Guidelines for Replacing Antennas

Laird Connectivity Modules

Application Note *v1.0*

1 Introduction

This purpose of this application note includes the following:

- Provides information and guidance for the process of changing the antenna in an FCC-certified module.
- Discusses additional factors that must be reviewed when making antenna changes.
- Specifically involves RF exposure/SAR evaluation and DFS testing.

1.1 Terms

The following terms are used in this application note:

- Class I Permissive Change – Does not requires submitting data to the TCB for FCC.
- Class II Permissive Change – Requires submitting data and other exhibits via the Equipment Authorization process through a TCB (Telecommunication Certification Body).

2 FCC Guidelines

2.1 FCC General Antenna Requirements

Antenna requirements are listed in FCC Part 15.203. The main antenna specification is that the module must use a permanently-attached antenna or an antenna that uses a unique antenna connector. The FCC does not specify the difference between standard and non-standard connecter types. In general, standard connector types are SMA, N-type, coaxial, etc. Non-standard types include u.FL, RPSMA (reverse polarity SMA), and reverse thread connectors.

The following are the high-level guidelines and assumptions for changing antennas.

Overall for Part 15 unlicensed devices the certification application should include a list of all antennas approved for use with the transmitter and photographs of each antenna (see Part 15.204).

Under the Permissive Change policy (KDB 178919 D01) Section II A(3) antennas being substituted that are considered equivalent antennas can be substituted as a Class I Permissive Change. By definition-equivalent antennas are of the same type (e.g., yagi, dish, etc.), must be of equal or less gain than an antenna previously authorized under the same grant of certification (FCC ID) and must have similar in-band and out-of-band characteristics (consult specification sheet for cutoff frequencies)[1].

The FCC does not specify further how to determine similarity to in-band and out-of-band characteristics. Manufacturers should review available information and provide an assessment outlining the similarities. In general, the easiest way to do this by collecting data in-band and out-of-band and comparing this information to the original antenna. However, it may be able to show similarities through other means.

A Class II Permissive change occurs when any new antenna type, or higher gain antenna is used; also, the antenna must meet requirements of Part 15.203.

[1] KDB 178919 D01 Permissive Change Policy v06 page 2

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2.2 Part 15 Equivalent Antennas

The following is a list of scenarios in which a Class II Permissive Change is required even though the antenna is being changed to an equivalent antenna (as outlined previously)[2].

- Unlicensed Personal Communications Service Devices (Part 15 Subpart D) – The lowest gain antenna is needed for detecting the lowest energy above the noise floor in addition to the highest gain of each type. The addition of a lower gain antenna requires a Class II permissive change.
- U-NII devices – The lowest gain antenna, in addition to the highest gain of each type, is needed because the lowest gain results in worst case radar reception. The addition of a lower gain antenna, whether the type is currently authorized, requires a Class II permissive change.
- For transmitters with antennas operating in portable exposure conditions. See *VI) B) 3) in KDB 178919 D01 Permissive Change Policy V06*.
- Transmitters subject to a vertical fundamental frequency radiation limit above the horizon (e.g., EIRP for certain U-NII devices in § 15.407(a)(1)(i) or attenuation for UWB devices in § 15.515(d)). Any change in antenna pattern, antenna type, or installation that results in an increase in the reported vertical radiation level requires a Class II permissive change.

2.3 Evaluating Replacement Antennas

The FCC does not list specific requirements for evaluating antennas for in-band and out of band performance except for the statement regarding cut-off frequencies that define the in-band operational frequency range. It is up the manufacturer/integrator making the antenna change to evaluate the replacement antenna and compare it to the originally-certified antennas.

In general, the antenna evaluation can be done in several ways. For example, an evaluation of VSWR and other antenna characteristics can help assist in determining the performance of the antennas. Also, the most direct approach is collecting antenna performance data for Radiated Band-Edge and Radiated Spurious Emissions. The scope of this could be limited in the number of channels and data rates as the intent is not to fully qualify the new antenna but rather investigate performance for comparison to the original antenna.

In the end, the manufacturer/integrator must do the risk assessment and determine the most appropriate path. The key is to document the assessment and the supporting information. This information should be set up for easy access if requested.

2.4 Off-Module Trace design

Off-module trace antenna designs must follow the manufacturer's module layout guidelines. Off-module trace design occurs when the antenna connector or antenna is not on the same PCB as the module and allows the integrators to incorporate the antenna trace design on their host board. Do not confuse this with reference designs which are radio IC layouts being integrated into the host board. Reference designs are not allowed for modular approval.

The FCC has identified specific guidelines regarding what must be provided to the integrators to ensure properly following the off-module trace design on their host board. If the integrator of the module follows the design guidelines exactly, their modular approval can be leveraged without additional testing for intentional emissions.

The following is an example of the off-module trace/connector design and an example of the information that should be provide to the module integrator to incorporate the trace reference design. The module manufacturer's installation/user guide document should include information regarding how the vertical geometry of the board must be maintained; specifically, the substrate configuration and material type/thickness specifications. Also, an inspection of the Gerber files to address the verification and conformance to the lateral geometry of the board layout

[2] KDB 178919 D01 Permissive Change Policy v06 page 2

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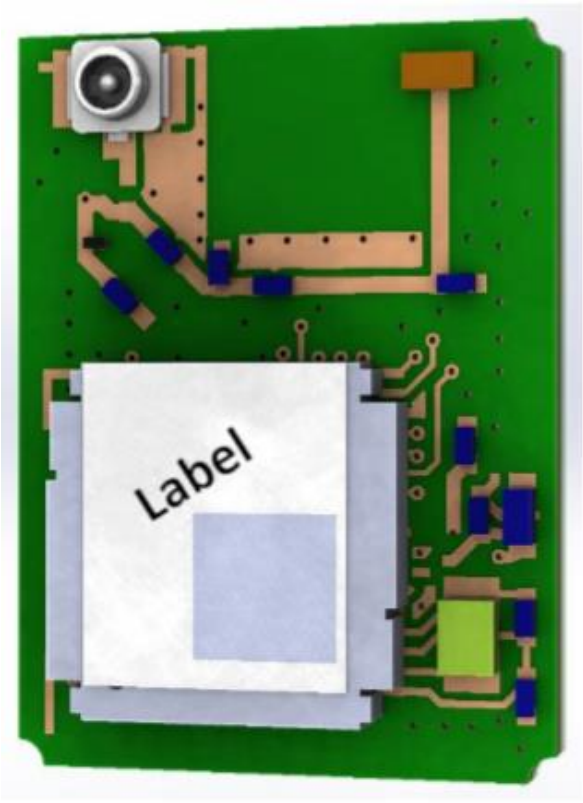
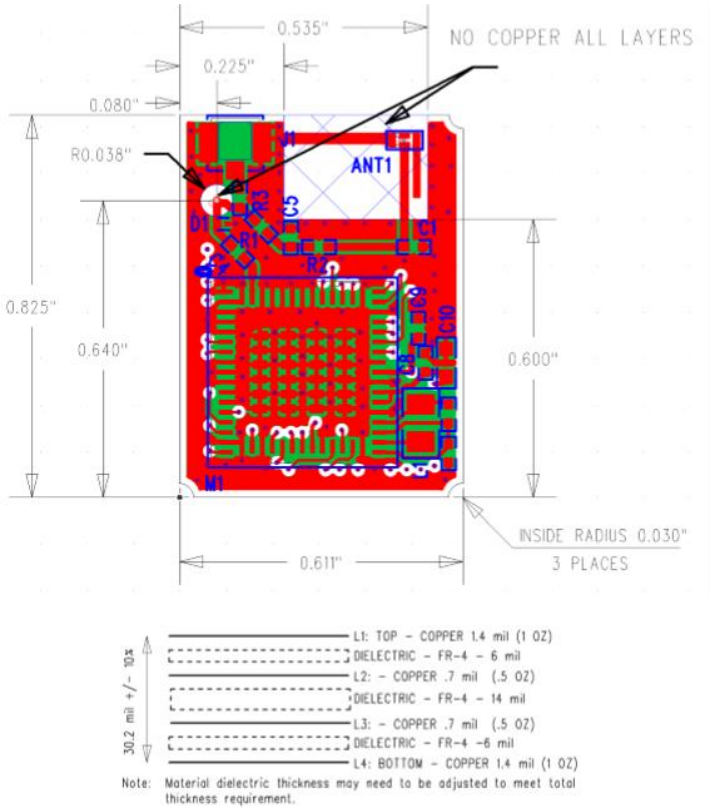
pertaining to trace design by the original grantee. Any deviations or changes shall be reviewed and confirmed by the original grantee.





However, integrators may encounter challenges when preparing the design. The following are the most common areas integrators modify which impact the ability to leverage the existing modular approval:

- Layout of trace design, parts, antenna, connectors, and isolation requirements;
- Boundary limits of size, thickness, length, width, shape(s), dielectric constant, and changing the for the antenna;
- Different antenna length and shapes.

  These changes can affect radiated emissions and each design shall be considered a different type; e.g., antenna length in multiple(s) of frequency wavelength and antenna shape (traces in phase) can affect antenna gain.

PCB circuit designs have an increased potential for design mishandling and are susceptible to cross-talk and increased unintentional radiation. Different antenna length and trace layouts can affect radiated emissions and each design shall be considered a different type[3]:

Only trace designs approved with an original grant or through permissive change can be used by an OEM. Therefore, any modifications or changes to the trace design layout must be heavily reviewed and should most likely include a review/comment from the Original Grantee of the module to ensure full compliance. In many cases the change results in a minimum of a Class II Permissive Change and/or a Change of ID.

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2.5 Additional Factors Impacted by Antenna Change

When making an antenna change, there are several other items that must be evaluated to determine if changing the antenna will impact the original certification. The following are some of the most common items:

- SAR/RF Exposure
- Grant Restrictions

2.5.1 SAR/RF Exposure

Changes in antenna gain and/or location can have an impact on the RF exposure/SAR calculations.

- Therefore, antennas need to be evaluated for impact to the SAR/RF exposure requirements. Higher gain antennas may result in increased exposure calculations which may not meet the exemptions and would require SAR testing.
- Those modules or products with SAR test data may also be impacted by a change in antenna. Measured results may deviate or be influenced by the antenna pattern of the new antenna and a result have higher concentrations of energy.

2.5.2 Grant Restrictions

Some modular and end-product approvals have specific antenna requirements as noted in the Grant of Authorization. One of the most common antenna restrictions is for professional installation. It is important to take note of the restrictions and ensure the antenna change is not in violation and requires a Class II Permissive Change to ensure that the new antenna is also incorporated.

In the case of professional installation, it may require additional instruction and training to ensure proper implementation. Also, there may be restrictions where this antenna may be incorporated in the field.

3 Conclusion

Any deviations or changes to the antenna used in the certification is the responsibility of the manufacturer/integrator to ensure compliance is maintained. As discussed, this can be accomplished through a variety of methods as the FCC doesn't dictate the method for confirming compliance. Maintaining compliance is not limited to the direct RF performance but should also include evaluation for impact ancillary requirements

4 Revision History

Version	Date	Notes	Contributor(s)	Approver
1.0	04 Jan 2019	Initial Release	Brian Petted Bill Steinike	Thomas T. Smith

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