WLT8761M antenna

Small Size 2.4 GHz PCB antenna

1   INTRODUCTION

The PCB antenna used on the WLT8761M reference design is described in this application note. Even if the antenna presented is for a WLT8761M it can be used in all 2.4 GHz designs, especially where small space is required for the antenna. This application note describes the antenna dimensions, the RF performance and considerations for complying with regulatory limits when using this design.

The suggested antenna design requires no more than 14.4x5.6mm of space and ensures a VSWR ratio of less than 2 across the 2.4 GHz ISM band when connected to a 50 ohm source.
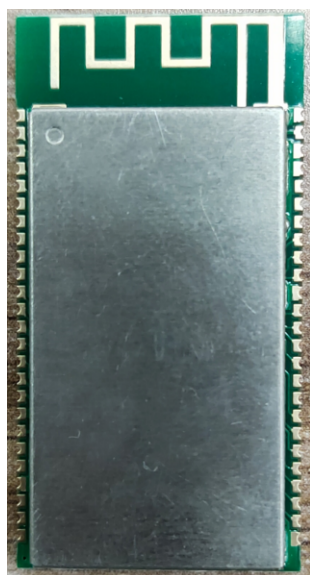
Figure 1 :WLT8761M

Antenna Name	Inverted F Antenna
Antenna Model	CBT-RBT11
Antenna Gain	3dBi
Lab Name	Yaodeng Diantong Technology (Kunshan) Co., Ltd.
Lab Address	15 Yingbin Road, Zhoushi Town, Kunshan City, Jiangsu

antenna information sheet				
Component name	Model number	specification	manufacturer	remark (Spare part)
PCB天线	CBT-RBT11	LDS,Gain =3dBi,SABICNX10302	Jiashi Communication Co., Ltd	Room 301, Building 27, Changping Jewelry Cultural Industry Center, No. 568 Huanchang North Road, Shangkeng Village, Changping Town, Dongguan City, Guangdong Province, PRC.

2   ANTENNA DESIGN

The PCB antenna on the WLT8761M reference design is a meandered Inverted F Antenna (IFA). The IFA was designed to match an impedance of 50 ohm at 2.45 GHz. Thus no additional matching components are necessary.

2.1   Design Goals

The reflection at the feed point of the antenna determines how much of the applied power is delivered to the antenna. A reflection of less than -10 dB across the 2.4 GHz ISM band, when connected to a 50 ohm source, was a design goal. Reflection of less than -10 dB, or VSWR less than 2, ensures that more than 90% of the available power is delivered to the antenna. Bandwidth is in this document defined as the frequency band where more than 90% of the available power is delivered to the antenna. Another design goal was to fit the size of the PCB antenna on a WLT8761M and to obtain good performance also when the dongle is connected to a computer.

2.2   Simulation

IE3D from Zeland, which is an electromagnetic simulation tool, was used to design the antenna. The accuracy of the simulation is controlled by the mesh. An increase of the mesh increases the simulation time. Thus, for initial simulations mesh = 1 should be used. When a fairly good result is achieved a higher mesh should be used to obtain more accurate results. Comparison of simulation and measurement results shows that the measured reflection is between the result obtained with mesh = 5 and mesh = 1; see Figure 2 for details.
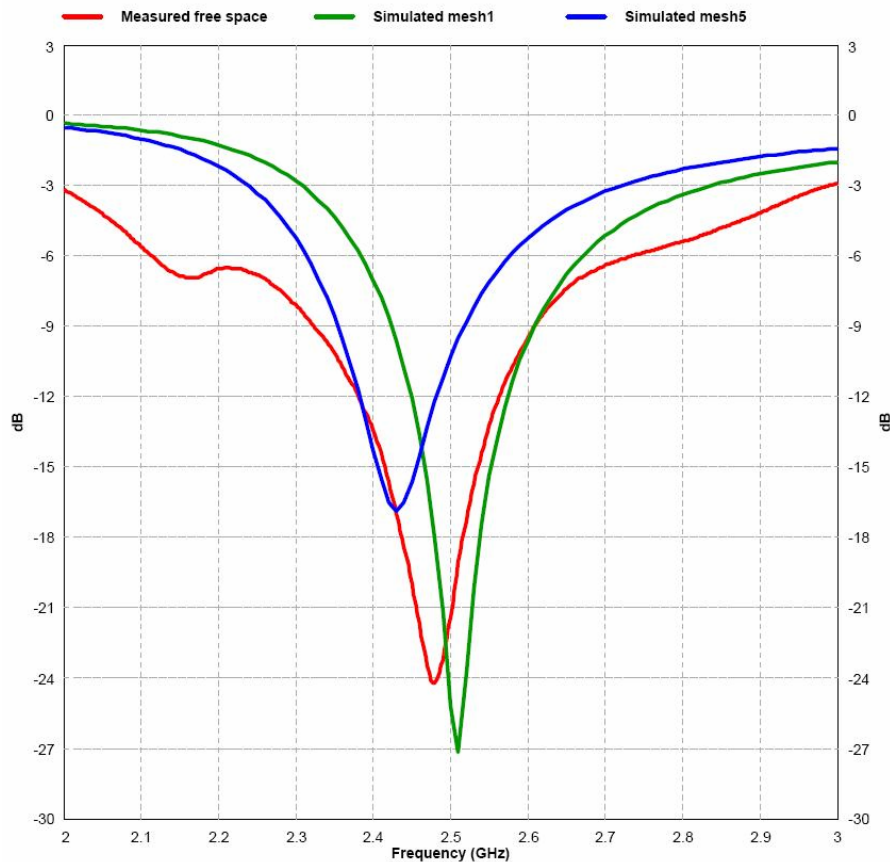

Figure 2: Comparison of Simulation and Measurements Results

2.3 Layout and Implementation

Small changes of the antenna dimensions may have large impact on the performance. Therefore it is strongly recommended to make an exact copy of the reference design to achieve optimum performance. The easiest way to implement the antenna is to import the gerber or DXF file showing the antenna layout. The imported file can be used as a template when drawing the antenna. By using this procedure it should be possible to make an exact copy. If the PCB CAD tool being used does not support import of DXF or gerber files, Figure 3 and Table 1 should be used to ensure correct implementation. It is recommended to generate a gerber file for comparison with IFA_USB.spl when making a manual implementation. Most gerber viewers have the possibility to import several gerber files at the same time. Thus by placing the gerber file, showing the manually implemented antenna, on top of IFA_USB.spl it is easy to verify that the antenna is correctly implemented. It is also recommended to use the same thickness and type of PCB material as used in the reference design. Information about the PCB can be found in a separate readme file included in the reference design. To compensate for a thicker/thinner PCB the antenna could be made slightly shorter/longer.
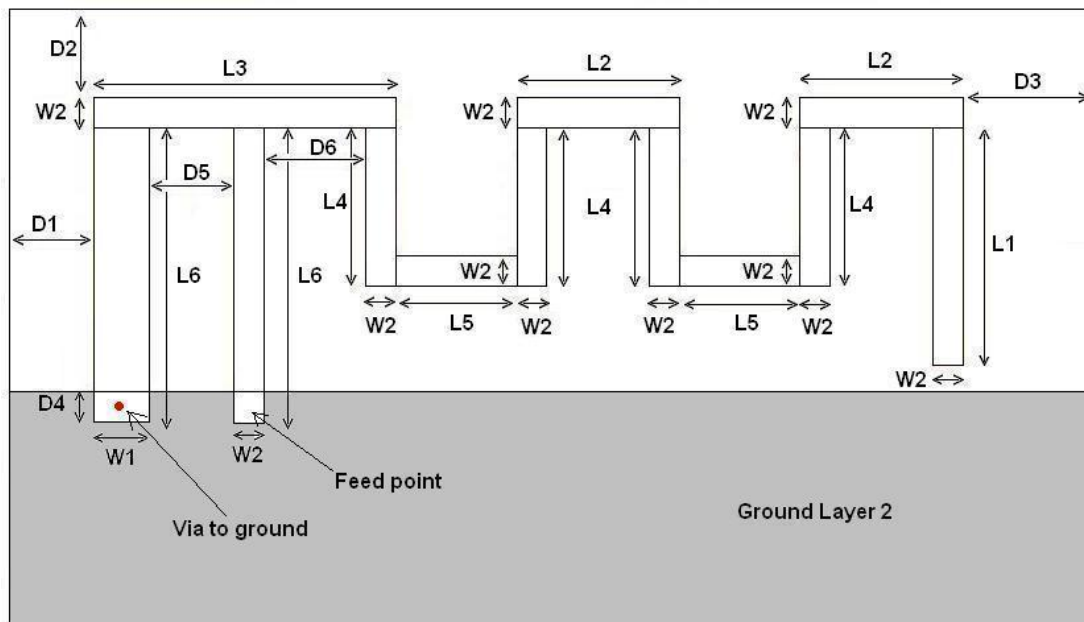
Figure 3: Antenna Dimensions

L1	3.95mm
L2	2.70mm
L3	5.00mm
L4	2.65mm
L5	2.00mm
L6	5.75mm
W1	0.90mm
W2	0.50mm
D1	1.38mm
D2	0.30mm
D3	2.24mm
D4	0.70mm
D5	1.40mm
D6	1.72mm

Table 1: Antenna Dimensions

3 TEST RESULTS

Reflection, radiation pattern and variation of output power across a wide frequency band were measured to verify the performance of the PCB antenna. Measurements of the dongle in free space and when connected to a laptop were performed to verify that the antenna is suitable both for WLT8761M designs and in a standalone application. Free space is in this document interpreted as a measurement performed without connecting the dongle to a computer. In such a measurement the dongle is only powered by a battery.

3.1 Reflection

All the reflection measurements were performed with a network analyzer connected to a semi-rigid coax cable, which was soldered to the feed point of the antenna. Because of the small size antenna and the small ground plane this kind of measurements is heavily affected by the presence and placement of the coax cable. This influence can result in a small uncertainty in resonance frequency and measured reflection. Typically different placement of the semi-rigid coax cable could change the resonance frequency with 5 -10 MHz and the reflection with 3 - 4 dB.
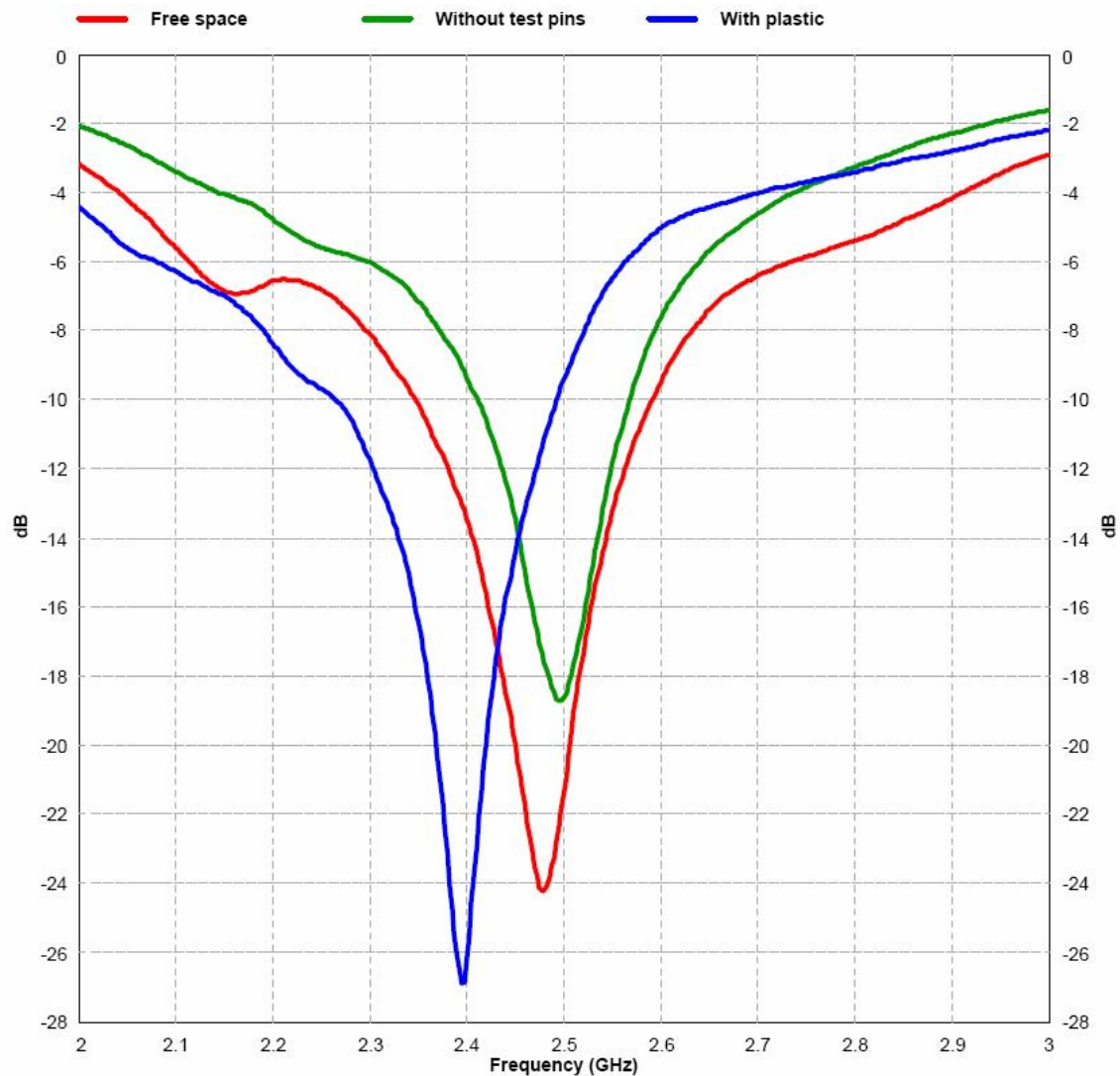

Figure 4: Influence of Plastic Encapsulation and Test Pins

A small part on the WLT8761M PCB is equipped with test pins. These are intended for use during development. This part of the PCB will typically be omitted in a final application. The red and green graph on Figure 4 shows that removing this part of the PCB has a small impact on the pe rformance. Figure 4 also shows that plastic encapsulation of the dongle will shift the resonance frequency to a lower frequency. This can be compensated by making the antenna slightly shorter.

The size of the ground plane affects the performance of the PCB antenna. Connecting the WLT8761M to a computer increases the size of the ground plane and thus the performance is affected. Figure 5 shows how the performance is affected when the WLT8761M is connected to a laptop. In free space the antenna has a bandwidth of approximately 250 MHz. When the WLT8761M is connected to the laptop the bandwidth is reduced to around 100 MHz, which still is enough to cover the whole 2.4 GHz ISM band.
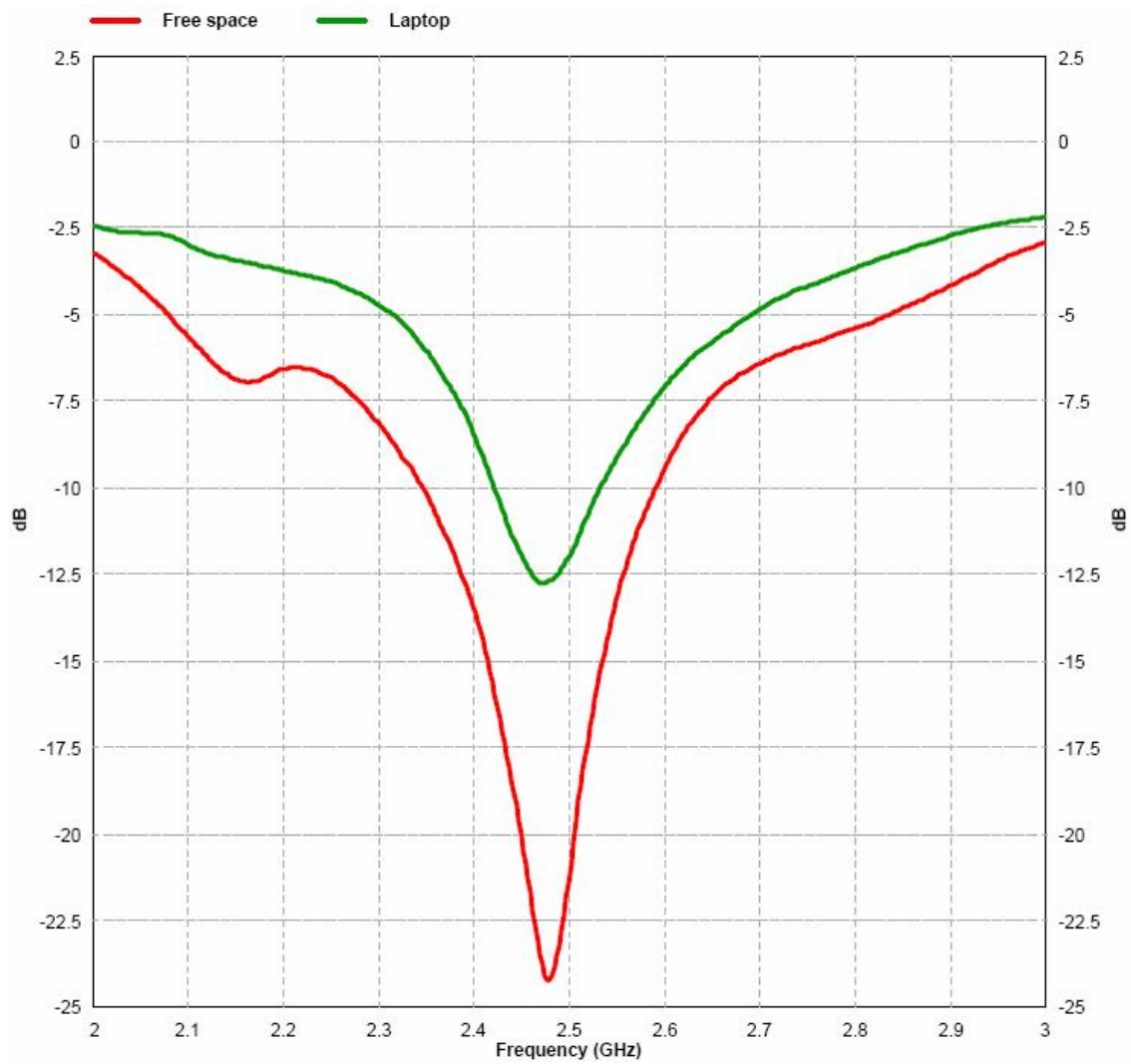
Figure 5: Comparison of Performance

3.2   Radiation Pattern

The radiation pattern for the antenna implemented on the WLT8761M reference design has been measured in an anechoic chamber. Figure 7 through Figure 12 shows radiation patterns for three planes, XY, XZ and YZ, measured with vertical and horizontal polarization. All these measurement were performed without connecting the dongle to a computer. Figure 13 and Figure 14 shows the radiation pattern when the dongle is connected to a laptop. All measurements were performed with 0 dBm output power. Figure 6 shows how the different radiation patters are related to the positioning of the antenna.
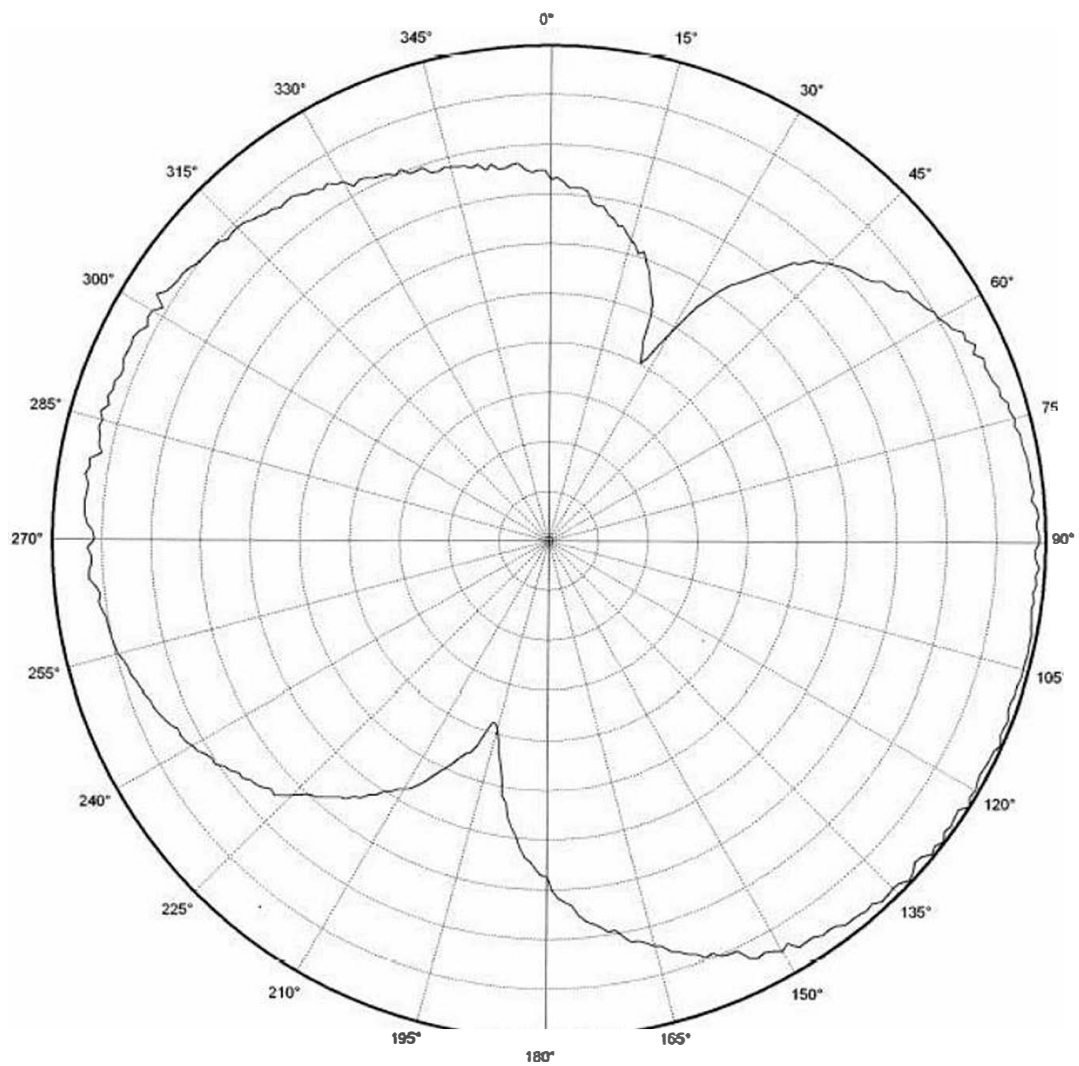

XY plane

YZ plane

XZ plane
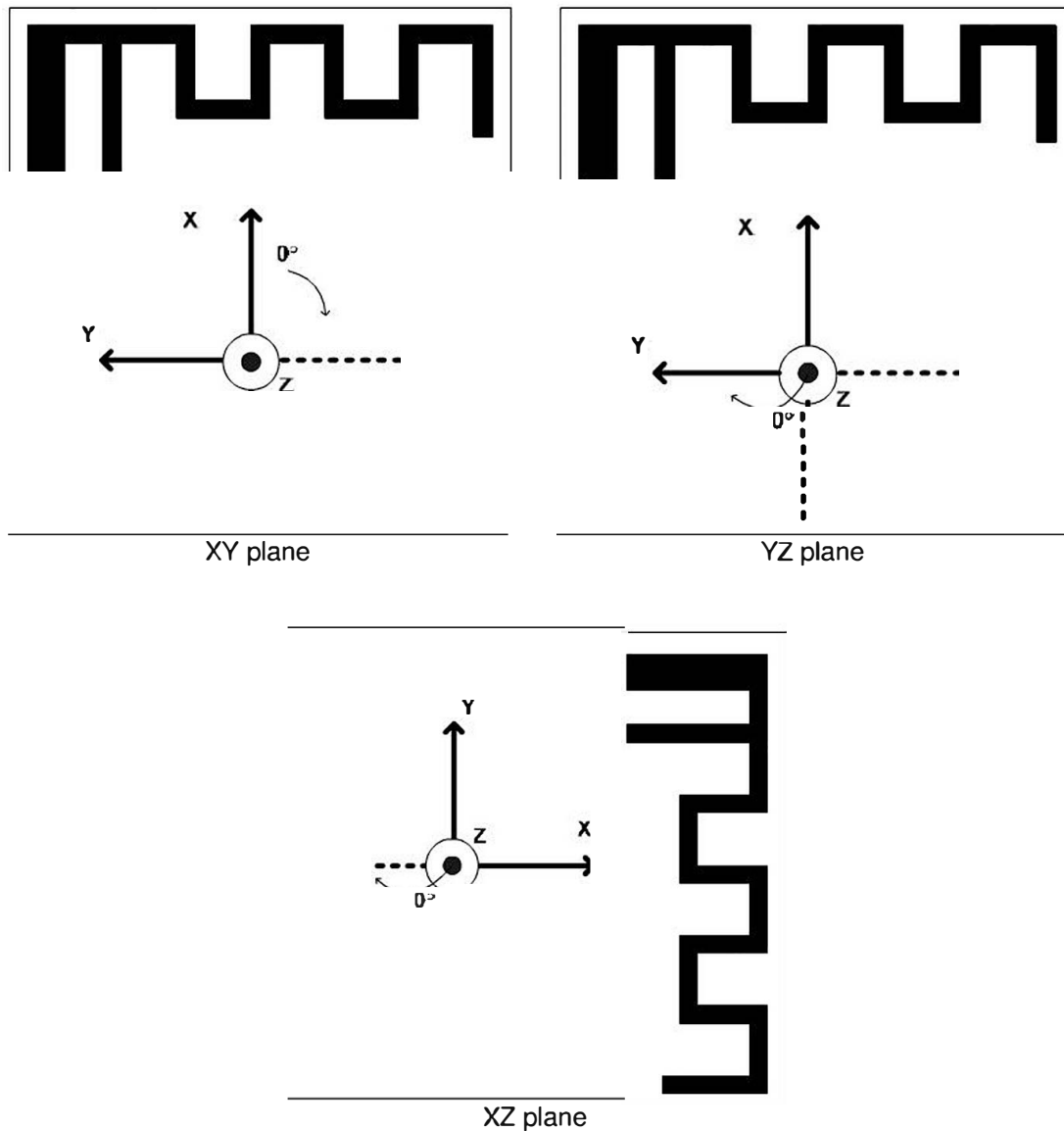
Figure 6: How to Relate the Antenna to the Radiation Patterns

Figure 7: WLT8761M XY Plane

CF 2450.000 MHz

Horisontal Polarization

usb XY

Figure 8: WLT8761M XY Plane
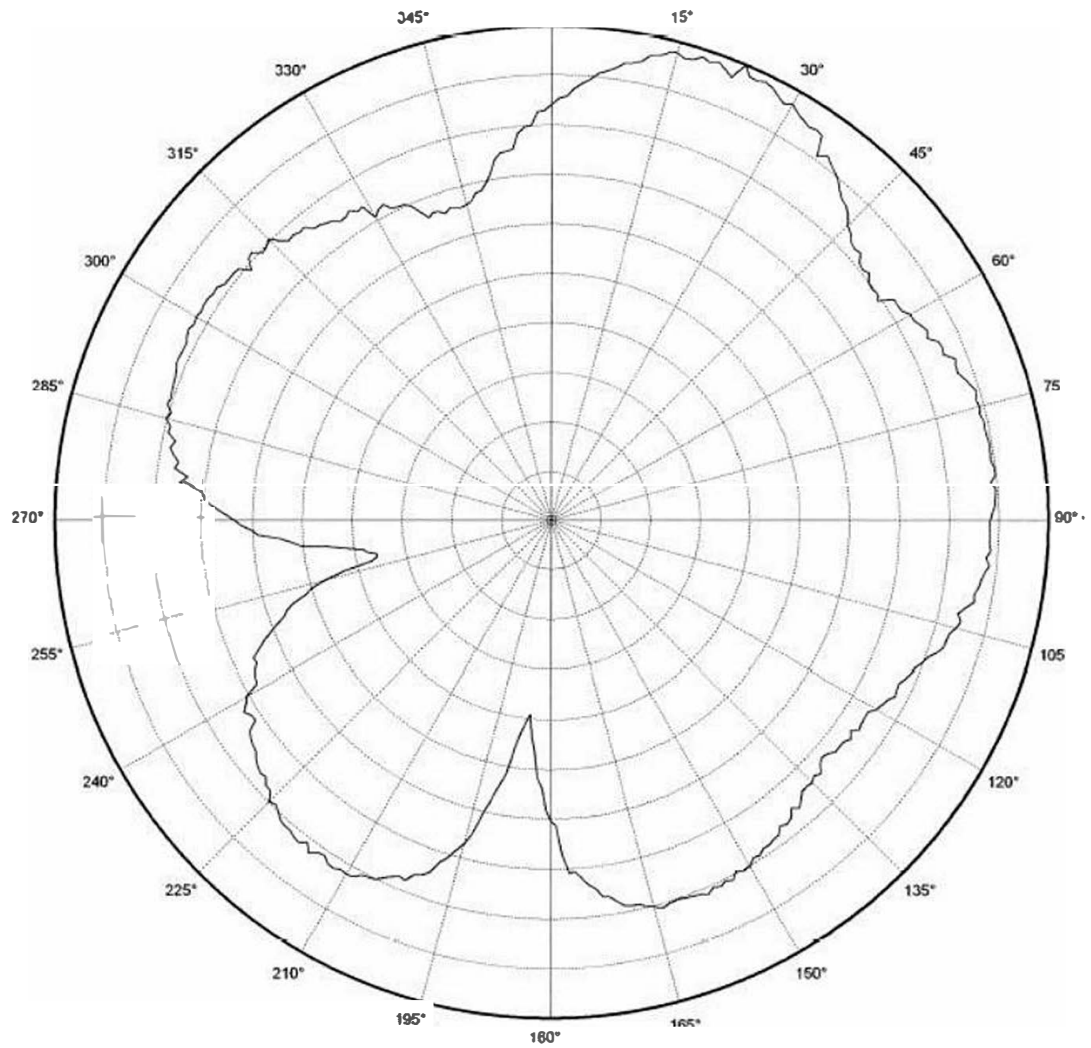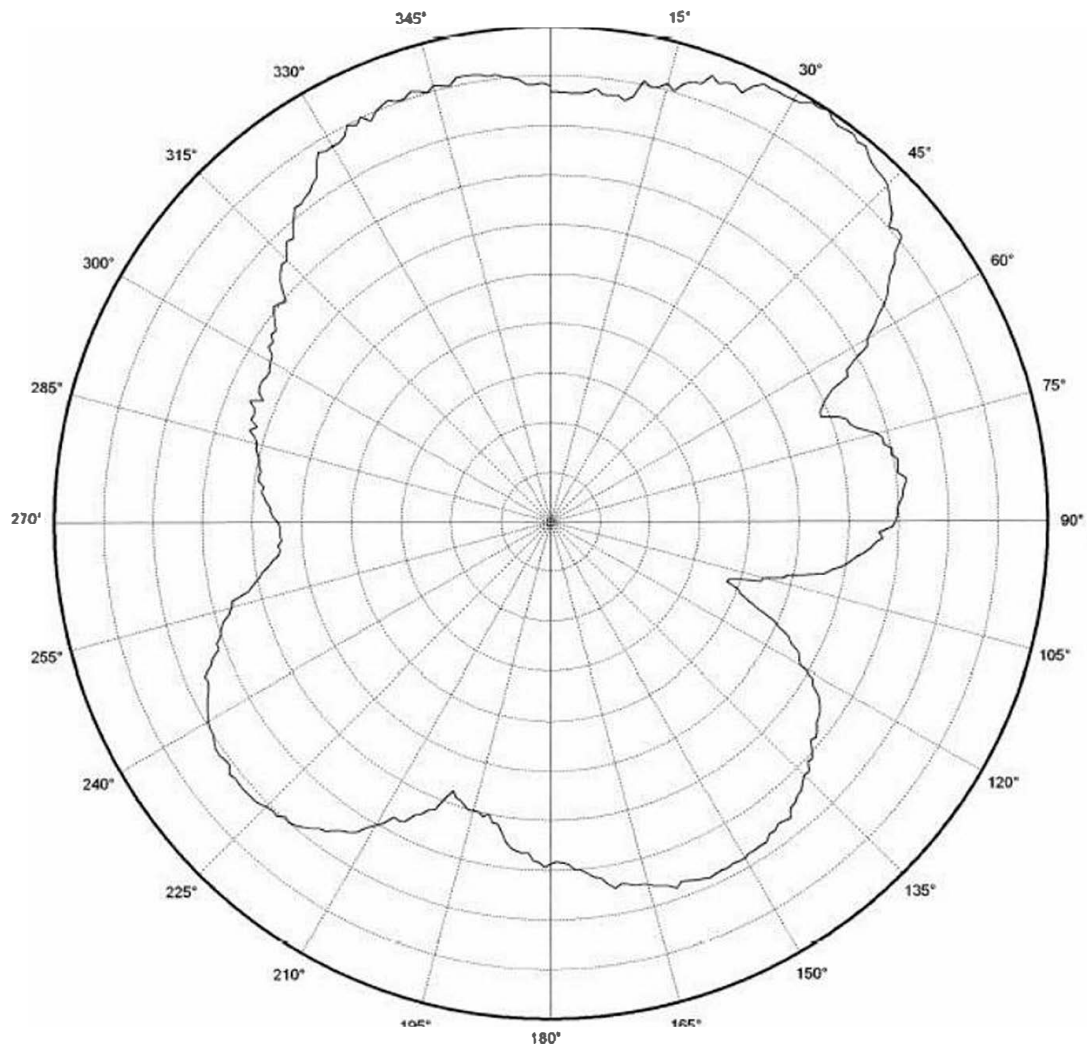
CF 2450.000 MHz

Vertical Polarization

usb XZ

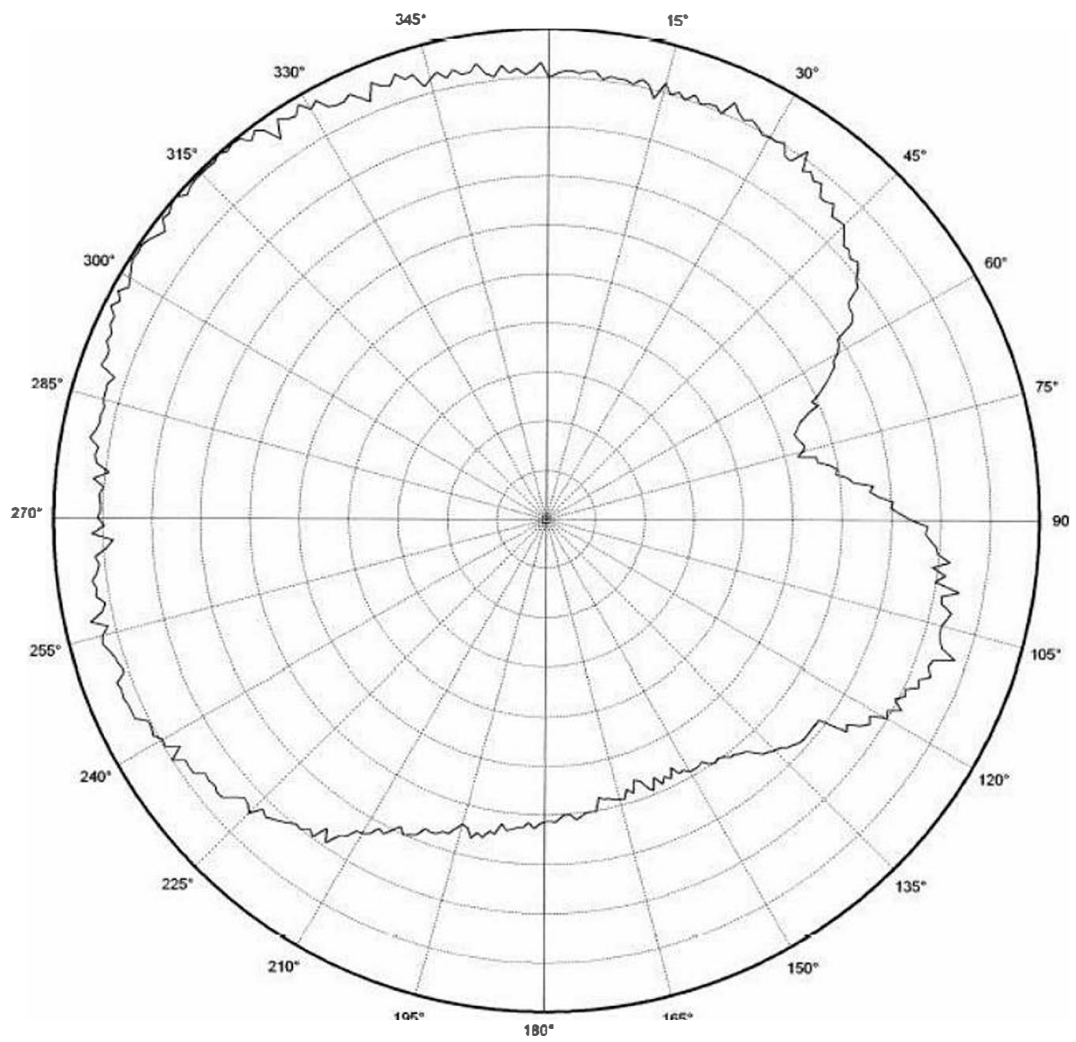**Figure 9: WLT8761M XZ Plane**

CF 2450.000 MHz

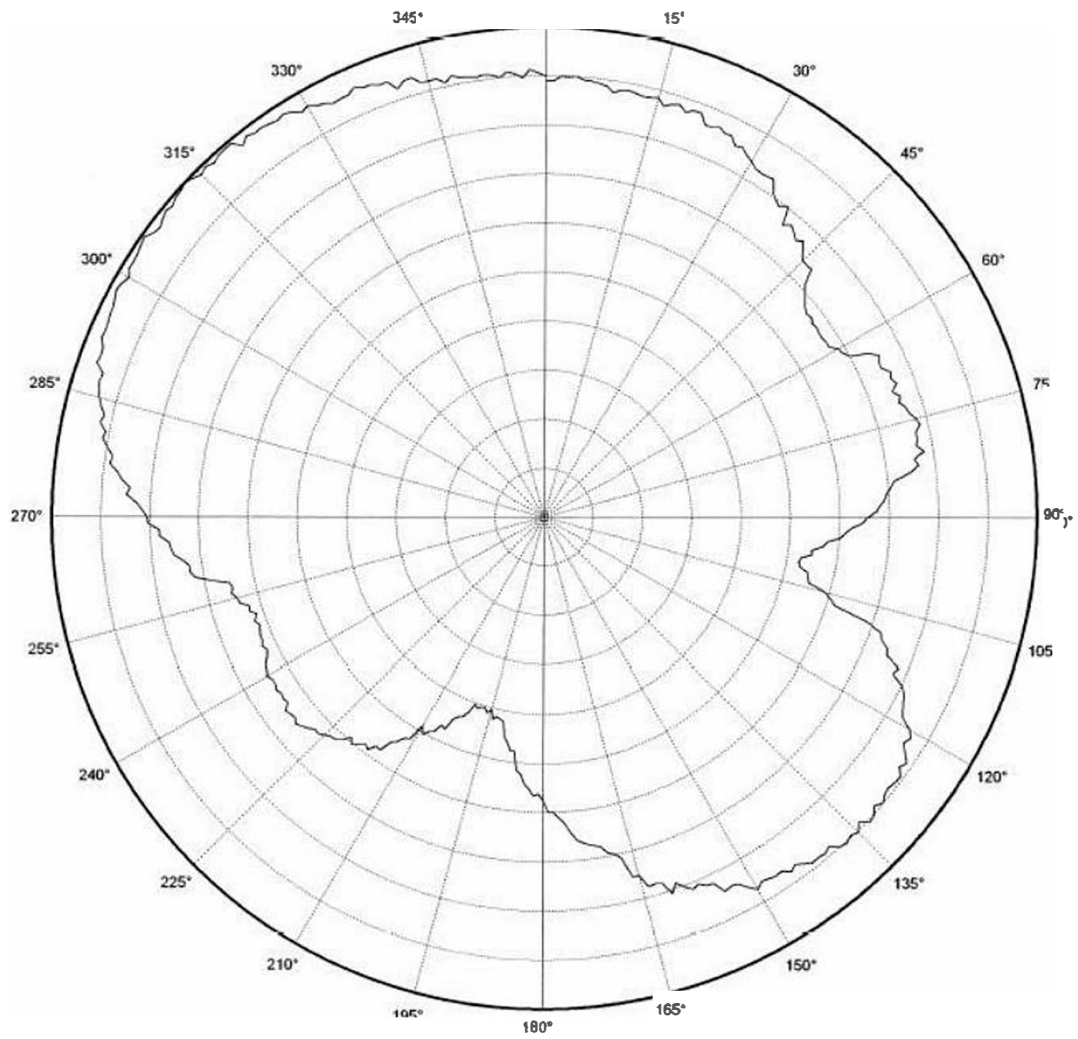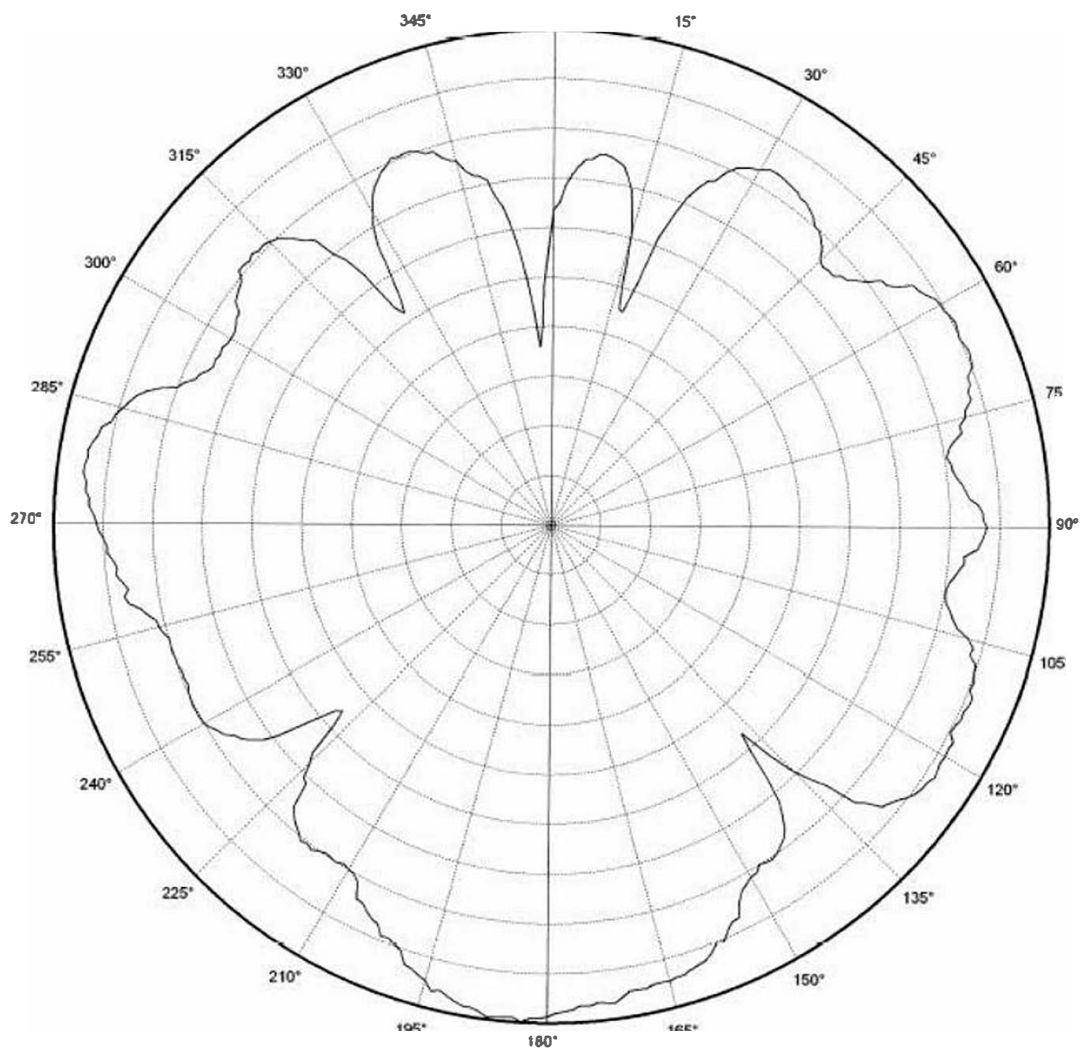**Horisontal Polarization**

XZ

Figure 10: WLT8761M XZ Plane

Vertical Polarization

YZ

CF 2450.000 MHz

Figure 11: WLT8761M YZ Plane

345°   15'
330°
315°
300°
285°
270°
255°
240°
225°
210°
195°   180°   165°
30°
45°
60°
75
90°
105
120°
135°
150°

CF 2450.000 MHz

Horisontal Polarization

YZ

Figure 12:WLT8761M YZ Plane

CF 2450.000 MHz

Vertical Polarization

Laptop XY

Figure 13: WLT8761M XY Plane
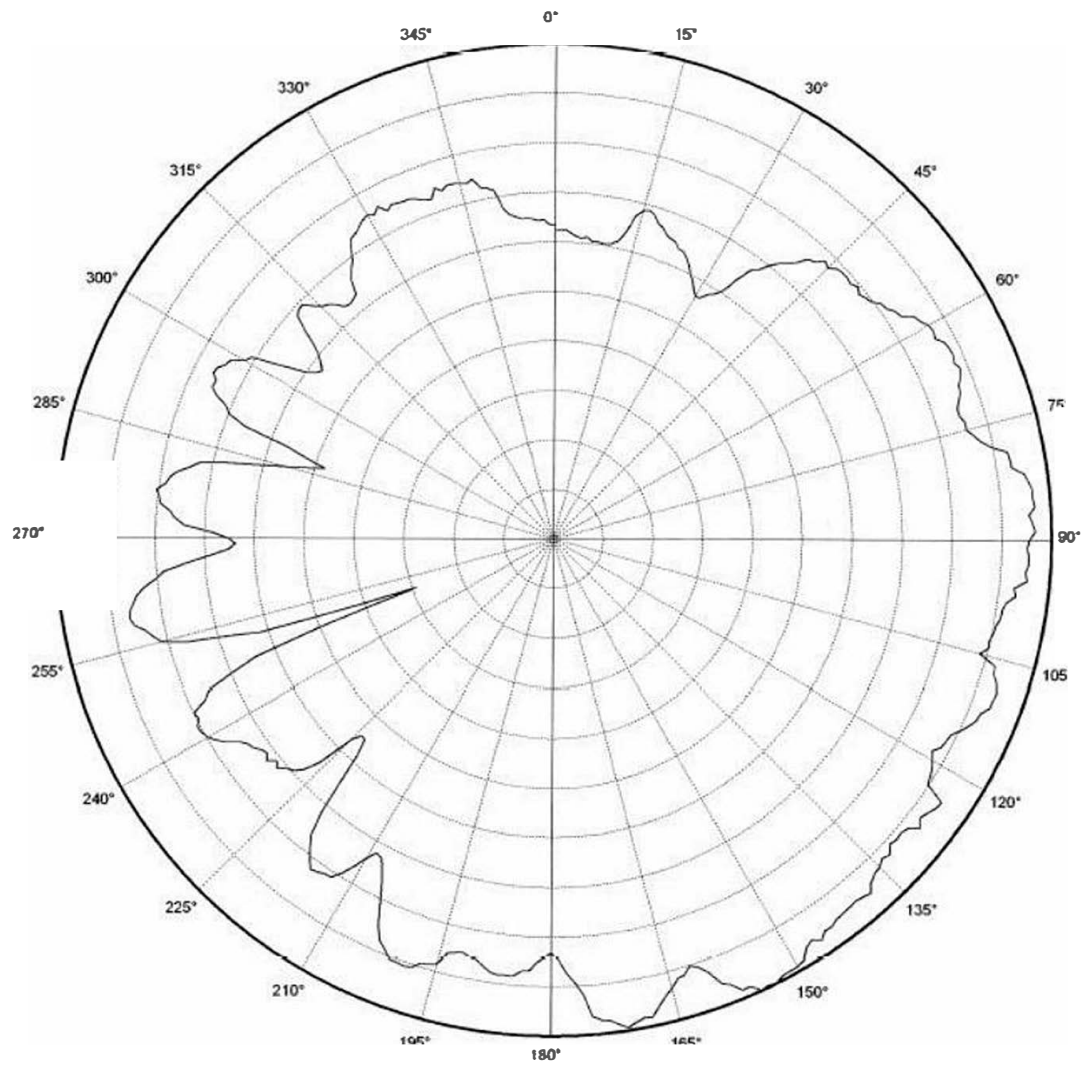
CF 2450.000 MHz

Horisontal Polarization

Laptop XY

Figure 14: WLT8761M XY Plane