

## INSTALLATION AND MAINTENANCE MANUAL

### WIRNET IFEMTOCELL



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**REFERENCES**

Reference	Document / link	Description
[1]	<a href="https://www.lora-alliance.org/For-Developers/LoRaWANDevelopers">https://www.lora-alliance.org/For-Developers/LoRaWANDevelopers</a>	LoRaWAN™ Specification V1.0.1 February 2016
[2]	E-CON-Product_Description_Wirnet_iFemtocell-V1.0.pdf	WIRNET IFEMTOCELL – PRODUCT DESCRIPTION

**GLOSSARY**

Abbreviation	Description
<b>ADC</b>	Analog to Digital Converter
<b>AES</b>	Advanced Encryption Standard
<b>AGC</b>	Automatic Gain Control
<b>ANATEL</b>	Agência Nacional de Telecomunicações (Brazilian agency of telecommunications)
<b>AP</b>	Access Point
<b>APAC</b>	Asia PACific
<b>APC</b>	Automated Power Control
<b>API</b>	Application Programming Interface
<b>APN</b>	Access Point Name
<b>ARM</b>	Advanced RISC Machine
<b>BER</b>	Bit error Rate
<b>BLER</b>	Block Error rate
<b>BTS</b>	Base Transceiver Station
<b>BW</b>	Band Width
<b>CAN</b>	Control Area Network
<b>CPU</b>	Central Processing Unit
<b>DAC</b>	Digital to Analog Converter
<b>DDR</b>	Double Data Rate
<b>DDRAM</b>	Double Data Rate RAM
<b>DHCP</b>	Dynamic Host Configuration Protocol
<b>DIN</b>	Deutsches Institut für Normung (German Institute for Standardization)
<b>DOTA</b>	Download Over The Air
<b>EDGE</b>	Enhanced Data rates for GSM Evolution
<b>EIRP</b>	Equivalent Isotropically Radiated Power
<b>EMC</b>	ElectroMagnetic Compatibility
<b>eMMC</b>	Embedded Multi Media Card
<b>FCC</b>	Federal Communications Commission
<b>FER</b>	Frame Error Rate
<b>FPGA</b>	Field Programmable Gate Array
<b>FTP</b>	File Transfer Protocol
<b>GMSK</b>	Gaussian Minimum Shift Keying
<b>GPIO</b>	General Purpose Input Output
<b>GPRS</b>	General Packet Radio Service
<b>GPS</b>	Global Positioning System
<b>GSM</b>	Global System for Mobile communication

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<b>HSPA</b>	High Speed Packet Access
<b>HTTP</b>	HyperText Transfer Protocol
<b>IC</b>	Integrated Circuit or Industry Canada
<b>IK</b>	Mechanical Impact
<b>IO</b>	In / Out
<b>IoT</b>	Internet of Things
<b>IP</b>	Internet Protocol or Ingress Protection
<b>ISM</b>	Industrial Scientific and Medical
<b>I2C</b>	Inter Integrated Circuit
<b>KLK</b>	KERLINK
<b>KNET</b>	KERLINK M2M network
<b>LBT</b>	Listen Before Talk
<b>LDO</b>	Low Drop Out
<b>LED</b>	Light-Emitting Diode
<b>LNA</b>	Low Noise Amplifier
<b>LoRa</b>	Long Range
<b>LTE</b>	Long Term Evolution
<b>LUT</b>	Look Up table
<b>M2M</b>	Machine to Machine
<b>MIPS</b>	Millions of Instructions Per Second
<b>MFLOPS</b>	Million Floating-point Operations Per Second
<b>NFS</b>	Network File System
<b>PA</b>	Power Amplifier
<b>PC</b>	Personal Computer or Polycarbonate
<b>PCB</b>	Printed Circuit Board
<b>PCI</b>	Peripheral Component Interconnect
<b>PER</b>	Packet Error Rate
<b>PLL</b>	Phase Locked loop
<b>RAM</b>	Random Access Memory
<b>RF</b>	Radio Frequency
<b>RSSI</b>	Received Signal Strength Indicator
<b>RTC</b>	Real Time Clock
<b>RX</b>	Receive
<b>SAW</b>	Surface Acoustic Wave
<b>SDIO</b>	Secure Digital Input Output
<b>SI</b>	Système d'Information
<b>SIM</b>	Subscriber Identity Module
<b>SMA</b>	SubMiniature version A
<b>SNR</b>	Signal to Noise Ratio

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<b>SPDT</b>	Single Pole Double Throw
<b>SPI</b>	Serial Peripheral Interface bus
<b>SSH</b>	Secure Shell
<b>SSTP</b>	Screened Shielded Twisted Pair
<b>STP</b>	Shielded Twisted Pair
<b>TBD</b>	To Be Defined
<b>TCP</b>	Transmission Control Protocol
<b>TPE</b>	ThermoPlastic Elastomer
<b>TX</b>	Transmit
<b>UART</b>	Universal Asynchronous Receiver Transmitter
<b>UFL</b>	Miniature coaxial RF connector manufactured by Hirose Electric Group
<b>UICC</b>	Universal Integrated Circuit Card
<b>UMTS</b>	Universal Mobile Telecommunications System
<b>USB</b>	Universal Serial Bus
<b>USIM</b>	Universal Subscriber Identity Module
<b>UV</b>	UltraViolet
<b>WAN</b>	Wide Area Network
<b>WLAN</b>	Wireless Local Area Network
<b>WPS</b>	Wi-Fi Protected Setup
<b>3G</b>	Third generation of mobile telecommunications technology
<b>3GPP</b>	3rd Generation Partnership Project
<b>4G</b>	Fourth generation of mobile telecommunications technology

**INTRODUCTION**

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

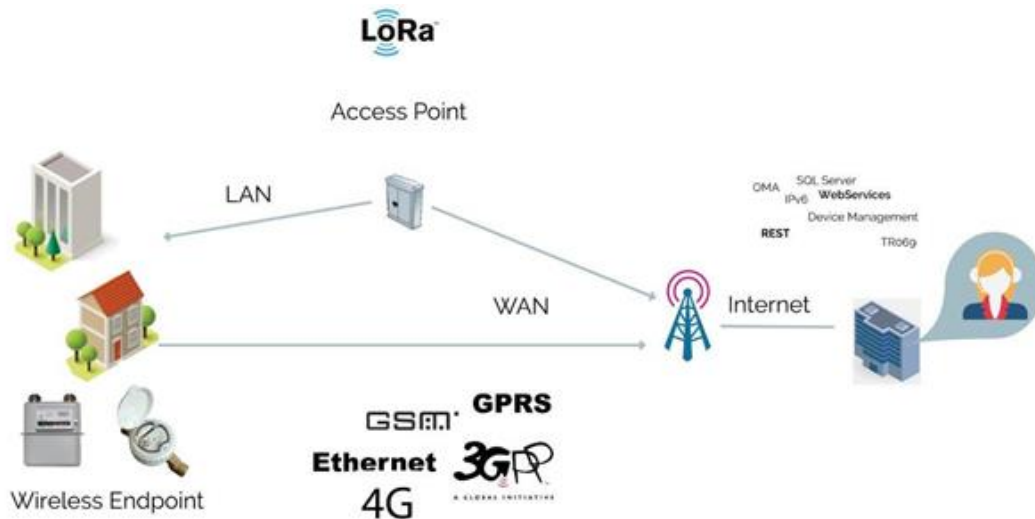


Figure 1: LoRa network topology

The Wirnet iFemtocell is based on “LoRa” technology provided by Semtech Company. It is compatible and interoperable with existing LoRa LPWAN.

Wirnet iFemtocell is declined into three versions to cover different countries and areas around the world:

	Wirnet iFemtoCell 868	Wirnet iFemtoCell 915 Please refer to Product Description reference [2] for availability and roadmap	Wirnet iFemtoCell 923 Please refer to Product Description reference [2] for availability and roadmap
<i>Geographical area</i>	Europe, Russia Africa Middle East, India	North America Central America South America with the exception of Brazil	Asia : Indonesia, Malaysia, Korea, Japan, Taiwan, Hong Kong, Thailand, Vietnam, Papua New Guinea, Singapore, Philippines Oceania : Australia, New Zealand Brazil
<i>ISM band</i>	863 - 876 MHz	902 - 928 MHz	915 - 928 MHz
<i>Downstream bandwidth (Tx of the LoRa IoT Station)</i>	863 - 873MHz	902 - 928 MHz	920 - 928 MHz
<i>Upstream bandwidth (Rx of the LoRa IoT Station)</i>	863 - 873 MHz	902 - 928 MHz	915 - 928 MHz
<i>Certifications</i>	EN 300 220	FCC and IC CB scheme for : Mexico, Argentina, Chile, Bolivia, Colombia, Venezuela, Uruguay, Peru, Ecuador	FCC and EN 300 220 CB scheme for : for Japan, Korea, Australia, Singapore, Indonesia, New-Zealand, Brazil

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

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## 1. Description of the Wirnet iFemtocell



Figure 2: Wirnet iFemtocell product

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## 1.1 Main functionalities

Here are the main functionalities of the Wirnet iFemtocell product:

- LongRange support:
  - Incorporate LoRa (TM) bidirectional communications technology:
    - 868 version => RX: 863- 873MHz , TX: 863-873MHz (according to HW capabilities)
    - 915 version => 902-928 MHz ISM (according to HW capabilities)  
*Please refer to Product Description reference [2][2] [2][2]for availability and roadmap*
    - 923 version => RX: 915-928 MHz, TX: 920-928MHz (according to HW capabilities)  
*Please refer to Product Description reference [2][2] [2][2]for availability and roadmap*
  - 49 LoRa demodulators over 9 channels + 1 x GFSK
- Embedded, remote and open low power communication station
- Open development framework based on standard Linux OS
- WAN connectivity over Wi-Fi, Ethernet or LTE/HSPA/GPRS (with USB dongle)
- USB host interface allowing:
  - Local software upgrade with simple USB mass-storage key

## 1.2 Hardware specifications

### 1.2.1 Design overview

The Wirnet iFemtocell is built on a plastic casing of around 160 x 90 x 35 mm. The following pictures show the casing:

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Figure 3: Design overview

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### 1.2.2 Casing assembly

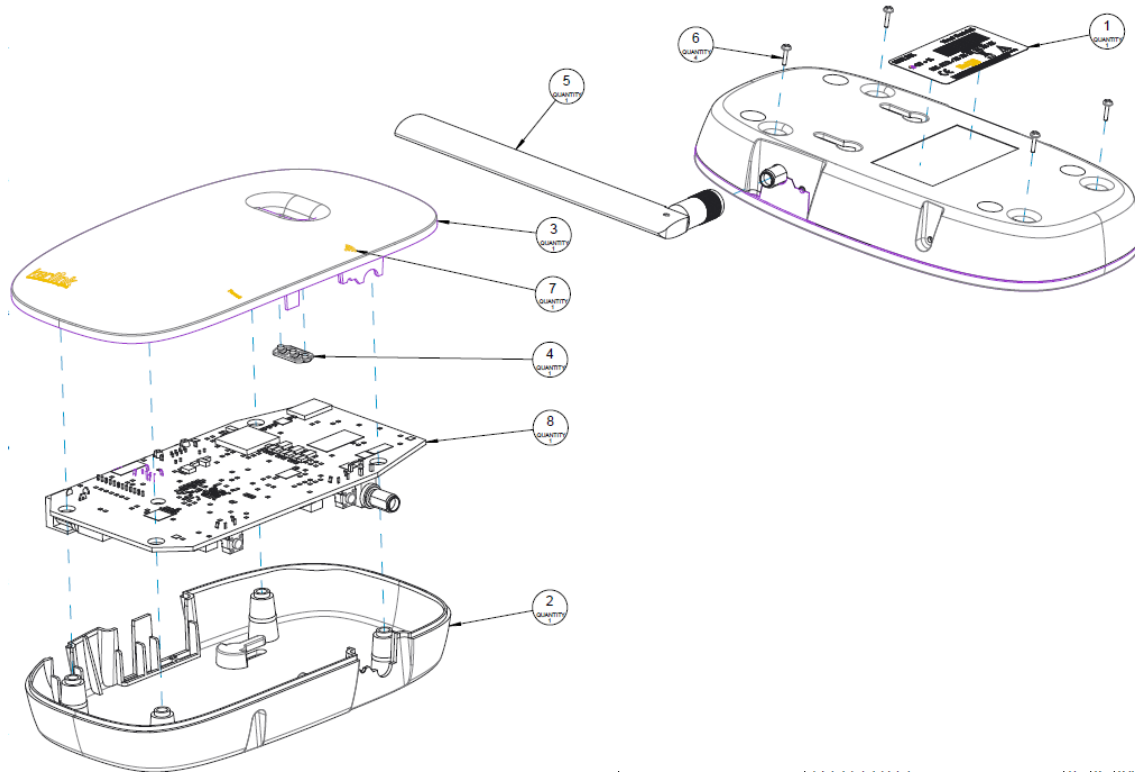


Figure 4: Casing assembly

### 1.2.3 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 35 mm
Dimensions with LoRa antenna	220 x 125 x 35 mm
Weight with AC power supply and LoRa Antenna	280g
Ingress protection	IP31 / EN 60529
Humidity	95% non-condensing
Impact resistance	IK07
Flammability rating	UL94-V0
Wirnet iFemtocell casing operating temperature range	-20°C to +55°C

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**Connectors**

- 1 x SMA (LoRa antenna)
- 1 jack connector (power supply)
- 1 x USB
- 1 x RJ45

*1.2.4 Casing dimensions*

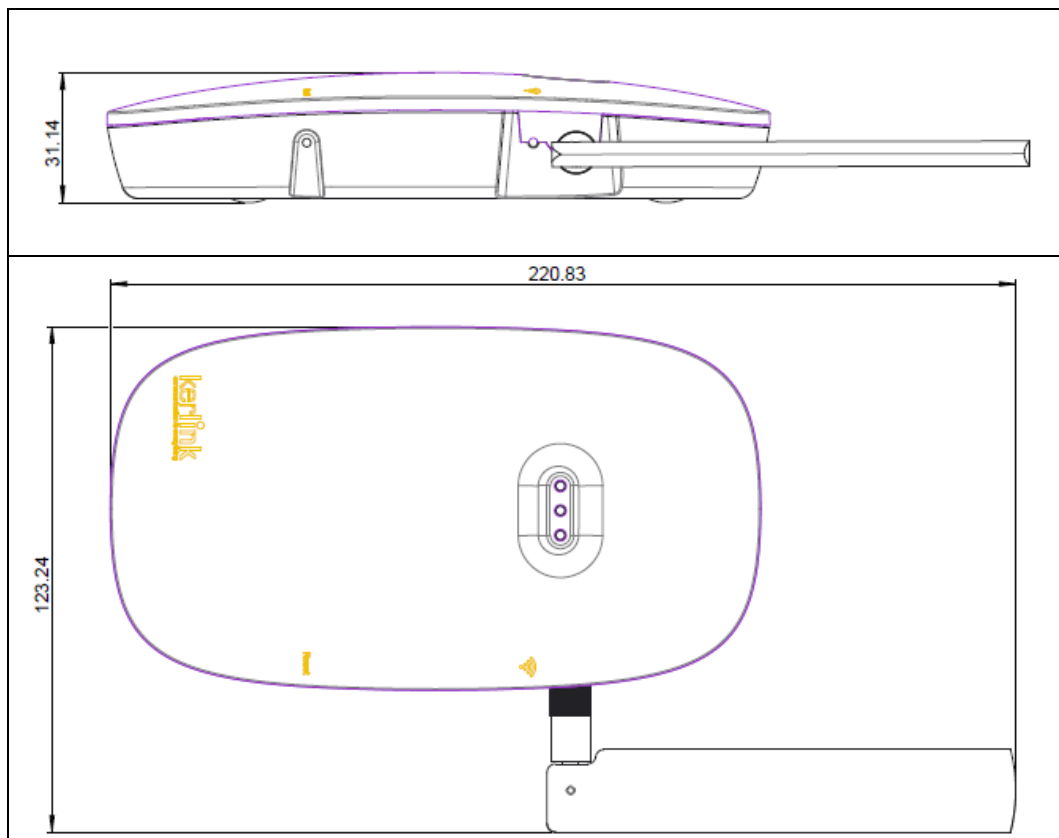
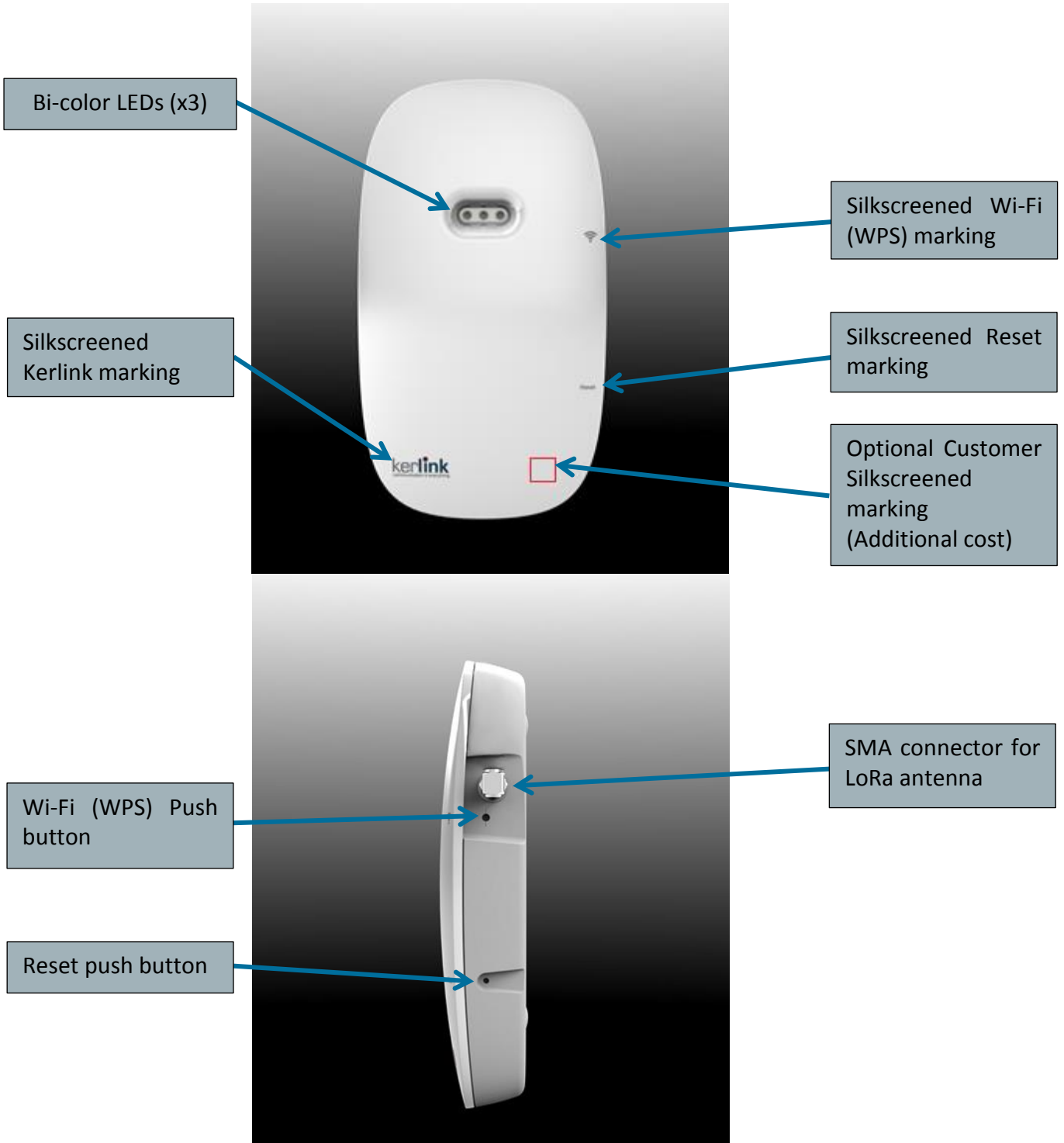


Figure 5: Casing dimensions

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1.2.5 Brief description



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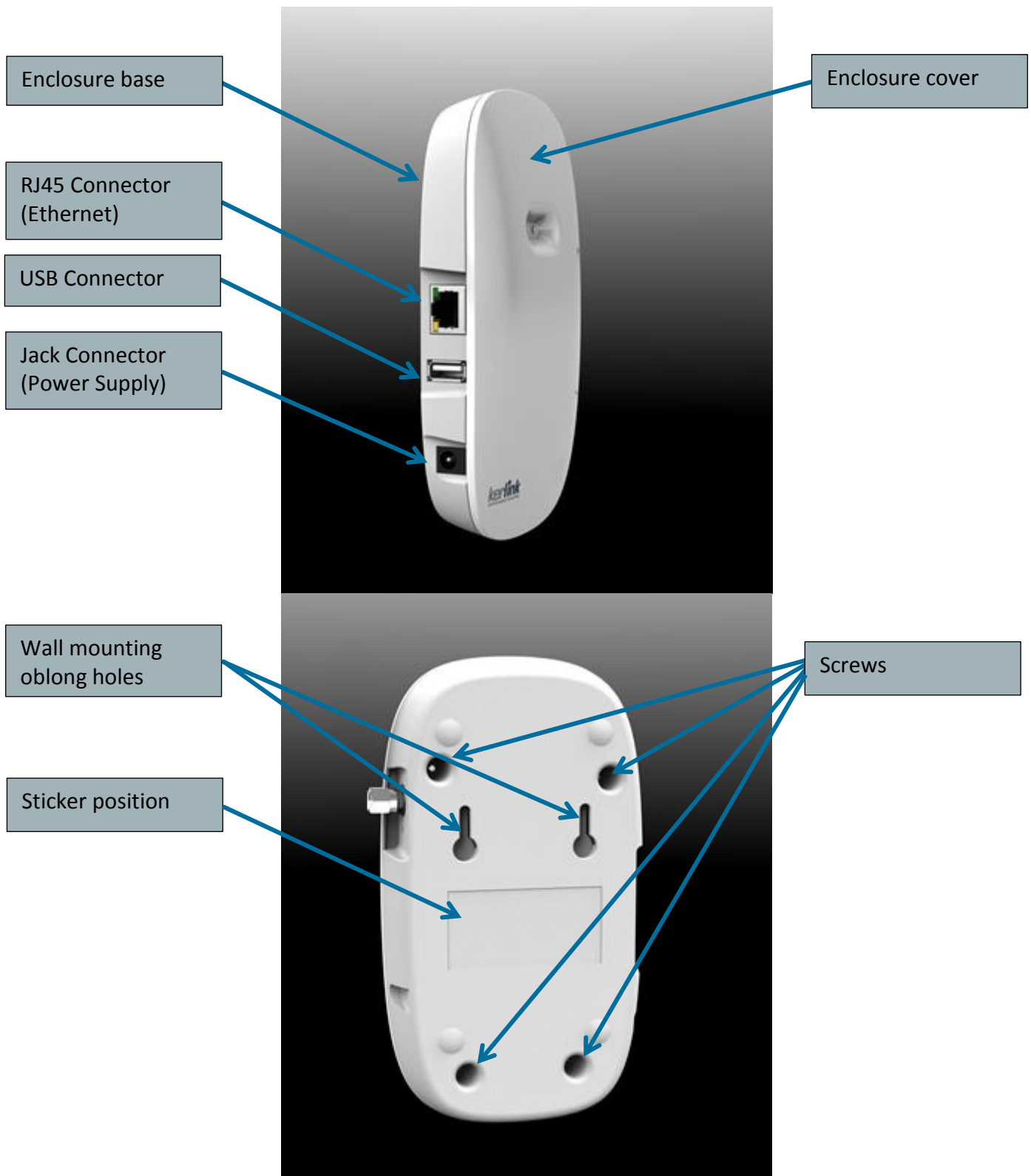


Figure 6: Casing description

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**1.2.6 Block diagram**

The block diagram below depicts the HW architecture of the Wirnet iFemtocell:

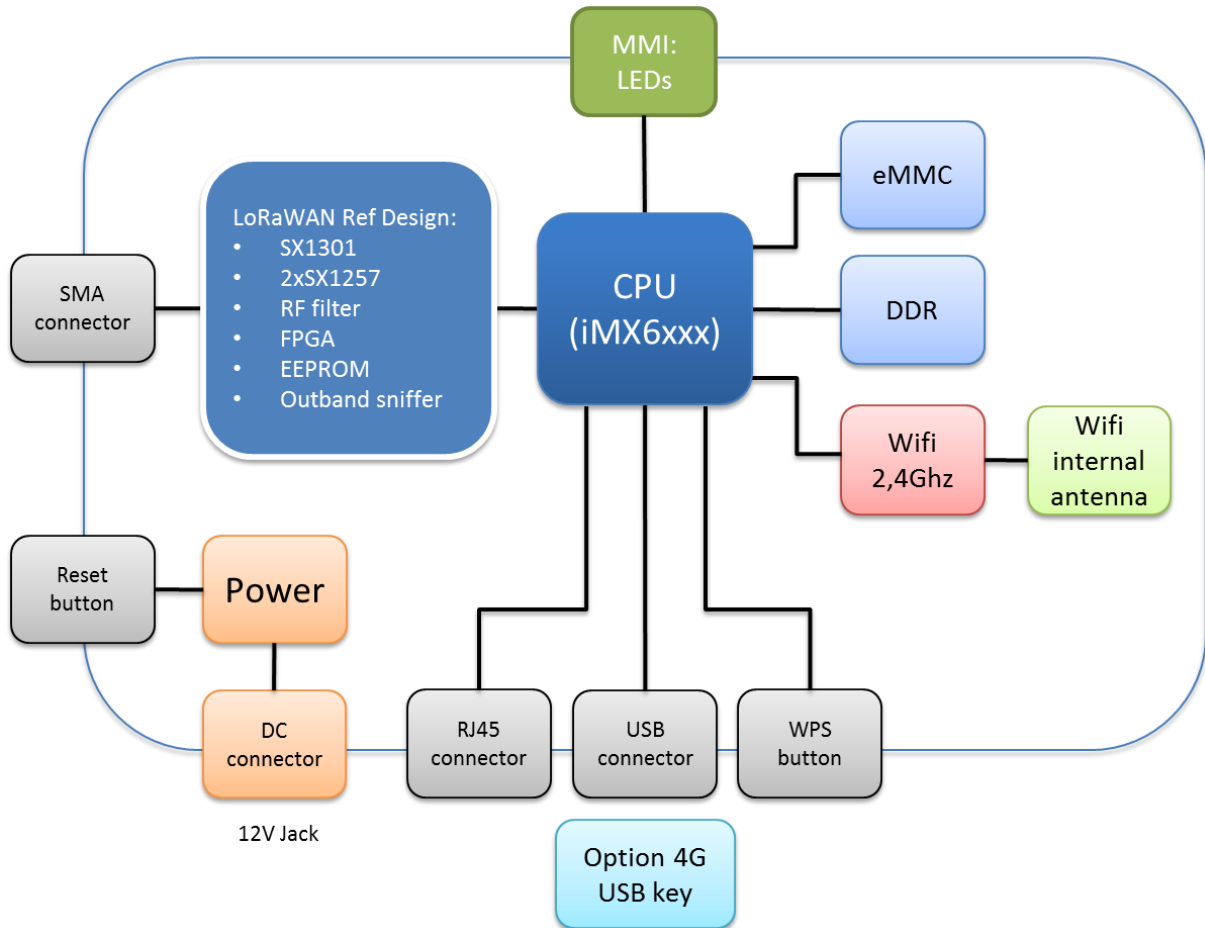


Figure 7: Hardware block diagram

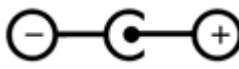
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Feature	Description
<b>Processor</b>	ARM Cortex A9, 800MHz core
<b>Memories</b>	256MB DDRAM – Volatile memory 8GB eMMC– Non-volatile memory
<b>Watchdog</b>	Hardware type
<b>Security</b>	Secure core Information encryption Secure Boot Secure software download
<b>RTC</b>	RTC clock (no back-up battery)
<b>Power</b>	External AC/DC – 12V/500mA Jack 2.5mm/5.5mm Integrated power management unit in CPU
<b>Ethernet</b>	10/100 Base-T 1 x RJ45 with activity LEDs
<b>USB</b>	USB Host HS type A 4G key or firmware upgrade & debug usage
<b>WLAN</b>	Wi-Fi chipset 2.4GHz 802.11 abgn Client and AP modes Internal Wi-Fi Antenna WPS button
<b>LoRa Radio</b>	Semtech Sx1301 + SX1257x2 + FPGA + EEPROM TX power 27dBm Outband radio sniffer RF external antenna (SMA connector) 3 versions of radio filter: 868 MHz 923 MHz 915 MHz
<b>DEBUG</b>	UART interface only available inside enclosure Loss of warranty if enclosure is opened Optional Debug tool to be used for UART to USB adaptation
<b>Auto test</b>	Internal power supplies check Interfaces and peripherals check
<b>User interface</b>	LED 1: Power LED 2: Backhaul connection LED 3: LoRa usage (Tx/Rx) Reset button
<b>Operating temperature range</b>	-20 to +55°C (Electronics board, casing, Antenna, excluding AC/DC power supply) 0 to 40°C (whole product with CUI Inc – SMI6 – AC/DC Power Supply) Additional AC/DC Power Supply solutions with extended temperature range are under study

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### 1.3 Power Supply

The power supply characteristics are detailed in the following table:

Description	Specification
Reference	CUI Inc – SMI6
Output Power	6 Watts (Guaranteed)
Output Voltage	12 VDC
Input Power Requirements	AC Input Voltage: 90 to 264 VAC AC Input Current: 0.3A @90-264VAC AC Frequency: 47 to 63 Hz
Dimensions	40.5 mm (W) x 30 mm (H) x 64 mm (L)
Weight	70g
Connectors	Jack 2.5mm/5.5mm
Polarity	 Positive polarity
Operating Ambient Temperature	0°C to +40°C @ 6W
Operating Humidity	Maximum 80%, Non-condensing
Storage Temperature	-10°C to +70°C
Storage Humidity	Maximum 90%, Non-condensing
Cable length	1.5 meters
Regulatory compliance	RoHS CE Limited Power Source recognised
Electromagnetic Emission & Immunity	FCC Part 15, Class B EN 55022 Class B (Emissions) EN 55024 (Immunity)
Safety Approvals	IEC 60950-1

**Note 1:** This power supply is intended for indoor applications only.

**Note 2:** Additional AC/DC Power Supply solutions with extended temperature range are under study.

### 1.4 Power consumption

The maximum power consumption is detailed hereafter:

Wirnet iFemtocell	Power consumption
CPU module (20% load), Ethernet link ON	1.3W max
Wi-Fi (25%Tx,75%Rx)	0.5W max
USB WAN dongle (HSPA, 25% Tx, 75% Rx)	1W max
Radio in Rx mode (x8 demodulator on)	1.6W max

**Note:** The power supply of the Wirnet iFemtocell must be a limited power source.

### 1.5 Omnidirectional LoRa antenna



Figure 8: LoRa antenna

The specifications of the omnidirectional 3dBi antenna are the following:

Item	Specification
Frequency range	862/873MHz , 902-928MHZ
Impedance	50 ohms
Technology	Dipole
VSWR	<1.7:1
Max gain	3dBi
Polarization	Vertical
Whip material	ABS
Color	White
Connector (Wirnet iFemtocell 868 & 923)	SMA
Connector (Wirnet iFemtocell 915)	RP-SMA

Size	135x20mm
Weight	15g
Antenna operating temperature range	-20°C to +55°C

### 1.5.1 Return loss

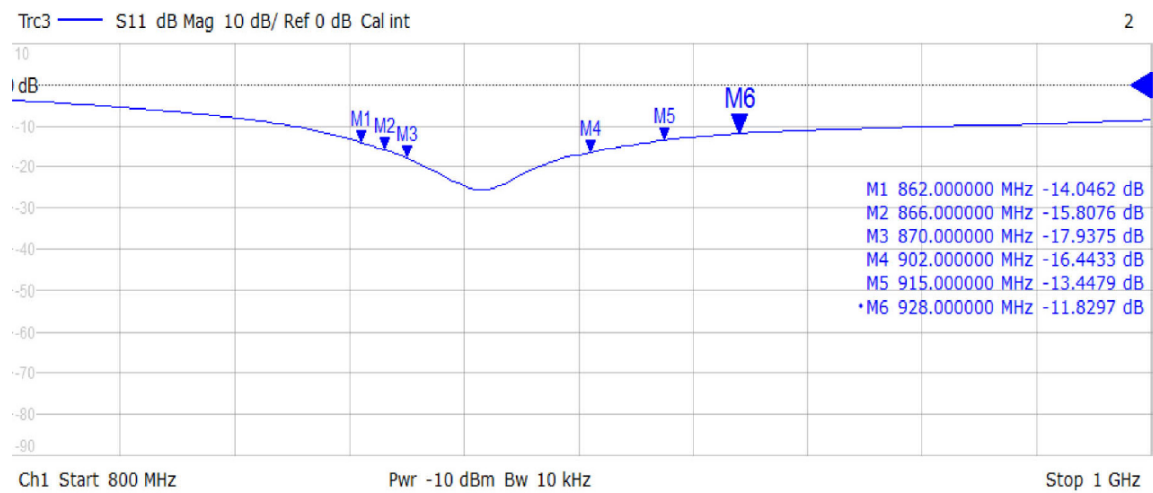


Figure 9: LoRa antenna return loss

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1.5.2 Radiation patterns

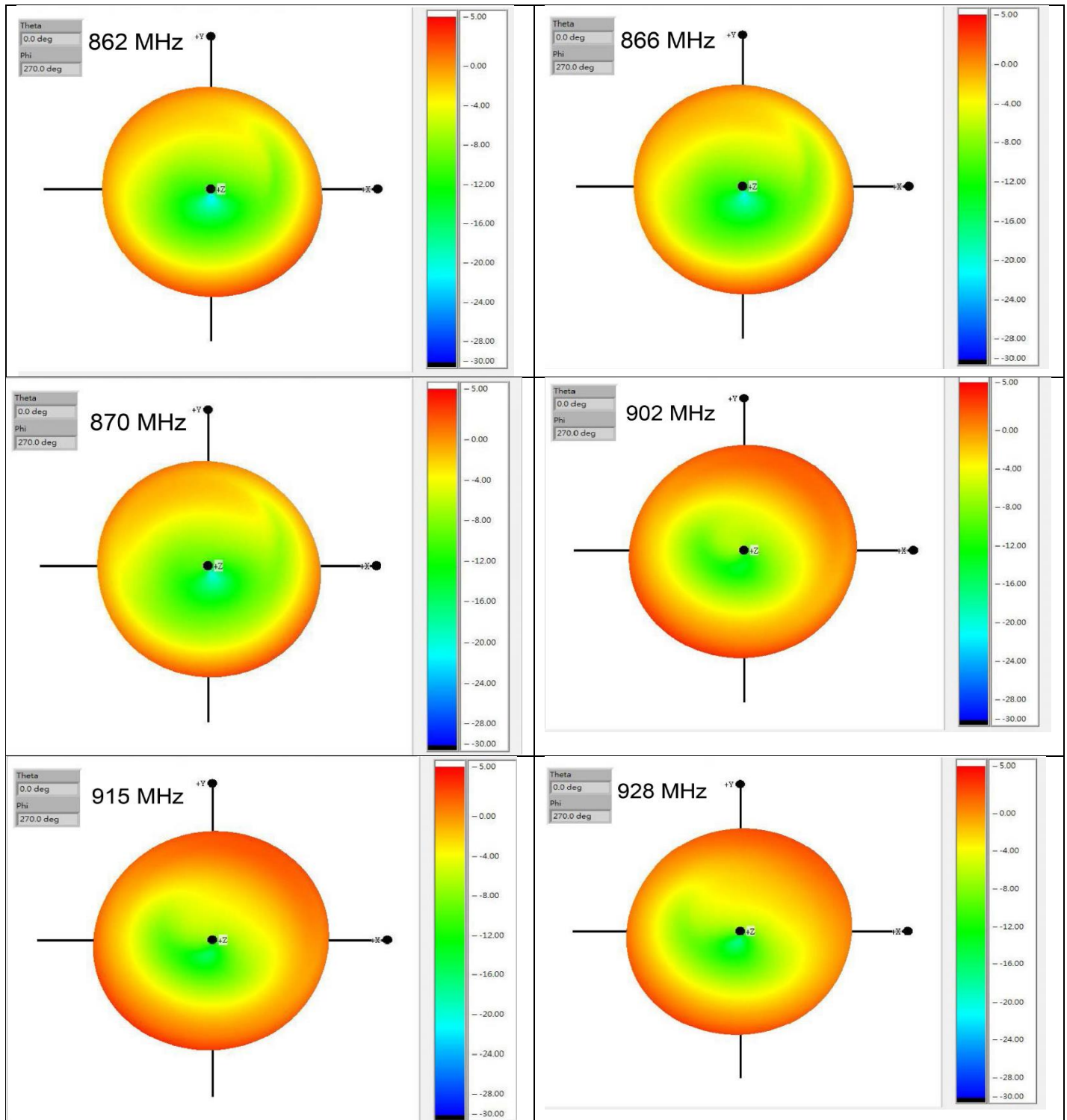


Figure 10: LoRa antenna radiation patterns

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## 1.6 Internal Wi-Fi antenna

The specifications of the omnidirectional 3dBi antenna are the following:

Item	Specification
Frequency range	2400-2483.5MHz
Impedance	50 ohms
Technology	Ceramic chip antenna
VSWR	<2.3:1
Max gain	3dBi
Antenna operating temperature range	-20°C to +55°C

### 1.6.1 Return loss

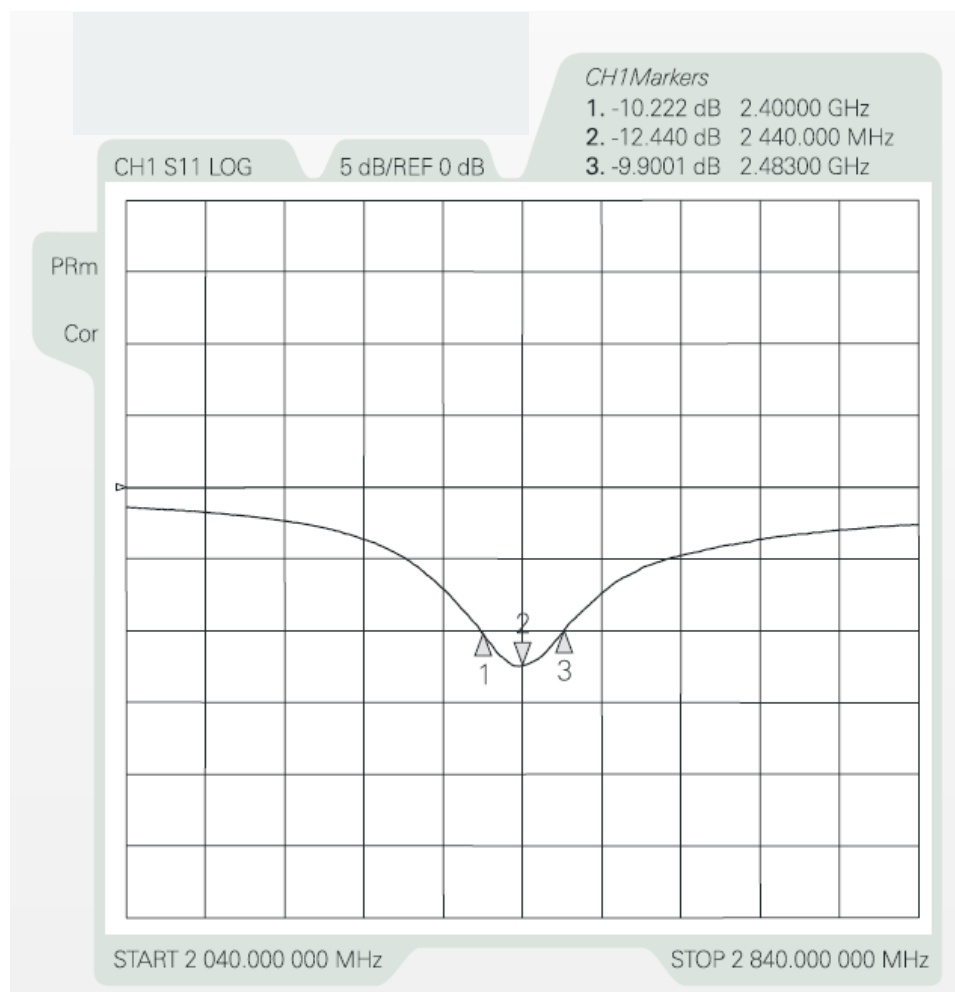


Figure 11: Wi-Fi antenna return loss

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1.6.2 Radiation patterns

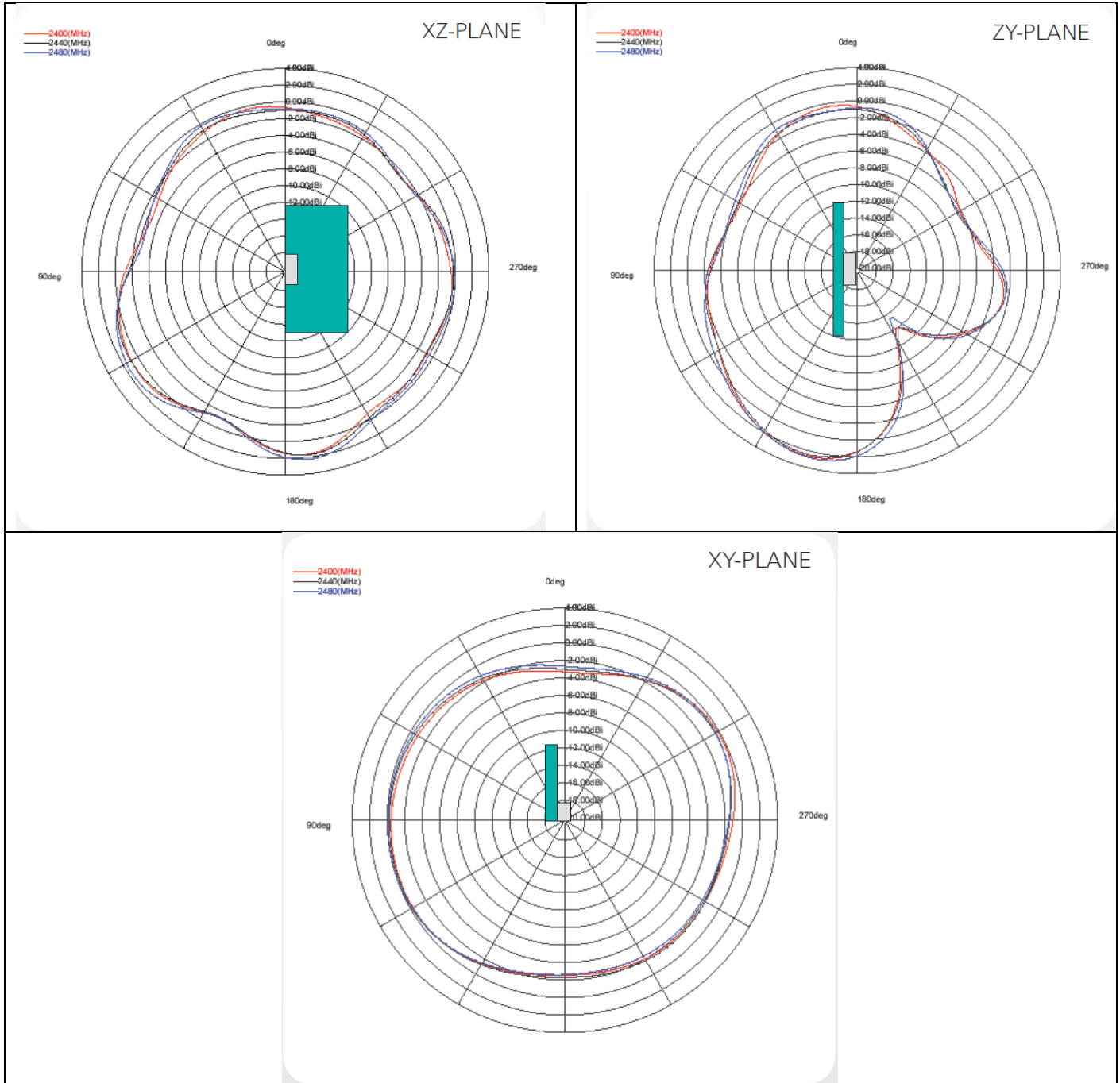


Figure 12: Wi-Fi antenna radiation patterns

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## 1.7 LEDs description



Figure 13: LEDs

The Wirnet iFemtocell owns 3 bi-color LEDs:

Item	Specification
<b>LED 1: Power</b>	Red blinking during the kernel boot Green blinking during system boot Green when boot is finished
<b>LED 2: Backhaul</b>	Red during boot Red if PacketForwarder is disconnected Green blinking during PacketForwarder connection Green fix if PacketForwarder is connected
<b>LED 3: LoRa traffic</b>	Red during boot PacketForwarder management Rx: green blinking Tx: red blinking

## 1.8 Push buttons

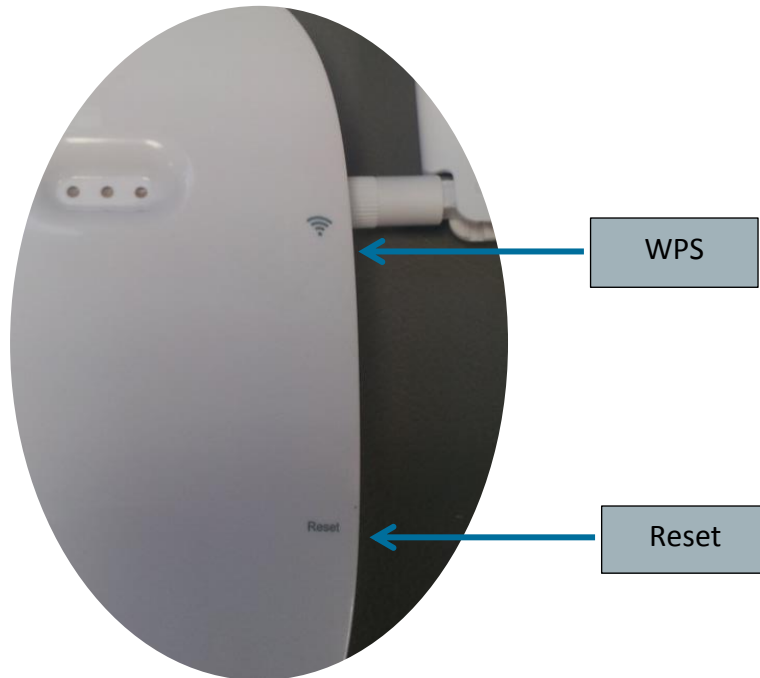


Figure 14: Push buttons

To press the buttons, a tool with a 1mm diameter must be used:



Figure 15: Push button tool

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### 1.8.1 Reset push button

The reset push button must be pressed during 1s to generate a hard reset of the product.

### 1.8.2 WPS

Wi-Fi Protected Setup (WPS) is a standard used to establish a secure connection between equipment and a Wi-Fi access point.

The principle is to press the WPS button on the Wirnet iFemtocell and on the Wi-Fi access point to get the connection.

## 1.9 Sticker



Figure 16: Sticker

The Wirnet iFemtocell own one sticker placed on the rear side of the casing. This sticker includes serial number, MAC address, regulatory markings and electrical information.

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### 1.10 Wall Mounting

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



Figure 17: Wall mounting

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

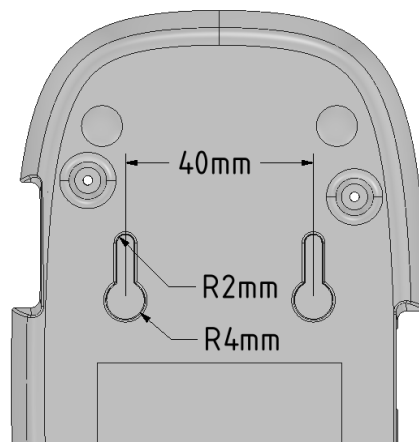


Figure 18: Wall mounting dimensions

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## 1.11 Radio specifications

### 1.11.1 Main characteristics

Feature	Description
<b>LoRa demodulator</b>	Based on SX1301 digital signal processing engine from Semtech Emulates 49 x LORA demodulators and 1 x (G)FSK demodulator per SX1301: <ul style="list-style-type: none"> <li>• 8 x LoRa demodulator at dynamic data rate with 125KHz BW</li> <li>• 1 x LoRa demodulator at fixed data rate</li> <li>• 1 x (G) FSK demodulator</li> </ul> Dynamic data-rate (DDR) adaptation Detect simultaneously 8 preambles corresponding to all data rates (Spreading Factor) at LoRa 125KHz BW 2MHz baseband BW
<b>Transceiver</b>	Based on Semtech SX1257 862MHz to 960MHz frequency range 250 kHz to 750KHz channel BW +8dBm typ. output power 10dB output power control range 128dBc/Hz Signal to Noise performance at 10MHz offset Receiver Noise Figure of 7 dB (External LNA Noise Figure of 0.7dB) -25dBm IIP3 at max gain Independent automatic gain control
<b>Sniffer</b>	Based on Semtech chipset 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
<b>External LNA</b>	Noise Figure of 0.7dB Gain 18dB at 900MHz 38dBm IIP3 at max gain
<b>External PA</b>	Maximum input power: 10dBm Maximum Output power: 27dBm Small signal gain: 32dB

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### 1.11.2 Radio front-end block diagram

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

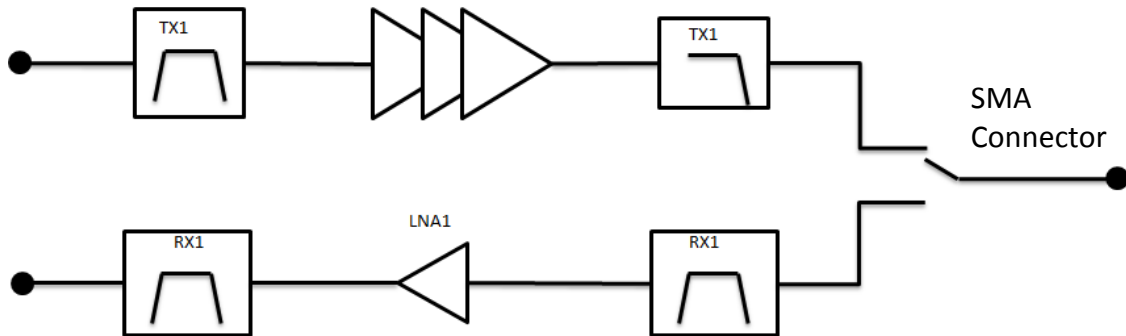


Figure 19: Front-end block diagram

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

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

- 868MHz (863-873MHz)
- 915MHz (902-928MHz)  
*Please refer to Product Description reference [2][2] [2][2]for availability and roadmap*
- 923MHz (915-928MHz)  
*Please refer to Product Description reference [2][2] [2][2]for availability and roadmap*

The details of the frequency bands, channelization, out of band rejection are detailed in §1.11.4.

### 1.11.3 Modulations and data rates

The Wirnet iFemtocell supports the following modulation schemes:

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

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

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

#### 1.11.4 Frequency bands and channelization

The frequency bands covered by the Wirnet iFemtocell depends on the version 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 iFemtocell)	863MHz / 873MHz
868	Downstream (TX Wirnet iFemtocell)	863MHz / 873MHz
915	Upstream (RX Wirnet iFemtocell)	902MHz / 928MHz
915	Downstream (TX Wirnet iFemtocell)	902MHz / 928MHz
923	Upstream (RX Wirnet iFemtocell)	915MHz / 928MHz
923	Downstream (TX Wirnet iFemtocell)	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 iFemtocell)	902,3+i*0,2MHz (i=0 à 63)	125	64	200
915	Upstream (RX Wirnet iFemtocell)	903,0+i*1.6MHz (i=0 à 7)	500	8	600
915	Downstream	923,3+i*0.6MHz (i=0 à 7)	500	8	600

	(TX Wirnet iFemtocell))				
<b>923</b>	Upstream (RX Wirnet iFemtocell))	915,2+i*0,2MHz (i= 0 à 63)	125	64	200
<b>923</b>	Upstream (RX Wirnet iFemtocell))	915,9+i*1.6MHz (i=0 à 7)	500	8	600
<b>923</b>	Downstream (TX Wirnet iFemtocell))	919,8+i*0,2MHz (i= 0 à 40)	125	41	200
<b>923</b>	Downstream (TX Wirnet iFemtocell))	920,3+i*0.6MHz (i=0 à 12)	500	13	600
<b>868</b>	Upstream (RX Wirnet iFemtocell))	863,1+i*0,2MHz (i= 0 à 27)	125	28	200
<b>868</b>	Downstream (TX Wirnet iFemtocell))	863,1+i*0,2MHz (i= 0 à 27)	125	28	200
<b>868</b>	Upstream (RX Wirnet iFemtocell))	868,9+i*0,2MHz (i= 0 à 1)	125	2	200
<b>868</b>	Downstream (TX Wirnet iFemtocell))	868,9+i*0,2MHz (i= 0 à 1)	125	2	200
<b>868</b>	Upstream (RX Wirnet iFemtocell))	869,525MHz	125	1	250
<b>868</b>	Downstream (TX Wirnet iFemtocell))	869,525MHz	125	1	250
<b>868</b>	Upstream (RX Wirnet iFemtocell))	869,850MHz	125	1	300
<b>868</b>	Downstream (TX Wirnet iFemtocell))	869,850MHz	125	1	300
<b>868</b>	Upstream (RX Wirnet iFemtocell))	870,1+i*0,2MHz (i= 0 à 14)	125	15	200
<b>868</b>	Downstream (TX Wirnet iFemtocell))	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.

### 1.11.5 Output Power

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

Description	Specification
Conducted output power range	0dBm to +27dBm
Ripple in the band	+/- 2dB
Variation over temperature range (-20°C to +55°C)	+/- 3dB

### 1.11.6 Out of band emissions

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

The performances are summarized in the following table:

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

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.

### 1.11.7 Sensitivity

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

Mode	868MHz	915MHz	923MHz
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SF7/125KHz	-127dBm	-127dBm	-126dBm
SF10/125KHz	-133dBm	-133dBm	-132dBm
SF12/125KHz	-141dBm	-141dBm	-140dBm
SF7/250KHz	-124dBm	-124dBm	-123dBm
SF12/250KHz	-136dBm	-136dBm	-135dBm
SF7/500KHz	-121dBm	-121dBm	-120dBm
SF12/500KHz	-133dBm	-133dBm	-132dBm

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

Description	Specification
Sensitivity variation over the band	+/- 2dB
Sensitivity variation over temperature range (-20°C to +60°C)	+/- 1dB

### 1.11.8 RSSI and SNR

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

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

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

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

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

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

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

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

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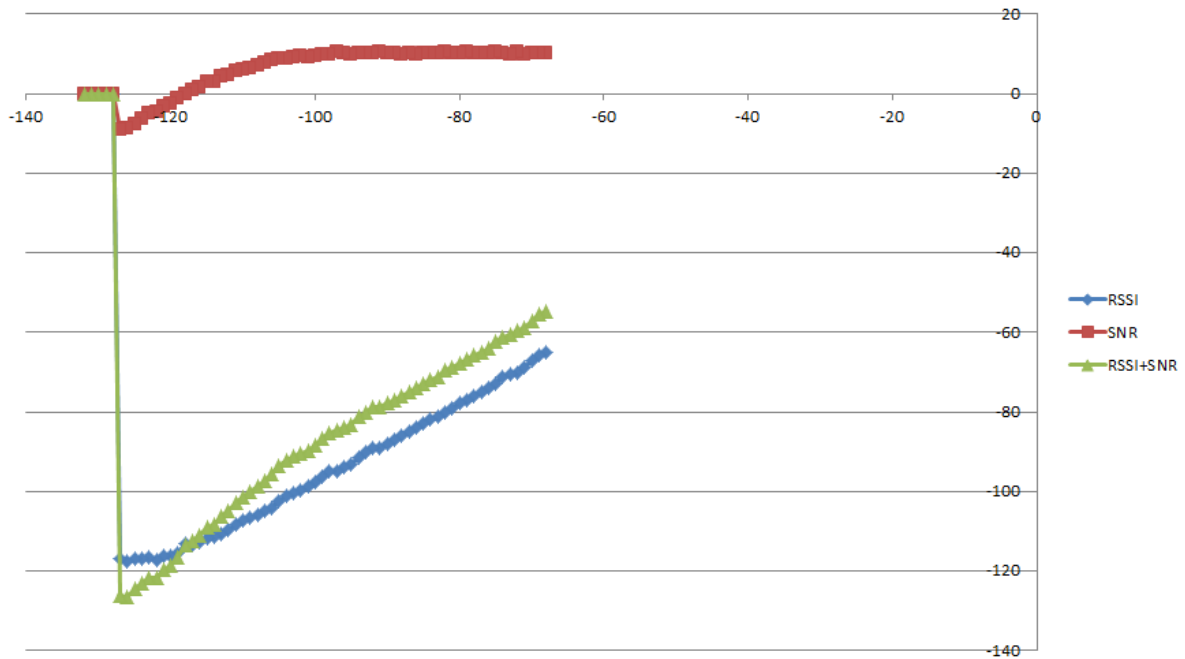


Figure 20: Example of SNR, RSSI and RSSI+SNR plots at 125KHz BW / SF7

### 1.11.9 Out of band blockers rejection

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

#### 1.11.9.1 868MHz

The useful signal is adjusted at 869.525MHz.

The blockers rejections, at different SF are the following:

Offset	SF7/125KHz	SF10/125KHz	SF12/125KHz
+2MHz	-47dBm (79dB)	-	-
-2MHz	-48dBm (78dB)	-	-
+10MHz	-15dBm (111dB)	-	-
-10MHz	-40dBm (86dB)	-	-
821MHz	-14dBm (112dB)	-	-
880MHz	-15dBm (111dB)	-	-
935MHz	-	-	-
960MHz	-	-	-

1.11.9.2 915MHz

*- Please refer to Product Description reference [2][2] [2][2] for availability and roadmap -*

The useful signal is adjusted at 915MHz.

The **expecting** blockers rejections, at different SF, are the following:

Offset	SF7/125KHz	SF10/125KHz	SF12/125KHz
+2MHz	-49dBm (77dB)	-44dBm (86dB)	-46dBm (92dB)
-2MHz	-49dBm (77dB)	-44dBm (86dB)	-46dBm (92dB)
+10MHz	-35dBm (91dB)	-33dBm (97dB)	-33dBm (105dB)
-10MHz	-38dBm (91dB)	-36dBm (94dB)	-36dBm (102dB)
850MHz	-12dBm (114dB)	-12dBm (118dB)	-13dBm (125dB)
894MHz	-15dBm (111dB)	-15dBm (115dB)	-15dBm (123dB)
935MHz	-15dBm (111dB)	-15dBm (115dB)	-15dBm (123dB)
960MHz	-13dBm (113dB)	-13dBm (117dB)	-13dBm (125dB)

1.11.9.3 923MHz

*- Please refer to Product Description reference [2][2] [2][2] for availability and roadmap -*

The useful signal is adjusted at 923MHz.

The **expecting** blockers rejections, at different SF are the following:

Offset	SF7/125KHz	SF10/125KHz	SF12/125KHz
+2MHz	-45dBm (80dB)	-	-43dBm (94dB)
-2MHz	-45dBm (80dB)	-	-40dBm (97dB)
+10MHz	-43dBm (82dB)	-	-40dBm (97dB)
-10MHz	-23dBm (102dB)	-	-34dBm (103dB)
850MHz	-	-	-
894MHz	-	-	-
910MHz	-	-	-
935MHz	-	-	-
960MHz	-	-	-

## 1.12 Description of the accessories

### 1.12.1 RJ45 cable

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

KERLINK recommends using a cable with the following characteristics:

Characteristics	Specification
Category	6A
Shielding	STP (U/FTP) or SSTP (S/FTP)
Section conductors	AWG26
External jacket	LSZH or PUR
Maximum length	100 meters
Operating temperature range	-20°C to +55°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:

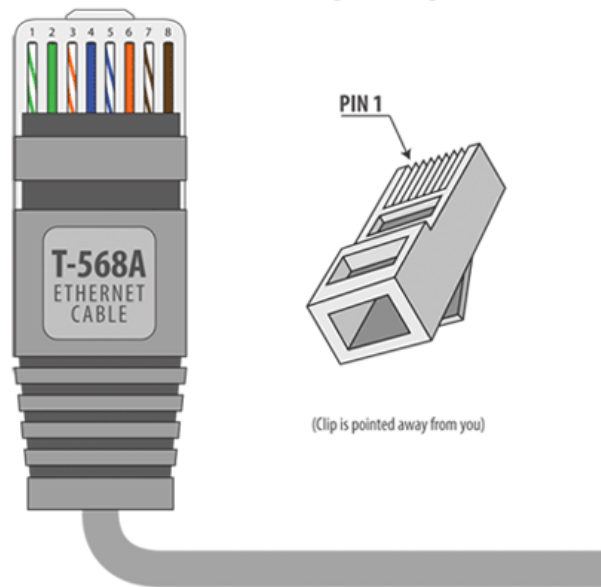


Figure 21: RJ45 T-568A plug

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### 1.12.2 Debug tool

The Wirnet iFemtocell has a proprietary serial debug interface available only inside the enclosure:

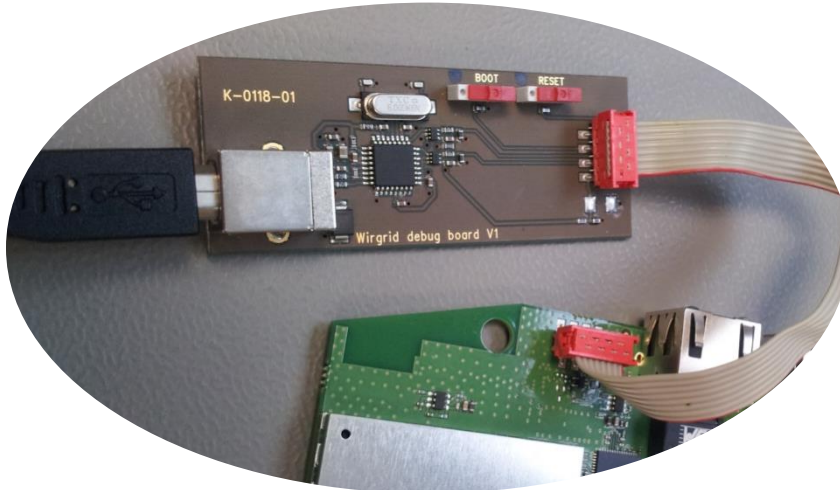


Figure 22: Debug tool connected to the Wirnet iFemtocell

The Wirnet iFemtocell is not warranted by KERLINK in case the enclosure is opened by customer.

Therefore, this purpose is only for specific customer needs.  
This debug interface is intended to be used by authorized and qualified personnel only.

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

The main characteristics of the debug tool are:

Characteristics	Specification
UART Interface	Micromatch (TE connectivity) 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)
Reset	Generate a hard reset
Boot	Select to boot mode
Operating temperature range	0°C to +60°C
Chipset	FT232BL (FTDI)

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The debug tool must be used with a ribbon cable and a USB2.0 type A to type B male cable. Those cables are provided with the debug tool by KERLINK.

The USB cable must be connected to a computer where must be installed a Terminal to visualize traces.

### 1.12.3 Surge protections

In harsh environment, especially if Ethernet cable or LoRa antenna is placed on outdoor conditions, additional protections must be used to achieve lightning immunity.

The Wirnet iFemtocell is not warranted by KERLINK in case of deterioration due to lightning. In such cases, KERLINK strongly recommends adding surge protection.

#### 1.12.3.1 RF coaxial surge protection

For the antenna link (LoRa), KERLINK recommends the P8AX09-6G-N/MF series from CITELE. Protections must be installed in accordance to its own specifications.

The following picture describes the RF coaxial surge protection:



Figure 23: P8AX Citel

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

#### 1.12.3.2 Indoor Ethernet surge protection

For the Ethernet link, KERLINK recommends the MJ8-CAT5E reference from CITELE. This surge protection must be installed indoor, according to its own specifications.

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The following picture describes the Ethernet surge protection:



Figure 24: MJ8-CAT5E Citel

**Note:** The Ethernet surge protector must be connected to the earth. No cables are provided by KERLINK for that purpose.

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## 2. Regulations

### 2.1 Wirnet iFemtocell 868

#### 2.1.1 Europe / CE

Wirnet iFemtocell 868 complies with requirements listed in the article 3 of the R&TTE 1999/5/EC Directive until June 15th 2016 and the RED 2014/53/EU directive from June 16th 2016:

1. Electromagnetic compatibility (article 3.1-b of the R&TTE Directive)
 

Applied standard(s):	EN 301 489-1	issue 1.9.2
	EN 301 489-3	issue 1.6.1
	EN 301 489-17	issue 2.2.1
  
2. Efficient use of the radio frequency spectrum (article 3.2 of the R&TTE Directive)
 

Applied standard(s):	EN 301 328	issue 1.9.1
	EN 300 220-1	issue 2.4.1
	EN 300 220-2	issue 2.4.1
  
3. Safety (article 3.1-a of the R&TTE Directive)
 

Applied standard(s):	EN 60 950-1 (Ed. 2006+A11:2009+A1:2010+A12:2011+A2:2013)	
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4. Magnetic field exposure
 

Applied standard(s):	EN 50 385	Ed. 2002
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The power supply of the Wirnet iFemtocell 868 must be a limited power source.

The Wirnet iFemtocell 868 is considered as a category 2 receiver according to the EN 300 220-1.

The Wirnet Femtocell 868 has CE marking.

In Europe, the Wirnet iFemtocell 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
<b>h1.3</b>	863-865	14dBm ERP	0,1%
<b>h1.3</b>	865-868	14dBm ERP	1%
<b>h1.4</b>	868-868,6	14dBm ERP	1%
<b>h1.5</b>	868,7-869,2	14dBm ERP	0,1%
<b>h1.6</b>	869,4-869,65	27dBm ERP	10%
<b>h1.7</b>	869,7-870	14dBm ERP	1%
<b>h2</b>	870-873	14dBm ERP	0,1%
<b>h2.1</b>	870-873	14dBm ERP	1%

Annex2/c	870-873	27dBm ERP	2,5%
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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. Check the local regulations before installing and commissioning the Wirnet iFemtocell 868.

For other countries, outside Europe, check the frequency range, the maximum EIRP and duty cycle allowed.

### 2.1.2 India

- **Wirnet iFemtocell 868 ready for Type approval and ISI Certification -**
- **Please refer to Product Description reference [2][2] [2][2] for availability and roadmap -**

In India, the Wirnet iFemtocell 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 LoRaWAN specification defined for Europe (863-870MHz band) can be reused for India, but with the following limitations:

- 125KHz BW only,
- Default channels and JointReq channels (868.1, 868.3 and 868.5MHz) are not available.

Therefore a new definition of the channels must be operated.

Ten channel are available such as  $865.1\text{MHz} + n \cdot 0.2$  ( $0 \leq n \leq 9$ ).

Eight channels among these ten must be selected.

KERLINK recommends removing the first one and the last one in order to improve the band edge spectrum.

The recommended channels are then:  $865.3\text{MHz} + n \cdot 0.2$  ( $0 \leq n \leq 7$ ).

### 2.1.3 South Africa

- Wirnet iFemtocell 868 ready for ICASA Type approval -
- Please refer to Product Description reference [2][2] [2][2] for availability and roadmap -

In South-Africa, the Wirnet iFemtocell 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 channel arrangement is the same as in Europe, according to the LoRaWAN specification.

### 2.1.4 Saudi Arabia

- Wirnet iFemtocell 868 ready for CITC approval -
- Please refer to Product Description reference [2][2] [2][2] for availability and roadmap -

In Saudi-Arabia, the Wirnet iFemtocell 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 channel arrangement is the same as in Europe, according to the LoRaWAN specification.

### 2.1.5 United Arab Emirates

- Wirnet iFemtocell 868 ready for TRA Type approval -
- Please refer to Product Description reference [2][2] [2][2] for availability and roadmap -

In United Arab Emirates, the Wirnet iFemtocell 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 channel arrangement is the same as in Europe, according to the LoRaWAN specification.

*2.1.6 Russia*

- *Wirnet iFemtocell 868 ready for Minsvyaz approval and EAC marking -*
- *Please refer to Product Description reference [2][2] [2][2]for availability and roadmap -*

In Russia, the Wirnet iFemtocell 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 channel arrangement is the same as in Europe, according to the LoRaWAN specification, except default channels and JointReq channels (868.1, 868.3 and 868.5MHz) are not available.

## 2.2 Wirnet iFemtocell 915

*- Please refer to Product Description reference [2][2] [2][2]for availability and roadmap -*

The Wirnet iFemtocell 915 **will be** compliant to:

- IEC 60950-1:2005/A1:2009/A2:2013
- UL 60950 -1 : 2007, Amendment A1:2011, Amendment A2:2014
- CAN/CSA-C22.2 NO. 60950-1-07 / A1: 2011 / A2: 2014

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

The Wirnet iFemtocell 915 **will also be** compliant to both FCC and IC regulations.

Applicable documents:

- CFR 47 FCC Part 15
  - FCC 47 CFR Part 15 : 2016 - 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
- RSS 247
  - RSP-100 Issue 11, January 2016 - Certification of Radio Apparatus
  - 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 FCC and IC identifiers of the Wirnet iFemtocell 915 are:

Model: WIRNET iFemtocell 915

FCC ID: **to be defined**

IC: **to be defined**

Some conditions have to be respected to maintain the FCC and IC compliance of the devices in USA and Canada. They are detailed in the following paragraphs.

For others countries, check the specific regulations regarding maximum EIRP and duty cycle allowed.

### 2.2.1 USA / FCC

*- Please refer to Product Description reference [2][2] [2][2]for availability and roadmap -*

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As stated by the external sticker on the enclosure, “This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.”

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

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

This device must be professionally installed.

Also, some specific recommendations for exposure to magnetic fields must be followed: This equipment complies with FCC’s radiation exposure limits set forth for an uncontrolled environment under the following conditions:

1. This equipment should be installed and operated such that a minimum separation distance of 20 cm is maintained between the radiator (antenna) and user’s/nearby person’s body at all times.
2. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

### 2.2.2 Canada / IC

**- Please refer to Product Description reference [2][2] [2][2] for availability and roadmap -**

This device **will be** compliant with Industry Canada’s license-exempt RSSs.

Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation of the device.

*Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence.*

*L'exploitation est autorisée aux deux conditions suivantes:*

1. *L'appareil ne doit pas produire de brouillage;*
2. *L'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.*

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Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, that antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed as accessories with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with the device.

This equipment should be installed and operated such that a minimum separation distance of 20 cm is maintained between the radiator (antenna) and user's/nearby person's body at all times.

The radio transmitter has been approved by Industry Canada to operate with a maximum duty cycle of 40% to not overrule the 2.784 W/m<sup>2</sup> RF Field Strength Limits for Devices. The duty cycle, in normal conditions, is far below this limit. Do not operate the Wirnet iFemtocell 915 out of the 40% duty cycle limit.

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### 2.3 Wirnet iFemtocell 923

*- Please refer to Product Description reference [2][2] [2][2]for availability and roadmap -*

The Wirnet iFemtocell 923 **will be** 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 iFemtocell 923 **will also be** compliant to both FCC and CE regulations.

Applicable documents:

- CFR 47 FCC Part 15 :
  - FCC 47 CFR Part 15 : 2016 - 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 :  
 Applied standard(s):
  - EN 300 220-1, issue 2.4.1
  - EN 300 220-2, issue 2.4.1

The Wirnet iFemtocell 923 is considered as a category 2 receiver according to the EN 300 220-1.

- AS/NZS 4268 2012 + A1 : 2013 : Radio equipment and systems – Short range devices – Limits and methods of measurement
- ARIB STD-T108 - 920MHz-Band Telemeter, Telecontrol and Data Transmission Radio Equipment
- Clause 2, Article 58-2 of Radio Waves Act (Republic of Korea)
- IDA Technical Specifications for Short Range Devices (IDA TS SRD) – Issue 1 Rev 7, April 2013

**Note 1:**

The power supply of the Wirnet iFemtocell 923 must be a limited power source.

**Note 2:**

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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...

Some specific rules are detailed hereafter for specific countries.

**Note 3:**

All proposed channel plans detailed in §0 use the FCC LoRaWAN implementation just changing actual frequencies and number of UL/DL channels.

- Upstream channel plan is fixed
- RX1 downstream channel and Data Rate are function of Upstream channel and Data Rate
- RX2 downstream channel and Data Rate are fixed but configurable

**2.3.1 Australia**

*- Wirnet iFemtocell 923 will be ready for ACMA declaration of conformity and RCM marking -*

*- Please refer to Product Description reference [2][2] [2][2] for availability and roadmap -*

In Australia, the Wirnet iFemtocell 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 plan and channel allocation is defined in the LoRaWAN specification for Australia.

Its usage summarized hereafter:

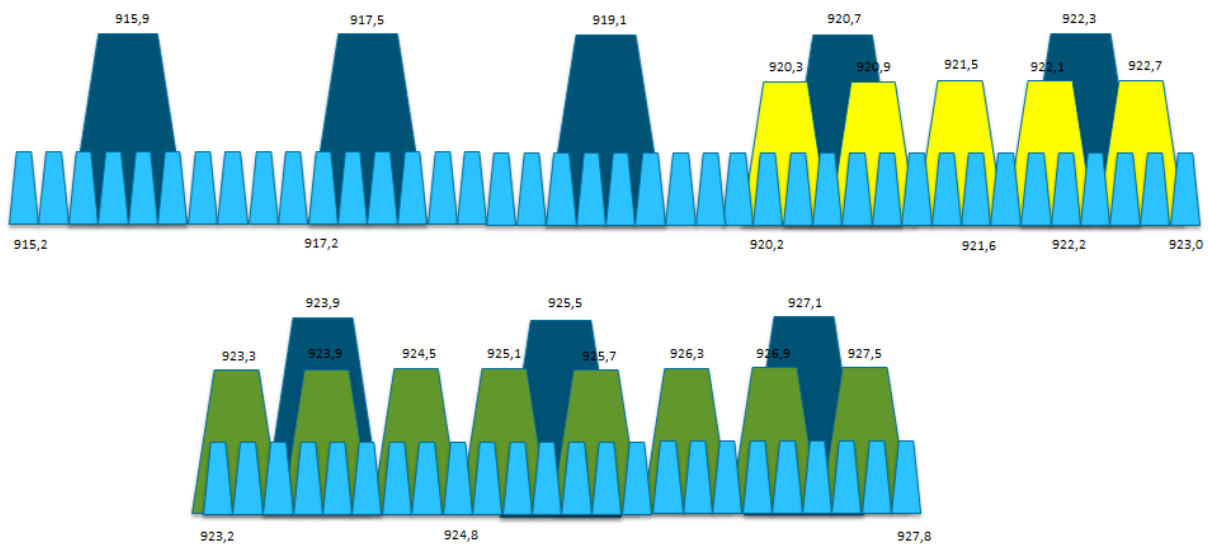


Figure 25: Channels allocation in Australia

**Note:**

In the above figure:

- Upstream channels are in blue (64 channels, 200KHz spacing, 125KHz BW + 8 channels, 1600KHz spacing, 500KHz BW)
- 125KHz upstream channels are limited from SF7 to SF10 to meet 400ms maximum frame length
- Downstream channels are in green (8 channels, 600 KHz spacing, 500KHz BW)
- Unused channels are in yellow

2.3.2 Korea (Republic of)

- Wirnet iFemtocell 923 will be ready for RRA Certification and KC label -
- Please refer to Product Description reference [2][2] [2][2] for availability and roadmap -

The Wirnet iFemtocell 923 is compliant the Clause 2, Article 58-2 of Radio Waves Act. In Republic of Korea, the Wirnet iFemtocell 923 can be used with the following limitations:

Item	Specification
Frequency range	917-923.5MHz
Max EIRP	10mW (10dBm)
Max conducted power with 6dBi antenna	4dBm
Max conducted power with 3dBi antenna	7dBm
Carrier sense (LBT)	5ms / -65dBm
Transmit duration	< 4s
Pause duration	> 50 ms

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**Duty cycle**

<2% in 20 s duration

The frequency plan and channel allocation is not yet defined in the LoRaWAN specification for Republic of Korea.

KERLINK recommends the following allocation:

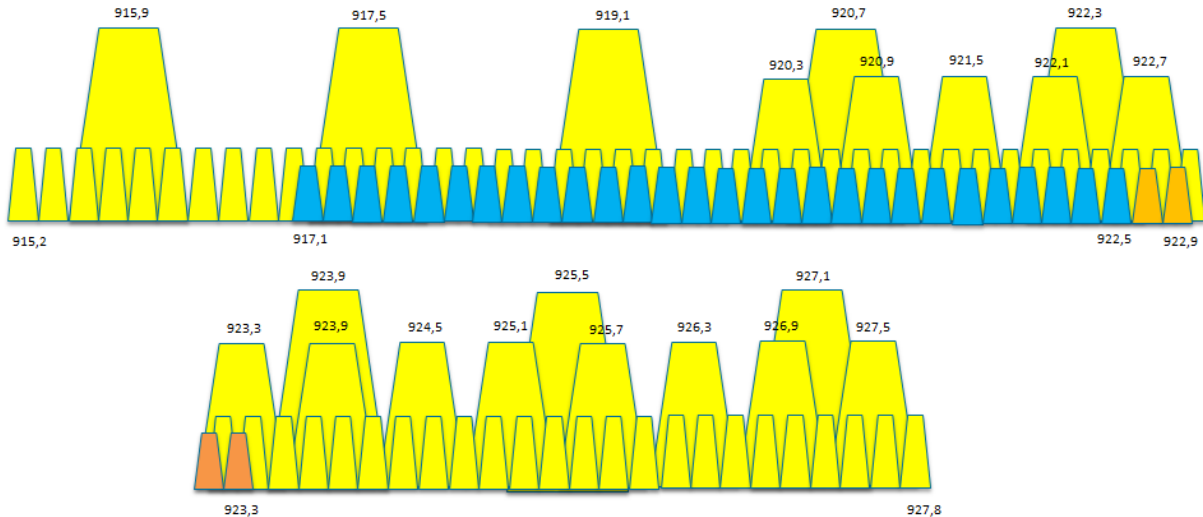


Figure 26: Channels allocation proposal in Korea

**Note:**

In the above figure:

- Upstream channels are in blue and orange (32 channels, 200KHz spacing, 125KHz BW)
- Downstream channels are in orange (4 channels, 200 KHz spacing, 125KHz BW)
- Unused channels are in yellow
- Channels are offset by 100KHz compared to other countries due to Korean regulations constraints

The channels allocation can be organized differently if needed.

**2.3.3 New-Zealand**

- **Wirnet iFemtocell 923 will be ready for declaration of conformity, R-NZ marking and Telepermit certification -**
- **Please refer to Product Description reference [2][2] [2][2]for availability and roadmap -**

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

Item	Specification
Frequency range	921-928 MHz all type of SRD

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<b>Frequency range</b>	915-921 MHz for telemetry only
<b>Max EIRP</b>	1W (30dBm)
<b>Max conducted power with 6dBi antenna</b>	24dBm
<b>Max conducted power with 3dBi antenna</b>	27dBm

The frequency plan and channel allocation is not yet defined in the LoRaWAN specification for New-Zealand.

In case of telemetry application, the full 915-928 MHz band can be used. Therefore, a frequency plan and channel arrangement similar to Australia can be used (see § 2.3.1).

If the application is not dedicated to telemetry, then KERLINK recommends the following allocation:

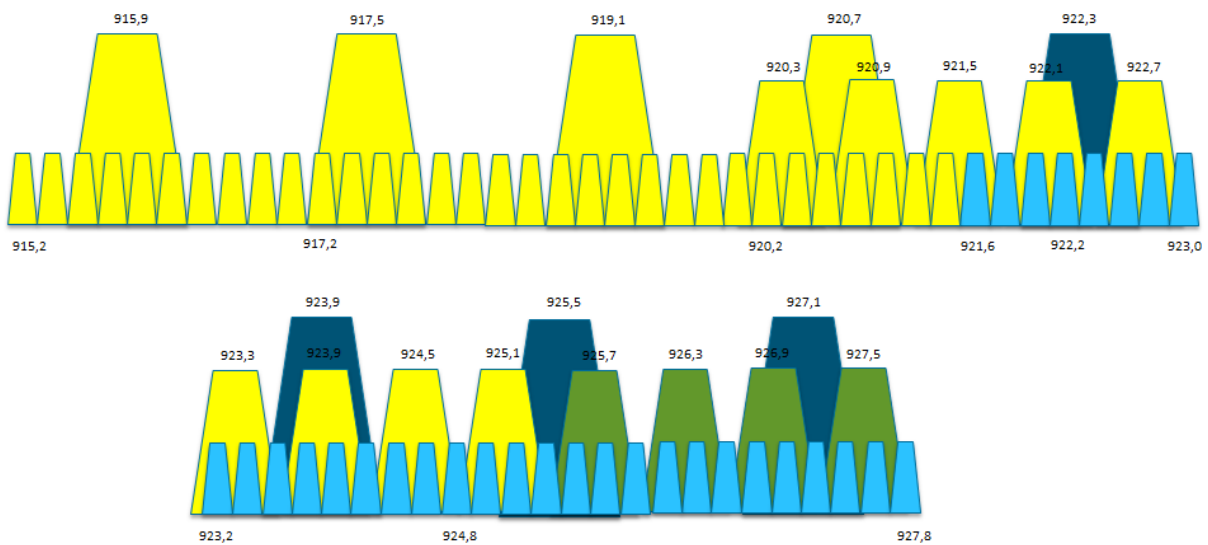


Figure 27: Channels allocation proposal in New-Zealand

**Note:**

In the above figure:

- Upstream channels are in blue (32 channels, 200KHz spacing, 125KHz BW + 4 channels, 1600KHz spacing, 500KHz BW)
- 125KHz upstream channels are limited from SF7 to SF10 to meet 400ms maximum frame length
- Downstream channels are in green (4 channels, 600 KHz spacing, 500KHz BW)
- Unused channels are in yellow

The channels allocation can be organized differently if needed.

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2.3.4 Singapore

- Wirnet iFemtocell 923 will be ready for IDA registration -
- Please refer to Product Description reference [2][2] [2][2] for availability and roadmap -

In Singapore, the Wirnet iFemtocell 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

The frequency plan and channel allocation is not yet defined in the LoRaWAN specification for Singapore.

KERLINK recommends the following allocation:

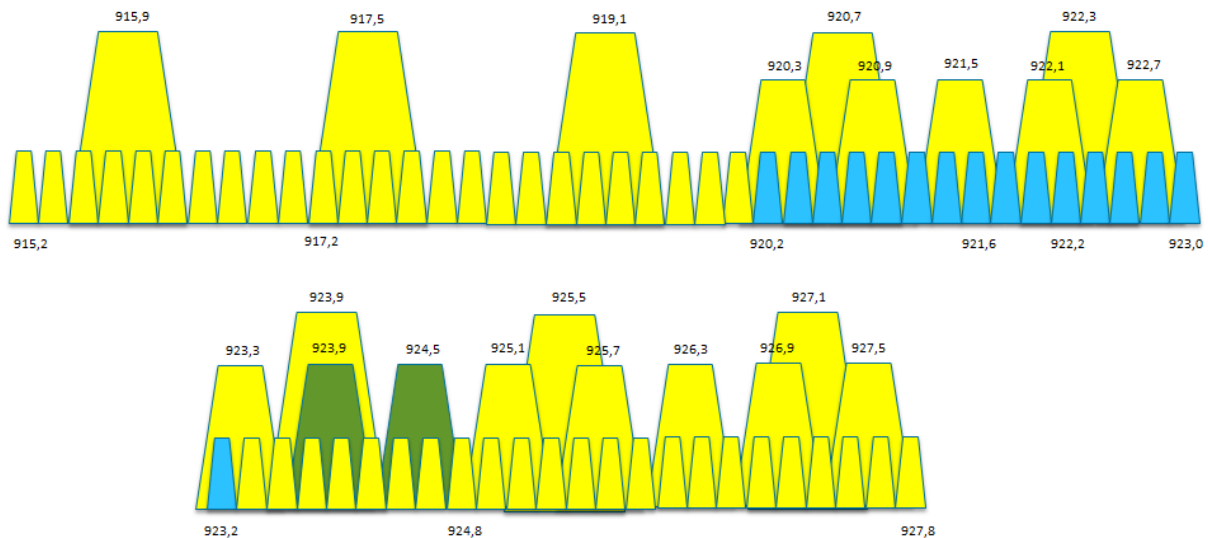


Figure 28: Channels allocation proposal in Singapore

**Note 1:**

In the above figure:

- Upstream channels are in blue (16 channels, 200KHz spacing, 125KHz BW)
- Downstream channels are in green (2 channels, 600 KHz spacing, 500KHz BW)
- Unused channels are in yellow

The channels allocation can be organized differently if needed.



2.3.5 Japan

- Wirnet iFemtocell 923 will be ready for RCAB certificate and Giteki marking -
- Please refer to Product Description reference [2][2] [2][2] for availability and roadmap -

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

Item	Specification
Frequency range 1	920.5-928.1MHz
Frequency range 2 (Rx only)	916.0-916.8MHz
Channelization	200KHz
Max EIRP (920.4-922.2MHz)*	500mW (27dBm)
Max conducted power (920.4-922.2MHz)*	250mW (24dBm)
Max EIRP (922.4-923.4MHz)*	500mW (27dBm)
Max conducted power (922.4-923.4MHz)*	250mW (24dBm)
Max EIRP (922.3-928.1MHz)**	40mW (16dBm)
Max conducted power (922.4-928.0MHz)**	20mW (13dBm)
Carrier sense (LBT)	5ms / -80dBm
Transmit duration (920.4-922.2MHz)	< 4s
Transmit duration (922.4-928.0MHz)	<400ms
Pause duration (920.4-922.2MHz)	> 50 ms
Pause duration (922.4-928.0MHz)	> 10*Tx duration

\*: ARIB STD-T108 Convenience Radio Station

\*\* : ARIB STD-T108 Specified low power radio station

The frequency plan and channel allocation is not yet defined in the LoRaWAN specification for Japan.

KERLINK recommends the following allocation:

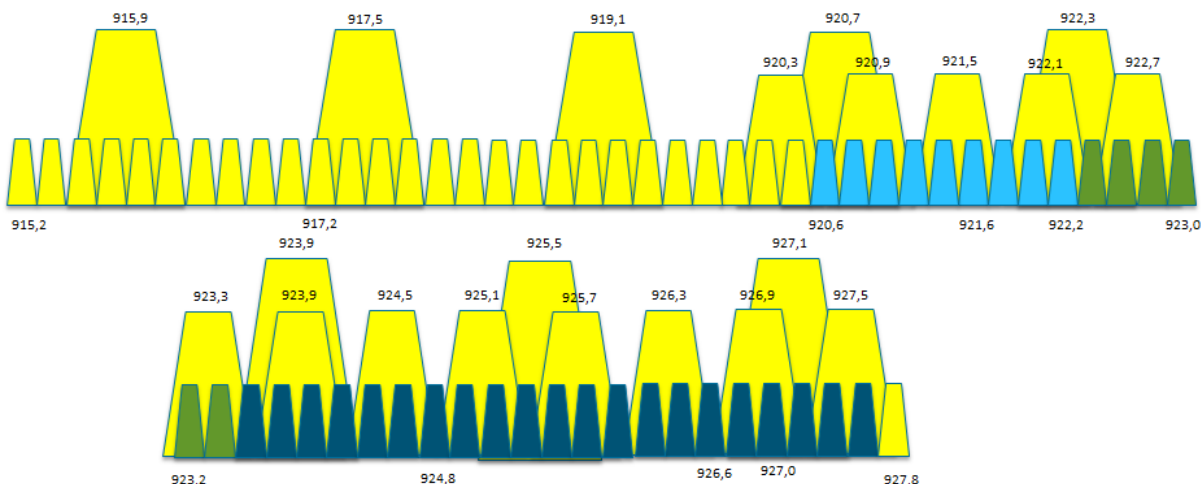


Figure 29: Channels allocation proposal in Japan

**Note:**

In the above figure:

- Upstream channels are in blue (30 channels, 200KHz spacing, 125KHz BW)
  - First 9 channels, SF7 to SF12, max frame length=4s
  - Last 21 channels, SF7 to SF10 (reduced payload), max frame length=400ms
- Downstream channels are in green (6 channels, 200 KHz spacing, 125KHz BW)
  - Downstream channel is upstream channel modulo 6 on RX1 and fixed channel on RX2
  - SF7 to SF10 at 500mW EIRP, 400ms frame length
  - Carrier sense makes transmission not fully predictable. Network might have to retry on next slot if carrier is busy
- Unused channels are in yellow

The channels allocation can be organized differently if needed.

**2.3.6 Taiwan**

- **Wirnet iFemtocell 923 will be ready for NCC Certification -**
- **Please refer to Product Description reference [2][2] [2][2] for availability and roadmap -**

In Taiwan, the Wirnet iFemtocell 923 can 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	922-928MHz
Max EIRP	2W
Max conducted power with 6dBi antenna	500mW (27dBm)

The frequency plan and channel allocation is not yet defined in the LoRaWAN specification for Taiwan.

KERLINK recommends the following allocation:

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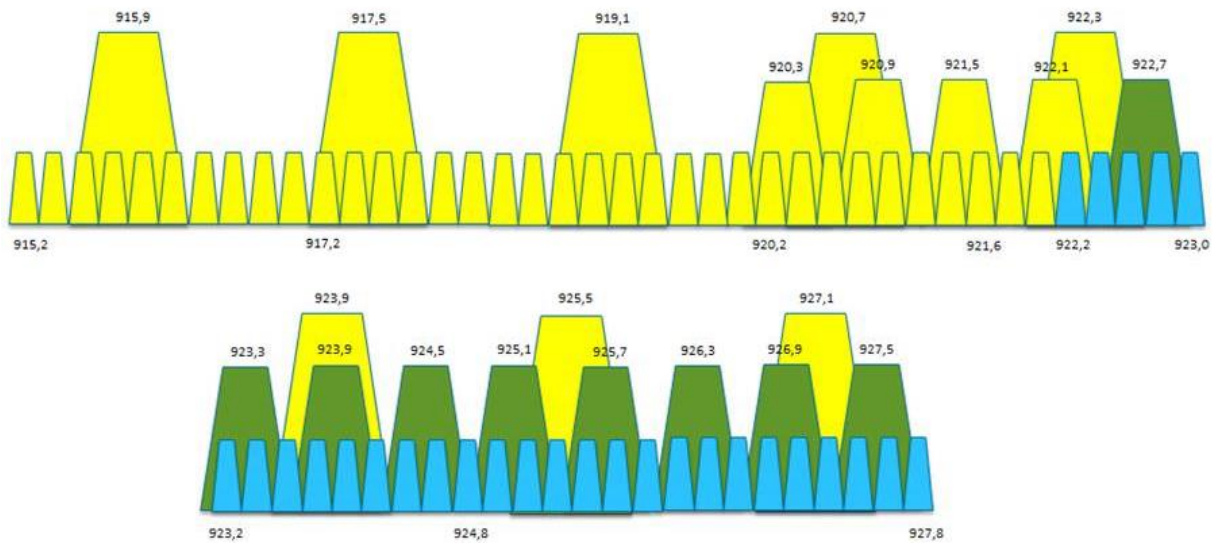


Figure 30: Channels allocation proposal in Taiwan

**Note:**

In the above figure:

- Upstream channels are in blue (29 channels, 200KHz spacing, 125KHz BW)
- Downstream channels are in green (9 channels, 600 KHz spacing, 500KHz BW)
- Unused channels are in yellow

The channels allocation can be organized differently if needed.

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### 3. Installation procedure

This device must be professionally installed.

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

#### 3.1 Installation topology

##### 3.1.1 Wirnet iFemtocell gateway installation

When a gateway is installed on a site, three configurations are possible regarding WAN technology used:

- Ethernet connection
- Wi-Fi connection
- LTE/HSPA/GPRS connection via USB dongle

The Ethernet connection requires an Ethernet access through a dedicated RJ45 cable.

The Wi-Fi connection requires a Wi-Fi access point.

The LTE/HSPA/GPRS connection requires a USIM subscription and an optional USB dongle. Kerlink recommends using the validated USB dongles (see §5List of the accessories). Alternative dongle may require additional drivers and firmware update to be used.

Obviously, the three configurations may be used in parallel. A typical example is the possibility to insure Ethernet WAN backup by a LTE WAN link.

The three configurations are detailed hereafter:

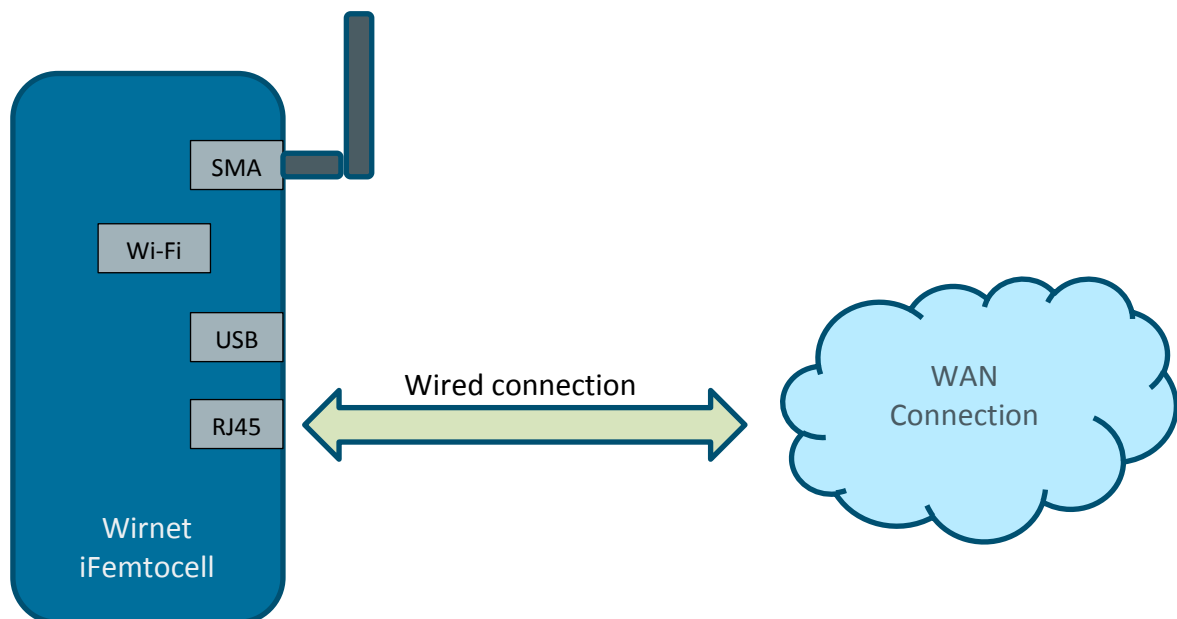


Figure 31: Ethernet WAN connection

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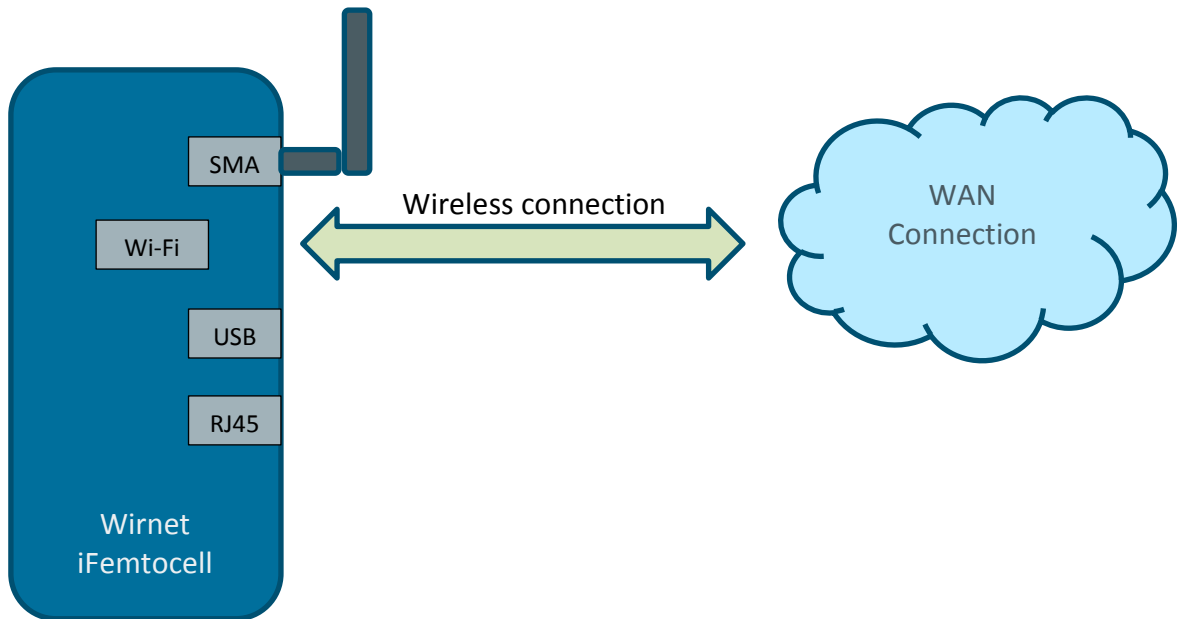


Figure 32: Wi-Fi WAN connection

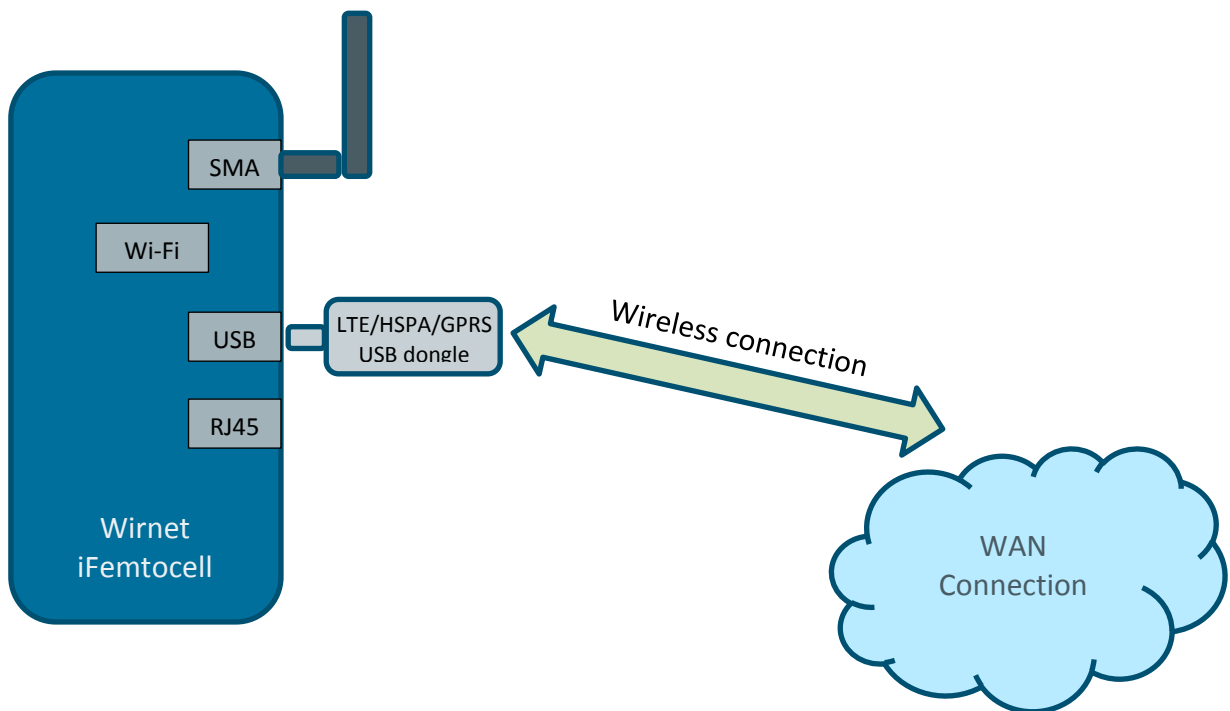


Figure 33: LTE/HSPA/GPRS USB dongle WAN connection

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## 3.2 Mounting of the enclosure

### 3.2.1 General considerations

The Wirnet iFemtocell enclosure must be mounted on any concrete pedestal, concrete wall or any non-flammable surface (UL94-V0).  
 It must not be mounted on a flammable surface.

Only two screws are needed.

Detailed information about fixing requirement is available on the corresponding paragraph 1.10.

### 3.2.2 Distance between LoRa antenna and LTE USB dongle

To avoid or minimize the intermodulation between the LoRa transmitter and the LTE transmitter, a minimum distance is required between the LoRa antenna and the LTE USB dongle. This minimum distance is also recommended to avoid mutual desensitization of the receivers.

To optimize the colocation between the internal LTE USB dongle and the external LoRa antenna, a distance of 1m is required between both radiated parts.

Therefore, when possible, Kerlink strongly recommends dissociating the LTE USB dongle away from the enclosure and the LoRa antenna by using a 1 meter extension cable.

### 3.2.3 Mounting of the accessories

In harsh environment, especially if Ethernet cable or LoRa antenna is placed on outdoor conditions, additional protections must be used to achieve lightning immunity.

The Wirnet iFemtocell is not warranted by KERLINK in case of deterioration due to lightning. In such cases, KERLINK strongly recommends adding surge protection.

#### 3.2.3.1 Indoor Ethernet surge protection

The indoor Ethernet surge protection is provided with a clip dedicated to DIN rail mounting. The DIN rail clip can be removed by unscrewing the nut:

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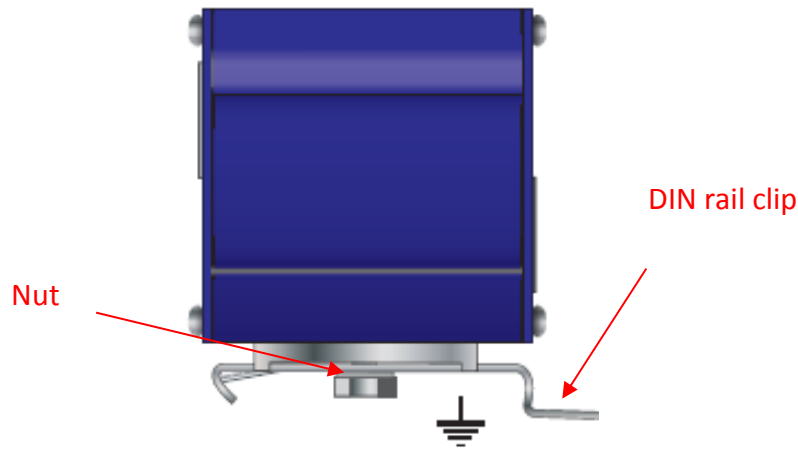


Figure 34: Indoor Ethernet surge protection – DIN rail clip

The earthing connection is completed through the DIN rail clip. Therefore, the earthing cable can be connected to the DIN rail itself or using the nut of the DIN rail clip.

### 3.2.3.2 RF coaxial surge protection

The RF coaxial surge protections are directly mounted (screwed) on the N connectors of the Kerlink optional antennas.

On the RF coaxial surge protection side, the earthing connection is completed through a ring tongue terminal. The earthing cable must be crimped inside this ring tongue terminal. A specific crimping tool is required to perform the operation.

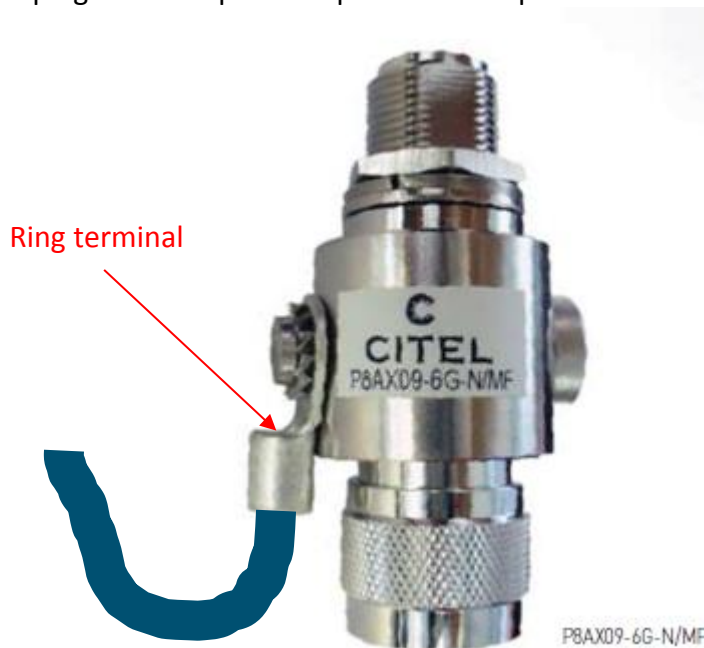


Figure 35: Earthing of the RF coaxial surge protection

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**Note 1:** The earthing cable is not provided by KERLINK.

**Note 2:** Use a crimping tool to crimp the ring tongue terminal with earthing cable.

### 3.3 Setting connections

Before setting all connections, ensure that the power supply is not connected to the mains supply.

The following pictures details all the Wirnet iFemtocell required connections, including power supply cable, Ethernet cable, USB mass-storage key and LoRa antenna connections:



Figure 36: Connections

The Wirnet iFemtocell gateway is provided with:

- Power supply detailed in §1.3
- LoRa antenna detailed in §1.5

The recommended Ethernet cable is detailed in §1.12.1.

**Note 1:** The Ethernet cable is not provided with the Wirnet iFemtocell.

**Note 2:** The maximum Ethernet cable length is 100m.

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The power supply detailed in §1.3 is provided with E/F type cable (Europe) or B type cable (USA).

Insert the plugs to the mains receptacle of the electrical installation.

**Note:** The E/F type or B type plugs must be inserted into the mains receptacle only once all other connections are settled and USIM card inserted (see §3.4).

### 3.4 Commissioning

#### 3.4.1 USIM card

The LTE/HSPA/GPRS connection requires a USIM subscription and an optional USB dongle. Kerlink recommends using the validated USB dongles (see §5List of the accessories). Alternative dongle may require additional drivers and firmware update to be used.

The USIM card is mandatory to establish the LTE/3G/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.

Before inserting the USIM card, pay attention that the Wirnet iFemtocell is unpowered by checking that all LEDs are OFF.

Then, insert a USIM card in the USB WAN dongle.

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.

After inserting the new USIM card as described above, the Wirnet iFemtocell can be re-powered on again.

In case of change of mobile operator, APN and login/password must be updated. This can be done through USB update.

For more details, contact KERLINK.

#### 3.4.2 Power ON

Once the RF antenna, the Ethernet cable and the power supply jack connector are connected and the USIM card is inserted, the Wirnet iFemtocell can be powered ON.

To POWER ON the Wirnet iFemtocell, connect the power supply onto the 230VAC mains supply.

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### 3.4.3 Functional check

To ensure the Wirnet iFemtocell is started up, check the behavior of the LED indicators:



Figure 37: Functional check with LEDs

Item	Specification
<b>LED 1: Power</b>	Red blinking during the kernel boot Green blinking during system boot Green when boot is finished
<b>LED 2: Backhaul</b>	Red during boot Red if PacketForwarder is disconnected Green blinking during PacketForwarder connection Green fix if PacketForwarder is connected
<b>LED 3: LoRa traffic</b>	Red during boot PacketForwarder management Rx: green blinking Tx: red blinking

Then, to check and analyze the status of the Wirnet iFemtocell, a standard laptop can be connected to the RJ45 connector or a Wi-Fi connection may be done.

### 3.4.4 First connection

When a gateway is installed, the first connection must be done by two different ways:

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- Ethernet connection
- Wi-Fi connection

### 3.4.4.1 Ethernet connection

Plug the Wirnet iFemtocell to the WAN access point with an Ethernet cable.

The connection will be established automatically.

### 3.4.4.2 Wi-Fi connection

Press the WPS button (Wi-Fi Protected Setup) on the Wirnet iFemtocell (§1.8 Push buttons). Press the WPS button on the Wi-Fi access point of the installation.

The connection will be established automatically.

### 3.4.5 Configuration

Once the connection established, open an explorer to access the configuration web interface. Wirnet iFemtocell IP address must be retrieve first from router.

For information the host name of the Wirnet iFemtocell is “klk-wifc\_xxxxxx” where xxxxxx is the end of the board ID. This information is present on the sticker placed on the rear side of the product. In this example, xxxxxx is 020010.



Figure 38: Board ID

This local maintenance Web interface is available to perform the specific configuration (Wi-Fi configuration...). The maintenance Web interface is described in chapter 4.2.3.

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## 4. Maintenance of the Wirnet iFemtocell

### 4.1 Simple checks

#### 4.1.1 Wirnet iFemtocell enclosure

Check the robustness of the installation:

- Screwing of the Wirnet iFemtocell in case of wall mounting

Check connections:

- Tightening of the antenna (SMA connector)
- Position/good connection of the power supply jack connector
- Position/good connection of the RJ45 Ethernet connector
- RJ45 cable is not deteriorated
- LoRa antenna is not deteriorated

#### 4.1.2 User interface

Check the LED indicators on the top of the enclosure:



Figure 39: Maintenance check with LEDs

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Item	Specification
<b>LED 1: Power</b>	Red blinking during the kernel boot Green blinking during system boot Green when boot is finished
<b>LED 2: Backhaul</b>	Red during boot Red if PacketForwarder is disconnected Green blinking during PacketForwarder connection Green fix if PacketForwarder is connected
<b>LED 3: LoRa traffic</b>	Red during boot PacketForwarder management Rx: green blinking Tx: red blinking

## 4.2 Interfaces for debug or maintenance purposes

### 4.2.1 USB interface / Firmware upgrade

Firmware upgrade can be performed with a USB key via the USB type A connector. The connector is located on the left side of the enclosure as described below:



Figure 40: USB dongle on the Wirnet iFemtocell

#### 4.2.1.1 Overview

- 1) Prepare a USB disk with following files:
  - *usb.autorun*: Auto executable script
  - *usbkey.txt*: USB password file
  - *keros\_x.y.z.ipk*: the update package
- 2) Plug the USB disk on the Wirnet iFemtocell product
- 3) Wait until green LED 1 stop blinking
- 4) Unplug USB disk
- 5) Wait for CPU reboot (Green LED 1)
- 6) Verify the new version inside the file */tmp/sys\_startup\_status.json*, firmware version of product is contained in the field "uc"."sw\_version"

#### 4.2.1.2 Specific Files

The 2 specific files for USB update are *usb.autorun* and *usbkey.txt*:

- *usbkey.txt* is a security file. It includes the "usbuser" password on the UC board. The password of usbuser is, by default "USBklkPassword", . ("*<serialNo>\_usbkey*" for firmwares versions < 1.5.0).
- *usb.autorun* is a script automatically executed by the board if the *usbkey.txt* file includes a correct password.

Visit Wirnet iFemtocell Wiki for additional information:

<http://www.wikikerlink.fr/wirnet-ifemtocell/>

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#### 4.2.2 Push buttons



Figure 41: Push buttons

To press the buttons, a tool with a 1mm diameter must be used:



Figure 42: Push button tool

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#### 4.2.2.1 Reset push button

The reset push button must be pressed during 1s to generate a hard reset of the product.

#### 4.2.2.2 WPS

Wi-Fi Protected Setup (WPS) is a standard used to establish a secure connection between equipment and a Wi-Fi access point.

The principle is to press the WPS button on the Wirnet iFemtocell and on the Wi-Fi access point to get the connection.

#### 4.2.3 Local Web maintenance interface

Once the connection is established (Ethernet or Wi-Fi), a configuration Web page is accessible from the product.

The following table gives a brief sum up of the configuration possibilities.

- Please note that functionalities in red will be available in next release -
- Please refer to Product Description reference [2][2] [2][2] for availability and roadmap -

Item	Specification
Web - login <i>- will be available in next release -</i>	Login/Password default value (admin/admin)
Ethernet configuration <i>- will be available in next release -</i>	DHCP : Y/N IP address by default IP (Static mode) Gateway address & broadcast mask
Wi-Fi configuration <i>- will be available in next release -</i>	SSID Password Mode : client/AP/Adhoc Scanning (SSID, RSSI)
LoRa radio configuration <i>- will be available in next release -</i>	LoRa Network Server access Real time radio spectrum scanning
Gateway status <i>- will be available in next release -</i>	Hardware version Firmware version Board diagnostic (voltage, memory, processor usage, ...) Firmware upgrade
Security <i>- will be available in next release -</i>	Change root password Local WEB interface password Local WEB interface certificate Backhaul interface certificate



## 5. List of the accessories

Basic configuration 868:

KERLINK Reference	Designation
PDTIOT-IFE00	Wirnet iFemtocell 868, including: <ul style="list-style-type: none"> <li>- 1 X Enclosure with a CPU board</li> <li>- 1 X Power supply</li> <li>- 1 X LoRa antenna</li> </ul>

Basic configuration 915:

*- Please refer to Product Description reference [2][2] [2][2] for availability and roadmap -*

KERLINK Reference	Designation
PDTIOT-xxxxx	Wirnet iFemtocell 915, including: <ul style="list-style-type: none"> <li>- 1 X Enclosure with a CPU board</li> <li>- 1 X Power supply</li> <li>- 1 X LoRa antenna</li> </ul>

Basic configuration 923:

*- Please refer to Product Description reference [2][2] [2][2] for availability and roadmap -*

KERLINK Reference	Designation
PDTIOT-xxxxx	Wirnet iFemtocell 923, including: <ul style="list-style-type: none"> <li>- 1 X Enclosure with a CPU board</li> <li>- 1 X Power supply</li> <li>- 1 X LoRa antenna</li> </ul>

LTE/HSPA/GPRS USB Dongle:

*- Please refer to Product Description reference [2][2] [2][2] for availability and roadmap -*

KERLINK Reference	Designation
	- <b>To be defined</b>
	-
	-

Outdoor LoRa antennas:

KERLINK Reference	Designation
KLK-I0145	Omnidirectional antenna 868MHz 3dBi kit, including: <ul style="list-style-type: none"> <li>- 1 X Universal antenna bracket</li> <li>- 1 X 1m coaxial cable</li> </ul>
KLK-I0167	Omnidirectional antenna 915MHz 3dBi kit, including: <ul style="list-style-type: none"> <li>- 1 X Universal antenna bracket</li> <li>- 1 X 1m coaxial cable</li> </ul>
KLK-I0158	Omnidirectional antenna 915MHz 6dBi kit, including: <ul style="list-style-type: none"> <li>- 1 X Universal antenna bracket</li> </ul>

	- 1 X 1m coaxial cable
<b>KLK02518</b>	Omnidirectional antenna 915MHz 6dBi from FT-RF with its own antenna bracket

Surge protections:

<b>KERLINK Reference</b>	<b>Designation</b>
<b>KLK02819</b>	RF coaxial surge protector
<b>KLK02874</b>	Ethernet surge protector, indoor

Debug tool:

<b>KERLINK Reference</b>	<b>Designation</b>
<b>KLK-I0037</b>	Debug tool
<b>KLK02134</b>	Ribbon cable, 150mm
<b>KLK02440</b>	USB2.0 A type / B type cable, 2m

## 6. KERLINK support

The Wirnet iFemtocell gateway must be installed and maintained by authorized and qualified personnel only.

In case of defect or breakdown, make sure the above recommendations detailed in this document are met.

If an issue is not addressed in this document, contact KERLINK at [support@kerlink.fr](mailto:support@kerlink.fr).

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