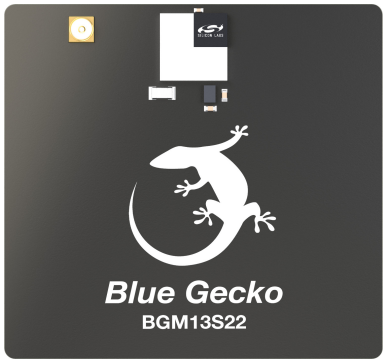
BGM13S22 Module Radio Board BRD4305C Reference Manual

The BRD4305C Blue Gecko Radio Board contains a Blue Gecko BGM13S22 module which integrates Silicon Labs' EFR32BG13 Blue Gecko SoC into a small form factor System-in-Package (SiP) module. The fully certified module contains all components (a high-performance transceiver, an energy efficient 32-bit MCU, HF crystal, RF passives, and antenna) required for a system-level implementation of Bluetooth® Low Energy and proprietary wireless networks operating in the 2.4 GHz band with 8 dBm output power.

The BRD4305C Blue Gecko Radio Board plugs into the Wireless Starter Kit Mainboard, which is included with the Blue Gecko Starter Kit and gives access to display, buttons, and additional features from expansion boards. With the supporting Simplicity Studio suite of tools, developers can take advantage of graphical wireless application development, BGScript for Python-like scripting, and visual energy profiling and optimization.

This document contains a brief introduction and description of the BRD4305C Radio Board features, focusing on the RF performance.



RADIO BOARD FEATURES

- Wireless Module: BGM13S22F512GA
  - CPU core: ARM Cortex®-M4 with FPU
  - Flash memory: 512 kB
  - RAM: 64 kB
  - Operation frequency: 2.4 GHz
  - Transmit power: 8 dBm
  - Integrated chip antenna, RF matching network, HF crystal, and decoupling
- Option for UFL connector
- Crystal for LFXO: 32.768 kHz
- 8 Mbit low-power serial flash for over-the-air updates

Table of Contents

1. Introduction

The BRD4305C Radio Boards provide a development platform (together with the Wireless Starter Kit Mainboard) for the Silicon Labs Blue Gecko BGM13S22 modules.

By carrying the BGM13S22 module, the BRD4305C Radio Board is designed to operate in the 2400-2483.5 MHz with the maximum of 8 dBm output power.

To develop and/or evaluate the BGM13S22 module, the BRD4305C Radio Board can be connected to the Wireless Starter Kit Mainboard to get access to display, buttons, and additional features from expansion boards (EXP boards).

2. Radio Board Connector

2.1 Introduction

The board-to-board connector scheme allows access to all BGM13S22 GPIO pins as well as the RESETn signal. For more information on the functions of the available pins, see the BGM13S22 data sheet.

2.2 Radio Board Connector Pin Associations

The figure below shows the mapping between the connector and the BGM13S22 pins and their function on the Wireless Starter Kit Mainboard.

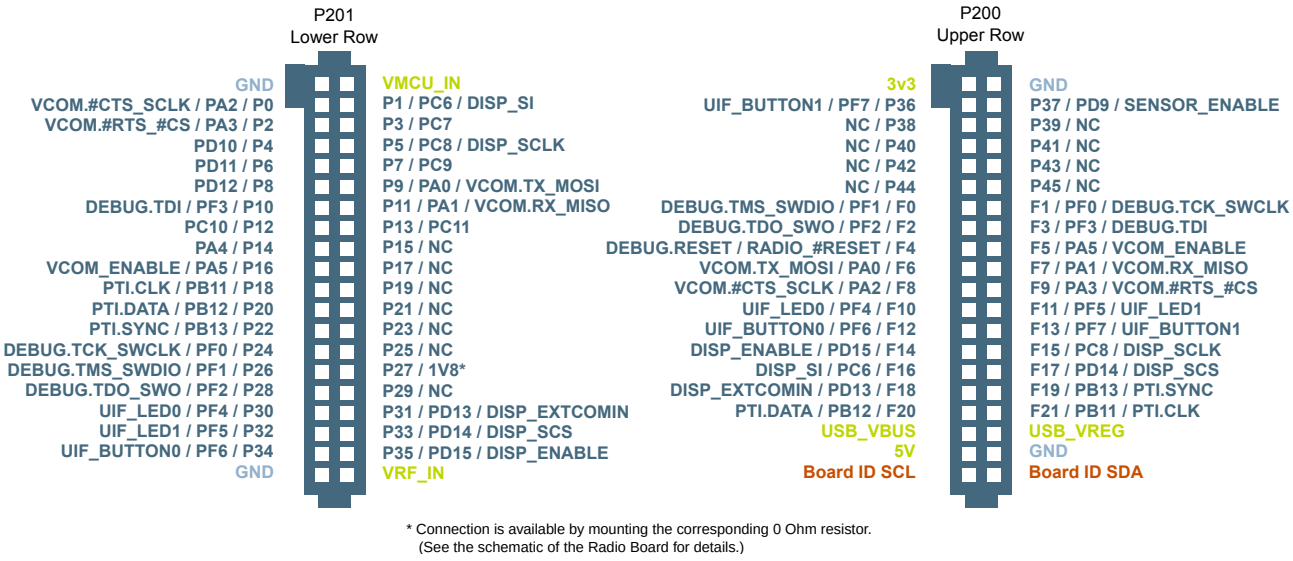


Figure 2.1. BRD4305C Radio Board Connector Pin Mapping

3. Radio Board Block Summary

3.1 Introduction

This section gives a short introduction to the blocks of the BRD4305C Radio Board.

3.2 Radio Board Block Diagram

The block diagram of the BRD4305C Radio Board is shown in the figure below.

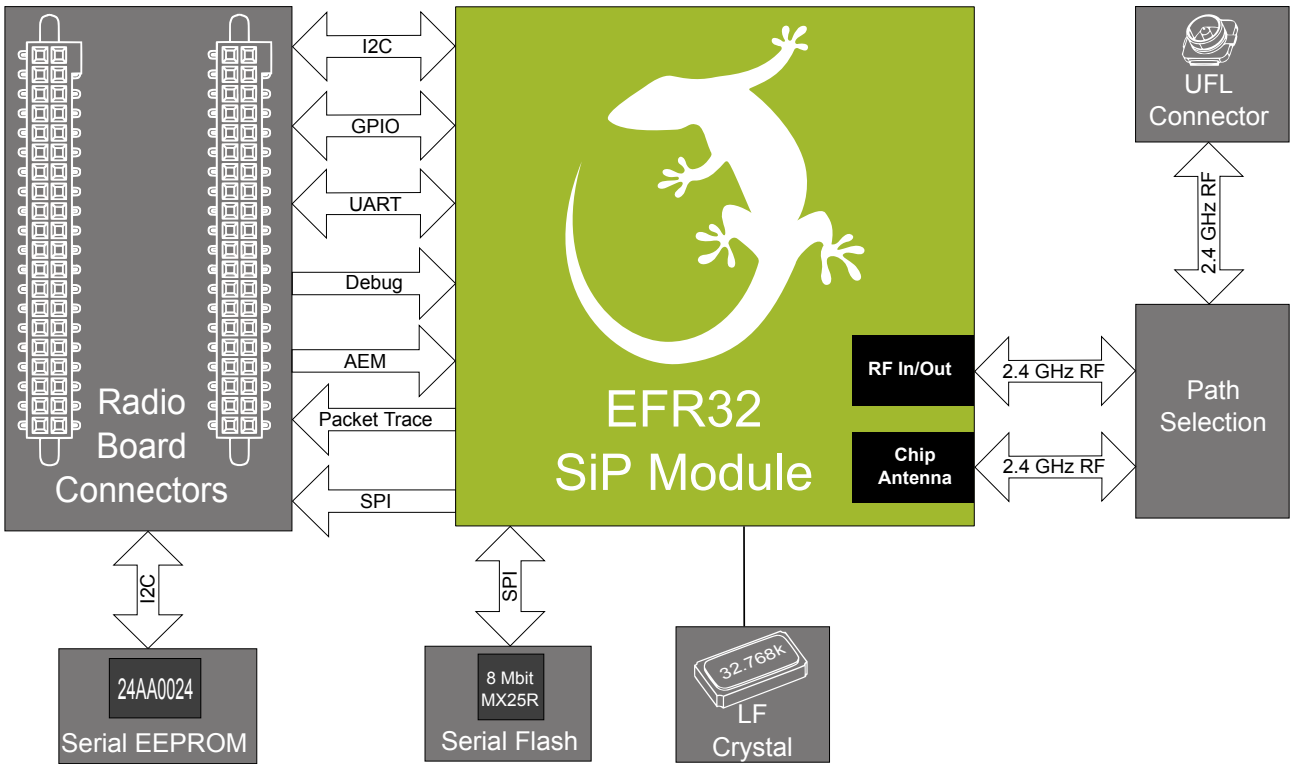


Figure 3.1. BRD4305C Block Diagram

3.3 Radio Board Block Description

3.3.1 Wireless SiP

The BRD4305C Blue Gecko Radio Board incorporates an BGM13S22F512GA Blue Gecko BGM13S22 module featuring 32-bit Cortex®-M4 with FPU core, 512 kB of flash memory, 64 kB of RAM and a 2.4 GHz band transceiver with output power up to 8 dBm. For additional information on the BGM13S22F512GA, refer to the BGM13S data sheet.

3.3.2 LF Crystal Oscillator (LFXO)

The BRD4305C Radio Board has a 32.768 kHz crystal mounted. For details regarding the crystal configuration, refer to Application Note "AN0016.1: Oscillator Design Considerations".

3.3.3 UFL Connector

To be able to perform conducted measurements, Silicon Labs added a UFL connector to the Radio Board. The connector allows an external 50 Ohm cable or antenna to be connected during design verification or testing.

Note: By default, the output of the matching network is connected to the printed inverted-F antenna by a series component. It can be connected to the UFL connector as well through a series 0 Ohm resistor, which is not mounted by default. For conducted measurements through the UFL connector, the series component to the antenna should be removed and the 0 Ohm resistor should be mounted (see section for further details).

3.3.4 Radio Board Connectors

Two dual-row, 0.05” pitch polarized connectors make up the BRD4305C Radio Board interface to the Wireless Starter Kit Mainboard.

For more information on the pin mapping between the BGM13S22F512GA and the Radio Board Connector, refer to section 2.2 Radio Board Connector Pin Associations.

3.3.5 Serial Flash

The BRD4305C Radio Board is equipped with an 8 Mbit Macronix MX25R SPI flash that is connected directly to the BGM13S22 to support over-the-air (OTA) updates. For additional information on the pin mapping see the BRD4305C schematic.

3.3.6 Serial EEPROM

The BRD4305C Radio Board is equipped with a serial I^2C EEPROM for board identification and to store additional board related information.

4. Mechanical Details

The BRD4305C Radio Board is illustrated in the figures below.

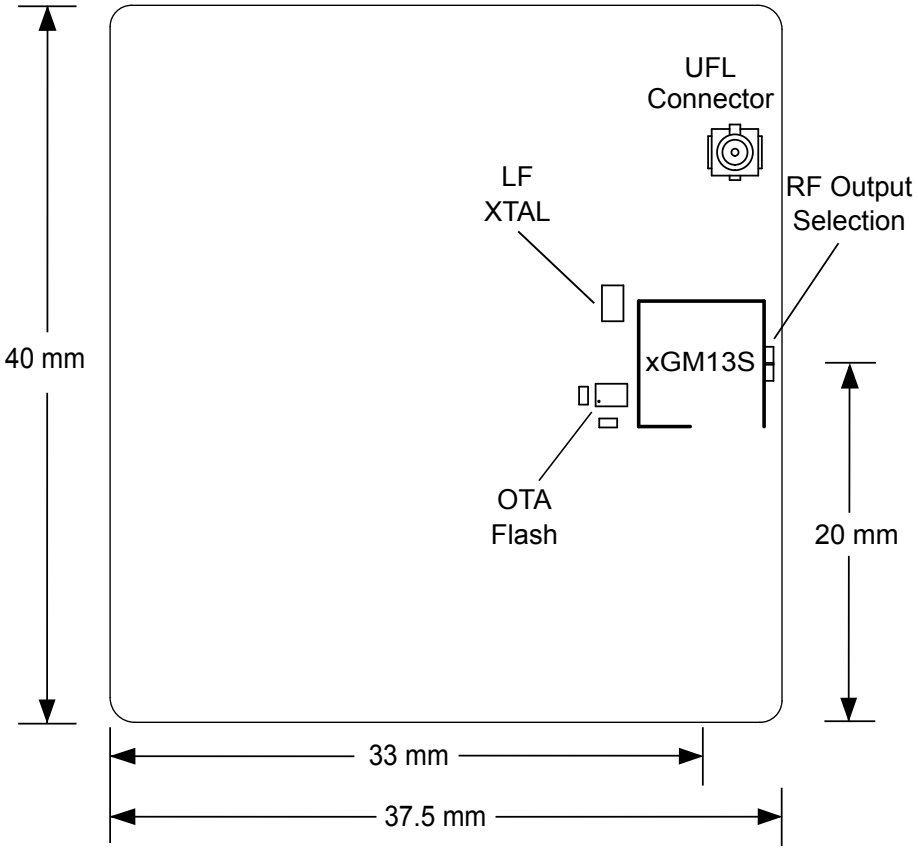


Figure 4.1. BRD4305C Top View

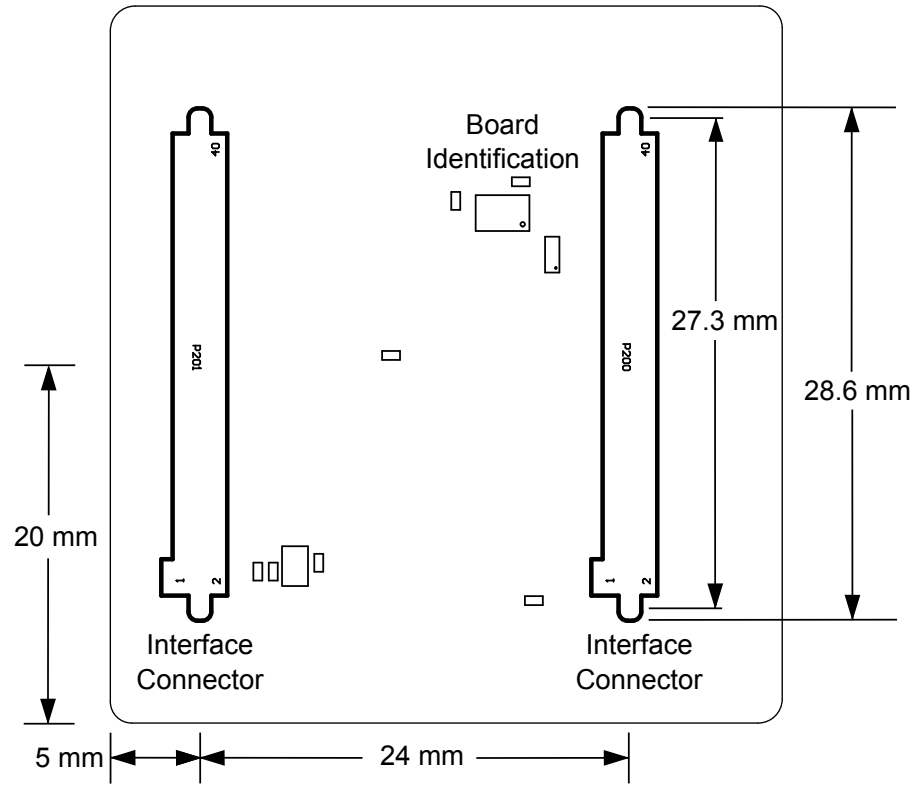


Figure 4.2. BRD4305C Bottom View

5. EMC Compliance

5.1 Introduction

Compliance of the fundamental and harmonic levels of the BRD4305C Radio Board is tested against the following standards:

- 2.4 GHz:
  - ETSI EN 300-328
  - FCC 15.247

5.2 EMC Regulations for 2.4 GHz

5.2.1 ETSI EN 300-328 Emission Limits for the 2400-2483.5 MHz Band

Based on ETSI EN 300-328, the allowed maximum fundamental power for the 2400-2483.5 MHz band is 20 dBm EIRP. For the unwanted emissions in the 1 GHz to 12.75 GHz domain, the specific limit is -30 dBm EIRP.

5.2.2 FCC15.247 Emission Limits for the 2400-2483.5 MHz Band

FCC 15.247 allows conducted output power up to 1 Watt (30 dBm) in the 2400-2483.5 MHz band. For spurious emissions the limit is -20 dBc based on either conducted or radiated measurement, if the emission is not in a restricted band. The restricted bands are specified in FCC 15.205. In these bands the spurious emission levels must meet the levels set out in FCC 15.209. In the range from 960 MHz to the frequency of the 5th harmonic, it is defined as 0.5 mV/m at 3 m distance which equals to -41.2 dBm in EIRP.

Additionally, for spurious frequencies above 1 GHz, FCC 15.35 allows duty-cycle relaxation to the regulatory limits. For the EmberZNet PRO the relaxation is 3.6 dB. Therefore, the -41.2 dBm limit can be modified to -37.6 dBm.

If operating in the 2400-2483.5 MHz band, the 2nd, 3rd, and 5th harmonics can fall into restricted bands. As a result, for those harmonics the -37.6 dBm limit should be applied. For the 4th harmonic the -20 dBc limit should be applied.

5.2.3 Applied Emission Limits for the 2.4 GHz Band

The above ETSI limits are applied both for conducted and radiated measurements.

The FCC restricted band limits are radiated limits only. In addition, Silicon Labs applies the same restrictions to the conducted spectrum. By doing so, compliance with the radiated limits can be estimated based on the conducted measurement, by assuming the use of an antenna with 0 dB gain at the fundamental and the harmonic frequencies.

The overall applied limits are shown in the table below.

Table 5.1. Applied Limits for Spurious Emissions for the 2.4 GHz Band

Harmonic	Frequency	Limit
2nd	4800~4967 MHz	-37.6 dBm
3rd	7200~7450.5 MHz	-37.6 dBm
4th	9600~9934 MHz	-30 dBm
5th	12000~12417.5 MHz	-37.6 dBm

6. RF Performance

6.1 Conducted Power Measurements

During measurements, the BRD4305C Radio Board was attached to a Wireless Starter Kit Mainboard which was supplied by USB. The voltage supply for the Radio Board was 3.3 V.

6.1.1 Conducted Measurements in the 2.4 GHz Band

The BRD4305C Radio Board was connected directly to a Spectrum Analyzer through its UFL connector (the was removed and a 0 Ohm resistor was soldered to the position). The supply for the module (VDD) was 3.3 V provided by the mainboard; for details, see the schematic of the BRD4305C. The transceiver was operated in continuous carrier transmission mode. The output power of the radio was set to 8 dBm.

The typical output spectrum is shown in the following figure.

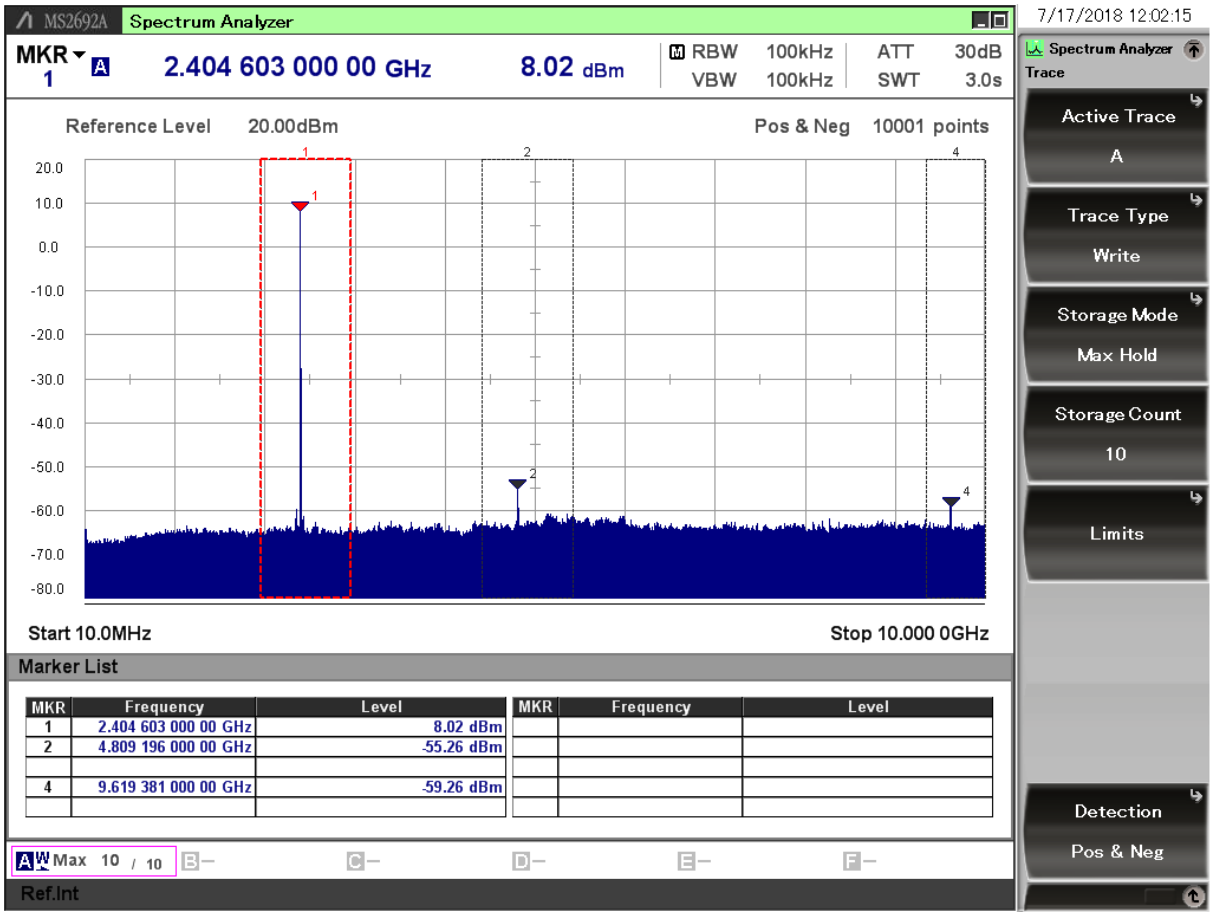


Figure 6.1. Typical Output Spectrum of the BRD4305C

As shown in the figure, the fundamental is 8 dBm and all of the unwanted emissions are under the -37.6 dBm applied limit.

Note: The conducted measurement is performed by connecting the on-board UFL connector to a Spectrum Analyzer through an SMA Conversion Adapter (P/N: HRMJ-U.FLP(40)). This connection itself introduces approximately 0.3 dB insertion loss.

6.2 Radiated Power Measurements

During measurements, the BRD4305C Radio Board was attached to a Wireless Starter Kit Mainboard which was supplied by USB. The voltage supply for the Radio Board was 3.3 V. The radiated power was measured in an antenna chamber by rotating the board 360 degrees with horizontal and vertical reference antenna polarizations in the XY, XZ, and YZ cuts. The measurement planes are illustrated in the figure below.

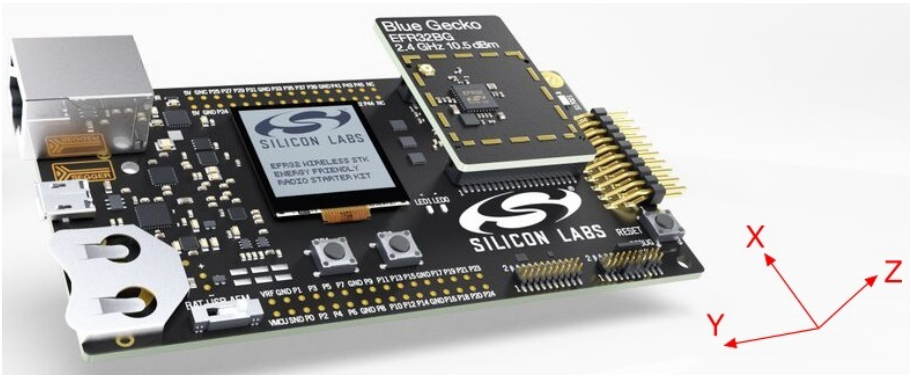


Figure 6.2. Illustration of Reference Planes with a Radio Board Plugged into the Wireless Starter Kit Mainboard

Note: The radiated measurement results presented in this document were recorded in an unlicensed antenna chamber. Also, the radiated power levels may change depending on the actual application (PCB size, used antenna, and so on). Therefore, the absolute levels and margins of the final application are recommended to be verified in a licensed EMC testhouse.

6.2.1 Radiated Measurements in the 2.4 GHz Band

The supply for the module (VDD) was 3.3 V provided by the mainboard; for details, see the BRD4305C schematic. The transceiver was operated in continuous carrier transmission mode. The output power of the radio was set to 8 dBm based on the conducted measurement.

The fundamental was set to the frequency where the maximum antenna gain was measured. The results are shown in the table below.

Note: The frequency in which the antenna gain has its maximum value can vary between modules due to the technological spreading of the passive RF components and the antenna.

Table 6.1. Maximums of the Measured Radiated Powers in EIRP [dBm]

Frequency	EIRP [dBm]	Orientation	Margin [dB]	Limit in EIRP [dBm]
Fund (2425 MHz)	7.6	XY/H	22.4	30
2nd	-52.3	XZ/H	14.7	-37.6
3rd	<-50*	-/-	>10	-37.6
4th	<-50*	-/-	>10	-30
5th	<-50*	-/-	>10	-37.6
* Signal level is below the Spectrum Analyzer noise floor.				

As shown in the table, the level of the fundamental is 7.6 dBm. The strongest harmonic is the double-frequency one and it is compliant with the -37.6 dBm applied limit with almost 15 dB margin.

7. EMC Compliance Recommendations

7.1 Recommendations for 2.4 GHz ETSI EN 300-328 Compliance

As shown in the previous section, the power of the fundamental frequency of the BRD4305C Blue Gecko Radio Board with 8 dBm output is compliant with the 20 dBm limit of the ETSI EN 300-328 regulation in both the conducted and radiated measurements. The harmonic emissions are under the -30 dBm limit with large margin.

7.2 Recommendations for 2.4 GHz FCC 15.247 Compliance

As shown in the previous section, the power of the fundamental frequency of the BRD4305C Blue Gecko Radio Board with 8 dBm output is compliant with the 30 dBm limit of the FCC 15.247 regulation. The harmonic emissions are under the -37.6 dBm applied limit.

8. Board Revision History

Table 8.1. BRD4305C Radio Board Revisions

Radio Board Revision	Description
A02	Updated module PCB footprint and antenna clearance dimensions.
A01	Updated module revision and footprint. Pin 1V8 to WSTK pad conn. option.
A00	Initial revision.

Note: The silkscreen marking on the board (e.g. PCBxxxx A00) denotes the revision of the PCB. The revision of the actual Radio Board is laser printed in the "Board Info" field on the PCB. Also, it can be read from the on-board EEPROM.

9. Errata

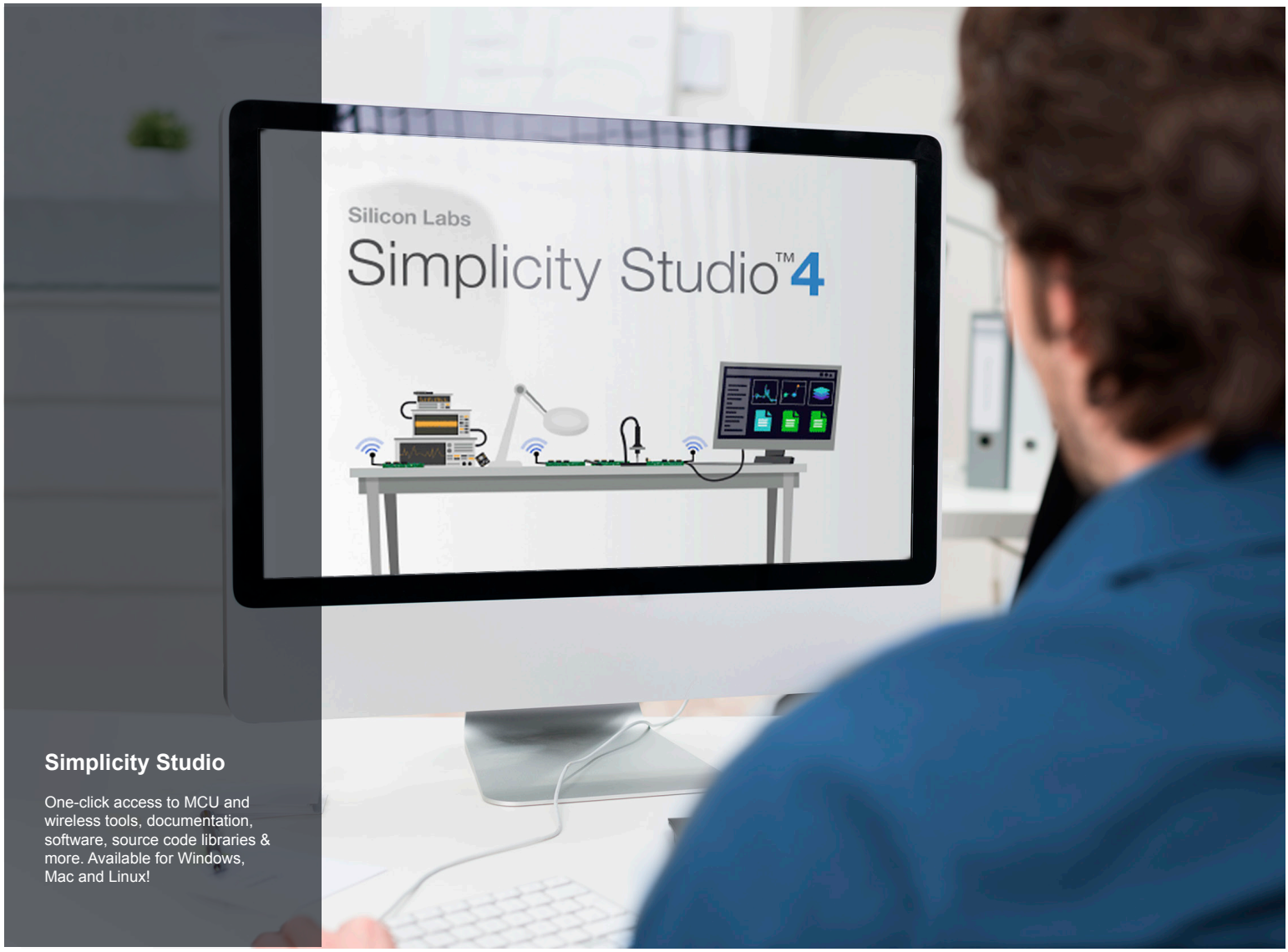
There are no known errata at present.

10. Document Revision History

Revision 1.00

July, 2018

- Initial document revision.



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