



INSTALLATION AND MAINTENANCE MANUAL

WIRNET IBTS

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Date	30/04/2019	30/04/2019	30/04/2019	30/04/2019



HISTORY

Date	Modification	Author	Version
03/17/2016	Preliminary version	MGI	0.1
04/06/2016	Removed specification part	MGI	0.2
06/08/2016	Updated accessories list	MGI	0.3
07/05/2016	Updates for IEC 60950-1 compliance	MGI	0.4
07/11/2016	Updates for FCC and IC certification	MGI	0.5
08/30/2016	Minor updates after internal review	MGI	0.6
09/08/2016	Updated regulation section	MGI	0.7
10/01/2017	Remove all references to DIN rail Add draft chapter for WAN module Dual SIM version	PTA	0.8
11/01/2017	New POE injector references Power supply recommendations WAN dual SIM (additional information)	SNI	0.9
20/02/2017	Update of WAN module Dual SIM version	PTA	0.10
08/03/2017	Dual WAN module adding LoRa Link lightning protection recommendations	SNI	0.11
13/03/2017	Official version	SNI	1.0
15/05/2017	Completed Dual WAN module and LoRa Link lightning protections, MC7430 and cavity filters Updated Certifications	MGI	1.1
25/07/2017	Updated certifications, cavity filters, insertion of modules and ON/OFF button	MGI	1.2
25/04/2018	Updated LoRa radio performance, certifications, accessories	MGI	1.3
25/04/2018	Added NBTC certification (Thailand) Added Wirnet iBTS 64 Highway	MGI	1.4
15/10/2018	Amend spectrum analysis possibility (§3); adapt §4.8.4 to	BCA	1.5

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	web interface configuration (with screenshot); fix web interface reference in §4.8.3 and §5.3.4 Updates Mechanical implementation (§1.3)	SNI	
04/12/2018	Official version	SNI	2.0
30/04/2018	Rename FDx in 64 Highway Updates certification	VLO	2.1

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GLOSSARY

Abbreviation	Description
ADC	Analog to Digital Converter
AES	Advanced Encryption Standard
AGC	Automatic Gain Control
AMR	Automatic Meter Reading
ANATEL	Agência Nacional de Telecomunicações (Brazilian agency of telecommunications)
AP	Access Point
APAC	Asia PACific
APC	Automated Power Control
API	Application Programming Interface
APN	Access Point Name
ARM	Advanced RISC Machine
BER	Bit error Rate
BLER	Block Error rate
BTS	Base Transceiver Station
BW	Band Width
CAN	Control Area Network
CDMA	Code Division Multiple Access
CMOS	Complementary Metal Oxide Semiconductor
CPU	Central Processing Unit
DAC	Digital to Analog Converter
DDR	Double Data Rate
DDRAM	Double Data Rate RAM
DHCP	Dynamic Host Configuration Protocol
DIN	Deutsches Institut für Normung (German Institute for Standardization)
DOTA	Download Over The Air
DSP	Digital Signal Processor
DVFS	Dynamic Voltage and Frequency Scaling
EDGE	Enhanced Data rates for GSM Evolution
EIRP	Equivalent Isotropically Radiated Power
EMC	ElectroMagnetic Compatibility
eMMC	Embedded Multi Media Card
FCC	Federal Communications Commission
FER	Frame Error Rate
FPGA	Field Programmable Gate Array
FTP	File Transfer Protocol
GNSS	Global Navigation Satellite System

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GMSK	Gaussian Minimum Shift Keying
GPIO	General Purpose Input Output
GPRS	General Packet Radio Service
GPS	Global Positioning System
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
IP	Internet Protocol or Ingress Protection
IrDA	Infrared Data Association
ISM	Industrial Scientific and Medical
I2C	Inter Integrated Circuit
I2S	Inter IC Sound
KLK	KERLINK
KNET	KERLINK M2M network
LBT	Listen Before Talk
LDO	Low Drop Out
LED	Light-Emitting Diode
LNA	Low Noise Amplifier
LoRa	Long Range
LSZH	Low Smoke Zero Halogen
LTE	Long Term Evolution
LUT	Look Up table
LVDS	Low Voltage Differential Signaling
M2M	Machine to Machine
MIPS	Millions of Instructions Per Second
MFLOPS	Million Floating-point Operations Per Second
NFS	Network File System
NMEA	National Marine Electronics Association
PA	Power Amplifier
PC	Personal Computer or Polycarbonate
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect
PER	Packet Error Rate
PLL	Phase Locked loop
PoE	Power over Ethernet

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PU	Polyurethane
RAM	Random Access Memory
RF	Radio Frequency
RSSI	Received Signal Strength Indicator
RTC	Real Time Clock
RX	Receive
SAW	Surface Acoustic Wave
SDIO	Secure Digital Input Output
SI	Système d'Information
SIM	Subscriber Identity Module
SMA	SubMiniature version A
SMB	SubMiniature version B
SNR	Signal to Noise Ratio
SPDT	Single Pole Double Throw
SPI	Serial Peripheral Interface bus
SSH	Secure Shell
SSTP	Screened Shielded Twisted Pair
STP	Shielded Twisted Pair
TBD	To Be Defined
TCP	Transmission Control Protocol
TDOA	Time Difference On Arrival
TPE	ThermoPlastic Elastomer
TX	Transmit
UART	Universal Asynchronous Receiver Transmitter
UFL	Miniature coaxial RF connector manufactured by Hirose Electric Group
UICC	Universal Integrated Circuit Card
UMTS	Universal Mobile Telecommunications System
USB	Universal Serial Bus
USIM	Universal Subscriber Identity Module
UV	UltraViolet
VLIW	Very Long Instruction Word
WAN	Wide Area Network
WLAN	Wireless Local Area Network
VHF	Very High Frequency
3G	Third generation of mobile telecommunications technology
3GPP	3rd Generation Partnership Project
4G	Fourth generation of mobile telecommunications technology
8PSK	Eight Phase shift Keying

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INTRODUCTION

The Wirnet iBTS 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 public networks operators.

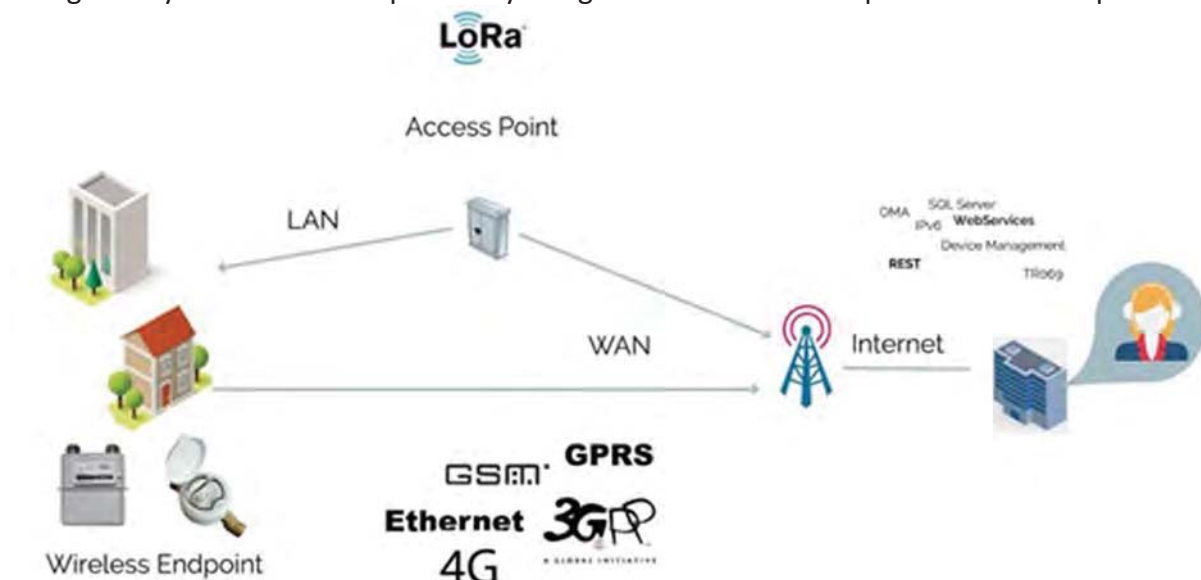


Figure 1: LoRa Network topology

The Wirnet iBTS is based on “Next Generation LoRa” technology provided by Semtech Company. It is compatible and interoperable with existing LoRa LPWAN and offers GPS-free geolocalization features compatibility.

Wirnet iBTS architecture is completely modular and upgradable to offer multiple configurations to cover different countries and areas around the world:

	Wirnet iBTS 868	Wirnet iBTS 915	Wirnet iBTS 64 Highway	Wirnet iBTS 923
Geographical area	Europe, Russia Africa Middle East, India	North America Central America South America Philippines	North America	Asia : Indonesia, Malaysia, Korea, Japan, Taiwan, Hong Kong, Thailand, Vietnam, Papua New Guinea, Singapore Oceania : Australia, New Zealand Latin America: Brazil, Argentina, Colombia
ISM band	863 - 876 MHz	902 - 928 MHz	902 - 928 MHz	915 - 928 MHz
Downstream band	863 - 873MHz	902 - 928 MHz	923 - 928 MHz	919 - 928 MHz
Upstream band	863 - 873 MHz	902 - 928 MHz	902 - 915 MHz	915 - 928 MHz

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WWAN capabilities	LTE B1, B3, B7, B8 and B20 HSPA B1, B2, B5 and B8 GSM/GPRS/EDGE 850, 900, 1800 and 1900	LTE B2, B4, B5, B13, B17 and B25 CDMA BC0, BC1 and BC10 HSPA B1, B2, B4, B5 and B8 GSM/GPRS/EDGE 850, 900, 1800 and 1900	LTE B2, B4, B5, B13, B17 and B25 CDMA BC0, BC1 and BC10 HSPA B1, B2, B4, B5 and B8 GSM/GPRS/EDGE 850, 900, 1800 and 1900	LTE B1, B3, B5, B7, B8, B18, B19, B20, B21, B28, B38, B39, B40 and B41 HSPA B1, B2, B5, B6, B8, B9 and B19 TD-SCDMA B39 GSM/GPRS/EDGE 850, 900, 1800 and 1900
Certifications	CE (Europe) WPC (India)	FCC (USA) IC (Canada) CB scheme for : Philippines, Mexico, Chile, Colombia	FCC (USA) IC (Canada)	ACMA (Australia, New-Zealand) MIC (Japan) OFCA (Hong-Kong) CB scheme for : Thailand, Korea, Singapore, Indonesia, Malaysia, Brazil, Argentina
Filters for installation in already existing telco-area	Usage in India requires a specific cavity filter for coexistence with CDMA800	Not able to share the same installation site with GSM900/HSPA900/LTE900 BTS (if necessary, use a specific cavity filter) Usage in Philippines requires a specific cavity filter.	Embedded cavity duplexer Not able to share the same installation site with GSM900/HSPA900/LTE900 BTS	Usage in Singapore, Hong-Kong and Malaysia requires a specific cavity filter.

Please check the appropriate version for the dedicated country. Contact KERLINK if required.

The present document addresses all the above Wirnet iBTS versions.

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1. Description of the Wirnet iBTS

1.1 Modular architecture

The Wirnet iBTS has a modular architecture allowing the operator to configure and upgrade the gateway to fulfill its needs.

Thanks to the modularity the operator is able to choose:

- The backhaul network: Ethernet or GPRS/EDGE/HSPA/CDMA/LTE
- The unlicensed band (ISM) where to operate the LoRa LPWAN: 863-873MHz (aka 868MHz), 902-928MHz (aka 915MHz) or 915-928MHz (aka 923MHz)
- The number of channels to operate the LoRa LPWAN: 8 to 64
- The antenna interface: single (omnidirectional), dual (space diversity or dual polarization) or tri (sectorization)

Four different modules can be integrated in the Wirnet iBTS:

- CPU Module, which includes the main following features:
 - Power management of the Wirnet iBTS
 - CPU
 - Memories
 - GNSS receiver (GPS)
- WAN Module, which provides the backhaul functionality:
 - Backup battery
 - 4G modem declined in 3 versions depending on the geographical area:
 - Europe
 - Americas
 - APAC
- LoRa module – LoRa LOC, which can be also derived in 4 versions :
 - 868MHz (863-873MHz)
 - 915MHz (902-928MHz)
 - 915MHz 64 Highway (902-915MHz uplink, 923-928MHz downlink)
 - 923MHz (915-928MHz)

The Wirnet iBTS can integrate from one to four « LoRa modules ». In this particular “4 LoRa modules” configuration, a specific “front-end” board and mechanical lid are used to combine the four “LoRa modules” together (see §1.4.3 for further details).

In its maximum size configuration, the Wirnet iBTS can then integrate six modules: one “CPU module”, one “WAN module” and four “LoRa modules”.

The Figure 2 below shows an external view of the Wirnet iBTS:

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Figure 2: Wirnet iBTS external view

The Figure 3 below shows an internal view of the Wirnet iBTS, featuring three “LoRa modules”, one “CPU module” and one “WAN module”:

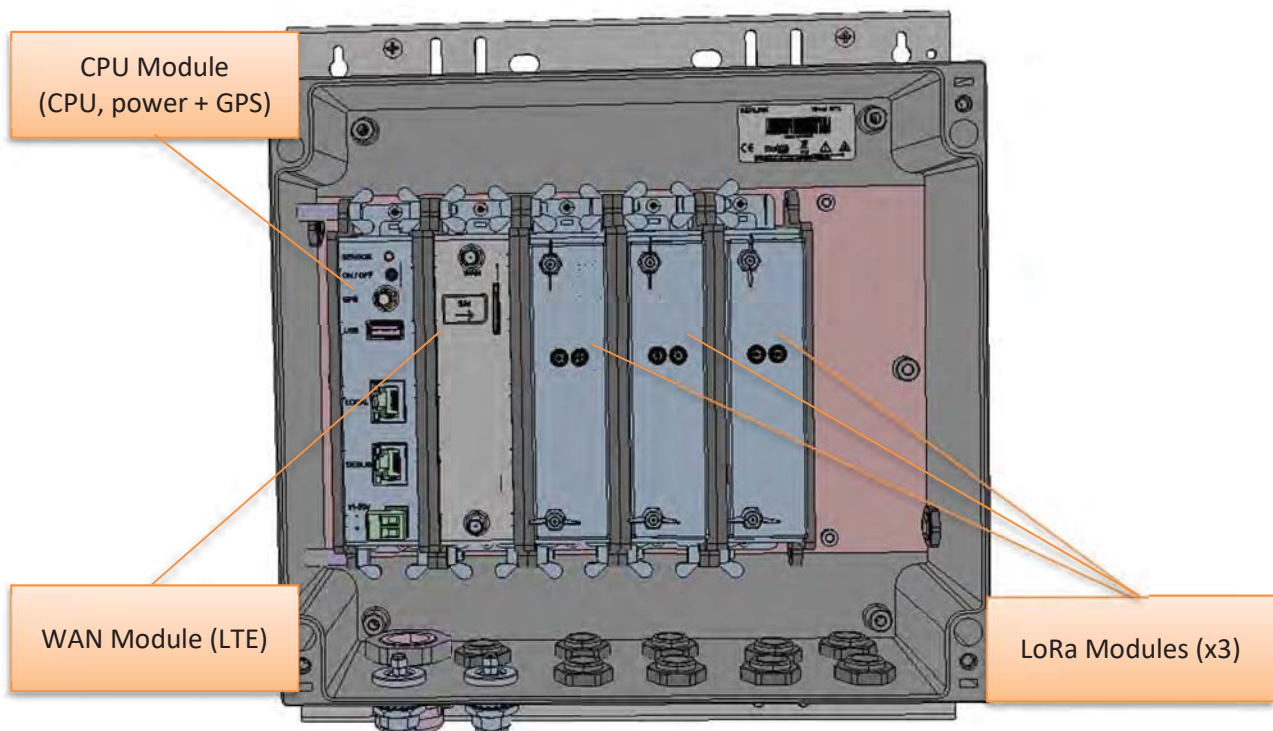


Figure 3: Wirnet iBTS internal view

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A dual cavity (or simple) duplexer is embedded in the Wirnet iBTS 64 Highway above the other modules

The Figure 4 below shows an internal view of the Wirnet iBTS 64 Highway, featuring three “LoRa modules”, one “CPU module” one “WAN module” and the dual duplexer:

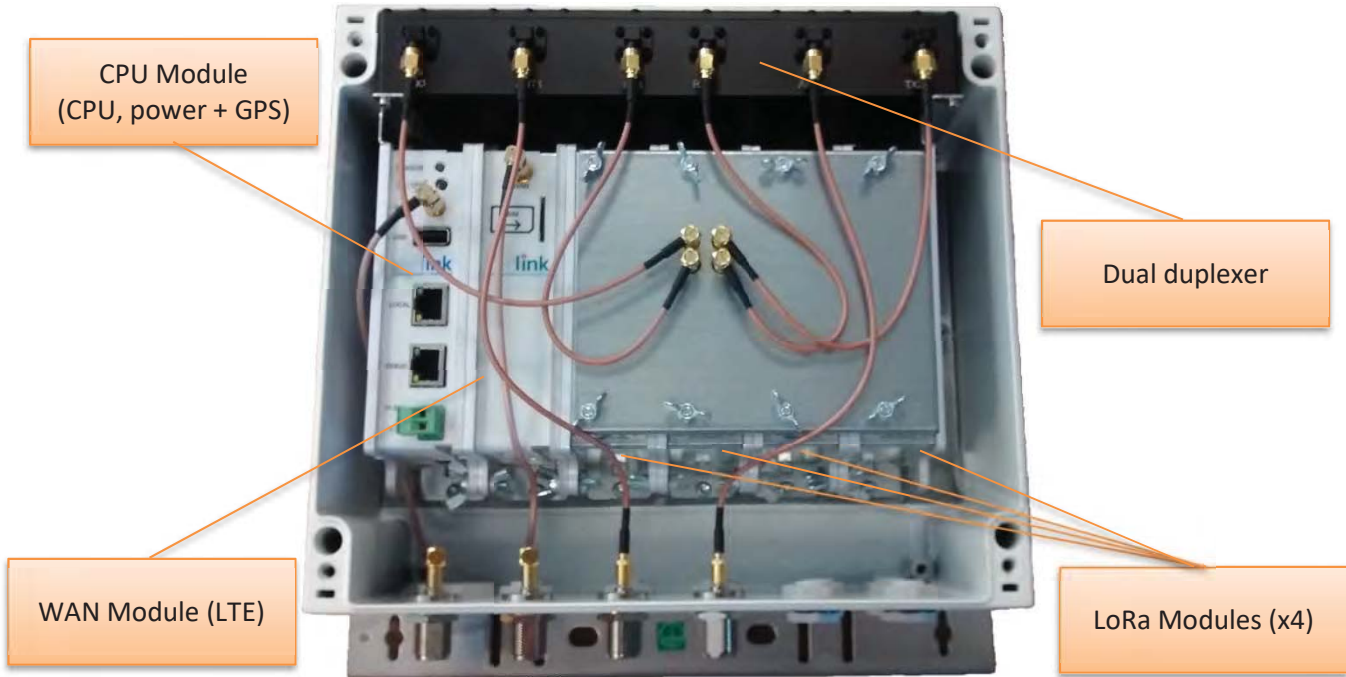


Figure 4: Wirnet iBTS 64 Highway internal view

As part of the Wirnet iBTS modularity, many accessories can be provided for configuration purpose:

- GNSS antennas
- LTE antennas
- LoRa antennas
- RF cavity filters
- PoE injectors
- Surge protections

The full list of accessories is detailed in §1.8 and §6.

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1.2 Mechanical implementation for standard casing

1.2.1 Standard casing

The Wirnet iBTS station is built on a robust IP66 aluminum enclosure of 280 x 250 x 120 mm. It is composed of two separated parts: the frame and a lid. The lid tightens to the frame through M5 screws, hidden by two plastic clip-on design covers.

A mounting kit is screwed on the back of the enclosure, allowing several mounting configurations: wall mount, pole mount and metallic strapping.

The left and right sides of the enclosure integrate two waterproof screw-in vents to equalize the pressure inside and outside. This reduces condensation by allowing air to flow freely into and out of the sealed enclosure. At the same time, they provide a durable barrier to protect the internal modules from contaminants like dust, sand, water, etc ... improving reliability, safety and longer product life.

The bottom side of the enclosure is dedicated for the connectors:

- 1 x M25 cable gland used to introduce the Ethernet cable (PoE) inside the enclosure
- 3 x N-SMB adapters used as RF interfaces for the antennas:
 - 1 for GNSS antenna (GPS)
 - 1 for WAN antenna (GSM/HSDPA/LTE)
 - 1 for LoRa antenna. The number of LoRa antenna interfaces can be extended to 6.
- 8 x M16 blind stops. They are considered as provisions for N-SMB connectors to be used for additional antennas (LoRa or WAN) or external power supply cable gland.

Blind threaded standoffs are inserted in the rear side the enclosure. They are used to screw and maintain the modules inside the enclosure. The modules can be easily inserted and extracted for maintenance and upgradability purposes.

The Figure 5 below shows the different components inside the enclosure.

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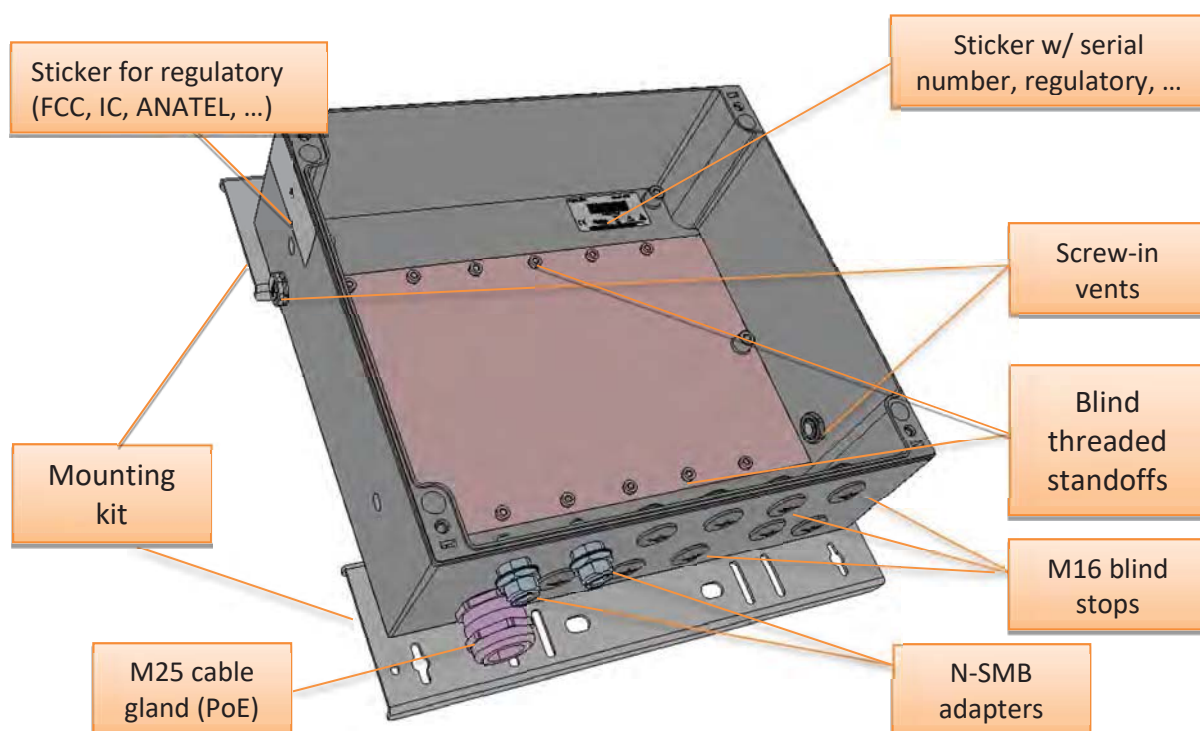


Figure 5: Enclosure internal view

The main characteristics of the enclosure are detailed hereafter:

Description	Specification
Enclosure material	Aluminum
Gasket material	TPE
Mounting kit material	Stainless steel
Color	RAL 9010
Dimensions with connectors	300 x 280 x 120 mm
Dimensions with connectors + mounting kit	300 x 320 x 125 mm
Weight – no modules	5.4 Kg
Weight – 3 modules configuration	7.2 Kg
Weight – 64 Highway version	10Kg
Ingress protection	IP66 / EN 60529
Humidity	95% non-condensing
Impact resistance	IK08
Flammability rating	UL94-V0
Number of pressure equalizer	2
Enclosure temperature range	-40°C to +120°C
Wirnet iBTS operating temperature range	-20°C to +55°C
Connectors	1 x M25 cable gland (PoE) 3 x N-SMB adapters (extension to 11 max) 8 x M16 blind stops (provisions for N-SMB or cable gland)

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The modules are screwed on the blind threaded standoffs to build the Wirnet iBTS according to customer requirements.

The modules are tightened all together with two mechanisms:

- the back panel board connectors,
- the wing screws assembling the mechanical sides (radiators) of the modules

SMB-SMB cables are provided to interconnect the RF interfaces of the modules to the SMB-N adapters, on the bottom side of the enclosure.

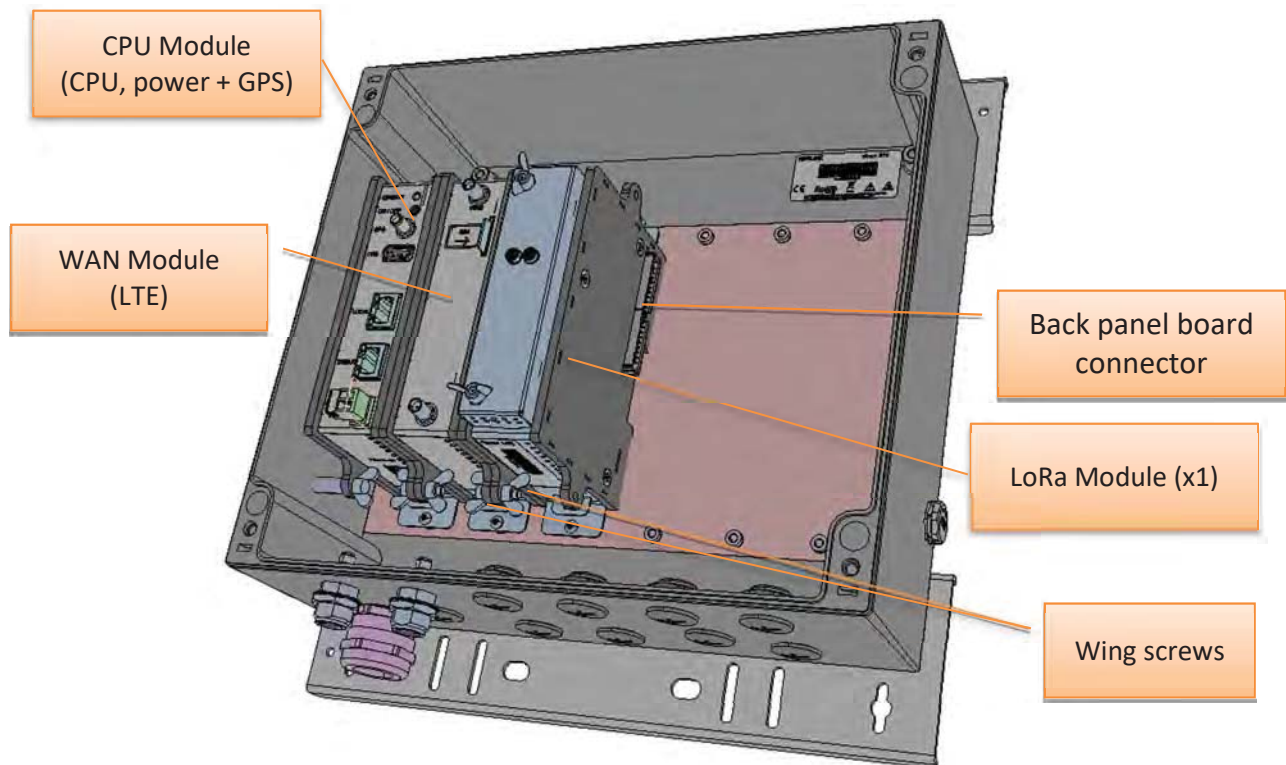


Figure 6: Insertion of the modules inside the enclosure

The modules are also screwed on the blind threaded standoffs to build the Wirnet iBTS 64 Highway.

The dual duplexer is assembled to the modules with a specific mounting kit.

SMB-SMB cables are provided to interconnect the RF interfaces of the modules to the SMB-N adapters, on the bottom side of the enclosure.

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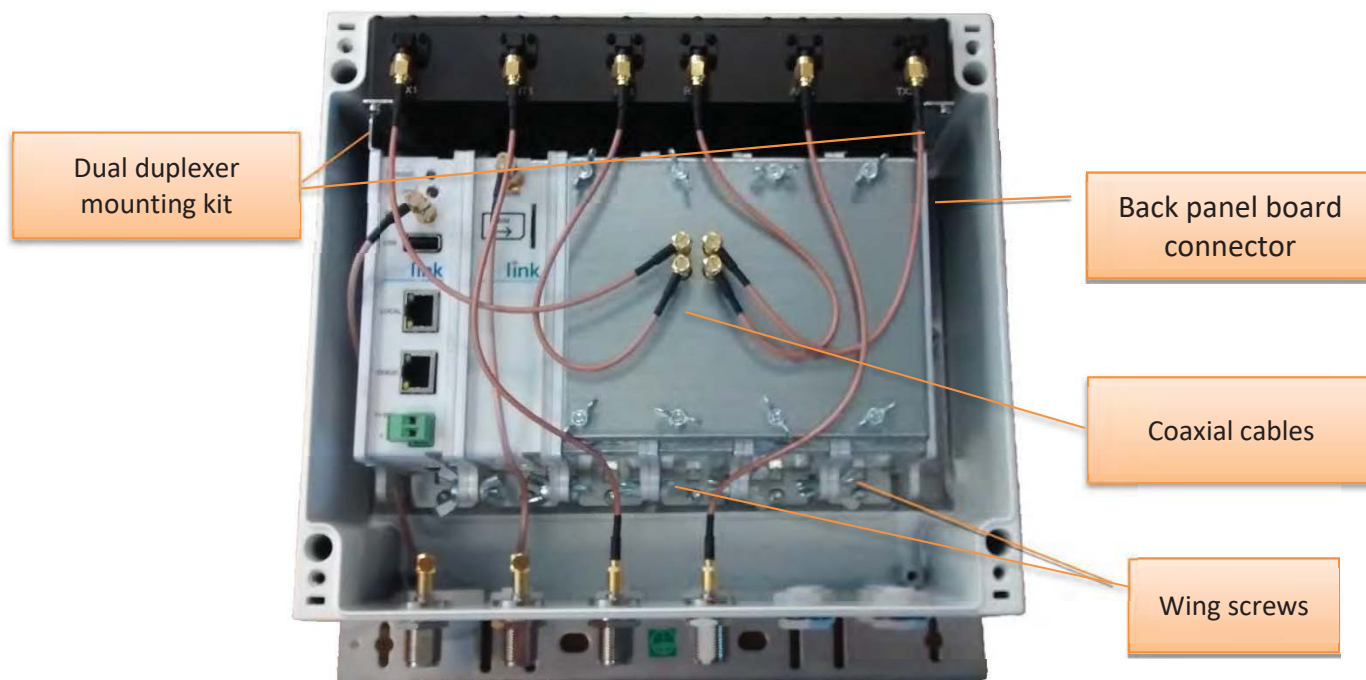


Figure 7: Insertion of the modules inside the enclosure

1.2.2 Stickers

The Wirnet iBTS has two stickers placed inside and outside the casing:

- A sticker on the rear of the Wirnet iBTS enclosure including serial number, regulatory markings and electrical information.
- A sticker outside the enclosure including regulatory marking, logo and sentences depending on the countries (FCC, IC, ANATEL, etc ...).

The placement of the stickers is described on Figure 5.

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1.3 Mechanical implementation for compact casing

1.3.1 Compact casing

The Wirnet iBTS Compact station is built on a high impact resistant IP67 polycarbonate wall mounting cabinet that withstands harsh industrial and outdoor environments.

It offers excellent flammability rating, good UV resistance and also good chemical resistance.

The dimensions of the cabinet are 260 mm x 170 mm x 120 mm.

It is composed of two separated parts: the frame and a lid. The lid tightens to the frame through two hinges that can be opened or closed by simple clipping. No screws are required but only optional.

A mounting kit, with embedded antenna brackets, is screwed on the back of the enclosure, allowing several mounting configurations: wall mount, pole mount and metallic strapping.

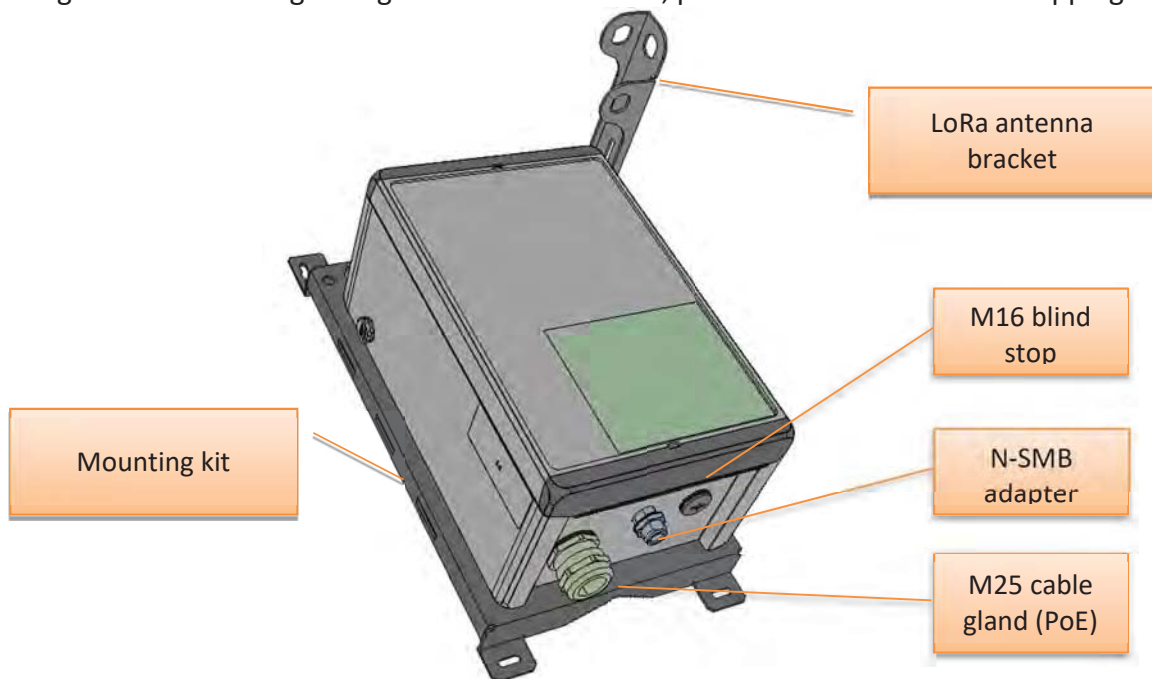


Figure 8: Wirnet iBTS Compact external view

The left and right sides of the enclosure integrate two waterproof screw-in vents to equalize the pressure inside and outside. This reduces condensation by allowing air to flow freely into and out of the sealed enclosure. At the same time, they provide a durable barrier to protect the internal modules from contaminants like dust, sand, water, etc ... improving reliability, safety and longer product life.

The bottom side of the enclosure is dedicated for the connectors:

- 1 x M25 cable gland used to introduce the Ethernet cable (PoE) inside the enclosure
- 1 x N-SMB adapters used as RF interfaces for LoRa antenna. The number of LoRa antenna interfaces can be extended to two.

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- 1 x M16 blind stop. It is considered as provision for an N-SMB connector to be used for additional LoRa antenna or external power supply cable gland.

An internal metal plate features a GNSS/LTE antenna bracket. An internal GNSS/LTE magnetic mount antenna is placed on this bracket.

Blind threaded standoffs are inserted in the rear side the enclosure. They are used to screw and maintain the modules inside the enclosure. The modules can be easily inserted and extracted for maintenance and upgradability purposes.

The Figure 9 below shows the different components inside the enclosure.

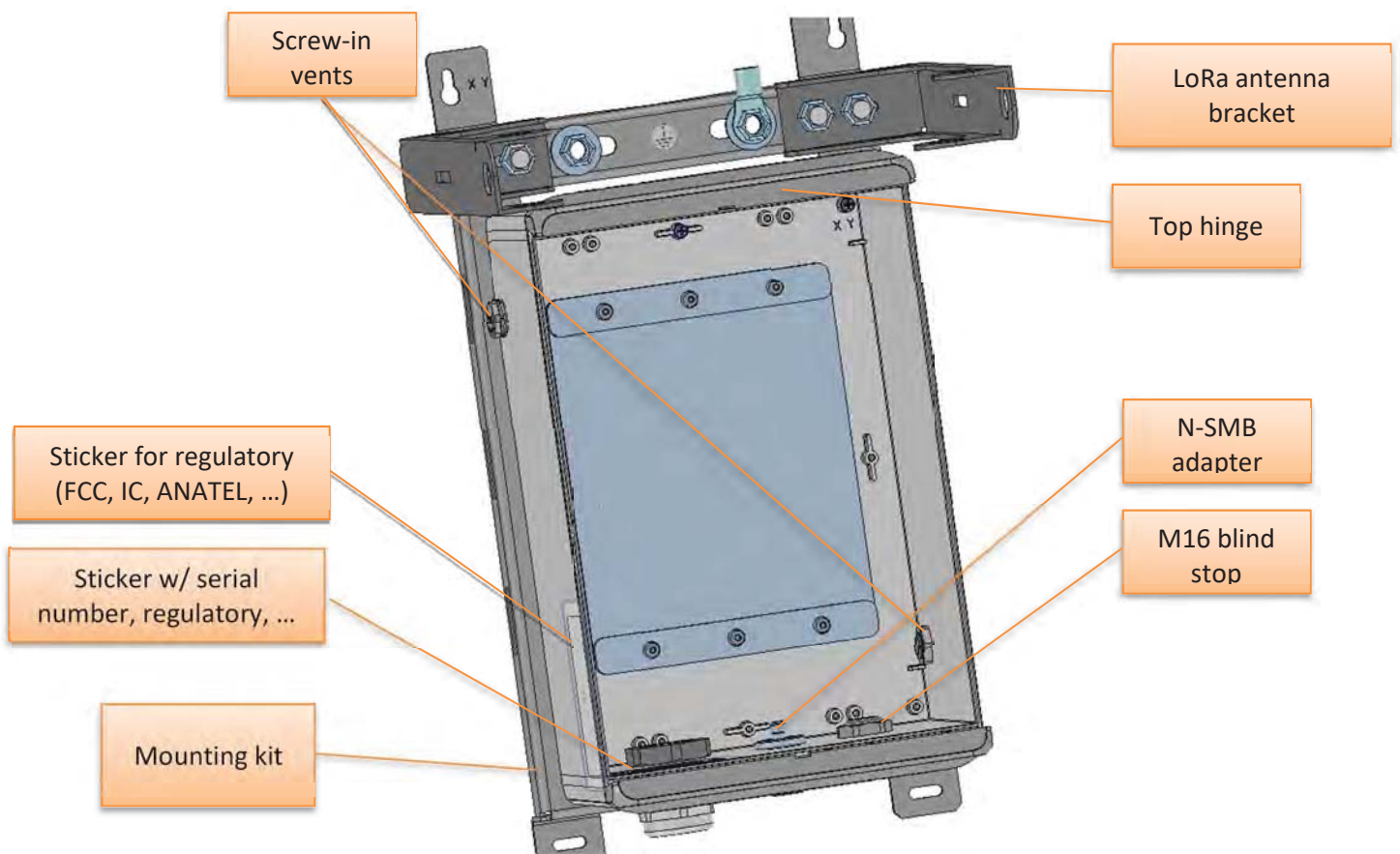


Figure 9 : Wirnet iBTS Compact internal view

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The main characteristics of the cabinet are detailed hereafter:

Description	Specification
Enclosure material	Polycarbonate (PC)
Gasket material	Polyurethane (PU)
Mounting kit material	Stainless steel
Color	RAL 7035
Dimensions with connectors	280 x 170 x 120 mm
Dimensions with connectors + mounting kit	360 x 190 x 150 mm
Weight – 3 modules configuration	3 Kg
Ingress protection	IP66 / EN 60529
Humidity	95% non-condensing
Impact resistance	IK08
Flammability rating	UL94-V0
Number of pressure equalizer	2
Cabinet temperature range	-40°C to +105°C
Wirnet iBTS operating temperature range	-20°C to +55°C
Connectors	1 x M25 cable gland (PoE) 1 x N-SMB adapters (extension to 2 max) 1 x M16 blind stops (provision for N-SMB or cable gland)

The modules are screwed on the blind threaded standoffs to build the Wirnet iBTS Compact according to customer requirements.

The Wirnet iBTS Compact can embed up to 3 modules.

The modules are tightened all together with two mechanisms:

- the back panel board connectors,
- the wing screws assembling the mechanical sides (radiators) of the modules

SMB-SMB cables are provided to interconnect the RF interfaces of the modules to the SMB-N adapters, on the bottom side of the enclosure.

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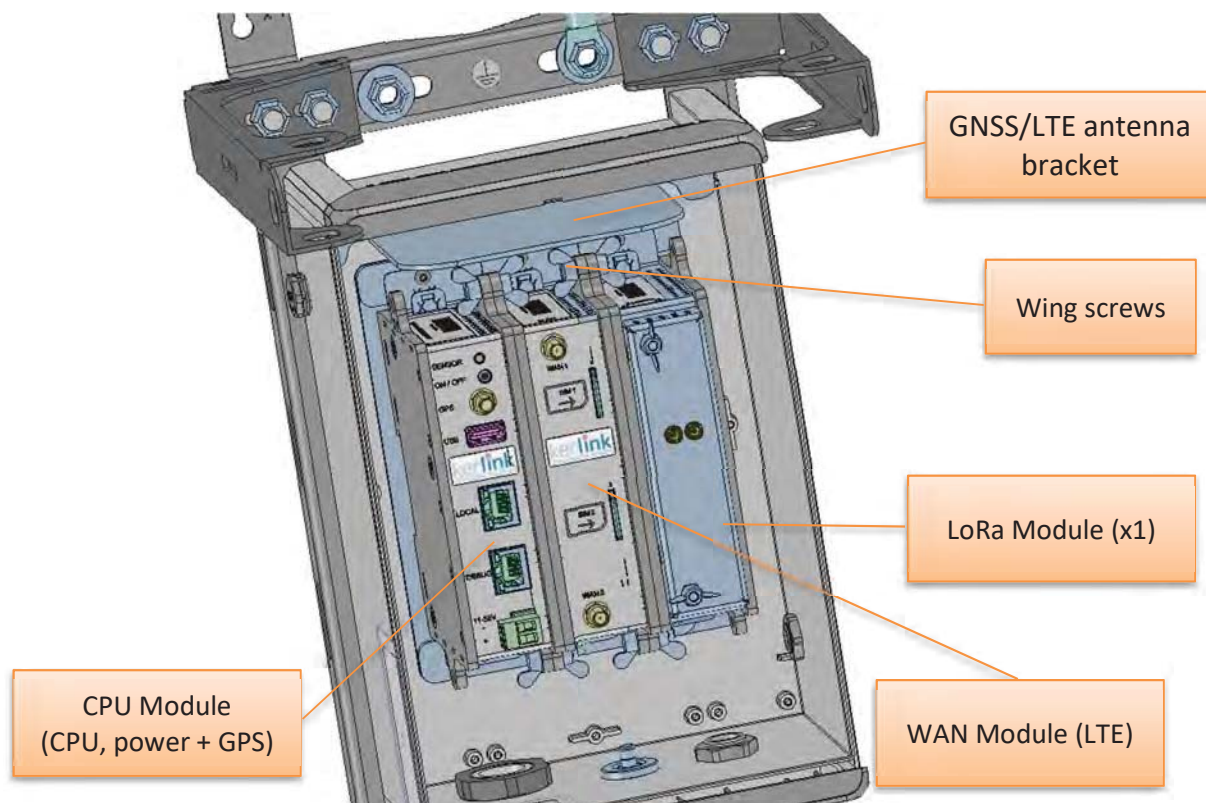


Figure 10: Insertion of the modules inside the cabinet

Depending on Wirnet IBTS compact versions, two kind of internal antennas are used:

- A combo Cellular/GPS antenna with a dedicated internal mounting bracket
- One single GPS antenna and a single cellular Antenna

Performances of both configurations are very similar.

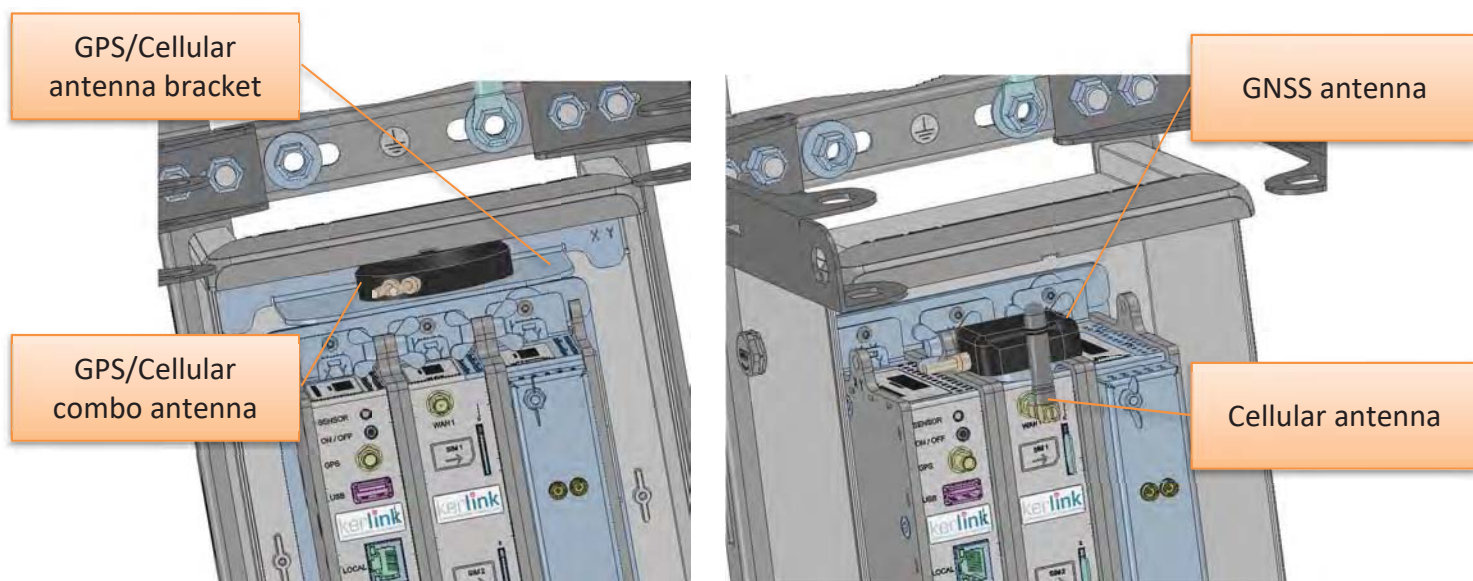


Figure 11: Wirnet iBTS Compact internal antennas

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1.3.2 Stickers

The Wirnet iBTS Compact has two stickers placed inside and outside the casing:

- A sticker on the bottom of the Wirnet iBTS Compact cabinet including serial number, regulatory markings and electrical information.
- A sticker outside the cabinet including regulatory marking, logo and sentences depending on the countries (FCC, IC, ANATEL, etc ...).

The placement of the stickers is described on Figure 9.

1.4 Block Diagram

1.4.1 Common functionalities

The following figure describes the hardware architecture and basic principles that are common to the many Wirnet iBTS versions. In this particular case, we consider a configuration with one "CPU module", one "WAN module" (or "Dual WAN module") and one "LoRa Module".

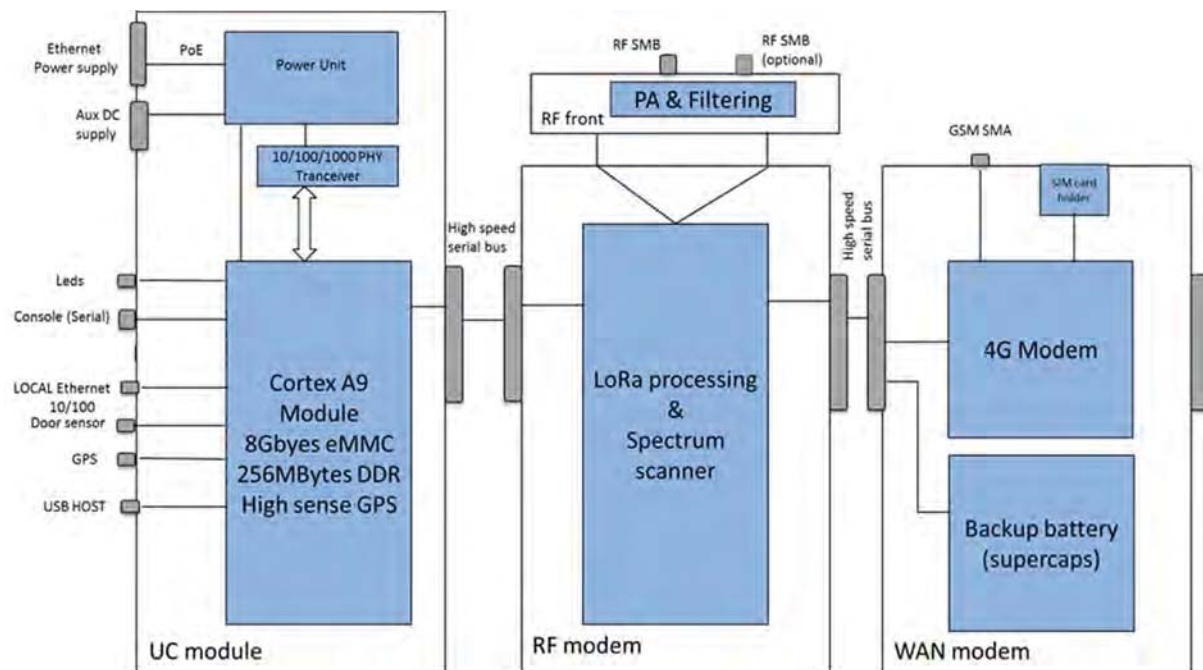


Figure 12: Common Wirnet iBTS block diagram

The Wirnet iBTS is power supplied by a PoE injector through the RJ45 cable.

The RJ45 cable is introduced into the enclosure through the M25 cable gland and connected to the RJ45 connector of the CPU module.

An alternate option of power supply consists in using an auxiliary power supply (11V-55V DC) and connects it to the Euroblock connector of the CPU module.

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The CPU Module insures the main followings features:

- Power management unit
- Cortex A9 CPU
- Memories (8GB eMMC and 256Mb DDR)
- GNSS receiver (GPS) with one RF SMA connector to connect the GNSS antenna

The CPU module is connected to the other modules through a back panel board allowing, the management of all the modules inside the Wirnet iBTS.

The “WAN Module” provides the backhaul functionality. It includes:

- Backup battery
- A 4G Mini PCI Express module that can be declined in 3 versions depending on the geographical area:
 - Europe
 - APAC
 - Americas
- The USIM card holder
- A RF SMA connector to connect a LTE antenna
- A 868MHz or 915MHz notch filter to avoid desensitization of the LoRa receivers

The “Dual WAN Module” is an alternative of the “WAN Module”. It provides also the backhaul functionality but includes:

- Backup battery
- Two 4G Mini PCI Express module dedicated to Europe
- Two USIM card holder
- Two RF SMA connectors to connect LTE antennas
- Two 868MHz notch filters to avoid desensitization of the LoRa receivers

The “LoRa modules” can be derived in 4 bands versions to address different countries:

- 868MHz (863-873MHz)
- 915MHz (902-928MHz)
- 915MHz 64 Highway (902-915MHz uplink, 923-928MHz downlink)
- 923MHz (915-928MHz)

The RF front-end board is configured to support a single antenna (16 channels) or two antennas (2x8 channels).

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1.4.2 Standard version of Wirnet iBTS

The following figure describes the functional architecture for the standard Wirnet iBTS version i.e. including from one to three “LoRa Modules”:

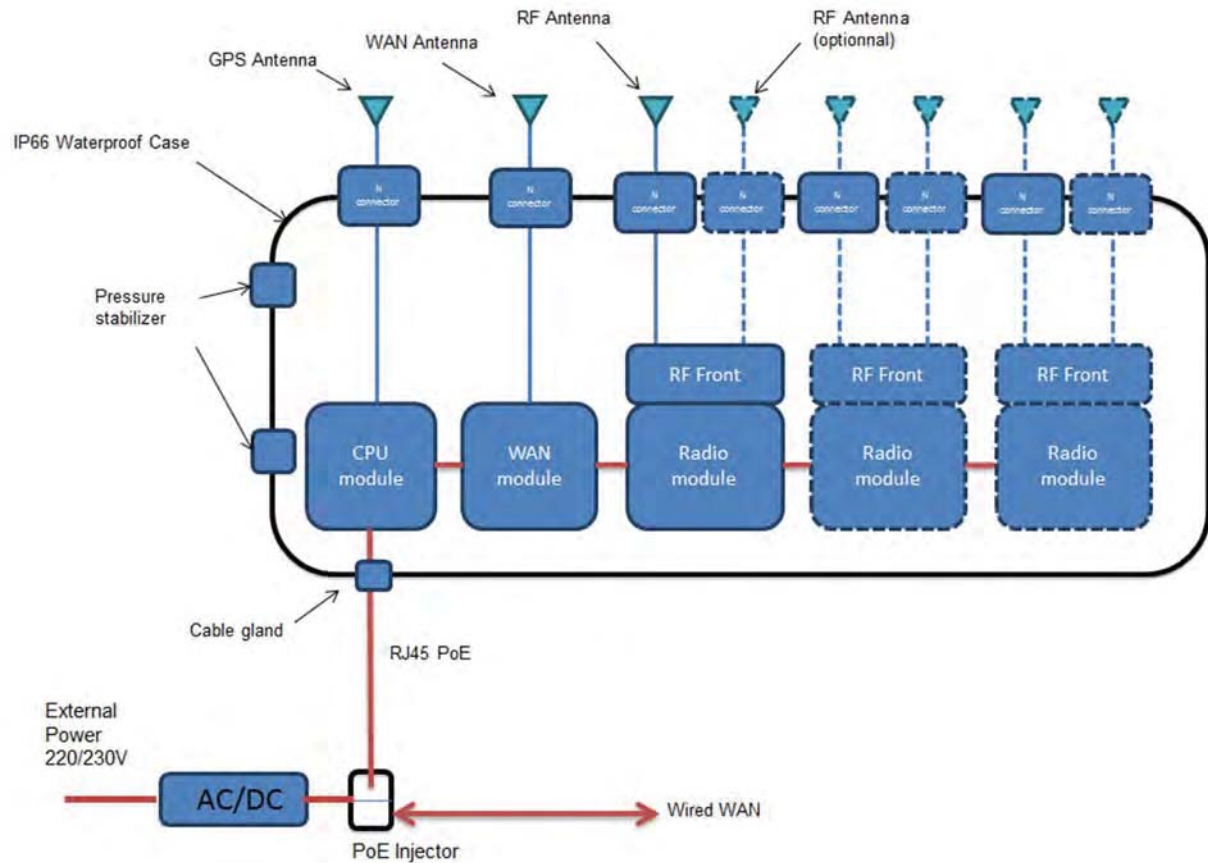


Figure 13: Standard Wirnet iBTS block diagram

The RF front-end board of the “Lora modules” can be derived in 3 bands versions to address different countries:

- 868MHz (863-873MHz)
- 915MHz (902-928MHz)
- 923MHz (915-928MHz)

The RF front-end board is configured to support a single antenna (16 channels) or two antennas (2x8 channels). This could lead then to a “six LoRa antennas” configurations in the maximum use case (tri-sectors, dual polarization antenna for instance).

The GPS (GNSS) connector, the WAN (LTE) connector and LoRa connectors are available on the bottom side of the enclosure. All antennas are external antennas.

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1.4.3 “Four LoRa Modules” version of Wirnet iBTS

The following figure describes the functional architecture for a “4 LoRa modules” version, featuring a maximum of 64 channels.

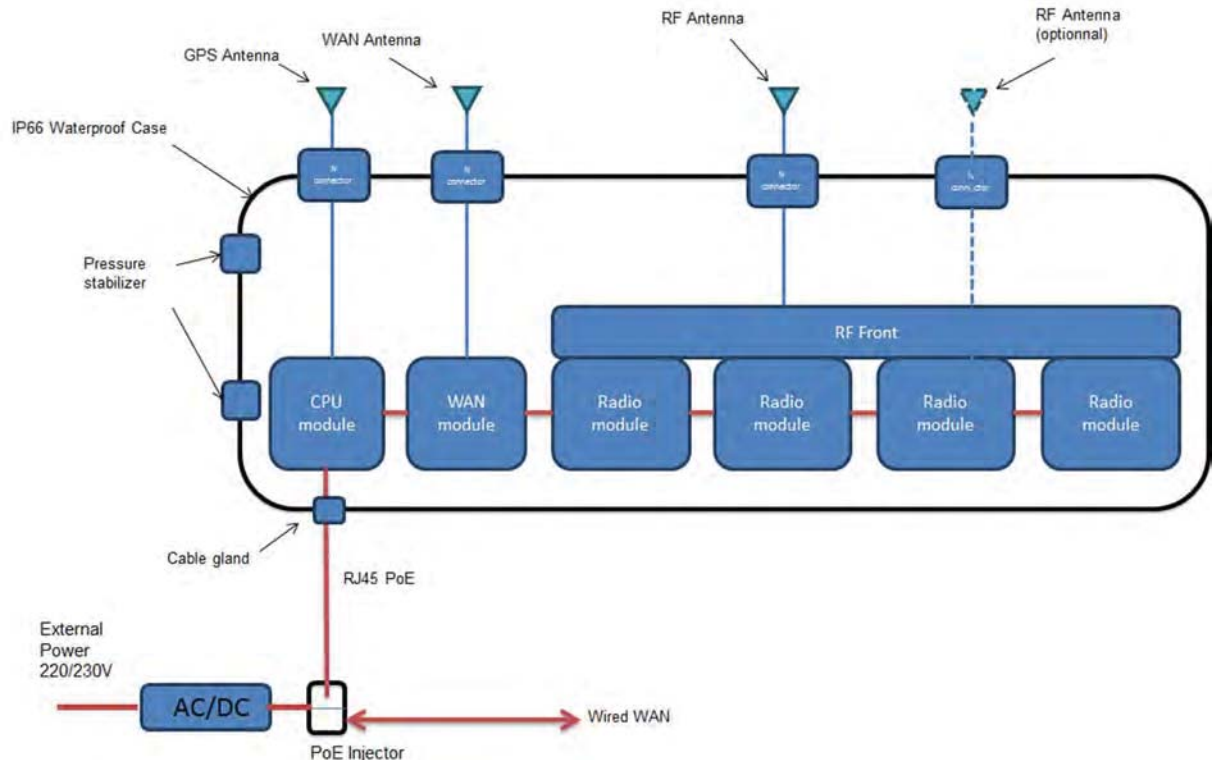


Figure 14: Wirnet iBTS “4 LoRa modules” block diagram

In this particular configuration, the mechanical front-end lids and front-end boards of each individual “LoRa Module” are removed. They are replaced by a bigger RF front end board and front-end lid that combine the 4 LoRa modules together.

This bigger RF front-end board can be derived in 2 bands versions to address different countries:

- 915MHz (902-928MHz)
- 923MHz (915-928MHz)

The 868MHz band is not available in this configuration.

The bigger RF front-end board is configured to support a single antenna (64 channels) or two antennas (2x32 channels).

The GPS (GNSS) connector, the WAN (LTE) connector and LoRa connectors are available on the bottom side of the enclosure. The antennas are all external antennas.

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1.4.4 Compact version of Wirnet iBTS

The following figure describes the functional architecture of the Wirnet iBTS Compact:

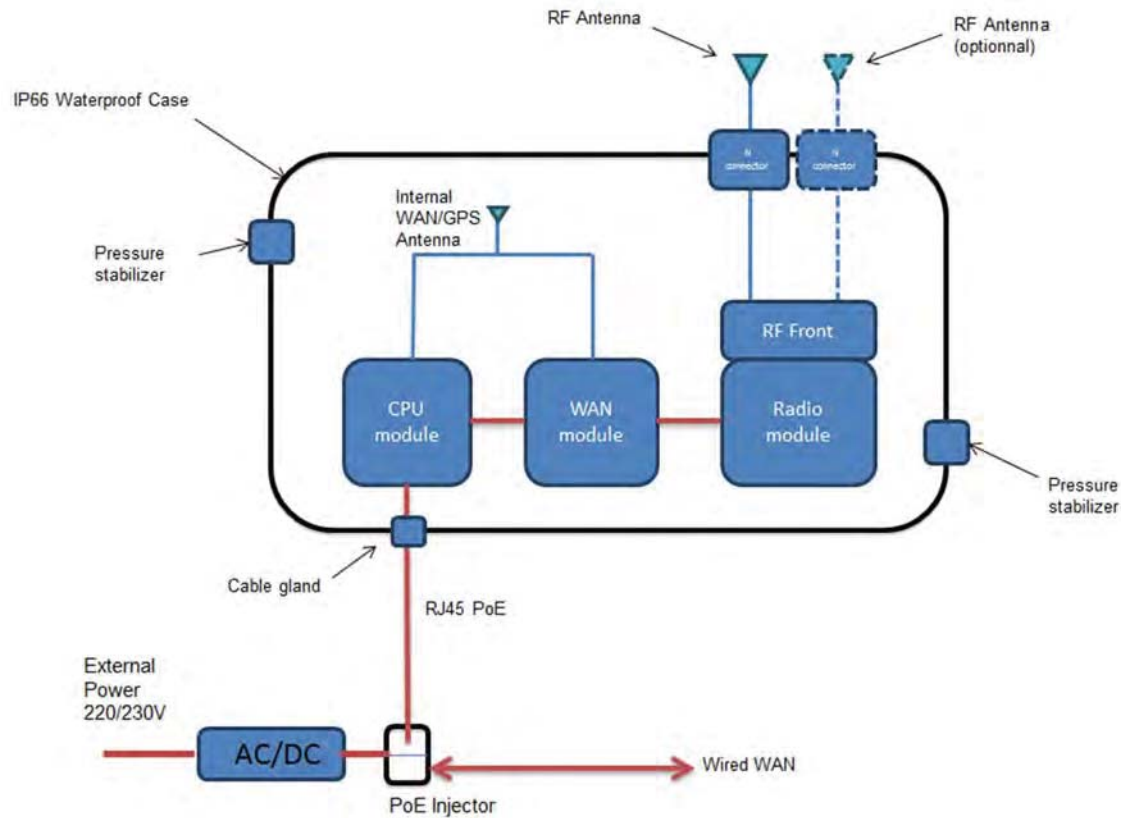


Figure 15: Wirnet iBTS Compact block diagram

The RF front-end board of the “Lora modules” can be derived in 3 bands versions to address different countries:

- 868MHz (863-873MHz)
- 915MHz (902-928MHz)
- 923MHz (915-928MHz)

The RF front-end board is configured to support a single antenna (16 channels) or two antennas (2x8 channels).

The Wirnet iBTS Compact embeds an internal GPS (GNSS) / WAN (LTE) combo antenna compared to external antenna for standard enclosure.

The LoRa connectors are available on the bottom side of the enclosure. The LoRa antennas are external antennas.

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1.4.5 Wirnet iBTS 64 Highway

The following figure describes the functional architecture of a 64 Highway version, featuring a maximum of 72 Rx channels and 8 Tx channels.

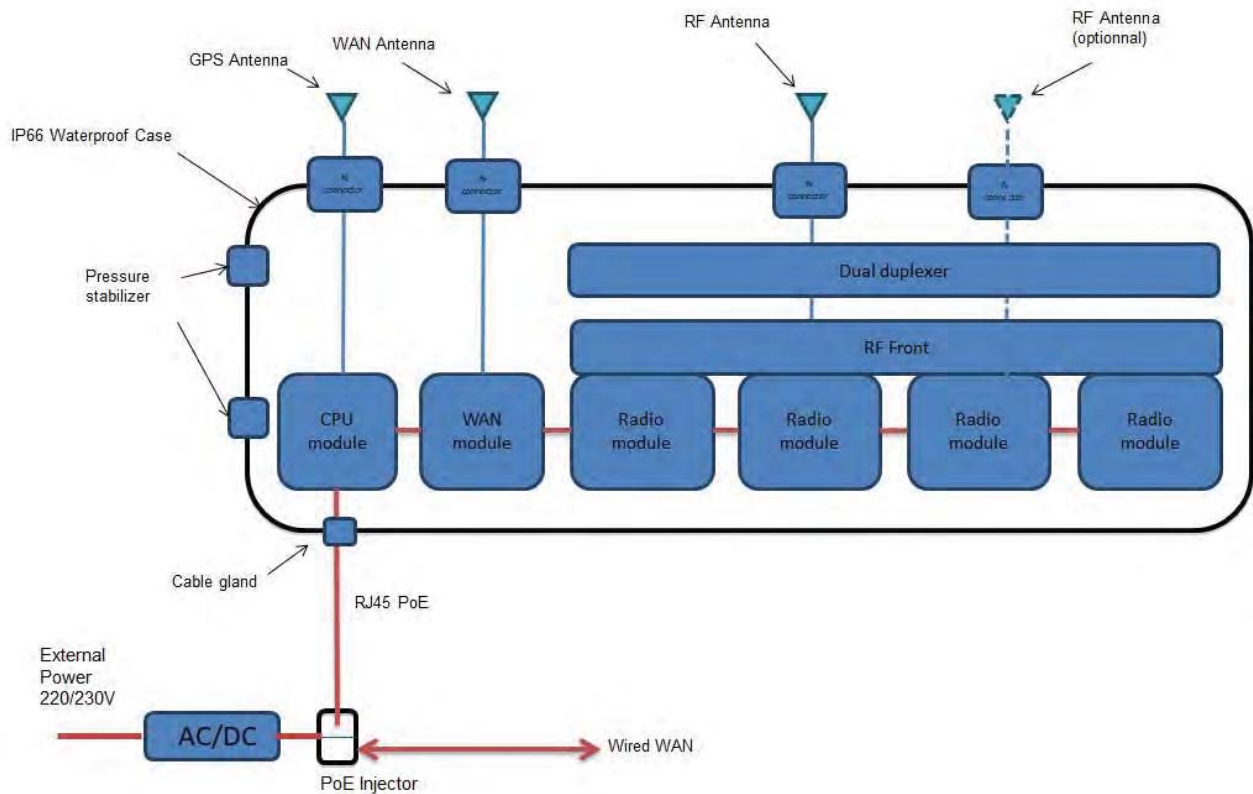


Figure 16: Wirnet iBTS 64 Highway block diagrams

In this particular configuration, the mechanical front-end lids and front-end boards of each individual “LoRa Module” are removed. They are replaced by a bigger RF front end board and front-end lid that combine the 4 LoRa modules together.

The bigger RF front-end board is configured to support a single antenna (72 Rx channels, 4 Tx channels) and two antennas (2x36 Rx channels, 2x4 Tx channels).

A dual cavity (or simple) duplexer is used for RF filtering and duplexing.

The GPS (GNSS) connector, the WAN (LTE) connector and LoRa connectors are available on the bottom side of the enclosure. The antennas are all external antennas.

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1.5 Description of the modules

1.5.1 CPU module

1.5.1.1 Mechanical description

The CPU module is composed of four main mechanical parts:

- A “three-sides” flange including:
 - the connectors and interfaces placement
 - venting of internal boards through many holes
- A rear plate with fixing points for screwing on the blind threaded standoffs
- Two radiators used as right and left side flanges

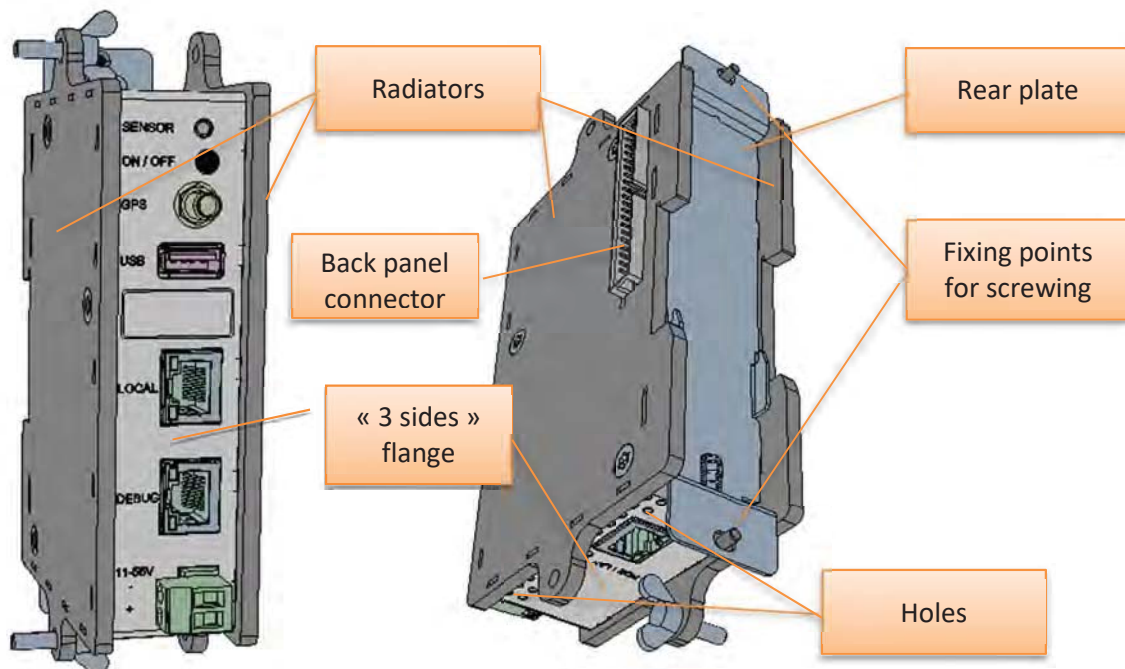


Figure 17: Mechanical description of the CPU module

The main mechanical characteristics of the CPU module are detailed hereafter:

Description	Specification
Radiators material	Aluminum
Other flanges material	Galvanized Steel
Dimensions	156 mm x 88 mm x 38 mm
Weight	500 g

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Ingress protection

IP30

1.5.1.2 Connectors and user interfaces

The CPU module includes the following user interfaces and connectors:

Module side	Connector / interface	Description
Front side	Sensor	Light sensor to detect aperture of the enclosure
Front side	ON/OFF button	Press this button to power ON and power OFF the CPU module and therefore the Wirnet iBTS
Front side	GPS SMA RF connector	GPS input signal to be connected to the GPS antenna (internal or external)
Front side	USB type A connector	Used for firmware upgrade with a USB stick
Front side	RJ45 Local connector	Local Ethernet connection – interface to portable PC
Front side	RJ45 Debug connector	Serial debug interface – use debug tool described in §1.8.7
Front side	11-56V Euroblock connector	Auxiliary power supply. Polarity indicated on the front panel
Right side	Back panel HE10 40 contacts connector	Distributes the power supplies and high speed serial bus to other modules
Bottom side	RJ45 PoE connector	Ethernet + powers supply coming from PoE injector and introduced in the enclosure through the M25 cable gland

The three RJ45 connectors (PoE, LOCAL and debug) integrates 2 LEDs, one green and one orange. The behavior of the LEDs is detailed hereafter:

Connector	LED	Description
LOCAL	Green	Ethernet data activity
LOCAL	Orange	Ethernet Link
PoE/LAN	Green	Ethernet data activity
PoE/LAN	Orange	Ethernet Link
DEBUG	Green	Power status
DEBUG	Orange	Software status/ activity

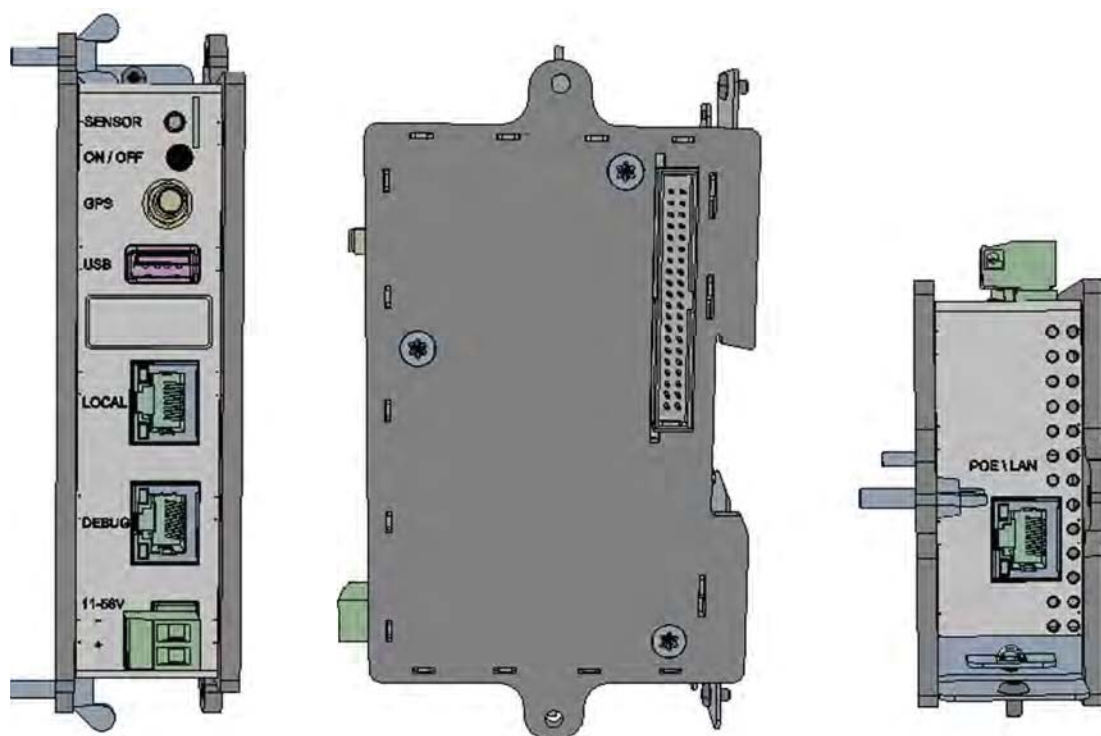


Figure 18: Connectors and user interfaces of the CPU module

Note: The debug interface is intended to be used by authorized and qualified personnel only. Only specific equipment developed by KERLINK must be connected to this interface (see §1.8.7.)

1.5.1.3 CPU module characteristics

The CPU module includes the following features:

Feature	Description
Processor	ARM Cortex A9, 800MHz core
Memories	256MB DDRAM – Volatile memory 8GB eMMC– Non-volatile memory
Watchdog	Hardware type
Security	Secure core Information encryption Secure Boot Secure software download
RTC	RTC clock saved by back-up battery
GPS	Integrated high sensitivity GNSS module GPS L1C/A, GLONASS L1OF, BeiDou B1, QZSS L1C/A, SBAS L1C/A and Galileo E1B/C ready

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	NMEA 0183, version 4.0
	Time pulse (PPS) accuracy < 20ns for LoRa geolocalization
Power	PoE controller 48V IEEE 802.3af/at
	LTPoE
	Auxiliary 11-56 VDC
	Backup-battery for RTC saving
	Integrated power management unit in CPU
Ethernet	10/100/1000 Base-T
	PoE IEEE802.3af/at and LTPoE++
	IEEE1588 version 2 time stamping compatible
	Automatic polarity correction
	1 x RJ45 WAN/POE
	1 x RJ45 LOCAL, interface to Portable PC
USB	USB HS type A Slave
DEBUG	UART interface
	Debug tool to be used for UART to USB adaptation
Sensors	Light sensor to detect aperture of the enclose
	Temperature sensor
Auto test	Internal power supplies check
	Interfaces and peripherals check
User interface	LED used for diagnostic (see §1.5.1.2)
	ON/OFF button
Operating temperature range	-20°C to +85°C
Current drain @48V	12mA in Power OFF mode (required to maintain PoE supply)
	35mA @ 20% load CPU + Ethernet Gbits (PoE)
	43mA @ 20% load CPU + Ethernet Gbits (PoE) + Local Ethernet

1.5.2 WAN module

1.5.2.1 Mechanical description

The WAN module is composed of four main mechanical parts:

- A “three-sides” flange including:
 - the connectors and interfaces placement
 - venting of internal boards through many holes
- A rear plate with fixing points for screwing on the blind threaded standoffs
- Two radiators used as right and left side flanges

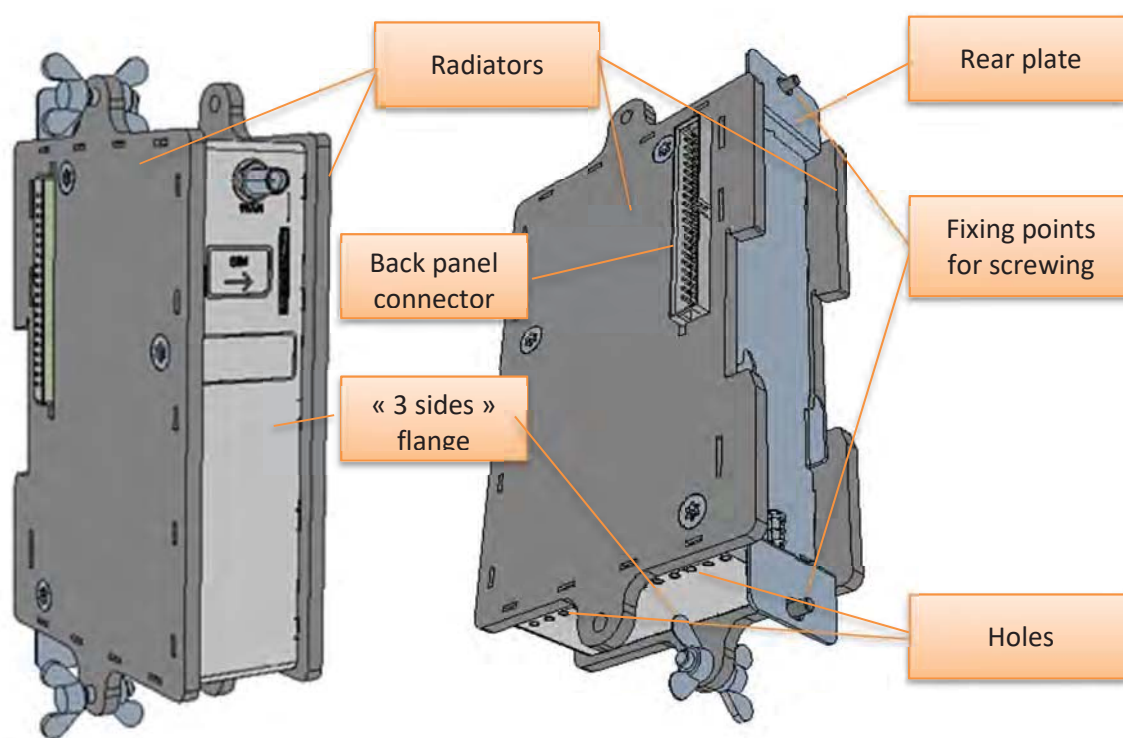


Figure 19: Mechanical description of the WAN module

The main mechanical characteristics of the WAN module are detailed hereafter:

Description	Specification
Radiators material	Aluminum
Other flanges material	Galvanized Steel
Dimensions	156 mm x 88 mm x 38 mm
Weight	500 g
Ingress protection	IP30

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1.5.2.1 Connectors and user interfaces

The WAN module includes the following user interfaces and connectors:

Module side	Connector / interface	Description
Front side	WAN RF connector	WAN 4G RF signal to be connected to the LTE antenna (internal or external)
Front side	USIM connector	Push-push connector Insert USIM according to the besides picture
Right side	Back panel HE10 male 40 contacts connector	Transmit the power supplies and high speed serial bus to the next module
Left side	Back panel HE10 female 40 contacts connector	Receive the power supplies and high speed serial bus from the previous module

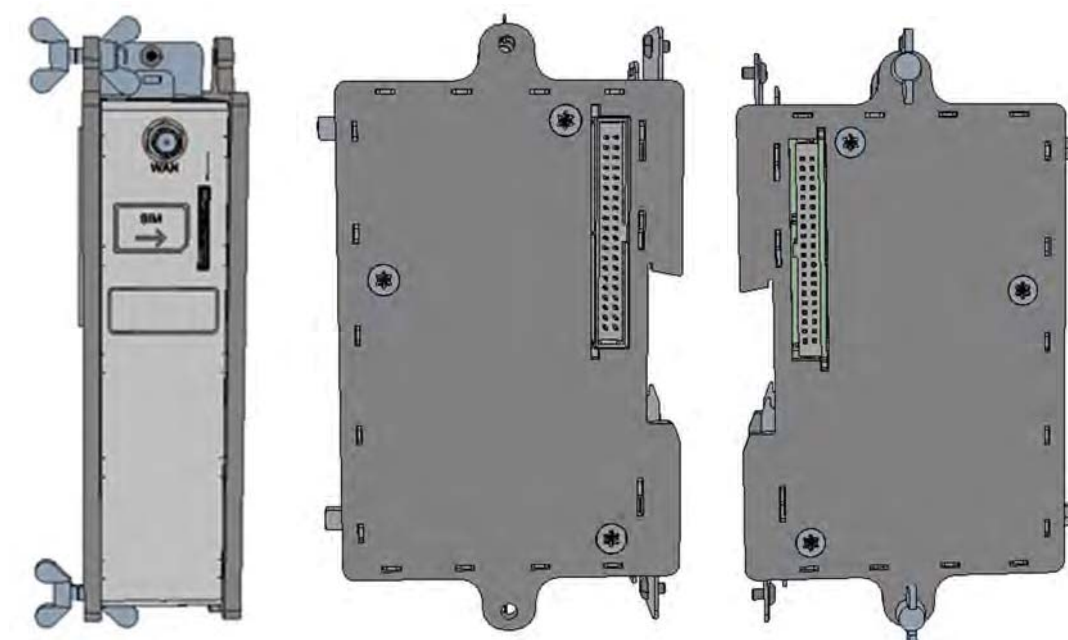


Figure 20: Connectors and user interfaces of the WAN module

Note: UFL to SMA coaxial cables are used to connect the Mini PCI Express card to the antennas.

1.5.2.2 WAN module characteristics

The WAN module supports the following features:

Feature	Description
Mini PCI Express Interface	USB only (no PCI Express interface available) Full Mini Card form factor (F1, F2) 2 versions available (see § 1.5.2.3)
Backup battery	5 x 25F/2.7V supercapacitors 15 minutes charging time Up to one minute capacity to ensure safe power down of the Wirnet iBTS
Operating temperature range	-20°C to +85°C
Current drain @48V	21mA HSPA Rx (attached) 72mA HSPA Tx@Pout max

The WAN module is then based on a Mini PCIe card allowing some flexibility and evolutivity regarding the supported technologies and bands.

Several Mini PCIe cards are currently supported to address different countries. They are detailed in the paragraph 1.5.2.3.

1.5.2.3 Supported mini PCIe cards

The WAN module embeds a Mini PCI express board which is a LTE modem that can be declined in 3 versions:

- One for Europe (and APAC), based on Sierra Wireless MC7304
- One for (Europe and) APAC, based on Sierra Wireless MC7430
- One for Americas, based on Sierra Wireless MC7354

1.5.2.3.1 LTE - Europe and APAC Mini PCI Express card – MC7304

The first 4G Mini PCI Express card is dedicated to the European and APAC markets.

The reference is MC7304.

This module is already GCF approved and meets the Radio Equipment and Telecommunications Terminal Equipment (R&TTE) Directive of the European Union.

The bands and data rate supported by the module are the following:

Technology	Band	Data rate
LTE	Band 1 (2100MHz)	Category 3
3GPP Release 9	Band 3 (1800MHz)	• Downlink:
	Band 7 (2600MHz)	○ 100Mbps (20MHz BW)
	Band 8 (900MHz)	○ 50Mbps (10MHz BW)
	Band 20 (800MHz)	• Uplink:
		○ 50Mbps (20MHz BW)

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○ 25Mbps (10MHz BW)		
UMTS	Band 1 (2100MHz)	HSPA+ rates:
HSPA	Band 2 (1900MHz)	• Downlink: up to 42Mbps (category 24)
3GPP Release 8	Band 5 (850MHz) Band 8 (900MHz)	• Uplink: up to 5.76Mbps (category 6)
GSM	GSM 850 (850MHz)	GPRS Multislot class 10
GPRS	EGSM 900 (900MHz)	GPRS Multislot class 12
EDGE	DCS 1800 (1800MHz)	CS1 to CS4
3GPP Release 99	PCS 1900 (1900MHz)	MCS1 to MCS9 EDGE throughput up to 236kbps

Compared to the MC7430 MiniPCIe card, the MC7304 offers one major advantage: GPRS and EDGE modes are supported. This MiniPCIe card is then suitable in rural areas for instance where 4G or 3G coverage is poor.

1.5.2.3.2 LTE - Europe and APAC Mini PCI Express card – MC7430

The first 4G Mini PCI Express card is dedicated to the European and APAC markets.

The reference is MC7430.

This module is already GCF approved and meets the Radio Equipment and Telecommunications Terminal Equipment (R&TTE) Directive of the European Union. The module is also already certified in Japan, Brazil, Korea, Taiwan and Korea.

The bands and data rate supported by the module are the following:

Technology	Band	Data rate
LTE	B1 (2100) - FDD	Category 6
3GPP Release 11	B3 (1800+) - FDD	• Downlink:
FDD and TDD	B5 (850) - FDD	○ FDD: 300Mbps
	B7 (2600) - FDD	○ TDD: 222Mbps
	B8 (900) - FDD	• Uplink:
	B18 (800 lower) - FDD	○ FDD: 50Mbps
	B19 (800 upper) - FDD	○ TDD: 26Mbps
	B21 (1500 upper) - FDD	
	B28 (700APT) - FDD	
	B38 (2600) – TDD	
	B39 (1900+) – TDD	
	B40 (2300) – TDD	
	B41 (2500) - TDD	
UMTS	B1 (2100)	HSPA+ rates:
HSPA	B5 (850)	• Downlink: up to 42Mbps (category 24)
3GPP Release 9	B6 (850 UMTS only)	• Uplink: up to 5.76Mbps (category 6)
	B8 (900)	
	B9 (1800)	

	B19 (800 upper)	
TD-SCDMA	B39 (1900+)	Data rates: • Downlink: Up to 2.8 Mbps • Uplink: Up to 2.2 Mbps Spreading rate: • Downlink: 1.28 Mcps
GSM	None	N/A
GPRS		
EDGE		
3GPP Release 99		

Compared to the MC7304 MiniPCle card, the MC7430 supports more 3G and 4G bands. This MiniPCle card is then suitable in urban areas for instance where 4G or 3G coverage excellent.

1.5.2.3.1 LTE - Americas Mini PCI Express card – MC7354

The next 4G Mini PCI Express card is dedicated to the American market.

The reference is Sierra Wireless MC7354.

This module is already PTCRB and CDG2 approved.

It is also FCC and IC certified:

- FCC ID: N7NMC7355
- IC ID: 2417C-MC7355

The bands and data rate supported by the module are the following:

Technology	Band	Data rate
LTE	Band 2 (1900MHz)	Category 3
3GPP Release 9	Band 4 (1700/2100MHz)	• Downlink: ○ 100Mbps (20MHz BW) ○ 50Mbps (10MHz BW) • Uplink: ○ 50Mbps (20MHz BW) ○ 25Mbps (10MHz BW)
CDMA	BC0 (800MHz)	CDMA IS-856 (1xEV-DO Release A)
EVDO release 0	BC1 (1900MHz)	• Up to 3.1 Mbps forward channel • Up to 1.8 Mbps reverse channel
EVDO release A	BC10 (800MHz)	CDMA IS-2000 • Up to 153 kbps, simultaneous forward and reverse channel Circuit-switched data bearers up to 14.4 kbps
UMTS	Band 1 (2100MHz)	HSPA+ rates:

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HSPA	Band 2 (1900MHz)	• Downlink: up to 42Mbps (category 24)
3GPP Release 8	Band 4 (1700/2100MHz)	• Uplink: up to 5.76Mbps (category 6)
	Band 5 (850MHz)	
	Band 8 (900MHz)	
GSM	GSM 850 (850MHz)	GPRS Multislot class 10
GPRS	EGSM 900 (900MHz)	GPRS Multislot class 12
EDGE	DCS 1800 (1800MHz)	CS1 to CS4
3GPP Release 99	PCS 1900 (1900MHz)	MCS1 to MCS9
		EDGE throughput up to 236kbps

1.5.3 Dual WAN Module

1.5.3.1 Mechanical description

The Dual WAN module is composed of four main mechanical parts:

- A “three-sides” flange including:
 - the connectors and interfaces placement
 - venting of internal boards through many holes
- A rear plate with fixing points for screwing on the blind threaded standoffs
- Two radiators used as right and left side flanges

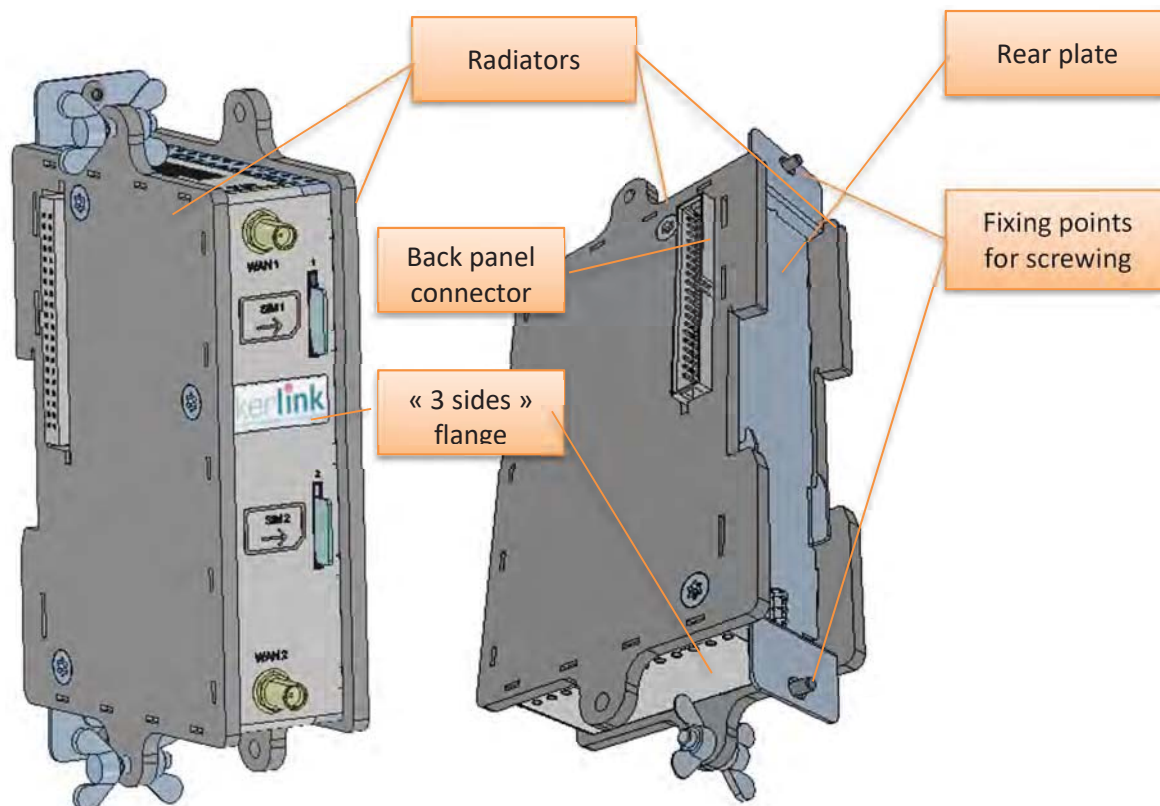


Figure 21: Mechanical description of the Dual WAN module

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The main mechanical characteristics of the Dual WAN module are detailed hereafter:

Description	Specification
Radiators material	Aluminum
Other flanges material	Galvanized Steel
Dimensions	156 mm x 88 mm x 38 mm
Weight	500 g
Ingress protection	IP30

1.5.3.2 Connectors and user interfaces

The Dual WAN module includes the following user interfaces and connectors:

Module side	Connector / interface	Description
Front side	WAN1 RF connector	WAN 4G RF signal to be connected to the LTE antenna (internal or external)
Front side	WAN2 RF connector	WAN 4G RF signal to be connected to the LTE antenna (internal or external)
Front side	USIM1 connector	Push-push connector Insert USIM according to the besides picture
Front side	USIM2 connector	Push-push connector Insert USIM according to the besides picture
Right side	Back panel HE10 male 40 contacts connector	Transmit the power supplies and high speed serial bus to the next module
Left side	Back panel HE10 female 40 contacts connector	Receive the power supplies and high speed serial bus from the previous module

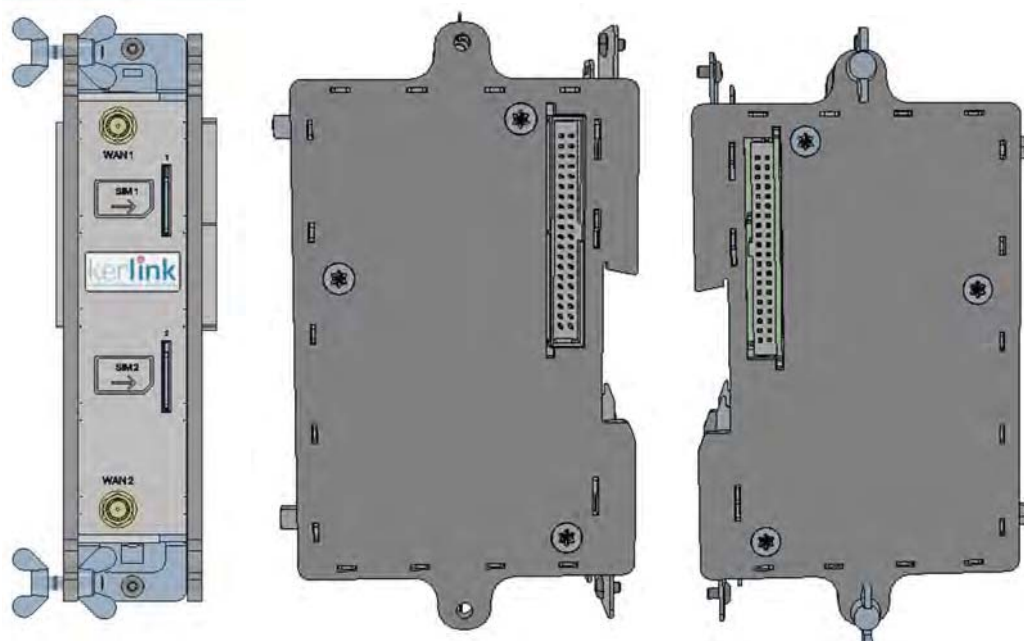


Figure 22: Connectors and user interfaces of the Dual WAN module

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1.5.3.3 Dual WAN module characteristics

The Dual WAN module supports the following features:

Feature	Description
2x Mini PCI Express Interfaces	USB only (no PCI Express interface available) Full Mini Card form factor (F1, F2) Only one frequency bands dependent version is available Both WAN 4G Mini PCI board may be active in parallel, i.e. attached to the network at the same time.
Backup battery	5 x 25F/2.7V supercapacitors 15 minutes charging time Up to one minute capacity to ensure safe power down of the Wirnet iBTS
Operating temperature range	-20°C to +85°C
Current drain @48V / PCI express interface	21mA HSPA Rx (attached) 72mA HSPA Tx@Pout max

1.5.3.4 Supported Mini PCIe cards

The Dual WAN module embeds two Mini PCI express boards.

So far, only one Mini PCIe board / LTE modem dedicated for Europe and APAC is available: MC7304 from Sierra Wireless. This MiniPCIe card is described in chapter 1.5.2.3.1.

If other Mini PCI express boards are required, contact KERLINK.

1.5.4 LoRa module – LoRa LOC

1.5.4.1 Mechanical description

1.5.4.1.1 Single “LoRa-LOC” module

The LoRa-LOC module is composed of five main mechanical parts:

- A “three-sides” flange including:
 - the connectors and interfaces placement
 - venting of internal boards through many holes
- A rear plate with fixing points for screwing on the blind threaded standoffs
- Two radiators used as right and left side flanges
- A front-end lid, used as a shield for the front-end board

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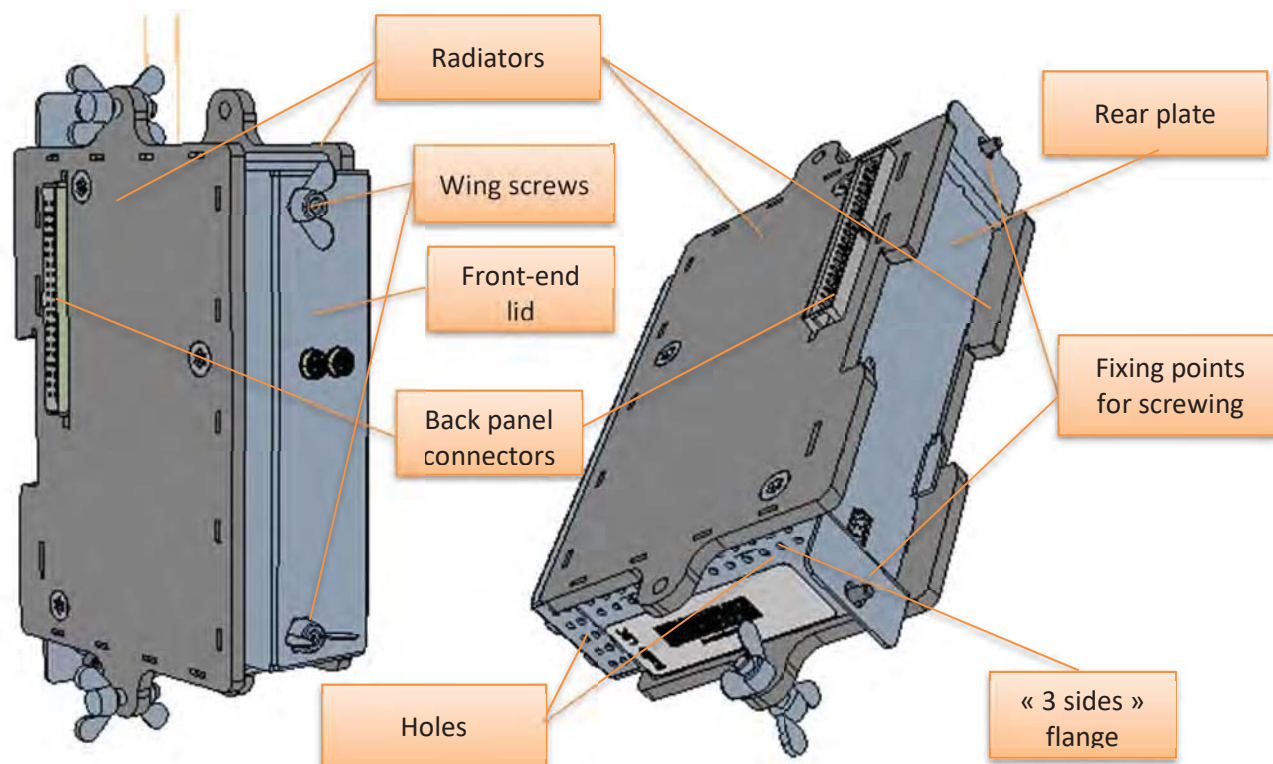


Figure 23: Mechanical description of the LoRa – LOC module

The rear plate and the two radiators side flanges are the same as the one used for the CPU module or the WAN module. The “three-sides” flange is different from the one used for the CPU module or WAN modules due to different interfaces and connectors but dimensions are the same.

The front-end lid is then a particular mechanical part dedicated only for the LoRa modules. The front-end lid is tightened to the other mechanical parts through the wing screws on the front.

The main mechanical characteristics of the Lora module are detailed hereafter:

Description	Specification
Radiators material	Aluminum
Other flanges and lid material	Galvanized Steel
Dimensions	156 mm x 102 mm x 38 mm
Weight	600 g
Ingress protection	IP30

The LoRa-LOC board integrates the LoRa-LOC modem based on the AD936x transceiver (Analog Devices) and SX1301 (Semtech) + DSP as demodulators.

A front-end board embeds the radio transmitters and receivers. Three versions are derived to support the different unlicensed bands:

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- 868MHz (863-873MHz)
- 915MHz (902-928MHz)
- 923MHz (915-928MHz)

1.5.4.1.2 Four "LoRa-LOC" modules

The four "LoRa-LOC" modules version is composed of 4 single LoRa-LOC RF modules. The front-end board and the front-end lid of each individual module are removed and replaced by a single common front-end board and front-end lid, covering and combining the four modules together.

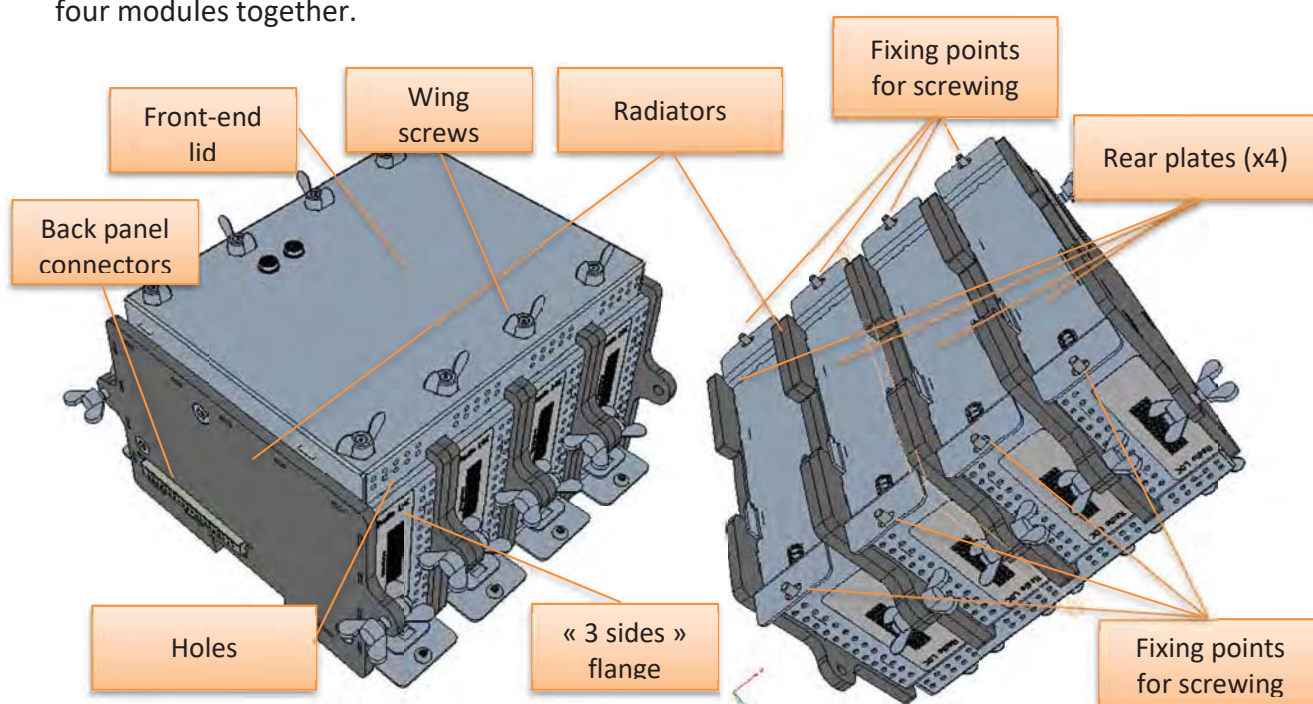


Figure 24: Mechanical description of the four LoRa LOC modules configuration

The rear plates and the two radiators side flanges are still unchanged. The front-end lid is tightened to the other mechanical parts through the wing screws on the front.

The main mechanical characteristics of the Lora module are detailed hereafter:

Description	Specification
Radiators material	Aluminum
Other flanges and lid material	Galvanized Steel
Dimensions	156 mm x 102 mm x 152 mm
Total weight	1700 g
Ingress protection	IP30

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Four Lora LOC boards are used. They integrate the AD936x transceiver and SX1301 + DSP as demodulators, as described previously.

A front-end board embeds the radio transmitters and receivers. Two versions are declined to support the different unlicensed bands:

- 915MHz (902-928MHz)
- 923MHz (915-928MHz)

1.5.4.1.3 Four “LoRa-LOC-64 Highway” modules

The four “LoRa-LOC-64 Highway” modules version is composed of 4 single LoRa-LOC RF modules.

The front-end board and the front-end lid of each individual module are removed and replaced by a single common front-end board and front-end lid, covering the four modules together.

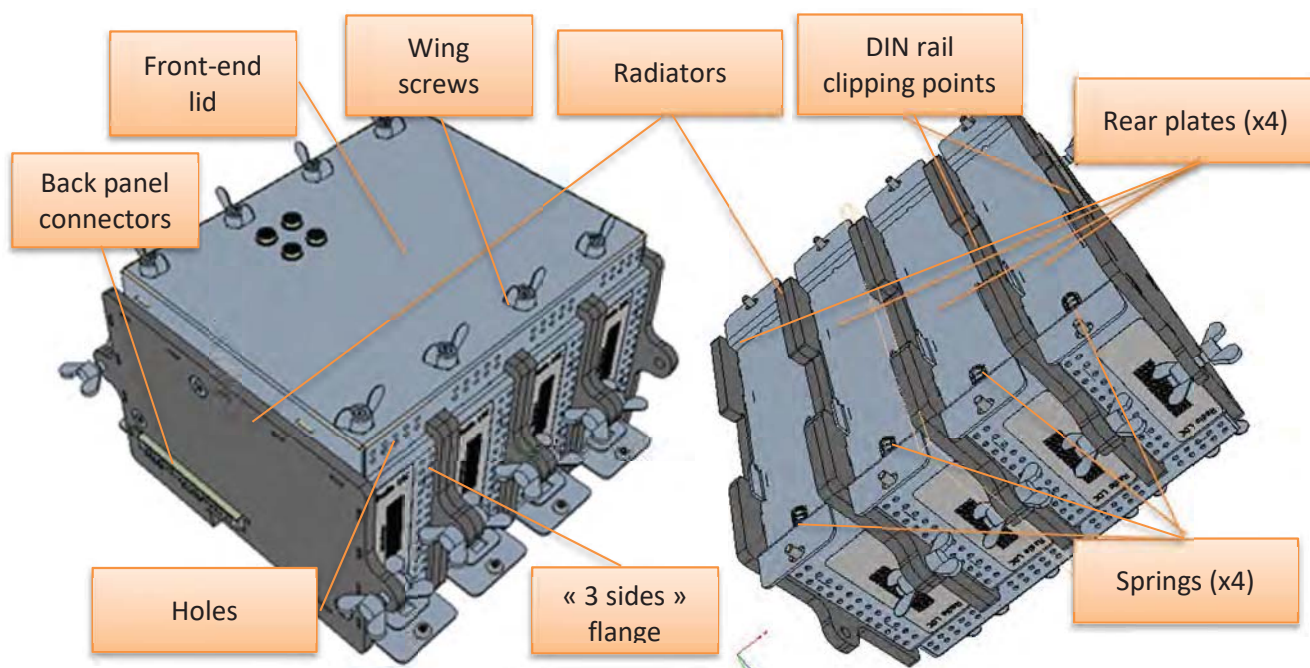


Figure 25: Mechanical description of the four LoRa LOC-64 Highway modules configuration

The rear plates and the two radiators side flanges are still unchanged.

The front-end lid is tightened to the other mechanical parts through the wing screws on the front.

The main mechanical characteristics of the Lora module are detailed hereafter:

Description	Specification
Radiators material	Aluminum

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Other flanges and lid material	Galvanized Steel
Dimensions	156 mm x 102 mm x 152 mm
Total weight	1700 g
Ingress protection	IP30

Inside the mechanical parts, the four “LoRa-LOC-64 Highway” modules version is composed of 9 boards:

- 4 back panel boards
- 4 LoRa-LOC modem boards
- A single front-end 64 Highway radio board

The back panel boards connect the four LoRa modems together and also to the CPU module. This board is the same as the one used in the WAN module and single LoRa module. The board will not be further more detailed.

Four Lora LOC boards are used. They integrate the AD936x transceiver and SX1301 + DSP as demodulators, as described previously.

The front-end board embeds the radio transmitters and receivers to support the ISM915 unlicensed bands (902-928MHz).

The front-end board is connected to the LoRa-LOC modules trough SMB RF connectors and a HE10 14 contacts. The first Lora-LOC board is plugged directly on the front-end board through the SMB connectors. The other LoRa-LOC boards are connected to the front-end board through SMB coaxial cables.

1.5.4.2 Connectors and user interfaces

1.5.4.2.1 Single LoRa-LOC module

The LoRa LOC module includes the following user interfaces and connectors:

Module side	Connector / interface	Description
Front side	LoRa RF SMB connector # RF1	LoRa RF signal to be connected to the LoRa antenna # 1
Front side	LoRa RF SMB connector # RF2	LoRa RF signal to be connected to the LoRa antenna # 2
Right side	Back panel HE10 male 40 contacts connector	Transmit the power supplies and high speed serial bus to the next module
Left side	Back panel HE10 female 40 contacts connector	Receive the power supplies and high speed serial bus from the previous module

The LoRa SMB RF connector's # RF1 and # RF2 are connected to the SMB/N adapters on the bottom side of the Wirnet iBTS via SMB coaxial cables.

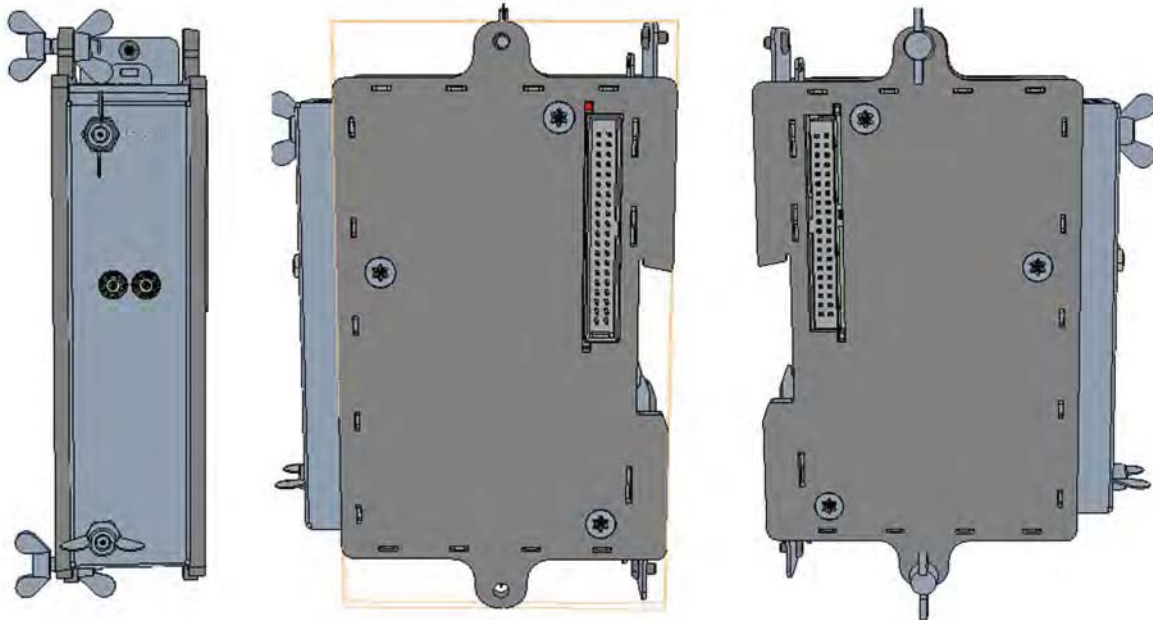


Figure 26: Connectors and user interfaces of the LoRa LOC module

The RF1 connector is on the left side of the front-end lid.

The RF2 connector is on the right side of the front-end lid.

The positions of the RF1 and RF2 connectors are indicated on the sticker on top of the LoRa LOC module as follows:

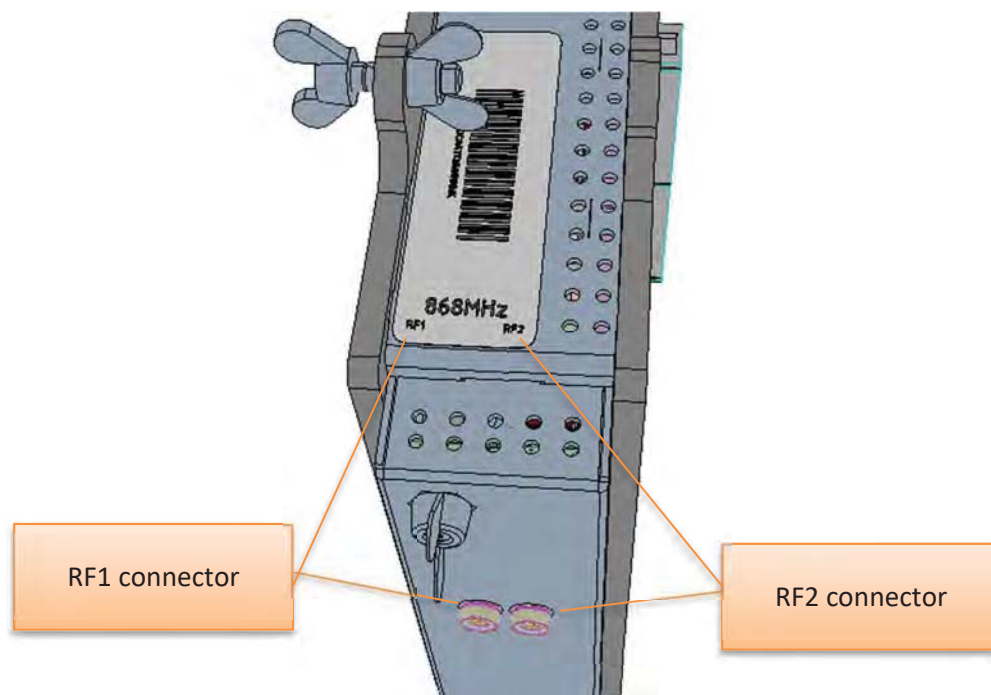


Figure 27: RF1 and RF2 connectors of the LoRa LOC module

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Note: RF1 stands for RF path 1, RF2 stands for RF path 2.

1.5.4.2.2 Four LORA-LOC modules

The LoRa LOC “4 modules” configuration includes the following user interfaces and connectors:

Module side	Connector / interface	Description
Front side	LoRa RF SMB connector # RF1	LoRa RF signal to be connected to the LoRa antenna # 1
Front side	LoRa RF SMB connector # RF2	LoRa RF signal to be connected to the LoRa antenna # 2
Right side	Back panel HE10 male 40 contacts connector	Transmit the power supplies and high speed serial bus to the next module
Left side	Back panel HE10 female 40 contacts connector	Receive the power supplies and high speed serial bus from the previous module

The LoRa SMB RF connector’s # RF1 and # RF2 are connected to the SMB/N adapters on the bottom side of the Wirnet iBTS via SMB coaxial cables.

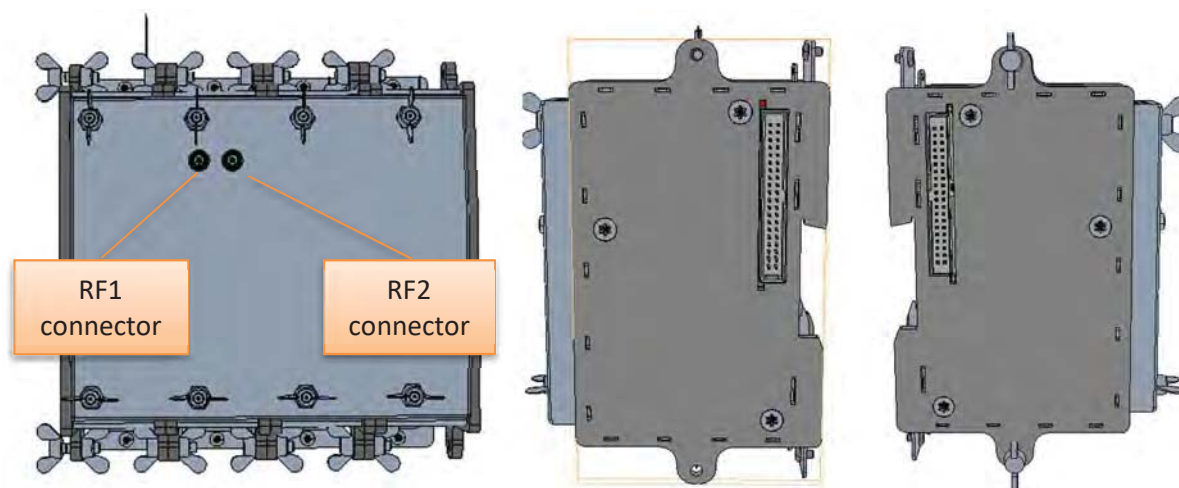


Figure 28: Connectors and user interfaces of the 4 LoRa LOC modules

The RF1 connector is on the left side of the front-end lid.
The RF2 connector is on the right side of the front-end lid.
The positions of the RF1 and RF2 connectors are indicated on the sticker on top of the LoRa LOC module (similar to single LoRa LOC module).

Note: RF1 stands for RF path 1, RF2 stands for RF path 2.

1.5.4.2.3 Four “LoRa-LOC-64 Highway” modules

The LoRa LOC 64 Highway “4 modules” configuration includes the following user interfaces and connectors:

Module side	Connector / interface	Description
Front side	LoRa RF TX SMB connector # RF1	LoRa RF transmit signal to be connected to the duplexer # 1
Front side	LoRa RF TX SMB connector # RF2	LoRa RF transmit signal to be connected to the duplexer # 2
Front side	LoRa RF RX SMB connector # RF1	LoRa RF receive signal to be connected to the duplexer # 1
Front side	LoRa RF RX SMB connector # RF2	LoRa RF receive signal to be connected to the duplexer # 2
Right side	Back panel HE10 male 40 contacts connector	Transmit the power supplies and high speed serial bus to the next module
Left side	Back panel HE10 female 40 contacts connector	Receive the power supplies and high speed serial bus from the previous module

The LoRa SMB TX/RX RF connectors # RF1 and # RF2 are connected to the dual duplexer via SMB/SMA coaxial cables.

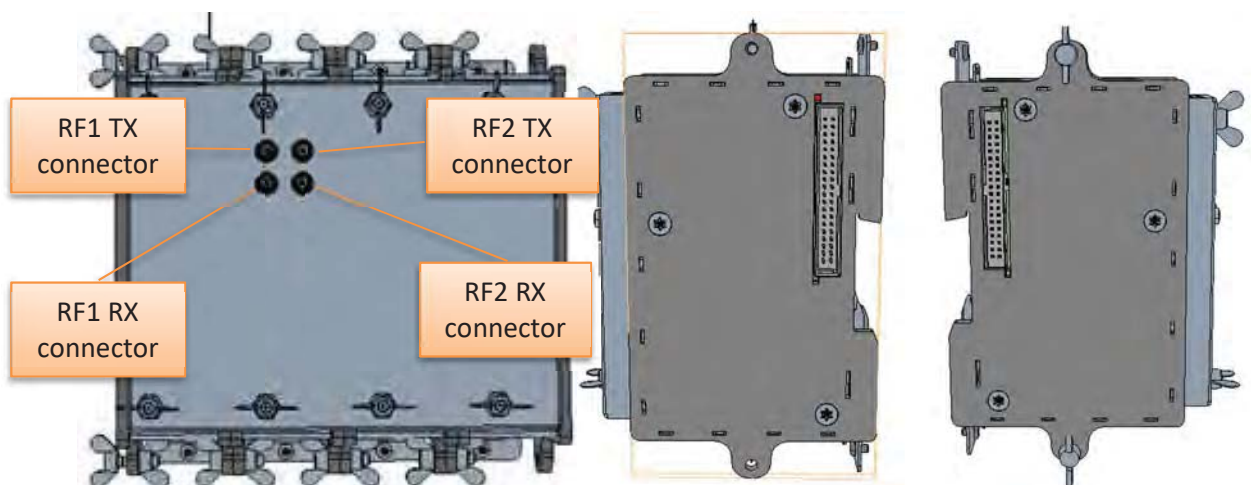


Figure 29: Connectors and user interfaces of the 4 LoRa LOC modules

The RF1 connectors are on the left side of the front-end lid.

The RF2 connectors are on the right side of the front-end lid.

The TX connectors are on the top side and RX connectors on the bottom side.

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The positions of the RF1 and RF2 connectors are indicated on the sticker on top of the LoRa LOC module (similar to single LoRa LOC module).

Note: RF1 stands for RF path 1, RF2 stands for RF path 2.

1.5.4.3 LoRa LOC modem characteristics

The mains characteristics of the LoRa-LOC modem are detailed in the following table:

Feature	Description
LoRa demodulator (x2)	Based on SX1301 digital signal processing engine from Semtech
	True antenna diversity or simultaneous dual-band operation
	10 programmable parallel receive paths
	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
Geolocalization Ready	2 MHz baseband BW
	FSK or LORA modulator
	Outdoor and indoor environments
	Synchronization with GPS PPS clock
Transceiver	Combines RSSI and TDOA measurements
	Accuracy < 50m (90% confidence, high density coverage)
	Based on Analog Devices AD9361/AD9363
	70MHz to 6000MHz / 325MHz to 3800MHz frequency range
	200 kHz to 56 MHz / 200 kHz to 20 MHz channel BW
	Integrated fractional-N synthesizers
	2 x 2 transceiver with integrated 12-bit DACs and ADCs
	- Dual transmitters: 4 differential outputs - Dual receivers: 6 differential or 12 single-ended inputs
	Highly linear broadband transmitter
	+8dBm typ. output power
	90dB output power control range
	164dBc/Hz Signal to Noise performance at 90MHz offset
	Receiver Noise Figure of 2 dB
	+40dBm IIP2 at max gain
	-18dBm IIP3 at max gain

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	Independent automatic gain control
	DC offset correction, quadrature correction and digital filtering
	Very low LO leakage
Sniffer (x2)	Based on Semtech SX1239
	300MHz 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
Auto test	Check of the LoRa LOC module power supplies by MCU
Operating temperature range	-20°C to +85°C
Current drain @48V	130mA in Receive Mode (all demodulators activated)
	120mA in Transmit mode@27dBm

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1.5.4.4 Front-end boards

1.5.4.4.1 Front-end board - Single module

The following block diagram details the architecture of the front-end board, in a single module configuration:

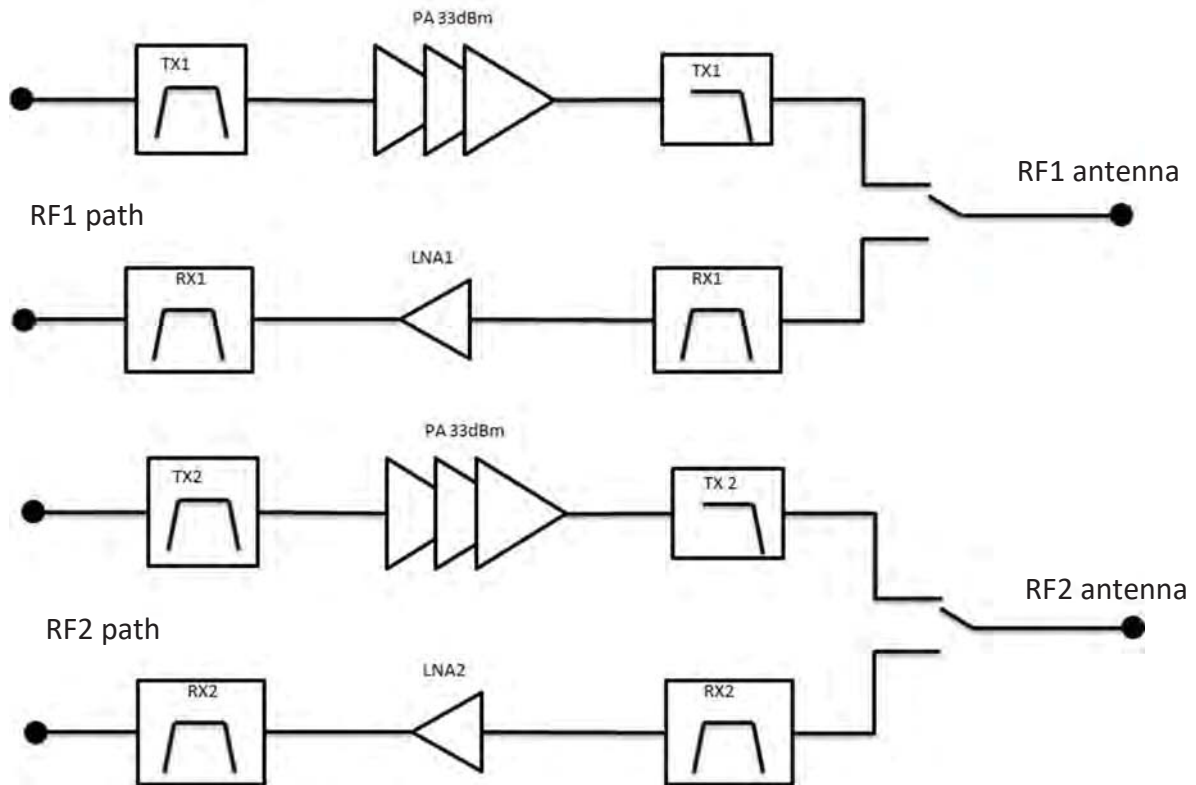


Figure 30: Front-end board block diagram

The front-end board integrates two duplicated TX and Rx paths (RF1 path and RF2 path). Each TX/RX path is connected to one SMB antenna port, referenced as RF1 and RF2. Each path is detailed hereafter:

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

- 868MHz (863-873MHz)
- 915MHz (902-928MHz)
- 923MHz (915-928MHz)

The details of the frequency bands, channelization, out of band rejection are detailed in §1.5.4.6.

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1.5.4.4.2 Front-end board - Four modules

The following block diagram details the architecture of the front-end board, in a four modules configuration:

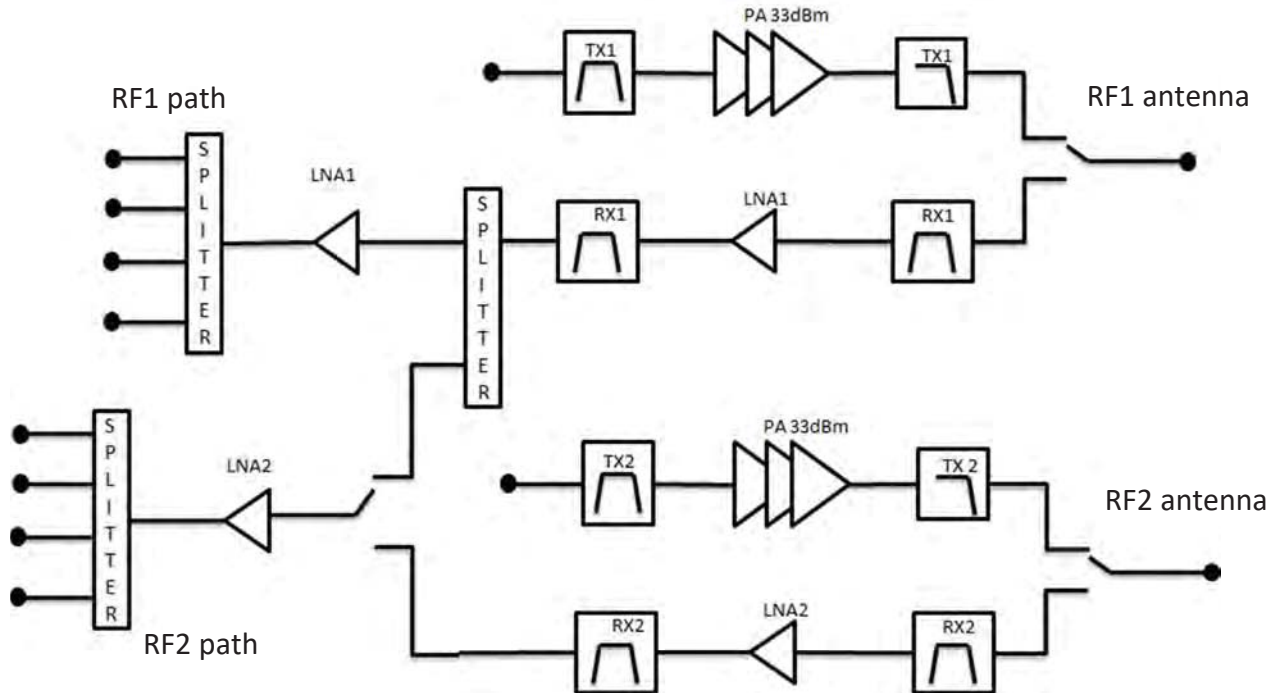


Figure 31: Front-end 4 modules board block diagram

The front-end board integrates two TX and two Rx paths (RF1 path and RF2 path). Each TX/RX path is connected to one SMB antenna port (RF1 and RF2 respectively).

The front-end board is derived in two different versions to cover the unlicensed bands:

- 915MHz (902-928MHz)
- 923MHz (915-928MHz)

The details of the frequency bands, channelization, out of band rejection are detailed in §1.5.4.6.

1.5.4.4.3 Front-end board- Four modules 64 Highway

The following block diagram details the architecture of the front-end board, in a four modules 64 Highway configuration:

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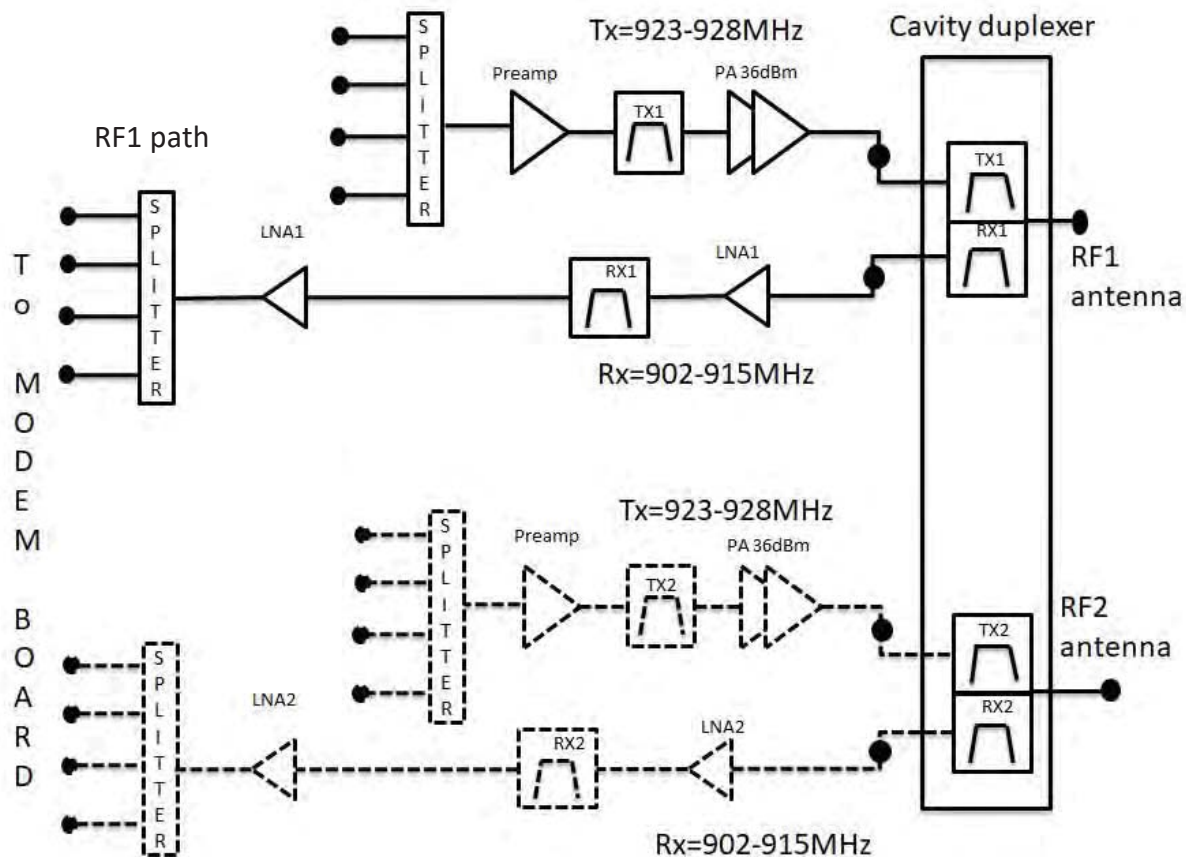


Figure 32: Front-end 4 modules 64 Highway board block diagram

The front-end board integrates two TX and two Rx paths (RF1 path and RF2 path). Each TX and RX path is connected to one SMB antenna port.

The two TX paths are similar and are detailed hereafter:

- The TX signal(s), coming from the 4 LoRa LOC board(s), is injected in a pre-amplifier filter via a combiner (splitter). The amplifier has very high linearity to minimize intermodulation.
- The signals are then injected into a RF band-pass filter. The main goal of this RF filter is to reject the harmonics and shape the noise outside the band pass, especially in the WAN bands.
- The TX signal is amplified by a 2W power amplifier. This amplifier has an excellent linearity to minimize intermodulation.

The front-end is then able to transmit 4 RF signals simultaneously per RF antenna port.

The receive paths are also similar.

The Rx path includes:

- A first LNA with a very low noise figure, in order to not degrade the sensitivity of the receiver.

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- A band pass filter offers higher attenuation of the out of band blockers.
- The signal is then transmitted to a second LNA used to compensate the insertion losses of the next 4 ways power splitter to not degrade the receiver noise figure.

The details of the frequency bands, channelization, out of band rejection are detailed in §1.5.4.6.

1.5.4.5 Modulations and data rates

The LoRa LOC module 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
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.

1.5.4.6 Frequency bands and channelization

The frequency bands covered by the Wirnet iBTS depends on the version of the front-end module used (868, 915 or 923).

The downstream frequencies and upstream frequencies are listed in the following table:

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Version	Link	Frequency range start/end
868	Upstream (RX Wirnet iBTS)	863MHz / 873MHz
868	Downstream (TX Wirnet iBTS)	863MHz / 873MHz
915	Upstream (RX Wirnet iBTS)	902MHz / 928MHz
915	Downstream (TX Wirnet iBTS)	902MHz / 928MHz
915 64 Highway	Upstream (RX Wirnet iBTS 64 Highway)	902MHz / 915MHz
915 64 Highway	Downstream (TX Wirnet iBTS 64 Highway)	923MHz / 928MHz
923	Upstream (RX Wirnet iBTS)	915MHz / 928MHz
923	Downstream (TX Wirnet iBTS)	920MHz / 928MHz

LoRaWAN specification defines a more accurate frequency plan and channelization, although different options could be envisaged.

The channels are summarized in the following table:

Version	Link	Channel frequency	LoRa BW (KHz)	Number of channels	Channel BW (KHz)
915	Upstream (RX Wirnet iBTS)	$902,3+i*0,2\text{MHz}$ ($i=0$ à 63)	125	64	200
915	Upstream (RX Wirnet iBTS)	$903,0+i*1.6\text{MHz}$ ($i=0$ à 7)	500	8	600
915	Downstream (TX Wirnet iBTS)	$923,3+i*0.6\text{MHz}$ ($i=0$ à 7)	500	8	600
915 64 Highway	Upstream (RX Wirnet iBTS 64 Highway)	$902,3+i*0,2\text{MHz}$ ($i=0$ à 63)	125	64	200
915 64 Highway	Upstream (RX Wirnet iBTS 64 Highway)	$903,0+i*1.6\text{MHz}$ ($i=0$ à 7)	500	8	600
915 64 Highway	Downstream (TX Wirnet iBTS 64 Highway)	$923,3+i*0.6\text{MHz}$ ($i=0$ à 7)	500	8	600
923	Upstream (RX Wirnet iBTS)	$915,2+i*0,2\text{MHz}$ ($i=0$ à 63)	125	64	200
923	Upstream (RX Wirnet iBTS)	$915,9+i*1.6\text{MHz}$ ($i=0$ à 7)	500	8	600
923	Downstream (TX Wirnet iBTS)	$919,8+i*0,2\text{MHz}$ ($i=0$ à 40)	125	41	200
923	Downstream (TX Wirnet iBTS)	$920,3+i*0.6\text{MHz}$ ($i=0$ à 12)	500	13	600
868	Upstream (RX Wirnet iBTS)	$863,1+i*0,2\text{MHz}$ ($i=0$ à 27)	125	28	200

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868	Downstream (TX Wirnet iBTS)	$863,1+i*0,2\text{MHz}$ ($i= 0 \text{ à } 27$)	125	28	200
868	Upstream (RX Wirnet iBTS)	$868,9+i*0,2\text{MHz}$ ($i= 0 \text{ à } 1$)	125	2	200
868	Downstream (TX Wirnet iBTS)	$868,9+i*0,2\text{MHz}$ ($i= 0 \text{ à } 1$)	125	2	200
868	Upstream (RX Wirnet iBTS)	869,525MHz	125	1	250
868	Downstream (TX Wirnet iBTS)	869,525MHz	125	1	250
868	Upstream (RX Wirnet iBTS)	869,850MHz	125	1	300
868	Downstream (TX Wirnet iBTS)	869,850MHz	125	1	300
868	Upstream (RX Wirnet iBTS)	$870,1+i*0,2\text{MHz}$ ($i= 0 \text{ à } 14$)	125	15	200
868	Downstream (TX Wirnet iBTS)	$870,1+i*0,2\text{MHz}$ ($i= 0 \text{ à } 14$)	125	15	200

Note : in South Korea, the channels defined for the “923” version must be shifted by 100KHz to meet Korean regulations i.e. 917.1MHz to 923.3MHz with 200KHz steps.

1.5.4.7 Output Power

The conducted output power can be adjusted from 0dBm to +30dBm.

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 +30dBm
Ripple in the band	+/- 2dB
Variation over temperature range (-20°C to +55°C)	+/- 2dB

For Wirnet iBTS 64 Highway, depending on the number of simultaneous Tx, the power of each carrier must be adjusted to not overrule the max +30dBm total power.

The Wirnet iBTS 64 Highway is able to transmit 4 RF signals simultaneously at each RF antenna port.

1.5.4.8 Out of band emissions

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

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The performances are summarized in the following table:

Version LoRa LOC module	LTE, UMTS or GSM band	Out of band emissions
868	E-GSM900 UL (880-915MHz)	-85dBm/100KHz
868	R-GSM900 UL (876-915MHz)	-75dBm/100KHz
868	LTE800 (832-862MHz)	-80dBm/100KHz
915	GSM850 DL (869-894MHz)	-85dBm/100KHz
915 64 Highway	GSM850 DL (869-894MHz)	-125dBm/100KHz
923	GSM900 UL(890-915MHz)	-85dBm/100KHz
923	GSM900 DL(935-960MHz)	-85dBm/100KHz

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.

The LORA-LOC module is therefore ideal in co-localization with BTS.

1.5.4.9 Sensitivity

The typical sensitivity performance, depending on the version, at 10% PER, 20 bytes payload is the following:

Mode	868	915	915 64 Highway	923
SF7/125KHz	-128dBm	-127dBm	-127dBm	-128dBm
SF10/125KHz	-136dBm	-136dBm	-135dBm	-134dBm
SF12/125KHz	-141dBm	-141dBm	-140dBm	-140dBm
SF7/250KHz	-125dBm	-	-	-125dBm
SF12/250KHz	-138dBm	-	-	-135dBm
SF7/500KHz	-121dBm	-121dBm	-121dBm	-122dBm
SF12/500KHz	-135dBm	-134dBm	-134dBm	-134dBm

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 (-20°C to +60°C)	+/- 1dB

1.5.4.10 RSSI and SNR

The Wirnet iBTS is able to receive LoRa frames from -20dBm to -141dBm, depending on the LoRa BW and SF.

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The Wirnet iBTS provides for each received frame, the RSSI and the SNR.

The RSSI is the “signal + noise” measurement of the received frame. Due to the wide spreading modulation, the LoRa receiver is able to demodulate signals below the noise floor i.e. with negative SNR.

To estimate the signal strength of the received frame, both SNR and RSSI have to be considered. As a rough estimate:

- If $SNR > 0$, the signal strength = RSSI (dBm)
- If $SNR < 0$, the signal strength = $RSSI + SNR$ (dBm)

RSSI varies from -20dBm to -120dBm. -120dBm is the noise floor measured in a 200KHz BW. SNR is between 10 to 15dB for strong signals. It is close to 0dB when the signal strength approaches -120dBm. It can decrease down to -7dB or -20dB depending on the SF:

Spreading Factor	LoRa demodulator SNR
SF7	-7.5dB
SF8	-10dB
SF9	-12.5dB
SF10	-15dB
SF11	-17.5dB
SF12	-20dB

The following picture is an example of LoRa receiver characterization at SF7 / 125KHz BW. It describes the SNR, RSSI and RSSI+SNR measured vs. the signal strength:

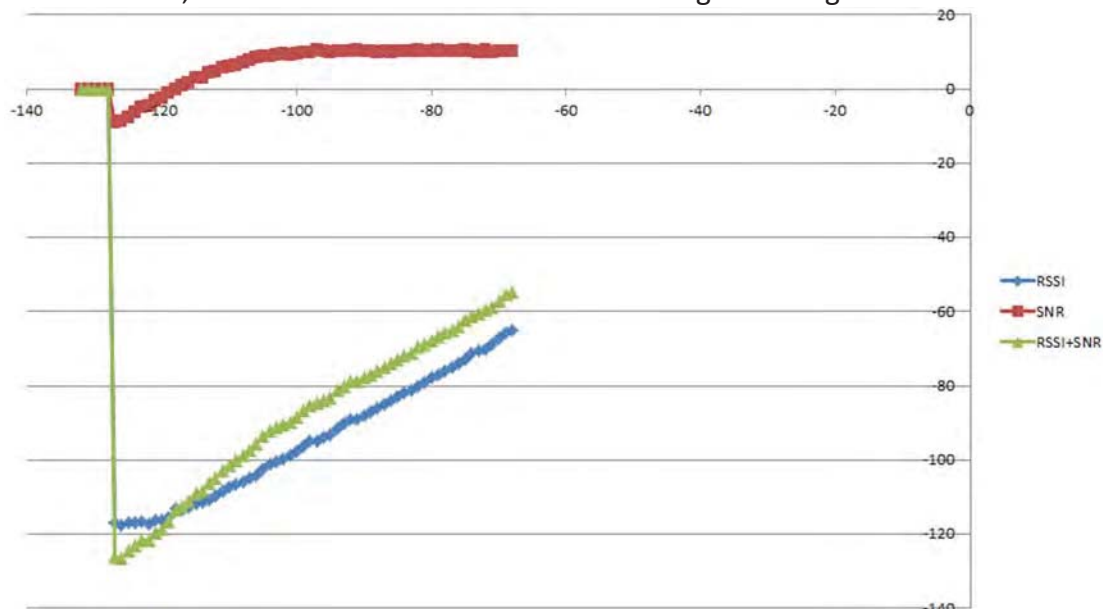


Figure 33: Example of SNR, RSSI and RSSI+SNR plots at 125KHz BW / SF7

1.5.4.11 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.

1.5.4.11.1 868MHz

The useful signal is adjusted at 869.525MHz.

The blockers rejections, at SF12 are the following:

Offset	SF12/125KHz
+/-2MHz	100dB
+/-10MHz	125dB
821MHz	>150dB
880MHz	130dB
935MHz	>150dB
960MHz	>150dB

1.5.4.11.2 915MHz

The useful signal is adjusted at 915MHz.

The blockers rejections, at SF10 are the following:

Offset	SF10/125KHz
+/-2MHz	90dB
+/-10MHz	100dB
850MHz	140dB
894MHz	110dB
935MHz	110dB
960MHz	140dB

1.5.4.11.1 915MHz 64 Highway

The useful signal is adjusted at 908.5MHz.

The blockers rejections, at SF10 are the following:

Offset	SF10/125KHz
+/-2MHz	90dB
+/-10MHz	120dB
850MHz	140dB
894MHz	140dB
935MHz	140dB
960MHz	140dB

1.5.4.11.2 923MHz

The useful signal is adjusted at 923MHz.

The blockers rejections, at SF12 are the following:

Offset	SF12/125KHz
+/-2MHz	100dB
+/-10MHz	115dB
850MHz	>150dB
894MHz	140dB
910MHz	120dB
935MHz	130dB
960MHz	>150dB

1.5.5 Dual duplexer

The dual duplexer is used only in the Wirnet iBTS 64 Highway.

1.5.5.1 Mechanical description

The dual duplexer features two duplexers in the same enclosure.

The main mechanical characteristics of the dual duplexer are detailed hereafter:

Description	Specification
Radiators material	Aluminum
Dimensions	236 mm x 100 mm x 40 mm
Weight	1300 g

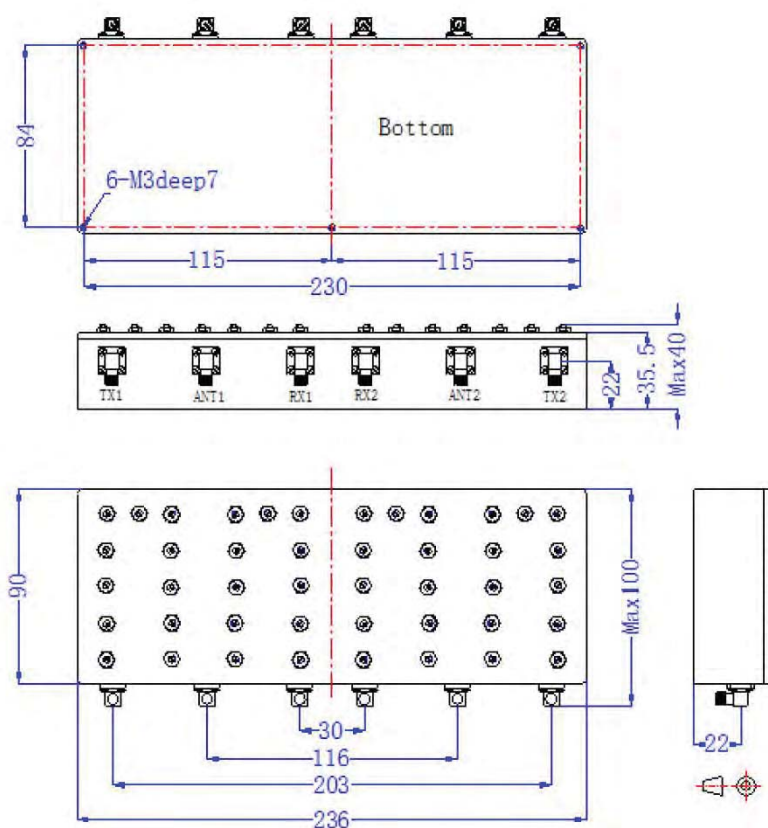


Figure 34: Dimensions of the dual duplexer

1.5.5.2 Connectors

The dual duplexer includes the following connectors:

Module side	Connector / interface	Description
Top side	ANT1 RF connector (SMA)	LoRa RF signal #1 to be connected to the LoRa antenna # 1
Top side	TX1 RF connector (SMA)	LoRa TX signal #1 to be connected to the front-end RF # 1 TX
Top side	RX1 RF connector (SMA)	LoRa RX signal #1 to be connected to the front-end RF # 1 RX
Top side	ANT2 RF connector (SMA)	LoRa RF signal #2 to be connected to the LoRa antenna # 2
Top side	TX2 RF connector (SMA)	LoRa TX signal #2 to be connected to the front-end RF # 2 TX
Top side	RX2 RF connector (SMA)	LoRa RX signal #2 to be connected to the front-end RF # 2 RX

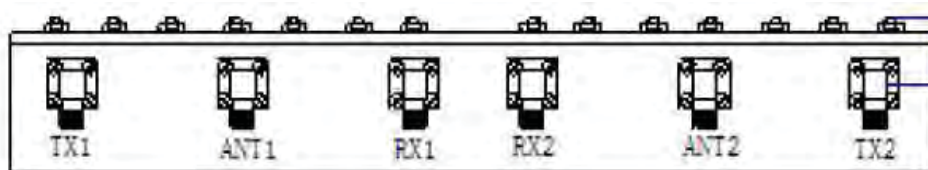


Figure 35: Connectors of the dual duplexer

Note: SMB to SMA coaxial cables are used to connect the duplexer to the antenna connectors.

1.5.5.3 Technical performance

The main RF characteristics of the dual duplexer are detailed hereafter:

Description	Specification RX band	Specification TX band
Band pass frequency range	902-915 MHz	923-928 MHz
Center frequency	908.5 MHz	925.5 MHz
Return Loss	>20dB	>20dB
Ripple	<1.0dB	<0.5dB
Insertion losses	<2.0dB	<2.0dB
Rejection	≥70 dB@923-928 MHz	≥70 dB@902-915 MHz
	≥60 dB@50-850 MHz	≥60 dB@50-850 MHz
	≥50 dB@850-894 MHz	≥60 dB@850-894 MHz
	≥60 dB@935-960 MHz	≥50 dB@935-960 MHz
	≥60 dB@960-2000 MHz	≥60 dB@960-2000 MHz
	≥50 dB@2000-3000 MHz	≥50 dB@2000-3000 MHz
Isolation TX/Rx	>70dB	
Connector	SMA F right angle	
Power handling	10W CW	
Impedance	50 ohms	
Operating temperature	-40°C to +85°C	

The amplitude / frequency response of the duplexer is presented below:

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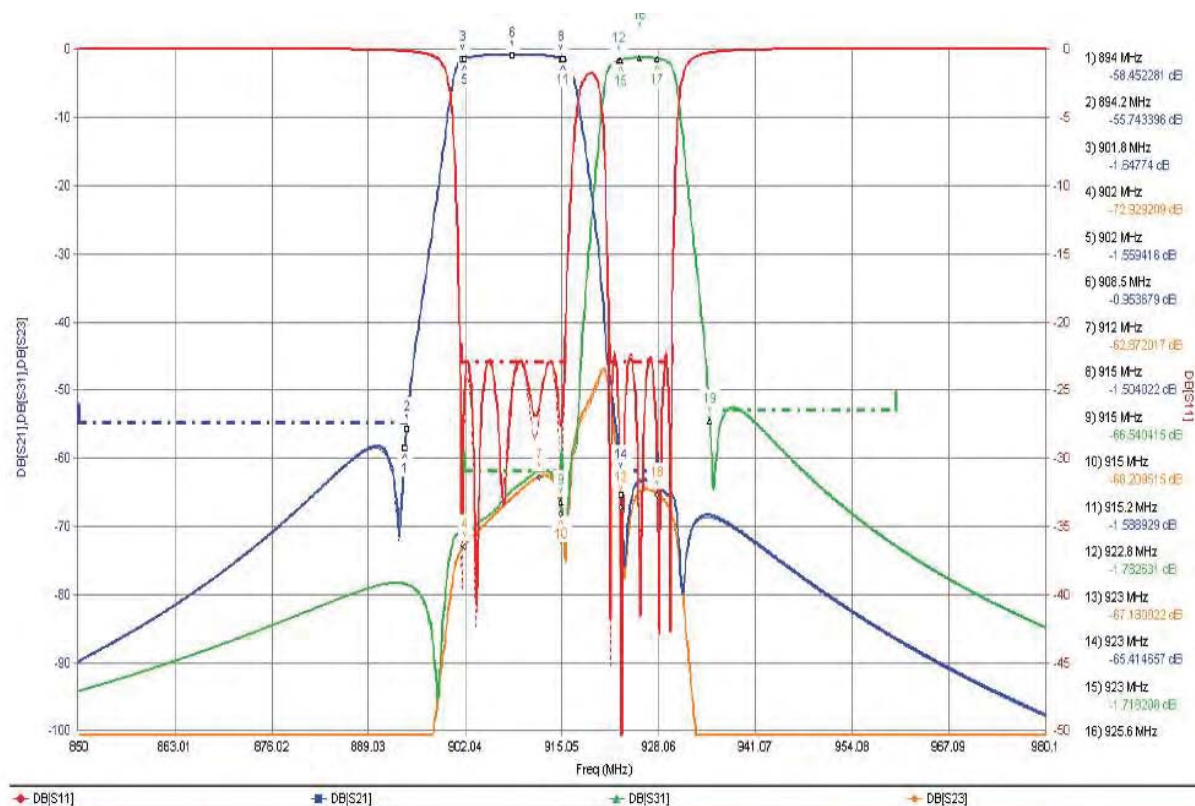


Figure 36: S parameters of the dual duplexer

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1.6 Power supply

1.6.1 PoE injectors

One Midspan PoE injector among the following list is provided with each Wirnet iBTS:

- Indoor AC/DC Midspan PoE injector 30W
- Indoor AC/DC Midspan PoE injector 60W
- Indoor DC/DC Midspan PoE injector 30W
- Indoor DC/DC Midspan PoE injector 60W
- Outdoor AC/DC Midspan PoE injector 30W
- Outdoor AC/DC Midspan PoE injector 60W
- Outdoor DC/DC Midspan PoE injector 60W

Detailed characteristics of those references are done on the following chapters.
Customers have to select the good reference during the ordering.

The Midspan PoE injector 30W is dedicated to the Wirnet iBTS Compact.
The Midspan PoE injector 60W is dedicated to the Wirnet iBTS gateways.
Both versions can be declined for indoor applications or outdoor applications.

AC/DC vs. DC/DC choice is application dependent.
In case only 110/220VAC is available, AC/DC solution is preferred.
In case additional DC backup (type 48V) is available, DC/DC solution may be envisaged.

Note 1: beware of the operating ambient temperature of the Midspan PoE injectors. Output power derating over +40°C has to be carefully considered to insure proper supply of the Wirnet iBTS. If the ambient temperature range cannot be guaranteed below +40°C, the Midspan PoE injector may have to be re-dimensioned. A 60W PoE injector could be then recommended instead of a 30W PoE injector.

Note 2: the power supply of the Wirnet iBTS must be a limited power source. All the PoE injectors listed below must then considered as limited power sources.

1.6.1.1 PoE injectors recommendations

Kerlink recommends using only the validated references of the provided list.

Some POE solutions may not be compatible with the Wirnet iBTS.
This is particularly true for specific DC application where the Wirnet iBTS is in power supply colocation with other equipments. In such cases, some equipment may have connection between earthing system and the power supply connection (either “+” or “-” wire) dependent if the application is in +48VDC or -48VDC. As the electrical ground of the Wirnet

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iBTS is directly connected to the earthing system of the installation, dysfunction may occur without POE insulation.

The following drawing shows the insulation importance of the PoE injector.

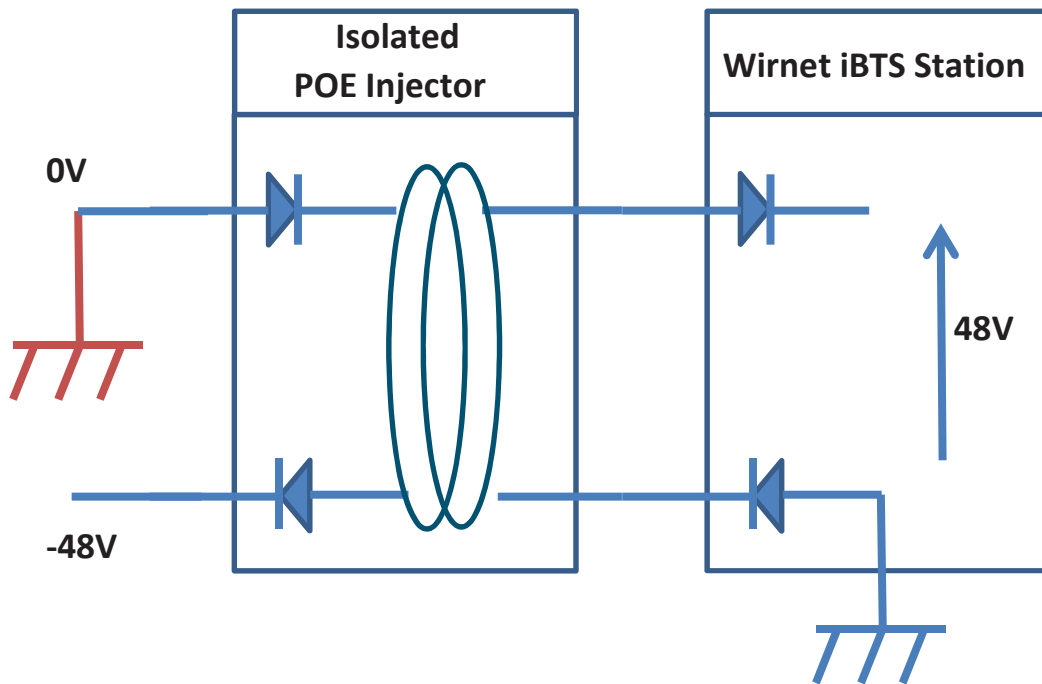


Figure 37 : Required isolation on PoE injector

1.6.1.2 Indoor AC/DC Midspan PoE injector 30W

The indoor AC/DC Midspan PoE injector 30W characteristics are detailed in the following table:

Description	Specification
Ethernet data rates	10/100/1000Base-T
Number of ports	1
PoE compatibility	IEEE 802.3at IEEE 802.3af backward compatible
PoE Output Power	30 Watts (Guaranteed)
PoE Output Voltage	55 VDC
PoE Pin Assignment and Polarity	4/5 (+), 7/8 (-)
Input Power Requirements	AC Input Voltage: 100 to 240 VAC AC Input Current: 0.8A @100-240VAC AC Frequency: 50 to 60 Hz
Dimensions	53 mm (W) x 32.5 mm (H) x 140 mm (L)

Weight	200g
Connectors	Shielded RJ-45, EIA 568A and 568B
Indicator	AC Power (Yellow) Channel Power (Green)
Operating Ambient Temperature	-20°C to +40°C @ 30W -20°C to +55°C @ 25W
Operating Humidity	Maximum 90%, Non-condensing
Storage Temperature	-20°C to +70°C
Storage Humidity	Maximum 95%, Non-condensing
Regulatory compliance	RoHS WEEE CE
Electromagnetic Emission & Immunity	FCC Part 15, Class B EN 55022 Class B (Emissions) EN 55024 (Immunity) VCCI
Safety Approvals	UL/cUL Per IEC 60950-1 GS Mark Per IEC 60950-1

Note 1: beware of the operating ambient temperature. Output power derating over +40°C has to be carefully considered to insure proper supply of the Wirnet iBTS.

The following figure details the indoor AC/DC Midspan PoE injector 30W:



Figure 38 : indoor 30W AC/DC POE injector

The indoor AC/DC Midspan PoE injector 30W can be provided with E/F type cable (Europe) or B type cable (USA). See §6 to order the required version.

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Note 2: this indoor PoE injector must be connected to an industrial electrical installation including lighting protections. It must include a main board with surge protections type 1 and a secondary board with surge protections type 2.

If the electrical installation does not meet those requirements, use an alternate PoE injector featuring better surge protection as detailed in §1.6.1.6.

Note 3: this PoE injector is intended for indoor applications only.

In case the PoE injector cannot be installed indoor, use an alternate PoE injector dedicated to outdoor applications as detailed in §1.6.1.6.

1.6.1.3 Indoor AC/DC Midspan PoE injector 60W

The indoor AC/DC Midspan PoE injector 60W characteristics are detailed in the following table:

Description	Specification
Ethernet data rates	10/100/1000Base-T
Number of ports	1
PoE compatibility	IEEE 802.3at IEEE 802.3af compatible
PoE Output Power	60 Watts over 4 pairs
PoE Output Voltage	55 VDC
PoE Pin Assignment and Polarity	Data Pairs 1/2 (-) and 3/6 (+) Spare Pairs 7/8 (-) and 4/5 (+)
Input Power Requirements	AC Input Voltage: 100 to 240 VAC AC Input Current: 1.2A @100-240VAC AC Frequency: 50 to 60 Hz
Dimensions	62 mm (W) x 38 mm (H) x 151 mm (L)
Weight	320g
Connectors	Shielded RJ-45, EIA 568A and 568B
Indicator	AC Power (Yellow) Channel Power delivered over 4 pairs (Green)
Operating Ambient Temperature	-10°C to +40°C @ 60W -10°C to +55°C @ 30W
Operating Humidity	Maximum 90%, Non-condensing
Storage Temperature	-20°C to +70°C
Storage Humidity	Maximum 95%, Non-condensing
Regulatory compliance	RoHS WEEE CE
Electromagnetic Emission & Immunity	FCC Part 15, Class B EN 55022 Class B (Emissions)

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	EN 55024 (Immunity) VCCI
Safety Approvals	UL/cUL Per IEC 60950-1 GS Mark Per IEC 60950-1

Note 1: beware of the operating ambient temperature. Output power derating over +40°C is critical and has to be carefully considered to insure proper supply of the Wirnet iBTS.

The following figure details the indoor AC/DC Midspan PoE injector 60W:



Figure 39 : indoor 60W AC/DC POE injector

The indoor AC/DC Midspan PoE injector 60W can be provided with E/F type cable (Europe) or B type cable (USA). See §6 to order the required version.

Note 2: this indoor PoE injector must be connected to an industrial electrical installation including lighting protections. It must include a main board with surge protections type 1 and a secondary board with surge protections type 2.

If the electrical installation does not meet those requirements, use an alternate PoE injector featuring better surge protection as detailed in §1.6.1.7.

Note 3: this PoE injector is intended for indoor applications only.

In case the PoE injector cannot be installed indoor, use an alternate PoE injector dedicated to outdoor applications as detailed in §1.6.1.7.

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1.6.1.4 Indoor DC/DC Midspan PoE injector 30W

The indoor DC/DC Midspan PoE injector 30W characteristics are detailed in the following table:

Description	Specification
Ethernet data rates	10/100/1000Base-T
Number of ports	1
PoE compatibility	IEEE 802.3at
PoE Output Power	30 Watts over 4 pairs
PoE Output Voltage	55 VDC 54-57 VDC under all conditions
PoE Pin Assignment and Polarity	Data Pairs 1/2 (-) and 3/6 (+) Spare Pairs 7/8 (-) and 4/5 (+)
Input Power Requirements	DC Input Voltage: 36-72VDC DC Input Current: 0.6A
Dimensions	65 mm (W) x 36 mm (H) x 140 mm (L)
Weight	200g
Connectors	Shielded RJ-45, EIA 568A and 568B
Indicator	Green LED 1: Input power "ON" Green LED 2: Valid IEEE8-2.3at load detected and connected "PoE PLUS" Green LED 3: Valid IEEE802.3af load detected and connected
Operating Ambient Temperature	-20°C to +50°C
Operating Humidity	Maximum 90%, Non-condensing
Storage Temperature	-25°C to +85°C
Storage Humidity	Maximum 95%, Non-condensing
Regulatory compliance	RoHS WEEE CE
Electromagnetic Emission	FCC Part 15, Class B EN 55022 Class B (Emissions)
Immunity	ESD: EN61000-4-2. Level 3 RS: EN61000-4-3. Level 3 EFT: EN61000-4-4. Level 2 Surge: EN61000-4-5. Level 3 CS: EN61000-4-6. Level 3

Note 1: beware of the operating ambient temperature. Output power derating over +50°C is critical and has to be carefully considered to insure proper supply of the Wirnet iBTS.

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The following figure details the indoor DC/DC Midspan PoE injector 30W:



Figure 40 : indoor 30W DC/DC POE injector

The indoor DC/DC Midspan PoE injector 30W is provided with Euroblock plug.

Note 2: this indoor PoE injector must be connected to an industrial electrical installation including lighting protections. It must include a main board with surge protections type 1 and a secondary board with surge protections type 2.

If the electrical installation does not meet those requirements, use an alternate PoE injector featuring better surge protection as detailed in §1.6.1.7.

Note 3: this PoE injector is intended for indoor applications only.

In case the PoE injector cannot be installed indoor, use an alternate PoE injector dedicated to outdoor applications as detailed in §1.6.1.7.

1.6.1.5 Indoor DC/DC Midspan PoE injector 60W

The indoor DC/DC Midspan PoE injector 60W characteristics are detailed in the following table:

Description	Specification
Ethernet data rates	10/100/1000Base-T
Number of ports	1
PoE compatibility	IEEE 802.3at IEEE 802.3af compatible
PoE Output Power	60 Watts over 4 pairs
PoE Output Voltage	55 VDC
PoE Pin Assignment and Polarity	Data Pairs 1/2 (-) and 3/6 (+) Spare Pairs 7/8 (-) and 4/5 (+)
Input Power Requirements	DC Input Voltage: 36-60VDC DC Input Current: 2A
Dimensions	87 mm (W) x 43 mm (H) x 166 mm (L)

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Weight	450g
Connectors	Shielded RJ-45, EIA 568A and 568B
Indicator	DC Power (Green) Channel Power delivered over 4 pairs (Green)
Operating Ambient Temperature	-20°C to +40°C @ 60W -20°C to +50°C @ 30W
Operating Humidity	Maximum 90%, Non-condensing
Storage Temperature	-20°C to +70°C
Storage Humidity	Maximum 95%, Non-condensing
Regulatory compliance	RoHS WEEE CE
Electromagnetic Emission & Immunity	FCC Part 15, Class B EN 55022 Class B (Emissions) EN 55024 (Immunity) VCCI
Safety Approvals	UL/cUL Per IEC 60950-1 GS Mark Per IEC 60950-1

Note 1: beware of the operating ambient temperature. Output power derating over +40°C is critical and has to be carefully considered to insure proper supply of the Wirnet iBTS.

The following figure details the indoor DC/DC Midspan PoE injector 60W:



Figure 41 : indoor 60W DC/DC POE injector

The indoor DC/DC Midspan PoE injector 60W is provided with Euroblock plug.

Note 2: this indoor PoE injector must be connected to an industrial electrical installation including lighting protections. It must include a main board with surge protections type 1 and a secondary board with surge protections type 2.

If the electrical installation does not meet those requirements, use an alternate PoE injector featuring better surge protection as detailed in §1.6.1.7.

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Note 3: this PoE injector is intended for indoor applications only.

In case the PoE injector cannot be installed indoor, use an alternate PoE injector dedicated to outdoor applications as detailed in §1.6.1.7.

1.6.1.6 Outdoor AC/DC Midspan PoE injector 30W

The outdoor AC/DC Midspan PoE injector 30W characteristics are detailed in the following table:

Description	Specification
Ethernet data rates	10/100/1000Base-T
Number of ports	1
PoE compatibility	IEEE 802.3at IEEE 802.3af backward compatible
PoE Output Power	30 Watts (Guaranteed)
PoE Output Voltage	55 VDC
PoE Pin Assignment and Polarity	4/5 (+), 7/8 (-)
Input Power Requirements	AC Input Voltage: 100 to 240 VAC AC Input Current: 1A @100-240VAC AC Frequency: 50 to 60 Hz
Dimensions	170 mm x 140 mm x 60 mm
Weight	1400g
Connectors	Shielded rugged RJ-45 with gasket EIA 568A and 568B
Indicator	None
Operating Ambient Temperature	-40°C to +65°C
Operating Humidity	Maximum 95%, Non-condensing
Storage Temperature	-40°C to +85°C
Storage Humidity	Maximum 95%, Non-condensing
Ingress protection	IP66, NEMA 4X
Corrosion resistance	ASTM B-117
Regulatory compliance	RoHS WEEE CE
Electromagnetic Emission & Immunity	FCC Part 15, Class B EN 55022 Class B (Emissions) EN 55024 (Immunity) EN 61000-4-5 Class 5 (6kV CM) VCCI
Surge protection	GR-1089-CORE Issue 4 ITU-T K.20 6 kV on AC lines
Safety Approvals	UL 60950-1, UL 60950-22 GS Mark

Note 1: beware of the operating ambient temperature. Output power derating over +55°C has to be carefully considered to insure proper supply of the Wirnet iBTS.

The following figure details the outdoor AC/DC Midspan PoE injector 30W:



Figure 42 : Outdoor 30W AC/DC POE injector

Note 2: this PoE injector must be connected to an industrial electrical installation including at least a main board with surge protections type 1.

1.6.1.7 Outdoor AC/DC Midspan PoE injector 60W

The outdoor AC/DC Midspan PoE injector 60W characteristics are detailed in the following table:

Description	Specification
Ethernet data rates	10/100/1000Base-T
Number of ports	1
PoE compatibility	IEEE 802.3at IEEE 802.3af compatible
PoE Output Power	60 Watts over 4 pairs
PoE Output Voltage	55 VDC
PoE Pin Assignment and Polarity	Data Pairs 1/2 (-) and 3/6 (+) Spare Pairs 7/8 (-) and 4/5 (+)
Input Power Requirements	AC Input Voltage: 100 to 240 VAC AC Input Current: 2A @100-240VAC AC Frequency: 50 to 60 Hz
Dimensions	170 mm x 140 mm x 60 mm
Weight	1400g

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Connectors	Shielded rugged RJ-45 with gasket EIA 568A and 568B
Indicator	None
Operating Ambient Temperature	-40°C to +65°C
Operating Humidity	Maximum 95%, Non-condensing
Storage Temperature	-40°C to +85°C
Storage Humidity	Maximum 95%, Non-condensing
Ingress protection	IP66, NEMA 4X
Corrosion resistance	ASTM B-117
Regulatory compliance	RoHS WEEE CE
Electromagnetic Emission & Immunity	FCC Part 15, Class B EN 55022 Class B (Emissions) EN 55024 (Immunity) EN61000-4-5 Class 5 (6kV CM) VCCI
Surge protection	GR-1089-CORE Issue 4 ITU-T K.20 6 kV on AC lines
Safety Approvals	UL 60950-1, UL 60950-22 GS Mark

Note 1: beware of the operating ambient temperature. Output power derating over +50°C is critical and has to be carefully considered to insure proper supply of the Wirnet iBTS.

The following figure details the outdoor AC/DC Midspan PoE injector 60W:



Figure 43 : Outdoor 60W AC/DC POE injector

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Note 2: this PoE injector must be connected to an industrial electrical installation including at least a main board with surge protections type 1.

1.6.1.8 Outdoor DC/DC Midspan PoE injector 60W

The outdoor AC/DC Midspan PoE injector 60W characteristics are detailed in the following table:

Description	Specification
Ethernet data rates	10/100/1000Base-T
Number of ports	1
PoE compatibility	IEEE 802.3at IEEE 802.3af compatible
PoE Output Power	60 Watts over 4 pairs
PoE Output Voltage	55 VDC
PoE Pin Assignment and Polarity	Data Pairs 1/2 (-) and 3/6 (+) Spare Pairs 7/8 (-) and 4/5 (+)
Input Power Requirements	DC Input Voltage: 36 to 60 VDC DC Input Current: 2.2A
Dimensions	150 mm (W) x 70 mm (H) x 214 mm (L)
Weight	750g
Connectors	Shielded rugged RJ-45 with gasket EIA 568A and 568B
Indicator	None
Operating Ambient Temperature	-40°C to +50°C @ 60W -40°C to +55°C @ 30W
Operating Humidity	Maximum 95%, Non-condensing
Storage Temperature	-40°C to +85°C
Storage Humidity	Maximum 95%, Non-condensing
Ingress protection	IP66, NEMA 4X
Corrosion resistance	ASTM B-117
Regulatory compliance	RoHS WEEE CE
Electromagnetic Emission & Immunity	FCC Part 15, Class B EN 55022 Class B (Emissions) EN 55024 (Immunity) EN61000-4-5 Class 5 (6kV CM) VCCI
Surge protection	GR-1089-CORE Issue 4
Safety Approvals	UL 60950-1, UL 60950-22 GS Mark

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Note 1: beware of the operating ambient temperature. Output power derating over +50°C is critical and has to be carefully considered to insure proper supply of the Wirnet iBTS.

The following figure details the outdoor DC/DC Midspan PoE injector 60W:



Figure 44 : Outdoor 60W DC/DC POE injector

Note 2: this PoE injector must be connected to an industrial electrical installation including at least a main board with surge protections type 1.

1.6.2 Auxiliary power supply

The Wirnet iBTS can be also supplied with an auxiliary DC power supply as a solar panel for instance. The input voltage range is 11 to 56VDC. A 24V DC solar system is then recommended for optimized performance.

The power supply must be qualified as a limited power source.

The maximum power is 30W.

The nominal current for a 24V power supply is about 1.2A in the following configuration:

- HSPA in a network attached mode
- 4 LoRa LOC modules / all demodulators activated
- 20% CPU load

A two-wires cable is required to interconnect the auxiliary power supply connector.

The installation of the cable is detailed in §4.6.5.

Specific DC applications where the Wirnet iBTS is in power supply colocation with other equipments require precautions. In such cases, some equipment may have connection between earthing system and the power supply connection (either “+” or “-” wire) dependent if the application is in +48VDC or -48VDC. As the electrical ground of the Wirnet

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iBTS is directly connected to the earthing system of the installation, dysfunction may occur without additional insulation. In such casing, Kerlink recommends using additional isolated DC/DC.

The following drawing shows the insulation importance of an additional isolated DC/DC power supply:

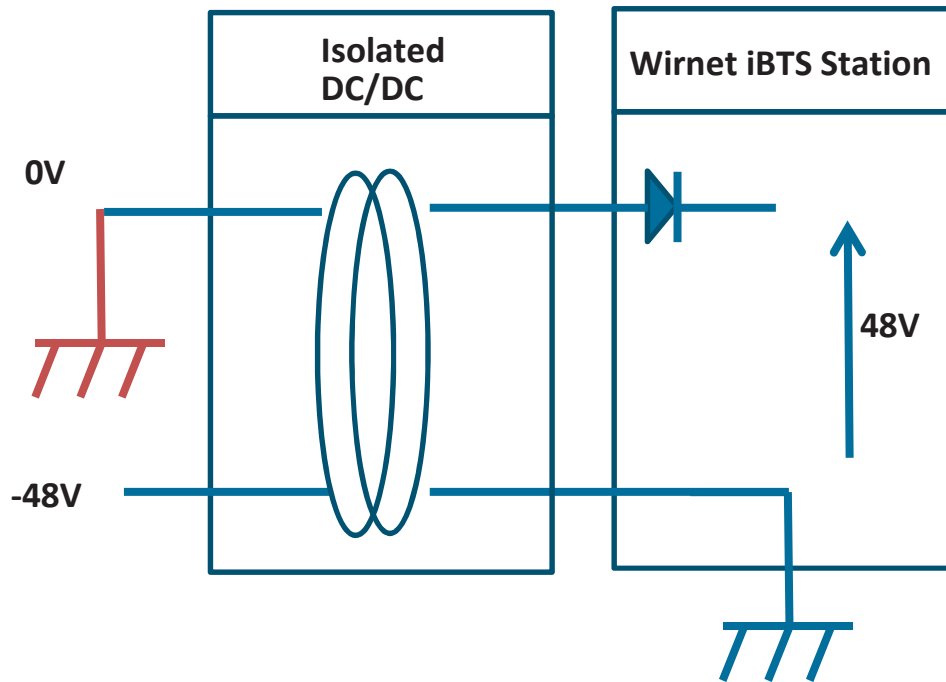


Figure 45 : Required isolation on auxiliary power supply input

An example of 40W isolated DC/DC converter is provided in the chapter 1.6.3

1.6.3 Isolated DC/DC converter 40W

As detailed in paragraph 1.6.2, some specific installation using -48V DC supply require an isolated DC/DC converter.

The characteristics of a 40W isolated DC/DC converter are detailed in the following table:

Description	Specification
Input Voltage	48V DC typ. 18-75V DC range
Input current at full load	0.93A
Undervoltage Lockout	ON at >18V OFF at <16V
Remote On/Off	On: Logic High (3.5-12 V) or open circuit Off: Logic Low (<1.2 V) or short pin 1 to pin 2

Output Voltage	48 VDC +/- 2%
Output Power	40 Watts > 30W at +60°C
Efficiency	Up to 90%
Maximum capacitive load	150uF
Line Regulation	±0.5 %
Load Regulation	1 % (0 - 10% load)
Ripple and noise	200 mV pk-pk 20MHz BW
Short Circuit Protection	Trip & Restart (hiccup mode), auto recovery
Overload Protection	150 % (Trip & Restart, hiccup mode)
Overvoltage Protection	120 % (Zener diode clamp)
Temperature Coefficient	0.02 %/ °C
Isolation	2500 VDC for 60 s
Isolation Resistance	1000 MΩ at 500 VDC
Dimensions	63.8 mm (W) x 25.6 mm (H) x 112 mm (L)
Weight	162g
Pins connections	1 Remote On/Off 2 -Vin 3 +Vin 4 +Vout 5 No Connection 6 -Vout 7 No Connection\ 8 No Connection
Operating Ambient Temperature	-40°C to +70°C
Operating Humidity	Maximum 95%, Non-condensing
Storage Temperature	-50°C to +125°C
Electromagnetic Emission	EN 55022 Class A (Emissions)
Thermal Impedance	4.25°C/W
Immunity	EN55024 ESD: EN61000-4-2, ±4 kV Contact, ±8 kV Air RS: EN61000-4-3, 10 V/m EFT: EN61000-4-4, Level 3 Surge: EN61000-4-5, Level 3 CS: EN61000-4-6, 10 Vm MF: EN61000-4-8, 30 A/m

Note 1: the 40W isolated DC/DC converter must be used with Wirnet iBTS Compact version. Do not use it with Wirnet iBTS version due to power limitations.

Note 2: beware of the operating ambient temperature. Output power derating over +60°C is critical and has to be carefully considered to insure proper supply of the Wirnet iBTS Compact.

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The following figure details the 40W indoor DC/DC converter:



Figure 46 : Isolated 40W DC/DC converter

1.7 Power consumption

The maximum power consumption of each individual module is detailed hereafter:

Module	Power consumption
CPU module (20% load)	1.8W max
WAN module (HSPA, 25% Tx, 75% Rx)	1.7W max
LoRa LOC module (Rx mode)	6.5W max
Four LoRa LOC module (Rx mode)	20W
Four LoRa LOC module (Rx + Tx mode - 64 Highway)	25W

The maximum power consumption per day of the Wirnet iBTS is then the following:

Wirnet iBTS	Power consumption
Wirnet iBTS Compact (1 LoRa LOC Module)	237Wh max
Wirnet iBTS with 2 x LoRa LOC Modules	392Wh max
Wirnet iBTS with 3 x LoRa LOC Modules	547Wh max
Wirnet iBTS with 4 x LoRa LOC Modules	702Wh max
Wirnet iBTS 64 Highway	720Wh max

Note: the power supply of the Wirnet iBTS must be a limited power source.

1.8 Description of the accessories

1.8.1 LoRa antennas

1.8.1.1 Omnidirectional antenna 868MHz 3dBi

The specifications of the omnidirectional 868MHz / 3dBi antenna are the following:

Item	Specification
Frequency range	868MHz +/- 5MHz
Impedance	50 ohms
Technology	Half wave
VSWR	<1.3:1
Max gain	3dBi
Polarization	Vertical
Power handling	50W
DC ground	Yes
Whip material	Fiberglass
Connector	N female
Length	30 cm
Weight	75g
IP rating	IP66K
Shock resistance	IK08
Wind resistance	150MPH
Operating temperature range	-20°C to +60°C
Salt, fog	EN 60068-2-52, severity 1

The radiation patterns are presented here after. They are measured at 870MHz (red), 868MHz (green) and 866MHz (blue):

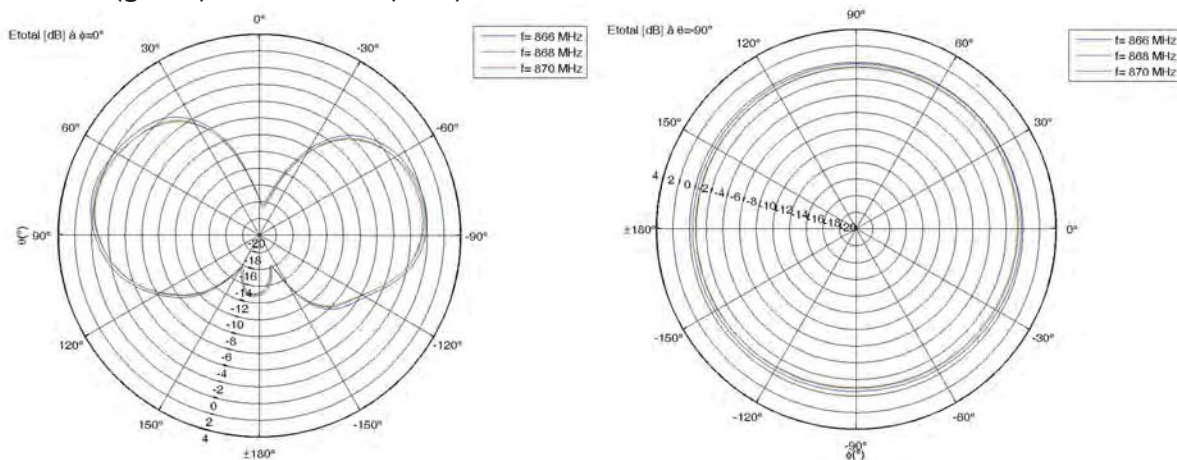


Figure 47 : Radiation pattern of omnidirectional 868MHz/3dBi antenna

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1.8.1.2 Omnidirectional antenna 868MHz 6dBi

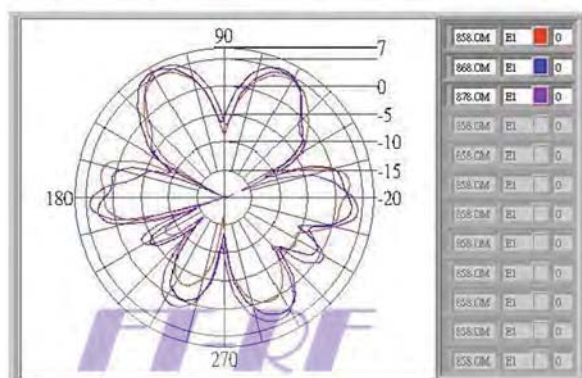
The specifications of the omnidirectional 868MHz / 6dBi antenna are the following:

Item	Specification
Frequency range	865MHz +/- 5MHz
Impedance	50 ohms
Technology	Collinear, dipole array
VSWR	<1.5:1 at 868MHz <2.0:1 at 860-870MHz
Max gain	6dBi
Polarization	Vertical
Vertical Beam width	25°
Power handling	100W
DC ground	Yes
Whip material	Fiberglass
Connector	N female
Length	110 cm
Weight	540g
IP rating	IP66K
Shock resistance	IK08
Wind resistance	150MPH
Operating temperature range	-20°C to +60°C
Salt, fog	EN 60068-2-52, severity 1

The radiation patterns are presented here after. They are measured at 858MHz (red), 868MHz (blue) and 878MHz (purple):

Vertical Pattern

E-plane co-pol ----- -3dB beam-width=25 Deg



Horizontal Pattern

H-plane co-pol ----- -3dB beam-width=360 Deg

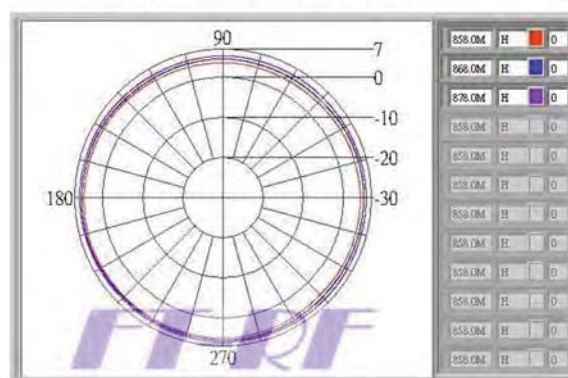


Figure 48 : Radiation pattern of omnidirectional 868MHz/6dBi antenna

Note: this antenna can not be installed on the universal antenna bracket but is provided with its own mounting kit.

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1.8.1.3 Omnidirectional antenna 915MHz 3dBi

The specifications of the omnidirectional 915MHz / 3dBi antenna are the following:

Item	Specification
Frequency range	915MHz +/- 15MHz
Impedance	50 ohms
Technology	Half wave
VSWR	<1.3:1
Max gain	3dBi
Polarization	Vertical
Power handling	50W
DC ground	Yes
Whip material	Fiberglass
Connector	N female
Length	30 cm
Weight	75g
IP rating	IP66K
Shock resistance	IK08
Wind resistance	150MPH
Operating temperature range	-20°C to +60°C
Salt, fog	EN 60068-2-52, severity 1

The radiation patterns are presented here after. They are measured at 930MHz (red), 915MHz (green) and 900MHz (blue):

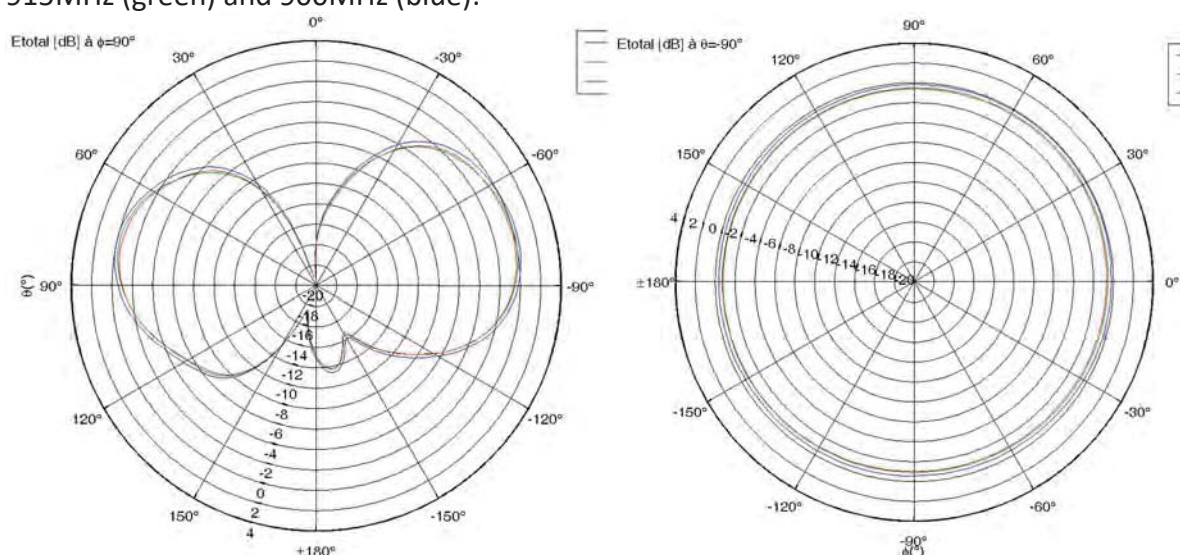


Figure 49 : Radiation pattern of omnidirectional 915MHz/3dBi antenna

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1.8.1.4 Omnidirectional antenna 915MHz 6dBi

The specifications of the omnidirectional 915MHz / 6dBi antenna are the following:

Item	Specification
Frequency range	915MHz +/- 15MHz
Impedance	50 ohms
Technology	Collinear, dipole array
VSWR	<1.2:1
Max gain	6dBi
Polarization	Vertical
Power handling	50W
DC ground	No
Whip material	Fiberglass
Connector	N female
Length	100 cm
Weight	380g
IP rating	IP66K
Shock resistance	IK08
Operating temperature range	-20°C to +60°C
Salt, fog	EN 60068-2-52, severity 1

The radiation patterns are presented here after. They are measured at 900MHz (red), 915MHz (green) and 930MHz (blue):

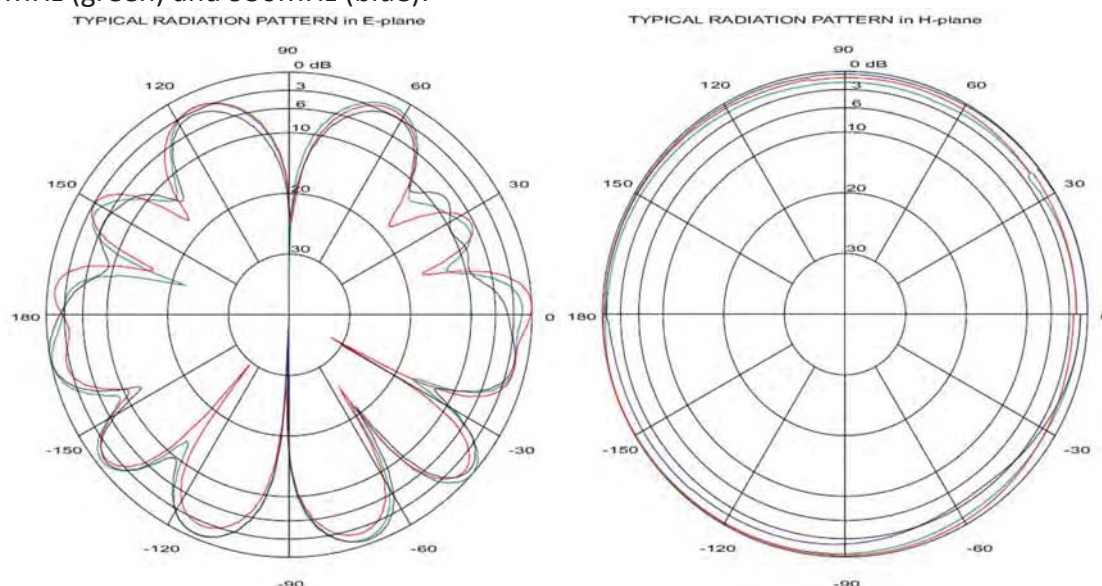


Figure 50 : Radiation pattern of omnidirectional 915MHz/6dBi antenna

KERLINK can provide two distinct references of 915MHz / 6dBi antennas, from two different suppliers. The first one must be installed on the universal antenna bracket whereas the second one has its own mounting kit. The second one cannot be installed on the universal antenna bracket.

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1.8.2 GNSS and WAN antennas

1.8.2.1 GNSS antenna

The GNSS antenna is required for the Wirnet iBTS standard casing only, when featuring a “CPU module”.

The Wirnet iBTS Compact embeds a GNSS/LTE internal antenna detailed in §1.8.2.3 and therefore does not require the GNSS antenna.

The GNSS antenna characteristics are detailed in the following table:

Characteristics	Detail	Specification
Frequency range		1572 - 1606 MHz
Antenna peak gain		3dBic
Typical VSWR		<2.0:1
Impedance		50 ohms
Polarization		RHCP
Noise figure		1.5dB typ
Total gain		27dB typ
Out of band rejection		30dB min at +/-100MHz
IIP3		-10dBm
IP1dB		-15dBm
Input voltage		3.0V - 5.5V
Current drain		11mA at 3V
Cable length		5 m
Cable type		RG58
Connector type		N male
Dimensions (DxH)	Diameter and Height	80 mm (D) x 42 mm (H)
Operating temperature		-40°C to +85°C
Wind resistance		> 200 km/h
IP rating		IP66

Note: a dome antenna bracket is provided with the GNSS antenna, allowing wall mounting, pole mounting and metallic strapping. Screws, nuts, U-bolt and metallic strapping are not provided by KERLINK.

1.8.2.2 LTE antenna

The LTE antenna is required for the Wirnet iBTS standard casing only, when featuring a “WAN module”.

The Wirnet iBTS Compact embeds a GNSS/LTE internal antenna detailed in §1.8.2.3 and therefore does not require the LTE antenna.

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The LTE antenna characteristics are detailed in the following table:

Characteristics	Detail	Specification
Frequency range	Band 1	698-960 MHz
	Band 2	1700-2700MHz
Peak gain	Band 1	4dBi
	Band 2	2dBi
Typical VSWR	Band 1 & 2	<2.4:1
Impedance		50 ohms
Polarization		Linear, Vertical
Radiation pattern		Omnidirectional
Type		No ground plane required
Power handling		10W min
Cable length		5 m
Cable type		RG58
Connector type		N male
Dimensions (DxH)	Diameter and Height	80 mm (D) x 42 mm (H)
Operating temperature		-40°C to +85°C
Wind resistance		> 200 km/h
IP rating		IP66

Note: a dome antenna bracket is provided with the LTE antenna, allowing wall mounting, pole mounting and metallic strapping. Screws, nuts, U-bolt and metallic strapping are not provided by KERLINK.

1.8.2.3 GNSS/LTE magnetic antenna

The GNSS/LTE magnetic antenna can be used with the Wirnet iBTS Compact casing only. It is not required for the Wirnet iBTS standard casing.

The GNSS/LTE magnetic antenna characteristics are detailed in the following table:

Characteristics	Description	Detail	Specification
LTE antenna	Frequency range	Band 1	698-960 MHz
		Band 2	1700-2700MHz
	Peak gain	Band 1	1dBi
		Band 2	0dBi
	Typical VSWR	Band 1 & 2	<2.0:1
	Impedance		50 ohms
	Polarization		Vertical
	Radiation pattern		Omnidirectional
	Type		No ground plane required

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GNSS antenna	Power handling	10W
	Frequency range	1574 - 1606 MHz
	Peak gain	3dBic
	Typical VSWR	<2.0:1
	Impedance	50 ohms
	Polarization	RHCP
	Type	Passive No ground plane required
Mechanical	DC block	Yes
	Mounting type	Magnetic mount
	Cable length (x2)*	15 cm
	Cable type (x2)	RG174
	Connector type (x2)*	SMA male, right angle
	Dimensions (DxH)	63 mm (D) x 16 mm (H)
	Operating temperature	-40°C to +85°C

Note: the antenna must be mounted on the internal GNSS/LTE bracket, a mechanical part provided as standard with the Wirnet iBTS Compact (see §1.3.1 and Figure 10).

1.8.2.4 Internal LTE antenna

The internal LTE antenna is required for the Wirnet iBTS Compact casing only, when featuring a “Dual WAN module”. It is not required for the Wirnet iBTS standard casing.

The internal LTE antenna characteristics are detailed in the following table:

Characteristics	Detail	Specification
Frequency range	Band 1	824-960 MHz
	Band 2	1700-2300MHz
Peak gain	Band 1 & 2	0dBi
Typical VSWR	Band 1 & 2	<2.5:1
Impedance		50 ohms
Polarization		Linear, Vertical
Radiation pattern		Omnidirectional
Type		Monopole
Power handling		10W min
Connector type	Right angle	SMA male
Dimensions		45 mm x 17.4 mm
Operating temperature		-30°C to +75°C

Note: the internal LTE antenna is directly mounted (screwed) on the SMA female connector of the Dual WAN module.

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1.8.3 Cavity filters

1.8.3.1 865-867MHz cavity filter

The 865-867MHz cavity filter is typically dedicated to the Indian market. The purpose of this filter is to avoid saturation and desensitization of the LoRa receiver due to co-located LTE850 or CDMA800 base stations.

The 862-867MHz cavity filter characteristics are detailed in the following table:

Characteristics	Specification
Pass band	865-867MHz
Insertion losses	≤4dB
Ripple	≤1.0dB
Return Loss	≥18db
Rejection	≥60dB @ 806-860MHz ≥40dB @ 862MHz ≥50dB @ 869MHz ≥70dB @ 871-960MHz
Impedance	50 ohms
Power Handling	≤10W
Temperature	-30°C to+60°C
Connectors	N-Female / N-Male
Waterproof	IP66
Surface Finish	Black Paint
Dimensions (w/o N connectors)	196 x 104 x 50 mm

The dimensions of the 865-867MHz cavity filter are detailed hereafter:

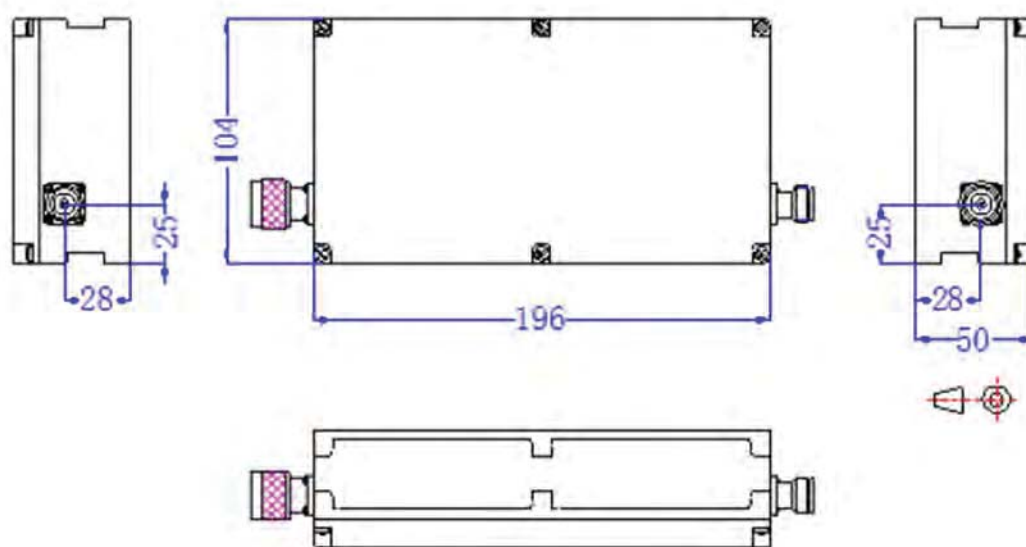


Figure 51 : Dimensions of the 865-867MHz cavity filter

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The frequency response of 862-867MHz cavity filter is as follows:

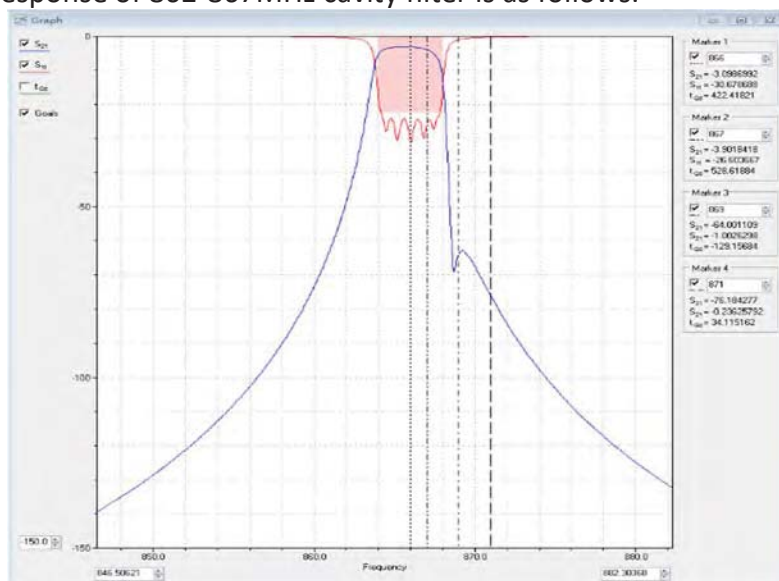


Figure 52 : Frequency response of the 865-870MHz cavity filter

1.8.3.2 865-870MHz cavity filter

The 865-870MHz cavity filter is typically dedicated to the European market. The purpose of this filter is to allow co-located LTE800 base stations, in case of poor isolation between antennas (less than 50dB).

The 865-870MHz cavity filter characteristics are detailed in the following table:

Characteristics	Specification
Center Frequency	867.5 MHz
Pass band	865-870MHz
Insertion losses	≤1dB
Ripple	≤0.5dB
Return Loss	≥20dB
Rejection	≥30dB @ 10-824MHz ≥20dB @ 832-862MHz ≥20dB @ 880-925MHz ≥30dB @ 925-960MHz ≥30dB @ 960-3000MHz
Impedance	50 ohms
Power Handling	≤10W
Temperature	-30°C to+60°C
Connectors	N-Female / N-Male
Waterproof	IP66
Surface Finish	Black Paint
Weight	<650g
Dimensions (w/o N connectors)	100 x 100 x 49 mm

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The dimensions of the 865-870MHz cavity filter are detailed hereafter:

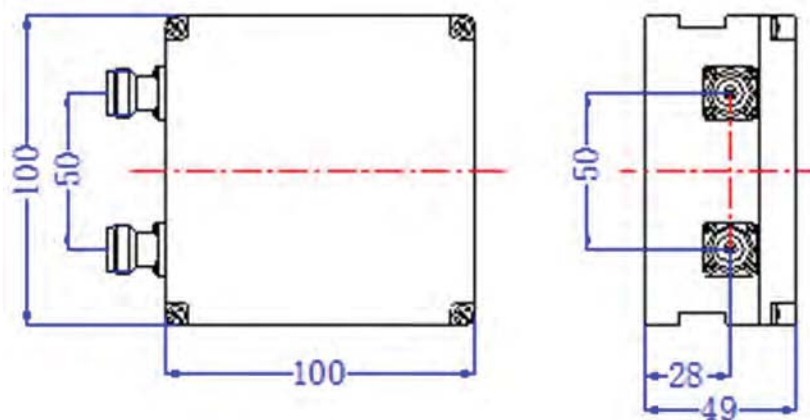


Figure 53 : Dimensions of the 865-870MHz cavity filter

The frequency response of 865-870MHz cavity filter is as follows:

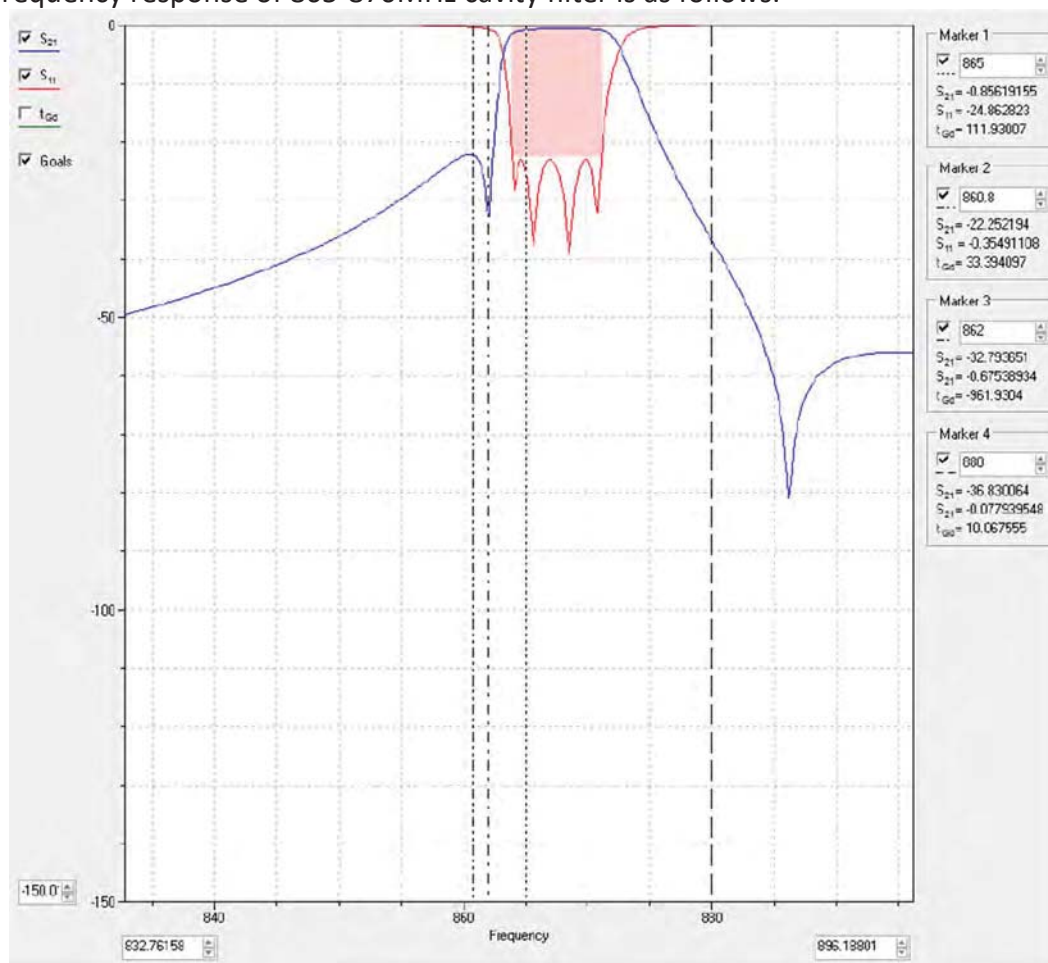


Figure 54 : Frequency response of the 865-870MHz cavity filter

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1.8.3.3 863-873MHz cavity filter

The 863-873MHz cavity filter is typically dedicated to the European market. The purpose of this filter is to allow co-located high power emitters (DVB-T, BTS), in case of poor isolation between antennas (less than 50dB).

The 863-873MHz cavity filter characteristics are detailed in the following table:

Characteristics	Specification
Center Frequency	868 MHz
Pass band	863-873MHz
Insertion losses	≤1dB
Ripple	≤0.5dB
Return Loss	≥20dB
Rejection	≥80dB @ 10-700MHz ≥70dB @ 700-791MHz ≥60dB @ 791-821MHz ≥60dB @ 925-960MHz ≥70dB @ 960-1000MHz ≥80dB @ 1000-2700MHz
Impedance	50 ohms
Power Handling	≤20W
Temperature	-40°C to +85°C
Connectors	N-Female / N-Male
Waterproof	IP66
Surface Finish	Black Paint
Weight	<600g
Dimensions (w/o N connectors)	148 x 46 x 50 mm

The dimensions of the 863-873MHz cavity filter are detailed hereafter:

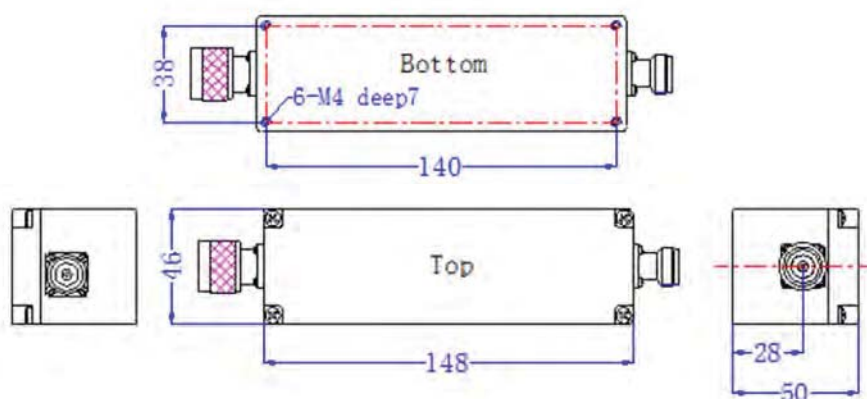


Figure 55 : Dimensions of the 863-873MHz cavity filter

The frequency response of 863-873MHz cavity filter is as follows:

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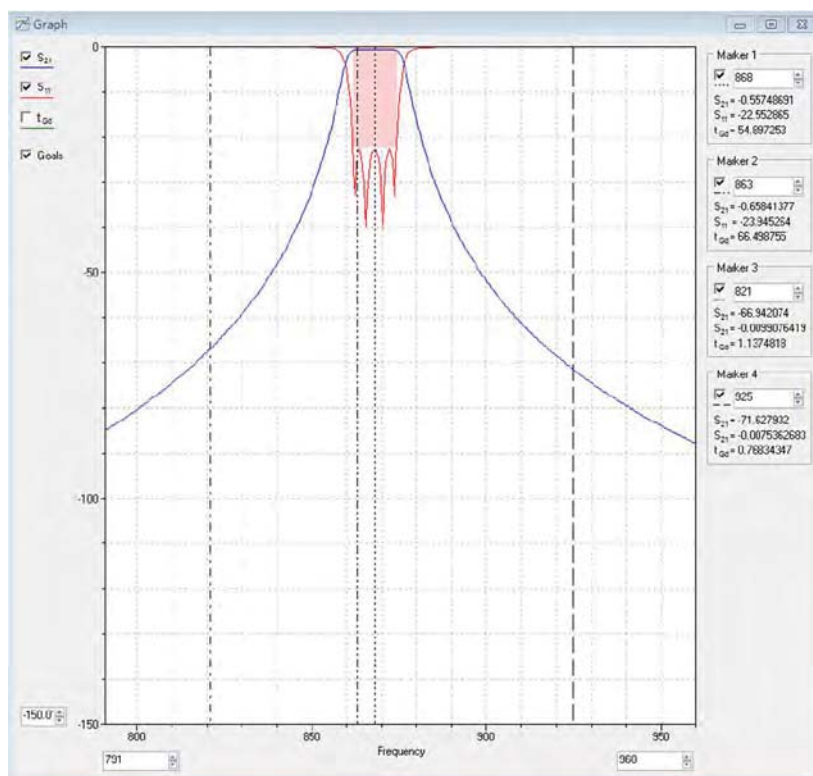


Figure 56 : Frequency response of the 863-873MHz cavity filter

1.8.3.4 915-920MHz cavity filter

The 915-920MHz cavity filter is typically dedicated to the Philippines market. It could be also used in Israel. The purpose of this filter is to avoid saturation and desensitization of the LoRa receiver due to co-located EGSM900 base stations.

The 915-920MHz cavity filter characteristics are detailed in the following table:

Characteristics	Specification
Band pass	915 to 920MHz
Center Frequency (Fc)	917,5MHz
Frequency bandwidth	5MHz
Insertion Loss	<2.8dB @full temp
Band Ripple	<1dB
Out of Band Rejection	>40dB @923MHz >40dB @912MHz >60dB @925MHz >60dB @910MHz
Return Loss	>20dB
Input and Output Impedance	50 Ohm
Max Input Power	10W CW
Temperature range	-30°C / +60°C
Ports	In N male / Out N female

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Positions of the ports	Opposite sides (right / left)
Dimensions	150mm x 80mm x 50 mm
Weight	<1Kg
Waterproof	IP66 min

The dimensions of the 915-920MHz cavity filter are detailed hereafter:

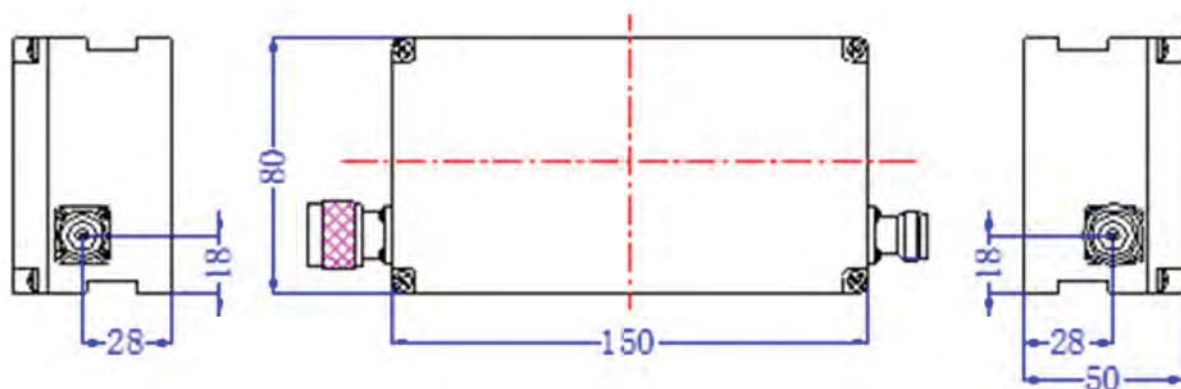


Figure 57 : Dimensions of the 915-920MHz cavity filter

The frequency response of 915-920MHz cavity filter is as follows:

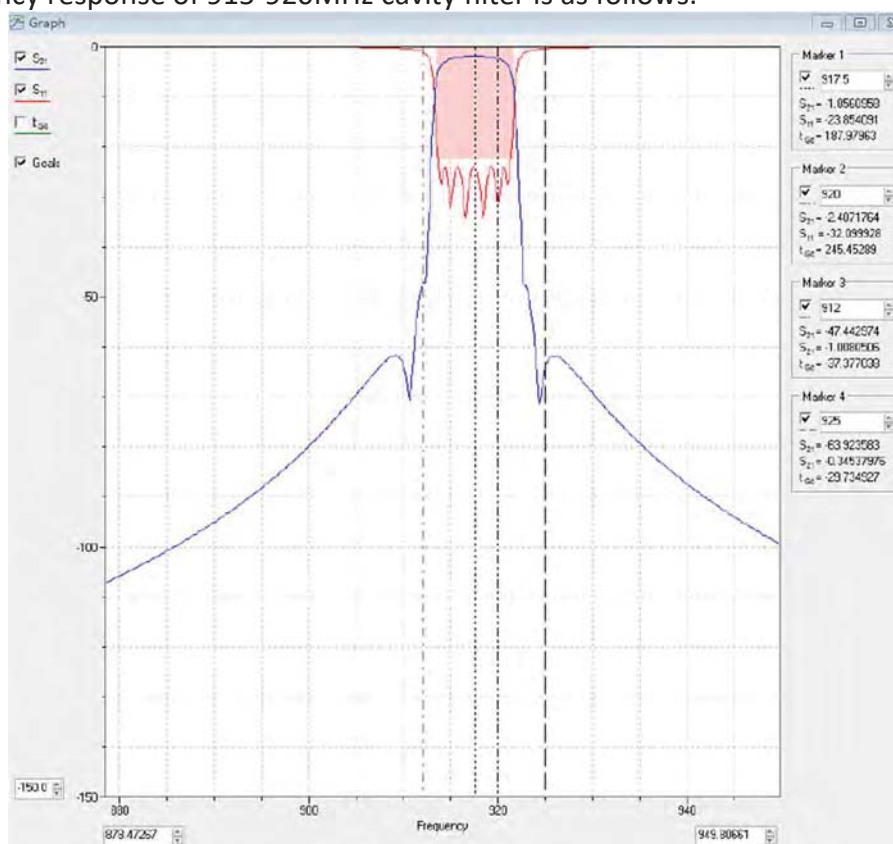


Figure 58 : Frequency response of the 915-920MHz cavity filter

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1.8.3.5 918-923MHz cavity filter

The 918-923MHz cavity filter is typically dedicated to Malaysia market. The purpose of this filter is to avoid saturation and desensitization of the LoRa receiver due to co-located EGSM900 base stations.

The 918-923MHz cavity filter characteristics are detailed in the following table:

Characteristics	Specification
Band pass	918 to 923MHz
Center frequency (Fc)	920,5MHz
Frequency bandwidth	5MHz
Insertion Loss	<3dB @25°C <5.7dB @full temp
Band Ripple	<1.8dB @25°C <3.2dB @full temp
Out of Band Rejection	>40dB @925MHz >40dB @915MHz >70dB @927MHz >70dB @910MHz
Return Loss	>20dB
Input and Output Impedance	50 Ohm
Max Input Power	10W CW
Temperature range	-30°C / +60°C
Ports	In N male / Out N female
Positions of the ports	Opposite sides (right / left)
Dimensions	150mm x 80mm x 50 mm
Weight	<1Kg
Waterproof	IP66 min

The dimensions of the 918-923MHz cavity filter are detailed hereafter:

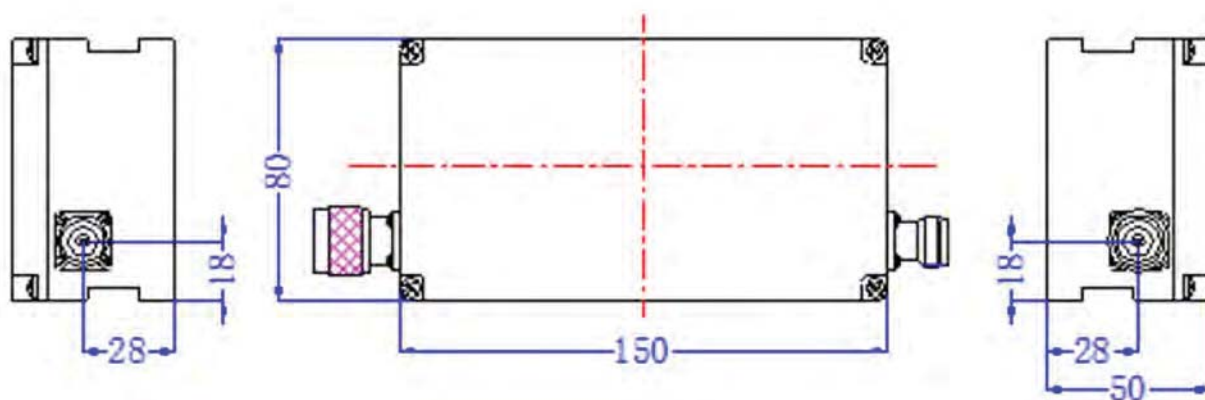


Figure 59 : Dimensions of the 918-923MHz cavity filter

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The frequency response of 918-923MHz cavity filter is as follows:

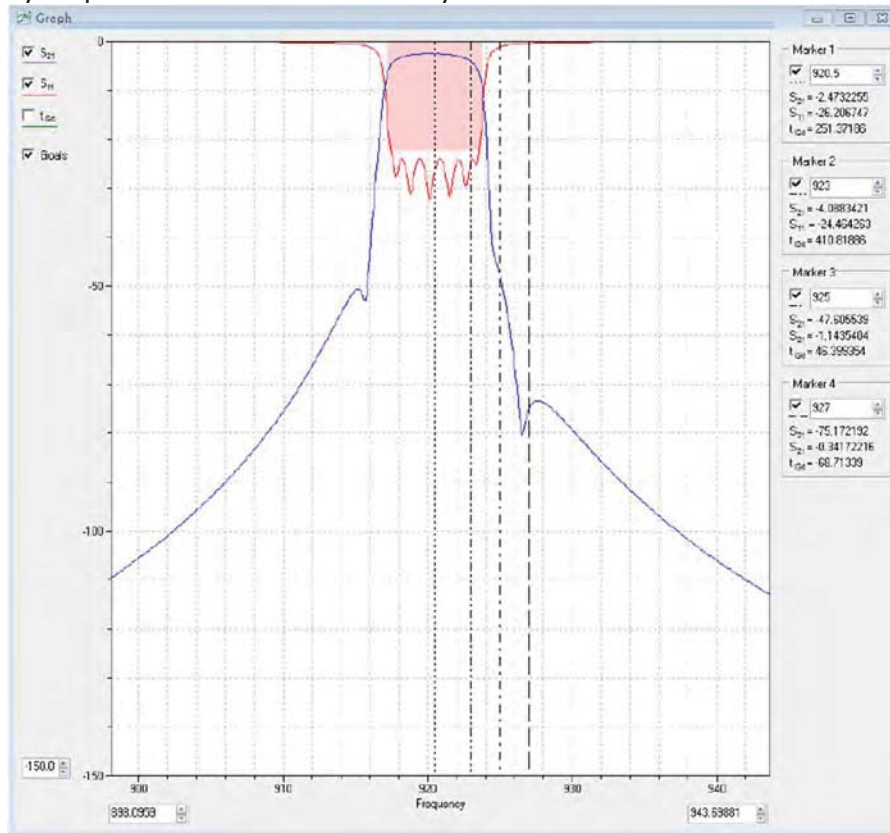


Figure 60 : Frequency response of the 918-923MHz cavity filter

1.8.3.6 920-925MHz cavity filter

The 920-925MHz cavity filter is typically dedicated to the Singapore market. The purpose of this filter is to avoid saturation and desensitization of the LoRa receiver due to co-located EGSM900 base stations.

The 920-925MHz cavity filter characteristics are detailed in the following table:

Characteristics	Specification
Center Frequency	922.5 MHz
Pass band	920-925MHz
Insertion losses	≤ 3 dB
Ripple	≤ 1.2 dB
VSWR	$\leq 1.3:1$
Rejection	≥ 60 dB @ 880-915MHz ≥ 60 dB @ 930-960MHz
Impedance	50 ohms
Power Handling	≤ 10 W
Temperature	-30°C to +60°C
Connectors	N-Female / N-Male

Waterproof	IP66
Surface Finish	Black Paint
Dimensions (w/o N connectors)	134 x 80 x 50 mm

The dimensions of the 920-925MHz cavity filter are detailed hereafter:

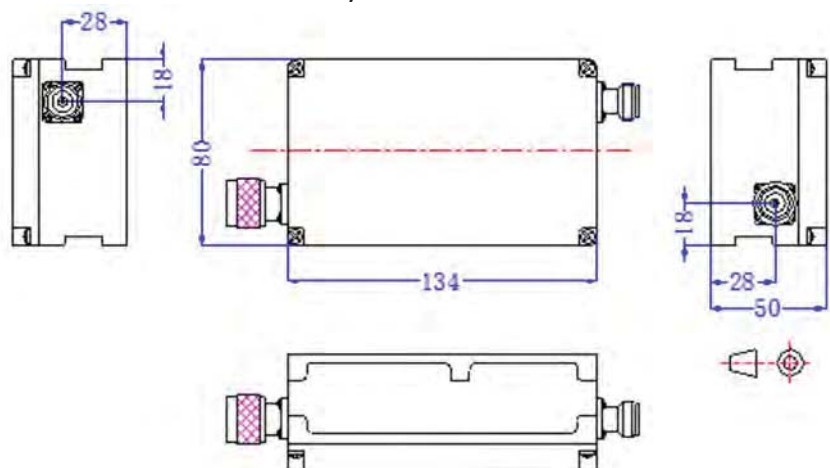


Figure 61 : Dimensions of the 920-925MHz cavity filter

The frequency response of 862-867MHz cavity filter is as follows:

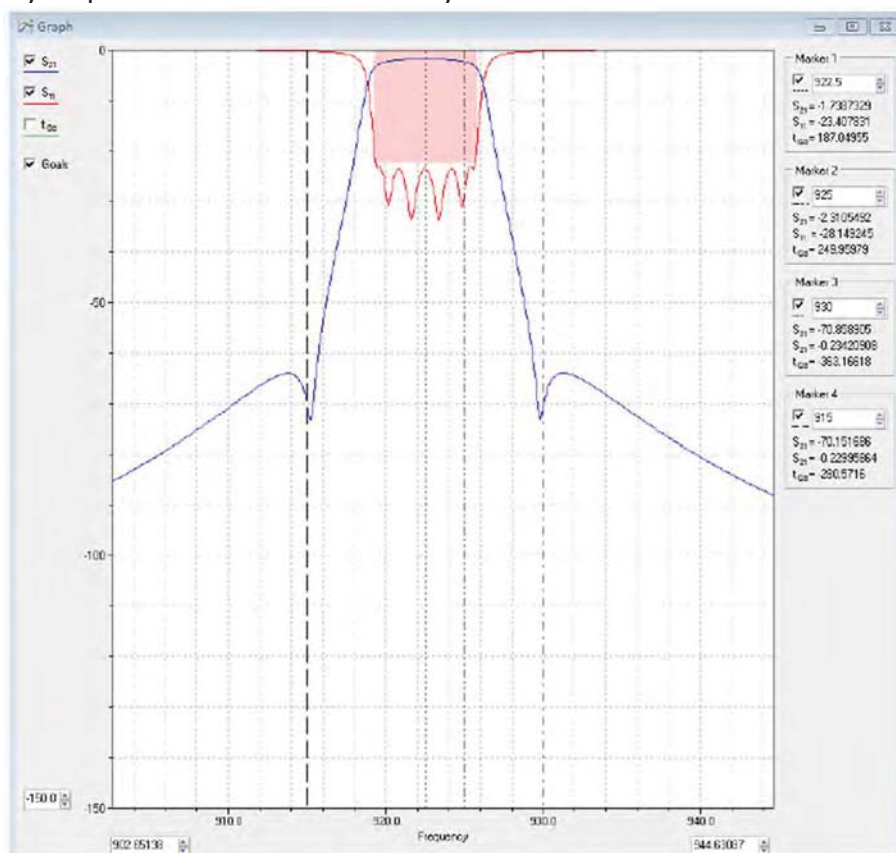


Figure 62 : Frequency response of the 920-925MHz cavity filter

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1.8.3.7 920-928MHz cavity filter

The 920-928MHz cavity filter is typically dedicated to the New-Zealand market. The purpose of this filter is to avoid saturation and desensitization of the LoRa receiver due to co-located GSM900 base stations.

The 920-928MHz cavity filter characteristics are detailed in the following table:

Characteristics	Specification
Band pass	920 to 928MHz
Center frequency (Fc)	924MHz
Frequency bandwidth	8MHz
Insertion Loss	<3dB
Band Ripple	<1dB
Out of Band Rejection	>60dB @935-960MHz >60dB @880-915MHz
Return Loss	>20dB
Input and Output Impedance	50 Ohm
Max Input Power	10W CW
Temperature range	-30°C / +60°C
Ports	In N male / Out N female
Positions of the ports	Opposite sides (right / left)
Dimensions	150mm x 80mm x 50 mm
Weight	<1Kg
Waterproof	IP66 min

The dimensions of the 920-928MHz cavity filter are detailed hereafter:

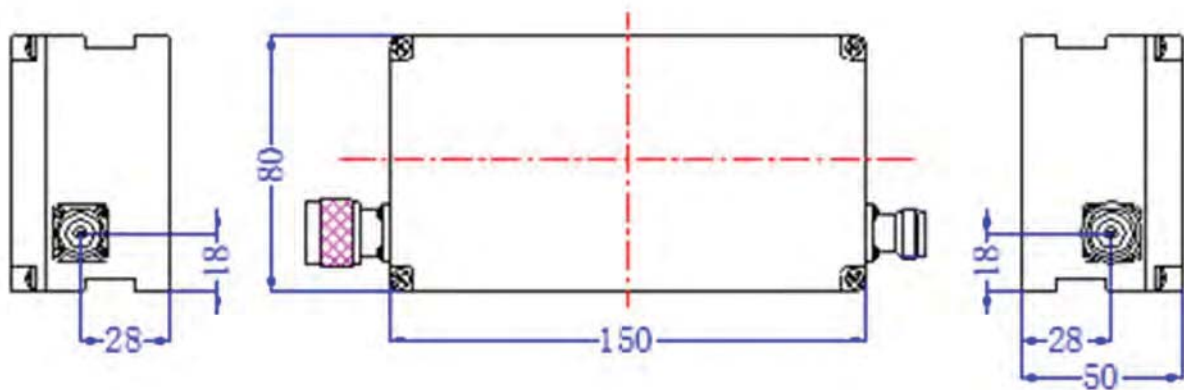


Figure 63 : Dimensions of the 920-928MHz cavity filter

The frequency response of 920-928MHz cavity filter is as follows:

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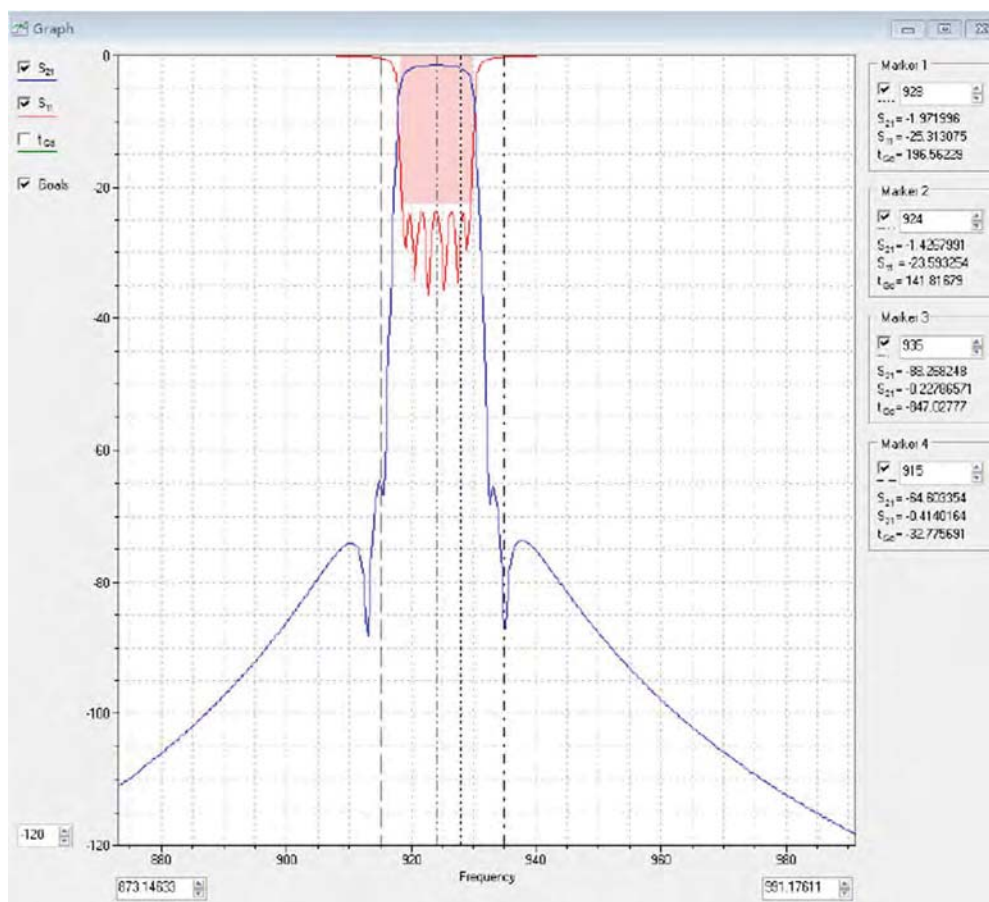


Figure 64 : Frequency response of the 920-928MHz cavity filter

1.8.3.8 902-928MHz cavity filter

The 902-928MHz cavity filter is typically dedicated to the North American market. The purpose of this filter is to allow co-located LTE850 base stations, in case of poor isolation between antennas (less than 50dB).

The 902-928MHz cavity filter characteristics are detailed in the following table:

Characteristics	Specification
Center Frequency	915 MHz
Pass band	902-928MHz
Insertion losses	≤1.5dB
Ripple	≤0.7dB
Return Loss	≥20dB
Rejection	≥45dB @ 850-894MHz ≥45dB @ 935-960MHz
Impedance	50 ohms
Power Handling	≤10W
Temperature	-40°C to +85°C

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Connectors	N-Female / N-Male
Waterproof	IP66
Surface Finish	Black Paint
Weight	<1Kg
Dimensions (w/o N connectors)	150 x 80 x 50 mm

The dimensions of the 902-928MHz cavity filter are detailed hereafter:

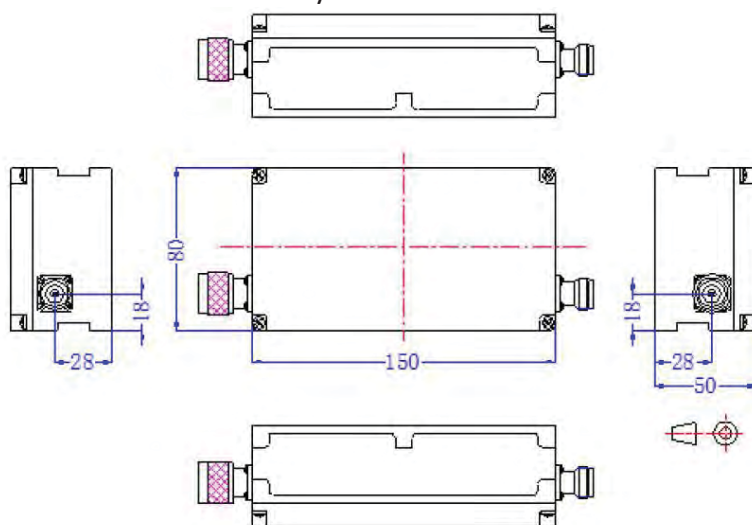


Figure 65 : Dimensions of the 902-928MHz cavity filter

The frequency response of 902-928MHz cavity filter is as follows:

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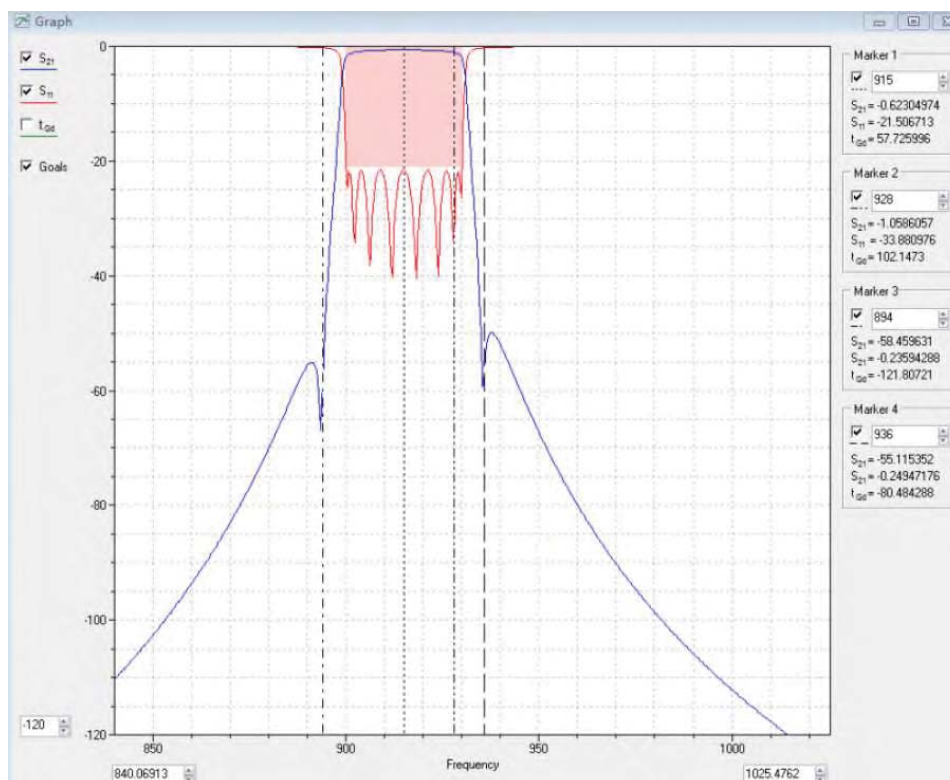


Figure 66 : Frequency response of the 902-928MHz cavity filter

1.8.4 Cables

The Wirnet iBTS are delivered with all required cables to start and operate the gateway, except the power supplies cables:

- RJ45 PoE cable is not provided by KERLINK
- Auxiliary power supply cable is not provided by KERLINK

The LoRa antennas are provided with 1m coaxial cable.

Specific installations may require deporting the LoRa antenna further. Extension coaxial cables are not provided by KERLINK.

The GNSS and LTE antennas are provided with 5m coaxial cable.

Specific installations may require deporting the GNSS antenna or LTE antenna further.

Deporting the GNSS antenna may be required to have a better sky view to optimize the reception of the satellites.

Deporting the LTE antenna may be required to optimize the LTE reception or improve isolation with other radio equipment's on the site.

Extension coaxial cables are not provided by KERLINK.

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1.8.4.1 RJ45 PoE cable

This cable is not provided with the Wirnet iBTS.
It neither can be delivered as an accessory.

KERLINK recommends using a PoE cable with the following characteristics:

Characteristics	Specification
Category	6A
Shielding	STP (U/FTP) or SFTP (S/FTP)
Section conductors	AWG26 or bigger
External jacket	LSZH or PUR
Maximum length	100 meters
Operating temperature range	-20°C to +60°C

KERLINK recommends the following reference:
TELEGARTNER AMJ 500 U/FTP 4x2x0.55 LSZH Cat. 6A IEC 600332-1

The Ethernet cable must be provided with two RJ45 T 568A (or 568B) plugs on each side:

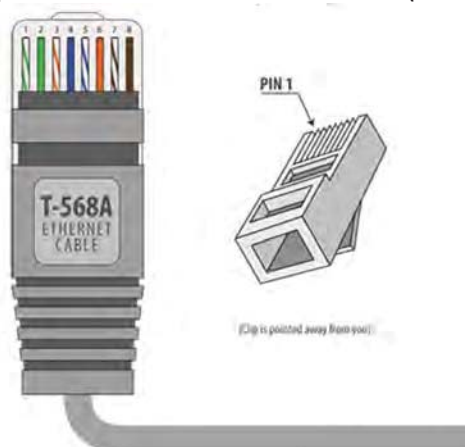


Figure 67 :RJ45 T-568A plug

1.8.4.2 Earthing cables

Several earthing cables, wires or tapes are required to connect the installation and the materials to earth for lightning immunity and electrical security.

The earthing cables are detailed hereafter with recommended wires and sections:

Cable description	Technical characteristics
Earthing of the Wirnet iBTS mounting kit	25mm ² , copper
Earthing of the antenna brackets (LoRa antenna, GNSS antenna, LTE antenna)	25mm ² , copper
Earthing of the RF coaxial surge protection	16mm ² , copper

Earthing of the Ethernet surge protection	16mm ² , copper
Earthing of the DC surge protection	16mm ² , copper
Earthing of the outdoor PoE injector	16mm ² , copper

Note: the earthing cables are not provided by KERLINK

1.8.5 Surge protections

In harsh environment, additional protections must be used to improve lightning immunity. The Wirnet iBTS is not warranted by KERLINK in case of deterioration due to lightning. KERLINK recommends adding surge protection, in high keraunic levels areas.

1.8.5.1 RF coaxial surge protection

1.8.5.1.1 GNSS, LTE Links

For the antenna links (GNSS, LTE), KERLINK recommends the P8AX09-6G-N/MF series from CITEL.

Protections must be installed in accordance to its own specifications.

The following picture describes the RF coaxial surge protection:



Figure 68 : P8AX Citel

Note: the RF coaxial surge protector must be connected to the Lightning Protection System down conductor, connecting the lightning rod to the earth. No cables are provided by KERLINK for that purpose.

1.8.5.1.1 LoRa Link

For the LoRa antenna link, KERLINK recommends the PRC822S-N/MF series from CITEL. Protections must be installed in accordance to its own specifications.

The following picture describes the RF coaxial surge protection:

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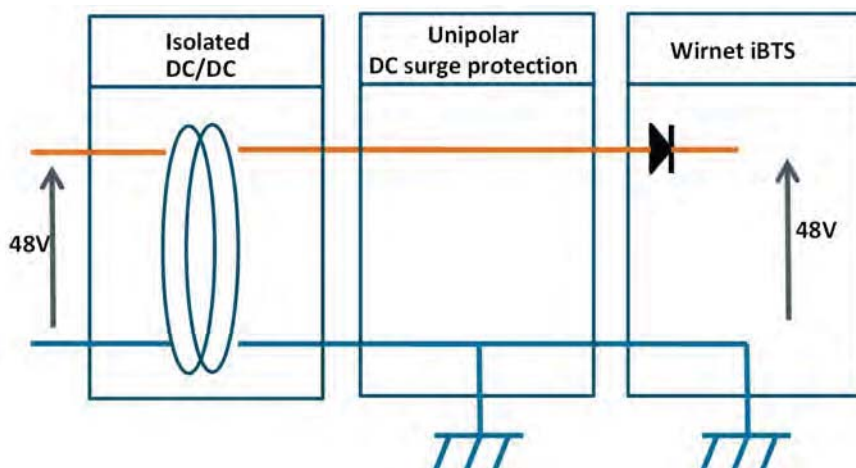


Figure 71 : DC surge protection 1 pole schematic

An example of connections is described below, while the DC surge protection is integrated in the Compact casing :

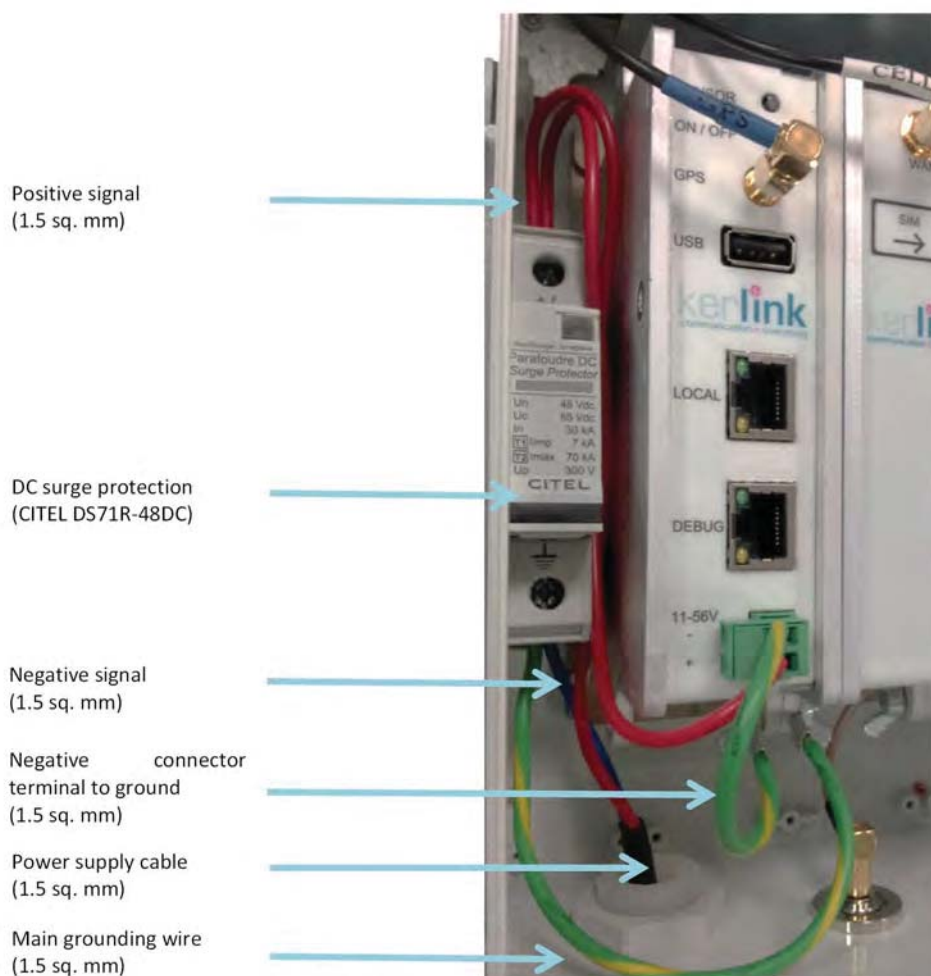


Figure 72 : Example of DC surge protection cabling

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To connect grounding cable to the metal heatsink of the product, Kerlink recommends using tongue terminals. Those terminals must be tightened with wing nuts.

Regarding the DC surge protection integration process inside the Wirnet iBTS enclosure, Kerlink recommends using the following guideline:

1. DS71R-48DC must be inserted on the left side of the UC module.
The mechanical holding must be ensured by using a double face tape.
Note: It is important to avoid any enclosure deformation which may imply ingress protection issue.
2. The M25 cable gland must be used to introduce the power supply cable inside the enclosure. As mentioned on the installation guide of the Wirnet iBTS product, the external cable diameter must be between 5 to 8 mm to insure a good ingress protection.
The power supply cable is a 1.5 sq. mm cable.
3. The positive wire of the power supply cable must be connected to the surge protector and then to the Wirnet iBTS connector.
4. The negative wire of the power supply cable must be connected to the Ground side of the surge protector.
5. A ground connection must be done between the ground side of the surge protector and the metal heatsink of the product. The best solution is to use tongue terminal.
6. A ground connection must be done between the metal heatsink of the product and the Wirnet iBTS connector.



Figure 73 : Tongue terminal

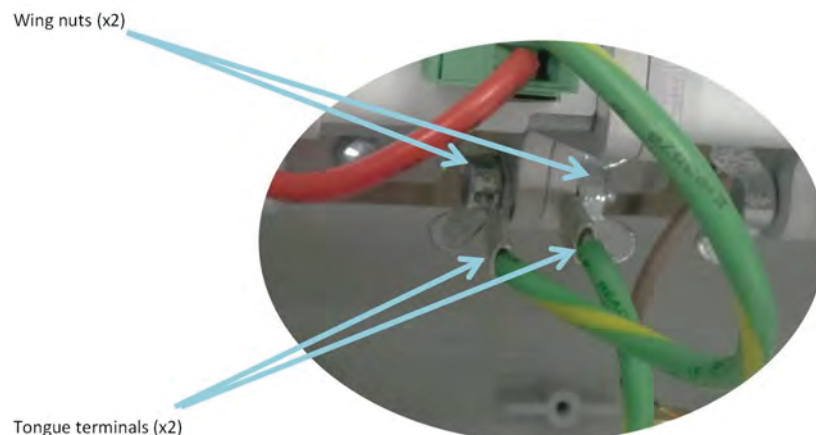


Figure 74 : Tongue terminal assembly

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1.8.5.3 DC surge protection, 2 poles

To avoid any lightning introduction inside the shelter Kerlink recommends using the following bipolar DC surge protection: DS72R-48DC from CITEL.

A picture of DS72R-48DC is presented in Figure 70.

The following schematic shows electrical connections of the bipolar DC surge protection to the Wirnet iBTS and the isolated DC/DC converter:

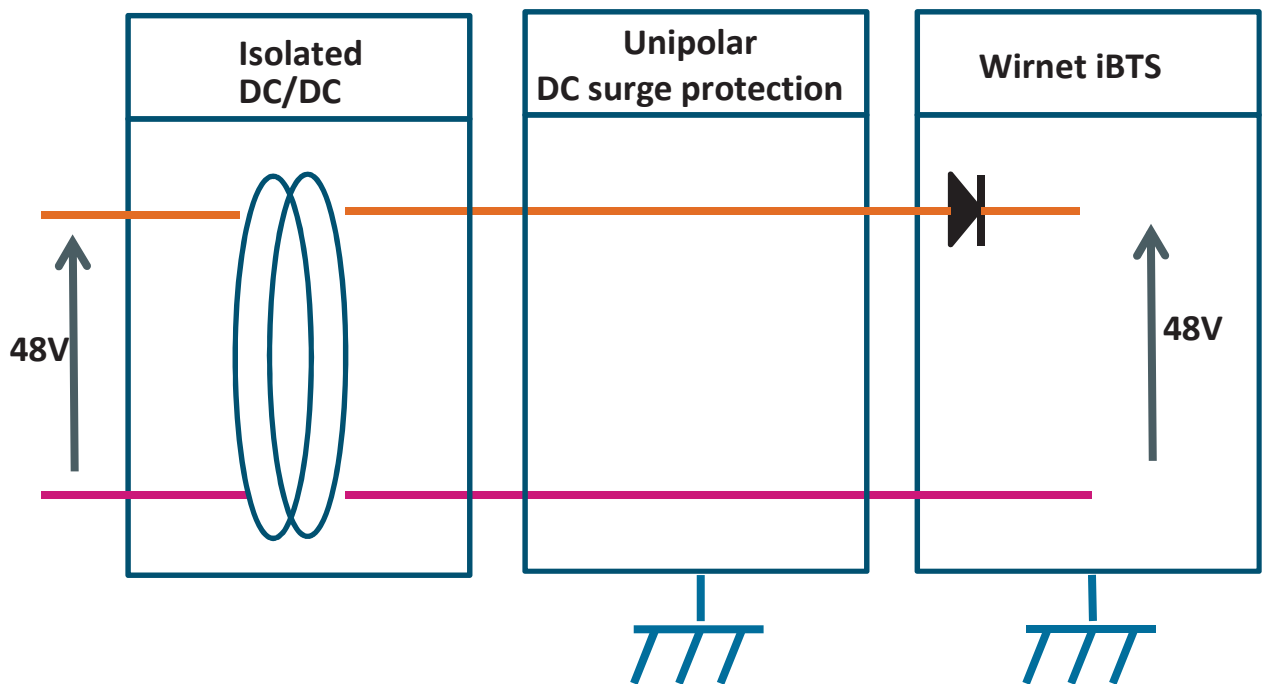


Figure 75 : DC surge protection 2 poles schematic

Kerlink recommends realizing a good direct connection between the Bipolar DC surge protection and the earthing system of the installation. The used earthing cable must be as short as possible (< 50 cm, 4 sq. mm).

The principles of cablig remain identical to those described in §1.8.5.2.

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1.8.5.4 Indoor Ethernet surge protection

For the Ethernet link, KERLINK recommends the MJ8-POE-A reference from CITEL. This surge protection must be installed indoor, according to its own specifications.

The following picture describes the PoE surge protection:



Figure 76 : MJ8-POE-A Citel

Note: the PoE surge protector must be connected to the earth. No cables are provided by KERLINK for that purpose. See §1.8.4.2 for additional information.

1.8.5.5 Outdoor Ethernet surge protection

In case the Ethernet surge protection cannot be installed indoor, then KERLINK recommends the PD-OUT/SP11 reference from Microsemi. This surge protection can be installed indoor, according to its own specifications.

The main characteristics of the PoE surge protection are:

Characteristics	Specification
Network	POE and Gigabit Ethernet, High POE (95W)
Technology	Clamping diode
SPD configuration	4 pairs + shielded
Connection to Network	RJ45 shielded connector female input/output
Format	Metallic box with connectors input/output
Mounting	Wall or pole mount
Operating temperature	-40°C to +85°C
Dimensions	30 x 30 x 190 mm
Weight	270g
Protection rating	IP66
Outdoor application	Yes

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Failsafe behavior	Short-circuit
Disconnection indicator	Transmission interrupt
Remote signaling of disconnection	None
Nominal line voltage (Un)	48 Vdc
Max. DC operating voltage (Uc)	60 Vdc
Max. line current (IL)	2A
Protection level (Up)	500V
Nominal discharge voltage 8/20μs	10 kV
Impulse current 2 x 10/350μs Test - D1 Category (Iimp)	100 A
Nominal discharge current 8/20μs Test x 10 - C2 Category (In)	5 kA
Max data rate	1000 Mbps
Certifications	IEC 61643-21 / EN 61643-21 GR1089 ITU-T K.45 UL497B IEEE 802-3ab/3at

The following picture describes the PoE surge protection:



Figure 77 : PD-OUT/SP11 Microsemi

Note: the PoE surge protector must be connected to the earth. No cables are provided by KERLINK for that purpose. See §1.8.4.2 for additional information.

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1.8.6 Mounting kits

1.8.6.1 Notched V-shaped pole mounting kit

The notched V-shaped pole mounting kit includes a notched V shaped plate and a U bolt with 2 nuts.

This mounting kit can be used in conjunction with the dome antenna brackets for pole mounting (see §1.8.6.3). The maximum diameter of the pole is 70mm.

The dimensions of the notched V shaped plate part are detailed hereafter:

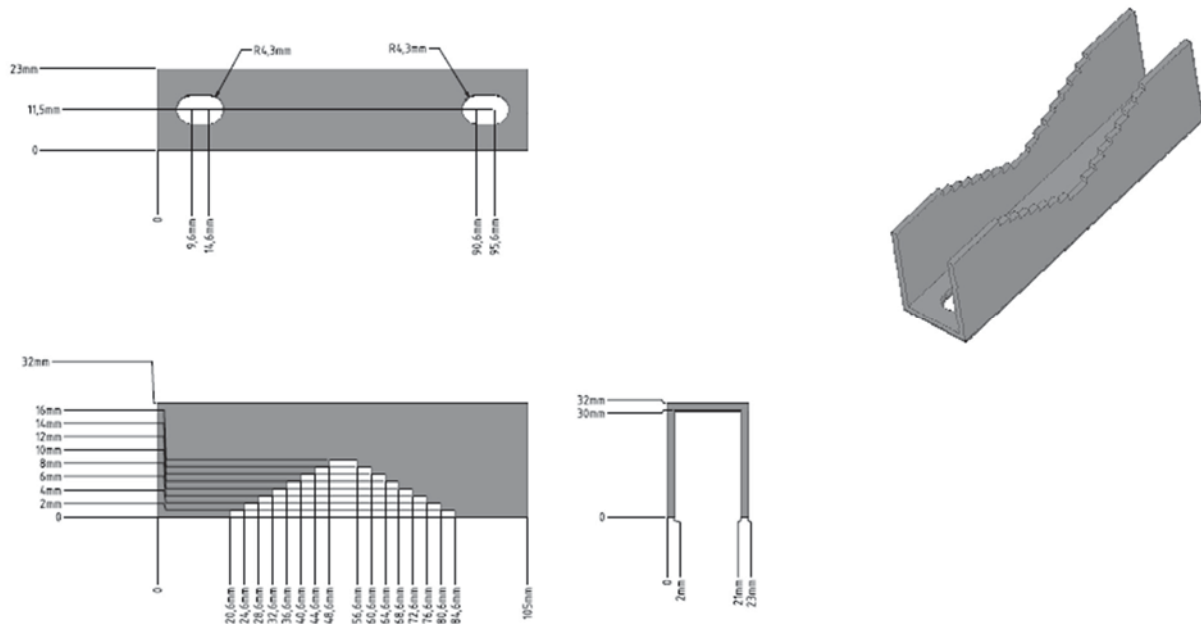


Figure 78 : Dimensions of the notched V shaped plate

1.8.6.2 Universal antenna bracket

The universal antenna bracket is used with the following antennas:

- 868MHz, 3dBi omnidirectional (see §1.8.1.1).
- 915MHz, 3dBi omnidirectional (see §1.8.1.3).
- 915MHz, 6dBi omnidirectional, except FT-RF antenna (see §1.8.1.4).

The universal antenna bracket is presented hereafter:

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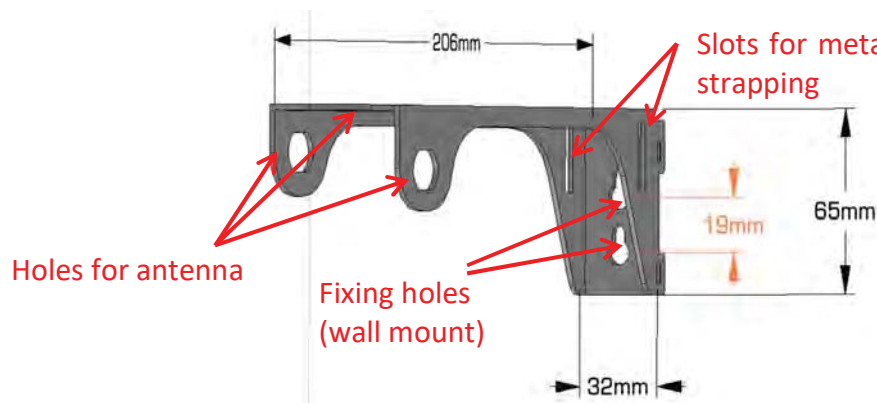


Figure 79 : Universal antenna bracket dimensions

The universal antenna bracket has 3 holes dedicated to the LoRa antenna N connector. The bracket can be then oriented in 3 different positions without compromising the antenna position.

The universal antenna bracket can be mounted:

- On a wall: use in this case two M4 screws separated by 19mm.
- On a pole: use metallic strapping through the two 5mm x 25mm slots.
- On the compact casing mounting kit, with 2 x M8 bolts and screws.

1.8.6.3 Dome antenna bracket

The dome antenna bracket is used for the following antennas:

- GNSS antenna (see §1.8.2.1)
- LTE antenna (see §1.8.2.2)
- GNSS/LTE combo antenna (see §1.8.2.3)

The dome antenna bracket is presented hereafter:

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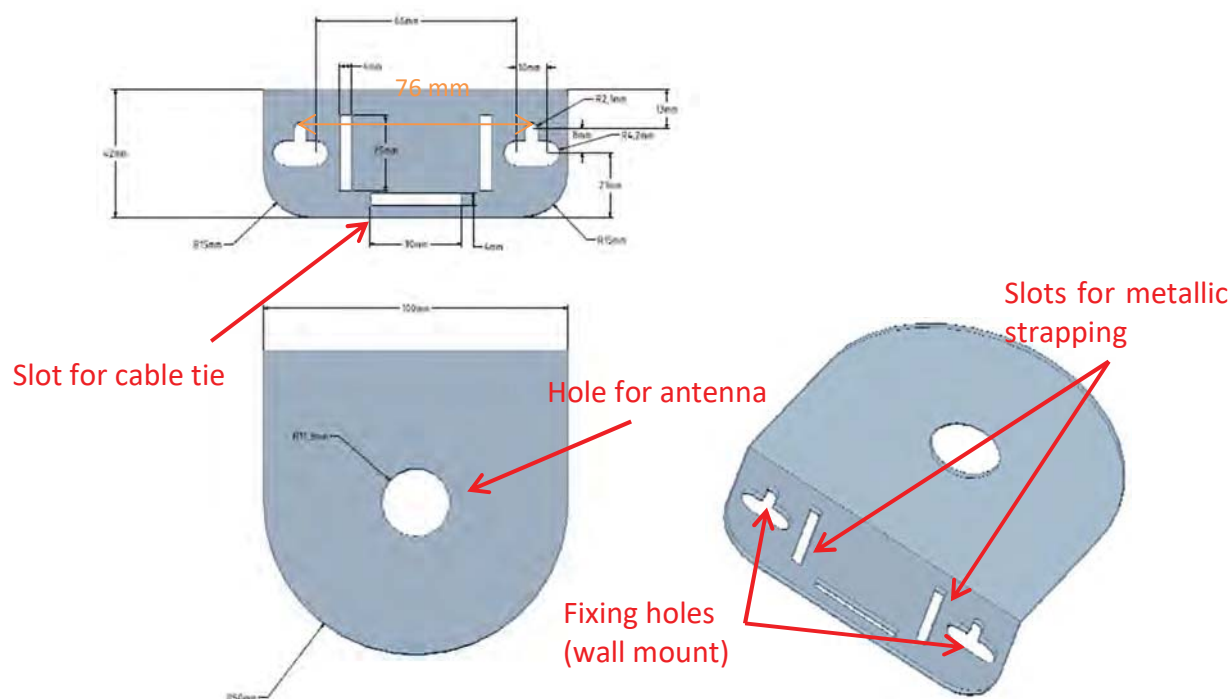


Figure 80 : Dome antenna bracket dimensions

The dome antenna bracket has a single hole dedicated to the LTE and / or GPS M22 screw.
The dome antenna bracket can be mounted:

- On a wall: use in this case 2 x M4 screws separated by 76mm (see figure above).
- On a pole: use metallic strapping through the two 4mm x 25mm slots (see figure above).
- On a pole: alternate option is to use the “notched V shaped plate and a U-bolt” as detailed in §1.8.6.1. The two parts are presented on the figure below. The maximum diameter of the pole is 60mm.

Another slot is available. It can be used for cable ties to tighten the RF coaxial cable to the antenna bracket.

Note 1: the M4 screws, the metallic strapping are not provided by KERLINK.

Note 2: the cables ties are not provided by KERLINK.

Note 3: the notched V shaped plate and a U-bolt can be provided by KERLINK as accessories (see §1.8.6.1).

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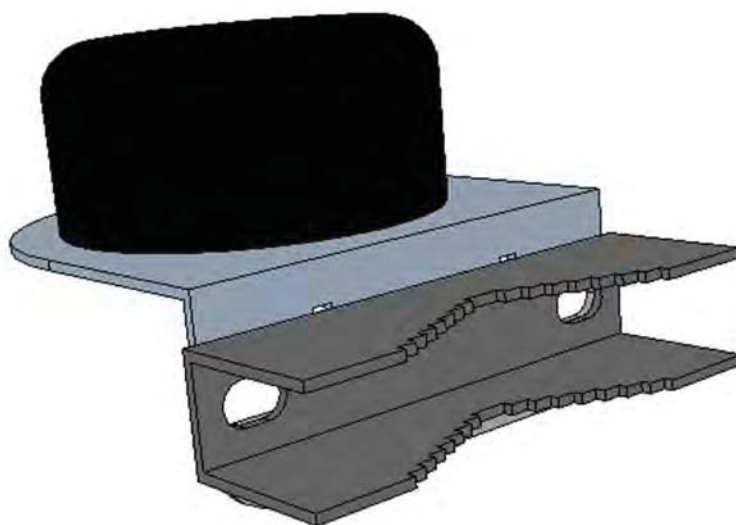


Figure 81 : Dome antenna bracket with notched V shaped bolt

1.8.7 Debug tool

The Wirnet iBTS has a proprietary serial debug interface named DEBUG available on the front panel of the CPU module.

This debug interface is intended to be used by authorized and qualified personnel only.

The WIRMA2 Debug tool is intended to be connected to the debug interface. It is mainly a simple UART to USB converter.

The main characteristics of the Wirma2 debug tool are:

Characteristics	Specification
UART Interface	RJ45 female
	3.3V internal LDO
	Up to 1Mb/s
USB2.0 interface	USB 2.0 A type
	USB Self Bus Powered at 5V
	Full Speed (12Mb/s)
Operating temperature range	0°C to +60°C
Chipset	FT232BL (FTDI)

The debug tool must be used with an Ethernet cable and a USB2.0 type A to type B male cable. They can be provided by KERLINK as options as detailed in §6.

The USB cable must be connected to a computer where must be installed HyperTerminal or Teraterm to visualize the traces.

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