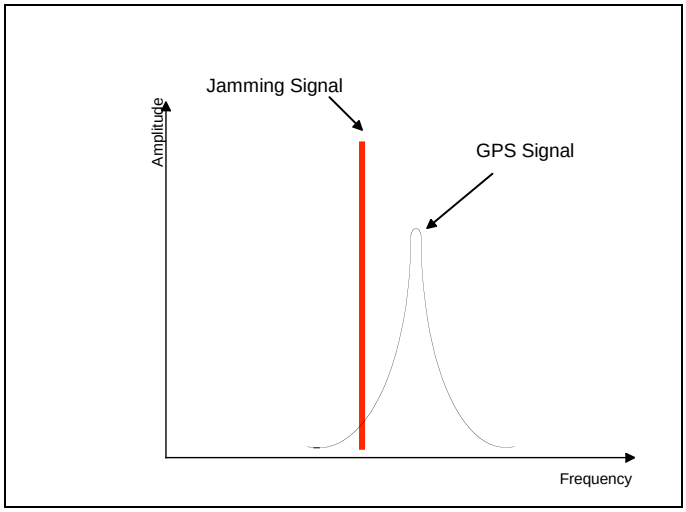
Application Note

Detection & Prevention of Self-Jamming Signals

Introduction

Because of the high level of integration in modern consumer products, receiver self-jamming around the GPS band is very common. The effect of a jamming signal upon GPS performance can take a number of forms; a) the time to first fix will be extended, b) no GPS data will be received, c) the receiver will lose signal lock intermittently and d) the C/No values will be lower.



The following sections give some general methods on detecting and removing internally generated jamming signals. Please note that all GPS receivers will have their own tolerance towards jamming signals, and it is worth contacting your GPS receiver manufacturer for further details on this subject. Selection of a GeoHelix GPS antenna can mitigate a prevalent cause of self-jamming, as will be discussed in this document.

Detecting Jamming Signals

The easiest method of determining the presence of a jamming signal is to move the antenna away from the product. This can be achieved be using a co-axial cable to connect the antenna to the receiver. It is suggested that the antenna is placed around 1 meter away. If the GPS performance is enhanced once the antenna is moved away, then there is a high probability that an internal jamming signal is present.

Once a jamming signal is known to exist, then it is necessary to identify its frequency and amplitude. This requires the use of a spectrum analyser and some form of probing antenna (e.g. small loop antenna). Set the analyser to have a frequency span of 1575MHZ ± 50MHz and configure the analyser's bandwidth setting to give a minimum instrument noise floor of at least –110dBm. The product should now be powered and the probe antenna moved slowly around the

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product. The jamming signals may not be continuous so the use of the 'max hold' feature may be required. Once a jamming signal is observed, its frequency and amplitude should be noted.

Eliminating the Jamming Signal

In many cases even if the jamming signal cannot be totally eliminated, its amplitude can be reduced so that it does not affect GPS performance. Investigating potential sources of jamming signals is not a trivial task. To assist in this, a number of suggested investigation topics are given below: -

1. Before starting an investigation it is recommended that a GPS evaluation kit be used to provide a baseline for the GPS performance. If an evaluation kit is not available, then a known good system should be used.

2. Look at the frequency plan for the whole circuit and determine which frequencies may be the cause – remember that the mixing of two or more signals at either their fundamental or harmonic frequencies may cause the actual jamming signal.

3. Look at spectrum during the system initialisation period; this is where most noise/inference will occur due to the microprocessor(s) booting; i.e., bus traffic will be increased. This is also the time when the GPS will be trying to achieve lock (maybe from cold start). If lots of noise is present during this time, delaying the GPS start until the noise subsides may help the time to first fix.

4. Use an external source to power the GPS circuit and also monitor the GPS data externally. With the product switched off, observe the GPS data and then selectively turn on parts of the product e.g. LCD, microprocessors etc. Observing the performance of the GPS will help to identify the source of the jamming signal(s).

5. Ensure that there are sufficient de-coupling capacitors used in the circuit and they are suitable for the product's frequency plan. A typical value good for decoupling noise at RF is 15pF in an 0402 package.

6. Harmonics of squared clock signals and other digital signals can often create jamming signals. It may be necessary to fit small value resistors (10Ω to 100Ω) in series with the clock lines to remove the high frequency transients (and hence the harmonics). Additionally it may be necessary to screen the clock using a metal shield.

It should also be noted that the selection of a GeoHelix GPS antenna addresses one of the main causes of self-jamming: conducted common mode noise. Often, the path for noise is not over the air but conducted by the ground plane to which the antenna is connected. Single-ended antennas will conduct such noise resident on the ground plane directly to the receiver. If the noise is in-band, it cannot be filtered out. However, GeoHelix GPS antennas are balanced and therefore do not couple with the ground plane. Even in-band ground plane noise is rejected by the antenna, and is not channeled to the receiver.

Conclusions

Self-jamming can be one of the most frustrating engineering problems to solve when designing a GPS product. It is often easy to assign fault to the antenna-receiver RF chain when that part of the design is actually optimised and not to blame. Selection of a GeoHelix GPS antenna further simplifies the troubleshooting task by eliminating the most prevalent source: noise coupled by the ground plane. Following these simple test guidelines will help diagnose the most common problems faced by design engineers, and will lead to superior performance by the GPS device.