Stratum™ X5
Hardware Installation Guide

Products Covered

Stratum™ X5

-SX5-1040A

-SX5-1042A

-SX5-1040A Quickbridge

-SX5-1042A Quickbridge

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Statum™ X5 - Hardware Installation guide

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Package Contents

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Each shipment includes the items listed in the following table. Please verify that you have received all the parts in this shipment, prior to installation:

What's in the Kit	SX5-1040A	SX5-1042A
Stratum Device		
Gigabit PoE Injector with country specific power cord US & TH - US power cord WD - US and EU power cord		
Connector Weather Proofing Kit		
Pole Mounting Kit		
Grounding Kit		

What's in the Kit	SX5-1040A	SX5-1042A
Quick Installation Guide		

Stratum™
X5 Series
Quick Installation Guide

IMPORTANT!
For regulatory information and latest product updates, including firmware and the MIBs, please visit Proxim's support site at http://support.proxim.com.

The device must be installed by a trained professional who is familiar with radio frequency planning and regulatory limits.

Introduction

The Stratum™ X5 is a highly efficient radio endpoint that delivers gigabit-plus throughput in both point-to-point and multipoint wide area network configurations. Able to operate as MIMO 4x4, with either integrated or external antennas (software switchable on some variant), the Stratum™ X5 is ideally suited to high-capacity backhaul, high-resolution video surveillance, or high-density multipoint deployments. Powered by Proxim WORP® (Wireless Outdoor Router Protocol), managed via web GUI, CLI, Bluetooth-enabled Proxim BlueConnect™ and SNMP for ProximVision® Advanced, this high-speed platform offers advanced Quality of Service, granular service level management, and very secure networking.

Products Covered in This Guide

Model	
SX5-1040A	SX5-1042A

Package Contents

Each shipment includes the items listed in the following table. Please verify that you have received all the parts in the shipment, prior to the installation.

What's in the Kit	SX5-1040A	SX5-1042A
Stratum Device		
PoE Injector with country specific power cord US & TH power cord WD - US and EU power cord		
Connector Weather Proofing Kit		
Pole Mounting Kit		
Grounding Kit		

:Quickbridge bundle includes each of the above twice.

Getting Started

2

2.1 Power-Up

To Power on the device, perform the following steps:

1. Connect the **OUT / POE** port on the PoE and the **Ethernet Port-1** of the device using a standard Cat5e / Cat6 cable terminated with RJ45 connectors.
2. Connect the **IN / LAN** port on the PoE and the **NIC** port of a computer.
3. Connect the AC power cord to PoE and switch ON the AC power.
4. The Power LED on of the PoE and device glows.
5. Ping the device's IP Address to check the network connectivity. (Please refer QIG for IP Address of the device).
6. If the ping is successful, continue with the installation process.

The device receives 36V - 56V DC via a a standard Cat5e / Cat6 cable connected between the PoE and the device.

: Due to DC power requirements, the maximum cable length between the PoE Injector and the device should be less than 100 meters.

Prior to the Pole Mounting or Wall Mounting procedure, it is always recommended to check the functionality by powering on the device with the temporary connections.

2.2 Pre-Installation Check List

It is mandatory to check the Safety & Regulatory Information before you perform the Installation procedure.

You will need the following tools to perform the Installation:

10mm Spanner

#2 Phillips Screw Driver

#3 Phillips Screw Driver

Crimping Tool

Device Overview

3

This section provides the hardware overview and installation procedure for the following product(s):

3.1 Stratum X5 Hardware Overview

Device Model	Description
SX5-1040A-US	Stratum X5, 5GHz All-purpose unit (BSU single or SU), 1+ Gbps, RP-SMA - US PoE
SX5-1040A-WD	Stratum X5, 5GHz All-purpose unit (BSU single or SU), 1+ Gbps, RP-SMA - WD PoE
SX5-1040A-TH	Stratum X5, 5GHz All-purpose unit (BSU single or SU), 1+ Gbps, RP-SMA - TH PoE
SX5-1040A-WD Quickbridge	Stratum X5 Quickbridge, Pair of 5 GHz All-purpose unit (BSU single or SU), 1+ Gbps, RP-SMA - WD PoE
SX5-1040A-TH Quickbridge	Stratum X5 Quickbridge, Pair of 5 GHz All-purpose unit (BSU single or SU), 1+ Gbps, RP-SMA - TH PoE
SX5-1042A-US	Stratum X5, 5GHz All-purpose unit (BSU single or SU), 1+ Gbps, 19° quad pol antenna and RP-SMA - US PoE
SX5-1042A-WD	Stratum X5, 5GHz All-purpose unit (BSU single or SU), 1+ Gbps, 19° quad pol antenna and RP-SMA - WD PoE
SX5-1042A-TH	Stratum X5, 5GHz All-purpose unit (BSU single or SU), 1+ Gbps, 19° quad pol antenna and RP-SMA - TH PoE
SX5-1042A-WD Quickbridge	Stratum X5 Quickbridge, Pair of 5 GHz All-purpose unit (BSU single or SU), 1+ Gbps, 19° quad pol antenna and RP-SMA - WD PoE
SX5-1042A-TH Quickbridge	Stratum X5 Quickbridge, Pair of 5 GHz All-purpose unit (BSU single or SU), 1+ Gbps, 19° quad pol antenna and RP-SMA - TH PoE

Figure 3-1 SX5-1040A

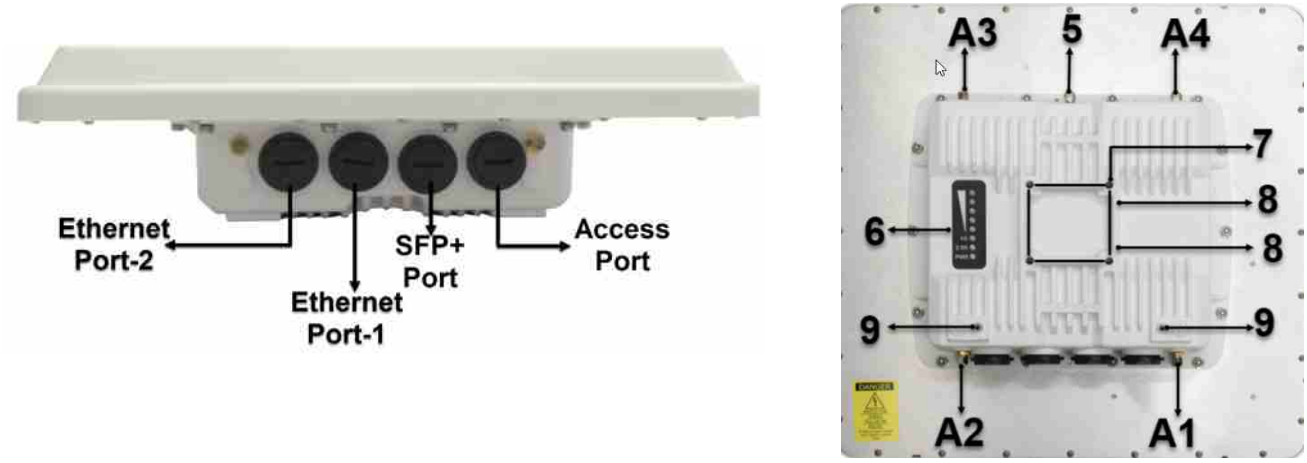


Figure 3-2 SX5-1042A

A detailed description about the various components of the device are explained in the following sections:

Item	Features	Description
1	Ethernet Port-1	• 2.5 Gbps Ethernet • 802.3at/bt PoE In
2	Ethernet Port-2	• 1 Gbps Ethernet • 802.3at PoE Out
3	SFP+ Port	• SFP + with Data transfer speed up to 10Gbps
4	Access Port	• 12V External DC IN supply
A1,A2, A3&A4	5 GHz Antenna Ports (A1,A2,A3 & A4)	• A provision to connect external antenna in MIMO 4x4 mode. • Connect A1 to Antenna Vertical Polarity port and A2 to Antenna Horizontal Polarity Port. • Connect A3 and A4 to Antenna Slant Polarity ports.
5	GPS Connector	• A provision to connect passive GPS antenna for device positioning.
6	View LEDs & RSSI LEDs Display	• Displays boot up information (see View LEDs section). • RSSI LEDs behavior Information (see RSSI LEDs Behavior Section).
7	Mounting Holes	• A provision to connect 10000-UMK mounting kit
8	Hose Clamp Slits	• A provision to attach hose clamps (1/2 inch or 12 mm width) for pole mounting.
9	Grounding Points	• A provision to ground the device.
Important: Stratum SX5-1042A device includes a quad polarization 18 dBi panel antenna which is enabled by default. To use external antenna instead, switch to external antenna mode via BlueConnect application or via Web GUI. Refer to the antenna switching procedure in the Device Management Guide.		

3.1.1 Gigabit Ethernet Ports

This device have two Ethernet Ports:

1. **Ethernet Port-1 (PoE IN and Data)**

   The 2.5 Gigabit Ethernet Port-1 (PoE IN and Data) of the device allows the user to connect to the LAN by using Cat5e / Cat6 Ethernet cable, and also power ON the device by using the Power over Ethernet (PoE) Injector supplied with the product package.

   - The device receives 48V - 56V DC via a STP Cat5e / Cat6 cable connected between the PoE and the device.

- Ethernet Ports supports the Auto MDI-X, auto configuration and fixed speed/duplex configurations.

Recommended Ethernet Cable Specifications	
Type	Cat5e, Cat6, STP, 24 AWG, UL rated, Shielded, UV Resistant and outdoor-rated
Impedance	100 ohms
Cable Length	330 feet / 100 meters *: The total length of cabling between the Personal Computer and the device cannot exceed 100 meters (includes cable from the Personal Computer to the PoE, and the cable from the PoE to the device). Due to DC power requirements, the maximum cable length between the PoE Injector and the device should be less than 100 meters.*

: 1. The device comes with a Gigabit PoE injector, to take full advantage of the port 2.5 Gigabit capacity, it is recommended to procure optional 2.5/5 Gigabit PoE injector (Part Number 949-00147).
2. Ethernet Port-1 is provided with 4KV surge protection on any wires of Ethernet Interface. Ethernet Port-1 allowing 2500Mbps, Ethernet communication with 100 meter Ethernet cable and upto 57V DC on the cable.

2. Ethernet Port-2 (PoE OUT and Data)

The Gigabit Ethernet Port -2 is used for PoE OUT and data. While using this port, the following points should be considered:

- 48V - 56V DC (25W maximum with 60W PoE injector, up to 45W maximum with 90W PoE injector) is available on the Ethernet Port-2. Make sure to verify if the connected device can support this voltage.
- When PoE IN receives 48V - 56V DC, PoE OUT delivers the same voltage, i.e., 48V - 56V DC.
- By default, the Ethernet Port-2 is for Data only; however, it is possible to enable the PoE OUT and Data feature to power up secondary device through Web configuration. Please make sure to disconnect the Ethernet Port-2 cable from the PC before enabling this feature.

: Ethernet Port-2 also is provided with 4KV surge protection on any wires of Ethernet Interface. Ethernet Port-2 allowing 1000Mbps, Ethernet communication with 100 meter Ethernet cable and upto 57V DC on the cable.

3.1.2 SFP+ Port

The SFP+ port is used to connect a fiber 10 Gigabit SFP module. Both Single-Mode 10Gbase-LR (up to 10 kilometers) and Multi-Mode 10Gbase-SR (up to 300 meters) version are supported. Stratum X5 only operate with Proxim certified i-temp modules designed for outdoor use with temperature ranging from -40°C to +85°C.

: Contact your reseller or distributor to produce optional modules (Part Number 949-99164 and 949-00165).

3.1.3 Access Port

It is possible to use 12V DC / 3 - 5A supply with suitable fuse capability to power the device through Access port.

: Supplying power through the Access port, when the device is powered by POE injector, damages the device.

RJ11 Pins	Pin Assignments
3	GND
6	12V DC / 3 - 5A
1,2,4,5	NC / Open

It is recommended to use Cat5e cables, to provide the 12V DC / 4 - 5A power supply to the device through Access port. Perform the Weatherproofing for Access Port as explained in the sections Step 5: Weatherproofing RJ45 Connections & Additional Weatherproofing Steps.

Figure 3-3 Powering the device through Access Port using 12 V DC Power Supply

3.1.4 Antenna Ports

The Antenna Ports A1 / A2 / A3 / A4 are used to connect external antenna(s). These antenna connectors are of RP-SMA female type. Use antenna port A1 and A2 for dual polarization antenna, and all four ports for quad polarization antenna.

: For quad polarization, you can use directly a quad polarization (Horizontal, Vertical and Dual-Slant) antenna, or two dual polarization antenna.
When using two dual polarization, ensure that the one connected to port A1 and A2 is set to operate in Horizontal and Vertical polarization (usually square mount), while the one connected to port A3 and A4 is set to operate in Dual-Slant polarization (usually diamond mount).

3.1.5 Grounding Points

To protect the device against lighting or ESD events, you must ground the device properly. To ensure proper grounding, use the ground point that is situated at the bottom corners of the device and the grounding screw (M4 thread size) to attach a ground wire of at least 12 AWG stranded to the device.

Device Installation

4

4.1 Installation Procedure

This section describes the steps to install and mount the device(s).

: The device must be installed by a trained professional who is familiar with radio frequency planning and regulatory limits. Please referSafety & Regulatory Information for details.

Perform the following steps to install and mount the device

Step 1: Plan for Installation

There are several planning factors to be considered before installing the device. In addition to selecting the installation site, you should do the following:

Calculate:

- Required RSL (Receive Signal Level) and fade margin to achieve link availability objectives. For more details on how to calculate RSL and fade margin, please refer to the Antenna Installation and Measuring Signal Performance.
- Required path availability
- Anticipated multi-path reflection points

Determine:

- System frequency plan
- Required antenna mounting height to obtain proper path clearance
- Required transmission line types (like RF cable, waveguides) and lengths

Plan for:

- Device's continuous power consumption needs
- Lightning protection and system grounding
- Hardware mounting
- Cable installation including ingress
- Pretesting equipment (back-to-back test)

Step 2: Choose a Location

To make optimal use of the device, you must find a suitable location to install the hardware. The range of the radio device largely depends upon the position of the antenna. Proxim recommends you do a site survey, observing the following requirements, before mounting the hardware.

- The location must allow easy disconnection of power to the radio device, if necessary.
- Ensure free flow of air around the device.
- The radio device must be kept away from vibration and excessive heat.
- The installation must conform to local regulations at all times. For details, please refer to Safety & Regulatory Information.

The device has designed to directly mount to a pole / Wall. By using the supplied mounting brackets and hardware, you can mount them to a 1.25 to 3 inch pole (outside diameter).

Step 3: Gather Required Materials

You should have the following materials available before installing the device:

- Weatherproofing material (such as butyl mastic tape and vinyl tape) for sealing external connectors.
- Straight-through UV-protected STP-rated Cat5e / Cat6 Ethernet cable for connecting to PC, or cable for connecting to a hub or a switch.
- Another straight-through UV-protected STP-rated Cat5e /C at6 Ethernet cable for connecting the OUT / POE port of PoE and device.

Step 4: Unpack the Product Package

1. Unpack the device and its accessories from the product package box.
2. Please make a note of the Ethernet addresses, the MAC addresses and the serial number. These addresses may be used when configuring the device. Note that the serial number helps you to seek support from the Proxim's Customer support team.

Step 5: Weatherproofing RJ45 Connection

1. Use an outdoor rated CAT5e / CAT6 cable with a straight-through terminated on both ends.
2. Insert the CAT5e / CAT6 cable through the Sealing Nut (D) and install the Compression Washer (C) to the cable. Compression Washer (C) has a slit in the middle for quick installation onto the cable.
3. Install the parts (D) and (C) in the direction as shown in Figure 4-1.
4. Insert the Flat Washer (A) onto the Connector Body (B) and then insert the CAT5e/CAT6 cable through the Connector Body (B).
5. Connect the cable end of RJ45 connector into Ethernet Port-1 of the device.
6. Make sure that the locking latch of RJ45 Connector is properly inserted into the Ethernet Port-1.
7. Fasten the Connector Body Assembly to the Device Ethernet Port-1 hole and fully tighten it.
8. Slide and Insert the Compression Washer (C) into the Connector Body Assembly.
9. Fasten the Sealing Nut (D) to the Connector Body Assembly and fully tighten it to weatherproof the cable.

Consider the following two conditions while weatherproofing RP-SMA connectors:

1. If the device uses Integrated Antenna:
   - Install weatherproofing caps to RP-SMA connectors that are supplied with the device.
2. If the device uses External Antenna:
   - Warp Butyl Mastic Tape and Vinyl Tape around the connectors to weatherproof the RP-SMA and antenna connections.

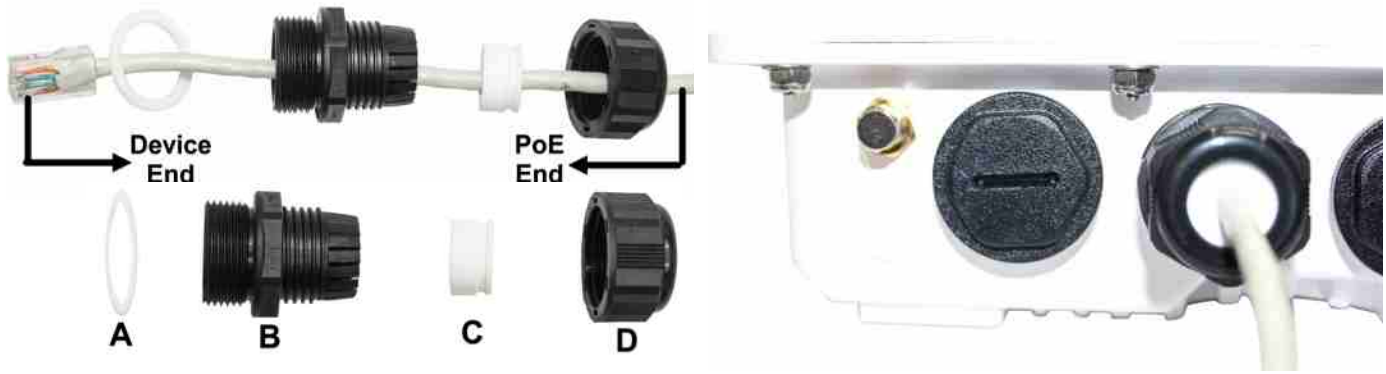


Figure 4-1 Weatherproofing RJ45 Connection

Additional Weatherproofing Steps

To add an additional layer of protection to the connectors against the environment, see Sealing the Cable Connectors.

Step 6: Assemble Mounting Hardware

The following steps explain how to mount the unit with each of the mounting hardware.

1. Fix the Mounting Plate (A) onto the bottom of the device using the provided screws and washers such that the antennas will be vertically and horizontally polarized when mounted; also, it is recommended to partially fasten the screws with washers into all the mounting holes, prior to final tightening of each screw. Torque the screws to 75 Lbf-in (86 Kgf-cm)
2. Fix the Extension Arm (B) to the fixed Mounting Plate (A) with the provided bolt, nut, and washers. The Extension Arm (B) gives the device more possible tilt, letting you adjust for azimuth or elevation over a larger angle.

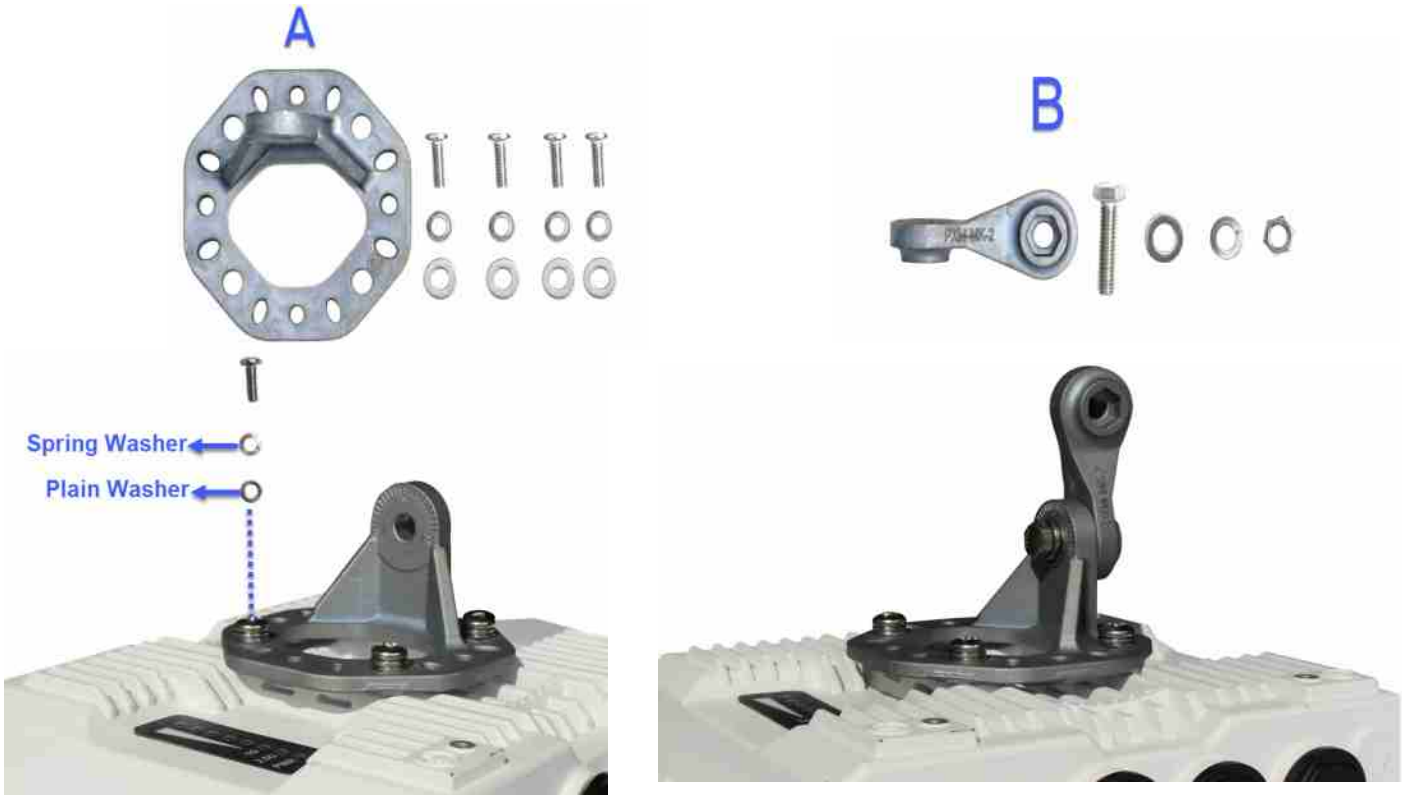


Figure 4-2 Assemble the Mounting Hardware

Step 7: Mount the Device

1. To pole-mount the device, insert the provided bolts through Bracket (D), mate with Bracket (C) around the pole, and secure with supplied washers torquing to 100 Lbf-in (115Kgf-cm). The supplied bolts (Hex. bolt 5/16” x 4”long) are designed for pole diameters from 32 to 89mm (1.25 to 3.5 inches).
2. Fix the fixed Extension Arm (B) to the Mounting Bracket (C) with the provided bolt, nut, and washers. Partially tighten the joints J1 and J2 to allow for alignment of the device.
3. Once satisfied with the alignment, tighten the assembled parts by applying torque 130 Lbf-in (150Kgf-cm).

4. While installing the device, make sure that the device Ethernet Port-1 with cable installation (using cable gland) faces downward only as shown in Figure 4-3 below

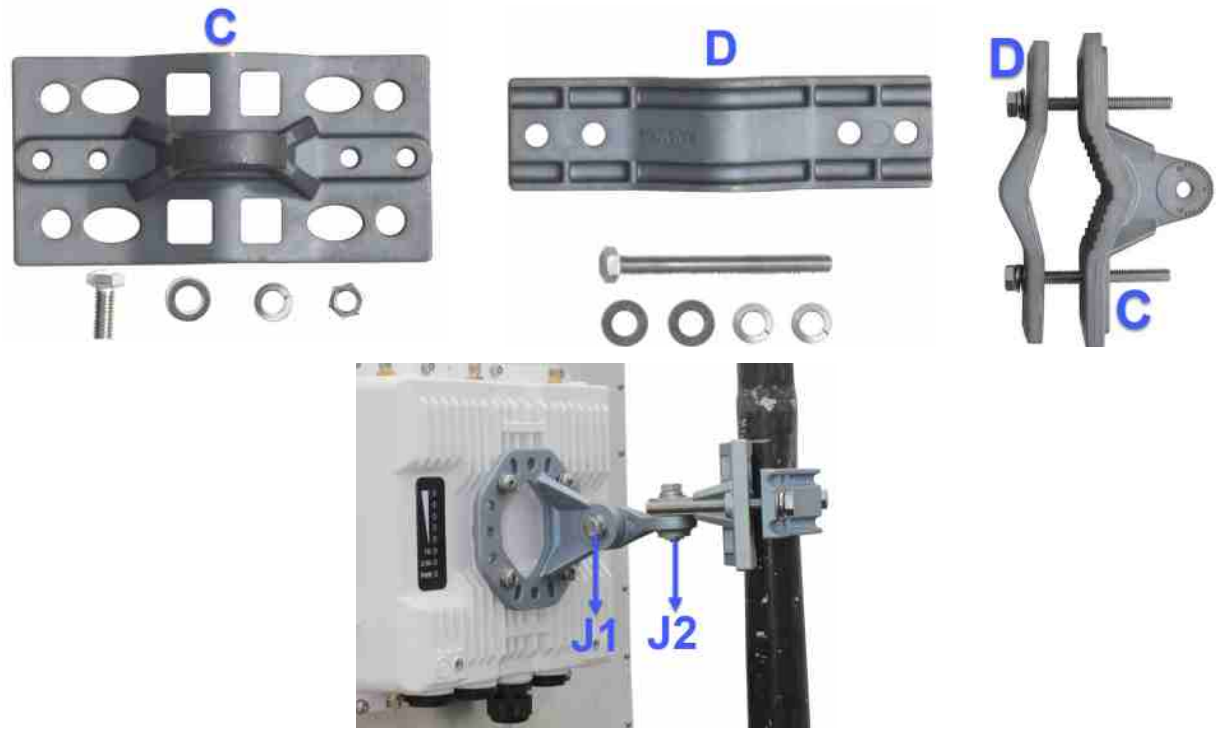


Figure 4-3 Pole Mounting

5. To wall-mount the device, mount the bracket (C) to a wall by using 4 screws (not supplied), as shown in figure below:

Figure 4-4 Pole Mounting

Step 8: Plug in the Cables

1. Plug one end of the straight-through Cat5e / CAT6 cable into the Ethernet Port-1 of the device by following the procedure explained under Step 5: Weatherproofing RJ45 Connection. Connect the other end of the cable into the **OUT / POE** port on the PoE Injector.

Figure 4-5 Cable Plugged In

2. To connect the device through a hub or a switch to a Personal Computer, connect an Ethernet cable between the network interface card in the Personal Computer and the hub, and between the hub and the RJ45 **IN / LAN** port on the PoE Injector.
3. To connect the device directly to a Personal Computer, connect an Ethernet cable between the network interface card in the Personal Computer and the RJ45 **IN / LAN** port on the PoE Injector.

Step 10: Install Surge Protector

Stratum ™ *X5 Series* products comes with a built-in Ethernet surge protection; however, it is mandatory to install an approved lightning surge protector at the building ingress point. Moreover, if you are installing the device in a region subjected to violent thunderstorms or severe weather conditions, then installation of an additional approved lightning surge protector near the device is recommended.

*: The Surge Arrestor (Part Number **235-00001**) is not provided with the Proxim's Package Contents, it needs to be procured by the customer. To buy an additional Surge Protector, place an order separately with your distributor.*

Perform the following steps to ensure proper surge protection:

1. Mount a surge protector near the building ingress and use 12AWG or larger wire to connect the surge protector's ground lug to earth ground.
2. The outdoor device and co-located surge protector (optional) should have a common grounding point using the shortest possible grounding cable.

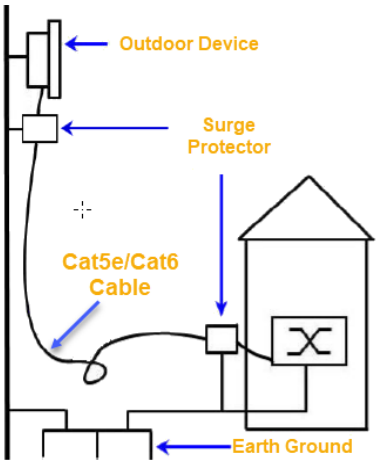


Figure 4-6 Surge Protector

: Use Outdoor-rated, UV protected, shielded Cat5e/CAT6 cable for the following:

3. Connect an RJ45 terminated cable between the indoor device and to the port on the surge protector at the building ingress.
4. Connect an RJ45 terminated cable between the surge protector and the outdoor device on the Ethernet Port.

:Ensure to loop the cable before entering the premise to prevent water ingress.

Step 11: Ground the Unit

To ensure proper grounding, attach a ground wire of at least 12AWG stranded to the device at the ground point which is located at the bottom corner of the device. It is important to follow the grounding guidelines below to protect the device against lighting or ESD events:

1. Connect one end of the grounding cable to the device and the other end to the closest earth ground point at the installation site.
2. Remove any extra ground wire length when finished connecting it to the single point earth ground.
3. Avoid sharp bends, loops or coiling the ground wire, always connect it straight to ground.
4. A proper earth ground impedance is less than 1.0 ohm.
5. Measure ground impedance at the point where the surge protector ground wire is connected and not at the grounding rod.
6. Connect the surge protector ground wire and equipment ground (both power ground and telecomm ground) to a single common ground.
7. Make sure all connections are fastened securely and tight.
8. Never install a link during a storm and always follow your local safety codes.

Connect the grounding wire, which is supplied with the device as shown below:

Figure 4-7 Ground the Device

Step 12: Power ON the Device

After connecting the PoE Injector and the device using straight-through CAT5e / CAT6 cable plug the power cord into a power outlet. There is no **ON / OFF** switch on the device. To power down the unit, unplug the RJ45 connector from the **OUT / POE** port on the PoE injector.

: When using a class I adapter (such as Proxim supplied PoE injector), protective earthing is used as a safeguard. Ensure to connect the power cord to a socket-outlet with earthing connection, or equivalent.'

Step 13: Power & Link LED Indicators

When the device is powered on, it performs startup diagnostics. When startup will be completed, the **Power LED** show the device's operational state. 1G LED glows when the Ethernet link is established and 2.5G LED glows when the Ethernet link is established.

Figure 4-8 Power & Link LEDs

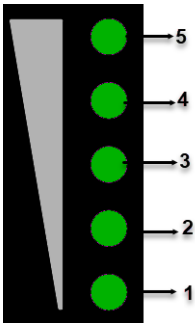
The following table describes the status of LEDs:

LED State	Off	On
PWR	Power Off	Power On
1G	Ethernet Port -2 not connected	Ethernet link established
2.5G	Ethernet Port -1 not connected	Ethernet link established

RSSI LED Behavior

During the first two minutes, after the device is turned on or rebooted, the unit LED indicators provide the following information:

LED State	Off	On
RSSI_LED-1 (Lower)	Power is OFF	Power is ON
RSSI_LED-2	Wireless 1 (5 GHz) is OFF	Wireless 1 (5 GHz) is ON
RSSI_LED-3	N/A	N/A
RSSI_LED-4	Flash is corrupted (requires RMA)	Flash is Ok
RSSI_LED-5 (Higher)	Ethernet is DOWN	Ethernet is UP



Device Link Establishment

5

Antenna alignment is the process of physically aligning the antenna of the radio receiver and transmitter to establish a link between two point-to-point devices with an optimal throughput. The antenna alignment process is usually performed during the installation of the antennas. Refer to section 8.2.6.1 Antenna Alignment using RSSI LEDs.

Technical Specifications 6

Device Models

Model	Part Number	Description
SX5-1040A-US	906-00001	Stratum X5, 5GHz All-purpose unit (BSU single or SU), 1+ Gbps, RP-SMA - US PoE
SX5-1042A-US	906-00002	Stratum X5, 5GHz All-purpose unit (BSU single or SU), 1+ Gbps, 19° quad pol antenna and RP-SMA - US PoE
SX5-1040A-WD	906-00003	Stratum X5, 5GHz All-purpose unit (BSU single or SU), 1+ Gbps, RP-SMA - WD PoE
SX5-1042A-WD	906-00004	Stratum X5, 5GHz All-purpose unit (BSU single or SU), 1+ Gbps, 19° quad pol antenna and RP-SMA - WD PoE
SX5-1040A-TH	906-00005	Stratum X5, 5GHz All-purpose unit (BSU single or SU), 1+ Gbps, RP-SMA - TH PoE
SX5-1042A-TH	906-00006	Stratum X5, 5GHz All-purpose unit (BSU single or SU), 1+ Gbps, 19° quad pol antenna and RP-SMA - TH PoE
SX5-1040A-WD Quickbridge	907-00003	Stratum X5 Quickbridge, Pair of 5 GHz All-purpose unit (BSU single or SU), 1+ Gbps, RP-SMA - WD PoE
SX5-1042A-WD Quickbridge	907-00004	Stratum X5 Quickbridge, Pair of 5 GHz All-purpose unit (BSU single or SU), 1+ Gbps, 19° quad pol antenna and RP-SMA - WD PoE.
SX5-1040A-TH Quickbridge	907-00005	Stratum X5 Quickbridge, Pair of 5 GHz All-purpose unit (BSU single or SU), 1+ Gbps, RP-SMA - TH PoE
SX5-1042A-TH Quickbridge	907-00006	Stratum X5 Quickbridge, Pair of 5 GHz All-purpose unit (BSU single or SU), 1+ Gbps, 19° quad pol antenna and RP-SMA - TH PoE

Accessories

Part Numbers	Accessories
949-00161	25m outdoor, RJ45 terminated, UV Rated, STP Shielded CAT6 cable with M25 cable gland
949-00162	50m outdoor, RJ45 terminated, UV Rated, STP Shielded CAT6 cable with M25 cable gland
949-00163	75 m outdoor, RJ45 terminated, UV Rated, STP Shielded CAT6 cable with M25 cable gland
949-00164	SFP+ module for Stratum X5, 10 Gbps, Long Range, Single-Mode Frame, 1310nm, 10km, Optical Transceiver + M25 Cable Gland
949-00165	SFP+ module for Stratum X5, 10 Gbps, Short Range, Multi-Mode Frame, 850nm, 300m, Optical Transceiver + M25 Cable Gland
235-00001	Surge Protector, Gigabit Surge Protector with Shielded RJ45 Connector
949-00145	Gigabit, 60W, Passive PoE injector with RJ45, level VI Compliance
949-00147	2.5/5 Gigabit, 60W, 802.3bt PoE injector with RJ45
400-00036	PoE Gigabit 48V DC Injector with terminal Jack, 802.3af Compliant

400-00002	PoE Gigabit 48V DC Injector with terminal Jack - 25 pack
949-00076	Outdoor Universal Mounting Kit
949-00149	4.9 - 6.4 GHz, Quad Polarity, Vertical /Horizontal/Dual Slant,19 dBi Panel Antenna - 19 degrees.Mounting kit Included.
76955	4.9-5.875 GHz, Dual Polarity, Vertical & Horizontal or Slanted (±45°), 23 dBi Panel Antenna
949-00019	4.9-6.1 GHz, Dual Polarity, Vertical & Horizontal or Slanted (±45°), 30 dBi Panel Antenna
949-00151	Passive GPS antenna for Edge integrated GPS module, SMA Male - 10 pack
949-00152	6 ft Low Loss Coaxial Antenna Cable, 0.240”, Reverse Polarity SMA Male to Right Angle N-Male
949-00153	SMA metal weatherproofing cap with O-ring (fits SMA and RP-SMA connectors) - 50 pack
949-00154	Cable Feed Thru, M25 Cable Gland Connector - 25 pack

OFDM Modulation Rates

Given below are the OFDM modulation rates for the **Stratum™** products:

MCS Index	Modulation	Coding Rate	High Efficiency (HE) Data Rates (Mbps) Per Stream		
			20 MHz Channels	40 MHz Channels	80 MHz Channels
MCS 0	BPSK	1/2	8.6	17.2	30.6
MCS 1	QPSK	1/2	17.2	34.4	72.1
MCS 2	QPSK	3/4	25.8	51.6	108.1
MCS 3	16 QAM	1/2	34.4	68.8	144.1
MCS 4	16 AM	3/4	51.6	103.2	216.2
MCS 5	64 QAM	2/3	68.8	137.6	288.8
MCS 6	64 QAM	3/4	77.4	154.9	324.3
MCS 7	64 QAM	5/6	86.0	172.1	360.3
MCS 8	256 QAM	3/4	103.2	206.5	432.3
MCS 9	256 QAM	5/6	114.7	229.4	480.4
MCS 10	1024 QAM	3/4	129.0	258.1	540.4
MCS11	1024 QAM	5/6	143.4	286.8	600.5

Wireless Protocol

Category	Specification
Wireless Protocol	WORP® (Wireless Outdoor Router Protocol)

Interfaces

Products	Category	Specification
SX5-1040A SX5-1042A	Wired Ethernet	Auto MDI-X, auto configuration and fixed speed/duplex configurations One auto MDI-X RJ45 2.5 Gbps Ethernet with PoE IN One auto MDI-X RJ45 1 Gbps Ethernet with PoE Out
	Extension	One SFP+ port for Fiber 10 Gbps SFP module (10GBase-SR or 10GBase-LR)

Transmit Power Specifications (5.150 - 5.925) GHz

Products	Stream	MCS Index	Modulation Type	Coding Rate	Data Rates (Mbps) Per Stream		
					HE20	HE40	HE80
SX5-1040A SX5-1042A	Single stream (or) Dual Stream (or) Quad Stream	MCS 0	BPSK	1/2	23	23	23
		MCS 1	QPSK	1/2	22	22	22
		MCS 2	QPSK	3/4	22	22	22
		MCS 3	16 QAM	1/2	21	21	21
		MCS 4	16 AM	3/4	21	21	21
		MCS 5	64 QAM	2/3	20	20	20
		MCS 6	64 QAM	3/4	20	20	20
		MCS 7	64 QAM	5/6	19	19	19
		MCS 8	256 QAM	3/4	19	19	19
		MCS 9	256 QAM	5/6	18	18	18
		MCS 10	1024 QAM	3/4	18	18	18
		MCS11	1024 QAM	5/6	17	17	17

Note:
- Tx Power value is given per RF chain
  ** in MIMO 4x4:4 mode, aggregate Tx power is 6 dB higher*
- Transmit Power Control (TPC): 0 – 21 dB, in 1 dB steps
  ** Attenuation is linear down to 3 dBm Tx power. Below 3 dBm, any extra dB attenuation result in less than 1 dB Tx power reduction.*
- Total EIRP must be calculated based on the antenna gain
- Tolerance = +/- 2 dB
  ** Tx Power indicates the power at the radio ports.*
  ** In case of integrated devices, the Tx Power at the antenna ports is 1 dB higher than the above tabulated values.*
- In the FCC United States 5.8 GHz band edge frequencies, the Maximum Tx Power of the radio will be restricted based on the FCC Certification and Antenna Type used. For details refer the Antenna Installation and Recommendation Guide.

Receive Sensitivity (5.150 - 5.925)GHz

Products	Stream	MCS Index	Modulation Type	Coding Rate	Receive Sensitivity* (dBm) (5.150 ~ 5.925) GHz		
					HE20	HE40	HE80
SX5-1040A SX5-1042A	Single Stream (or) Dual Stream (or) Quad Stream	MCS 0	BPSK	1/2	-92	-90	-87
		MCS 1	QPSK	1/2	-91	-89	-85
		MCS 2	QPSK	3/4	-89	-87	-83
		MCS 3	16 QAM	1/2	-87	-85	-81
		MCS 4	16 QAM	3/4	-85	-83	-79
		MCS 5	64 QAM	2/3	-83	-81	-77
		MCS 6	64 QAM	3/4	-80	-78	-74
		MCS 7	64 QAM	5/6	-77	-75	-71
		MCS 8	256 QAM	3/4	-74	-72	-68
		MCS 9	256 QAM	5/6	-71	-69	-65
		MCS 10	1024 QAM	3/4	-68	-66	-62
		MCS 11	1024 QAM	5/6	-65	-63	-59

Note:
- Receive Sensitivity values should be considered with a tolerance + 2 dB.

SNR Information (5.150 - 5.925) GHz (To be Updated)

If DDRS is disabled, the user can configure the Data Rate values manually as per the reference table below.

MCS Index	Modulation	No. of Streams	5.150 - 5.925 GHz					
			20 MHz					
			Full (GI = 800ns)			Short (GI =400ns)		
			Data Rate	Min SNR	Max SNR	Data Rate	Min SNR	Max SNR
MCS0	BPSK 1/2							
MCS1	QPSK 1/2							
MCS2	QPSK 3/4							
MCS3	16 QAM 1/2							
MCS4	16 QAM 3/4							
MCS5	64 QAM 2/3							
MCS6	64 QAM 3/4							
MCS7	64 QAM 5/6							
MCS8	256 QAM 3/4							
MCS9	256 QAM 5/6							
MCS10	1024QAM3/4							
MCS11	1024QAM5/6							
MCS0	BPSK 1/2							
MCS1	QPSK 1/2							
MCS2	QPSK 3/4							
MCS3	16 QAM 1/2							
MCS4	16 QAM 3/4							
MCS5	64 QAM 2/3							
MCS6	64 QAM 3/4							
MCS7	64 QAM 5/6							
MCS8	256 QAM 3/4							
MCS9	256 QAM 5/6							
MCS10	1024QAM3/4							
MCS11	1024QAM5/6							
MCS0	BPSK 1/2							
MCS1	QPSK 1/2							
MCS2	QPSK 3/4							

MCS Index	Modulation	No. of Streams	5.150 - 5.925 GHz					
			20 MHz					
			Full (GI = 800ns)			Short (GI =400ns)		
			Data Rate	Min SNR	Max SNR	Data Rate	Min SNR	Max SNR
MCS3	16 QAM 1/2							
MCS4	16 QAM 3/4							
MCS5	64 QAM 2/3							
MCS6	64 QAM 3/4							
MCS7	64 QAM 5/6							
MCS8	256 QAM 3/4							
MCS9	256 QAM 5/6							
MCS10	1024QAM3/4							
MCS11	1024QAM5/6							

MCS Index	Modulation	No. of Streams	5.150 - 5.925 GHz					
			40 MHz					
			Full (GI = 800ns)			Short (GI =400ns)		
			Data Rate	Min SNR	Max SNR	Data Rate	Min SNR	Max SNR
MCS0	BPSK 1/2							
MCS1	QPSK 1/2							
MCS2	QPSK 3/4							
MCS3	16 QAM 1/2							
MCS4	16 QAM 3/4							
MCS5	64 QAM 2/3							
MCS6	64 QAM 3/4							
MCS7	64 QAM 5/6							
MCS8	256 QAM 3/4							
MCS9	256 QAM 5/6							
MCS10	1024 QAM 3/4							
MSC11	1024 AQM 5/6							
MCS0	BPSK 1/2							
MCS1	QPSK 1/2							
MCS2	QPSK 3/4							
MCS3	16 QAM 1/2							
MCS4	16 QAM 3/4							
MCS5	64 QAM 2/3							
MCS6	64 QAM 3/4							
MCS7	64 QAM 5/6							
MCS8	256 QAM 3/4							
MCS9	256 QAM 5/6							
MCS10	1024 QAM 3/4							
MCS11	1024 QAM 5/6							
MCS0	BPSK 1/2							
MCS1	QPSK 1/2							
MCS2	QPSK 3/4							
MCS3	16 QAM 1/2							
MCS4	16 QAM 3/4							
MCS5	64 QAM 2/3							

MCS Index	Modulation	No. of Streams	5.150 - 5.925 GHz					
			40 MHz					
			Full (GI = 800ns)			Short (GI =400ns)		
			Data Rate	Min SNR	Max SNR	Data Rate	Min SNR	Max SNR
MCS6	64 QAM 3/4							
MCS7	64 QAM 5/6							
MCS8	256 QAM 3/4							
MCS9	256 QAM 5/6							
MCS10	1024QAM3/4							
MCS11	1024QAM5/6							

MCS Index	Modulation	No. of Streams	5.150 - 5.925 GHz					
			80 MHz					
			Full (GI = 800ns)			Short (GI =400ns)		
			Data Rate	Min SNR	Max SNR	Data Rate	Min SNR	Max SNR
MCS0	BPSK 1/2							
MCS1	QPSK 1/2							
MCS2	QPSK 3/4							
MCS3	16 QAM 1/2							
MCS4	16 QAM 3/4							
MCS5	64 QAM 2/3							
MCS6	64 QAM 3/4							
MCS7	64 QAM 5/6							
MCS8	256 QAM 3/4							
MCS9	256 QAM 5/6							
MCS10	1024 QAM 3/4							
MCS11	1024 QAM 5/6							
MCS0	BPSK 1/2							
MCS1	QPSK 1/2							
MCS2	QPSK 3/4							
MCS3	16 QAM 1/2							
MCS4	16 QAM 3/4							
MCS5	64 QAM 2/3							
MCS6	64 QAM 3/4							
MCS7	64 QAM 5/6							

MCS Index	Modulation	No. of Streams	5.150 - 5.925 GHz					
			80 MHz					
			Full (GI = 800ns)			Short (GI =400ns)		
			Data Rate	Min SNR	Max SNR	Data Rate	Min SNR	Max SNR
MCS8	256 QAM 3/4							
MCS9	256 QAM 5/6							
MCS10	1024QAM3/4							
MCS11	1024QAM5/6							
MCS0	BPSK 1/2							
MCS1	QPSK 1/2							
MCS2	QPSK 3/4							
MCS3	16 QAM 1/2							
MCS4	16 QAM 3/4							
MCS5	64 QAM 2/3							
MCS6	64 QAM 3/4							
MCS7	64 QAM 5/6							
MCS8	256 QAM 3/4							
MCS9	256 QAM 5/6							
MCS10	1024QAM3/4							
MCS11	1024QAM5/6							

Power Supply

Products	Category	Specification
SX5-1040A SX5-1042A	Input Voltage	Via RJ45 Ethernet interface supplying 36V - 57V DC on Ethernet Port 1 (Passive and 802.3at/bt PoE injector supported) Via Access Port supplying 12V DC (11V-14V DC supported). Minimum and Maximum power consumption for MIMO 2x2 is (14 -17)W Minimum and Maximum power consumption for MIMO 4x4 is (22 - 25)W *:Power consumption increases if PoE out is enabled.*
	Output voltage	48V or 56 V DC through Ethernet Port 2 (PoE out voltage is identical to PoE in voltage) PoE OUT feature can be switched ON/ OFF through Web Interface or Using CLI Commands
	PoE Injector	Input: 100V – 240V AC (50Hz / 60 Hz) Output: 48V / 56V DC (60Watts) *Pin-out: +V on pins 1/2/4/5, - V on pins 3/6/7/8 Temp: -10ºC to 40ºC * Refer supplied PoE model for actual power Pin-out specification.

Hardware Specifications

Products	Radio	Processor Speed	Memory	Input Power	Power Consumption
SX5-1040A SX5-1042A	5.150GHz - 5.925GHz MIMO radio	2200 MHz Quad Core	Flash:8MB NOR & 128MB NAND RAM: 1GB DDR4L	Power-over-Ethernet 48V- 56V DC /0.65A - 1.1A	14W -17W(MIMO 2x2) 22W -25W(MIMO 4x4)

Physical Specifications

Products	Category	Specification
SX5-1040A	Dimensions (L x W x H)	250mm x 220mm x 62mm / 9.84 in x 8.66 in x 2.44 in
	Weight	1.60 kg / 3.53 lbs
SX5-1042A	Dimensions (L x W x H)	371mm x 371mm x 97mm / 14.6 in x 14.6 in x 3.82 in
	Weight	3.0kgs / 6.6lbs

MTBF

Products	MTBF
SX5-1040A SX5-1042A	>450,000 hours

Environmental Specifications

Products	Operating Temperature	Storage Temperature	Humidity	Wind Loading
SX5-1040A SX5-1042A	-40ºC - 60ºC -40°F - 140°F	-50°C - 70ºC -58ºF - 158°F	100% relative humidity IP67	180kmph 112.5mph

Recommended Antennas 7

7.1 Introduction to Antennas

Antenna is an electrical device which distributes signals transmitted by the wireless radios, through the medium of air in a particular pattern. Antennas focus the signals on a given frequency, by reducing the signal flow in other directions. Directional antennas (sector, parabolic, flat), therefore provide maximum range. But due to their narrow beamwidth, these antennas require precise antenna alignment to achieve optimal performance. The higher the antenna gain, the more precise is their alignment. Directional antennas are typically used to connect:

- A Base Station and a Subscriber Station in a point-to-multipoint or point-to-point network.
- An End Point A and an End Point B in a point-to-point network.

7.2 Antennas Supported

Proxim supports two types of directional antennas:

- Flat Panel Antennas
- Sector Antennas

7.2.1 Flat Panel Antennas

Flat panel antennas are patch type antennas in the shape of a square or rectangle. Flat panel antennas are directional, as they have most of their power radiated in both vertical and horizontal planes. A flat panel antenna is frequently used for sectorized base station installations, where it is desirable to provide coverage in a limited azimuthal direction. This reduces the interference from the out of coverage areas and provides high throughput with increased signal strength, within the coverage area. Since a reduced azimuth area is covered, the radio covers only limited subscribers, hence providing increased bandwidth.

Flat panel antennas have varying amounts of gain based on the construction. Hence, they produce hemispherical coverage of narrow beamwidth, spreading away from the mount point to a width of 5 to 30 degrees typically. Concentrating the signal on such smaller area increases the system range. These antennas are used for the point-to-point or multi-point links used on the subscriber side. The figure below depicts the radiation pattern for the flat panel.

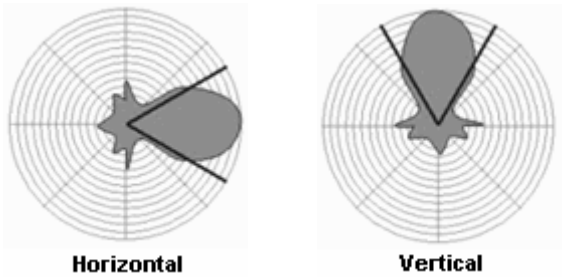


Figure 7-1 Flat Panel Antenna Coverage

7.2.2 Sector Antennas

The wide-angle sector antenna is a good Base Station antenna for hilly terrain. It combines a wide opening angle “sector” with relatively high gain, while the mounting brackets allow tilting of the antenna. This antenna is also used when the amount of traffic in a cell is too high for a single Base Station with an omni-directional antenna. The wide-angle antenna allows dividing the cell into three sectors, where each can be serviced by a Base Station. Sector antennas are better for corridors, hallways, tunnels, long narrow buildings, and point-to-point medium range connections between outdoor bridges (for example, connecting two buildings in an office park or campus).

Sector antennas produce hemispherical coverage, spreading away from the mount point to a width of 30 to 180 degrees typically. The figure below depicts the radiation pattern for the sector antenna.

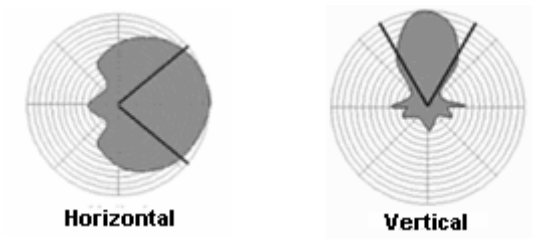


Figure 7-2 Sector Antenna Coverage

7.3 Integrated Antenna Specifications

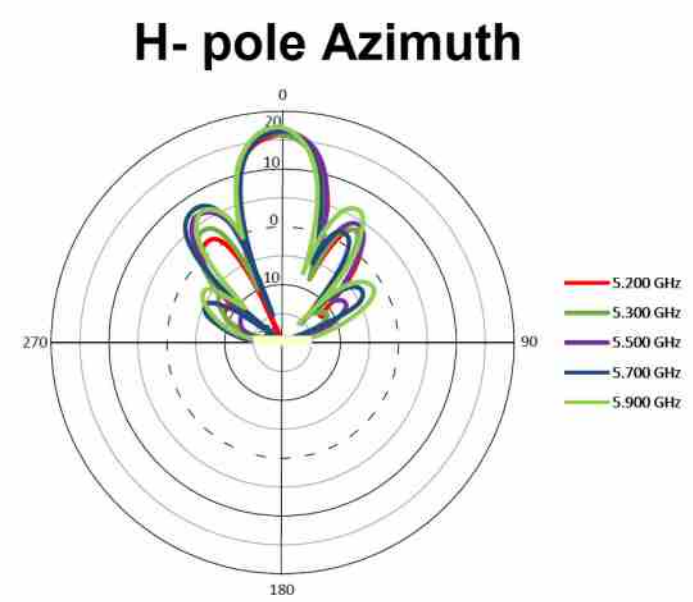
This section illustrates the technical specifications of the following:

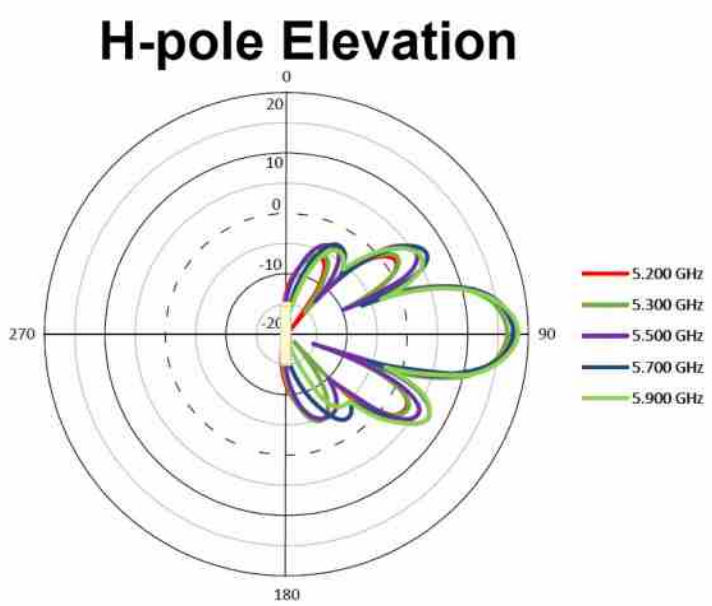
SX5-1042A

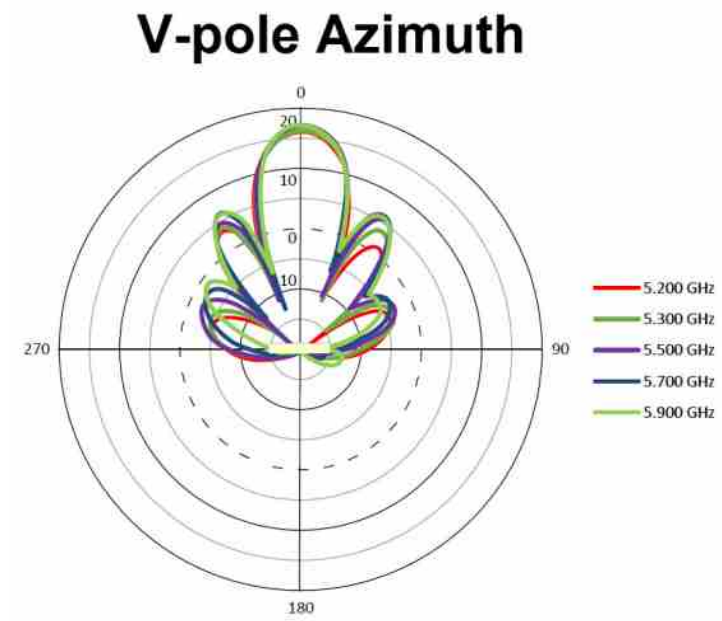
Electrical Specification

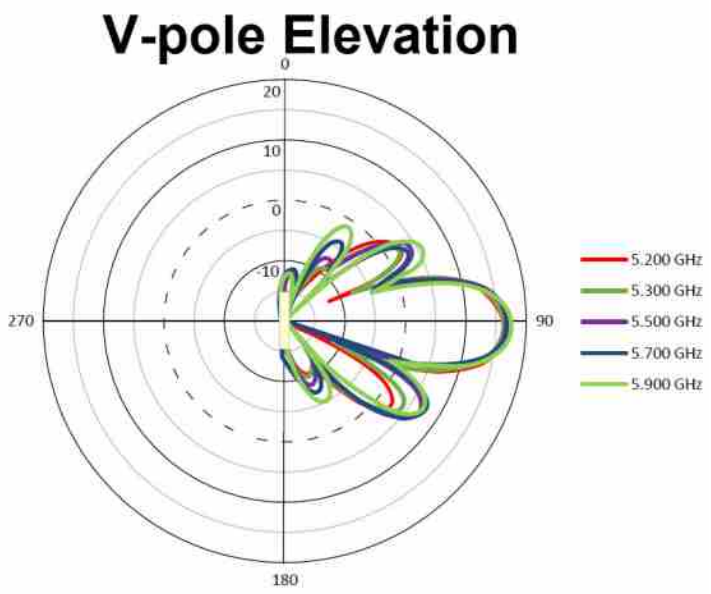
Frequency Range	4.9 - 6.425 GHz
Gain	4.9 - 5.15 @ 4x17 dBi 5.15 - 6.425 @ 4x18 dBi
VSWR, max.	1.7:1
Polarization Quad Pole	Vertical, Horizontal & Dual Slant (±45°)
3 dB Beam-Width-Azimuth, typ.	19º
3 dB Beam-Width-Elevation, typ.	19º
Side Lobes, min.	-12 dB
Front to Back Ratio, min.	-35 dB
Port to Port Isolation, min.	-34 dB
Input Impedance	50 Ohms
Input Power	10 W (max)
Lightning Protection	DC Grounded

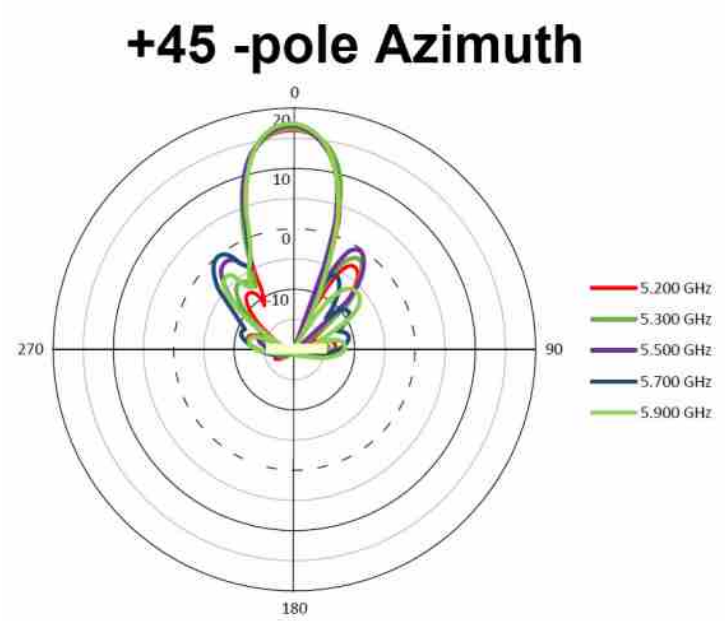
Antenna patterns

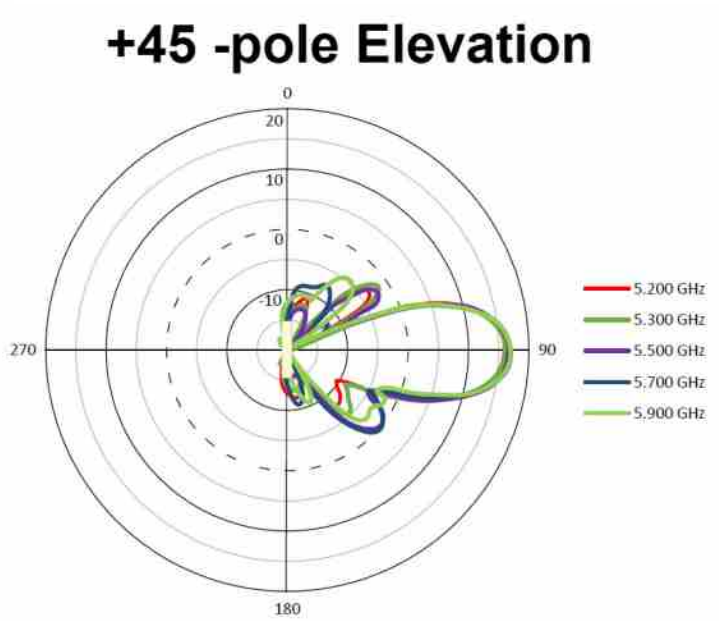


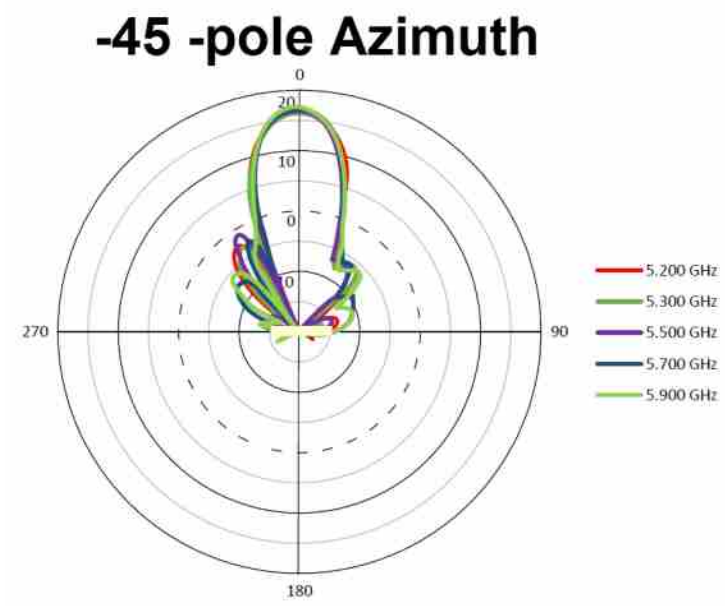


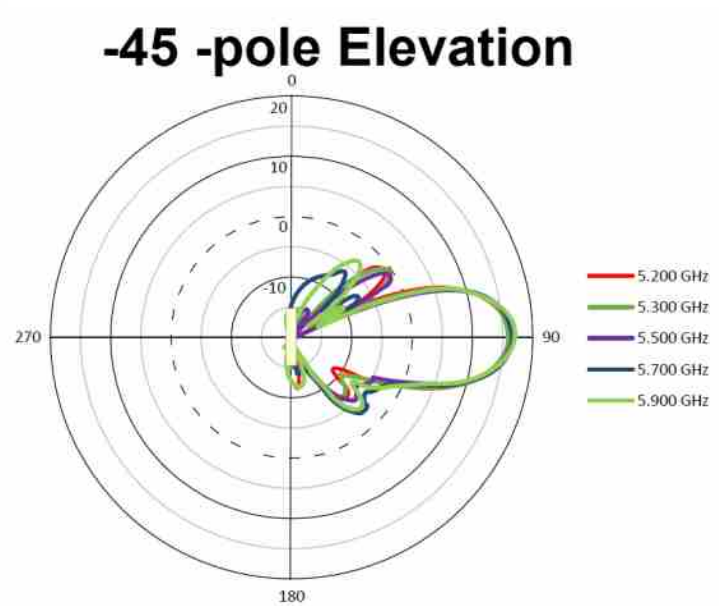





+45 -pole Azimuth
0
20
10
0
-10
270
90
180
5.200 GHz
5.300 GHz
5.500 GHz
5.700 GHz
5.900 GHz


+45 -pole Elevation
0
20
10
0
-10
270
90
180
5.200 GHz
5.300 GHz
5.500 GHz
5.700 GHz
5.900 GHz


-45 -pole Azimuth
0
20
10
0
-10
270
90
180
5.200 GHz
5.300 GHz
5.500 GHz
5.700 GHz
5.900 GHz


-45 -pole Elevation
0
20
10
0
-10
270
90
180
5.200 GHz
5.300 GHz
5.500 GHz
5.700 GHz
5.900 GHz

7.4 Recommended Antennas

: Tabulated below are the antennas that Proxim recommends you to use with the Stratum TM x5 Series devices. To buy these antennas, place an order separately with your distributor.

Dual - Polarized Antennas			
Product(s)	**Part Number**	**Antenna Type**	**Description**
SX5 - 1040A SX5 - 1042A	PA5 - 0823 - DP	Panel Antenna	4.9-5.875 GHz, Dual Polarity, Vertical & Horizontal or Slanted (±45º), 23 dBi Panel Antenna
	PA5 - 0530 - DP	Panel Antenna	4.9-6.1 GHz, Dual Polarity, Vertical & Horizontal or Slanted (±45º), 29 dBi Panel Antenna
Quad - Polarized Antenna			
Product(s)	**Part Number**	**Antenna Type**	**Description**
SX5 - 1040A	PA5 - 1919 - QP	Panel Antenna	4.9-6.425 GHz, Quad Polarity, Vertical & Horizontal & Dual Slant, 19 dBi Pannel Antenna - 19 degrees

:

- *To ensure proper installation of antenna(s), refer to* Antenna Installation.
- *Ensure, you meet all the pre-requisites described in the Antenna Installation, while selecting the antennas and antenna cables.*
- *Antennas should be aligned and installed on both the sides of a wireless link, maintaining the same polarization.*
- *We recommend you to use higher gain antennas for better coverage.*
- *Stratum TM x5 Series products requires professional installation.*

7.5 Recommended Antenna Specifications

This section illustrates the technical specifications of the following:

- Panel Antenna Specifications

: Ensure to use the same antenna specifications listed below, while using any of the non-proxim antennas.

7.5.1 Panel Antenna Specifications

- 23 dBi Dual Polarized Panel Antenna
- 29 dBi Dual Polarized Panel Antenna
- 19 dBi Quad Polarized Panel Antenna

7.5.1.1 23 dBi Dual Polarized Panel Antenna

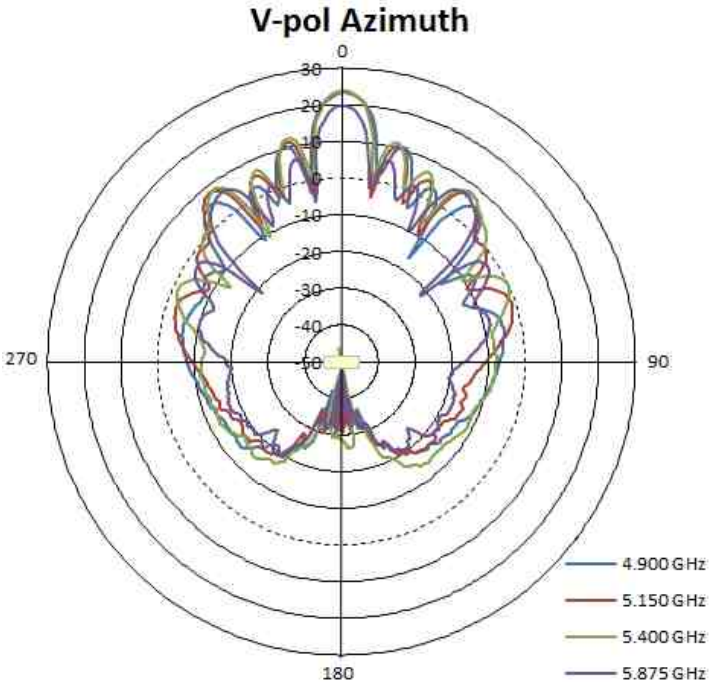
Electrical Specifications

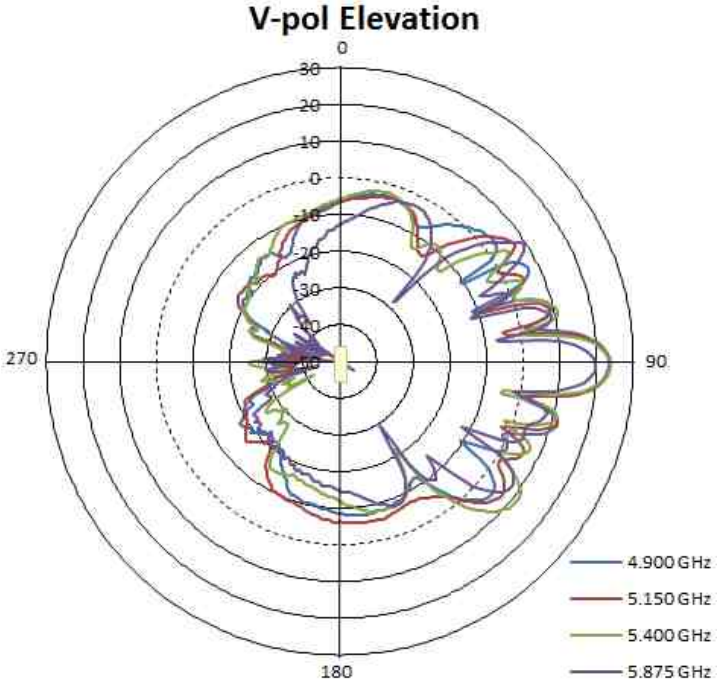
Frequency Range	4.9 GHz - 5.875 GHz
Gain	23.5 dBi V-Pol:24.5 ± 1 dBi H-Pol:23.5 ± 1 dBi
VSWR	1.7: 1
3 dB Beam-Width, H-Plane, typ.	7° to 9°
3 dB Beam-Width, E-Plane, typ.	7° to 9°
Side Lobes, min.	ETSI TS3, TS4, TS5
Polarization	Linear, Vertical and Horizontal
Cross Polarization, typ.	-25 dB
F/B Ratio, min	ETSI TS3, TS4, TS5
Port To Port Isolation	-30 dB
Input Impedance	50 Ohms
Input Power	5 W (max)
Lightning Protection	DC Grounded

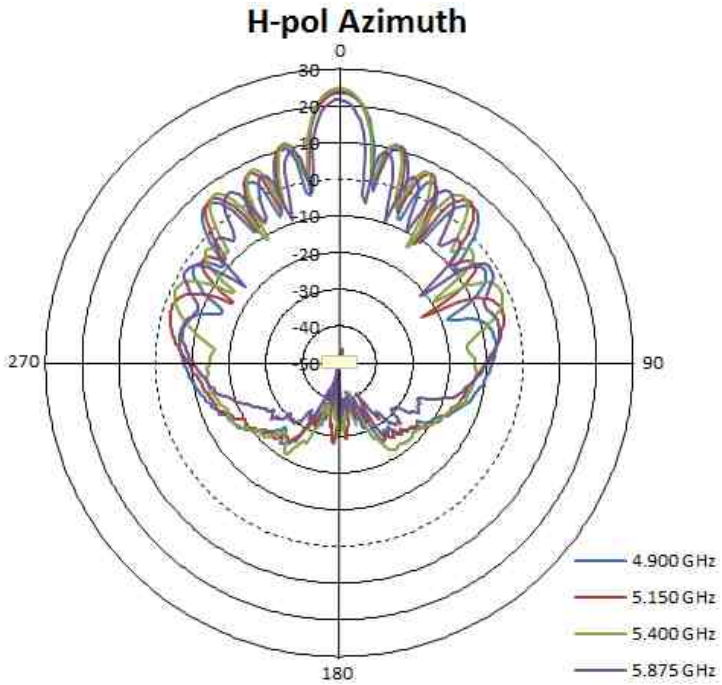
Environmental and Mechanical Specifications

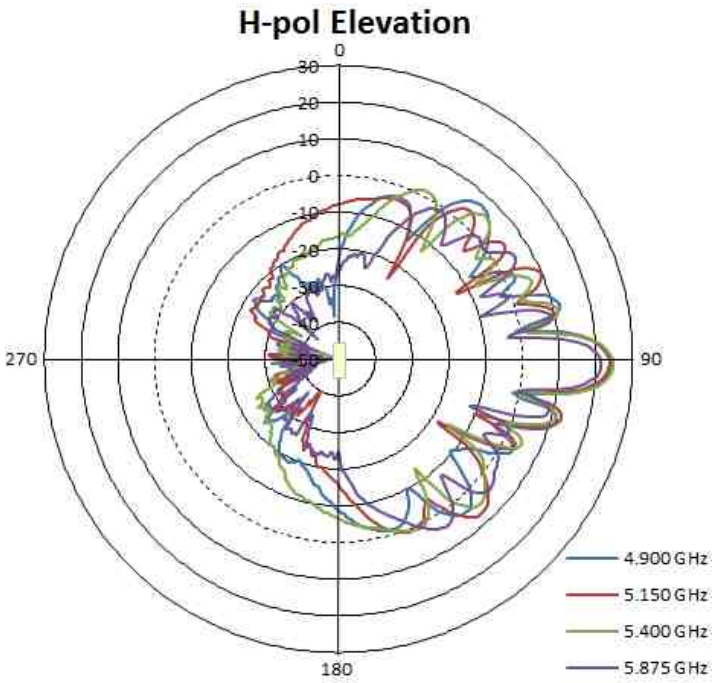
Wind Survival	200 km/hr.
Temperature Range	-40 to +65 °C
Humidity	ETS 300 019-1-4, EN 302 085
Water Proofing	IP67
Dimension (L x W x H)	370 x 370 x 40 mm
Weight	2.1 kg
Connectors	2 x N-type female
Radome Material	UV Protected Poly carbonate
Back Plane	Aluminum protected through chemical passivation

Antenna Patterns









7.5.1.2 29 dBi Dual Polarized Panel Antenna

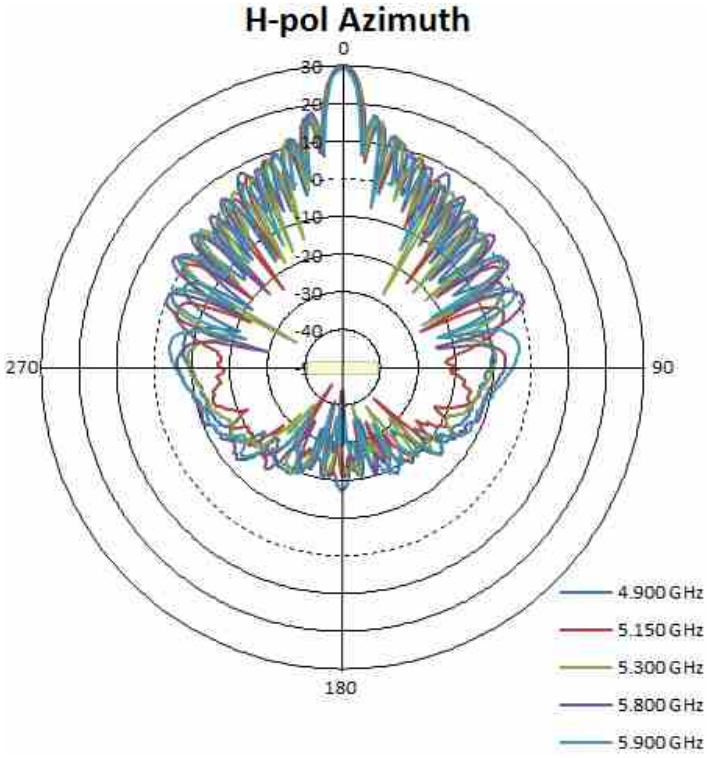
Electrical Specifications

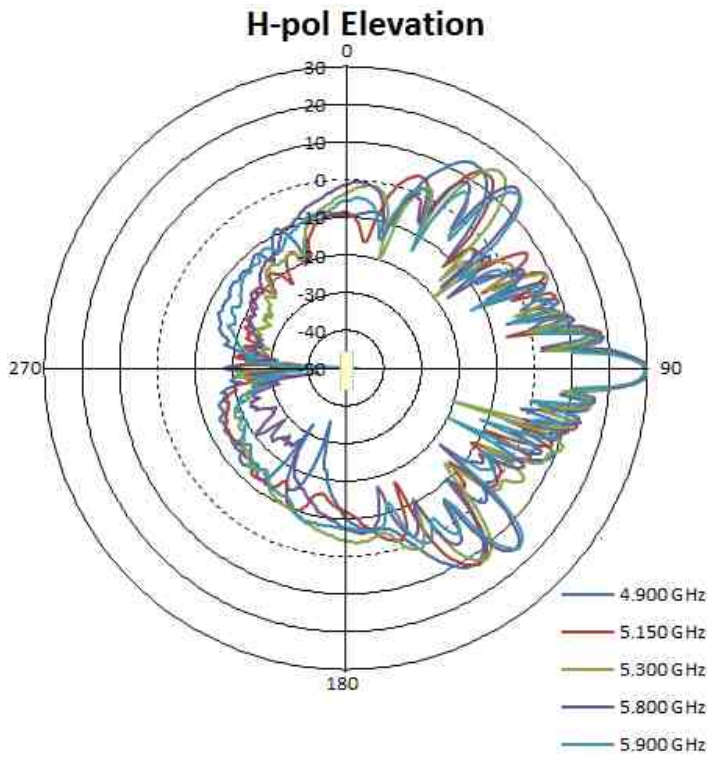
Frequency Range	4.9 - 5.15 GHz	5.15 - 5.875 GHz	5.875 - 6.1 GHz
Gain • Vertical Pol. • Horizontal Pol.	28.5±0.5 dBi 28±0.5 dBi	29±0.5 dBi 28.5±0.5 dBi	28.5±0.5 dBi 28±1 dBi
VSWR, max	2:1	1.7:1	2:1
3 dB Beam-Width, H-Plane, typ.	5.2º	4.7º	4.4º
3 dB Beam-Width, E-Plane, typ.	5.2º	4.7º	4.4º
Side Lobes, min.	ETSI TS3		
Polarization Dual Pole	Dual Polarization Vertical and Horizontal ± 45°		
Cross Polarization, min • V-Pol • H-Pol	-26 dB -25 dB	-23 dB -23 dB	-23 dB -23 dB
F/B Ratio, min	ETSI TS3		
Port To Port Isolation	-30 dB		
Input Impedance	50 Ohms		
Input Power	10 W (max)		
Lightning Protection	DC Grounded		

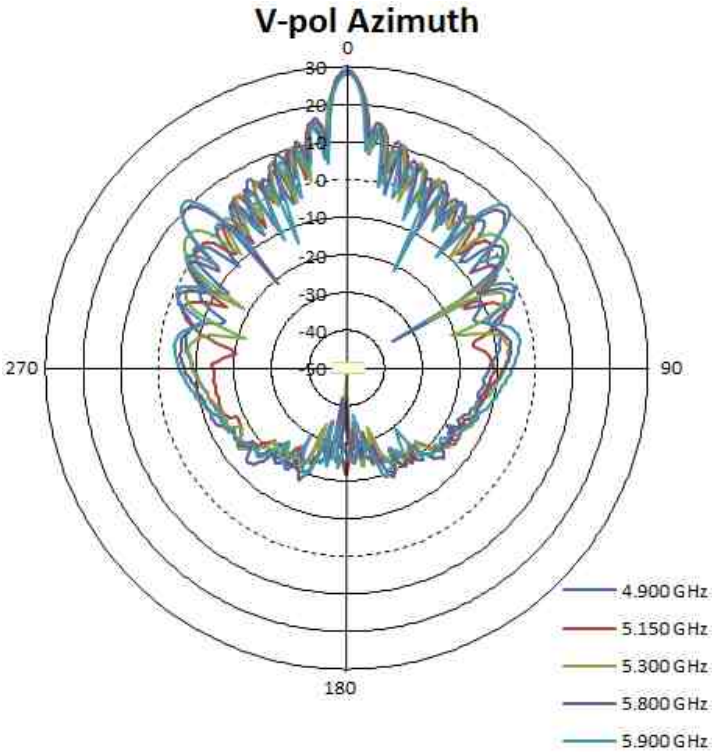
Environmental and Mechanical Specifications

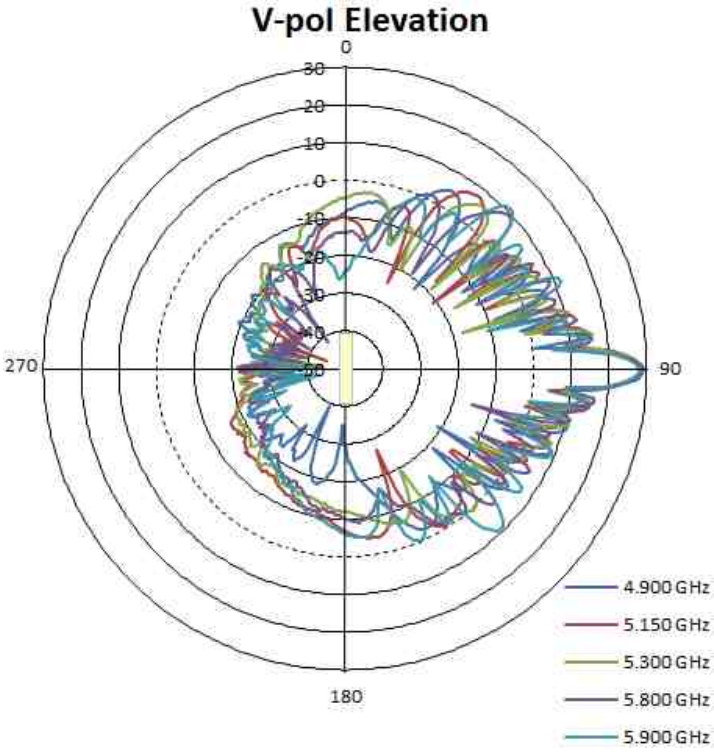
Wind Survival	200 km/hr
Temperature Range	-40 to +65 °C
Humidity	ETS 300 019-1-4, EN 302 085
Water Proofing	IP67
Dimension (L x W x H)	600 x 600 x 22 mm
Weight	4.7 kg
Connectors	2 x N-type female
Radome Material	UV Protected Poly carbonate
Back Plane	Aluminum protected through chemical passivation

Antenna Patterns









7.5.1.3 19 dBi Quad Polarized Panel Antenna

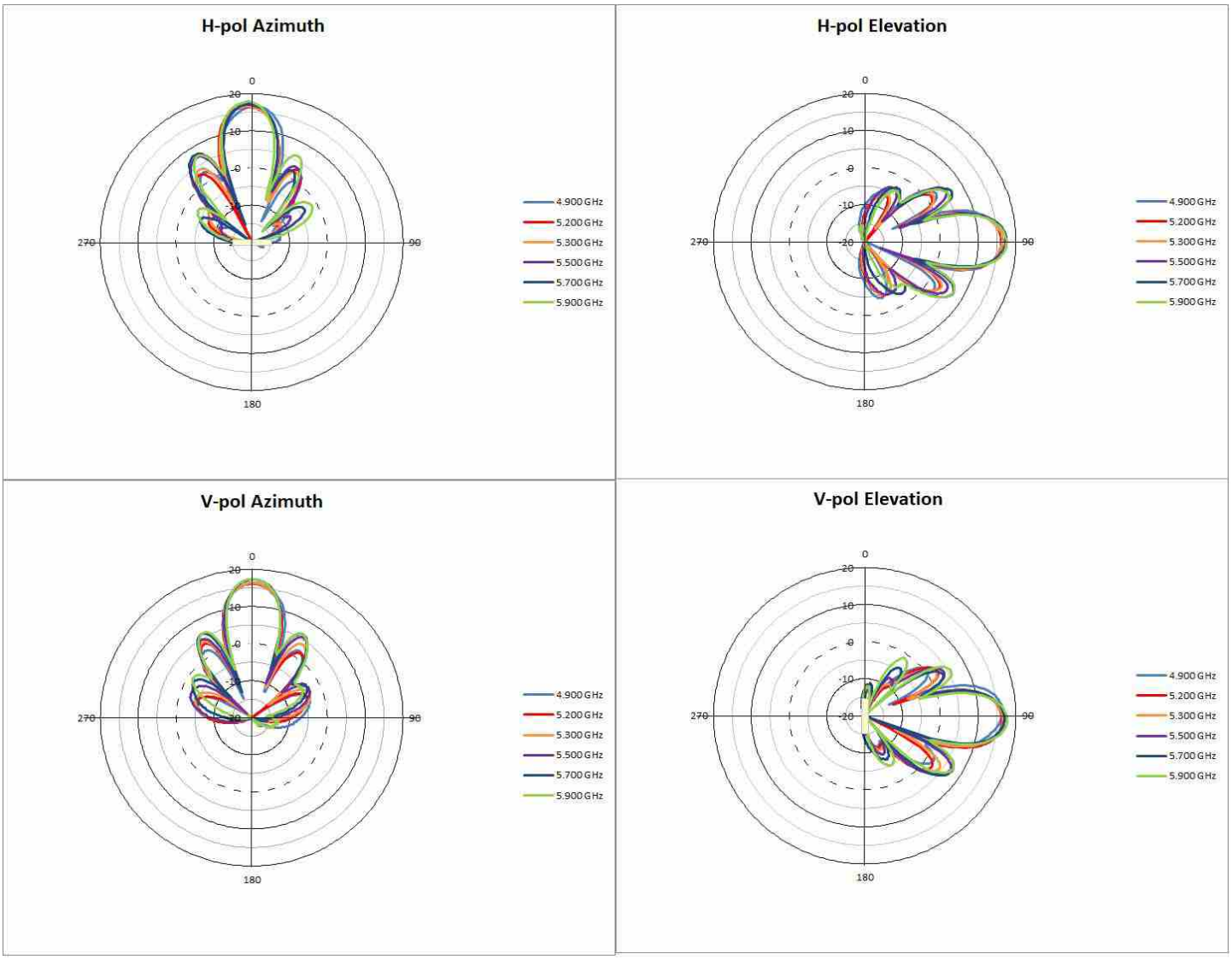
Electrical Specifications

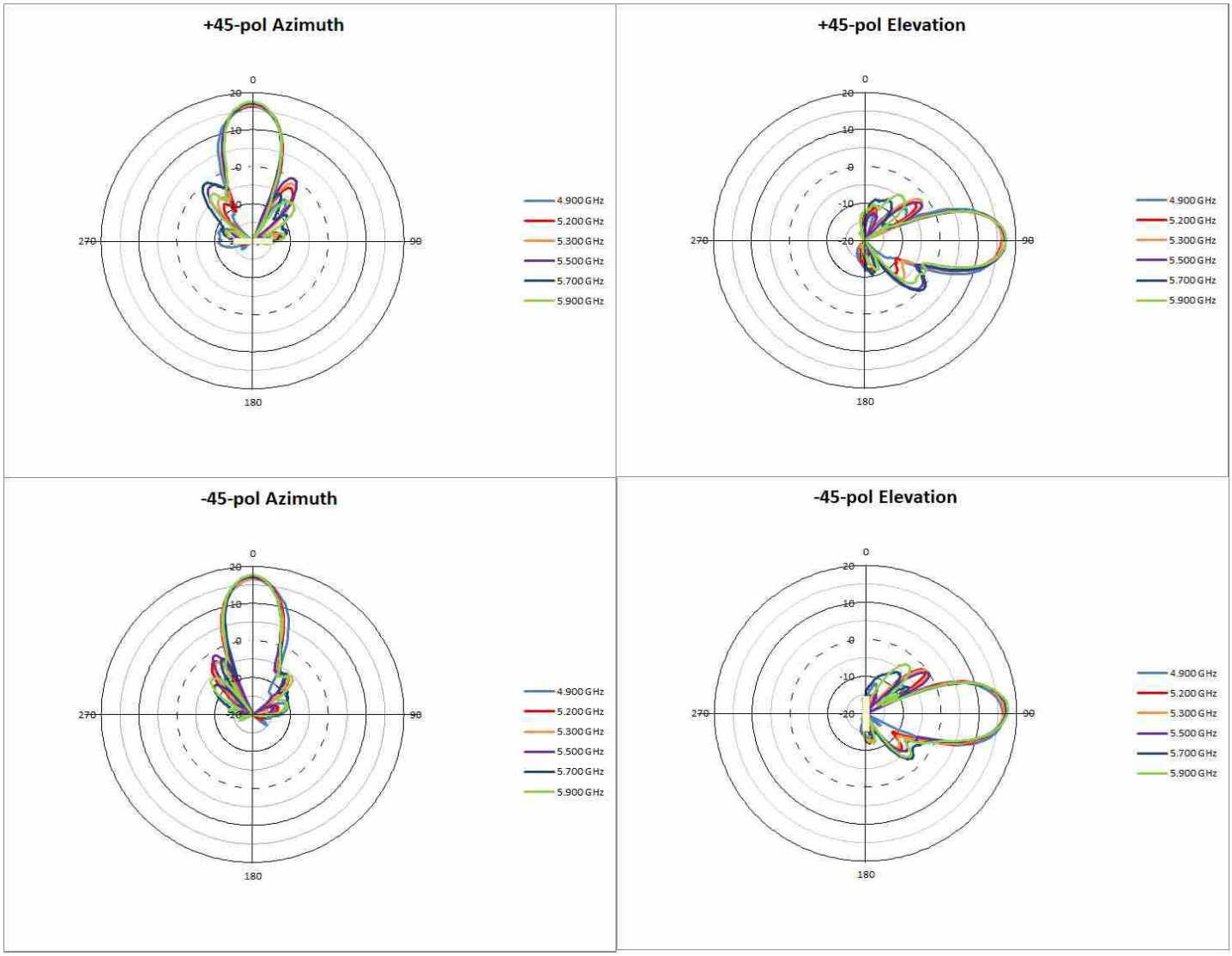
Frequency Range	4.9 - 6.425 GHz
Gain	4.9 - 5.15 @ 4x18 dBi 5.15 - 6.425 @ 4x19 dBi
VSWR, max.	1.7:1
Polarization Quad Pole	Vertical, Horizontal & Dual Slant (±45°)
3 dB Beam-Width-Azimuth, typ.	19º
3 dB Beam-Width-Elevation, typ.	19º
Side Lobes, min.	-12 dB
Front to Back Ratio, min.	-35 dB
Port to Port Isolation, min.	-34 dB
Input Impedance	50 Ohms
Input Power	10 W (max)
Lightning Protection	DC Grounded

Environmental and Mechanical Specifications

Dimensions (HxWxD)	370 x 370 x 40 mm (14.6" x 14.6" x 1.5")
Connector	4 X N-type Female
Weight	2 kg.
Radome	UV Protected Polycarbonate
Back Plane	Aluminum protected through chemical passivation
Operating Temperature Range	-55°C to +65°C
Vibration	According to IEC 60721-3-4
Wind Load	200 Km/h (Survival)
Flammability	UL94
Water Proofing	IP-67
Humidity	ETS 300 019-1-4,EN 302 085 (Annex A.1.1)
Salt Fog	According to IEC 68-2-11

Antenna Patterns




+45-pol Azimuth
+45-pol Elevation
-45-pol Azimuth
-45-pol Elevation
0
90
180
270
20
10
0
-10
-20
4.900 GHz
5.200 GHz
5.300 GHz
5.500 GHz
5.700 GHz
5.900 GHz

Antenna Installation 8

8.1 Safety Precautions

Listed below are the safety precautions to be satisfied, prior to the outdoor antennas installation:

Outdoor antennas and antenna cables (good conductors of electricity) should be installed properly to avoid the transients or electrostatic discharges (that occur due to lightning during thunderstorm) which is damages your equipment and causing personal injury or death to the persons touching the exposed metal connectors of the equipment.

When installing, disconnecting, or replacing one of the cable components, ensure that each of the exposed metal connectors of the antenna cabling system are grounded locally.

Do not install the antenna, where there is a possibility of contact with the high-voltage arc-over from the power cables or service drops to the buildings. Ensure that the antenna-mast or antenna-tower are not close by any power line, during the installation or removal of antennas.

Apply a **"Danger"** label on a plainly visible area of the antenna support structure.

Do not climb the rooftops during a thunderstorm, in wet or windy conditions, or on the equipment installation area which is covered with ice or snow.

Do not touch the antennas, surge arrestors, or antenna cables during a thunderstorm.

Install the antennas at a safe distance (at least twice the height of the antenna-mast plus the antenna) from power lines or telephone lines.

Mount the antennas at a safe distance, avoiding any human contact during the normal equipment operation.

Humans should ensure 50cm separation from the antenna (8 inches), avoid the possibility of exceeding the FCC radio frequency exposure limits, during the normal operation of the equipment.

Verify that the low-loss antenna cable used to connect the antenna with the surge arrestor, or the Ethernet cable used to connect the surge arrestor, are at least 1m (3ft.) away from any high voltage current cable.

Check whether the antenna mast and its guy wires or wall bracket are positioned correctly and secured properly to the roof or walls. Also, ensure that the base area, where the antenna-mast is mounted is weatherproofed.

Ensure, that the grounding system for the antenna mast and the surge arrestor have been installed. The grounding system must comply with the local electrical code and other requirements. See **Grounding the Antenna**.

Always consult an experienced electrician to assure that the antenna mast, surge arrestor, and the equipment hardware are grounded properly.

The antenna cable between the antenna and the surge arrestor should be grounded. Ensure that the exposed metal connector of the cable is grounded locally, if the cable is disconnected at one end (disconnected to replace the surge arrestor).

8.2 Installation Process

Follow the following step-by-step procedure to install outdoor antennas:

1. Ensure that all the materials, essential to install the outdoor antennas are acquired. See Required Materials.
2. Once you have acquired all the required materials, refer ***Quick Installation Guide*** (that comes along with your product) to mount the outdoor equipment and begin the outdoor antenna installation.
3. Verify the optimal antenna placement, maintaining a clear line-of-sight. See Determining the Optimal Antenna Placement.
4. Mount the antenna to the support structure, following the guidelines as described in Mounting the Antenna.
5. Verify that the device, support structure for antenna (antenna-mast) and entire cable set-up for the antenna are connected properly. See Connecting the Antenna Cable.

6. Connect the antenna cable to the antenna. See **Connecting the Antenna Cable**.
7. Ensure that the cabling of Ethernet / power cables and the surge arrestor is proper. See **Connecting the Surge Arrestor and Ethernet / Power cables**.
8. Ensure that the antennas are grounded properly to the grounding system, satisfying the local electrical code requirements. See **Grounding the Antenna**.
9. Once the antenna is properly positioned, grounded and the outdoor cable setup is verified, secure all the cables and use weatherproofing tape to seal all the outdoor connectors. See **Sealing the Cable Connectors** .
10. Make sure that the outdoor antennas at both the ends maintain the same antenna polarizations.

: *For easy outdoor antenna installation, note the following:*

- *Go through the* **Safety Precautions**.
- *Read all the requirements outlined in this chapter. See* **Required Materials**.
- *Familiarize yourself with the antenna and the radio-specific mounting instructions, prior to climbing any roof or ladder.*
- *Verify that you have arranged all safety measures for outdoor installation or rooftop installation. See* ***Safety Precautions****.*
- *Test all the equipment before beginning the actual rooftop installation, to determine if all the required equipment is functioning properly.*
- *Install the grounding system for the antenna mast, device, and surge arrestor before connecting the cables. This protects your system against lightning strikes during installation.*
- *When you remove or relocate the antenna, verify the* ***Required Materials*** *and* ***Safety Precautions****, before you restart the installation process, and follow the above steps in exactly the reverse order.*

8.2.1 Required Materials

The outdoor installation of the equipment and the antennas, require the following:

- An outdoor radio unit.
- An outdoor antenna, supporting the local electrical code.
- A low-loss antenna cable.

: *We recommend you to use a coaxial antenna cable (P/N CBL-240-6-RA), that is available with your distributor.*

- Antenna mast or wall bracket for the antenna/device**.**
- A grounding system that meets the local electrical code. SeeGrounding the System.
- Weatherproofing kit for sealing all the cable connections. See Sealing the Cable Connectors.
- Tools and material to mount the antenna. See Mounting the Antenna.
- Tape or wraps to attach the antenna cable to the mast.
- Ethernet cable (RJ 45 cable / Cat6 Ethernet cable) with waterproof cap.
- Proper tools for system installation.
- Ethernet Surge Arrestor and Surge Protector (RF-cable). See **Connecting the Surge Arrestor and Ethernet / Power cables**.

Ensure that you have acquired all the materials listed above, to begin with the outdoor antenna installation. Refer to the *Quick Installation Guide,* that comes along with your product, for details on mounting the outdoor equipment.

8.2.2 Determining the Optimal Antenna Placement

To achieve the maximum throughput, the outdoor antenna must have clear line-of-sight with the antenna at the other end. The outdoor antennas are said to have a clear line-of-sight, when there are:

- No obstacles in the direct path between the antennas (antenna beam)
- No obstacles within a defined zone around the antenna beam

Although, the radio signal can work well without the clear line-of-sight in urban environments, where the signal is transported by reflection rather than transporting it directly along the obstacles. The following figure shows some typical examples of obstacles you must avoid in urban environments, for the directional antenna to operate effectively.

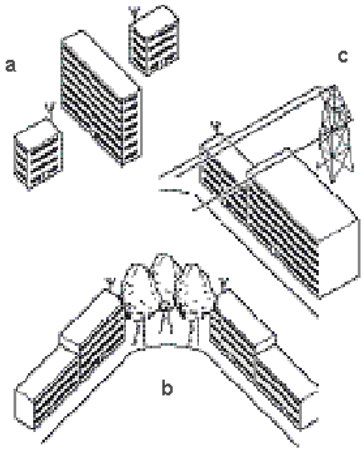


Figure 8-1 Obstacles to be avoided: (a) Neighbouring Buildings (b) Tall Trees (c) Power Lines

To minimize the signal interference or reflections due to obstacles, note the following guidelines:

- Mount the antenna as high as possible above the ground to allow maximum clearance.
  - In open areas, ‘ground’ is the actual surface of the earth.
  - In dense urban areas, ‘ground’ is to be interpreted as the height of the highest obstacle in the signal path between the two antenna sites.
- Avoid trees in the signal path to avoid signal absorption due to seasonal changes (leaves or ice).
- Install the antenna at least 2m (6ft.) away from all other antennas.

Other situations in which reflections of the radio signal may cause interference are environments with large reflecting surfaces, parallel or partly perpendicular to the antenna beam, such as:

- Mirror-glass buildings.
- Crowded parking lots.
- Water surface, moist earth and moist vegetation.
- Electric power lines and telephone lines above the ground level.

: *Reflective surfaces can be used to improve the performance of a link, if the direct line-of-sight is impaired or absent.*

In the absence of a direct path or clear line-of-sight, transporting a signal through reflection depends on two factors:

- **Fresnel Zone**: It is required to calculate the distance of the obstacle from the antenna. See **Fresnel Zone**.
- **Clearance Factor**: It is required for optimal performance (See **Clearance Factor**). Ensure that the type and placement of the antennas leave sufficient clearance of the Fresnel Zone at the maximum width of the bulge, which is typically at the mid-point between the antennas.

8.2.3 Mounting the Antenna

Mounting an antenna directly to the wall does not let you align the antenna properly with the corresponding antenna at the opposite end of your wireless link. Poor antenna alignment typically results in poor performance and therefore, we recommend mounting the antennas to a mast.

The two methods followed frequently to erect an antenna mast are:

- **Tripod Mount**: The tripod mount is used primarily on peak and flat roofs. The antenna mast must be secured to the roof using three or four guy wires equally spaced around the mast. When the height of the antenna mast is more than 3m(10ft), you should use at least three guy wires for every 3m(10ft) section of the mast.
- **Wall (Side) Mount:** A wall (side) mount allows you to mount the antenna (mast) on the side of a building or on the side of an elevator penthouse. This provides you with a convenient mounting location, when the roof overhang is not excessive or when the location is high enough to provide a clear line-of-sight.

When mounting multiple antennas on a single mast, use the following methods to minimize the influence of cross-talk interference between the antennas:

  – Place your antennas as far as possible.
  – Mount the directional antennas, such that the identical side of both the antennas face the same direction.

***:** As the mounting procedures for the various antennas differ from one another, refer to the guide that comes along with the antenna.*

: The antennas installed at both the ends of a wireless link should maintain same antenna polarizations.

8.2.3.1 Antenna Mast Requirements

To accommodate the antennas, the antenna mast must satisfy the following requirements:

- The construction of the antenna mast must contain sturdy, weatherproof, and non-corrosive material (for example, galvanized or stainless steel construction pipe).
- Diameter of the mast should be at least 35mm (1.4 inches). The diameter of the antenna mast vary depending on the type of antenna you intend to install.
- The height of the antenna mast must be high enough to allow the antenna to be installed at least 1.5m(5ft) above the roof. The height of the antenna should be at least 3m (10ft) above, if it is a metal roof.
- The antenna mast or wall bracket must be free from any material (like paint) that prevents a good electrical conduction with the antenna.

8.2.3.2 Antenna Tilt Angles and corresponding EIRP values

***:** The below mentioned particulars are applicable only to the devices operating in U-NII-1US frequency band 5.15 GHz - 5.25 GHz.*

The Federal Communications Commission (FCC) established new rules for the 5.15GHz - 5.25GHz U-NII-1 band in the Report and Order FCC-14-30A1 are effective from June 2nd, 2014. With the help of professional installation, all the Proxim devices can be configured to comply with the power requirements set in the rules. For an angle of elevation which is above 30°, the maximum EIRP limit should be set to 125mW (21dBm). The compliance can be achieved through proper selection of antenna, angle of elevation, and Tx power control to provide reasonable protection from harmful interference to users, authorized devices, and co-channel NGSO/ MSS operations.

The antenna/devices located at different altitudes should be tilted at the correct angle to efficiently transmit/receive the signals between the devices in the wireless network. The following figure shows the antenna tilt and its importance when the successive devices are located at different elevations above the ground.

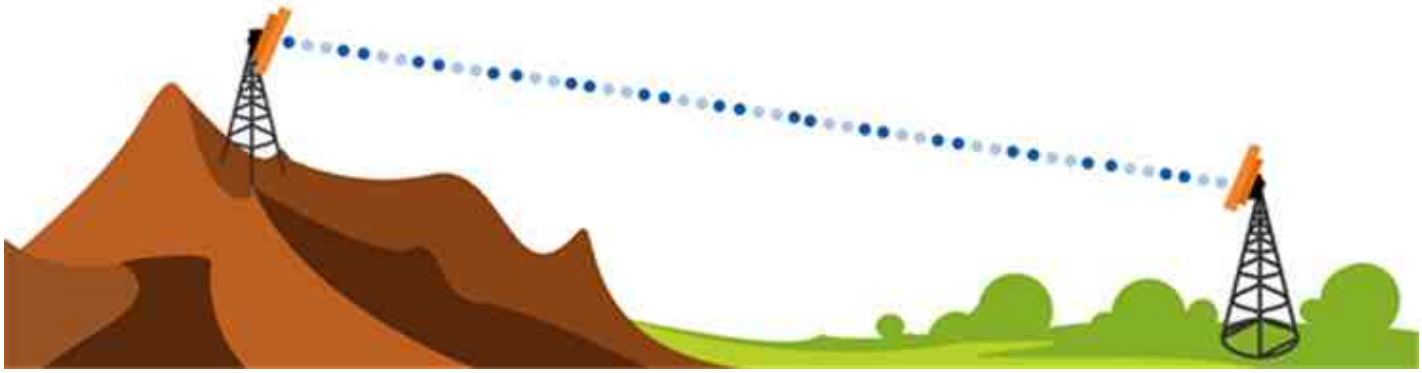


Figure 8-2 Typical installation showing device/antenna tilt angle

The radiation patterns for a device with Dual polarized antenna in **Elevation** planes are shown below in **Figure 8-3**. As per the regulatory domain, there are no limitations to the Azimuthal plane with respect to EIRP, but the Elevation plane has a limit specific to EIRP above 30° as 21dBm. To comply with this specification, Proxim products have an option to control the transmit power based on the installation tilt angle and the radiation pattern of the antenna.

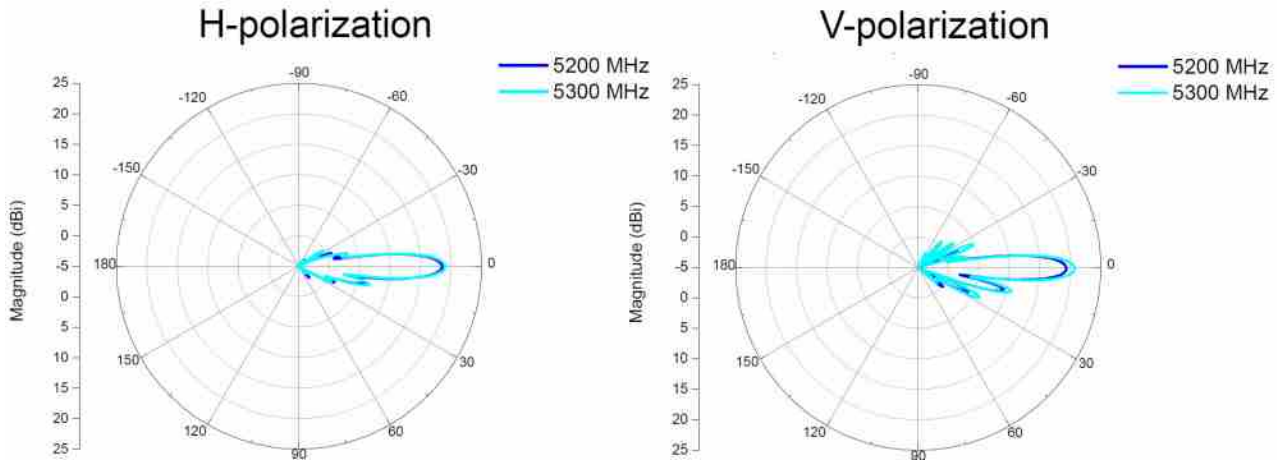


Figure 8-3 Antenna radiation patterns for Elevation Planes

The formula used for the calculation of **Transmit Power** is given below:

Transmit Power = EIRP - G $_{(30 - ø)}$ - MIMO Gain

Where,

EIRP - Equivalent Isotropically Radiated Power

G $_{(30 - ø)}$ - Antenna gain at (30 - ø) in the elevation plane

MIMO Gain - Gain for Multi Input Multiple Output products *(2x2 MIMO Gain is 3dB, 3X3 MIMO Gain is 4.8dB and 4X4 MIMO Gain is 6dB).*

- The calculation of Transmit Power to comply with the EIRP limits for an antenna with a gain of 22dB is explained below for three different tilt angles:
  - **Case 1**: ø = 0° (No antenna tilt)

– The antenna gain for ø = 0° is shown in the following figure:

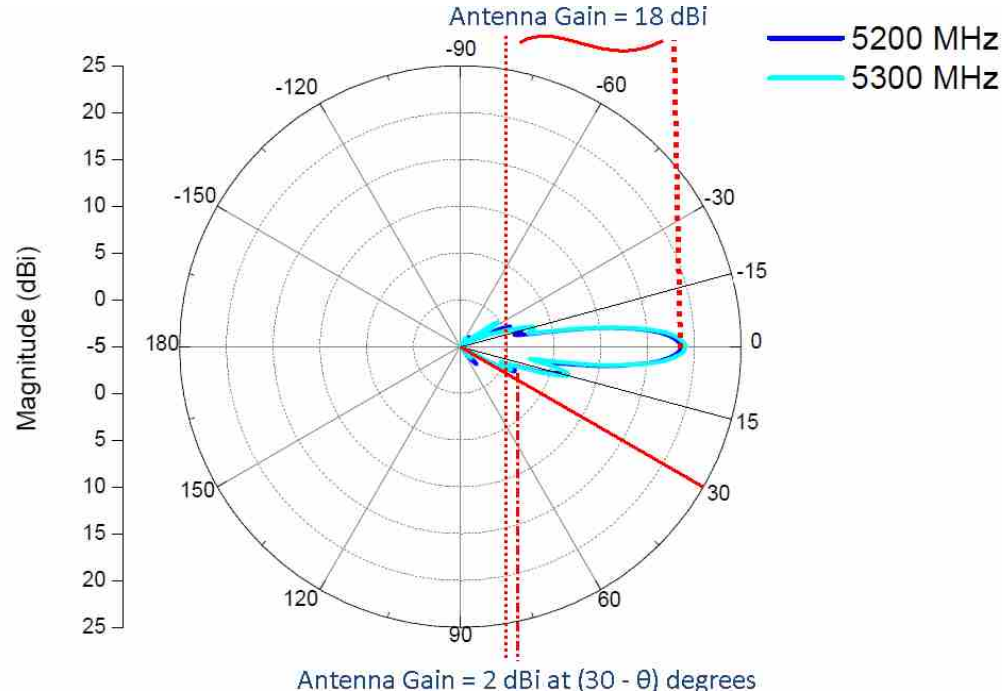


Figure 8-4 Antenna gain at (30- 0) = 30^0

– Transmit Power = EIRP - G $_{(30-ø)}$ - MIMO Gain

= 21 - 5 = 16dBm

- **Case 2**:ø = 15° (antenna tilted upward)
  – The antenna gain for **ø = 15°** is shown in the following figure:

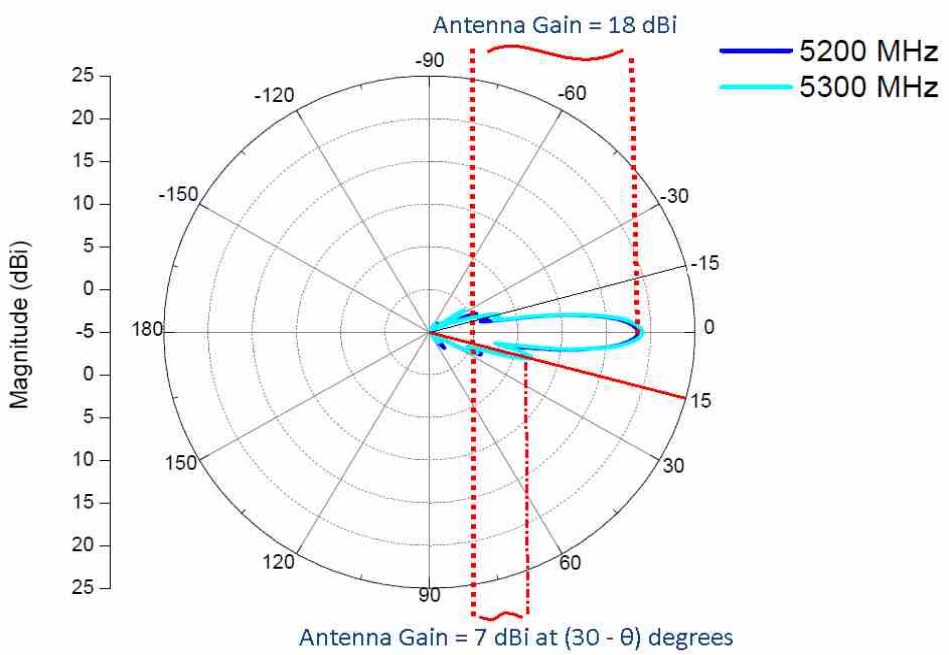


Figure 8-5 Antenna gain at (30- θ) = 15^0

– Transmit Power = EIRP - $G_{(30-ø)}$ - MIMO Gain

= 21 - 10 = 11dBm

- **Case 3**: ø = -15° (antenna tilted downward)

  – The antenna gain for ø **= -15°** is shown in the following figure:

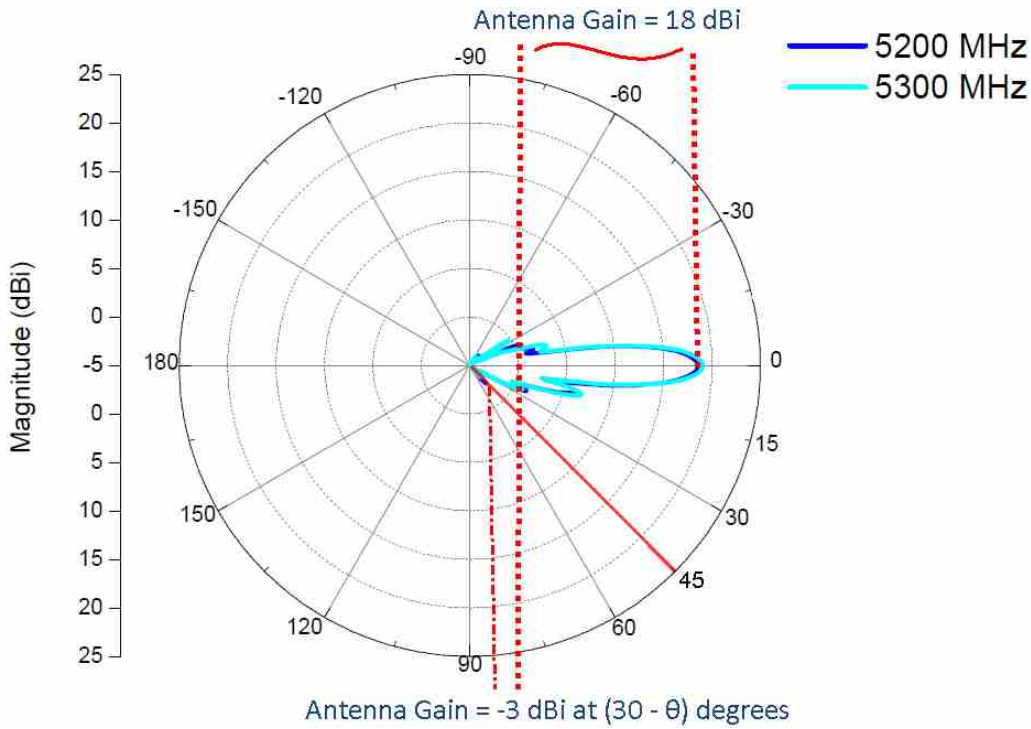


Figure 8-6 Antenna gain at (30- θ) = 45^0

– Transmit Power = EIRP - $G_{(30-ø)}$ - MIMO Gain

= 21 - 0 = 21dBm

:

- *-10 degree indicates that the antenna is tilted downwards.*
- *10 degrees indicates that the antenna is titled upwards.*

Tilt Angle (degrees)	Allowed Transmit Power per Single chain (dBm)	EIRP of Product (dBm)	Remarks
0	12	37	
-10	13	42	
-20	13	38	
-30	17	42	
10	10	35	
20	10	35	
30	-5	21	Not Recommended

8.2.4 Connecting the Cables

Once the outdoor antennas are properly mounted, the cable setup essential to complete the outdoor antenna installation is depicted in the following figure:

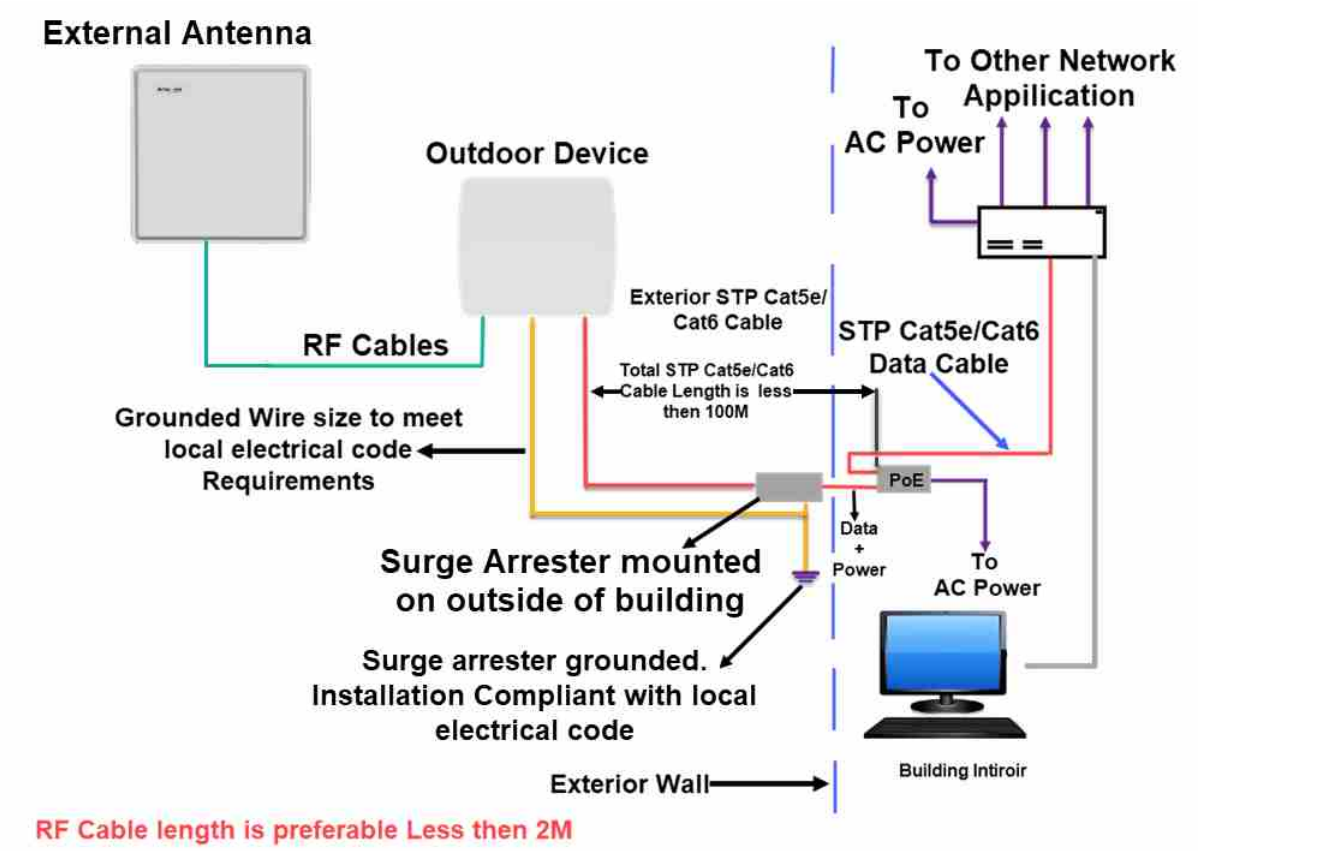


Figure 8-7 Cable Setup

The entire outdoor cabling setup requires the following cabling to be done:

1. Connecting the Antenna Cable
2. Connecting the Surge Arrestor and Ethernet / Power cables
3. Grounding the System

8.2.4.1 Connecting the Antenna Cable

Follow the following steps to connect an antenna to the device, by using an antenna cable.

1. Use RF cable (antenna cable) to connect the outdoor device to an external antenna.
2. Connect the right-angled N-male connector of RF cable on the antenna. The antenna cables run from the external antenna to the RP-SMA connectors on the device.
3. Secure the antenna cable to the antenna mast, as the cable connectors do not support the full weight of the cable.
4. Connect the other end of the antenna cable to the device.

: Do not use tools to tighten the cable connectors, as they damage the antenna cable and connectors.

5. If required, adjust the direction of the antenna.
6. Tighten the nuts of the antenna to lock the antenna into its position.

: Avoid over-tightening of the connector, nuts and screws that are used to mount the antenna, to protect the antenna and device from getting damaged.

7. Secure the cable along its complete length with a cable or electrical tape to relieve strain on the antenna connector. No part of the cable should be allowed to hang free, especially the parts that are routed outside the building.
8. Weatherproof all the outdoor connectors. See Sealing the Cable Connectors.

Ensure you follow the below guidelines while using the antenna cable:

- The entire cable used must be secured and no part of the antenna cable should be allowed to hang free, precisely the outdoor cable parts.
- The antenna cable and cable connectors are not designed to withstand excessive force.
- Do not use the connectors like 'cable grips', to pull the cable through raceways or conduits.
  - Do not use the cable connector to support the weight of the cable during or after installation.
  - Do not use any tool to tighten the connectors.
- Always seal the connectors using the weatherproofing tape.
- Avoid any water or moisture entering the cable, as it impacts the performance of the wireless link.
- Prior to sealing the outdoor connectors and permanently securing the cable to the wall with cable ties and wall hooks, assure that the components that are installed are functioning properly.

Antenna Cable Routing

The antenna cable must be routed and fixed in such a way, that the installation technicians have a clear passage area. All the connectors that are located outdoor must have a weatherproof seal. We recommend you to seal the connectors only after completing the final radio test. See Sealing the Cable Connectors.

8.2.4.2 Connecting the Surge Arrestor and Ethernet / Power cables

Perform the following steps to ensure proper surge protection, and Ethernet or power cabling:

- Connect the surge arrestor near the outdoor device with a CAT6 Ethernet cable (properly ground it near to the cable ingress point of the building, complying with the local electrical code requirements).
- Connect the RJ 45 **IN / LAN** port on the POE (power injector) and the network interface card of the personal computer with a Cat5e Ethernet cable.
- Plug one end of the Cat6 Ethernet cable into the Ethernet Port of the surge arrestor (near building ingress point) and connect the other end of the cable to the **OUT / POE** port on the POE. Ensure that the cable connector is latched securely.
- Connect the remaining ports on both the surge arrestors (one near the outdoor device and other at the building ingress point) with an RJ 45 terminated cable.

IMPORTANT! Ensure to loop the cable before entering the premise to prevent water ingress.

: It is mandatory to install an approved lightening surge protector at the building ingress point. If the device is installed in a region subjected to violent thunderstorms or severe weather conditions, then installation of an additional approved lightening surge protector near the device is recommended. To buy an additional Surge Protector (Part Number: 235-00001), place an order separately with your distributor.

: The surge arrestor and the antenna mast must be connected to the same grounding system, by using the shortest cable possible, as prescribed by local electrical codes.

8.2.4.3 Grounding the System

Direct grounding of the antenna mast, device, and surge arrestor is extremely important. Refer to the *Quick Installation Guide*, that comes along with your product, for detailed illustration on grounding the outdoor device and surge arrestors.

: *A safety grounding system is necessary to protect your radio from lightning strikes and the static electricity generated from it.*

Grounding the Antenna

Following precautions should be satisfied, while grounding the antenna:

- The antenna mast and the grounding system should be installed only by qualified installation professionals and electrician, who are familiar with local building, safety, and electrical codes in the country of use.
- The antenna mast, the device, and the surge arrestor must be connected to the same ground, by using an equi-potential bonding conductor.
- A good electrical connection should be made to one or more ground rods, by using at least a 12 AWG ground wire and non-corrosive hardware.

8.2.5 Sealing the Cable Connectors

Corrosion of the antenna cable, cable connectors and other wireless outdoor installations degrade the performance of the wireless link. To avoid, you must always seal the outdoor cable connectors using weatherproofing tape. To weatherproof the antenna connectors at both the ends of a wireless link, follow the following step-by-step procedure:

1. **Collect the required material:**

   The material required for weatherproofing connectors are,

   - Any standard Butyl Mastic Tape
   - Any standard Vinyl Tape

   We have used the following Butyl Mastic Tape and Vinyl Tape as an example to demonstrate the weatherproofing steps:

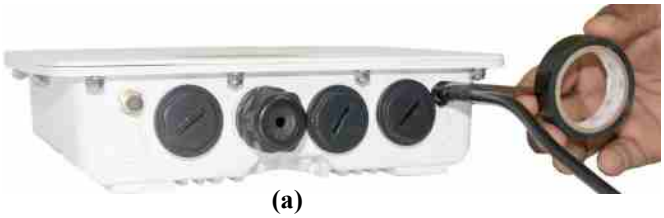
Butyl Mastic Tape

Vinyl Tape

2. Follow the following weatherproofing steps:

Step 1: Wrap vinyl tape in a half-lapped fashion, from the weatherproof connector end and continue wrapping down 3 inches onto the RF cable.

a. Weatherproofing at the device end:



(a)

(b)

b. Weatherproofing at the antenna end:

(a)

(b)

(c)

Step 2: Wrap a second layer of vinyl tape in the reverse direction over the first layer of tape.

a. Weatherproofing at the device end:

(a)

(b)

b. Weatherproofing at the antenna end:

(a)

(b)

Step 3: Now, wrap a third layer of vinyl tape over the other two layers but with the adhesive side up as this provides a sticky surface for the next layer.

a. Weatherproofing antenna connectors on the device:

(a)

(b)

b. Weatherproofing antenna cable:

(a)

(b)

Step 4: Next, wrap a layer of the butyl mastic tape over the adhesive side of the tape, covering all of the tape and connector.

a. Weatherproofing antenna connectors on the device:

(a)

(b)

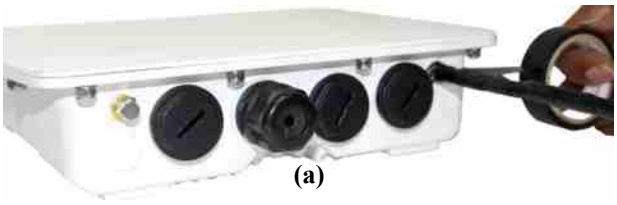
b. Weatherproofing antenna cable:

(a)

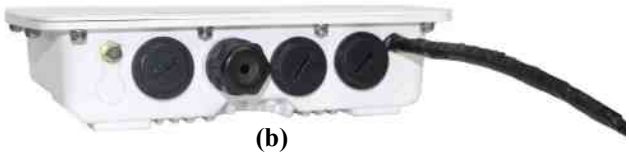
(b)

Step 5: Wrap vinyl tape over the butyl layer and cover the entire tape assembly.

a. Weatherproofing antenna connectors on the device:



(a)



(b)

b. Weatherproofing antenna cable:

(a)

(b)

Step 6: Place a small zip tie over the last wrap of tape to prevent it from unwrapping over time.

The figure below depicts the complete weatherproofing of the RF connection:

8.2.6 Aligning the Antenna

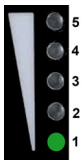
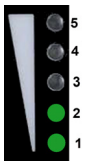
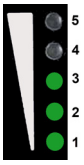
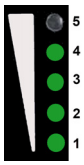
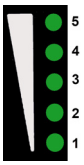
Antenna alignment is the process of physically aligning the antenna of the radio receiver and transmitter to establish a link with a better throughput. The antenna alignment process is usually performed during the installation of the antennas. We can align the antennas by using the following method:

- Antenna Alignment using RSSI LEDs

Alternatively, consult an antenna installation service professional to optimize the antenna alignment.

8.2.6.1 Antenna Alignment using RSSI LEDs

RSSI LEDs helps to align/adjust the antennas such that the signal between the devices is optimal. The number of RSSI LEDs which glow as per the signal level are as below:

SNR Range (dB)	Number of glowing RSSI LEDs	
1 - 12	1	
13 - 18	2	
19 - 24	3	
25 - 30	4	
> 30	5	

Measuring Signal Performance 9

9.1 Introduction

The performance of a microwave link (wireless link established between two outdoor antennas) is closely related to the following factors:

- Range
- Fresnel Zone
- Clearance Factor

Calculating the above factors help you align the antennas properly and achieve a better throughput.

9.2 Determining the Range

Range is the maximum distance a microwave link travels and is based on the:

- Type of the outdoor antenna equipment (Outdoor antennas differ in technical specifications).
- Data speed of the wireless link.
- Clearance of the signal path (see Clearance Factor).

Use the following formula to determine the range of the microwave link:

Range = Maximum Range x Clearance Factor

1. **Maximum Range**: It is the theoretically calculated value achieved under optimal circumstances, by using the available products and their technical specifications that comply with the local radio regulations. The calculations made assuming the optimal radio conditions do not guarantee of achieving the same maximum distance at your location.
2. **Clearance Factor**: See Clearance Factor.

Variations in calculations of the above two factors occur due to any of the following reasons:

- Incorrect alignment of antennas.
- Polarization mismatch of the antennas.
- Sources of interference or unexpected reflections in the signal path that affect the quality of communication (Refer Determining the Optimal Antenna Placement).
- Severe weather conditions such as heavy rainfall, snow or strong winds.
- Unexpected obstacles in the link path.
- Seasonal influences such as leaves on trees or icing of the antennas.

9.3 Fresnel Zone

The narrow antenna beam emerged from the antennas contain a bulged area called as Fresnel Zone. The first Fresnel Zone is known to be an imaginary boundary line offset along the direct path of the signal, where a signal reflected will travel an additional one-half distance of wavelength. Each succeeding Fresnel Zone boundary adds an additional half-wavelength to the reflected path distance than the direct signal path between the antennas.

When any significant part of the Fresnel Zone is obstructed, a portion of the radio energy is lost that results in reduced performance. Reduced performance can also occur when obstacles close to the antenna beam cause signal reflections or noise that interfere with the radio signal.

Weather conditions (rain or snow) usually do not have much impact on the performance of your device, provided you have sealed all the cable connectors with weatherproofing tape. Seasonal influence on signal propagation can occur in the following situations:

- Marginal communications quality in late fall (with no leaves on the trees along the signal path) might fail in the summer (with leaves on the trees along the signal path).

- In winter, a wireless link can fail when the antenna is exposed to ice buildup or when the antenna elements are covered with snow.

Radio paths over water or extremely flat ground require optimization of antenna height at one end. This is due to in-phase or out-of-phase reflections. Adjustment of antenna height by 1 to 3 meters may move the signal from null to peak. Long distance links may be obstructed by earth curvature, so the antenna height requirements must not only take the height of obstructions and Fresnel Zone into account but also the earth bulge. The earth bulge is approximately 5 meters (16.4 ft.) at a link distance of 16 Kilometers (10 millimeters). Consult your supplier to take appropriate steps to maintain or optimize wireless link performance.

9.3.1 Fresnel Zone Calculation

The exact shape and width of the Fresnel Zone is determined by calculating the Fresnel Radius. The distance between the Fresnel Zone boundary and a straight line running along the signal path (shortest path) between the antennas is called the Fresnel Radius. Fresnel Radius can be determined by using the path difference (difference between the shortest path and alternative path) and frequency of the radio signal. If there are no obstacles in the space forming 60% of the path difference, then the propagation characteristics are said to be the same as that in free space.

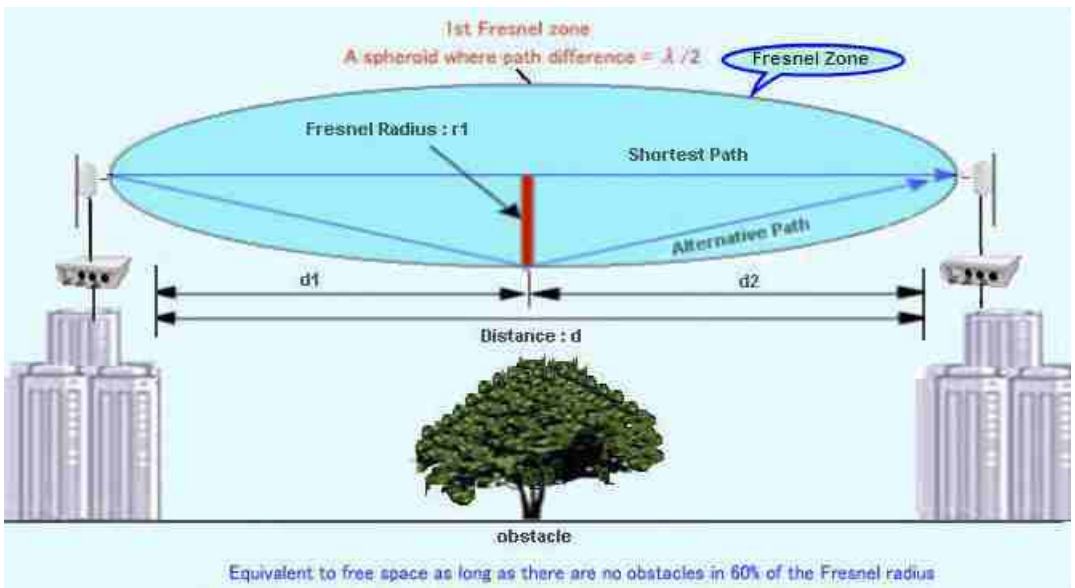


Figure 9-1 Fresnel Zone Calculation

Let's say, in the above figure:

- **d1** is the distance between the obstacle and the antenna at one end.
- **d2** is the distance between the obstacle and the antenna at the other end.
- λ is the wavelength of the operating frequency.

Then, Path Difference (**d3**) and Fresnel Radius ($\mathbf{r_n}$, radius of the $\mathbf{n^{th}}$ Fresnel Zone) can be calculated from the formula below:

$$\text{Path difference: } d3 = \sqrt{d1^2 + r_n^2} + \sqrt{d2^2 + r_n^2} - d = \frac{\lambda}{2}$$

$$\text{Fresnel radius: } r_n = \sqrt{n\lambda \frac{d1 \times d2}{d1 + d2}}$$

(where **n** = 1, for the first Fresnel Zone and $\mathbf{r_n} = \mathbf{r_1}$)

The path difference is the required clearance of the antenna beam from obstacles in its path to avoid loss of radio signal. Signals reflected from any even-numbered Fresnel Zone result in signal cancellation while the odd-numbered Fresnel Zones add to the direct path signal.

9.4 Clearance Factor

Clearance Factor is a correction value (in percentage) that should be used in case, where the signal path of your wireless link does not provide the minimum clearance as listed in the Maximum Range Table. In general, clearance factor is taken as 60% of the Fresnel Zone and is calculated as:

Clearance Factor = Fresnel Zone x 60%

For optimal performance of your outdoor wireless link, the signal path between the BSU and SU must provide sufficient clearance. Clearance is interpreted as:

- The total height above the surface of the earth, in the open areas without obstacles in the signal path. Let's say antenna is mounted on the roof, then clearance is the total height including the height of the building and the height of the mast above the rooftop.
- The height above the highest possible obstacle, in the areas with obstacles along the signal path (path between two antennas).
- The height above the rooftop or highest obstacle in the signal path, in dense urban areas.

: An outdoor wireless link that lacks sufficient clearance will exhibit poor performance, which is typically perceived as slow network response time. However, your radio equipment automatically retransmits every lost data frame due to an out-of-range situation or frame collision. The larger the number of retransmissions, the lower is the throughput efficiency of your wireless link.

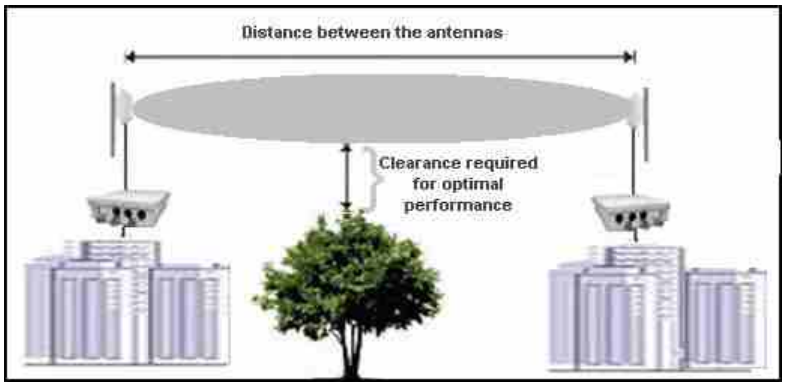


Figure 9-2 Clearance required for the Optimal Performance

As shown in the above figure, the clearance required for optimal performance is interpreted as:

- Vertical clearance above the ground and the highest buildings or objects along the signal path
- Horizontal clearance from neighboring buildings and objects along the signal path

For optimal range and throughput performance, you must ensure that your antenna installation provides maximum clearance in both horizontal and vertical directions.

If the local authorities, proprietor of the premises or other miscellaneous factors do not allow you to set up an antenna mast for the clearance requirements, then you may not achieve a full line-of-sight clearance. However, if the distance that your wireless outdoor installation covers is less than the listed maximum range, you don't need full clearance.

To determine the effect of insufficient signal path clearance, you must determine the Clearance Factor and also calculate its effect on the range for your antenna installation, by using the formula described in Determining the Range.

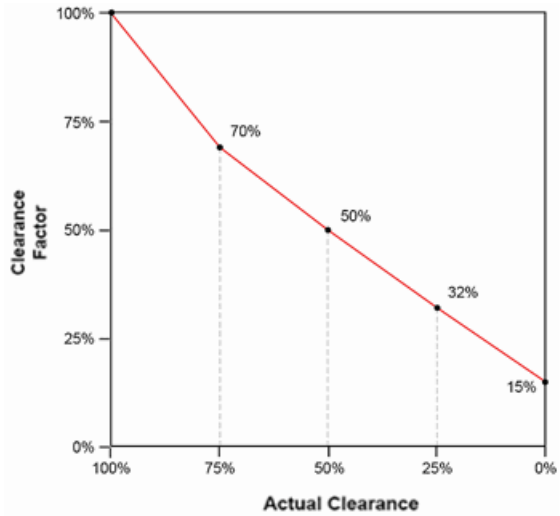


Figure 9-3 Clearance Factor

If the clearance for your antenna installation is equal to or better than the minimum clearance required, then the Clearance Factor for your installation is 100%. If your actual clearance is less than the minimum clearance, then refer the above figure to determine the actual range that applies to the current requirement.

: *Practically, it is impossible to achieve the maximum range due to the interference from the other radio products.*

Proxim recommends you to maintain at least 60-70% of the first Fresnel Zone free. If the clearance is lower than this percentage, then the **Link Budget** and acquired **Fade Margin** are affected. Clearances more than 100% of the Fresnel Zone can cause reflections that are 180 degrees out of phase and can cancel the signal. The Fresnel Zone works in both the horizontal and vertical paths.

9.5 Calculations

A microwave link is established along the path between antennas. Availability of the microwave path is therefore a prediction of the percent of time that the wireless link operates. In the absence of direct interference, availability of microwave path is affected by the following factors:

- Path length
- Fade margin
- Frequency
- Terrain (Smooth, Average, Mountainous)
- Climate (Dry, Temperate, Humid)

Availability of the microwave path can be improved by increasing the fade margin, either by making the path shorter or by using the higher gain antennas in conjunction with lower loss antenna cable (using a higher quality antenna cable, shortening the length, or both).

Establish a wireless link for a specific availability rate of microwave path, depending upon the type of information carried over the link and the overall network design redundancy. Let's say, the data or voice traffic carried by the radio is critical, then the link can be established at a very high availability rate of microwave path (say, 99.999% or 5.3 minutes of predicted outage per year).

9.5.1 Calculating Link Budget

Use the following formula to estimate the received signal level (RSL):

$$\mathbf{RSL\ (dBm) = P_{out} - L_1 + G_1 + G_2 - L_2 - L_p}$$

where:

- $\mathbf{P_{out}}$ is the output power (in dBm) of the transmitter.

- $\mathbf{L_1}$ is the total loss of all transmission elements between the antenna and the RF device on one side of the link (in dB).
- $\mathbf{G_1}$ is the gain of the antenna on one side of the link (in dB).
- $\mathbf{G_2}$ is the gain of the antenna on the opposite side of the link (in dB).
- $\mathbf{L_2}$ is the total loss of all transmission elements between the antenna and the RF device on the opposite side of the link (in dB).
- $\mathbf{L_p}$ is the Path loss, defined by:
  $Lp\ (dB) = 96.6 + 20\ log_{10}F + 20\ log_{10}D$; where:
  – **F** is the frequency of the radio system in GHz.
  – **D** is the distance of the path in miles.

:

- *This formula is available on a calculation sheet provided by Proxim to generate an estimate of link distance and reliability.*
- *The path loss must be smaller than the link budget minus the minimum required fade margin. The maximum ranges cause the path loss plus the fade margin to be the same as the link budget.*

The following figure is a pictorial representation of the elements in the Link Budget equation.

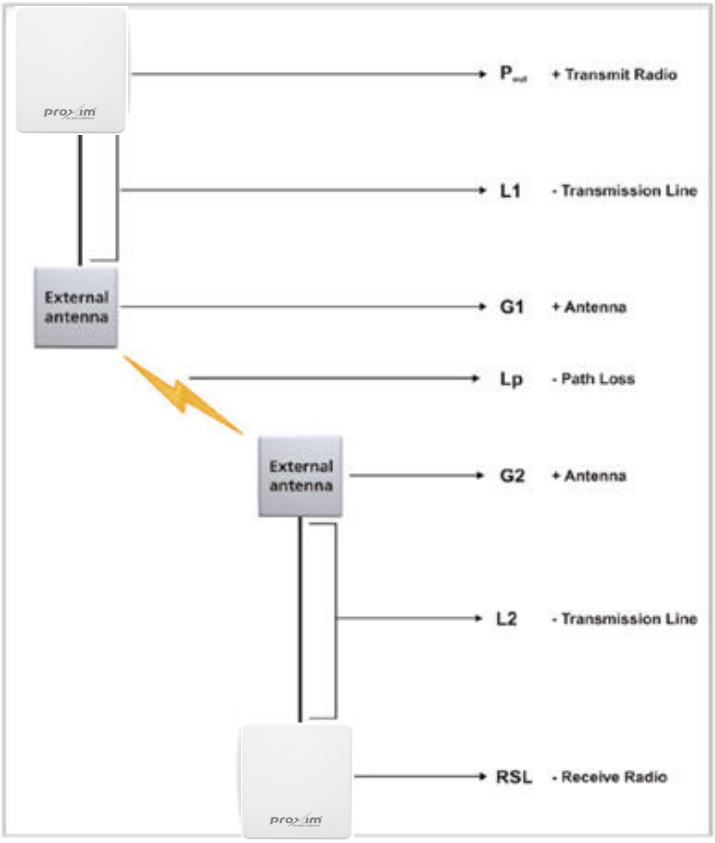


Figure 9-4 Link Budget Equation-Pictorial Representation

Procedure

1. Start with the transmit power and the number of the channel to be used in dBm. Subtract the total loss of all transmission elements between the antenna and the radio on one side of the link (dB).
2. Add the gain of the antenna you will be using. The total is the **EIRP** (Equivalent Isotropically Radiated Power).
3. Determine the path loss of the microwave link by using the mathematical formula of $\mathbf{L_p}$, illustrated in Calculating Link Budget.
4. Add the gain of the antenna on the second side of the link.

5. Subtract the total loss of all transmission elements between the antenna and the radio on the second side of the link. The result is the **Received Signal Level** (RSL).
6. For details on the receive sensitivity and data rate values used for the wireless link, for details refer to *Stratum TM Hardware Installation Guide*.
7. Subtract this value from the Received Signal Level; this is the **Fade Margin**.

:

- *The RSL must be higher than the Receiver Sensitivity plus the Fade Margin for a good link. The amount of Fade Margin indicates the reliability of the link. The more the Fade Margin, the more reliable is the link.*

The results of this link budget calculation are very important for determining any potential problems during installation. If you have calculated the expected RSL, you can verify that it has been achieved during installation and troubleshooting.

Tabulated below is the relation between the **Distance** and **Link Budget**, for a selected frequency:

Reference Frequency: 5600 MHz Center Frequency for Europe								
Link Budget (dB)	**Distance (m)**	**Fresnel Zone (m)**	**Link Budget (dB)**	**Distance (m)**	**Fresnel Zone (m)**	**Link Budget (dB)**	**Distance (m)**	**Fresnel Zone (m)**
61	4.8	0.3	91	151	1.4	121	4.8	8.0
62	5.4	0.3	92	170	1.5	122	5.4	8.5
63	6.0	0.3	93	190	1.6	123	6.0	9.0
64	6.8	0.3	94	214	1.7	124	6.8	9.5
65	7.6	0.3	95	240	1.8	125	7.6	10.1
66	8.5	0.3	96	269	1.9	126	8.5	10.7
67	9.5	0.4	97	302	2.0	127	9.5	11.3
68	11	0.4	98	339	2.1	128	10.7	12.0
69	12	0.4	99	380	2.3	129	12.0	12.7
Link Budget (dB)	**Distance (m)**	**Fresnel Zone (m)**	**Link Budget (dB)**	**Distance (m)**	**Fresnel Zone (m)**	**Link Budget (dB)**	**Distance (m)**	**Fresnel Zone (m)**
70	13	0.4	100	426	2.4	130	13.5	13.4
71	15	0.5	101	478	2.5	131	15.1	14.2
72	17	0.5	102	537	2.7	132	17.0	15.1
73	19	0.5	103	602	2.8	133	19.0	16.0
74	21	0.5	104	676	3.0	134	21.4	16.9
75	24	0.6	105	758	3.2	135	24.0	17.9
76	27	0.6	106	850	3.4	136	26.9	19.0
77	30	0.6	107	954	3.6	137	30.2	20.1
78	34	0.7	108	1071	3.8	138	33.9	21.3
79	38	0.7	109	1201	4.0	139	38.0	22.6
80	43	0.8	110	1348	4.2	140	42.6	23.9
81	48	0.8	111	1512	4.5	141	47.8	25.3
82	54	0.8	112	1697	4.8	142	53.7	26.8
83	60	0.9	113	1904	5.0	143	60.2	28.4
84	68	1.0	114	2136	5.3	144	67.6	30.1
85	76	1.0	115	2397	5.7	145	75.8	31.9
86	85	1.1	116	2689	6.0	146	85.0	33.7
87	95	1.1	117	3018	6.4	147	95.4	35.7

88	107	1.2	118	3386	6.7	148	107.1	37.9
89	120	1.3	119	3799	7.1	149	120.1	40.1
90	135	1.3	120	4263	7.6	150	134.8	42.5

*: The **Distance (m)** is calculated by assuming the 60% of the 1st Fresnal to be clear.*

Effective Isotropic Radiated Power (EIRP)

In countries like USA and Canada, radio can be installed with any directional antennas gain, as there is no Effective Isotropic Radiated Power (EIRP) limit for the application of these systems for fixed point-to-point applications in the 5.8 GHz frequency band. In other bands and in other countries, EIRP limits may apply. In the case of EIRP limits, use the lower values of either (P_{out} - L_1+ G_1) or the EIRP limit, within the Link Budget equation. You should check this calculation in both the directions to assure legal application. An EIRP limit is the maximum RF energy that can be transmitted as measured at the transmitting antenna and is usually determined by government regulations. For details, we recommend you to refer the **Max EIRP** values listed under the **Wireless Interface properties**, in the *Stratum TM - Hardware Installation Guide*.

The figure below shows the Proxim Link Calculator, available at http://support.proxim.com. Refer to *Link Calculator - User Guide* to understand:

- How to install the Link calculator
- How to use the Link Calculator

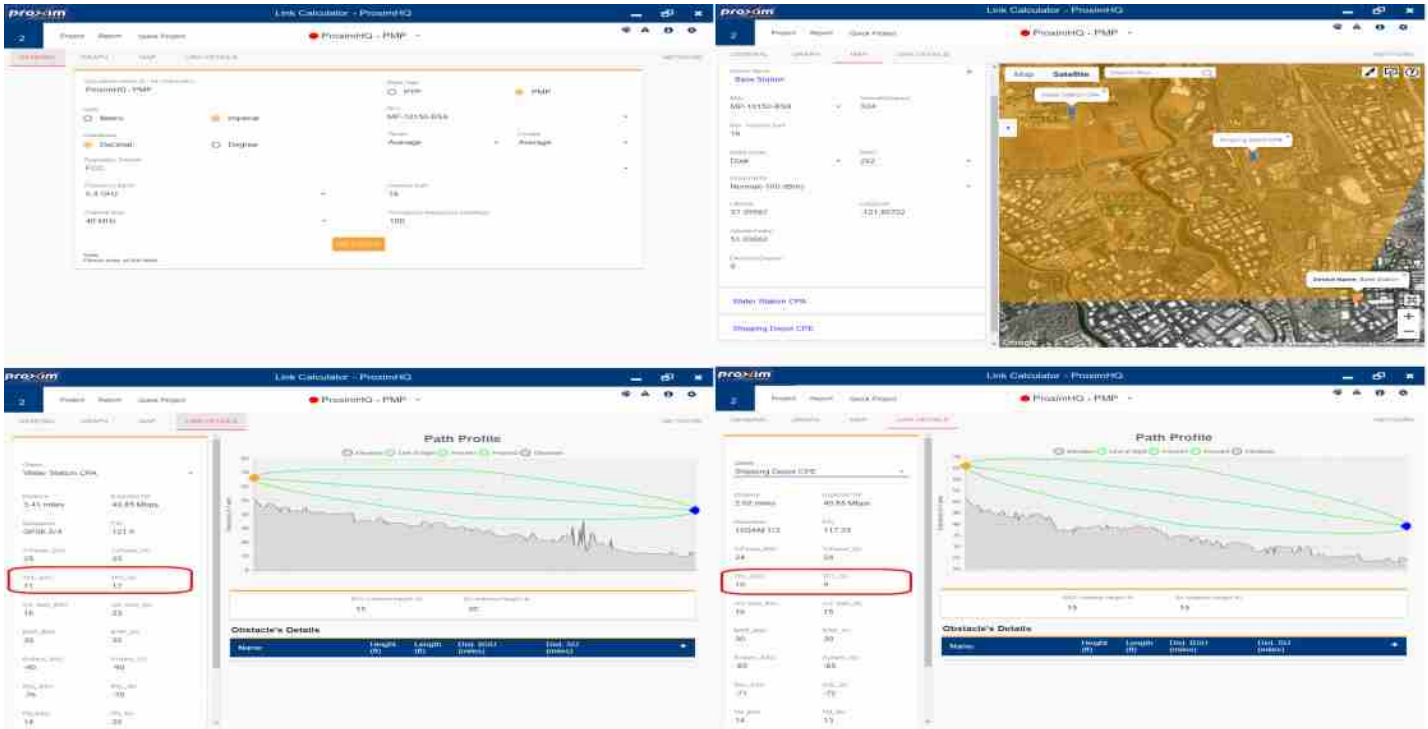


Figure 9-5 Proxim Link Calculator

Lightning Protection

A

Lightning protection is used to maximize the reliability of the communications equipment by safely re-directing current from a lightning strike or a power surge traveling along the STP Cat5e/Cat6 Ethernet cabling to the ground using the shortest path possible. Designing a proper grounding system prior to installing any communications equipment is critical to minimize the possibility of equipment damage, void warranties, and cause serious injury.

The surge arrestor (sometimes referred to as a lightning protector) can protect your sensitive electronic equipment from high-voltage surges caused by discharges and transients at the PoE.

Proxim Wireless offers superior lightning and surge protection for *Stratum ™ X5 Series* products. Contact your reseller or distributor for more information.

Abbreviations

B

Abbreviations	
AWG	American Wire Gauge
BSU	Base Station Unit
CLI	Command Line Interface
CPE	Customer Premises Equipment
DC	Direct Current
ESD	Electrostatic Discharge
FCS	Frame Check Sequence
LED	Light Emitting Diode
MIMO	Multiple-input and Multiple-output
MTBF	Mean Time Between Failures
OFDM	Orthogonal frequency-division multiplexing
PC	Personal Computer
PoE	Power Over Ethernet
PTMP	Point-to- multipoint
PTP	Point-to-point
QIG	Quick Installation Guide
RSSI	Received Signal Strength Indicator
Rx	Receiver
STP	Shielded Twisted Pair
SU	Subscriber Unit
TCP	Transmission Control Protocol
Tx	Transmission
UDP	User Diagram Protocol
UTP	Unshielded Twisted Pair
WORP	Wireless Outdoor Router Protocol

Safety & Regulatory Information

C

For Safety & Regulatory Information, please refer Safety and Regulatory guide for Series. To download the Safety and Regulatory Guide, visit http://support.proxim.com.

Warranty and Technical Support

D

For Warranty and Technical Support Policy, please visit http://proxim.com/support.

Obtaining Technical Service and Support

If you are having trouble using the Proxim product, please read this manual and the additional documentation provided with your product. If you require additional support to resolve your issue, please be ready to provide the following information before you contact Proxim's Technical Services team:

- Product information
  - Part number and number of the suspected faulty device
- Trouble/error information
  - Trouble/symptom being experienced
  - Activities completed to confirm fault
  - Network information (What kind of network are you using?)
  - Circumstances that preceded or led up to the error
  - Message or alarms viewed
  - Steps taken to reproduce the problem
- ServPak information (if a Servpak customer):
  - ServPak account number
- Registration information
  - If the product is not registered, date and location where you purchased the product

: *Technical Support is free for the warranty period from the date of purchase.*

Support Options

Proxim Customer Support Website

The Proxim Customer Support Website is available 7x24x365 at http://support.proxim.com.

On the Proxim Customer Support Website, you can access the following services:

- **Product Download Page**: Provides quick links to product firmware, software, and documentation downloads.
- **Proxim TV Links**: A link to helpful video tutorials.
- **Knowledge base**: A solution database of all the resolved problems. You can search by product, category, keywords, or phrases.
- **Live Chat**: Chat with a support technician on-line or request to call back at a later time.
- **Create a Support Request**: Create a support request with our technical support staff who will reply to you by email.
- **Case Management**: Login to check the status of your support cases, update your personal profile, or access restricted information and features.
- **Provide Feedback**: Submit a suggestion, complaint, or other feedback about the support site and our products.

Telephone Support

Contact technical support via telephone as follows:

USA and Canada Customers

- **Phone**: +1-408-383-7700; +1-866-674-6626
- **Business Hours**: Tier 1 support: 24x7 live response. Tier 3 support: 8 a.m. to 5 p.m. M-F PST (UTC/GMT -7 hrs)

International Customers

- **Phone**: +1-408-383-7700
- **Business Hours**: Tier 1 support: 24x7 live response. Tier 3 support: 8 a.m. to 5 p.m. M-F PST (UTC/GMT -7 hrs)

ServPak Support

To provide even greater investment protection, Proxim Wireless offers a cost-effective support program called ServPak. ServPak is a program of enhanced service support options that can be purchased as a bundle or individually, tailored to meet your specific needs. Whether your requirement is round the clock technical support or advance replacement service, we are confident that the level of support provided in every service in our portfolio will exceed your expectations.

All ServPak service bundles are sold as service contracts that provide coverage for specific products from 1 to 3 years. Servpak bundles are considered an upgrade to the standard product warranty and not an extension.

All Plans Include	ServPak Plus	ServPak Prime
24x7 Basic Technical Support	Basic Advanced Replacement (Two business days/ International economy shipment service)	Priority Advanced Replacement (Next business day/ International priority shipment service)
8x7 Advanced Technical Support		24x7 Advanced Technical Support
Software Maintenance		Proxim Vision Support
Access to Knowledge Base		

Additional Information on ServPak Options

Advanced Replacement of Hardware

In the event of a hardware failure, our guaranteed turnaround time for return to factory repair is 30 days or less. Customers who purchase this service are guaranteed replacement of refurbished or new hardware to be shipped out within one or two business days, as applicable. Options are available for shipment services depending on the customer's support needs. Hardware is shipped on business days, Monday – Friday excluding Holidays, 8:00 AM – 3:30 PM Eastern Time.

7x24x365 Availability

Unlimited, direct access to technical support engineers 24 hours a day, 7 days a week, 365 days a year including Holidays.

8x5 Availability

Unlimited, direct access to world-class technical support engineers 8 hours a day, 5 days a week, Monday through Friday from 8:00AM - 5:00PM Pacific Standard Time.

Basic Technical Support

Customers who purchase this service can be rest assured that their call will be answered by Proxim's Tier 1 technical support and a case opened immediately to document the problem and provide initial troubleshooting to identify the solution and resolve the incident in a timely manner.

Advanced Technical Support

In addition to Proxim's world-class Tier 1 technical support, customers will be able to have their more complex issues escalated to our world-class Tier 3 technical support engineers. Our Tier 3 engineers will review specific configurations to troubleshoot intricate issues and will also provide helpful insights regarding Proxim's products and various tips from decades of collective experience in the wireless industry.

Software Maintenance

It's important to maintain and enhance security and performance of wireless equipment and Proxim makes this easy by providing a Software Maintenance program that enables customers to access new feature and functionality rich software upgrades and updates. Customers will also have full access to Proxim's vast Knowledge base of technical bulletins, white papers and troubleshooting documents.

To purchase ServPak support services, please contact your authorized Proxim distributor. To receive more information or for questions on any of the available ServPak support options, please visit our website at http://www.proxim.com/support/servpak, call Proxim Support (For telephone numbers, see Telephone Support) or send an email to servpak@proxim.com.