*ApplicationReport*

# *2.4-GHzInvertedFAntenna*


**ABSTRACT**

Thisdocumentdescribesaprinted-circuitboard(PCB)designthatcanbeusedwithall2.4-GHz transceiversandtransmittersfromTexasInstruments™.Themaximumgainismeasuredtobe+3.3dBi, andtheoverallsizerequirementsforthisantennaare25.7×7.5mm.Thus,thisantennaiscompact,low cost,andhighperformance.


**Contents**

# 1 DescriptionofInvertedFAntennaDesign

## *1.1 ImplementationofInvertedFAntenna*

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. 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.

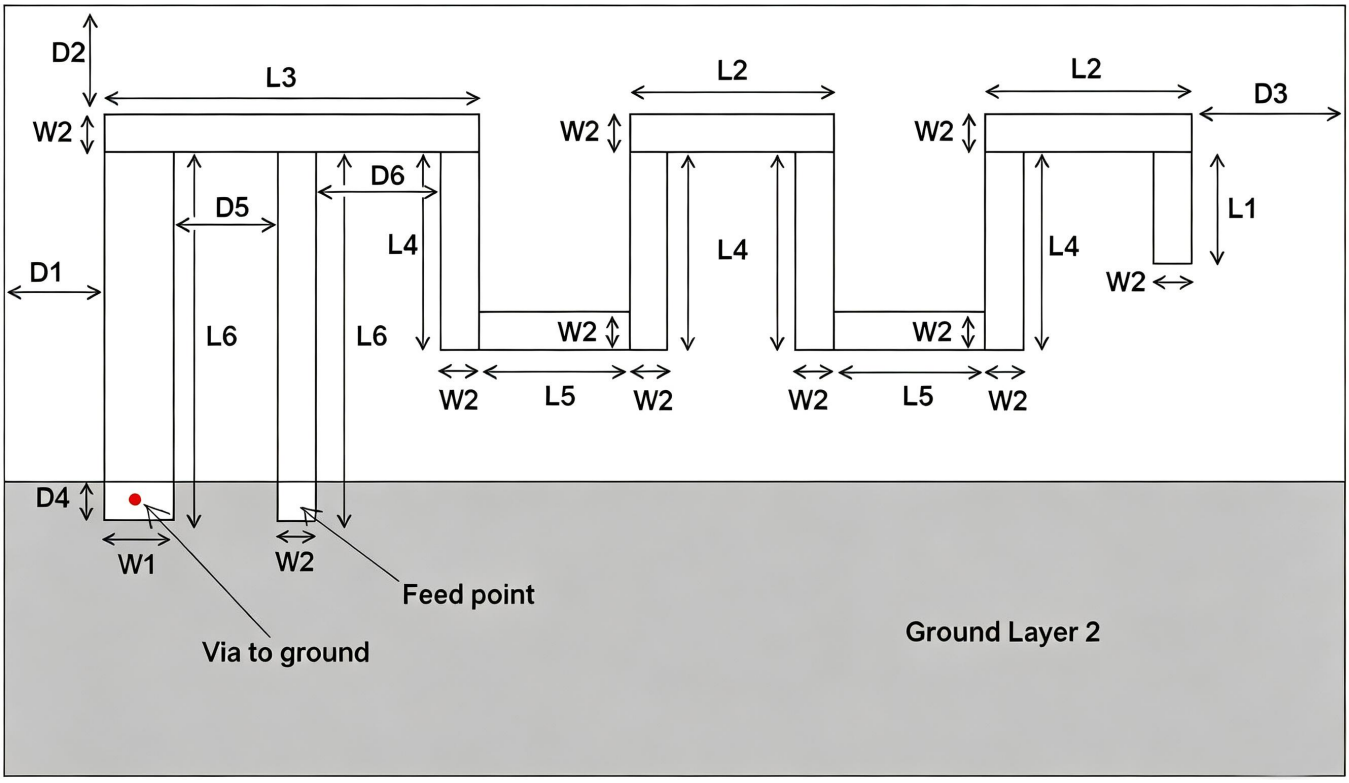


**Figure 3: Antenna Dimensions**

| | |
|---|---|
| L1 | 0.93 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**

## 2 Results

Figure3showstheXYplaneverticalpolarization.

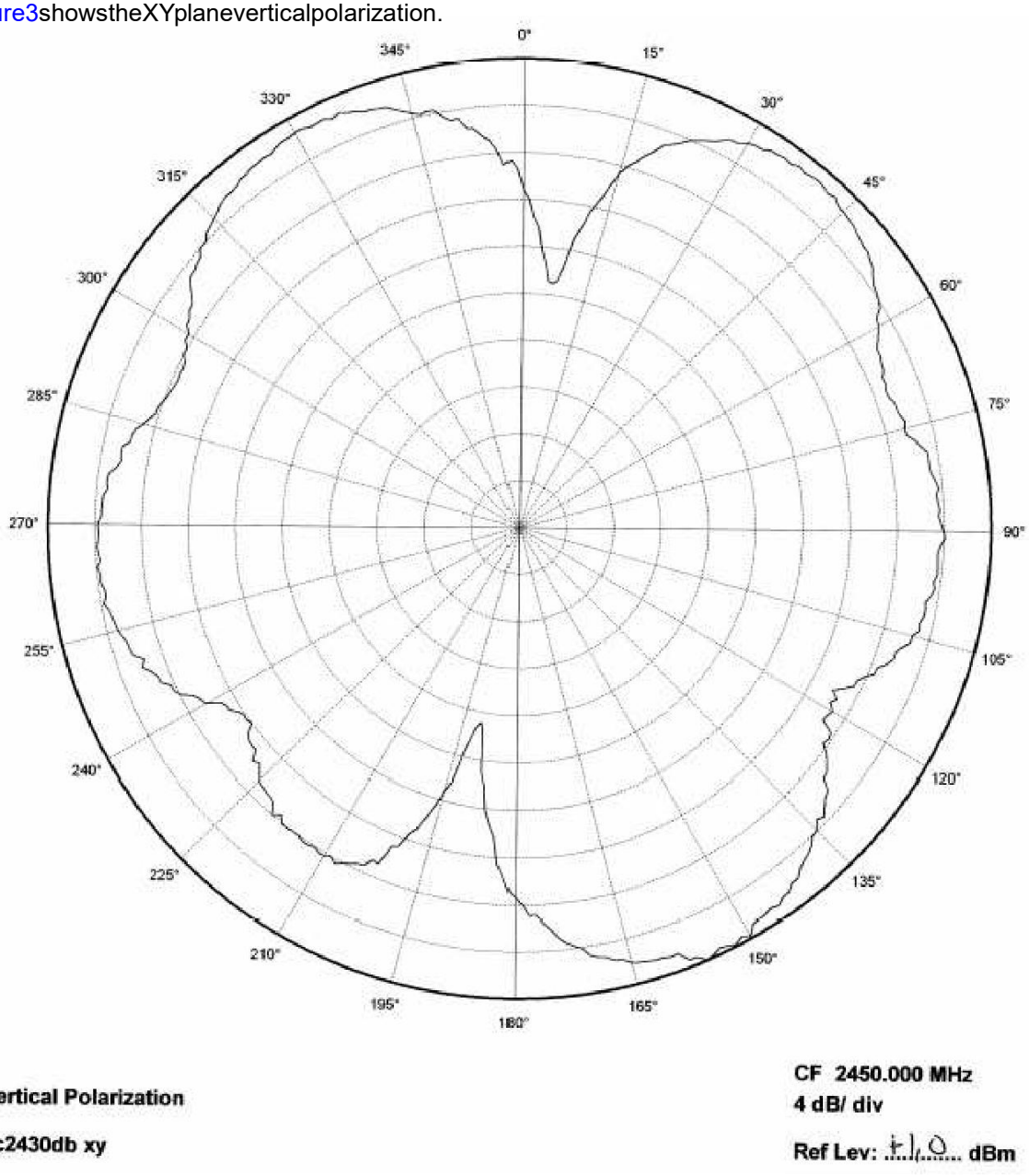


**Figure3.XYPlane–VerticalPolarization**

Figure4showstheXYplanehorizontalpolarization.

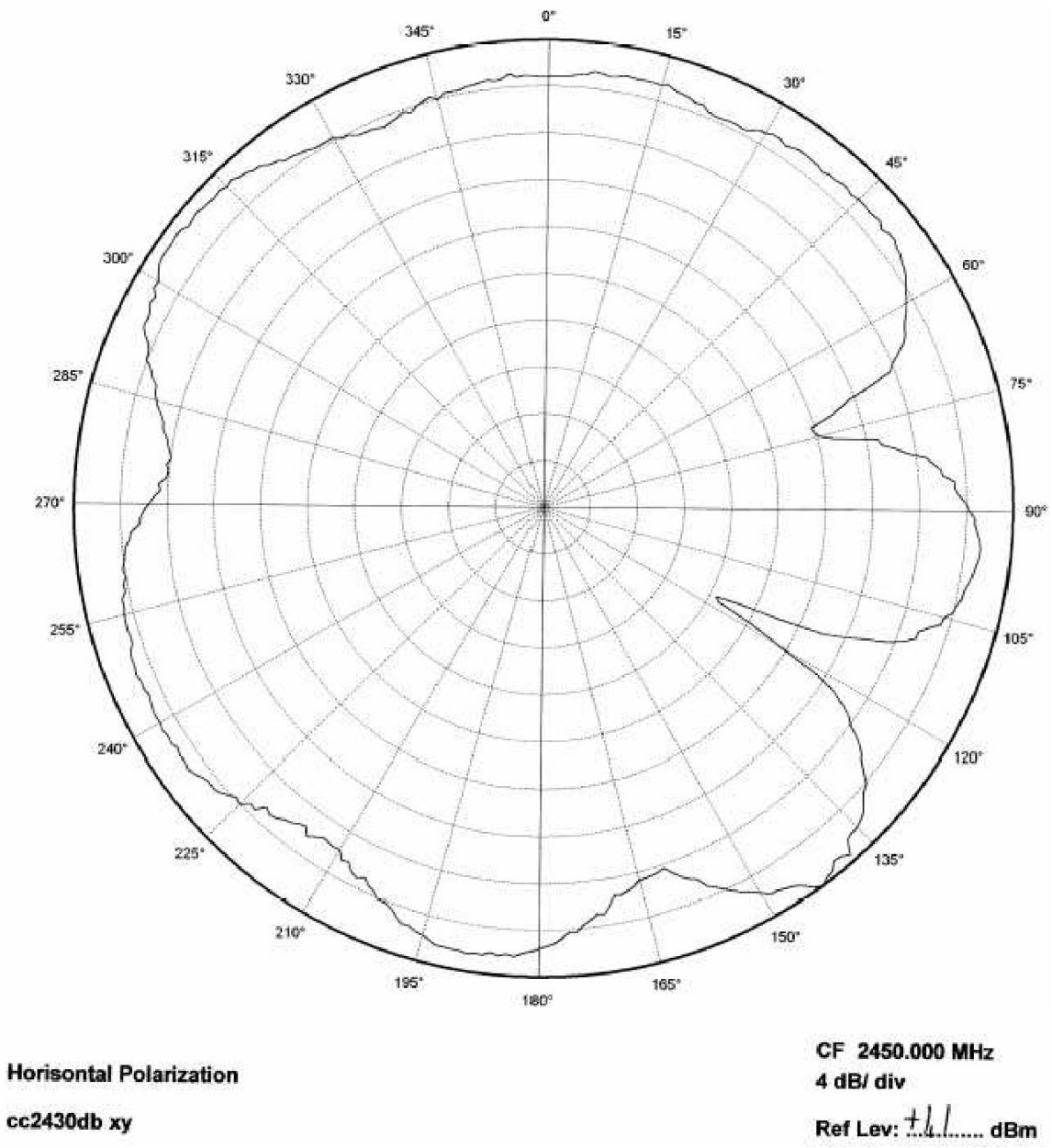


**Figure4.XYPlane–HorizontalPolarization**

Figure5showstheXZplaneverticalpolarization.

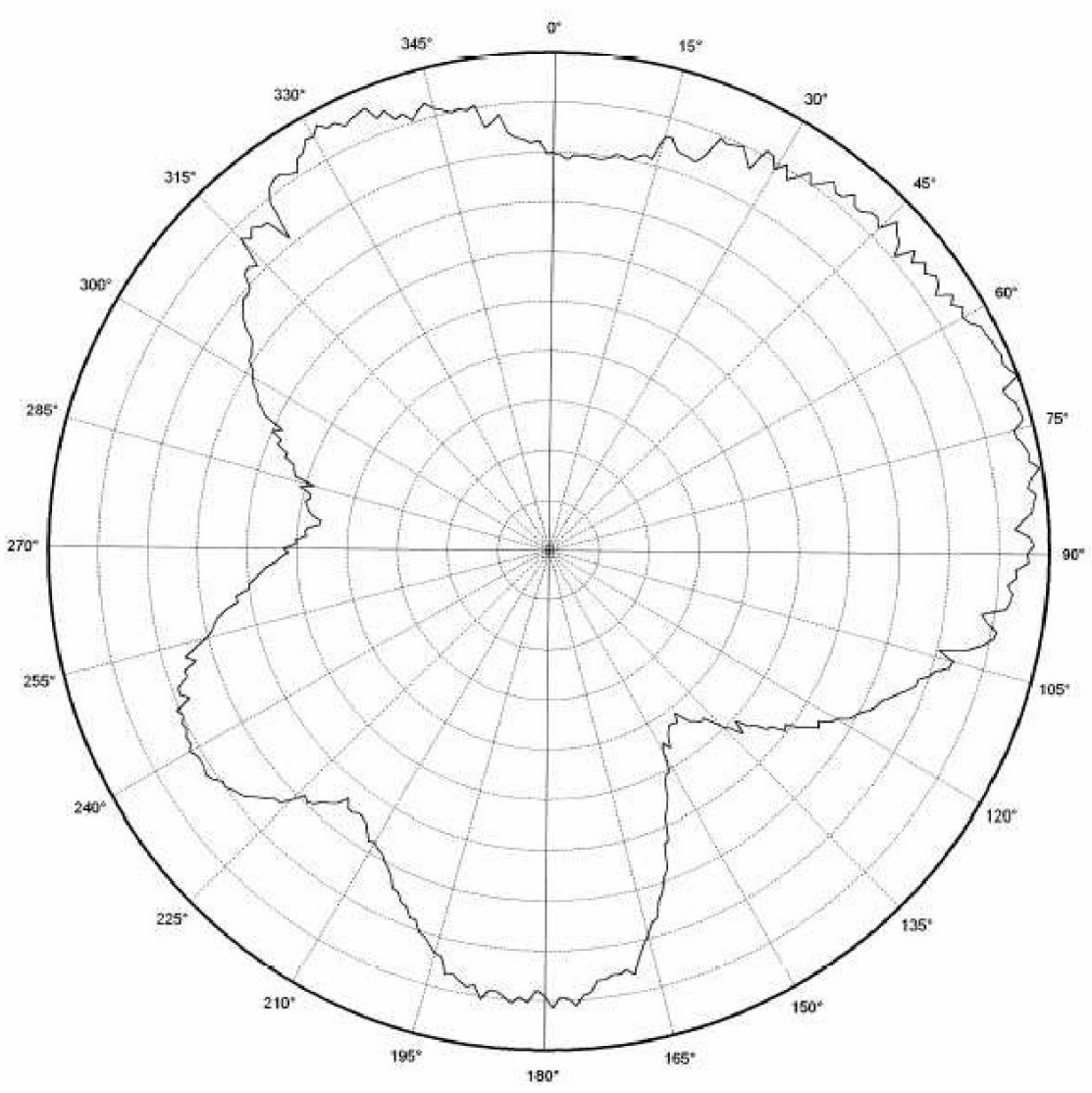


**Figure5.XZPlane–VerticalPolarization**

Figure6showstheXZplanehorizontalpolarization.

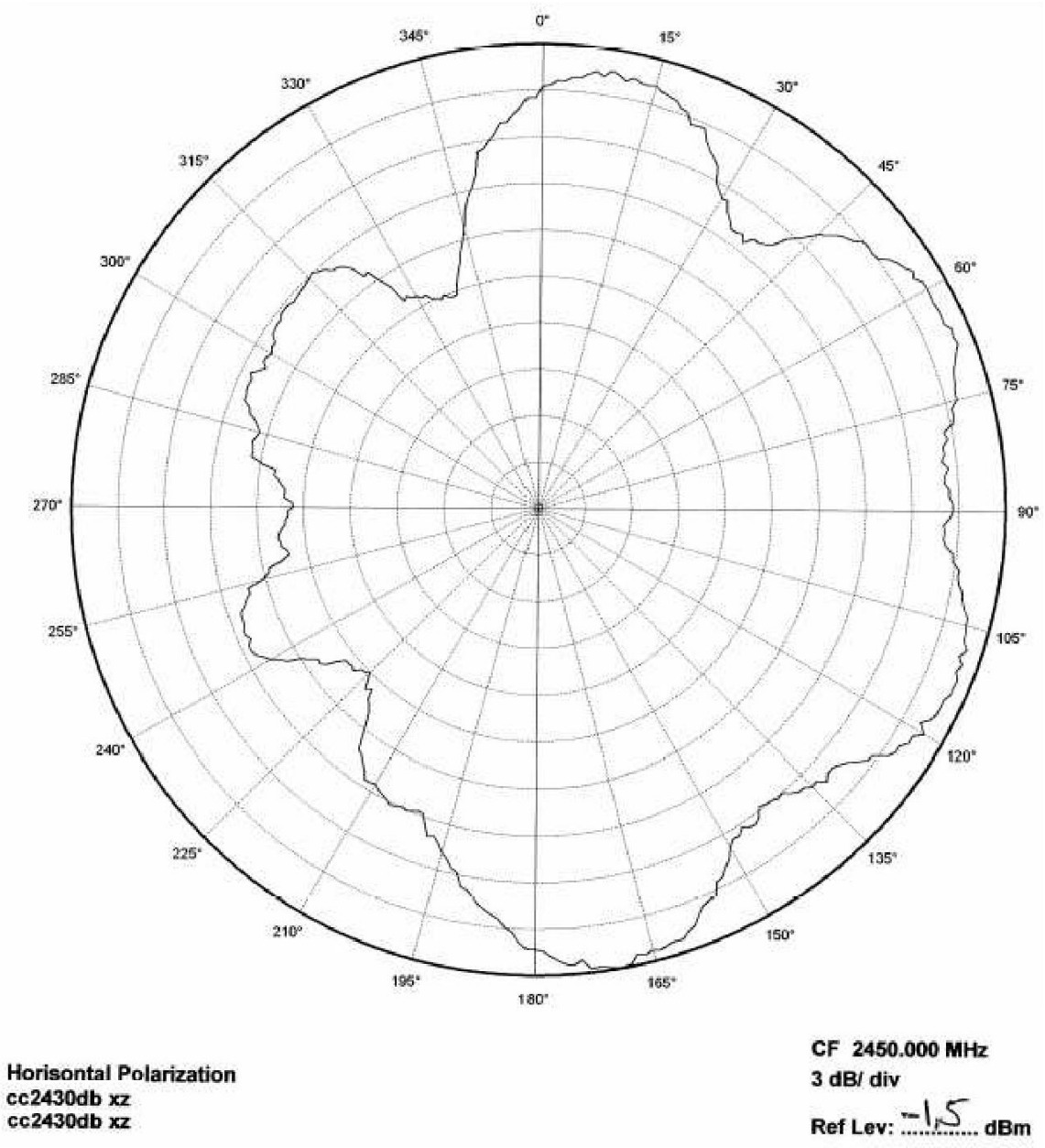


**Figure6.XZPlane–HorizontalPolarization**

Figure7showstheYZplaneverticalpolarization.

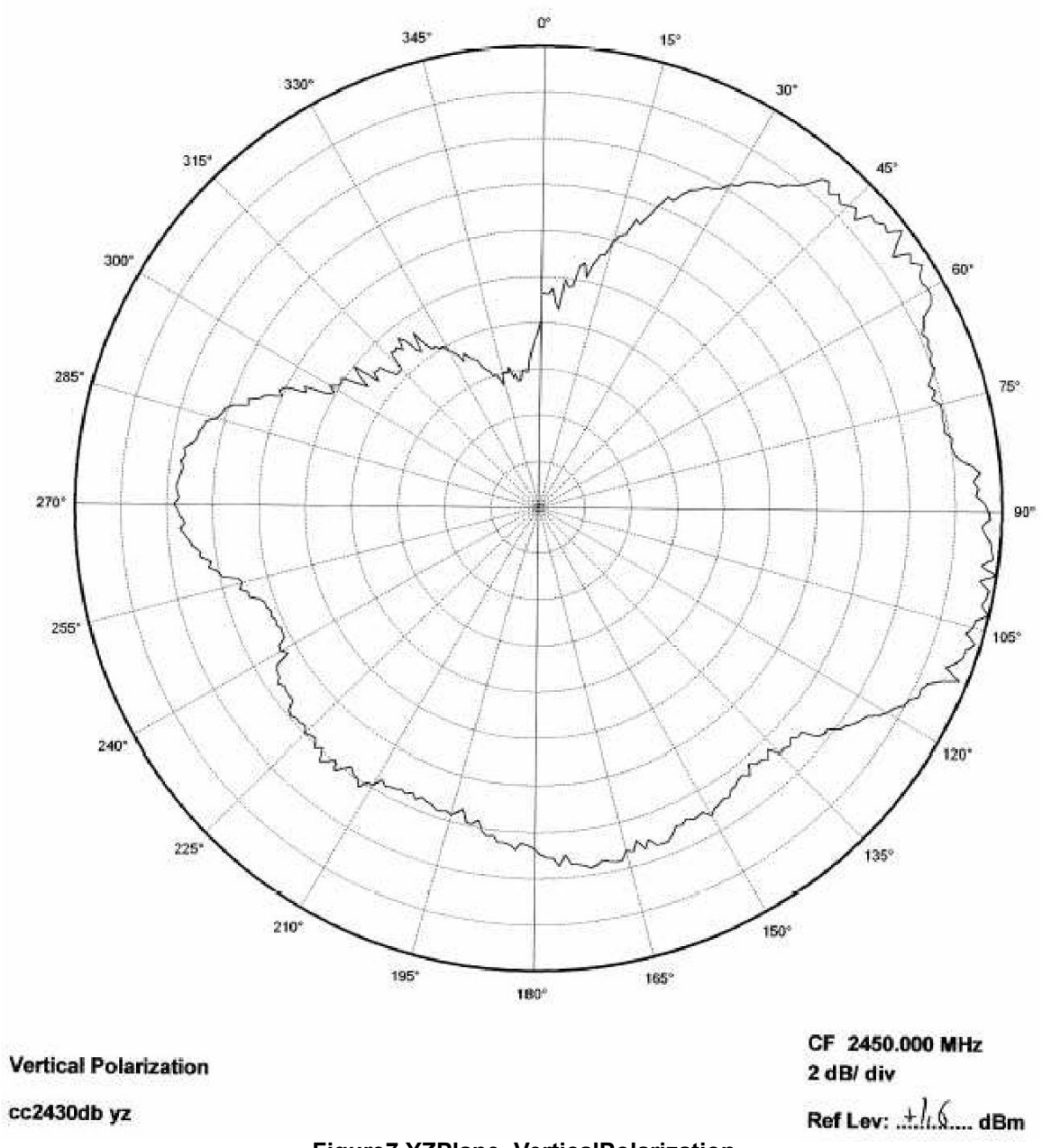


**Figure7.YZPlane–VerticalPolarization**

Figure8showstheYZplanehorizontalpolarization.

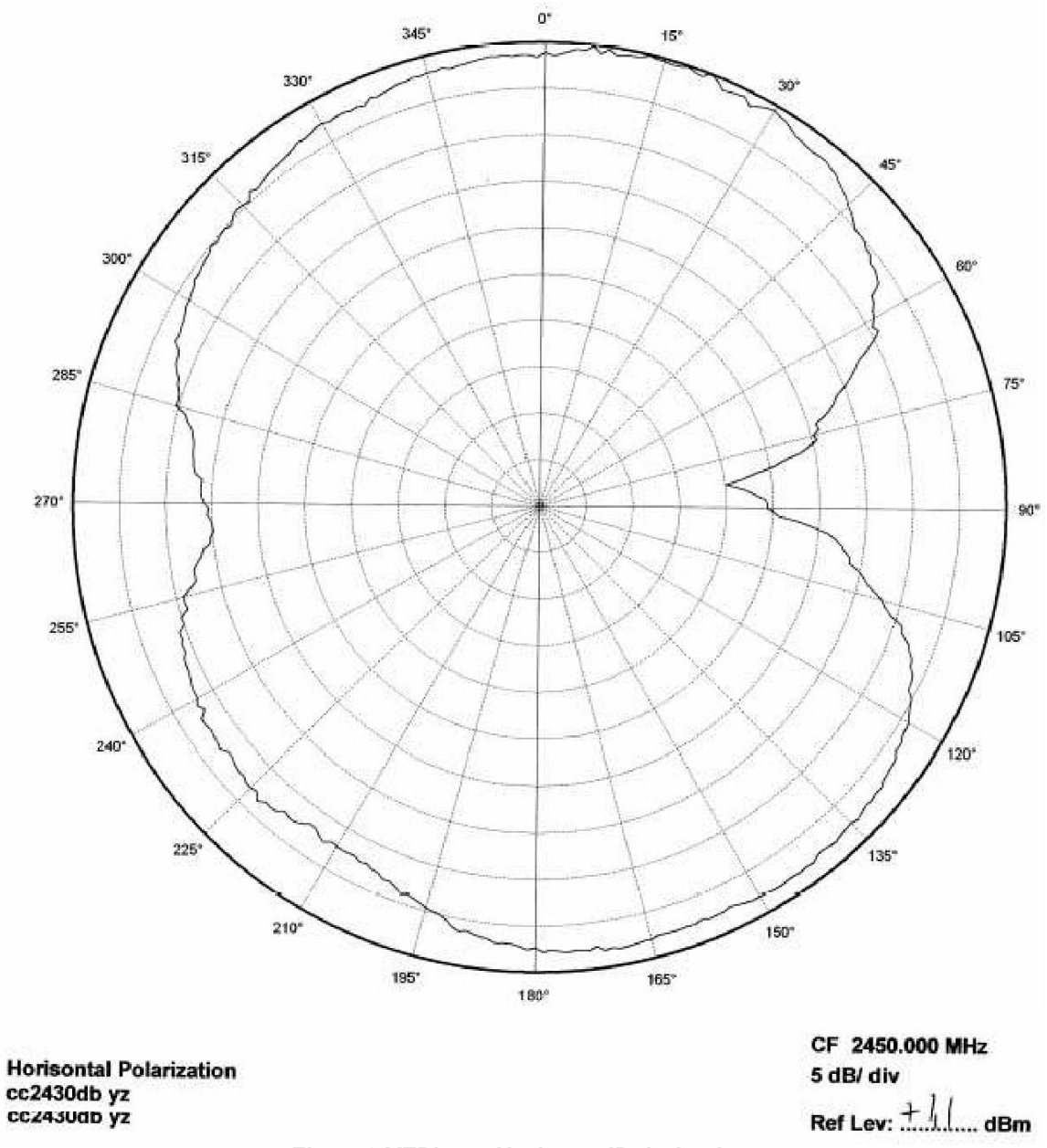


**Figure8.YZPlane–HorizontalPolarization**

## 2.2 Reflection

Figure9showsthattheIFAensureslessthan10%reflectionoftheavailablepowerforabandwidthof morethan300MHz.Alargebandwidthmakestheantennalesssensitivetodetuningbecauseofplastic encapsulationorotherobjectsinthevicinityoftheantenna.

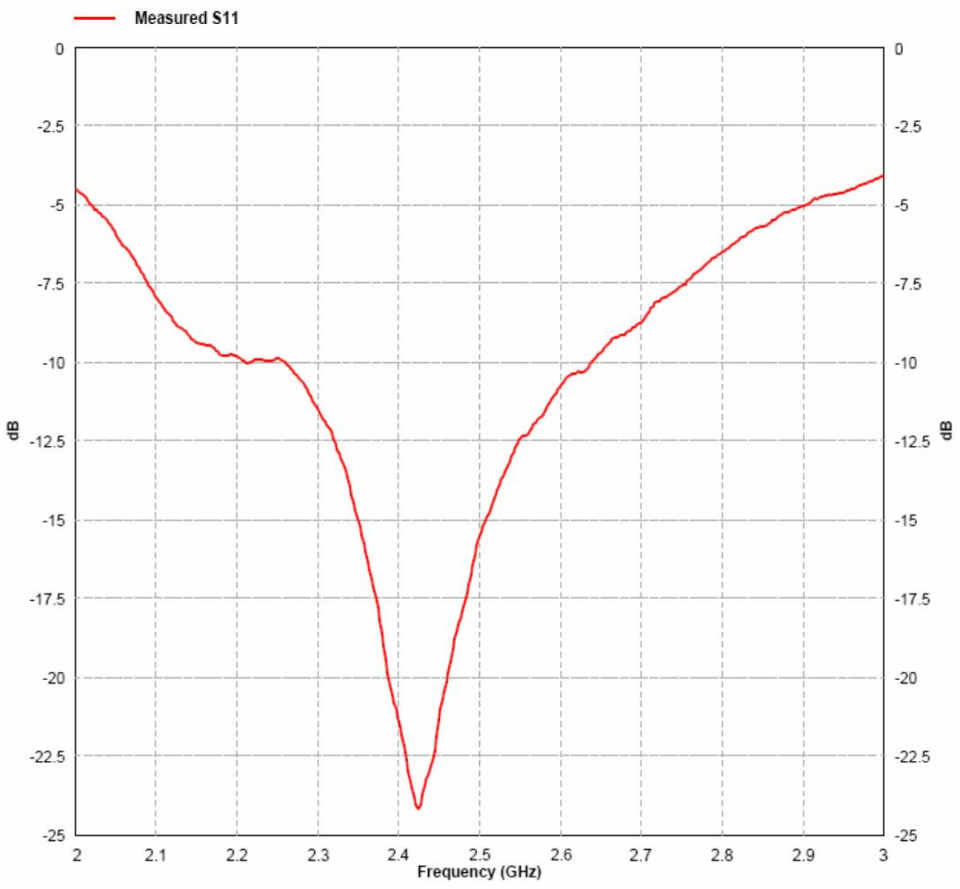


**Figure9.MeasuredReflectionatFeedPointofAntenna**

## 2.3 Bandwidth

AnotherwayofmeasuringthebandwidthaftertheantennaisimplementedonaPCBandconnectedtoa transmitteristowritetestsoftwarethatstepsacarrieracrossthefrequencybandofinterest.Byusingthe maximumholdfunctiononaspectrumanalyzer,thevariationinoutputpoweracrossfrequencycaneasily bemeasured.

Figure10showshowtheoutputpowervariesontheIFAwhenthePCBishorizontallyorientedandthe receivingantennahashorizontalpolarization.Thismeasurementwasnotperformedinananechoic chamber,thusthegraphshowsonlytherelativevariationforthegivenfrequencyband.

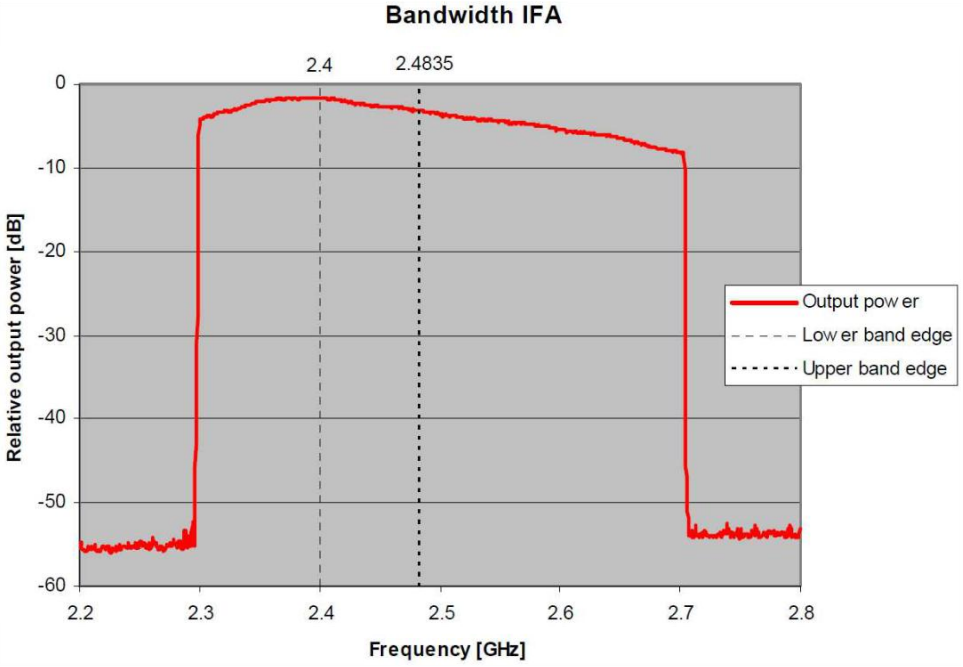


**Figure10.BandwidthofIFA**

## 3 Conclusion

ThePCBantennapresentedinthisdocumentperformswellforallfrequenciesinthe2.4-GHzISMband. Exceptfortwonarrowdips,theantennahasanomnidirectionalradiationpatterninthe planeofthePCB. Thesepropertieswillensurestableperformanceregardlessofoperatingfrequencyandpositioningofthe antenna.Table2liststhemostimportantpropertiesfortheIFA.

**Table2.SummaryofIFAProperties**

| | |
|---|---|
| GaininXYplane | 1.1dBi |
| GaininXZplane | 3.3dBi |
| GaininYZplane | 1.6dBi |
| Reflection | <–15dB |
| Antennasize | 25.7×7.5mm |

## 4 References

1.*CC2430DBReferenceDesign*

## RevisionHistory

NOTE:Pagenumbersforpreviousrevisionsmaydifferfrompagenumbersinthecurrentversion.

| ChangesfromBRevision(April2008)toCRevision | Page |
|---|---|
| • Changed+3.3dBtobe+3.3dBi | 1 |
| • ChangeddBinTable2todBi | 11 |