



SSD 025 USB BLE module

Antenna measurements

Doc.no: 3-3-TR-865 004-01

Manufacturer: Smart Sensor Devices in Sweden AB

Sollentunavaegen 67A, 191 40 Sollentuna, Sweden

Revision History

Date	Rev.	Author	Description
2023-11-07	A	Pär Berglund	Released after internal review



Table of Contents

1	REFERENCES.....	3
2	TABLE OF FIGURES.....	4
3	TABLE OF TABLES	5
4	INTRODUCTION	6
5	ANTENNA MEASUREMENTS.....	7
5.1	ANTENNA MATCHING CIRCUIT	7
5.2	VOLTAGE STANDING WAVE RATIO.....	8
5.3	ANTENNA EFFICIENCY.....	9
5.4	RADIATION PATTERNS	10
5.4.1	USB DONGLE INSERTED INTO LENOVO B590 LAPTOP WITH DISPLAY OPEN	11
5.4.2	USB DONGLE INSERTED INTO LENOVO B590 LAPTOP WITH DISPLAY CLOSED	13
5.4.3	USB DONGLE STAND-ALONE.....	15
6	SUMMARY.....	17



Prepared:
Pär Berglund
Approved:
Jonas Strandell

Release:
2023-11-07
Doc.no:
3-3-TR-865 004-01

Page:
3 of 17
Rev:
A

1 References

There are no sources in the current document.

2 Table of Figures

Figure 5-1 Updated matching circuit for SSD025 USB dongle BLE antenna. The antenna matching consists of a parallel capacitor 0,6pF closest to the antenna followed by a serial inductor 6,2nH. C102, C103 and L100 represents a low pass filter.....	7
Figure 5-2 SSD025 USB dongle inserted into USB port in Lenovo B590 laptop.	8
Figure 5-3 VSWR SSD 025 USB dongle inserted into USB port in Lenovo B590 laptop.	8
Figure 5-4 Satimo SG-23 6 GHz Stargate Antenna Test Chamber.....	10
Figure 5-5 Radiation pattern in XY-plane for SSD025 USB dongle inserted into Lenovo B590 laptop, display open.....	11
Figure 5-6 Radiation pattern in XZ-plane for SSD025 USB dongle inserted into Lenovo B590 laptop, display open.....	11
Figure 5-7 Radiation pattern in YZ-plane for SSD025 USB dongle inserted into Lenovo B590 laptop, display open.....	11
Figure 5-8 3D radiation pattern for SSD025 USB dongle inserted into Lenovo B590 laptop, display open. Maximum antenna peak gain is found to be in a cut that is not covered by the three planes XY, XZ and YZ.....	12
Figure 5-9 Radiation pattern in XY-plane for SSD025 USB dongle inserted into Lenovo B590 laptop, display closed.....	13
Figure 5-10 Radiation pattern in XZ-plane for SSD025 USB dongle. Dongle inserted into Lenovo B590 laptop with display closed.....	13
Figure 5-11 Radiation pattern in YZ-plane for SSD025 USB dongle. Dongle inserted into Lenovo B590 laptop with display closed.....	13
Figure 5-12 3D radiation pattern for SSD025 USB dongle. Dongle inserted into Lenovo B590 laptop with display closed. Maximum antenna peak gain is found to be in a cut that is not covered by the three planes XY, XZ and YZ.....	14
Figure 5-13 Radiation pattern in XY-plane for SSD025 USB dongle. USB dongle stand-alone.	15
Figure 5-14 Radiation pattern in XZ-plane for SSD025 USB dongle. USB dongle stand-alone.	15
Figure 5-15 Radiation pattern in YZ-plane for SSD025 USB dongle. USB dongle stand-alone.	15
Figure 5-16 3D radiation pattern for SSD025 USB dongle as stand-alone. Maximum antenna peak gain is found to be in a cut that is not covered by the three planes XY, XZ and YZ.	16



3 Table of Tables

Table 5-1 Matching component values for SSD025 USB dongle BLE antenna ..	7
Table 5-2 Antenna efficiency for SSD025 USB dongle inserted into Lenovo B590 laptop, display open.	9
Table 5-3 Antenna efficiency for SSD025 USB dongle inserted into Lenovo B590 laptop, display closed.	9
Table 5-4 Antenna efficiency for SSD025 USB dongle stand-alone.	9



Prepared:
Pär Berglund
Approved:
Jonas Strandell

Release:
2023-11-07
Doc.no:
3-3-TR-865 004-01

Page:
6 of 17
Rev:
A

4 Introduction

This report presents BLE antenna measurements for the SSD025 USB dongle.

5 Antenna measurements

The BLE antenna performance for the SSD025 USB dongle has been characterized by Voltage Standing Wave Ratio, antenna efficiency and radiation patterns.

As a preparation for the measurements, a coaxial cable has been soldered at the main board with the signal connected at the position of the RFIOp pad. The low pass filter, C102, C103 and L100, has been included in every measurement.

Measurements have been performed for the USB dongle inserted into a Lenovo B590 laptop as well as stand-alone.

5.1 Antenna matching circuit

The initial component values for the antenna matching have been updated. The updated value are presented in Figure 5-1 and Table 5-1.

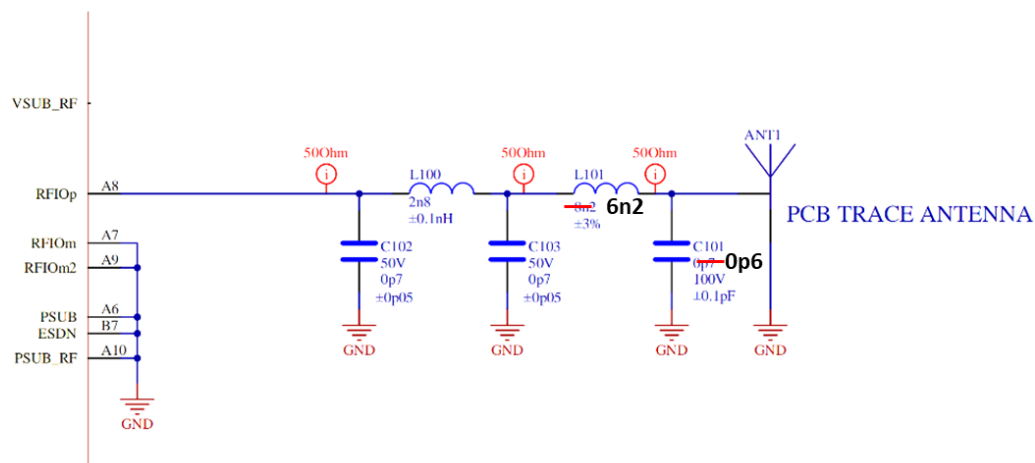


Figure 5-1 Updated matching circuit for SSD025 USB dongle BLE antenna. The antenna matching consists of a parallel capacitor 0,6pF closest to the antenna followed by a serial inductor 6,2nH. C102, C103 and L100 represents a low pass filter.

Table 5-1 Matching component values for SSD025 USB dongle BLE antenna.

Designator	Initial value	Updated value
C101	0,7pF	0,6pF
L101	8,2nH	6,2nH

5.2 Voltage Standing Wave Ratio

The VSWR for the SSD025 BLE antenna has been measured with the dongle inserted into a USB port in a Lenovo B590 laptop.



Figure 5-2 SSD025 USB dongle inserted into USB port in Lenovo B590 laptop.

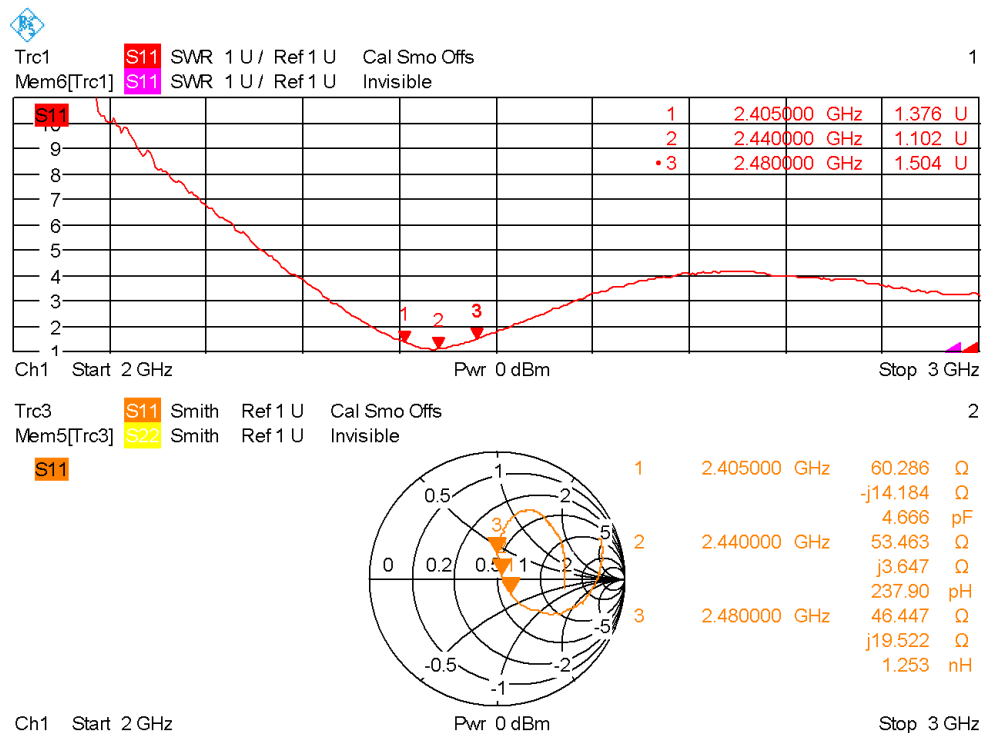


Figure 5-3 VSWR SSD 025 USB dongle inserted into USB port in Lenovo B590 laptop.

5.3 Antenna efficiency

The antenna efficiency measurements are carried out in a Satimo SG-23 6 GHz Stargate Antenna Test Chamber. The antenna efficiency, ε_T , is the ratio of the power delivered at the 50Ω antenna interface, P_t , relative to the power radiated from the antenna, $P_{radiated}$.

$$\varepsilon_T = \frac{P_{radiated}}{P_t}$$

The antenna efficiency has been measured with the USB dongle inserted into a USB port in a Lenovo B590 laptop, with the display open and closed, and as stand-alone.

Table 5-2 Antenna efficiency for SSD025 USB dongle inserted into Lenovo B590 laptop, display open.

Freq [MHz]	Efficiency [dB]
2400	-5.8
2410	-5.7
2420	-5.7
2430	-5.4
2440	-5.4
2450	-5.4
2460	-5.4
2470	-5.5
2480	-5.4

Table 5-3 Antenna efficiency for SSD025 USB dongle inserted into Lenovo B590 laptop, display closed.

Freq [MHz]	Efficiency [dB]
2400	-6.2
2410	-6.2
2420	-6
2430	-5.8
2440	-5.8
2450	-5.8
2460	-5.8
2470	-5.8
2480	-5.7

Table 5-4 Antenna efficiency for SSD025 USB dongle stand-alone.

Freq [MHz]	Efficiency [dB]
2400	-8.4
2410	-8.1
2420	-7.8
2430	-7.2
2440	-7.1
2450	-6.8
2460	-6.7
2470	-6.4
2480	-6.3

5.4 Radiation patterns

The antenna radiation pattern measurements are carried out in a Satimo SG-23 6 GHz Stargate Antenna Test Chamber. Radiation patterns are presented for three measurement planes: XY-, XZ- and YZ-planes as well as a 3D-view visualising the radiation pattern around the DUT.



Figure 5-4 Satimo SG-23 6 GHz Stargate Antenna Test Chamber.

Radiation patterns for the antenna has been measured with the USB dongle as stand-alone and inserted into a USB port in a Lenovo B590 laptop, with the display open and closed.

5.4.1 USB dongle inserted into Lenovo B590 laptop with display open

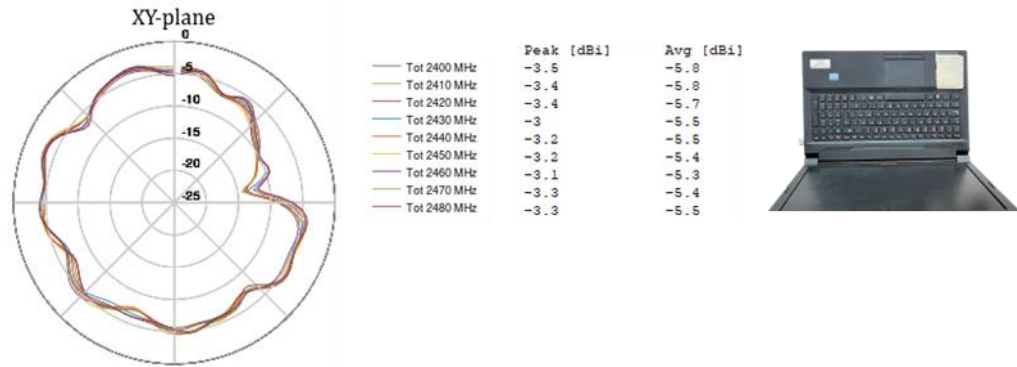


Figure 5-5 Radiation pattern in XY-plane for SSD025 USB dongle inserted into Lenovo B590 laptop, display open.

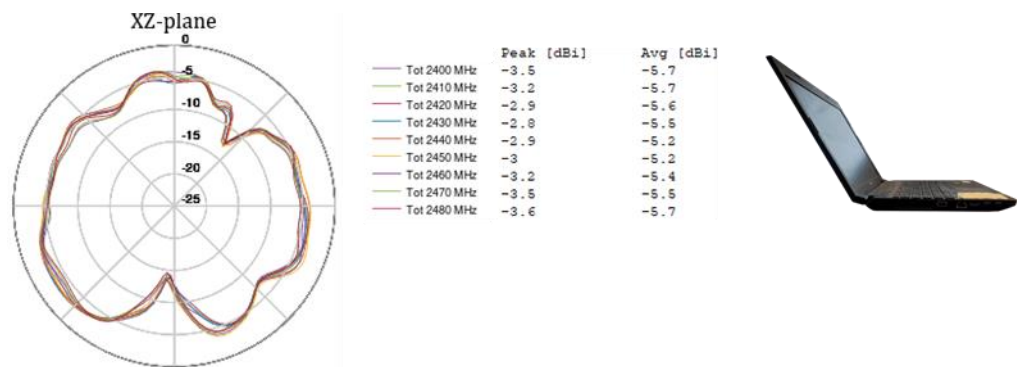


Figure 5-6 Radiation pattern in XZ-plane for SSD025 USB dongle inserted into Lenovo B590 laptop, display open.

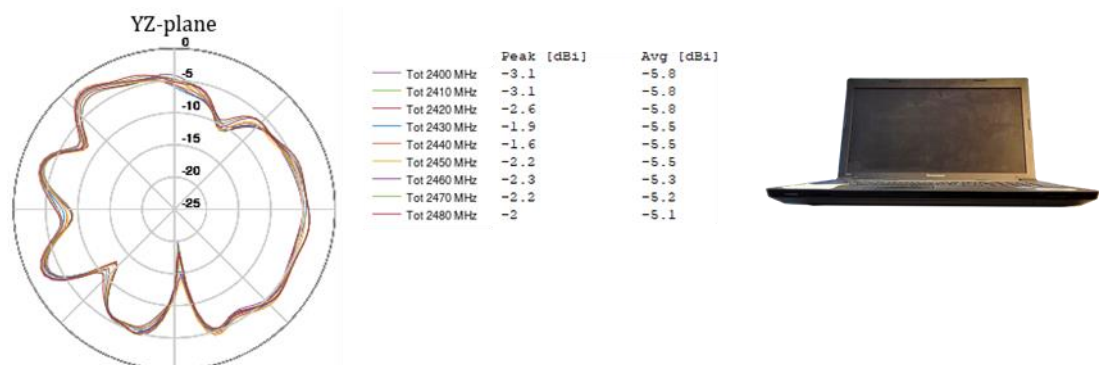


Figure 5-7 Radiation pattern in YZ-plane for SSD025 USB dongle inserted into Lenovo B590 laptop, display open.

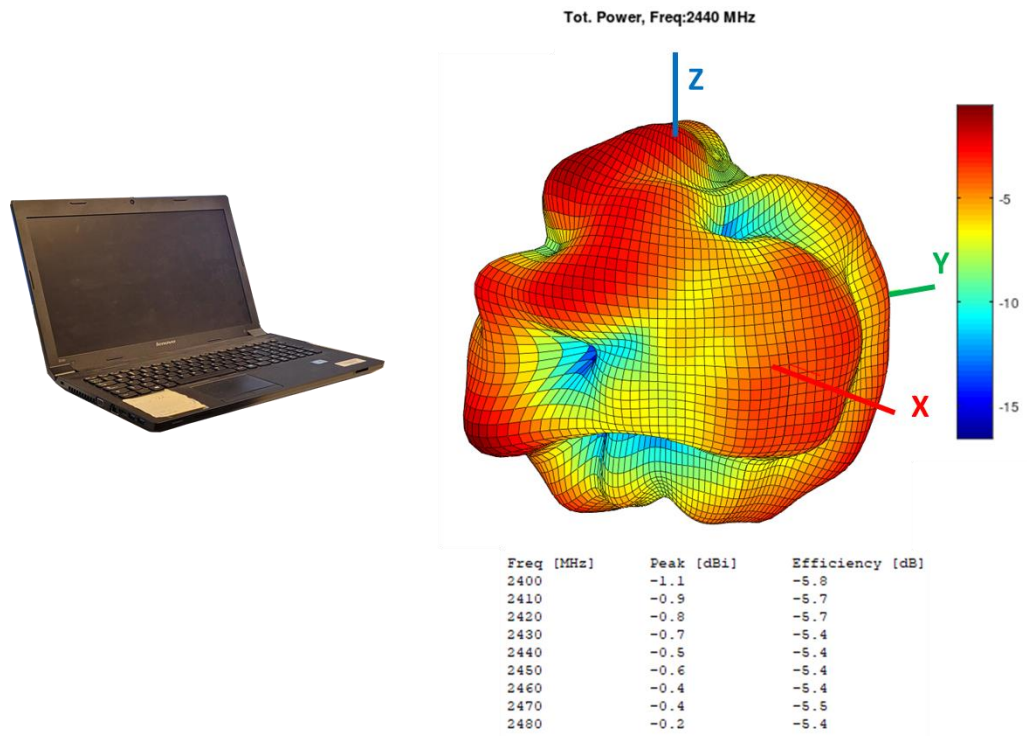


Figure 5-8 3D radiation pattern for SSD025 USB dongle inserted into Lenovo B590 laptop, display open. Maximum antenna peak gain is found to be in a cut that is not covered by the three planes XY, XZ and YZ.

5.4.2 USB dongle inserted into Lenovo B590 laptop with display closed

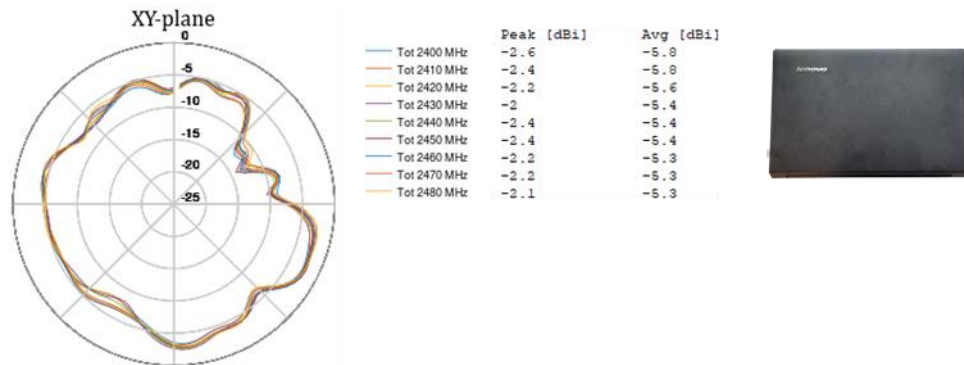


Figure 5-9 Radiation pattern in XY-plane for SSD025 USB dongle inserted into Lenovo B590 laptop, display closed.

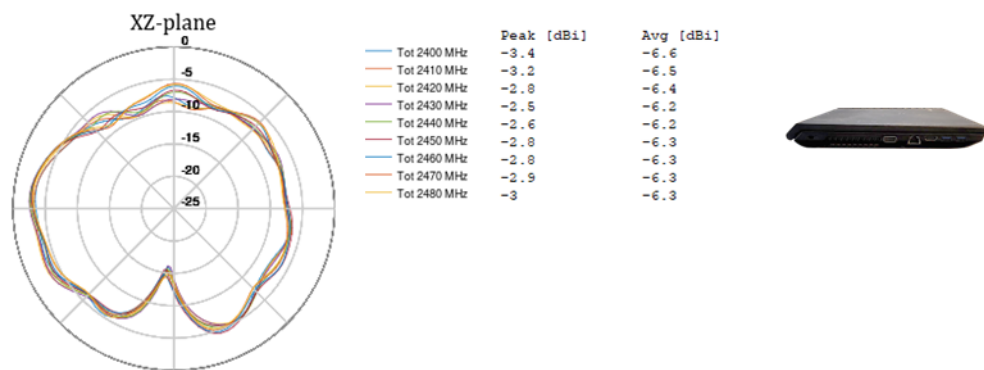


Figure 5-10 Radiation pattern in XZ-plane for SSD025 USB dongle. Dongle inserted into Lenovo B590 laptop with display closed.

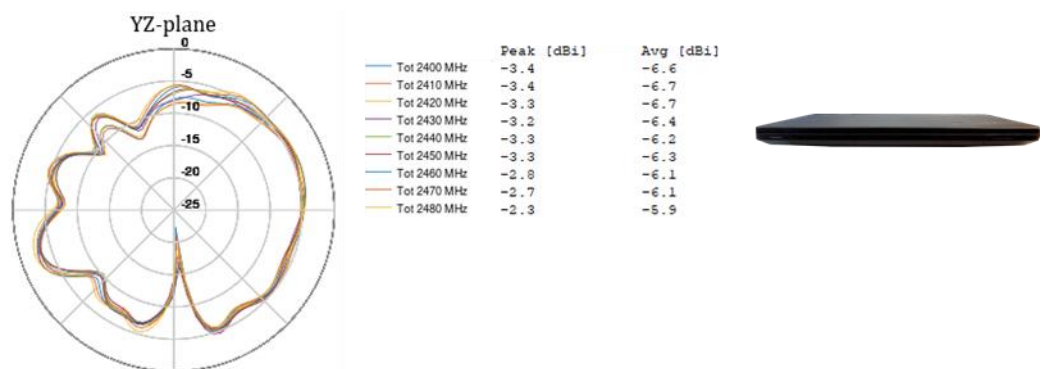


Figure 5-11 Radiation pattern in YZ-plane for SSD025 USB dongle. Dongle inserted into Lenovo B590 laptop with display closed.

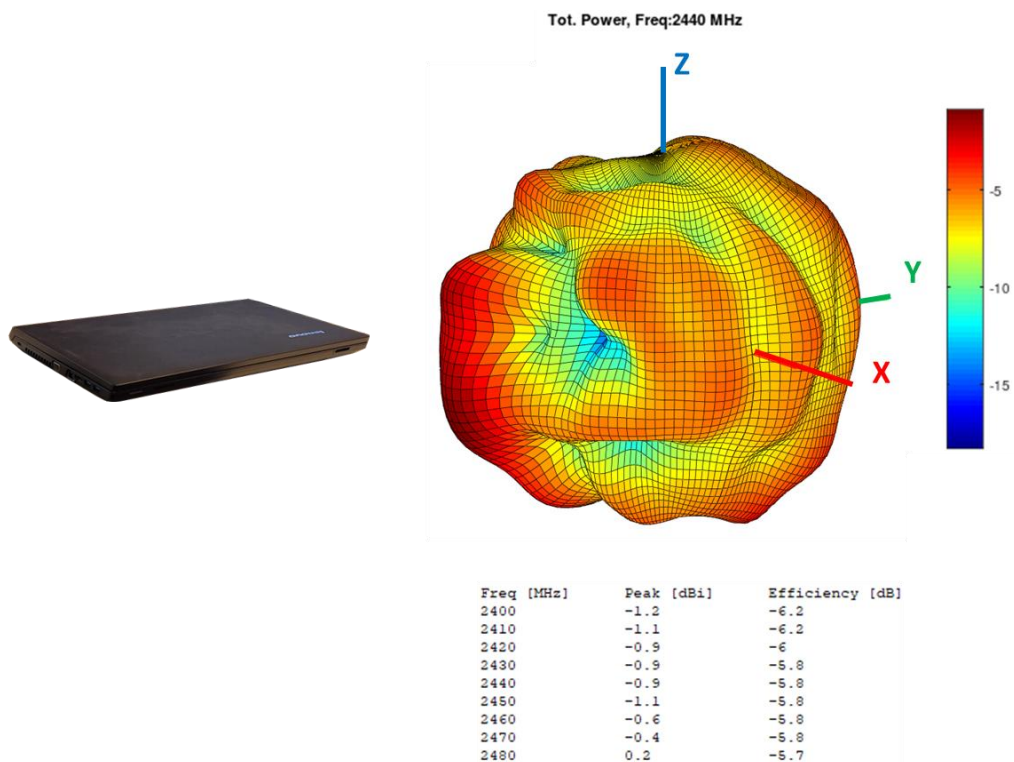


Figure 5-12 3D radiation pattern for SSD025 USB dongle. Dongle inserted into Lenovo B590 laptop with display closed. Maximum antenna peak gain is found to be in a cut that is not covered by the three planes XY, XZ and YZ.

5.4.3 USB dongle stand-alone

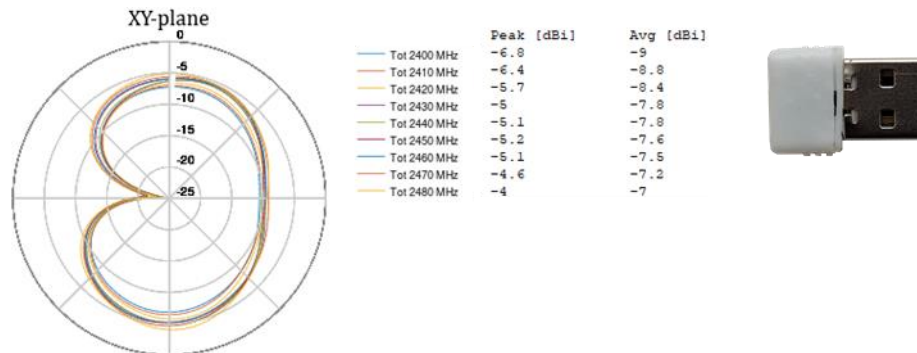


Figure 5-13 Radiation pattern in XY-plane for SSD025 USB dongle. USB dongle stand-alone.

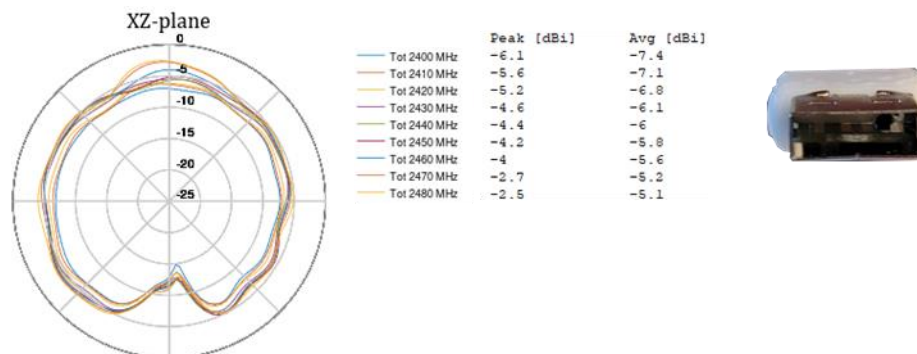


Figure 5-14 Radiation pattern in XZ-plane for SSD025 USB dongle. USB dongle stand-alone.

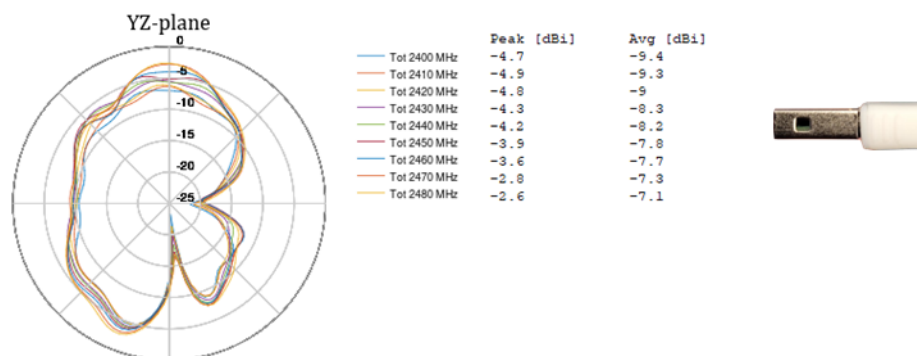


Figure 5-15 Radiation pattern in YZ-plane for SSD025 USB dongle. USB dongle stand-alone.

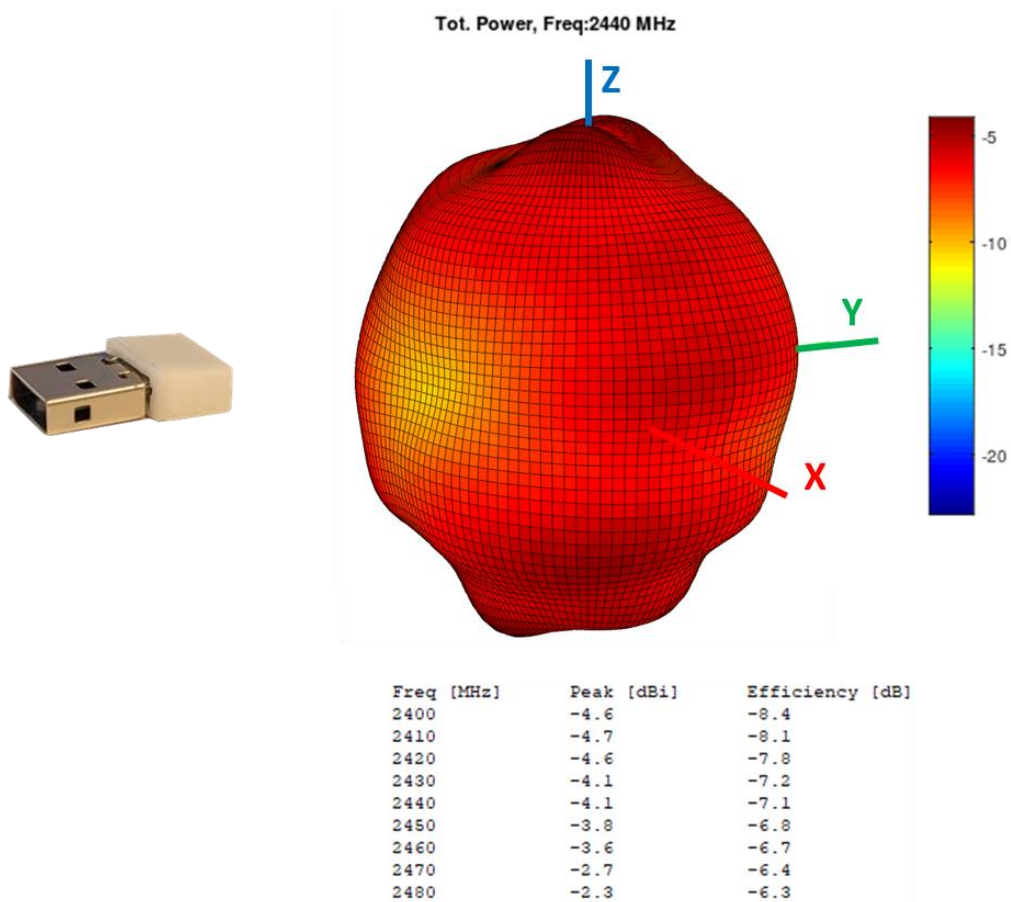


Figure 5-16 3D radiation pattern for SSD025 USB dongle as stand-alone. Maximum antenna peak gain is found to be in a cut that is not covered by the three planes XY, XZ and YZ.

6 Summary

The BLE antenna performance for the SSD025 USB dongle has been characterized.

The initial antenna matching has been updated and the resulting VSWR, with the USB dongle positioned in a Lenovo laptop, is less than 1.5:1.

The antenna efficiency is in the order of -5.5 to -6dB with the USB dongle positioned in a Lenovo laptop.

The maximum antenna peak gain is measured to be:

USB dongle as stand-alone:	-2.3dBi
USB dongle positioned in a Lenovo laptop, display closed:	+0.2dBi
USB dongle positioned in a Lenovo laptop, display open:	-0.2dBi