2.4 GHz Inverted F Antenna

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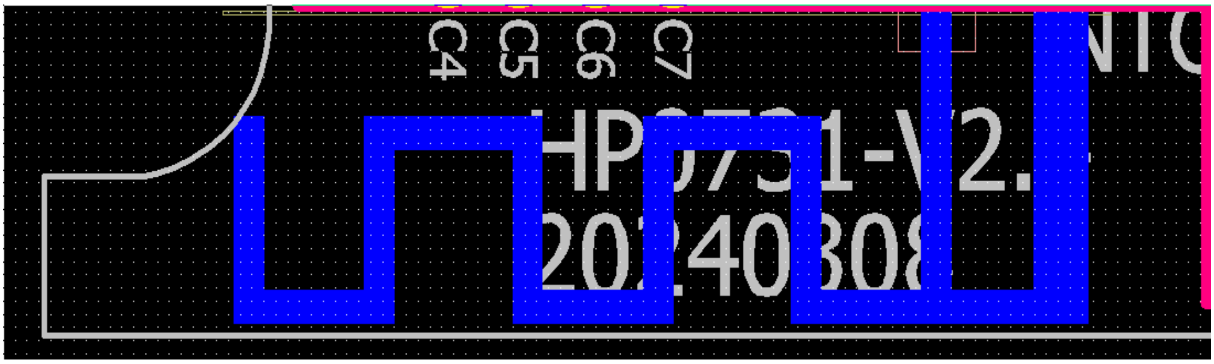
Keywords

- *CC2400*
- *CC2420*
- *CC2430*
- *CC2431*
- *CC2500*
- *CC2510*
- *CC2511*
- *CC2550*
- *PCB Antenna*
- *2.4 GHz*
- *Inverted F Antenna*

1 Introduction

This document describes a PCB antenna design that can be used with all 2.4 GHz transceivers and transmitters from Texas Instruments. Maximum gain is measured to be +3.3 dBi and overall size requirements for this antenna is 14.5 x 4.7 mm. Thus, this is a compact, low cost and high performance antenna.



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2 Abbreviations

EM	Evaluation Module
IFA	Inverted F Antenna
ISM	Industrial, Scientific, Medical
PCB	Printed Circuit Board

3 Description of the Inverted F Antenna Design

Since the impedance of the Inverted F Antenna is matched directly to 50 ohm no external matching components are needed.

3.1 Implementation of the Inverted F Antenna

It is important to make an exact copy of the antenna dimensions to obtain optimum performance. The easiest approach to implement the antenna in a PCB CAD tool is to import the antenna layout from either a gerber or DXF file. Such files are included in CC2430DB reference design [1]. The gerber file is called "Inverted_F_Antenna.spl" and the DXF file is called "Inverted_F_Antenna.dxf". If the antenna is implemented on a PCB that is wider than the antenna it is important to avoid placing components or having a ground plane close to the end points of the antenna. If the CAD tool being used doesn't support import of gerber or DXF files, Figure 1 and Table 1 can be used.

Table 1. IFA Dimensions

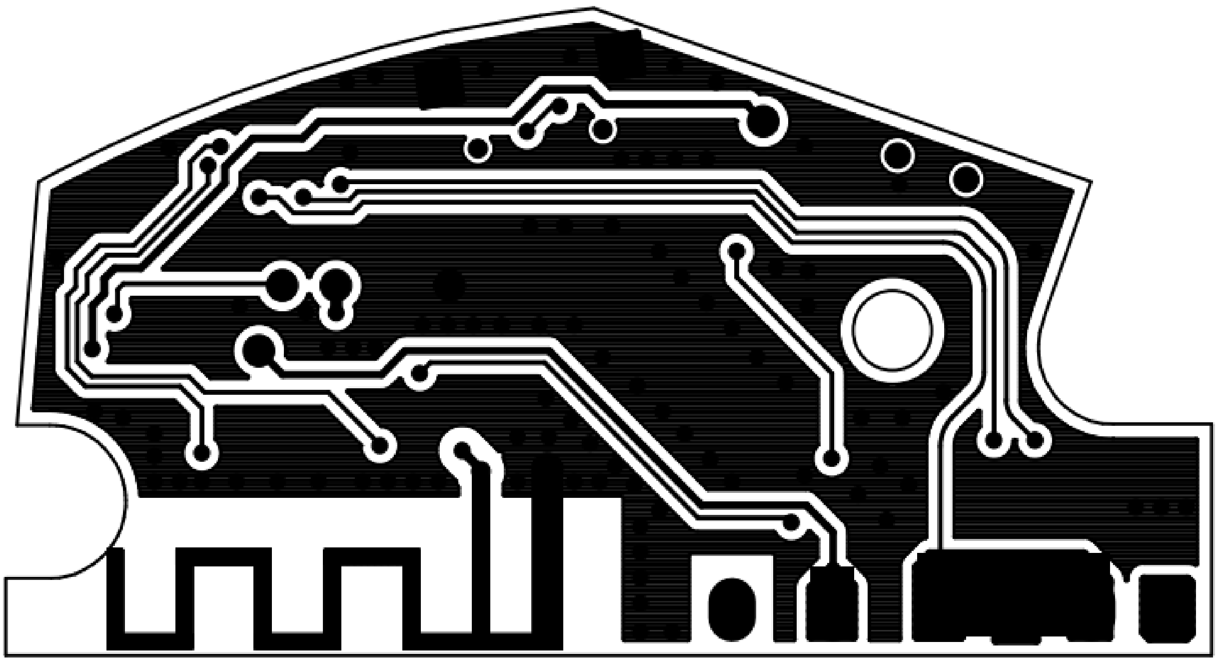
Since there is no ground plane beneath the antenna, PCB thickness will have little effect on the performance. The results presented in this design note are based on an antenna implemented on a PCB with 1 mm thickness.

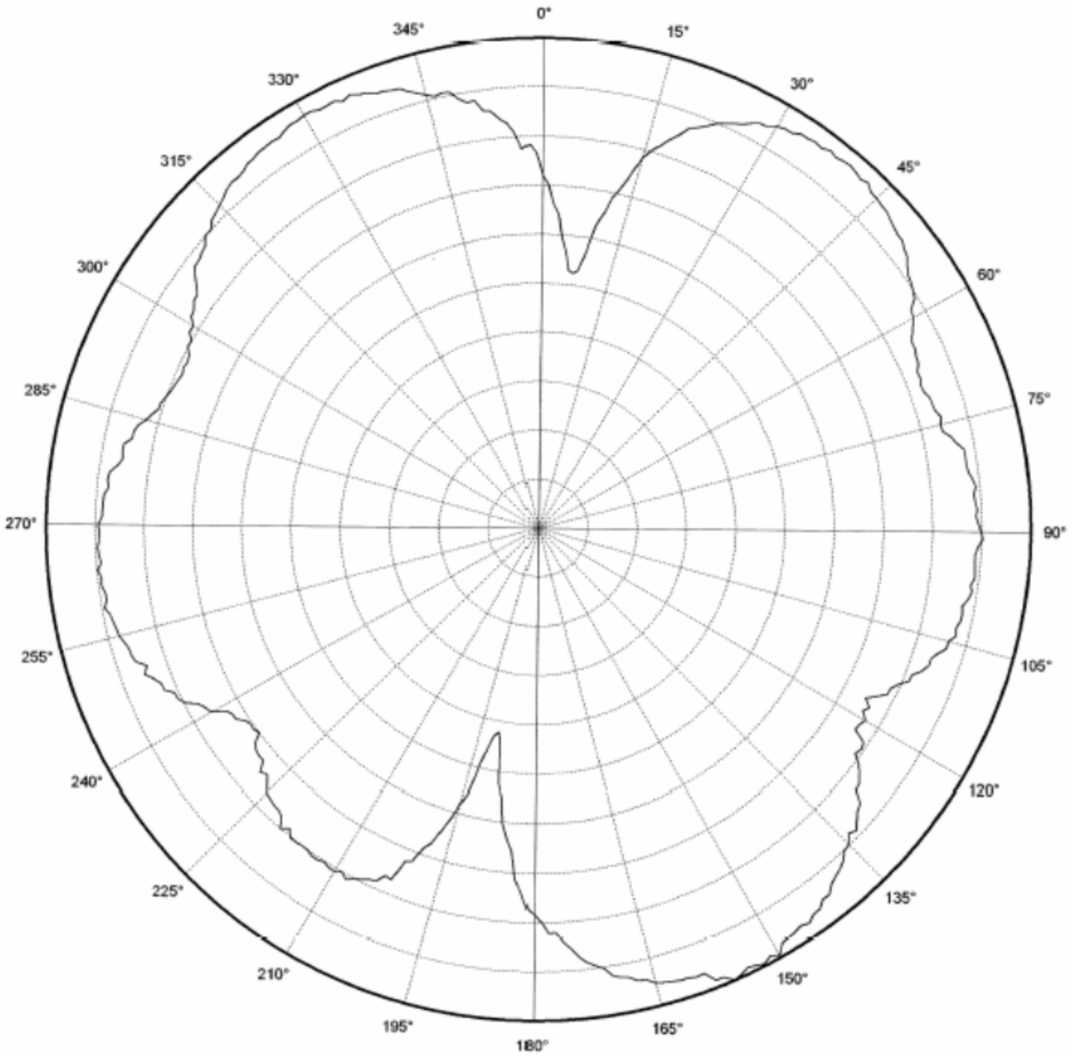
4 Results

All results presented in this chapter are based on measurements performed with CC2430DB [1].

4.1 Radiation Pattern

Figure 2 shows how to relate all the radiation patterns to the orientation of the antenna. The radiation patterns were measured with CC2430 programmed to 0 dBm output power.





Vertical Polarization

cc2430db xy

CF 2450.000 MHz
4 dB/ div
Ref Lev: +1.0 dBi

Figure 3. XY Plane Vertical Polarization

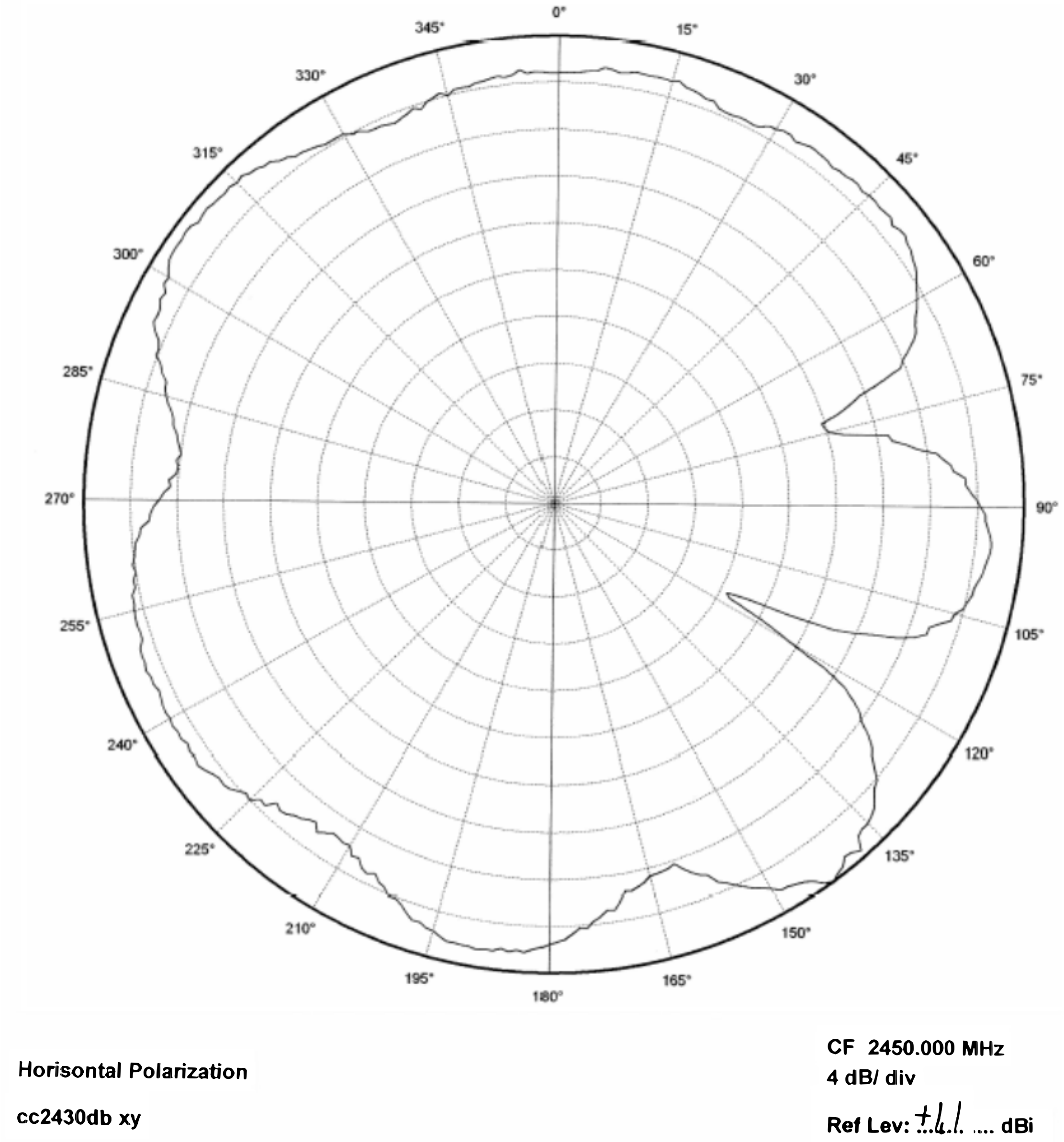


Figure 4. XY Plane Horizontal Polarization

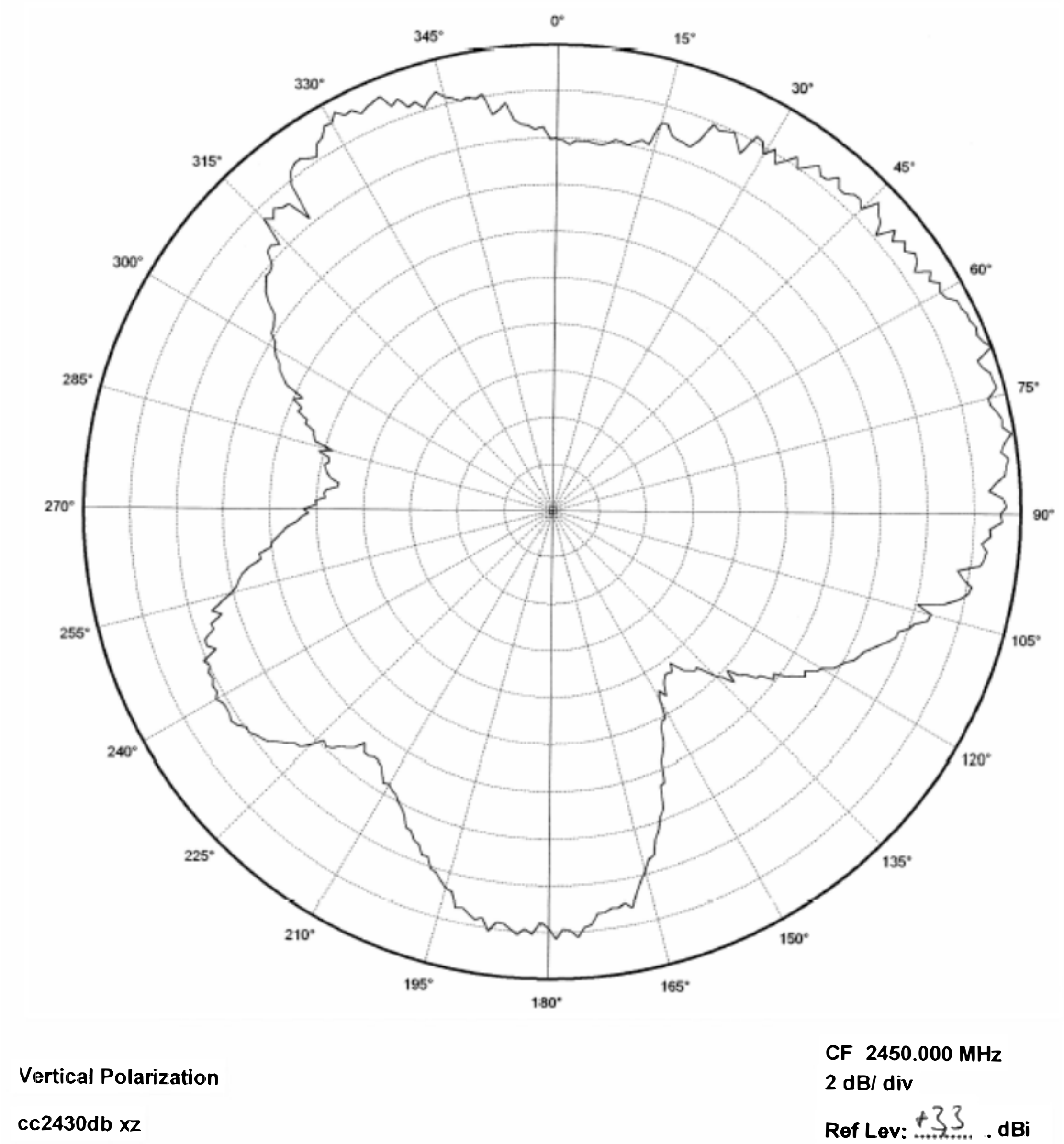


Figure 5. XZ Plane Vertical Polarization

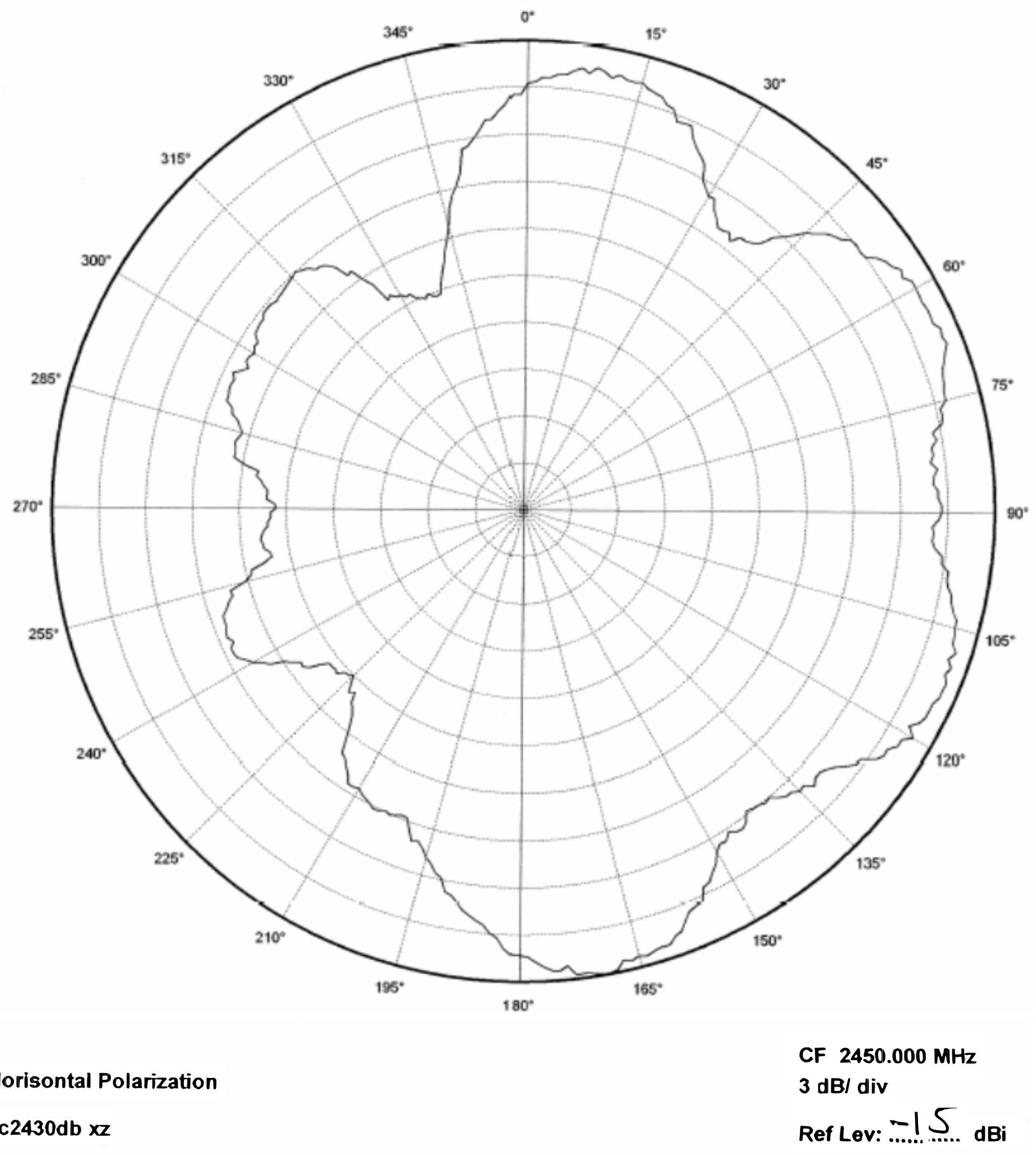


Figure 6. XZ Plane Horizontal Polarization

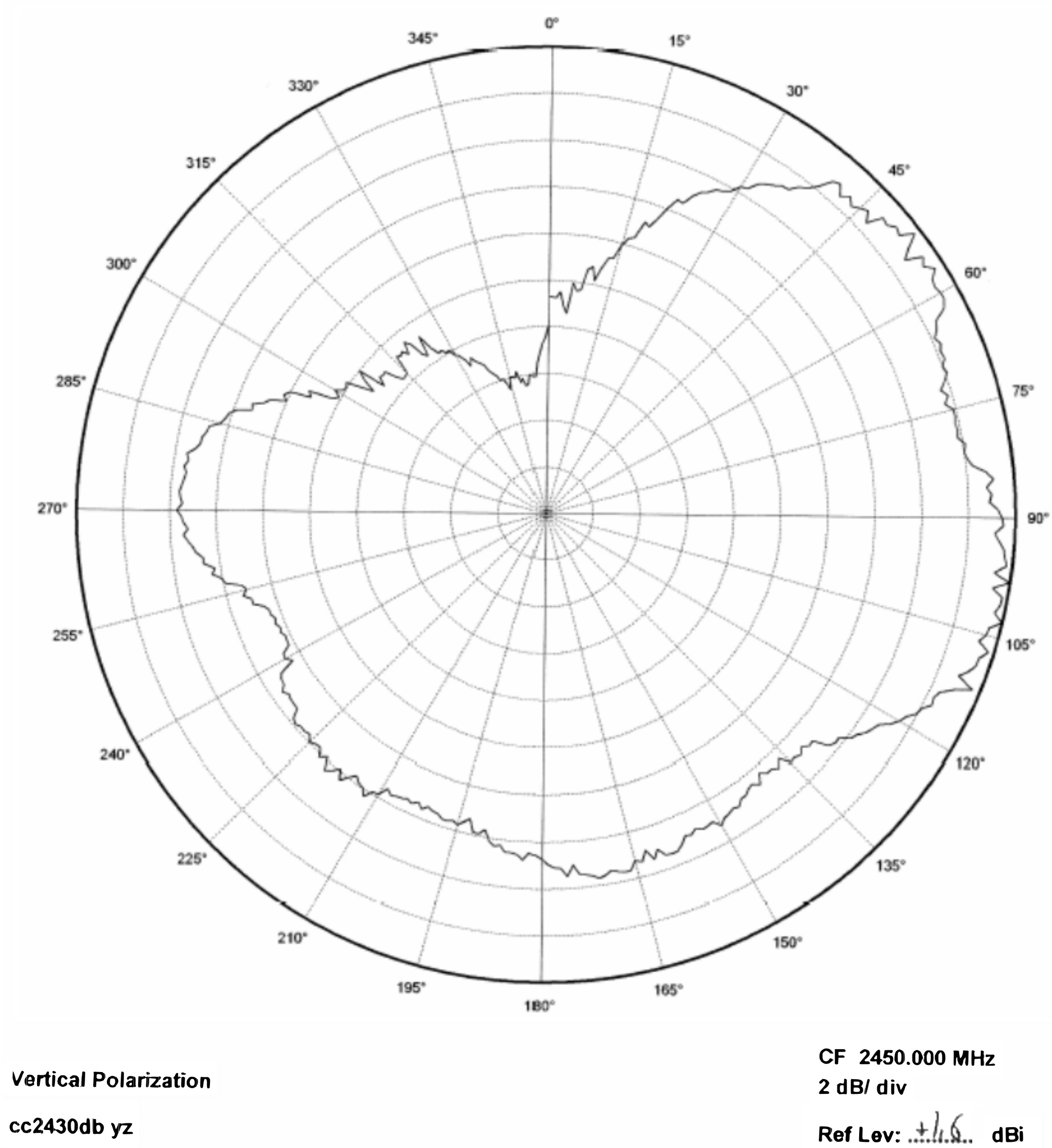


Figure 7. YZ Plane Vertical Polarization

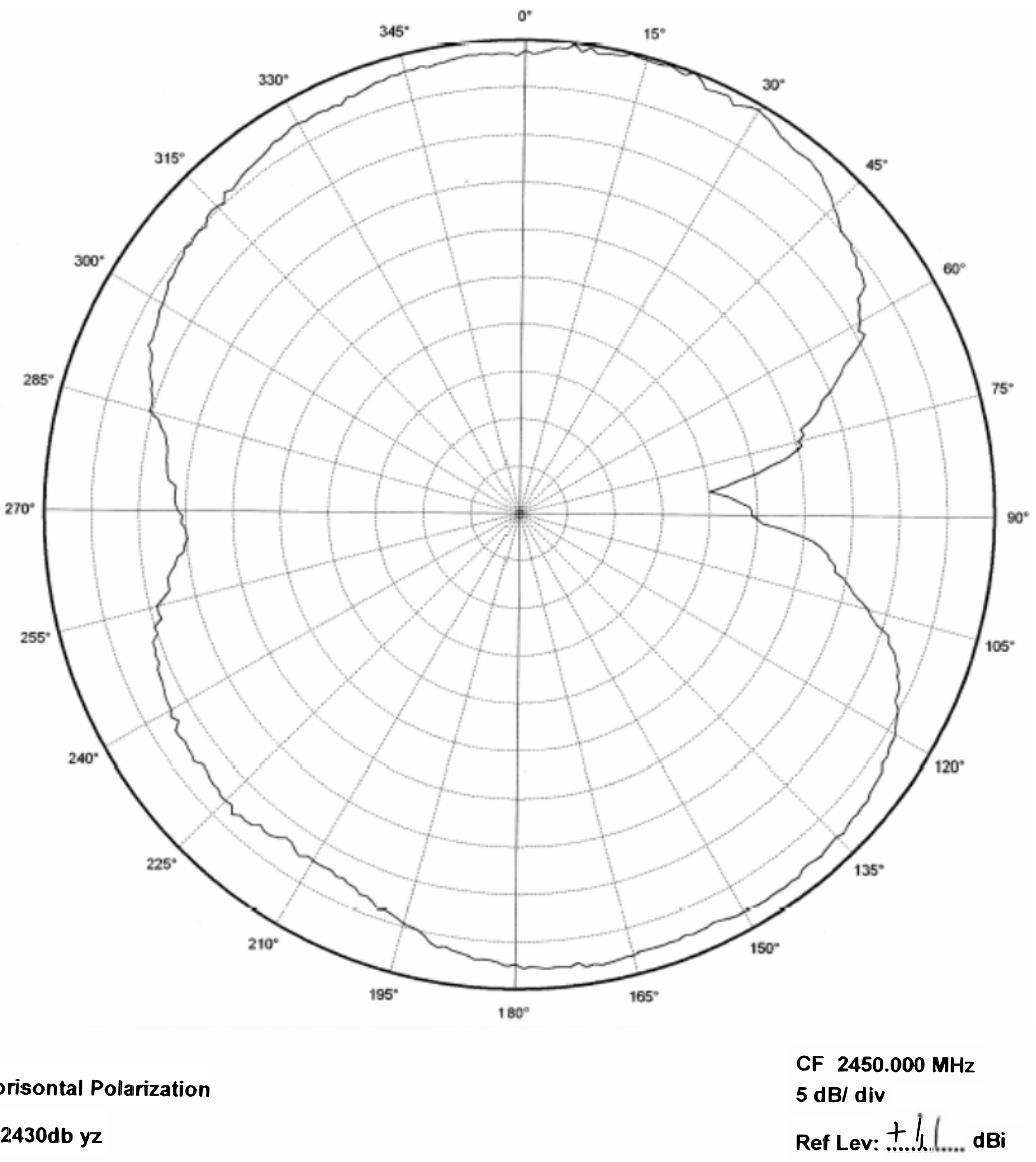


Figure 8. YZ Plane Horizontal Polarization

4.2 Reflection

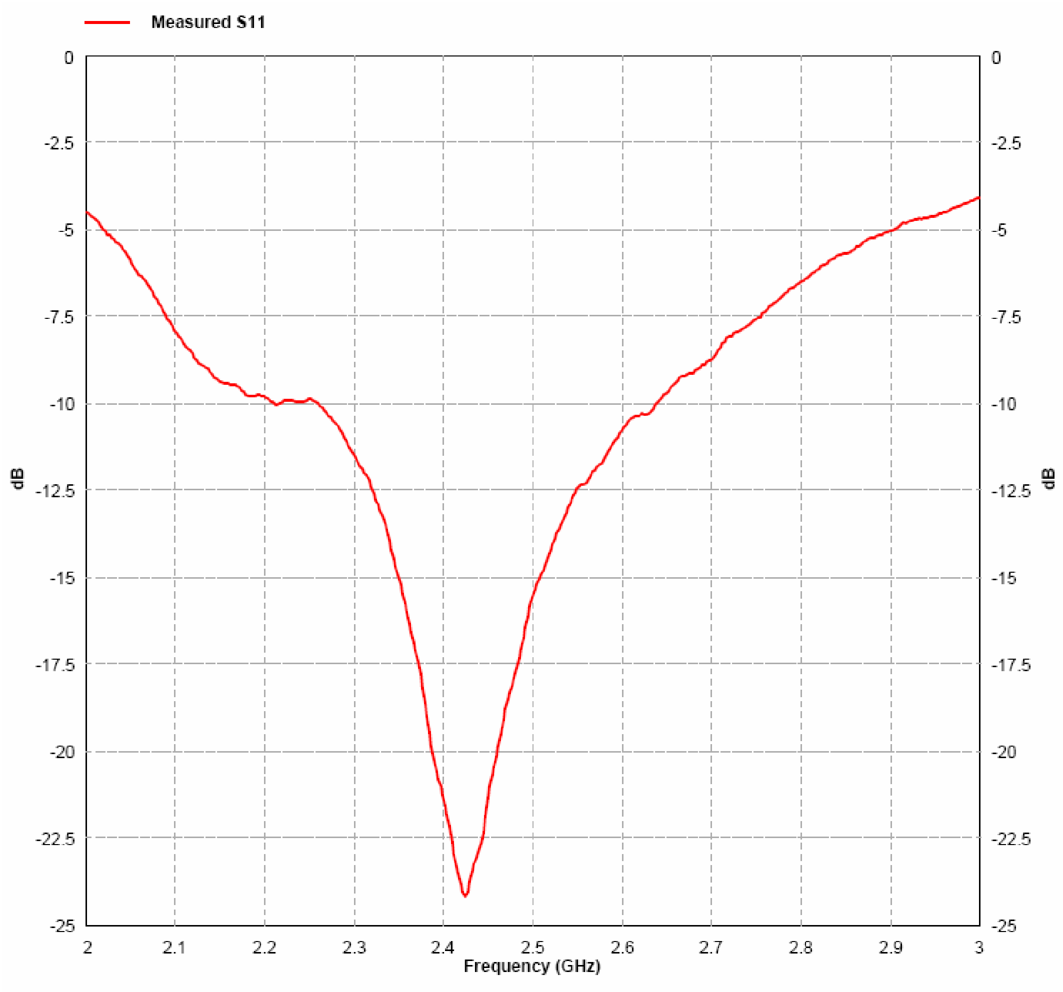


Figure 9. Measured Reflection at the Feed Point of the Antenna

Figure 9 show that the IFA ensures less than 10 % reflection of the available power for a bandwidth of more than 300 MHz. A large bandwidth makes the antenna less sensitive to detuning due to plastic encapsulation or other objects in the vicinity of the antenna.

4.3 Bandwidth

Another way of measuring the bandwidth after the antenna is implemented on a PCB and connected to a transmitter is to write test software that steps a carrier across the frequency band of interest. By using the "Max hold" function on a spectrum analyzer the variation in output power across frequency can easily be measured. Figure 10 shows how the output power varies on the IFA when the PCB is horizontally oriented and the receiving antenna has horizontal polarization. This measurement was not performed in an anechoic chamber thus the graph shows only the relative variation for the given frequency band.

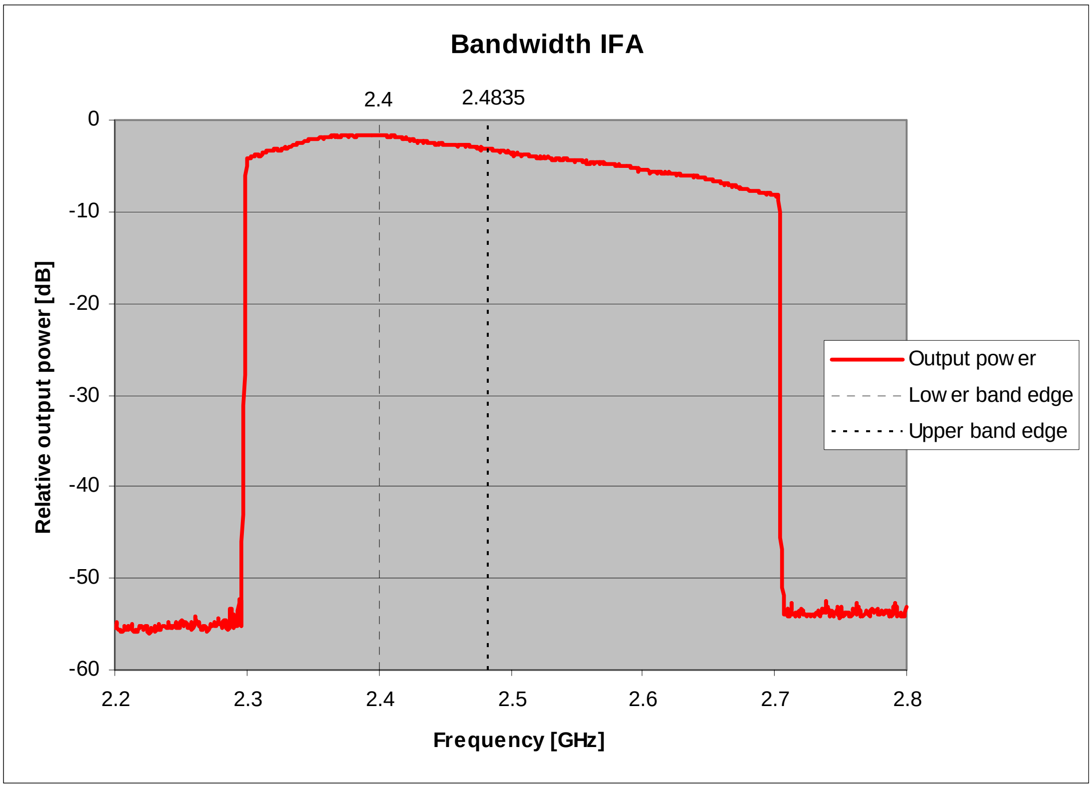


Figure 10. Bandwidth of IFA

5 Conclusion

The PCB antenna presented in this document performs well for all frequencies in the 2.4 GHz ISM band. Except for two narrow dips, the antenna has an omni directional radiation pattern in the plane of the PCB. These properties will ensure stable performance regardless of operating frequency and positioning of the antenna. Table 2 lists the most important properties for the inverted F antenna.

Gain in XY Plane	1.1 dBi
Gain in XZ Plane	3.3 dBi
Gain in YZ Plane	1.6 dBi
Reflection	< -15 dBi
Antenna Size	25.7 x 7.5 mm

Table 2. Summery of the Properties of the IFA

6 References

[1] CC2430DB Reference Design (swrr034.zip)

7 General Information

7.1 Document History

Revision	Date	Description/Changes
SWRU120	2007.04.16	Initial release.

8 Important Notice

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