WIRNET IBTS - PRODUCT DESCRIPTION

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Date	**04/10/2018**	**08/10/2018**	**22/10/2018**	**31/10/2018**

HISTORY

Version	Modification	Author	Date
V1.0	First release	Pierre TALVAZ	04/03/2016
V1.1	Update	Michel GILBERT	04/04/2016
V1.2	Update after internal review	Michel GILBERT	21/04/2016
V1.3	Add chapter on software specifications	Pierre TALVAZ	04/07/2016
V1.4	Updated accessories list	Michel GILBERT	08/07/2016
V1.5	Update after internal review	Michel GILBERT	29/07/2016
V1.6	§4 Add integration of the OverlayFS technology §4.5.3 Add Hotfix support	Benoît LE TEXIER	19/09/2018
V1.7	§4.3.2 Remove HTTPS support for the local web interface	Benoît LE TEXIER	19/09/2018
V1.8	Updated references, introduction, WAN and dual WAN description, power consumption, output power, sensitivity, out of band blockers, regulations, list and description of accessories, colocalization recommendations	Michel GILBERT	19/10/2018
V2.0	Approbation and validation	Benoît LE TEXIER	05/11/2018

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FIGURES

REFERENCES

Reference	Document / link	Description
[1]	https://www.lora-alliance.org/For-Developers/LoRaWANDevelopers	LoRaWAN™ Specification V1.0.3 2018 March 19th
[2]	https://www.lora-alliance.org/For-Developers/LoRaWANDevelopers	LoRaWAN™ 1.1 Regional Parameters Revision B, 2018 January
[3]		

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
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
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	Thermo Plastic 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

1. Introduction

The Wirnet iBTS 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.

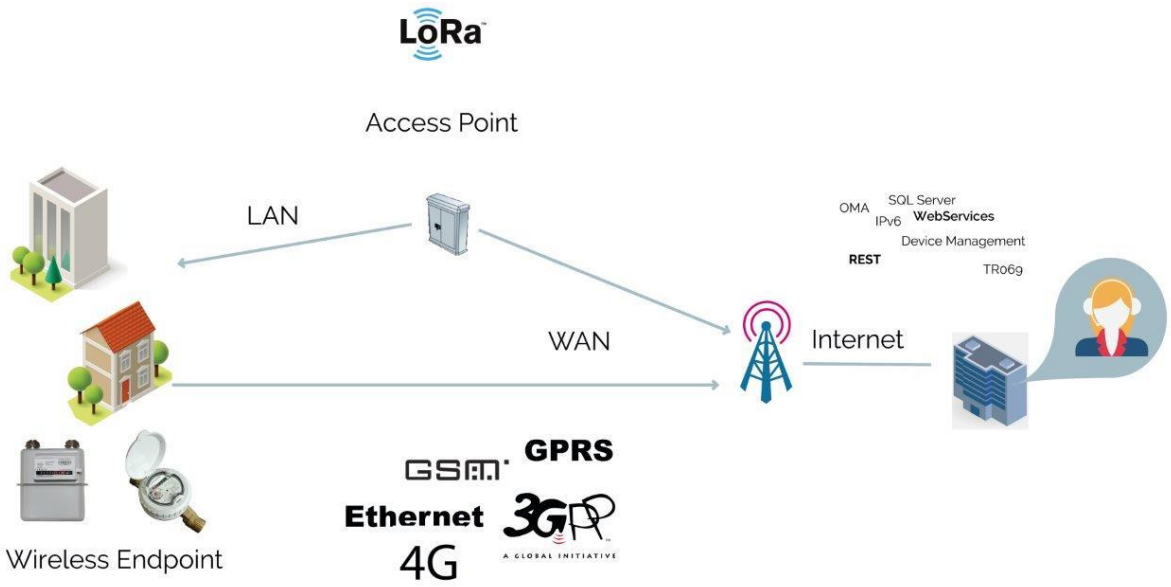


Figure 1: LoRa Network topology

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 geolocation features.

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 923
Geographical area	Europe, Russia Africa Middle East, India	North America Central America South America Philippines	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	915 - 928 MHz
Downstream band	863 - 873MHz	902 - 928 MHz	919 - 928 MHz
Upstream band	863 - 873 MHz	902 - 928 MHz	915 - 928 MHz

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 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	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.	Usage in Singapore, Hong-Kong and Malaysia requires a specific cavity filter.

The present document addresses all the above Wirnet iBTS versions.

2. Main functionalities

Here are the main functionalities of the Wirnet iBTS product:

- Long Range support:
  - Modular "LoRa RF modem" architecture
  - SDR evolutive architecture including two dual core SoC DSP and ARM processor per LoRa RF modem
  - Incorporate LoRa (TM) half-duplex communications technology:
    - RX: 863-873MHz, TX: 863-873MHz (according to HW capabilities)
    - RX: 902-928MHz, TX: 902-928MHz (according to HW capabilities)
    - RX: 915-928MHz, TX: 919-928MHz (according to HW capabilities)
  - One LoRa RF modem (16 radio channels) extendable to four LoRa RF modems (64 radio channels)
  - Configurable for single omnidirectional antenna, space diversity antennas, dual polarization antenna, tri-sectorization antennas
- Geolocation:
  - LoRa geolocation combining RSSI and Time Difference of Arrival (TDOA)
  - Outdoor and indoor environments
  - Synchronization with GPS
- WAN connectivity over GPRS/EDGE/HSPA/LTE or Ethernet
- Web local interface allowing configuration, diagnostic and maintenance
- USB host interface allowing local secured software upgrade
- Highly secured device relying on a hardware secure core
- Embedded Base Station Controller (BSC) agent relying on standard SNMP protocol:
  - Alarm notifications
  - Firmware upgrade
  - File transfer
  - Remote shell control
  - Configuration
  - Monitoring (platform statistics, RF statistics, RF spectrum analyzer...)

3. Hardware specifications

3.1 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 can choose:

- The backhaul network: Ethernet or GPRS/EDGE/HSPA/CDMA/LTE
- The unlicensed band (ISM) where to operate the LoRa LPWAN: 868MHz, 902-928MHz or 915-928MHz
- The number of channels to operate the LoRa LPWAN: 8 to 64
- The antenna interface: single (omnidirectional), dual (spatial 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
  - LTE modem declined in 3 versions depending on the geographical area:
    - Europe
    - Americas
    - APAC
- LoRa module – LoRa LOC, which can be also declined in 3 versions:
  - 868MHz (863-873MHz)
  - 915MHz (902-928MHz)
  - 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 a mechanical lid are used to combine the four “LoRa modules” together (see §3.4.3 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:

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”:

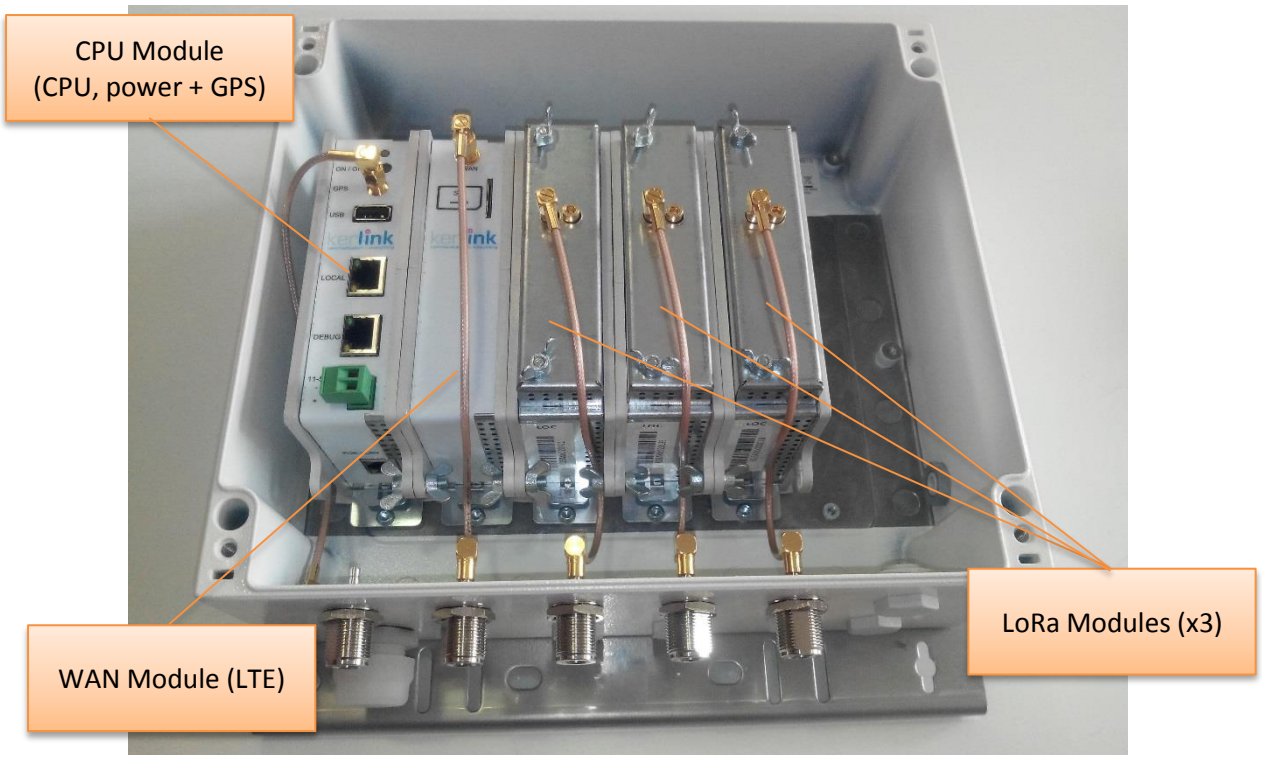


Figure 3: Wirnet iBTS internal view

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

- GNSS antennas
- LTE antennas
- RF cavity filters
- RF coaxial cables
- PoE injectors
- Surge protections

The full list of accessories is detailed in §6.

3.2 Mechanical implementation for standard casing

3.2.1 *Standard casing*

The Wirnet iBTS 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 trough 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 4 below shows the different components inside the enclosure.

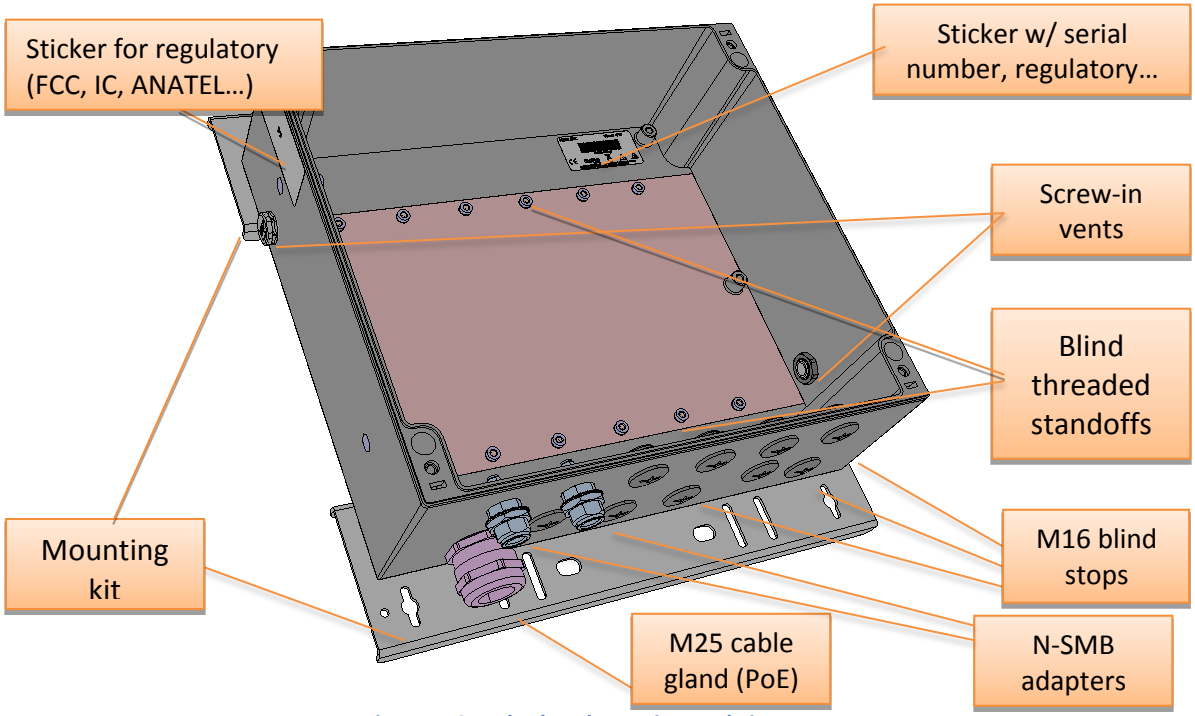


Figure 4: Standard enclosure internal view

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 – 1 modules configuration	6.2 Kg
Weight – 3 modules configuration	7.2 Kg
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)

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.

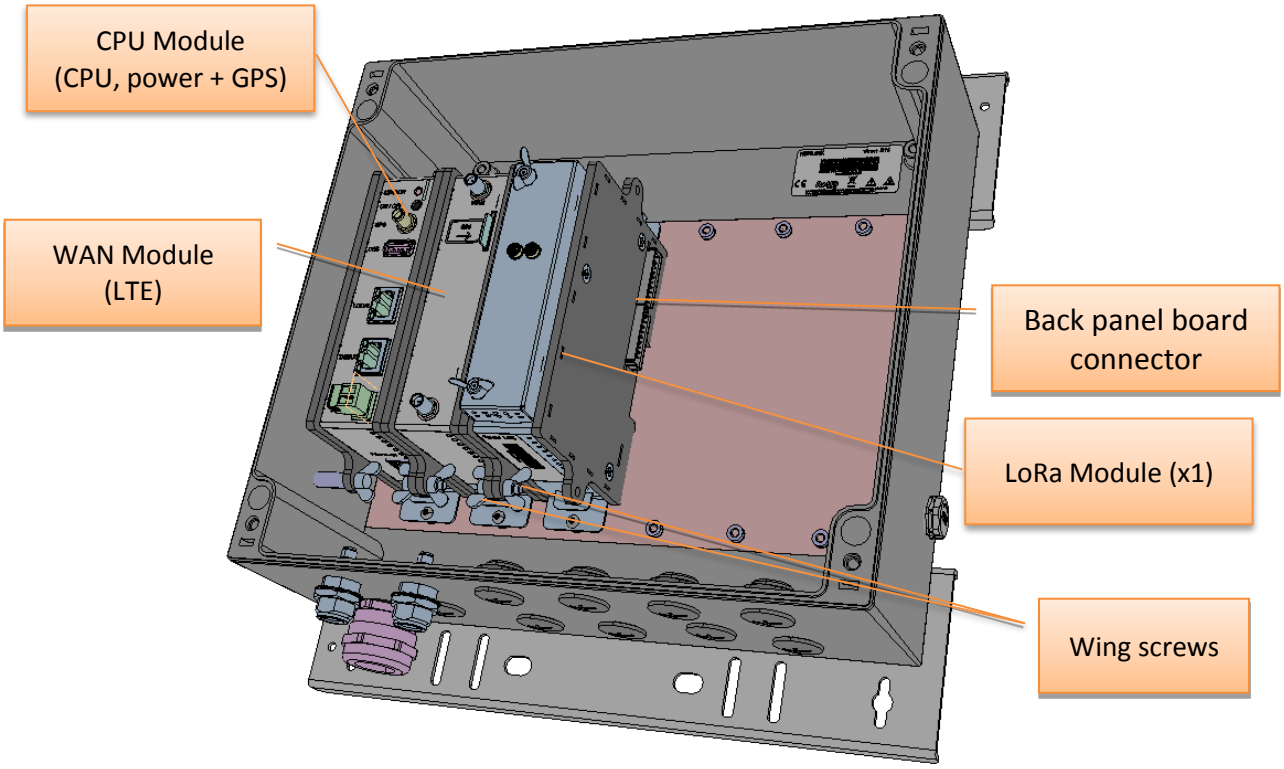


Figure 5: Insertion of the modules inside the standard enclosure

3.2.2 *Stickers*

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

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

The placement of the stickers is described on Figure 4.

3.3 Mechanical implementation for compact casing

3.3.1 *Compact casing*

The Wirnet iBTS Compact station is built on a high impact resistant IP67 polycarbonate wall mounting cabinet that withstand harsh industrial and outdoor environments.
It offers excellent flammability rating, good UV resistance and 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 trough 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.

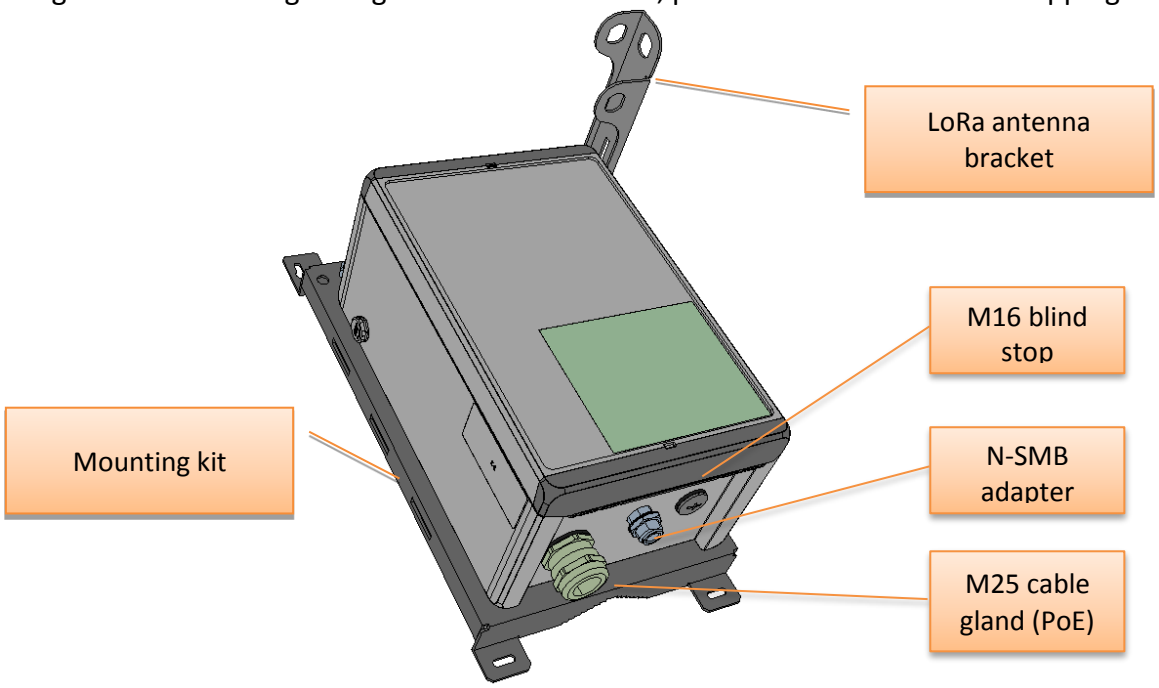


Figure 6: Wirnet iBTS Compact external view

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.

- 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. The 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 7 below shows the different components inside the enclosure.

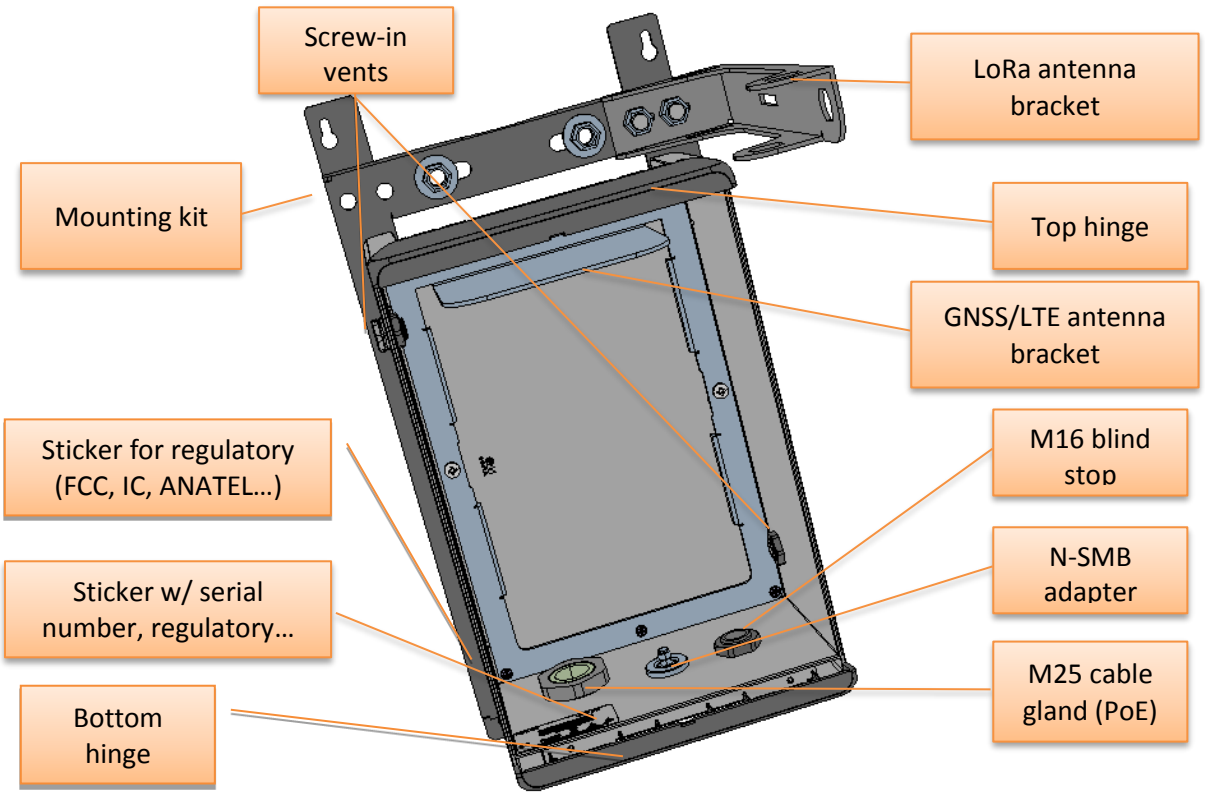


Figure 7: Wirnet iBTS Compact internal view

The main characteristics of the cabinet are detailed hereafter:

Description	Specification
Enclosure material	Polycarbonate (PC)
Gasket material	Polyurethane (PU)
Mounting kit material	Galvanized steel
Color	RAL7035
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.

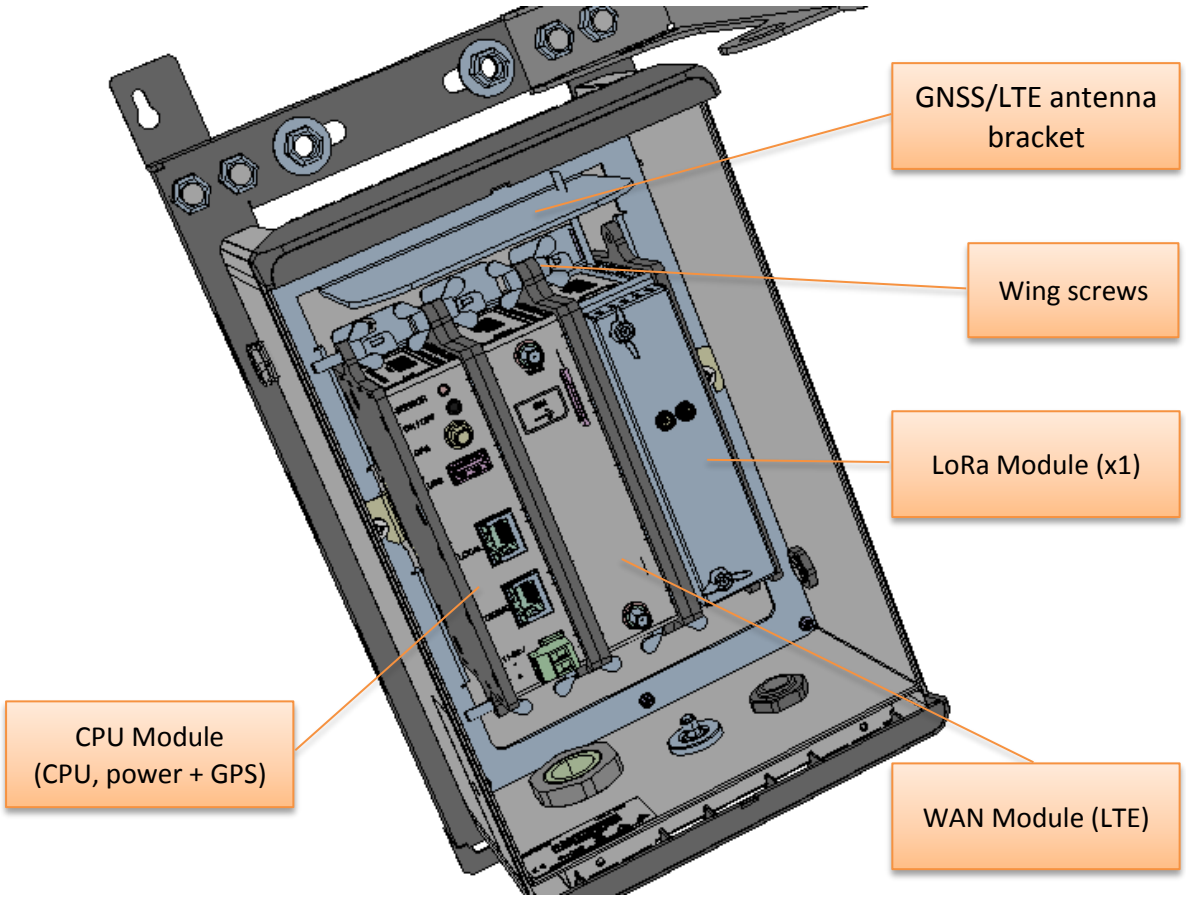


Figure 8: Insertion of the modules inside the compact cabinet

3.3.2 *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 and sentences depending on the countries (FCC, IC, ANATEL, etc …).

The placement of the stickers is described on Figure 7.

3.4 Block Diagram

3.4.1 *Common functionalities*

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

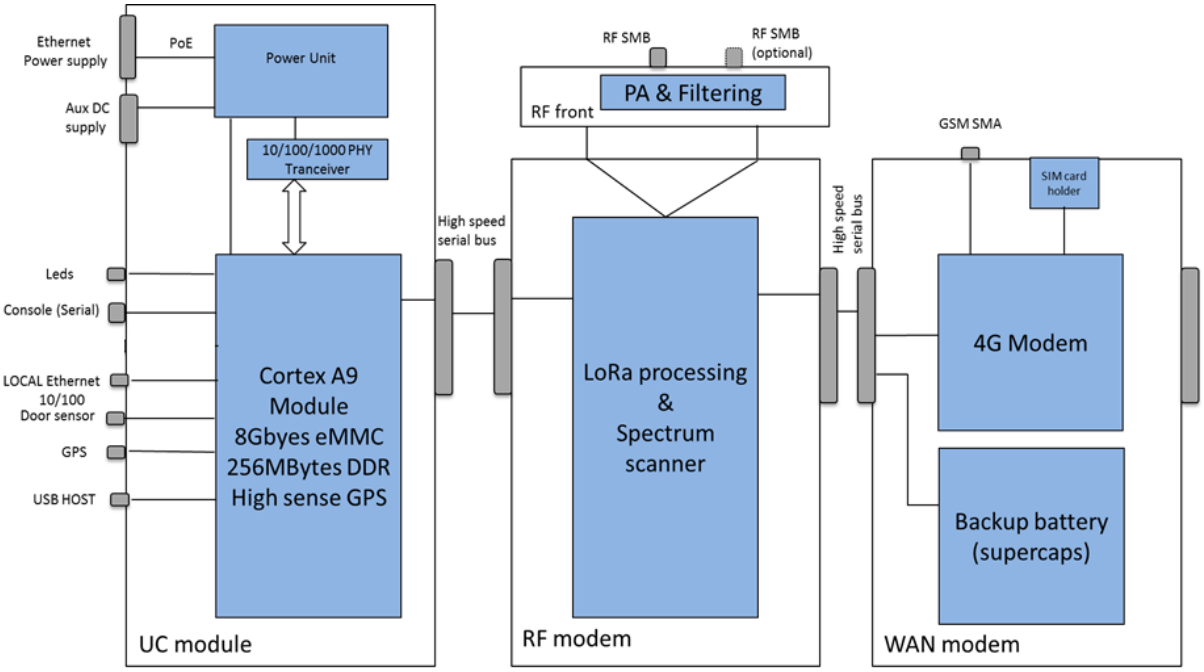


Figure 9: Common Wirnet iBTS block diagram

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

The CPU Module insures the main following 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

Therefore, the “CPU module” can manage all the modules inside the Wirnet iBTS.

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

- Backup battery (supercaps)

- A 4G Mini PCI Express module that can be declined in 2 versions depending on the geographical area:
  - Europe and APAC
  - Americas
- The USIM card holder
- A RF SMB connector to connect an LTE antenna
- An 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 module” can be derived in 3 bands versions to address different countries:

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

This band tuning is possible by only changing the RF front-end board (PA and filtering).
The RF front-end board is configured to support a single antenna (16 channels) and two antennas (2x8 channels).

3.4.2 *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":

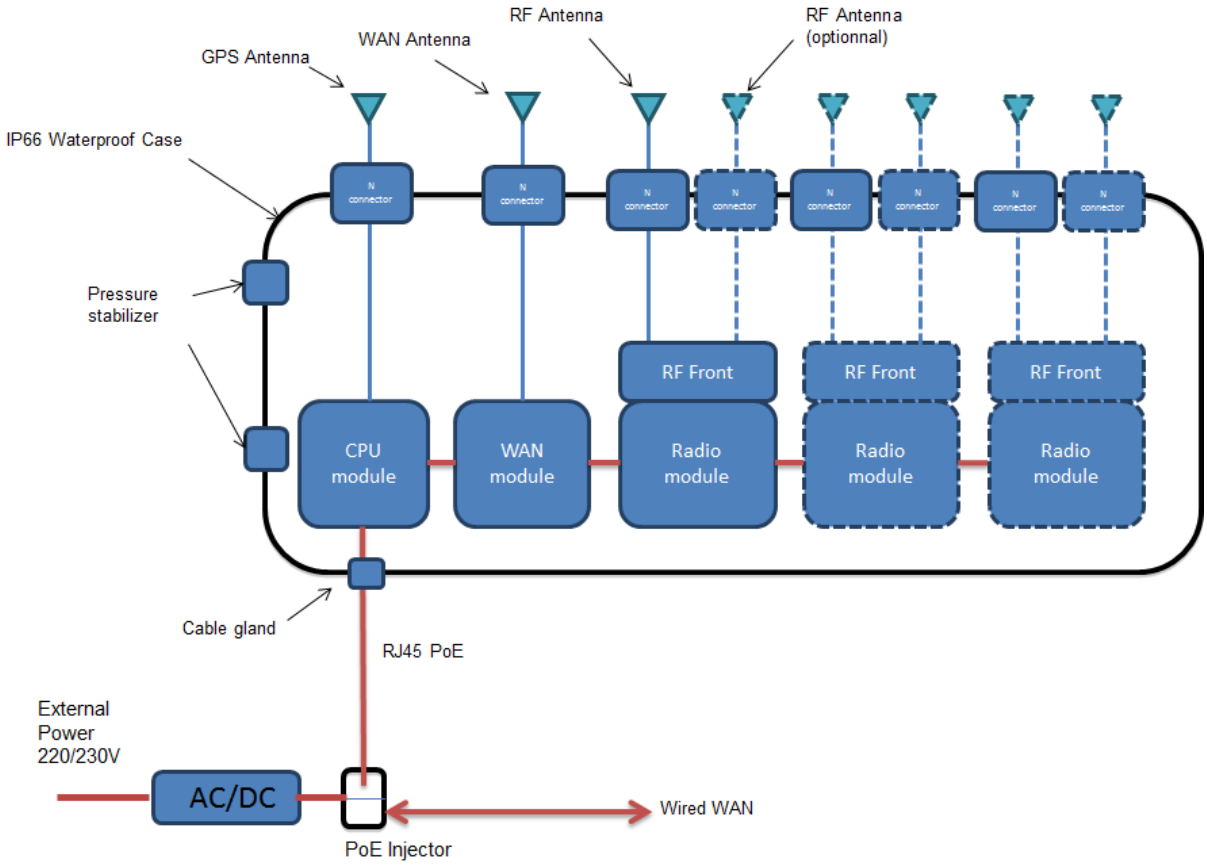


Figure 10: Standard Wirnet iBTS block diagram

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) and two antennas (2x8 channels). This could lead then to a "six LoRa antennas" configurations in the maximum use case (tri-sector, 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. The antennas are all external antennas.

3.4.3 *"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.

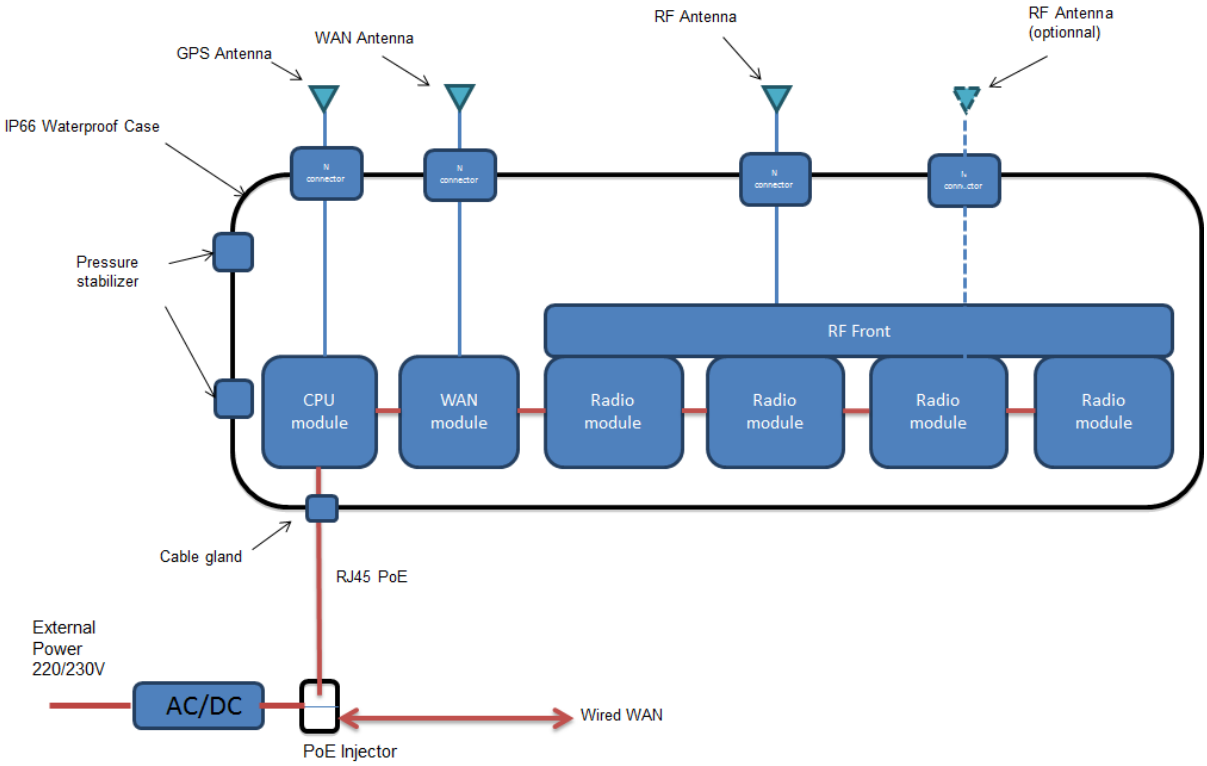


Figure 11: Wirnet iBTS "4 LoRa modules" block diagram

In this 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) and 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.

3.4.4 *Compact version of Wirnet iBTS*

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

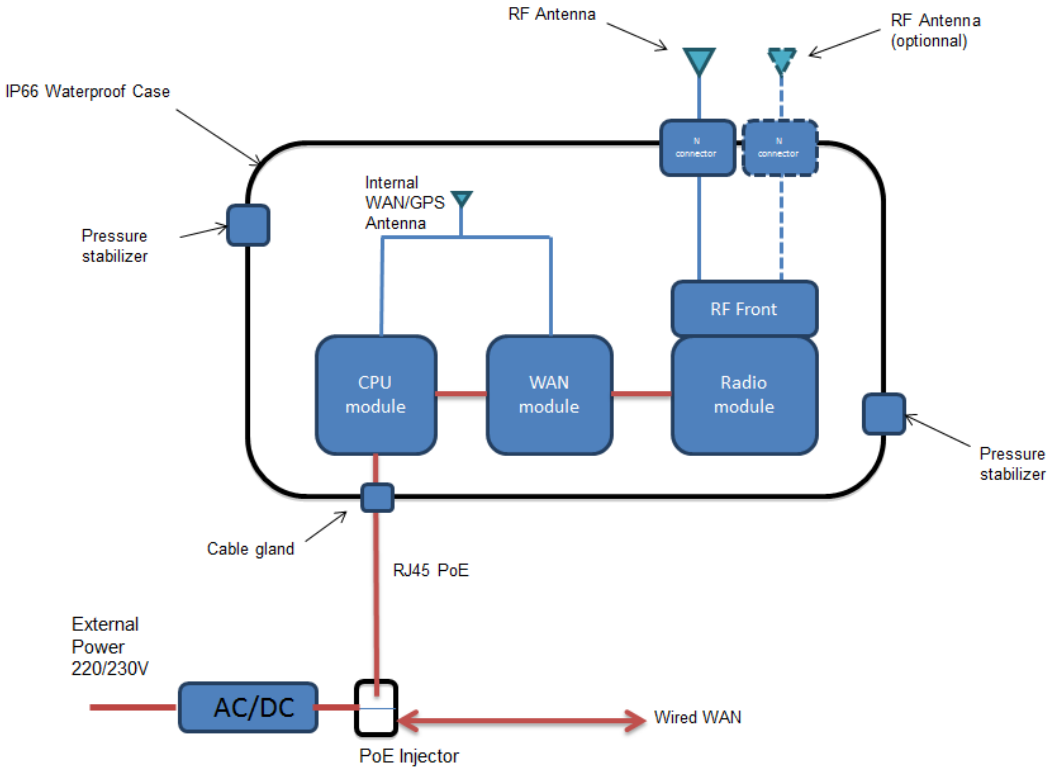


Figure 12: Wirnet iBTS Compact block diagram

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) and 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.

3.5 Power consumption

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

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

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
Wirnet iBTS with 2 x LoRa LOC Modules	392Wh
Wirnet iBTS with 3 x LoRa LOC Modules	547Wh
Wirnet iBTS with 4 x LoRa LOC Modules	702Wh

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

3.6 Detailed description of the modules

3.6.1 *CPU module*

3.6.1.1 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

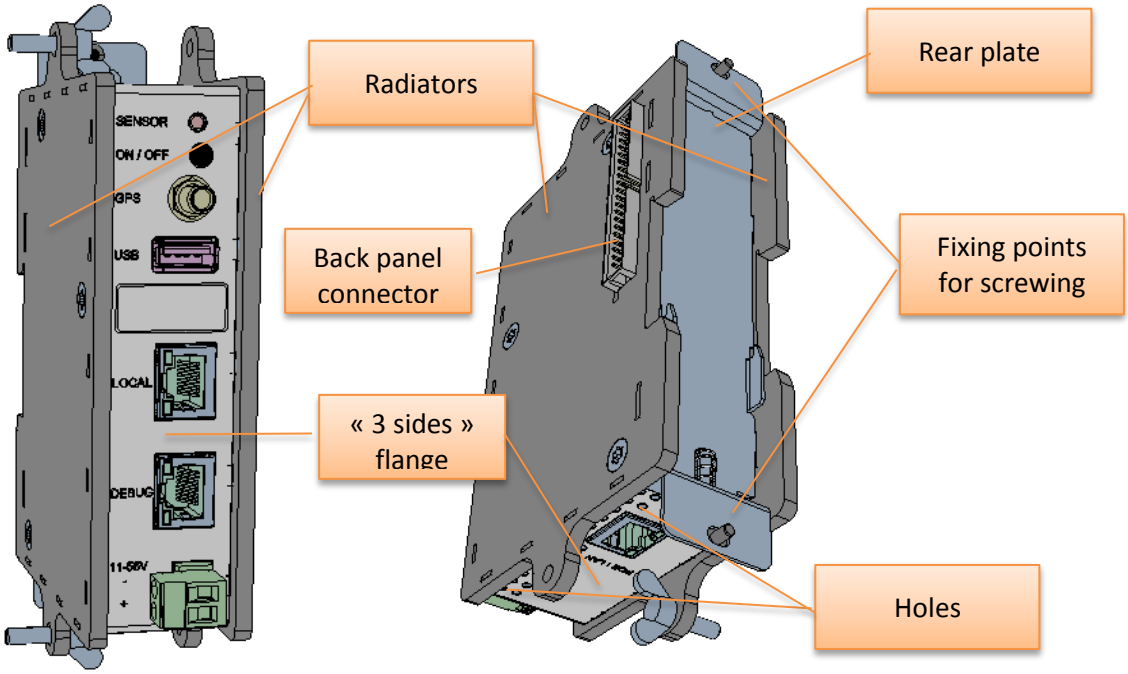


Figure 13: Mechanical description of the CPU module

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
Ingress protection	IP30

The CPU module must be positioned on the left side of the Wirnet iBTS enclosure to distribute the power supplies and high-speed serial bus to other modules.

3.6.1.2 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 §3.7.11
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

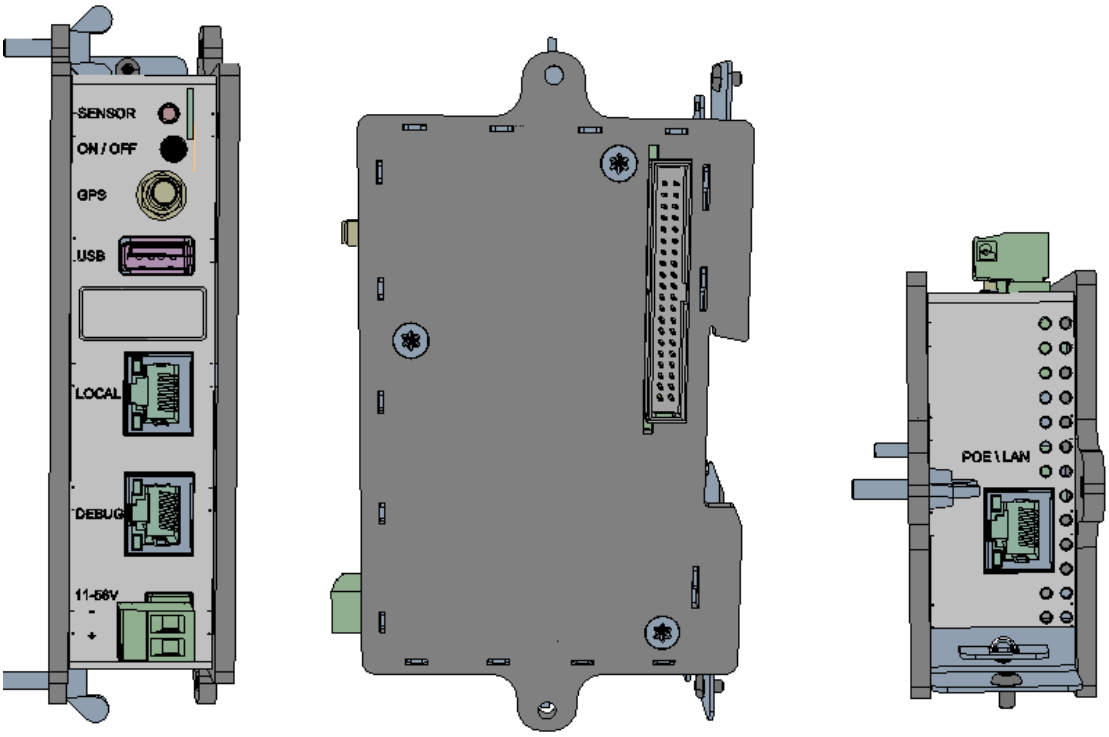


Figure 14: Connectors and user interfaces of the CPU module

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 §3.7.11.)

3.6.1.3 Detailed features

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 the core management unit of the Wirnet iBTS.

The CPU module includes the following detailed features:

Feature	Description
Processor	ARM Cortex A9, 800MHz core
	IEEE1588 Gigabit Ethernet controller
	1 USB HS Host
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
	NMEA 0183, version 4.0
	Time pulse (PPS) accuracy < 20ns for LoRa geolocation
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
PLL	High performance, low jitter PLL
	PTP, IEEE1588 capabilities
	GPS PPS used as reference clock
	Free-run and holdover modes
DEBUG	UART interface
	Debug tool to be used for UART to USB adaptation
Sensors	Light sensor to detect aperture of the enclose
	Pressure sensor
	Temperature sensor
Auto test	Internal power supplies check
	Interfaces and peripherals check
User interface	LED used for diagnostic (see §3.6.1.2)
	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

3.6.2 *WAN module*

3.6.2.1 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

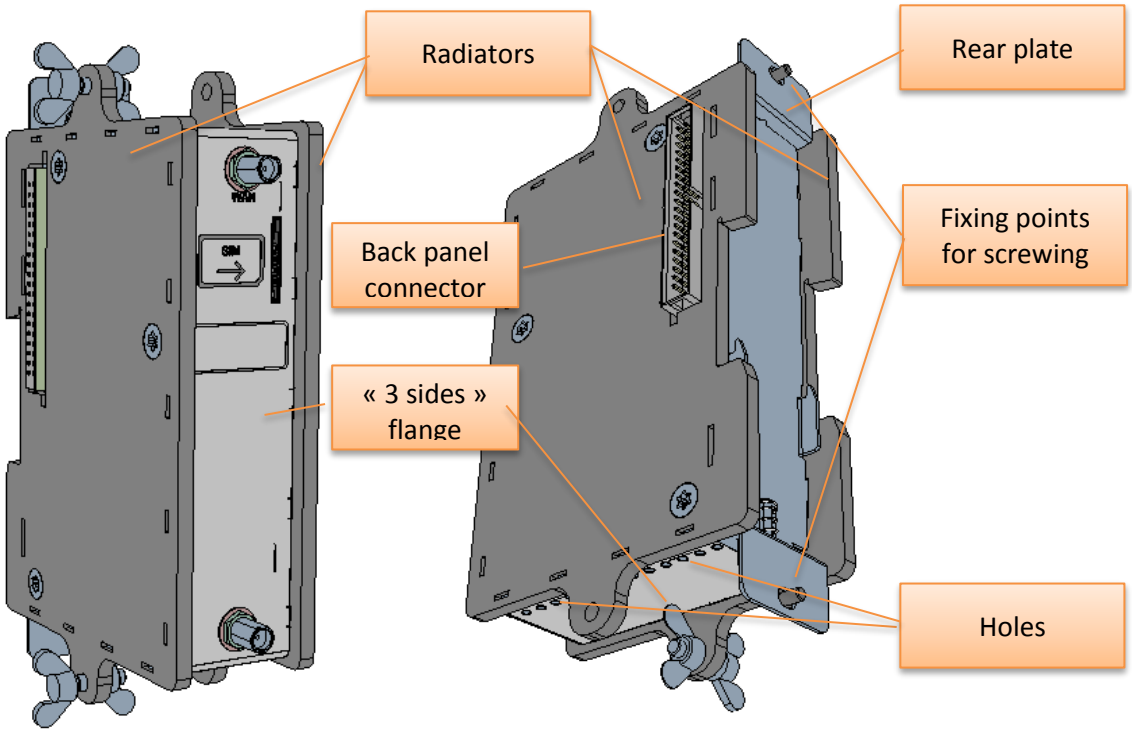


Figure 15: Mechanical description of the WAN module

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

The WAN module embeds four boards:

- The WAN board
- A back panel board
- One Mini PCI express board
- A notch filter board

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

- One for Europe
- One for APAC
- One for Americas

The notch filter board is a tiny PCB including 2 UFL connectors that can be plugged directly onto the Mini PCI Express card RF connector.
There are two versions of the notch filter:

- 868MHz notch filter
- 915MHz notch filter

The WAN board embeds a backup battery based on five supercaps.

3.6.2.2 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

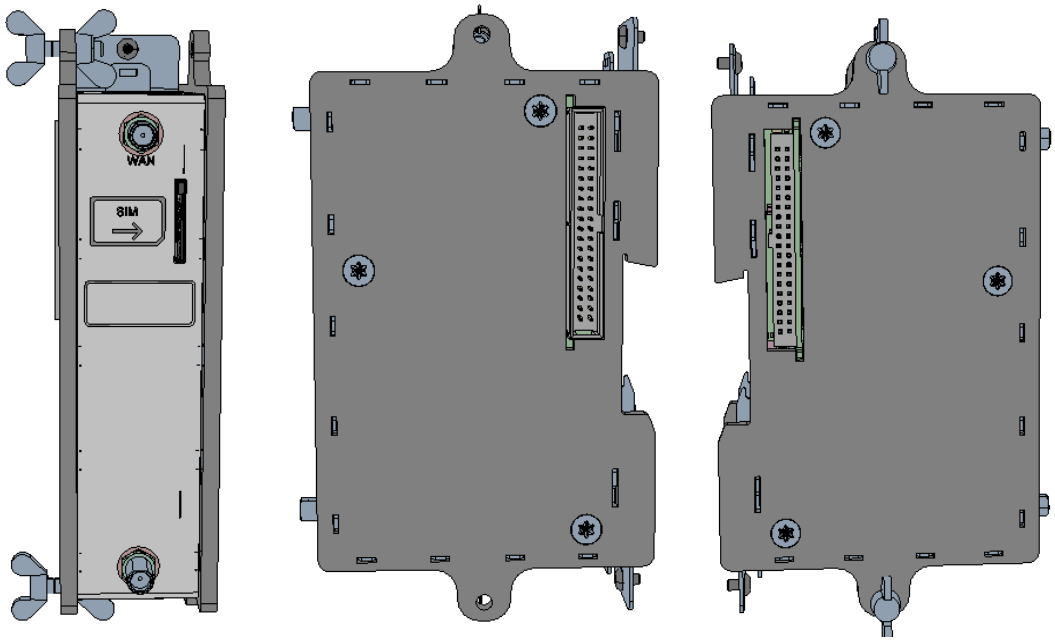


Figure 16: Connectors and user interfaces of the CPU module

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

3.6.2.3 Detailed features

3.6.2.3.1 WAN board

The architecture of the WAN board is very simple as it only includes:

- DC/DC converters to supply the Mini PCI Express cards. The Input voltage is the 9V provided by the back-panel board
- Five supercaps and the associated charging circuit, featuring a backup battery
- A USB Hub to manage the USB bus available on the back-panel board between the two MiniPCI Express cards
- Two Mini PCI Express connectors
- A USIM connector
- A HE10 40 contacts connectors for the back-panel board

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)
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
User interface	USIM connector, push-push type
	SMA RF connector (LTE)
Operating temperature range	-20°C to +55°C
Current drain @48V	21mA HSPA Rx (attached)
	72mA HSPA Tx@Pout max

3.6.2.3.2 LTE - Europe and APAC Mini PCI Express card

The first 4G Mini PCI Express card is dedicated to the European and APAC markets.
The reference is Sierra Wireless MC7304.
This module is already GCF approved and meets the Radio Equipment and Telecommunications Terminal Equipment (R&TTE) Directive of the European Union.

The mains characteristics are summarized hereafter, but more information can be found on Sierra Wireless website.

The bands and data rate supported by the MC7304 are the following:

Technology	Band	Data rate
LTE **3GPP Release 9**	Band 1 (2100MHz) Band 3 (1800MHz) Band 7 (2600MHz) Band 8 (900MHz) Band 20 (800MHz)	Category 3 • Downlink: ○ 100Mbps (20MHz BW) ○ 50Mbps (10MHz BW) • Uplink: ○ 50Mbps (20MHz BW) ○ 25Mbps (10MHz BW)
UMTS **HSPA** **3GPP Release 8**	Band 1 (2100MHz) Band 2 (1900MHz) Band 5 (850MHz) Band 8 (900MHz)	HSPA+ rates: • Downlink: up to 42Mbps (category 24) • Uplink: up to 5.76Mbps (category 6)
GSM **GPRS** **EDGE** **3GPP Release 99**	GSM 850 (850MHz) EGSM 900 (900MHz) DCS 1800 (1800MHz) PCS 1900 (1900MHz)	GPRS Multislot class 10 GPRS Multislot class 12 CS1 to CS4 MCS1 to MCS9 EDGE throughput up to 236kbps

The conducted receiver sensitivity of the MC7304, depending on the bands and the technologies are:

Technology	Conducted RX sensitivity (typical)
LTE band 1 (10MHz BW)	-98.7dBm
LTE band 3 (10MHz BW)	-99.5dBm
LTE band 7 (10MHz BW)	-98.0dBm
LTE band 8 (10MHz BW)	-99.3dBm
LTE band 20 (10MHz BW)	-99.6dBm
HSPA band 1 (0.1% BER, 12.2 kbps)	-111.4dBm
HSPA band 2 (0.1% BER, 12.2 kbps)	-110.8dBm
HSPA band 5 (0.1% BER, 12.2 kbps)	-111.4dBm
HSPA band 8 (0.1% BER, 12.2 kbps)	-111.8dBm
GSM850 (10% BLER)	-112dBm CS1 -104dBm MCS5
EGSM900 (10% BLER)	-112dBm CS1 -104dBm MCS5
DCS1800 (10% BLER)	-112dBm CS1 -105dBm MCS5
PCS1900 (10% BLER)	-112dBm CS1 -104dBm MCS5

The conducted output power of the MC7304, depending on the bands and the technologies are:

Parameter	Conducted TX power	Notes
LTE band 1, 3, 8, 20	+23dBm +/- 1dB	Can vary as per 3GPP MPR table
LTE band 7	+22dBm +/- 1dB	Can vary as per 3GPP MPR table
HSPA band 1, 2, 5, 8	+23dBm +/- 1dB	Class 3
GSM850, EGSM900	+32dBm +/-1dB +27dBm +/-1dB	GMSK, class 4 8PSK, class E2
DCS1800, PCS1900	+29dBm +/-1dB +26dBm +/-1dB	GMSK, class 1 8PSK, class E2

LTE antenna gain must be considered to determine the associated EIRP and radiated sensitivity.

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

The second 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 **3GPP Release 11** **FDD and TDD**	B1 (2100) - FDD B3 (1800+) - FDD B5 (850) - FDD B7 (2600) - FDD B8 (900) - FDD B18 (800 lower) - FDD B19 (800 upper) - FDD B21 (1500 upper) - FDD B28 (700APT) - FDD B38 (2600) – TDD B39 (1900+) – TDD B40 (2300) – TDD B41 (2500) - TDD	Category 6 • Downlink: ○ FDD: 300Mbps ○ TDD: 222Mbps • Uplink: ○ FDD: 50Mbps ○ TDD: 26Mbps
UMTS **HSPA** **3GPP Release 9**	B1 (2100) B5 (850) B6 (850 UMTS only) B8 (900) B9 (1800) B19 (800 upper)	HSPA+ rates: • Downlink: up to 42Mbps (category 24) • Uplink: up to 5.76Mbps (category 6)
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 **GPRS** **EDGE** **3GPP Release 99**	None	N/A

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

3.6.2.3.4 LTE - Americas Mini PCI Express card

The last 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 mains characteristics are summarized hereafter, but more information can be found on Sierra Wireless website.

The bands and data rate supported by the MC7354 are the following:

Technology	Band	Data rate
LTE **3GPP Release 9**	Band 2 (1900MHz) Band 4 (1700/2100MHz) Band 5 (850MHz) Band 13 (700MHz) Band 17 (700MHz) Band 25 (1900MHz)	Category 3 • Downlink: ○ 100Mbps (20MHz BW) ○ 50Mbps (10MHz BW) • Uplink: ○ 50Mbps (20MHz BW) ○ 25Mbps (10MHz BW)
CDMA **EVDO release 0** **EVDO release A**	BC0 (800MHz) BC1 (1900MHz) BC10 (800MHz)	CDMA IS-856 (1xEV-DO Release A) • Up to 3.1 Mbps forward channel • Up to 1.8 Mbps reverse channel CDMA IS-2000 • Up to 153 kbps, simultaneous forward and reverse channel Circuit-switched data bearers up to 14.4 kbps
UMTS **HSPA** **3GPP Release 8**	Band 1 (2100MHz) Band 2 (1900MHz) Band 4 (1700/2100MHz) Band 5 (850MHz) Band 8 (900MHz)	HSPA+ rates: • Downlink: up to 42Mbps (category 24) • Uplink: up to 5.76Mbps (category 6)
GSM **GPRS** **EDGE** **3GPP Release 99**	GSM 850 (850MHz) EGSM 900 (900MHz) DCS 1800 (1800MHz) PCS 1900 (1900MHz)	GPRS Multislot class 10 GPRS Multislot class 12 CS1 to CS4 MCS1 to MCS9 EDGE throughput up to 236kbps

The conducted receiver sensitivity of the MC7354, depending on the bands and the technologies are:

Technology	Conducted RX sensitivity (typical)
LTE band 2 (10MHz BW)	-99.1dBm
LTE band 4 (10MHz BW)	-99.7dBm
LTE band 5 (10MHz BW)	-98.0dBm
LTE band 13 (10MHz BW)	-98.7dBm

LTE band 17 (10MHz BW)	-99.7dBm
LTE band 25 (10MHz BW)	-98.8dBm
CDMA BC0 CDMA 1x (0.5% FER)	-109.6dBm
CDMA BC0 EVDO rev A (0.5% PER)	-109.8dBm
CDMA BC1 CDMA 1x (0.5% FER)	-110.8dBm
CDMA BC1 EVDO rev A (0.5% PER)	-110.6dBm
CDMA BC10 CDMA 1x (0.5% FER)	-110.3dBm
CDMA BC10 EVDO rev A (0.5% PER)	-110.7dBm
HSPA band 1 (0.1% BER, 12.2 kbps)	-111.0dBm
HSPA band 2 (0.1% BER, 12.2 kbps)	-111.4dBm
HSPA band 4 (0.1% BER, 12.2 kbps)	-112.1dBm
HSPA band 5 (0.1% BER, 12.2 kbps)	-110.8dBm
HSPA band 8 (0.1% BER, 12.2 kbps)	-111.8dBm
GSM850 (10% BLER)	-111dBm CS1 -102dBm MCS5
EGSM900 (10% BLER)	-111dBm CS1 -102dBm MCS5
DCS1800 (10% BLER)	-111dBm CS1 -101dBm MCS5
PCS1900 (10% BLER)	-111dBm CS1 -101dBm MCS5

The conducted output power of the MC7354, depending on the bands and the technologies are:

Parameter	Conducted TX power	Notes
LTE band 2, 4, 5, 13, 25	+23dBm +/- 1dB	Can vary as per 3GPP MPR table
CDMA BC0, BC1, BC10	+24dBm +0.5/- 1dB	
HSPA band 1, 2, 4, 5, 8	+23dBm +/- 1dB	Class 3
GSM850, EGSM900	+32dBm +/-1dB	GMSK, class 4
	+27dBm +/-1dB	8PSK, class E2
DCS1800, PCS1900	+29dBm +/-1dB	GMSK, class 1
	+26dBm +/-1dB	8PSK, class E2

LTE antenna gain must be considered to determine the associated EIRP and radiated sensitivity.

3.6.2.3.5 Notch filter

A notch filter is included in the WAN module. The purpose of this notch filter is to reject the noise generated by the 4G modem in the LoRa unlicensed band. This may happen for instance when the LTE antenna and the LoRa antenna are very close to each other.

The notch filter insures that the LTE modem does not desensitize the LoRa receiver.

There are two versions of the notch filter:

- 868MHz notch filter
- 915MHz notch filter

The performances of the 868MHz notch filter are the following:

Parameter	Specification
Band pass 1	880 - 960 MHz
Band pass 2	1710 – 1880 MHz
Band pass 3	1920 – 2170 MHz
Insertion Loss at BP1	1.6dB typ (2.5dB max)
Insertion Loss at BP2	1.15dB typ (2.0dB max)
Insertion Loss at BP3	1.4dB typ (2.0dB max)
Attenuation 863 - 868 MHz	>9dB typ
Attenuation 868 - 870 MHz	>33dB typ
Input/output impedance	50 ohms
RF connectors	UFL

The performances of the 915MHz notch filter are the following:

Parameter	Specification
Band pass 1	824 - 890 MHz
Band pass 2	890 – 894 MHz
Band pass 3	1710 – 1880 MHz
Band pass 4	1880 – 1990 MHz
Band pass 5	2100 – 2170 MHz
Insertion Loss at BP1	0.85dB typ (2.0dB max)
Insertion Loss at BP2	1.4dB typ (5.0dB max)
Insertion Loss at BP3	2.2dB typ (2.8dB max)
Insertion Loss at BP4	2.3dB typ (3.0dB max)
Insertion Loss at BP5	2.45dB typ (3.0dB max)
Attenuation 902-908.5 MHz	>11.5dB typ
Attenuation 908.5-920.5 MHz	>12.5dB typ
Attenuation 920.5-928 MHz	>14.1dB typ
Input/output impedance	50 ohms
RF connectors	UFL

3.6.3 *Dual WAN Module*

3.6.3.1 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

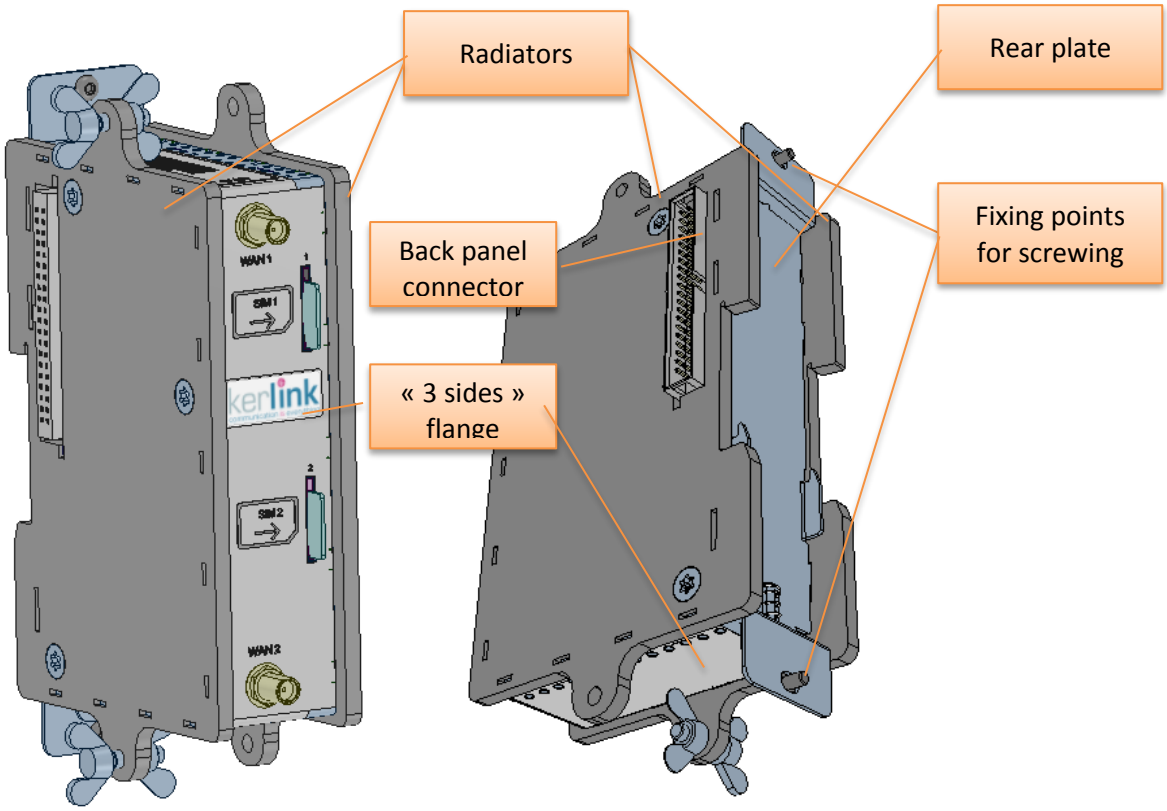


Figure 17: Mechanical description of the Dual WAN module

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

3.6.3.1 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

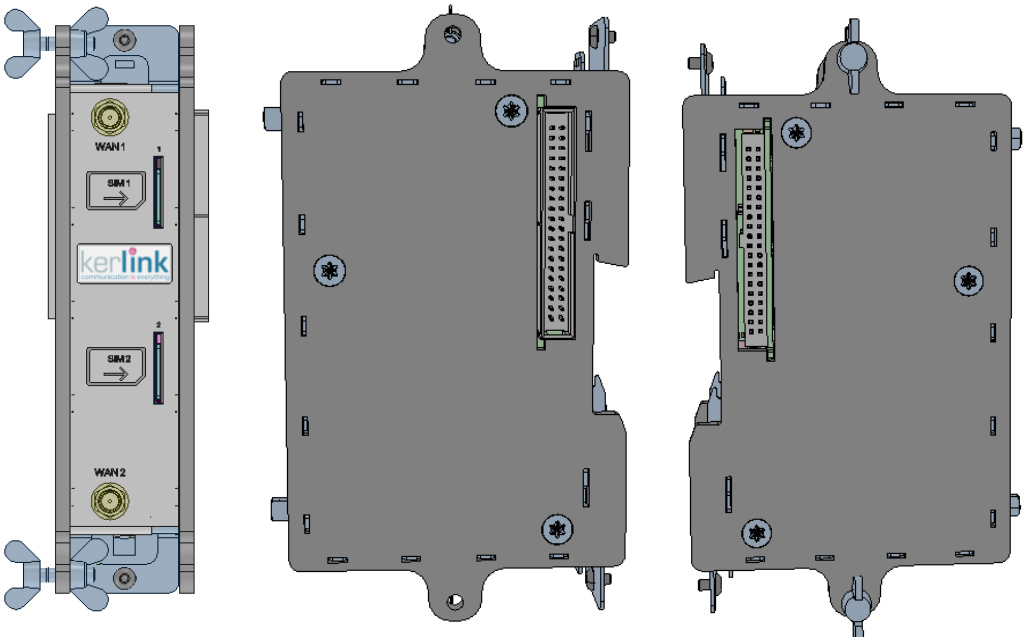


Figure 18: Connectors and user interfaces of the Dual WAN module

3.6.3.2 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

3.6.3.3 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 3.6.2.3.2.

3.6.4 *LoRa module – LoRa LOC*

3.6.4.1 Mechanical description

3.6.4.1.1 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

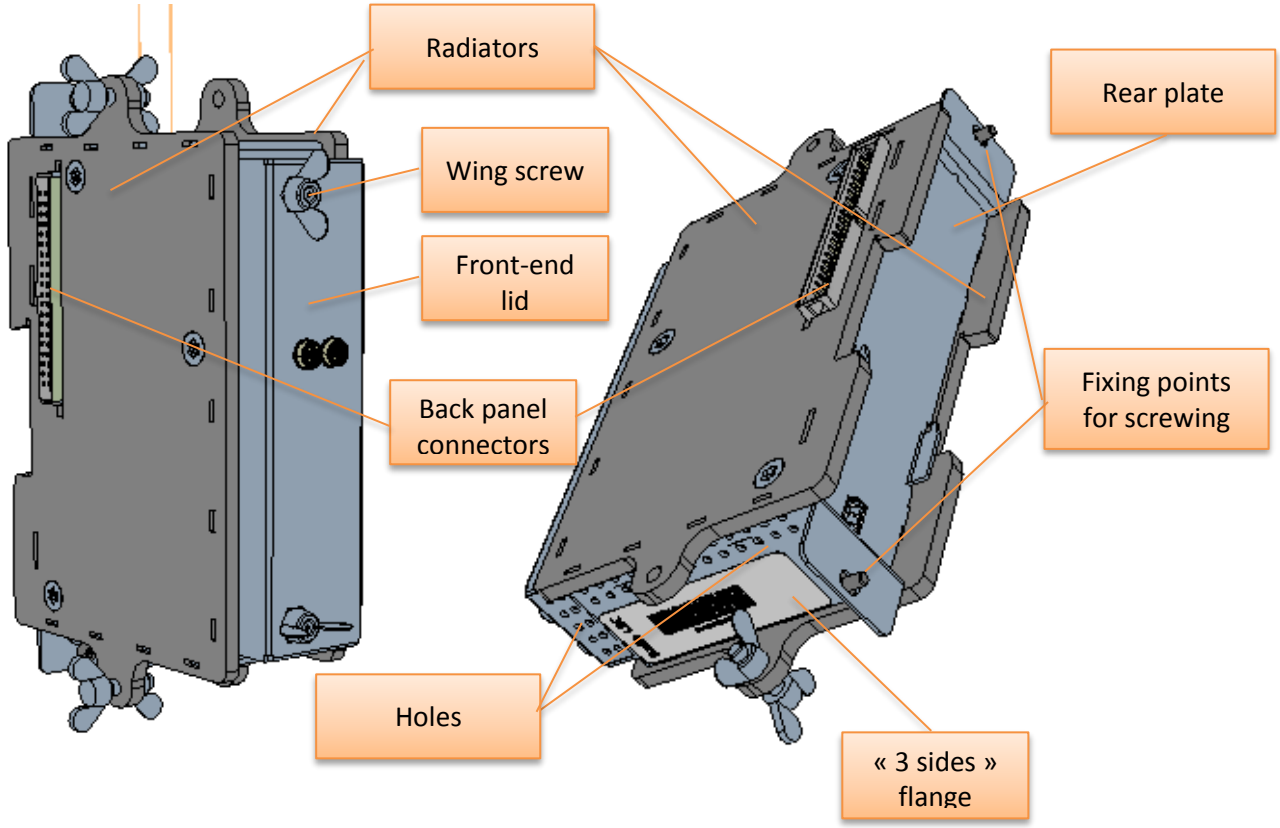


Figure 19: Mechanical description of the LoRa – LOC module

The rear plate and the two radiators side flanges are the same as the one used for the CPU module. 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 module embeds three boards:

- A back panel board
- The LoRa-LOC modem board
- A front-end radio board

The back-panel board is used to connect the CPU module through the back panel connector and provide another back panel connector to the next module. This board is the same as the one used in the WAN module.

The Lora-LOC board integrates the LoRa-LOC modem based on the AD9361 transceiver (Analog Devices) and SX1301 (Semtech) + DSP as demodulators.

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

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

The front-end board is connected to the LoRa-LOC board trough SMB RF connectors and a HE10 14 contacts.

3.6.4.1.2 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 the four modules together.

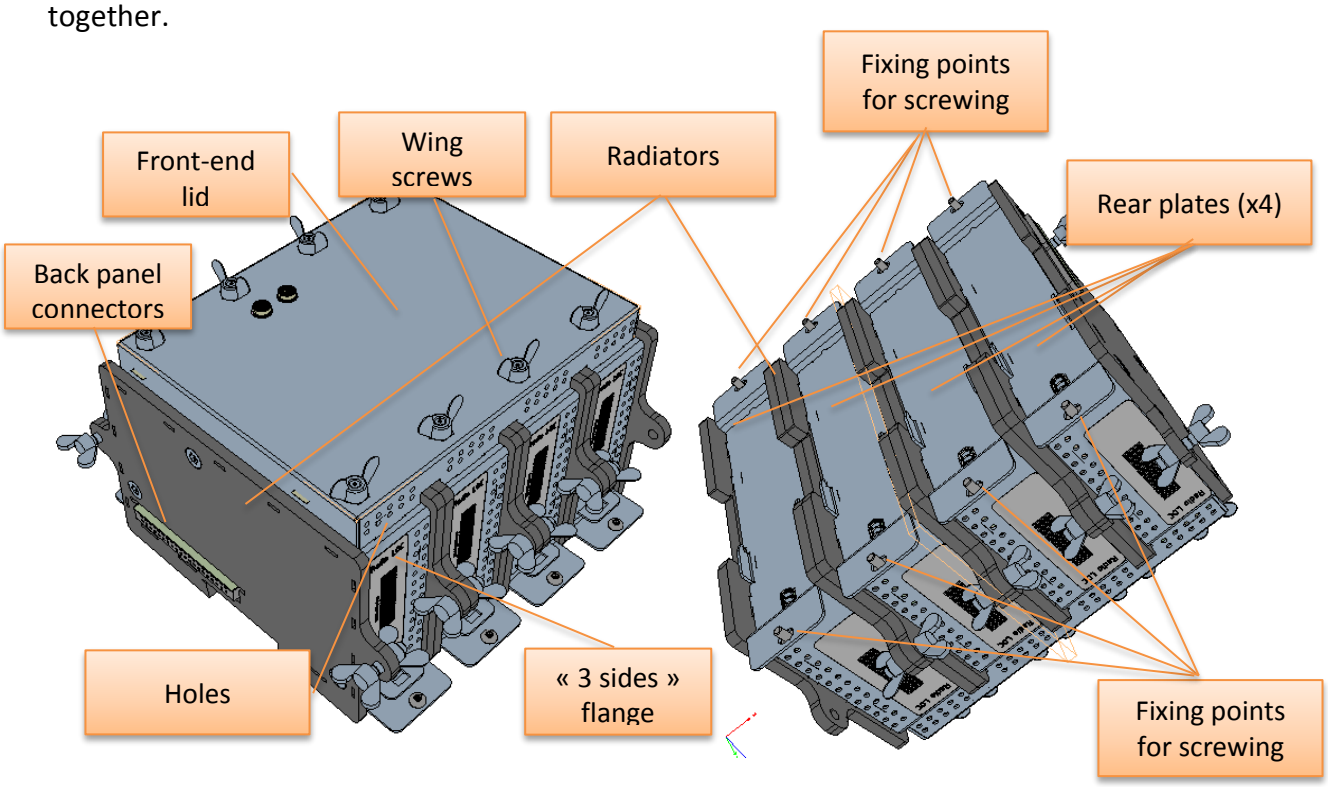


Figure 20: Mechanical description of the four LoRa LOC modules configuration

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

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

- 4 back panel boards
- 4 LoRa-LOC modem boards
- A single front-end 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 furthermore detailed.

Four Lora LOC boards are used. They integrate the AD9361 transceiver and SX1301 + DSP as demodulators, as described previously.

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

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

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.

3.6.4.2 Connectors and user interfaces

3.6.4.2.1 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 connectors # RF1 and # RF2 are connected to the SMB/N adapters on the bottom side of the Wirnet iBTS via SMB coaxial cables.

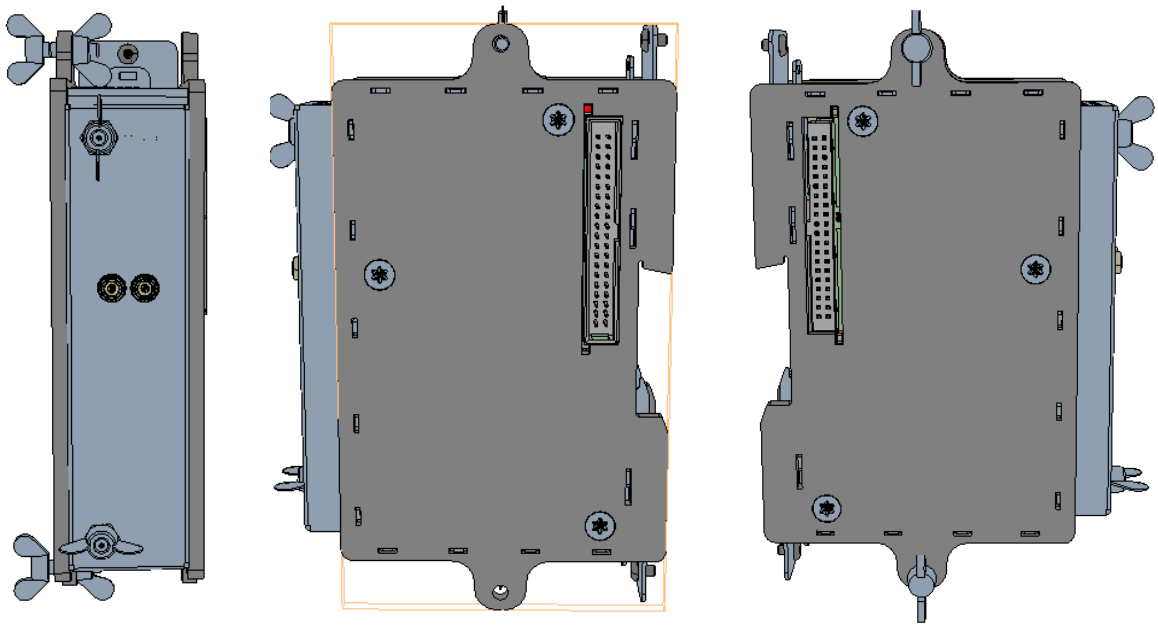


Figure 21: Connectors and user interfaces of the LoRa LOC module

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:

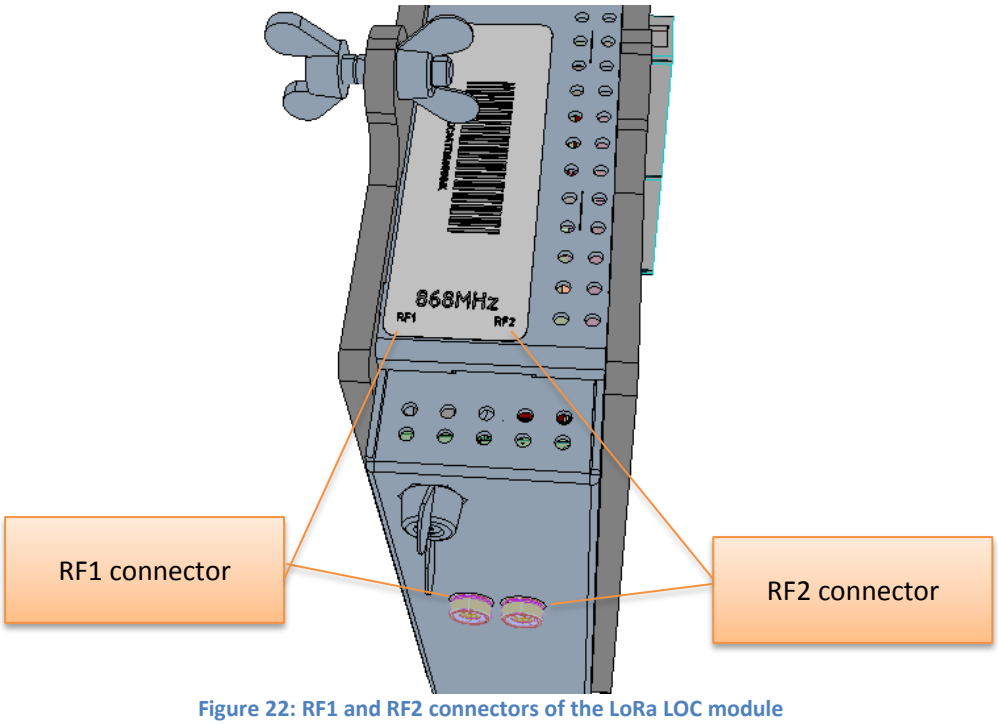


Figure 22: RF1 and RF2 connectors of the LoRa LOC module

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

3.6.4.2.2 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 connectors # RF1 and # RF2 are connected to the SMB/N adapters on the bottom side of the Wirnet iBTS via SMB coaxial cables.

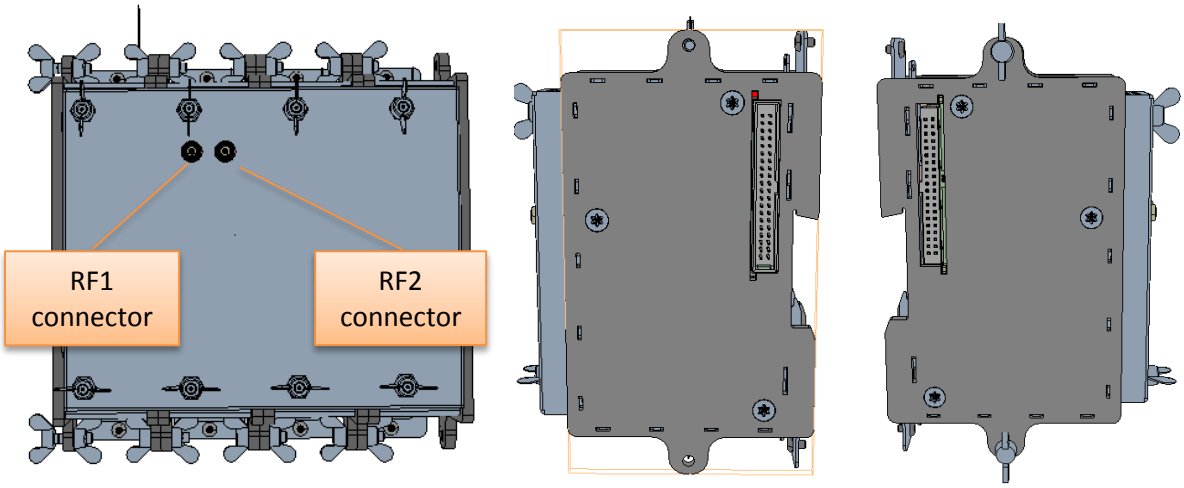


Figure 23: Connectors and user interfaces of the 4 LoRa LOC modules

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.

3.6.4.3 LoRa LOC modem board

The following block diagram details the architecture of the LoRa LOC module:

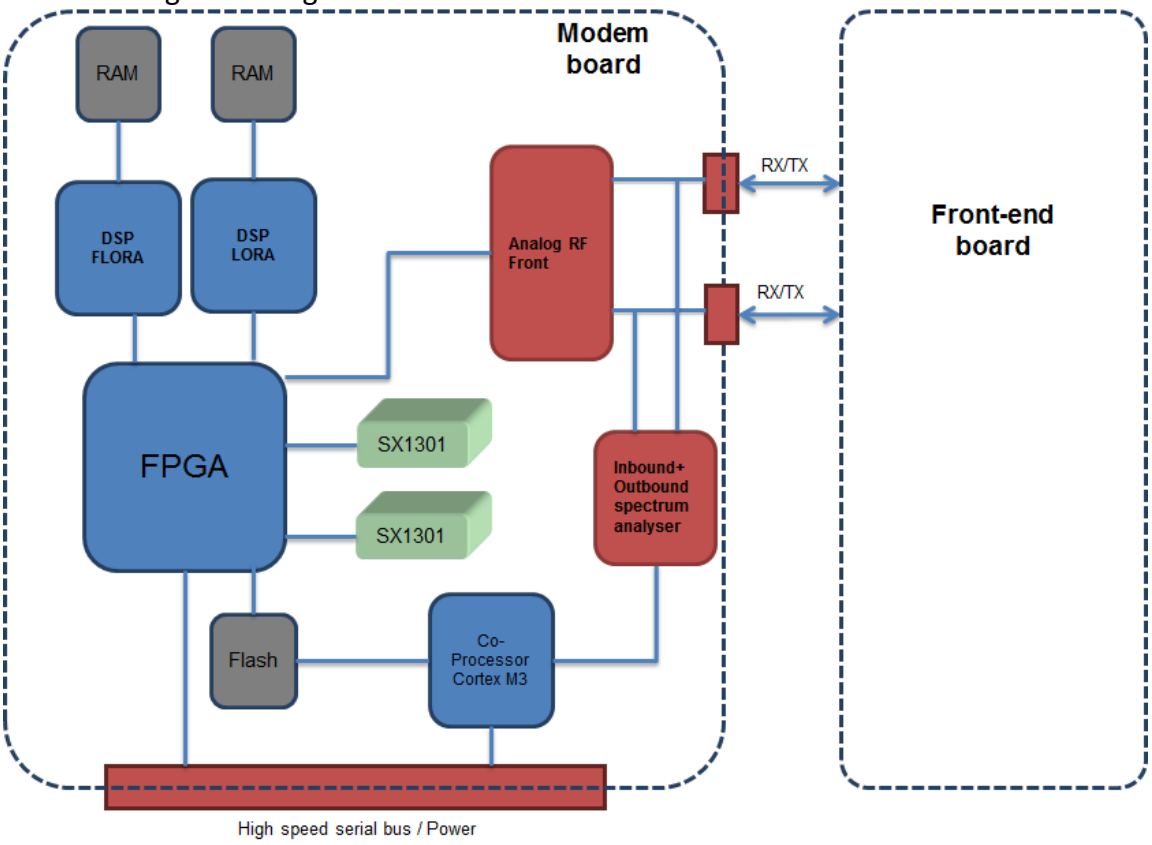


Figure 24: LoRa LOC board block diagram

a. Transmitter :

The Tx LoRa modulator is based on the AD9361 from Analog Devices. This modem includes two identical transmitters path (RF path 1 and RF path 2). The data are provided by the two SX1301 through the FPGA via the digital interface. The FPGA complete some pulse shaping filtering to optimize the RF output spectrum.
The AD9361 is a direct conversion transmitter achieving high modulation accuracy and ultra-low noise performance. It can achieve about -160dBc/Hz at 20MHz offset and about -150dBc/Hz at 7MHz offset. Therefore, the noise generated by the transmitter in the WAN bands is very low, causing no desensitization of the co-localized BTS.
The two TX signals are then injected in the front-end board where they are filtered and amplified.

b. Receiver :

The receiver is a SDR receiver including wide band downconverter and DSP demodulators.
Two RX signals are coming from the front-end board where it were amplified and filtered.
The down conversion of the RF signals is completed by the AD9361, which manages the two RF inputs simultaneously. The Baseband signals are provided then to the two SX1301,

through the FPGA, which demodulates the LoRa signals. Each SX1301 can demodulate up to 8 channels, so 16 channels in total.
The time stamping of the signals, for geolocation purpose, are completed by the first DSP.
A second DSP is available for possible future evolutions.

In parallel of the two Rx paths, two SX1239 (Semtech) are used to perform spectrum analysis. They are controlled by a M3 co-processor. This analysis can be completed without impacting the LoRa reception on the mainstream.

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

Feature	Description
DSP (x2)	Texas Instruments OMAP-L138
	Dual core SoC
	ARM926EJ-S™ RISC MPU
	C674x fixed – and floating – point VLIW DSP
	Core running at up to 456MHz
	Up to 3648 MIPS and 2746 MFLOPS
	64 general-purpose registers (32-Bit)
	Six ALU (32- and 40-Bit) Functional Units
	Two Multiply Functional Units
	16 bits DDR2 SDRAM (256MB) Memory Controller
	EMIFA Memory Controller for NOR, NAND and 16 bits SDRAM (128MB)
	Three configurable UART Modules
	Two Serial Peripheral Interfaces (SPIs)
	Two Master and Slave I2C Bus
	Two Multimedia Card (MMC)/Secure Digital (SD) Card Interfaces
	Programmable Real-Time Unit Subsystem
	USB 2.0 OTG Port with Integrated PHY
	10/100 Mbps Ethernet MAC IEEE 802.3 Compliant
	High-Speed Parallel Interface to FPGAs and Data Converters
	Two Enhanced High-Resolution Pulse Width Modulators
	Real-Time Clock (RTC) with 32-kHz Oscillator
	Three 64-Bit General-Purpose Timers
	One 64-Bit Watchdog Timer
FPGA	Dual-core SoC, ARM Cortex-A9 MPCore processor and FPGA
	925 MHz maximum frequency
	8-input Adaptive Logic Modules (ALM)
	Up to 13.59 Mb of embedded memory with ECC
	Variable-precision DSP blocks
	875Mbps LVDS receiver and 840 Mbps LVDS transmitter

	614 Mbps to 6.144 Gbps integrated transceiver speed
	Hard memory controllers DDR3, DDR2, and LPDDR2 with 16 and 32 bit ECC support
	USB 2.0 OTG controller
	SD/MMC controller
	UART, SPI and I2C interfaces
	Up to 85 GPIO interfaces
	Precision PLLs, integer and fractional modes
Flash	NOR Flash
	128Mb
	SPI interface
	100 000 erase cycles per sector
	20 years data retention
RAM (x2)	DDR2 SDRAM
	512Mb
	16 bits
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
	2 MHz baseband BW
	FSK or LORA modulator
	70 dB CW interferer rejection at 1 MHz offset
	SPI interface to MCU
	Digital interface to radio transceiver
	5 x GPIO
Geolocation	Completed by OMAP-L138 DSP
	Outdoor and indoor environments
	Synchronization with GPS PPS clock
	Combines RSSI and TDOA measurements
	Accuracy < 50m (90% confidence, high density coverage)
Transceiver	Analog Devices AD9361
	70MHz to 6000MHz frequency range
	200 kHz to 56 MHz channel BW
	Integrated fractional-N synthesizers

	2 × 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
	Independent automatic gain control
	DC offset correction, quadrature correction and digital filtering
	Very low LO leakage
Sniffer (x2)	Based on Semtech SX1239
	Zero-IF receiver
	Fractional-N PLL
	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
M3 MCU	ARM Cortex-M3 CPU platform
	High Performance 32-bit processor @ up to 48 MHz
	Memory Protection Unit
	Flexible Energy Management System
	512 KB Flash
	128 KB RAM
	Hardware AES with 128/256-bit keys in 54/75 cycles
	12-bit 1 Msamples/s ADC
	12-bit 500 ksamples/s DAC
	2× Analog Comparators
	3× Operational Amplifiers
	Low Energy Sensor Interface
	9 x Timers/Counters
	Watchdog Timer
	RTC and retention registers

	3× UART/SPI/SmartCard/IrDA/I2S interfaces
	2× Low Energy UART
	2× I2C Interfaces
	Universal Serial Bus (USB2.0) with Host & OTG support
	50 x configurable GPIO
	Debug Interface
Autotest	Check of the LoRa LOC module power supplies by M3 MCU
Operating temperature range	-20°C to +85°C
Current drain @48V	130mA in Receive Mode (all demodulators activated)
	120mA in Transmit mode@27dBm

3.6.4.4 Front-end boards

3.6.4.4.1 Front-end board - Single module

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

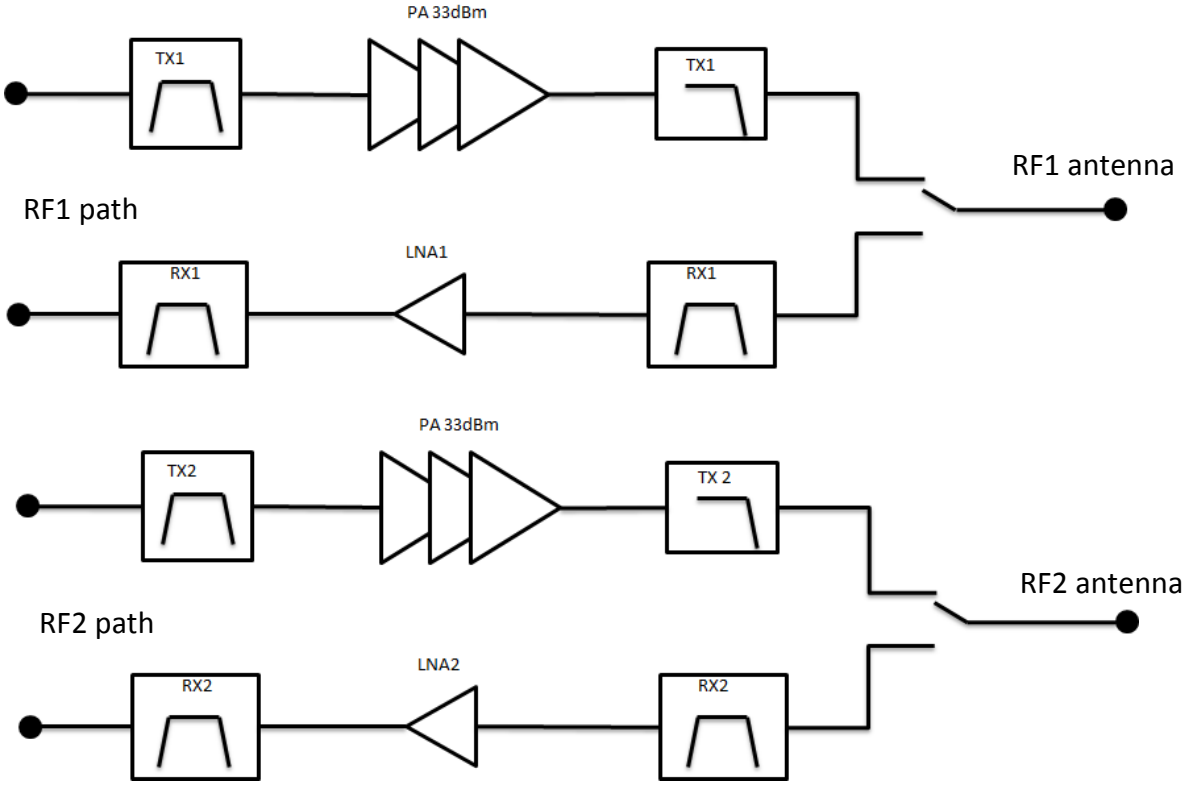


Figure 25: Front-end board block diagram

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:

Transmitter:

- The TX signal, coming from the LoRa LOC board, is injected in a RF band pass filter. The main goal of this 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 noise figure to not degrade the SNR performance of the modulator.
- A low pass filter rejects the harmonics generated by the amplifier.
- A SPDT combines both TX and RX paths together as LoRa is a half-duplex system.

Receiver:

- A first band pass filter is used to reject the out of band blockers and the WAN transmitters especially.
- The signal is amplified by a LNA with a very low noise figure, in order to not degrade the sensitivity of the receiver.
- A second band pass filter offers higher attenuation of the out of band blockers.
- The down conversion of the RF signal is completed in the LoRa LOC board by the AD9361.

A single PCB is used for all the front-end boards but they are declined in three different versions to cover the unlicensed bands:

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

The BOM is adjusted for the different versions. Frequency adjustment is completed through different SAW filters, low pass filters and matching circuits.

The details of the frequency bands, channelization, out of band rejection are detailed in §3.6.4.6.

3.6.4.4.2 Front-end board - Four modules

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

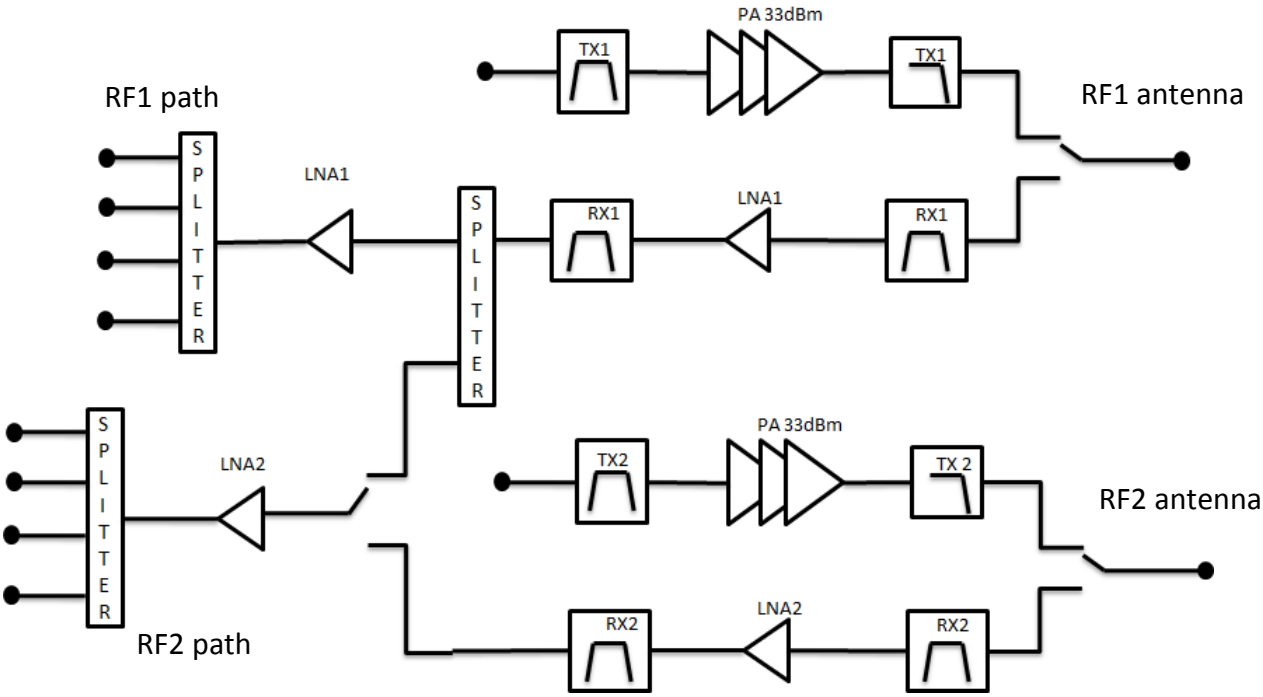


Figure 26: Front-end 4 modules board block diagram

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 two TX paths are similar and are detailed hereafter:

- The TX signal, coming from the LoRa LOC board, is injected in a RF band pass filter. The main goal of this 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 noise figure to not degrade the SNR performance of the modulator.
- A low pass filter rejects the harmonics generated by the amplifier.
- A SPDT combines both TX and RX paths together as LoRa is a half-duplex system.

The receive paths are somehow more complicated. We can retrieve almost the same configuration for both paths but there are some differences. The purpose of the RX architecture is to allow the reception on two antennas but also on a single antenna. This is the goal of the splitter and SPDT allowing connection of the two paths together.

The Rx path #1 (main path) includes:

- A first band pass filter that is used to reject the out of band blockers and the WAN transmitters especially.
- The signal is amplified by a first LNA with a very low noise figure, to not degrade the sensitivity of the receiver.
- A second band pass filter offers higher attenuation of the out of band blockers.

- The signal is then split in 2 ways:
  - On the main way, to another LNA used to compensate the insertion losses of the next 4 ways power splitter to not degrade the receiver noise figure
  - On the second way, to the Rx path #2 via a SPDT

If the SPDT is "opened", then the Rx path #1 and #2 are separated. The LoRa signal coming from antenna #RF1 is only transmitted through the Rx path #1. The RF signal is transmitted through a 4 ways splitter to 2 LoRa-LOC boards to insure the down conversion of the RF signal and the LoRa demodulation.

The Rx path #2 (secondary path) includes:

- A first band pass filter that is used to reject the out of band blockers and the WAN transmitters especially.
- The signal is amplified by a first LNA with a very low noise figure, to not degrade the sensitivity of the receiver.
- A second 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. This connection to the LNA is done via a SPDT and is only possible when the SPDT is "opened" i.e. when Rx path #1 and #2 are separated.

If the SPDT is "opened", then the RF signal is transmitted through a 4 ways splitter to 2 LoRa-LOC boards to insure the down conversion of the RF signal and the LoRa demodulation.

If the SPDT is "closed", then the Rx path #1 and #2 are mixed. The LoRa signal coming from antenna #RF1 is transmitted through the Rx path #1 and Rx path #2. The antenna port #RF2 is useless. The RF signal from antenna # RF1 is transmitted through a 2 x 4 ways splitter to 4 LoRa-LOC boards to insure the down conversion of the RF signal and the LoRa demodulation.

A single PCB is used for all the front-end boards but they are declined in two different versions to cover the unlicensed bands:

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

The BOM is adjusted for the different versions. Frequency adjustment is completed through different SAW filters, low pass filters and matching circuits.

The details of the frequency bands, channelization, out of band rejection are detailed in §3.6.4.6.

3.6.4.5 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.

3.6.4.6 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:

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
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*0,2MHz (i=0 à 63)	125	64	200
915	Upstream (RX Wirnet iBTS)	903,0+i*1.6MHz (i=0 à 7)	500	8	600
915	Downstream (TX Wirnet iBTS)	923,3+i*0.6MHz (i=0 à 7)	500	8	600
923	Upstream (RX Wirnet iBTS)	915,2+i*0,2MHz (i= 0 à 63)	125	64	200
923	Upstream (RX Wirnet iBTS)	915,9+i*1.6MHz (i=0 à 7)	500	8	600
923	Downstream (TX Wirnet iBTS)	919,8+i*0,2MHz (i= 0 à 40)	125	41	200
923	Downstream (TX Wirnet iBTS)	920,3+i*0.6MHz (i=0 à 12)	500	13	600
868	Upstream (RX Wirnet iBTS)	863,1+i*0,2MHz (i= 0 à 27)	125	28	200
868	Downstream (TX Wirnet iBTS)	863,1+i*0,2MHz (i= 0 à 27)	125	28	200
868	Upstream (RX Wirnet iBTS)	868,9+i*0,2MHz (i= 0 à 1)	125	2	200
868	Downstream (TX Wirnet iBTS)	868,9+i*0,2MHz (i= 0 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*0,2MHz (i= 0 à 14)	125	15	200
868	Downstream (TX Wirnet iBTS)	870,1+i*0,2MHz (i= 0 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.

3.6.4.7 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 must 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

3.6.4.8 Out of band emissions

Due to the very low noise transmitter, the LoRa LOC module can achieve excellent out of band emissions levels in the LTE, UMTS and GSM uplink or downlink bands.
The performances are summarized in the following table:

Version 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
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.

3.6.4.9 Sensitivity

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

Mode	868MHz	915MHz	923MHz
SF7/125KHz	-128dBm	-127dBm	-128dBm
SF10/125KHz	-136dBm	-136dBm	-134dBm
SF12/125KHz	-141dBm	-141dBm	-140dBm
SF7/250KHz	-125dBm	-	-125dBm
SF12/250KHz	-138dBm	-	-135dBm

SF7/500KHz	-121dBm	-121dBm	-122dBm
SF12/500KHz	-135dBm	-134dBm	-134dBm

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

Description	Specification
Sensitivity variation over the band	+/- 1dB
Sensitivity variation over temperature range (-20°C to +55°C)	+/- 1dB

3.6.4.10 RSSI and SNR

The Wirnet iBTS can receive LoRa frames from -20dBm to -141dBm, depending on the LoRa BW and SF.
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 can demodulate signals below the noise floor i.e. with negative SNR.
To estimate the signal strength of the received frame, both SNR and RSSI must be considered. As a rough estimate:

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

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 / 125 KHz BW. It describes the SNR, RSSI and RSSI+SNR measured vs. the signal strength:

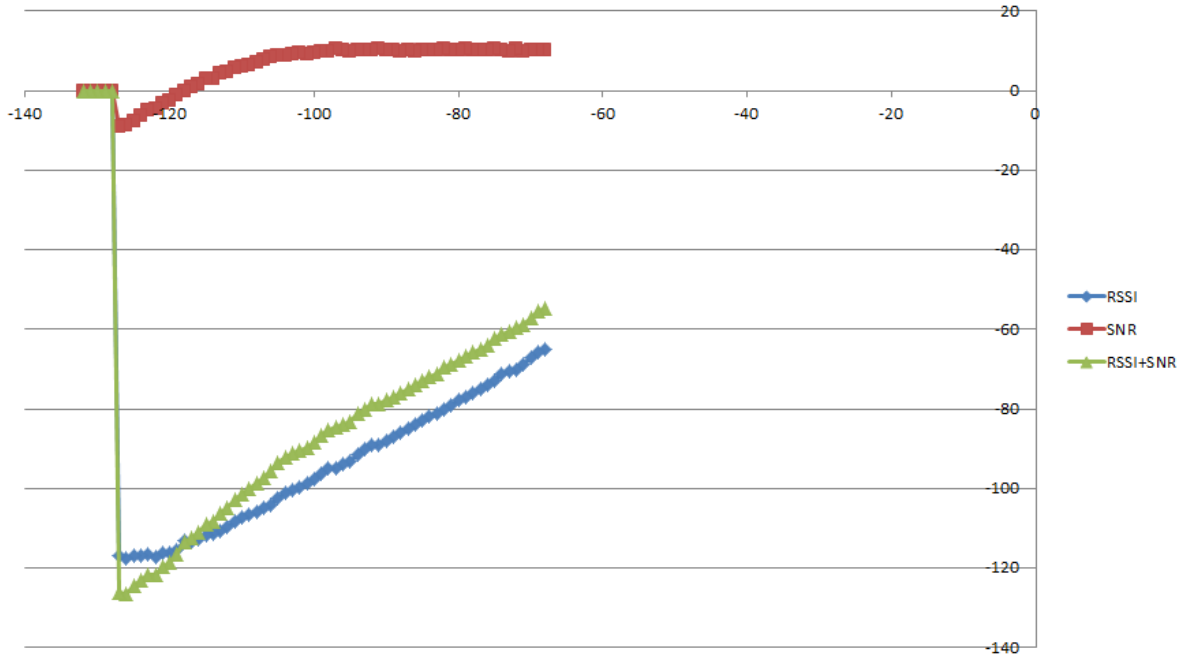


Figure 27: Example of SNR, RSSI and RSSI+SNR plots at 125KHz BW / SF7

3.6.4.11 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.

3.6.4.11.1 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

3.6.4.11.2 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

3.6.4.11.3 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

3.7 Detailed description of the other accessories

3.7.1 *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.

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 must 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. A 90W PoE injector could be also recommended instead of a 60W 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.

Note 3: 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 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.

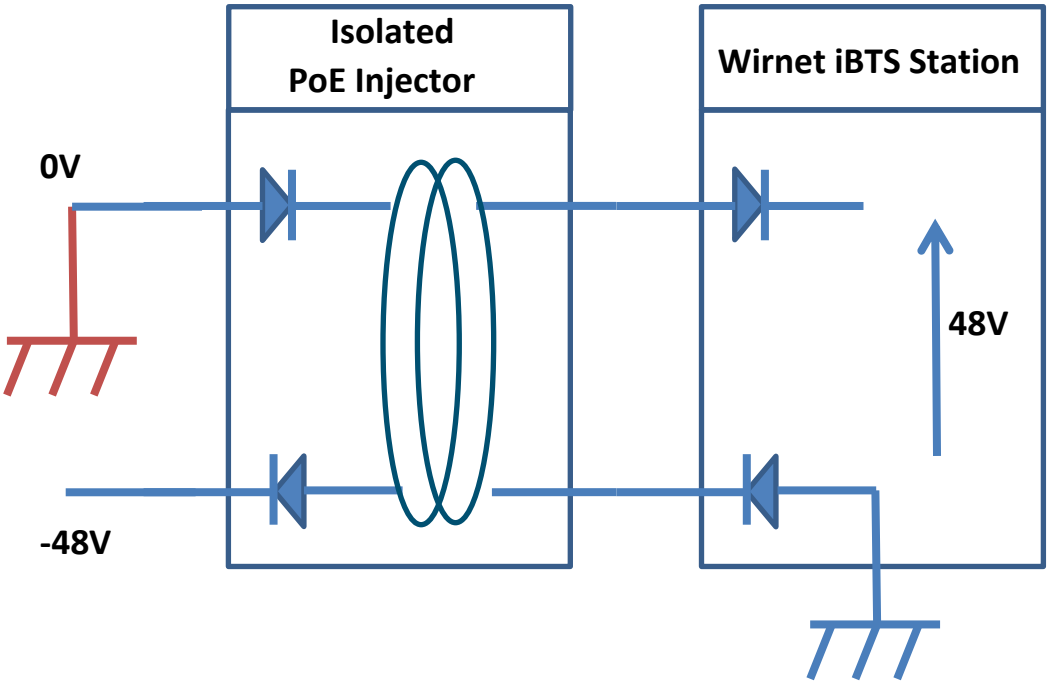


Figure 28 : Required isolation on PoE injector

3.7.1.1 Indoor Midspan PoE injector 30W

The indoor 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 compliance	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 must be carefully considered to insure proper supply of the Wirnet iBTS.

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

Figure 29: indoor 30W POE injector

The indoor Midspan PoE injector 30W can be provided with E/F type cable (Europe) or B type cable (USA).

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 §3.7.1.5.

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 §3.7.1.5.

3.7.1.2 Indoor Midspan PoE injector 60W

The indoor 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 compliance	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) 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 must be carefully considered to insure proper supply of the Wirnet iBTS.

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

Figure 30: 60W POE injector

The indoor Midspan PoE injector 60W can be provided with E/F type cable (Europe) or B type cable (USA).

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 §3.7.1.6.

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 §3.7.1.6.

3.7.1.3 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 must be carefully considered to insure proper supply of the Wirnet iBTS.

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

Figure 31 : 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 §3.7.1.6.

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 §3.7.1.6.

3.7.1.4 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)
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 must be carefully considered to insure proper supply of the Wirnet iBTS.

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

Figure 32 : 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 §3.7.1.6.

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 §3.7.1.6.

3.7.1.5 Outdoor Midspan PoE injector 30W

The outdoor 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 compliance	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) 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 +65°C has to be carefully considered to insure proper supply of the Wirnet iBTS.

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

Figure 33: 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.

3.7.1.6 Outdoor Midspan PoE injector 60W

The outdoor 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 compliance	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

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 +65°C is critical and has to be carefully considered to insure proper supply of the Wirnet iBTS.

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

Figure 34: Outdoor 60W 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.

3.7.1.7 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

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:

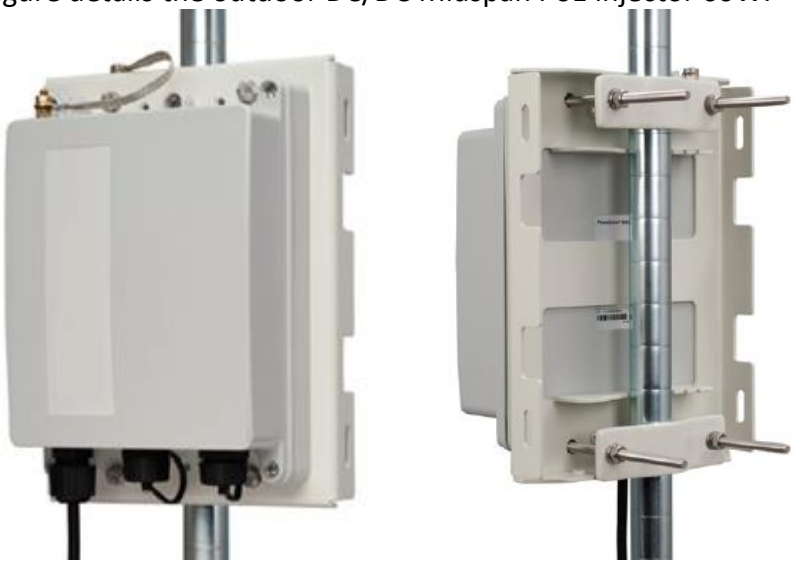


Figure 35 : Outdoor 60W DC/DC POE injector

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

3.7.2 *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.

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 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:

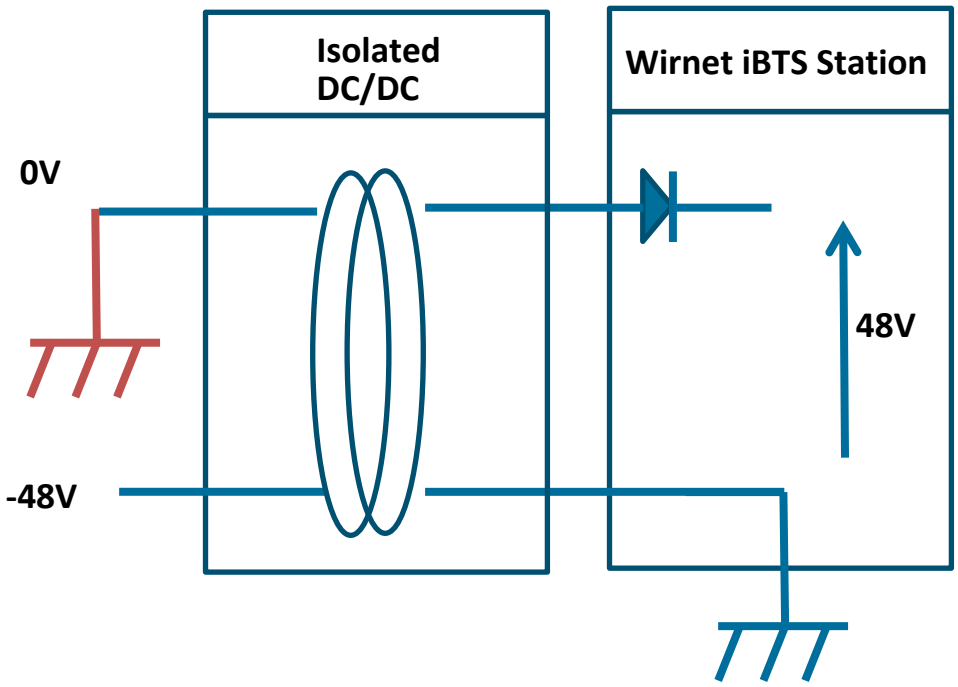


Figure 36 : Required isolation on auxiliary power supply input

An example of 40W isolated DC/DC converter is provided in the chapter 3.7.3

3.7.3 *Isolated DC/DC converter 40W*

As detailed in paragraph 3.7.2, 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 Impendance	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 must be carefully considered to insure proper supply of the Wirnet iBTS Compact.

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

Figure 37 : Isolated 40W DC/DC converter

3.7.4 *LoRa antennas*

3.7.4.1 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):

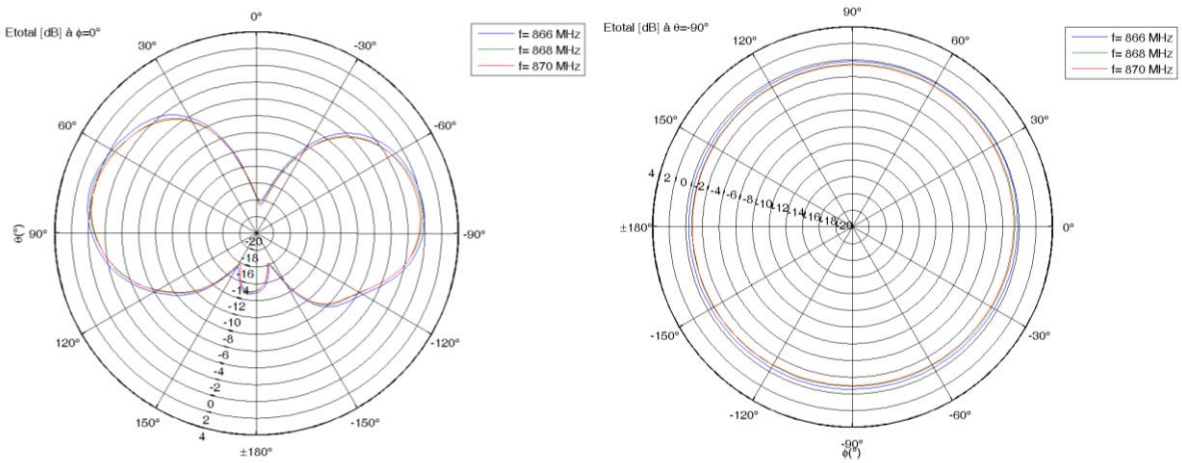


Figure 38: Radiation pattern of omnidirectional 868MHz/3dBi antenna

3.7.4.2 Omnidirectional antenna 868MHz 6dBi

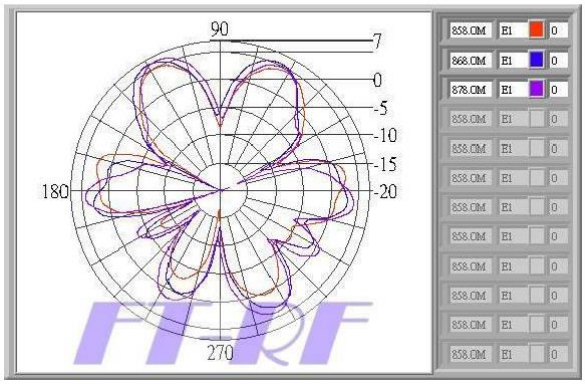
The specifications of the omnidirectional 868MHz / 6dBi antenna are the following:

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

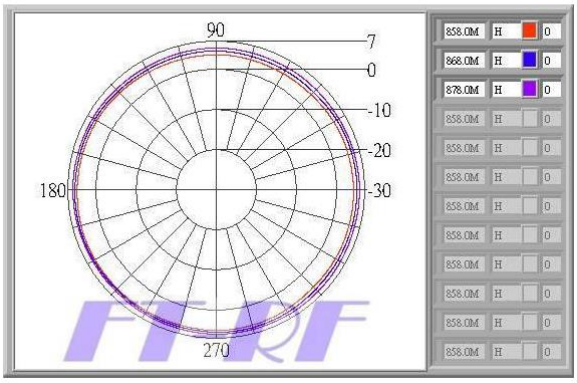


Figure 39 : Radiation pattern of omnidirectional 868MHz/6dBi antenna

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

3.7.4.3 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):

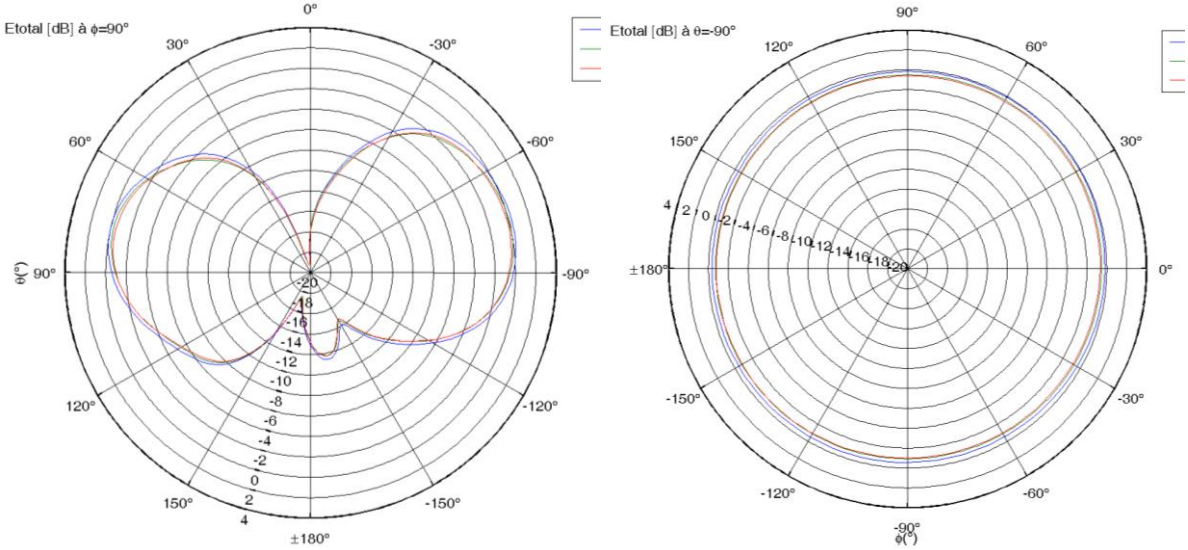


Figure 40: Radiation pattern of omnidirectional 915MHz/3dBi antenna

3.7.4.4 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):

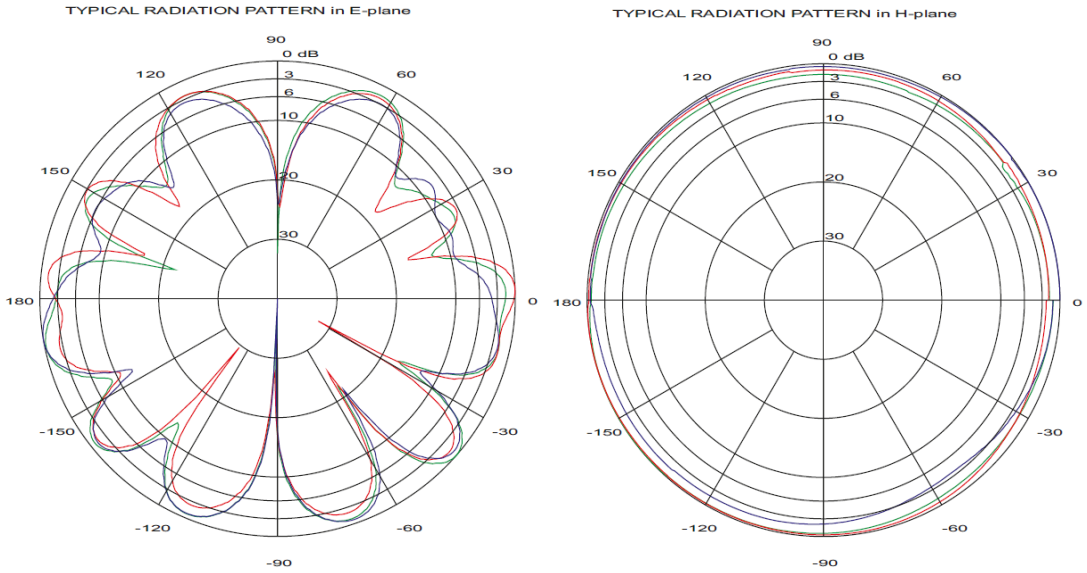


Figure 41: Radiation pattern of omnidirectional 915MHz/6dBi antenna

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 (from FT-RF) has its own mounting kit. The second one cannot be installed on the universal antenna bracket.

3.7.5 *GNSS and WAN antennas*

3.7.5.1 GNSS antenna

The GNSS antenna is required for the Wirnet iBTS standard casing only, once featuring a "WAN module".
The Wirnet iBTS Compact embeds a GNSS/LTE internal antenna detailed in §3.7.5.3 and then do 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.

3.7.5.2 LTE antenna

The LTE antenna is required for the Wirnet iBTS standard casing only, once featuring a "WAN module".
The Wirnet iBTS Compact embeds a GNSS/LTE internal antenna detailed in §3.7.5.3 and then do not require the LTE antenna.

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.

3.7.5.3 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
	Power handling		10W
GNSS antenna	Frequency range		1574 - 1606 MHz
	Peak gain		3dBic
	Typical VSWR		<2.0:1
	Impedance		50 ohms
	Polarization		RHCP
	Type		Passive No ground plane required
	DC Block		Yes
Mechanical	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 is mounted on the internal GNSS/LTE bracket, a mechanical part provided as standard with the Wirnet iBTS Compact (see §3.3.1 and Figure 8).

3.7.5.4 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.

3.7.6 *Cavity filters*

3.7.6.1 865-867MHz 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:

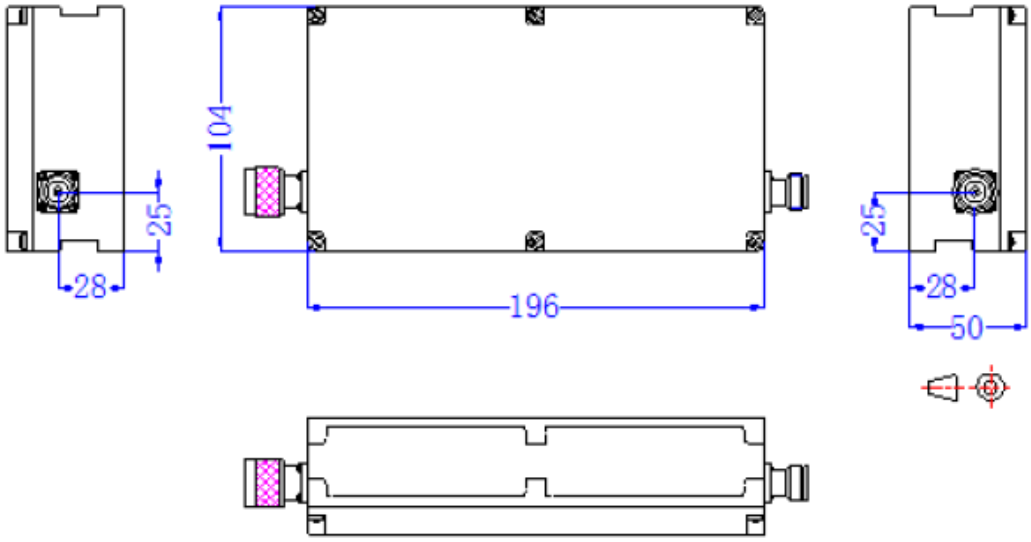


Figure 42 : Dimensions of the 865-867MHz cavity filter

The frequency response of 865-867MHz cavity filter is as follows:

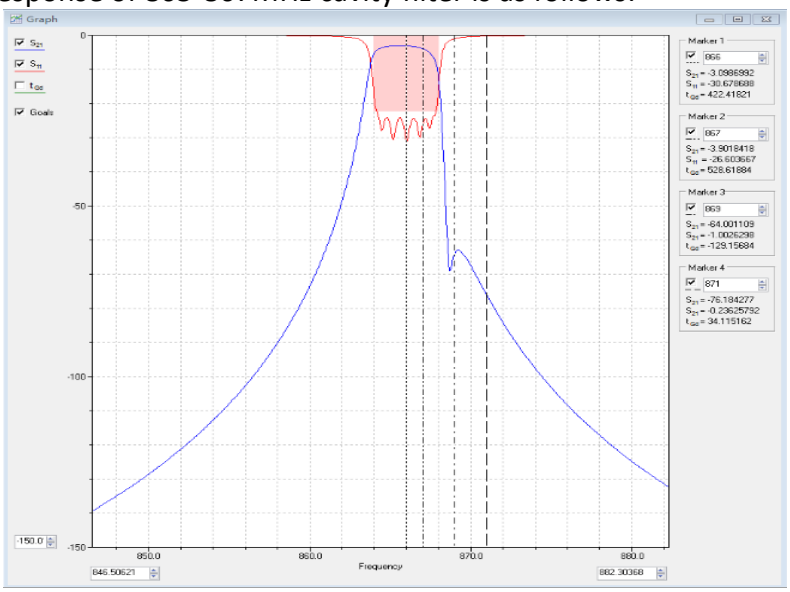


Figure 43 : Frequency response of the 865-867MHz cavity filter

3.7.6.1 865-870MHz 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

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

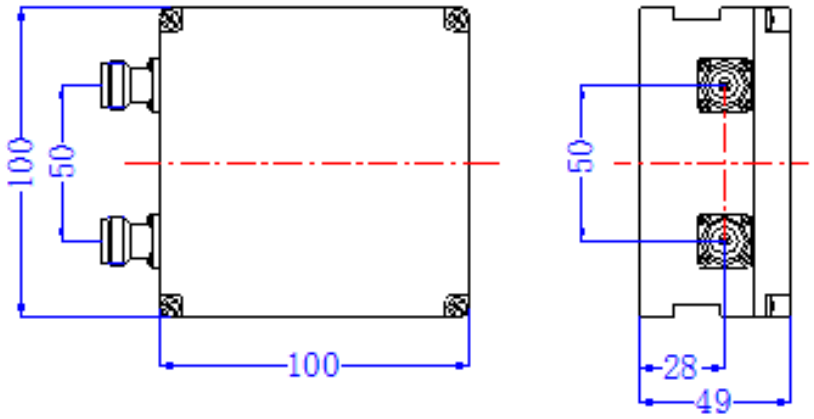


Figure 44 : Dimensions of the 865-870MHz cavity filter

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

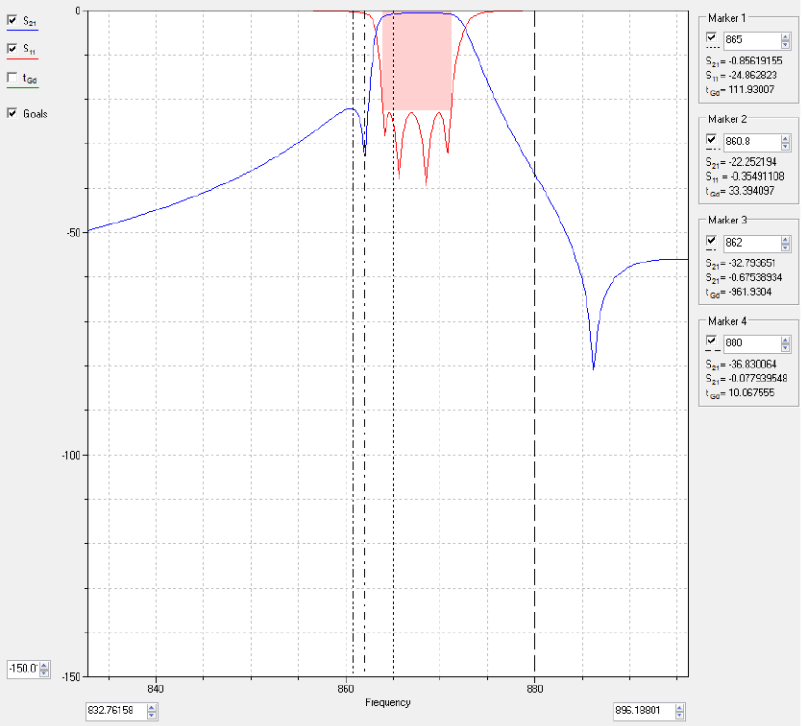


Figure 45 : Frequency response of the 865-870MHz cavity filter

3.7.6.2 863-873MHz 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:

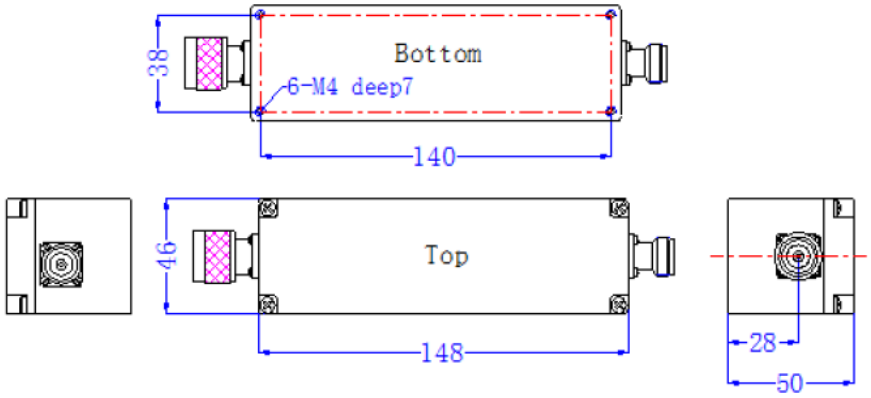


Figure 46 : Dimensions of the 863-873MHz cavity filter

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

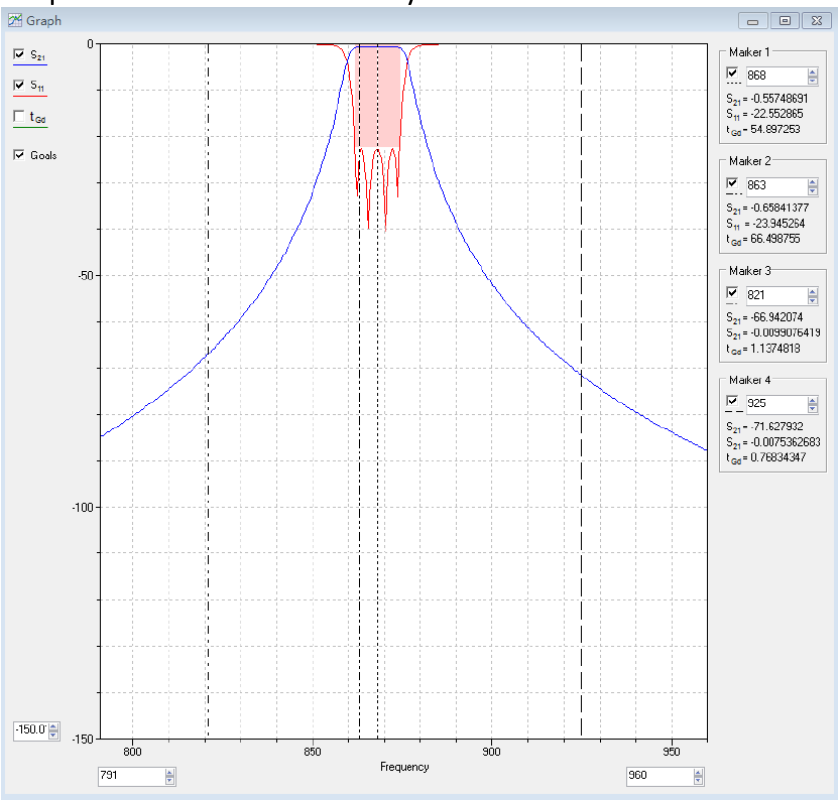


Figure 47 : Frequency response of the 863-873MHz cavity filter

3.7.6.3 915-920MHz 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
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:

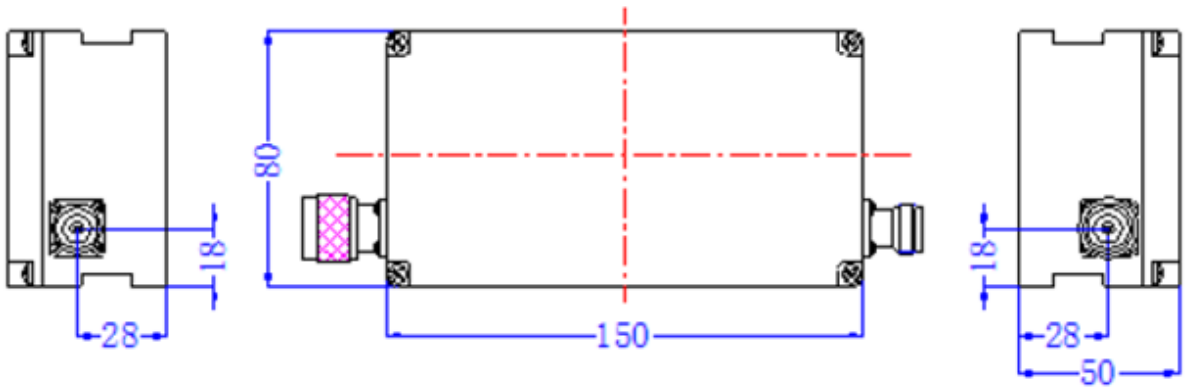


Figure 48 : Dimensions of the 915-920MHz cavity filter

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

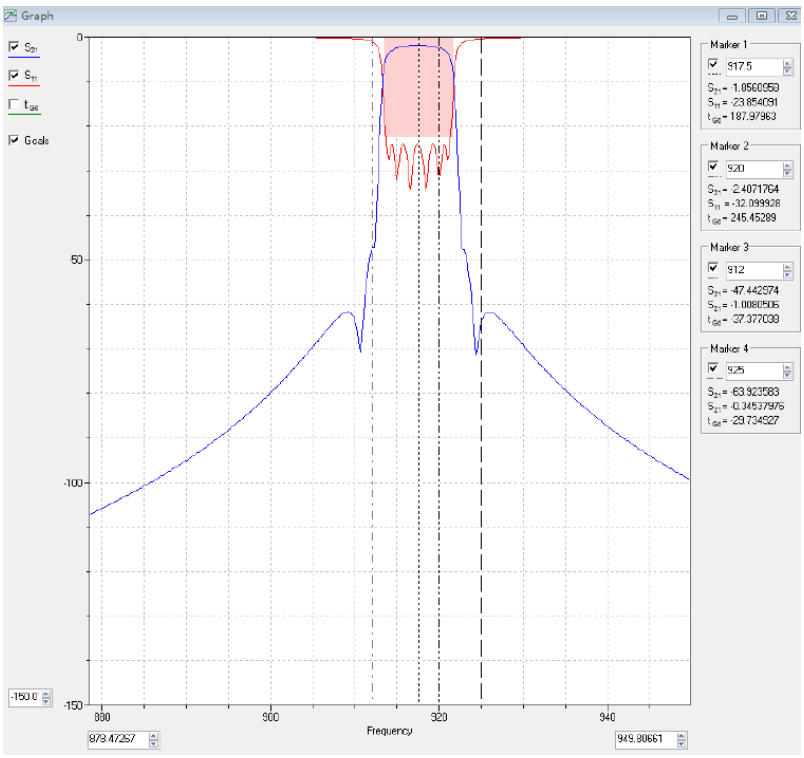


Figure 49 : Frequency response of the 915-920MHz cavity filter

3.7.6.4 918-923MHz 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:

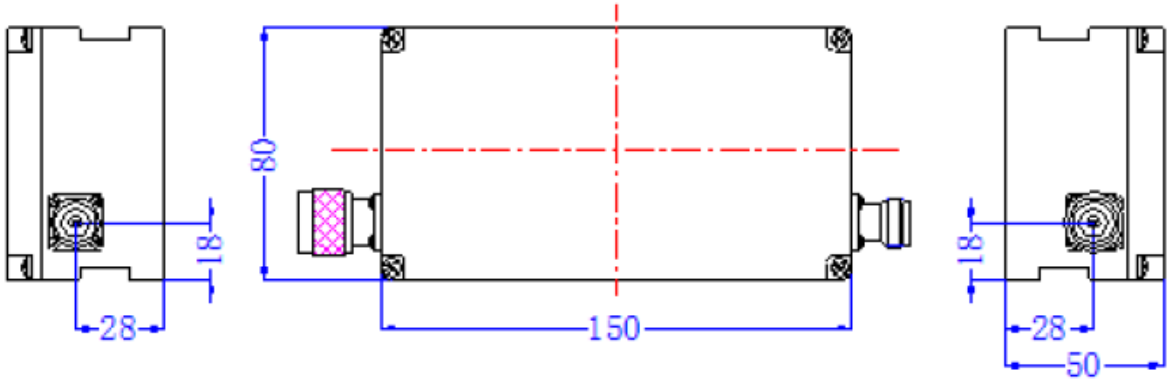


Figure 50 : Dimensions of the 918-923MHz cavity filter

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

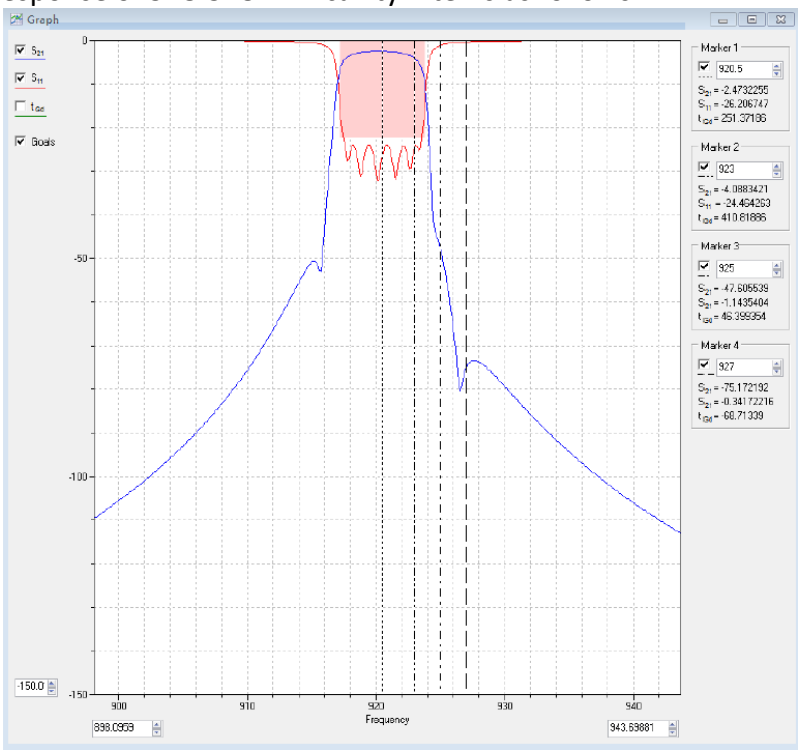


Figure 51 : Frequency response of the 918-923MHz cavity filter

3.7.7 *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	≤3dB
Ripple	≤1.2dB
VSWR	≤1.3:1
Rejection	≥60dB @ 915MHz ≥60dB @ 930MHz
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)	128 x 74 x 48 mm

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

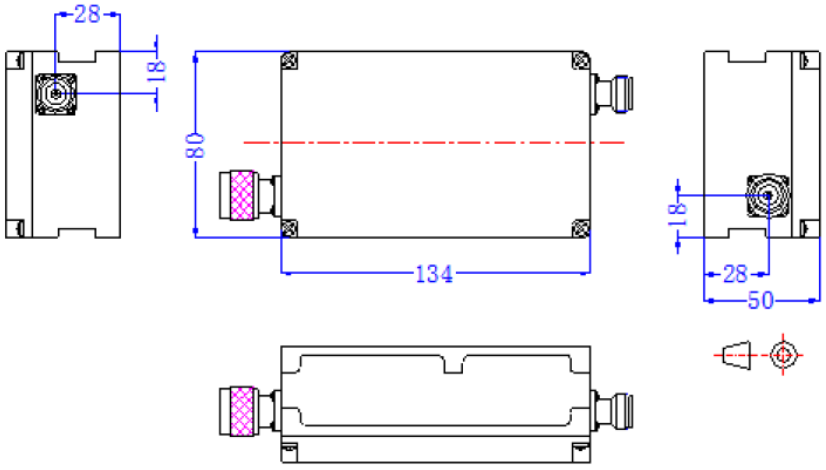


Figure 52 : Dimensions of the 920-925MHz cavity filter

The frequency response of 920-925MHz cavity filter is as follows:

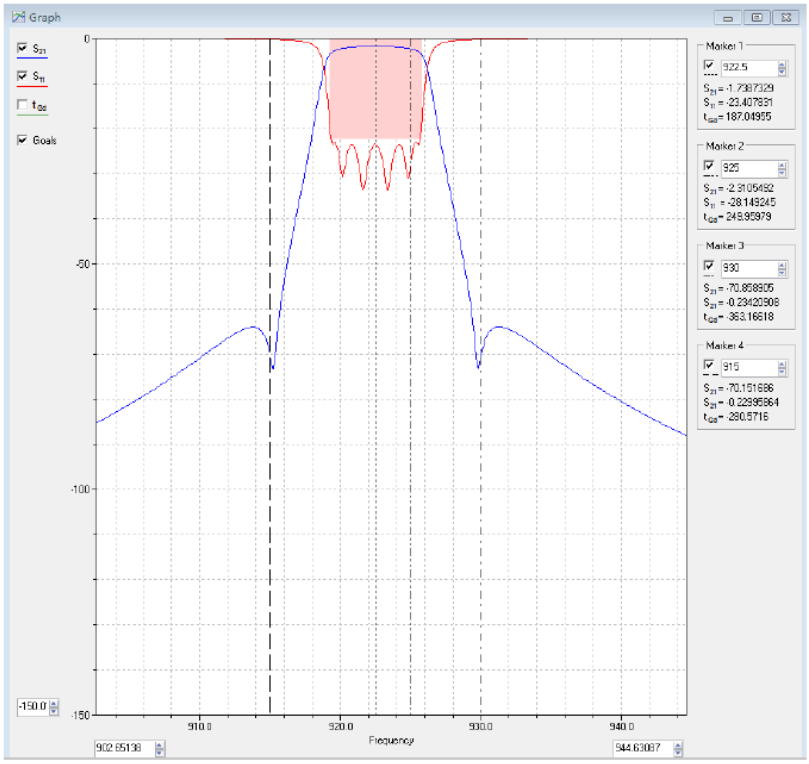


Figure 53 : Frequency response of the 920-925MHz cavity filter

3.7.7.1 920-928MHz 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:

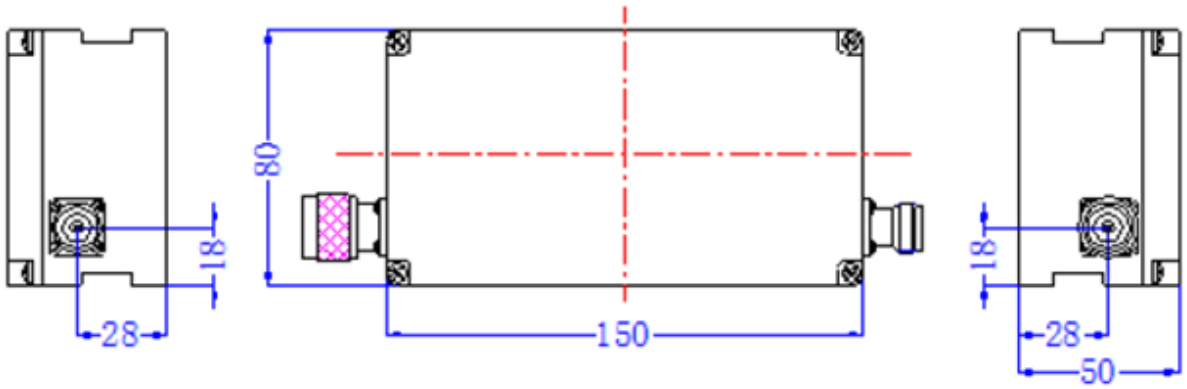


Figure 54 : Dimensions of the 920-928MHz cavity filter

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

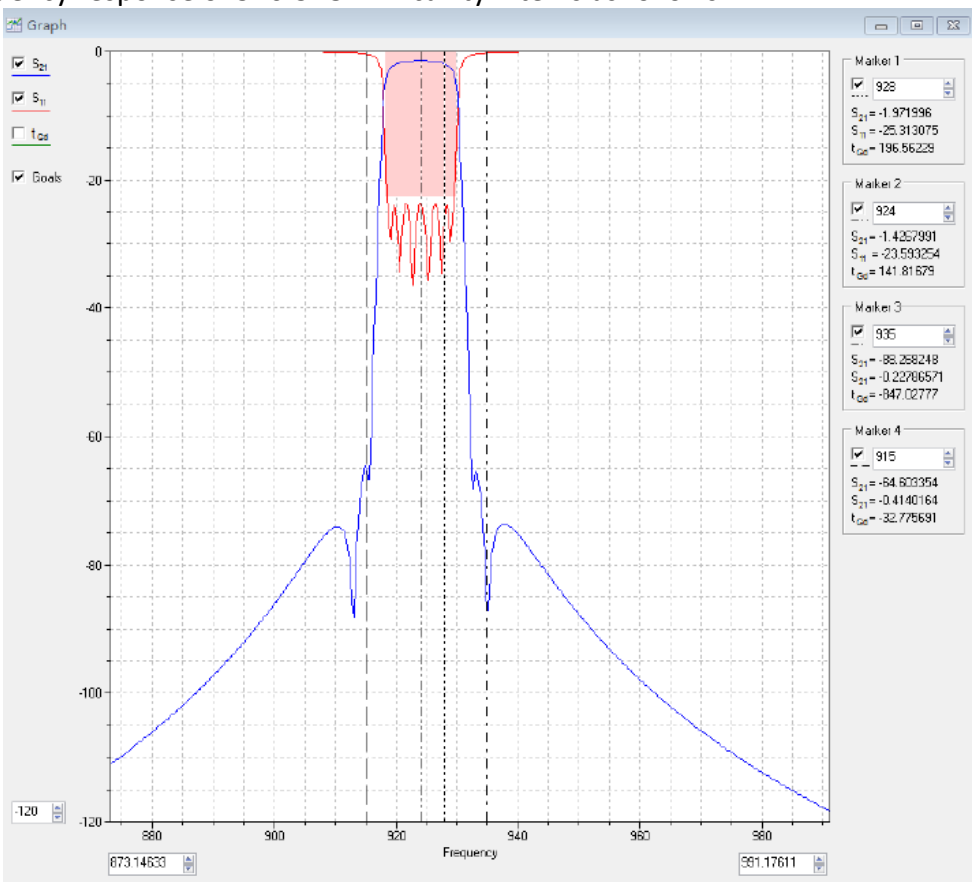


Figure 55 : Frequency response of the 920-928MHz cavity filter

3.7.7.2 902-928MHz 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
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:

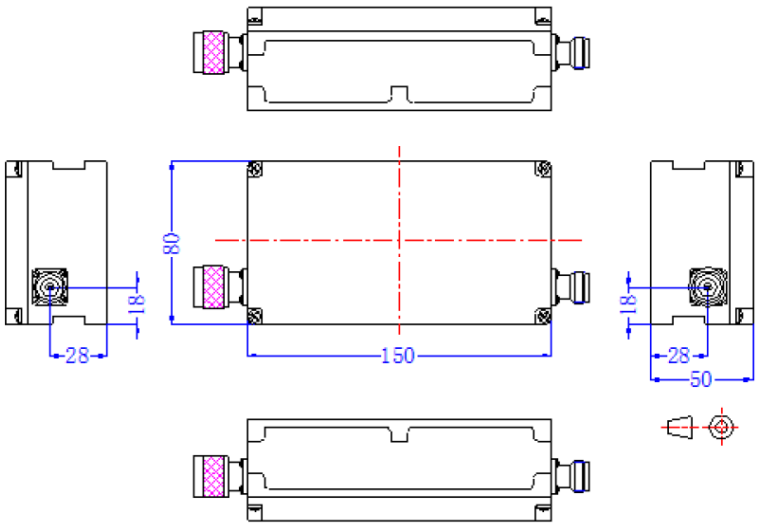


Figure 56 : Dimensions of the 902-928MHz cavity filter

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

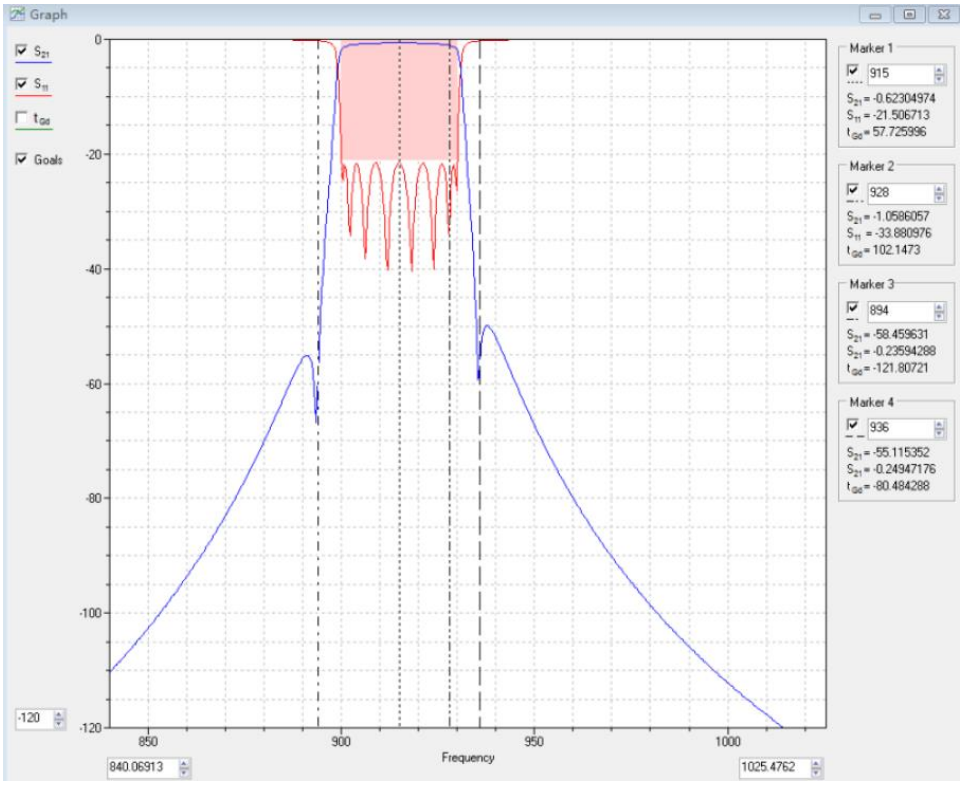


Figure 57 : Frequency response of the 902-928MHz cavity filter

3.7.8 *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.

3.7.8.1 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 SSTP (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:

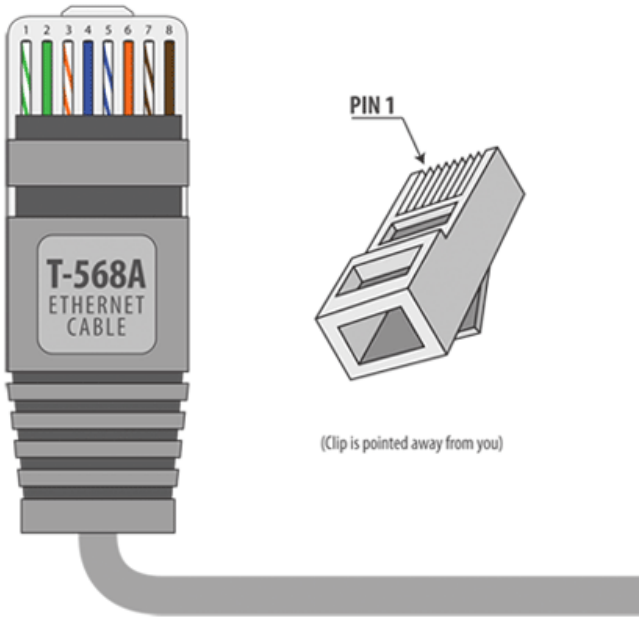


Figure 58: RJ45 T-568A plug

3.7.8.2 Earthing cables

Several earthing cables, wires or tapes are required to connect the installation and the materials to earth for lighting 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	25mm2, copper
Earthing of the antenna brackets (LoRa antenna, GNSS antenna, LTE antenna)	25mm2, copper
Earthing of the RF coaxial surge protection	16mm2, copper
Earthing of the Ethernet surge protection	16mm2, copper
Earthing of the outdoor PoE injector	16mm2, copper

Note: the earthing cables are not provided by KERLINK

3.7.9 *Surge protections*

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

3.7.9.1 RF coaxial surge protection

3.7.9.1.1 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 main characteristics of the RF coaxial surge protection are:

Characteristics	Specification
Technology	Gas discharge tube
Connection to Network	Connector N Male/ N Female
Mounting	Feedthrough
Housing material	Brass/Surface plating Cu Zn Sn
Operating temperature	-40°C to +85°C
Protection rating	IP65
Outdoor application	Yes
Failsafe behavior	Short-circuit
Disconnection indicator	Transmission interrupt
Remote signaling of disconnection	None
Contacts	Bronze/Surface Au-Ag
Insulation material	PTFE
Operating current **Leakage current at Uc (Ic)**	None

Max discharge current **Max withstand @ 8/20 µs by pole (Imax)**	20 kA
Max. line current (IL)	10A
Protection mode(s)	CM
Protection level (Up)	< 700 V
Impulse current **2 x 10/350µs Test - D1 Category (Iimp)**	2.5 kA
Nominal discharge current **8/20µs Test x 10 - C2 Category (In)**	5 kA
Frequency range	DC-6GHz
Impedance	50 ohms
Insertion loss	< 0.2dB
Max Power	70 W
Return loss	> 20 dB
VSWR	<1.25:1
DC Pass	Yes
Certifications	IEC 61643-21 / EN 61643-21 UL497C / UL497E
RoHS compliance	PTFE

The following picture describes the RF coaxial surge protection:

Figure 59: P8AX Citel

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

3.7.9.1.1 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 main characteristics of the RF coaxial surge protection are:

Characteristics	Specification
Technology	Quarter wave
Connection to Network	Connector N Male/ N Female
Mounting	Feedthrough
Housing material	Brass/Surface plating Cu Zn Sn
Operating temperature	-40°C to +85°C
Protection rating	IP65
Outdoor application	Yes
Failsafe behavior	Short-circuit
Contacts	Bronze/Surface Au-Ag
Insulation material	PTFE
Max discharge current Max withstand @ 8/20 µs by pole (Imax)	50 kA
Max. line current (IL)	10A
Protection level (Up)	< 30 V
Impulse current 2 x 10/350µs Test - D1 Category (Iimp)	25 kA
Nominal discharge current 8/20µs Test x 10 - C2 Category (In)	25 kA
Frequency range	800-2200MHz
Impedance	50 ohms
Insertion loss	< 0.2dB
Max Power	1500 W
Return loss	> 20 dB
VSWR	<1.2:1
DC Pass	No
Certifications	IEC 61643-21 / EN 61643-21 UL497C / UL497E

The following picture describes the RF coaxial surge protection:

Figure 60 : PRC822S Citel

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

3.7.9.2 DC surge protection, 1 pole

Kerlink recommends using the DS71R-48DC reference from CITEL.
The main characteristics of the DC surge protection are:

Characteristics	Specification
Typical use	48 Vdc power line surge protector
Nominal DC voltage (Un)	48V DC
Maximum operating voltage (Uc)	65V DC
Operating current – leakage current at Un (Ic)	<0.1mA
Nominal discharge current 15 x 8/20µs impulse (In)	30 kA
Max discharge current 1x 8/20 µs impulse (Imax)	70 kA
Max lighting current by pole Maw withstand at 10/350µs (Iimp)	7 kA
Protection level (Up)	< 300 V
Operating temperature	-40°C to +85°C
Thermal disconnector	Internal
Fuses	Type gG-50A
Connection	Screw terminals 4-25 mm2
Mounting	Symetrical rail (EN50022/DIN46277-3)
Housing material	UL94-V0
Certifications	IEC 61643-11 / EN 61643-11 UL1449 ed.3

A picture of the DS71R-48DC is presented below:

Figure 61 : DC surge protections (1 pole and 2 poles)

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

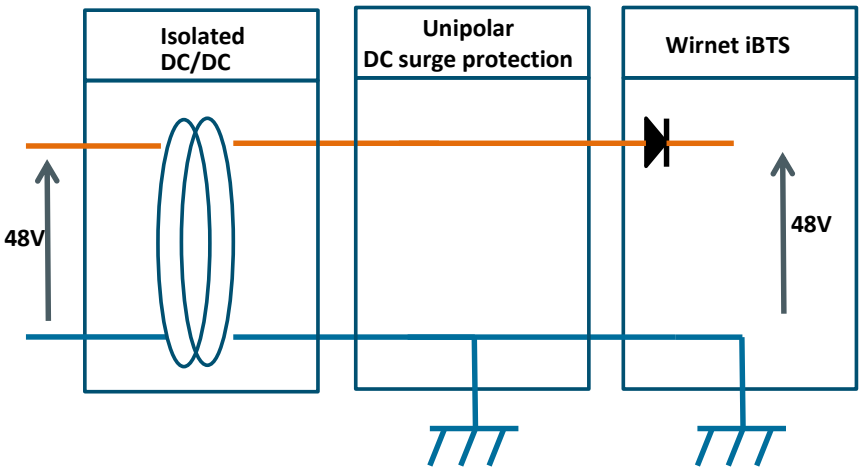


Figure 62 : DC surge protection 1 pole schematic

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

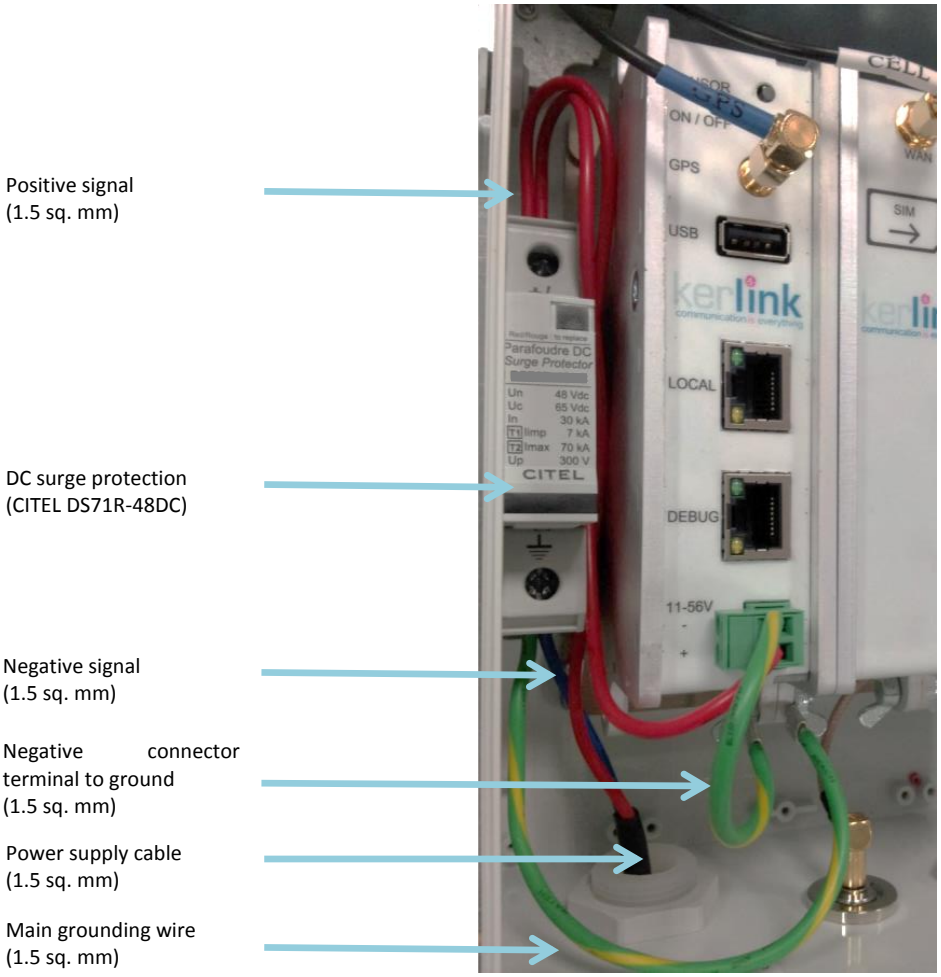


Figure 63 : Example of DC surge protection cabling

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 64 : Tongue terminal

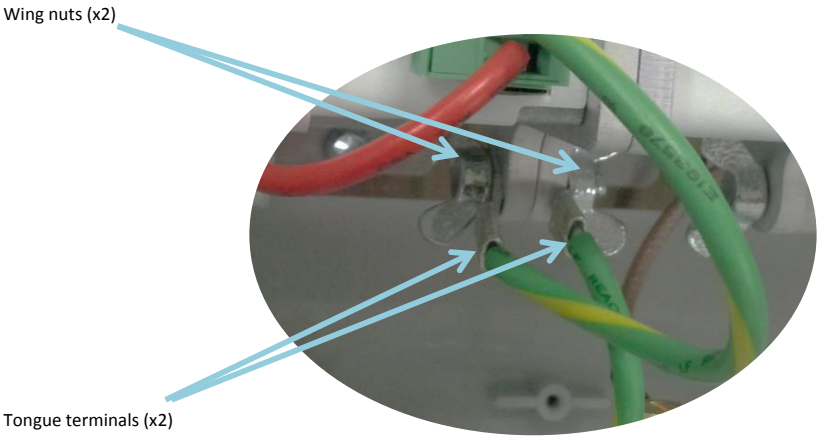


Figure 65 : Tongue terminal assembly

3.7.9.3 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.

The main characteristics of the DC surge protection are:

Characteristics	Specification
Typical use	48 Vdc power line surge protector
Nominal DC voltage (Un)	48V DC
Maximum operating voltage (Uc)	65V DC
Operating current – leakage current at Un (Ic)	<0.1mA
Nominal discharge current	30 kA

15 x 8/20µs impulse (In)	
Max discharge current **1x 8/20 µs impulse (Imax)**	70 kA
Max lighting current by pole **Maw withstand at 10/350µs (Iimp)**	7 kA
Protection level (Up)	< 300 V
Operating temperature	-40°C to +85°C
Thermal disconnector	Internal
Fuses	Type gG-50A
Connection	Screw terminals 4-25 mm2
Mounting	Symetrical rail (EN50022/DIN46277-3)
Housing material	UL94-V0
Certifications	IEC 61643-11 / EN 61643-11 UL1449 ed.3

A picture of DS72R-48DC is presented in Figure 61.

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

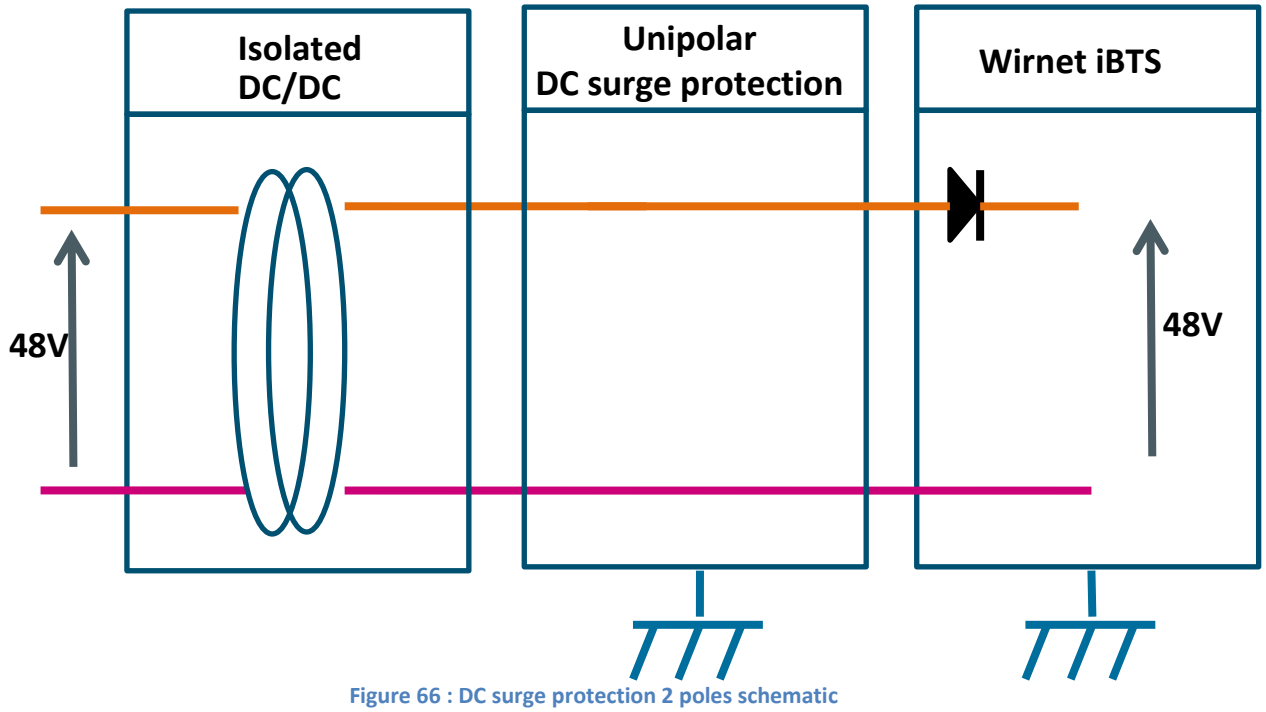


Figure 66 : DC surge protection 2 poles schematic

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 cabling remain identical to those described in §3.7.9.2.

3.7.9.4 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 main characteristics of the PoE surge protection are:

Characteristics	Specification
Network	POE and Gigabit Ethernet, High POE
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	Mounting flange, Screw lug, DIN Rail
Housing material	Aluminum
Operating temperature	-40°C to +85°C
Protection rating	IP20
Outdoor application	No
Failsafe behavior	Short-circuit
Disconnection indicator	Transmission interrupt
Remote signaling of disconnection	None
Pin outs	(1-2)(3-6)(4-5)(7-8)
Nominal line voltage (Un)	48 Vdc
Max. DC operating voltage (Uc)	60 Vdc
Max. line current (IL)	1.2A
Protection level (Up)	70V
Max shunt capacitance	25pF
Impulse current 2 x 10/350µs Test - D1 Category (Iimp)	500 A
Nominal discharge current 8/20µs Test x 10 - C2 Category (In)	2 kA
Max data rate	1000 Mbps
Max frequency	> 100MHz
Insertion loss	< 1dB
Certifications	IEC 61643-21 / EN 61643-21 UL497A IEEE 802-3ab/3at

The following picture describes the PoE surge protection:

Figure 67: MJ8-POE-B Citel

Note: the PoE surge protector must be connected to the earth. No cables are provided by KERLINK for that purpose. See §3.7.8.2 for additional information.

3.7.9.5 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
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:

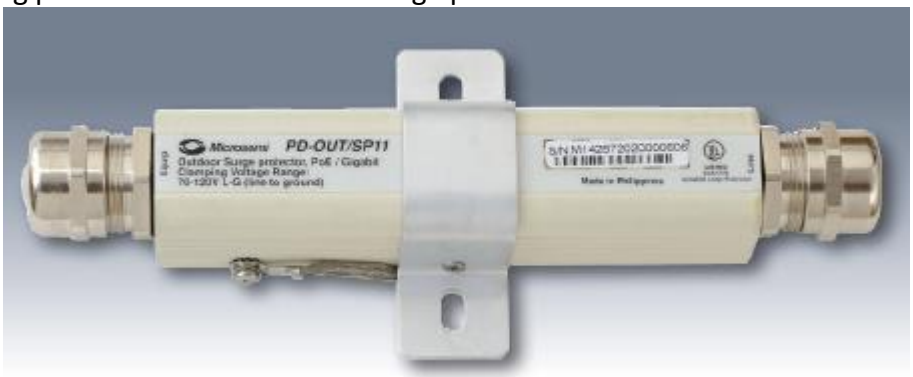


Figure 68: PD-OUT/SP11 Microsemi

Note: the PoE surge protector must be connected to the earth. No cables are provided by KERLINK for that purpose. See §3.7.8.2 for additional information.

3.7.10 *Mounting kits*

3.7.10.1 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 §3.7.10.3). The maximum diameter of the pole is 70mm.

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

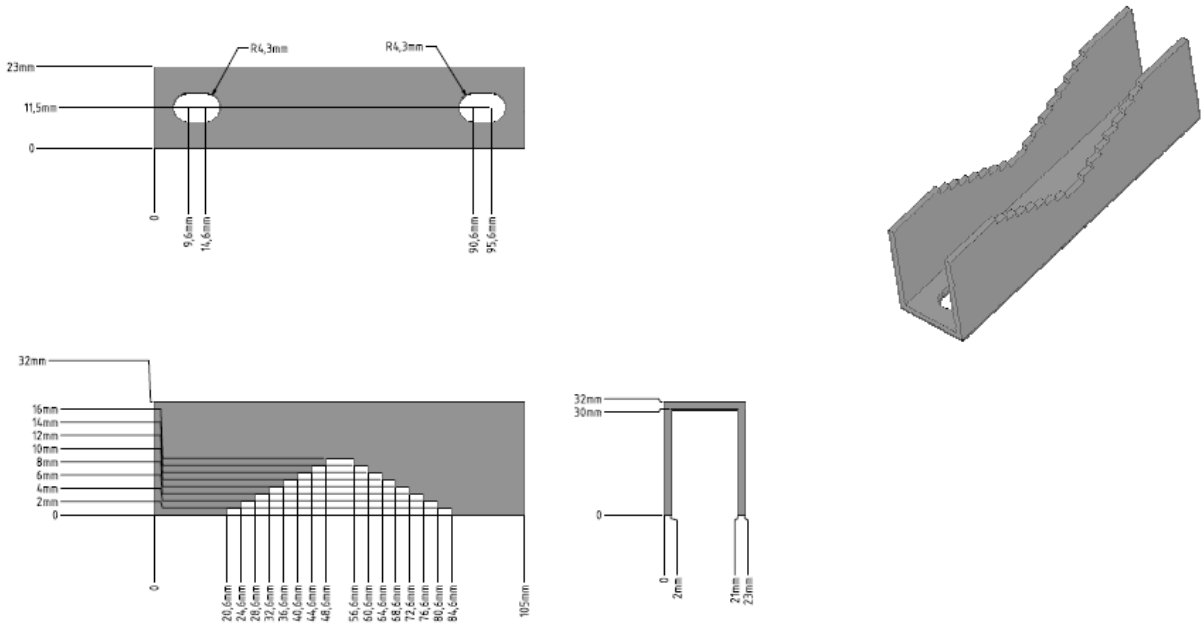


Figure 69: Dimensions of the notched V shaped plate

3.7.10.2 Universal antenna bracket

The universal antenna bracket is used with the following antennas:

- 868MHz, 3dBi omnidirectional (see §3.7.4.1).
- 915MHz, 3dBi omnidirectional (see §3.7.4.3).
- 915MHz, 6dBi omnidirectional, except FT-RF antenna (see §3.7.4.4).

The universal antenna bracket is presented hereafter:

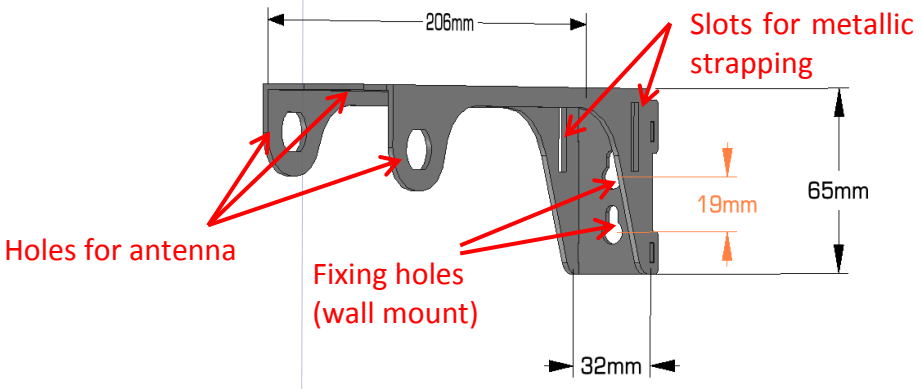


Figure 70: Universal antenna bracket dimensions

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.

3.7.10.3 Dome antenna bracket

The dome antenna bracket is used for the following antennas:

- GNSS antenna (see §3.7.5.1)
- LTE antenna (see §3.7.5.2)

The dome antenna bracket is presented hereafter:

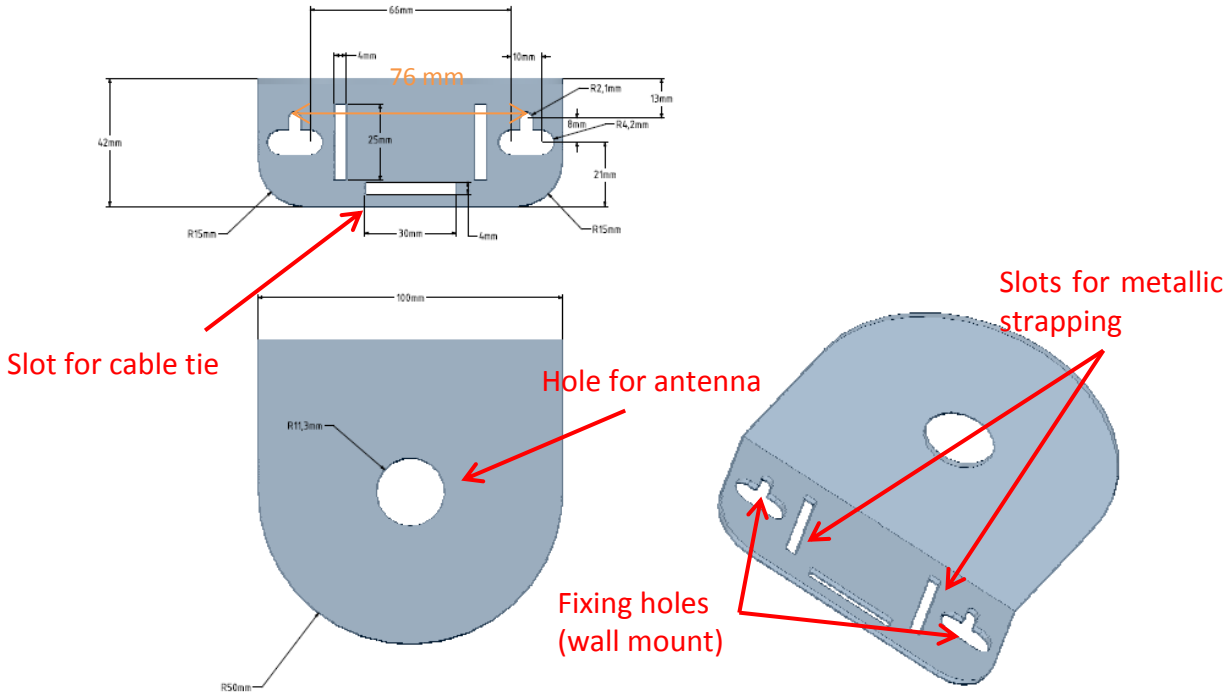


Figure 71: Dome antenna bracket dimensions

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 §3.7.10. 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 §3.7.10.1).

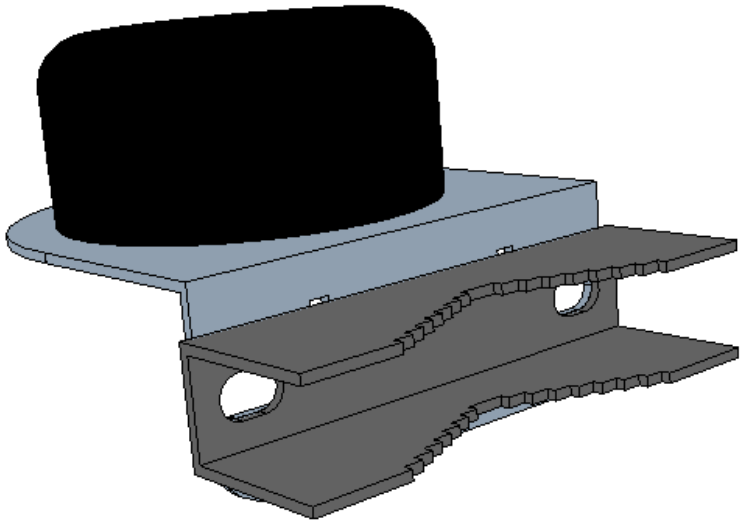


Figure 72: Dome antenna bracket with notched V shaped bolt

3.7.11 *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.

The following picture describes the Wirma2 debug tool connected to the CPU module:

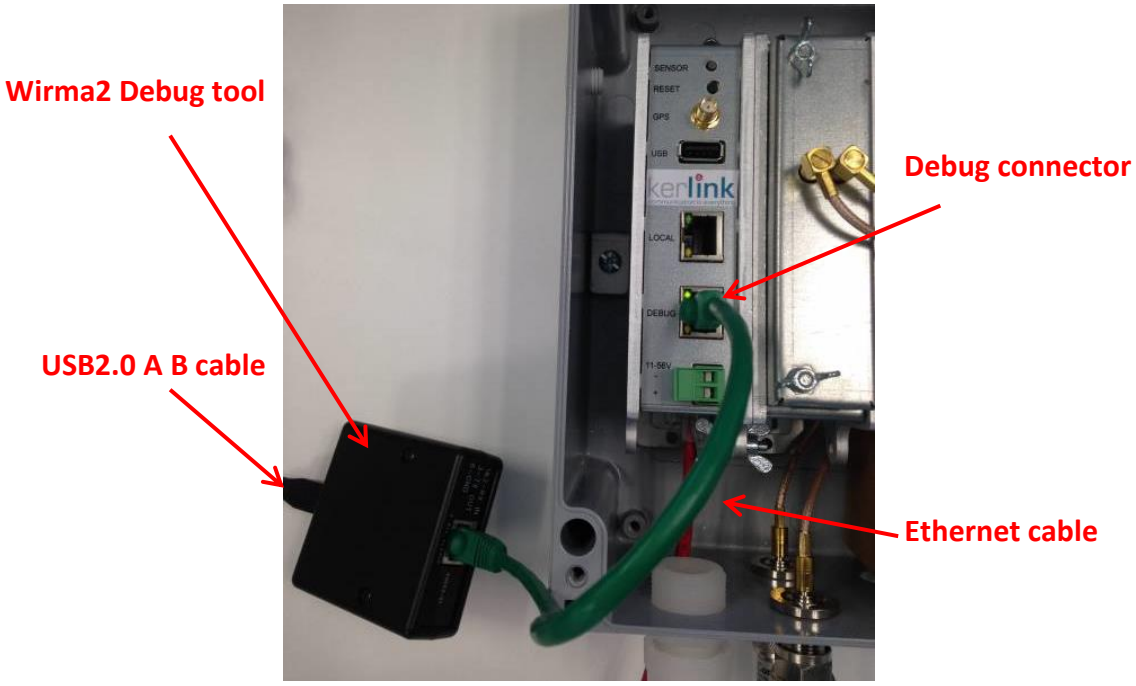


Figure 73: WIRMA2 Debug Tool connected to the CPU module

4. Software specifications

4.1 Architecture

The figure below depicts the software architecture of the Wirnet iBTS product:

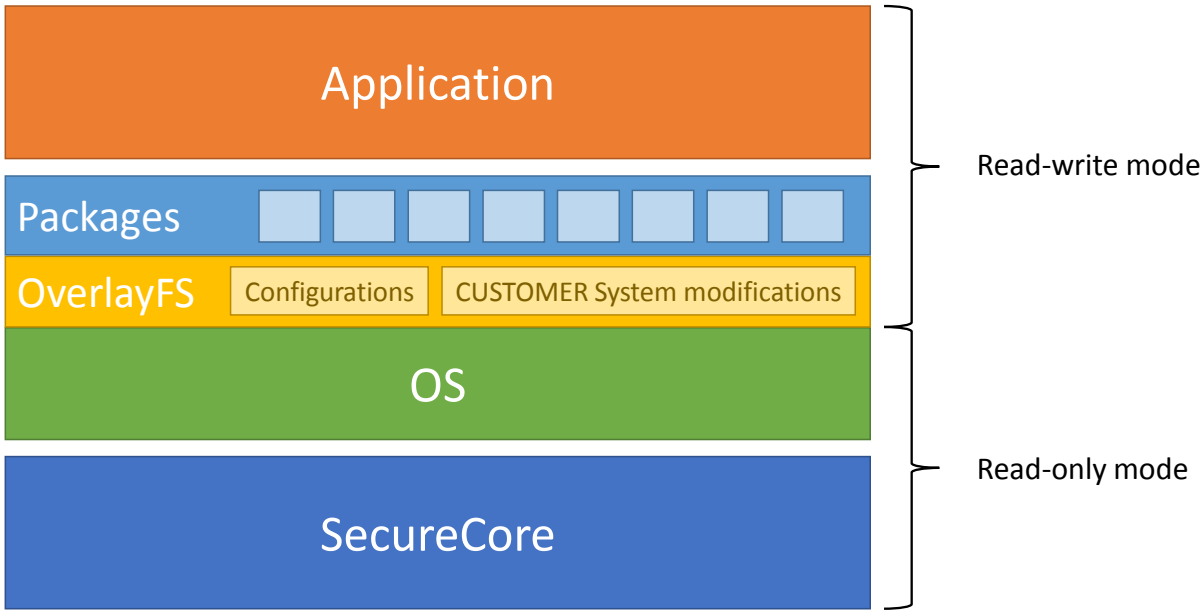


Figure 74: Software architecture

The Operating System of the Wirnet iBTS is mainly in read-only mode. Only the applications, the packages and the OverlayFS parts (configurations and customer system modifications) are in read-write mode.

The firmware of the Wirnet iBTS is authenticated contrary to Wirnet Station's firmware (V1).

4.2 System

Software is based on a standard Long-Term Support (LTS) Linux 4.14 kernel.

Only the toolchain is delivered, no SDK is available whereas this is the case on the Wirnet Station (V1).

4.3 Security

4.3.1 *Safety of operations*

The following elements are implemented to ensure the safety of operations:

- Hardware watchdog to prevent for software deadlocks
- Firmware filesystem rootfs is not alterable and authenticated
- Modifications of the firmware filesystem are saved alongside the firmware but not authenticated
- Authentication of the software by SecureBoot, as described in the diagram below:

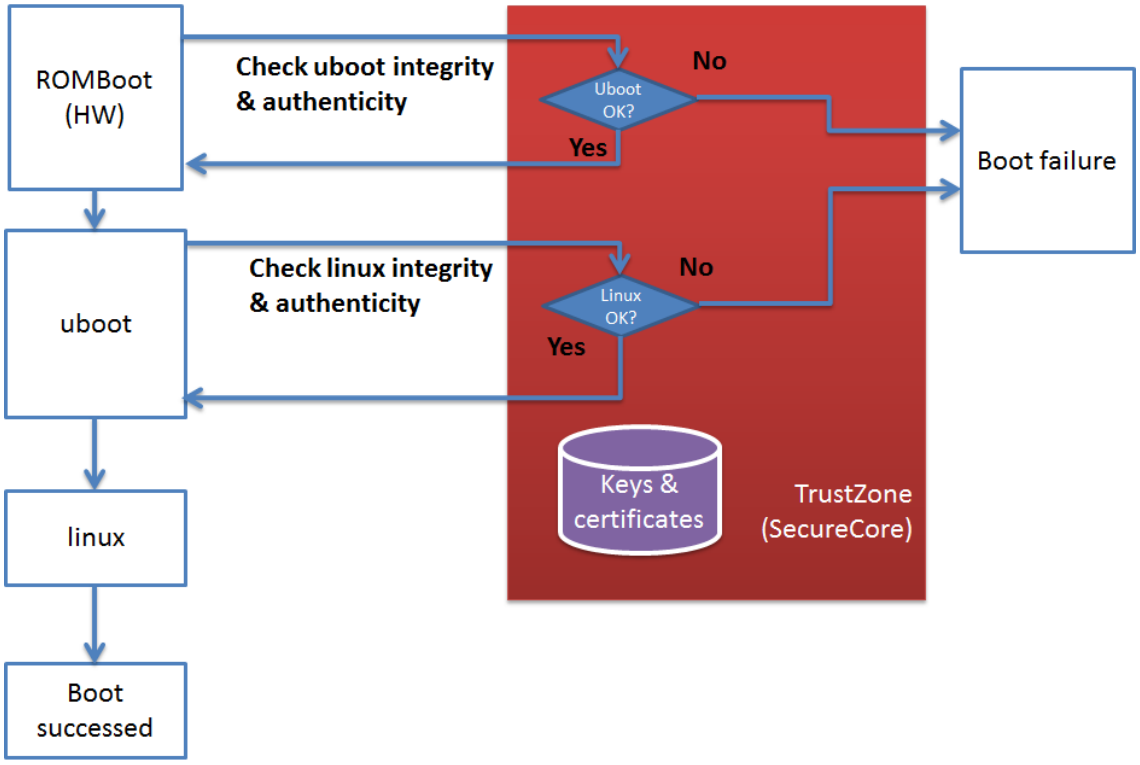


Figure 75: SecureBoot process

- Limited Linux drivers
- Firmware restoration
- Factory firmware restoration
- Continuous platform parameters monitoring (CPU, RAM, disk, door, …)

4.3.2 *Safety of local access*

The following elements are implemented to ensure the safety of local access:

- JTAG disabled
- Local Ethernet access protected by a restrictive firewall

- Local Web interface for maintenance protected by login/password
- All keys (public/private) and certificates are stored inside an unbreakable hardware secured module (SecureCore)
- Limited USB drivers, no unnecessary drivers are available
- USB key secured with a generic password (with possibility to change it)

4.3.3 *Safety of remote access*

The following elements are implemented to ensure the safety of remote access:

- Very restrictive firewall, only needed ports are opened
- Backhaul link protected using standard openVPN tunneling for BSC (Base Stations Controller) and LNS (LoRaWAN™ Network Server) interfaces
- All credentials (private/public keys, certificates) are stored inside an unbreakable hardware secured module (SecureCore), these credentials are used by security applications but never go out from the SecureCore

The following diagram shows how application can access credentials without leak risks:

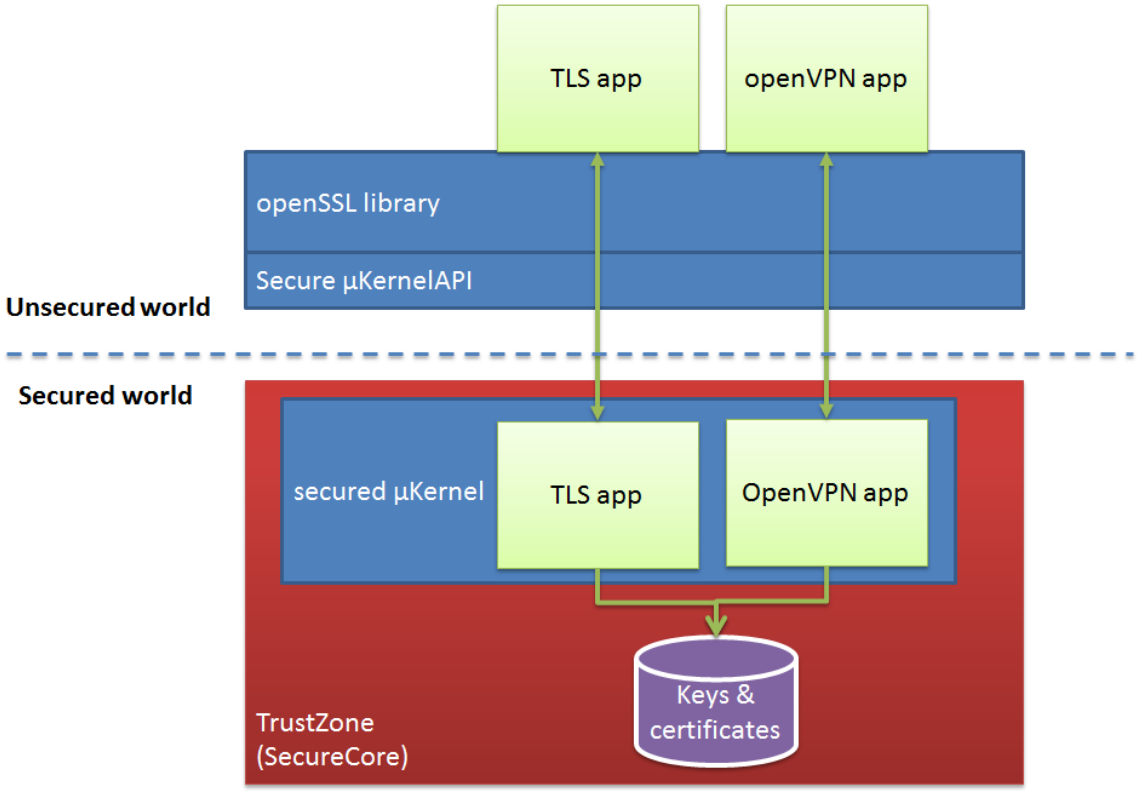


Figure 76: Access to credentials without leak risks

4.3.4 *Safety of firmware upgrade*

The following elements are implemented to ensure the safety of firmware upgrade:

- Firmware upgrade package is signed using device upgrade private key
- During the secured boot sequence, authenticity and integrity of the package is checked and safely installed
- Secured access to credentials

The following diagram presents the boot procedure including secured firmware upgrade:

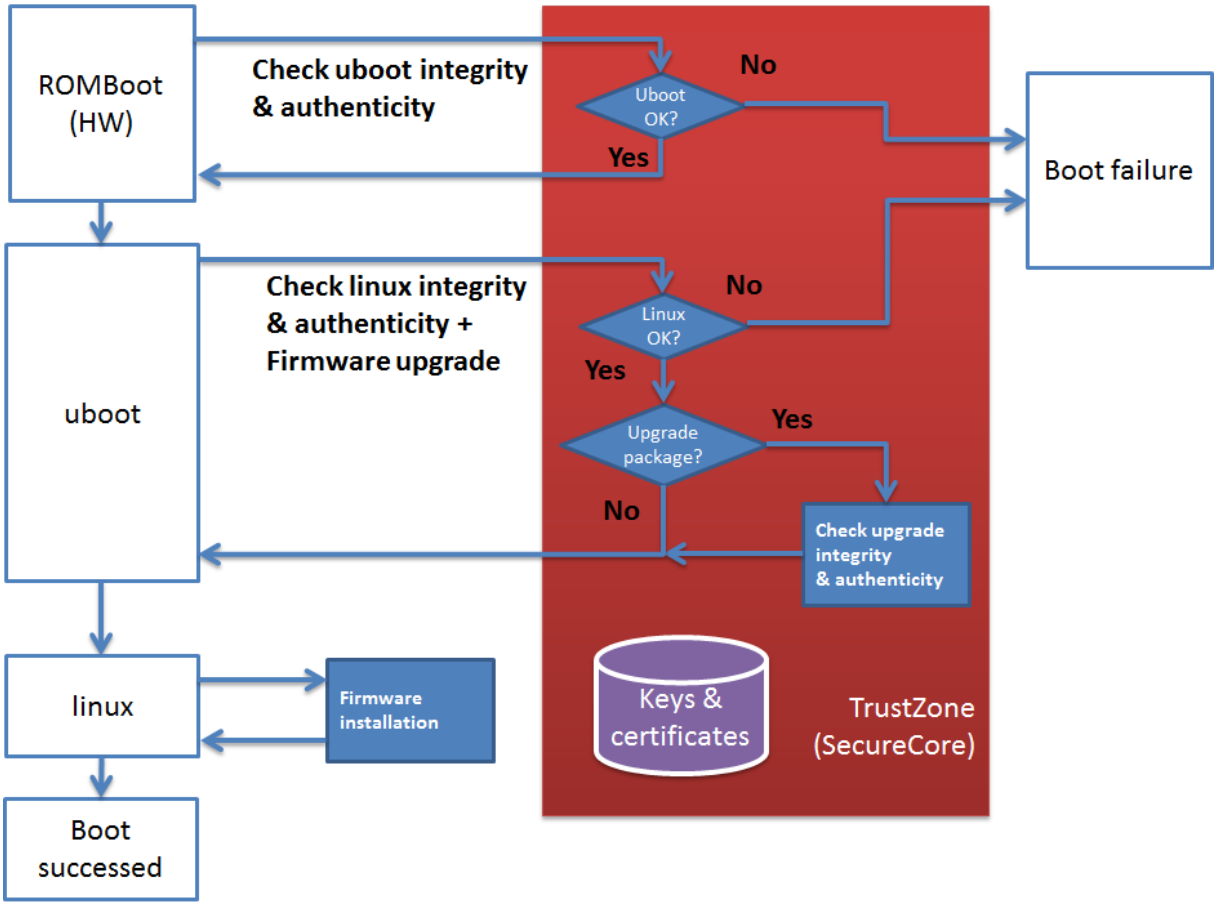


Figure 77: Boot procedure including secured firmware upgrade

4.4 Applications

Two applications can be embedded on the platform: the LoRa packet forwarder and the BSC (Base Station Controller) client.

These applications are not delivered by default and can be replaced by customer's ones.

Kerlink provides to the customer the list of packages made available by the Wirnet iBTS platform base firmware. Customer's libraries or binaries can be freely compiled and added to application part using provided toolchain.

4.4.1 *LoRa packet forwarder*

This application is responsible for forwarding all received RF packets to the LoraMac server using WAN interface and to emit on RF link all the messages received from the LoraMac server.

The packet forwarder is relaying on the Semtech HAL (Hardware Abstraction Layer) providing very simple access to RF features (transmit, receive…).

Here are the main modifications compared to the packet forwarder which is available on the Wirnet Station (V1):

- Support multi-Sx1301 with a single JSON configuration file
- Support of transmission retry mechanism to avoid messages loss
- Backup of messages during power off
- LoRa class A, B, C

All LoRa messages are treated by the LoraMac server which can be considered as a proxy between LoRa network and customer IT. This server is responsible for:

- Endpoints management
- Security management
- Endpoints addressing

The availability of the LoraMac server is out of the scope of Wirnet iBTS product.

4.4.2 *BSC client*

4.4.2.1 Services

This application is a client for BSC (Base Station Controller) and is responsible for link with the IoT Platform "WANESY RAN" provided by Kerlink to ensure the Device Management services of monitoring, provisioning and maintenance.

The services provided by the application are the followings (non-exhaustive list):

- Supervision of power supply
- Supervision of the enclosure's lid
- Maintaining the watchdog
- Configuration of the GPS daemon
- Recovery of the GPS position
- Configuration of time source and NTP steering
- Recovery of the configuration data
- Maintenance: firmware upgrade, remote shell, file explorer…
- Construction / retrieving statistics
- System configuration (network management...)
- RF modems configuration
- Registration of RF spectrums on demand

The communication with the IoT Platform is based on SNMP-v2c protocol.

4.4.2.2 Alarms

The alarms generated by the application are the followings (non-exhaustive list):

- Power loss after 5 seconds without power supply (only possible with backup-battery)
- Opening or closing of the door (light sensor detection, configurable threshold)
- Restoration of the firmware
- Restoration of the configuration
- RAM occupancy exceeded the configurable threshold for 30s (*)
- CPU load exceeded the configurable threshold for 30s (*)
- System disk occupancy exceeded the configurable threshold (*)
- User disk occupancy exceeded the configurable threshold (*)
- Temperature exceeded the configurable threshold (*)
- RSSI exceeded the configurable threshold (*)
- GPS not fixed for a configurable duration

A notification is sent when the alarm triggered and then at the end of the alarm.

For the alarms marked with (*), a hysteresis mechanism associated with the configurable threshold allows to avoid oscillation phenomena.

4.4.2.3 KPIs

The system offers a number of KPIs that are available for the platform (non-exhaustive list):

- Platform data:
  - RX/TX by interface
  - Temperature
  - RSSI
  - GPS lock ratio
- Charges:
  - CPU
  - RAM
  - Disk
- Radio station:
  - Number of messages RX/TX
  - CRC KO
  - Total lengths
  - Distribution of SF
  - RSSI
  - Data rate average
  - Duty cycle
- Radio Modem:
  - Number of messages RX/TX
  - CRC KO
  - Total lengths
  - Distribution of SF
  - RSSI
  - Data rate average
  - Duty cycle
  - Load of modulators
  - Load of RF channels
  - Potential interferers

4.5 Update system

4.5.1 *Updates*

Contrary to Wirnet Station (V1), only OPKG packages are supported.

4.5.2 *Auto-recovery*

The firmware of Wirnet iBTS has a “2-levels” auto-recovery mechanism based on watchdog reboots detection.

Contrary to the firmware of Wirnet Station (V1), only watchdog reboots can trigger a recovery operation.

After 16 consecutive watchdog reboots detected, a “restore backup” operation is triggered. This backup is a stored state of the firmware before the last update.

If 32 watchdog reboots are detected, a “restore stock firmware” operation is triggered. In this case, all the stock firmware is re-installed (configuration, modifications and user data are deleted).

4.5.3 *Hotfix*

The firmware of Wirnet iBTS supports hotfix packages to allow modifications of the root filesystem in the overlay to fix a limited problem in the system. These packages can be delivered quicker than waiting for a full release of firmware with the fix.

4.6 WAN

WAN interface relays on IP mechanism and can be established either on Ethernet link or GSM link.

The WAN connectivity is handled by a daemon providing a powerful interface for network configuration and statistics. Additionally, it allows to get a “fallback” mechanism when using a GSM module.

Security is provided by using an SSL tunnel (openVPN).

5. Regulations

5.1 Wirnet iBTS 868

5.1.1 *Europe / CE*

Wirnet iBTS 868 complies with requirements listed in:

- RED Directive 2014/53/EU
- Low Voltage Directive 2014/35/EU
- Electromagnetic Compatibility Directive 2014/30/EU
- The limitation of exposure of the general public to electromagnetic fields specified in the Council Recommendation 1999/519/EC:

The power supply of the Wirnet iBTS 868 must be a limited power source.
The Wirnet iBTS 868 is considered as a category 1.5 receiver according to the EN 300 220-1.
The Wirnet iBTS 868 has CE marking.

In Europe, the Wirnet iBTS 868 station must comply with the ERC 70-3 requirements regarding duty cycle and maximum EIRP. They are summarized in the following table:

ERC 70-03 Band	Frequency (MHz)	Power	Duty cycle
h1.2	865-868	14dBm ERP	1%
h1.4	868-868,6	14dBm ERP	1%
h1.5	868,7-869,2	14dBm ERP	0,1%
h1.6	869,4-869,65	27dBm ERP	10%
h1.7	869,7-870	14dBm ERP	1%
h2.1	870-873	14dBm ERP	1%

The frequency channels arrangement must be compliant to the LoRaWAN specification and the regional parameters (EU 863-870 MHz) as defined in [1] and [2].

If the LoRa antenna is changed, the output power must be adjusted to take into account the gain of the antenna to not overrule the ERC 70-3 regulation.
Be careful, some countries in Europe may have specific frequency range, EIRP and duty cycles regulations:

- Greece, Sweden: bands h1.2 and h2.1 must not be used
- Andorra, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, France, Germany, Spain, Netherlands, Italy, Liechtenstein, Lithuania, Latvia, Macedonia, Malta, Montenegro, Portugal, Romania, Switzerland, Serbia, Turkey: band h2.1 must not be used

Check the local regulations before installing and commissioning the gateway.
For other countries, outside Europe, check the frequency range, the maximum EIRP and duty cycle allowed.

5.1.2 *India*

The Type Approvals No NR-ETA/5251-RLO(NR), NR-ETA/6064-RLO(NR) and NR-ETA 354/2017-RLO(SR) were granted by WPC to the Wirnet iBTS Compact 868.
However:

- Separate Import license is required to be obtained for each import as per WPC procedures,
- Record of all the equipments imported needs to be maintained and submitted to the Ministry as and when required.

In India, the Wirnet iBTS Compact 868 can be used with the following limitations:

Item	Specification
Frequency range	865-867MHz
Max EIRP	4W
Max conducted power with 6dBi antenna	1W
Channelization	200KHz

The frequency channels arrangement must be compliant to the LoRaWAN specification and the regional parameters (India 865-867 MHz) as defined in [1] and [2].

Note: A 865-867MHz cavity filter may be required in India to avoid saturation and desensitization of the LoRa receiver due to co-located LTE850 or CDMA800 base stations. This cavity filter is described in §3.7.6.1.

5.1.3 *South Africa*

- Wirnet iBTS 868 ready for ICASA Type approval -

The Wirnet iBTS 868 is compliant to:

- Radio Frequency Spectrum Regulations, 2015
- SANS 301489-1: Electromagnetic compatibility and Radio spectrum Matters (ERM) - ElectroMagnetic Compatibility (EMC) standard for radio equipment and services Part 1: Common technical requirements
- SANS 301489-3: Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services Part 3: Specific conditions for Short-Range Devices (SRD) operating on frequencies between 9 kHz and 246 GHz
- SANS 60950-1: Information technology equipment - Safety Part 1: General requirements

In South-Africa, the Wirnet iBTS 868 can be used with the following limitations:

Frequency (MHz)	Power	Duty cycle
868-868,6	14dBm erp	1%
868,7-869,2	14dBm erp	0,1%
869,4-869,65	27dBm erp	10%
869,7-870	7dBm erp	100%

The frequency channels arrangement is the same as in Europe i.e. must be compliant to the LoRaWAN specification and the regional parameters (EU 863-870 MHz) as defined in [1] and [2].

5.1.4 *Saudi Arabia*

- Wirnet iBTS 868 ready for CITC approval -

The Wirnet iBTS 868 is compliant to:

- RI054 – Specifications for Non-specific Short-Range Devices and Ancillary Equipment
- National Guideline for Human Exposure to Radiofrequency Electromagnetic Fields, 2009
- GEN001 – Technical Specification – General Requirements
- IEC 60950-1: 2005 + A1: 2009 + A2: 2013 - Information technology equipment - Safety - Part 1: General requirements

In Saudi-Arabia, the Wirnet iBTS 868 can be used with the following limitations:

Frequency (MHz)	Power
865-868	14dBm erp
868-868,6	14dBm erp
868,7-869,2	14dBm erp
869,4-869,65	27dBm erp
869,7-870	7dBm erp

The frequency channels arrangement is the same as in Europe i.e. must be compliant to the LoRaWAN specification and the regional parameters (EU 863-870 MHz) as defined in [1] and [2].

5.1.5 *United Arab Emirates*

- Wirnet iBTS 868 ready for TRA Type approval -

The Wirnet iBTS 868 is compliant to:

- TS031 – Non-Specific Short range Devices
- TS001 – EMC and Safety Requirements
- UAE.S GSO 1799: Safety Levels with Respect to Human Exposure To Radio Frequency Electromagnetic Fields, 3 kHz To 300 GHz

In United Arab Emirates, the Wirnet iBTS 868 can be used with the following limitations:

Frequency (MHz)	Power
865-870	17dBm EIRP*
870-873	10dBm EIRP

*: can be increased to 20dBm EIRP with authorization of the TRA.

The frequency channels arrangement is the same as in Europe i.e. must be compliant to the LoRaWAN specification and the regional parameters (EU 863-870MHz) as defined in [1] and [2].

5.1.6 *Russia*

- Wirnet iBTS 868 ready for Minsvyaz approval and EAC marking -

The Wirnet iBTS 868 is compliant to:

- CU TR 020/2011 : Electromagnetic Compatibility of Technical Products
- CU TR 004/2011 : Safety of Low Voltage Equipment
- GOST R IEC 60950-1 - Information technology equipment. Safety. Part 1. General requirements.

In Russia, the Wirnet iBTS 868 can be used with the following limitations:

Frequency (MHz)	Power	Duty cycle
864-865	14dBm ERP	1%
868.7-869.2	14dBm ERP	N/A

The frequency channels arrangement is defined in the LoRaWAN specification and the regional parameters (RU 864) as defined in [1] and [2].

5.2 Wirnet iBTS 915

5.2.1 *USA / FCC*

The Wirnet iBTS 915 is compliant to:

- UL 60950 -1 : 2007, Amendment A1:2011, Amendment A2:2014

The power supply of the Wirnet iBTS 915 must be a limited power source.

The Wirnet iBTS 915 is also compliant to CFR 47 FCC Part 15 regulations:

- FCC 47 CFR Part 15 : 2014 - Part 15- Radio frequency devices
- FCC PART 15.247 - Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz (frequency hopping and digitally modulated)
    - FCC Part 15.207 conducted emissions on AC mains in the band 150kHz – 30MHz
    - FCC Part 15.247 intentional radiated emissions
    - FCC Part 15.215 Additional provisions to the general radiated emissions limitations

The associated FCC identifiers of the Wirnet iBTS 915 are:

FCC ID : 2AFYS-KLK915IBTS
Model : WIRNET iBTS 915
Contains FCCID : N7NMC7355
Model : MC7355

The associated FCC identifiers of the Wirnet iBTS Compact 915 are:

FCC ID : 2AFYS-KLK915IBTSC
Model : WIRNET iBTS Compact 915
Contains FCCID : N7NMC7355
Model : MC7355

5.2.2 *Canada / IC*

The Wirnet iBTS 915 is compliant to:

- CAN/CSA-C22.2 NO. 60950-1-07 / A1: 2011 / A2: 2014

The power supply of the Wirnet iBTS 915 must be a limited power source.

The Wirnet iBTS 915 is also compliant to IC - RSS 247 regulations:

- RSS-Gen – Issue 4, November 2014- General requirements and Information for the Certification of radio Apparatus
- RSS-247 Issue 1, May 2015 - Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSS) and License-Exempt Local Area Network (LE-LAN) Devices

The associated IC identifiers of the Wirnet iBTS 915 are:

IC : 20637-KLK915IBTS
Model : WIRNET iBTS 915
Contains / Contient IC : 2417C-MC7355
Model : MC7355

The associated IC identifiers of the Wirnet iBTS Compact 915 are:

IC : 20637-KLK915IBTSC
Model : WIRNET iBTS Compact 915
Contains / Contient IC : 2417C-MC7355
Model : MC7355

5.2.3 *Mexico*

-IFETEL certification required-

The Wirnet iBTS 915 is compliant to "IFT-008-2015 (PROLAB-89) – Telecomunicaciones – Radiocomunicación - Sistemas de radiocomunicación que emplean la técnica de espectro disperso - Equipos de radiocomunicación por salto de frecuencia y por modulación digital a operar en las bandas 902-928 MHz, 2400-2483.5 MHz y 5725-5850 MHz - Especificaciones, límites y métodos de prueba".

"La operación de este equipo está sujeta a las siguientes dos condiciones: (1) es posible que este equipo o dispositivo no cause interferencia perjudicial y (2) este equipo o dispositivo debe aceptar cualquier interferencia, incluyendo la que pueda causar su operación no deseada."

The frequency channels arrangement must be compliant to the LoRaWAN specification and the regional parameters (US 902-928 MHz) as defined in [1] and [2].

5.2.4 *Philippines*

-NTC Type Approval required-

The Wirnet iBTS 915 is compliant to:

- Memorandum Circular MC 03-08-2013 amending MC 09-09-20003 for Wireless data Networks and Devices
- Memorandum Circular n°20-12-92 : Implementing guidelines for Cellular Mobile Telephone System (CMTS) operations in the Philippines
- Memorandum Circular n°07-08-2005 : Rules and regulations on the Allocation and Assignment of 3G Radio Frequency bands

- Memorandum Circular n°01-03-2010 : Rules on the Assignment of the Remaining Allocated 3G Radio Frequency Band
- PNS –IEC 60950-1 - Information Technology Equipment – Safety – Part 1: General requirements.

In Philippines, the Wirnet iBTS 915 can be used with the following limitations:

Item	Specification
Frequency range	915-918MHz
Max ERP	250mW
Max conducted power with 3dBi antenna	+23dBm (200mW)
Max conducted power with 6dBi antenna	+20dBm (100mW)
Channelization	200KHz
Number of channels	14
Channels center frequency	915.2 MHz +n*0.2MHz (0<=n<=13)

No frequency channels arrangement defined in LoRaWAN specification and the regional parameters as defined in [1] and [2] can be applicable to Philippines. Alternate JoinReq channels must be then defined.

Note: A 915-920MHz cavity filter may be required in Philippines to avoid saturation and desensitization of the LoRa receiver due to co-located EGSM900 base stations. This cavity filter is described in §3.7.6.3.

5.3 Wirnet iBTS 923

The Wirnet iBTS 923 is compliant to:

- IEC 60950-1:2005/A1:2009/A2:2013
- CENELEC EN 60 950-1 (Ed. 2006/A11 : 2009/A1 : 2010/A12:2011/A2:2013)
- AS/NZS 60950.1 : 2011
- GB4943-2011
- K60950-1
- J60950-1

The Wirnet iBTS 923 is also compliant to both FCC and CE regulations.
Applicable documents:

- CFR 47 FCC Part 15 :
  - FCC 47 CFR Part 15 : 2014 - Part 15- Radio frequency devices
  - FCC PART 15.247 - Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz. (frequency hopping and digitally modulated)

- FCC Part 15.207 conducted emissions on AC mains in the band 150kHz – 30MHz
- FCC Part 15.247 intentional radiated emissions
- FCC Part 15.215 Additional provisions to the general radiated emissions limitations

- Article 3.2 of the R&TTE Directive:
  - EN 300 220-1, issue 3.3.1
  - EN 300 220-2, issue 3.3.1

  The Wirnet iBTS 923 is considered as a category 1.5 receiver according to the EN 300 220-1.

Note :
Depending on the countries, check the specific regulations applying, especially regarding frequency range, maximum EIRP, duty cycle allowed, maximum transmit duration, carrier sense mandatory or not, etc …
Some specific rules are detailed hereafter for specific countries.

5.3.1 *Australia*

M2M Connectivity is the only Responsible Supplier of the Wirnet iBTS 923 and Wirnet iBTS Compact 923 under the ACMA registration process. The company acts as importer of the Wirnet Station 923 and agreed to let Kerlink affix the product with the RCM mark.

The Wirnet iBTS 923 complies with the requirements of the relevant ACMA Standards made under the Radiocommunications Act 1992 and the Telecommunications Act 1997. These Standards are referenced in notices made under section 182 of the Radiocommunications Act and 407 of the Telecommunications Act.
The applicable Standard are:

- Radiocommunications (Short Range Devices) Standard 2014
  AS/NZS 4268: 2017: Radio equipment and systems – Short range devices – Limits and methods of measurement
- AS/CA S042.1: 2015 - Requirements for connection to an air interface of a Telecommunications Network - Part 1: General
- AS/ACIF S042.3: 2005 - Requirements for connection to an air interface of a Telecommunications Network - Part 3: GSM Customer Equipment
- AS/CA S042.4: 2015 - Requirements for connection to an air interface of a Telecommunications Network—Part 4: IMT Customer Equipment
- AS/NZS 60950.1: 2015 - Information technology equipment - Safety - General requirements

In Australia, the Wirnet iBTS 923 can be used with the following limitations:

Item	Specification
Frequency range	915-928MHz
Max EIRP	1W (30dBm)
Max conducted power with 6dBi antenna	24dBm
Max conducted power with 3dBi antenna	27dBm

The frequency channels arrangement must be compliant to the LoRaWAN specification and the regional parameters (AU 915-928MHz) as defined in [1] and [2].

5.3.2 *Hong-Kong*

The Wirnet iBTS 923 can be used in Hong-Kong, based on a Voluntary Certification Scheme.
The Wirnet iBTS 923 is compliant to:

- Hong Kong Telecommunications Equipment Evaluation and Certification (HKTEC) Scheme OFCA I 421, Issue 6, 2012, based on a Voluntary Certification Scheme.
- HKCA 1035 – Issue 7, 2016: Performance specification for radio equipment exempted from licensing
- HKCA 1078 – Issue 1, 2017: Performance specification for Radio Equipment operating in the 920-925 MHz band for the provision of public telecommunications services.
- HKCA 1049 – Issue 1, 2005: Performance specification for RFID Equipment operating in the 865-868 MHz and/or 920-925 MHz bands.
- HKCA 1033 – Issue 7, 2012: Performance Specification for Mobile Stations and Portable Equipment for use in the Global System for Mobile Communications (GSM) 900 and 1800 MHz Bands.
- HKCA 1048 – Issue 2, 2008: Performance specification for user equipment for use in the third generation (3G) mobile communication services employing CDMA Direct Spread (UTRA FDD).
- HKCA 1057 – Issue 1, 2011: Performance Specification for User Equipment for Use in Public Mobile Communications Services based on Evolved Universal Terrestrial Radio Access (E-UTRA) Frequency Division Duplex (FDD).
- HKCA 2001 – Issue 12, 2012: Compliance test specification – Safety and Electrical Protection requirements for subscriber Telecommunications Equipment.

In Hong-Kong, the Wirnet iBTS 923 can be then used with the following limitations:

Item	Specification
Frequency range	920-925MHz
Max EIRP	36dBm
Max conducted power with 6dBi antenna	30dBm
Channelization	200KHz

Number of channels	24
Channels center frequency	920.2 MHz +n*0.2MHz (0<=n<=23)

The frequency channels arrangement may be compliant to the LoRaWAN specification and the regional parameters (AS 923MHz) as defined in [1] and [2].

Note:
A 920-925MHz cavity filter may be required in Hong-Kong to avoid saturation and desensitization of the LoRa receiver due to co-located EGSM900 base stations. This cavity filter is described in §3.7.6.1.

5.3.3 *Indonesia*

- Wirnet iBTS 923 ready for SDDPI Certification -

In Indonesia, the Wirnet iBTS 923 can be used with the following limitations:

The Wirnet iBTS 923 is compliant to:

- PERSYARATAN TEKNIS ALAT DAN PERANGKAT TELEKOMUNIKASI JARAK DEKAT (SHORT RANGE DEVICE) – 22 November 2012
- KEPDIRJEN No. 370 / DIRJEN / 2010 for 2G WAN part
- KEPDIRJEN No. 173 / DIRJEN / 2009 for 3G WAN part

Item	Specification
Frequency range	923-925MHz
Max ERP	500mW (27dBm)
Max EIRP	29dBm
Max conducted power with 6dBi antenna	23dBm
Max conducted power with 3dBi antenna	26dBm
Channelization	200KHz
Number of channels	9
Channels center frequency	923.2 MHz +n*0.2MHz (0<=n<=8)

The frequency channels arrangement must be compliant to the LoRaWAN specification and the regional parameters (AS 923MHz) as defined in [1] and [2].

Note: A 920-925MHz cavity filter may be required in Indonesia to avoid saturation and desensitization of the LoRa receiver due to co-located EGSM900 base stations. This cavity filter is described in §3.7.6.1.

5.3.4 *Korea (Republic of)*

- Wirnet iBTS 923 ready for RRA Certification and KCC label -

The Wirnet iBTS 923 is compliant to:

- Regulations on Radio Equipment (KCC Public Notification 2013-01, Jan 3, 2013)
- Unlicensed Radio Equipment Established Without Notice (KCC Public Notification 2012-102, Dec 5, 2012)
- Technical Requirements of Radio Wave Application (RRA Public Notification 2012-29, Dec 28, 2012)
- Measurements of the high-frequency output of radio wave application equipment and antenna power calculation methods (RRA Announce 2012-30, Dec 28, 2012)
- Technical Requirements for Radio Equipment of Standard of Safety Facility (RRA Public Notification 2012-31, Dec 28, 2012)
- Technical Requirements for the Human Protection against Electromagnetic Waves (KCC Public Notification 2012-2, Jan 5, 2012)
- Technical Requirements for Measurement and Test Procedure of Specific Absorption Rate (RRA Public Notification 2012-23, Dec 6, 2012)
- Technical Requirements for Measurement of Electromagnetic Field Strength (RRA Public Notification 2012-21, Nov 6, 2012)
- Equipment to be subject of Test Procedure for Electromagnetic Field Strength and Specific Absorption Rate (KCC Public Notification 2012-1, Jan 5, 2012)
- Conformity Assessment Procedure of Radio Equipment (RRA Announce 2011- 32, Dec 27, 2011)
- KN 301489-1: 2012-06 – test method of common technical EMC for radio equipment
- KN 301489-3 – Test method of EMC for radio equipments of short-range.
- KN 301489-7: 2008-5 – Test method of EMC for mobile and portable radio telecommunications systems.
- KN 301489-24: 2008-5 – test method for EMC for mobile and portable radio and ancillary equipment
- K60950-1 (2.0) - Information technology equipment – Safety – Part 1: General requirements

In Republic of Korea, the Wirnet iBTS 923 can be used with the following limitations:

Item	Specification
Frequency range	920.9-923.3MHz
Max EIRP	200mW (23dBm)
Max conducted power with 6dBi antenna	17dBm
Max conducted power with 3dBi antenna	20dBm
Carrier sense (LBT)	5ms / -65dBm
Transmit duration	< 4s
Pause duration	> 50 ms
Duty cycle	<2% in 20 s duration

The frequency channels arrangement must be compliant to the LoRaWAN specification and the regional parameters (KR 920-923MHz) as defined in [1] and [2].

5.3.5 *New-Zealand*

Due to mutual Recognition with Australia, the Wirnet iBTS 923 is exempted from the requirement to be the subject of a New Zealand declaration of conformity and to comply with New Zealand labelling requirements, provided the product is declared, labelled and supplied in accordance with the Radiocommunications (Compliance Labelling) Notice 2003, or a notice in replacement thereof, issued by the ACMA under section 182 of the Radiocommunications Act 1992 (Australia). See §5.3.1.

The Wirnet iBTS 923 is compliant to General User Radio License (GURL) for Short Range Devices (SRD) and all the applicable deviations such as item 23:
Transmissions must not exceed the following unwanted emission limits: –79 dBW (–49 dBm) e.i.r.p. within 800 – 915 MHz and –63 dBW (–33 dBm) e.i.r.p. within 928 MHz – 1 GHz. The reference bandwidth for emissions is 100 kHz. Outside the band 800 MHz – 1 GHz, the limits prescribed in applicable standards prescribed in the Radiocommunications (Radio Standards) Notice 2016 apply. In the absence of applicable standards, the limits prescribed in Table 2 of the notice apply.*

In New-Zealand, the Wirnet iBTS 923 can be used with the following limitations:

Item	Specification
Frequency range	920-928 MHz
Max EIRP	4W (36dBm)
Max conducted power with 6dBi antenna	30dBm
Upstream channels	8 channels 915.9 MHz to 927.1 MHz Steps of 1.6 MHz 500 kHz BW LoRa modulation SF7 to SF12
Upstream channels	64 channels 915.2 MHz to 927.8 MHz Steps of 200 kHz 125 kHz BW LoRa modulation SF7 to SF12
Downstream channels	8 channels 923.3 MHz to 927.5 MHz Steps of 600 kHz 500 kHz BW LoRa modulation SF7 to SF12

Or:

Item	Specification
Frequency range	915-928 MHz
Max EIRP	1W (30dBm)
Max conducted power with 6dBi antenna	24dBm
Max conducted power with 3dBi antenna	27dBm
Upstream channels	64 channels 915.2 MHz to 927.8 MHz Steps of 200 kHz 125 kHz BW LoRa modulation SF7 to SF12
Downstream channels	64 channels 915.2 MHz to 927.8 MHz Steps of 200 kHz 125 kHz BW LoRa modulation SF7 to SF12

Therefore, two different frequency plans can be used:

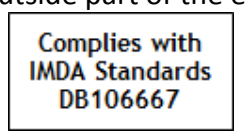
- Frequency plan and channel arrangement similar to Australia, according to the LoRaWAN specification and the regional parameters (AU 915-928MHz) as defined in [1] and [2].
- Frequency plan compliant to the LoRaWAN specification and the regional parameters (AS 923MHz) as defined in [1] and [2].

Note: A 920-928MHz cavity filter may be required in New-Zealand to avoid saturation and desensitization of the LoRa receiver due to co-located GSM900 base stations in harsh environments. This cavity filter is described in §3.7.7.1.

5.3.6 *Singapore*

The equipments are registered by IMDA under telecommunications (dealers) regulations. The Registration Numbers are N4572-17 and N4573-17, expiring on 30/11/2022. A dealer license is required to operate the gateways in Singapore. Kerlink Singapore Dealer License is DB106667.

The following label is placed on the outside part of the enclosure:



The Wirnet iBTS 923 is compliant to:

- IMDA Technical Specifications for Short Range Devices (IMDA TS SRD) – Issue 1, 1 October 2016
- IDA Technical Specifications for Cellular Mobile Terminal (IMDA TS CMT) – Issue 1, 1 October 2016
- IEC 60950-1: 2005 + A1: 2009 + A2: 2013 - Information technology equipment - Safety - Part 1: General requirements

In Singapore, the Wirnet iBTS 923 can be used with the following limitations:

Item	Specification
Frequency range	920-925MHz
Max ERP	500mW
Max EIRP	29dBm
Max conducted power with 6dBi antenna	23dBm
Channelization	200KHz
Number of channels	24
Channels center frequency	920.2 MHz +n*0.2MHz (0<=n<=23)

The frequency channels arrangement must be compliant to the LoRaWAN specification and the regional parameters (AS 923MHz) as defined in [1] and [2].

Note: A 920-925MHz cavity filter may be required in Singapore to avoid saturation and desensitization of the LoRa receiver due to co-located EGSM900 base stations. This cavity filter is described in §3.7.6.1.

5.3.7 *Japan*

The Wirnet iBTS 923 is certified by C&S in Japan and registered with number CSRT170147.
The specified Radio Equipment marking is visible on the external sticker on the enclosure:

The Wirnet iBTS Compact 923 is also certified by C&S in Japan and registered with number CSRT170148.
The specified Radio Equipment marking is visible on the external sticker on the enclosure:

The Wirnet iBTS 923 is compliant to “ARIB STD-T108 - 920MHz-Band Telemeter, Telecontrol and Data Transmission Radio Equipment”.

The certifications are valid for 3dBi, 6dBi and 8dBi referenced antennas from KERLINK:

- SCOUT KER-915-3 (3dBi) – KLK02658
- FT-RF OA-915M06-NF (6dBi) – KLK02518
- Terrawave T09080O100061 (8dBi)

Contact Kerlink for more information.

In Japan, the Wirnet iBTS 923 can be used with the following limitations:

Item	Specification
Frequency range	920.5-928.0MHz
Channelization	200KHz
Max EIRP (920.6-923.4MHz)**	500mW (27dBm)
Max conducted power (920.6-923.4MHz)**	250mW (24dBm)
Max EIRP (923.6-928MHz)*	40mW (16dBm)
Max conducted power (923.6-928.0MHz)*	20mW (13dBm)
Carrier sense (LBT) 920.6-922.2MHz**	5ms / -80dBm
Carrier sense (LBT) 922.4-923.4MHz**	128uS / -80dBm
Carrier sense (LBT) 923.6-928.0MHz*	128uS / -80dBm
Transmit duration (920.6-922.2MHz)**	< 4s
Transmit duration (922.4-923.4MHz)**	<400ms
Transmit duration (923.6-928.0MHz)*	<400ms
Pause duration (920.4-922.2MHz)	> 50 ms
Pause duration (922.4-923.4MHz)	> 10*Tx duration
Pause duration (923.6-928.0MHz)	> 10*Tx duration

*: ARIB STD-T108 Convenience Radio Station
**: ARIB STD-T108 Specified low power radio station

The frequency plan and channel allocation is defined for Japan in the LoRaWAN specification and the regional parameters as defined in [1] and [2], according to “AS 923MHz” plan.

The full frequency plan proposed by Kerlink is the following:

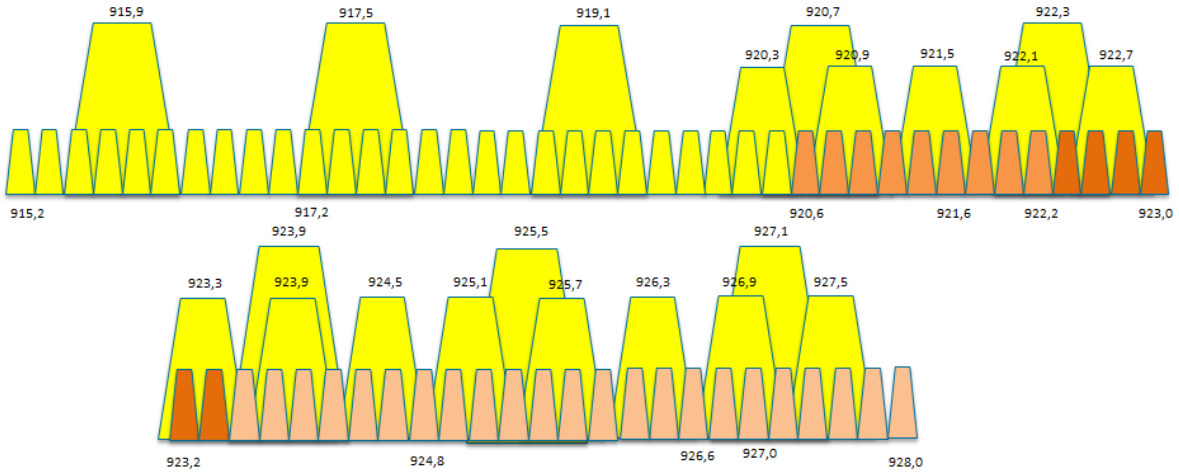


Figure 78 : Channels allocation proposal in Japan

Note:

In the above figure:

- Upstream and downstream channels are in orange: 38 channels, 200KHz spacing, 125KHz BW
- Upstream channels in medium orange:
    - 9 channels (920.6MHz to 922.2MHz)
    - SF7 to SF12
    - Max frame length=4s
    - 50 ms between frames
    - 500mW EIRP
    - 5ms min carrier sense
- Upstream channels in dark orange:
    - 6 channels (922.4MHz to 923.4MHz)
    - SF7 to SF10
    - Max frame length=400ms
    - 10% duty cycle max
    - 500mW EIRP
    - 128us min carrier sense
- Upstream channels in light orange:
    - 23 channels (923.6MHz to 928.0MHz)
    - SF7 to SF10
    - Max frame length=400ms
    - 10% duty cycle max
    - 40mW EIRP
    - 128us min carrier sense
- Unused channels are in yellow

The channels allocation can be organized differently if needed.

5.3.8 *Taiwan*

-NCC Certification required-

In Taiwan, the Wirnet iBTS 923 can be used be used as a « digitally modulated techniques systems" according to item 1, chapter 4.8.1 of the "Low Power 0002 (LP0002)" specifications.

Item	Specification
Frequency range	920-925MHz
Max EIRP	0.5W
Max conducted power with 6dBi antenna	125mW (21dBm)

For Reducing RF Influence, Use Properly.
'減少電池波影響，請妥適使用。

注意！
依據 低功率電波輻射性電機管理辦法
第十二條 經型式認證合格之低功率射頻電機，非經許可，
公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計
之特性及功能。
第十四條 低功率射頻電機之使用不得影響飛航安全及干擾合法通信；
經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。
前項合法通信，指依電信規定作業之無線電信。
低功率射頻電機須忍受合法通信或工業、科學及醫療用電波輻射性
電機設備之干擾。

The Wirnet iBTS 923 is also compliant to:

- PLMN01: GSM900 and DCS1800 Mobile Equipment Technical Specifications, rev 09-05-2012
- PLMN08: the Third Generation Mobile Telecommunication Terminal Equipment Technical Specifications
- CNS 13438: 2006 - Information technology equipment – Radio disturbance Characteristics – limits and methods of measurement.
- CNS 14336-1: 2010 - Information Technology Equipment – Safety – Part 1: General requirements.

The LoRa frequency plan and channel allocation for Taiwan is defined in the LoRaWAN specification and the regional parameters, as defined in [1] and [2], according to "AS 923MHz".

5.3.9 *Malaysia*

The Wirnet iBTS 923 and Wirnet iBTS Compact 923 own a MCMC Type Approval with the identification number RFFT/01A/1117/S(17-3593) and RFFT/02A/1117/S(17-3594) respectively. The expiry date is 23/11/2022.
The following SLP certification mark is available on the external label:

No CID is available so far. It will be provided later on.

In Malaysia, the Wirnet iBTS 923 is considered as a Short-Range Device (SRD) according to "MCMC MTSFB TC T007: 2014, 1st Rev".
The Wirnet iBTS 923 uses the 919-924MHz band with a maximum 500mW EIRP, according to "CLASS ASSIGNMENT NO. 1 OF 2017".

Item	Specification
Frequency range	919-923MHz
	923-924MHz (1% duty cycle)
Max EIRP	0.5W
Max conducted power with 3dBi antenna	250mW (24dBm)
Max conducted power with 6dBi antenna	125mW (21dBm)
Channelization	200KHz
Number of channels	19
Channels center frequency	919.2 MHz +n*0.2MHz (0<=n<=18)

The Wirnet iBTS 923 is also compliant to:

- SKMM WTS GSM-MT Rev. 1.01:2007 for the WAN / GSM part
- SKMM WTS IMT-MT Rev. 1.01:2007 for the WAN /3G part
- MS IEC 60950-1:2007 - Information Technology Equipment – Safety – part 1: General Requirements

The LoRa frequency plan and channel allocation for Malaysia is defined in the LoRaWAN specification and the regional parameters as defined in [1] and [2], according to "AS 923" plan.

Note: A 918-923MHz cavity filter may be required in Malaysia to avoid saturation and desensitization of the LoRa receiver due to co-located EGSM900 base stations. This cavity filter is described in §3.7.6.4.

5.3.10 *Thailand*

The Wirnet iBTS 923 is compliant to "NTC TS 1033-2560 – Technical Standard for non-RFID Radio Communication Equipment 920-925MHz.

The Wirnet iBTS 923 is NBTC certified as a Class B equipment. The certification number are B69006-18 (Wirnet iBTS 923) and B69007-18 (Wirnet iBTS 923 Compact)
The following labels are placed on the outside part of the enclosures:

CLASS B NBTC ID. B69006-18-3723	CLASS B NBTC ID. B69007-18-3723

The Wirnet iBTS 923 is also compliant to:

- NTC TS 1004-2553 – User Equipment of Cellular land Mobile Service using GSM Technology
- NTC TS 1015-2549 - User equipment operating in cellular land mobile service using IMT-2000 CDMA Direct Spread (WCDMA) technology
- NTC TS 5001-2550 : Radiocommunication Equipment (Radio Frequency Radiation Exposure in 9 kHz-300 GHz)
- TISI 1956-2548 : Information Technology Equipment – Radio Disturbance Limits
- NTC TS 4001-2550: Electrical Safety of Telecom Terminal Equipment

In Thailand, the Wirnet iBTS 923 can be then used with the following limitations:

Item	Specification
Frequency range	920-925MHz
Max EIRP	33dBm (2W)
Max conducted power with 6dBi antenna	27dBm (500mW)
Duty cycle	<10%
Channelization	200KHz
Number of channels	24
Channels center frequency	920.2 MHz +n*0.2MHz (0<=n<=23)

The frequency channels arrangement in Thailand must be compliant to the LoRaWAN specification and the regional parameters (AS 923MHz) as defined in [1] and [2].

5.3.11 *Brazil*

-ANATEL Certification required-

In Brazil, the Wirnet iBTS 923 can be used according to « Resolução n°680 de 27 de junho de 2017– Regulamento Sobre Equipementos de Radiocomunicaçao de radiaçao Restrita.”

Item	Specification
Frequency range	915-928MHz
Max conducted power	1W (30dBm)
Max EIRP (6dBi max antenna)	4W (36dBm)
System type	DSSS / DTS

The Wirnet iBTS 923 is also compliant to:

- Resolução nº 477, de 7 de agosto de 2007 - Regulamento do Serviço Móvel Pessoal – SMP.
- Resolução nº 303, de 2 de julho de 2002 - Aprova o Regulamento sobre Limitação da Exposição a Campos Elétricos, Magnéticos e Eletromagnéticos na Faixa de Radiofreqüências entre 9 kHz e 300 GHz.
- Resolução nº 442, de 21 de julho de 2006 – Aprova o Regulamento par Cartificaçao de Equipamentos de Telecomunicaçoes quanto aos Aspectos de Compatibilidade Eletromagnética.
- Resolução nº 529, de 3 de junho de 2009 – Aprova o Regulamento par Cartificaçao de Equipamentos de Telecomunicaçoes quanto aos Aspectos de Segurança Elétrica.

The frequency channels arrangement is not defined for Brazil in the LoRaWAN specification and the regional parameters as defined in [1] and [2], but Kerlink recommends following the Australian plan (AU 915-928MHz).

6. List of the accessories

Basic configuration:

KERLINK Reference	Designation
KLK-I0144	Wirnet iBTS enclosure, including: • 1 X Wall mount kit • 1 X U bolt mounting kit • 1 X M25 cable gland • 2 X N-SMB adapters • 2 x RF coaxial SMB/SMA cables • 9 X M16 blind stop • 1 X CPU Module
KLK-I0151	Wirnet iBTS Compact enclosure, including: • 1 X Wall mount kit • 1 X U bolt mounting kit • 1 x combo antenna LTE / GNSS • 1 X M25 cable gland • 1 X N-SMB adapters • 1 x RF coaxial SMB/SMA cables • 1 X M16 blind stop • 1 X CPU Module

LoRa modules:

KERLINK Reference	Designation
PDTIOT-ACS02 (KLK-I0181)	Single LoRa Module 868 – LoRa LOC, including: • 2 X N-SMB adapter • 2 x RF coaxial SMB/SMB cable
KLK-I0164	Single LoRa Module 915 – LoRa LOC, including: • 2 X N-SMB adapter • 2 x RF coaxial SMB/SMB cable
KLK-I0153	Quad LoRa Modules 915 – LoRa LOC – 64 channels, including: • 2 X N-SMB adapter • 2 x RF coaxial SMB/SMB cable
PDTIOT-ACS03 (KLK-I0183)	Single LoRa Module 923 – LoRa LOC, including: • 2 X N-SMB adapter • 2 x RF coaxial SMB/SMB cable
KLK-I0160	Quad LoRa Modules 923 – LoRa LOC – 64 channels, including: • 2 X N-SMB adapter • 2 x RF coaxial SMB/SMB cable

UC module:

KERLINK Reference	Designation
KLK-I0177	UC Module, including: • 1 X N-SMB adapter • 1 x RF coaxial SMB/SMA cable

WAN modules:

KERLINK Reference	Designation
ACCIOT-MWA00 (KLK-I0178)	WAN Module – LTE Europe – with backup battery, including: • 1 X 868MHz notch filter • 1 X LTE Europe / APAC Mini PCI Express module MC7304 • 1 X N-SMB adapter • 1 x RF coaxial SMB/SMA cable • 1 x backup battery
ACCIOT-MWA01 (KLK-I0179)	WAN Module – LTE Americas – with backup battery, including: • 1 X 915MHz notch filter • 1 X LTE Americas Mini PCI Express module MC7354 • 1 X N-SMB adapter • 1 x RF coaxial SMB/SMA cable • 1 x backup battery
ACCIOT-MWA02 (KLK-I0180)	WAN Module – LTE APAC – with backup battery, including: • 1 X 915MHz notch filter • 1 X LTE Europe / APAC Mini PCI Express module MC7304 • 1 X N-SMB adapter • 1 x RF coaxial SMB/SMA cable • 1 x backup battery
ACCIOT-MWA03 (KLK-I0189)	WAN Module – LTE APAC – with backup battery, including: • 1 X 915MHz notch filter • 1 X LTE Europe / APAC Mini PCI Express module MC7430 • 1 X N-SMB adapter • 1 x RF coaxial SMB/SMA cable • 1 x backup battery

Dual WAN module:

KERLINK Reference	Designation
ACCIOT-MWA04 (KLK-I0174)	Dual WAN Module – LTE Europe – with backup battery, including: • 2X 868MHz notch filter • 2 X LTE Europe / APAC Mini PCI Express module MC7304 • 2 X N-SMB adapter • 2 x RF coaxial SMB/SMA cable • 1 x backup battery

LoRa antennas:

KERLINK Reference	Designation
ACCIOT-KAN00 (KLK02124)	Omnidirectional antenna 868MHz 3dBi kit, including: • 1 X Universal antenna bracket • 1 X 1m coaxial cable
ACCIOT-KAN01 (KLK02373)	Omnidirectional antenna 868MHz 6dBi from FT-RF with its own antenna bracket
ACCIOT-KAN03 (KLK02658)	Omnidirectional antenna 915MHz 3dBi kit, including: • 1 X Universal antenna bracket • 1 X 1m coaxial cable
ACCIOT-KAN04 (KLK02648)	Omnidirectional antenna 915MHz 6dBi kit, including: • 1 X Universal antenna bracket • 1 X 1m coaxial cable
ACCIOT-KAN02 (KLK02518)	Omnidirectional antenna 915MHz 6dBi from FT-RF with its own antenna bracket

GNSS and WAN antennas:

KERLINK Reference	Designation
KLK-I0149	GNSS antenna kit, including: • 1 X 5m coaxial cable • 1 X Dome antenna bracket
KLK-I0150	LTE antenna kit, including: • 1 X 5m coaxial cable • 1 X Dome antenna bracket

Cavity filters:

KERLINK Reference	Designation
ACCIOT-CAV01 (KLK02522)	920-925MHz cavity filter, IP66, N connectors
ACCIOT-CAV02 (KLK02523)	865-867MHz cavity filter, IP66, N connectors
KLK02905	918-923MHz cavity filter, IP66, N connectors
KLK02906	915-920MHz cavity filter, IP66, N connectors
ACCIOT-CAV03 (KLK02909)	920-928MHz cavity filter, IP66, N connectors
KLK02915	865-870MHz cavity filter, IP66, N connectors
KLK02916	863-873MHz cavity filter, IP66, N connectors
KLK02973	902-928MHz cavity filter, IP66, N connectors

PoE injectors:

KERLINK Reference	Designation
ACCIOT-INJ04 (KLK02681)	Indoor AC/DC Midspan PoE injector 30W with E/F type cable (Europe)
ACCIOT-INJ06 (KLK02765)	Indoor AC/DC Midspan PoE injector 30W with B type cable (USA)
ACCIOT-INJ05 (KLK02744)	Indoor AC/DC Midspan PoE injector 60W with E/F type cable (Europe)
ACCIOT-INJ07 (KLK02766)	Indoor AC/DC Midspan PoE injector 60W with B type cable (USA)
ACCIOT-INJ00 (KLK02815)	Outdoor AC/DC Midspan PoE injector 30W, IP66 – end of life
KLK02953	Outdoor AC/DC Midspan PoE injector 30W, IP66 – new version
ACCIOT-INJ08 (KLK02816)	Outdoor AC/DC Midspan PoE injector 60W, IP66 – end of life
KLK02954	Outdoor AC/DC Midspan PoE injector 60W, IP66 – new version
ACCIOT-INJ02 (KLK02855)	Indoor DC/DC Midspan PoE injector 30W
ACCIOT-INJ03 (KLK02863)	Indoor DC/DC Midspan PoE injector 60W
ACCIOT-INJ08 (KLK02879)	Outdoor DC/DC Midspan PoE injector 60W

48V DC/DC converter:

KERLINK Reference	Designation
ACCIOT-DCD01 (KLK02898)	40W 48V DC/DC isolated converter

Surge protections:

KERLINK Reference	Designation
ACCIOT-RSP00 (KLK02819)	RF coaxial surge protector (GNSS, GSM Link)
ACCIOT-RSP01 (KLK02900)	RF coaxial surge protector (LoRa Link)
KLK02818	PoE surge protector, indoor
KLK02817	PoE surge protector, outdoor
ACCIOT-DSP00 (KLK02881)	DC surge protection, 1 pole
KLK02880	DC surge protection, 2 poles

Cables:

KERLINK Reference	Designation
ACCIOT-CAB00	RF coaxial cable N-N 1m

Debug tool:

KERLINK Reference	Designation
ACCWM2-SDE00 **KLK-I0036**	Wirma2 debug tool
KLK02314	RJ45 cable, 40cm
KLK02440	USB2.0 A type / B type cable, 2m

Mounting kits:

KERLINK Reference	Designation
KLK-I0168	Notched V-shaped pole mounting kit, including: • 1 X notched V shaped plate • 1 X U bolt
KLK02453	Universal antenna bracket
KLK02692	Dome antenna bracket

7. ANNEXE 1 - Wirnet iBTS connections

The following picture details all the Wirnet iBTS required connections, including power supply cables, data cables, RF coaxial cables and earthing connections:

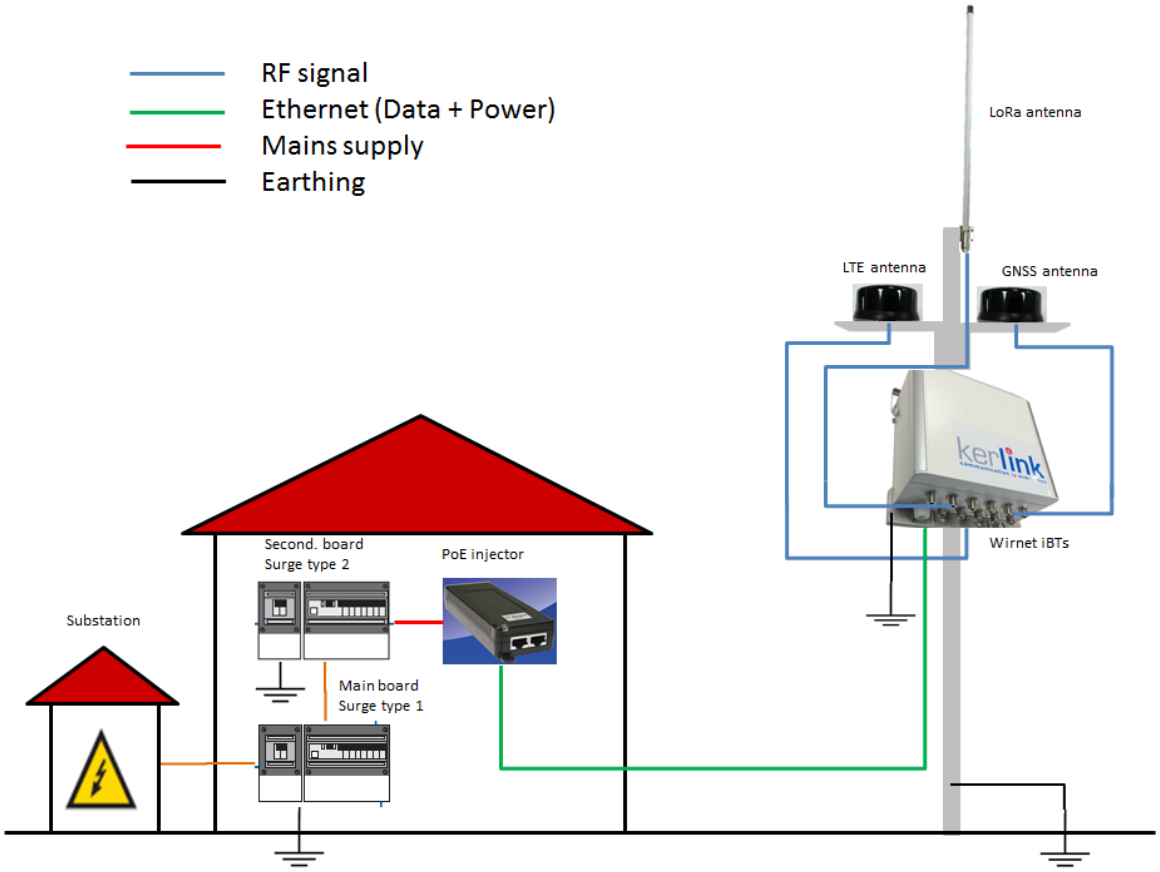


Figure 79: connection settings of the installation

The installation must comply with EN 60728-11 (Cabled distribution systems standard - Security).
Earthing is a key parameter for a secure installation.
Earthing of the installation is mandatory for:

- Indoor installation parts: mains supply, PoE injector
- Outdoor installation parts: tower, pole, Wirnet iBTS mounting kit, antennas.

The mains supply is not injected directly into the Wirnet iBTS but into the PoE injector.
The mains supply must be an indoor installation composed of:

- A main electrical board including:
  - A circuit breaker
  - A surge protection type 1
  - A connection to “earth”
- A secondary electrical board including:

- A circuit breaker
- A surge protection type 2
- A connection to “earth”

Surge protections type 1 and 2 are required to protect the PoE injector.

Note: in case surge protections type 1 and 2 are not available, specific PoE injectors for outdoor applications are required (see §3.7.1.5 and 3.7.1.6).

8. ANNEXE 2 - Lighting protections

In its standard configuration, the Wirnet iBTS is provided with optimal internal surge protections, as detailed in §7. In harsh environment, additional protections may be used to improve lightning immunity. The Wirnet iBTS gateways are not warranted by KERLINK in case of deterioration due to lighting. KERLINK recommends adding surge protections, especially in high keraunic levels areas and on high points.
The lighting surge protection must be completed on three interfaces to be efficient:

- Mains supply
- Ethernet (PoE) cable
- RF coaxial cable (antenna interfaces)

Another key parameter for an efficient lighting surge protection is “earthing”. The earthing connection insures that the lighting surge is driven to the ground properly.
Earthing of the installation is mandatory for:

- Indoor installation (mains supply, PoE injector)
- Outdoor installation (tower, pole, …)

The following figure describes the lighting protections that are required in a high keraunic area configuration:

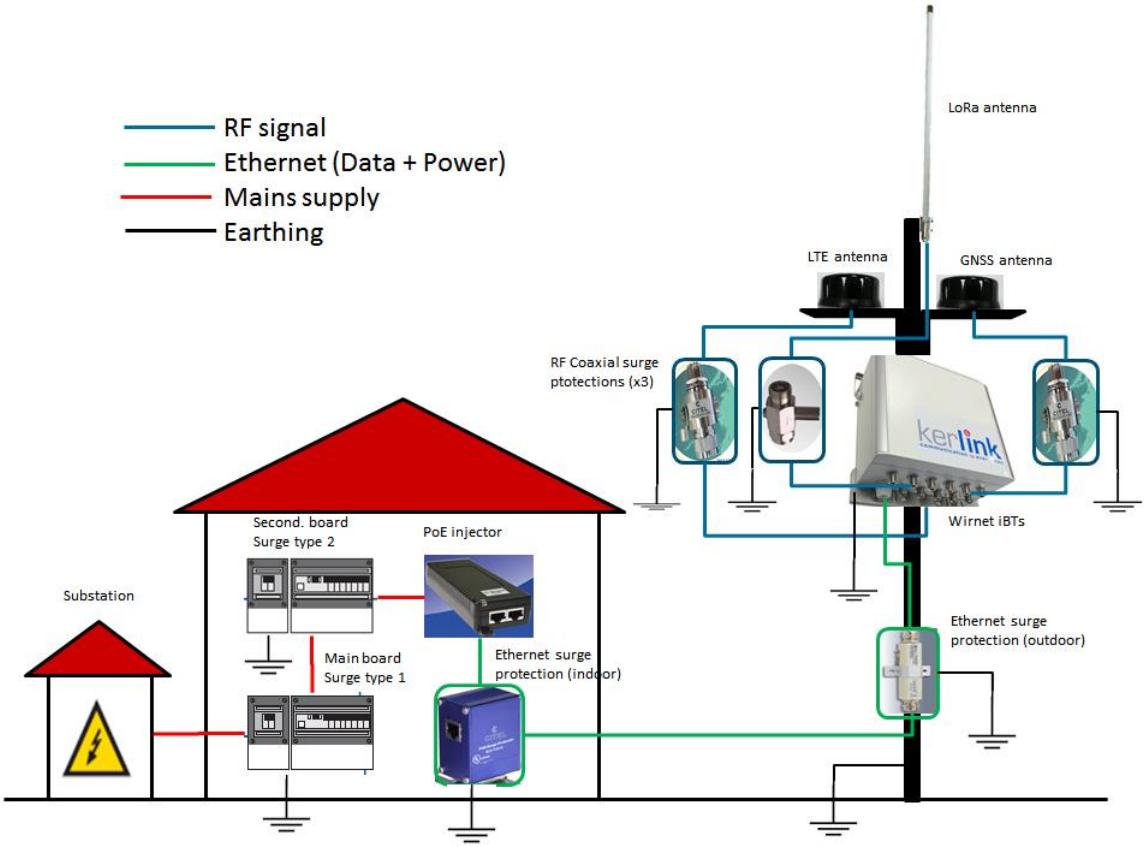


Figure 80: Installation with recommended lighting protections

The installation is composed of two separated areas: indoor installation and outdoor installation.
The indoor installation is composed of:

- A main electrical board including:
  - A circuit breaker
  - A surge protection type 1
  - A connection to “earth”
- A secondary electrical board including:
  - A circuit breaker
  - A surge protection type 2
  - A connection to “earth”
- The PoE injector (see §3.7.1.1 and §3.7.1.2)
- An Ethernet surge protection connected to “earth” (see §3.7.9.4)

The outdoor installation is composed of:

- A tower, mast or pole that must be connected to “earth”
- The Wirnet iBTS and its mounting kit

The mounting kit must be connected to earth:

- The antennas (LoRa, LTE, GNSS) with their RF coaxial surge protections (see §3.7.9.1) connected to “earth”

A lighting rod with a down conductor to earth is strongly recommended for this kind of applications. The lighting rod avoids direct impacts on the aerials (antennas and Wirnet iBTS).

Note 1: the PoE injector must be connected to the mains supply through a main electrical board with surge protections type 1 and a secondary electrical board with surge protections type 2. If the electrical installation does not meet those requirements, use an alternate PoE injector featuring better surge protection. Contact KERLINK for more information.

Note 2: the PoE injector is intended for indoor applications only.

Note 3: the Ethernet surge protection is intended for indoor applications only.

In some use cases the electrical installation does not have the required surge protections type 1 and type 2. Also, the PoE injector and Ethernet surge protection could not be installed indoor. Therefore, an alternate PoE injector and an Ethernet surge protection dedicated to outdoor applications are required. These are detailed in §3.7.1.5, § 3.7.1.6 and §3.7.9.5.
In this use case, the installation is still composed of two separated areas: indoor installation and outdoor installation.

The indoor installation is composed of:

- A main electrical board including:
  - A circuit breaker
  - A surge protection type 1
  - A connection to “earth”

The outdoor installation is composed of:

- A tower, mast or pole that must be connected to “earth”.
- The Wirnet iBTS and its mounting kit

The mounting kit must be connected to earth:

- The antennas (LoRa, LTE, GNSS) with their RF coaxial surge protections (see §3.7.9.1) connected to “earth”
- The PoE injector (see §3.7.1.5 and § 3.7.1.6)
- An Ethernet surge protection connected to “earth” (see §3.7.9.5.)

A lighting rod with a down conductor to earth is still strongly recommended for this kind of applications to avoid direct impacts on the aerials.

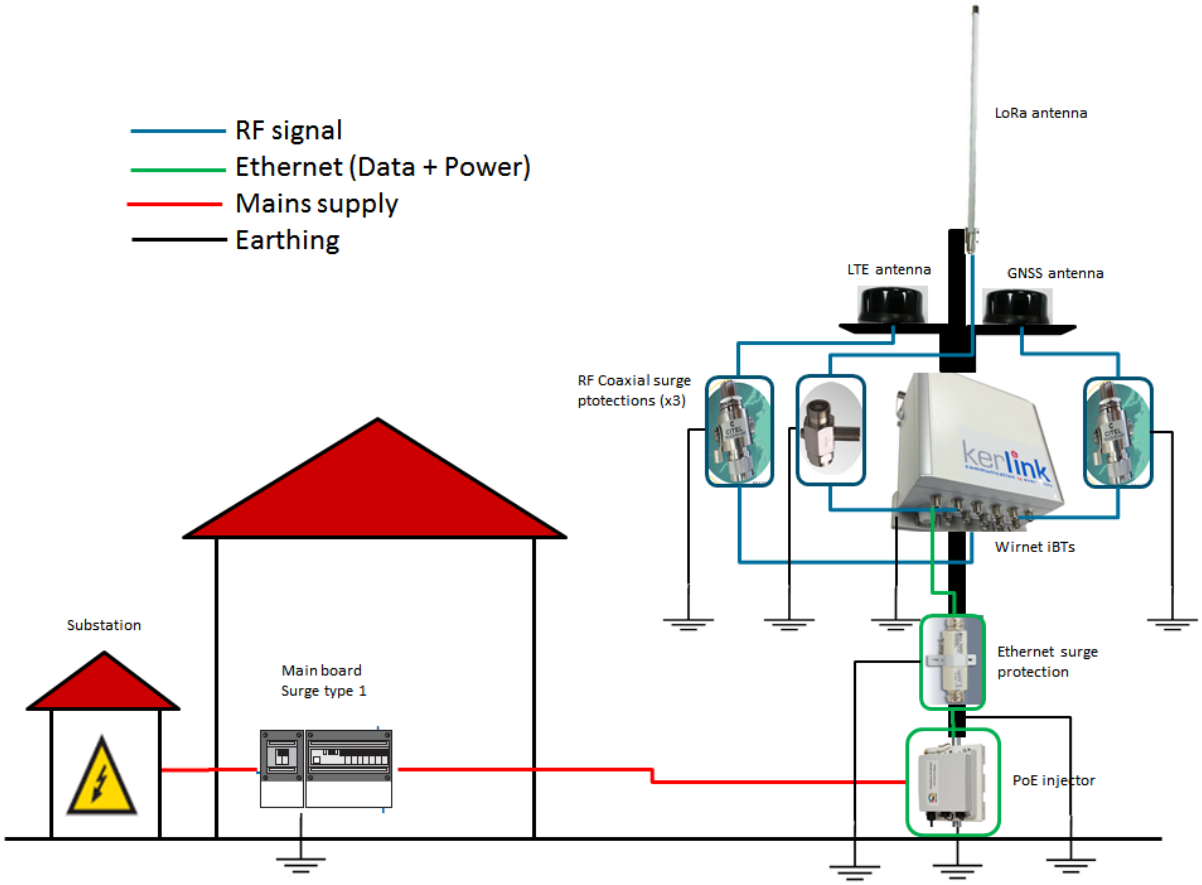


Figure 81: Installation with recommended lighting protections / Outdoor PoE injector

Note 1: the outdoor PoE injector and Ethernet surge protectors have cable glands to insure the ingress protection. RJ45 connectors must be inserted into the POE injector through the cable glands.

Note 2: in both use cases, the earthing cables for the PoE injector, Ethernet surge protection, RF coaxial surge protection and Wirnet iBTS mounting kit are not provided by KERLINK.

9. ANNEXE 3 - LoRa RF antennas configurations

Several LoRa antennas can be used with the Wirnet iBTS as detailed in §3.7.4.
The RF coaxial cable delivered by default is only 1m length. This is suitable for many installations, but extension cable can be used when the distance between the LoRa antenna and the Wirnet iBTS is greater than 1 meter.
Several configurations of antennas are possible depending on the number of LoRa modules used. They are listed in the following paragraphs.

9.1 Single LoRa module / single omnidirectional antenna

In this configuration, the Wirnet iBTS receiver supports 16 channels:

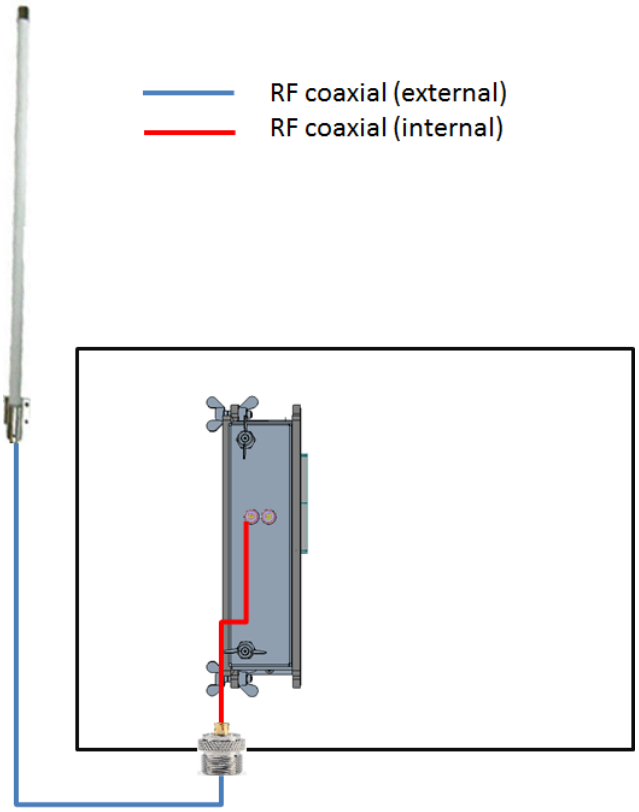


Figure 82: Single LoRa module / single omnidirectional antenna connections

9.2 Single LoRa module / dual omnidirectional antennas / diversity

In this configuration, the Wirnet iBTS receiver supports 2 x 8 channels:

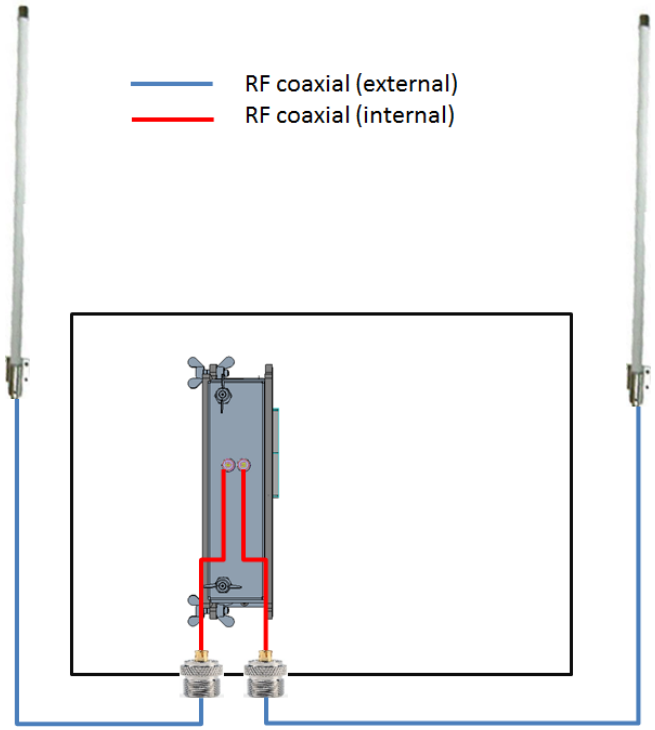


Figure 83: Single LoRa module / dual omnidirectional antennas connections

9.3 Single LoRa module / single dual polarization antenna

In this configuration, the Wirnet iBTS receiver supports 2 x 8 channels:

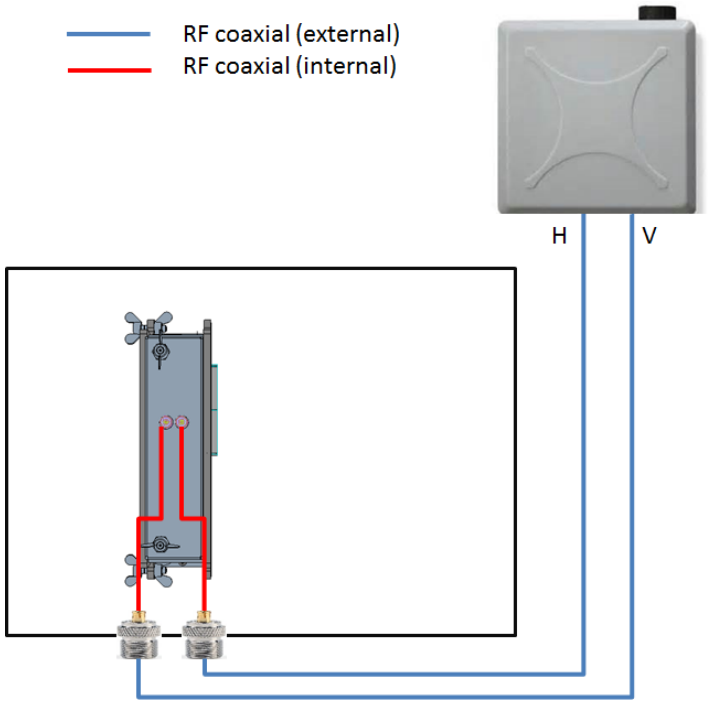


Figure 84: Single LoRa module / single dual polarization antenna connections

9.4 Two LoRa modules / two omnidirectional antennas / diversity

In this configuration, the Wirnet iBTS receiver supports 2 x 16 channels:

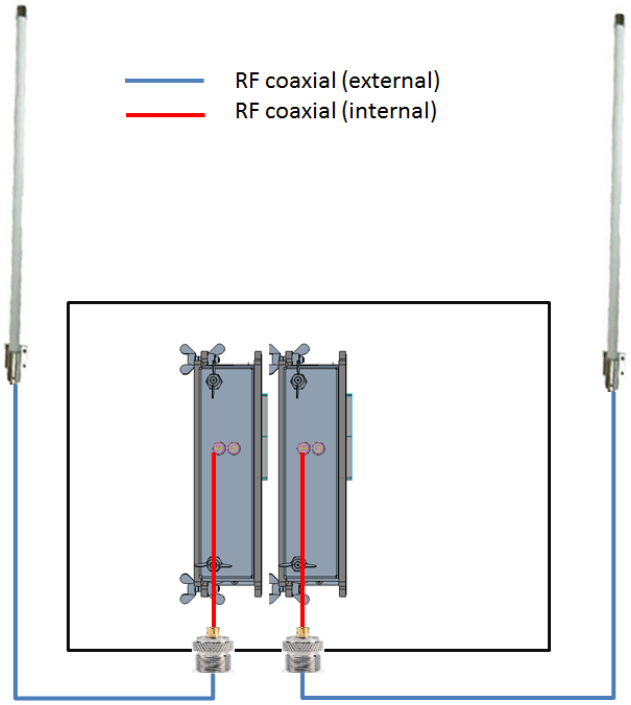


Figure 85: Two LoRa modules / two omnidirectional antennas / diversity connections

9.5 Two LoRa modules / two dual polarization antennas

In this configuration, the Wirnet iBTS receiver supports 2 x 2 x 8 channels:

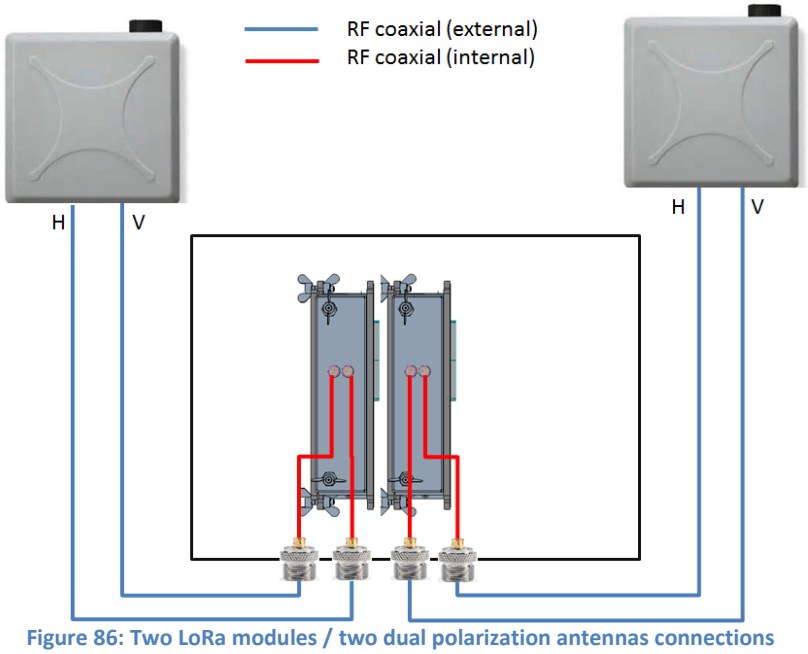


Figure 86: Two LoRa modules / two dual polarization antennas connections

9.6 Three LoRa modules / three sectors antennas

In this configuration, the Wirnet iBTS receiver supports 3 x 16 channels:

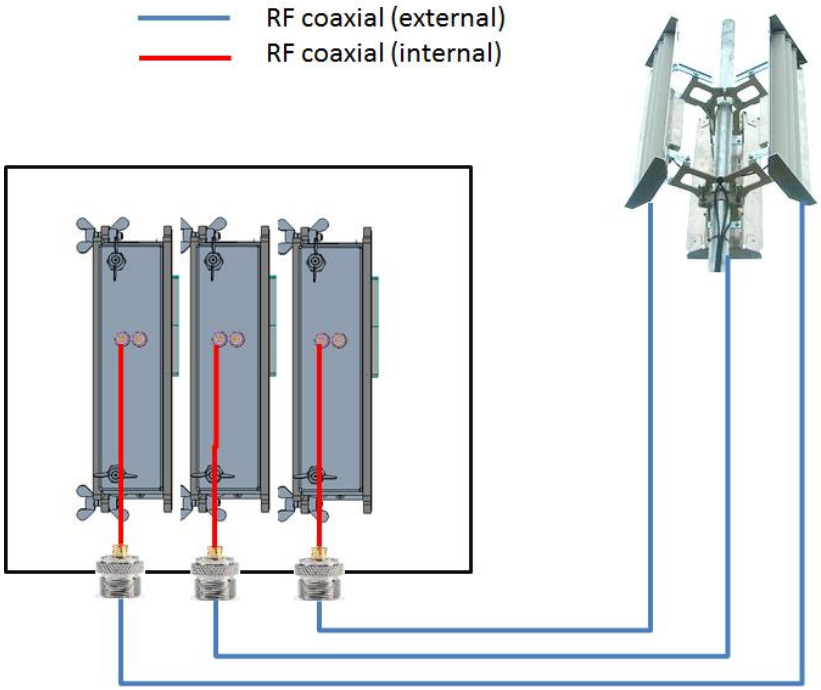


Figure 87: Three LoRa modules / three sectors antennas connections

9.7 Three LoRa modules / three sectors antennas / dual polarization

In this configuration, the Wirnet iBTS receiver supports 3 x 2 x 8 channels:

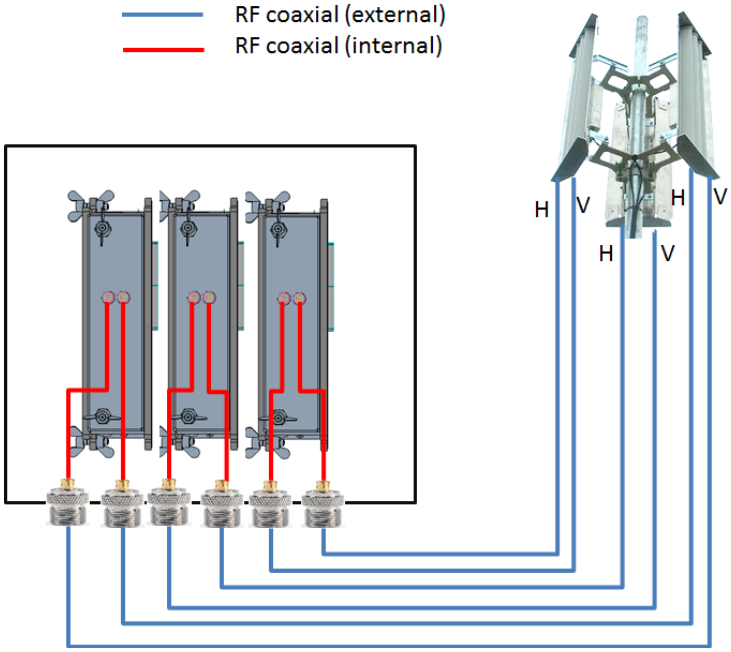


Figure 88: Three LoRa modules / three sectors antennas / dual polarization connections

9.8 Four LoRa modules / single omnidirectional antenna

In this configuration, the Wirnet iBTS receiver supports 64 channels:

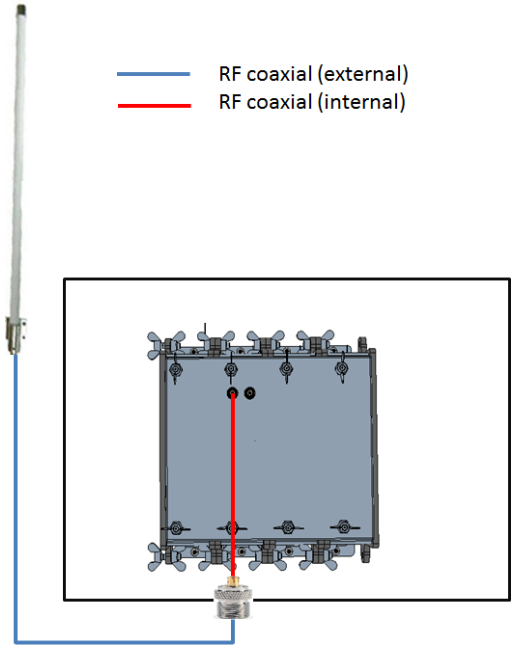


Figure 89: Four LoRa modules / single omnidirectional antenna connections

9.9 Four LoRa modules / dual omnidirectional antennas / diversity

In this configuration, the Wirnet iBTS receiver supports 2 x 32 channels:

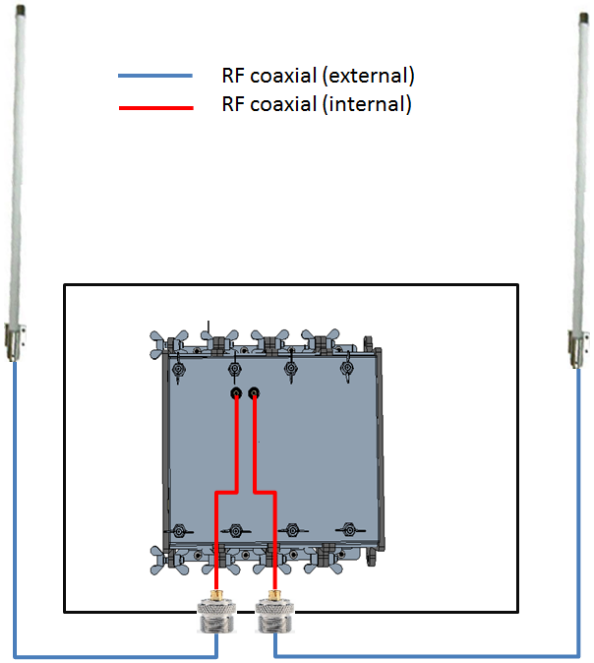


Figure 90: Four LoRa modules / dual omnidirectional antennas / diversity connections

9.10 Four LoRa modules / dual polarization antenna

In this configuration, the Wirnet iBTS receiver supports 2 x 32 channels:

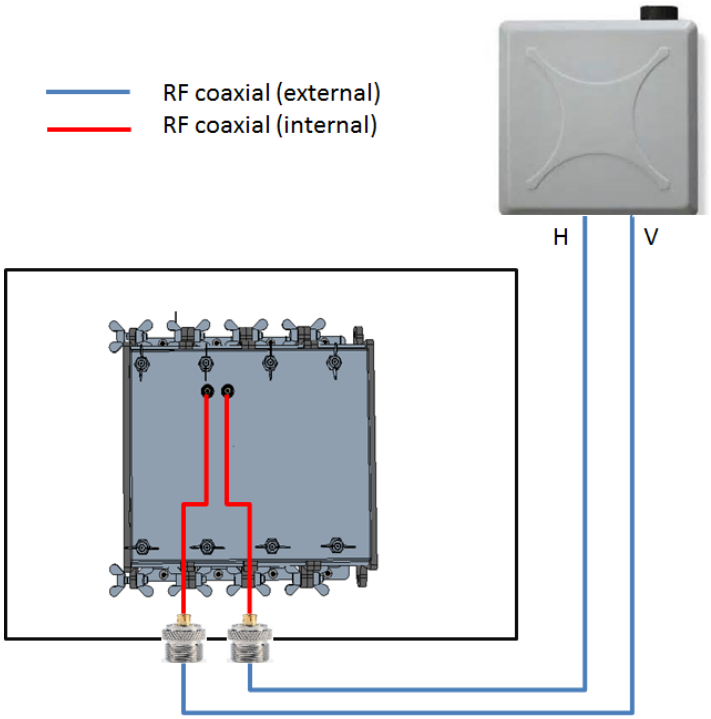


Figure 91: Four LoRa modules / dual polarization antenna connections

10. ANNEXE 4 - Key parameters to optimize the radio performance

The installation site is very important and can determinate the coverage area of the Wirnet iBTS. Some keys points are detailed hereafter. They are general rules that must be considered in every installation.
However, each individual installation is a case with specific constraints and sometimes with unexpected interferers. The proximity of other emitters, bad electrical installations may cause desensitization of the LoRa receiver.
KERLINK recommends performing spectrum analysis to validate the choice of the installation site. This analysis can be completed with a portable spectrum analyzer for instance.
The Wirnet iBTS has also the ability to perform spectrum analysis through the Web interface. This analysis is however only possible once the installation is completed.

10.1 Height of the site

A key factor to have an optimized Wirnet iBTS reception is the height of installation site and moreover the height of the LoRa antenna. The Wirnet iBTS gateway must be installed as high as possible to have the better reception and wider coverage area.
The figure below shows the RSSI of the signal (dBm) vs. the distance to the end-point (meters) vs. the height of the Wirnet iBTS (4m, 8m, 12m and 30m). Two uses cases are presented: one for a small city configuration (urban area) and one for countryside area.
The propagation model used is based on Hata model.
The frequency is 868MHz in this case but performance and conclusions at 915MHz would be almost identical. The RSSI is the received signal by the Wirnet iBTS. The end-point EIRP is assumed to be 25mW. The height of the end-point is 1m.

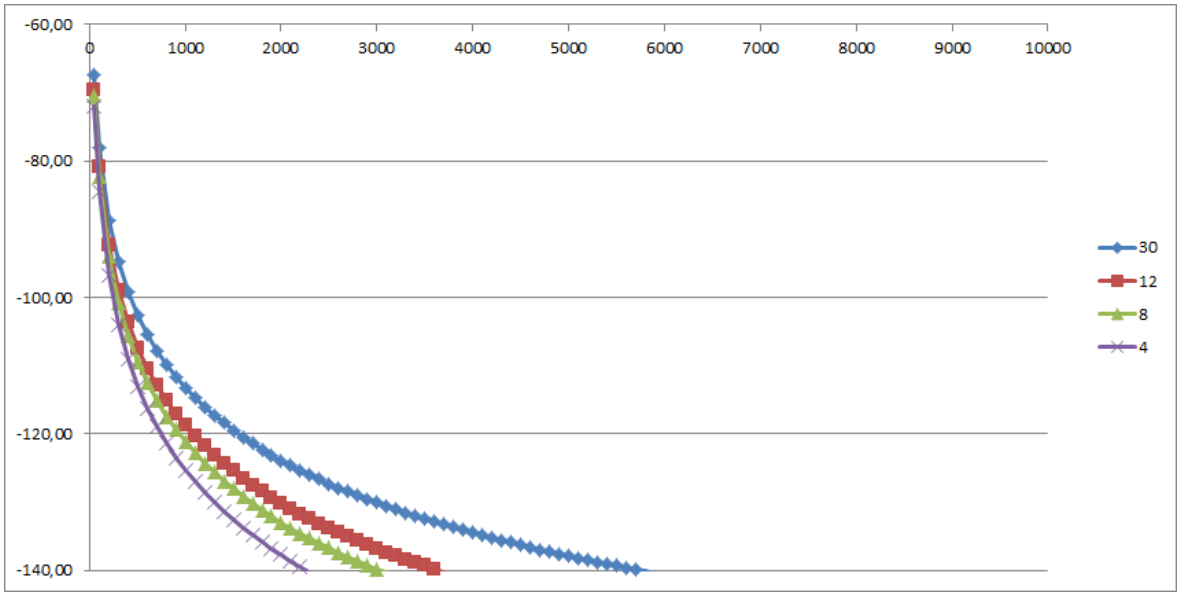


Figure 92: Urban (small city) Hata propagation model – RSSI (dBm) vs distance (meters) vs height of the antenna

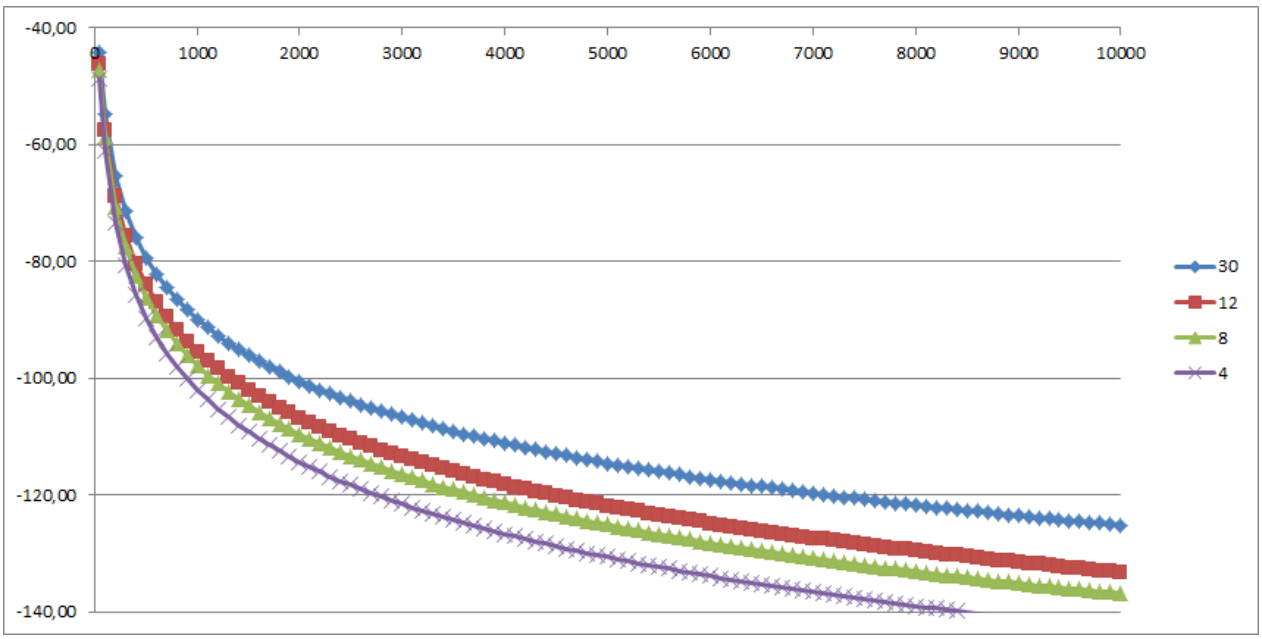


Figure 93: Rural countryside Hata propagation model - RSSI (dBm) vs distance (meters) vs height of the antenna

What is noticeable is that the coverage distance at a fixed RSSI is doubled depending on the height of the antenna.

10.2 Propagation model vs area type

Predicting the RSSI and more generally the coverage of the Wirnet iBTS depends on many factors. The propagation channel must be well defined and known to have an efficient prediction.
Radio coverage simulations are recommended before the installation of the Wirnet iBTS to make sure the gateway would cover the expected area. Contact KERLINK for more information.
In a first approach, the figures below show the RSSI of the signal (dBm) vs. the distance to the end-point (meters) vs. the type of area (urban, suburban, countryside and desert). The height of the LoRa antenna is assumed to be 12 meters and 30 meters.

The propagation model used is based on Hata model.
The frequency is 868MHz in this case but performance and conclusions at 915MHz would be almost identical. The RSSI is the received signal by the Wirnet iBTS. The end-point EIRP is assumed to be 25mW. The height of the end-point is 1m.

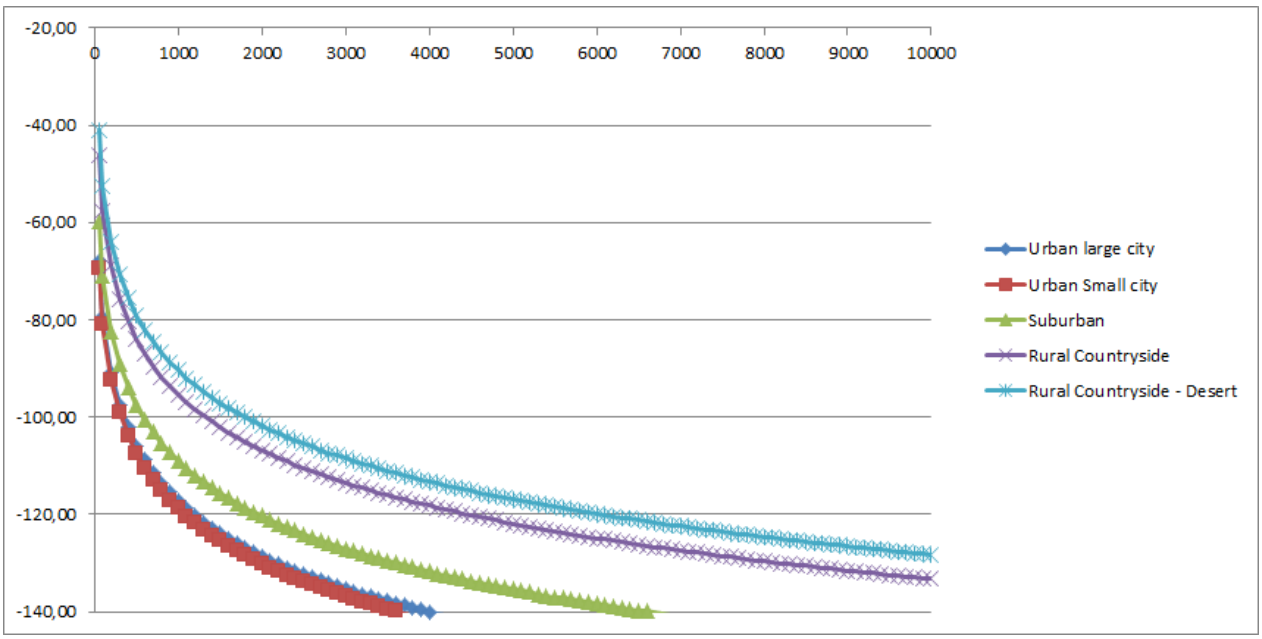


Figure 94: Hata propagation model vs area configuration (Height = 12m) – RSSI (dBm) vs distance (m)

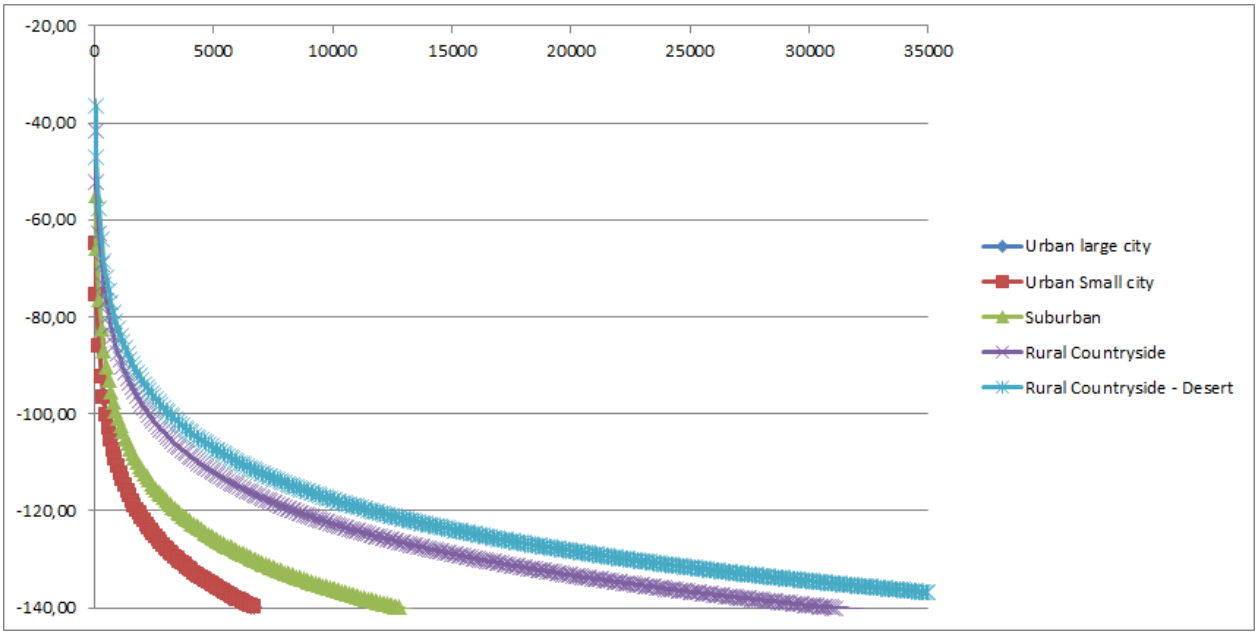


Figure 95: Hata propagation model vs area configuration (Height = 30m) – RSSI (dBm) vs distance (m)

The coverage radius of the Wirnet iBTS, depending on the area type can vary from 2 km (urban areas, low height of the LoRa antenna), up to 40 km (countryside, very high sites).

10.3 Fresnel ellipsoid

Radio waves generally travel in a straight line from the emitter to the receiver. This is obviously true when there are no obstacles between the transmitter and the receiver. However, there are, most of the time, some obstacles between the transmitter and the receiver. Then, the radio waves bump into the obstacles and are reflected or diffracted with dephasing. These diffracted waves when arriving on the receiver can cause phase cancelling with the straight-line signals reducing the received power (fading). The fading effect depends on the distance between the receiver and the emitter, the nature of the obstacles and the associated out of phase.

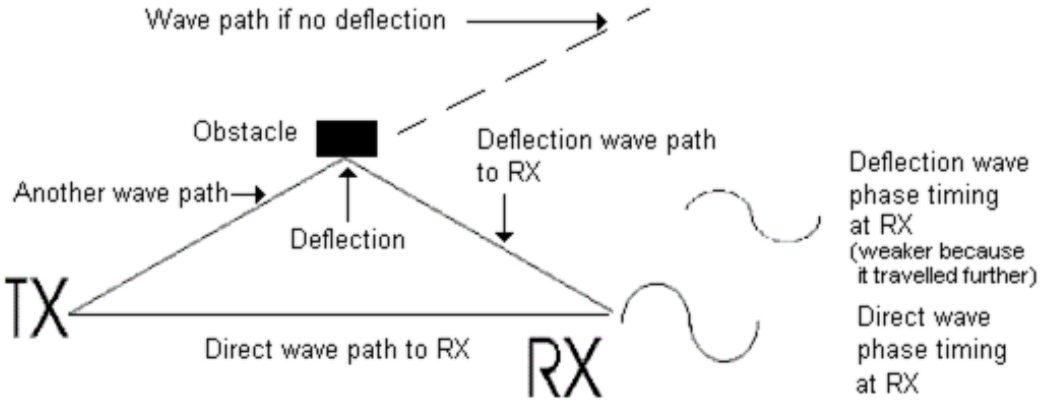


Figure 96: Fading effects due to obstacles

To minimize the fading effects, obstacles in a “Fresnel ellipsoid” must be avoided.
The Fresnel ellipsoid is a theoretical ellipsoid located between the transmitter and the receiver.
The radius of the ellipsoid is defined as follows:

$$r1 = \sqrt{\frac{d1 * d2 * c}{f * (d1 + d2)}}$$

Where:

- d1 = distance from Tx antenna
- d2 = distance from Rx antenna
- f = frequency
- c = celerity (3E8 m/s)
- r1 = radius at the distance d1

A global rule is that 60% of the Fresnel ellipsoid must be clear of obstacles.
In case of buildings between the end-point and the Wirnet iBTS, the antenna height must be adjusted to make sure the building is not close to 60% of r1.

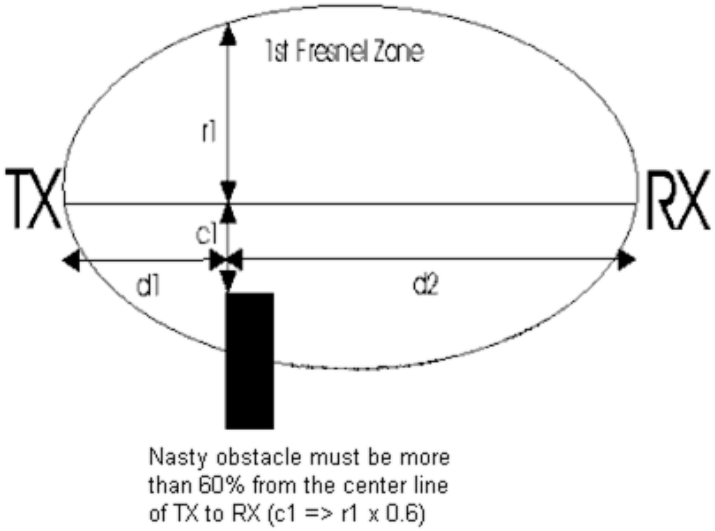


Figure 97: Fresnel ellipsoid clearance

Be careful, if the antennas heights are not enough, then the ground (earth curve) can get inside the Fresnel ellipsoid and overrule the 60% criteria.

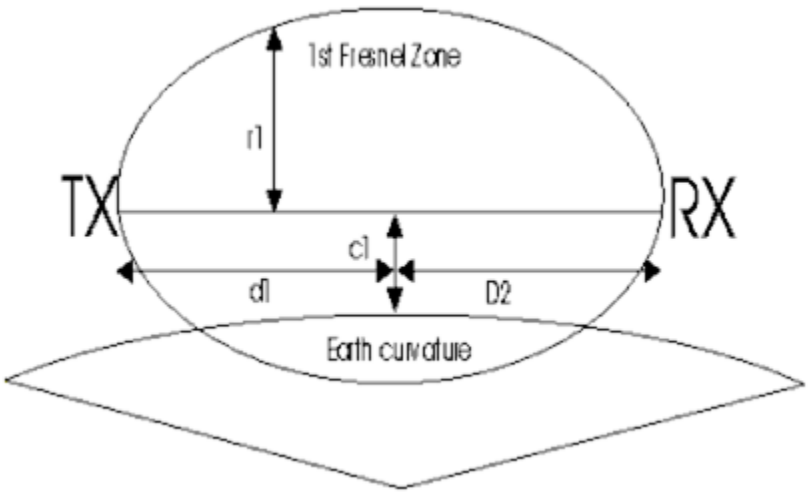


Figure 98: Fresnel ellipsoid and earth curvature

Example:

An end-point is located at 3500m from the Wirnet iBTS.
The Wirnet iBTS is installed on the roof of a building. The building roof is 30 meters long vs 20m large.
What is the required height of the LoRa antenna for have an optimized reception?

Answer:

If we want to receive end points i.e. 360° area coverage, it should be better to have the antenna located in the mid of the building roof.
The antenna is therefore at 15m from the edge of the roof.

Then we have:

- d1 = 15m
- d2 = 3600 -15 = 3585m
- f = 868MHz
- c = 3E8 m/s

So, r1 = 2.3m
The antenna must be installed at a minimum height of 2.3m from the roof top, on a mast for instance.

11. ANNEXE 5 - Co-localization with GSM/UMTS/LTE transmitters

The design of the Wirnet iBTS gateway insures good co-localization with other transmitters on the same site, and especially with BTS, in two ways:

- Limited spurious and noise generated in the BTS receiver bands
- Immunity to BTS transmitter

The Wirnet iBTS is obviously compliant to all EMC emissions and immunity regulations specific to each country. However, meeting these regulations is not enough to insure good coexistence with BTS when sharing the same site.

Therefore, KERLINK has reinforced these specifications to allow the coexistence.
KERLINK has designed the transmitter (LoRa-LOC module) to reduce the spurious and the noise generated in the BTS RX bands below -80dBm in a 100KHz resolution bandwidth. This is then pretty much in line with BTS specifications to insure co-localization between BTS.

The measurements made on the iBTS station show typical values of -85dBm/100KHz.
The receiver offers also high attenuation outside the receive band.

High attenuation of out of band blockers is obtained:

- >105dB at +/-10MHz
- >150dB in BTS downlink bands

This means that the blockers levels, due to the BTS, could be up to +10dBm causing no interference with the gateway.

Based on this performance, this means that about 50dB isolation is required between the Lora antenna of the Wirnet iBTS and the base station antenna to avoid desensitization of the BTS. Specifying a minimum distance between antennas may not guarantee the 50dB isolation, unless over specifying the required distance. This is mainly because both LoRa antenna and BTS antennas are directive antennas. This means that the antenna gain is not omnidirectional in both cases.

BTS antenna have about 10 to 15dB antenna maximum gain but the gain above or below the antenna is reduced by 20dB to 30dB as described below:

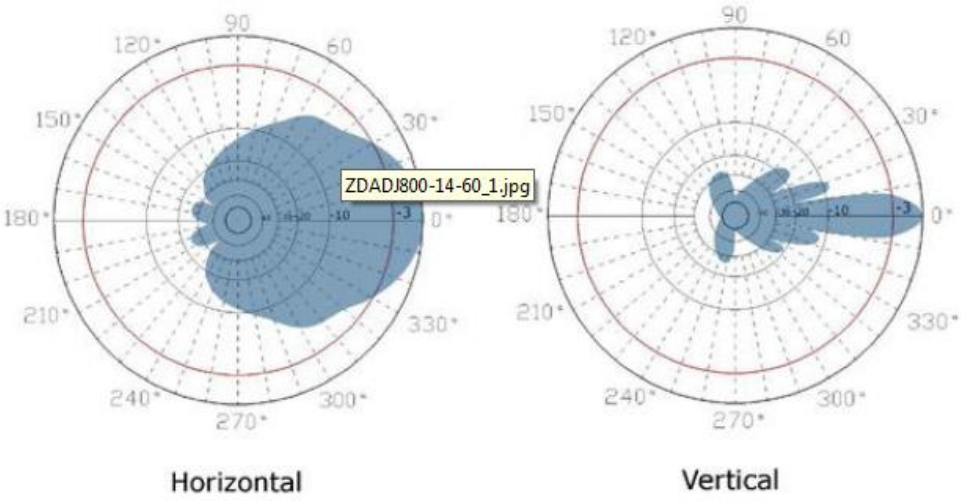


Figure 99: Typical antenna gain pattern of a GSM BTS

Mounting the LoRa antenna just above or below the 4G antenna allows then to get 20 to 30dB isolation among the 50dB required.

The LoRa antenna can be an omnidirectional antenna. The worst case would be a 3dBi antenna which has the “less directive” antenna pattern. An example is presented below:

Vertical Pattern
E-plane co-pol ------ 3-dB beam-width=75 Deg

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

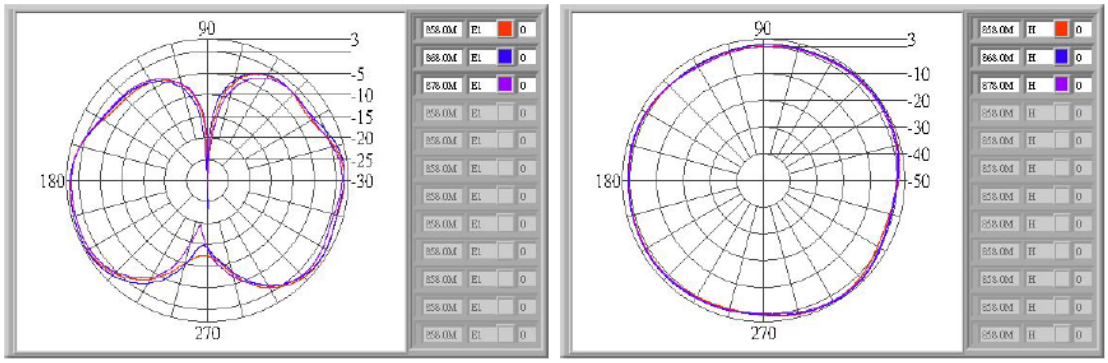


Figure 100: Typical gain of 3dBi omnidirectional antenna

We can see that the gain on the top of the antenna or below the antenna is about -15dBi to -20dBi.

In case of sectorial antenna, the antenna gain above or below the antenna is also significantly reduced to -10 to -15dB as shown below:

Vertical Pattern
E-plane co-pol ------ 3-dB beam-width=50Deg

Horizontal Pattern
H-plane co-pol ------ 3-dB beam-width=55Deg

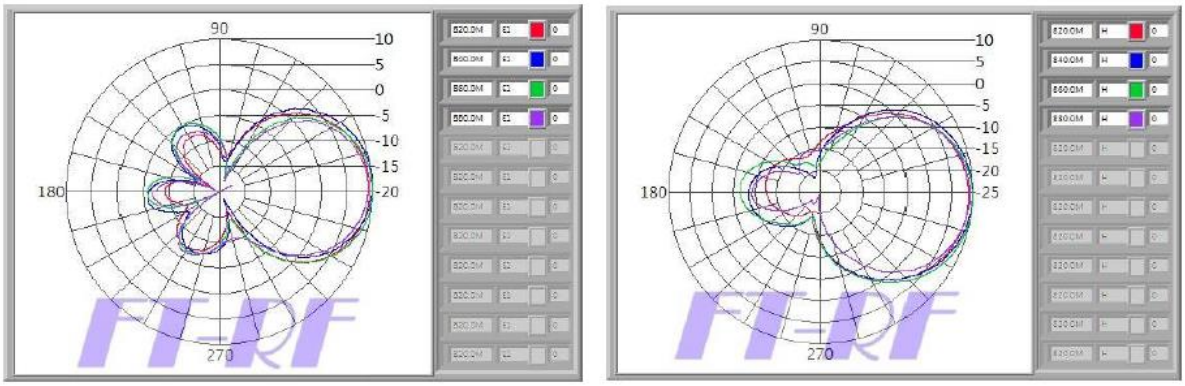


Figure 101: Typical gain of a sectorial antenna

Then, considering the performance of the antenna, we need to get about 10 to 20dB more isolation to meet the 50dB isolation between antennas.
A gap of 1 meter between antennas would insure 30dB additional attenuation.

Therefore, our recommendation is to have the LoRa antenna just above the BTS antenna with 1 meter gap min.
Placing the LoRa antenna below the BTS antenna could be also possible. However, this is not recommended as reception could be impacted by metallic structures in the close area.

11.1 Wirnet iBTS 868

Co-localization is possible with the following BTS:

- EGSM900, GSM1800, GSM1900
- UMTS900, UMTS1900, UMTS2100
- LTE800, LTE 900, LTE 1800, LTE 2100, LTE 2300, LTE2600

The most difficult use case is the LTE 800 band that is very close to the 868MHz band. Actually, the end of the LTE 800 band is 862MHz whereas the beginning of the 868MHz band is 863MHz. Insuring -80dBm/100KHz at 862MHz while transmitting at 863MHz or even at 868MHz is not achievable with the state of the art of SAW filters. Therefore, the Wirnet iBTS gateway embeds specific SAW filters allowing the transmitter (LoRa-LOC module) to achieve the -80dBm/100KHz spurious limit in the LTE 800 band.

Co-localization is not possible with GSM850, UMTS850 and LTE850

Note:
In India, co-localization with CDMA800 / LTE 850 requires usage of a specific cavity filter.
See §3.7.6.1.

11.2 Wirnet iBTS 915

Co-localization is possible with the following BTS:

- GSM850, GSM1800, GSM1900
- UMTS850, UMTS1900, UMTS1700, UMTS2100
- LTE700, LTE850, LTE1700, LTE 1800, LTE1900, LTE2600

Co-localization is not possible with (E)GSM900, UMTS900 and LTE900.

In case of co-localization with GSM900, UMTS900 or LTE900, then the Wirnet iBTS 923 is a more suitable gateway. If Wirnet iBTS 915 want to be used when co-localized with GSM900, UMTS900 or LTE900, then a specific cavity filter is required. Contact KERLINK for more information.

Note:
In Philippines, co-localization with EGSM900 requires usage of a specific cavity filter (see §3.7.6.3). Contact KERLINK for more information.

11.3 Wirnet iBTS 923

Co-localization is possible with the following BTS:

- GSM850, GSM900, GSM1800, GSM1900
- UMTS850, UMTS900, UMTS2100
- LTE700, LTE800, LTE850, LTE 900, LTE 1800, LTE 2100, LTE 2300, LTE2500, LTE2600

Co-localization is not possible with EGSM900, only GSM900.

Note 1:
In Singapore, Indonesia and Hong-Kong, co-localization with EGSM900 requires usage of a specific cavity filter.
See §3.7.6.1.

Note 2:
In Malaysia co-localization with EGSM900 may require usage of a specific cavity filter (see §3.7.6.4).

Note 3:
In New-Zealand co-localization with GSM900 may require usage of a specific cavity filter in harsh environments (see §3.7.7.1).

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