ANTENNADESIGN

Manufacturer: FULLINK TECHNOLOGY Co., LTD

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.

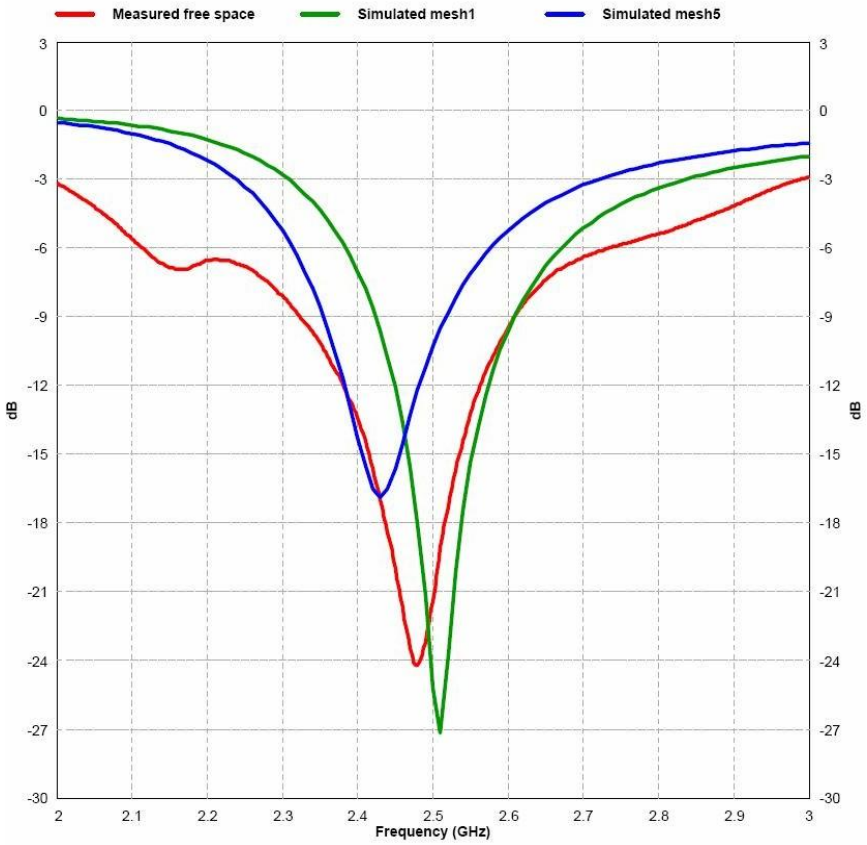


Figure 2: Comparison of Simulation and Measurements Results

Layout andImplementation

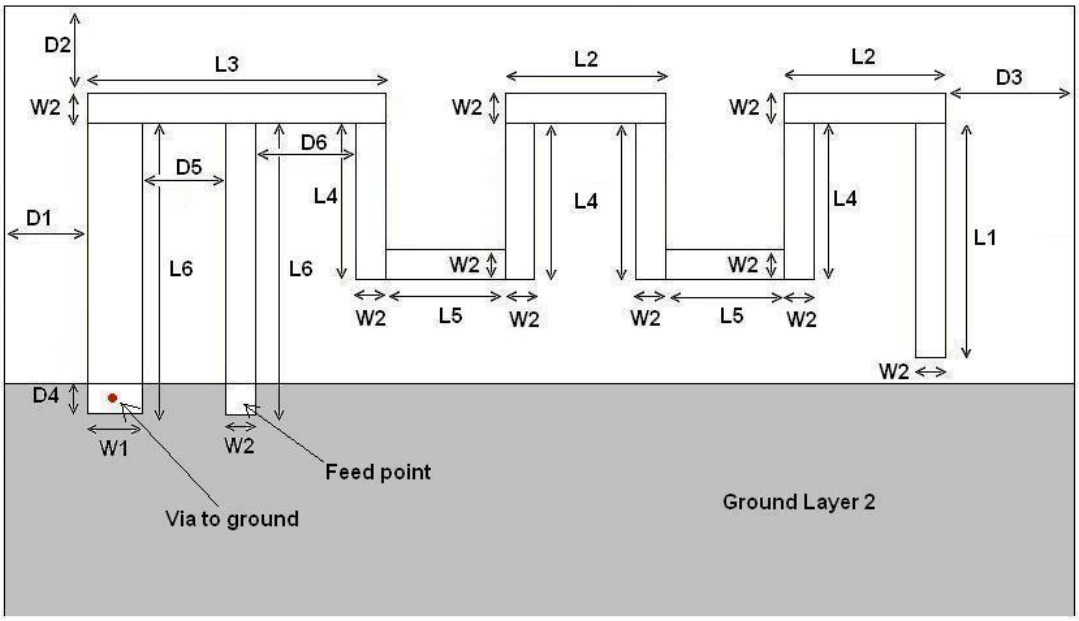


Figure 3: Antenna Dimensions

L1	3.94 mm
L2	2.70 mm
L3	5.00 mm
L4	2.64 mm
L5	2.00 mm
L6	4.90 mm
W1	0.90 mm
W2	0.50 mm
D1	0.50 mm
D2	0.30 mm
D3	0.30 mm
D4	0.50 mm
D5	1.40mm
D6	1.70 mm

Table 1: Antenna Dimensions

TESTRESULTS

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 USB dongle 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.

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.

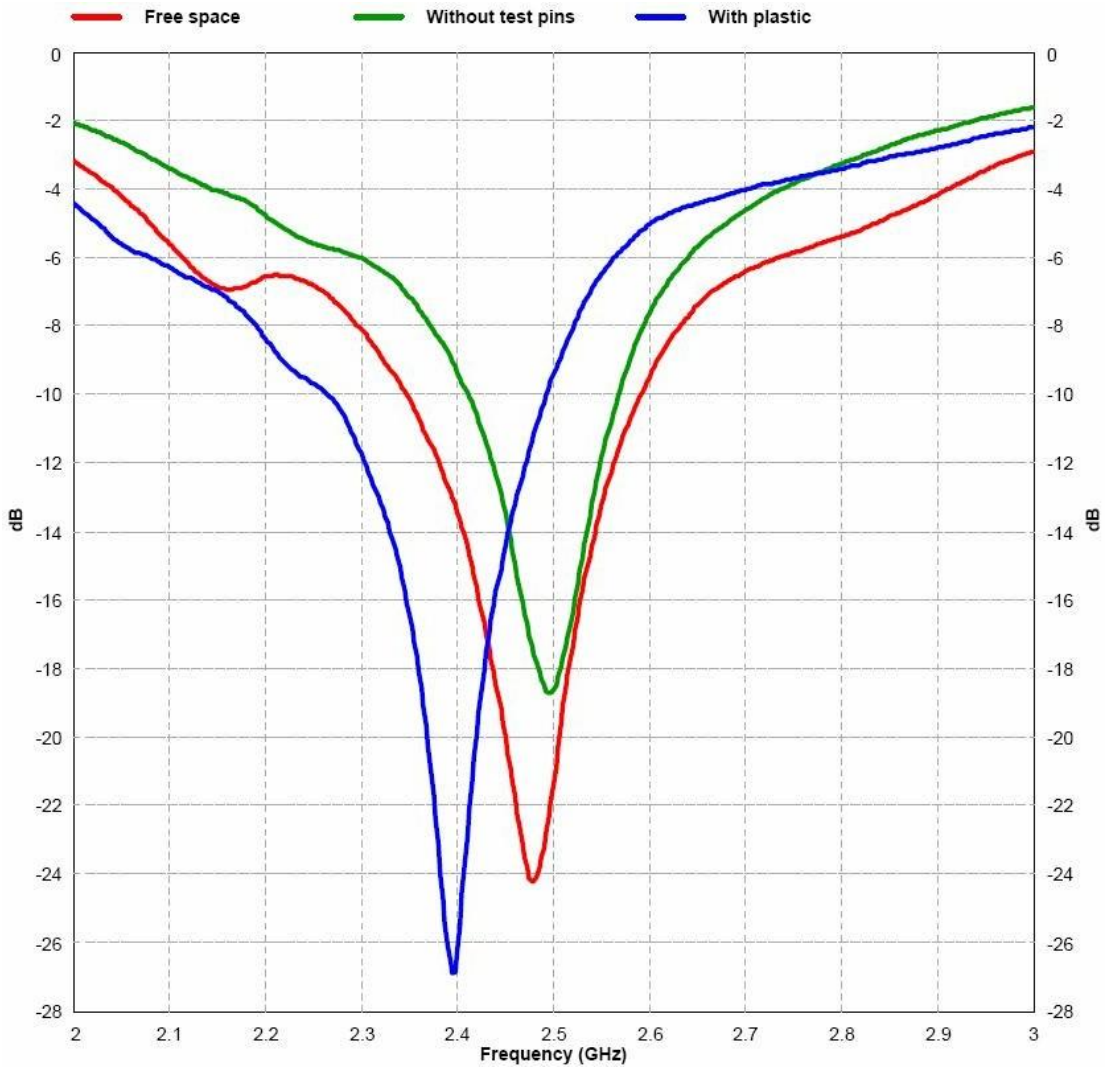


Figure 4: Influence of Plastic Encapsulation and Test Pins

A small part on the CC2511 USB dongle 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 performance. 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 USB dongle 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 USB dongle is connected to a laptop. In free space the antenna has a bandwidth of approximately 250 MHz. When the USB dongle is connected to the laptop the bandwidth is reduced to around 100 MHz, which still is enough to cover the whole 2.4 GHz ISMband.

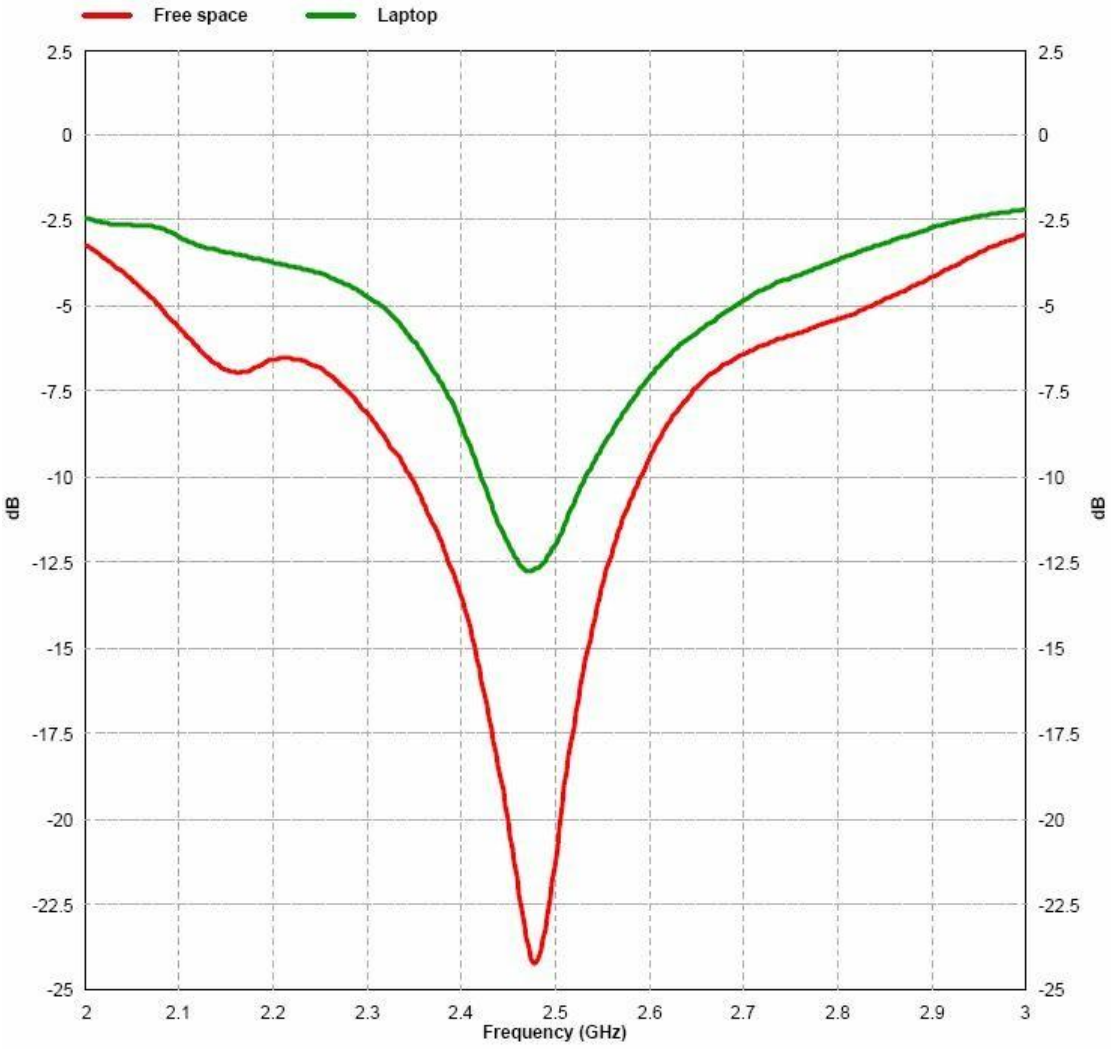


Figure 5: Comparison of Performance

RadiationPattern

The radiation pattern for the antenna implemented on the CC2511 USB dongle 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.

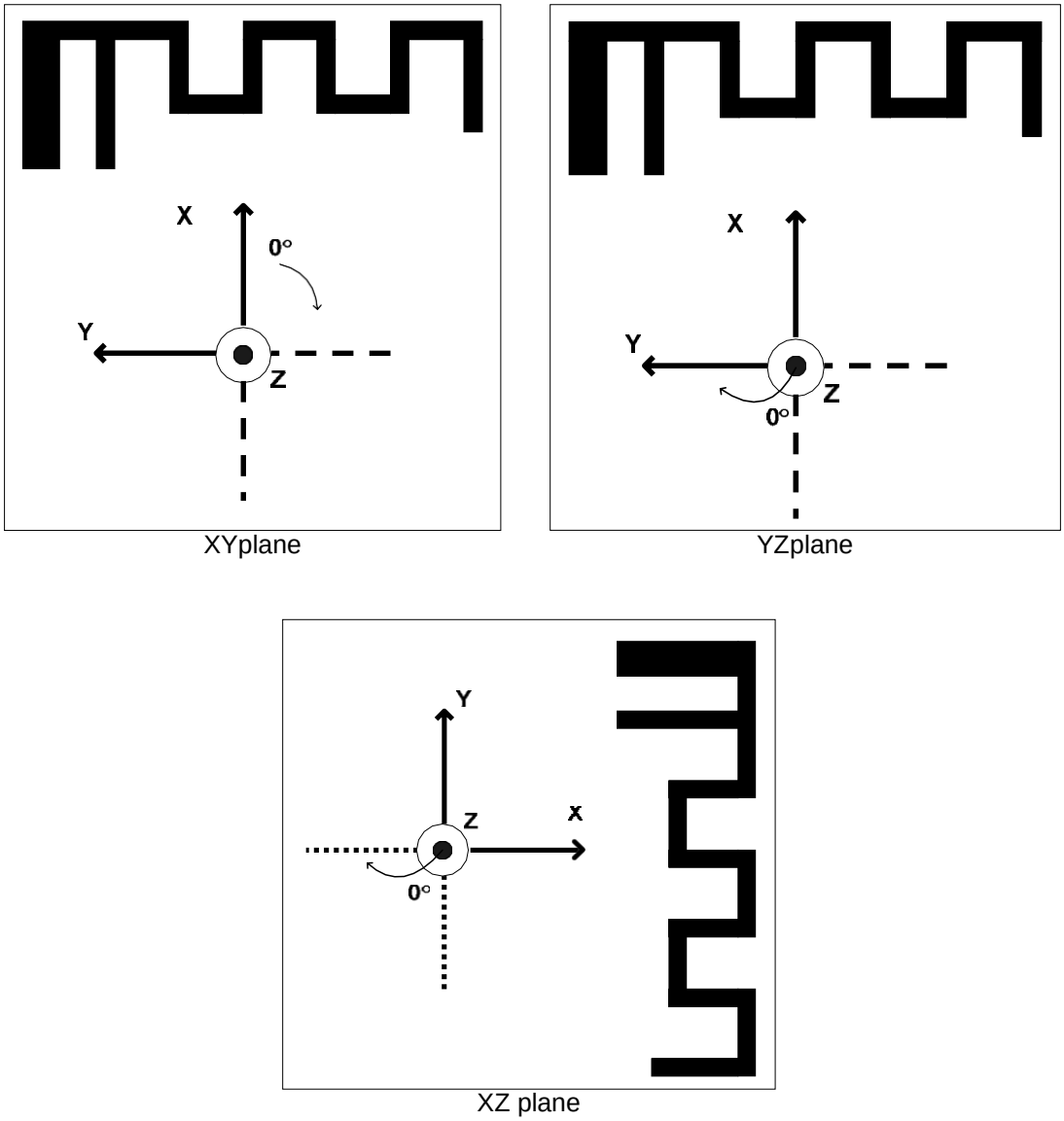
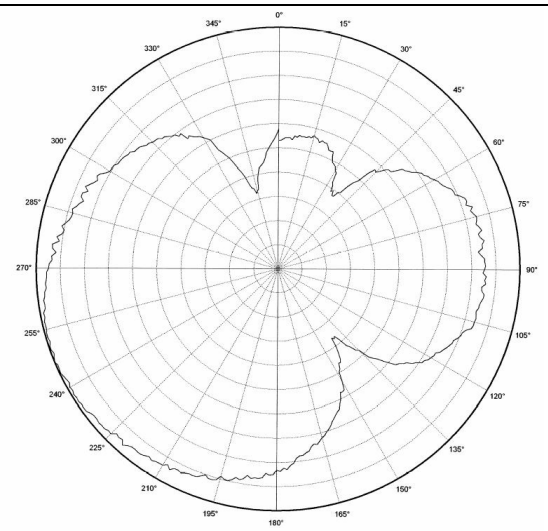
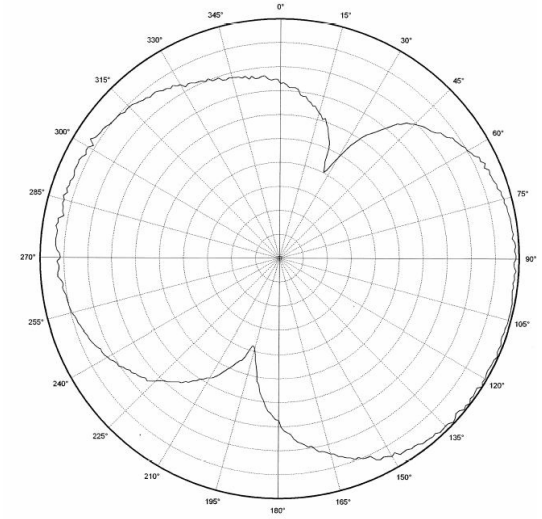


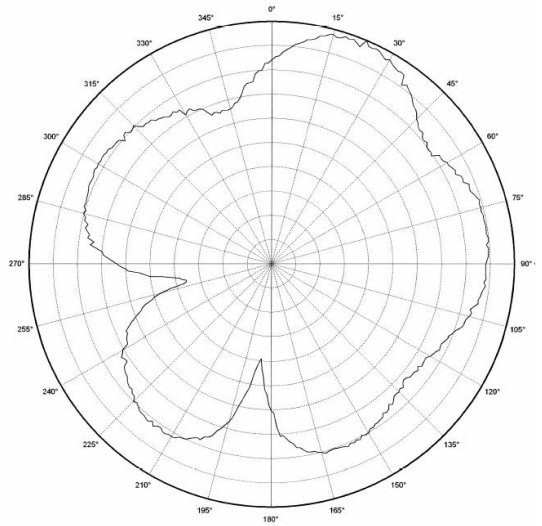
Figure 6: How to Relate the Antenna to the Radiation Patterns



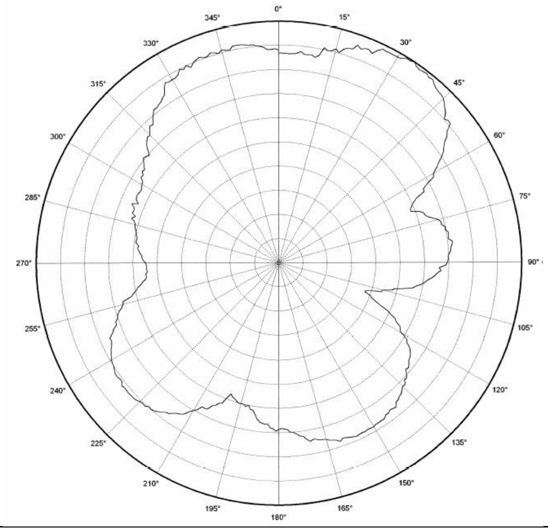
USB Dongle XY Plane



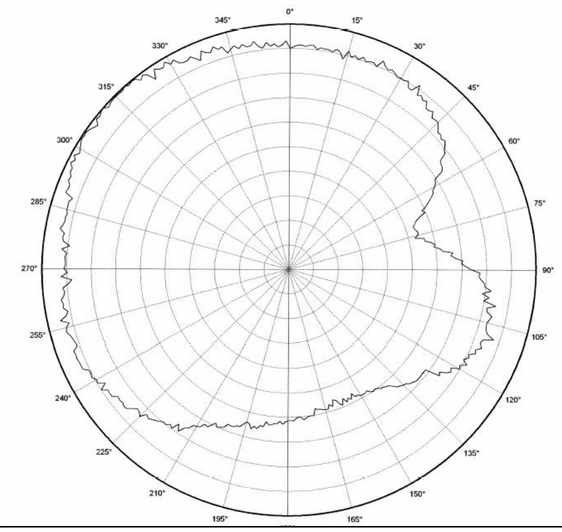
USB Dongle XY Plane



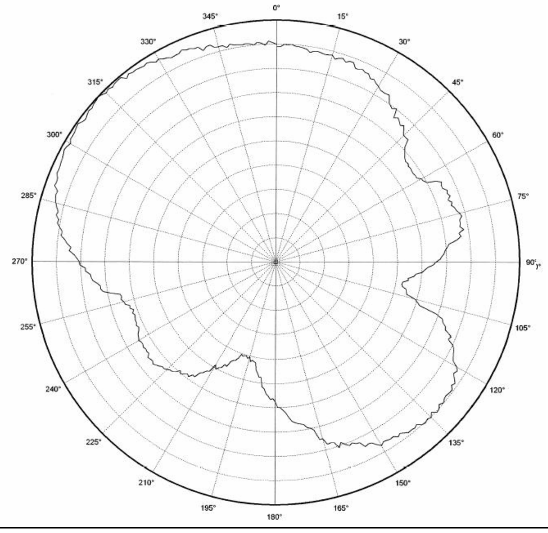
USB Dongle XZ Plane



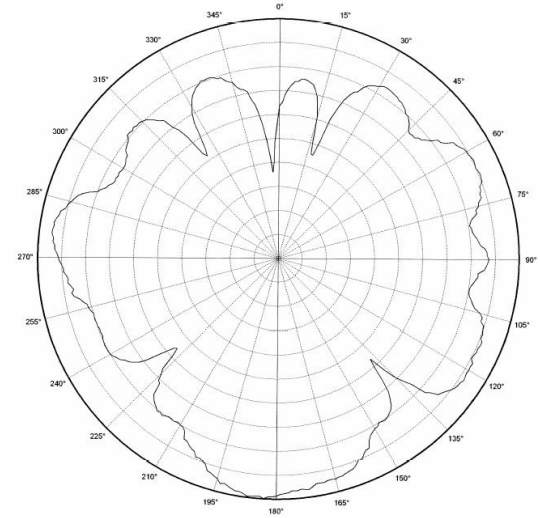
USB Dongle YZ Plane



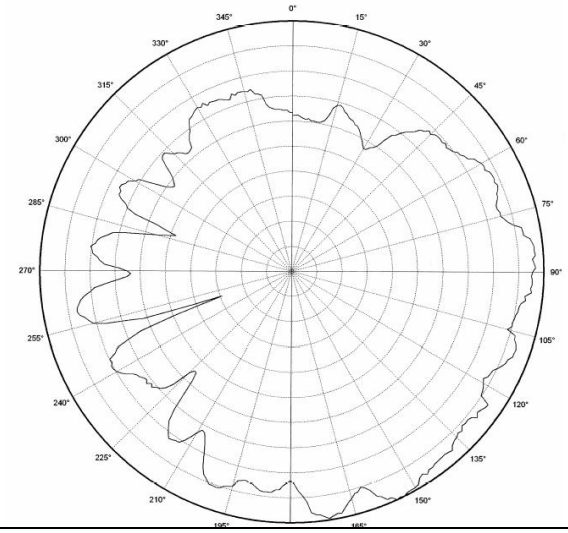
USB Dongle YZ Plane



USB Dongle YZ Plane



USB Dongle XY Plane



USB Dongle XY Plane

Unit in dBi @2.48GHz	XY-plane		XZ-plane		YZ-plane	
	Peak	Avg.	Peak	Avg.	Peak	Avg.
Module Board	0.25	-1.25	0.33	-0.99	**0.76**	-0.24