Successful Antenna Selection in Embedded IoT Applications

For electronic design engineers working on wireless enabled embedded systems, the antenna is often the last part of a design consideration but one of the most critical after radio module and power requirement selection. The following pointers should provide an appraisal of each of the antenna solutions available, providing some guidance on which type to short list for selection.

There are 3 types of antenna design solution available to an engineer each with its own advantages and disadvantages. Design issues range from real estate available on a PCB to the amount of time required to get a product to market. Questions raised can be quite tricky to answer especially when a short time to market is required. Additionally, many antenna manufacturers are biased on their own particular area of expertise rather than providing the best solution from a full range of products.

Ceramic Antennas

Many ceramic antennas are available tuned to different technologies such as cellular, ISM, LTE and WiFi. They are amongst the most compact solutions available and require a dedicated space on a PCB with adequate ground plane clearance.

This will differ depending on the wireless technology used and the frequency of operation but as a guide, the higher the frequency, the smaller the wavelength and therefore the ground-plane. As the ground-plane needs to be taken into consideration for the antenna to function correctly you will need to take into account the recommended ground-plane size when considering the PCB real estate and not just the base antenna dimensions. Embedded designs using ceramic antennas will take the longest to design in to your solution as the PCB layout will require some tuning and this will take longer. In addition to the hardware design there will also be a requirement to perform emissions testing for the complete design to ensure RF interference is minimal and the system will not interfere with other systems.

Ceramic antennas tend to be the lowest cost solution overall. However, they are targeted at volume users and as such evaluation kits tend to be required for testing and evaluation with minimum order quantities required to achieve a lower price.

PCB antennas

PCB antennas answer the need for a pluggable solution which can be easily integrated in to the system utilising a micro RF connector. Many existing wireless modules incorporate a micro connector which can be connected directly to an embedded PCB antenna and provides a very simple method to incorporate an antenna into a system. These embedded PCB antennas are tuned to various frequencies and can be terminated with differing lengths of cable and connector styles which offer compatibility with most wireless modules available.

One consideration is the overall size of the enclosure to ensure the antenna fits. For instance, there are antennas built to a specific wavelength i.e. ¼ wave which are both tuned to work on a given frequency or frequencies and harmonics to cover a range of different network frequencies. As a result, each band of interest will have a different gain at a particular frequency and therefore one antenna may well fit a number of different applications.

Some applications are governed by the need to be the smallest possible size. For cellular solutions, we are generally spoilt in that there is a dense network coverage, especially in built up areas such as cities and industrial areas. Many engineers opt for having a true quarter wave antenna for their application, however, there are then issues with the size of the antenna. For example a 900MHz cellular network can provide up to 2 Watts and a ¼ wavelength at 900MHz is around 7cm, at 1800MHz a ¼ wavelength is around 3.5cm. As a result, the size of the antenna is directly affected by the frequency of operation and can be too large to fit in to the application, therefore, consideration must be taken to select the best overall solution.

Embedded PCB antennas are designed are easily attached to the inside of the enclosure via an adhesive pad allowing quick connectivity, offering reliable performance and flexibility of fitting away from other components prone to RF interference.

External Antennas

In some situations a metal enclosure has been specified which will block the RF signal as it creates a Faraday cage effect around an internal antenna. To overcome this, an internal cable assembly linking the wireless module to a bulkhead connector can bridge the gap allowing an external antenna to be fitted directly onto the bulkhead connector on the outside of the enclosure.

This option also gives the benefit of expanding the range of antennas available to be used on the application. This can be ideal for using with

equipment which will be installed in areas of poor coverage or installed in difficult to access locations. It also allows an organisation to offer a range of 'After Market Solutions' which overcome specific installation challenges.

Each example of antenna solution brings its own advantages and disadvantages to the market and these need to be weighed up prior to selecting a solution. In practice, an external antenna generally performs better than an internal antenna. Therefore unless there is a strict requirement in the specification for an embedded antenna to be used - such as a vandal resistant or high IP rated environment then increasing the likelihood of good wireless communications has to be the highest priority using an external antenna solution.

Speak to Siretta for more information.