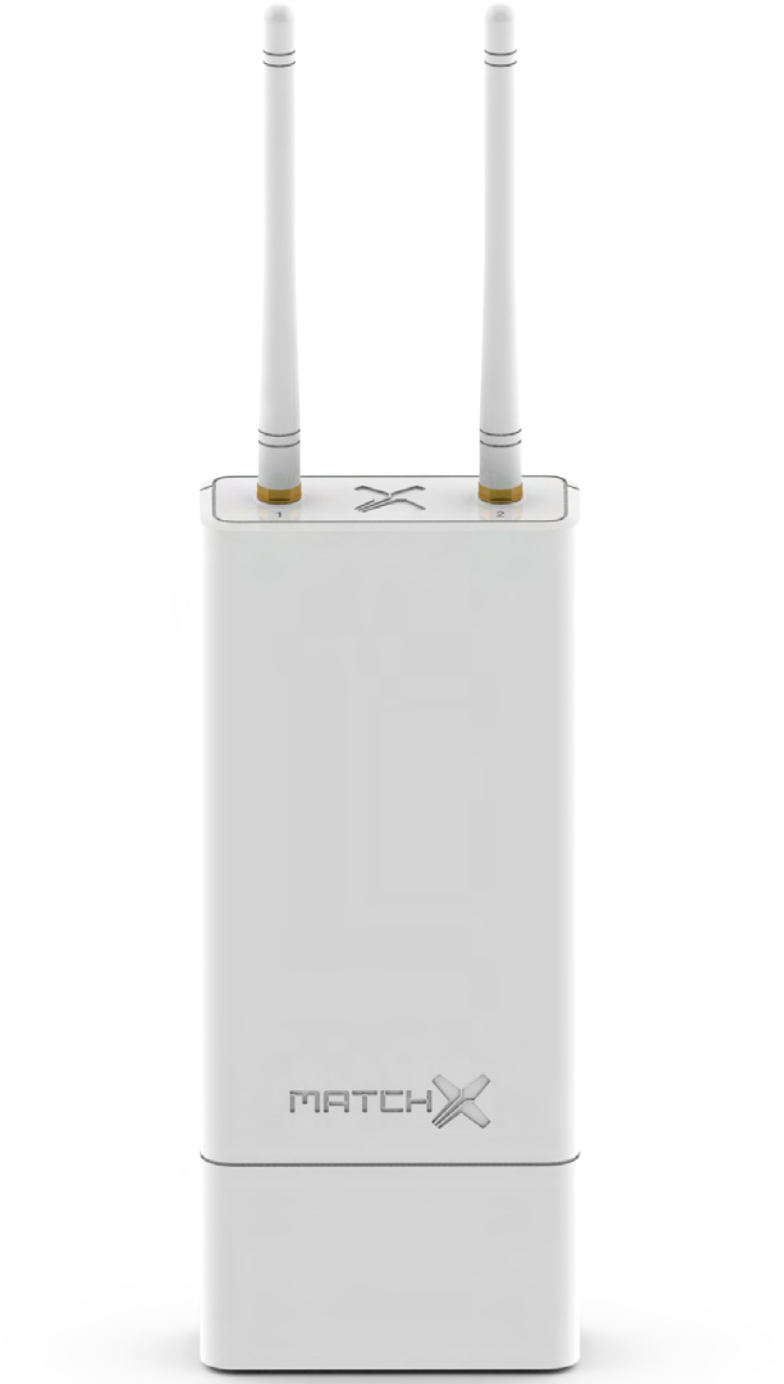


Box

LPWAN gateway

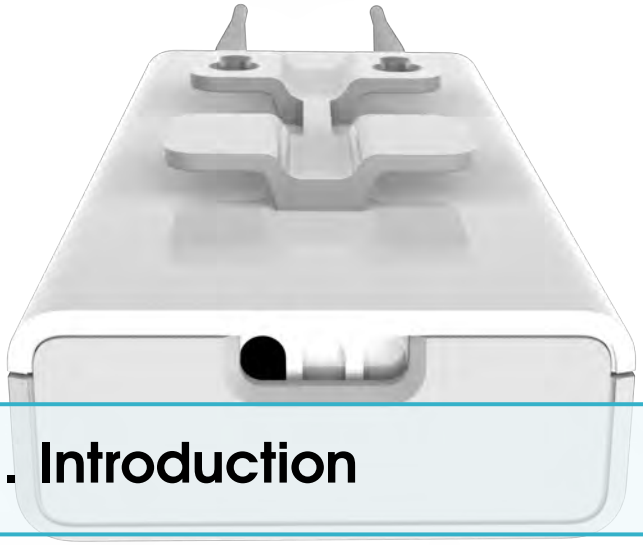
MX1702

User Guide

WWW.MATCHX.IO

First release, May 2017

Contents



1. Introduction

1.1 Product overview

Thanks for choosing MatchX LPWAN products for your IoT applications. The Box includes a set of high-performance hardware and MatchX LPWAN controller software that allows you to manage your IoT devices through web browser or API.

This guide covers the US and EU version of Box, with the MatchX LPWAN controller version 1.0 or above. The main difference between the US and EU version is listed in the Table 1.1:

Item	US MX1702	EU MX1701
Band	902-928MHz	863-873MHz
Special RX	920-925MHz	865-867MHz
Maximum Conducted Power	+30dBm	+27dBm
LBT	South Korea	Europe
SF	7-10	7-12
Certification	IEC 60950 -1 FCC PART 15.247	EN 300200 EN 301489
IP Rating	IP65	IP65

Table 1.1: Comparison of US and EU Box

1.1.1 Lora

Box supports LoraWAN protocol that brings up to 20km coverage in open spaces, with superior network capacity that can accommodate more than 65535 nodes in a cell, and larger network coverage.

It supports network roaming and adaptive data rate management, which brings conveniences to system managers for IoT network plan and deployment. Box fully supports LoraWAN V1.0.2 and

can be remotely upgraded for the future versions of LoraWAN. The whole solution is compatible with all the LoraWAN devices.The RX band in some regions is narrower than US and EU version, please refer to the details in Section 3.4.

1.1.2 WiFi

Box augmented WiFi for the on-site device configuration and management. WiFi is used both as an access point and wireless bridge to local network, it provides integrated web interface for LoraWAN device management. Box support 802.11 abgn and runs in 2.4GHz.

1.2 Main Features

Box is the industry's first IoT gateway that brings breakthroughs in both hardware and software, the network capacity, range coverage, security and device management are enhanced in both US and EU versions.

1.2.1 Hardware

- Maximum +27dBm conducted output power in 868MHz, +30dBm in 915MHz
- -143dBm sensitivity of LoraWAN packets
- FPGA integrated for Listen-Before-Talk AFA
- 580MHz CPU and 128MB RAM, 32MB flash
- 24V passive POE for power supply
- USB-C for debug and management
- Wifi,Ethernet or backhaul

1.2.2 Software

- Supports OpenWrt and LEDE
- Integrated with the most updated packet forwarder
- Supports LoraWAN class A,B,C
- Runs LoraWAN network server and application server locally (optional)
- Firmware upgrade over the air
- Gateway and end device management on-site

Currently Class B support in MatchX cloud is still in beta version, but the hardware is fully prepared for Class B specification, it is expected to have a final Class B support in future cloud upgrade.

1.3 Interface and Connectors

1.3.1 Front panel of Box

The shell part can be removed to connect cables and check the status of the Box. The panel has USB, USB-C and POE connectors and Link status LED.

USB2.0 is used to connect 3G/4G stick or USB disk.

USB-C can be used to debug the Box.

Ethernet port supports 24V passive POE, please pay attention to the voltage rating of the POE injector.

1.3.2 Link activity of Box

Box uses one RGB LED to indicate the activity of the connections. The Table 1.2 describes the LEDs on the Box

LED Color	Activity
Flashing Blue	Initializing
Steady Blue	Connected to Internet, no LoraWAN is configured
Alternative Blue and Red	Device is busy, don't unplug power
Flashing Red	No GPS fix
Steady Red	No Internet or no LoraWAN
Flashing Green	Configuring Box
Steady Green	Indicates that the Box is well-connected

Table 1.2: LED activity of Box

1.3.3 Connector of Box

Antenna 2 is for Lora radio and antenna 1 is for GPS. It is waterproof and has a mounting facility that can mount on the fields, rooftop or the outside wall of a building. The enclosure is made of ASA plastic, which is much more resistant to UV, wind, sand and acid rains.

2. Quick Installation Guide

The Box is pre-configured to connect MatchX network without any need of setup, the installation guide will introduce how to set it up and configure WiFi and Lora parameter.

This device must be professionally installed.

2.1 Software environment

To configure the Box, users will need to have the following software environment:

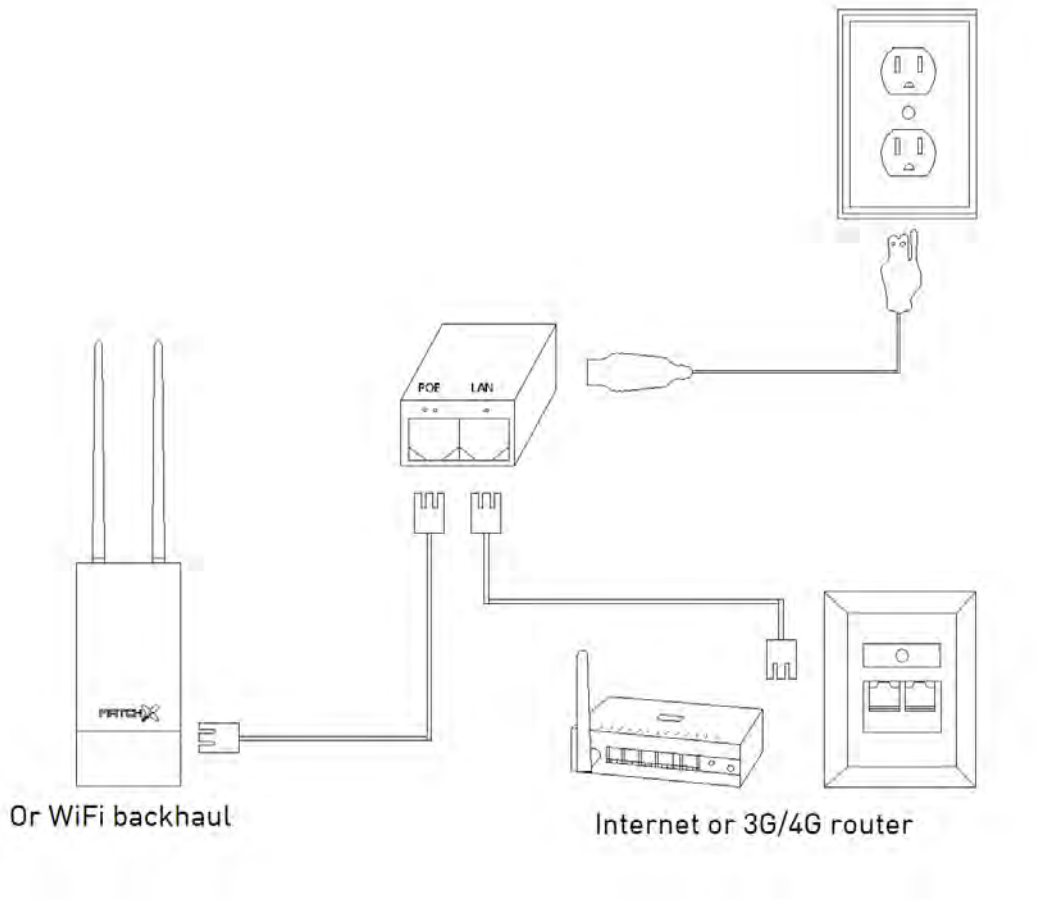
- Windows system with SSH client or iOS/Linux distributions with terminal
- Web browser like Chrome or Firefox
- Mobile browser like Chrome or Safari
- MatchX network account

2.2 Hardware environment

- WiFi or Ethernet connection
- Laptop or PC
- Mobile phone
- LoraWAN compatible end device

2.3 Connection

Here we only illustrate the POE power supply method, and the USB-C power option is not discussed here. Users can find the POE power supply inside the package, and the corresponding plug that specific to the country or region.



Firstly connect to power cords from your wall sockets or panel sockets to POE, then connect the RJ45 cable from your Internet modem/switch/wall port, or any 3G/4G router to the POE's port labeled with "LAN". Next, grab a RJ45 cable and connect from the POE's port labeled with "POE" to Box.

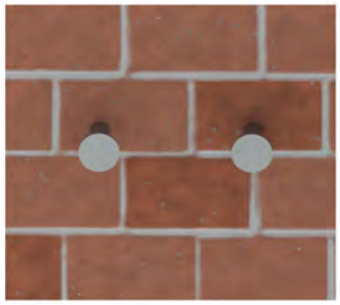
Box can also use any 2.4GHz WiFi as a backhaul while powered by POE.

2.4 Mounting

2.4.1 Wall Mounting

The screws and screw anchors are included in the package, users can drill two 6mm hole on the wall and apply screw anchors to them.

- Determine the place of mount, should be a even surface
- Mark two holes that are going to be drilled, the distance is 32.2mm, should be horizontally aligned
- Drill two 6mm hole, pply screw anchors and screws
- Adjust the screw space
- Mount Box to the screws



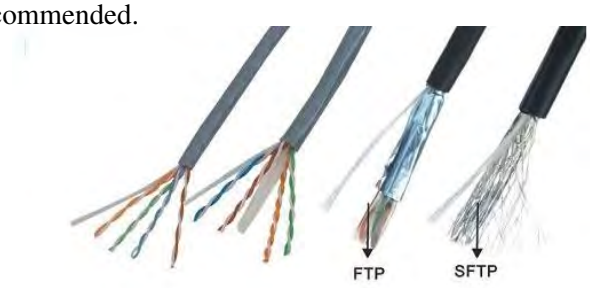
2.4.2 Pole mounting

To mount Box to a pole, users can find the stainless steel clamps in the package. The steps are:

- Determine the place of mount, should be a round pole
- Position the Box to the place, and fasten the stainless steel clamp.

2.5 Surge protection and Shielded Ethernet cable

It is recommended to use the shielded RJ45 cable to connect the Box, in order to protect the device from thunder and electricity surge. Both shielded FTP and S-FTP cable from Cat5e are recommended.

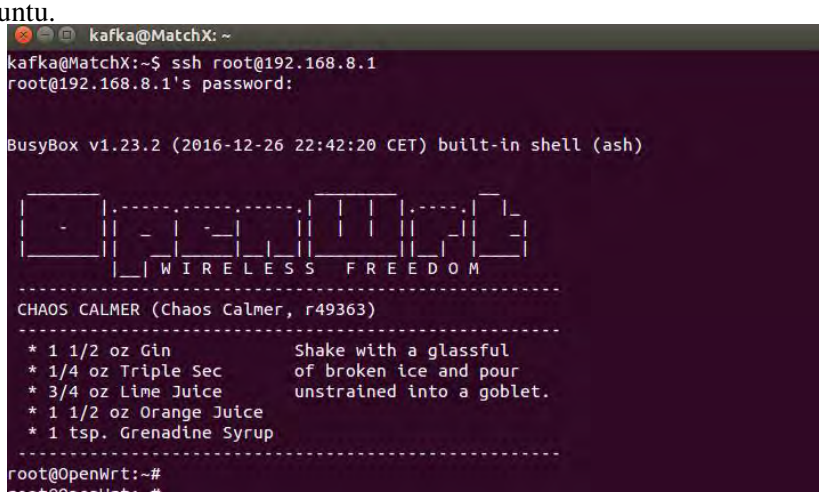


2.6 Setup

The Box will be automatically connected to MatchX cloud after the Internet is connected. This guide will illustrate how to connect to the Box and configure it.

2.6.1 WiFi connection

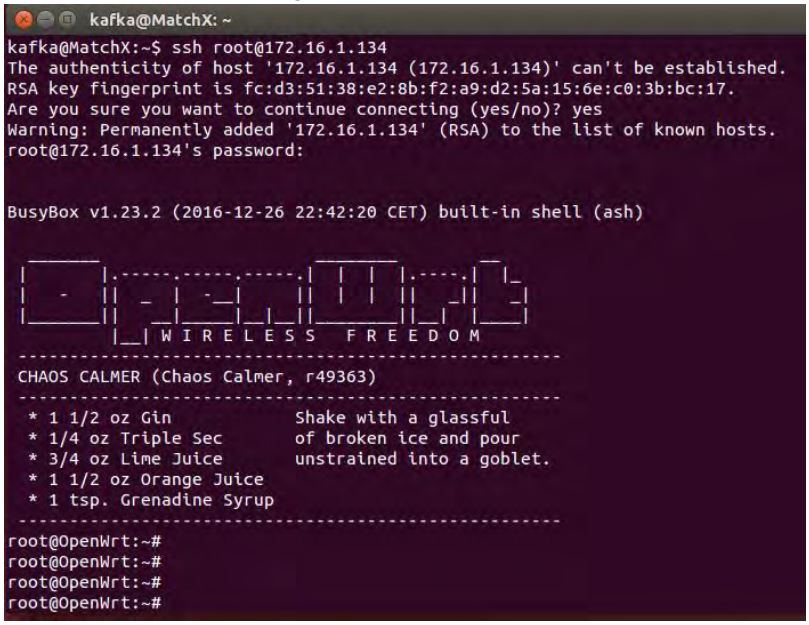
Users need to have a laptop or a PC that has WiFi connectivities, then after the Box is powered on, the SSID that in a format "**MatchX_BOX_xxxx**" will be available for connection. The default password is **matchxiot**. After connected, users can use ssh with terminal or putty in Windows to login 192.168.8.1, the default password is root. The following picture shows the connection under Ubuntu.



2.6.2 Ethernet connection

In this case users should have connection to LAN by either an Ethernet cable or WiFi, and they should know the IP address of the BOX in their LAN.

In this example we assume that the IP address that obtained by Box is 172.16.1.134, and we connect from the LAN through ssh in Ubuntu:



2.6.3 Packet forwarder and gateway library

The Box includes the most updated packet forwarder and gateway library from Semtech's github. The folder is in **/root/lora_lib** and **/root/lora_pkt_fwd**.

Lora gateway library integrates the basic tools like Listen-Before-Talk test, Spectrcal-Scan test and TX test for different spreading factor and bandwidth.

The utilities that contain in lora_lib are:

- **util_lbt_test**: it will use the specified parameters like frequencies to conduct Listen-Before-Talk tests.
- **util_pkt_logger**: it will listen to specified frequency and log all the packets to a csv file.
- **util_spectral_scan**: it will generate rssi histogram based on the specified frequency.
- **util_spi_stress**: it will generate SPI test write and read to test the stability of SPI interface.
- **util_tx_continous**: it will use the mixer, PA and digital divider values to send lora modulated signals continuously. This is mainly used for compliance test.
  For example: ./util_tx_continuous -f 868 -r 1257 - -dig 0 - -mix 15 - -pa 3

  This will set the TX to maximum continuous mode for regulation testing and antenna tuning.
- **util_tx_test**: it will send the test lora packets periodically with specified parameters like frequency and spreading factor. Optionally the "Polite Spectrum access" can be tested
  For example: ./util_tx_test -r 1257 -f 868.1 - -lbt-freq 868.1 - -lbt-rssi-offset -7 - -lbt-nbch 1 - -lbt-sctm 5000 - -lbt-rssi -80 -t 5000
  This will set a CCA threthold at -80dBm, then listen to 868.1MHz, wait to send until the channel is not busy.

The utilities in lora_pkt_fwd are mainly used for testing the packet-forwarder. They are:

- **lora_pkt_fwd**: it will use the JSON configuration file like global_conf.json to forward data to the specified server.

To run any test that relates to RX, users should use this daemon to display the packets that are received at the Box.

- **util_ack**: it will listen on a single UDP port and responding to PUSH_DATA datagrams with PUSH_ACK, and to PULL_DATA datagrams with PULL_ACK.
- **util_sink**: it will listen on a single port for UDP datagrams, and displaying a message each time one is received. The content of the datagram itself is ignored.
- **util_tx_test**: it will send the test lora packets periodically with specified parameters like frequency and spreading factor.

2.6.4 WiFi backhaul

Normally the Box is powered by POE and get Internet access through the POE's LAN port. It is also possible to use WiFi as a backhaul when there is no Ethernet connection, users should first log into the Box as the steps described before, use aps command to check the available WiFi near by then type in:

```
aps
setwifi yourSSID yourpassword
```

```
root@OpenWrt:~# setwifi TECH_CODE_STAFF techcode@2015
MatchX wireless-WAN tool
setting apcli
root@OpenWrt:~#
root@OpenWrt:~#
root@OpenWrt:~#
root@OpenWrt:~# ping google.com
PING google.com (172.217.23.174): 56 data bytes
64 bytes from 172.217.23.174: seq=0 ttl=53 time=22.301 ms
64 bytes from 172.217.23.174: seq=1 ttl=53 time=22.122 ms
```

2.6.5 GPS setting

In Box, the GPS model is UBLOX MAX-7Q, which is connected via UART interface. And GPIO 41 is used to enable the GPS, the logic is active high.

It complies with ***u-blox7 (V14) Receiver Description Protocol Specification***, which can be downloaded from Ublox's support website. The protocol has some proprietary commands that used in LoraWAN, and it is automatically communicated by packet-forwarder.

It is not advised to set GPS since it is mainly used for LoraWAN's time synchronization and location, but users can have GPSD as a daemon to connect the GPS for debugging. It is important to make sure that GPS is not used by any other processes when launching GPSD. The command for bringing up GPSD is:

```
gpsd -D 5 -N -n -G /dev/ttyS1
```

The GPSD'S client command to check the GPS output is:

```
cgps -s
```

3. Product specification

The Box is designed for better LPWAN performance and manageability. In this chapter we briefly introduce the specifications for both hardware and software.

3.1 Hardware environment

Box is mainly designed for network operators, it can both be deployed outdoor and indoor, the enclosure is made of weather-resistant material. It is much more durable than the normal plastics. The hardware specification is listed in the table blow:

Item	Description
CPU	MT7688AN 580MHz MIPS
Memory	128MB DDR2 RAM/ 32MB FLASH
GPS	UBlox Max 7Q
LAN	10/100 Mbit LAN with 24V POE
Interface	USB-C with GPIO, USB 2.0 and reset
Enclosure	ASA plastic, anti-UV
Size	78 x 340 x 30mm
Operating Temperature	-40°C to 85°C
Power	3.5W in average, peak 6W

Table 3.1: Key hardware specifications

3.2 Software environment

To facilitate the network deployment, we have included a lot of good features, which include:

- Open source operating system
- LoraWAN network server and application server running inside of Box

- Official packet-forwarder and lora-gateway libraries
- OTA upgrade and end device firmware upgrade
- remote management of gateway and connectivity

3.3 RF performance

There are several RF systems in Box, which include Lora, WiFi and GPS . In this section we will briefly introduce the performance of these systems.

For Lora, the transmission and receive performance are listed in Table 3.2:

For WiFi, Table 3.3 listed the performance, and GPS is listed in Table 3.4. The GPS's performances are in accordance with the models' data sheets.

Item	Description
TX	Maximum +27dBm in 868 version
TX	Maximum +30dBm in 915 version
RX	-128dBm at SF7BW125
RX	-143dBm at SF12BW125

Table 3.2: Lora RF performance

Item	Description
RF	1T1R 150Mbps
Protocol	IEEE 802.11 a/b/g/n
TX Power	+19dBm
RX Sensitivity	-91.5dBm

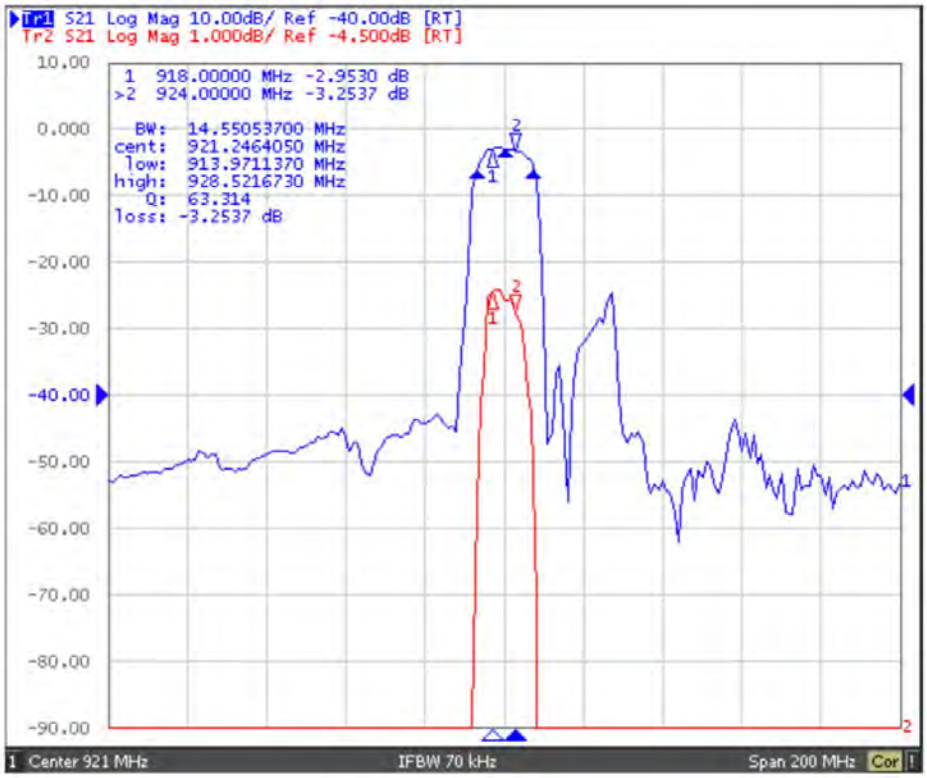
Table 3.3: WiFi RF performance

Item	Description
Tracking	-160dBm
Cold Start	-147dBm

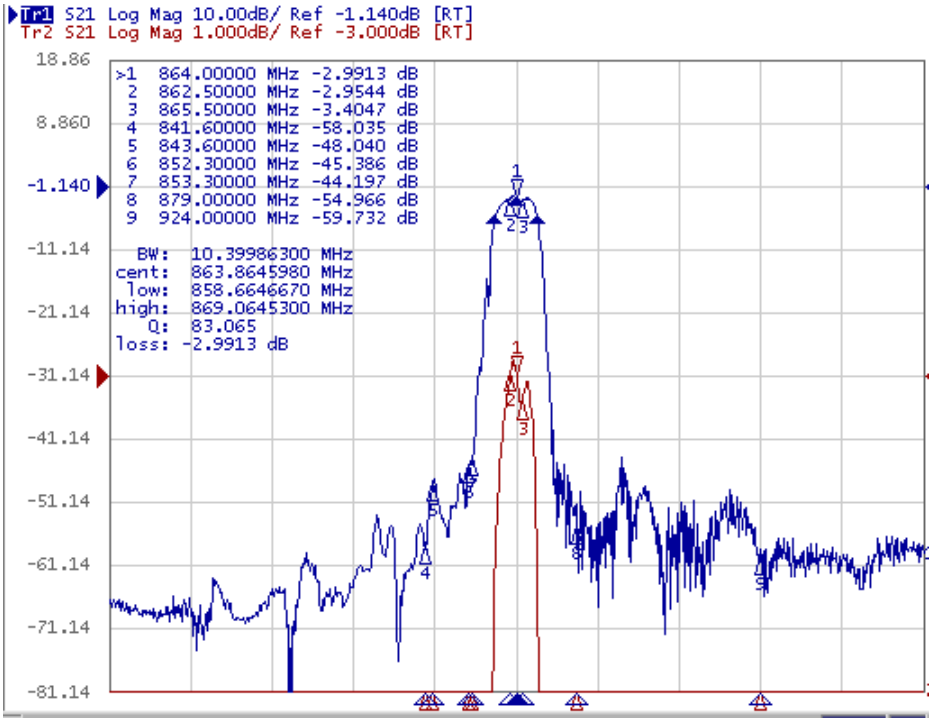
Table 3.4: GPS RF performance

3.4 RX Filter for narrow band regions(IN/HK/SIN/THA)

Different regions like Thailand, Singapore, India and Hongkong just allocate 2-5MHz to ISM usage, which usually near the LTE/CDMA bands. In order to prevent the receiver desensitization and saturation, the following filters are used in RX path.



920-925MHz RX filter for Singapore, Hong Kong, Thailand, Vietnam



865-867MHz RX filter for India

3.5 Antenna Performance

The performance of the GPS antenna 1 is listed in the following table:

Item	Description
Frequency range	1574 - 1606MHz
Impedance	50ohms
VSWR	<1.2:1
Max gain	2.5dbi
Polarization	Vertical
Radiation Pattern	Omni-directional
Connector	SMA(M)
Length	108mm
IP Rating	IP65

Table 3.5: GPS Antenna performance

The performance of the Lora antenna 2 is listed in the following table:

Item	Description
Frequency range	863-873MHz
Or	902-928MHz
Impedance	50ohms
VSWR	<1.2:1
Max gain	2.5dbi
Polarization	Vertical
Radiation Pattern	Omni-directional
Connector	SMA(M)
Length	108mm
IP Rating	IP65

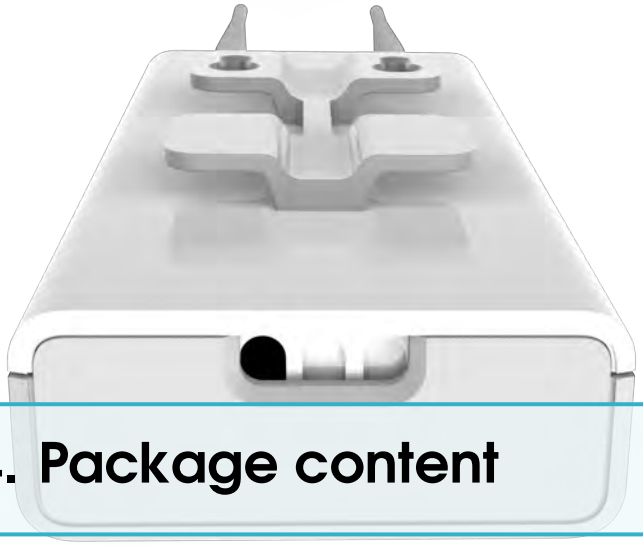
Table 3.6: Lora Antenna performance

3.6 Operational frequencies

The operational frequencies in European countries is listed in the table.

Operational Frequency band		Maximum e.r.p	Channel access and occupation rules (e.g. Duty cycle or LBT + AFA)	Band number from EC Decision 2013/752/EU [i.3]	Class 1 sub-class number according Commission Decision 2000/299/EU [i.7]
K	863 MHz to 865 MHz	25 mW e.r.p.	⩽ 0.1 % duty cycle or polite spectrum access	46a	66
L	865 MHz to 868 MHz	+6.2 dBm/100 kHz	⩽ 1 % duty cycle or polite spectrum access	47	67
M	868.0MHz to 868.6 MHz	25 mW e.r.p.	⩽ 1 % duty cycle or polite spectrum access	48	28
N	868.7 MHz to 869.2MHz	25 mW e.r.p.	⩽ 0.1% duty cycle or polite spectrum access	50	29
P	869.4MHz to 869.65MHz	500 mW e.r.p.	⩽ 10 % duty cycle or polite spectrum access	54b	30
Q	869.7MHz to 870.0 MHz	5 mW e.r.p.	No requirement	56a	31

The rest of frequency plans in US, Australia, India, Korea and the rest of the world can be found on MatchX website.



4. Package content

Thanks for purchasing MatchX Box LPWAN gateway, it carries the most advanced IoT technology with a plug-and-play design. With the default package users can easily setup an IoT LPWAN. The package includes the following items:

Box(1 pcs)

Antenna(2 pcs)

30mm M6 Screw anchor,M4 Screw(2 sets)

Stainless Steel Clamp(1 pcs)

24V POE(1 pcs)

Power cords(1 pcs)

.FCC Statement

1. This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference.

(2) This device must accept any interference received, including interference that may cause undesired operation.

2. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: The manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications to this equipment. Such modifications could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a **Class B** digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.

-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

-Consult the dealer or an experienced radio/TV technician for help

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance of 20 cm between the radiator and your body.

IC Statement

This device complies with RSS-247 of Industry Canada.

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.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

(1) l'appareil ne doit pas produire de brouillage, et

(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.