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Technical Note

Embedded Antennas Reference Guide

Version 7.0

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1. Introduction

Tallysman sells a range of embedded antennas for integration into customers' products. To ensure optimal performance of the antenna within the product, there are a number of issues which should be addressed.

This document is a guide covering the issues and the best practices approach to addressing the issues.

2. Radome

Patch antenna resonant frequency is significantly changed by the presence of any plastics in proximity to the radiating face of the patch. Adding a radome over the patch detunes the resonant frequency down as shown in Figure 1. The proximity of the radome to the antenna determines the amount of frequency shift, the closer the radome to the patch, the greater the frequency shift. If there is a measured frequency shift, it reduces the antenna gain at the frequencies of interest and degrades the GNSS performance of the complete system. For example. in 'Radome Case II', the antenna gain is reduced by 2dB at L1 and by 3.5dB at L2. This loss of antenna gain will directly decrease the noise performance of the GNSS system.

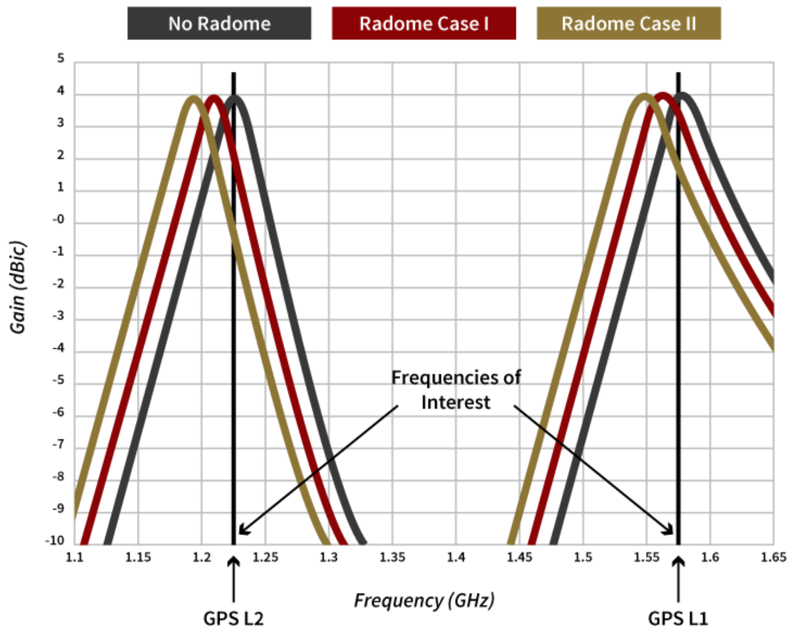

Figure 1 – Effect of Radome on Dual Frequency Antenna Gain

3. Ground Planes

The response of a patch is also greatly influenced by the presence of a ground plane beneath the patch. A ground plane improves the gain of the patch by redirecting the back radiation in the opposite direction. Figure 2 shows the effect of the ground plane on a dual frequency antenna gain. It is seen that without a ground plane, the maximum of gain decreases by 5 dB at L2 and by 4 dB at L1. This loss of antenna gain will directly decrease the noise performance of the GNSS system.

Antenna without Ground Plane

Antenna with Ground Plane

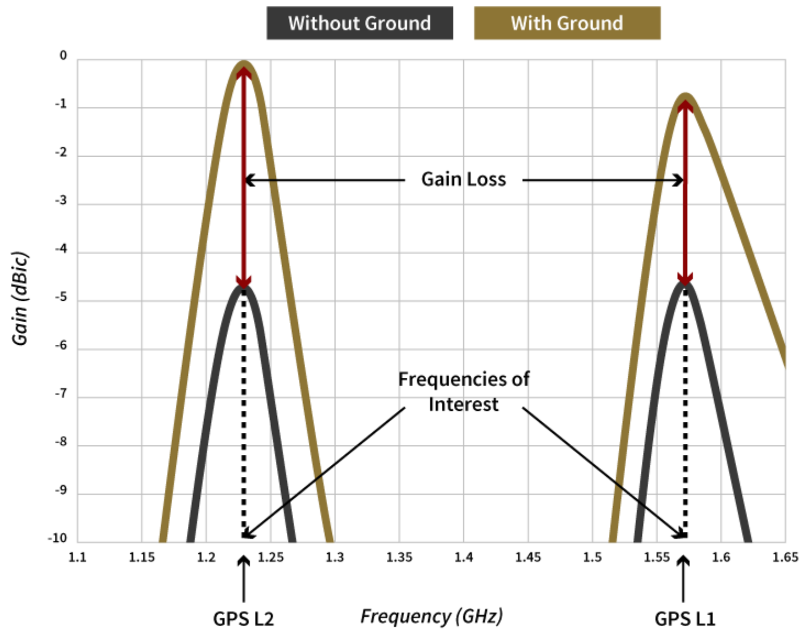

Figure 2 – Effect of Ground Plane on Dual Frequency Antenna Gain

The optimal ground plane size is 100mm (for antennas receiving only the upper GNSS signals), 120mm (for antennas receiving both the lower and the upper GNSS signals), and symmetric in shape around the antenna (square or round). The range of recommended ground plane sizes is 80mm to 120mm respectively. Symmetry of the ground plane preserves the axial ratio of the antenna thus ensuring maximum rejection of multi-path signals. It is also important to position the ground plane at or above any other metal portion of the enclosure. It should be noted that the PCB of the other electronics in the enclosure, potentially can serve as the ground plane for the antenna.

The ground plane is not an electrical ground, but must be made from an RF reflective material, such as copper, aluminum, steel, silver, metalized plastic (like Mylar), etc. The thickness of the material should be kept to under 2mm.

4. Custom Tuning

Tallysman's embedded antennas are typically tuned 5MHz higher than the desired end frequency. This is done on the assumption that typical placements will detune the antenna by approximately the same 5MHz.

Tallysman can custom tune embedded antennas to ensure the antenna is tuned perfectly on frequency when operated in the working environment (radome and ground plane). Tallysman offers custom tuning services for a fee.

The process involves the customer sending the enclosure, the ground plane, and a specification showing the placement of the antenna within the enclosure. Tallysman will then test and tune, incrementally, until the optimal tuning of the antenna is attained. A report will be provided comparing the gain at zenith with an optimally tuned patch on a symmetrical ground plane. Every antenna ordered from Tallysman will then be tuned to match this antenna.

5. Cable Routing

The cable exiting the PCB of the antenna can interfere with the performance of the antenna. It is recommended to "hide" the cable as much as possible from the ceramic patch. In other words, it is recommended to route the cable under the ground plane as much as physically possible. If the ground plane is thin, it is recommended to cut a hole in the centre of the ground plane which is the same dimensions as the ceramic patch, then place the ground plane over the ceramic patch. In this way, the cable is routed completely beneath the ground plane. As shown below:

Figure 3 – Ground Plane

6. Mounting / Attaching

When mounting or attaching the embedded antenna to your product, it is important to ensure there are no metal screws or screw heads appearing on the ceramic side of the antenna. Attachment by plastic screws or thin pan head screws is recommended. Any metal component near the ceramic patch will cause performance degradation.

7. Electro-Magnetic Interference (EMI)

Another potential problem to be avoided is electro-magnetic interference created by electronics in close proximity to the embedded antenna. It is worth the time and effort to test the effect the electronics have on the embedded antenna. Here is a recommended method of doing that:

1. Install all of the electronics in the housing, including the intended GNSS receiver and power them up, but use an external GNSS antenna with a 3 metre cable. Move the antenna about 3 metres from the electronics. Record the reported C/No values output by the GNSS receiver in the $GPGSV NMEA message (the message format is on the web).

2. Move the external antenna as close as possible to the intended location on/in the box, and re-measure the reported C/No. The two measurements should be relatively close in time so that the satellite constellation can be considered quasi-stationary. Compare the signal strength of the top 3 satellites for both arrangements.

3. If the signal strength is significantly reduced when the antenna is co-located with the functioning electronics, this may indicate that the other electronics are generating harmful harmonics. This can usually be ameliorated by an RF screen for the other electronics, but if there is problem, each configuration should be checked.

About Tallysman

Tallysman® is a developer, provider, and manufacturer of global positioning components and intelligent location based wireless infrastructure solutions for tracking systems.

Based in Ottawa, Canada, Tallysman is focused on high function, high performance technology and solutions. Our core competencies include digital wireless networks, RF and Global Navigation Satellite Systems (GNSS) component design.

Tallysman is known for its brands of Accutenna® and VeraPhase®. These technologies have proven themselves to provide the highest performance antennas (low axial ratios, high multi-path signal rejection, tight PCV) in their size and weight, while setting lower economical price points. Tallysman's antennas are the antennas of choice for a wide variety of applications.

Learn more at www.tallysman.com.