BLE Antenna Specification

Rev 2.0 — May 2018 Application note

Antenna model: WF154 BT Antenna

Document information

Info	Content
Keywords	PCB Antenna test procedure
Abstract	This document is served as a basic antenna selection guide for the customer.

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Revision history

Rev	Date	Description
0.1	20130607	Initial release
0.2	20130709	Grammatical corrections made some text added
1.0	20150324	Reviewed and migrated to NXP template
2.0	20180509	Removed the security watermark

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Contents

Contact information

For more information, please visit: http://www.nxp.com

1. Overview

The following document serves as a basic antenna selection guide for the customer. Various antennas are showcased and insight on their dimension, design process, radio frequency performance, PCB layout, etc. is provided. This is to allow the customer to select an appropriate antenna for their application. Detailed design questions or concerns should be communicated to the FAE at NXP.

A small description with regards to Antenna test procedure is also presented. Some of the Antenna's discussed in this note may require more detailed simulation depending on the actual application. From the types of Antenna's discussed, chip antenna's have the smallest footprint but are low on efficiency, similarly microstrip antenna's are cheap but are tedious in design and the metal antenna's have high efficiency. In order to guide the customer a few Antenna suppliers are mentioned, so that customers can also have option of directly buying from them.

For the Antenna's described in this note, 50 Ohm input impedance has been considered along with Omni-directional radiation pattern with a center frequency of 2.45GHz.

2. Typical BLE antennas comparing

The Following table shows the three antenna types that will be briefly discussed in this app note. A very basic comparison of key parameters has been shown as well. This chart helps the customer to qualify a specific antenna type for their application.

Table 1 Typical BLE antennas comparing

	Micro-strip antenna	**Metal plate antenna**	**Chip antenna**
Efficiency	Moderate	High	Low

Cost	Low	High	Moderate
Bandwidth	High	Low	Moderate
Average Gain	Moderate	High	Low
Dimension	Moderate	High	Low
Typical Applications	Sports, fitness, healthcare, medical, remote control	Sports, fitness, healthcare, medical, remote control	Sports, fitness, healthcare, medical, remote control
Polarization	Linear	linear	Linear
Power Handling	Low	high	Medium
Typical Impedance	50ohm	50ohm	50ohm

3. Micro-Strip Antenna

3.1 Overview

The Micro-Strip antenna is one of the most popular antennas, because of its low cost and ease of production. With the help of advanced simulation tools such as HFSS, Microwave Office and ADS, it has become easier to design and develop such antennas. The micro-strip antenna can also be seen as a simple fracture antenna due to its flexible appearance. The micro-strip antenna RF performance is highly depended on the size of the reference ground. Therefore, changing the default reference ground size, the antenna RF characteristic including the resonance frequency, port input impedance, etc, will change as well.

The micro-strip antenna can be designed as a circular polarized antenna. One example will be illustrated in this document, such a design may occupy more PCB area compared to other typical micro-strip antennas.

Micro-strip antennas can be designed into antenna arrays to get high antenna gain, which is not used widely in the consumer electronics products due to the increased PCB size.

3.1 Design steps

Following are some basic steps required to bring up the design.

- ◆Select the antenna type, for example, monopole, dipole or IFA antenna;
- ◆Roughly calculate the antenna dimension using the experience formula;
- ◆Set up the simulation module using simulation tools, such as, HFSS, ADS;
- ◆Simulate and adjust the antenna dimension till the simulation result meets the requirement;

The third step is the most critical. If the antenna model is not correct or has significant error, caused by incorrect parameters or module structure, the simulation result may be incorrect. S11, bandwidth, input impedance, gain, cross polarization and axial ratio are the determining parameters for the antenna performance.

3.2 Some examples of PCB antenna

3.2.1 PCB “L” antenna

As a micro-strip antenna, the L shaped antenna is the simplest solution. Its resonance frequency is related with the antenna line width “w”, the antenna length “L”, the dimension and the dielectric constant of the substrate. Shown below is an example of such a design. The dielectric constant for the FR4 substrate is 4.4, the thickness is 0.5mm. Following figure shows the dimension and layout of the antenna.

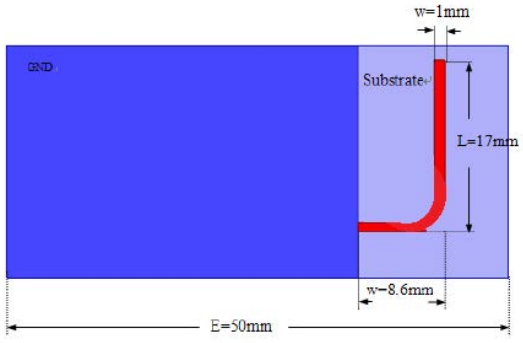


Figure 1 “L” antenna dimension

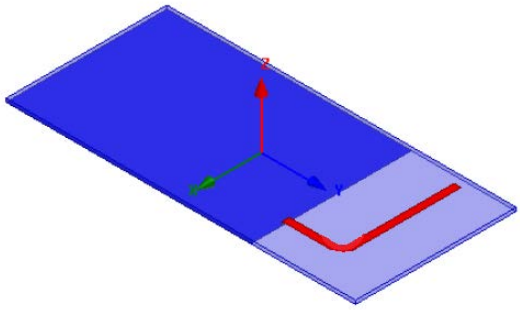


Figure 2 "L" antenna 3D structure

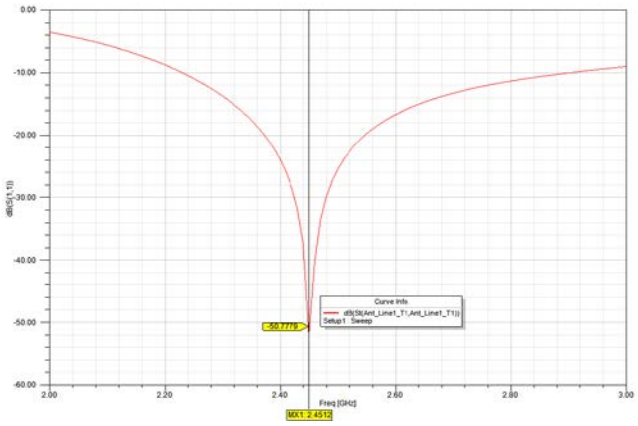


Figure 3 "L" antenna S11 performance

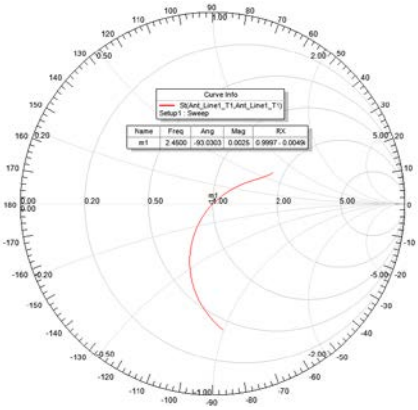


Figure 4 "L"antenna Smith chart

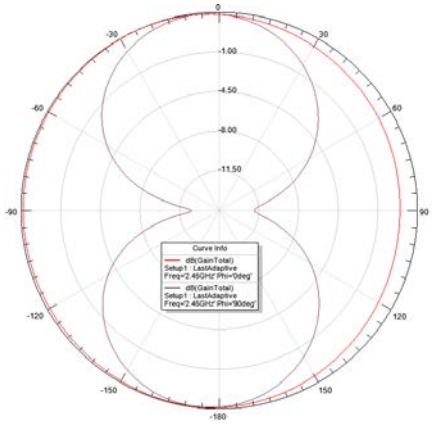
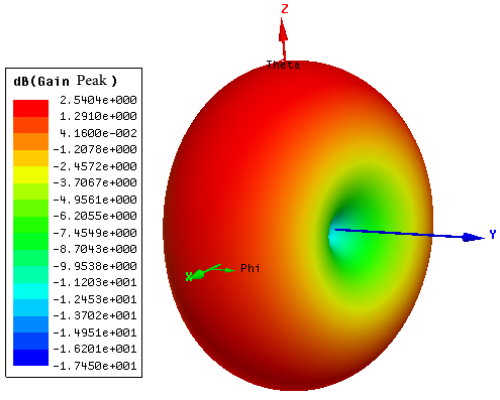


Figure 5 "L" antenna EH plane gain characteristic



Peak Gain: 2.54 dBi

Figure 6 "L" antenna 3D radiation pattern