However, there is no protection afforded.

As an example, consider a surge, rising from 0 to 50,000 volts in five nanoseconds, connected to a Surge Arrestor, which starts to conduct at five nanoseconds (the response time), and clamps the surge to 500 volts in 100 nanoseconds. At any given point in time during the 105 nanoseconds, the Clamping (discharge) Voltage is unique. Even though the Clamping Voltage may be 500 volts, after 25 nanoseconds the Clamping Voltage would be above 25,000 volts.

Surge Arrestors with a high conductivity (low internal resistance) can conduct surges from a circuit more rapidly. The same applies to Surge Arrestors having a high **Current Rating**. The quicker a surge is removed, the more likely it is that the equipment will be protected. To summarize, any reference to Clamping Voltage must always include the amount of current being clamped, and the clamping time.

Alvarion products contain embedded Lightning Protectors at their IF input ports. If additional protection is required, for example, in high lightning activity (**Keraunic**) areas, external Lightning Protectors can be installed at strategic points at the site.

**NOTE**

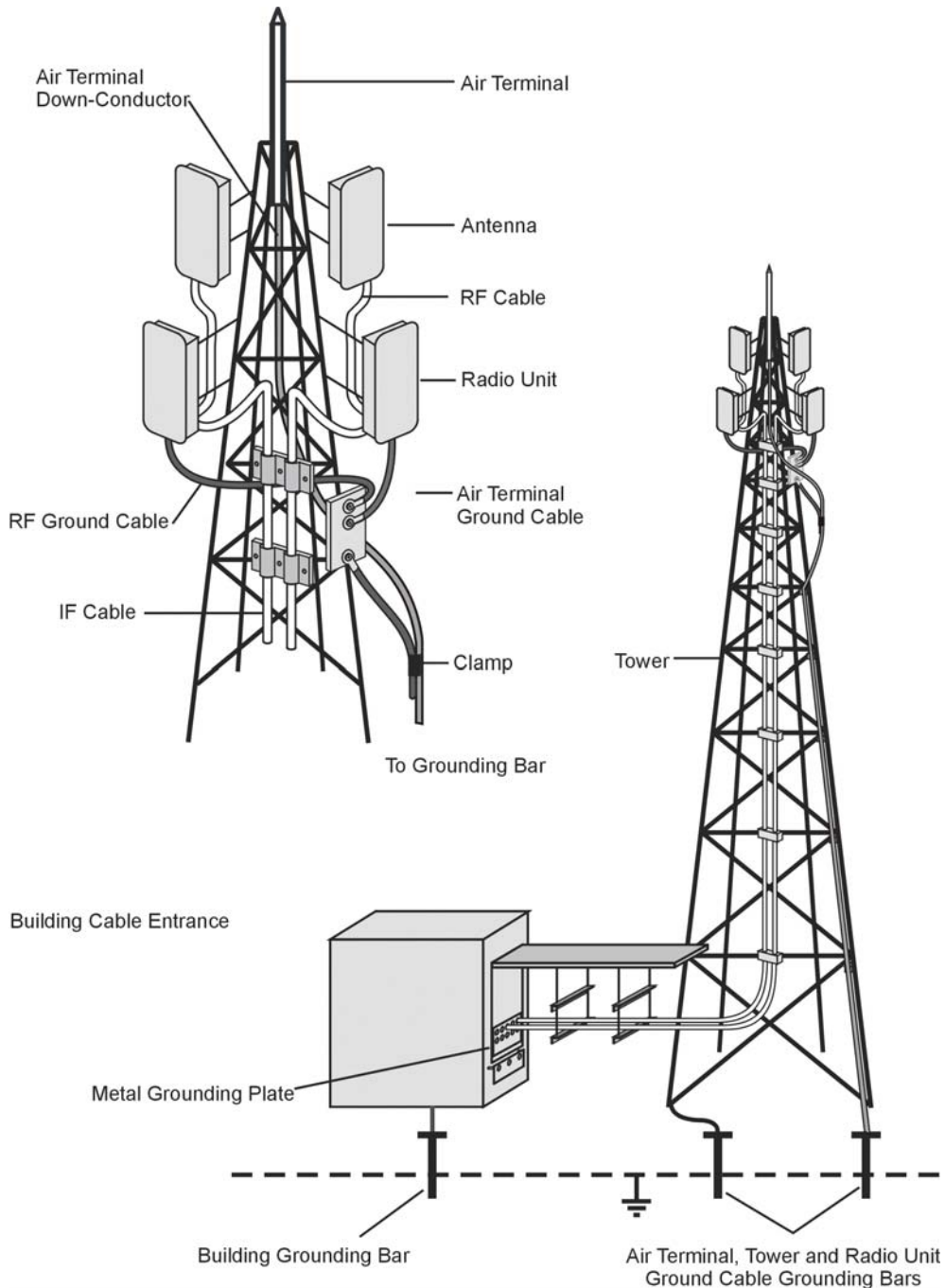
Keraunic maps are available from the following link to “Worldwide map of Keraunic levels”. (<http://perso.wanadoo.fr/parafoudres.eurema/Surges/WWMKL.htm>)

A Lightning Protector will “clip” any excessive surge voltage that may be present on the center conductor.

For Alvarion IF solutions, only “**Gas Gap**” Lightning Protectors types, designed to cover the IF frequency range, **must** be used. Only “Gas Gap” Lightning Protectors are capable of passing the DC current required to power the Outdoor Unit.

# Installation Practices for an IF Type System

This section relates to Base Station outdoor installation practices. Figure 3 shows radio equipment installed on a tower.



**Figure 3: Radio Equipment Mounted on a Tower**

Referring to Figure 3, an **Air Terminal (Lightning Rod)** is attached to the top of the tower.

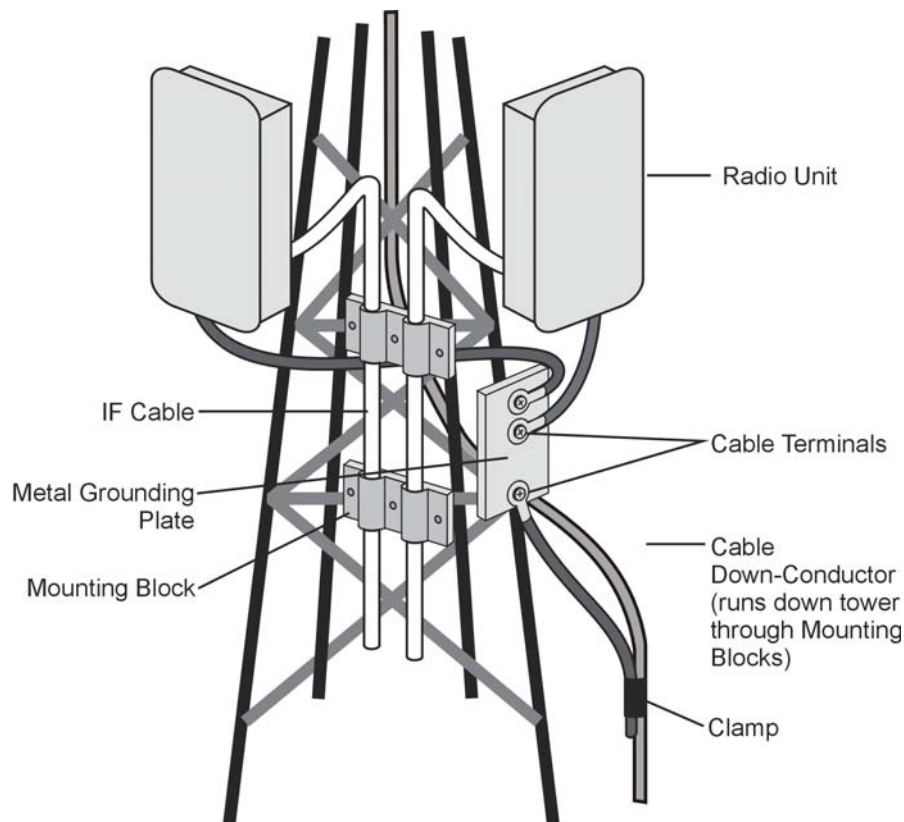
The Air Terminal connects to a **Down-Conductor** that runs to an **Earth Termination** at the foot of the tower.



#### IMPORTANT

The ground system must be maintained and checked periodically in accordance with local regulations.

The Antenna and Radio Units (two sectors are shown in Figure 3 on page 10) are attached to the tower with mounting brackets. The Radio Units are connected to the Antennas via RF Cables. The IF Cables from the Radio Units (to the Indoor Units), run down the tower through Mounting Blocks, as shown in Figure 4.

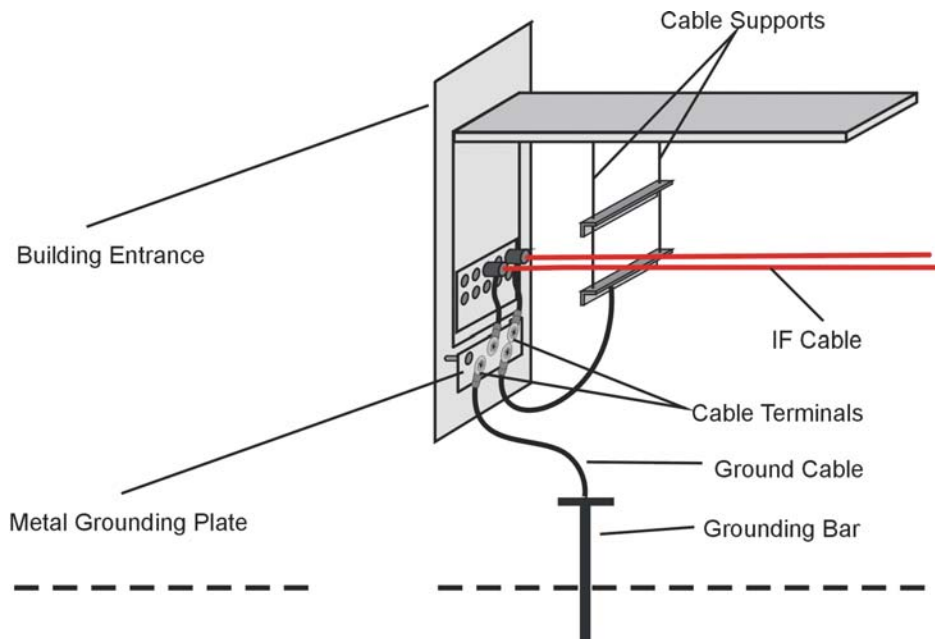


**Figure 4: Mounting Blocks and Metal Grounding Plate**

Referring to Figure 3 on page 10, and Figure 4 on page 11, the Radio Units' (ODU) ground cables are connected to a **Metal Grounding Plate** using **Cable Terminals**. The Metal Grounding Plate is connected (welded) to the tower. The Air Terminal Down Conductor is clamped to the cable that runs down from the Metal Grounding Plate.

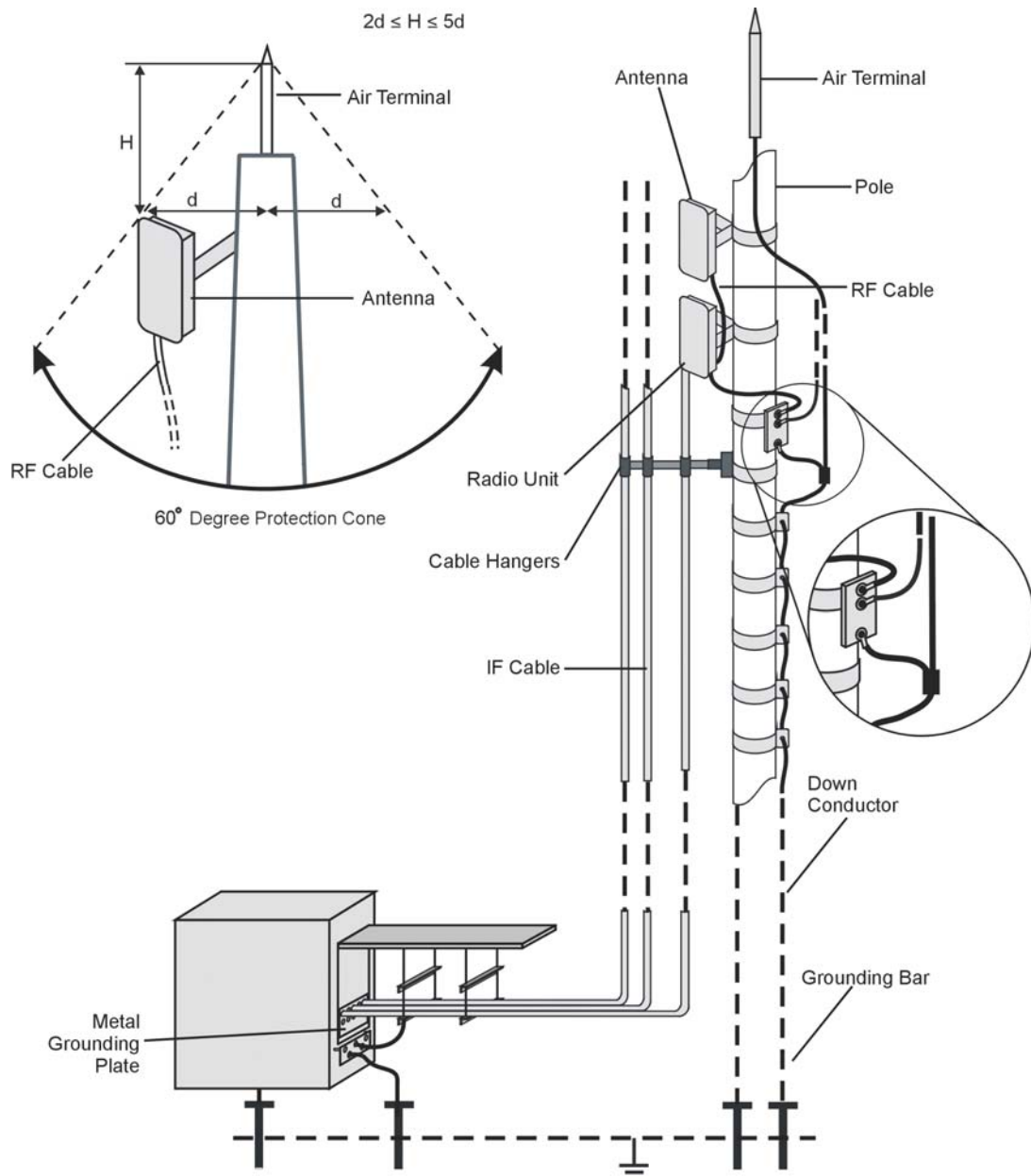


At the entry point to the facility building, the IF Cable shields are physically attached to another **Metal Grounding Plate** (with feed through panel mount coaxial connectors for each cable- see Figure 5 below). The building's **Metal Grounding Plate** is grounded separately from the tower. This ensures that the lightning current from the tower is diverted from the building.



**Figure 5: Metal Grounding Plate and Cable Entry to Facility Building**

Figure 6 shows a similar layout for radio equipment installed on a pole.



**Figure 6: Radio Equipment Installed on a Pole**

In Figure 6, an Air Terminal must provide a 60° protection cone, in the same manner as for the tower scenario described earlier.

The Antenna and Radio Unit (ODU) are attached to the tower with mounting brackets. The Radio Unit is connected to the Antenna via an RF Cable. The IF Cable from the Radio Unit (to an Indoor Unit) runs down the pole via **Cable Hangers**, and enters the building via a **Metal Grounding Plate** grounded at the building wall.

The IF Cable shields are physically attached to the building's **Metal Grounding Plate**, with feed through panel mount coaxial connectors for each cable. The building's **Metal Grounding Plate** is grounded separately from the pole. This ensures that the lightning current from the pole is diverted from the building. The Radio Unit's ground cable is attached to a **Metal Grounding Plate** (welded to the pole) using **Cable Terminals**.

The Radio Unit's ground cable, pole and the Air Terminal all run to **Earth Terminations**.

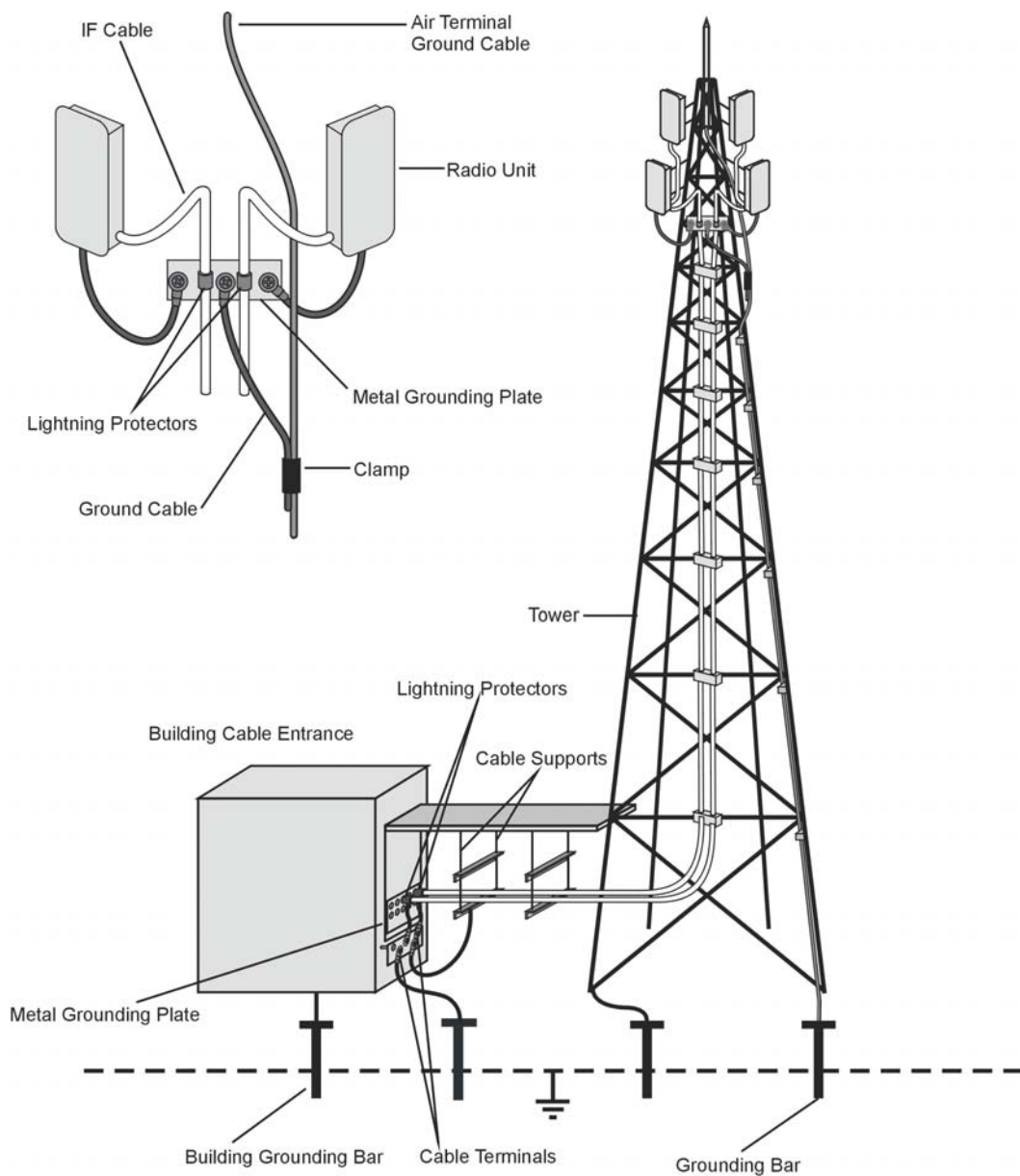
**NOTE**

For information on the attachment of a grounding cable to an Alvarion Outdoor Unit, see Appendix B.

## Lightning Protectors for an IF-Type System

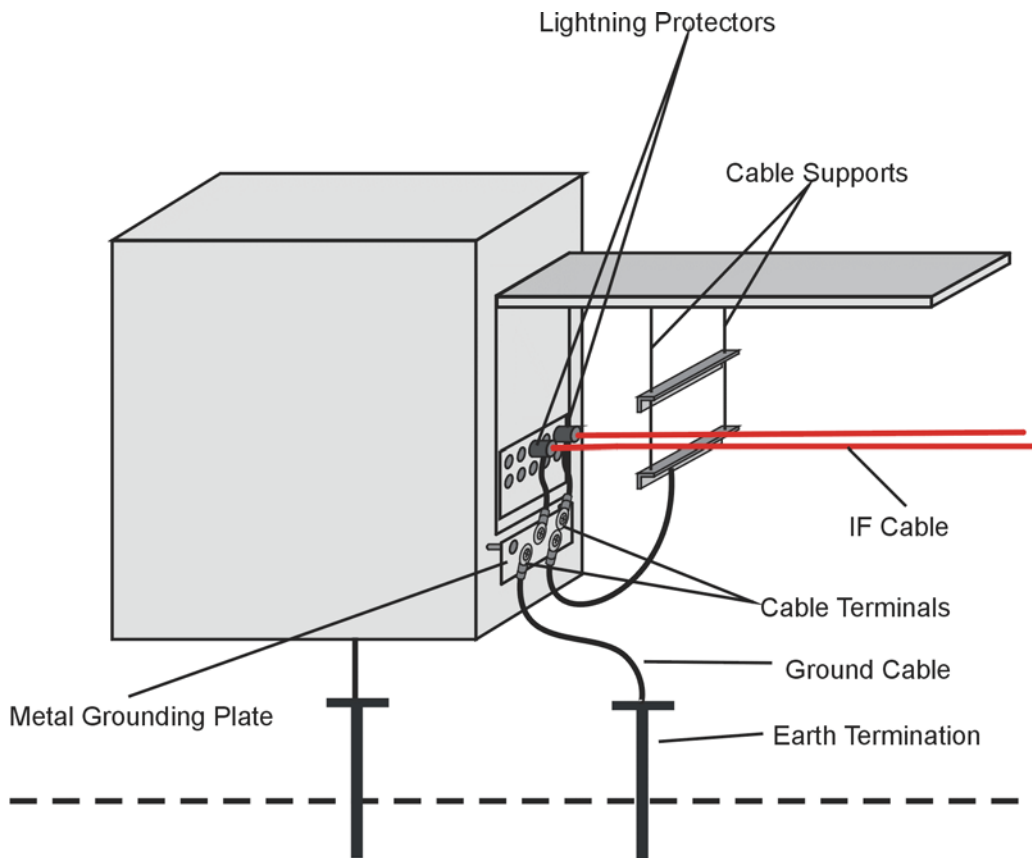
Figure 7 shows radio equipment installed on a tower, with external Lightning Protectors (Surge Arrestors) installed.

**Lightning Protectors** are installed on the IF Cables at close proximity to the Radio Units. The IF Cables run through the **Metal Grounding Plate** (isolated). The Lightning Protectors' ground leads are connected to the Metal Grounding Plate using Cable Terminals.



**Figure 7: Radio Equipment and Lightning Protectors (Surge Arrestors)**

At the facility building entrance, **Lightning Protectors** are installed on the IF Cables close to the **Metal Grounding Plate** apertures. The Lightning Protector ground lead is connected to an **Earth Termination** via another **Metal Grounding Plate** and cable terminals (see Figure 8).



**Figure 8: Lightning Protectors (Surge Arrestors) at Building Entrance**



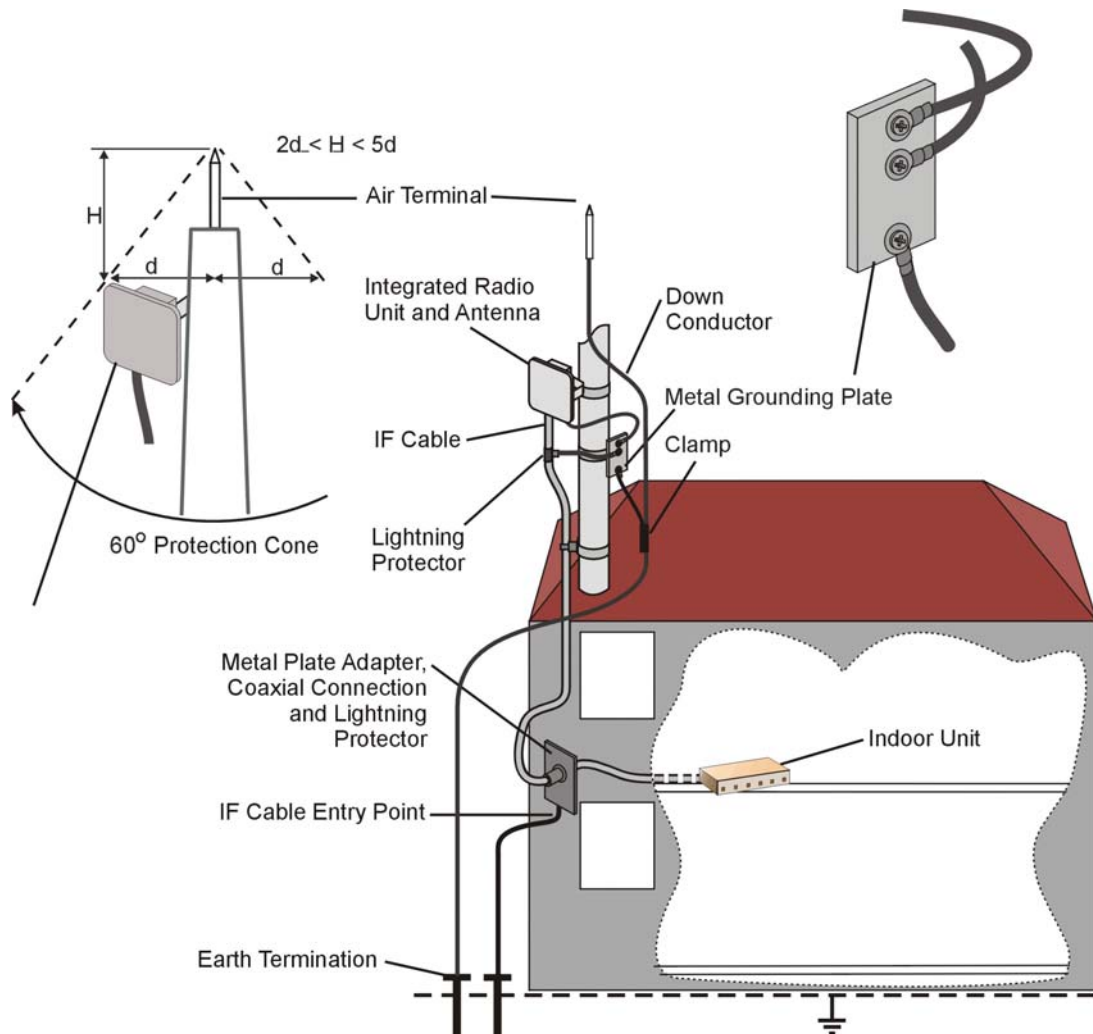
**NOTE**

For **IF Cables and Earth Termination** recommended Lightning Protection devices, see Lines 1 and 2 in Table A-2 on page 23.

# Subscriber Unit Grounding and Lightning Protection

The internal grounding system at a site is based on first grounding all the indoor units to the internal grounding system, and then to the site grounding system.

## Subscriber Unit (CPE) IF Protection Practices



**Figure 9: Integrated Radio and Antenna Unit Installed at CPE**

Figure 9 shows an integrated Radio and Antenna Subscriber Unit (ODU) installed on a pole at a Subscriber location. An **Air Terminal** is installed at the top of the pole. The Air Terminal must be placed such that a **60° protection cone** exists around the pole, and must run to an **Earth Termination** via a **Down-Conductor**.

The integrated Radio Unit and Antenna is attached to the pole with a mounting adapter. The **IF Cable** enters the building via a **Metal Plate Adapter** (bulkhead connector) with coaxial connectors, and terminates at an Alvarion **Indoor Unit**.

At the building's cable entry point, the **Metal Plate Adapter** secures the connection of the IF Cable shield to the building Earth Termination.

**Lightning Protectors** (Surge Arrestors) are attached to the IF Cable in the proximity of the integrated Radio Unit and Antenna (ODU), and also close to the building's cable entry point.

The Lightning Protector ground lead at the Radio Unit and Antenna end and the Radio Unit and Antenna ground cable, are both connected to a **Metal Grounding Plate** (using Cable terminals). The Metal Grounding Plate runs to an **Earth Termination** via a ground cable.

**NOTE**

For the recommended Lightning Protection device, see Line 1 in Table A-2 on page 23.

## Indoor Unit Protection Practices

Figure 10 shows an Antenna installed on a pole at a Subscriber location. An **Air Terminal** is installed at the top of the pole. The Air Terminal must be placed such that a **60° protection cone** exists around the pole, and must run to an **Earth Termination** via a **Down-Conductor**.

The RF Cable from the Antenna is connected to the indoor **Subscriber Unit** via a grounded **Metal Plate Adapter** (bulkhead connector) located at the entrance to the building. The Subscriber Unit is also connected to a PC via **CAT5 Ethernet** cable. The **Metal Plate Adapter** secures the connection of the RF Cable shield to the building Earth Termination.

The Antenna ground also runs to an **Earth Termination**.

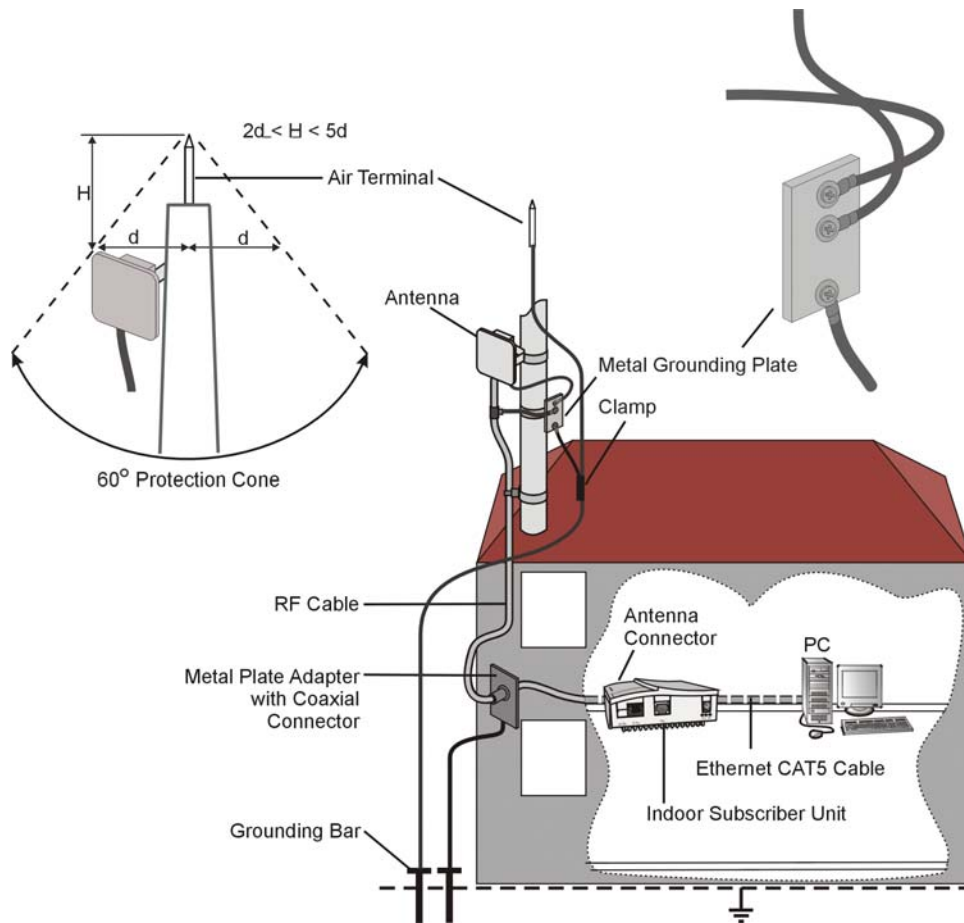


Figure 10: Indoor Unit Protection



#### NOTE

An optional Lightning Protector can be installed at the Antenna port of the indoor Subscriber Unit.

## Baseband Protection Practices

Figure 11 shows a Radio Unit and Antenna (ODU) installed on a pole at a Subscriber location. An **Air Terminal** is installed at the top of the pole. The Air Terminal must be placed such that a **60° protection cone** exists around the pole, and run to at an **Earth Termination** via a **Down Conductor**.

The **CAT5 Baseband shielded** outdoor cable consists of twisted pair wires for Ethernet data and another pair of wires for the DC supply. The Baseband Cable connects to the indoor unit via an grounded **External Lightning Protector Box** (recommended for high Keraunic areas). The External Lightning Box is connected to an **Earth Termination** via a **Down-Conductor**.



The Radio Unit's ground cable and an optional Lightning Protector ground lead are attached to a **Metal Grounding Plate** using Cable Terminals. The Metal Grounding Plate runs to an Earth Termination.



#### NOTE

For the recommended Lightning Protection device, see Line 4 in Table A-2 on page 23.

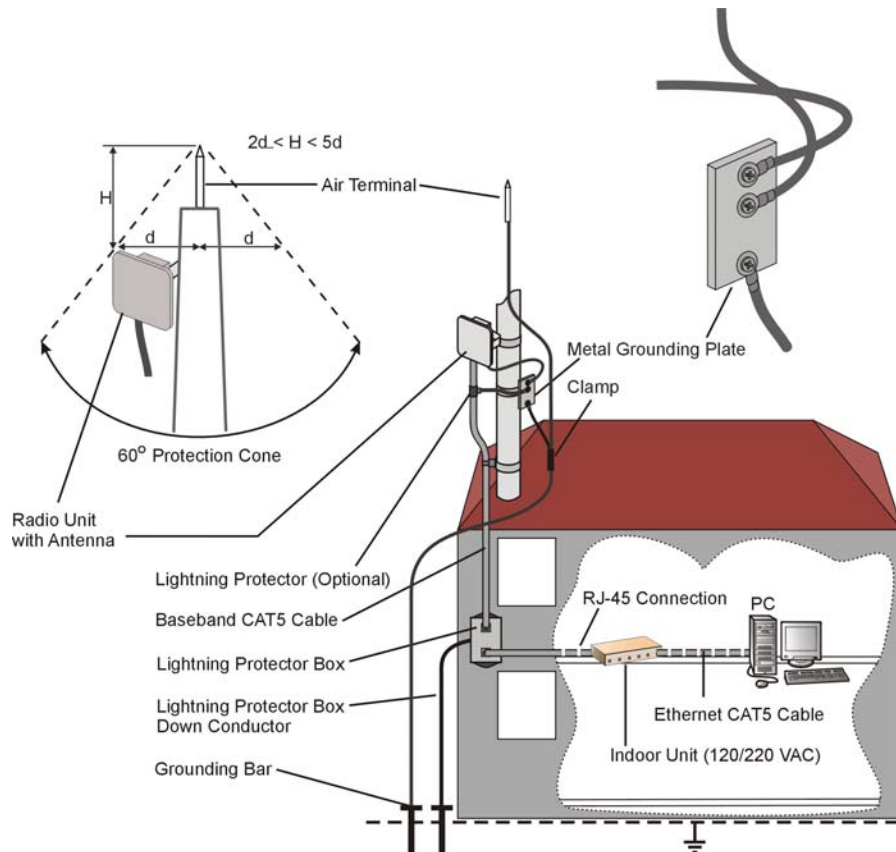


Figure 11: Baseband Protection

# References and Notes

## References

1. Z.A Hatono & I.Robin, "Location factor and its impact on antenna safety with reference to direct lightning strike", IEEE Tencon Proceedings, 2000.
2. <http://www.polyphaser.com/>
3. Protection of structures against lightning, International Electrotechnical Commission, IEC-1-1024.
4. Worldwide Map of Keraunic Levels at:
5. <http://perso.wanadoo.fr/parafoudres.eurema/Surges/WWMKL.htm>

## Notes

### IMPORTANT



Make sure that the Lightning Protector case is grounded to the Chassis of the Radio Unit box, without any paint on the mating surface of the box. On the facility entrance, the protector ground must be connected to the grounded entry plate. Use a ground strip for this purpose.

To ensure your Grounding system is properly installed and in working order, consult an Electrician to verify that the outdoor grounding point and the indoor AC outlet ground.

## Appendix A - Specifications

<b>Table A-1: IF DC Voltage Levels of Alvarion Systems</b>			
	<b>System name</b>	<b>IF Coax DC Supply</b>	<b>Comment</b>
1	BreezeACCESS GFSK	12 V	
2	BreezeACCESS OFDM	24 V	
3	WALKair 1000	48 V	
4	WALKair 3000	48 V	
5	BreezeNET DS.11	Refer to Table A-2	Transtector Model
6	SU-R, SU-I	N/A	For additional protection at Antenna port with rooftop mounted antenna use Alvarion: 872905. Refer to Table A-2
7	BreezeACCESS VL	Refer to Table A-2	Transtector Model
	BreezeMAX AU	48 V	
	BreezeMAX SU	Refer to Table A-2	Transtector Model

<b>Table A-2: Lightning Protectors and Part Numbers</b>		
	Lightning Protector Description	Part Number
1	LA-IF. IF Triple mode Lightening Arrestor with TNC connectors. For use on IF cable of AU-A/E and SU-A/E For 12 VDC, coax	Alvarion: 872945
2	IF Lightening Arrestor with female TNC connectors. For use on IF cable of AU for 48 VDC, coax.  For use on BreezeMAX 3000 Access Units only.  For device specifications and installation instructions, please contact sales at:  PolyPhaser Corporation Tel: (1) 775.782.2511 800.325.7170(US only)  <a href="http://www.polyphaser.com/">http://www.polyphaser.com/</a>	PolyPhaser Model: 105- 0526A-B
3	Earth Termination	Alvarion: 872935
4	Protector for Antenna Port <b>ONLY!</b> 2300-2600MHz signals	Alvarion: 872905
5	Baseband protection. For use on BreezeNET DS.11, BreezeACCESS VL and BreezeMAX SU  <b><u>Manufacturers:</u></b>  <ul style="list-style-type: none"> <li>■ PolyPhaser Corporation Tel: (1) 775.782.2511  <a href="http://www.polyphaser.com/">http://www.polyphaser.com/</a></li> </ul>	PolyPhaser Model:  IX-ALVR
	<ul style="list-style-type: none"> <li>■ Transtector Systems Inc Tel: (1) 208.772.8515 800.882.9110(US only)  <a href="http://www.transtector.com/peripherals/alvarion/index.html">http://www.transtector.com/peripherals/alvarion/index.html</a></li> </ul>	Transtector Model: ALPU- ALVR

## Appendix B - Grounding Alvarion Units

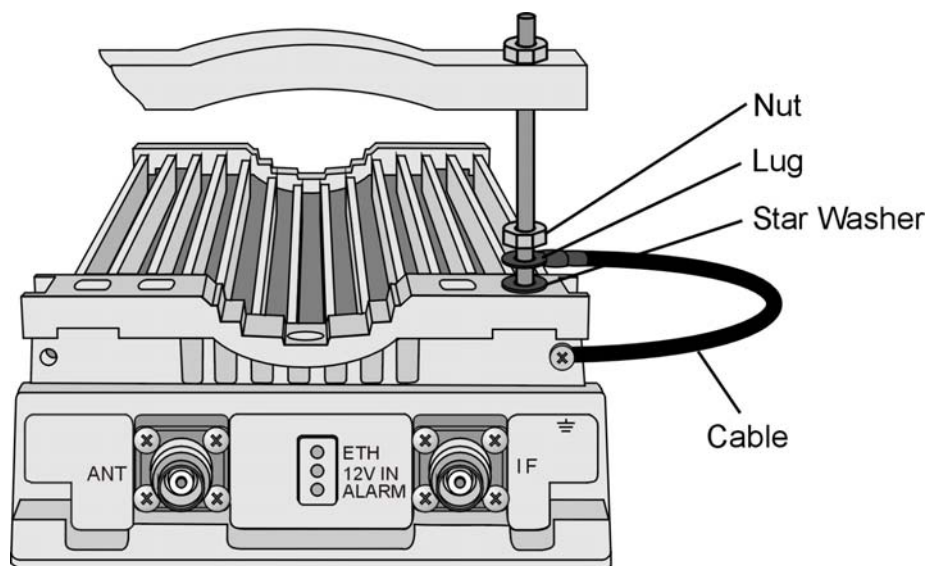
This Appendix includes:

- [Grounding Outdoor Units](#), on page 24
- [Grounding Indoor Units](#)T, on page 26

### Grounding Outdoor Units

When grounding Alvarion Outdoor Radio Units, use the GND (ground) screw on the unit as a grounding point.

A 16-mm<sup>2</sup> cable may not easily attach to the “ground screw”. Therefore, it is recommended to crimp a lug on to the end of cable, and attach the cable to the same threaded rods that are used as part of the bracket as shown in Figure B-1- Alvarion BreezeACCESS ODU with Grounding Point.



**Figure B-1: Alvarion BreezeACCESS ODU Grounding Point**

The shield (outside conductor) of the coaxial cable must be connected to the Outdoor Unit chassis ground via the coax connector at the top, and to ground on entering the building/shelter.

**NOTE**

It is important for the Alvarion IF product line that only the shield of the cable is bonded to the grounding points. Since there is a DC current flowing on the center conductor of cable, any connection to the center conductor would interfere with this DC current. This includes the insertion of any lightning protection devices.

Figure B-2 shows an Alvarion WALKair 1000 3.5 GHz ODU with Grounding Point.



**Figure B-2: Alvarion WALKair ODU Grounding Point**

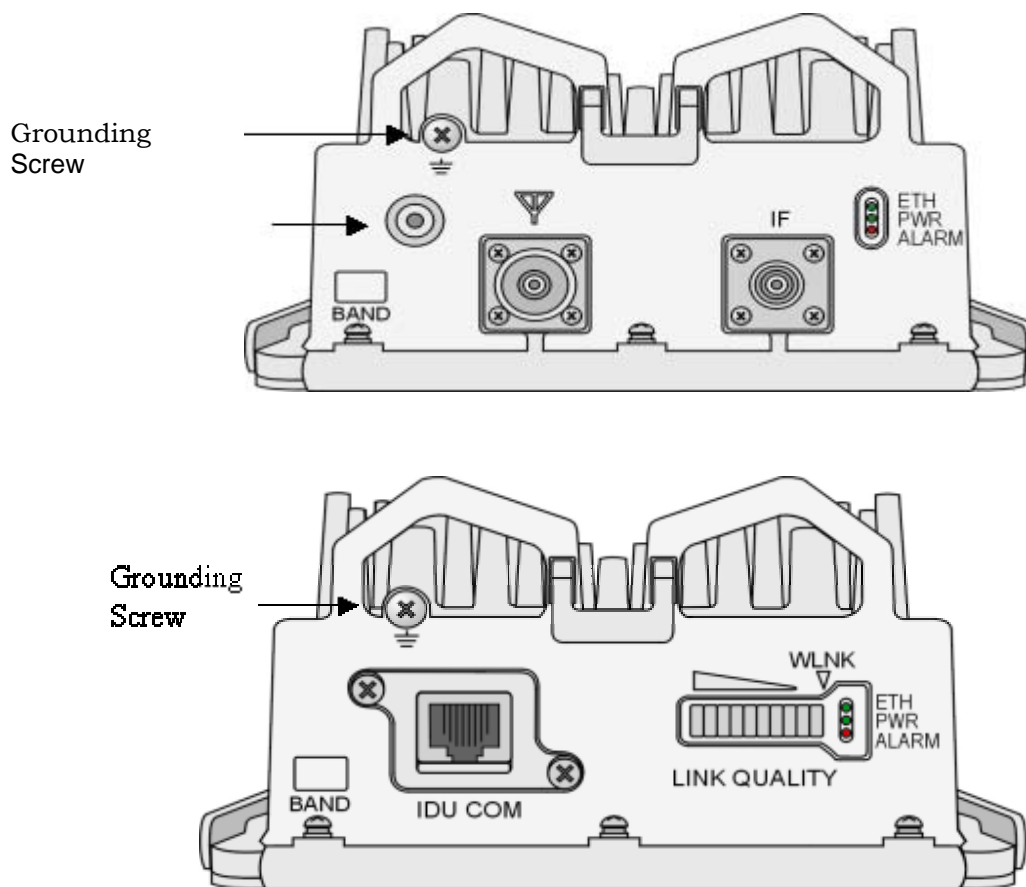


Figure B-3: Alvarion BreezeMAX (SU and AU) ODU Grounding Points

## Grounding Indoor Units

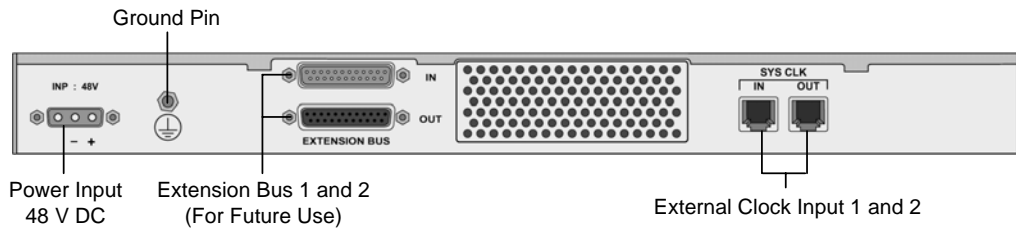
Figure B-4 and Figure B-5 show the rear panels of an IF MUX and a WALKair Base Station Basic Unit respectively, and Figure B-6 shows the rear panel of a BreezeACCESS BS-SH unit.

The Base Station Indoor Unit equipment should preferably be connected to the **Equipment Earth Grounding Bar (EGB)**, which is in turn connected to the site ground. In small sites where there is no EGB, BS-BU grounding can be made via a ground bolt, inserted at the back of the shelf-chassis.

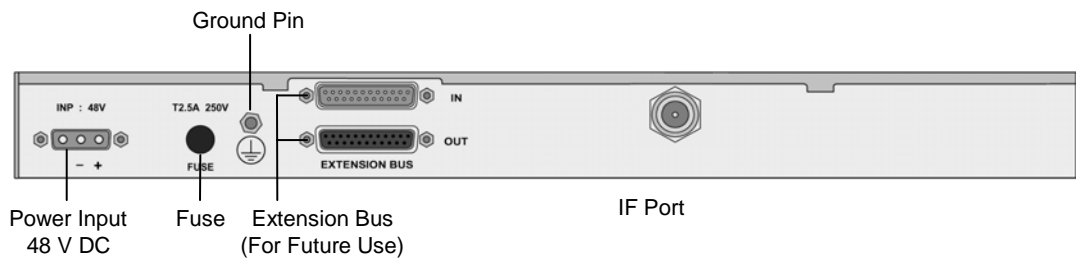
A grounding wire connects the shelf to the EGB. **Double connection must be avoided** in order to eliminate ground loops.

The gauge of the Ground wire must be no less than 18 AWG.

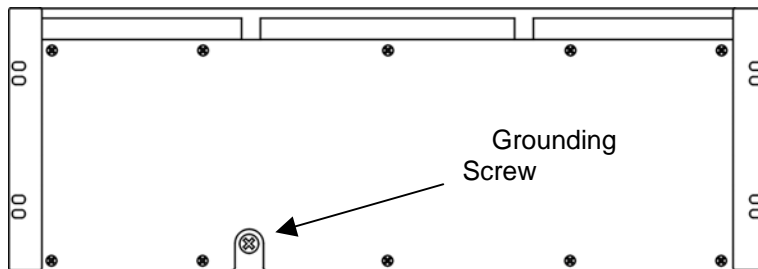
For the GND point connection, use a closed loop terminal crimped to GND wire.



**Figure B-4: IF MUX Rear Panel –WALKair System**



**Figure B-5: BS Rear Panel – WALKair System**



**Figure B-6: BS-SH Rear Panel – BreezeACCESS VL Base Station , IDU**



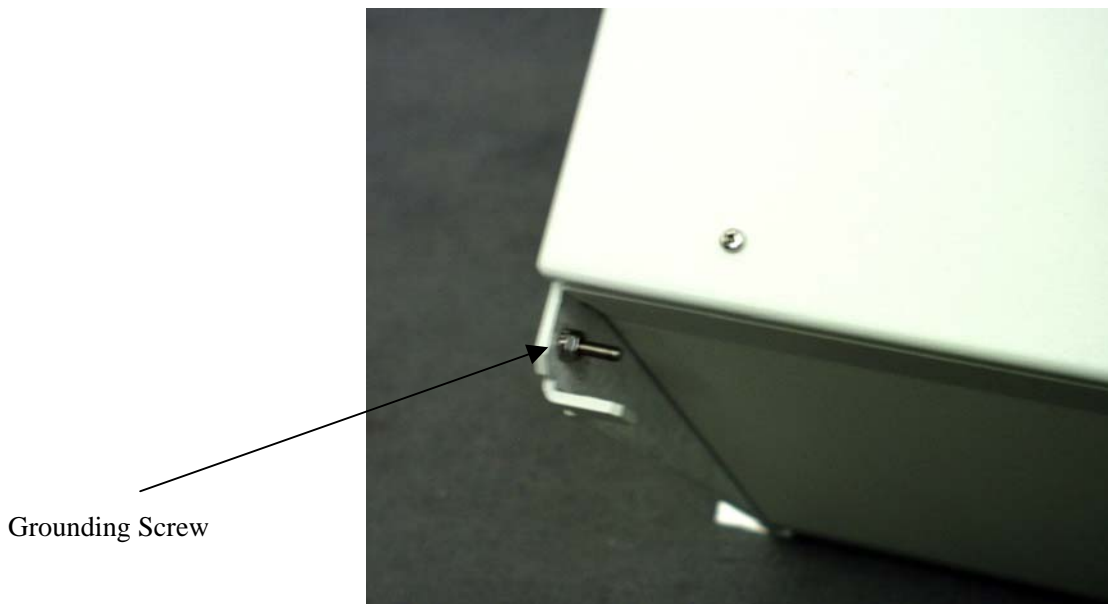
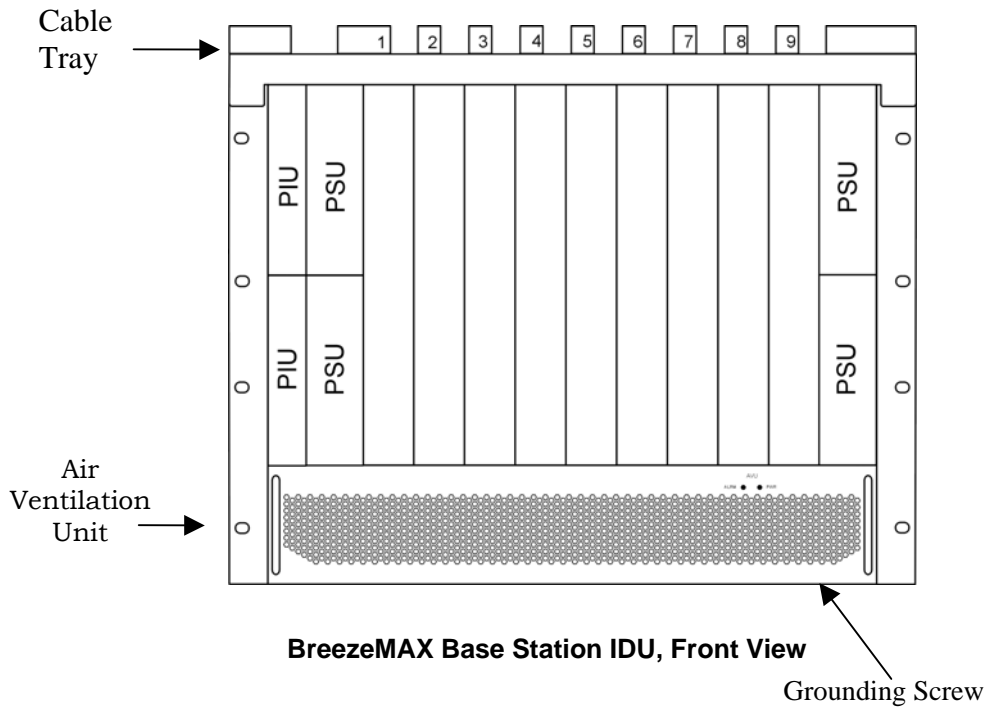


Figure B-7: BreezeMAX Base station IDU, Rear View