WIRNET ISTATION

PRODUCT DESCRIPTION

	Written by	Approved by	Validated by
Name	SNI	FLM	LGE
Entity	PRGM	DRD	Customer Services
Date	2020-07-22	2020-07-22	2020-07-28

HISTORY

Date	Modification	Author	Version
2019-07-04	Creation	FLM	0.1
2019-07-12	Minor update	FLM	1.0
2019-08-06	Minor update on paragraphs 3.1 & 3.3.1	FLM	1.1
2020-02-17	Minor update on paragraph 3.6, 3.8.2 & 4	FLM	1.2
2020-03-13	Dimensions on drawing	FLM	1.3
2020-05-14	Changes in paragraphs 3.3.3, 3.4.3, 3.7 Addition of new paragraph 4	FLM	1.4
2020-07-22	Detailed connection of external antennas	SNI	1.5
2020-07-28	Official version	SNI	2.0

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Figures

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REFERENCE

Reference	Document / link	Description
[1]	https://lora-alliance.org/lorawan-for-developers	LoRaWAN™ Specification V1.0.3 2018 March 19th
[2]	https://lora-alliance.org/lorawan-for-developers	LoRaWAN™ 1.1 Regional Parameters Revision B, 2018 January
[3]	https://www.lora-alliance.org/For-Developers/LoRaWANDevelopers	LoRaWAN™ Regional Regulation Summary Version 1.5 draft 10 May 15th, 2018

GLOSSARY

Abbreviation	Description
BW	Band Width
CPU	Central Processing Unit
DDR	Double Data Rate
EDGE	Enhanced Data rates for GSM Evolution
EIRP	Equivalent Isotropically Radiated Power
EMC	ElectroMagnetic Compatibility
eMMC	Embedded Multi Media Card
FPGA	Field Programmable Gate Array
GMSK	Gaussian Minimum Shift Keying
GPRS	General Packet Radio Service
GSM	Global System for Mobile communication
HSPA	High Speed Packet Access
HTTP	HyperText Transfer Protocol
IC	Integrated Circuit or Industry Canada
IK	Mechanical Impact
IO	In / Out
IoT	Internet of Things
ISM	Industrial Scientific and Medical
KLK	KERLINK

LED	Light-Emitting Diode
LNA	Low Noise Amplifier
LoRa	Long Range
LTE	Long Term Evolution
M2M	Machine to Machine
PA	Power Amplifier
PCB	Printed Circuit Board
PER	Packet Error Rate
PoE	Power over Ethernet
RAM	Random Access Memory
RF	Radio Frequency
RSSI	Received Signal Strength Indicator
RX	Receive
SAW	Surface Acoustic Wave
SNR	Signal to Noise Ratio
SPI	Serial Peripheral Interface bus
TX	Transmit
UMTS	Universal Mobile Telecommunications System
USB	Universal Serial Bus
WWAN	Wireless Wide Area Network
3G	Third generation of mobile telecommunications technology
4G	Fourth generation of mobile telecommunications technology

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1. Introduction

The Wirnet™ iStation gateway is part of the global Long Range Radio fixed network to provide M2M connectivity link between low power end-point and Internet Access.
The gateway architecture is specifically designed for the needs of outdoor environment.
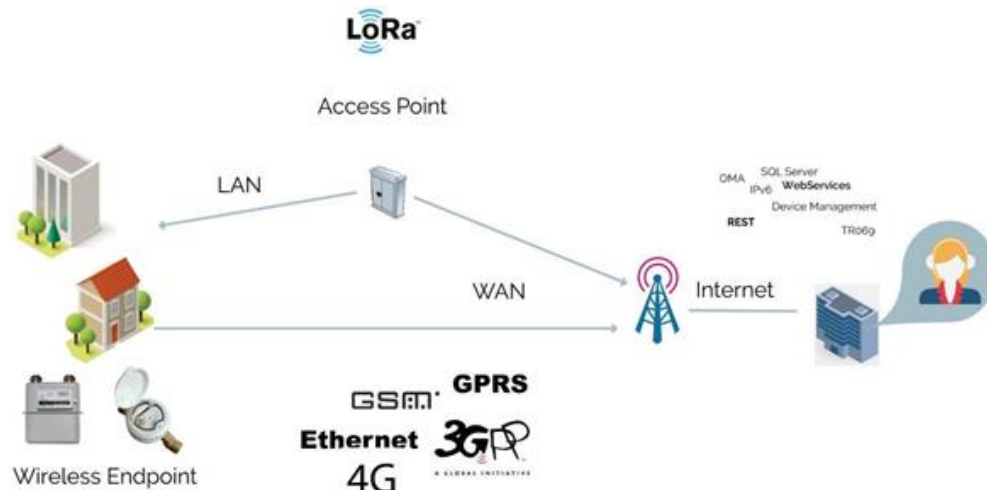

Figure 1: LoRa Network topology

The Wirnet™ iStation is based on "LoRa" technology provided by Semtech Company. It is compatible and interoperable with existing LoRa LPWAN.

This gateway is declined into three versions to cover different countries and areas around the world:

	Wirnet iStation 868	Wirnet iStation 915	Wirnet iStation 923
Geographical area	Europe, Russia Africa Middle East, India	North America Central America South America	Asia: Indonesia, Malaysia, Korea, Japan, Taiwan, Hong Kong, Thailand, Vietnam, Papua New Guinea, Singapore, Philippines Oceania: Australia, New Zealand Latin America: Brazil, Argentina, Colombia
ISM band	863 - 876MHz	902 - 928 MHz	915 - 928 MHz
Rx Band (DL)	863 - 873MHz	922 - 928 MHz	915 - 928 MHz
Tx band (UL)	863 - 873 MHz	902 - 915 MHz	915 - 928 MHz

Please check the appropriate version for the dedicated country. Contact KERLINK if required.
The present document addresses all the above Wirnet™ iStation versions.

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2. Main functionalities

Here are the main functionalities of the Wirnet™ iStation product:

- LongRange support:
  - Incorporate LoRa (TM) bidirectional communications technology:
    - RX: 863- 873MHz, TX: 863-873MHz (according to HW capabilities)
    - RX: 902-915MHz, TX: 922-928MHz (according to HW capabilities)
    - RX: 915-928 MHz, TX: 915-928MHz (according to HW capabilities)
  - Emulates 49 LoRa demodulators over 9 channels + 1 x GFSK
- Embedded, remote and open low power communication station
- Open development framework based on standard Linux OS
- WWAN connectivity over Ethernet or LTE/HSPA/EDGE/GPRS
- USB host interface allowing local secured software upgrade
- Web local interface allowing configuration, diagnostic and maintenance
- Highly secured device relying on a hardware secure core
- Embedded Base Station Controller (BSC) agent relying on standard SNMP protocol:
  - Alarm notifications
  - Firmware upgrade
  - File transfer
  - Remote shell control
  - Configuration
  - Monitoring (platform statistics, RF statistics, RF spectrum analyzer...)

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3. Hardware specifications

3.1 Block diagram

This product has the following specifications:
- High performance CPU:
    - iMX6xxx (SoloX or UL), under Linux OS
    - None volatile memory eMMC (8Go)
    - Volatile memory DDR (256Mo)
- LoRa radio reference design:
    - Semtech SX1301 + SX1257x2 + FPGA + EEPROM
    - TX power 27dBm
    - Outband radio sniffer
    - RF external antenna via N connector or RF internal antenna
    - 3 versions of radio filter:
        - 868 MHz
        - 915 MHz
        - 923 MHz

- 10/100 Base-T/TX Ethernet transceiver with RMII Interface
- Waterproof RJ45 access using a cable gland
- WWAN connectivity with worldwide LTE, UMTS/HSPA+ and GSM/GPRS/EDGE coverage
- Waterproof SIM access (mini-SIM format)
- GNSS receiver (GPS, GLONASS, QZSS & SBAS) with an embedded antenna
- Powered by POE or DC supply
- IHM: 1 green LED for power + 1 red LED for status + ON/OFF/RST button
- USB-C connectivity for firmware upgrade & debug
- Waterproof IHM access using an IP67 cap
- Earthing connection
- Six supercapacitors and the associated charging circuit, featuring a backup power system. Around 20 minutes charging time & up to one minute capacity to ensure safe power down.

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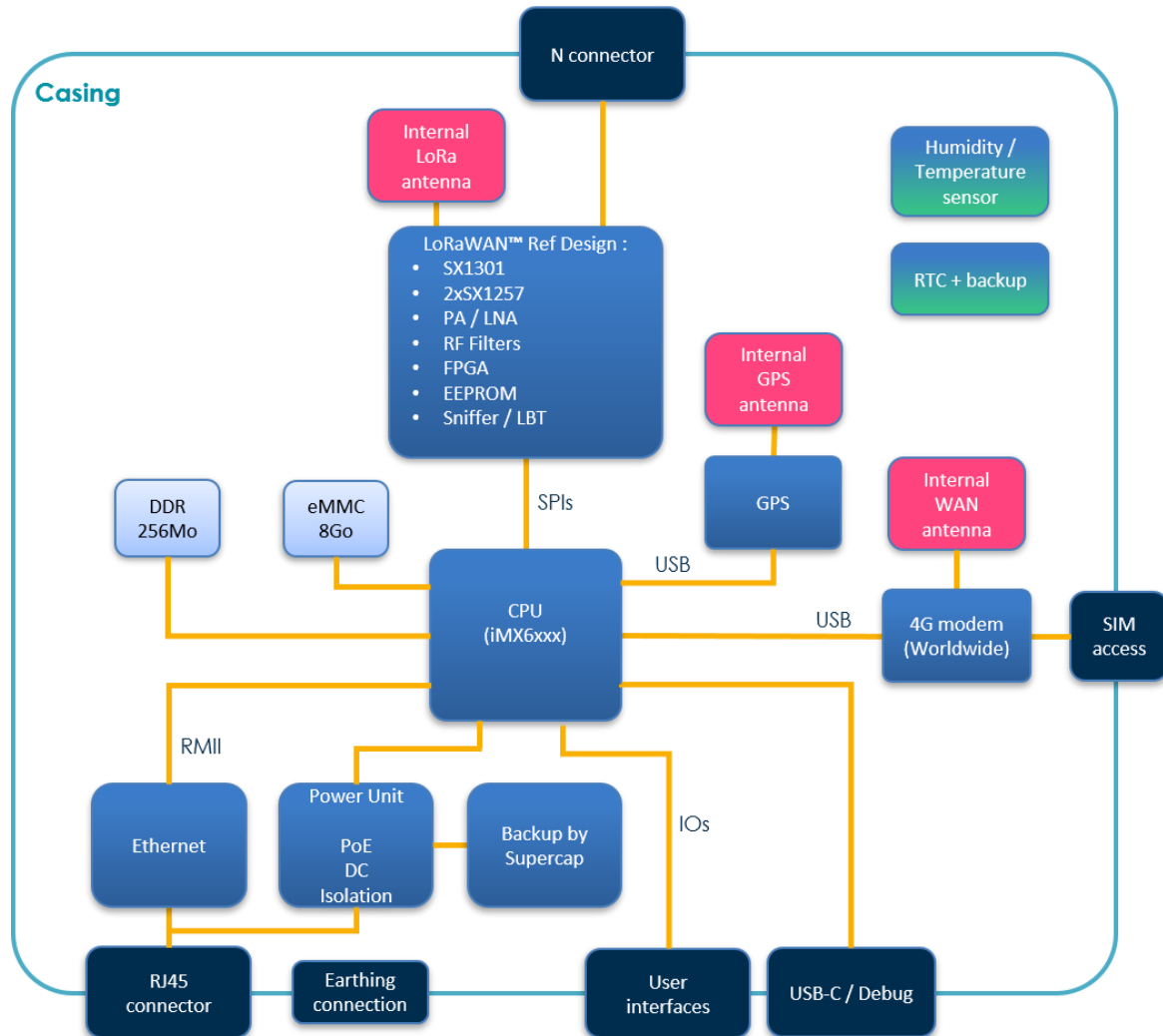The block diagram below depicts the HW architecture of the Wirnet™ iStation:

Figure 2: Hardware block diagram

3.2 Mechanical implementation

3.2.1 Casing
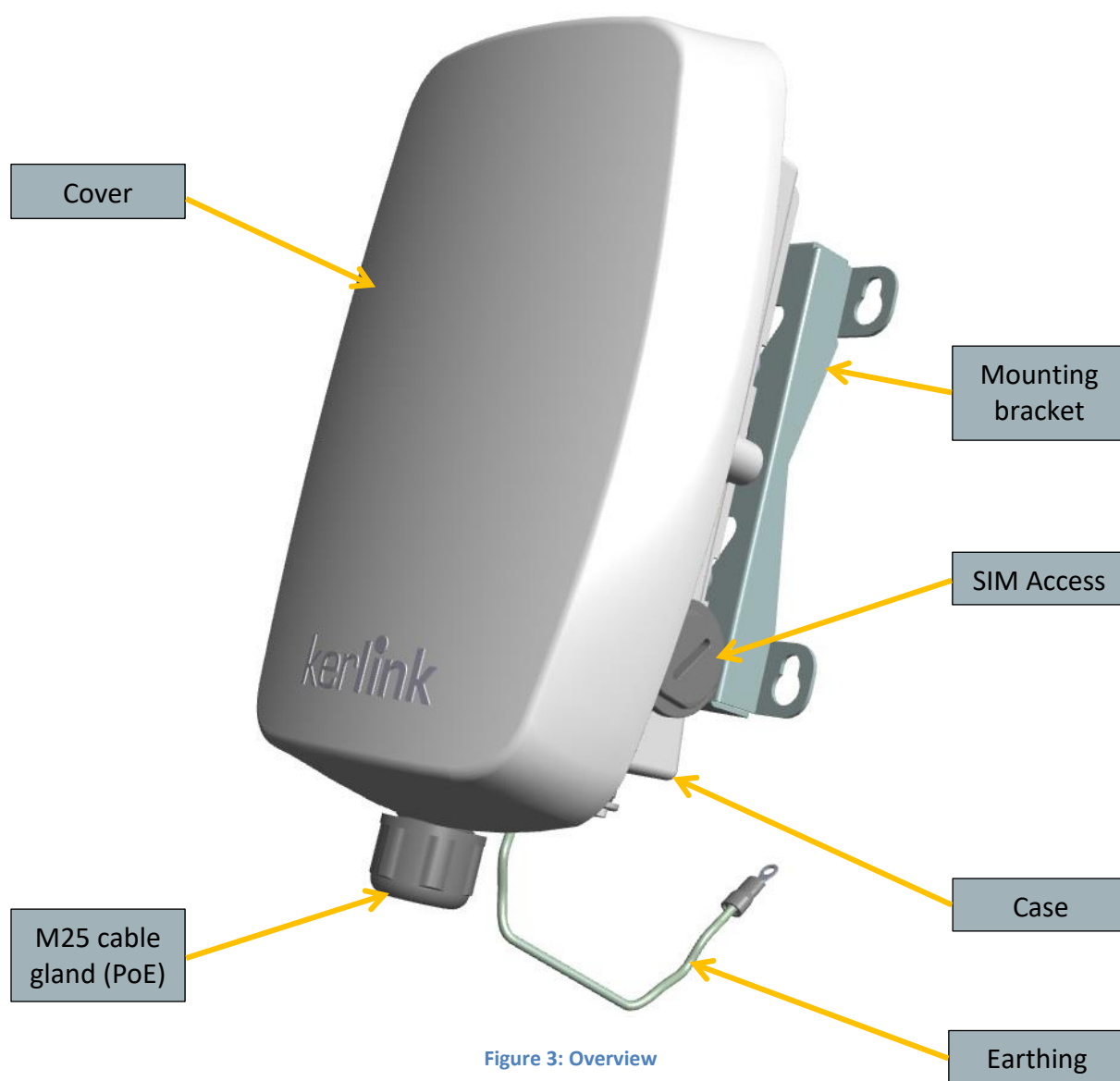
<div align="center">**Figure 3: Overview**</div>

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Bottom view

Right view

Front view

Left view

265mm

165mm

Top view

100mm

Figure 4: Multiple views

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The main characteristics of the enclosure are detailed hereafter:

Description	Specification
Enclosure material	Case in Aluminium alloy Cover in Polycarbonate
Gasket material	Silicone rubber with UL94-V0
Mounting bracket	Fast slide-in mounting Stainless steel material
Weight of mounting bracket	220g
Dimensions without external LoRa antenna	265 x 165 x 100 mm
Gateway weight with his mounting bracket	1400g
Ingress protection	IP67
Humidity	95% non-condensing
Impact resistance	IK07 (for the cover part)
Flammability rating for cover	UL94-V0
Operating temperature range	-40°C to +60°C
Connectors	1 x N.m for external LoRa antenna 1 SIM connector (Mini-SIM Format) 1 x USB-C receptacle 1 x RJ45

3.2.2 Mounting bracket

The Wirnet™ iStation may be mounted on a wall using four oblong holes located on the mounting bracket.
The screws for mounting on a wall are not included, the maximum diameter of the screws is 6mm.

Also, gateway may be mounted on a tubular using the openings provided for this purpose on the mounting bracket.
The Stainless Steel Hose Clamp for mounting on a pole are not included. The width should not exceed 14mm.

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N.m connector for ext. LoRa Antenna

Mounting bracket

Openings for Worm Drive Stainless Steel Hose Clamp

120mm
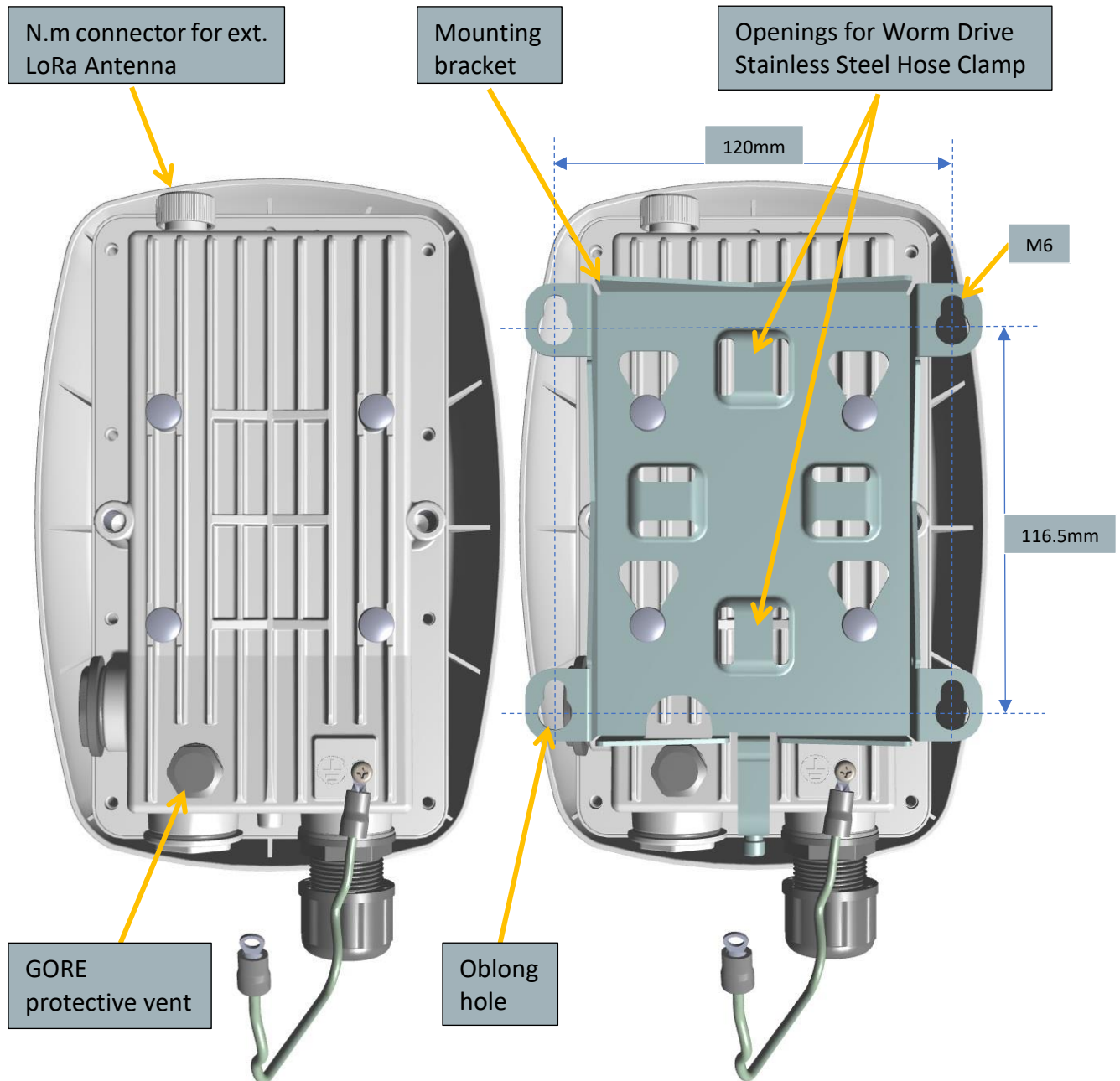
M6

116.5mm

GORE protective vent

Oblong hole

Figure 5: Rear view

3.2.3 Stickers

The Wirnet™ iStation own two stickers placed on one side of the gateway.
Stickers includes serial number, MAC address, electrical information and regulatory markings.

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3.3 Power Supply

3.3.1 PoE injectors

Wirnet™ iStation can be supplied by End-Span or Mid-Span PoE injectors.
- Endspan mode A (Data & Power are on 1/2, 3/6 pairs)
- Midspan mode B (Data is on 1/2, 3/6 pairs, Power is on 4/5, 7/8 pairs)

The Wirnet™ iStation is compatible with:
- 15.4W PoE injector (IEEE 802.3af)
- 30W PoE+ injector (IEEE 802.3at)

A 15.4W PoE injector is enough to supply the gateway.

PoE injector is an option. Contact KERLINK if required.

3.3.2 DC power supply

It is also possible to supply from DC power.
The input voltage range is 42 to 57VDC and power supply is isolated.
So, applications in +48VDC or -48VDC are possible with a RJ45 Female to 8 pins screw terminal block adapter or DIN Rail RJ45 to terminal block adapter.
⇨ For more details, contact KERLINK

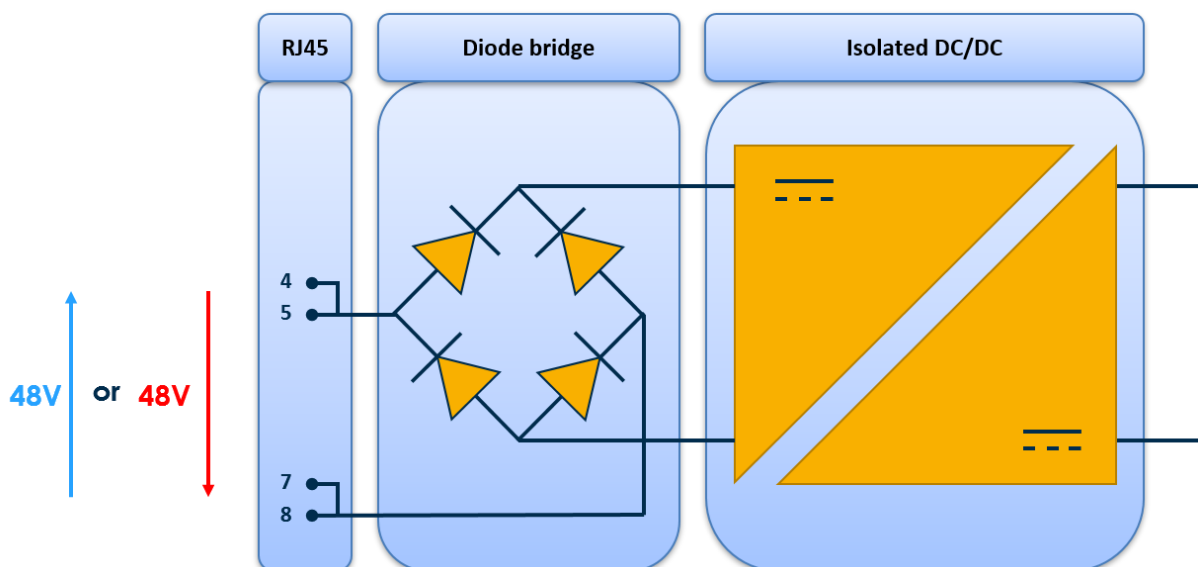The following drawing shows the supply input of the gateway:

Figure 6: Internal diagram of supply input

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3.3.3 Power consumption

The average power consumption under 48V is detailed hereafter:

Wirnet™ iStation	Power consumption
CPU block	1.48W avg
Ethernet block	0.175W avg
GPS block	0.161W avg
WWAN block (25%Tx,75%Rx)	1.7W avg
Radio block in Rx mode (x8 demodulator on)	1.76W avg

The maximum input power under 48V is approximately 8W.
This includes CPU, ethernet enabled, GPS enabled, WWAN enabled and maximum RF power in Tx LoRa mode.
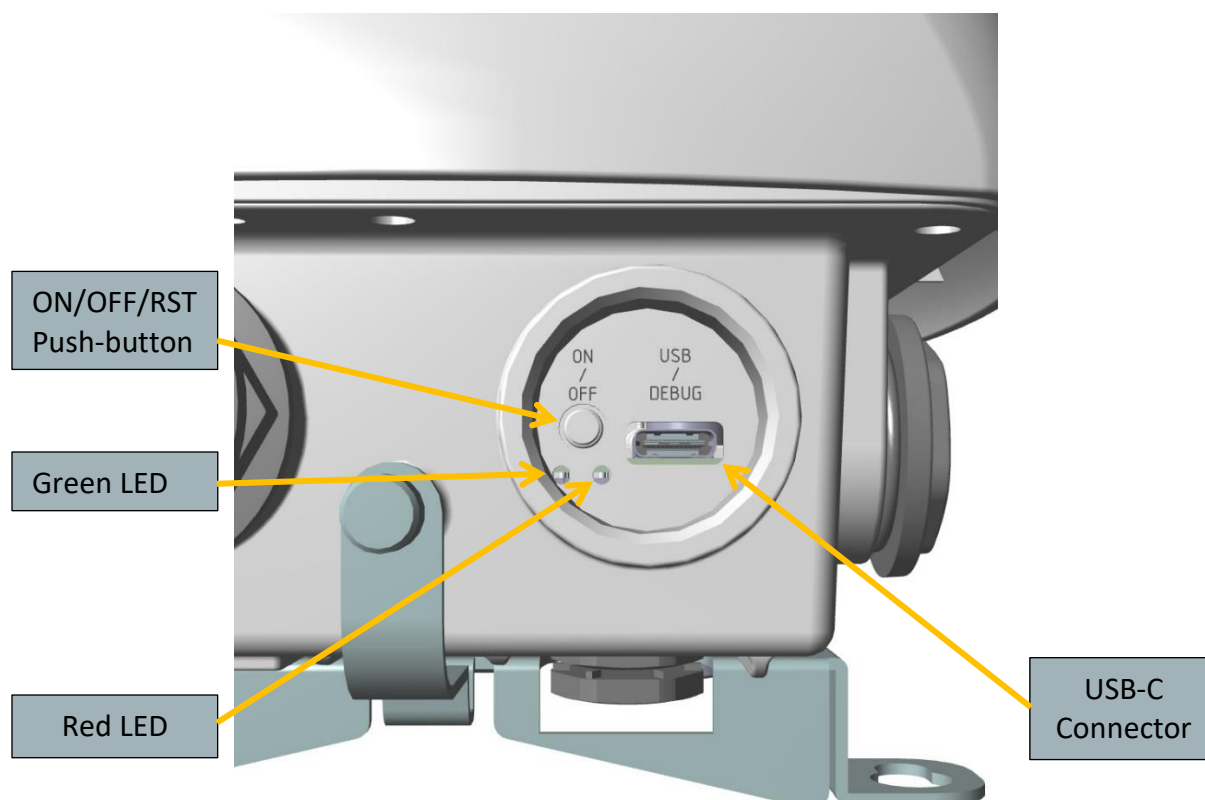
3.4 User interface

Figure 7: Bottom Interface

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3.4.1 LEDs

Two LED indicators are available on the bottom of enclosure:

Item	Specification
LED 1: Power	Green if power supply is present otherwise light off
LED 2: Status	Red blinking during kernel boot & system boot Light off when boot is finished

3.4.2 Push-button

A push-button is available on the bottom of enclosure.
The ON/OFF/RST button must be pressed during 1s to generate a SW reset of the product.
A long press for 5s turns off the gateway.

3.4.3 USB-C Connector

This connector allows to plug:
- a Kerlink debug probe to use debug mode
  Used by developers, UART allows communication with the OS, to verify log…)
  ⇨ Contact KERLINK if required

- a simple USB mass-storage key to upgrade gateway

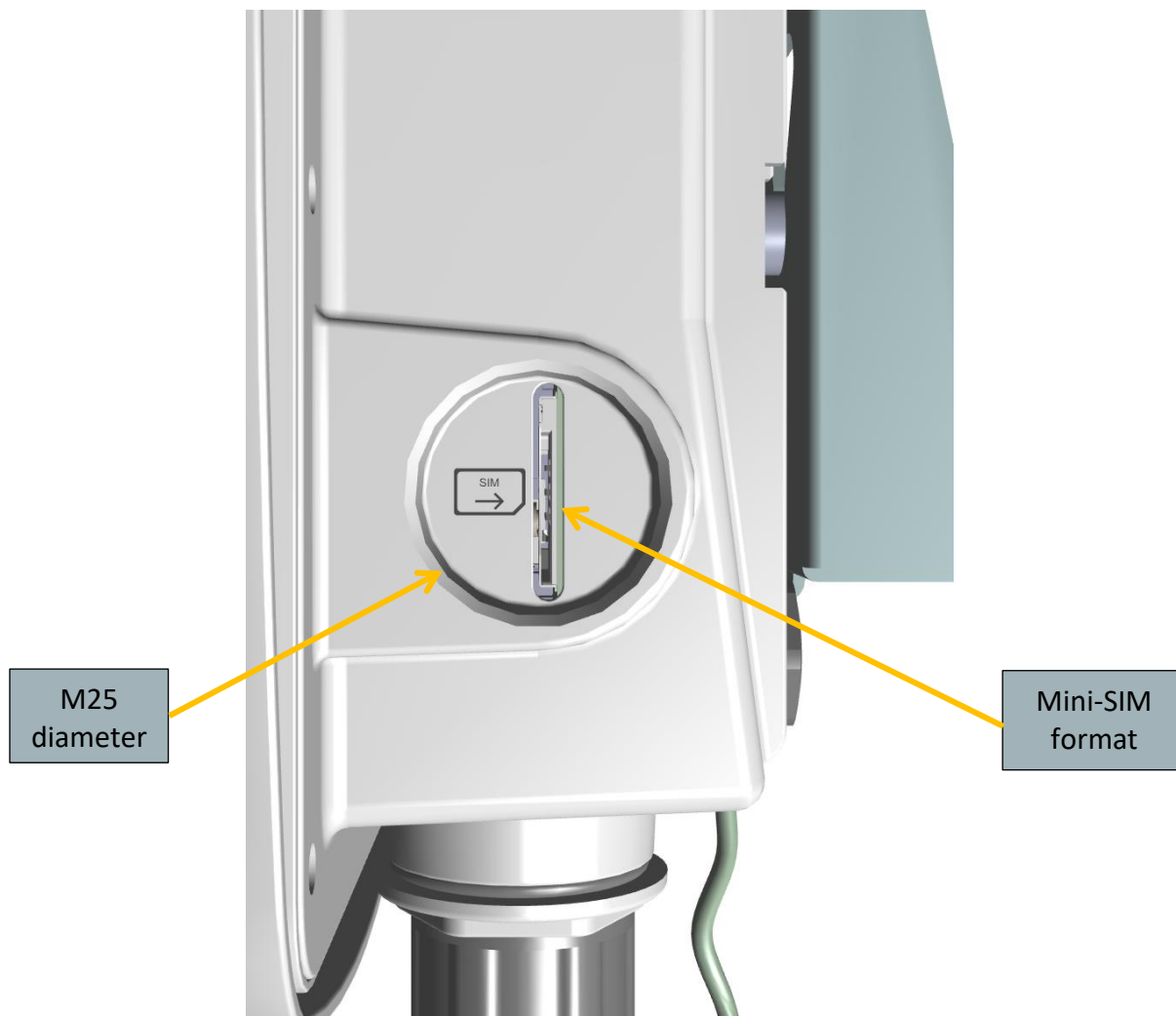| Classification	This document is the strict property of Kerlink and shall not be either copied nor sent without express written authorization of Kerlink	
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3.4.4 SIM access

<p align="center">Figure 8: SIM Interface</p>

3.5 Radio specifications

3.5.1 Mains characteristics

Feature	Description
LoRa demodulator	Based on SX1301 digital signal processing engine from Semtech Emulates 49 x LORA demodulators and 1 x (G)FSK demodulator per SX1301: • 8 x LoRa demodulator at dynamic data rate with 125KHz BW • 1 x LoRa demodulator at fixed data rate • 1 x (G) FSK demodulator Dynamic data-rate (DDR) adaptation Detect simultaneously 8 preambles corresponding to all data rates (Spreading Factor) at LoRa 125KHz BW 2MHz baseband BW
Transceiver	Based on Semtech SX1257 862MHz to 960MHz frequency range 250 kHz to 750KHz channel BW +8dBm typ. output power 10dB output power control range 128dBc/Hz Signal to Noise performance at 10MHz offset Receiver Noise Figure of 7 dB (External LNA Noise Figure of 0.7dB) -25dBm IIP3 at max gain Independent automatic gain control
Sniffer	Based on Semtech chipset 860MHz to 1020MHz frequency range FSK, GFSK, MSK, GMSK and OOK demodulator FSK Bit rates up to 300 kb/s Digital filtering, demodulation, AGC, AFC, synchronization and packet handling Accurate RSSI measurements through automatic gain calibration 115dB Dynamic Range RSSI +35dBm to +75dBm IIP2 depending on AGC configuration -18dBm to +20dBm IIP3 depending on AGC configuration 66 dB typ. CW interferer rejection at 1 MHz offset 79 dB typ. CW interferer rejection at 10 MHz offset
External LNA	Noise Figure of 0.7dB Gain 18dB at 900MHz 38dBm IIP3 at max gain
External PA	Maximum input power: 10dBm Maximum Output power: 27dBm Small signal gain: 32dB

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3.5.2 Radio front-end block diagram

The following block diagram details the architecture of the radio front-end:
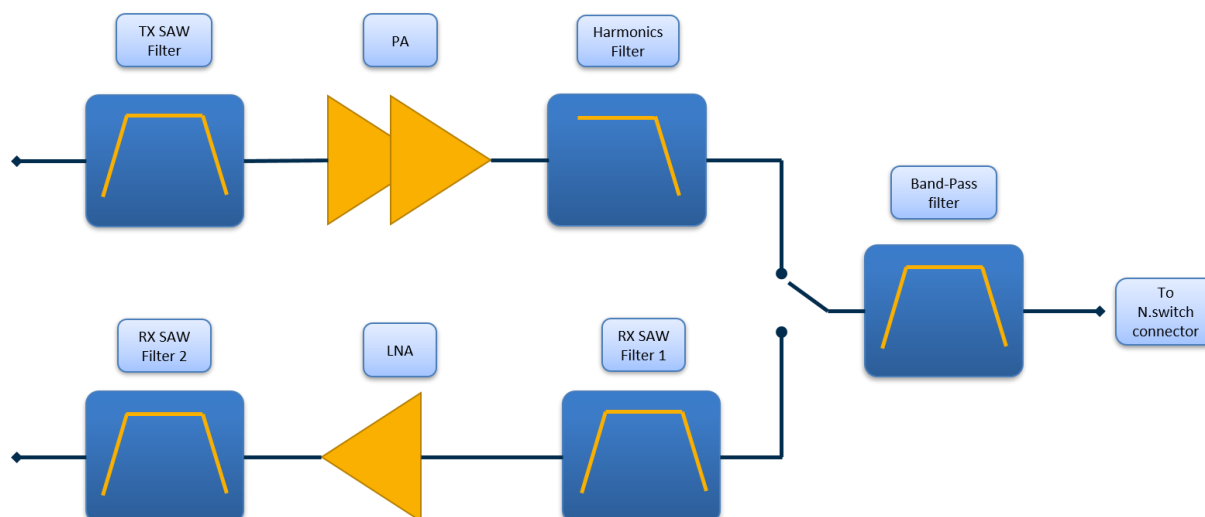

Figure 9: Front-end block diagram

The radio front-end integrates TX and RX paths.
Each path is detailed hereafter:

The radio front-end is derived in three different versions to cover the unlicensed bands:

- 868MHz (863-873MHz)
- 915MHz (Rx-Band: 902-915MHz / Tx-Band: 922-928MHz)
- 923MHz (Rx-Band: 915-928MHz / Tx-Band: 919-928MHz)

3.5.3 Modulations and data rates

The Wirnet™ iStation supports the following modulation schemes:

SF	BW (KHz)	Data rate (kbps)
7	500	21875
8	500	12500
9	500	7031
10	500	3906
11	500	2148
12	500	1172
7	250	10938
8	250	6250

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9	250	3516
10	250	1953
11	250	1074
12	250	586
7	125	5469
8	125	3125
9	125	1758
10	125	977
11	125	537
12	125	293

Note: Payload may have to be adjusted to not overrule 400ms frame length, depending on the local regulations. In this case, SF11/125KHz and SF12/125KHz are not used.

3.5.4   Output Power

The conducted output power can be adjusted from 0dBm to +27dBm.
This offers a wide range of adjustment to cover all specific countries EIRP requirements.
Antenna gain has to be considered to adjust the conducted output power to not overrule the max allowed EIRP.

Description	Specification
Conducted output power range	0dBm to +27dBm
Ripple in the band	+/- 2dB
Variation over temperature range (-40°C to +60°C)	+/- 3dB

3.5.5   Out of band emissions

Due to the very low noise transmitter, the Wirnet™ iStation is able to achieve excellent out of band emissions levels in the LTE, UMTS and GSM uplink or downlink bands.

The performances are summarized in the following table:

Version	LTE, UMTS or GSM band	Out of band emissions
868	E-GSM900 UL (880-915MHz)	-80dBm/100KHz
868	R-GSM900 UL (876-880MHz)	-60dBm/100KHz
868	LTE800 (832-860MHz)	-75dBm/100KHz
868	LTE800 (860-862MHz)	-70dBm/100KHz
915	GSM850 DL (869-894MHz)	-85dBm/100KHz
923	GSM900 UL(890-915MHz)	-85dBm/100KHz
923	GSM900 DL(935-960MHz)	-85dBm/100KHz

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The performances detailed here are worst case i.e. when transmitting at maximum output power at the edge of the band.
Out of band emissions in other LTE, UMTS or GSM bands are not detailed but are obviously better.

3.5.6 Sensitivity

The sensitivity performance, depending on the version, at 10% PER, coding rate 4/5, preambule 8 symbols, 20 bytes payload is the following:

Mode	868MHz	915MHz	923MHz
SF7/125KHz	-127dBm	-127dBm	-126dBm
SF10/125KHz	-134dBm	-134dBm	-133dBm
SF12/125KHz	-141dBm	-141dBm	-140dBm
SF7/250KHz	-125dBm	-125dBm	-124dBm
SF12/250KHz	-135dBm	-135dBm	-134dBm
SF7/500KHz	-122dBm	-122dBm	-121dBm
SF12/500KHz	-134dBm	-134dBm	-133dBm

The sensitivity may vary over the frequency band and over temperature as follows:

Description	Specification
Sensitivity variation over the band	+/- 2dB
Sensitivity variation over temperature range (-40°C to +60°C)	+/- 1.5dB

3.5.7 Out of band blockers rejection

In the following tables, the out of band rejection is measured with a useful signal (LoRa) adjusted 3dB above the sensitivity. The blocker level (CW) is adjusted to reach 10% PER.
The level of the blockers is noticed in the table and also the difference (in dB) with the useful LoRa signal.

The useful signal is adjusted at 868.1MHz for a Wirnet iStation 868MHz.
The blockers rejections, at SF7 are the following:

Offset	SF7/125KHz
+/-2MHz	80dB
+/-10MHz	120dB

The useful signal is adjusted at 908MHz 1MHz for a Wirnet iStation 915MHz.
The blockers rejections, at SF10 are the following:

Offset	SF10/125KHz
+/-2MHz	90dB
+/-10MHz	120dB

The useful signal is adjusted at 923MHz for a Wirnet iStation 923MHz.
The blockers rejections, at SF12 are the following:

Offset	SF12/125KHz
+/-2MHz	90dB
+/-10MHz	120dB

3.6   WWAN capabilities

The bands and data rate supported by the Wirnet iStation are the following:

Technologies	Band	Data rate
LTE	Band 1 (2100) Band 2 (1900 PCS) Band 3 (1800+) Band 4 (1700/2100 AWS-1) Band 5 (850) Band 7 (2600) Band 8 (900) Band 12 (700 ac) Band 13 (700 c) Band 18 (800 Lower) Band 19 (800 Upper) Band 20 (800 DD) Band 25 (1900+) Band 26 (850+) Band 28 (700 APT) Band 38 (TD 2600) Band 39 (TD 1900+) Band 40 (TD 2300) Band 41 (TD 2600+)	• LTE FDD: o Max 150Mbps (DL) o Max 50Mbps (UL) • LTE TDD: o Max 130Mbps (DL) o Max 35Mbps (UL)
WCDMA	Band 1 (2100) Band 2 (1900 PCS)	• DC-HSDPA: Max 42Mbps (DL) • HSUPA: Max 5.76Mbps (UL)

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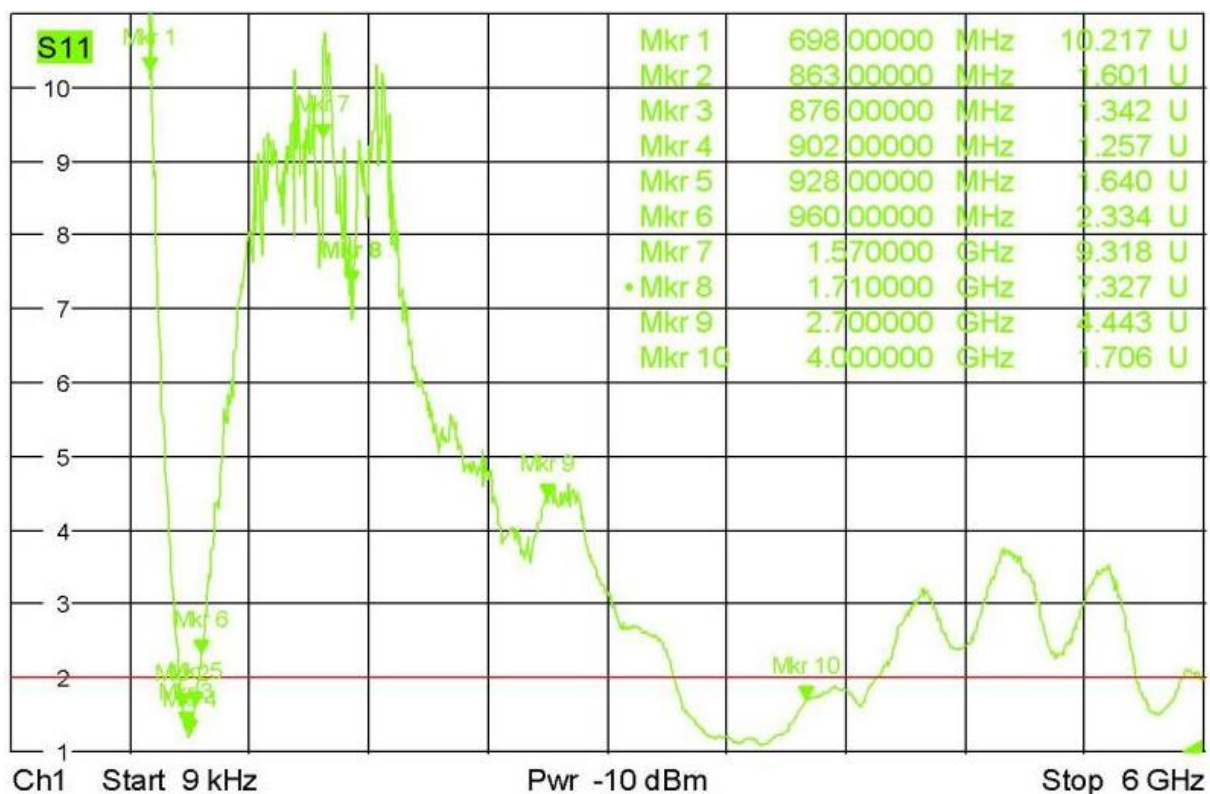|	Band 4 (1700/2100 AWS-1) Band 5 (850) Band 6 (850 Japan) Band 8 (900) Band 19 (800 Japan)	• WCDMA: ○ Max 384Kbps (DL) ○ Max 384Kbps (UL)
GSM	B2 (1900 PCS) B3 (1800 DCS) B5 (850) B8 (900)	• EDGE: ○ Max 296Kbps (DL) ○ Max 236.8Kbps (UL) • GPRS: ○ Max 107Kbps (DL) ○ Max 85.6Kbps (UL)

3.7   External antenna

It is possible to connect an external antenna.
If external antenna is mated on N connector, then the internal antenna is bypassed.
When external antenna is unmated on N connector, then RF signal passes through the internal antenna. It's a mechanical switch, no need to logically control.
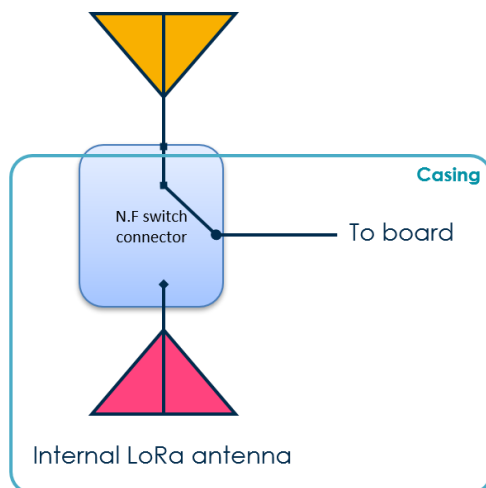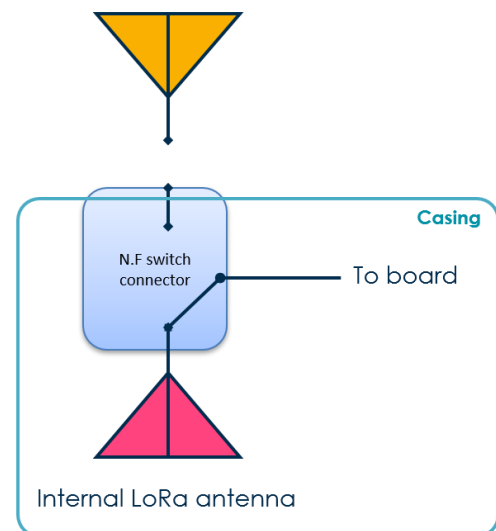
Figure 10: RF Switch circuit diagram

Also, an external cavity filter may be recommended with the presence of BTS.
It is connected between the external antenna and the gateway.
This filter is to avoid saturation and desensitization of the LoRa receiver due to co-located LTE800/LTE850 base stations for example.
Kerlink offers different technical solutions depending on the region.
⇨ Contact KERLINK if required

3.8 Internal antennas

3.8.1 Internal LoRa antenna

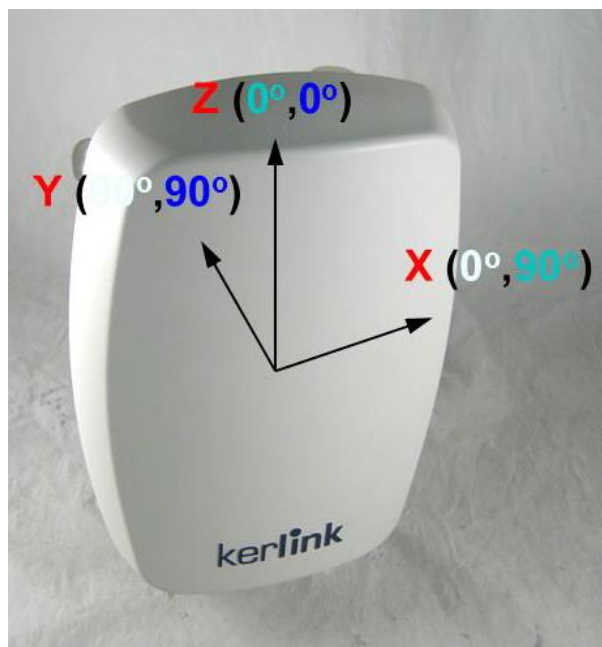#### 3.8.1.1 Specifications

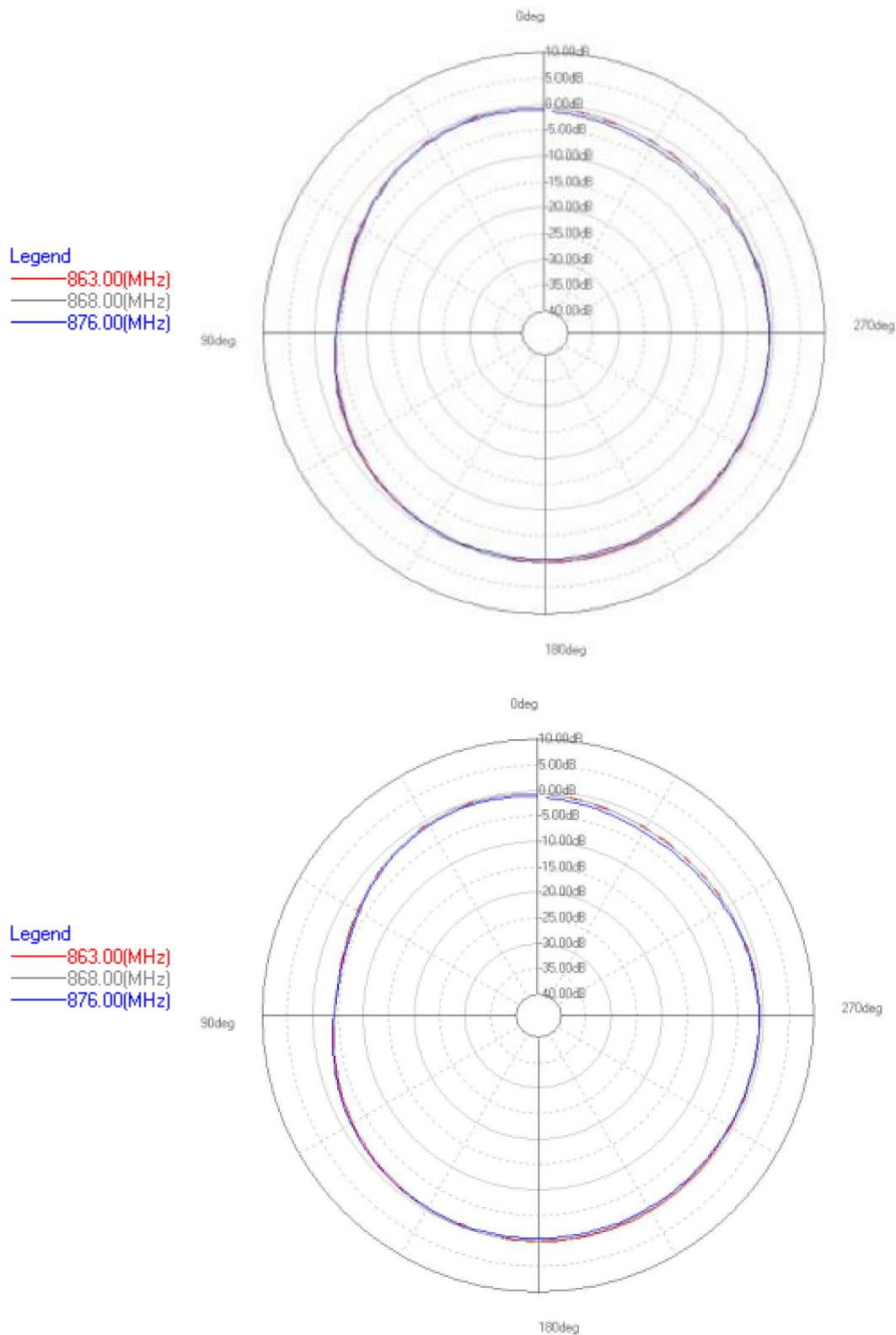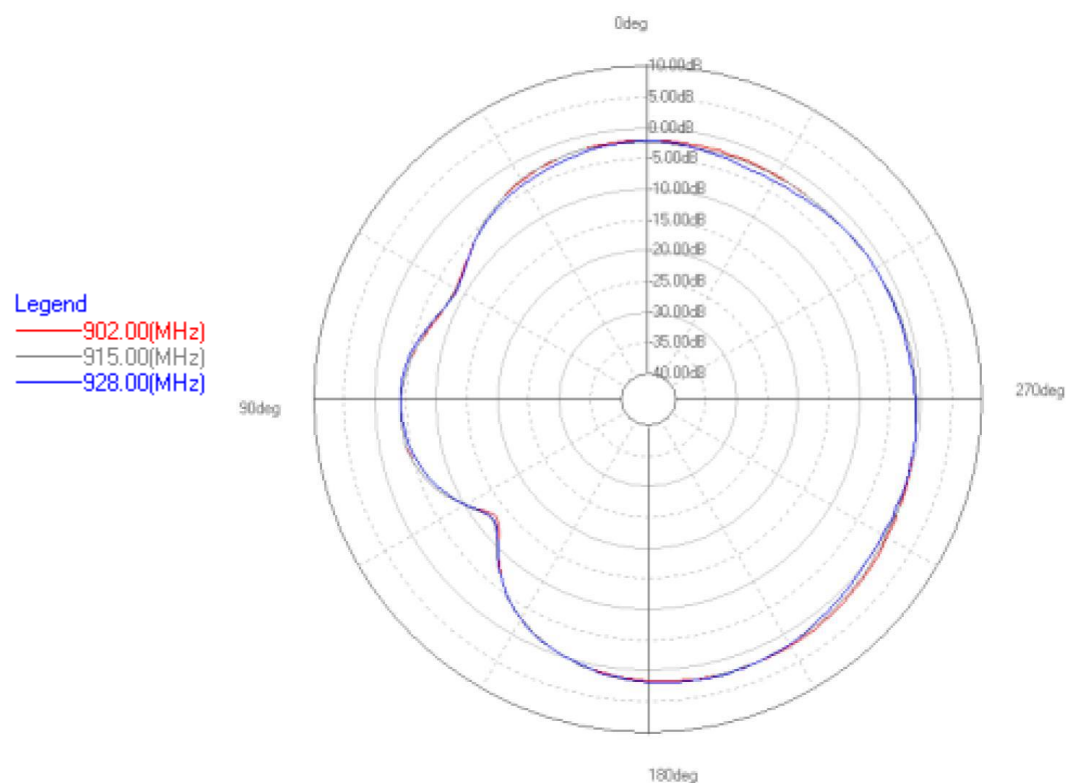| Item	Specification
Frequency range	863-928MHz
Max gain	2.6dBi
Avg gain	-1dBi
VSWR	<2:1
Impedance	50 ohms
Polarization	Vertical

3.8.1.2 VSWR
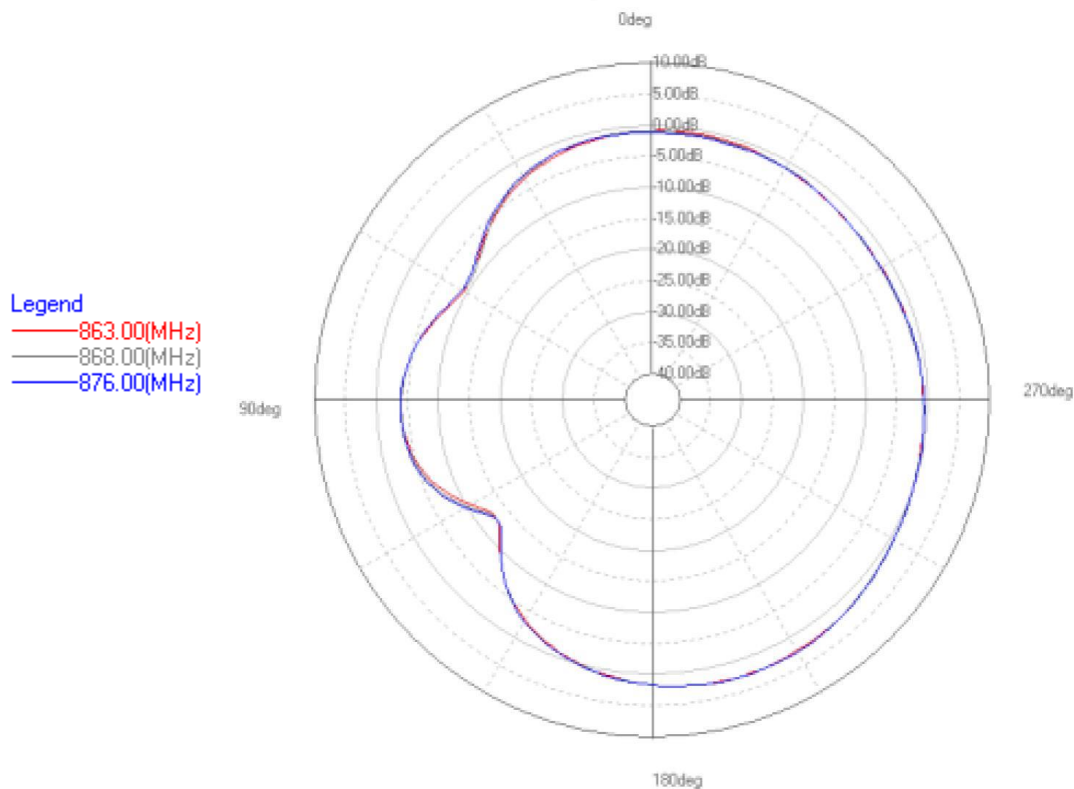
3.8.1.3 Radiation patterns

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XY-plane

Legend
863.00(MHz)
868.00(MHz)
876.00(MHz)

Legend
863.00(MHz)
868.00(MHz)
876.00(MHz)

ZY-plane

Legend
863.00(MHz)
868.00(MHz)
876.00(MHz)

Legend
902.00(MHz)
915.00(MHz)
928.00(MHz)

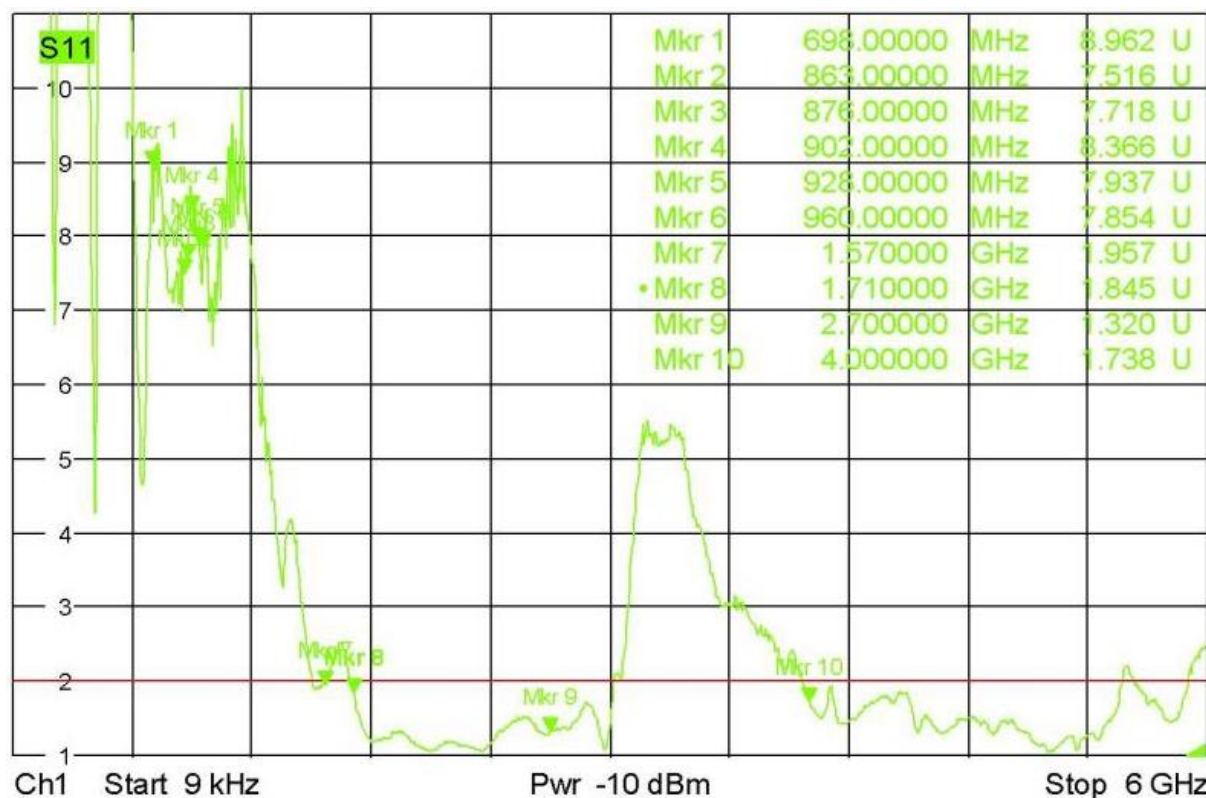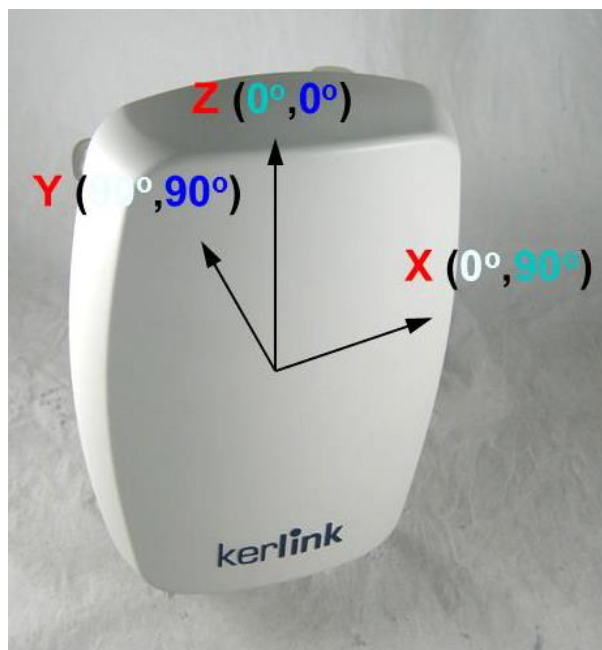| Classification	This document is the strict property of Kerlink and shall not be either copied nor sent without express written authorization of Kerlink	
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3.8.2 Internal WWAN antenna

3.8.2.1 Specifications

Item		Specification
Frequency range	Band 1	698-960MHz
	Band 2	1710-1785MHz
	Band 3	1785 -2170MHz
	Band 4	2300-2690MHz
Max gain	Band 1	-0.7dBi
	Band 2	5.0dBi
	Band 3	5.4dBi
	Band 4	6.9dBi
VSWR	Band 1	<9:1
	Band 2	<2:1
	Band 3	<2:1
	Band 4	<2:1
Impedance		50 ohms
Polarization		Vertical

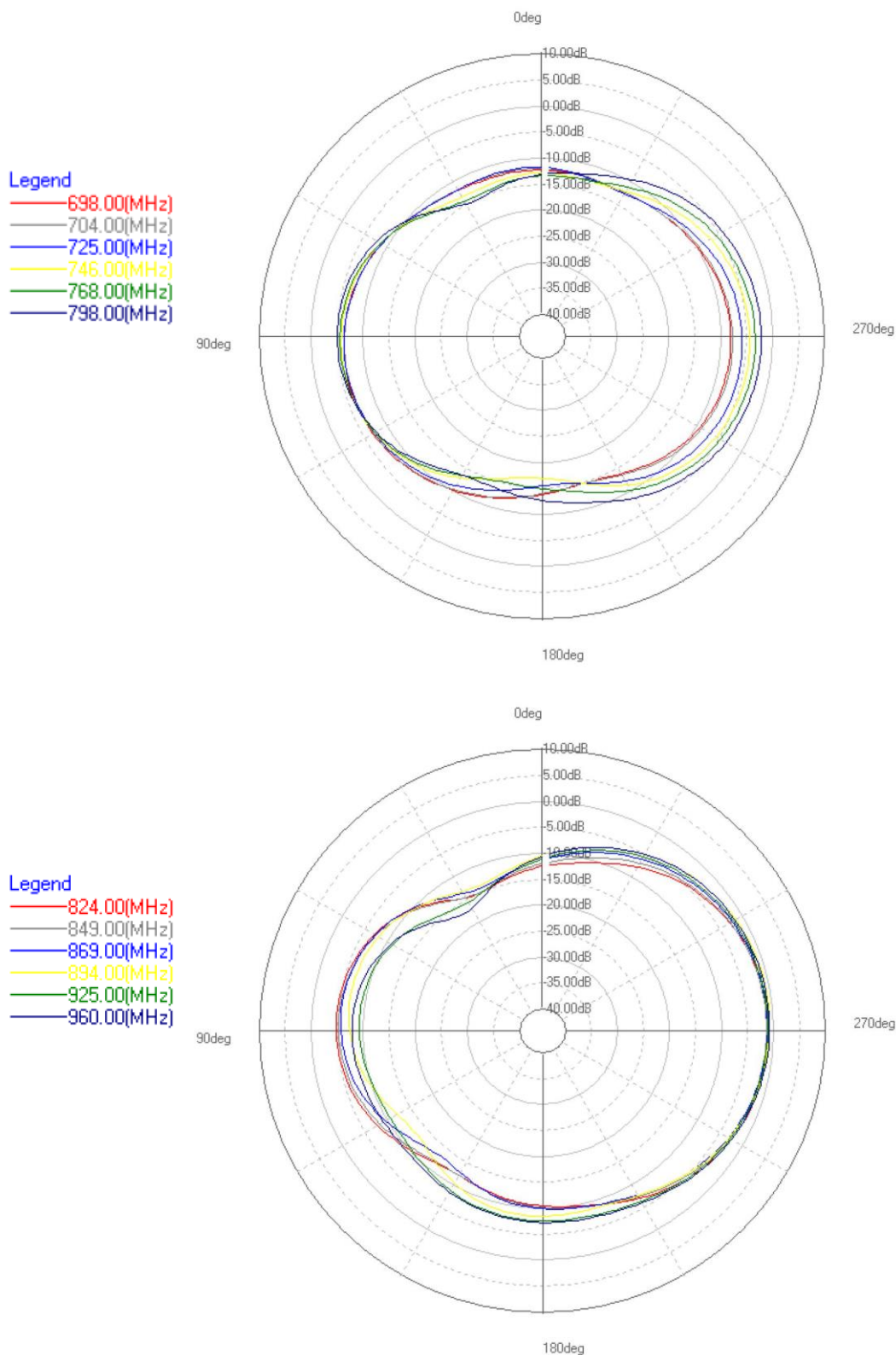#### 3.8.2.2 VSWR

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3.8.2.3 Radiation patterns

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XY-plane

Legend
- 698.00(MHz)
- 704.00(MHz)
- 725.00(MHz)
- 746.00(MHz)
- 768.00(MHz)
- 798.00(MHz)

Legend
- 824.00(MHz)
- 849.00(MHz)
- 869.00(MHz)
- 894.00(MHz)
- 925.00(MHz)
- 960.00(MHz)

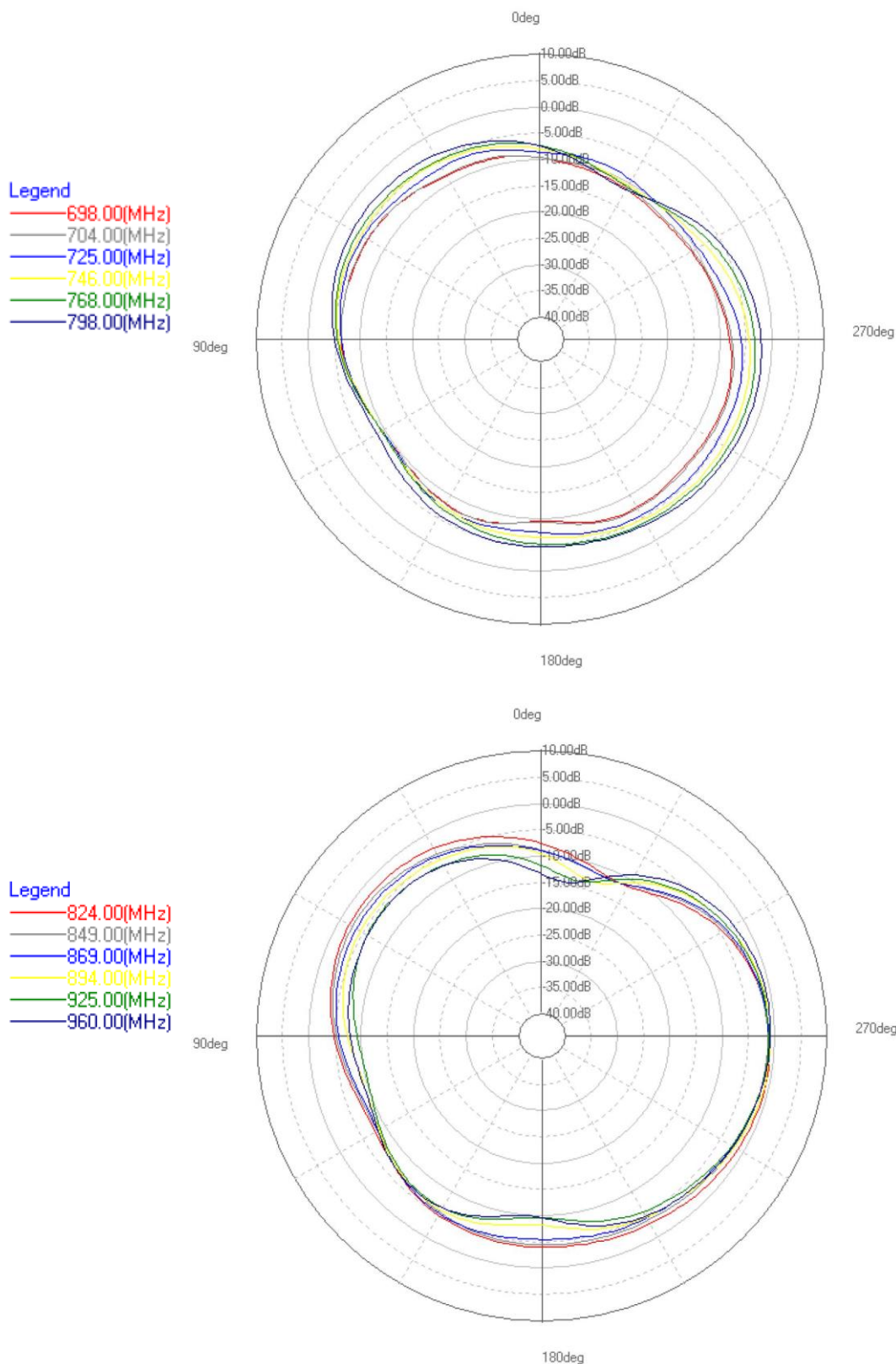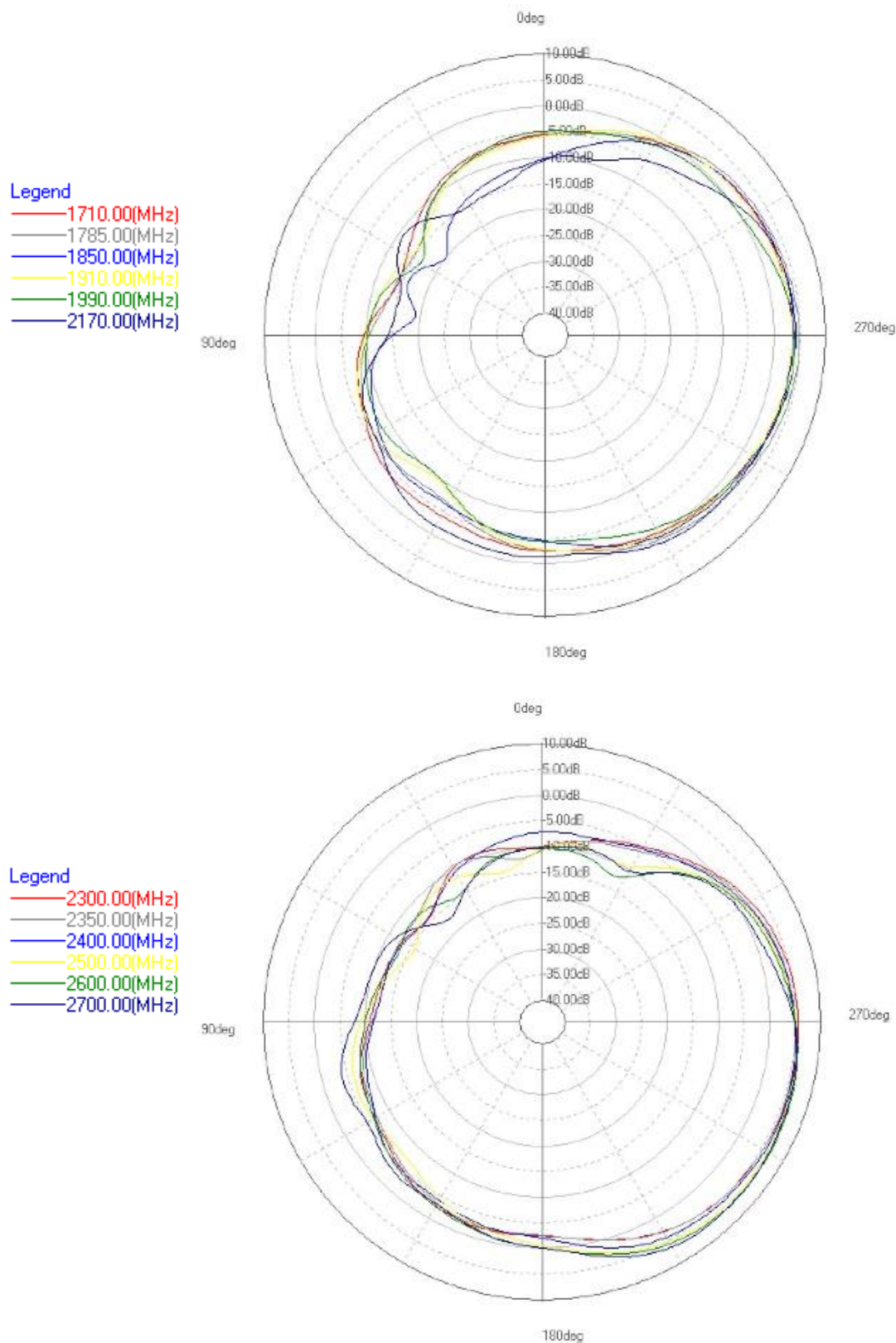| Classification	This document is the strict property of Kerlink and shall not be either copied nor sent without express written authorization of Kerlink
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XY-plane

ZY-plane

ZY-plane

Legend
—— 1710.00(MHz)
—— 1785.00(MHz)
—— 1850.00(MHz)
—— 1910.00(MHz)
—— 1990.00(MHz)
—— 2170.00(MHz)

Legend
—— 2300.00(MHz)
—— 2350.00(MHz)
—— 2400.00(MHz)
—— 2500.00(MHz)
—— 2600.00(MHz)
—— 2700.00(MHz)

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3.8.3 Internal GNSS Antenna

The specifications of the antenna are the following:

Item	Specification
Frequency range	1570-1610MHz
VSWR	<2.0:1
Impedance	50 ohms
Polarization	RHCP
Type	Passive

4. Installation recommendations

Note: In addition to the following chapters, Kerlink strongly recommends reading the following application notes:
- AN-KLK03355 - Improving radio coexistence performance of LoRaWAN gateways.pdf
- AN-KLK03357 - LoRaWAN gateways installation recommendations.pdf

Many notions are mentioned in those documents about cavity filters, LoRaWAN coexistence issues due to cellular networks, installation recommendations, lightning protections, etc…

4.1 RJ45 PoE cable

This cable is not provided with the Wirnet iStation.

KERLINK recommends using a PoE cable with the following characteristics:

Characteristics	Specification
Category	6 min
Shielding	STP (U/FTP) or SSTP (S/FTP)
U/V resistant	Yes
External jacket	Polyethylene for outdoor use
Maximum length	100 meters
Cable diameter	From 6.6mm to 8.8mm
Operating temperature range	Depending on the application

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4.2   Ethernet connection

The seal of cable gland allows external cable diameter (cable and RJ45 connector) from 6.6mm to 8.6 mm. Position the different elements as show on the figure 11.
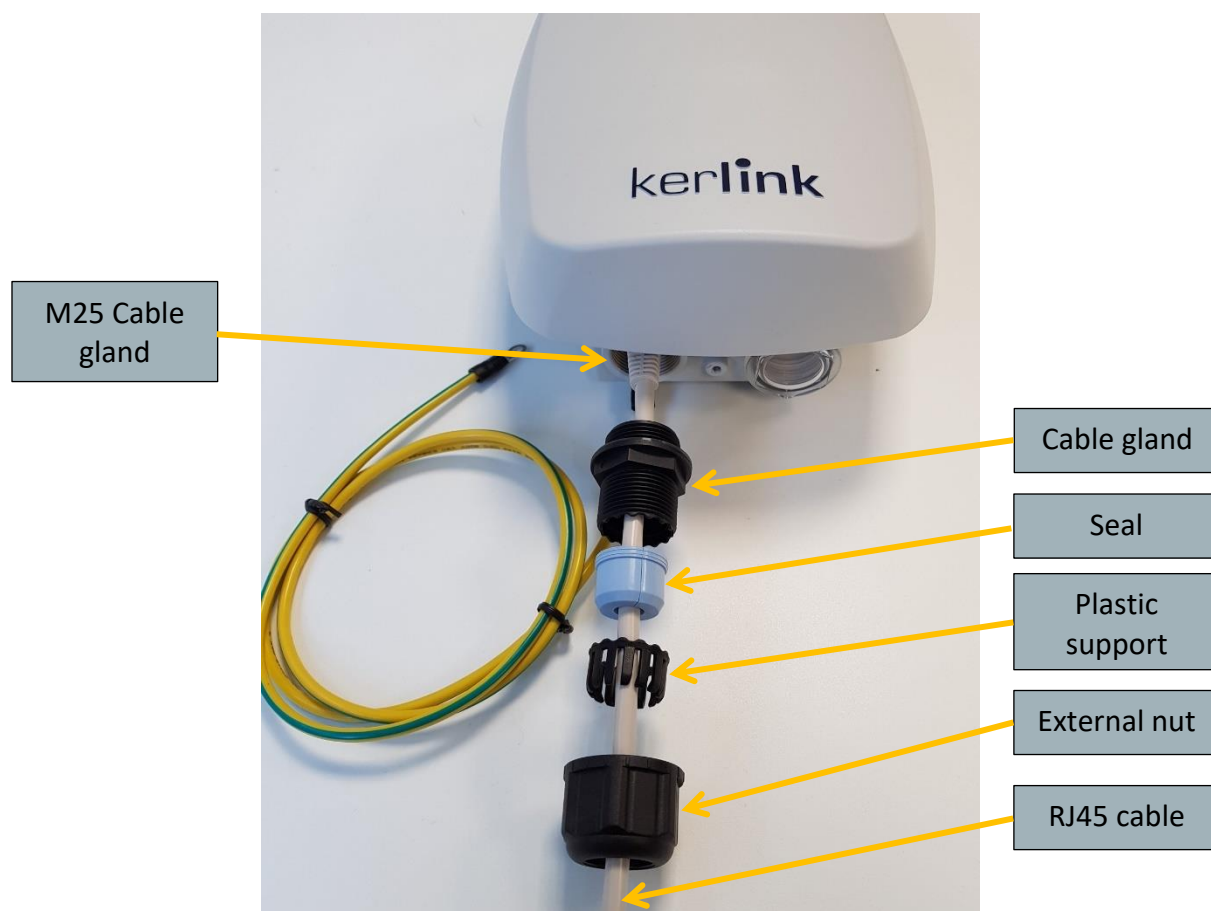This before connecting the RJ45 of cable through the M25 of gateway.

Figure 11: Ethernet connection on Wirnet iStation

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4.3 Earthing of the Wirnet iStation mounting kit

Kerlink provides a mounting kit as shown on the figure 12.
It is strongly recommended to earth for lightning immunity and electrical security.

Figure 12: Earthing with mounting kit provided

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4.4 External antenna

Kerlink found disparity in the length of the pins of the market accessories that could be connected to the Wirnet iStation: if these pins are too long, they can mechanically permanently damage the Wirnet iStation connector internal mechanical switch that selects the internal or external antenna, thus potentially generating loss of performance and preventing the later use of the internal antenna.

Kerlink provides then a N adapter with each product. This adapter ensures a controlled pin length of the N connector and prevent any damage of the product.

To use an external antenna with or without any additional accessories (surge protection, cavity filter, …), please first, screw the Kerlink Adapter directly on the Wirnet iStation.
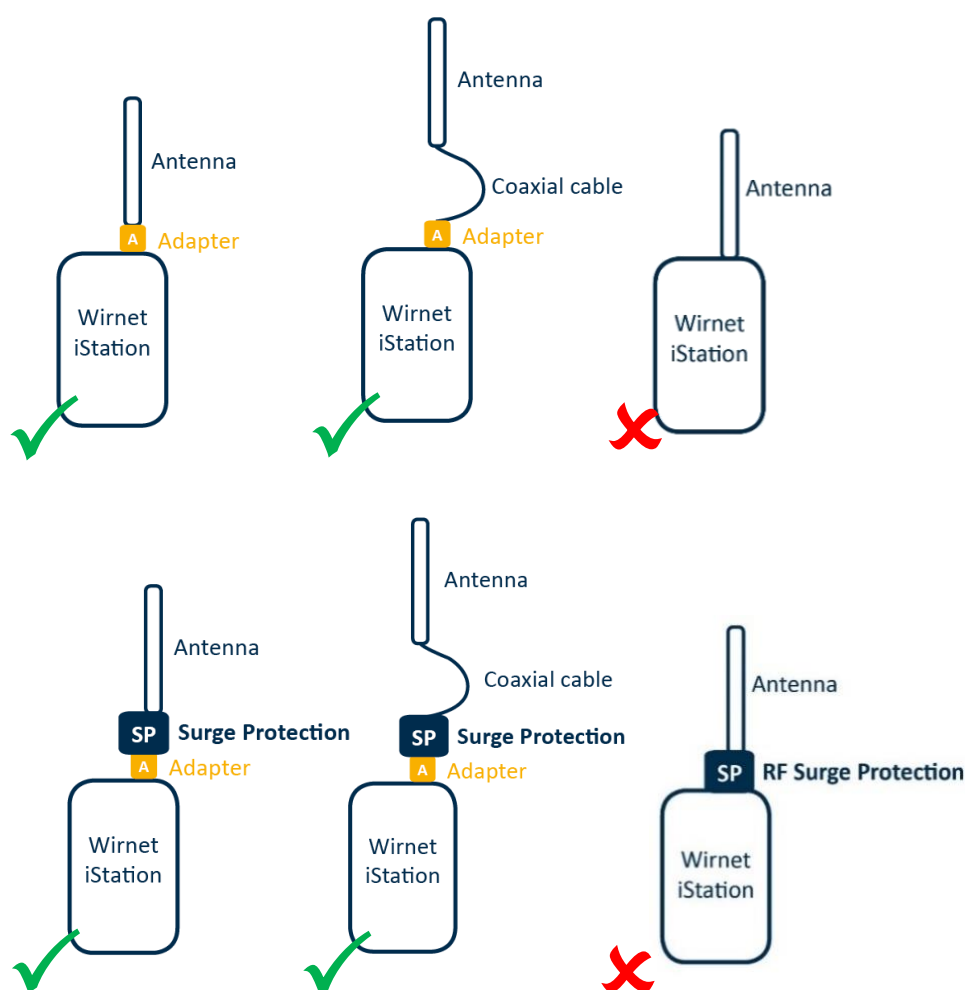
Please strictly comply with these diagrams

Figure 13: External antenna connection

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Individual parts (adapter, antenna, surge protection, …) are designed for manual clamping so as not to damage the connectors.

To finish, once the adapter is installed and the accessories are connected (external antenna / surge protection), be sure to apply the self-amalgamating industrial tape as shown in the picture below.

This is simply an additional way to improve the durability of the RF connections against environmental aggression (moisture, pollution, etc.) and ensure their reliability overtime.

Figure 14: Self-amalgamating tape

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5. Software specifications

Firmware provided by default on gateway is a GNU/Linux distribution named Keros (Kerlink Operating System).

At the time these lines are written, this operating system is based on Yocto Rocko 2.4 and Long-term Linux kernel 4.14.

This firmware is focused on main topics listed below:

- Stability: by providing a read-only base and handling recoveries if instability is detected (based on HW watchdog).
- Security: by supporting optional SecureBoot mechanism and by securing assets like VPN keys (thanks to Prove&Core^{TM} Secure Storage).
- Flexibility: by providing ways to handle various user configurations and/or applications.

Firmware is continuously improved to add new features, simplify usage and improved stability. Please refer to online software documentation for further details: http://wikikerlink.fr/wirnet-productline

END OF DOCUMENT