2.4-GHz Antenna

ABSTRACT

The PCB antenna 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 15.2 x 5.7 mm 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.

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1 ANTENNA DESIGN

The PCB antenna 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.

1.1 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.

1.2 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 1 for details.

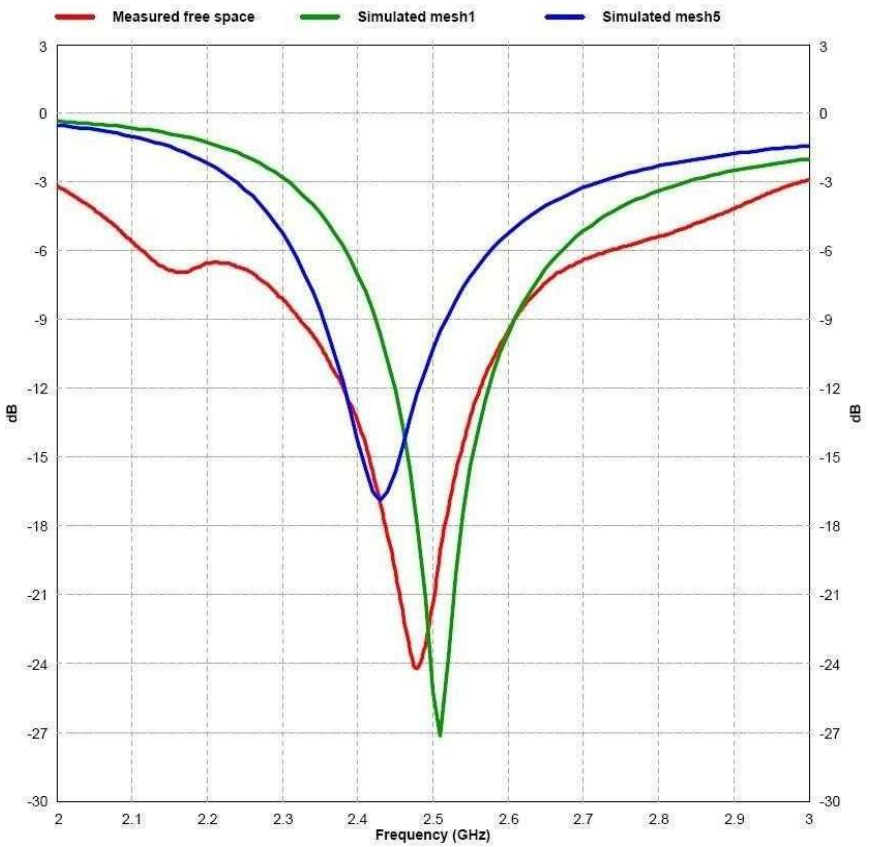
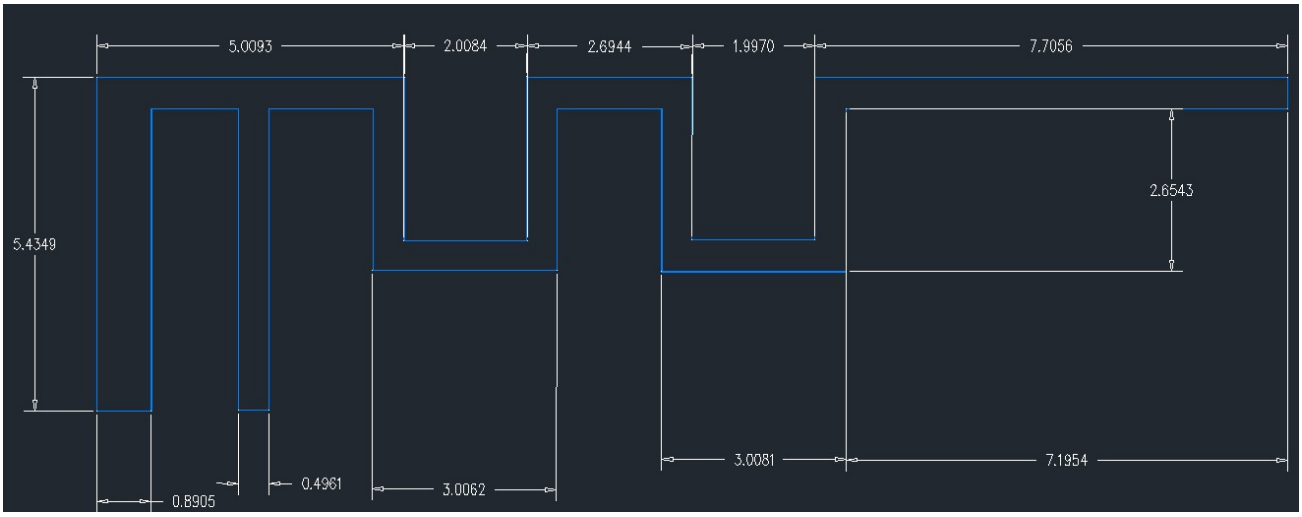


Figure 1: Compariso n of Simulation and Measurements Results

1.3 Layout and Implementation

Small changes of the antenna dimensions may have large impact on the performance. Therefore it is 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. If the PCB CAD tool being used does not support import of DXF or gerber files, Figure 2 and Table 1 should be used to ensure correct implementation. Because there is no ground plane beneath the antenna, the PCB thickness will have little effect on the performance. The results presented in this document are based on an antenna implemented on a PCB with a 1-mm thickness.



2 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. All of the results presented in this section are based on measurements performed with E73-2G4M04S1B.

2.1 Radiation Pattern

The radiation pattern for the antenna implemented on the dongle reference design has been measured in an anechoic chamber. Figure 4 through Figure 9 shows radiation patterns for three planes, XY, XZ and YZ, measured with vertical and horizontal polarization. All measurements were performed with 0 dBm output power. Figure 3 shows how the different radiation patters are related to the positioning of the antenna.

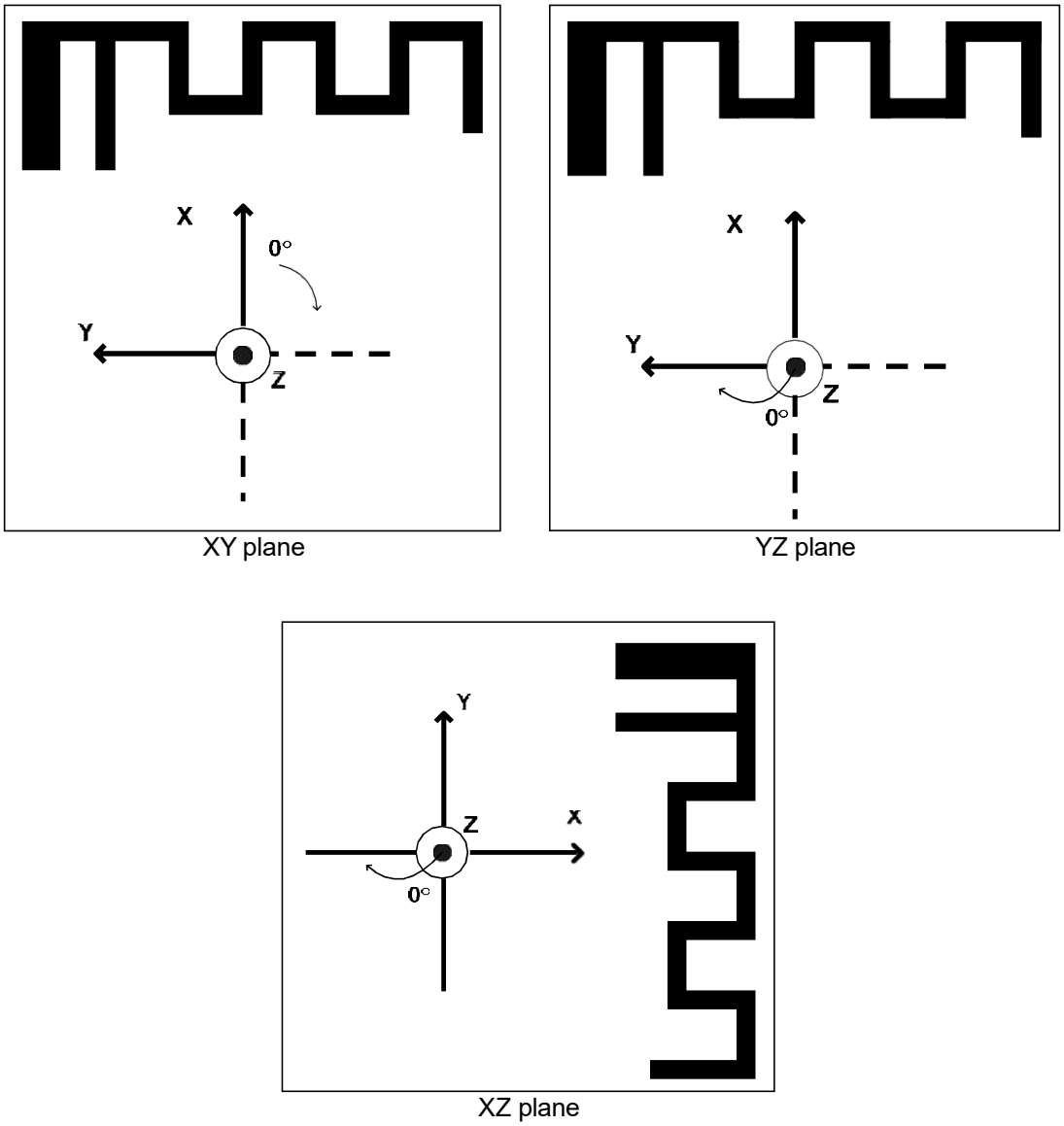


Figure 3: Relating Antenna to Radiation Patterns

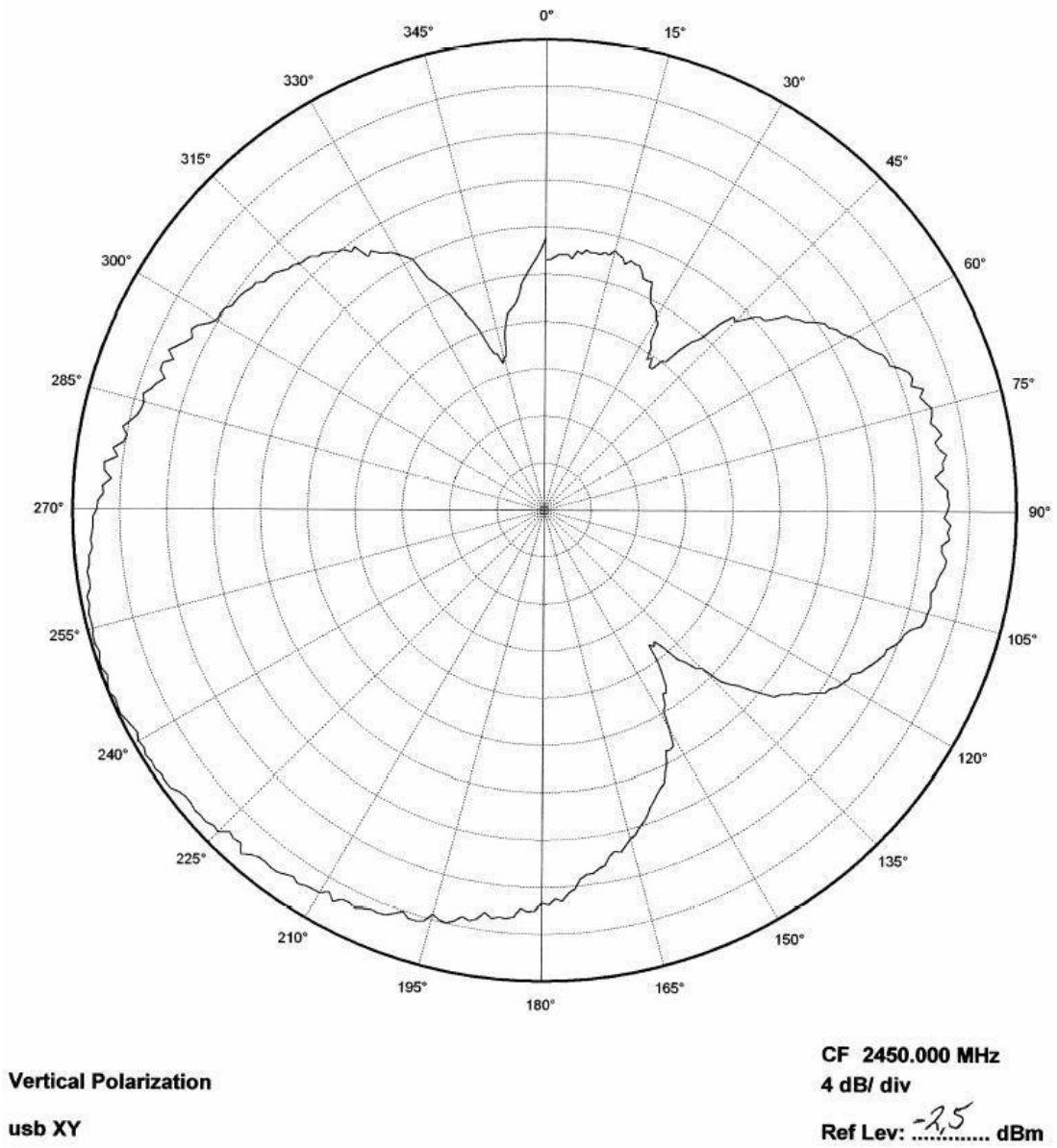


Figure 4: shows the XY plane vertical polarization.

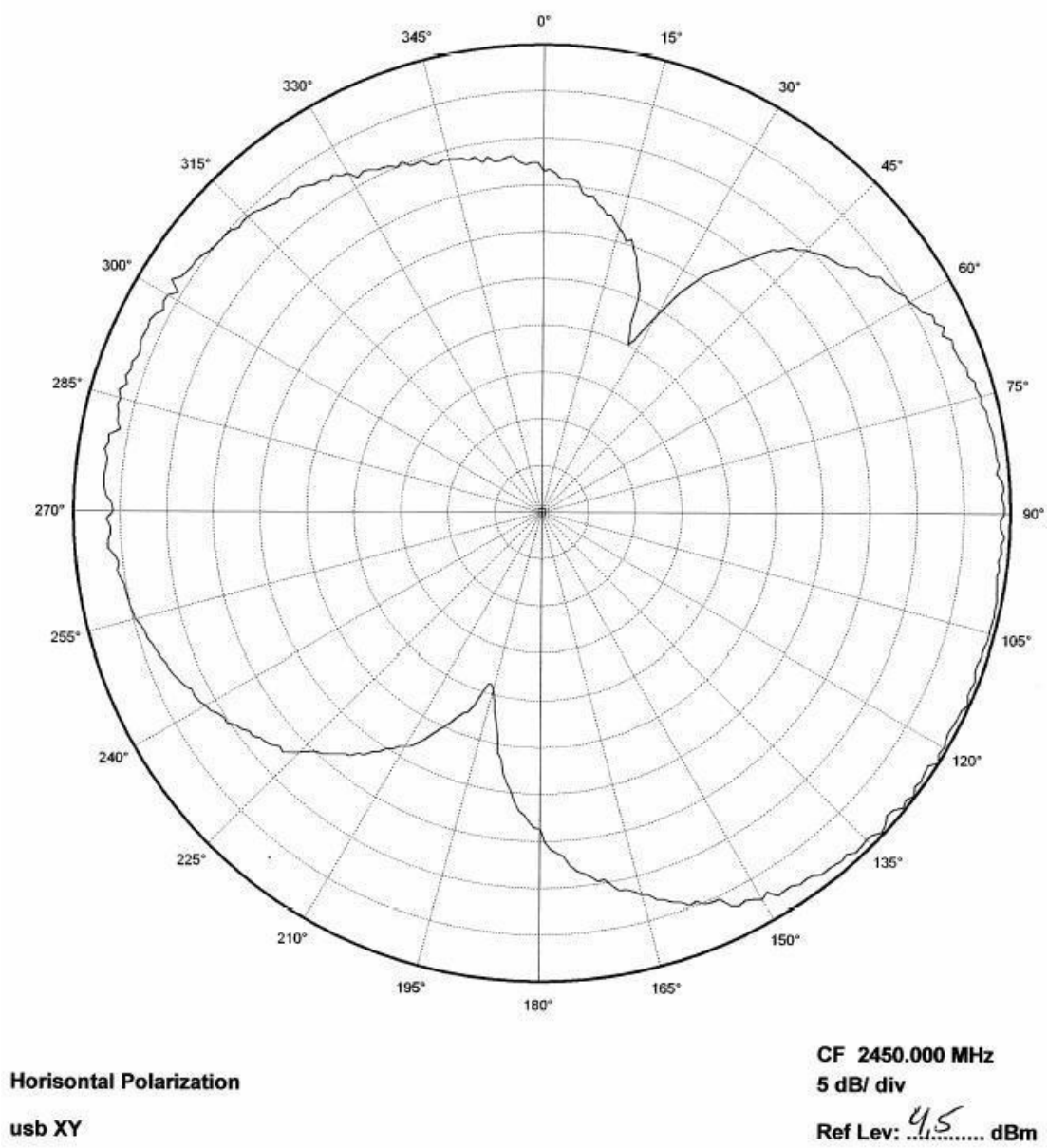


Figure 5: shows the XY plane horizontal polarization.

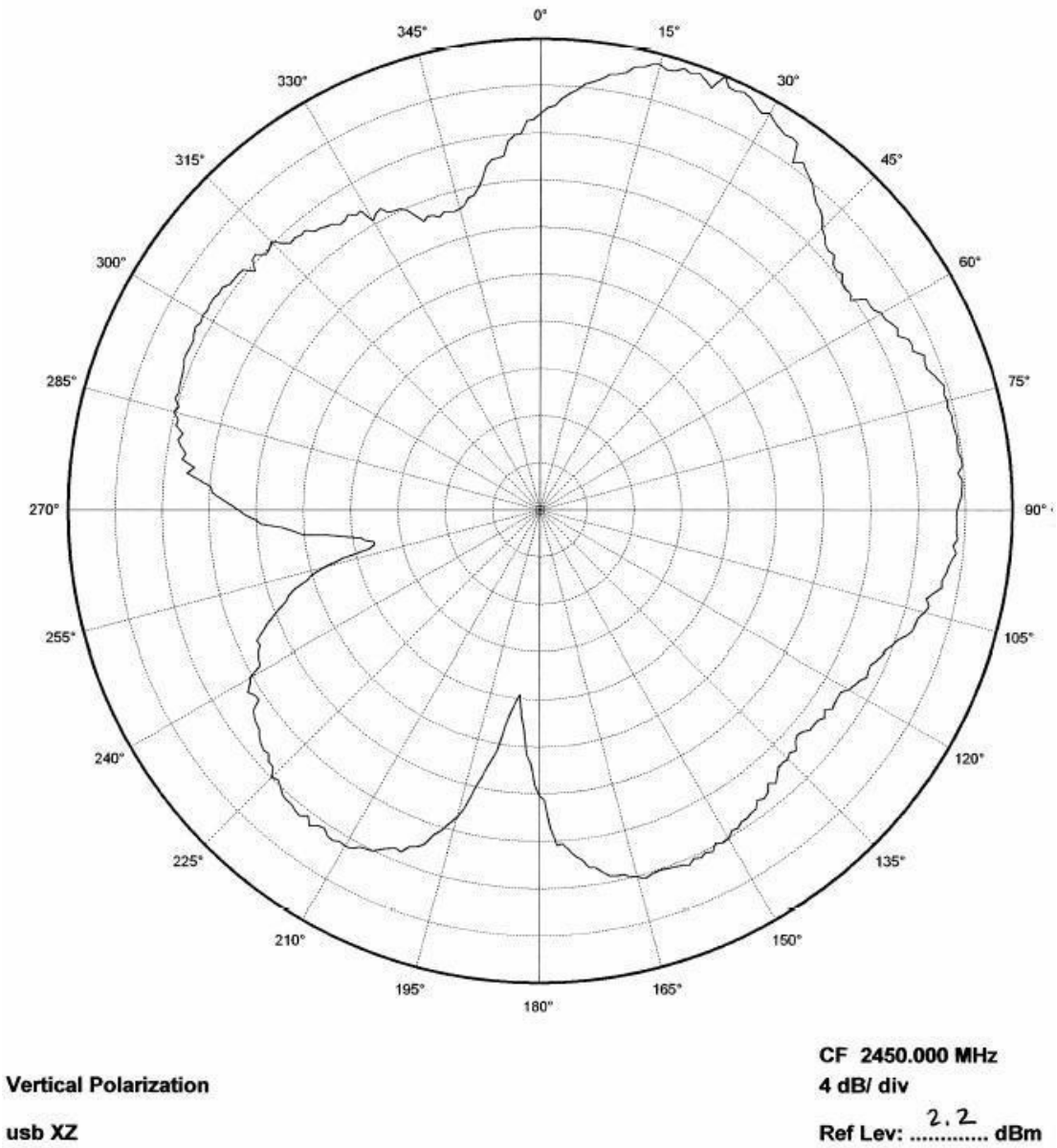


Figure 6: shows the XZ plane vertical polarization.

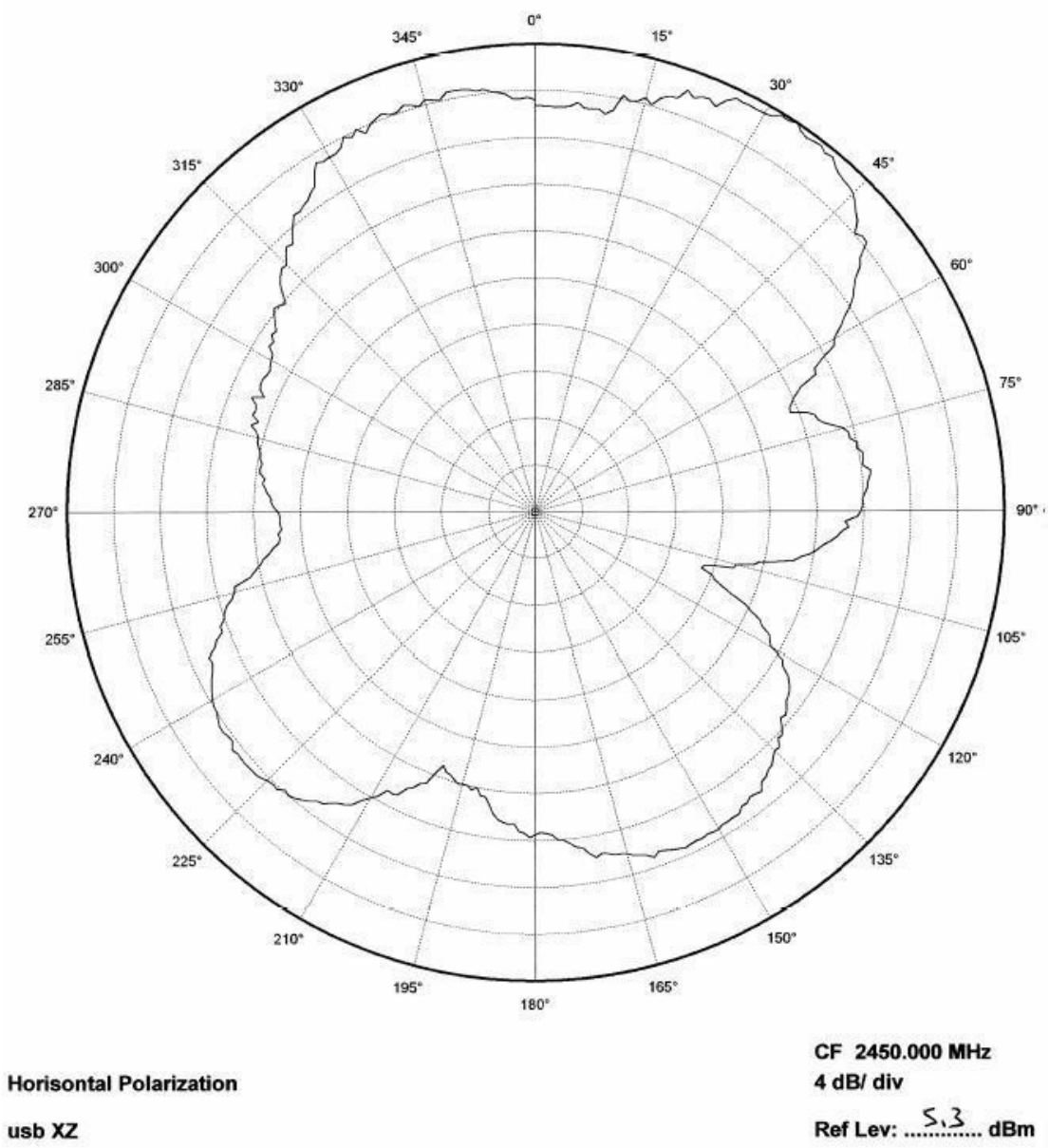


Figure 7: shows the XZ plane horizontal polarization.

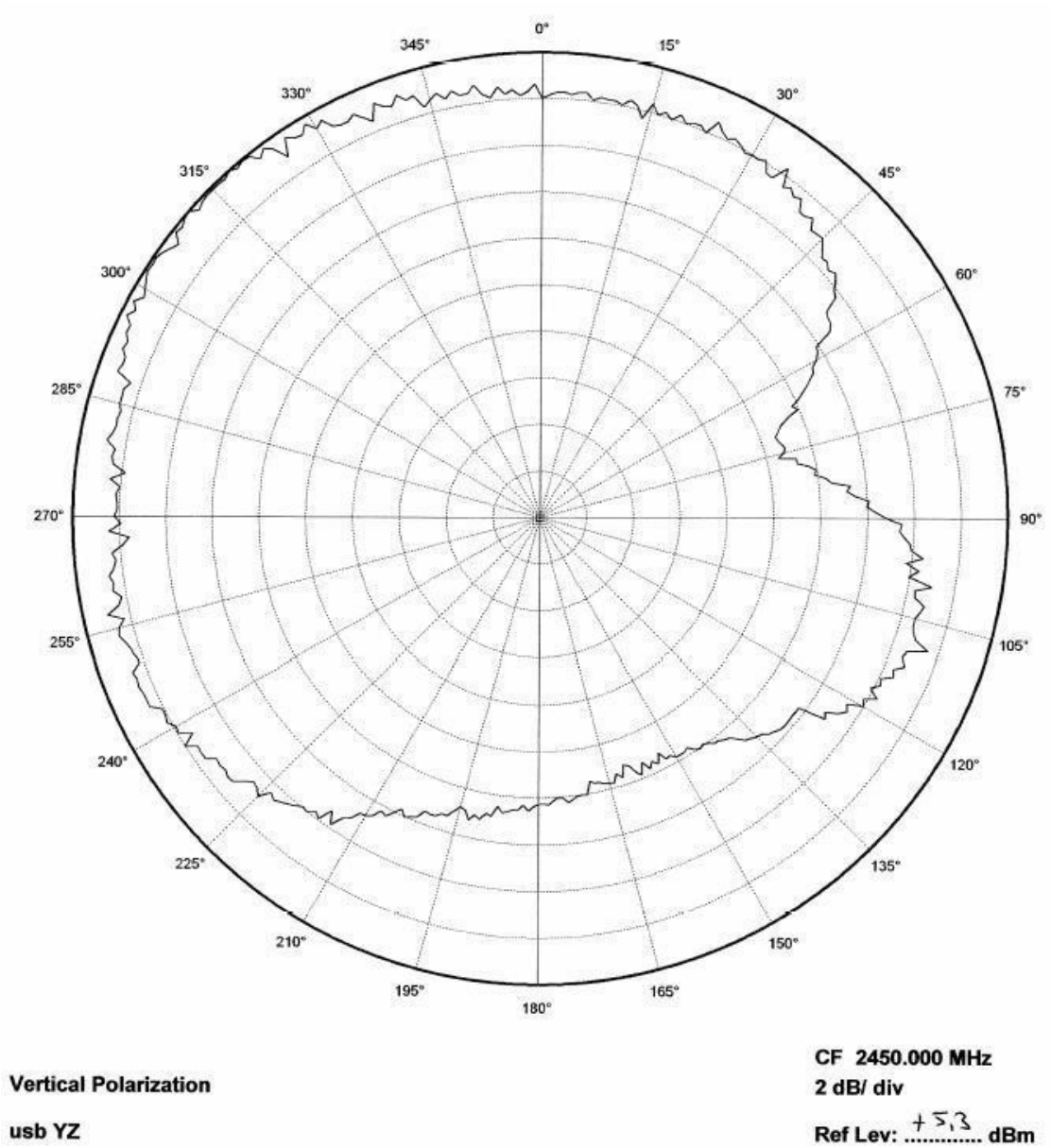


Figure 8: shows the YZ plane vertical polarization.

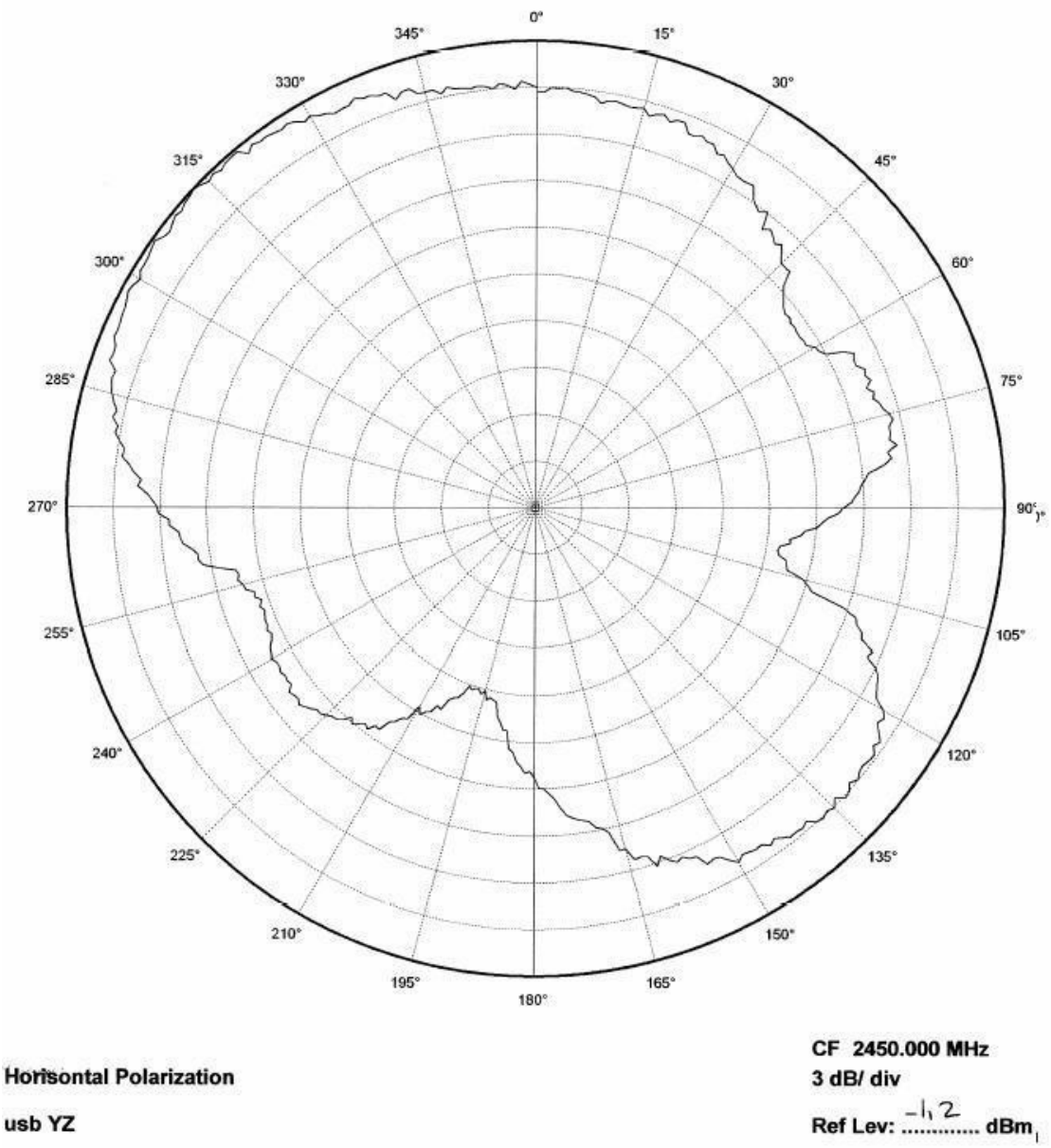


Figure 9: shows the YZ plane horizontal polarization.

3 CONCLUSION

The PCB antenna presented in this document perfoms well for all frequencies in the 2.4GHz ISM band. Table 2 lists the most important properties of the Inverted F Antenna, described in this document. The free line of sight (LOS) range was measured with 250 kbps and 1 % PER.

Gain in XY plane	4.5 dB
Gain in XZ plane	5.3 dB
Gain in YZ plane	5.3 dB
Gain in XY plane, connected to laptop	3.3 dB
LOS range	240 m
Antenna size	15.2 x 5.7 mm

Table 2: IFA Properties

Related Information： Antenna is made in LETARON ELECTRONIC CO., LTD, Model is Sm all Size 2.4 GHz PCB antenna, Antenna gain is 2.0 dBi Max.