WIRNET™ IFEMTOCELL-EVOLUTION

PRODUCT DESCRIPTION

	Written by	Approved by	Validated by
Name	**MGI**	**FLM**	**MCH**
Entity	**DTI**	**DRD**	**DRD**
Date	**2020-10-20**	**2020-11-02**	**2020-11-02**

HISTORY

Date	Modification	Author	Version
2019-09-10	Creation	MGI	0.1
2019-10-02	Update after review	MGI	0.2
2019-10-03	Update after 2nd review	MGI	0.3
2019-10-17	Updated radio performance after tests Updated UPS section	MGI	0.4
2019-11-22	Updated accessories section Added link to Wiki for software specifications	MGI	0.5
2019-11-25	Software description updated by MCH	MGI	0.6
2020-01-10	Updated “915” and “923” sections	MGI	0.7
2020-03-18	Updated LEDs description, corrected typo errors Official release	MGI	1.0
2020-09-14	Updated output power and sensitivity performance according to last measurements	MGI	1.1
2020-11-02	Document approved – Official release	MGI	2.0

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REFERENCE

Reference	Document / link	Description
[1]	https://lora-alliance.org/lorawan-for-developers	LoRaWAN™ L2 Specification V1.0.4 2019 December
[2]	https://lora-alliance.org/lorawan-for-developers	LoRaWAN™ Regional Parameters RP002-1.0.1, February 2020
[3]	https://www.lora-alliance.org/For-Developers/LoRaWANDevelopers	LoRaWAN™ Regional Regulation Summary Version 1.6 draft 2 June 30th, 2020

GLOSSARY

Abbreviation	Description
ABS	Acrylonitrile Butadiene Styrene
ADC	Analog to Digital Converter
BSC	Base Station Controller
BW	Band Width
CPU	Central Processing Unit
CW	Continuous Wave
DDR	Double Data Rate
DL	Down Link
DRP	Dual Role Port
EDGE	Enhanced Data rates for GSM Evolution
EEPROM	Electrically Erasable Programmable Read-Only Memory
EIRP	Equivalent Isotropically Radiated Power
EMC	ElectroMagnetic Compatibility
eMMC	Embedded Multi Media Card
FPGA	Field Programmable Gate Array
GMSK	Gaussian Minimum Shift Keying
GPIO	General Purpose Input/Output
GPRS	General Packet Radio Service
GSM	Global System for Mobile communication
HSPA	High Speed Packet Access
HTTP	HyperText Transfer Protocol
HW	Hardware
IC	Integrated Circuit or Industry Canada
IK	Mechanical Impact
IO	In / Out

IoT	Internet of Things
ISM	Industrial Scientific and Medical
KLK	KERLINK
LED	Light-Emitting Diode
LNA	Low Noise Amplifier
LoRa®	Long Range
LPWAN	Low Power Wide Area Network
LTE	Long Term Evolution
MLC	Multi Level Cell
M2M	Machine to Machine
OTG	On The Go
PA	Power Amplifier
PC	Polycarbonate
PCB	Printed Circuit Board
PER	Packet Error Rate
PoE	Power over Ethernet
RAM	Random Access Memory
RF	Radio Frequency
RSSI	Received Signal Strength Indicator
RX	Receive
SAW	Surface Acoustic Wave
SDIO	Secure Digital Input Output,
SDRAM	Synchronous Dynamic Random Access Memory
SIM	Subscriber Identity Module
SNMP	Simple Network Management Protocol
SNR	Signal to Noise Ratio
SPI	Serial Peripheral Interface bus
SW	Software
TX	Transmit
UART	Universal Asynchronous Receiver Transmitter
UL	Up Link
UMTS	Universal Mobile Telecommunications System
UPS	Uninterruptible Power Supply
USB	Universal Serial Bus
USIM	Universal Subscriber Identity Module
WAN	Wide Area Network
WWAN	Wireless Wide Area Network
3G	Third generation of mobile telecommunications technology
4G	Fourth generation of mobile telecommunications technology

1. Introduction

The Wirnet™ iFemtoCell-evolution gateway is part of the global Long-Range Radio fixed network to provide M2M connectivity link between low power end-point and Internet Access.

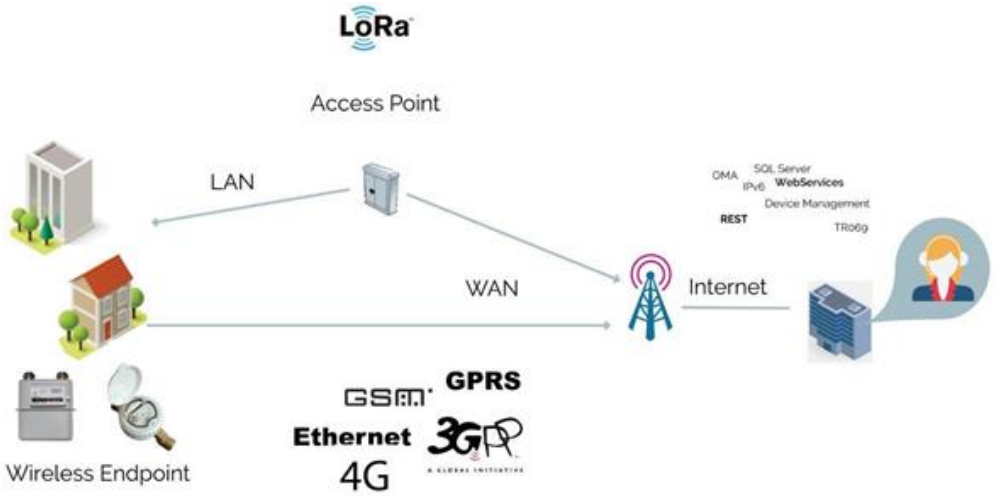


Figure 1: LoRa® Network topology

The Wirnet ™ iFemtoCell-evolution is the ideal gateway for smart city, smart building or every smart project that requests dedicated indoor coverage and/or network densification, providing both a unique superior coverage and operational excellence with an internal 3G/ 4G backhaul.

The Wirnet™ iFemtoCell-evolution is based on "LoRa®" technology provided by Semtech Company. It is compatible and interoperable with existing LoRaWAN LPWAN.

This gateway is available in three versions to cover different countries and areas around the world:

	Wirnet™ iFemtoCell-evolution 868 (PDTIOT-IFE04)	Wirnet™ iFemtoCell-evolution 915 (PDTIOT-IFE05)	Wirnet™ iFemtoCell-evolution 923 (PDTIOT-IFE06)
Geographical area	Europe, Turkey, Russia Africa Middle East, India	North America Central America	Asia: Indonesia, Malaysia, Korea, Japan, Taiwan, Hong Kong, Thailand, Vietnam, Singapore, Philippines Oceania: Australia, New Zealand Latin America: Brazil, Argentina, Colombia
ISM band	863 – 874.4 MHz	902 - 928 MHz	915 - 928 MHz
Downstream band	863 – 874.4MHz	923 - 928 MHz	915 - 928 MHz
Upstream band	863 – 874.4 MHz	902 - 915 MHz	915 - 928 MHz

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

2. Main functionalities

Here are the main functionalities of the Wirnet™ iFemtoCell-evolution product:

- Long Range support:
  - Incorporate LoRa® bidirectional communications technology:
    - Version 868: RX: 863- 874.4MHz, TX: 863-874.4MHz
    - Version 915: RX: 902-915MHz, TX: 923-928MHz
    - Version 923: RX: 915-928 MHz, TX: 915-928MHz
  - Emulates 49 LoRa® demodulators over 9 channels + 1 x FSK:
    - 8 x 125KHz BW, Multi-SF (7 to 12)
    - 1 x 250KHz BW or 500KHz BW, mono SF (7 to 12)
    - 1 x FSK
- Supported LoRaWAN ® regional parameters:
  - EU863-870 (version 868)
  - IN865-867 (version 868)
  - RU864-870 (version 868)
  - US902-928 (version 915)
  - AU915-928 (version 923)
  - AS923 (version 923)
  - KR920-923 (version 923)
- Embedded, remote and open low power communication station
- Open development framework based on standard Linux OS
- WWAN connectivity over Ethernet or LTE/HSPA/UMTS/EDGE/GPRS
- USB host interfaces allowing local secured software upgrade
- Web local interface allowing configuration, diagnostic and maintenance
- 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 Block diagram

The block diagram below describes the HW architecture of the Wirnet™ iFemtoCell-evolution:

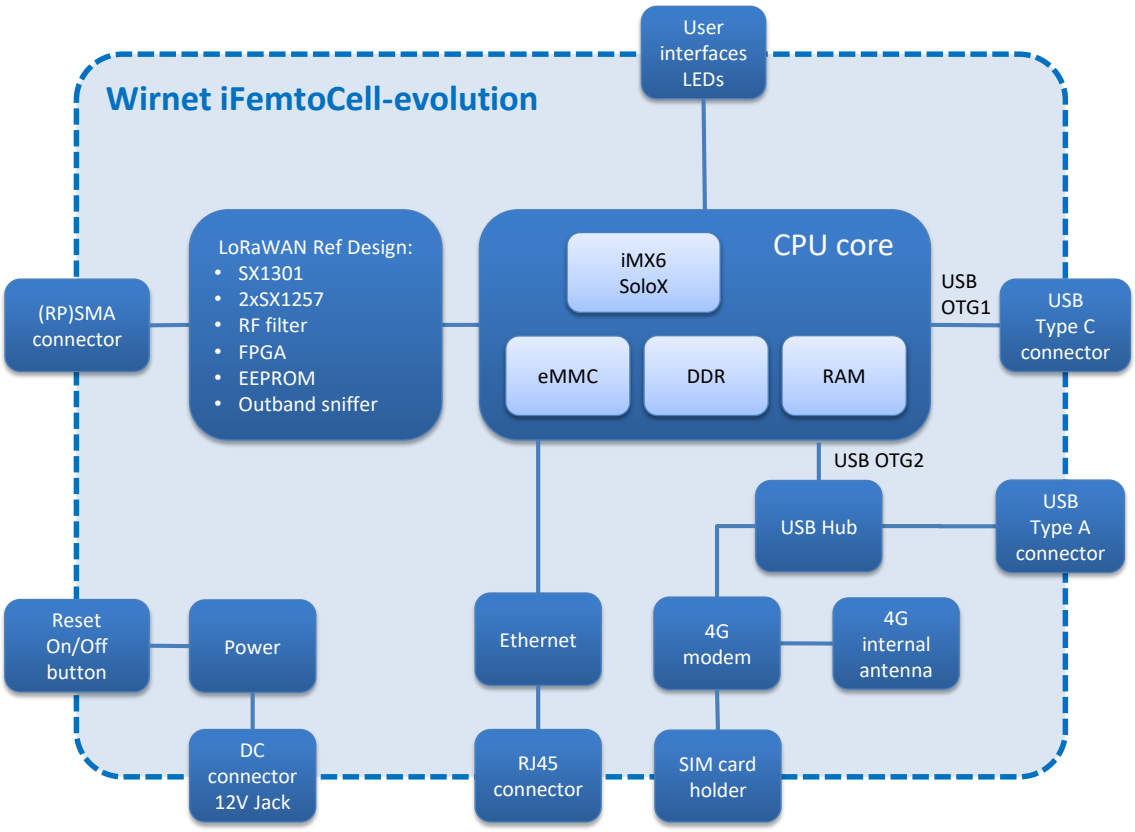


Figure 2: Hardware block diagram

Wirnet™ iFemtoCell-evolution integrates:

- High performance CPU:
  - iMX6 (SoloX), ARM Cortex A9, 800MHz core, under Linux OS
  - Non-volatile memory eMMC (8Go)
  - Volatile memory DDR (256Mo)
- LoRa® radio reference design V1.5 based:
  - Semtech Sx1301 + SX1257x2 + FPGA + EEPROM
  - TX conducted power: 0dBm to 24dBm
  - Sensitivity: -140dBm/SF12
  - Out of band radio sniffer
  - Dedicated SAW filters depending on Wirnet™ iFemtoCell-evolution version (863 MHz, 915 MHz, 923 MHz)
  - SMA or RP-SMA connector for LoRa® antenna (3dBi swivel antenna provided)
- 10/100 Base-T Ethernet with RJ45 connector

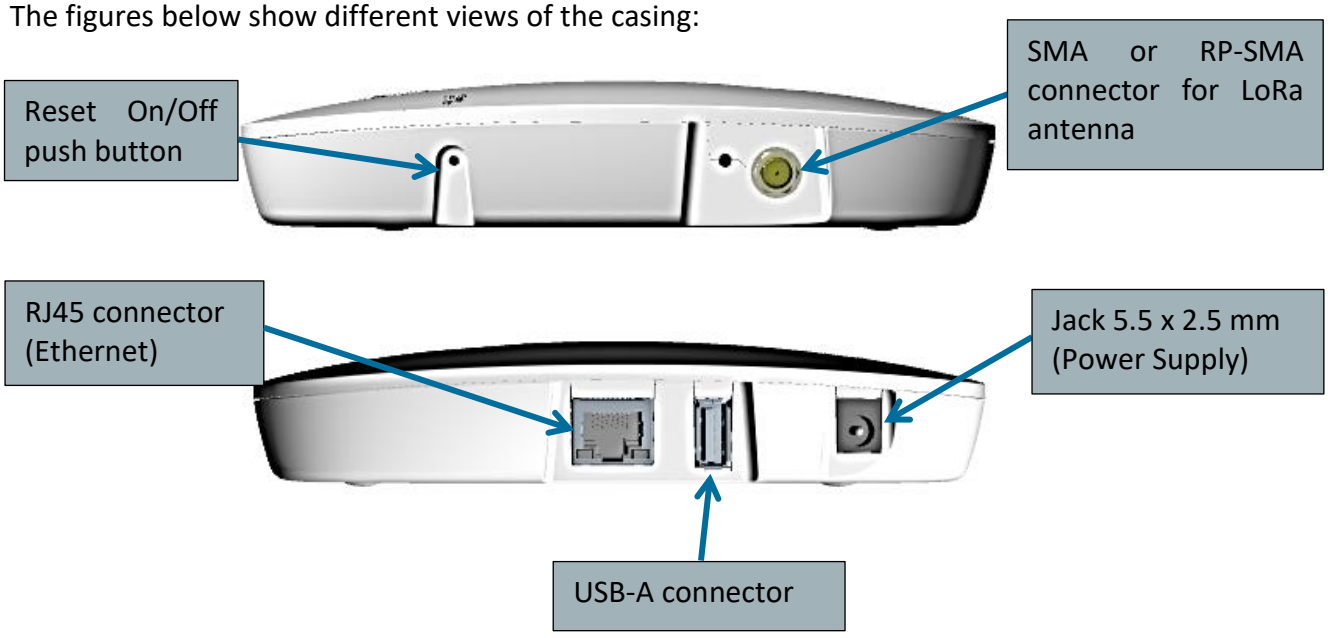
- WWAN connectivity with worldwide LTE, UMTS/HSPA+ and GPRS/EDGE coverage
- USIM access (mini-SIM format)
- Powered by DC supply:
  - 12V DC supply via 5.5 x 2.5mm jack
    - AC/DC power supply /12VDC) with 5.5 x 2.5mm plug provided
    - Uninterrupted power supply with 4-5h or 20-24h autonomy can be provided as accessory
    - Cigarette lighter adapters can be provided as accessory
  - 5V DC supply via USB-C plug
- 3 programmable LEDs as IHM:
  - 1 LED (green/red) for Power status
  - 1 LED (green/red) for Backhaul status
  - 1 LED (green/red) for LoRa® RF activity Rx/Tx
- ON/OFF/Reset button
- USB-A host connectivity for firmware upgrade
- USB-C OTG connectivity for power supply (5VDC), firmware upgrade & debug

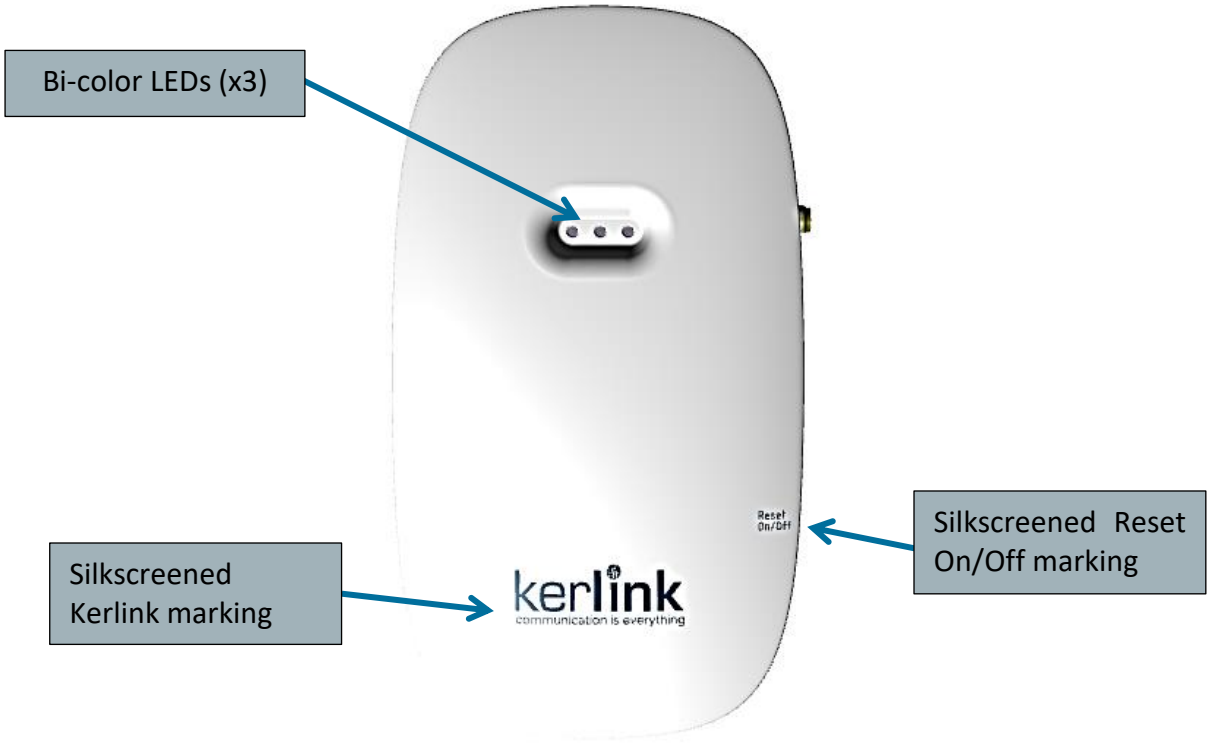
3.2 Mechanical implementation

3.2.1 Casing description

The Wirnet™ iFemtoCell-evolution is built on a plastic casing of 160 x 90 x 35 mm approximately (see details §3.2.3).
It is composed of two separated parts: the base and a cover. The cover is screwed to the base with four screws located on the rear side of the product.

The figures below show different views of the casing:




Bi-color LEDs (x3)
Silkscreened Kerlink marking
Silkscreened Reset On/Off marking
kerlink
communication is everything
Reset
On/Off

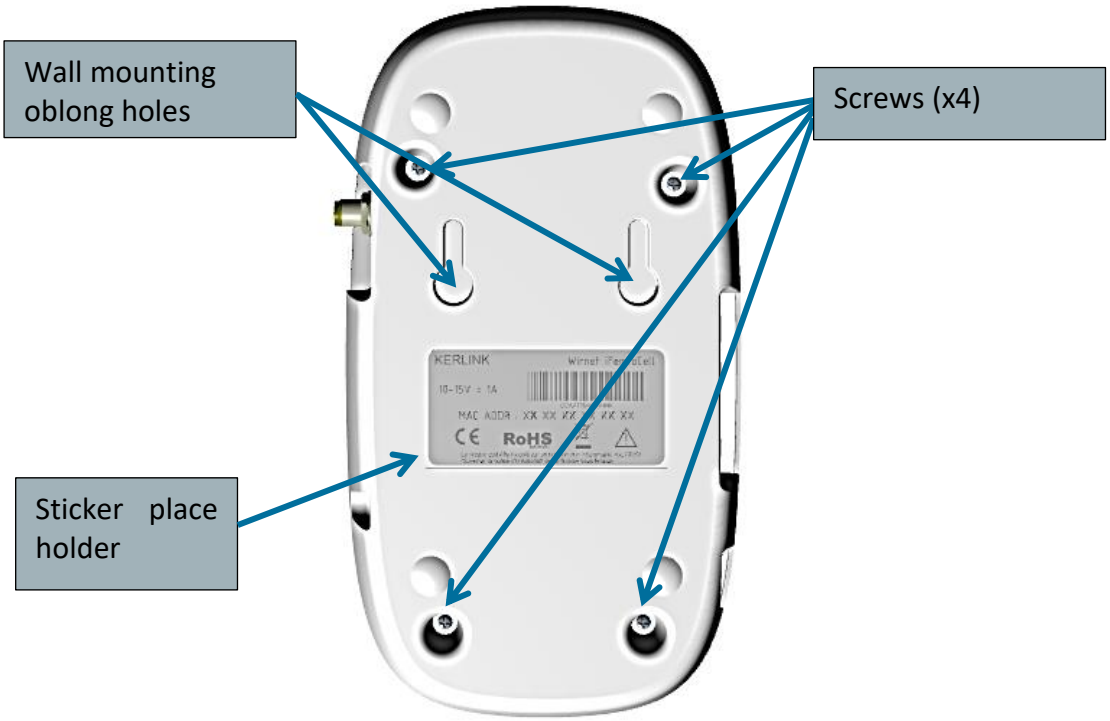

Wall mounting oblong holes
Screws (x4)
Sticker place holder
KERLINK
RoHS

Figure 3: Views of the casing

3.2.2 Casing characteristics

The main characteristics of the enclosure are detailed hereafter:

Description	Specification
Enclosure material	PC + ABS
LED gasket material	Elastomer compound based on styrene-butadiene-styrene (SBS)
Color	RAL 9003
Dimensions without LoRa® antenna	160 x 90 x 31.5 mm
Dimensions with LoRa® antenna	220 x 124 x 31.5 mm
Weight with AC power supply and LoRa® Antenna	163g
Weight with AC/DC power supply and antenna	280g
Weight with packing	372g
Ingress protection	IP30 / EN 60529
Humidity	95% non-condensing
Impact resistance	IK07
Flammability rating	UL94-V0
Wirnet™ iFemtoCell-evolution operating temperature range	-20°C to +55°C
Wirnet™ iFemtoCell-evolution storage temperature range	-40°C to +85°C
Connectors	1 x USIM connector (2FF format) 1 x SMA or RP-SMA (LoRa® antenna) 1 x jack 5.5x2.5mm (power supply) 1 x jack USB-A (USB Host) 1 x jack USB-C (USB OTG, power supply, debug) 1 x jack RJ45 (Ethernet)

3.2.3 Casing dimensions

Dimensions of Wirnet™ iFemtoCell-evolution are detailed hereafter, including the swivel antenna:

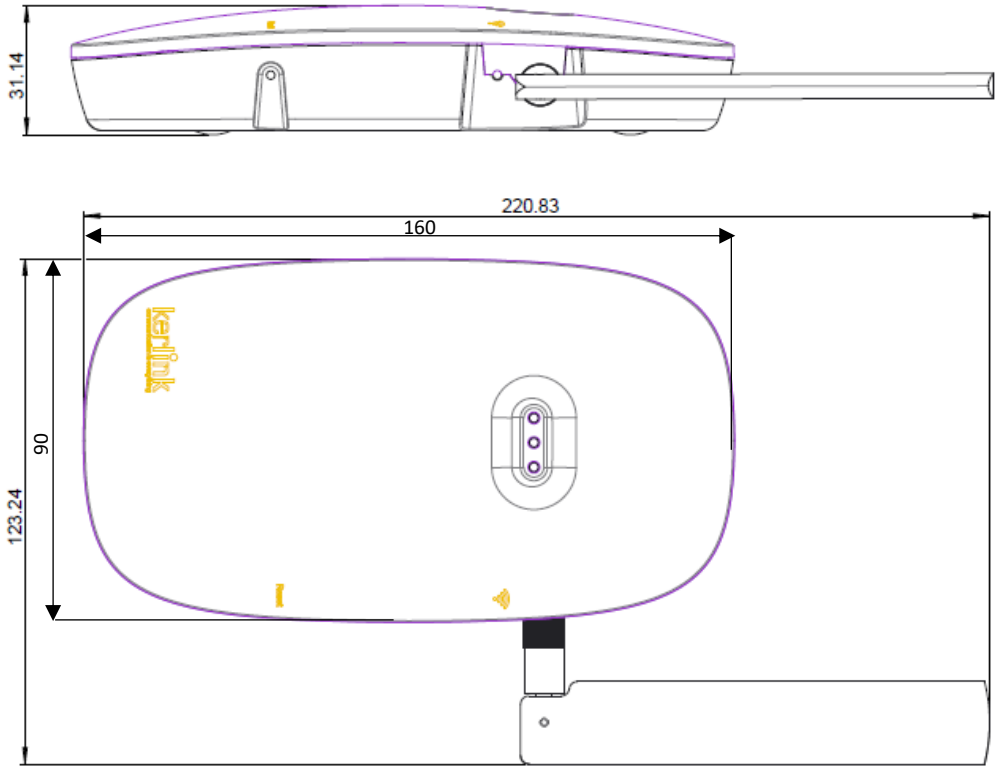


Figure 4: Casing dimensions with swivel antenna

3.2.4 Wall Mounting

The Wirnet™ iFemtoCell may be mounted on a wall using the two oblong holes:

Figure 5: Wall mounting

Only two screws are needed. All needed information is mentioned on the following drawing:

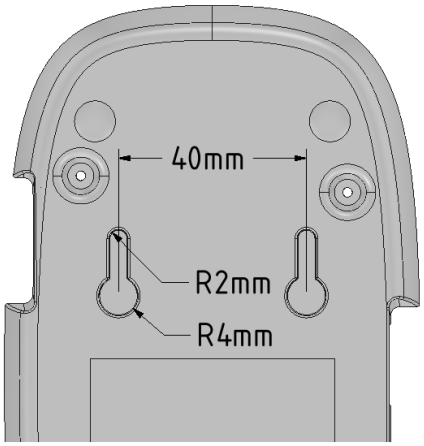


Figure 6: Wall mounting dimensions

3.2.5 Stickers

The Wirnet™ iFemtoCell-evolution has one sticker placed on the rear side of the casing, in a specific place holder.
This sticker includes serial number, MAC address, regulatory markings and electrical information.
Each version has its own specific sticker due to different product references (PDTIOT-IFE03, PDTIOT-IFE04 and PDTIOT-IFE05) and due to specific regulations.

An example is presented below:

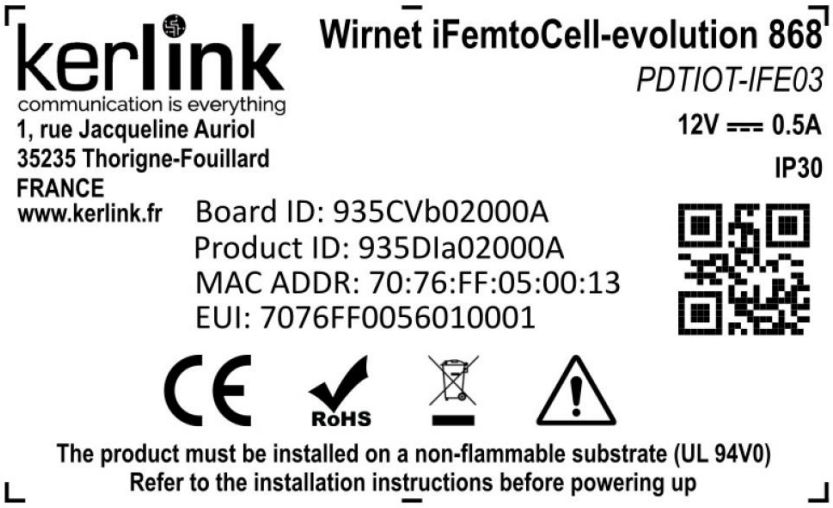


Figure 7: Sticker for WIFC-EVO 868

Later, it may occur that, due to many passed regulations, there is no sufficient place on the sticker for all mandatory labels. In this case, a second sticker will be added on the rear side, including all the needed additional labels. An example is presented below:

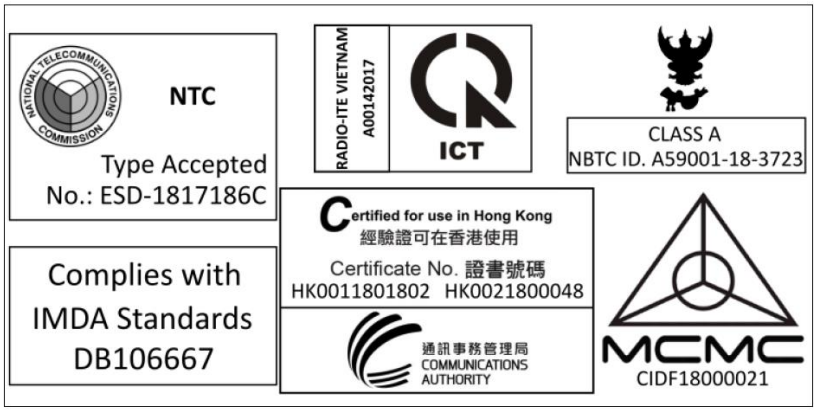


Figure 8: Second optional sticker (example only)

The position of the stickers are as follows

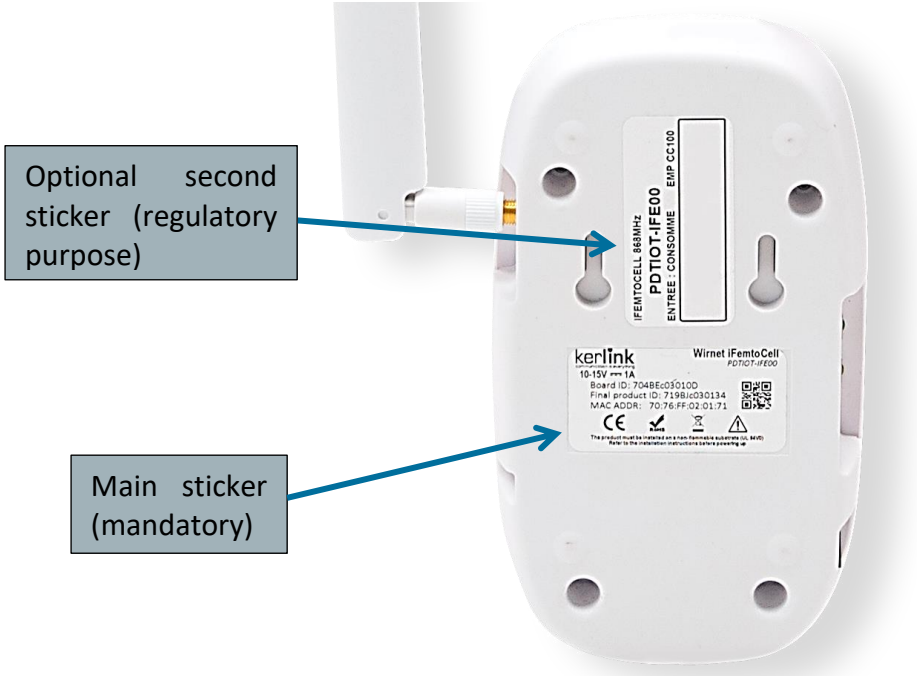


Figure 9: Position of stickers for WIFC-EVO

3.3 Power Supply

3.3.1 12VDC power supply

The Wirnet™ iFemtoCell-evolution, in nominal configuration, is supplied with 12VDC voltage via a 5.5mmx2.5mm socket located on the left side of the gateway.
This interface is the preferred supply interface due to the robustness of the sockets and plugs, which must be considered, especially in industrial or harsh environments.

Figure 10: View of the 5.5x2.5mm socket

An AC/DC supply voltage (see §3.3.3) is provided to interface this socket but additional accessories could be also eventually used (see §4).

The main "DC" characteristics of the 5.5mm x 2.5 mm jack interface, are detailed below:

Description	Specification
Connector type	5.5mm x 2.5 mm female socket (jack)
Input voltage	5.5V DC min 12V DC typ. 17V DC max
Input current	0.5A max @ 12VDC
Protections	Over Voltage Polarity inversion Short circuit Over temperature (thermal shutdown)
Additional features	Plug detection

3.3.2 5VDC power supply

The Wirnet™ iFemtoCell-evolution integrates an autonomous USB Type-C Port controller providing logic detection for Source Port role, Sink Port role, DRP and accessory detection support and Dead Battery support as defined in USB−C specifications.
Therefore, the USB-C port can be used either to supply OTG devices (source port role), either to supply the Wirnet™ iFemtoCell-evolution itself (sink port role).

The USB-C connector is located at the bottom side of the gateway as shown below:

Figure 11: View of USB-C connector

The main "DC" characteristics if the USB-C interface are detailed below:

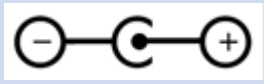
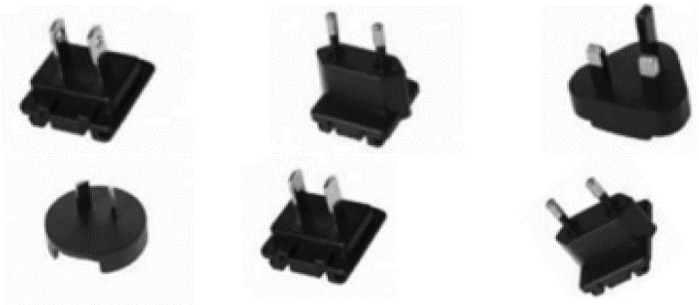
Description	Specification
Connector type	USB-C female socket (jack)
Input voltage (sink port)	5VDC typ 4.75V DC min, 5.25VDC max
Input current (sink port)	1A min, 3A max
Output Voltage (source port)	5VDC
Output Current (source port)	1.2A max
Protection (source port)	Thermal shutdown at 135°C

Note: In order to supply the Wirnet™ iFemtoCell-evolution through the USB-C connector, a specific cable including USB-C male plug is required. This cable is not provided with the Wirnet™ iFemtoCell-evolution.

3.3.3 AC/DC power supply

An AC/DC switching power supply with interchangeable AC plugs is provided with Wirnet™ iFemtoCell-evolution.
The main characteristics of the AC/DC supply are:

Description	Specification
Output Power	5W min guaranteed by manufacturer 9W typical over temperature measured by Kerlink
Output Voltage	12 VDC +/-0.6V
No load power consumption	0.1W max
Ripple and noise	120mVpp max
Output overshoot	10% max
Line regulation	1% max
Load regulation	5% max
Input Power Requirements	AC Input Voltage: 90 to 264VAC AC Input Current: 0.30 A @ 90-264VAC Inrush current: 40A max @ 100-264VAC at 25°C AC Frequency: 47 to 63Hz Efficiency > 78%
Turn-on delay time	3s max
Hold-up time	10ms min @ 115VAC 20ms min @ 230VAC

Polarity	 Positive polarity
Protections	Over current protection at max load 120-180% Short circuit protection
Dimensions	40 mm (W) x 32 mm (H) x 62 mm (L)
Weight	150 g
Connectors	Jack 2.5 mm / 5.5 mm
Color	White
Cord length	1.5 meters
Operating Ambient Temperature	-20°C to +60°C @ 6W
Operating Humidity	5% - 90%, Non-condensing
Storage Temperature	-30°C to +70°C
Storage Humidity	Maximum 90%, Non-condensing
Regulatory compliance	UL/cUL/FCC CE/CB/GS PSE/KC/CCC/BSMI/PSB SAA/C-Tick DOE VI/ RoHS
Electromagnetic Emission & Immunity	FCC Part 15, Class B EN 55022 (Emissions class B) EN 55024 (Immunity)
Interchangeable blades	US, EU, KC, UK, AU, CN 

Note: This power supply is intended for indoor applications only.

3.3.4 Power consumption

The nominal power consumption of Wirnet™ iFemtoCell-evolution, versus various use cases, is detailed hereafter:

	Use case	Current consumption (mA)	Power consumption (mW)
#1	Gateway OFF	0	0
#2	Boot mode	70 to 290 during boot 145 boot completed	840 to 3480 during boot 1740 boot completed
#3	LoRa Receiver ON	210	2520
#4	LoRa Transmitter ON (Pmax)	280	3360
#5	Connected LTE B8	170	2040
#6	Data call LTE B8	365	4380

#7	LoRa Receiver ON + LTE B8 connection	230	2760
#8	LoRa Receiver ON + Data call LTE B8	410	4920
#9	LoRa Transmitter ON (Pmax) + Data call LTE B8	450	5400

The mean power consumption of the Wirnet™ iFemtoCell-evolution is estimated at 3.0W.

3.4 CPU core

3.4.1 Processor

Wirnet™ iFemtoCell-evolution embeds an iMX6 (SoloX) high performance processor. It offers a wide range of connectivity and features. Only the features and interfaces used on the gateway are detailed in the following table:

Description	Specification
Reference	i.MX 6 SoloX
Core	Dual-core ARM® Cortex®-A9 ARM® Cortex®-M4
OS	Linux
Speed	800MHz for -A9 227MHz for -M4
Boot mode	eMMC
Interfaces	32-bits DDR3/DDR3L memory interface eMMC up to version 4.5 Gigabit Ethernet 2 x USB OTG with PHY 2 x 12-bits ADC (voltage sensors) 2 x UART 2 x SPI 1 x SDIO Multiple GPIO
Protection	Watchdog External Low Voltage Detector
Security	High Assurance Boot Secure Non-Volatile Storage Trust Zone On-chip Secure RAM On-chip electrical fuses Central Security Unit Hardware Cryptographic Accelerators True and Pseudo Random Number Generator
Power management	General Power Controller Integrated linear regulators
Operating temperature range	-40 to +85°C

3.4.2 Non-volatile memory

Wirnet™ iFemtoCell-evolution embeds a 8GB eMMC. The main characteristics are detailed below:

Description	Specification
Technology	MLC NAND flash
Standard interface	eMMC 5.1 HS400
Capacity	8GB
Cache	Dedicated volatile memory at the size of 512KB
Form factor	JEDEC 11.5x13mm (153 balls)
Bus transfer rate	Up to 300 MB/sec
Features	Enhanced User Data Area (EUDA) for higher endurance or performance Field Firmware Updates (FFU) Boot Partition Enhanced Reliable Write Sanitize Secure Erase Secure Trim Partition Management Device Health EOL Status Enhanced Write Protection
Protections	Advanced LDPC ECC engine Automatic refresh Advanced power protection
Data retention	Up to 3K P/E cycles on MLC and 30K on SLC with 1 year data retention @ 55°C 10 years data retention @ 55°C for fresh devices
Write endurance	20 Terabytes Written
Uncorrectable Bit Error Rate	1 sector in 10^{15} bits read
Operating temperature range	–25C° to +85C°

3.4.3 Volatile memory

Wirnet™ iFemtoCell-evolution embeds a 256MB DDR SDRAM. The main characteristics are detailed below:

Description	Specification
Technology	DDR3L SDRAM
Capacity	256MB
Features	Self Refresh Auto Self Refresh Self Refresh Temperature Write leveling
Package	FBGA 96-balls (8mm x 14mm x 1.2mm)
Operating temperature range	–40C° to +85C°

3.5 User interface

3.5.1 LEDs

Wirnet™ iFemtoCell-evolution has three bicolor LEDs located on the front side of the gateway as described below:

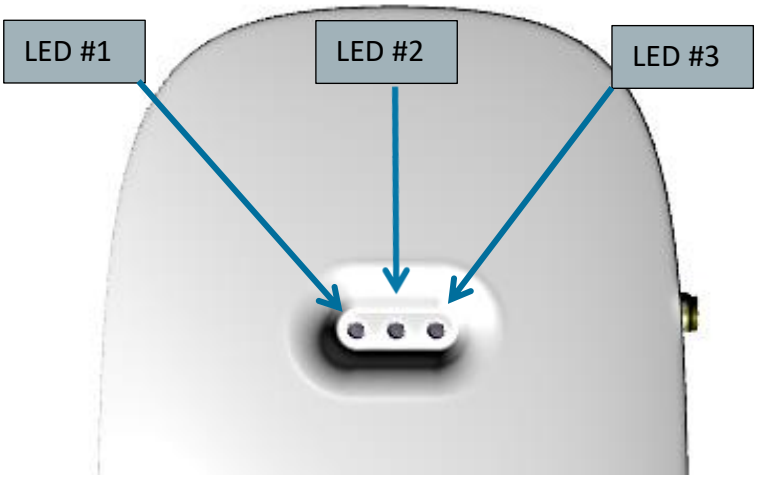


Figure 12: View of LEDs

The LEDs are used to indicate the behavior of the gateway as follows:

Item	Specification
LED 1: Power	A solid Green for Power LED A Status Red LED • Boot part 1 -> Fix on • Boot part 2 -> Heartbeat • Boot part 3 -> Blink every second • Run time -> Off • Power down sequence -> Heartbeat • Update -> Blink / 0.4 second • Restore backup -> Blink / 2 seconds • Restore stock -> Blink / 4 seconds
LED 2: Backhaul	RED during boot If the applicative software provided by Kerlink is installed: • RED if applicative software is disconnected • GREEN blinking during applicative software connection • GREEN fix if applicative software is connected
LED 3: LoRa® traffic	RED during boot If the applicative software provided by Kerlink is installed: • Applicative software management • Rx: GREEN blinking • Tx: RED blinking

3.5.2 Reset On/Off Push-button

The Reset On / Off push button is located on the right side flounge of the Wirnet™ iFemtoCell-evolution. The Reset On / Off button is identified with the silkscreen “Reset On / Off” marking placed on the top side of the gateway to clearly identify the placement.

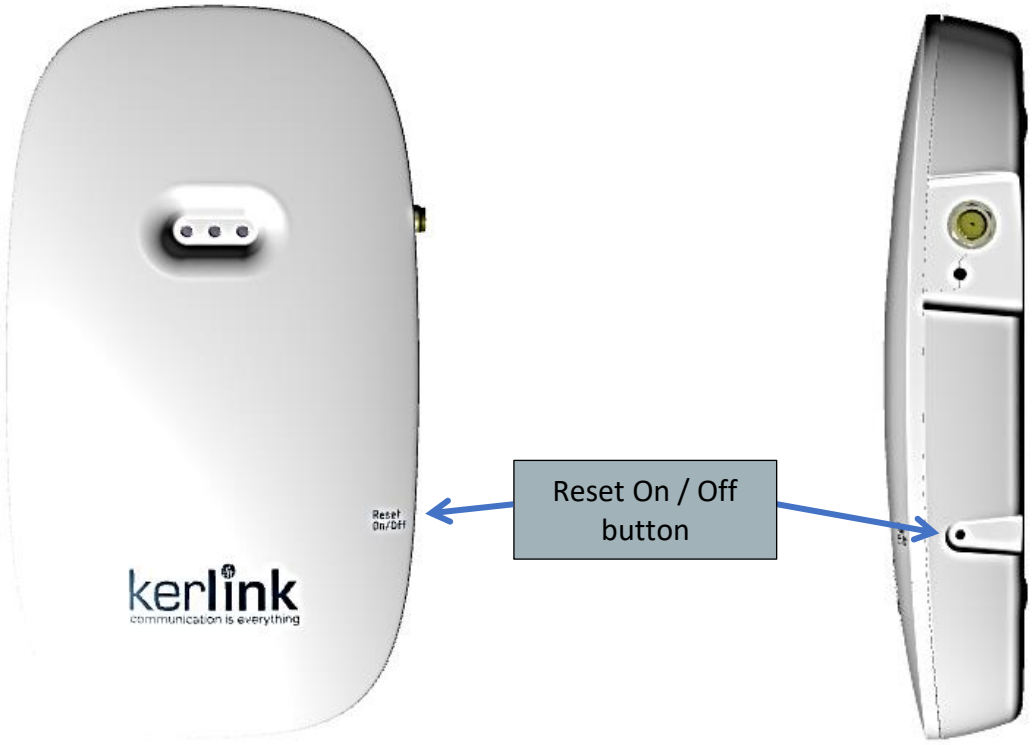


Figure 13: Push buttons

The Reset On / Off button must be pressed during 1s to generate a SW reset of the product.
A long press for 5s turns off the gateway. Another short press turns on the gateway.
To press the buttons, a tool with a 1mm diameter must be used:

Figure 14: Push button tool

3.5.3 USB-A connector

The Wirnet™ iFemtoCell-evolution integrates a USB-A female connector allowing connection of devices such as a USB mass-storage stick.
The Wirnet™ iFemtoCell-evolution embeds a USB 2.0 High Speed Hub to interface both USB-A and WWAN module interfaces to a single USB PHY of the CPU (OTG2). It is a high-performance multiple transaction translator which provides one transaction translator per port. It fully integrates USB termination and pull-up/pulldown resistors. This Hub is required because of the CPU limited number (x2) of USB PHY.

The USB-A connector is a female socket located on the left flange of the gateway:

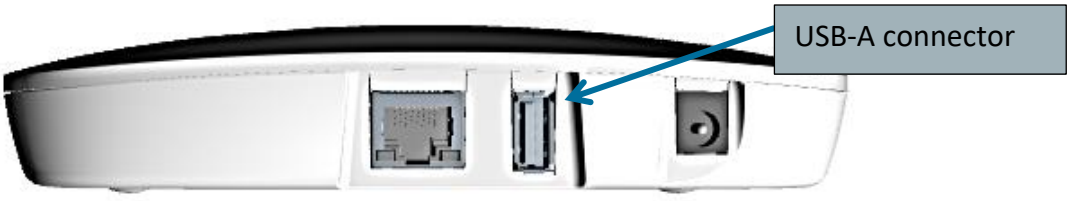


Figure 15: View of the USB-A connector

The main characteristics if the USB-A interface are detailed below:

Description	Specification
USB compliance	2.0
USB modes supported	Low-speed, full-speed and hi-speed
Connector type	USB-A female socket
Output Voltage (source port)	5VDC
Output Current (source port)	1.2A max
Protection (source port)	Thermal shutdown at 135°C

3.5.4 USB-C Connector

The Wirnet™ iFemtoCell-evolution integrates an autonomous USB Type-C Port controller providing logic detection for Source Port role, Sink Port role, DRP and accessory detection support and Dead Battery support as defined in USB−C specifications.
The USB Type-C Port controller is connected to a dedicated USB PHY of the CPU (OTG1).

The USB-C connector allows then to connect:

- A 5V DC supply as detailed in §3.3.2
- A Wirnet™ Debug Probe, from Kerlink, to use debug mode
- A USB mass-storage stick to upgrade the gateway

The USB-C connector is located at the bottom side of the gateway as shown below:

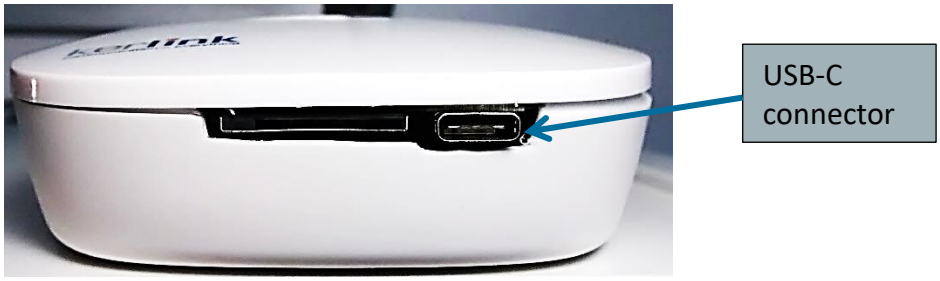


Figure 16: View of USB-C connector

The main characteristics if the USB-C interface are detailed below:

Description	Specification
USB compliance	Type–C™ Specification Release 1.3
USB norm	2.0
Features supported	Source, Sink, DRP, Dead Battery
Connector type	USB-C female socket
Input voltage (sink port)	5VDC typ. 4.75V DC min, 5.25VDC max
Input current (sink port)	1A min, 3A max
Output Voltage (source port)	5VDC
Output Current (source port)	1.2A max
Protection (source port)	Thermal shutdown at 135°C

The different pins of the USB-C connector as used to both comply USB type C specification and allow usage of the Wirnet™ Debug Probe. The pins are allocated as follows:

Pin number	Pin name	Wirnet™ iFemtoCell-evolution usage
A1	GND	GND
A2	TX1+	TX Wirnet™ Debug Probe
A3	TX1-	RX Wirnet™ Debug Probe
A4	VBus	VBus
A5	CC1	CC1
A6	D+	D+
A7	D-	D-
A8	SUB1	3.3V DC
A9	VBus	VBus
A10	RX2-	Reset Wirnet™ Debug probe
A11	RX2+	Boot Mode Wirnet™ Debug probe RX2+
A12	GND	GND
B1	GND	GND
B2	TX2+	Not Connected
B3	TX2-	Not connected
B4	VBus	VBus
B5	CC2	CC2
B6	D+	D+
B7	D-	D-
B8	SUB2	Detect Wirnet™ Debug probe
B9	VBus	VBus
B10	RX1-	Control of LED#2 Wirnet™ Debug probe

B11	RX1+	Control of LED #1 Wirnet™ Debug probe
B12	GND	GND

Note: the pins highlighted in yellow in the above table are "Kerlink specific" to allow usage of the Wirnet™ Debug Probe

Note: In order to connect the Wirnet™ iFemtoCell-evolution through the USB-C connector, a specific cable including USB-C male plug is required. No such cable is provided with the Wirnet™ iFemtoCell-evolution. The necessary USB-C cables are however provided with Wirnet™ Debug Probe.

3.5.5 USIM access

A USIM card is mandatory to establish the LTE/HSPA/UMTS/GPRS communications.
KERLINK recommends the usage of a M2M UICC compliant with 3GPP TS 102.671. It offers then a better temperature operating range, improved data retention and increased number of UPDATE commands.

The USIM connector is located on the bottom side of the Wirnet™ iFemtoCell-evolution.
It is intended for Mini-SIM (2FF) form factor.
It is a push-push connector with card detection.
The supply voltage is 1.8V DC.

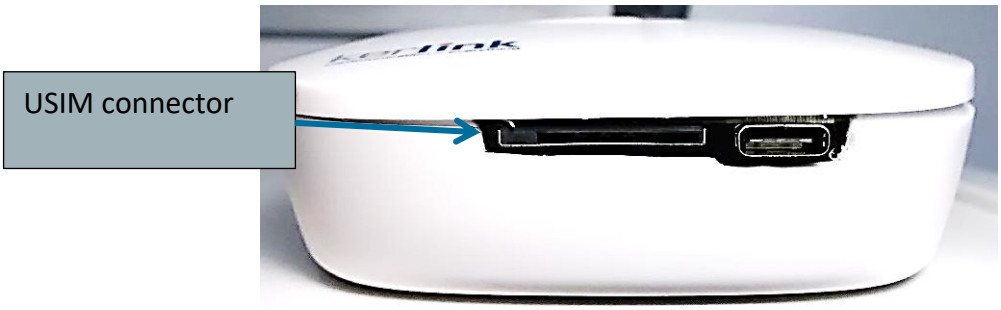


Figure 17: Views of the USIM connector

Before inserting the USIM card, pay attention that the Wirnet™ iFemtoCell-evolution is unpowered by checking that all LEDs are OFF.
Then, insert the USIM card in the Wirnet™ iFemtoCell-evolution into the USIM connector. Beware on the side of the USIM before insertion:

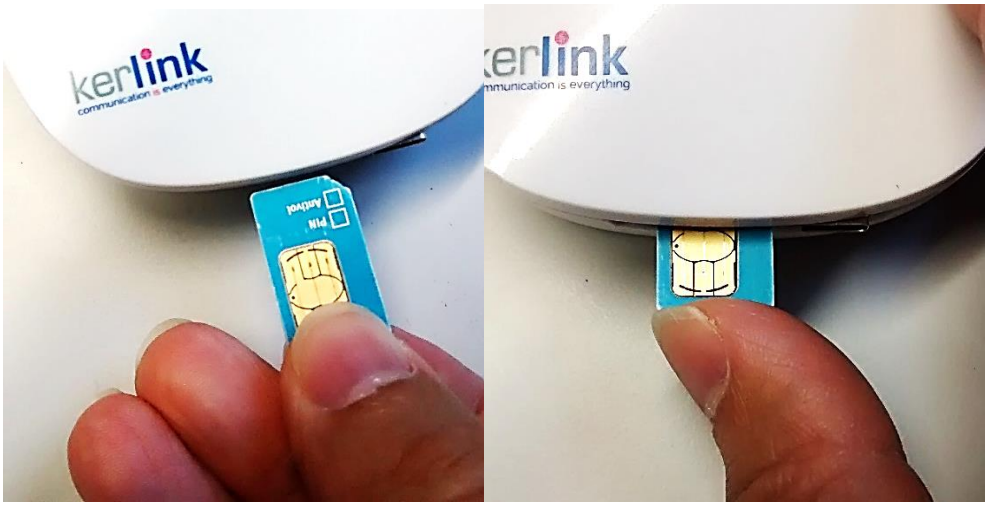


Figure 18: Position of the USIM card before insertion into the USIM connector

Once introduced into the connector, push the USIM card until locking.
To remove the USIM card, push it again.
In case of replacement of the USIM card, the power supply must be firstly switched off by disconnecting the power supply. Wait and check the LEDs are switched off before extracting the USIM card.

3.5.6 Ethernet

The Wirnet™ iFemtoCell-evolution embeds a RJ45 Ethernet connector, an Ethernet transformer and an Ethernet 10BASE-T/100BASE-TX physical layer (PHY) transceiver connected to the CPU core through an RMII interface.
The transceiver implements auto negotiation to automatically determine the best possible speed and duplex mode of operation.
The device is configured to operate on a single 3.3V supply.
No synchronization via Ethernet (PTP or other) is required.

The RJ45 Ethernet socket is located on the left side of the Wirnet™ iFemtoCell-evolution:

Figure 19: Views of the Ethernet RJ45 connector

The RJ45 connectors also integrates two LEDs:

- Green LED on the left side for Ethernet Data Activity
- Orange LED on the right side for Ethernet Link

3.5.7 LoRa® antenna interface

The LoRa® antenna interface of Wirnet™ iFemtoCell-evolution is a SMA female or RP-SMA female connector.
SMA is provided on Wirnet™ iFemtoCell-evolution version 868 whereas RP-SMA is provided on Wirnet™ iFemtoCell-evolution versions 915 and 923.

The difference between RP-SMA and SMA are detailed below:

Figure 20: Differences between RP-SMA female and SMA female connectors

The connector is located on the right side of the Wirnet™ iFemtoCell-evolution:

Figure 21: View of the LoRa® RF connector

The radio performance at the LoRa® antenna port is detailed in § 0.

3.6 LoRa® radio specifications

3.6.1 LoRa® radio block diagram

LoRa® radio architecture is based on Semtech Reference Design V1.5 including SX1301 demodulator and FPGA, SX1257 transceivers and SX1272 as sniffer.
The following block diagram details the architecture of the LoRa® radio front-end:

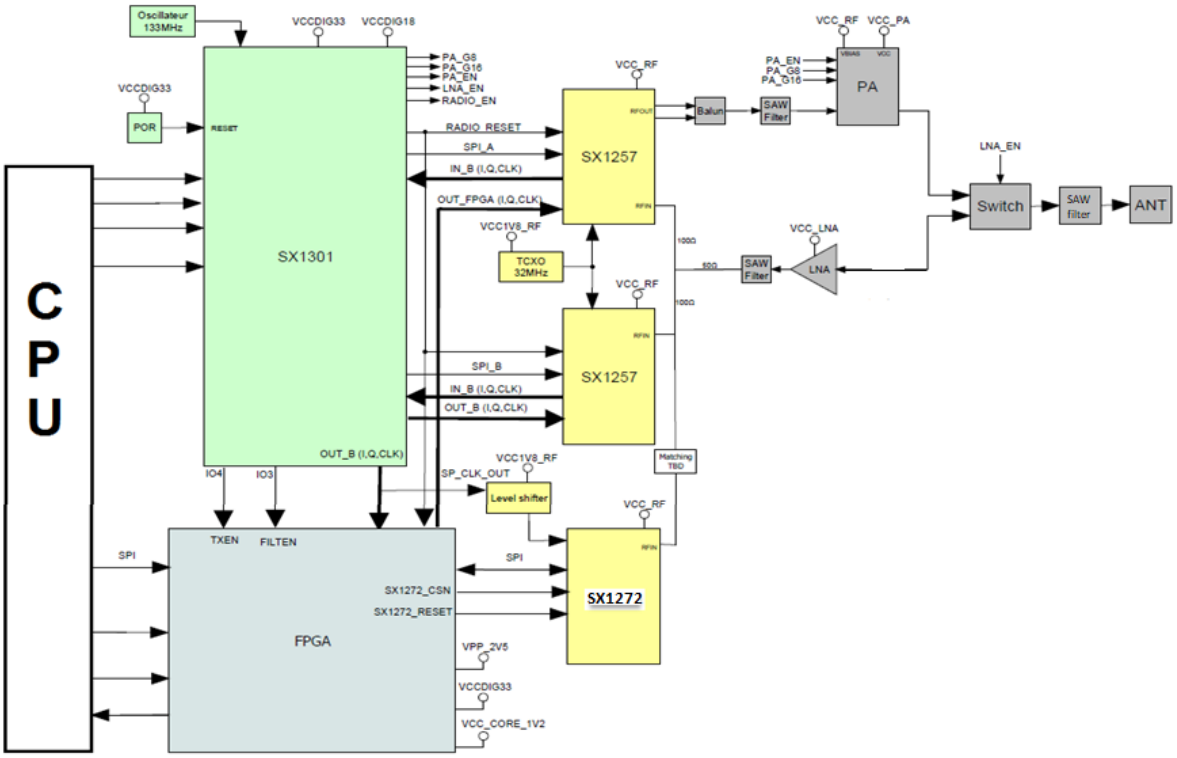


Figure 22: LoRa® radio block diagram

However, some specific Kerlink tunings were injected in the design to achieve superior best in class performance:

- A specific SAW filter is inserted at the antenna port to achieve better out of band spurious and out of band immunity. This filter is also required to achieve radio coexistence between LoRa®.
- Specific RX SAW filters are used on the receiver path to achieve better out of band rejection, especially for cellular bands.
- Specific TX SAW filters are used on the transmitter path to achieve better noise shaping before the PA and reduce out of band emissions, especially in cellular bands.

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

- 868MHz version:
  - RX Band = 863-874.4MHz[1]
  - TX Band = 863-874.4MHz

[1] 874.4MHz is considered as a future evolution of unlicensed band in Europe

- 915MHz version:
  - RX Band = 902-915MHz
  - TX Band = 923-928MHz
- 923MHz version:
  - RX Band = 915-928MHz
  - TX Band = 915-928MHz

3.6.2 LoRa® RF characteristics

The RF characteristics of the main radio chipsets are detailed below:

Feature	Description
LoRa® demodulator	Based on SX1301 digital signal processing engine from Semtech Emulates 49 x LORA® demodulators and 1 x (G)FSK demodulator per SX1301: • 8 x LoRa® demodulator at dynamic data rate with 125KHz BW • 1 x LoRa® demodulator at fixed data rate • 1 x (G) FSK demodulator Dynamic data-rate (DDR) adaptation Detect simultaneously 8 preambles corresponding to all data rates (Spreading Factor) at LoRa® 125KHz BW 2MHz baseband BW
Transceiver	Based on Semtech SX1257 862MHz to 960MHz frequency range 250 kHz to 750KHz channel BW +8dBm typ. output power 10dB output power control range 128dBc/Hz Signal to Noise performance at 10MHz offset Receiver Noise Figure of 7 dB -25dBm IIP3 at max gain Independent automatic gain control
Sniffer	Based on Semtech SX1272 chipset 860MHz to 1020MHz frequency range FSK, GFSK, MSK, GMSK and OOK demodulator FSK Bit rates up to 300 kb/s Digital filtering, demodulation, AGC, AFC, synchronization and packet handling Accurate RSSI measurements through automatic gain calibration 125dB Dynamic Range RSSI +57dBm IIP2 -12.5dBm IIP3 82 dB typ. CW interferer rejection at 1 MHz offset 89 dB typ. CW interferer rejection at 10 MHz offset
External LNA	Noise Figure of 0.7dB 18dB Gain at 900MHz 38dBm IIP3 at max gain
External PA	Maximum input power: 10dBm Maximum Output power: 27dBm Small signal gain: 32dB

3.6.3 Modulations and data rates

The Wirnet™ iFemtoCell-evolution 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 Output Power

The conducted output power can be adjusted from 0dBm to +24dBm.
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 +24dBm
Ripple in the band at max power (24dBm)	+/- 1dB
Ripple in the band at mid-range power (14dBm)	+/- 1.5dB
Variation over temperature range (-20°C to +55°C)	+/- 2dB

3.6.5 Out of band emissions

Due to the very low noise transmitter and SAW filter at the antenna port, the Wirnet™ iFemtoCell-evolution 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	LTE, UMTS or GSM band	Out of band emissions
868	E-GSM900 UL (880-915MHz)	-80dBm/100KHz
868	LTE800 (832-857MHz)	-80dBm/100KHz
868	LTE800 (857-862MHz)	-60dBm/100KHz
915	GSM850 DL (869-894MHz)	-80dBm/100KHz
923	GSM900 UL(890-915MHz)	-60dBm/100KHz
923	GSM900 DL(935-960MHz)	-80dBm/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.

3.6.6 Sensitivity

The sensitivity performance of Wirnet™ iFemtoCell-evolution, depending on the version, at 10% PER, coding rate 4/5, preamble 8 symbols, 20 bytes payload is the following:

Mode	868MHz	915MHz	923MHz
SF7/125KHz	-126dBm	-126.5dBm	-125.5dBm
SF10/125KHz	-134.5dBm	-135dBm	-134dBm
SF12/125KHz	-140dBm	-141dBm	-139.5dBm

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

Description	Specification
Sensitivity variation over the band (868 and 915 versions)	+/- 0.5dB
Sensitivity variation over the band (923 version)	+1* / - 0.5 dB
Sensitivity variation over temperature range (-20°C to +55°C) for 868 and 915 versions	+/- 1.0dB
Sensitivity variation over temperature range (-20°C to +55°C) for 923 version	+2* /- 1.0dB

*: maximum degradation is observed between 927MHz and 928MHz

3.6.7 Receiver dynamic range – RSSI and SNR

The Wirnet™ iFemtoCell can receive LoRa® frames from -10dBm to -140dBm, depending on the LoRa® BW and SF.
The Wirnet™ iFemtoCell-evolution 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 = RSSI (dBm)
- If SNR <0, the signal strength = RSSI+SNR (dBm)

RSSI varies from -10dBm 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 SF12 / 125KHz BW. It describes the SNR, RSSI and RSSI+SNR measured vs. the signal strength:

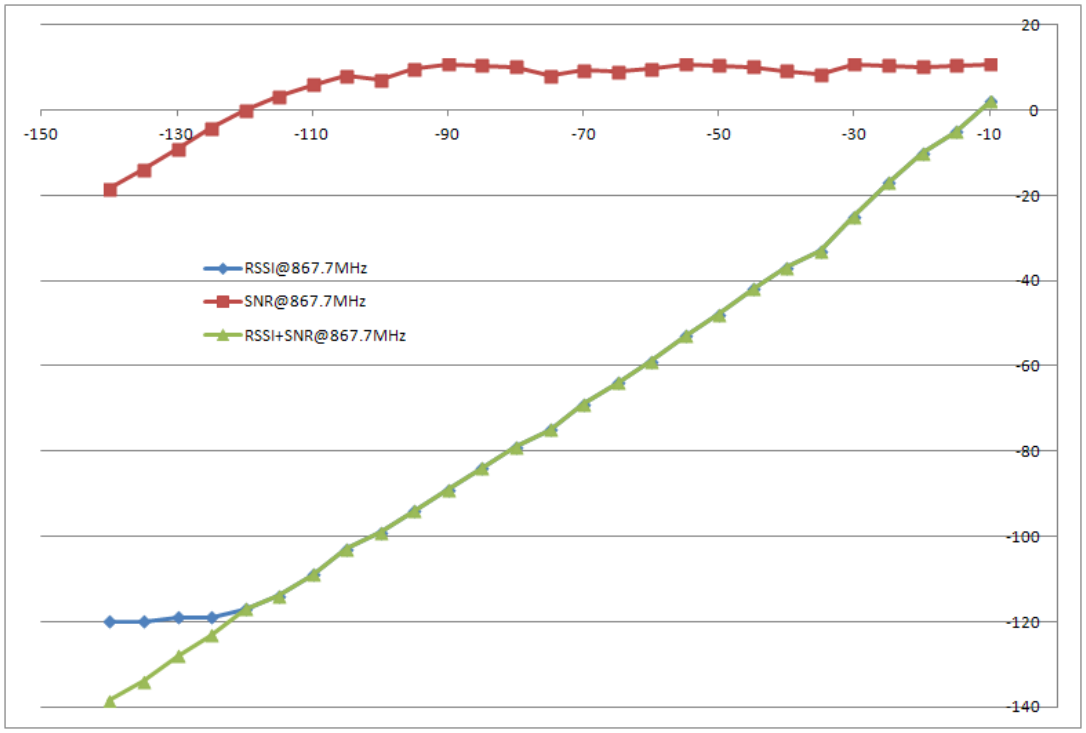


Figure 23: Example of SNR, RSSI and RSSI+SNR plots at 125KHz BW / SF12

Note : RSSI vs. Signal strength or RSSI+SNR vs. Signal strength is linear in the -35dBm to -140dBm range. Above -35dBm, saturation of the receiver is observed and RSSI measurement is not accurate.

3.6.8 In-band blockers rejection

Wirnet™ iFemtoCell-evolution can achieve excellent in band blocker rejection due to the linearity of the receiver and digital channel filters of SX1301.

In the following table, the in-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 the difference (in dB) with the useful LoRa® signal.

The useful signal is adjusted at SF12, 125KHz BW, -137dBm and frequency is adjusted in the middle of the band.
The typical in band blockers rejections, are the following:

Frequency offset	SF12/125KHz (absolute)	SF12/125KHz (relative)
+/-200KHz	-62dBm	75dB
+/-2MHz	-47dBm	90dB
+/-5MHz	-33dBm	104dB

3.6.9 Out of band blockers rejection

Due to the specific SAW filters used in the receiver path, the Wirnet™ iFemtoCell-evolution can achieve excellent out of band blocker rejections especially in the LTE, UMTS and GSM uplink or downlink bands.
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 and the difference (in dB) with the useful LoRa® signal are noticed in the tables below.

3.6.9.1 Version 868MHz

The useful signal is adjusted at 867.7MHz, SF7, 125KHz BW, -137dBm.
The blockers rejections, are the following:

Blocker frequency	SF7/125KHz (absolute)	SF7/125KHz (relative)
796MHz	>+13dBm	>150dB
824MHz	>+13dBm	>150dB
857.7MHz (-10MHz)	-25dBm	112dB
877.7MHz (+10MHz)	-10dBm	127dB
925MHz	>+13dBm	>150dB
960MHz	>+13dBm	>150dB

Note: Blockers rejection characterization is limited to +13dBm due to measurement set-up. We can only then guarantee that minimum performance is 150dB rejection min.

3.6.9.2 Version 915MHz

The useful signal is adjusted at 908MHz, SF10, 125KHz BW, -132dBm.
The blockers rejections, are the following:

Blocker frequency	SF7/125KHz (absolute)	SF7/125KHz (relative)
850MHz	>+11dBm	>143dB
890MHz	>+11dBm	>143dB
894MHz	+7dBm	139dB
898MHz (-10MHz)	-28dBm	104dB
918MHz (+10MHz)	-27dBm	105dB
935MHz	+4dBm	136dB
960MHz	>+11dBm	>143dB

Note: Blockers rejection characterization is limited to +11dBm due to measurement set-up. We can only then guarantee that minimum performance is 143dB rejection min.

3.6.9.3 Version 923MHz

The useful signal is adjusted at 923MHz, SF7, 125KHz BW, -137dBm.
The blockers rejections, are the following:

Blocker frequency	SF7/125KHz (absolute)	SF7/125KHz (relative)
850MHz	>+13dBm	>150dB
894MHz	>+13dBm	>150dB
905MHz	>+13dBm	>150dB
913MHz (-10MHz)	-23dBm	114dB
933MHz (+10MHz)	-20dBm	117dB
935MHz	>+13dBm	>150dB
945MHz	>+13dBm	>150dB
960MHz	>+13dBm	>150dB

Note: Blockers rejection characterization is limited to +13dBm due to measurement set-up. We can only then guarantee that minimum performance is 150dB rejection min.

3.6.10 Sniffer

Sniffer feature consists in a RSSI measurement path in parallel of the LoRa® receiver path. Both sniffer and LoRa® receiver can be then used simultaneously. L
Sniffer is used for LBT feature and in band / out of band spectrum analysis.

The RSSI measurement is possible in the -10dBm to -115dBm range but the linear range is limited to -40dBm to –110dBm (70dB).
The receiver saturates above -35dBm.
Noise floor is -115dBm in 200KHz BW.

The typical characteristic of the sniffer is presented below:

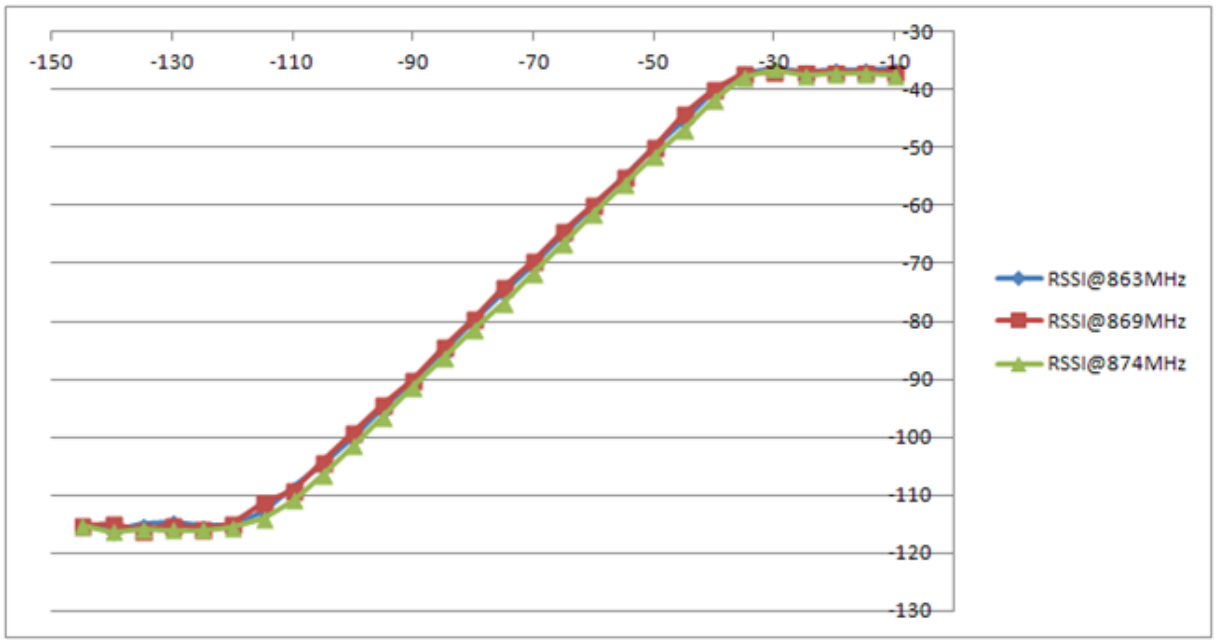


Figure 24: Example of sniffer RSSI characteristic

3.6.11 LoRa® antenna

A dual band swivel antenna is provided with Wirnet™ iFemtoCell-evolution. Depending on the version, this external antenna is equipped with SMA or RP-SMA connector.

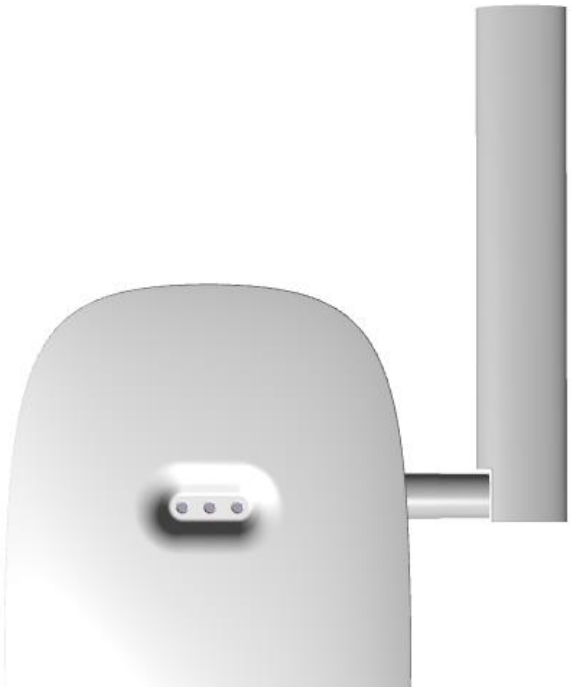


Figure 25: LoRa® swivel antenna

3.6.11.1 Specifications

The specifications of the omnidirectional LoRa® antenna are the following:

Item	Specification
Frequency range	862-873MHz and 902-928MHz
Impedance	50 ohms
Technology	Dipole
VSWR	<1.7:1
Max gain	3dBi
Polarization	Vertical
Whip material	ABS
Color	White
Connector (Wirnet™ iFemtoCell-evolution 868)	SMA
Connector (Wirnet™ iFemtoCell-evolution 915 & 923)	RP-SMA
Size	135x20mm
Weight	15g
Operating temperature range	-20°C to +55°C

3.6.11.2 Return loss

Typical return loss performance is presented hereafter:

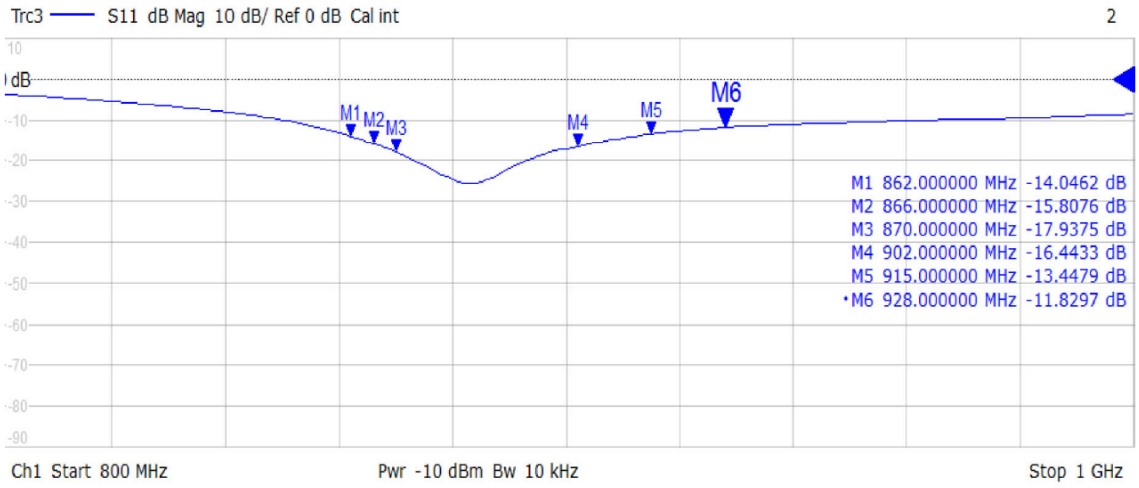


Figure 26: LoRa® antenna return loss

3.6.11.3 Radiation patterns

Radiations patterns of the LoRa® antenna are presented below at different frequencies:

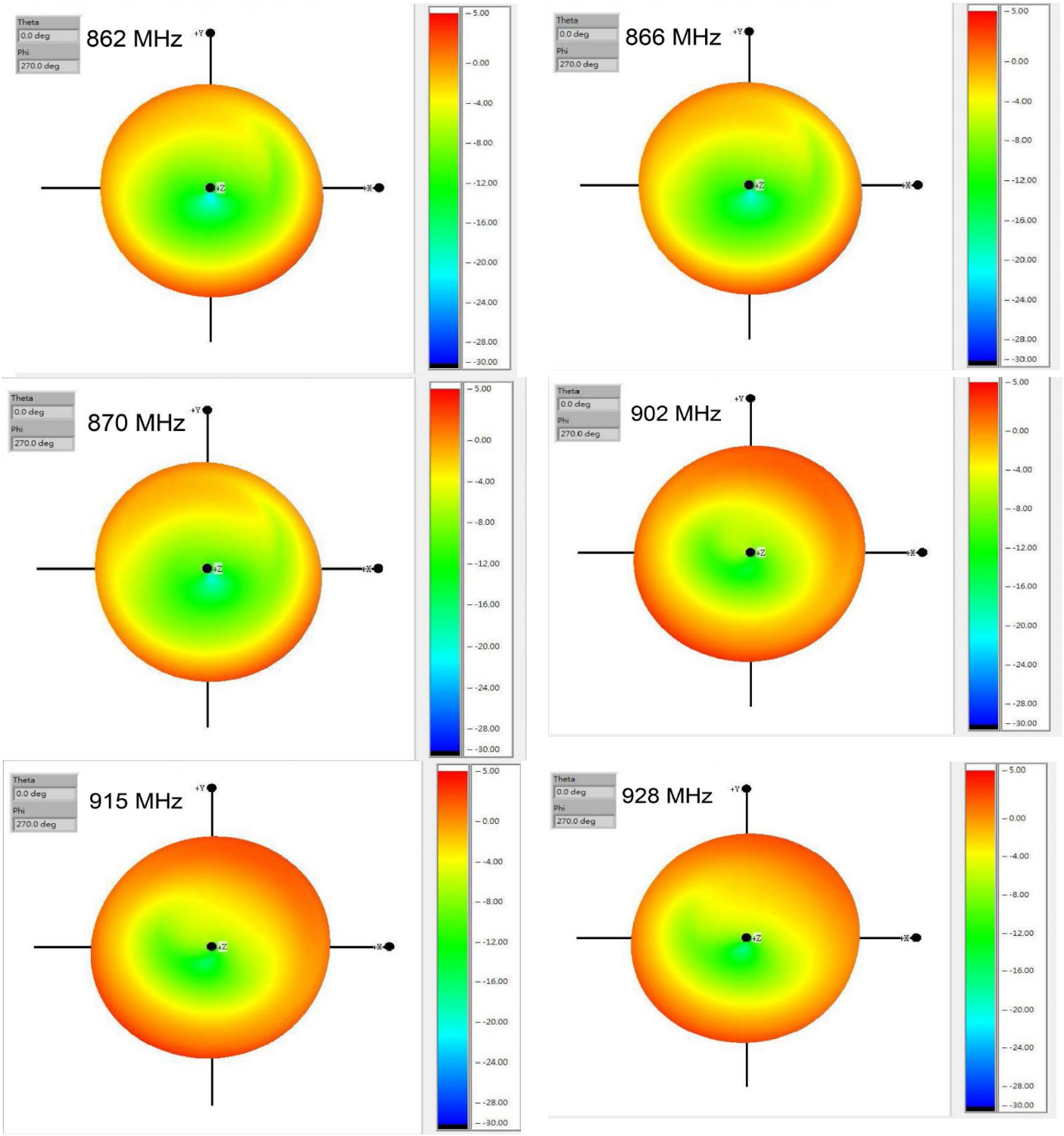


Figure 27: LoRa® antenna radiation patterns

3.7 WWAN capabilities

3.7.1 LTE module

Wirnet™ iFemtoCell-evolution embeds a worldwide Quectel EG25-G LTE Cat 4 module. Adopting the 3GPP Rel. 11 LTE technology, it delivers 150Mbps downlink and 50Mbps uplink data rates. It is backward-compatible with existing EDGE and GSM/GPRS networks, ensuring that it can be connected even in remote areas devoid of 4G or 3G coverage.

The module is controlled via an USB interface connect to a USB PHY of the CPU (OTG2) via an USB hub as detailed in §3.5.3. The USB port is then shared with devices connected to USB-A interface.

The bands and data rate supported by the Wirnet™ iFemtoCell-evolution are the following:

Technologies	Band	Data rate

LTE	Band 1 (2100)
	Band 2 (1900 PCS)
	Band 3 (1800+)
	Band 4 (1700/2100 AWS-1)
	Band 5 (850)
	Band 7 (2600)
	Band 8 (900)
	Band 12 (700 ac)
	Band 13 (700 c)
	Band 18 (800 Lower)
	Band 19 (800 Upper)
	Band 20 (800 DD)
	Band 25 (1900+)
	Band 26 (850+)
	Band 28 (700 APT)
	Band 38 (TD 2600)
	Band 39 (TD 1900+)
	Band 40 (TD 2300)
	Band 41 (TD2600+)
		• LTE FDD:
		  ○ Max 150Mbps (DL)
		  ○ Max 50Mbps (UL)
		• LTE TDD:
		  ○ Max 130Mbps (DL)
		  ○ Max 35Mbps (UL)

WCDMA	Band 1 (2100)
	Band 2 (1900 PCS)
	Band 4 (1700/2100 AWS-1)
	Band 5 (850)
	Band 6 (850 Japan)
	Band 8 (900)
	Band 19 (800 Japan)
		• DC-HSDPA: Max 42Mbps (DL)
		• HSUPA: Max 5.76Mbps (UL)
		• WCDMA:
		  ○ Max 384Mbps (DL)
		  ○ Max 384Mbps (UL)

GSM	B2 (1900 PCS)
	B3 (1800 DCS)
	B5 (850)
	B8 (900)
		• EDGE:
		  ○ Max 296Mbps (DL)
		  ○ Max 236.8Mbps (UL)
		• GPRS:
		  ○ Max 107Mbps (DL)
		  ○ Max 85.6Mbps (UL)

Output power and sensitivity are summarized in the following table:

Technologies	Band	Output Power	Sensitivity
LTE	All bands	Class 3 (23dBm±2dB)	-99.5dBm (10M)
WCDMA	All bands	Class 3 (24dBm+1/-3dB)	-110dBm
GSM	High bands	Class 1 (30dBm±2dB) Class E2 (26dBm±3dB)	-107.5dBm
	Low bands	Class 4 (33dBm±2dB) Class E2 (27dBm±3dB)	-108dBm

The WWAN module offers a worldwide coverage according to all the listed bands but also because it already passed many regulatory approvals. This "modular approval" facilitates the current and future regulatory approvals of Wirnet™ iFemtoCell-evolution.

3.7.2 Notch filter

A notch filter is inserted between the WWAN module and the WWAN antenna. The purpose of this notch filter is to reject the noise generated by the LTE module in the LoRa® unlicensed band and avoid desensitization of the LoRa® receiver during LTE data call. The filter is needed because of the proximity of LoRa® antenna and WWAN antenna. The small distance does not provide enough natural isolation. The notch filter provides the additional required isolation.

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

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

3.7.3 WWAN antenna

Wirnet™ iFemtoCell-evolution embeds a small size multi-band LTE internal antenna. It is a chip antenna component built on glass epoxy substrate.
A matching circuit is embedded on the PCB to improve efficiency.
The main characteristics are presented hereafter.

3.7.3.1 Specifications

The specifications of the LTE antenna are the following:

Item		Specification
Frequency range	Band 1	698-960MHz
	Band 2	1710-2690MHz
Max gain	Band 1	2.3dBi
	Band 2	3.0dBi
Average gain	Band 1	0.8dBi
	Band 2	2.5dBi
Efficiency	Band 1	40.2% to 71.1%
	Band 2	71.6% to 90.3%
VSWR	Band 1	<3:1
	Band 2	<3:1
Impedance		50 ohms
Polarization		Linear

3.7.3.2 VSWR

Typical VSWR and efficiency performance is detailed below:

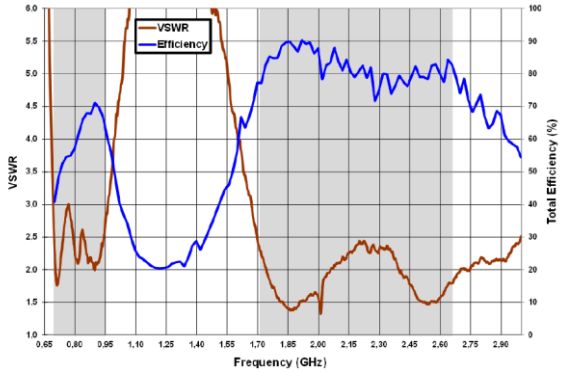


Figure 28: LTE antenna VSWR

3.7.3.3 Radiation patterns

Radiations patterns of the LTE antenna are presented below at different frequencies:

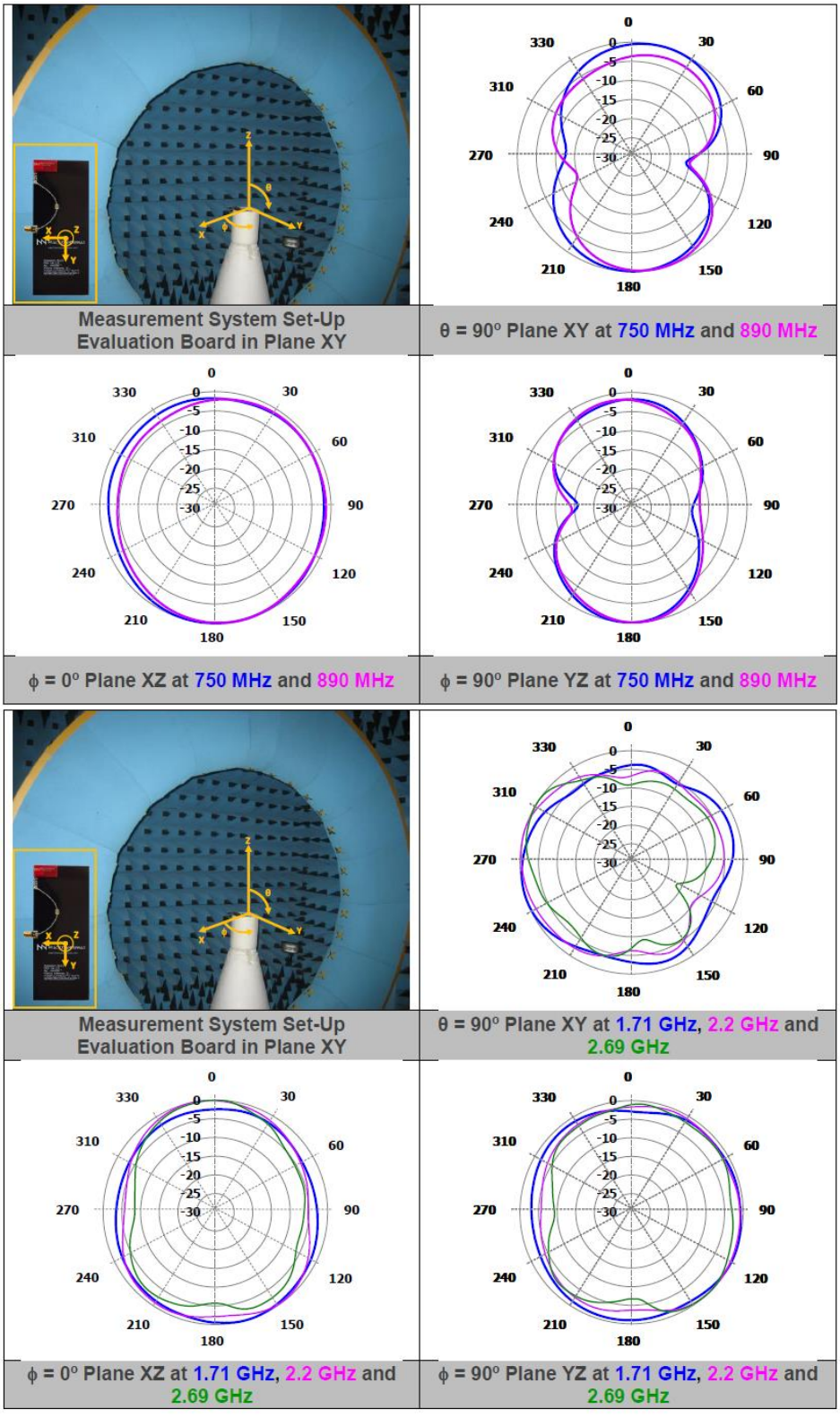


Figure 29: LTE antenna radiation patterns

4. Accessories

4.1 Cigarette lighter cord

An auto cigarette coil cord can be provided for installation of Wirnet™ iFemtoCell-evolution in vehicles.
Wirnet™ iFemtoCell-evolution can be then supplied via the power outlet of the vehicle. The 5.5x2.5mm plug allows direct 12VDC supply of the gateway.

The main characteristics of the cigarette lighter cord are the following:

Item	Specification
Type	Coil cord
LED indicator	Red
Fuse	5A
Voltage	12VDC
Material	ABS
Color	Black
Connector #1	Auto cigarette plug
Connector #2	5.5 x 2.5 mm plug
Length	3.65m (12')

Description of the KLK03371 cord and details of the plugs are presented below:

Figure 30: KLK03371 Cigarette lighter cord

The Kerlink part number is KLK03371.

4.2 Nano Uninterrupted Power Supply

A nano UPS can be provided with Wirnet™ iFemtoCell-evolution providing 4-5 hours autonomy when mains supply fails. This UPS is equipped with Europlug and 5.5x2.1mm plugs but includes a 5.5x2.5mm adapter for Wirnet™ iFemtoCell-evolution usage.

The main characteristics of UPS are the following:

Item	Specification
Input Voltage	100-240 VAC 0.3A MAX
Output voltage	5VDC 2A 6VDC 2A, 9VDC 1.3A 12VDC 1A via switch selector
Input plug	Europlug CEE 7/16
Output plug	5.5x2.1mm
Adapter sockets	5.5x2.5mm 5.5x1.7mm
ON/OFF button	Yes (2s press) + LED
Battery Capacity	6000mAh (3.6V)
Autonomy	4-5 hours
Cell type	Li-Polymer
Battery Charging Cycles	≈500 times
Battery Charging Time	8 hours
Load Protection	>%100 >15 sec
Short Circuit Protection	Yes
Operating temperature range	0°C to +40°C
Dimensions (mm)	120 x 72 x 39 mm
Cord length	1 meter
Weight	265g

The output voltage must be adjusted at 12VDC through the voltage selector on the top of the UPS:

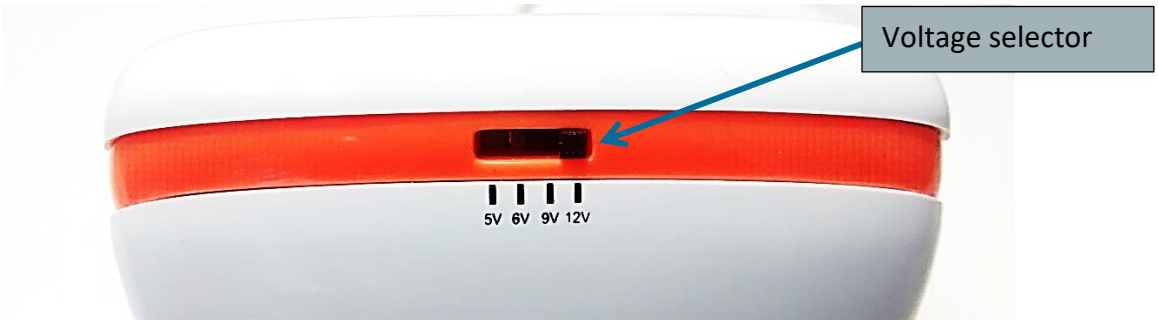


Figure 31: Voltage selector

The UPS, plugs and adapters are detailed below:

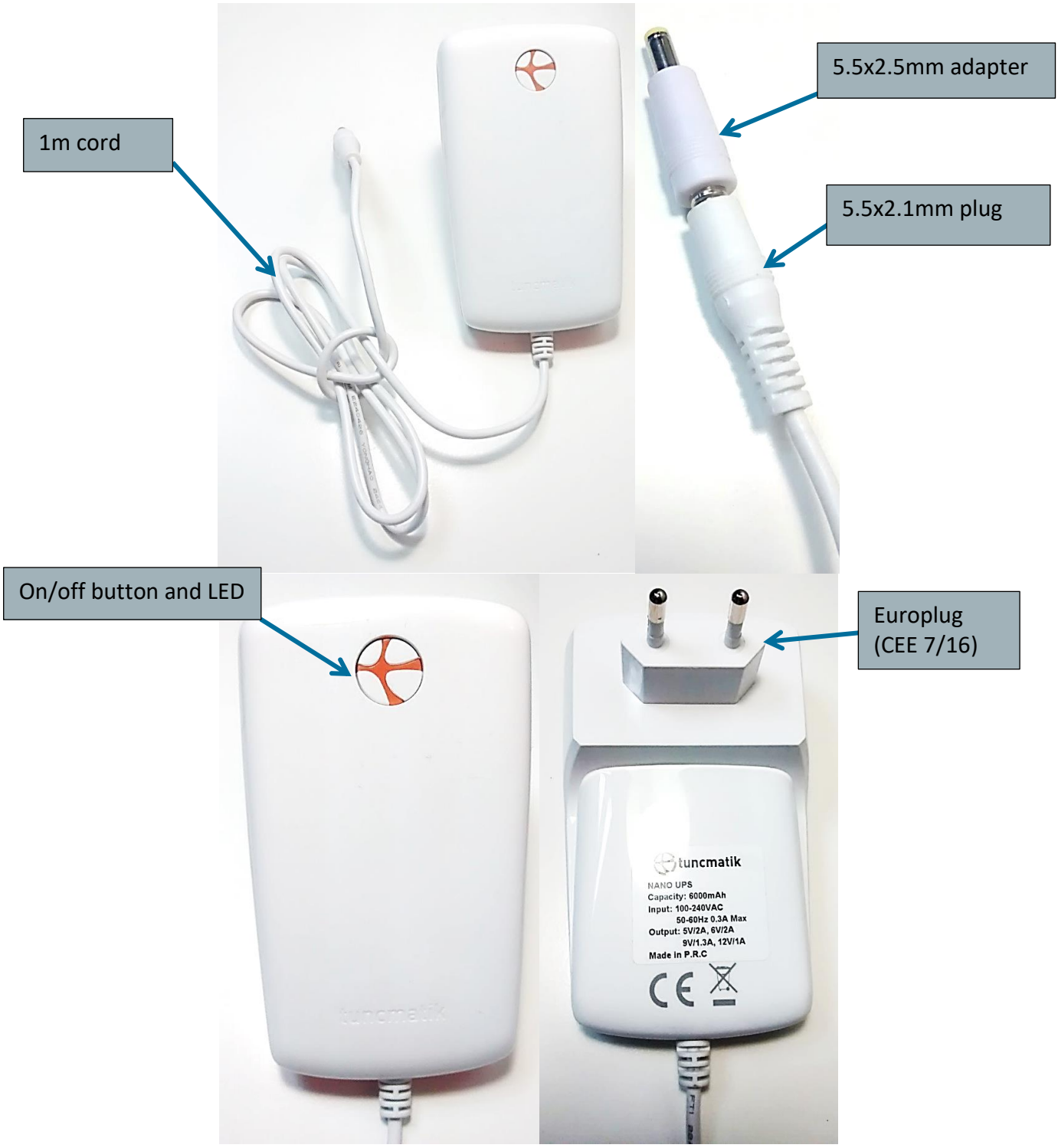


Figure 32: KLK03374 Nano UPS

The Kerlink part number is KLK03374.

4.3 Mini Uninterrupted Power Supply

A "lead-acid" mini industrial UPS can be supplied with Wirnet™ iFemtoCell-evolution providing about 20-24 hours autonomy when mains supply fails. This mini UPS embeds a 12V interchangeable lead-acid battery. It is provided with mains cord and Europlug and 5.5x2.5mm plug for Wirnet™ iFemtoCell-evolution usage.

The main characteristics of mini UPS are the following:

Item	Specification
Material	ABS + PC
Input Voltage	230VAC +/-15%
Output voltage	13.6VDC 5A
Input plug[2]	CEE 7/7 (Europe) BS 1363A (UK) NEMA 5-15P (USA) AS 3112 (Australia) JIS 8303 (Japan) KSC 8305 (Korea) IRAM 2073 (Argentina) NBR 14136 (Brazil) Custom plug could be considered
Output plug	5.5x2.5mm
Battery Capacity	7Ah (12V)
Autonomy	20-24 hours (10.5V, battery recovery)
Cell type	Lead-Acid
Battery Charging Time	24 hours
Short Circuit Protection	Yes (polyswitch)
Signalization	2 LEDs (see description)
Operating temperature range	-10°C to +40°C
Relative humidity	5% to 90%
Dimensions (mm)	240 x 180 x 84 mm
Mains cord length	2.5 meters
DC cord length	1 meter
Weight	3000g (with battery)

The block diagram of the mini UPS is presented below:

[2] To be defined by customer when placing order

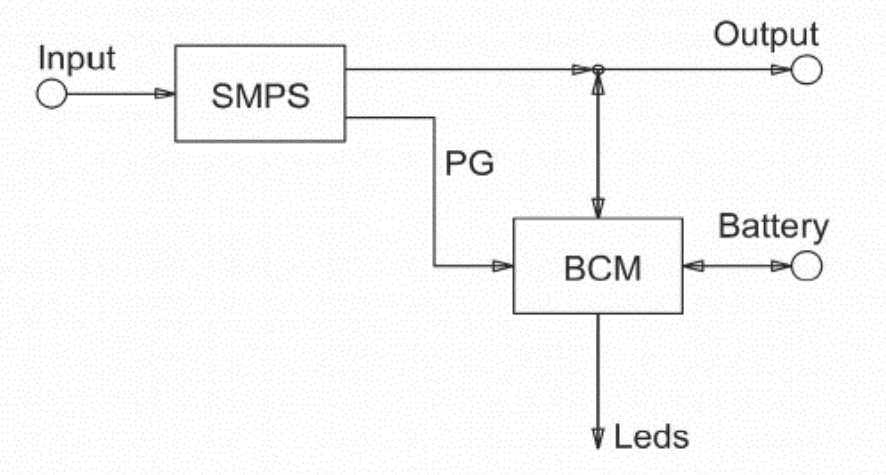


Figure 33: Mini UPS block diagram

The SMPS stage (power stage) is connected directly to the output. The BCM stage (battery management) switches the battery via a relay with two contacts. When the mains voltage is present, the 13.8VDC of the SMPS stage is the main output, while the battery is disconnected but is charged by the BCM stage. When the mains voltage is absent, the battery is connected to the main output, while the SMPS stage is off.
The SMPS stage is a switching mode power supply, whose output can provide 13.8VDC 5A. It is a quasi-resonant flyback converter that improves efficiency and reduces electromagnetic emissions. The adjustment of output is obtained by a V/I regulator, placed on the primary side. It can control both the voltage feedback and the current (maximum). For Iout <Imax the voltage loop has priority; if the device works in overload or short-circuit the current loop is activated and it reduces the output voltage while maintaining the current constant at the value Imax (until about 1/3 of the rated output voltage).

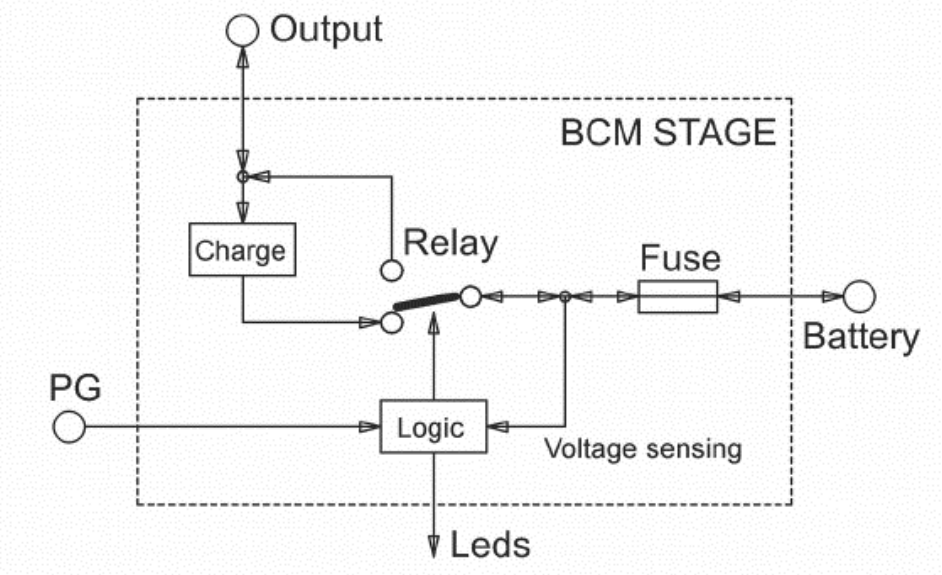


Figure 34: Mini UPS BCM stage block diagram

The BCM stage controls the battery during charging and during operation in the absence of the input mains voltage. During the absence of the supply voltage, the relay connects the battery directly to the main output. The output voltage, therefore, follows the value of the battery voltage (output not stabilized). The following protections are assured:
- Short-circuit and overload by fuse;
- Under-voltage by electronic circuitry, latch type.

In the presence of the supply voltage, the battery is connected to a passive network and is charged with a limited current, the value of which depends on the degree of charge. In the presence of a full discharged battery, the current is about 900mA. The value decreases during the charge until a few mA, while the voltage settles around 13.8V.

The mini UPS and associated cords and plugs are presented below:

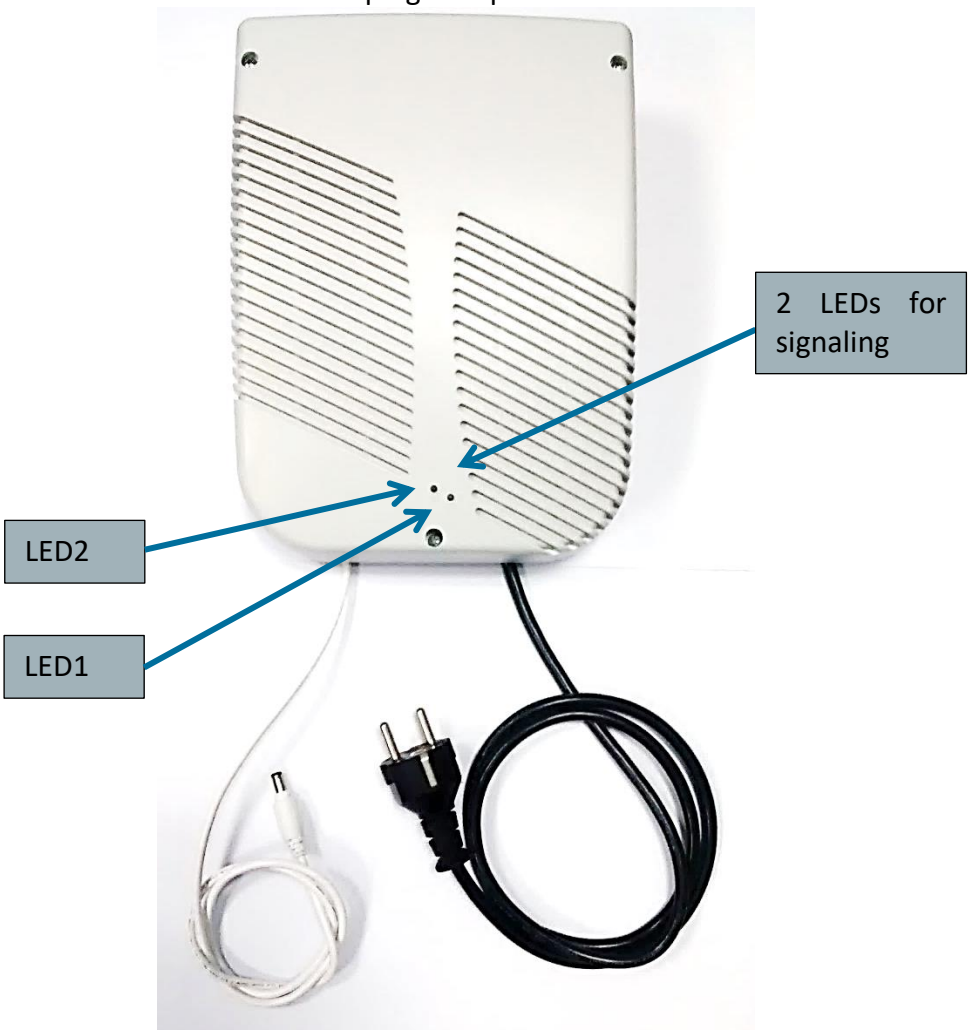


Figure 35: Mini UPS and provided cords and plugs

The Kerlink part number of the UPS (standalone) is KLK03375.
The Kerlink part number of the mains cord is KLK03373.
The Kerlink part number of the DC (jack 2.5x5.5mm) cord is KLK03372.

The Kerlink part number of the Mini UPS kit, including KLK03375, KLK03373 and KLK03372, is ACCIOT-UPS01.

Here is an internal view of the Mini UPS with controller circuit board and lead-acid battery:

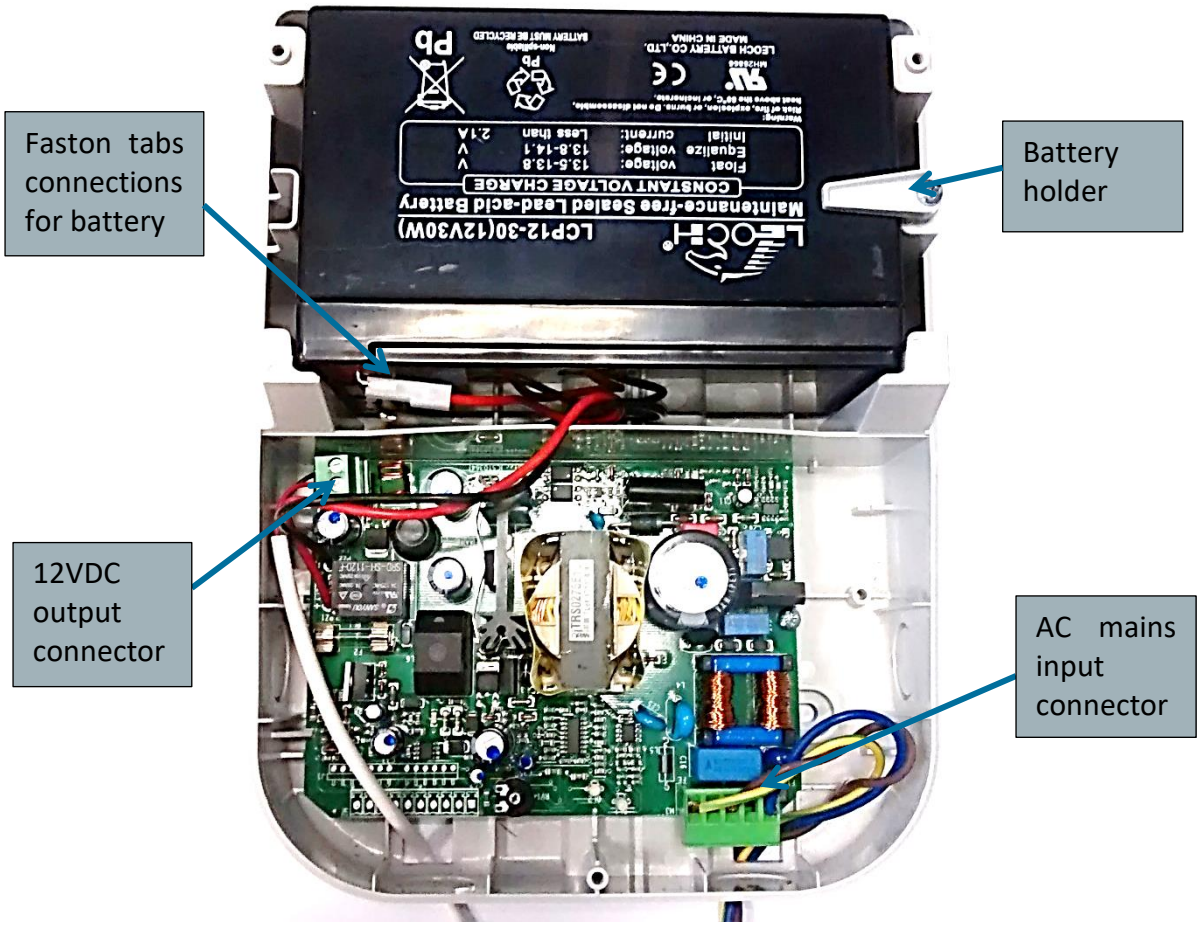


Figure 36: Internal view of Mini UPS

Two LEDs on the front cover are used for signaling as follows:

Signaling	LED1	LED2
AC mains present, Output present	RED	GREEN
AC mains present, Output absent	RED	OFF
AC mains present, Light output overload	RED	OFF
AC mains present, Heavy output overload or short circuit	RED BLINKING	OFF
AC mains absent, Output present	OFF	RED
AC mains absent, Output absent	OFF	OFF

The Mini UPS can be DIN-Rail mounted but also frame mounted. In this case, a fixing set composed of dowels and screws is provided. Regarding the wall mounting, 6 mounting holes are foreseen. For a correct mounting it is enough to use 4 holes: 2 on the upper part of the case and 2 on the lower one.

Figure 37: Rear view of Mini UPS with mounting features

The battery is a sealed rechargeable battery with standard dimensions of 151 x 93.5 x 65 mm. The battery could then easily be replaced to increase duration life of the mini UPS.

The main characteristics of the battery are the following:

Item	Specification
Material	ABS
Nominal Voltage	12VDC
Minimum voltage for battery recovery	10.5VDC
Nominal Capacity	>7Ah
Autonomy	20-24 hours (10.5V, battery recovery)
Cell type	Lead-acid
Battery Charging Current	2A max
Battery Discharge Current	105A max
Internal resistance	25mohms max
Storage capacity loss per month at 20°C	Approx. 3%
Operating temperature range	-10°C to +40°C
Relative humidity	5% to 90%
Dimensions (mm)	151 x 93.5 x 65 mm
Terminals	Faston tabs F1, T1 (4.7mm)
Weight	2500g

An example of battery is provided below:

Figure 38: Details of Mini UPS battery

Be careful: Do not leave the battery connected to the mini UPS when the electrical system is deliberately put into rest conditions (absence of the mains voltage) for a long time. Connect the battery only when it is put into operation. Otherwise, this would result to completely exhaust the battery (deep discharge) and no longer recoverable after about 100-200 hours. The battery would have to be replaced by a new one!

4.4 Wirnet™ Debug Probe

See relevant documentation.

5. Software specifications

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

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

This firmware is focused on main topics listed below:

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

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

End of document