


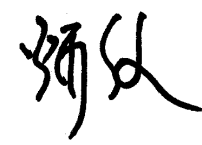
FCC Approval Sheet

Halogen free



MSL Level 1

ROHS-Y

| | | | |
|---------------|-------------------------|---|---|
| Products | Dielectric Chip Antenna | | |
| Customer | Inkel | | |
| Model | HDMI Dongle | | |
| Supplier | PARTRON | | |
| Supplier CODE | ACS2450HFL57 | | |
| SAMSUNG | By designed | By checked | By approved |
| | | | |
| | / | / | / |
| PARTRON | By designed | By checked | By approved |
| | 김 홍 기 |  |  |
| | Antenna 2 Team | Quality Assurance | Laboratory |
| | Hongki.Kim | Nam-Sik. Min | Byoung-Jun.Yim |
| | 10/08 | 10/08 | 10/08 |

2014. 10.08

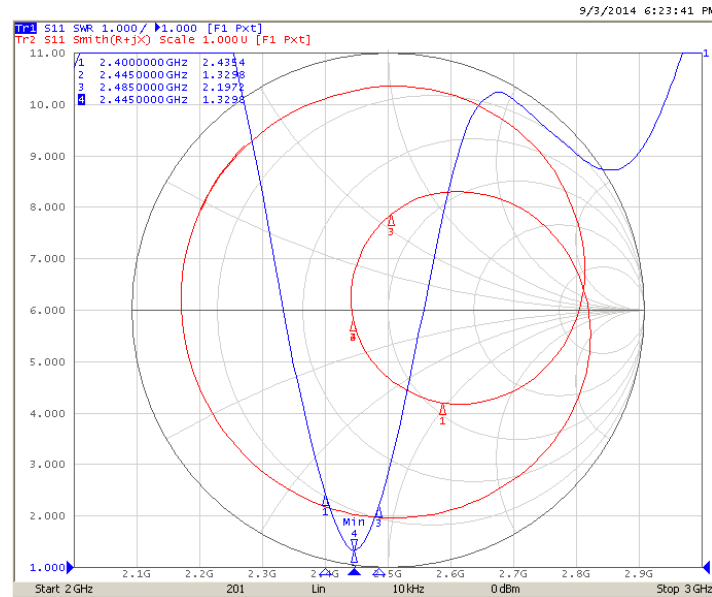


22-6, Seokwoo-dong, Hwaseong-si, Gyeonggi-do
Korea, 440-170
Tel : 82-31-201-7870~6
Fax : 82-31-201-7800
www.partron.co.kr

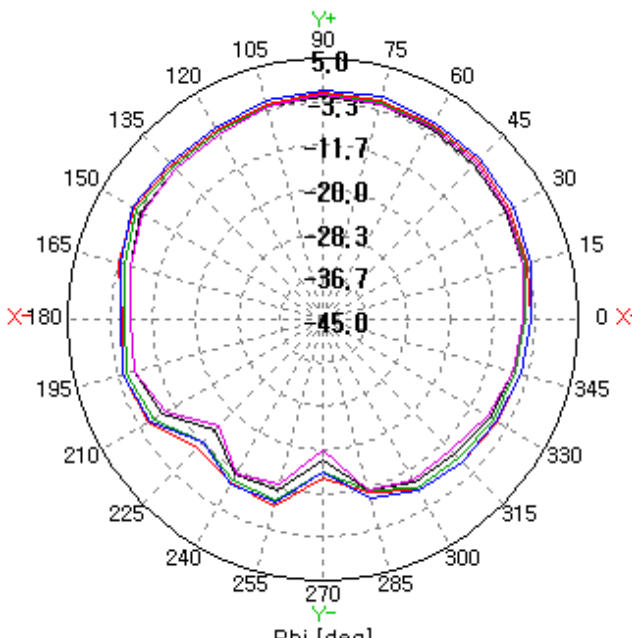
- Contents -

| | |
|--------------------------------|----|
| ※ Cover | 1p |
| ※ Contents | 2p |
| 1. Antenna specification | 3p |
| 2. Structure | 7p |

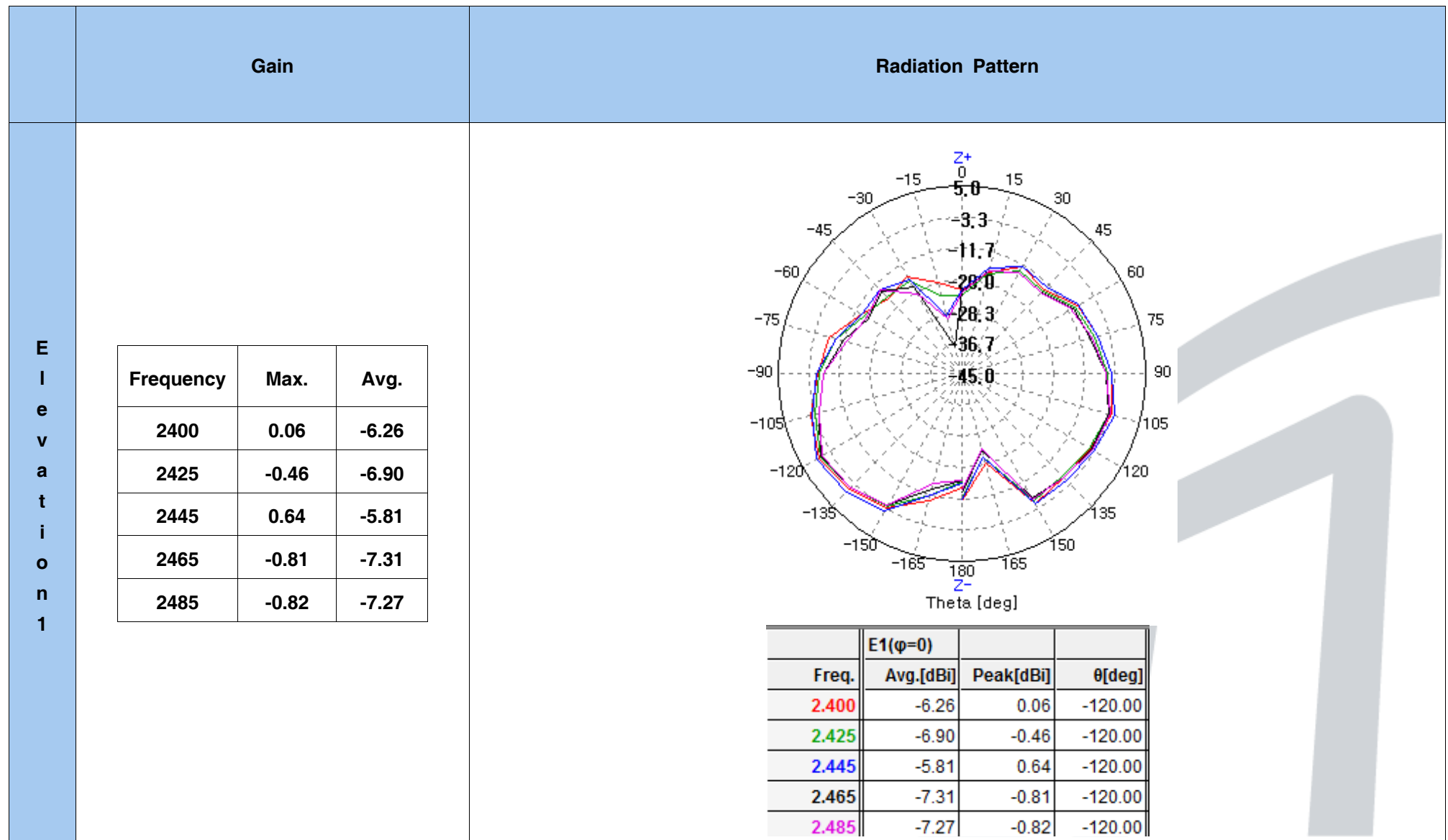
1. Antenna specification

| Specification | VSWR | | | | | | | | | | | | |
|---|---|--------|--------------|--------|---|--------------|--------|---|--------------|--------|---|--------------|--------|
| Dielectric Chip Ant. Monopole Type Ant. | <div><div>9/3/2014 6:23:41 PM</div><div><div>Tr1 S11 SWR 1.000 / 1.000 [F1 Pxt]</div><div>Tr2 S11 Smith(R+jX) Scale 1.000 U [F1 Pxt]</div><table><tr><td>1</td><td>2.400000 GHz</td><td>2.4314</td></tr><tr><td>2</td><td>2.445000 GHz</td><td>1.3298</td></tr><tr><td>3</td><td>2.485000 GHz</td><td>2.1971</td></tr><tr><td>4</td><td>2.445000 GHz</td><td>1.3298</td></tr></table></div><p>Start 2 GHz 2.1G 2.2G 2.3G 2.4G 2.5G 2.6G 2.7G 2.8G 2.9G Stop 3 GHz</p><p>201 Lin 10Hz 0dBm</p></div> | 1 | 2.400000 GHz | 2.4314 | 2 | 2.445000 GHz | 1.3298 | 3 | 2.485000 GHz | 2.1971 | 4 | 2.445000 GHz | 1.3298 |
| 1 | 2.400000 GHz | 2.4314 | | | | | | | | | | | |
| 2 | 2.445000 GHz | 1.3298 | | | | | | | | | | | |
| 3 | 2.485000 GHz | 2.1971 | | | | | | | | | | | |
| 4 | 2.445000 GHz | 1.3298 | | | | | | | | | | | |
| 0dBi Nondirectional | | | | | | | | | | | | | |
| Cross Polarization | | | | | | | | | | | | | |
| Internal Antenna | | | | | | | | | | | | | |
| PARTRON / HDMI Dongle | | | | | | | | | | | | | |

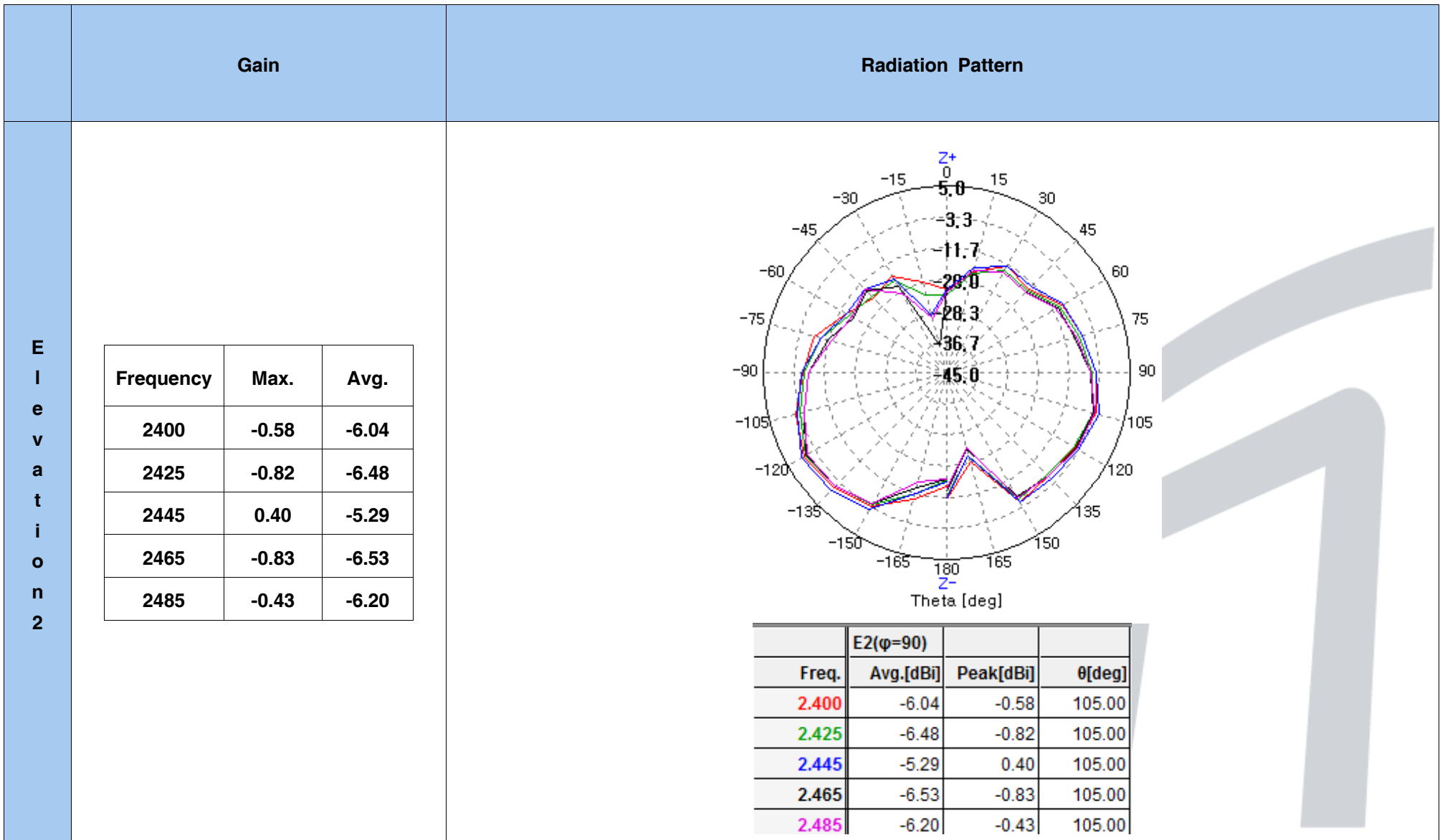
[Azimuth]

| | Gain | Radiation Pattern | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---------|--|-------------------|--------|------|------|-------|-------|------|-------|-------|------|-------|-------|------|-------|-------|------|-------|-------|---|--|---------|--|--|-------|-----------|-----------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Azimuth | <table><thead><tr><th>Frequency</th><th>Max.</th><th>Avg.</th></tr></thead><tbody><tr><td>2400</td><td>-1.46</td><td>-4.24</td></tr><tr><td>2425</td><td>-1.87</td><td>-4.86</td></tr><tr><td>2445</td><td>-0.84</td><td>-3.89</td></tr><tr><td>2465</td><td>-2.36</td><td>-5.52</td></tr><tr><td>2485</td><td>-2.11</td><td>-5.56</td></tr></tbody></table> | Frequency | Max. | Avg. | 2400 | -1.46 | -4.24 | 2425 | -1.87 | -4.86 | 2445 | -0.84 | -3.89 | 2465 | -2.36 | -5.52 | 2485 | -2.11 | -5.56 |  <table><thead><tr><th></th><th>H(θ=90)</th><th></th><th></th></tr><tr><th>Freq.</th><th>Avg.[dBi]</th><th>Peak[dBi]</th><th>φ[deg]</th></tr></thead><tbody><tr><td>2.400</td><td>-4.24</td><td>-1.46</td><td>90.00</td></tr><tr><td>2.425</td><td>-4.86</td><td>-1.87</td><td>75.00</td></tr><tr><td>2.445</td><td>-3.89</td><td>-0.84</td><td>75.00</td></tr><tr><td>2.465</td><td>-5.52</td><td>-2.36</td><td>75.00</td></tr><tr><td>2.485</td><td>-5.56</td><td>-2.11</td><td>90.00</td></tr></tbody></table> | | H(θ=90) | | | Freq. | Avg.[dBi] | Peak[dBi] | φ[deg] | 2.400 | -4.24 | -1.46 | 90.00 | 2.425 | -4.86 | -1.87 | 75.00 | 2.445 | -3.89 | -0.84 | 75.00 | 2.465 | -5.52 | -2.36 | 75.00 | 2.485 | -5.56 | -2.11 | 90.00 |
| | Frequency | Max. | Avg. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2400 | -1.46 | -4.24 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2425 | -1.87 | -4.86 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2445 | -0.84 | -3.89 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2465 | -2.36 | -5.52 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2485 | -2.11 | -5.56 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | H(θ=90) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Freq. | Avg.[dBi] | Peak[dBi] | φ[deg] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.400 | -4.24 | -1.46 | 90.00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.425 | -4.86 | -1.87 | 75.00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.445 | -3.89 | -0.84 | 75.00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.465 | -5.52 | -2.36 | 75.00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.485 | -5.56 | -2.11 | 90.00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

[Elevation1]

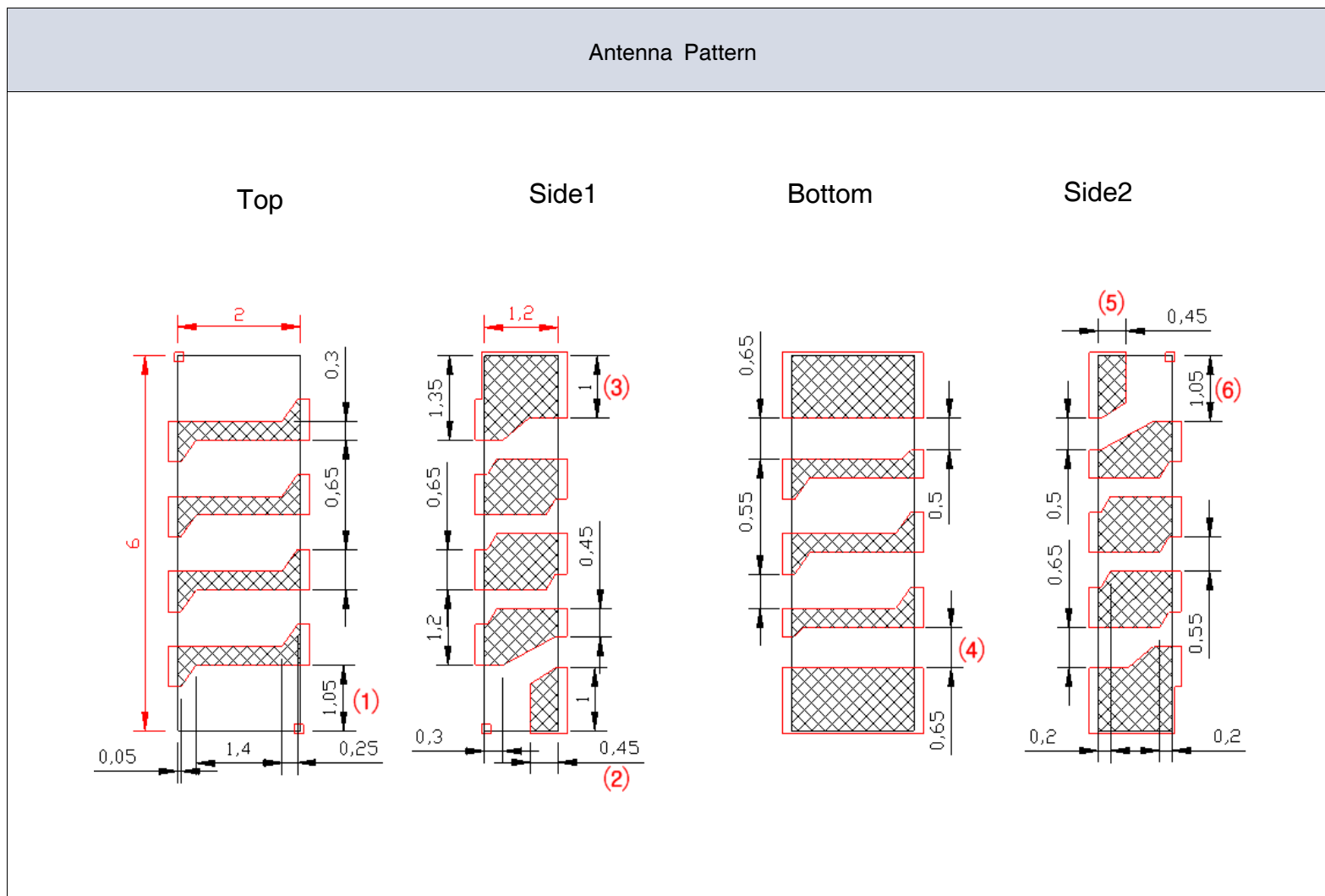


[Elevation2]



2. Structure

Antenna Pattern



4 ANTENNA DESIGN

The PCB antenna on the CC2511 USB dongle 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.

4.1 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 USB dongle and to obtain good performance also when the dongle is connected to a computer.

4.2 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.

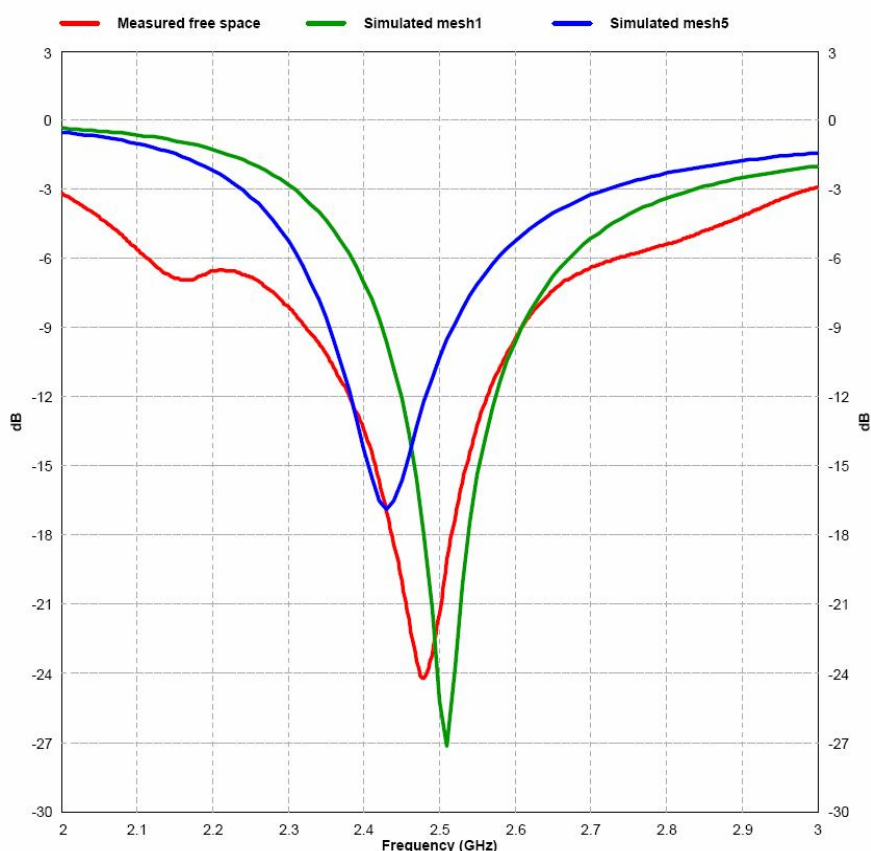


Figure 2: Comparison of Simulation and Measurements Results

4.3 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. These files are named IFA_USB.spl and IFA_USB.dxf respectively and are included in the CC2511 USB dongle reference design available from <http://www.ti.com/lpw>. 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.

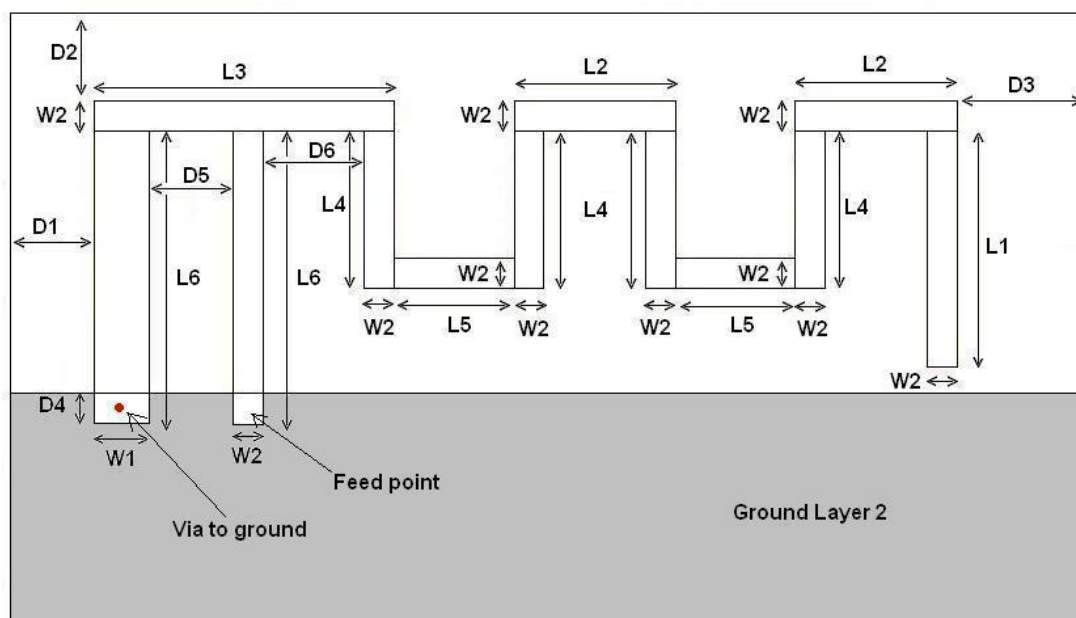


Figure 3: Antenna Dimensions

| | |
|----|---------|
| L1 | 3.94 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

5.2 Radiation Pattern

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 patterns are related to the positioning of the antenna.

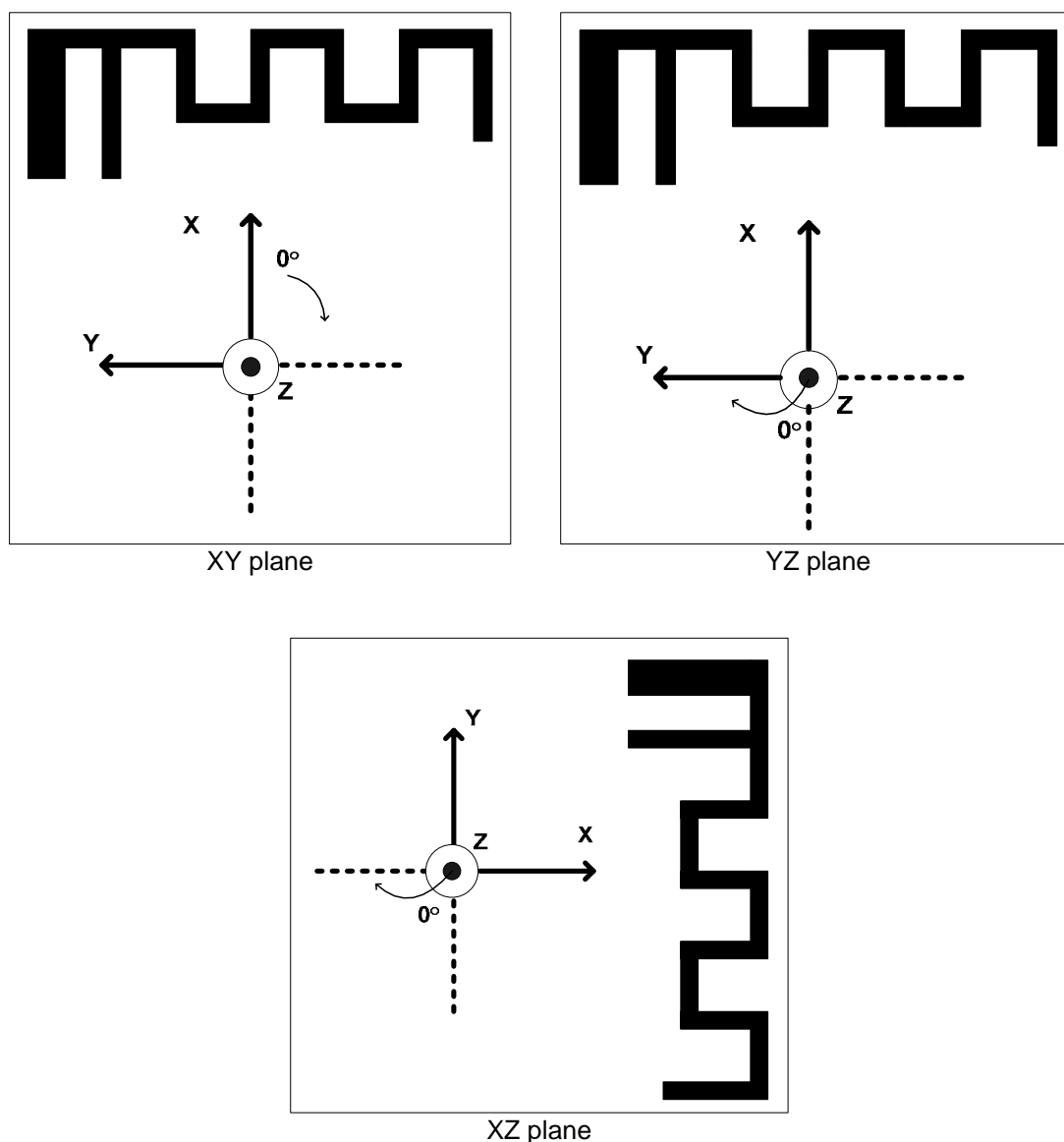


Figure 6: How to Relate the Antenna to the Radiation Patterns

Application Note AN043

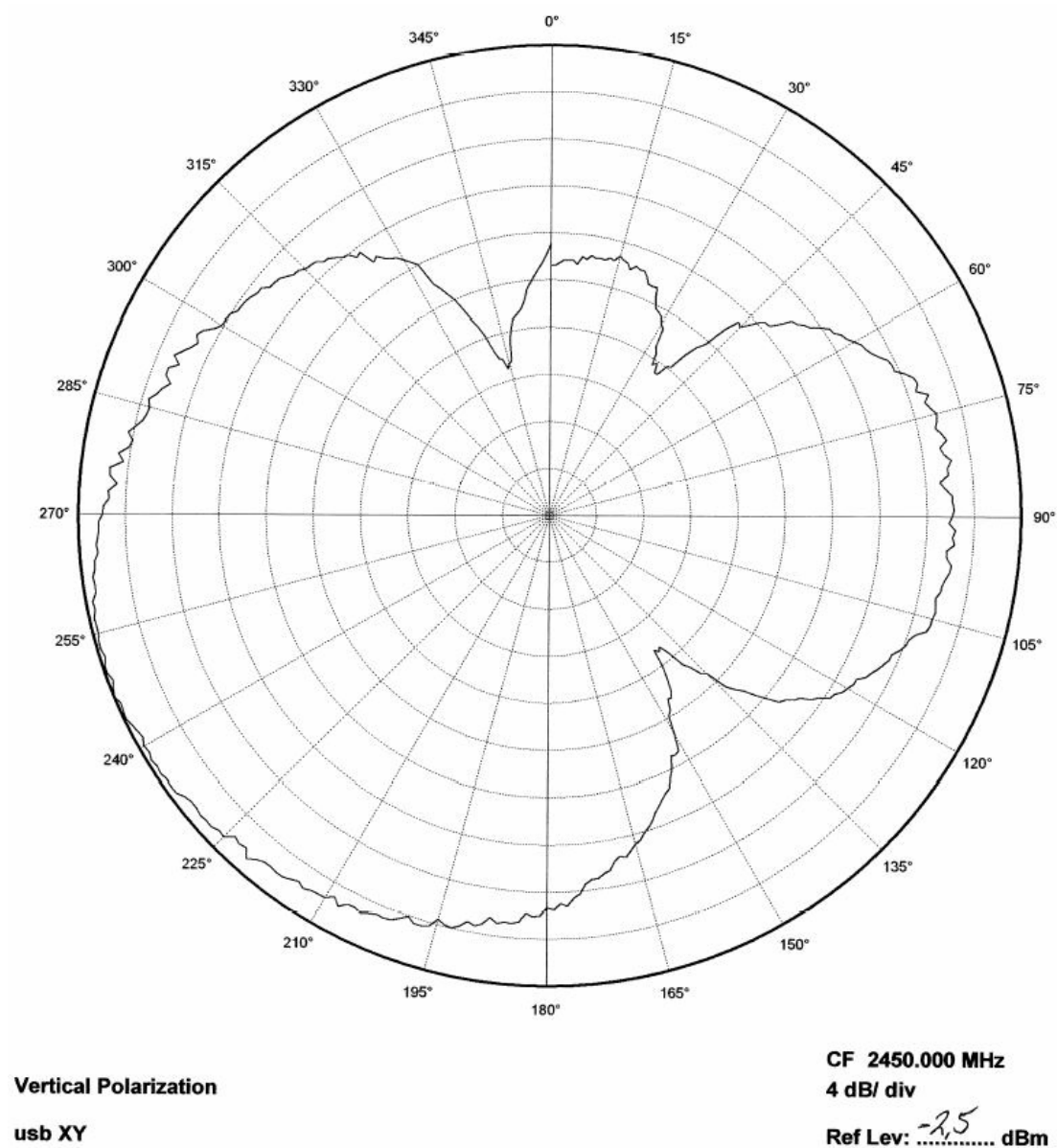


Figure 7: USB Dongle XY Plane

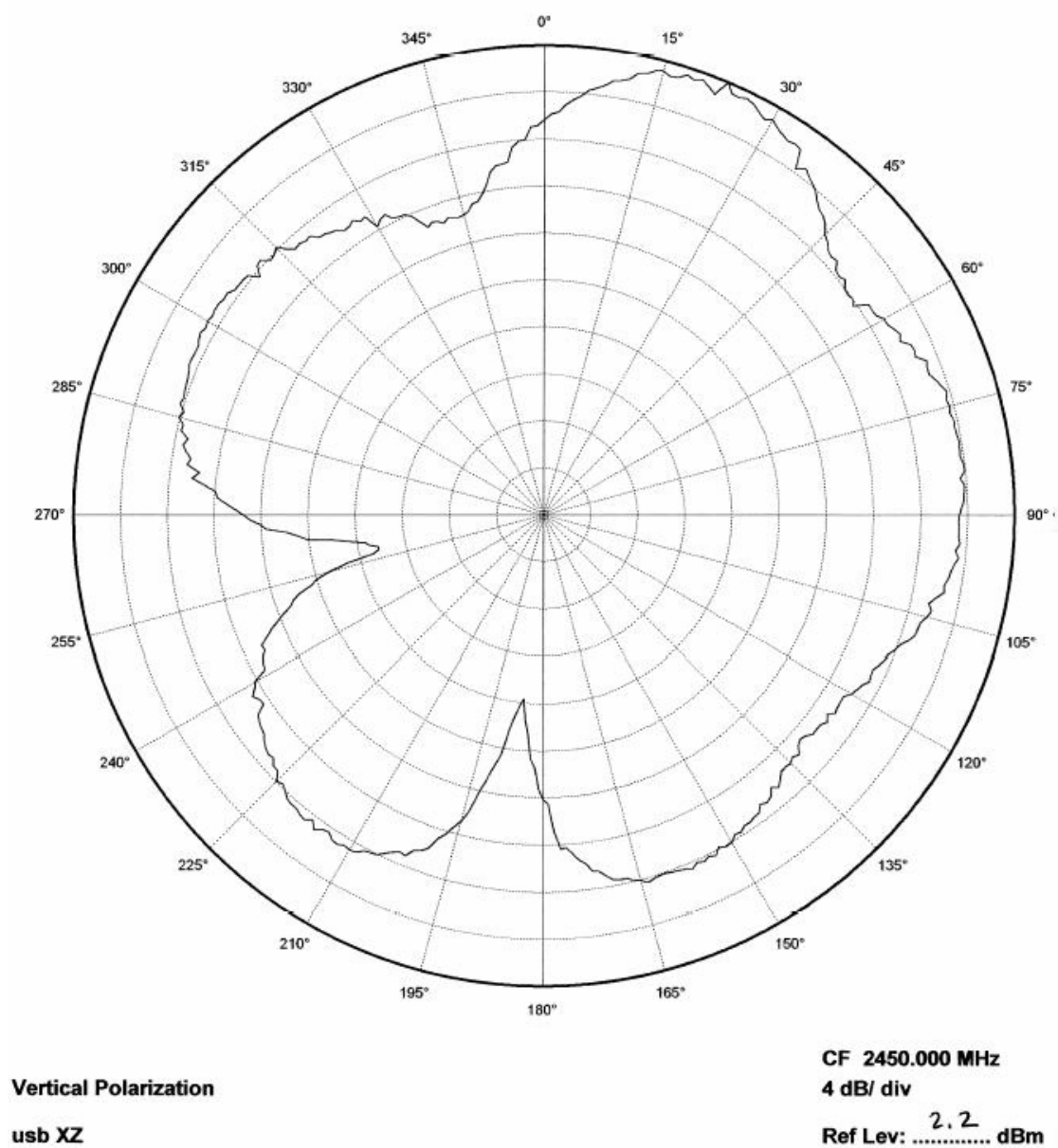


Figure 9: USB Dongle XZ Plane

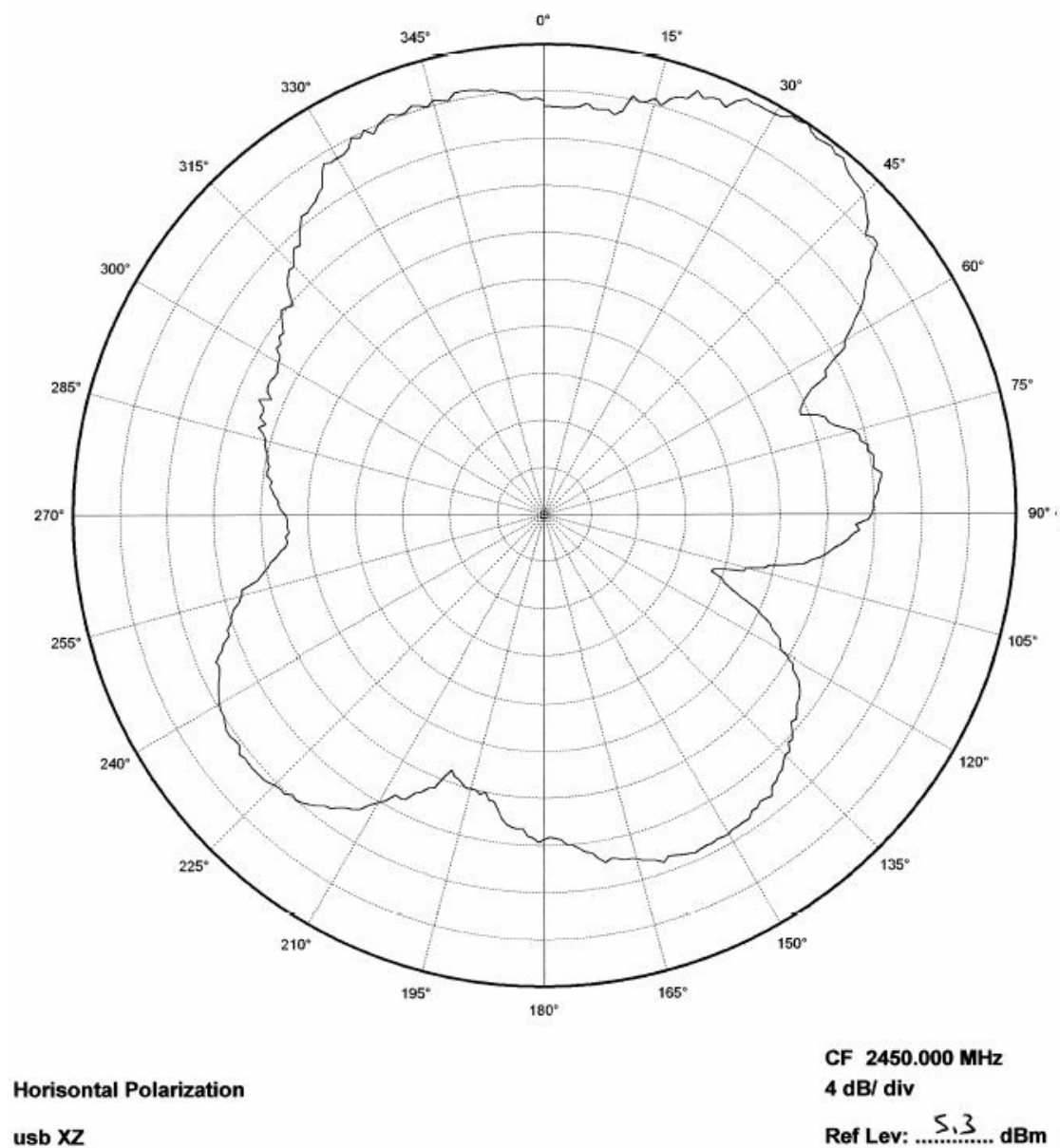


Figure 10: USB Dongle XZ Plane

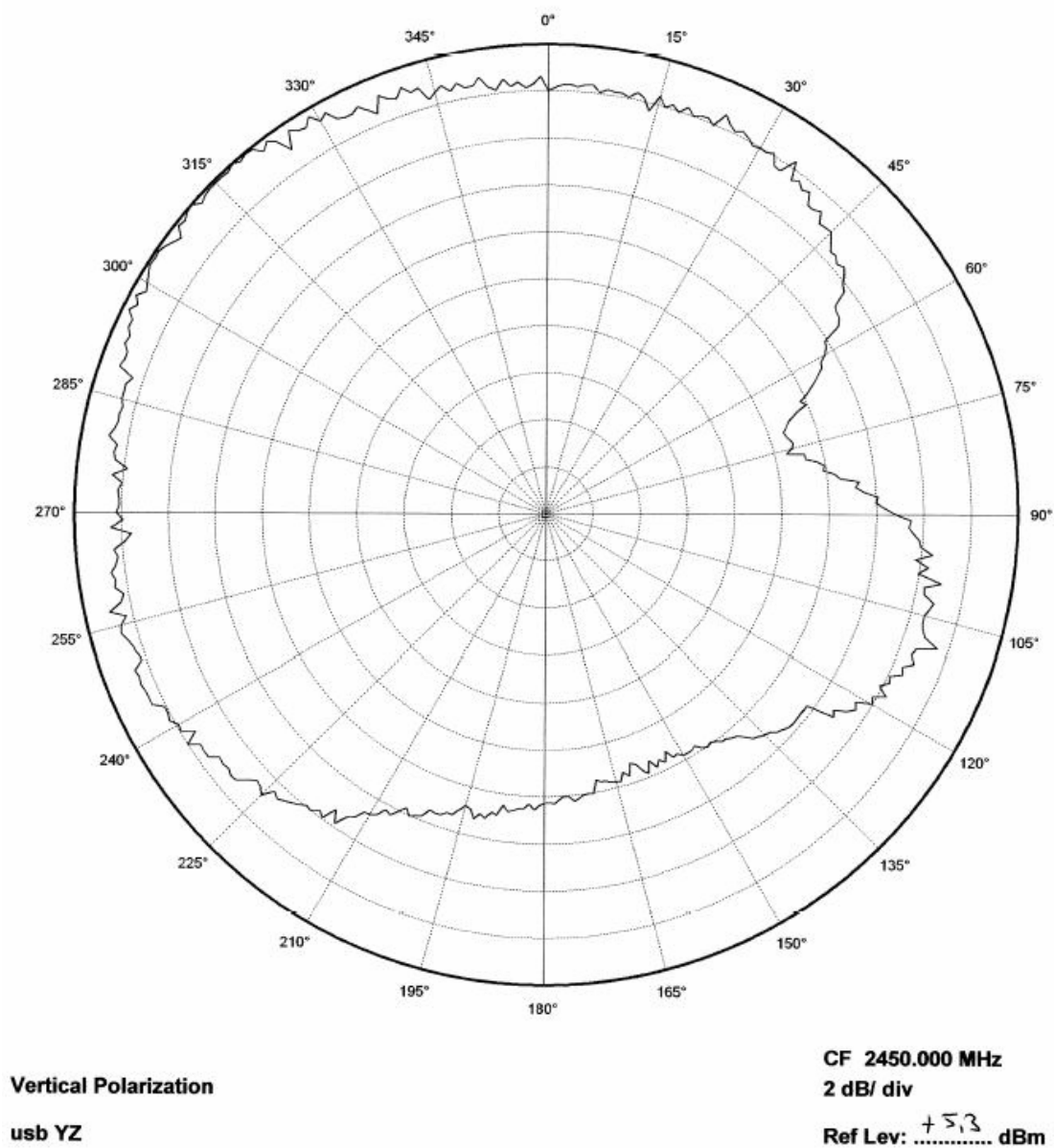


Figure 11: USB Dongle YZ Plane

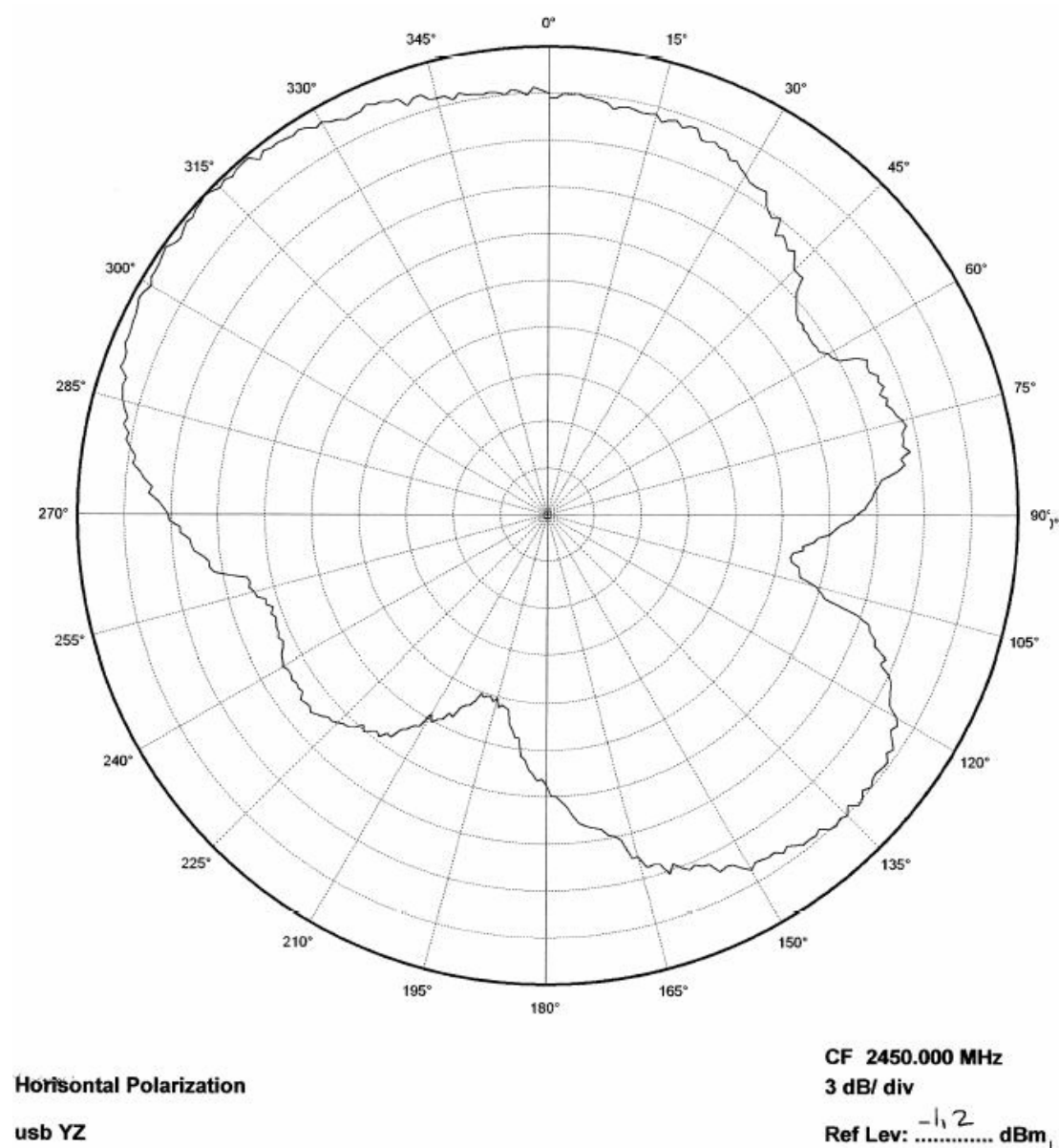


Figure 12: USB Dongle YZ Plane

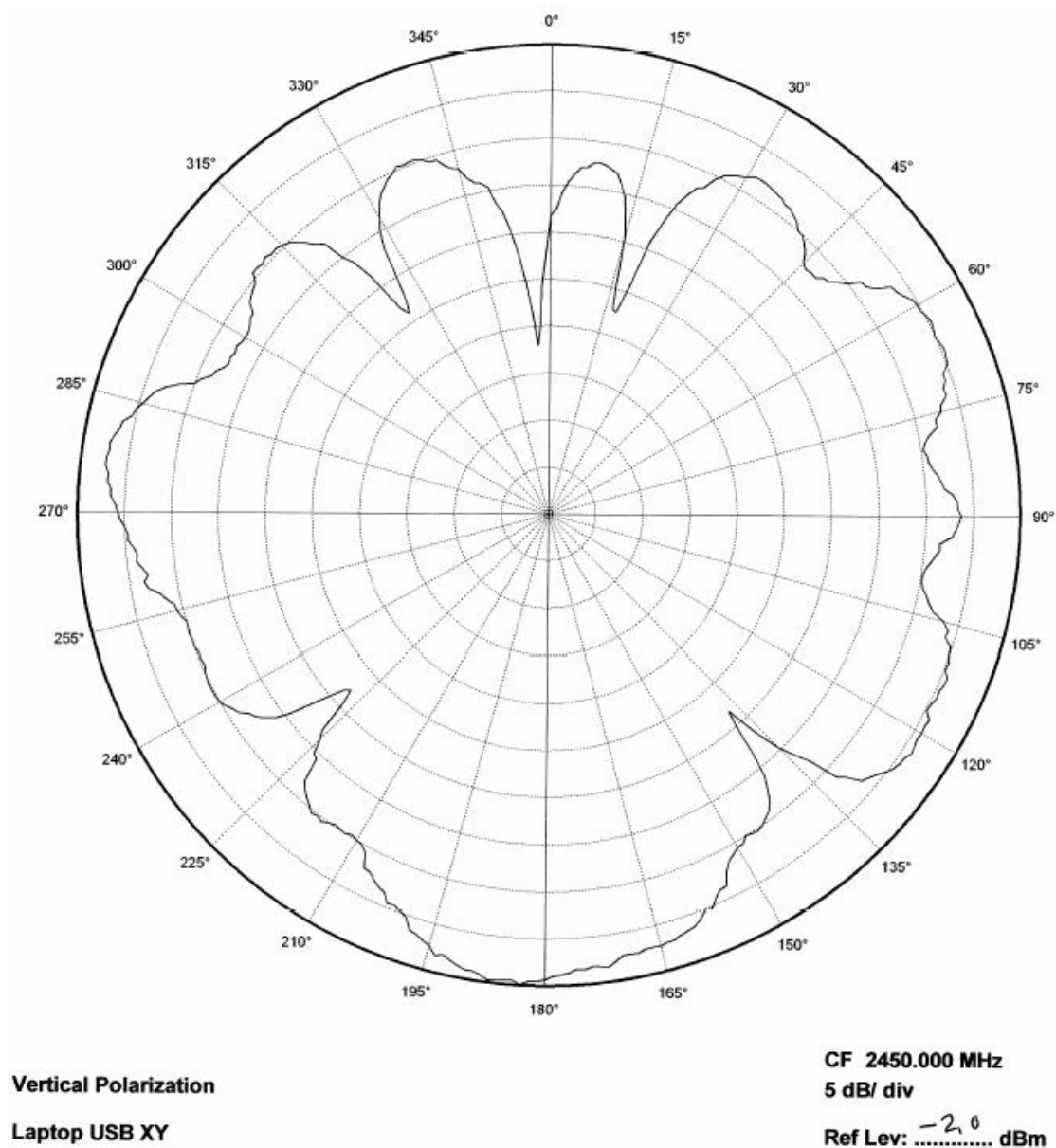


Figure 13: USB Dongle in Laptop XY Plane

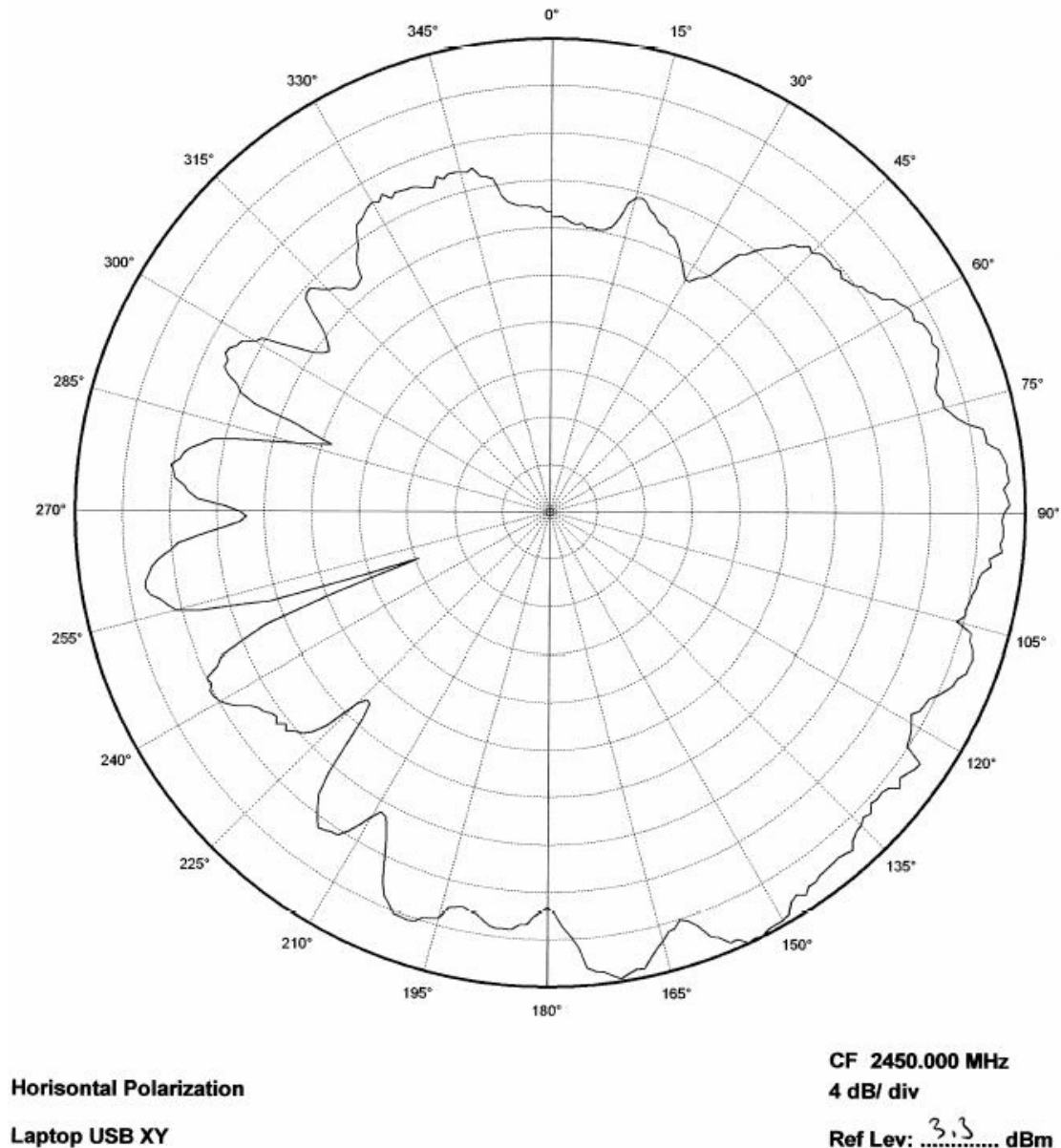


Figure 14: USB Dongle in Laptop XY Plane

5.3 Output Power

To make a realistic bandwidth measurement of the antenna a small test program was used. The test program stepped the center frequency of a carrier from 2.3 to 2.8 GHz. This bandwidth measurement was also done to verify the result from the reflection measurements, described in section 5.1. The output power was measured using max hold on a spectrum analyzer. CC2511 was programmed for 0 dBm output power and the antenna was horizontally oriented and directed towards the receiving antenna. This corresponds to 0° in the XY plane on Figure 6. The bandwidth measurements were not performed with a correction factor on the spectrum analyzer. Thus, the results in Figure 15 and Figure 16 only show the relative changes in output power and not the actual level.

Figure 15 shows the bandwidth of the antenna when the dongle is not connected to a computer. The result shows that the antenna has a variation in output power of less than 3 dB across a frequency band of more than 350 MHz. This demonstrates that the antenna has a