freeRAN™ IoT Base Station

User Manual

v1.0, February, 2023

UBIIK

CONTENTS

01 FCC Statement

1.1. Overview

The freeRAN™ IoT Base Station complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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

Method	Action
1	Reorient or relocate the receiving antenna
2	Increase the separation between the device and receiver
3	Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
4	Consult the dealer or an experienced RF technician for help

Table 1.1: Approaches to correcting interference

CAUTION: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this device. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

1.2. Radiation Exposure Statement

The antenna(s) used for this transmitter must not be co-located of operating in conjunction with any other antenna or transmitter. This device complies with FCC radiation exposure limits set forth for an uncontrolled environment. In order to avoid the possibility of exceeding the FCC radio frequency exposure limits, human proximity to the antenna shall not be less than 20 cm during normal operation.

1.3. Professional Installation Statement

1. <u>Installation personnel</u>: This device is designed for specific applications and needs to be installed by a qualified personnel who has RF and related regulations knowledge. The general user should not attempt to install or change the settings.

2. <u>Installation location</u>: The device should be installed at a location where the radiating antenna can be kept 8 inches from nearby persons in normal operation condition to meet regulatory RF exposure requirements.

3. <u>Installation procedure</u>: Please refer to procedure for mounting the device to a wall or pole.

4. <u>Warning</u>: Please carefully select the installation position and make sure that the final output power does not exceed the limits set in relevant rules. Violation of rules could lead to serious federal penalties.

1.4. Safety Statement

All instructions, warning and caution statements that accompany this device must be strictly followed at all times to ensure its safe use. Observe all warning and caution symbols that are fixed to this device. This device is designed with the utmost care for the safety of those who install and use it. However, when using this device, basic safety precautions should always be followed to reduce the risk of fire and injury to persons, and the dangers of electric shock and static electricity. Do not cover the device or block the airflow to the device with any other objects. This device was qualified under test conditions that included the use of the supplied cables between system components.

To be in compliance with regulations, the user must use the cables supplied with the unit and install them properly. This includes the power adapter that is provided. Place the unit to allow for easy access when disconnecting the power adapter from the main wall outlet. Operate this device only with the type of power source indicated on the marking label. If you are not sure of the type of power supplied to your facility, consult your dealer or local electricity provider.

Do not use this product near water, for example a swimming pool or a bathroom. Keep the device away from excessive heat and humidity and keep the device free from vibration and dust. Wipe the unit with a clean, dry cloth. Never use cleaning fluid or similar chemicals. Do not spray cleaners directly on the unit or use forced air to remove dust.

Avoid installing or using this product during an electrical storm. There may be remote risk of electric shock from lightning. During a lightning storm for added protection please unplug it from the wall outlet and disconnect all cables. This will prevent damage due to lightning and power surges. For safety reasons, only authorized service technicians should open the device. If the device is opened the warranty will become void. The device may affect medical equipment and so please take account of any technology restrictions with this equipment. This device, like other radio devices, emits radio frequency electromagnetic energy, but operates within the guidelines found in radio frequency safety standards and recommendations. It is recommended that the minimum operating distance from the installed Base Station to persons is 8 inches.

1.5. General Hazard Statement

Safety notes are marked with symbols. Ignoring the safety notes may lead to personal injury, damage to the instrument and malfunctions. Signal Words identify the hazard severity level as the following:

Word	Meaning
DANGER	Indicates an extremely hazardous situation which, if not avoided, will result in death or serious injury, permanent damage to equipment or large fines and penalties
WARNING	Indicates a hazardous situation which, if not avoided, could result in serious injury or damage to equipment and moderate fines or penalties
CAUTION	Indicates a hazardous situation which, if not avoided, could result in minor injury or minor damage to equipment or minor to moderate penalty fees
NOTICE	Indicates a hazardous situation not related to personal injury or damage to equipment

02 Product Overview

2.1. Overview

The deployment of wireless network systems utilizing a diverse range of technologies has been a prevalent trend in the ISM bands in the 902 MHz to 928 MHz range in the United States. The Advanced Metering Infrastructure (AMI) sector, an area in which Ubiik has expertise, has seen the utilization of technologies such as RF mesh, Wi-SUN, and point-to-multipoint technologies by utility companies over the past three decades. In addition, since the early 2010s, LPWAN (low-power wide-area network) technologies, including LoRaWAN, Sigfox, RPMA, Weightless, and other IEEE 802.15.4-based protocols, have entered the market and gained popularity. These innovative technologies have significantly contributed to the advancement of the AMI sector and ultimately benefiting consumers.

The freeRAN™ IoT Base Station is an innovative solution utilizing LTE-M technologies, announced by 3GPP in 2016 through Release 13, to serve the utility and IoT sectors. It expands on a standards-compliant FDD LTE-M implementation and is specifically engineered to operate within the 3 MHz bands of uplink (902-905 MHz) and downlink (925-928 MHz), which fall within the ISM bands of 902-928 MHz.

The freeRAN™ IoT Base Station provides a solution-in-a-box approach for remote data collection, monitoring and management of IoT devices with full two-way communication. It is equipped with RF antenna and onboard GPS. The freeRAN™ IoT Base Station connects to the cloud in two ways, using a router through PoE (Power over Ethernet), or via LTE backhaul. The freeRAN™ IoT Base Station offers advanced functionality, such as integrated base station function, core function and the Linux operating system to allow for easy plug-and-play operation.

Figure 2.1:
freeRAN™ IoT Base Station

This product offers a seamless combination of simplicity, cost-effectiveness, and the many benefits of LTE-M technology, such as scalability, efficiency, data security and reliability. Furthermore, the device supports bidirectional wireless communication of data for both stationary and mobile IoT devices and serves as a foundation for building private LTE networks for various solutions such as AMI, and can benefit from a vibrant and future-proof ecosystem available worldwide.

On the other hand, operating in the ISM bands also means that the user must share this license-free spectrum with others; furthermore, the restriction on transmit power applied to all systems operating in ISM bands also implies that the freeRAN™ IoT Base Station may not achieve the same quality of service, coverage and data rate as a wireless base station operating in licensed bands, which typically transmits at 43dBm or more.

The freeRAN™ IoT Base Station's integration of royalty-free ISM bands and LTE-M based technologies empowers utility companies to establish cost-effective, secure, and future-proof private LTE-based AMI networks, which is a crucial element in grid infrastructure modernization to enhance grid reliability and resilience.

2.2. Architecture

The freeRAN™ IoT Base Station includes a number of options available for customization by the user. LTE-M equipment with support of uplink frequency: 902-905 MHz, and downlink frequency: 925-928 MHz can be configured to operate with the freeRAN™ IoT Base Station. Figure 2.2a below shows an example of the freeRAN™ IoT Base Station internal architecture.
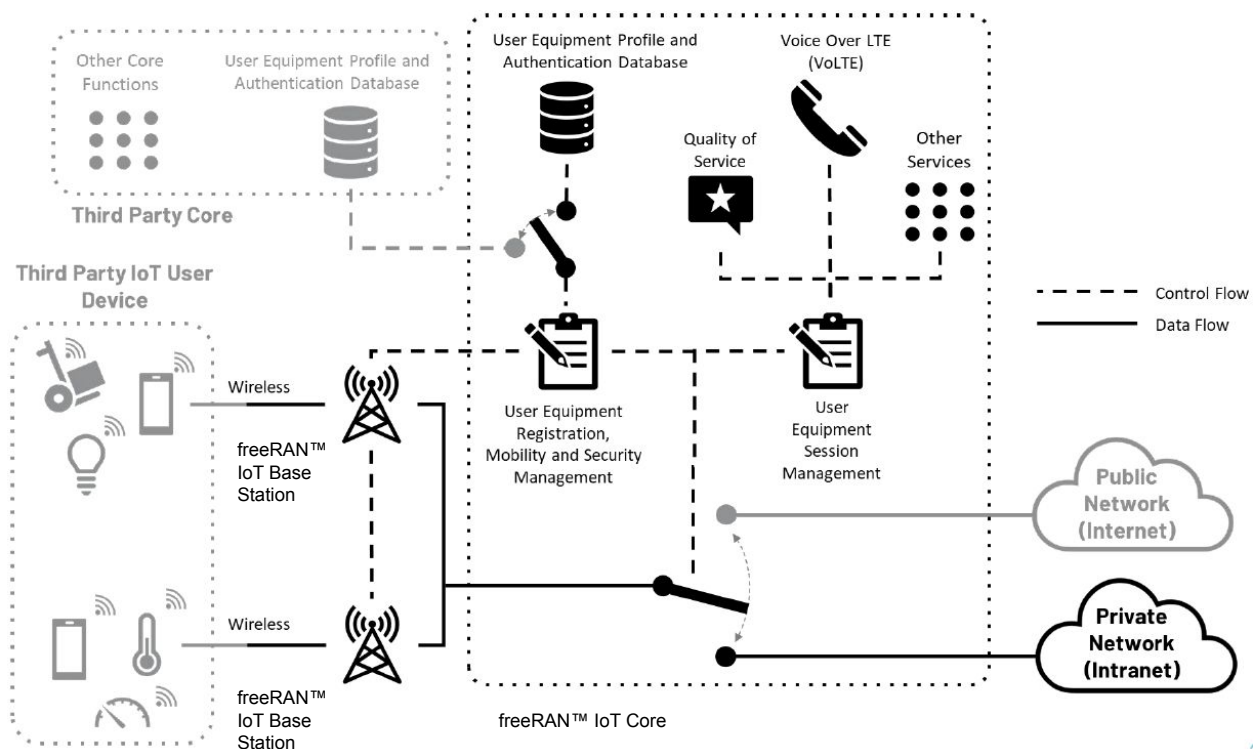
Figure 2.2a: How the freeRAN™ IoT Base Station fits the standard cellular infrastructure

02 Product Overview

The freeRAN™ IoT Base Station, when setup, forms a simplified network to the one shown in the earlier diagram (see Figure 2.2a). In standalone operation (see Figure 2.2b), the internal core network of the freeRAN™ IoT Base Station is used - this simplifies setup, for the user, over that of an external core network. Though it should be noted that the freeRAN™ IoT Base Station can be configured easily for use with a complete or partial external third-party core network as well.
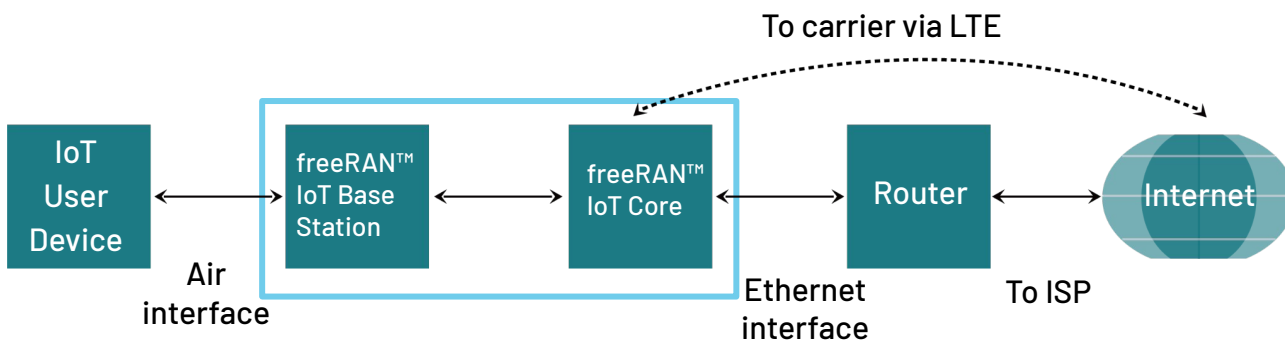
Figure 2.2b: The freeRAN™ IoT Base Station operating as a standalone private network

2.3. Hardware

The items shown in Table 2.3 are included as standard options for the freeRAN™ IoT Base Station - see Figure 2.3 for an example of the accessories included as part of this standard offering. The unit provided is configured to the user's specification during the ordering process and accessories may vary from those shown in the diagram below.

The unit can be configured using a cloud tool called the freeRAN™ IoT Base Station Management System. The freeRAN™ IoT Base Station provides air-interface and core network functions that allows management of large number of devices.

The unit can be used for creating LTE-M standalone private IoT networks. Full detailed specifications of the freeRAN™ IoT Base Station are provided in the Specifications section of this document.

02 Product Overview

Ref	Item	Qty.
A	freeRAN™ IoT Base Station	1
B	GPS antenna	1
C	RF Antenna (one of two kinds as shown in **Figure 2.3**)	1
D	Power-Over-Ethernet (PoE) injector with Ethernet cable (as needed)	1
E	Cable grip for Ethernet (as needed)	1
F	Mounting kit	1
G	Backhaul LTE antenna	1

Table 2.3: Items included in a standard freeRAN™ IoT Base Station product offering. Note that these items are subject to Options specified below.
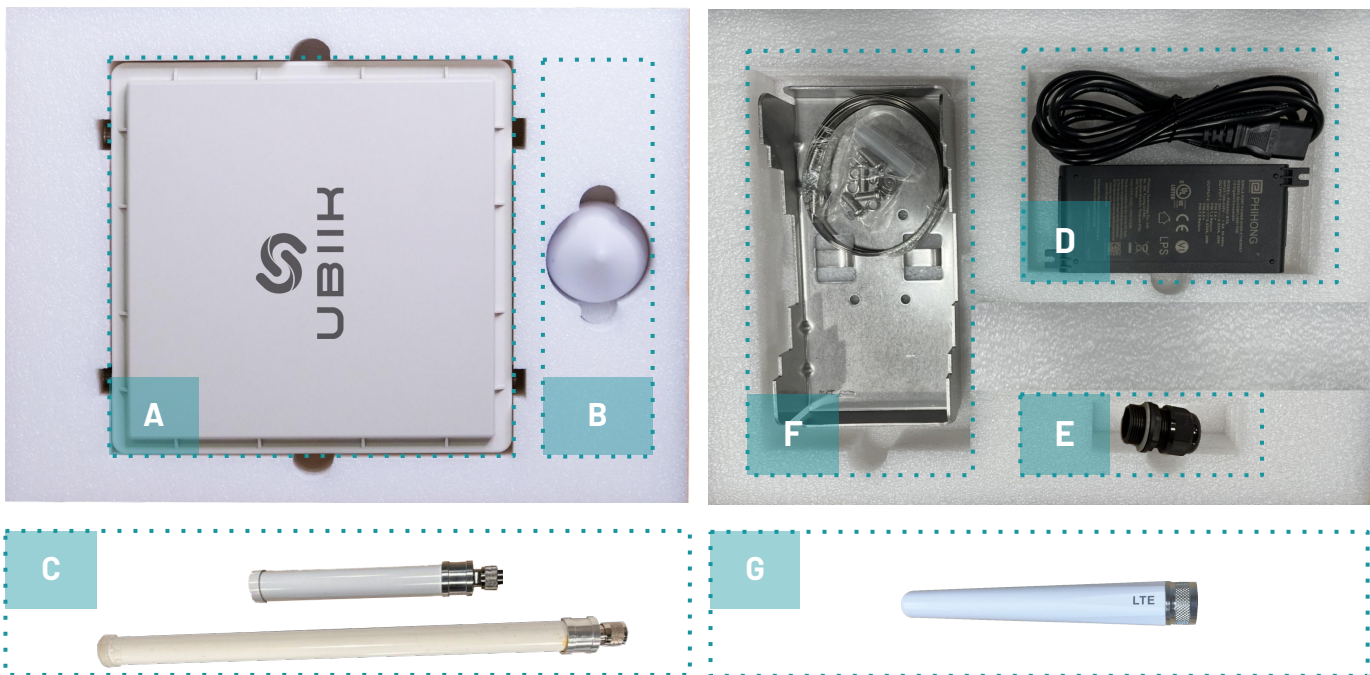
Figure 2.3: Items included in as part of a standard freeRAN™ IoT Base Station product offering

2.4. Options

The freeRAN™ IoT Base Station comes with a few customizable options as seen in Table 2.4. For further technical details please see the section on Specifications provided at the end of this manual.

The freeRAN™ IoT Base Station is configured by Ubiik before delivery, however the configurable parameters can be set using the freeRAN™ IoT Base Station Management System (cloud platform).

WARNING: Do not exceed the power handling capability of the power amplifier for the unit to avoid permanent damage.

	Options	Description	Sub-options
A	Backhaul	Configured for Ethernet or LTE backhaul	– Ethernet – LTE
B	Location	Configured for various installation location types	– Enclosure Types – Cable Types – Power Supply Types

Table 2.4: Options available for the freeRAN™ IoT Base Station, configured at time of ordering

03 Installation

3.1. Overview

The pole mounting kit provides a mounting system for the typical installation environment. With this kit the freeRAN™ IoT Base Station can be mounted directly on to a pole of diameter between 3.9 inches to 11.8 inches.

1	freeRAN™ IoT Base Station
2	Mounting Plate
3	Screw
4	Wall and Anchor plus Screws
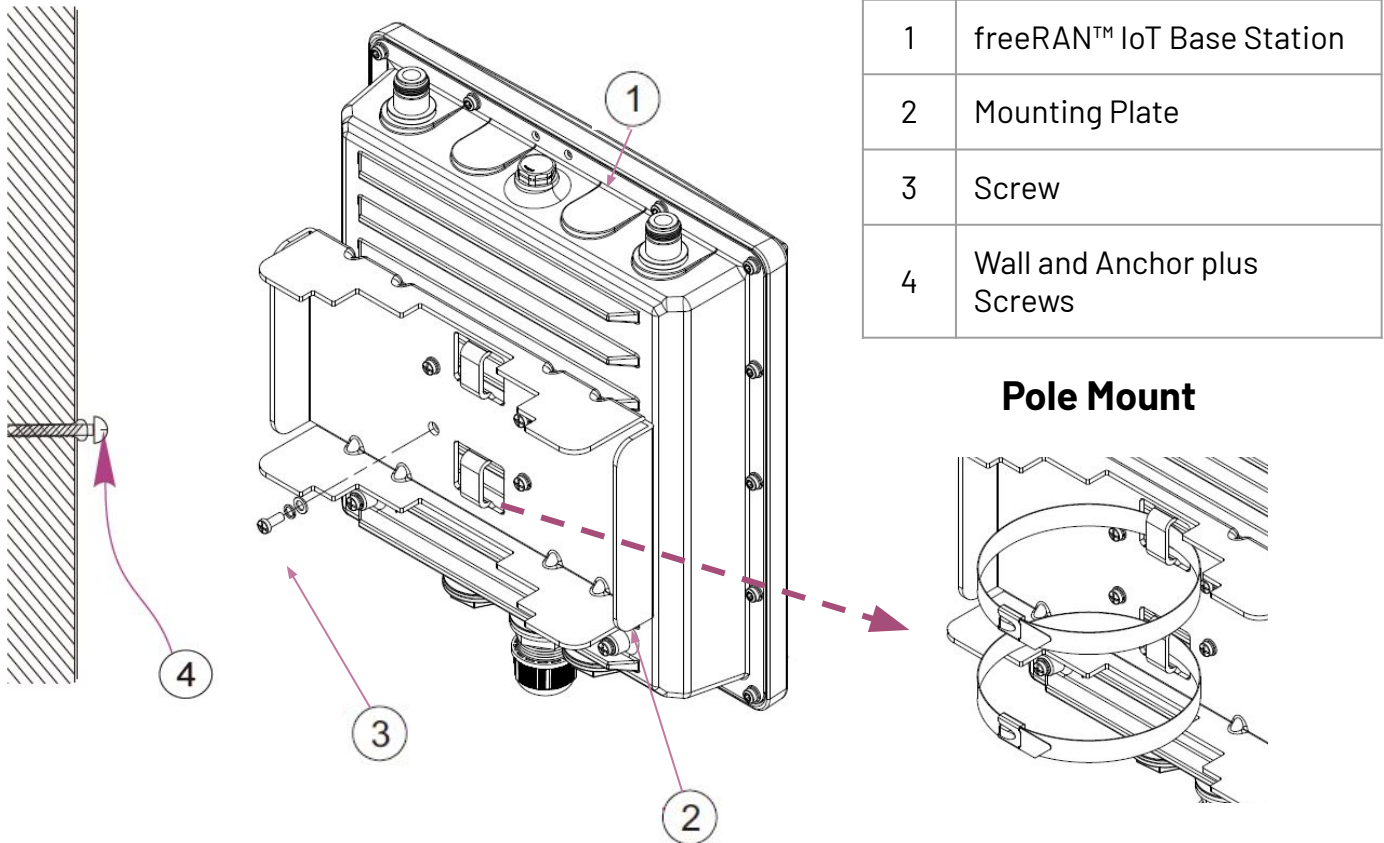
Pole Mount

3.2. Hardware

The pole mounting kit should include the following hardware items. Note that the Anchor & Screw can be substituted with the Hose Clamps or Hose Clamps can be provided as an expansion to support pole mounting.

Qty	Description
1	freeRAN™ IoT Base Station
1	Mounting Plate
4	Angle Screws
4	Spring Washers

| Qty	Description
4	Washers
4	Screws
4	Anchor & Screws
2	Hose Clamps

3.3. Assembly Steps

Step 1

Use the four Angle Screws, Spring Washers and Washers to attach the mounting plate onto the freeRAN™ IoT Base Station as with the wall mounting approach.

Step 2

Pass the two Hose Clamps (3) through the matching hole in the mounting plate as shown.
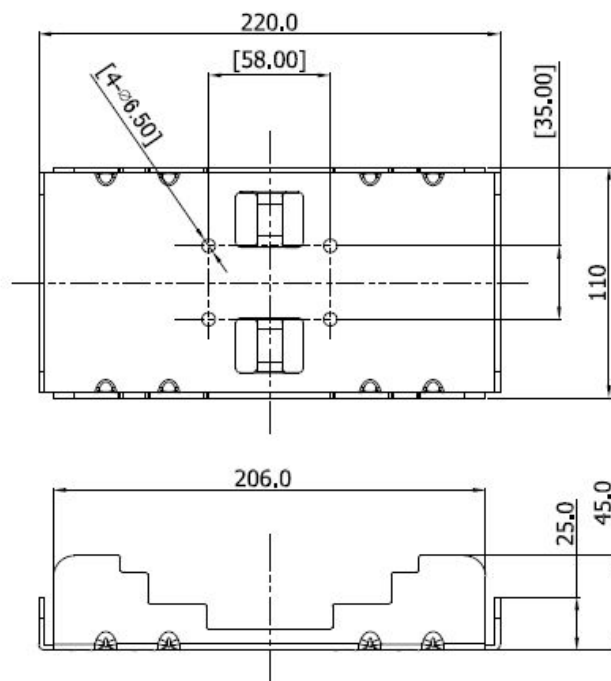
Step 3

Loop the open Hose clamps around the pole chosen for the installation and tighten the screw until the unit is secure.
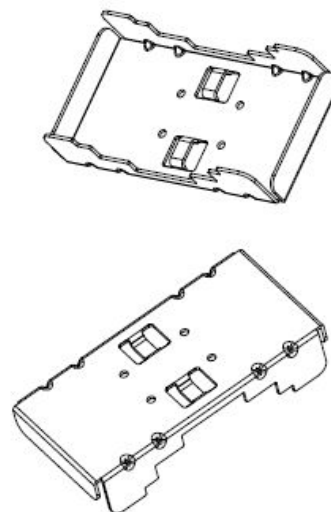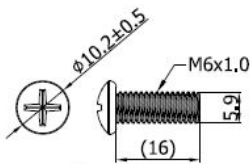

③
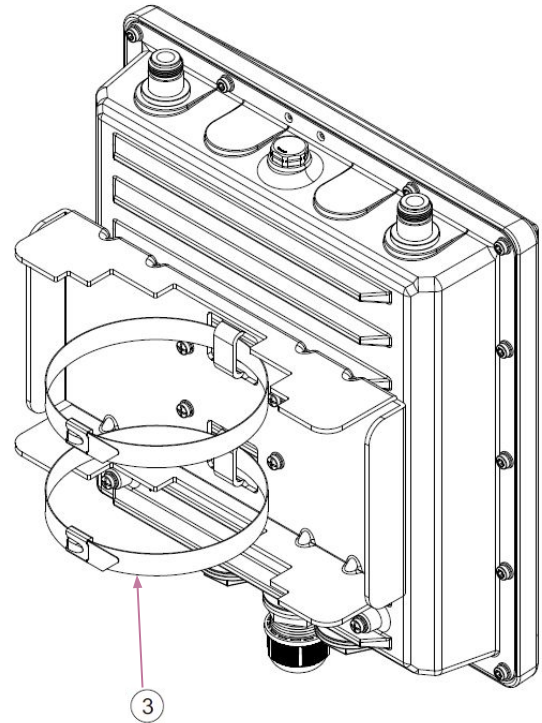
3.4. Mechanical Drawings

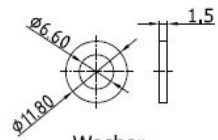*Note that all dimensions are in mm unless otherwise stated.*
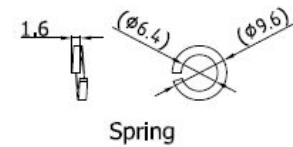
Mounting Plate
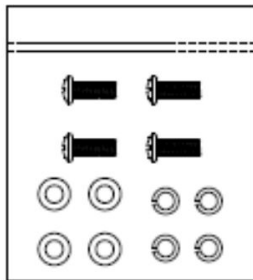
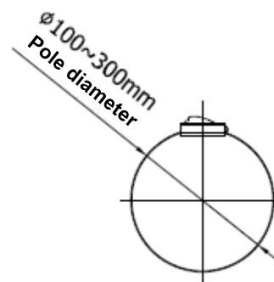# 03 Installation

Screw, Spring Washer and Washer

Screw

Washer

Spring

(W)50x(L)70mm
Plastic zip lock bag

Hose Clamp (Pole Mount Option)

Ø100~300mm
Pole diameter
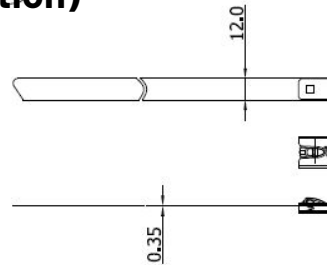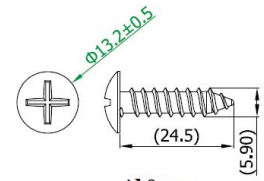
Anchor & Screw

A】Screws
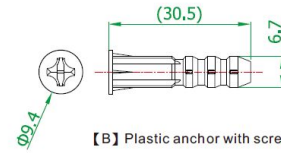
【B】Plastic anchor with screw

04 **Configuration**

The following steps should be completed in the order listed to get the freeRAN™ IoT Base Station up and running.

4.1. Hardware Power Up

A. Mounting Antennas

The standard freeRAN™ IoT Base Station only requires one RF antenna and one GPS antenna on the top side. The process of attaching this antenna is shown in <u>Figure 4.1a</u>.

Connect the Top RF Antenna

Connect the GPS Antenna
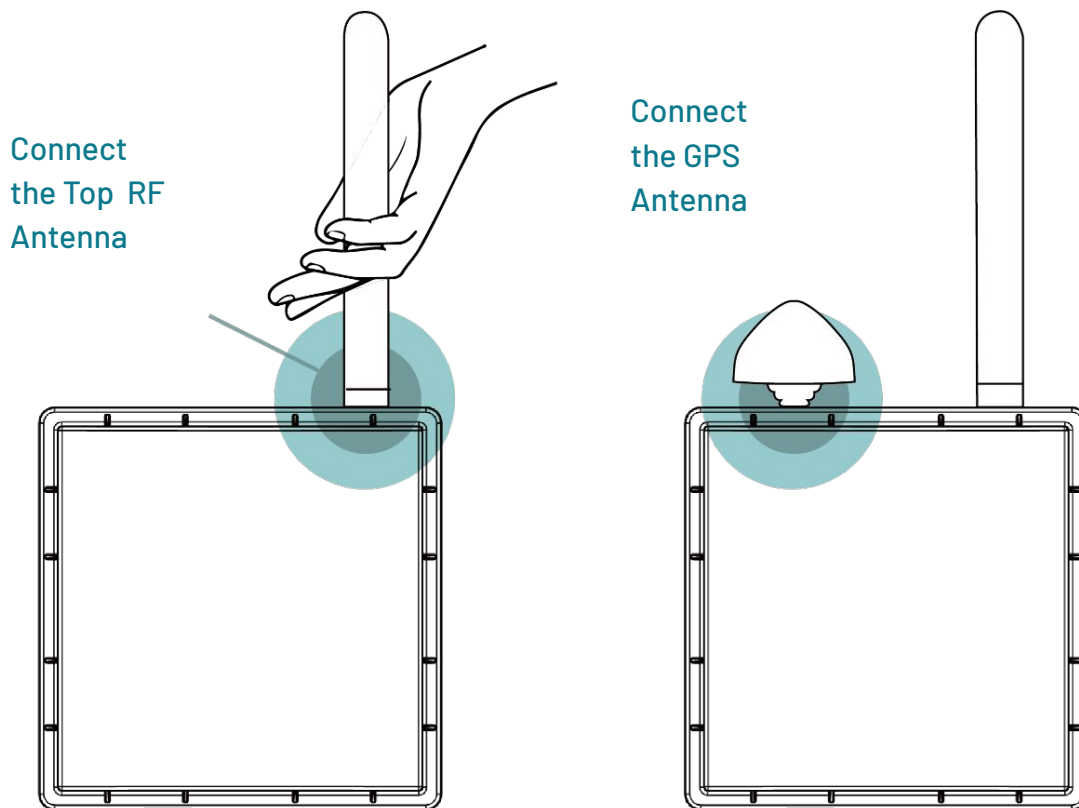
Figure 4.1a: Attaching the RF and GPS antennas to the freeRAN™ IoT Base Station

B. Mounting the freeRAN™ IoT Base Station

While not necessary for testing purposes, the freeRAN™ IoT Base Station can be mounted to a wall or pole to provide a more permanent setup as describ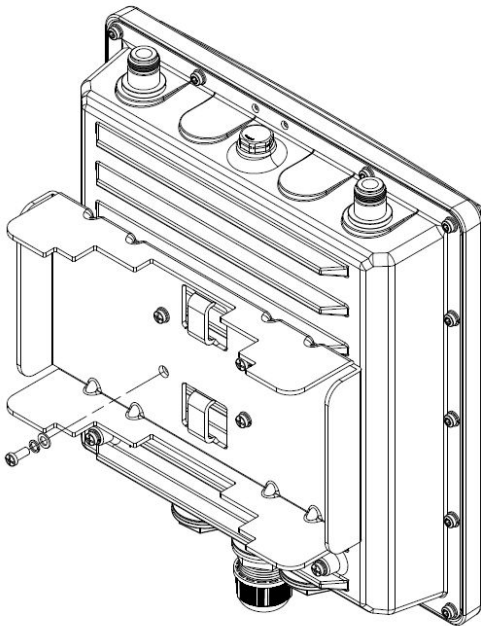ed in the figures below. Depending on request from the user, the freeRAN™ IoT Base Station comes with a pole mounting kit. Please refer to the previous Installation section for a step by step set of instructions for mounting the freeRAN™ IoT Base Station to either a wall or a pole.

Qty	Description
1	freeRAN™ IoT Base Station
1	Mounting Plate
4	Angle Screws
4	Spring Washers
4	Washers
4	Screws
4	Anchor & Screws
2	Hose Clamps

C. Physical Network Connection

The freeRAN™ IoT Base Station comes with an Ethernet cable and a corresponding cable grip. Attach the cable grip to the Ethernet wire and plug in the freeRAN™ IoT Base Station on one end and plug in the local network router on the other end as shown in Figure 4.1c. For outdoor installation of the freeRAN™ IoT Base Station, screw in the cable grip to provide a water-tight seal for outdoor use. Note that, in the picture below, the power connector has not been shown as connected. And no cable grips are present. In a real outdoor installation, cable grips must be installed to ensure IP67 ingress protection.

Ethernet port

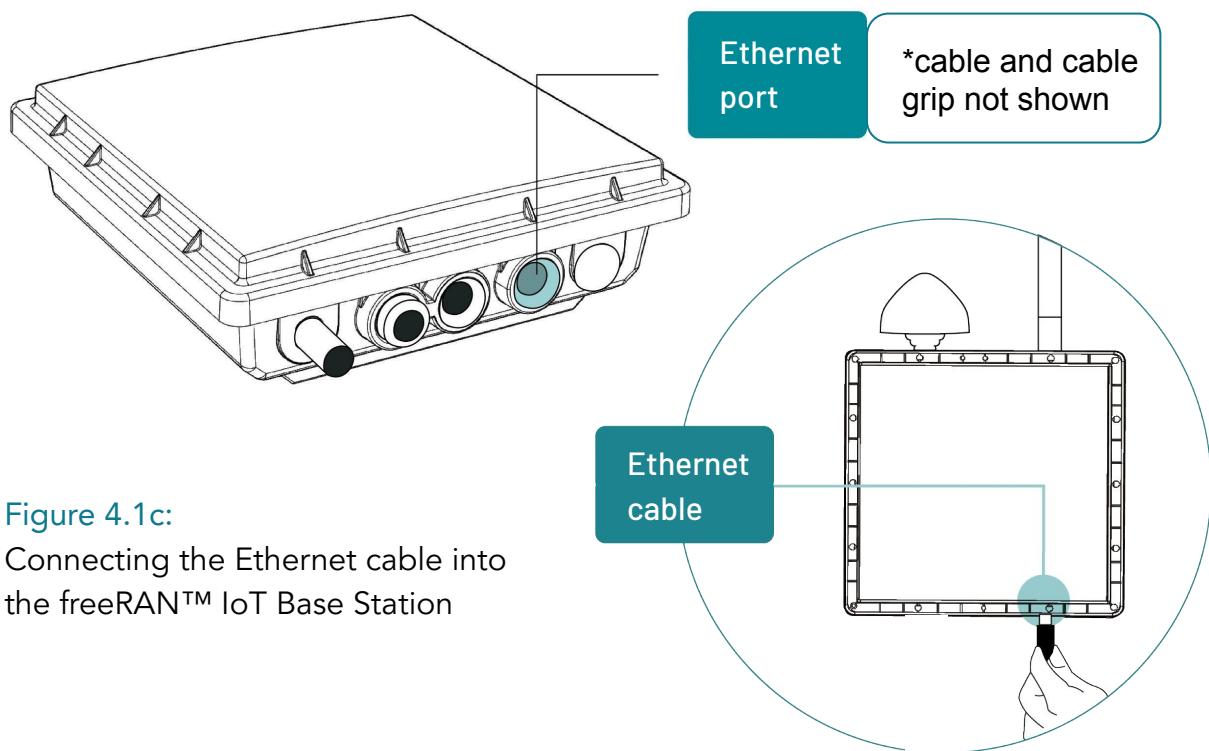*cable and cable grip not shown

Ethernet cable

Figure 4.1c:
Connecting the Ethernet cable into the freeRAN™ IoT Base Station

CAUTION: The default freeRAN™ IoT Base Station offering comes with an indoor Ethernet cable – this cable is not suited for outdoor use. Choose the outdoor option as indicated in the **Options** section for outdoor use.

D. Connecting Power

The freeRAN™ IoT Base Station comes with a Power-Over-Ethernet (PoE) injector customized to the user specification during the ordering process. This provides power without the need of a power adaptor.

Once connected to power, the freeRAN™ IoT Base Station will attempt to connect to a network automatically. The unit can be reset by disconnecting and reconnecting the injector. This may be needed in the event that there is a connection error as indicated by the green and white LEDs.

4.2. Network Connection Setup

A. Checking the freeRAN™ IoT Base Station Network IP Address

Before shipping, the user can request Ubiik engineers to configure the freeRAN™ IoT Base Station with a static IP address. By default, however, the freeRAN™ IoT Base Station is configured for DHCP. For the DHCP configured version, the user's local network router should be set up to assign an IP address to the freeRAN™ IoT Base Station via DHCP. Please refer to your specific router's documentation for help with this setup.

To verify the IP address assigned to the freeRAN™ IoT Base Station via your router and DHCP, the user can log into their router and check the IP assignment for the MAC address associated with their freeRAN™ IoT Base Station. A MAC address label for the freeRAN™ IoT Base Station is provided on a label on the unit to support this. The format for the MAC address should be a colon separated 12 digit hexadecimal value (e.g. 2C:54:91:88:C9:E3). If for some reason, this MAC address is not available, please contact Ubiik Support.

B. Confirming Connection to Local Network via LED status

A basic check to verify connection is to look at the green and white status LEDs. These LEDs are located on the freeRAN™ IoT Base Station as shown in Figure 4.2b. Note that Ethernet cable and power cable are shown as disconnected in this picture. They should however be connected to see the real status of the LED.

Table 4.2b provides various states for the Status LED. There are two LEDs present, a white and a green. These LEDs, together, will be in one of the four states. If the freeRAN™ IoT Base Station is up and running and connected to the core network, the LEDs should be in the solid state. The LEDs should cycle through all other states to achieve this solid state. If for some reason, the last state is not reached, a problem exists either with the power supply, the OS, the system or with the connection to the core.

Figure 4.2b:
The location of the green and white status LEDs

Status LEDs
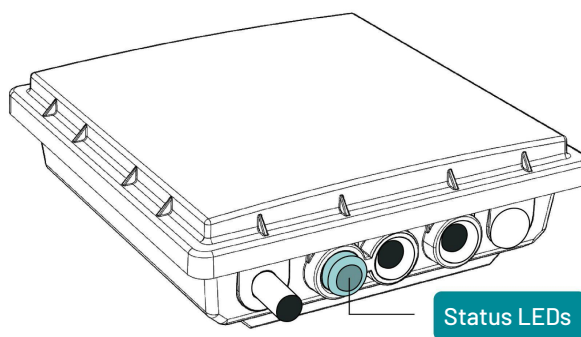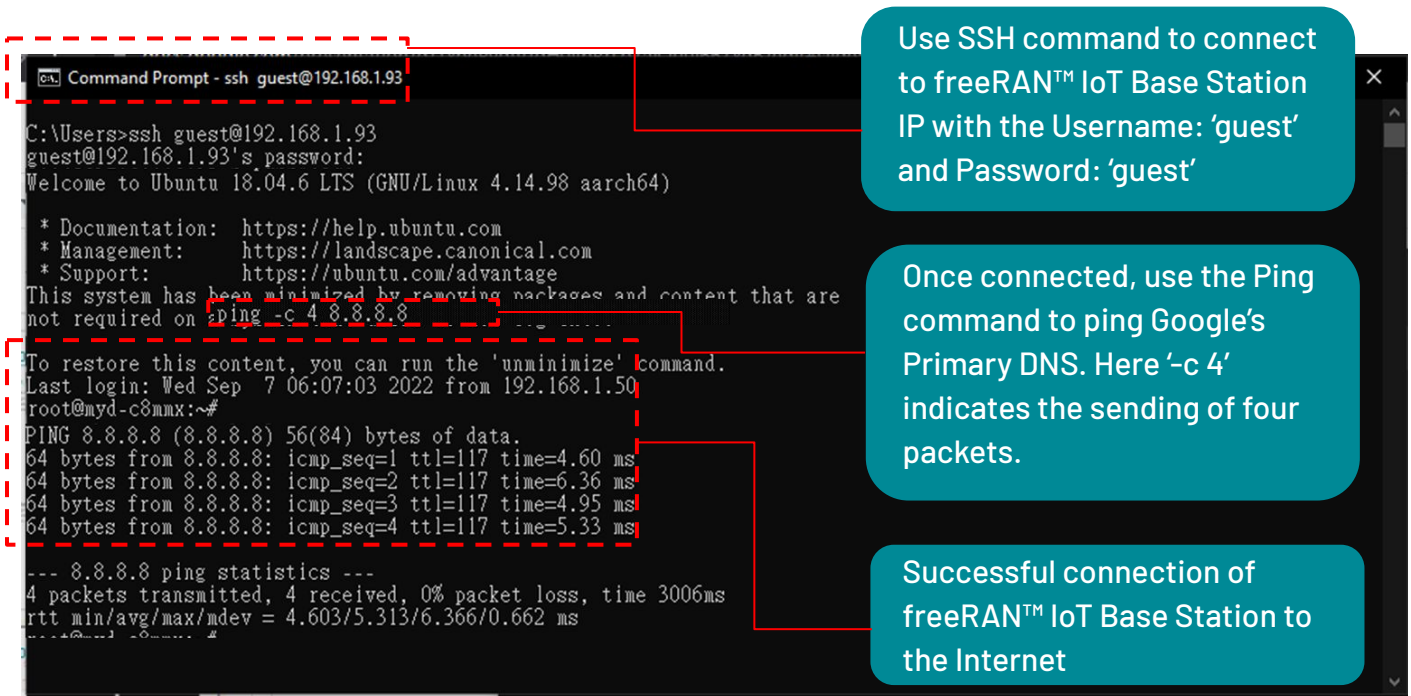
Table 4.2b: Checking the status of the freeRAN™ IoT Base Station to verify power and connection

Green LED	White LED	System Status
Off	Off	Power Off, Disconnected
Off	On	Power On, OS Running
Flashing	On	Power On, System Running
On (Solid)	On	Power On, System Running and Connected to the core network

04 Configuration

C. Confirming Internet Connection via Ping from the freeRAN™ IoT Base Station

After confirming that the freeRAN™ IoT Base Station is connected to your local network, it is time to check that it can access the internet. At this stage it is necessary to connect to the unit from your computer using SSH as shown in Figure 4.2c below. Use the username: guest and password: guest. Once connected perform the same ping operation to Google's primary domain at 8.8.8.8.

Use SSH command to connect to freeRAN™ IoT Base Station IP with the Username: 'guest' and Password: 'guest'

Once connected, use the Ping command to ping Google's Primary DNS. Here '-c 4' indicates the sending of four packets.

Successful connection of freeRAN™ IoT Base Station to the Internet

Figure 4.2c: Pinging the internet from the freeRAN™ IoT Base Station.
At the command line, use ssh guest@XXX.XXX.XXX.XXX
followed by ping -c 8.8.8.8 (Replace XXX.XXX.XXX.XXX with your Base Station's IP address.)

05 Specifications

The freeRAN™ IoT Base Station comes with various options to support core network configuration, backhaul interfaces and mounting. A discussion of these additional configuration options is provided in the prior section on Options. The sections below provide a detailed overview of the specification of the freeRAN™ IoT Base Station.

Performance	OFDMA 16 QAM (downlink), SC-FDMA 16 QAM (uplink) SDR-based (Linux/ARMv8-A); > 70 concurrent RRC connections
Bandwidth	3 MHz
System	Linux Ubuntu 18.04
Memory	8GB eMMC flash and 2GB DDR4
Frequency Bands	902 MHz to 928 MHz (UL: 902-905 MHz, DL: 925-928 MHz)
Output Power	30 dBm maximum
GPS Antenna	5 dBi peak gain
RF Antenna	2.65 dBi peak gain
Backhaul Specifications	Ethernet 10/100/1000 Mbps LTE antenna peak gain: 1.8 dBi (band 2), 0.6 dBi (band 4), 1.4 dBi (band 13)
LED Indication	1 x System Power 1 x Network Connection Status (Ethernet or LTE)
I/O Interfaces	2 x external antennas for GPS and RF 1 x external antenna for LTE backhaul 1 x Gigabit Ethernet port, LAN/WAN 1 x Reset button 1 x USIM slot 1 x Micro SD slot 1 x Power-Over-Ethernet (PoE)
Physical and environmental	Dimensions: 10" × 10" x 3.28" Operating temperature: -4° to 131°F Storage temperature: -4° to 158°F Operating humidity: 5% to 90% non-condensing Ingress protection rating: IP67

REVISION HISTORY

Revision	Date	Description
1.0	Feb. 2023	Initial release