Embedded Antennas – Reference Guide

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 customers have to concern themselves with. This document is a guide covering the issues and the best practices approach to addressing the issues.

Tuning

To optimize the performance of an embedded antenna, it must be tuned to accommodate the effect caused by any cover over the antenna. When a high dielectric material is in the near field of the antenna, it causes the antenna to experience a downshift in the resonance frequency. Tallysman's "untuned" embedded antennas are tuned to be 5 MHz higher than the GNSS target frequency to accommodate a plastic cover not closer than 5 mm above the patch antenna.

Ground Planes

GNSS signals are reflected by any metallic object, including the earth. In the absence of a ground plane, the signals are reflected by the next closest object beneath the antenna. The reflected signal is flipped in polarity (to a Left Hand Circular Polarized signal), but is travelling in the reverse direction. The reflective signal can either be additive or destructive to the incident signal depending on the distance between the reflecting surface / object and the antenna. Therefore, to be cautious, the ground plane should be attached directly to the back of the antenna. By positioning the antenna in such a manner the reflected signal adds to the direct signal and can substantially improve the gain of the antenna (by 2 to 3 dB).

The optimal ground plane size is 100mm or bigger and symmetric in shape around the antenna (square or round). 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.

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 meter 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.

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.

CAUTION: Use of an asymmetrical ground plane will result in an asymmetrical axial ratio thereby degrading the performance of the antenna.