

# **GNSS** Patch Antenna Module Design Guide

## **GNSS Module Series**

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# About the Document

## History

Revision	Date	Author	Description
1.0	2015-12-22	Neil WU	Initial
1.1	2016-02-24	Neil WU	Updated the description of design recommendations

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# 1 Introduction

GNSS module with an embedded patch antenna makes great demands on the surroundings, this document mainly introduces module design rules and tests to achieve a better performance.

This document is applicable to the following GNSS modules with the embedded patch antenna:

- L80 module
- L80-R module
- L86 module

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## 2 Design Guidelines

When the module is integrated into the customer's products, it is recommended to comply with the following rules for an optimal performance.

### 2.1. Design Recommendations

The radiation characteristic of antenna depends on various factors, such as the size, shape of the PCB and the dielectric constant of components nearby. It is recommended to follow the rules listed below.

- Keep the module at least 5mm away from the nearest edge of the mother board, that is, it will be better to be placed in the center of the mother board.

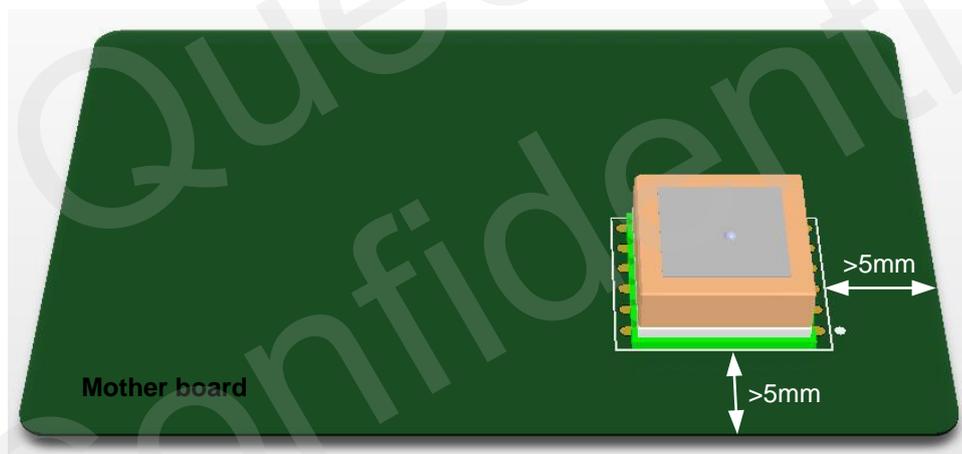
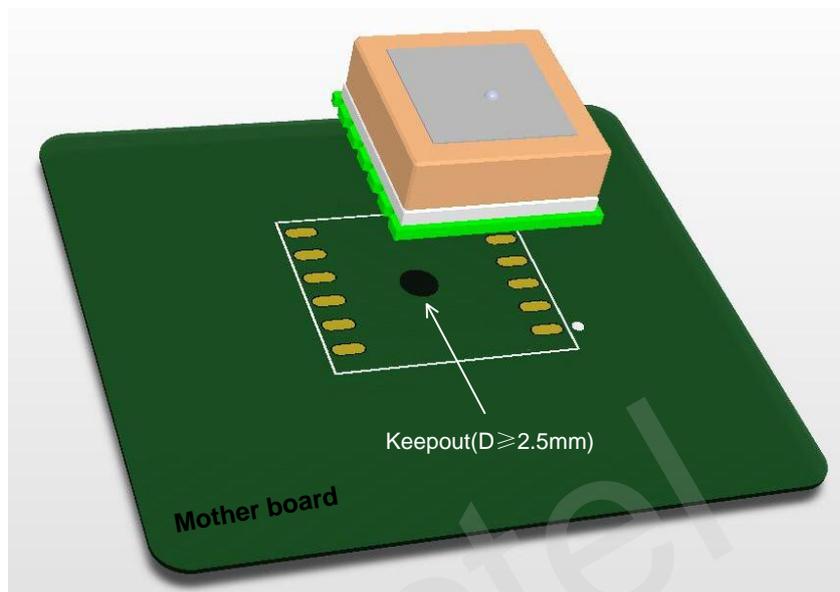


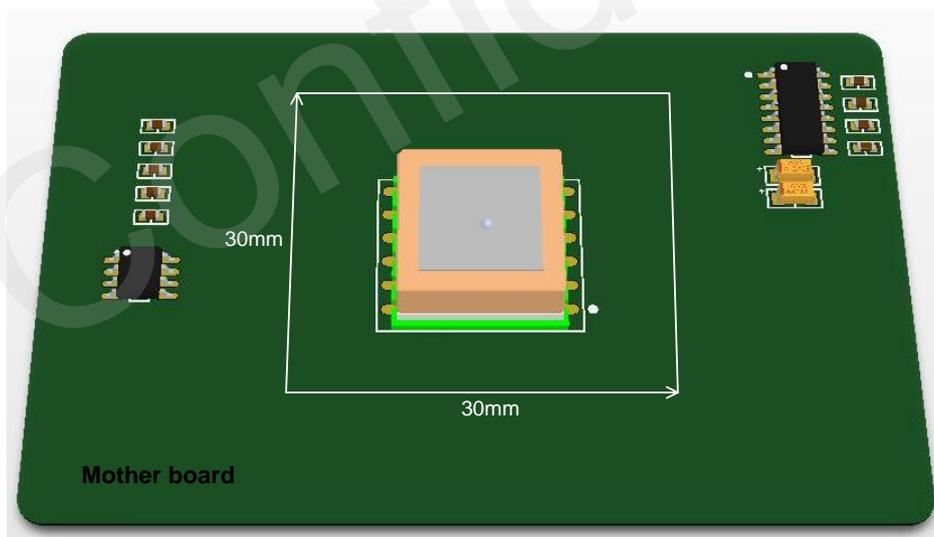
Figure 1: Recommended Distance between Module and the Edge of Mother Board

- The position on the mother board corresponding to the feed point of the patch antenna should be kept out on each layer, and the diameter of the keepout area should not be less than 2.5mm.



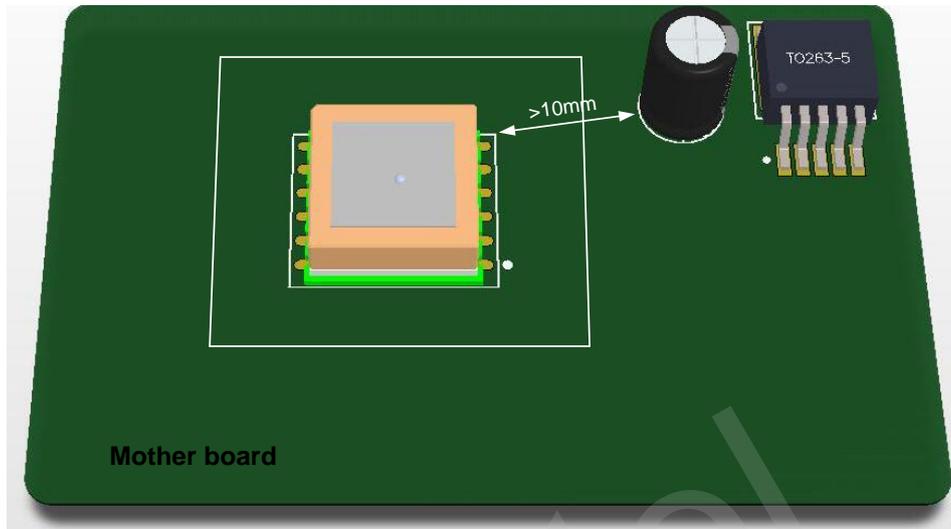
**Figure 2: Recommended Keepout Area on Mother Board**

- Make sure the antenna points to the sky.
- The performance of embedded patch antenna depends on the actual size of the ground plane around the module, it is recommended to design a 30mm×30mm ground plane as shown below. Meanwhile, do not put any components especially tall components in the areas whenever possible. (Interfering vias is not allowed either).



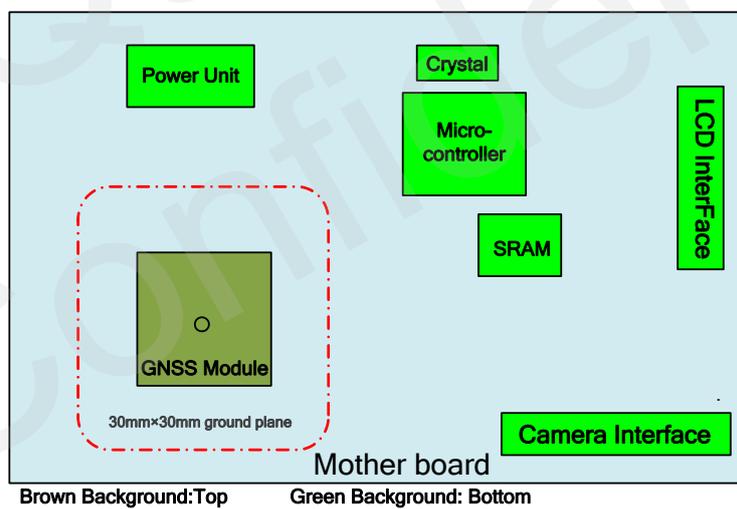
**Figure 3: Recommended Ground Plane**

- Keep the patch antenna at least 10mm away from other tall metal components. Otherwise, the antenna performance will be affected.



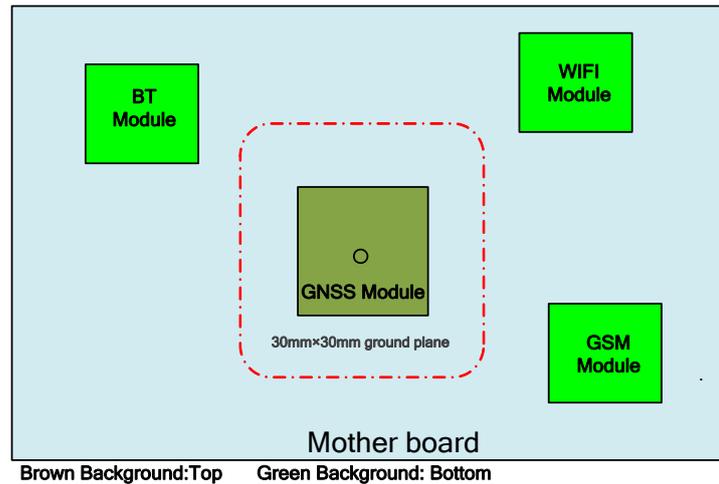
**Figure 4: Recommended Distance between GNSS Module and Tall Metal Components**

- Make sure the microcontroller, crystal, LCD, camera and other high speed components and interfaces are placed on the opposite side of the module, and keep them away from the module as far as possible, such as in diagonal position of the mother board.



**Figure 5: Recommended Placement of GNSS Module**

- Make sure interfering signals (USB, LCD, Camera, Crystal, etc.) are in inner layer and shielded by ground plane, and keep them and their vias far away from the module.
- Make sure RF system such as BT/WIFI/GSM is on the opposite side of the module, and keep them away from the module as far as possible, such as in diagonal position of the board.



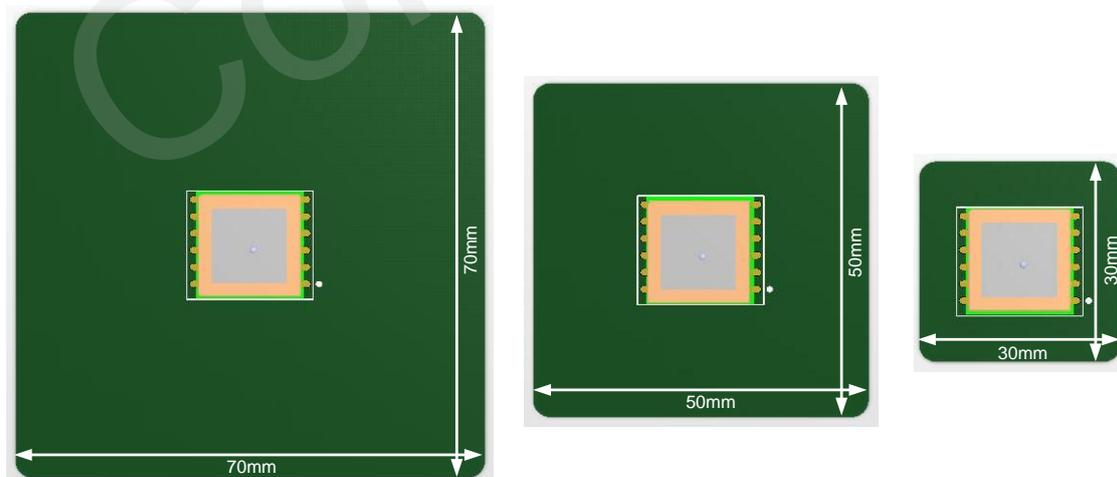
**Figure 6: Recommended Placement of GNSS Module with the RF System**

- Keep DCDC far away from the module.
- Device enclosure should be made of non-metal materials especially for those which are around antenna area. The minimum distance between antenna and enclosure is 3mm.
- The RF part of GNSS module is sensitive to temperature, please keep them away from heat-emitting circuit.
- It is recommended to reserve an integrate ground layer to isolate GNSS module from others.

## 2.2. Performance Test in Different Conditions

### 2.2.1. The Influence of the Ground Plane

The performance of embedded patch antenna depends on the actual size of the ground plane around the antenna on the main PCB.



**Figure 7: Test Board of Ground Plane**

**Table 1: The Performance Comparison for Different Sizes of Ground Plane**

Actual Size of Ground Plane	Efficiency (%)	Peak Gain (dBic)	Bandwidth (MHz)
70*70mm	84.99	4.9	19.76
50*50mm	78.29	3.31	15.19
30*30mm	68.19	2.25	8.78

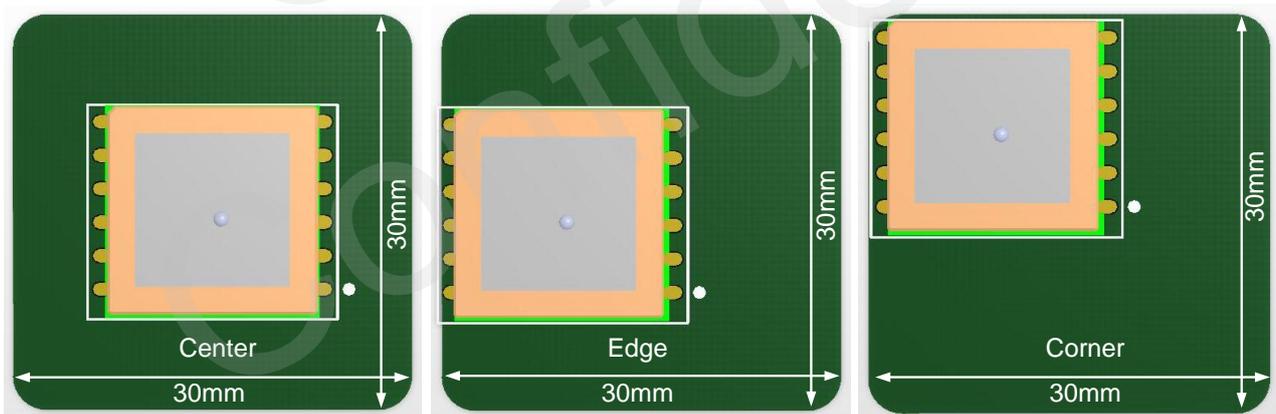
The testing data comes from the manufacturer of the patch antenna. They made a comparison test for the antenna on the different size of PCB which is fully covered with ground copper. From the data, it can be concluded that under the same condition except the size of the ground plane, the bigger the size of the ground plane is, the wider the bandwidth is and higher the efficiency is.

**NOTE**

1. The frequency of signal which is provided for the patch antenna is 1.57542GHz.
2. The size of the ground plane is related to the frequency, it is not recommended to exceed  $\lambda / 2$ .
3. The test object is just the antenna, not the module.

**2.2.2. The Influence of the Placement**

The placement of the antenna on the mother board can also affect the performance.



**Figure 8: Test Board of Placement**

**Table 2: The Performance Comparison for Different Placements**

Placement of Module	Efficiency (%)	Peak Gain (dBic)	Bandwidth (MHz)
Center	68.19	2.25	8.78
Edge	60.23	2.01	8.57
Corner	55.63	1.92	8.08

The testing data comes from the manufacturer of the patch antenna. They made a comparison test for the antenna on the different position of PCB which is fully covered with ground copper. From the data, it can be concluded that under the same condition except the distance between the antenna and the center of the ground plane, the closer the distance between the antenna and the center of the ground plane is, the wider the bandwidth is and higher the efficiency is.

**NOTES**

1. The frequency of signal which is provided for the patch antenna is 1.57542GHz.
2. The test object is just the antenna, not the module.

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# 3 Performance Analysis

This section introduces how to analyze the antenna performance after customers' devices have integrated Quectel GNSS modules.

- In the open sky, make a contrast test on device and EVB, and detect whether the CN value of the device is similar to the EVB, then save the log. Make sure the device and the EVB are in the same condition including time and place.
- Under the half view of the sky, make a contrast test on device and EVB, and detect whether the CN value of the device is similar to the EVB, then save the log. Make sure the device and the EVB are in the same condition including time and place.
- Generate a GPS signal whose power is -130dbm by the signal generator, make a contrast test on the device and EVB, and detect whether the CN value of the device is similar to the EVB, then save the log.
- Detect whether GPS performance of the device is weakened by the jamming from the microcontroller. Make a comparison test with and without the microcontroller and contrast the CN values to determine whether there is interference.
- If the performance is still not good, it is recommended to provide the debug log to Quectel Technical Support.