

# Treon Gateway 2 antenna details

**U-blox Sara-R422** FCC ID: XPYUBX20VA01 (cellular)  
**U-blox Sara-R422** IC: 8595A-UBX20VA01 (cellular)  
**U-blox Nina B301** FCC ID: XPYNINAB30 (BLE/Wirepas mesh)  
**U-blox Lily-W131** FCC ID: XPYLILYW1 (WiFi)

Date	Version	Editor	Status	Notes
21.12.2018	0.1	Rami Koskinen	Draft	Initial draft created
31.12.2018	0.2	Rami Koskinen	Draft	
18.1.2019	1.0	Rami Koskinen	Approved	
9.3.2019	1.1	Rami Koskinen	Approved	Wirepas Mesh antenna update
2.6.2023	2.0	Timo Y-P	Draft	Modem IC's and cellular antenna updated for Treon Gateway 2
19.6.2023	2.1	Timo Y-P	Approved	Radio parameters (table 1) updated and SARA-R422 model number corrected

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## Acronyms and abbreviations

EGPRS	Enhanced General Packet Radio Service
CatM1	Category M1
WLAN	Wireless Local Area Network
SMD	Surface-Mount Device
PIFA	Planar Inverted-F Antenna
PCB	Printed Circuit Board
EIRP	Effective Isotropic Radiated Power

# 1 General information

## 1.1 Introduction of Treon Gateway antennas

Treon Gateway has three separate radio modules and each of them have own antenna. Every antenna is so-called internal antenna and they locate inside the product casing on the product pcb. There are no external RF connectors on the product.

The radio modules and antenna types of Treon gateway are:

1. Cellular (EGPRS, LTE CatM1) (updated for Treon Gateway 2)
  - Radio module: u-blox Sara-R422M
  - Antenna: CoreloT (Vertical Mount chip antenna for LGW, monopole)
2. WLAN 2.4GHz (WiFi)
  - Radio module: u-blox Lily-W131
  - Antenna: TDK ANT162442DT-2001A2 (multilayer chip antenna, loop)
3. Wirepas Mesh (BLE) 2.4GHz
  - Radio module: u-blox Nina-B301
  - Antenna: Inverted-F antenna on PCB

Placement of the antennas is shown in figure 1.

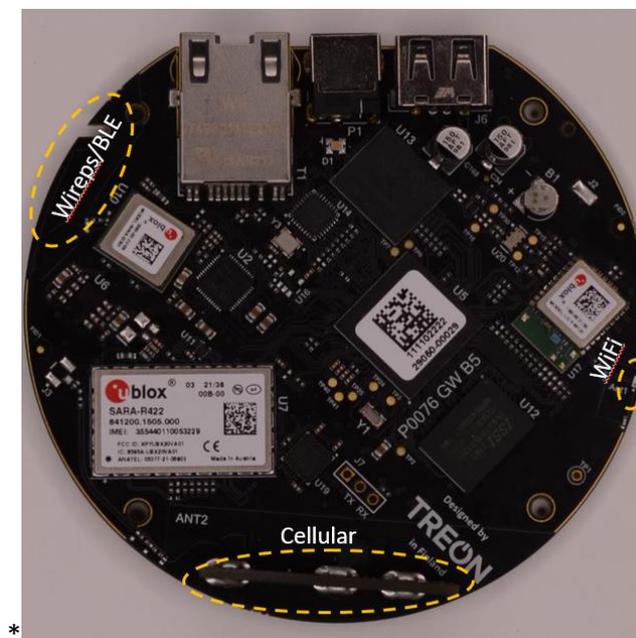


Figure 1: Top side of the product pcb.

## 1.2 Test equipment used in antenna tests

The antenna parameter graphs like Return Loss have been measured with Agilent E5071C Vector Network Analyzer. The peak EIRP, Efficiency and Radiation Patterns have been measured in ETS AMS 8050 antenna chamber.

## 2 Cellular antenna

Treon Gateway supports several cellular radio systems (EGPRS, LTE CatM1) with a single radio module (u-blox SARA-R422M). The antenna functionality for this radio module is implemented with antenna component (CoreIoT Vertical Mount antenna for LGW) and a matching circuitry.

The supported frequency bands of the cellular antenna are:

- B2 (1900 MHz)
- B3 (1800 MHz)
- B4 (1700/2100 MHz)
- B5 (850 MHz)
- B8 (900 MHz)
- B20 (800 MHz)

### 2.1 Antenna impedance and tuning

Matching circuitry for the cellular antenna is shown in Figure 3.

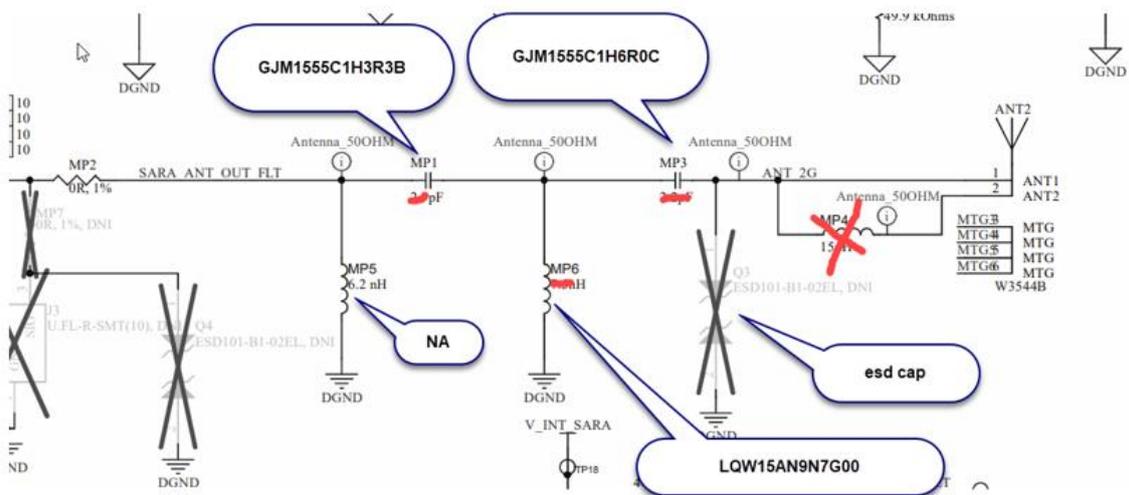


Figure 3. Antenna matching circuitry of the cellular antenna.

Antenna return loss is shown in Figure 4.

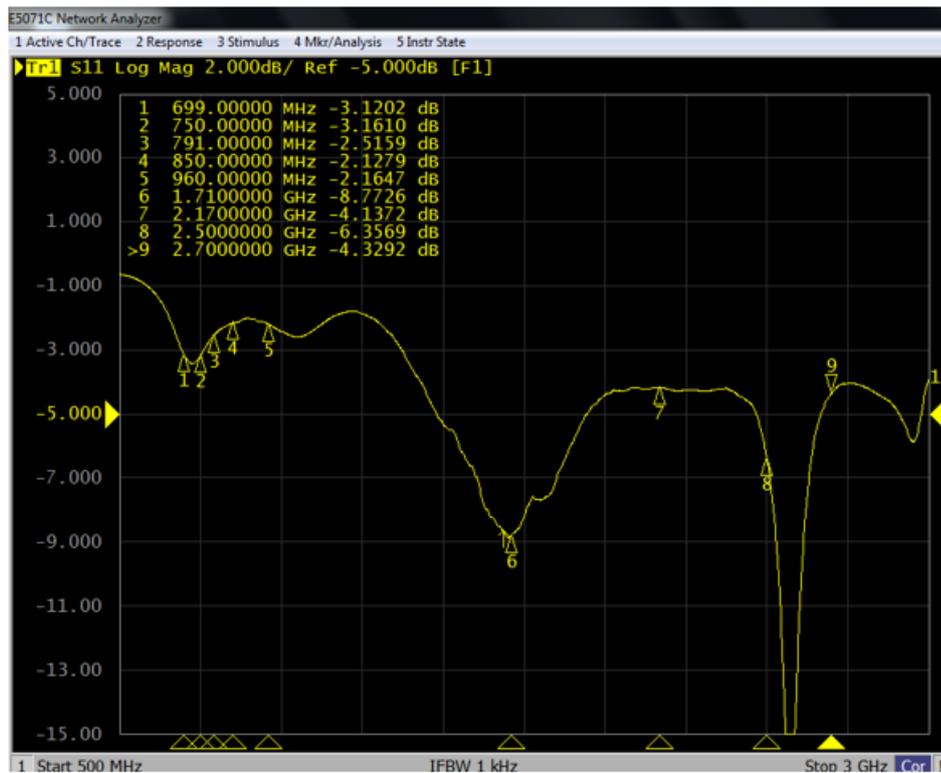
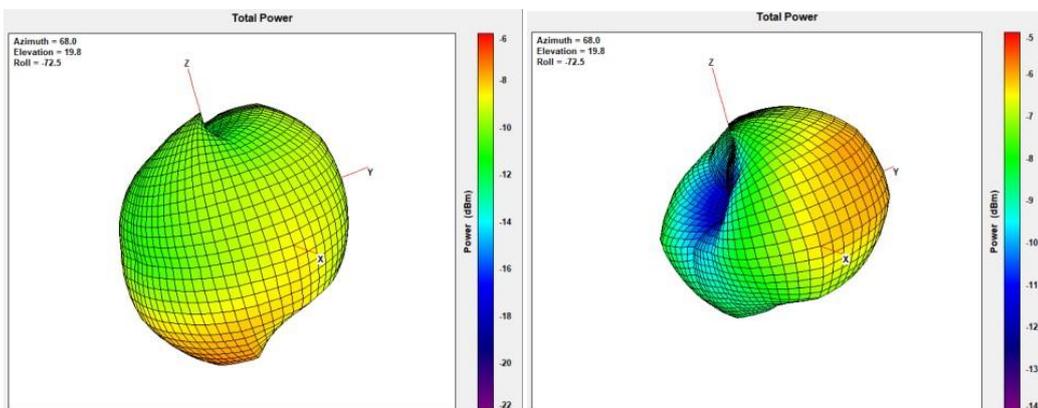


Figure 4. Antenna return loss of the cellular antenna (S11) in dB scale.

## 2.2 Radiation characteristics

Radiation characteristics of the cellular antenna are shown in Figure 6. They include the 3D radiation patterns, efficiency and gain graphs.

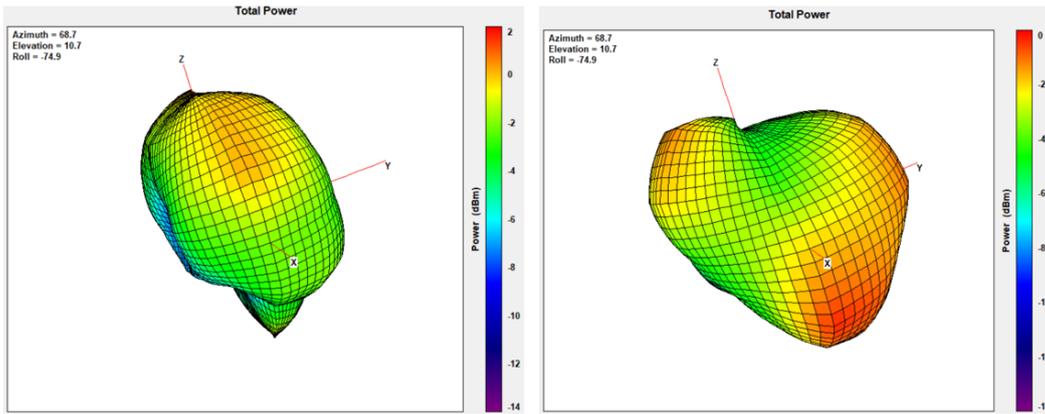
### 3D Radiation pattern



3D Radiation pattern @700MHz

3D Radiation pattern @950MHz

Confidential



3D Radiation pattern @1798MHz

3D Radiation pattern @2506MHz

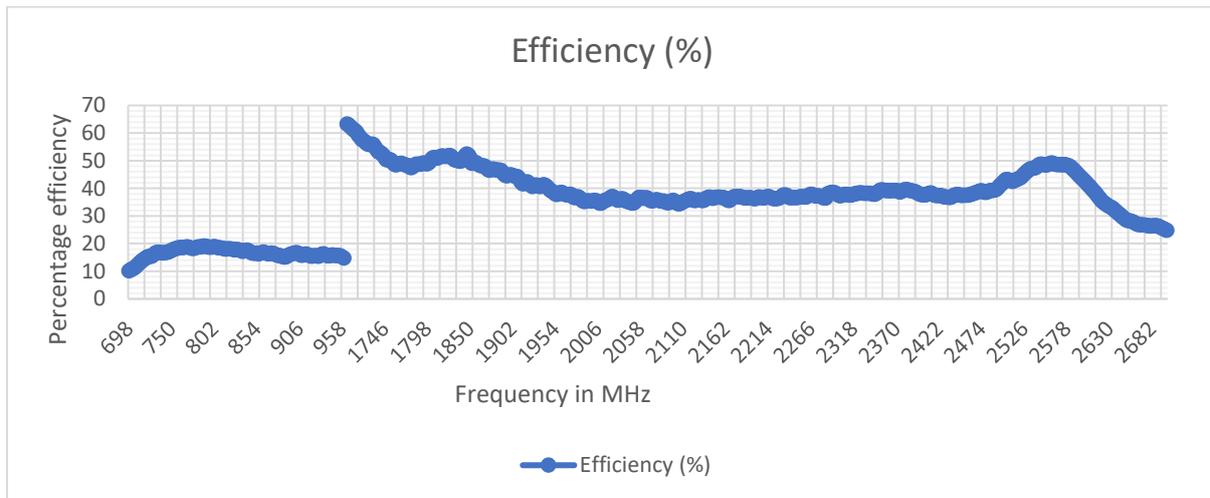


Figure 6. Radiation patterns (Theta, Phi, Total), Efficiency and Gain of the cellular antenna.

## 2.3 Summary of electrical characteristics

Electrical characteristics for antennas are summarized in Table 1.

Radio	Frequency	Max. transmit power (conducted) of the radio module/chip* (dBm)	Max. transmit power EIRP (dBm)	Antenna gain (dBi)	Module antenna gain limit (dBi)*
WiFi (IEEE 802.11 b/g/n)**	2,4Ghz	16	17,05	1,05	3
BLE (with Wirepas mesh)***	2,4GHz	7,5	9,09	1,59	3
LTE-M1 ****	High bands (1,2,3,4,25,66)	23	25	2	7,45
LTE-M1	Low bands (5,8,12,13,18,19,20,26, 28,85)	23	18	-5	11,33
2G E/GPRS ****	1800MHz	30	32	2	7,45
2G E/GPRS	850MHz	33	28	-5	11,33
* From radio module/chip specification					
** Modulation type DSSS, CCK, OFDM. Radio module u-blox Lily-W131					
*** Modulation type 2GFSK. Only BLE/Wirepas can operate simultaneously with other radios. Radio module u-blox Nina B301					
**** LTE-M/EGPRS radio module Sara R422					

Table 1. Max. EIRP for cellular radio and also WiFi and Wirepas(BLE).

## 3 WLAN antenna (WiFi)

Treon Gateway supports WLAN system on 2.4 GHz ISM frequency band. WLAN radio module is LILY-W131 from u-blox. WLAN antenna functionality is implemented by a chip antenna component from TDK (ANT162442DT-2001A2) together with a layout feature on the product pcb.

### 3.1 Antenna impedance and tuning

Matching circuitry for the WLAN antenna is shown in Figure 8.

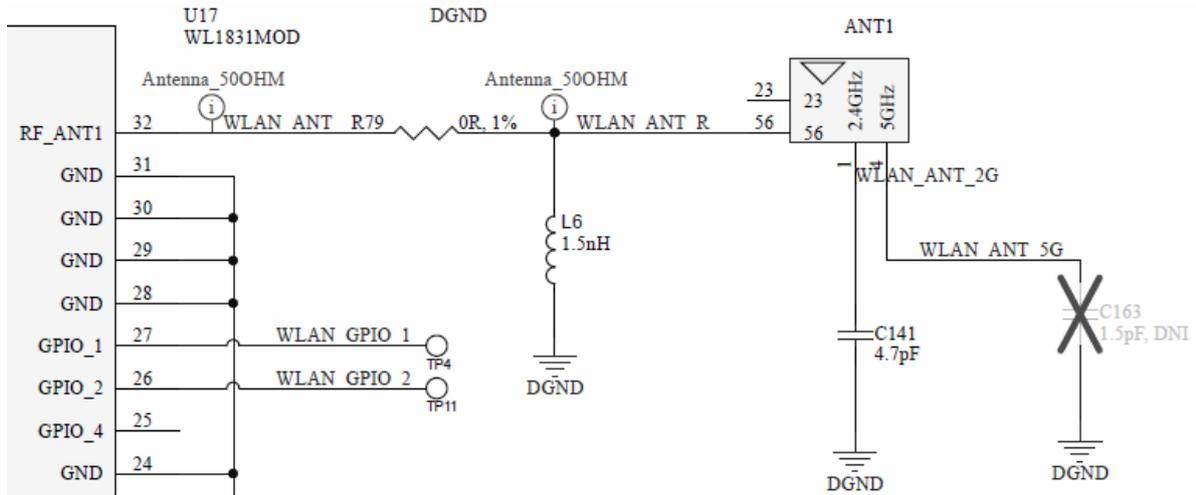


Figure 8. Antenna matching circuitry of the WLAN antenna.

Return loss of the WLAN antenna is shown in Figure 9. Isolation (S21) between the WLAN and cellular antennas more than 11dB which can be seen in the same graph.

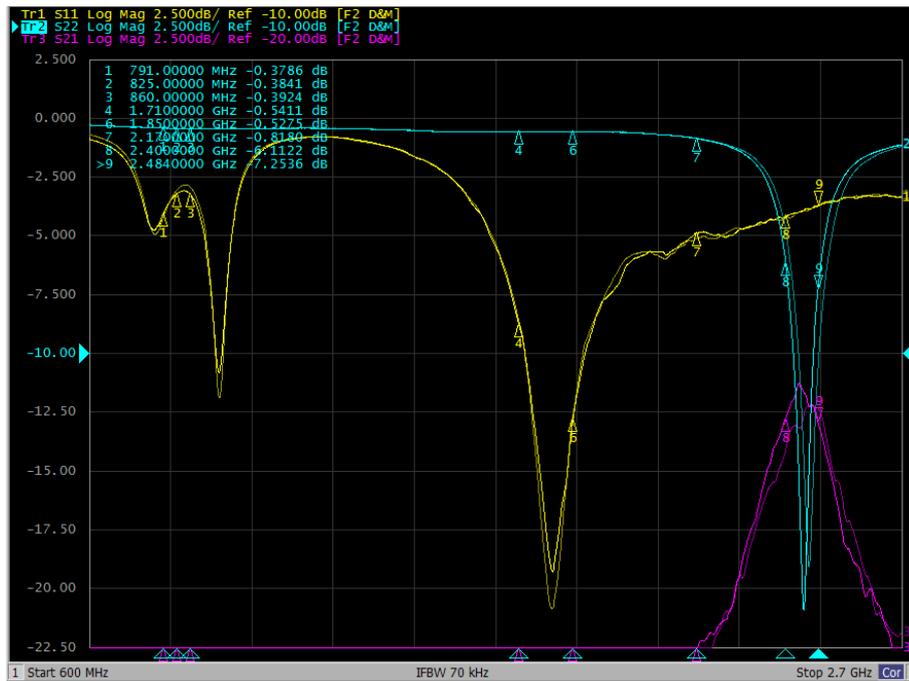


Figure 9. WLAN antenna return loss (S11, cyan curve).

Isolation between the WLAN and cellular antennas (S21, purple curve)

### 3.2 Radiation characteristics

Radiation characteristics of the WLAN antenna are shown in Figure 10. They include the 3D radiation patterns as well the Efficiency and Gain graphs. Figure 11 shows the peak EIRP and Figure 12 the efficiency.

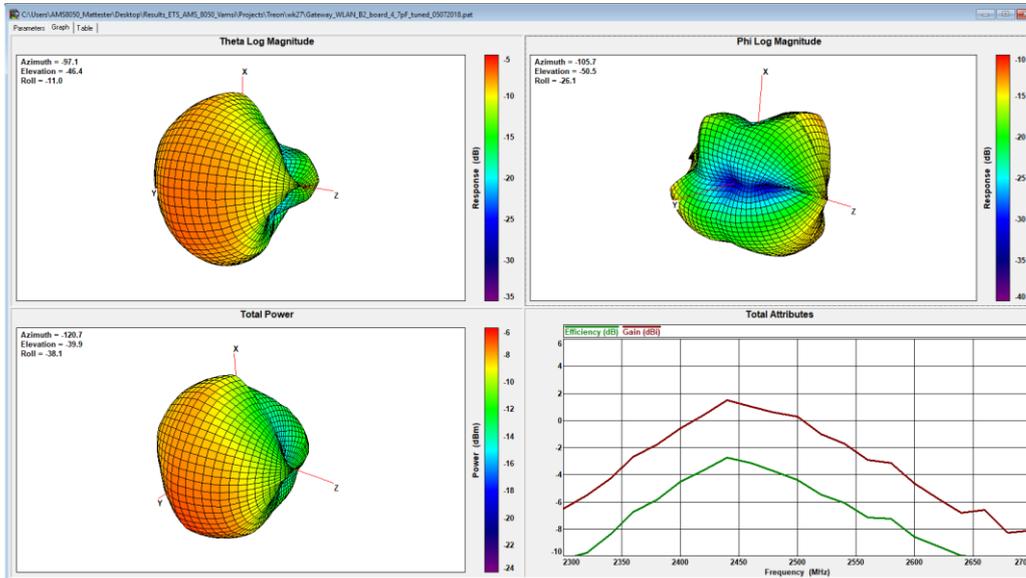


Figure 10. Radiation patterns (Theta, Phi, Total), Efficiency and Gain of WLAN antenna.

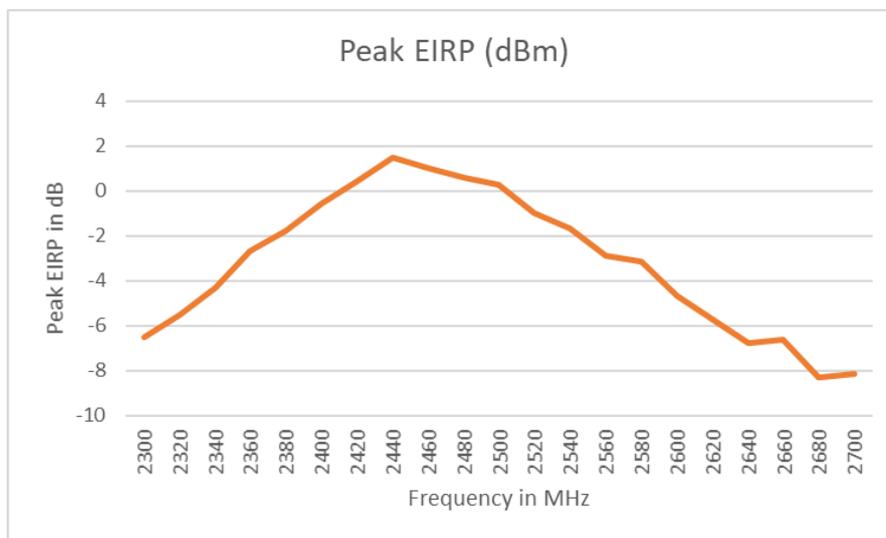


Figure 11. Peak EIRP of WLAN antenna

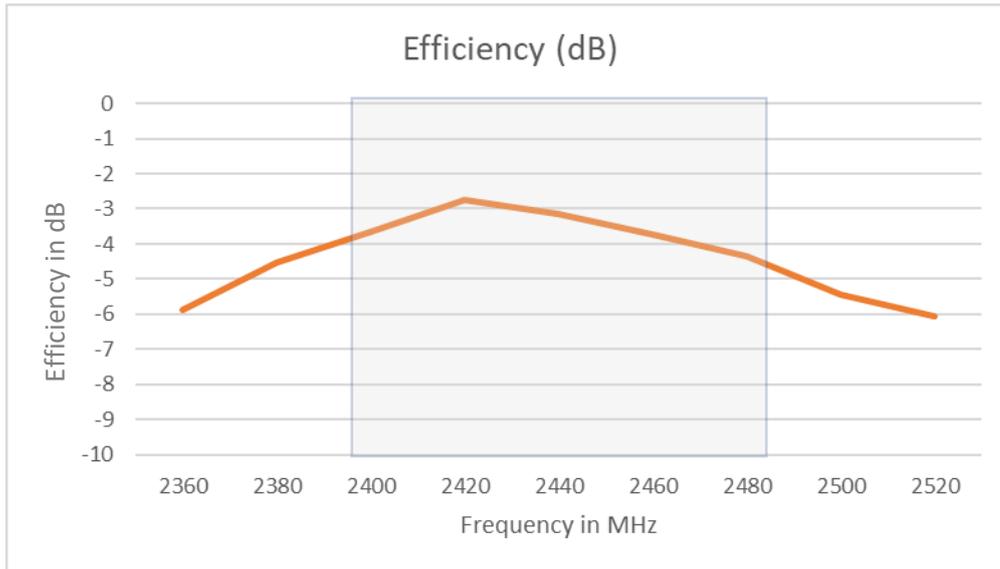


Figure 12. WLAN antenna efficiency in dB.

### 3.3 Summary of electrical characteristics

The electrical characteristics of the WLAN antenna are summarized in Table 2.

Frequency	2400-2484 MHz
Nominal impedance	50 ohm
Return loss (dB)	< -6 dB
Total efficiency (dB) on band edges	> -4.5 dB
Peak Gain (dB)	1.05

Table 2: Electrical characteristics of WLAN chip antenna

## 4 Wirepas Mesh (BLE) antenna

Treon Gateway supports Wirepas Mesh radio protocol on 2.4 GHz ISM frequency band. There is a dedicated radio module for Wirepas Mesh functionality, u-blox NINA-B301. The antenna is an inverted-F antenna on the pcb.

#### 4.1 Summary of electrical characteristics

The electrical characteristics of the Wirepas Mesh antenna are summarized in Table 3.

Frequency	2400-2484 MHz
Nominal impedance	50 ohm
Return loss (dB)	< -6 dB
Total efficiency (dB) on band edges	> -3.84
Peak Gain (dB)	1.59

Table 3. Details of the Wirepas Mesh antenna.