

# **WB002 HARDWARE BUILD INSTRUCTION**

**Version 1.1**

**This document is subject to change without  
notice**

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## 1 Scope

This document details the performance, construction details and design trade-offs for DecaWave's WB002 Reference antenna, also called the MAN antenna. The document and its associated gerber / DXF files are intended to provide all the information required to integrate this antenna into a DW1000 based product.

## 2 General

The WB002 antenna is designed to be integrated onto a DW1000 based tag or anchor design. It is designed specifically to work with DecaWave's DW1000 UWB transceiver providing a low or zero cost, high efficiency compact solution with excellent fidelity and low group delay variation with antenna orientation. When implemented correctly it should meet the following basic goals:

**Operational Frequency Range:** 3 GHz to 8 GHz

**Maximum Gain:** 2.2 dBi at 4 GHz  
3.3 dBi at 6.5 GHz

**Radiation Pattern:** Omni-directional

## 3 Build Details

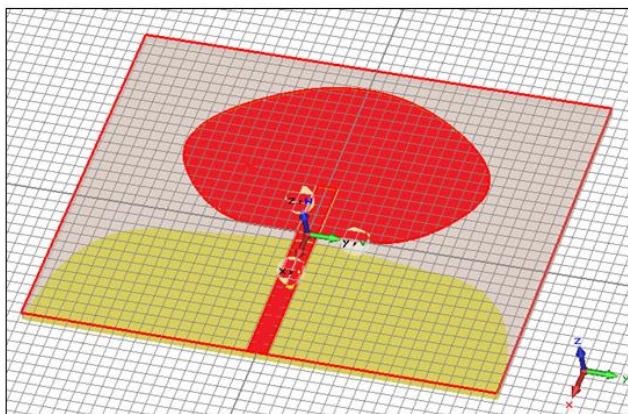
The WB002 antenna is designed to be printed on 0.8 mm FR4 PCB. The following files are provided to assist with the integrating this antenna into your PCB layout:

**Table 1 Deliverables**

File Name	File Type	Description
Decawave_WB002_top_layer.grb	Gerber	Top layer copper
Decawave_WB002_btm_layer.grb	Gerber	Bottom layer copper
DecaWave_WB002_outline.grb	Gerber	Outline File
WB002_MAN_BTM	DXF	Bottom layer copper
WB002_MAN_TOP	DXF	Top layer copper

It should be noted that the ground plane forms part of the antenna. The more ground plane the better the performance but at minimum the ground plane structure (shape and size) given in the bottom layer copper gerber file needs to be present for optimal performance.

It is recommended that the PCB manufacturer uses impedance control to ensure that the 50  $\Omega$  feed line and hence the rest of the antenna design is within a  $\pm 5\%$  tolerance.



**Figure 1 WB002 antenna, graphic and photo**

## 4 Simulation Results

The following results show the expected performance of WB002 when using a full ground plane as shown in the layout files in section 3.

### 4.1 Radiation patterns

The following plots show the expected radiation patterns for different antenna orientations

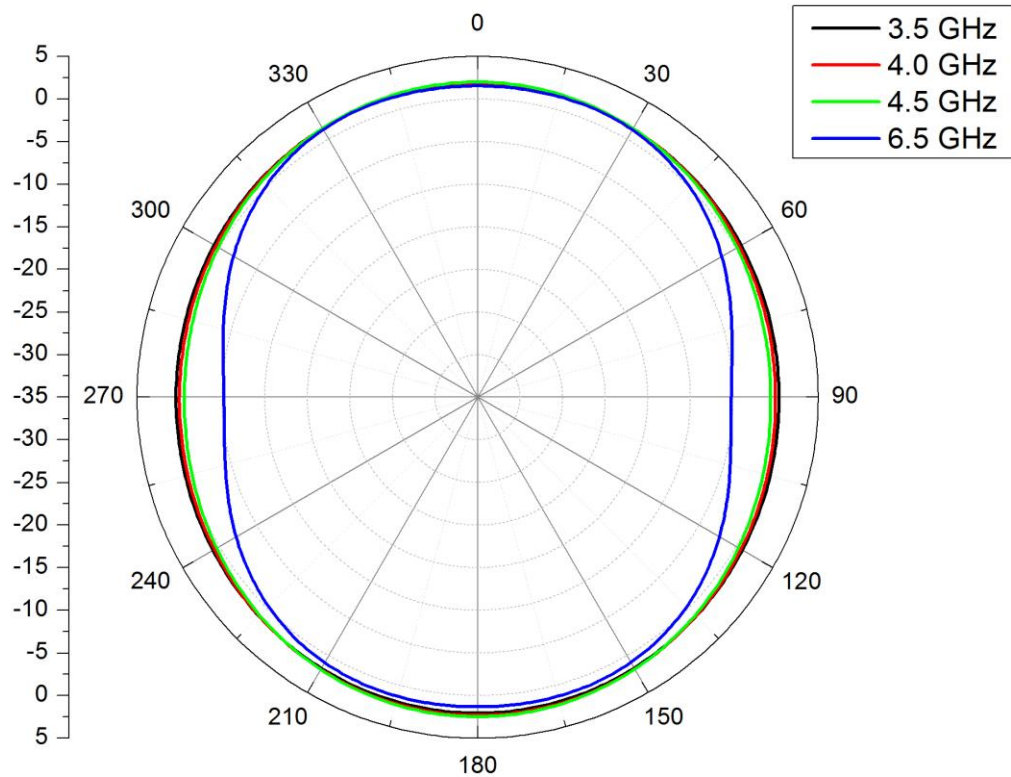


Figure 2 Radiation Patterns Azimuth plane (Theta 90°)

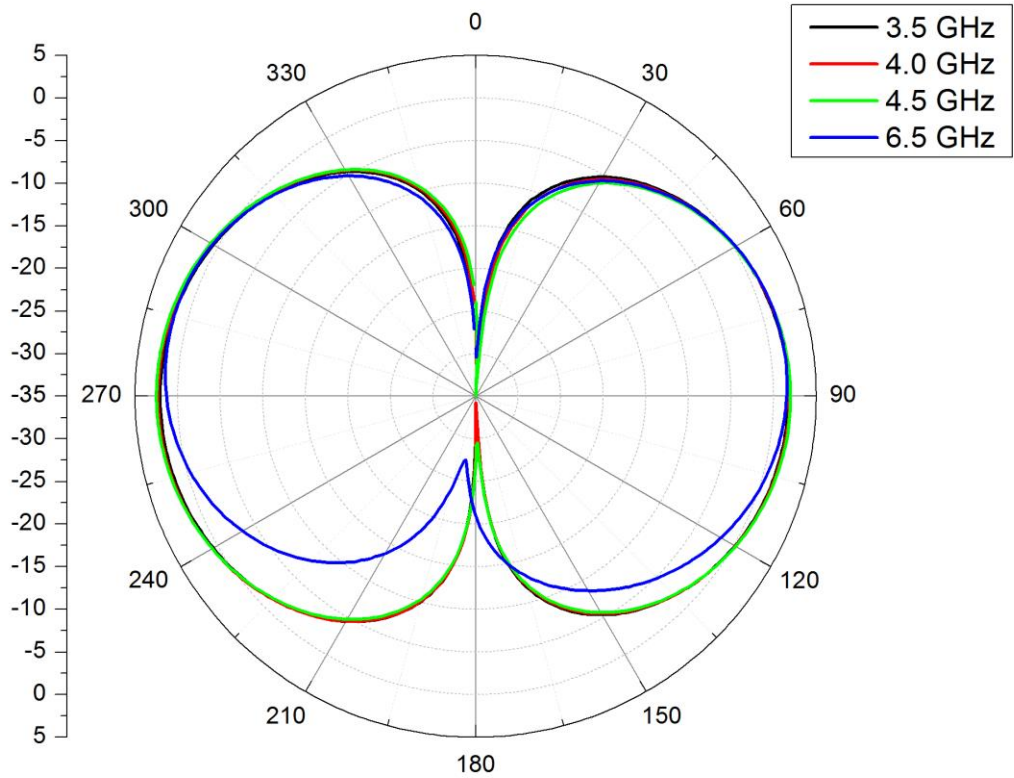


Figure 3 Radiation Patterns Elevation (phi 0°)

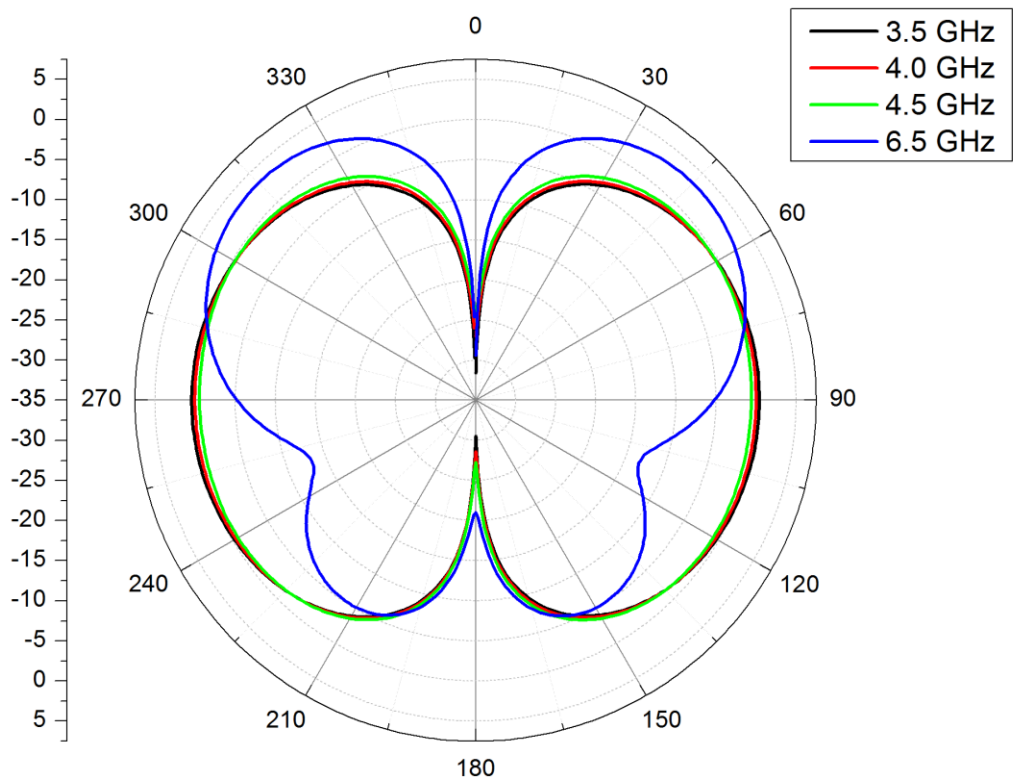


Figure 4 Radiation Patterns Elevation (phi 90°)

## 4.2 Return Loss (S11)

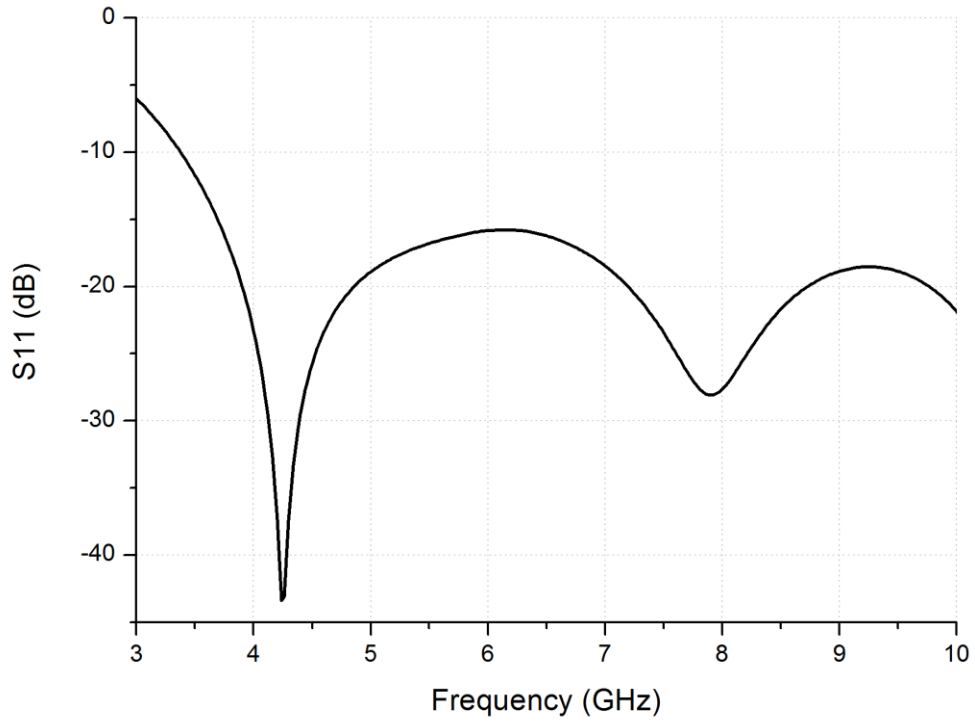


Figure 5 Antenna match versus frequency

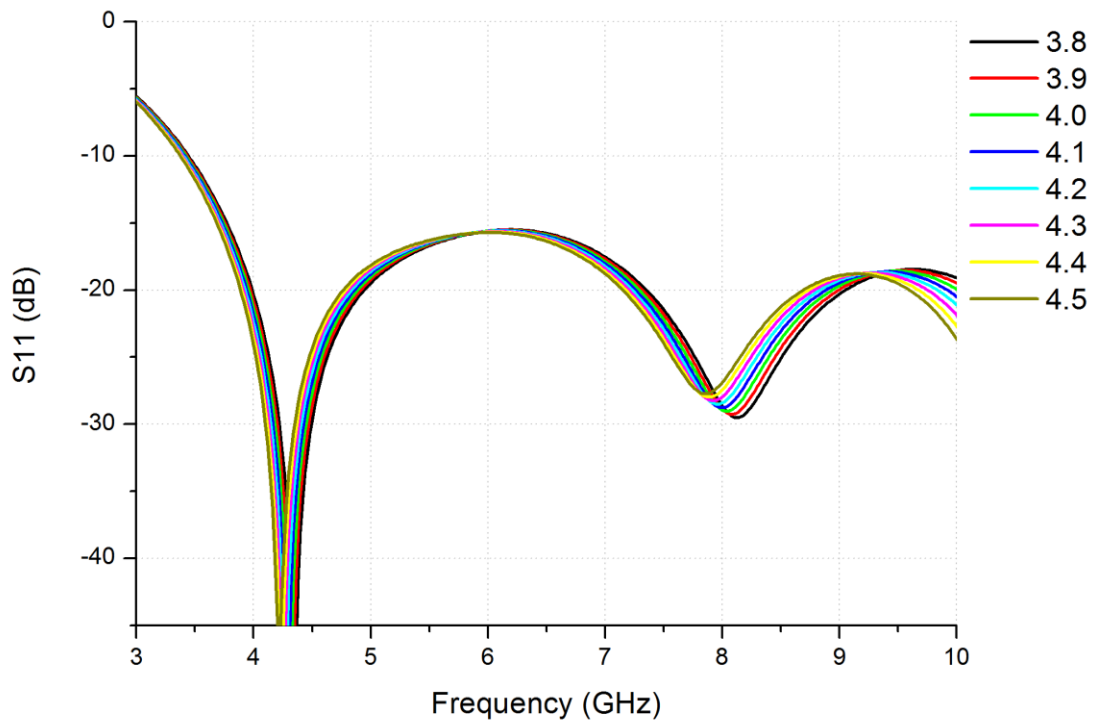


Figure 6 Antenna Match with FR4 Dielectric variation from 3.8 to 4.5

### 4.3 Efficiency

The following plot shows simulated WB002 efficiency in free space and when spaced 5 mm from a large metal plate. This shows that for best performance the antenna should be position away from walls etc.

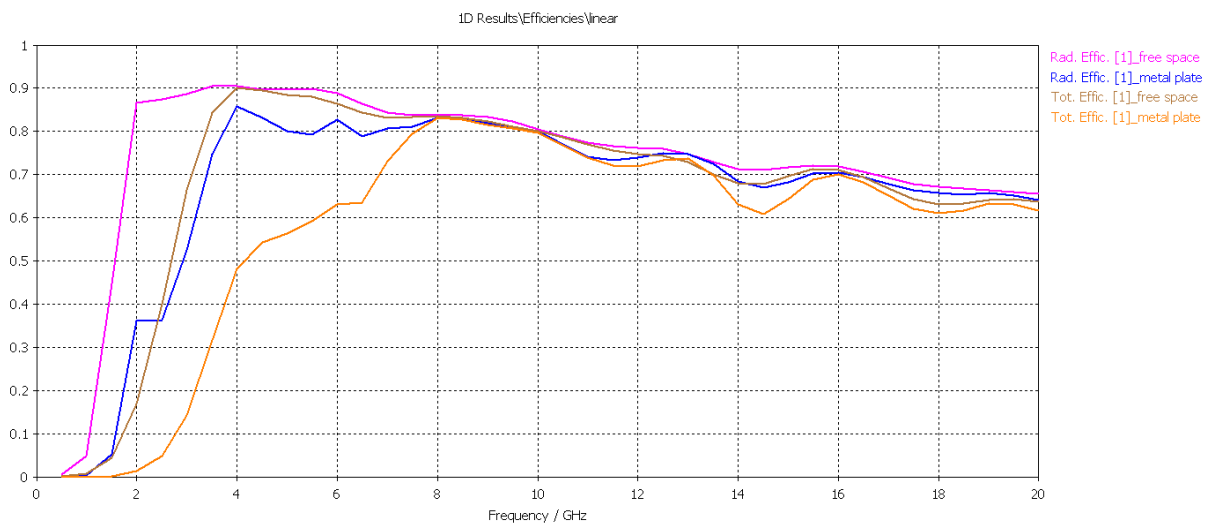


Figure 7 Efficiency in free space and in proximity to a metal space

## 4.4 Maximum Gain

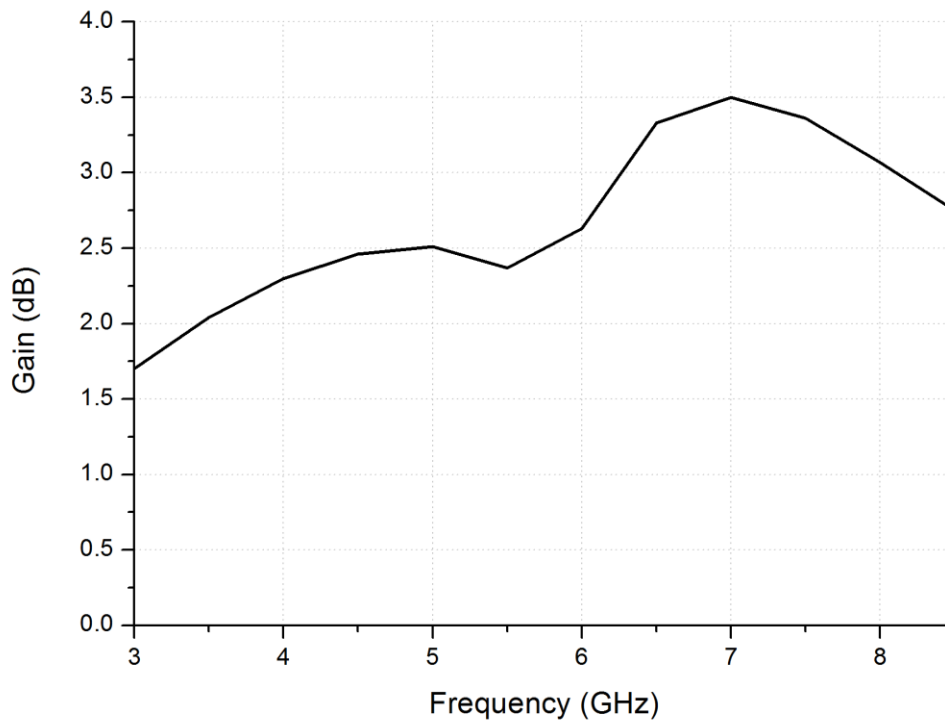


Figure 8 Maximum Gain across frequency

## 4.5 Group Delay Variation

Group delay variation is an important parameter to consider for antennas to be used in location solutions using IR-UWB such as DW1000. Here we mean how the group delay of the antenna changes as the antenna is rotated. 1ns of variation would represent 30 cm variation in the reported distance, so we aim for a group delay variation with antenna rotation of  $<\pm 100$  ps. The plot below shows the variation in group delay as the antenna is rotated. The scale is in nanoseconds and as can be seen there is very little variation with the antenna.



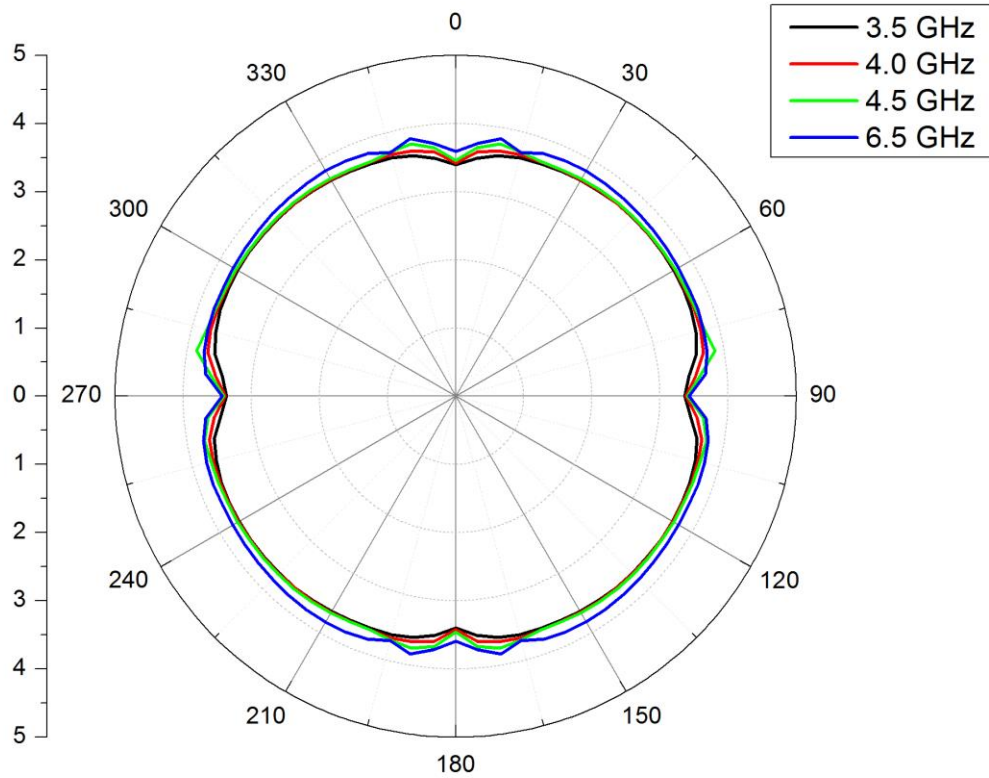


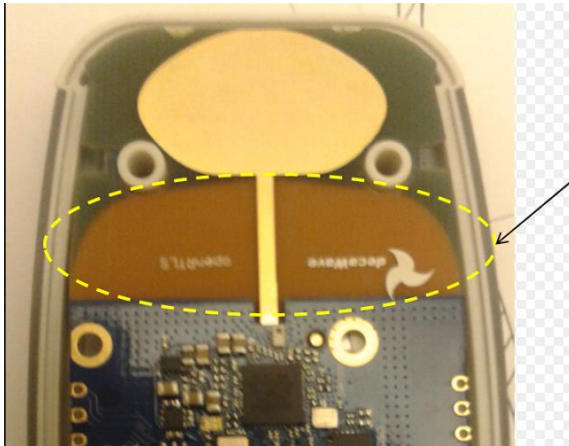
Figure 9 Variation in group delay with angle (Azimuth plane at 1m)

#### 4.6 Fidelity Factor

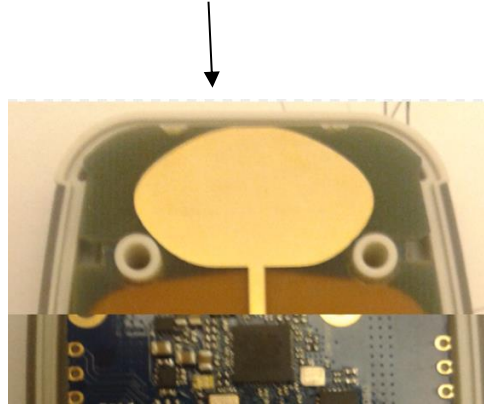
For antennas used in IR-UWB systems Fidelity Factor shows how well the antenna will perform in the time domain. A figure of 1 is ideal with 0.9 being the target. This antenna presents a Fidelity Factor which is above 90% in the azimuth plane across the operational frequency range 3 – 8 GHz

## 4.7 Reducing antenna size

The ground plane can host circuit elements for board space optimization provided that the monopole antenna is fed by a  $50\ \Omega$  transmission line and the tapered spacing between the antenna and the ground plane is not altered.



By incorporating part of the antenna ground plane into the rest of the ground-filled PCB design, the overall size of a tag can be reduced.



## 5 References

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## 6 Document History

Revision	Date	Description
1.0	30 <sup>th</sup> September 2016	Initial release.
1.1	8 <sup>th</sup> October 2018	Scheduled update Updated Logo

## 7 Major Changes

### V1.0

Page	Change Description
All	Initial external release

### v1.1

Page	Change Description
All	New logo and template.
	DXF files included
2	Reference made to MAN antenna

## 8 Further Information

Decawave develops semiconductors solutions, software, modules, reference designs - that enable real-time, ultra-accurate, ultra-reliable local area micro-location services. Decawave's technology enables an entirely new class of easy to implement, highly secure, intelligent location functionality and services for IoT and smart consumer products and applications.

For further information on this or any other Decawave product, please refer to our website [www.decawave.com](http://www.decawave.com).