GNSS Antenna Selection for Embedded Applications

Embedded designer engineers are looking to improve on the performance of their built in GNSS equipment particularly in underground and partially shielded installations.

As more electronics are integrated into ever decreasing sized enclosures and at a lower cost, it looks like corners are starting to be cut with respect to good engineering practice at the design stage. Below are some pointers with respect to designing in GNSS antennas into compact and handheld equipment.

Antenna Placement

The most important item to consider is the best siting for the antenna. Even with today's latest generation chipsets, a GNSS antenna still needs a clear view of the sky especially during first acquisition when it needs to download the latest ephemeris data or on some occasions, a complete almanac.

This almanac and ephemeris data provides a virtual map to the GPS / GNSS receiver constellation allowing it to know the current and future locations and status of the satellites, relevant for that particular location. The almanac is a long-term picture of what the whole GNSS network is doing whilst the ephemeris is for a short-term picture. The delay when the GNSS receiver is first switched on is due to the latest ephemeris data being downloaded, which is essential for the GNSS receiver. The data is valid for around 4 hours and takes approximately 20 seconds to download with a clear line of site to a satellite. It takes longer if using multiple satellites, for instance if the GNSS receiver is moving during first acquisition.

The antenna needs to be facing the sky through a non-metallic enclosure. A metallic enclosure will prevent the RF signal being received by the antenna and cause a Faraday cage effect. Likewise, positioning the antenna near to obstructions such as power supplies, LCD displays or where large objects will be over the antenna should also be avoided as the shield will have a negative impact on performance.

Try to avoid routing cables across other electronic equipment or the back of screens, instead try to route around the perimeter of active electronic components. Whilst it is a good idea to keep the cable relatively short, (thin RF coaxial cable used on electronic equipment has quite a high loss at 1575.42 MHz) and is susceptible to interference. However, the length consideration is not as essential as placement as most GNSS antennas have a 1 or 2 stage pre amplifier depending on GNSS receiver used.

Smaller is not always Better

When designing in a GNSS antenna, do not always look for the smallest possible antenna. Although this can seem attractive, particularly in hand held or portable equipment when size is everything, the effect of a smaller GPS antenna means it is more sensitive to de-tuning. GNSS works on a spot frequency of 1575.42MHz rather than a frequency range. This means that when other materials cover it - human tissue, LCD screens, metal, it de-tunes the antenna away from this frequency. The smaller the antenna, the more susceptible it is to the de-tuning effect, which results in a reduced GNSS signal being received.

As a general rule a 25mm x 25mm patch antennas might be considered too large but will work well, whilst a 10 x 10mm patch antennas will tick the size requirement but could take a longer time to get the first fix and sub-sequentially a navigation state. Similarly, helical antennas sound good on paper but during field trials are poor when compared to a patch antenna with a comparable pre- amplifier. The sweet spots seems to be around 17 x 17mm where the thickness of the antenna with LNA underneath using a 2mm thick ceramic patch gives an overall thickness of around 6mm. This sized patch antenna provides good resistance to noise and reasonable performance to acquisition whilst keeping a small footprint.

Low Noise Amplifier

Siretta provide GNSS antennas which provide either a 1 or 2 stage low noise amplifier (LNA) to optimise the final design. 1 stage designs provide a gain of around 12-18dB and are reliant on either the GNSS receiver having its own LNA or a very short cable run. 2 stage LNA solutions provide a gain of between 25-30dB and are more popular on antennas where the GNSS receiver does not have an amplifier. Although the preconception of the higher the gain the better the performance, this is not always true. If the gain is too high constantly, this can have an over saturation effect on the GNSS receiver, de-sensitising the RF front end over time and causing poor navigation.

In addition, using a high gain 2 stage LNA also amplifies the noise received at the patch antenna and results in errors being picked up at the

receiver which must be removed from the position calculation.

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