

Mechanical Integration of SL1206 and SL1204 Active Antennas

INTRODUCTION

Integration of the antenna in a GPS receiver is an area of engineering that requires very careful consideration. Long path lengths attenuate the transmitted signals, which can reduce received levels below the level of background thermal noise. Additionally the antenna must cope with the detuning effects of body loading, and the impact of very low level interferers can be dramatic to overall system performance. Coupled with a less than optimum integration, this can cause significant losses and have the potential to seriously affect the user's experience of the product. Sarantel use patented ceramic-loaded quadrifilar helical structures to create an antenna ideally suited to GPS applications. The benefit of this technology includes:

- Small: A small volume antenna ideally suited to mobile applications where space is a premium;
- Broad beam-width: Sarantel antennas all have a typical beam-width of 135°, allowing reception of satellites close to the horizon, which gives increased positional accuracy;
- Filtering frequency response: Rejects out-of-band interferers, without the additional losses incurred by SAW filters;
- Balanced structure: The antenna has an integrated balun which isolates the antenna from the device ground plane and rejects common mode noise, including in-band noise;
- Constrained near field: Prevents detuning due to external influences, and maintains the antenna efficiency when body-loaded.

These unique characteristics all combine to give an antenna solution that is simple and quick to integrate. It also produces high performance, allowing the best opportunity for GPS reception under the most challenging conditions. However, as with all antennas, it is vital to consider antenna integration as early in the design process as possible. This will present the fewest compromises to the overall performance and give a more useable, successful product.

This document discusses four most common antenna locations within a device, and discusses the relative merits of each. Detailed information is then given to allow the designer to successfully integrate the antenna into their product.

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Antenna terminology

The following terminology is used throughout this report. Please note that the cap (or radome) in the diagram is shown in transparency for clarity.

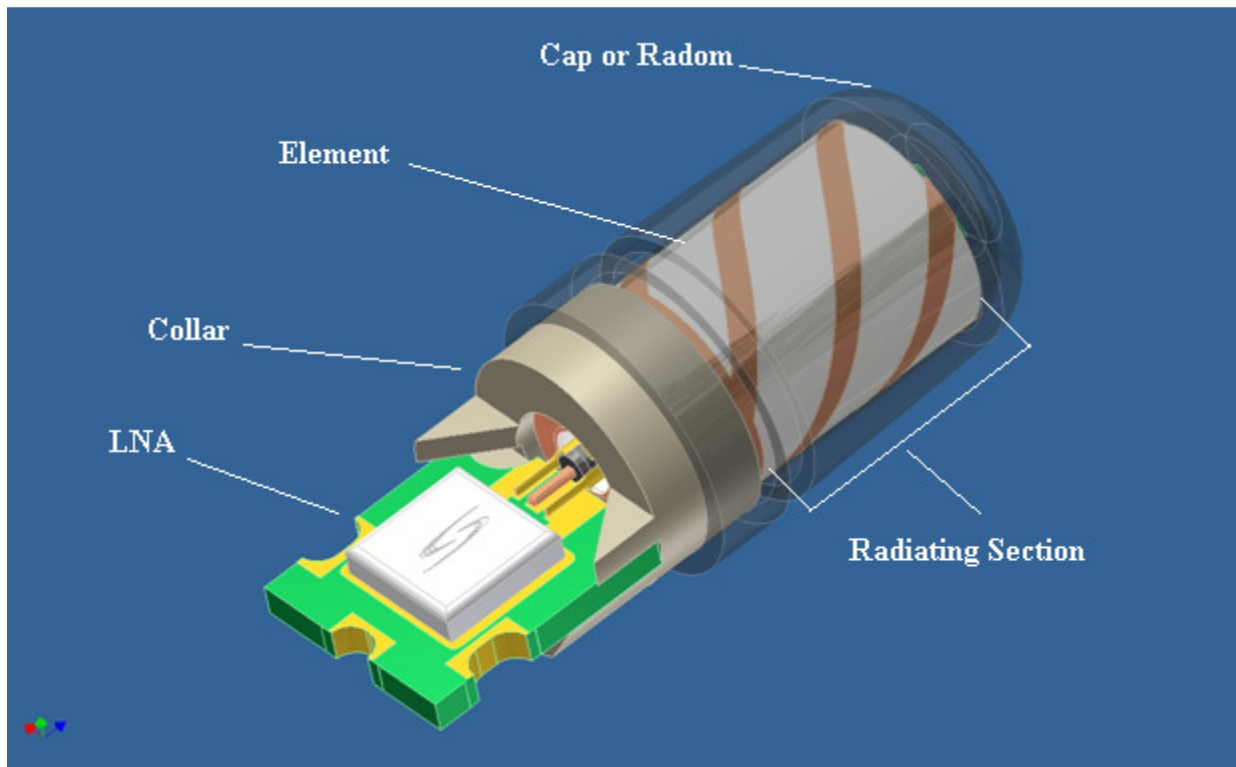


Figure 1 - GeoHelix®-Active Antenna Terminology

Additional Documents

To aid in product development, Sarantel has released a series of product guidelines. It is recommended that the reader obtain these for reference, all of which are available from the applications group at Sarantel.

- Electrical Guide for the Integration of the GeoHelix®-S and GeoHelix®-M
- Sarantel GPS Antennas Testing Guidelines

PLACEMENT OF THE ANTENNA IN THE UNIT

The correct placement of the antenna will help to minimise interference from other components and allow the antenna the optimum view of the sky. In all cases the antenna should be soldered to the main PCB and GPS receiver should be placed as close to the antenna as possible. Situating the GPS receiver further away from the antenna may create noise issues, and is discussed in the “Remote siting of the Antenna” section.

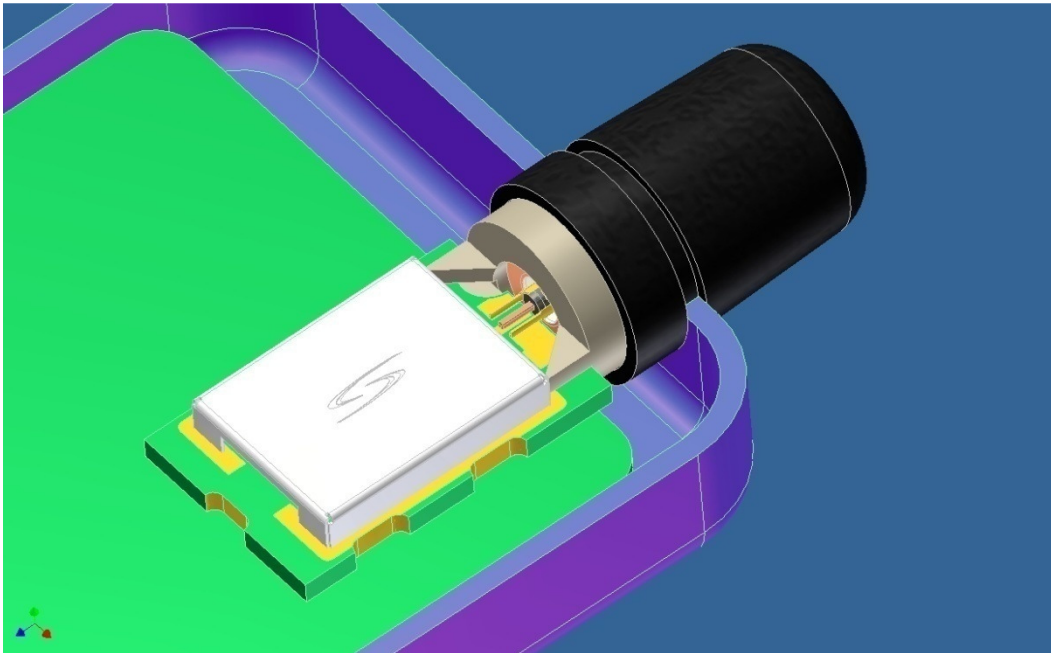
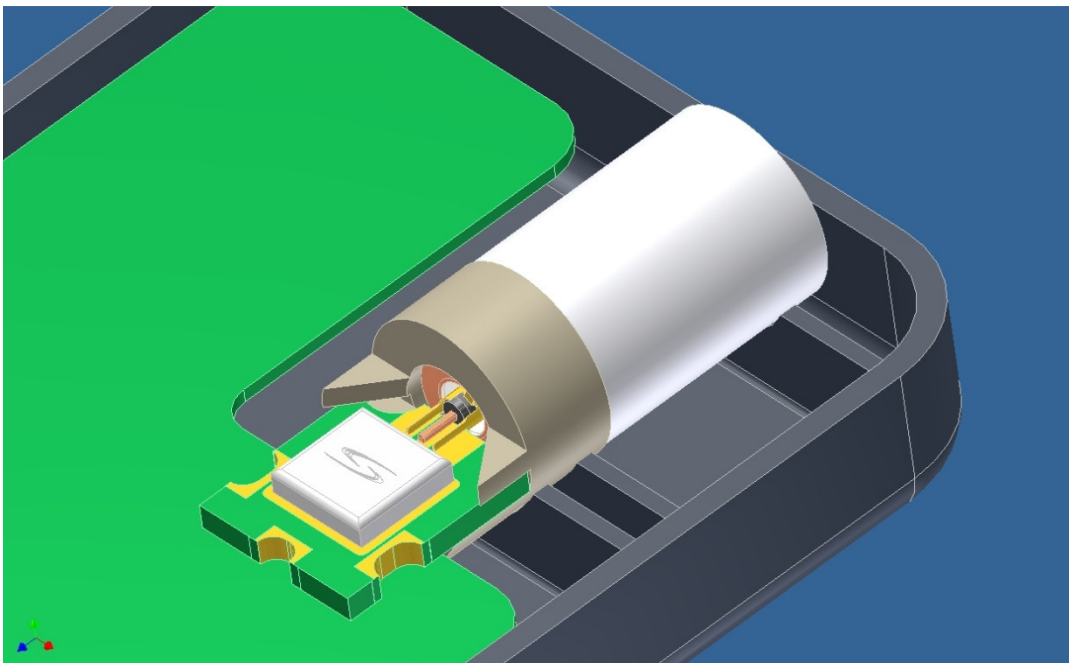
Antenna on Top of unit**Figure 2 -Antenna on Top of Unit, Mounted on PCB**

Figure 2 shows an antenna on the top of a unit. It will have a good view of the sky under normal conditions, and should give optimal performance with the minimum of complexity. This is the simplest implementation approach, and is discussed in the “External Integration” section.

Antenna embedded internally at Top of unit**Figure 3 - Antenna Embedded Internally at Top of Unit with ABS Sleeve**

In figure 3 the antenna has been embedded into the device, and an ABS sleeve has been used to tune the antenna on frequency. This allows much more scope for the industrial design of the product, however care must be taken in the mechanical support of the antenna and in the choice of plastics used for the casing. To ease integration issues it is recommended that there is clear space around the antenna. Once integrated, the unit should be measured in an anechoic chamber to characterise the losses prior to start of production. This is discussed in the “Internal Antenna Integration” section.

Embedded Antennas and Groundplanes

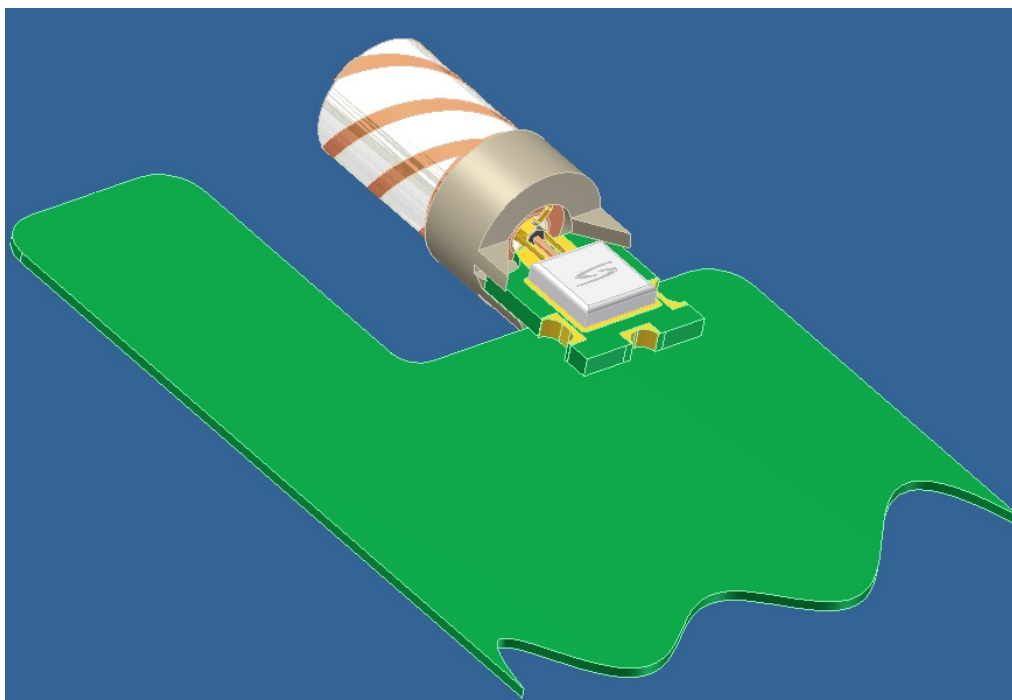


Figure 4 - Embedded Antenna with Nearby Ground Plane

In this example the PCB has enlarged alongside the antenna, and while this can be done, it is recommended that there should be a minimum of 5mm from the antenna to the PCB. If the PCB is to be covered, or contains a ground plane, then this should be increased to 10mm. In both cases the antenna radiation pattern must be measured in an anechoic chamber to ensure any variations in radiation pattern caused by interaction with the PCB are tolerable to the application, and can be allowed for in the system design.

If the ground plane is closer than 10 mm there is the potential for interaction with the near field of the antenna, which can reduce its overall gain. If tighter integration is desired, the performance tradeoffs must be fully understood before committing to volume production. This is discussed in the “Internal Antenna Integration” section.

Remote Siting of the Antenna from the GPS Engine

There are some circumstances where it is desirable to fit the antenna remotely from the GPS receiver, for example in a noisy environment, or when integrating GPS into an existing product. In these situations an active antenna may help to prevent noise from coupling onto the raw signal.

The simplest method of cable connection is by using a daughterboard with a connector socket to take the RF signal to the GPS engine. A number of sub-miniature RF connectors are available. Care must be taken in the routing of the cable to ensure that noise is not coupled

onto it. Ground loops may also be an issue if the PCB layout uses high impedance connections between ground planes, and may need to be addressed using conductive pads to ground the antenna to the main chassis ground.

EMBEDDING THE ANTENNA IN THE UNIT

The GeoHelix[®]-S and GeoHelix[®]-M GPS active antennas have been successfully embedded in a variety of ways. This section will describe two of the most common methods.

General Considerations

There are two fundamental issues to be considered prior to the mechanical integration of the antenna:

1. Mechanical support of the antenna; and
2. Mechanical features affecting RF performance.

The choice of mechanical support is vital as this can affect the ruggedness of the device. With handheld devices it is very likely that they will be dropped, which can lead to PCB tracks being ripped from the substrate. Providing adequate support for the antenna can largely eliminate this potential problem.

RF performance can be compromised by the choice of plastics, antenna positioning, and positioning of other components within the device. These issues will be dealt with in each section, as there are differing concerns for each method of integration.

EXTERNAL INTEGRATION USING SARANTEL'S RADOME

Designers may choose to mount the antenna externally to their product, using the Sarantel supplied radome, or "black cap," to protect the antenna element. This method of mounting the antenna is the most straightforward, and has the least potential to compromise the performance of the antenna or receiver.

Antenna Support

The antenna should be mounted by mechanical features supporting the groove in the cap, and at the base of the cap at the collar. An example is shown in figure 5 and figure 6, with cap dimensions given in figure 7. The feature should be in both the front and back of the plastics to give sufficient mechanical support.

Mounting the antenna in this way will be sufficiently rugged for most hand held civilian applications, where the antenna is not expected to withstand severe shocks. Drop testing is still recommended early in the plastics design cycle to ensure the survivability of the antenna. Care must be taken to ensure that the tolerance on the support feature does not create too tight a fit on the antenna. The mechanical support should not extend above the groove, which will ensure that case features do not interfere with the radiating section of the antenna.

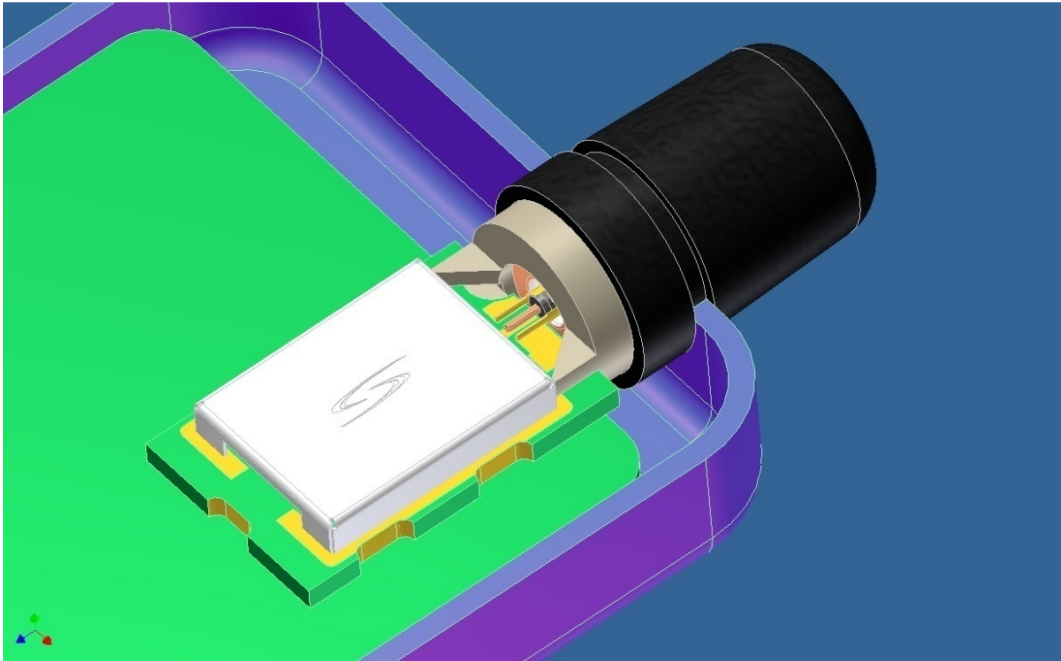


Figure 5 - Correct Antenna Mounting

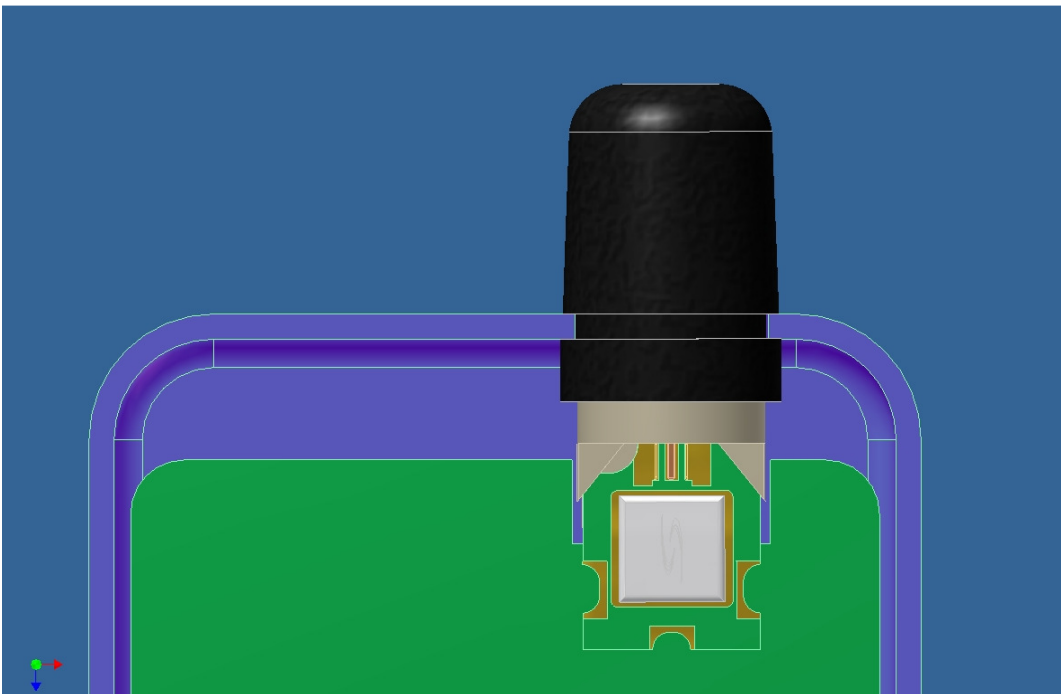


Figure 6 - Correct Antenna Mounting

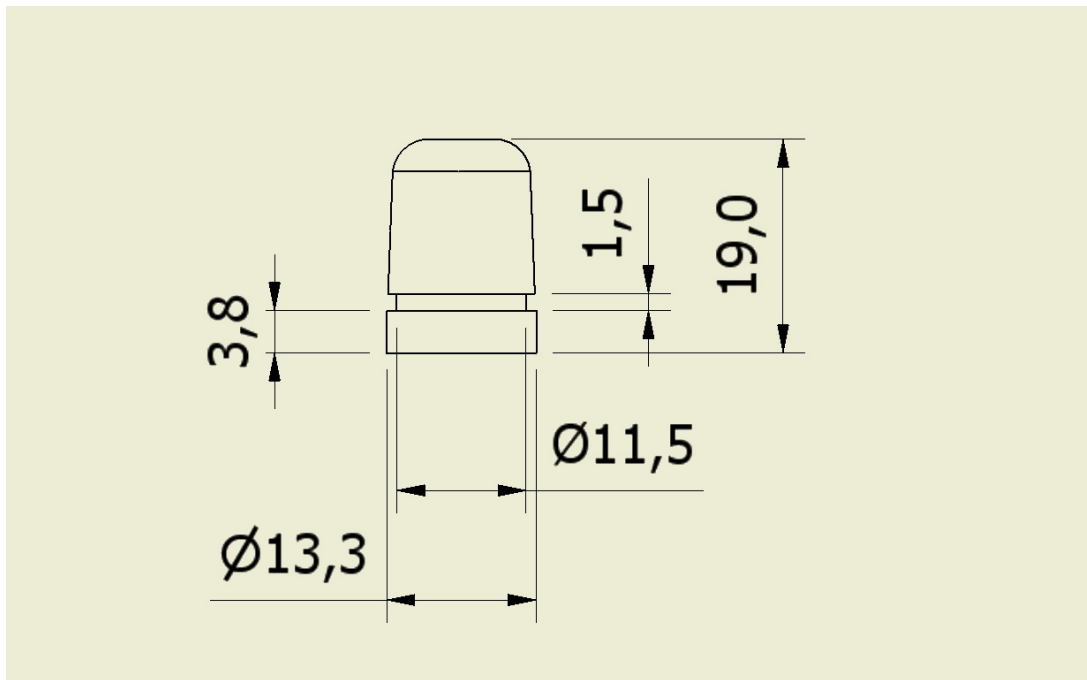


Figure 7 - Radome Dimensions

RF Integration

Provided there are no large features in the plastics adjacent to the antenna, RF integration should be straightforward. However it is recommended that potential sources of noise inside the device be removed as far from the antenna as possible. Additionally the radiation patterns should be measured in an anechoic chamber to ensure the field pattern is consistent.

Summary

What to do:

- Ensure the groove in the cap mates with the retaining feature;
- Locate antenna at the top of the product to get optimum performance;
- Ensure that any extra mechanical support is below the groove (and balun);
- Keep the area around the element clear to prevent pattern distortion; and
- Measure radiation patterns in an anechoic chamber.

What to avoid:

- The mechanical support extending beyond the groove on the cap;
- A tight fit that could lead to distortion of the plastics; and
- Placing noisy components close to antenna.

INTERNAL ANTENNA INTEGRATION

With a tightly constrained near field, the GeoHelix[®] antenna lends itself to being internally embedded within a device. This greatly simplifies the integration process relative to a more conventional antenna, and allows much greater freedom in industrial design. However this is much more involved process than externally mounting the antenna, and it is not without pitfalls, which with care the successful designer will avoid.

Low Profile ABS Sleeve

To minimize the volume of the antenna when embedding within a device, a low profile ABS sleeve can replace the black cap. Either the sleeve or cap must be used, or the antenna will de-tune and performance will degrade. The sleeve dimensions are shown in figure 8.

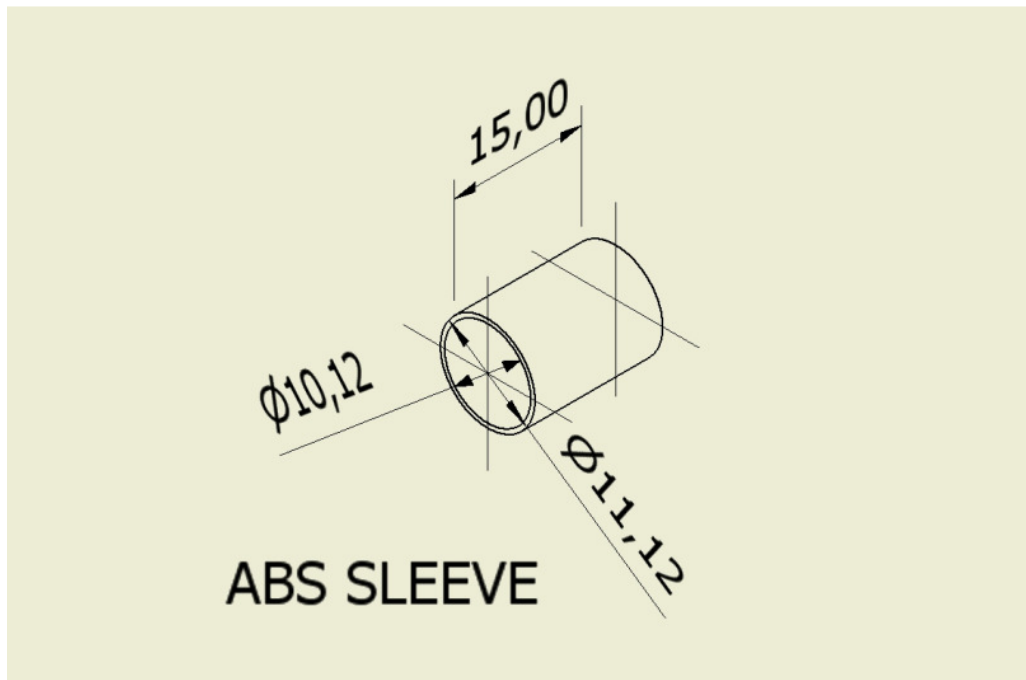


Figure 8 - ABS Sleeve

If the mechanical design lends itself to the sleeve becoming integrated into another section of plastics, e.g., to form a mechanical support for the antenna, please contact the Applications Engineering Group at Sarantel for advice on suitable materials, as this has a direct bearing on antenna performance.

Antenna Support

The antenna requires features designed into the plastics to support it. Failure to incorporate these into the design will cause mechanical failures resulting in field returns. If integration is within a large open space a supporting feature should be moulded into the plastics that surround the collar of the antenna, as shown in figure 9.

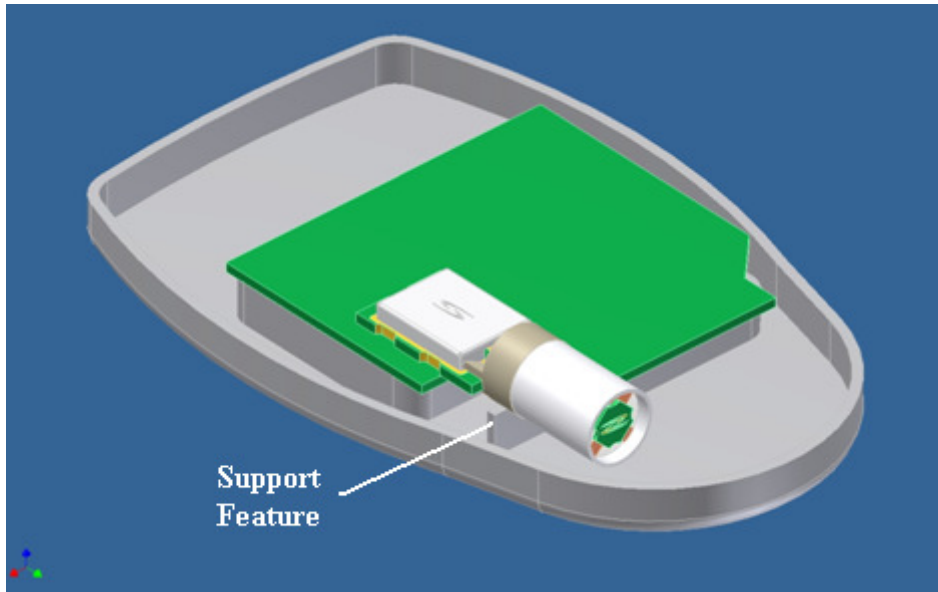


Figure 9 - Antenna Integration in an Open Structure

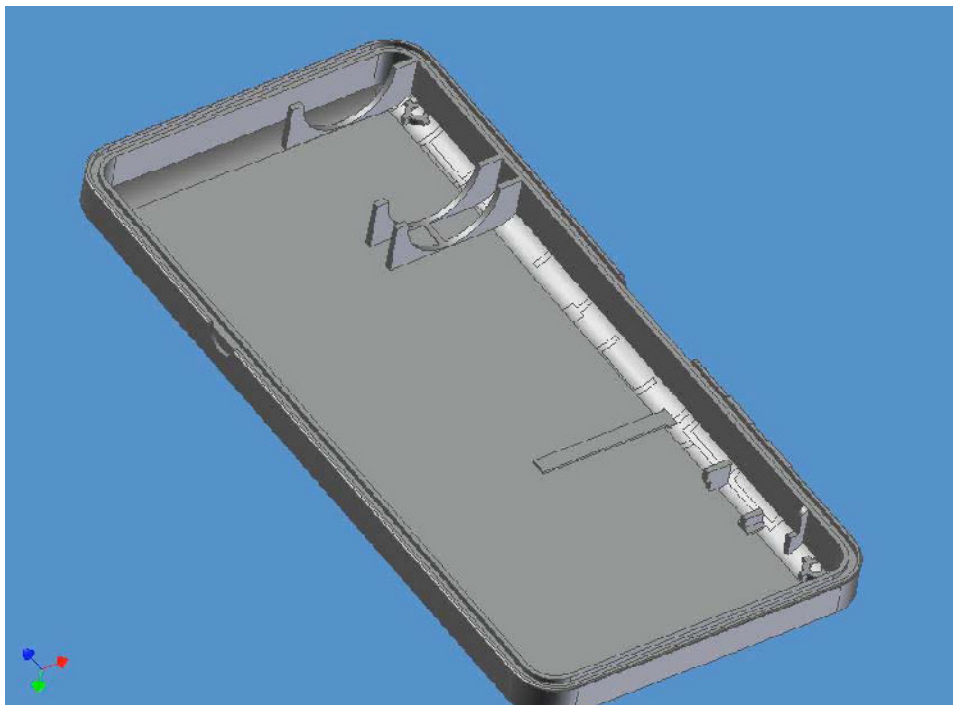


Figure 10 - Support Ribs and Clearance for Radiating Lengths

This support feature should be in both sides of the plastics and should clamp around the collar of the antenna. If integrating the antenna tightly into the unit where there is an increased risk of severe shocks another option is recommended, as shown in figures 10 - 13.

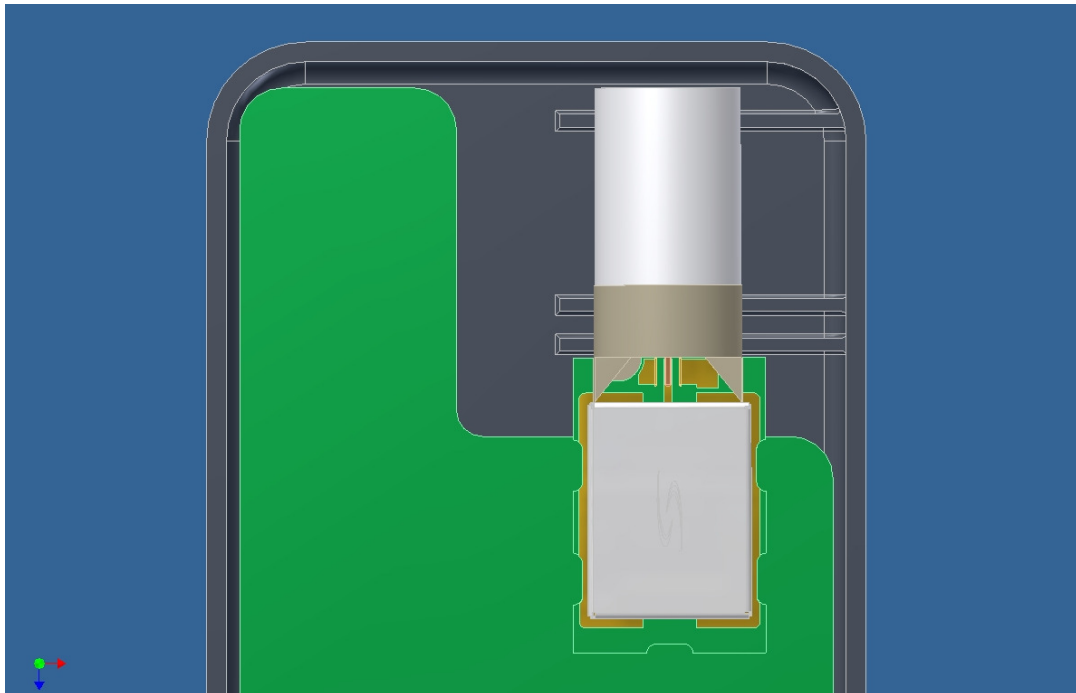


Figure 11 - Antenna Supported by Ribs

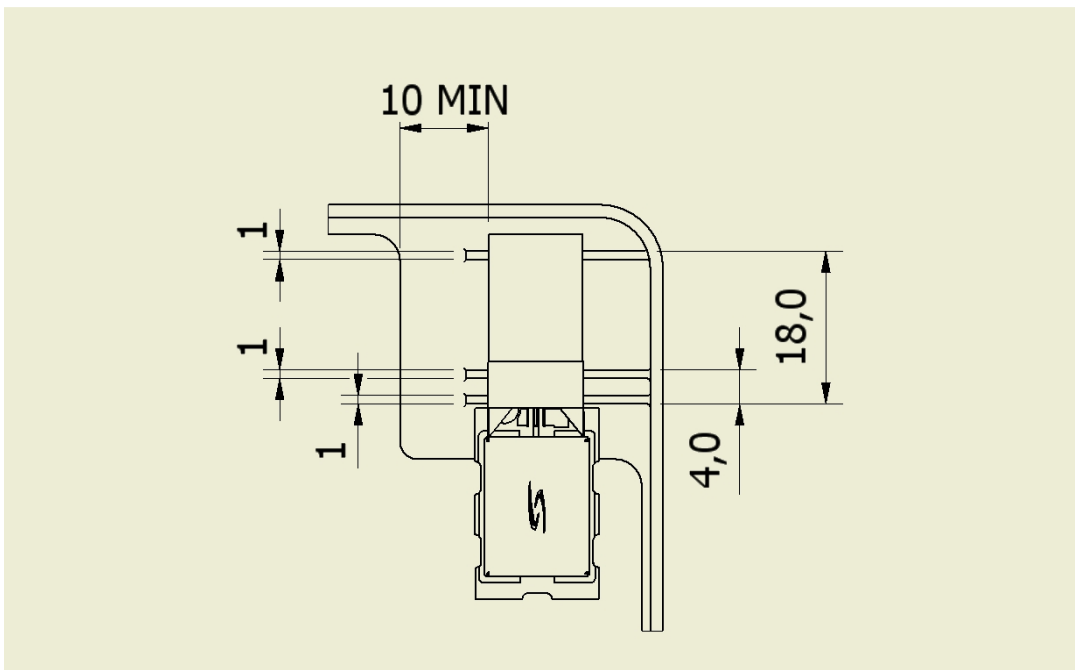


Figure 12 - Support Ribs and Clearance for Radiating Lengths

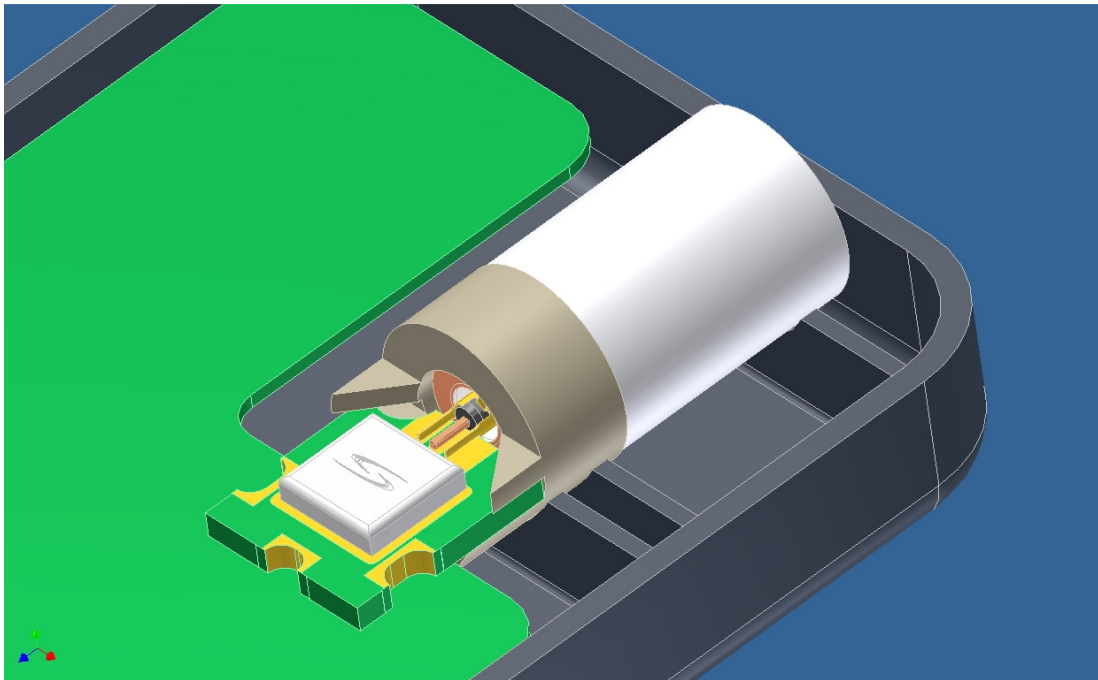


Figure 13 - Antenna Supported by Ribs

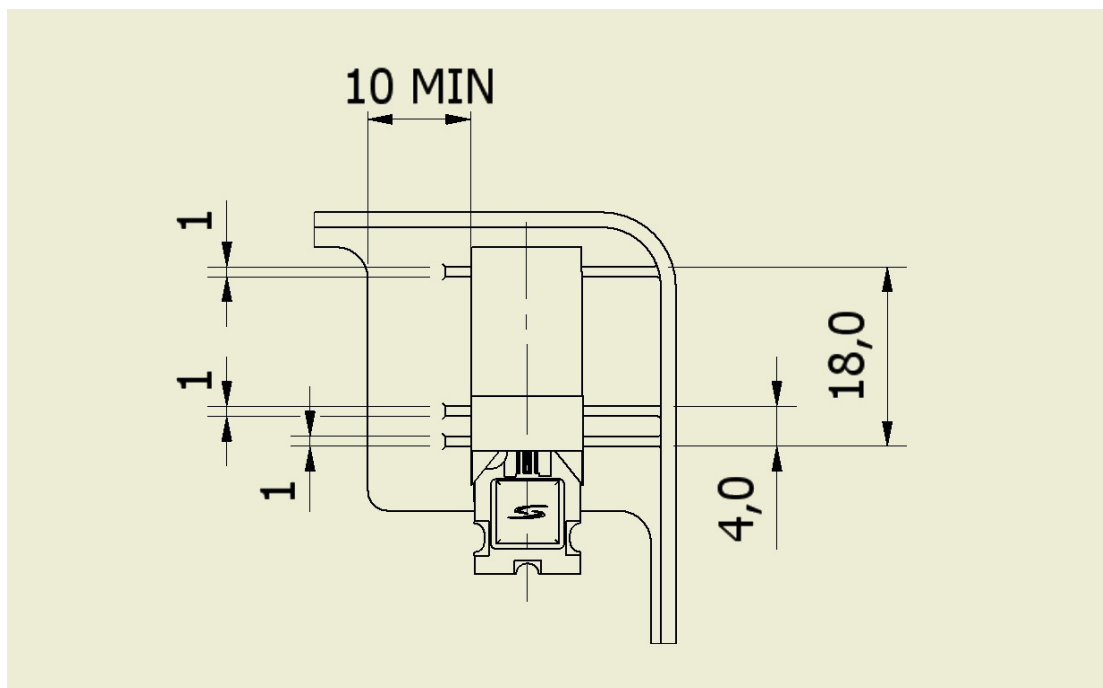


Figure 14 - Support Ribs and Clearance for Radiating Lengths

Mechanical Fixtures

It is recommended that metal fixings such as screws be placed at least 10 mm away from the antenna. If this is not possible, it is prudent to test the unit in an anechoic chamber to ensure that the antenna performance has not significantly degraded.

Material Selection

The material chosen for the plastics can have a significant effect on the radiated performance of the antenna. The primary concern is the dielectric constant (ϵ_r) and loss tangent ($\tan\delta$). Typical values are given in **Table 1**.

Table 1 - Typical values for Dielectric Constant and Loss Tangent of Case Materials

	ϵ_r (at 1MHz)	$\tan\delta$ (at 1MHz)
ABS	2.7	0.01
PC/ABS	2.8	0.01
TPE	3.1	0.008

Wall thickness and dielectric constants can cause a shift in the frequency response of the antenna, and it is vital to consider the effect of the external plastics on the antenna tuning in the design phase.

Allowing the loss tangent to increase beyond the values in **Table 1** will increase losses in the RF path and may significantly degrade performance. It has been found through experience that dark plastics with high carbon content are problematic, as are rubber materials. These should be avoided where possible.

Proximity to Ground Planes and Other Metallised Parts

An issue to consider when tightly integrating the antenna into a product is the proximity of the ground plane to the antenna. See figure 15.

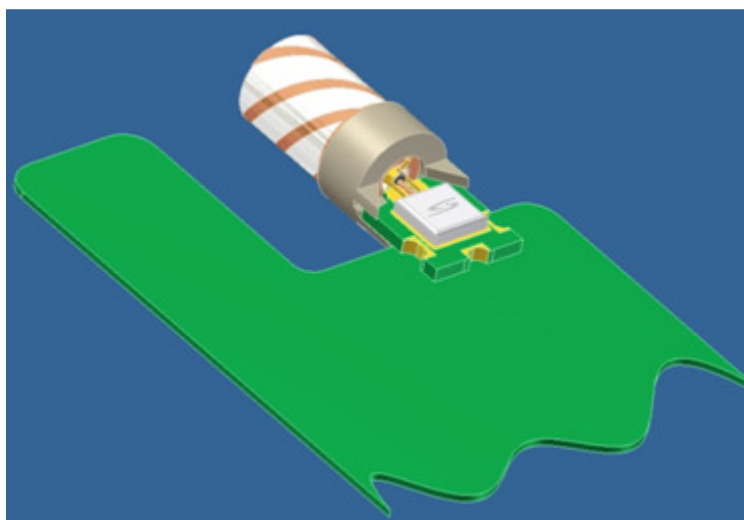


Figure 15 - Antenna Proximity to Ground Plane

This image shows the coupling path from the peak current points of the radiating section to a ground plane inside the near field of the antenna. The near field extends approximately 10mm from the edge of the antenna and currents will be induced in any ground plane inside of this region. This can negatively affect the radiation pattern of the antenna, and hence the overall performance, and additionally increases the antenna's susceptibility to hand loading and interference.

It is therefore recommended that any ground plane should be at least 10mm from the radiating section of the antenna, and if PCB should protrude inside this area, ground planes should be stripped back such that they are 10mm away. Bare PCB should stop at least 5mm from the antenna. These guidelines also apply to other metalised parts that may be used in a device, such as liquid crystal displays, batteries and screening cans. These parts should be connected to the system ground by low impedance paths to prevent currents being induced by the antenna and affecting performance.

It is also strongly recommended that anechoic chamber measurements be done to ensure that the antenna performs as expected.

NOISE SOURCES

Another consideration is the proximity of noise sources such as power supplies, digital frequency references and processors. This can be more of an issue with embedding as the antenna will be physically closer to the sources. Sarantel have produced an application note on self-jamming, however careful consideration of this issue at the initial stages of a design can significantly reduce the time to market.

Summary

What to do:

- Symmetry around the antenna;
 - Use of a sleeve or cap;
 - Sufficient clearances to plastics and ground planes;
 - Good support for shock & vibration; and
 - Sufficient distance to other components, e.g., battery, LCD metal framing;
 - Good location in the device, close as possible to GPS engine to reduce track losses;
- and
- Using plastics with correct dielectric constant and low loss.

What to avoid:

- Fixing ONLY by the solder pads;
- Rubber materials around product;
- Ribs along the radiating section;
- Metal screws, fixings or metal components within 10mm of the radiating section;
- Antenna close to high frequency tracks;
- Antenna close to batteries or other impeding devices (screens, etc.);
- Poor location;
- Jamming signals – oscillators, VCO's, LCD screens, etc.; and
- Unshielded microstrip tracks (ground planes).

APPLICATION SUPPORT

This document gives a set of general guidelines that can be used to avoid the most significant issues facing designers. However, every product is slightly different and has its own unique set of requirements. For this reason it is prudent to contact the applications group at Sarantel to discuss your design.

Sarantel's applications group have significant previous design experience at the system and component level in a number of blue chip telecommunication and electronics companies. Combined with state of the art test facilities, this gives Sarantel the ability to offer unique support tailored to the customer's requirements.

This expertise can help avoid performance issues in the design phase, reducing the time to market, hence overall engineering costs, and ensure a more successful product.

IMPORTANT NOTICE

The SL1206 and SL1204 incorporates active ESD protective circuits, however the Active Antennas contain active circuitry which has some sensitivity to damage by electrostatic discharge (ESD). Sarantel recommend using standard ESD precautions handling the antenna unit.

REVISION LOG

Version	Release Date	Description
1.0	APRIL 2009	Initial revision

Application Guides: www.sarantel.com/technology/applicationnotes

More Information

For technical support: www.sarantel.com/contact/

For samples: <https://samples.sarantel.com/>

Other questions and comments: www.sarantel.com/contact/

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