PCB Notch Antenna

RM1xx Module

Reference Design *v1.0*

1 Introduction

The goal of this document is to provide application guidance in the integration of either an 868-MHz or 915-MHz PCB notch antenna, depending on the module type, into a product design. This document describes the PCB details required to retain Laird modular certification for the RM1xx module.

2 Overview

The PCB notch antenna is used in conjunction with the Laird 080-0041 U.FL-to-U.FL cable to provide an external antenna solution for the Laird RM1xx module. This document briefly reviews the on-board chip antenna on the RM1xx module criteria and focus mainly on the PCB notch antenna design.

3 Antenna Performance

The Laird 868 and 915-MHz PCB notch antennas are used in conjunction with the Hirose PCB-mounted U.FL connector (Figure 9) to provide an externally-mounted antenna solution for the RM1xx module.

3.1 868 MHz (863 – 870 MHz)

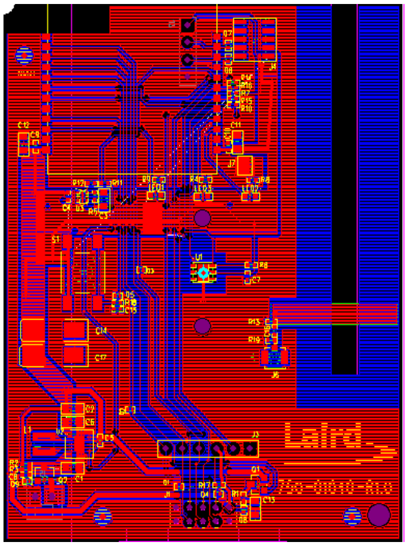


Figure 1: RM1xx 868 MHz PCB Notch Antenna

Specification	Value
Peak Gain	-1 dBi
Average Gain	> - 3.5 dBi
Impedance	50 ohms, Nominal
Type	PCB Trace Notch
Polarization	Linear Vertical
VSWR	≤ 2.0 : 1, Maximum
Frequency	863 - 870MHz
Size	60 ×16 mm
Operating Temp	-40°C to +85°C

Table 1: Typical Antenna Performance

3.1.1 Matching Circuit

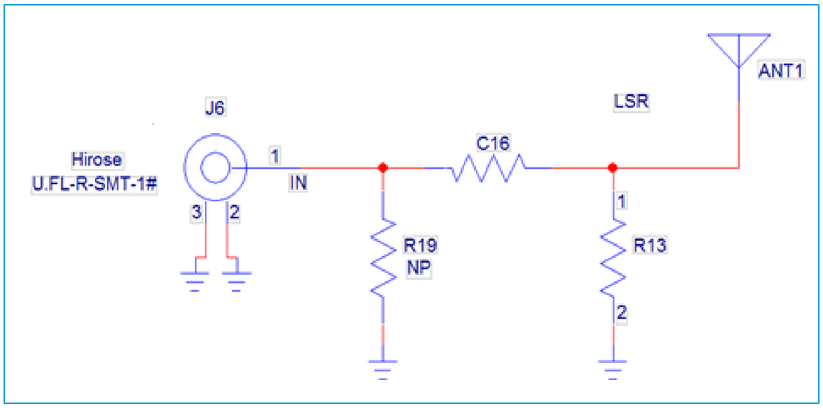


Figure 2: 868 MHz Matching Circuit

3.1.2 Components

R13	8nH ± 2%	MFG Part Number: LQW15AN8N0G80D
C16	5.4nH ± 2%	MFG Part Number: LQW15AN5N4B80D
R19	No component populated	

3.1.3 Typical Radiation Performance

Table 2: Typical antenna performance chart

Channel	Frequency (MHz)	Pant (dBm)	TRP (dBm)	Avg. G (dBi)	MRP (dBm)	Max. G (dBi)
1	863	12.43	9.30	-3.13	11.8	-0.6
2	867	9.25	6.32	-2.93	8.8	-0.4
3	870	11.06	8.62	-2.44	11.1	0.0

Pant	Measured power at the antenna port
TRP	Measured total radiated power in dBm
MRP	Maximum radiated power in dBm
Average G	TRP−Pant
Maximum G	MRP−Pant
dBi	dB above an isotropic radiator

Azimuthal Conical Cuts at 867 MHz

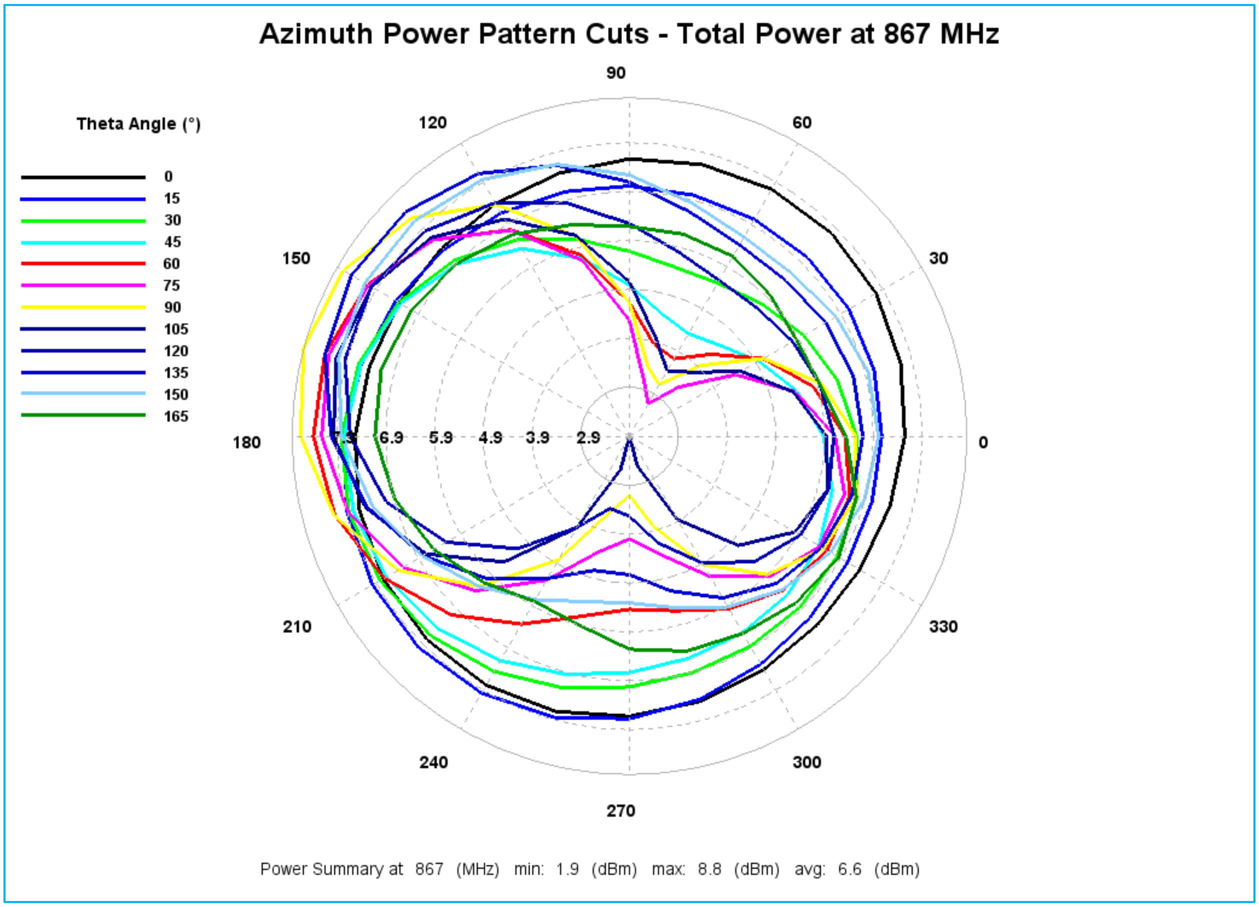


Figure 3 Total Gain Pattern

3D Plots at 867 MHz

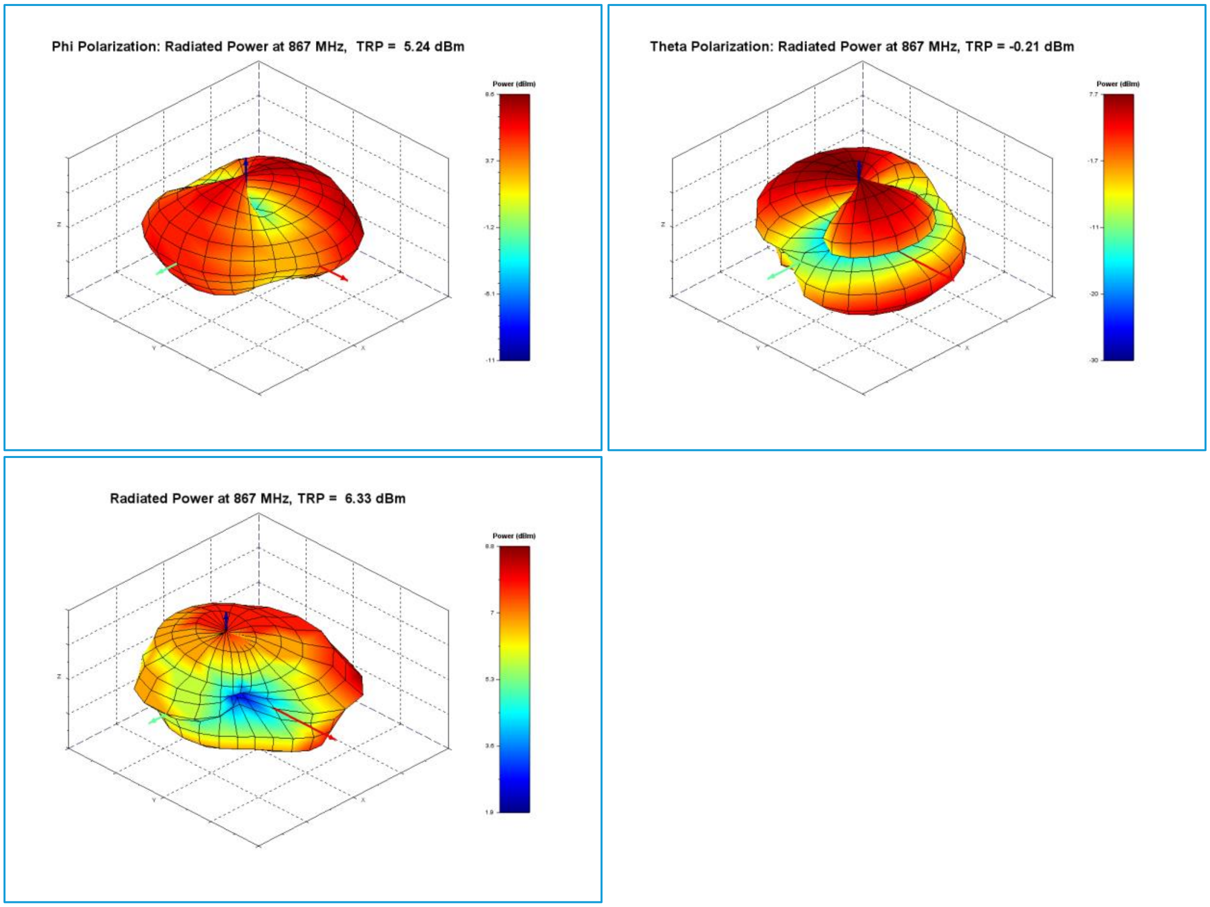


Figure 4 Phi, Theta, and Total Gain Plot

3.2 915 MHz (902 – 928 MHz)

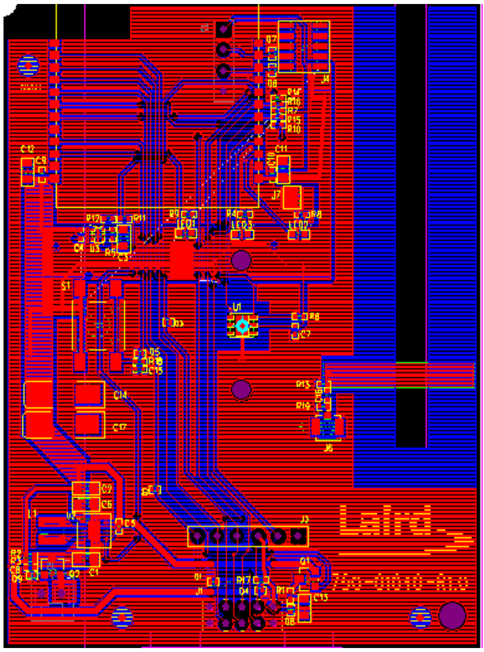


Figure 5: RM1xx 915 MHz PCB Notch Antenna

Specification	Value
Peak Gain	-1.5 dBi
Average Gain	> - 3.7 dBi
Impedance	50 ohms, Nominal
Type	PCB Trace Notch
Polarization	Linear Vertical
VSWR	≤ 3.0 : 1, Maximum
Frequency	902 - 928MHz
Size	60 ×16 mm
Operating Temp	-40°C to +85°C

Table 3: Typical Antenna Performance

3.2.1 Matching Circuit

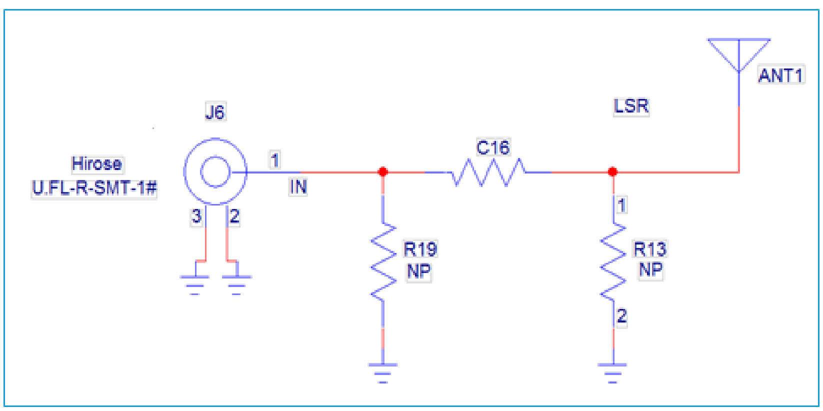


Figure 6: 868 MHz Matching Circuit

3.2.2 Components

R13 = No Component Populated

C16 = 13nH ± 2% MFG PN: LQW15AN13NG80D

R19 = No Component Populated

3.2.3 Typical Radiation Performance

Table 4: Typical antenna performance chart

Channel	Frequency (MHz)	Pant (dBm)	TRP (dBm)	Avg. G (dBi)	MRP (dBm)	Max. G (dBi)
1	902	8.77	6.29	-2.48	8.2	-0.6
2	915	8.77	5.98	-2.79	7.9	-0.9
3	928	8.77	5.23	-3.54	7.3	-1.5

Pant	Measured power at the antenna port
TRP	Measured total radiated power in dBm
MRP	Maximum radiated power in dBm
Average G	TRP−Pant
Maximum G	MRP−Pant
dBi	dB above an isotropic radiator

Azimuthal Conical Cuts at 915 MHz

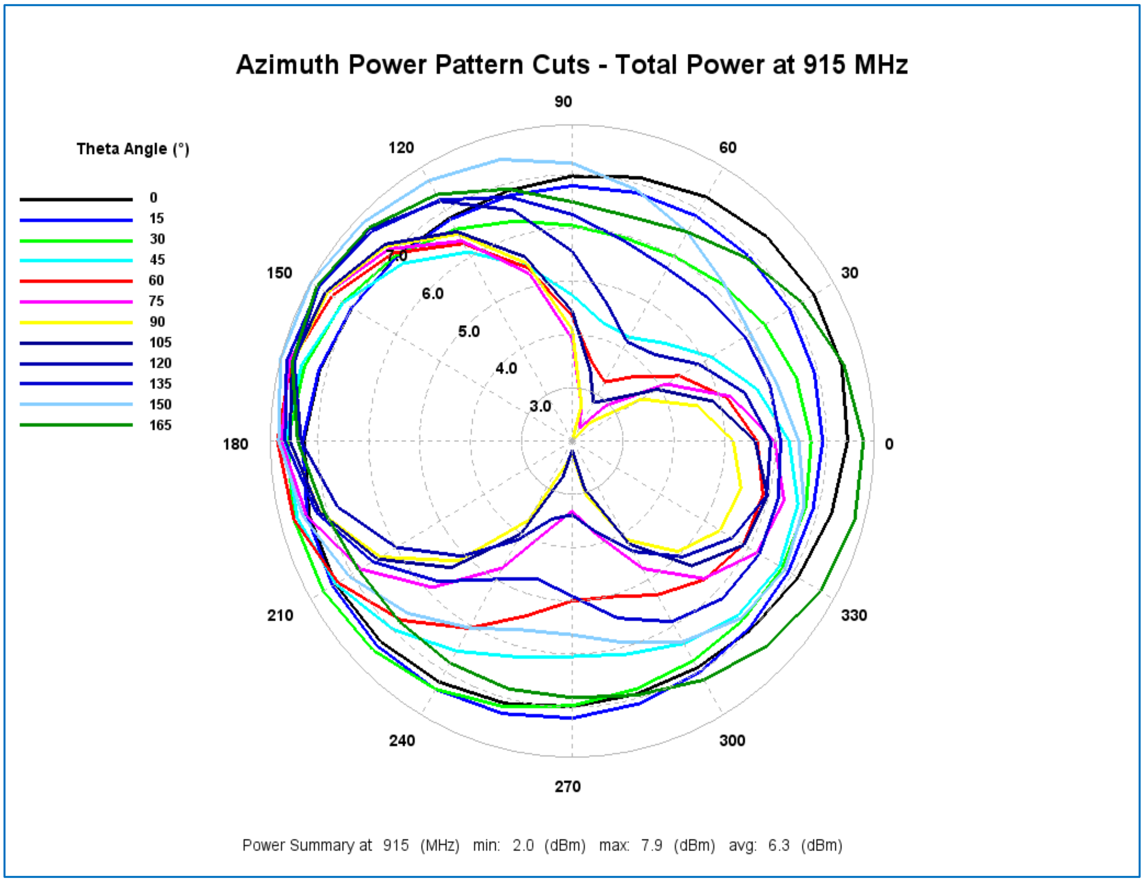


Figure 7 Total gain pattern

3D Plots at 915 MHz

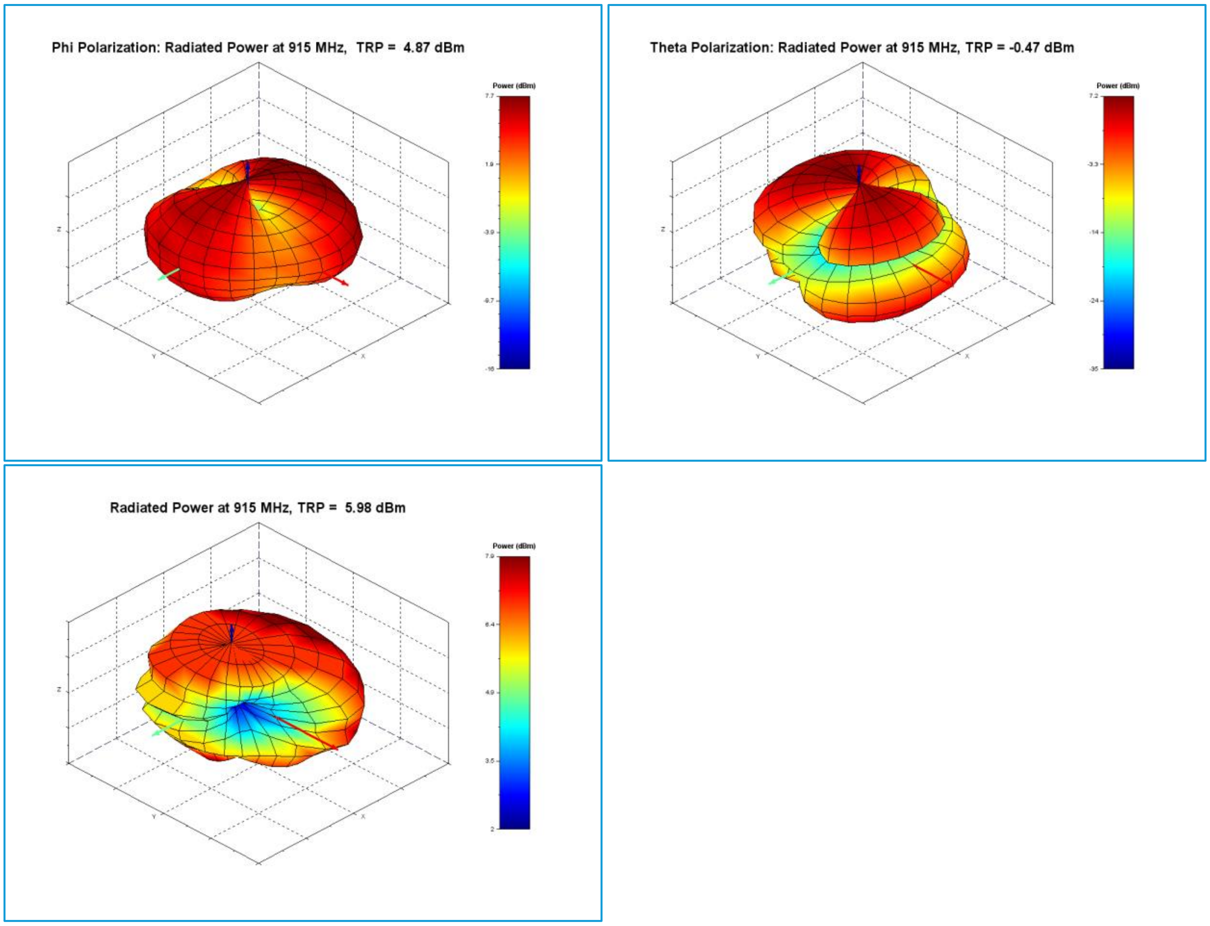


Figure 8 Phi, Theta, and total gain plot

3.3 External Antenna Connector

All external antennas are used in conjunction with the Hirose PCB mounted U.FL connector to provide an externally mounted antenna solution for the RM1xx module.

3.3.1 U.FL Connector Drawing

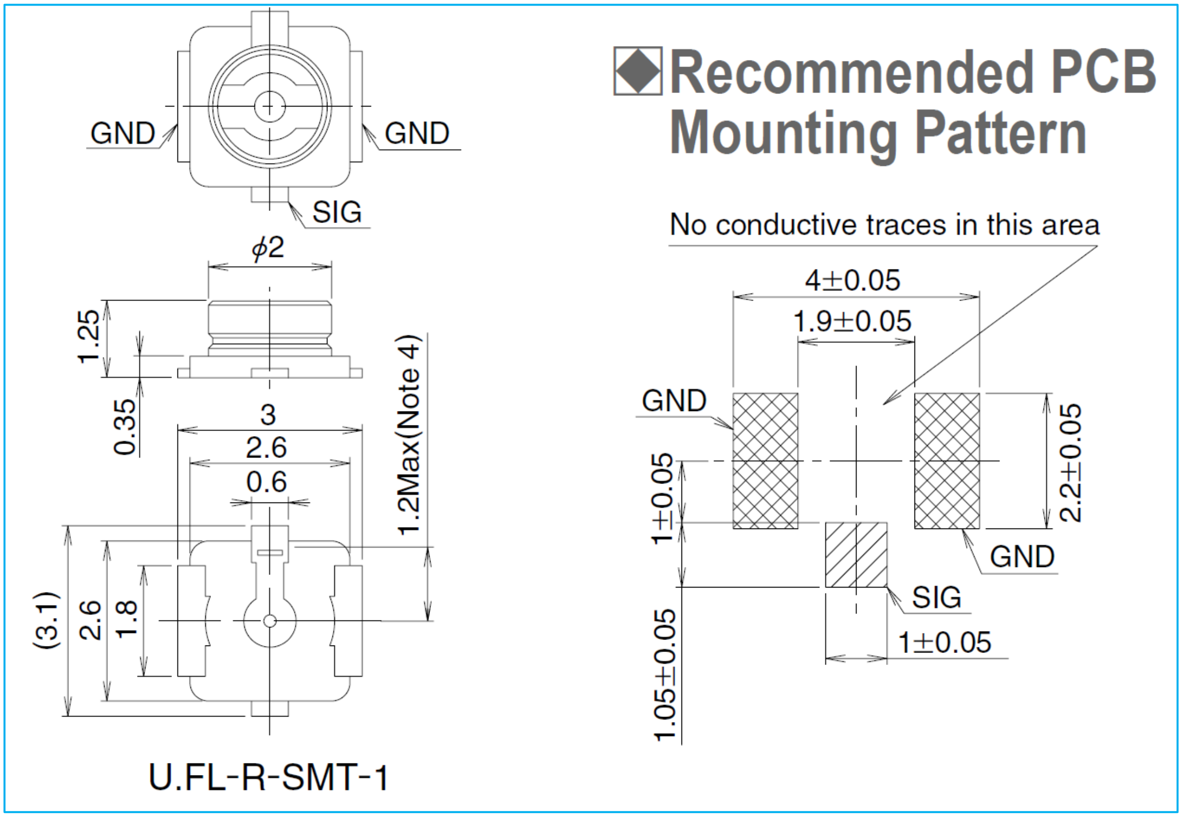


Figure 9: U.FL Connector Drawing

4 PCB Layout Requirements

This module and its associated set of approved antennas has been certified by the FCC and Industry Canada (IC) as a Modular Radio, the end user is authorized to integrate this module into an end-product, and is solely responsible for the Unintentional Emissions levels produced by the end-product.

Note: It is not required to replicate the entire design, but what is required is the circuitry and layout as it pertains to the antenna configuration being used in your design as shown in *Figure 11*.

The module must be used with one of the approved external antennas:

- Laird 868 MHz PCB Notch Antenna design and 080-0041 U.FL to U.FL connector cable
- Laird 915 MHz PCB Notch Antenna design and 080-0041 U.FL to U.FL connector cable

4.1 RM1xx Placement on Host PCB

Below are the high-level points for placing the RM1xx module on your host PCB. For more detailed information, see section "PCB Layout on Host PCB – General" in the RM1xx datasheet. (RM1xx Product Page under the Documentation Section).

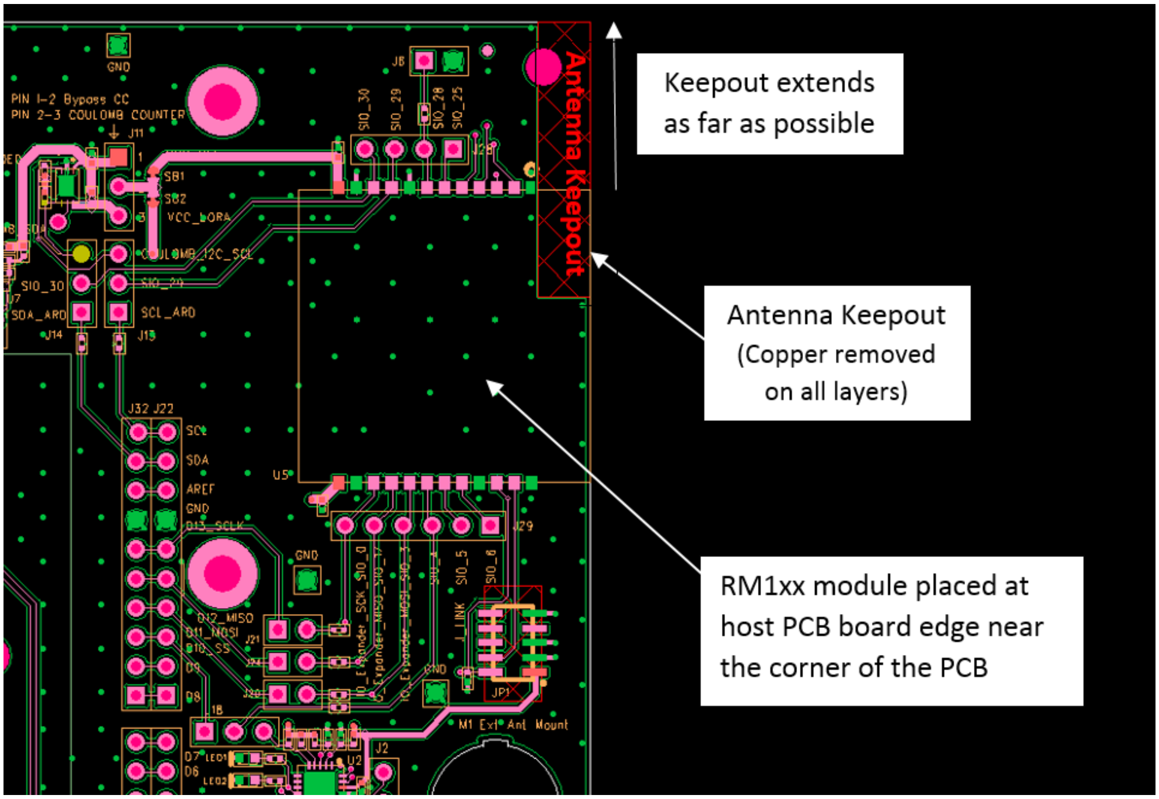
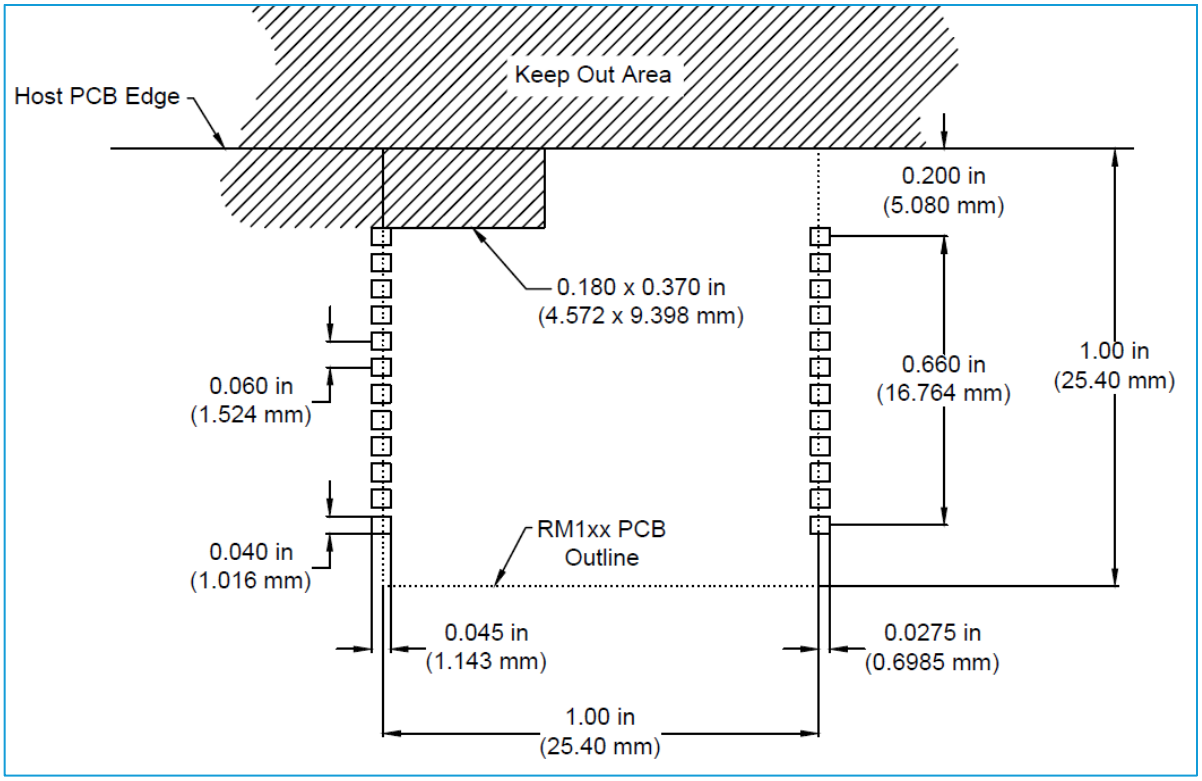


Figure 10: BLE Chip Antenna Keep-Out and Module Placement Example on DVK-RM1xx PCB

Notes:

1. RM1xx module **MUST** be placed on edge of host PCB (close to the corner of the PCB for best RF performance) with the BLE chip antenna in the upper left corner as shown below.



2. No copper in all layers of the *Antenna Keep-out Area* for a host PCB.

4.2 PCB Notch Antenna Reference Design PCB

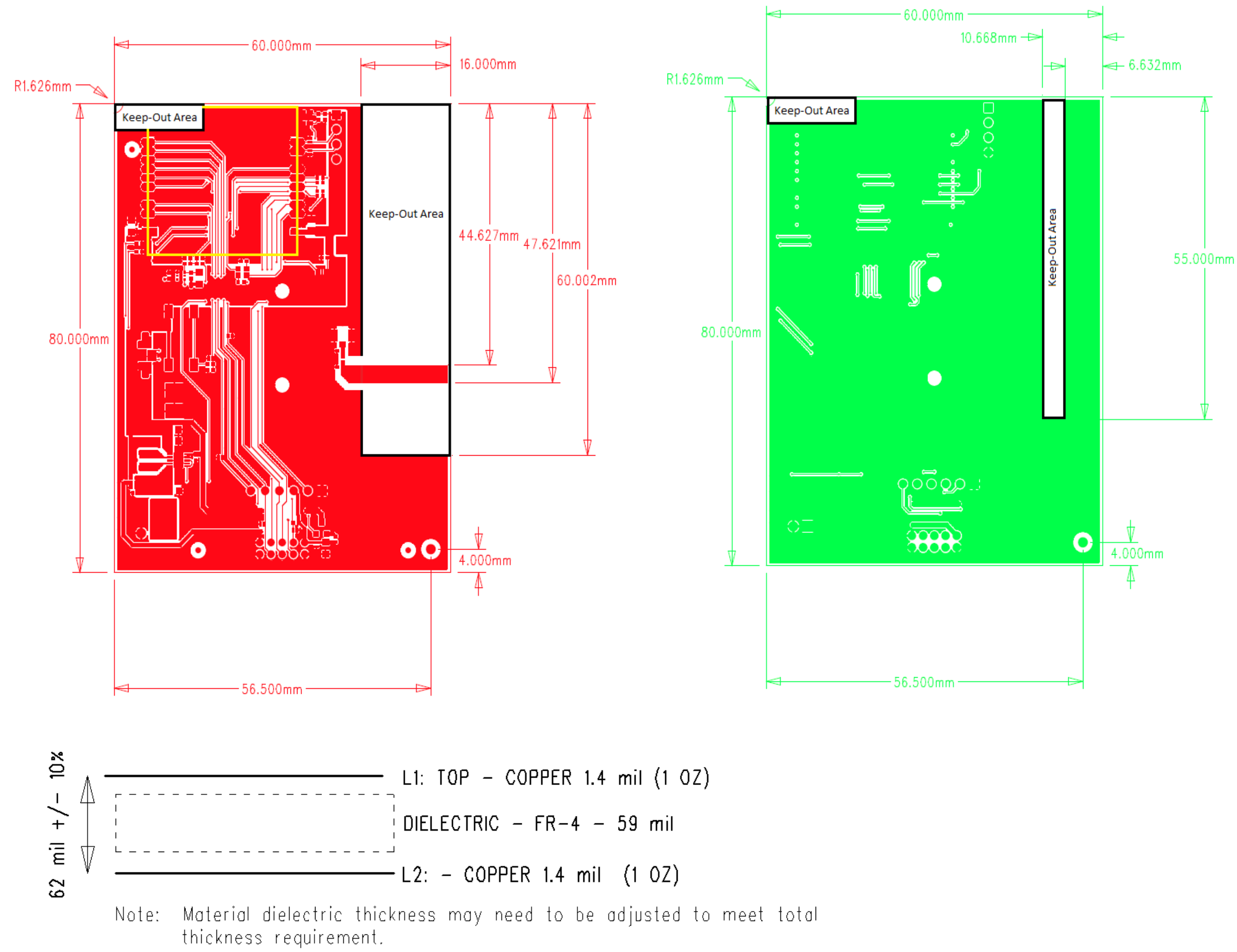


Figure 11: PCB Notch Antenna Reference Design PCB (Front and Back View)

Notes:

1. No copper all layers in keep-out areas besides where needed for the PCB Notch Antenna Composition.
2. **Antenna Feed-Line width: 2.994 mm.**
3. The host PCB thickness, copper weight, and stack-up must adhere to the details shown in *Figure 11*.

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Europe: +44-1628-858-940
Hong Kong: +852 2923 0610

5 EMC Compliance

5.1 FCC and Industry Canada (IC) – Labeling Requirements

The RM1xx module has been tested and approved as a Modular Radio in accordance with the appropriate FCC and IC standards. The supporting test data may be found in the modular test report.

> Since this module and its associated set of approved antennas have been certified as a Modular Radio, this allows the end user to integrate this module into an end-product without the requirement of re-certifying the radio module. The module-integrator is responsible for the unintentional conducted and radiated emissions and must ***verify*** that the integrated product is compliant with the rules associated with unintentional radiators. The module integrator is also required to maintain an engineering record of the verification testing and declare on the product through proper labeling and marking that the device is compliant with these particular rules:

The installed module's FCC ID and IC numbers need to be clearly marked on the product with the following verbiage "Contains FCC ID: SQG-RM191" and "Contains IC: 3147A-RM191".

5.2 Module Integration Considerations - Antenna Systems

The module must be used with one of the approved antennas:

- Laird 868 MHz PCB Notch Antenna design and 080-0041 U.FL to U.FL connector cable
- Laird 915 MHz PCB Notch Antenna design and 080-0041 U.FL to U.FL connector cable

The antenna should be placed such that it is minimally disturbed by the product's packaging material. The incorporation of the largest practical free-space clearance around the antenna is important for maximizing overall performance. Further, the antenna must be placed such that at least a 20-cm separation distance is maintained from the antenna to all other radio transmitters.

5.3 Module Integration Considerations - Circuit Implementation

It is recommended that all connection PCB (printed circuit board) traces to the power supply and digital control terminal be as short as possible. Though not necessarily required in all cases, it is a best practice to provide an optional shunt capacitor placement at the module pin on all active and routed power supply and digital control lines. Further, a series damping resistor placement should be incorporated between the module pin/shunt capacitor node and the source/sink of the digital control signals. This provides for effective bypassing and decoupling of digital lines from the radio module, in the event that the application circuit has longer power supply and digital routing.

5.4 Module Integration Considerations – Top Assembly

In addition to the recommendations given for the antenna systems and the module placement onto a product PCB, it is recommended that all wiring and interconnect systems within the product not be routed anywhere close to the module and its associated circuitry on the PCB, doing so could change the emission characteristics of the module.

5.5 FCC and IC – Testing Requirements for End-Product

Once the module is integrated and the end-product is realized, the end-product must be tested and follow the verification process for Unintentional Conducted and Radiated Emissions in accordance to the FCC and IC guidelines. The module needs to be powered and placed in the receive mode for this test. The receiver must be tuned to its lowest frequency channel, mid-frequency channel, and highest frequency channel. The supporting test data does not need to be submitted to the FCC or IC.

The implementation of the module in a specific end-product should also be reviewed to ensure compliance with the FCC and IC requirements for SAR and MPE.

6 Revision History

Version	Date	Notes	Contributor(s)	Approver
1.0	13 March 2018	Initial Release	Robert Gosewehr	Jonathan Kaye