Garmin International, Inc.
1200 East 151st Street
Olathe, Kansas 66062
P: 913-397-8200 F: 913-397-8282

30-Jan-26

**Manufacturer:** Garmin International, Inc.
**Address:** 1200 E. 151st St.
Olathe, KS 66062-3426
U.S.A.
**Chile Representative:** Matías Rodríguez Correa
Rosario Norte 660 piso 24, Las Condes Santiago
Province CP 7550083, Chile
**Contact Email:** matias.rodriguez@garmin.com

**Subject:** SUBTEL, Chile (Resolution 737) Certification Compliance 2026

**Commercial Name:** Edge 840

| | **Información (Information)** |
|---|---|
| **Tipo de equipo (Equipment type)** | Portable Digital Transceiver |
| **Marca (Brand)** | Garmin GARMIN |
| **Modelo (Model)** | A04394 |
| **Tecnología o modulación (Technology or modulation)** | GFSK for ANT/ GFSK for BLE / DSSS for 802.11b / OFDM for 802.11g/n |
| **Frecuencias (Frequencies)** | 2402-2480 MHz / 2402-2480 MHz / 2412-2462 MHz |
| **Ganancia de antena (dBi) (Antenna gain (dBi)** | ANT 2.2 dBi / BLE 2.2 dBi / 802.11b/g/n 2.2 dBi |
| **P.i.r.e. (E.I R P.)** | 5.18 dBm, 3.30 mW / 5.18 dBm, 3.30 mW / 19.53 dBm, 89.75 mW |
| **Módulos (Modules)** | ANT, BLE, WiFi |

Declaration of Conformity Statement: the equipment previously identified complies with the provisions established in the Technical Standard for Small Range Equipment, approved by Exempt Resolution No.1,985 of 2017, of the Undersecretary of Telecommunications.

Declaración de conformidad: El equipo anteriormente identificado cumple con las disposiciones establecidas en la Norma Técnica para Equipos de Corto Alcance, aprobada mediante la Resolución Exenta N° 1.985 de 2017, de la Subsecretaría de Telecomunicaciones.

NVLAP Lab Code 200087-0


# ROGERS LABS, INC.

4405 West 259th Terrace
Louisburg, KS 66053
Phone / Fax (913) 837-3214


## 47CFR, PART 15C - Intentional Radiators
## 47CFR Paragraph 15.247 and
## Industry Canada RSS-247 Issue 2 and RSS-GEN Issue 5

# Application For Grant of Certification

# Model: A04394

2402-2480 MHz (DTS)
Broadband Digital Transmission System

## FCC ID: IPH-04394
## IC: 1792A-04394

# Garmin International, Inc.

1200 East 151st Street
Olathe, KS 66062

FCC Designation: US5305
ISED Registration: 3041A

Test Report Number: 220810

Test Date: August 10, 2022

Authorized Signatory: Scot D Rogers
Scot D. Rogers

# Table of Contents

## Revisions

Revision r1 Isued December 14, 2022 – updated diagram 3

Revision 1 Isued October 9, 2022

# Executive Summary

The following information is submitted for consideration in obtaining Grant of Certification for License Exempt Digital Transmission System Intentional Radiator operating under Code of Federal Regulations Title 47 (47CFR) Part 15C paragraph 15.247, Industry Canada RSS-247 Issue 2, and RSS-GEN Issue 5, operation in the 2400 – 2483.5 MHz band.

Name of Applicant: Garmin International, Inc.
1200 East 151st Street
Olathe, KS 66062

M/N: A04394 HVIN: A04394
FCC ID: IPH-04394 IC: 1792A-04394
Frequency Range: operation in the 2402-2480 MHz band

Operational communication modes two through seven

| Mode | Power (Watts) | 99% OBW (kHz) | 6-dB OBW (kHz) |
|---|---|---|---|
| Mode 1, ANT | 0.002 | 1,959.0 | 967.5 |
| Mode 2, BLE | 0.002 | 1,362.0 | 773.0 |
| Mode 3, 802.11b (CCK, DSSS) | 0.050 | 14,805.0 | 8,805.1 |
| Mode 4, 802.11g (OFDM) | 0.054 | 17,400.0 | 16,346.2 |
| Mode 5, 802.11n (MCS) | 0.047 | 18,200.0 | 17,197.7 |

This report addresses EUT Operations as Digital Transmission System using transmitter modulations in modes 1 through 5. Note, the production device utilizes integral antenna systems with the 2.4 GHz PIFA providing 2.2 dBi gain.

## Opinion / Interpretation of Results

| Tests Performed | Margin (dB) | Results |
|---|---|---|
| Emissions 15.205, RSS-GEN, RSS-247 | -1.2 | Complies |
| Emissions as per 47CFR 15.207, RSS-GEN 8.8 | -8.4 | Complies |
| Radiated Emissions 47 CFR 15.209, RSS-GEN 8.9 | -3.4 | Complies |
| Harmonic Emissions per 47CFR 15.247, RSS-247 | -0.8 | Complies |
| Power Spectral Density per 47CFR 15.247, RSS-247 | -14.0 | Complies |

Tests performed include
47CFR
15.247 (a) (2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.
(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:
(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one-Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.
(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).
(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in

accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

RSS-247 Issue 2

**5.2 Digital transmission systems**

DTS's include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400-2483.5 MHz

a)The minimum 6 dB bandwidth shall be 500 kHz.

b)The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of section 5.4(d),(i.e., the power spectral density shall be determined using the same method as is used to determine the conducted output power).

**5.4 Transmitter output power and equivalent isotropically radiated power (e.i.r.p.) requirements**

d) For DTS's employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

**5.5 Unwanted emissions**

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

## Equipment Tested

Model: A04394

Garmin International, Inc.
1200 East 151st Street
Olathe, KS 66062

| Equipment | Model / PN | Serial Number |
|---|---|---|
| EUT | A04394 | 3422741281 |
| EUT2 | A04394 | 3422741353 |
| USB-A cable (0.5-meter) | 320-01483-03 | N/A |
| USB-C cable (0.5-meter) | 320-01578-90 | N/A |
| AC Adapter (USB-A) | 362-00112-00 | N/A |
| AC Adapter (USB-C) | AQ27A-59CFA | N/A |
| DC Power Supply | BK 1745 | 209C13 |
| Laptop Computer | Latitude 7480 | EFSPSN2 |
| USB Printer | Dell 0N5819 | 5D1SL61 |

Test results in this report relate only to the items tested. Worst-case configuration data recorded in this report.

Software: 4.07, Antenna: PIFA (2.2 dBi)

### *Equipment Operational Modes*

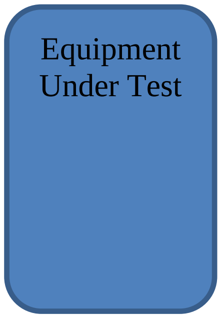
| Mode | Transmitter Operation |
|---|---|
| 1 | ANT |
| 2 | BLE |
| 3 | 802.11b |
| 4 | 802.11g |
| 5 | 802.11n |

## *Equipment Function*

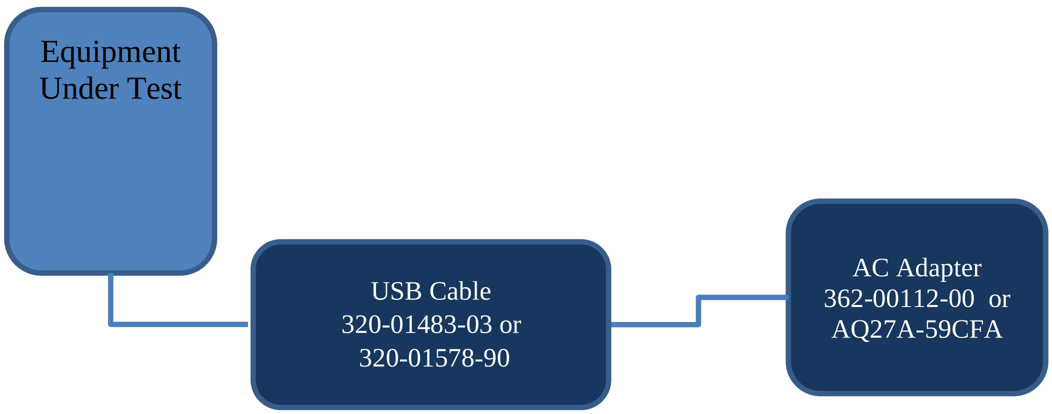
The EUT is a GPS receiver, display, and user interface unit providing GPS reception and graphical display of location, navigation, and other information for the user. The design offers use as a hand-held, portable, or transportation mounted configuration for use in navigational applications. The design incorporates transmitter circuitry operating in the 2402-2480 MHz frequency band. The EUT operates from direct current power provided from internal rechargeable battery or Complaint USB interface with AC/DC adapter or input. The battery may be charged through the USB interface connected to AC/DC adapter as documented this report. The EUT was arranged as described by the manufacturer emulating typical user configurations for testing purposes. The EUT offers no other interface connections than the configuration options as described by the manufacturer and presented below. For testing purposes, the EUT received power from freshly charged internal battery power, AC/DC power adapter, or laptop computer. During testing, the test system was configured to operate in manufacturer defined modes. As requested by the manufacturer the equipment was tested for emissions compliance using the available configurations with the worse-case data presented. Test results in this report relate only to the products described in this report.

## ***Equipment Configuration***

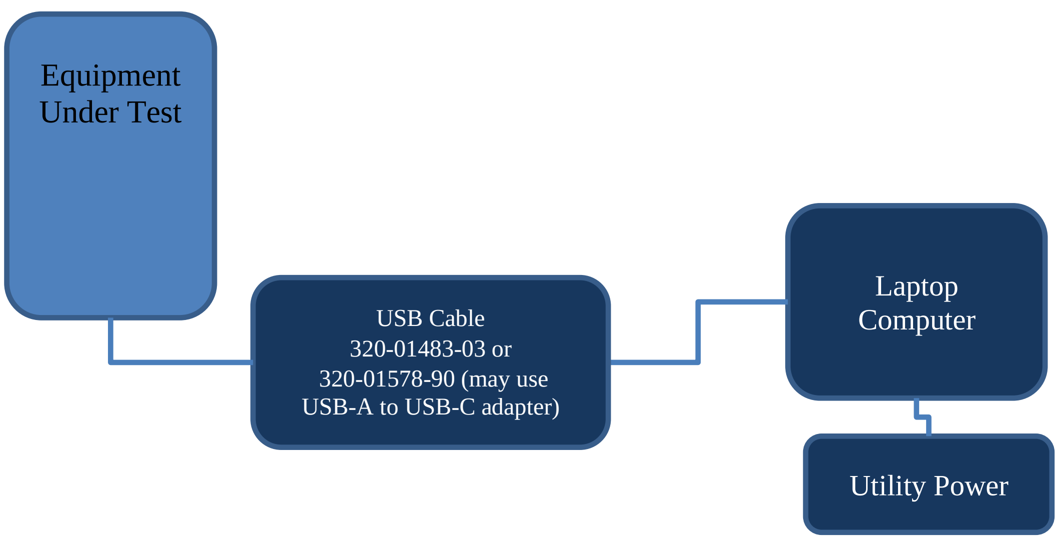
1) EUT operating on internal battery




2) Unit connected to USB Charging cable (320-01483-03 and AC power adapter 362-00112-00, or 320-01578-90 and AC power adapter (AQ27A-59CFA)




3) Unit connected to USB cable (320-01483-03 or 320-01578-90) to Laptop Computer



## Application for Certification

(1) Manufacturer: Garmin International, Inc.
1200 East 151st Street
Olathe, KS 66062

(2) Identification: HVIN: A04394
FCC ID: IPH-04394 IC: 1792A-04394

(3) Instruction Book:
Refer to Exhibit for Instruction Manual.

(4) Description of Circuit Functions:
Refer to Exhibit of Operational Description.

(5) Block Diagram with Frequencies:
Refer to Exhibit of Operational Description.

(6) Report of Measurements:
Report of measurements follows in this Report.

(7) Photographs: Construction, Component Placement, etc.:
Refer to Exhibit for photographs of equipment.

(8) List of Peripheral Equipment Necessary for operation. The equipment operates from internal battery power or external direct current power provided from authorized sources. The EUT provides USB-C interface port for power and communications as presented in this filing.

(9) Transition Provisions of 47CFR 15.37 are not requested.

(10) Not Applicable. The unit is not a scanning receiver.

(11) Not Applicable. The EUT does not operate in the 59 – 64 GHz frequency band.

(12) The equipment is not software defined and this section is not applicable.

(13) Applications for certification of U-NII devices in the 5.15-5.35 GHz and the 5.47-5.85 GHz bands must include a high-level operational description of the security procedures that control the radio frequency operating parameters and ensure that unauthorized modifications cannot be made. This requirement is not applicable to his DTS device.

(14) Contain at least one drawing or photograph showing the test set-up for each of the required types of tests applicable to the device for which certification is requested. These drawings or photographs must show enough detail to confirm other information contained in the test report. Any photographs used must be focused originals without glare or dark spots and must clearly show the test configuration used. This information is provided in this report and Test Setup Exhibits provided with the application filing.

## Applicable Standards & Test Procedures

The following information is submitted in accordance with the eCFR Title 47 Code of Federal Regulations (47CFR), 2 Part 2, Subpart J, Part 15C Paragraph 15.247, Industry Canada RSS-247 Issue 2, and RSS-GEN Issue 5. Test procedures used are the established Methods of Measurement of Radio-Noise Emissions as described in ANSI C63.10-2013. This report documents compliance for the EUT operations as Digital Transmission Systems operation.

## Testing Procedures

### *AC Line Conducted Emission Test Procedure*

Testing for the AC line-conducted emissions were performed as required in 47CFR 15C, RSS-247 Issue 2, RSS-GEN and specified in ANSI C63.10-2013. The test setup, including the EUT, was arranged in the test configurations as presented during testing. The test configuration was placed on a 1 x 1.5-meter bench, 0.8 meters high located in a screen room. The power lines of the system were isolated from the power source using a standard LISN with a 50-µHy choke. EMI was coupled to the spectrum analyzer through a 0.1 µF capacitor internal to the LISN. The LISN was positioned on the floor beneath the wooden bench supporting the EUT. The power lines and cables were draped over the back edge of the table. Refer to diagram one showing typical test arrangement and photographs in exhibits for EUT placement used during testing.

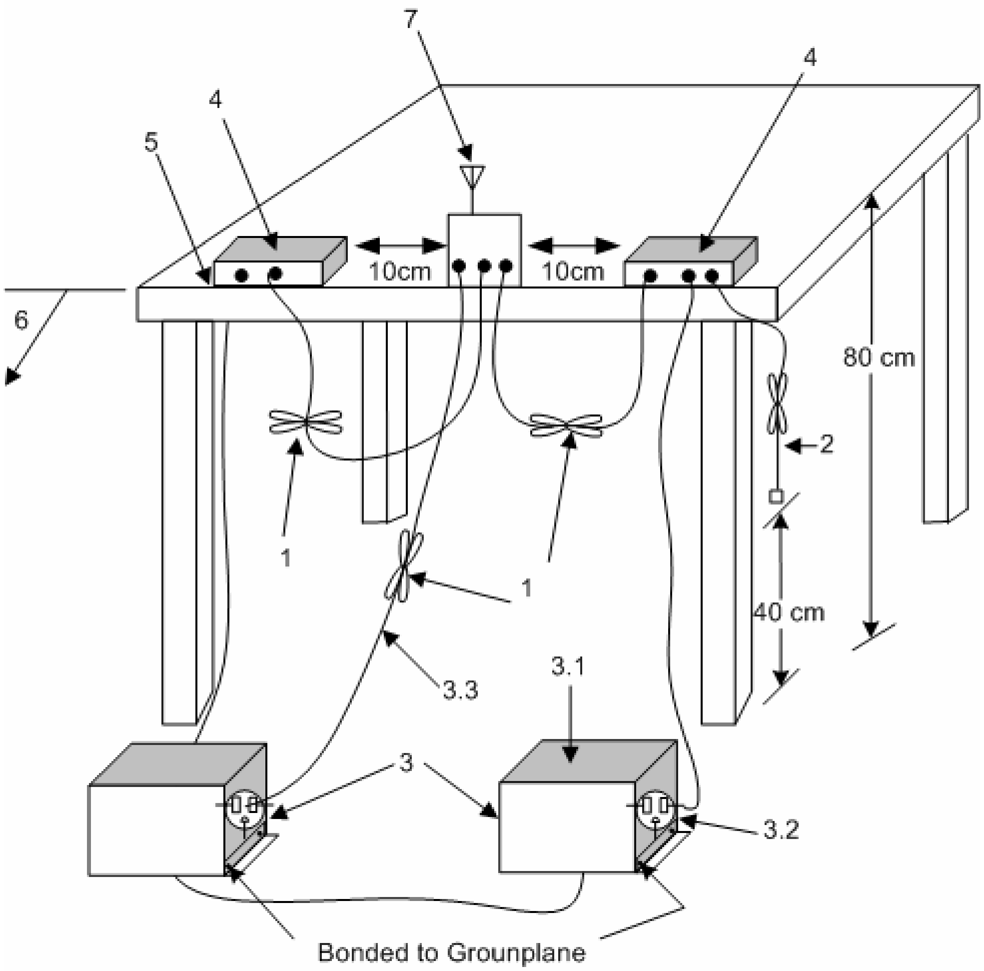
### *Radiated Emission Test Procedure*

Radiated emissions testing was performed as required in 47CFR 15C, RSS-247 Issue 2, RSS-GEN and specified in ANSI C63.10-2013. The EUT was placed on a rotating 0.9 x 1.2-meter platform, elevated as required above the ground plane at a distance of 3 meters from the FSM antenna. EMI energy was maximized by equipment placement permitting orientation in three orthogonal axes, raising, and lowering the FSM antenna, changing the antenna polarization, and by rotating the turntable. Each emission was maximized before data was taken and recorded. The frequency spectrum from 9 kHz to 25,000 MHz was searched for emissions during preliminary investigation. Refer to diagrams two and three showing typical test setup. Refer to photographs in the test setup exhibits for specific EUT placement during testing.

### *Antenna Port Conducted Emission Test Procedure*

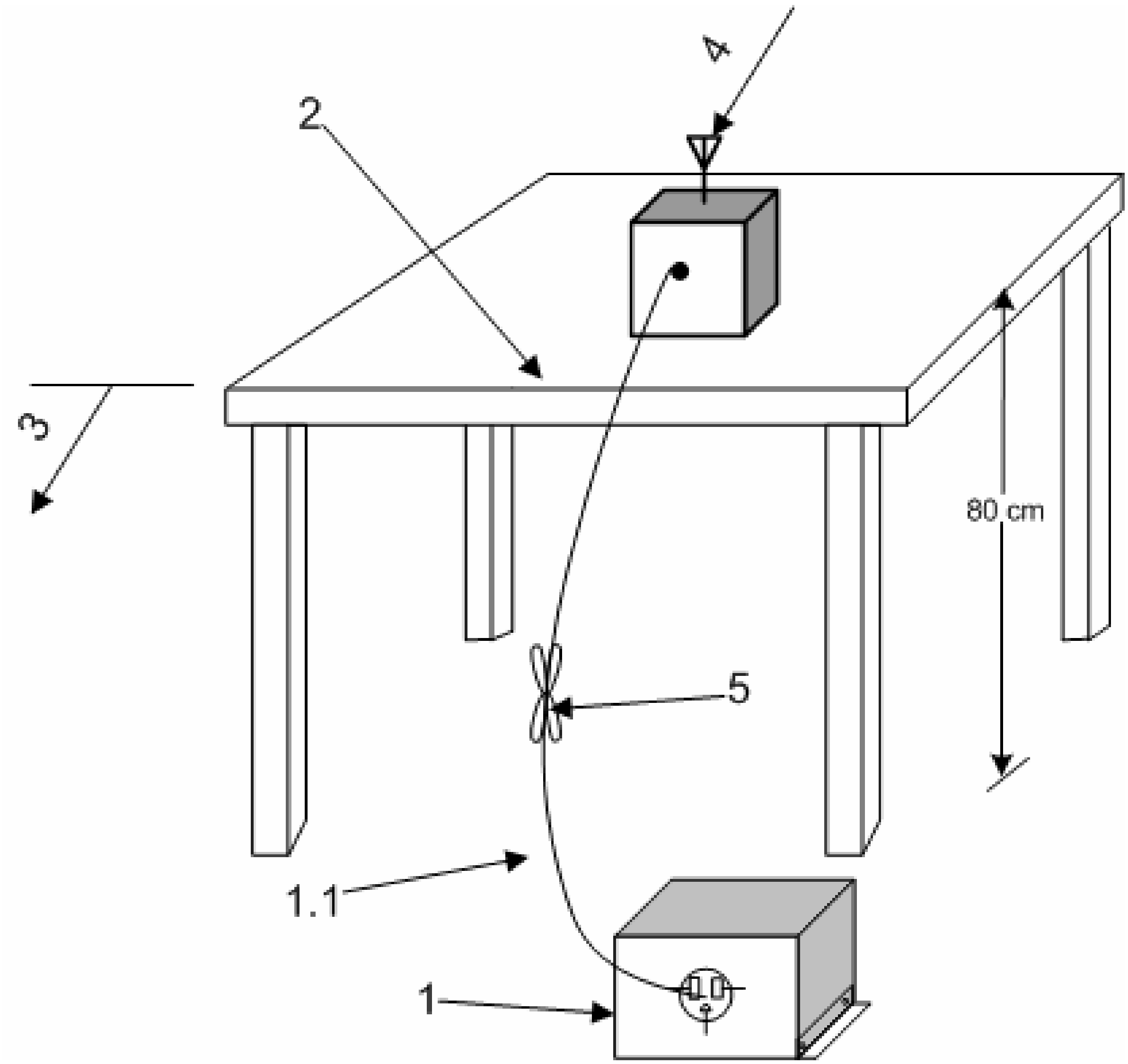
The EUT was assembled as required for operation and placed on a benchtop. This configuration provided the ability to connect test equipment to the provided test antenna port Antenna Port conducted emissions testing was performed as presented in this document and specified in ANSI C63.10-2013. Testing was completed on a laboratory bench in a shielded room. The active antenna port of the device was connected to appropriate attenuation and the spectrum analyzer. Refer to diagram four showing typical test arrangement and photographs in the test setup exhibits for specific EUT placement during testing.

**Diagram 1 Test arrangement for Conducted emissions**




1. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long see (see 6.2.3.1).
2. I/O cables that are not connected to an accessory shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m (see 6.2.2).
3. EUT connected to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω loads. LISN can be placed on top of, or immediately beneath, reference ground plane (see 6.2.2 and 6.2.3).
   3.1 All other equipment powered from additional LISN(s).
   3.2 Multiple-outlet strip can be used for multiple power cords of non-EUT equipment.
   3.3 LISN at least 80 cm from nearest part of EUT chassis.
4. Non-EUT components of EUT system being tested.
5. Rear of EUT, including peripherals, shall all be aligned and flush with rear of tabletop (see 6.2.3.1).
6. Edge of tabletop shall be 40 cm removed from a vertical conducting plane that is bonded to the ground plane (see 6.2.2 for options).
7. Antenna may be integral or detachable. If detachable, the antenna shall be attached for this test.

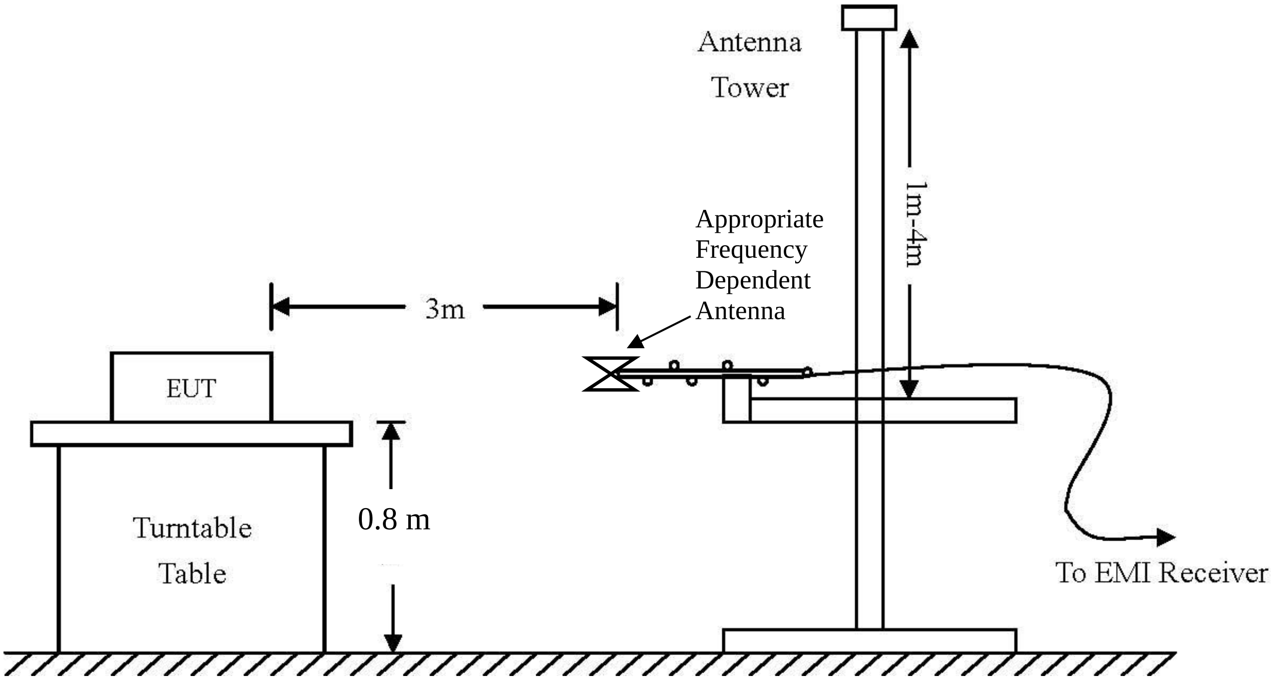
**Diagram 2 Test arrangement for radiated emissions of tabletop equipment**




1—A LISN is optional for radiated measurements between 30 MHz and 1000 MHz but not allowed for measurements below 30 MHz and above 1000 MHz (see 6.3.1). If used, then connect EUT to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω loads. The LISN may be placed on top of, or immediately beneath, the reference ground plane (see 6.2.2 and 6.2.3.2).
1.1—LISN spaced at least 80 cm from the nearest part of the EUT chassis.
2—Antenna can be integral or detachable, depending on the EUT (see 6.3.1).
3—Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long (see 6.3.1).
4—For emission measurements at or below 1 GHz, the table height shall be 80 cm. For emission measurements above 1 GHz, the table height shall be 1.5 m for measurements, except as otherwise specified (see 6.3.1 and 6.6.3.1).

**Diagram 3 Test arrangement for radiated emissions tested on Open Area Test Site (OATS)**

Below 1 GHz




Above 1 GHz

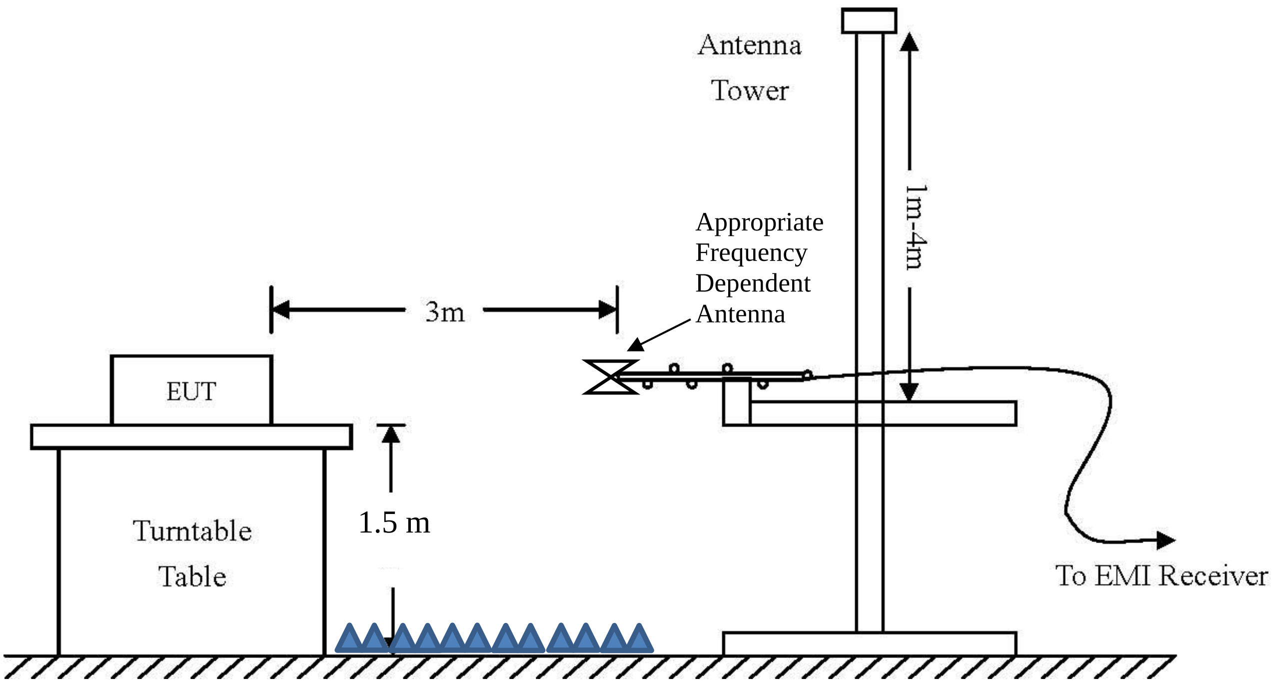
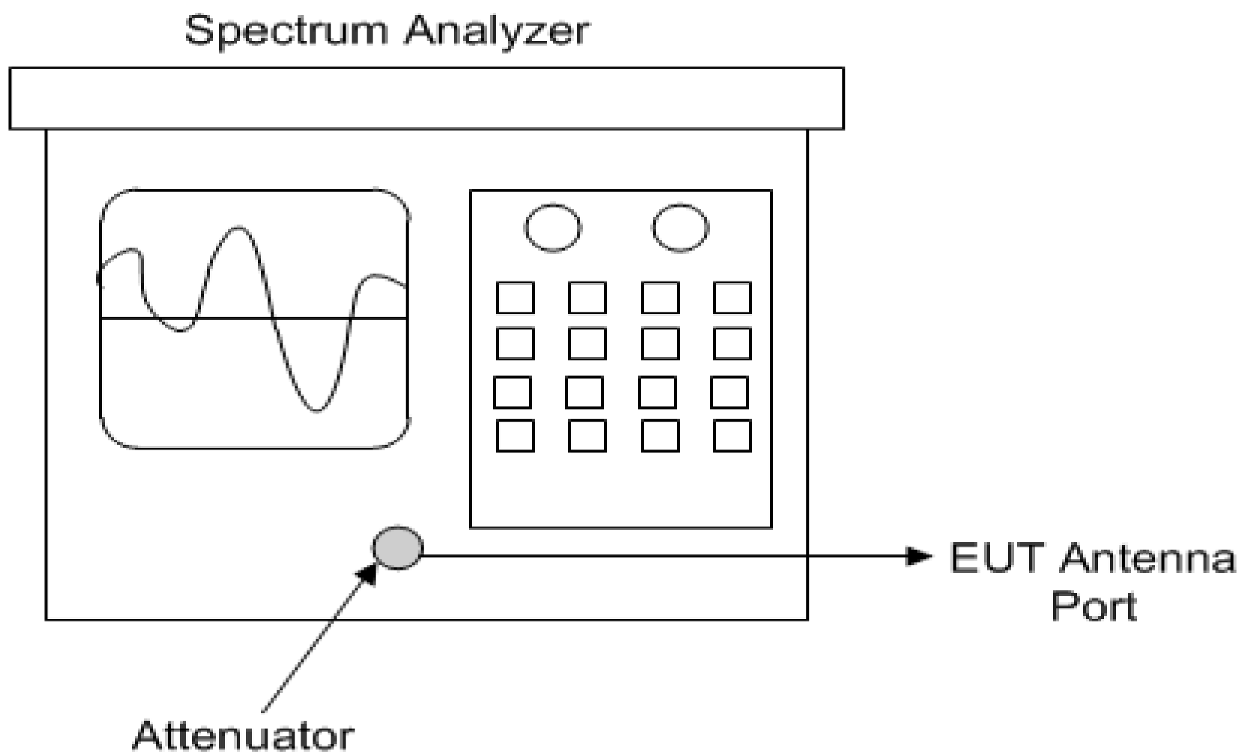


**Diagram 4 Test arrangement for Antenna Port Conducted emissions**




## Test Site Locations

| | |
|---|---|
| Conducted EMI | AC line conducted emissions testing performed in a shielded screen room located at Rogers Labs, Inc., 4405 West 259th Terrace, Louisburg, KS |
| Antenna port | Antenna port conducted emissions testing was performed in a shielded screen room located at Rogers Labs, Inc., 4405 West 259th Terrace, Louisburg, KS |
| Radiated EMI | The radiated emissions tests were performed at the 3 meters, Open Area Test Site (OATS) located at Rogers Labs, Inc., 4405 West 259th Terrace, Louisburg, KS |

Registered Site information: FCC Site: US5305, ISED: 3041A, CAB Identifier: US0096

NVLAP Accreditation Lab code 200087-0

## Units of Measurements

Conducted EMI Data presented in dBμV; dB referenced to one microvolt

Antenna port Conducted Data is in dBm; dB referenced to one milliwatt

Radiated EMI Data presented in dBμV/m; dB referenced to one microvolt per meter

Note: Radiated limit may be expressed for measurement in dBμV/m when the measurement is taken at a distance of 3 or 10 meters. Data taken for this report was taken at distance of 3 meters. Sample calculation demonstrates corrected field strength reading for Open Area Test Site using the measurement reading and correcting for receive antenna factor, cable and test system losses, and amplifier gains.

Sample Calculation:

RFS = Radiated Field Strength, FSM = Field Strength Measured
A.F. = Receive antenna factor, Losses = attenuators/cable losses, Gain = amplification gains
RFS (dBμV/m @ 3m) = FSM (dBμV) + A.F. (dB/m) + Losses (dB) - Gain (dB)

## Environmental Conditions

| | |
|---|---|
| Ambient Temperature | 23.7° C |
| Relative Humidity | 41 % |
| Atmospheric Pressure | 1023.3 mb |

## Statement of Modifications and Deviations

No modifications to the EUT were required for the unit to demonstrate compliance with 47CFR Part 15C, RSS-247 Issue 2, and RSS-GEN Issue 5 emission requirements. There were no deviations to the specifications.

# Intentional Radiators

The following information is submitted in support demonstration of compliance with the requirements of 47CFR, Paragraph 15 Subpart C, paragraph 15.247, Industry Canada RSS-247 Issue 2, and RSS-GEN Issue 5.

## *Antenna Requirements*

The EUT incorporates integral antenna system and offers no provision for connection to alternate antenna system. The antenna connection point complies with the unique antenna connection requirements. There are no deviations or exceptions to the specification.

## *Restricted Bands of Operation*

Spurious emissions falling in the restricted frequency bands of operation were measured at the OATS. The EUT utilizes frequency, determining circuitry, which generates harmonics falling in the restricted bands. Emissions were investigated at the OATS, using appropriate antennas or pyramidal horns, amplification stages, and a spectrum analyzer. Peak and average amplitudes of frequencies above 1000 MHz were compared to the required limits with worst-case data presented below. Test procedures of ANSI C63.10-2013 were used during testing. No other significant emission was observed which fell into the restricted bands of operation. Computed emission values consider the received radiated field strength, receive antenna correction factor, amplifier gain stage, and test system cable losses.

**Table 1 Radiated Emissions in Restricted Frequency Bands Data Mode 1 ANT**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2390.0 | 44.3 | 30.9 | 44.6 | 31.0 | 54.0 | -23.1 | -23.0 |
| 2483.5 | 53.5 | 39.3 | 53.3 | 38.6 | 54.0 | -14.7 | -15.4 |
| 4804.0 | 49.8 | 36.5 | 49.7 | 36.6 | 54.0 | -17.5 | -17.4 |
| 4914.0 | 49.5 | 36.5 | 50.0 | 36.5 | 54.0 | -17.5 | -17.5 |
| 4960.0 | 51.1 | 36.6 | 50.2 | 36.6 | 54.0 | -17.4 | -17.4 |
| 7206.0 | 54.0 | 40.7 | 53.3 | 40.6 | 54.0 | -13.3 | -13.4 |
| 7371.0 | 53.4 | 40.5 | 53.4 | 40.6 | 54.0 | -13.5 | -13.4 |
| 7440.0 | 53.9 | 40.8 | 53.7 | 40.8 | 54.0 | -13.2 | -13.2 |
| 12010.0 | 60.5 | 47.9 | 60.0 | 47.4 | 54.0 | -6.1 | -6.6 |
| 12285.0 | 60.8 | 48.0 | 61.2 | 48.0 | 54.0 | -6.0 | -6.0 |
| 12400.0 | 60.7 | 47.7 | 61.4 | 48.0 | 54.0 | -6.3 | -6.0 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

**Table 2 Radiated Emissions in Restricted Frequency Bands Data Mode 2 BLE**

| Frequency in MHz | Horizontal Peak (dBμV/m) | Horizontal Average (dBμV/m) | Vertical Peak (dBμV/m) | Vertical Average (dBμV/m) | Limit @ 3m (dBμV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2390.0 | 44.4 | 30.8 | 44.9 | 31.0 | 54.0 | -23.2 | -23.0 |
| 2483.5 | 53.6 | 41.5 | 52.2 | 39.9 | 54.0 | -12.5 | -14.1 |
| 4804.0 | 50.2 | 36.6 | 49.9 | 36.6 | 54.0 | -17.4 | -17.4 |
| 4884.0 | 50.0 | 36.7 | 50.1 | 36.5 | 54.0 | -17.3 | -17.5 |
| 4960.0 | 50.1 | 36.8 | 50.1 | 36.6 | 54.0 | -17.2 | -17.4 |
| 7206.0 | 53.8 | 40.7 | 53.6 | 40.6 | 54.0 | -13.3 | -13.4 |
| 7326.0 | 53.5 | 40.8 | 54.3 | 40.7 | 54.0 | -13.2 | -13.3 |
| 7440.0 | 53.9 | 40.6 | 53.8 | 40.7 | 54.0 | -13.4 | -13.3 |
| 12010.0 | 60.1 | 47.4 | 60.2 | 47.5 | 54.0 | -6.6 | -6.5 |
| 12210.0 | 61.2 | 48.1 | 61.5 | 48.1 | 54.0 | -5.9 | -5.9 |
| 12400.0 | 60.4 | 47.3 | 59.8 | 47.3 | 54.0 | -6.7 | -6.7 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

**Table 3 Harmonic Radiated Emissions in Restricted Bands Mode 3 802.11b**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2390.0 | 49.6 | 34.5 | 49.5 | 34.5 | 54.0 | -19.5 | -19.5 |
| 2483.5 | 62.8 | 52.4 | 61.6 | 50.3 | 54.0 | -1.6 | -3.7 |
| 4824.0 | 50.0 | 36.3 | 49.9 | 36.3 | 54.0 | -17.7 | -17.7 |
| 4874.0 | 49.8 | 36.5 | 49.6 | 36.4 | 54.0 | -17.5 | -17.6 |
| 4924.0 | 49.4 | 36.5 | 49.6 | 36.5 | 54.0 | -17.5 | -17.5 |
| 7236.0 | 53.2 | 40.4 | 53.9 | 40.4 | 54.0 | -13.6 | -13.6 |
| 7311.0 | 53.8 | 40.5 | 53.9 | 40.5 | 54.0 | -13.5 | -13.5 |
| 7386.0 | 54.1 | 40.6 | 53.8 | 40.6 | 54.0 | -13.4 | -13.4 |
| 12060.0 | 60.4 | 47.7 | 60.2 | 47.3 | 54.0 | -6.3 | -6.7 |
| 12185.0 | 60.7 | 48.1 | 61.1 | 48.0 | 54.0 | -5.9 | -6.0 |
| 12310.0 | 61.2 | 48.1 | 61.5 | 48.2 | 54.0 | -5.9 | -5.8 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

**Table 4 Harmonic Radiated Emissions in Restricted Bands Mode 4 802.11g**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2390.0 | 56.8 | 40.5 | 56.5 | 39.7 | 54.0 | -13.5 | -14.3 |
| 2483.5 | 64.9 | 51.2 | 62.9 | 47.4 | 54.0 | -2.8 | -6.6 |
| 4824.0 | 49.3 | 36.2 | 49.7 | 36.2 | 54.0 | -17.8 | -17.8 |
| 4874.0 | 49.7 | 36.4 | 49.4 | 36.4 | 54.0 | -17.6 | -17.6 |
| 4924.0 | 50.0 | 36.5 | 49.6 | 36.5 | 54.0 | -17.5 | -17.5 |
| 7236.0 | 53.4 | 40.2 | 52.9 | 40.2 | 54.0 | -13.8 | -13.8 |
| 7311.0 | 53.3 | 40.5 | 53.8 | 40.5 | 54.0 | -13.5 | -13.5 |
| 7386.0 | 53.6 | 41.0 | 53.1 | 40.5 | 54.0 | -13.0 | -13.5 |
| 12060.0 | 60.0 | 47.3 | 61.0 | 47.2 | 54.0 | -6.7 | -6.8 |
| 12185.0 | 61.0 | 48.5 | 60.7 | 47.9 | 54.0 | -5.5 | -6.1 |
| 12310.0 | 60.4 | 48.1 | 60.9 | 48.1 | 54.0 | -5.9 | -5.9 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

**Table 5 Harmonic Radiated Emissions in Restricted Bands Mode 5 802.11n**

| Frequency in MHz | Horizontal Peak (dBμV/m) | Horizontal Average (dBμV/m) | Vertical Peak (dBμV/m) | Vertical Average (dBμV/m) | Limit @ 3m (dBμV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2390.0 | 55.1 | 38.5 | 53.7 | 37.9 | 54.0 | -15.5 | -16.1 |
| 2483.5 | 68.6 | 52.8 | 65.5 | 49.1 | 54.0 | -1.2 | -4.9 |
| 4824.0 | 49.9 | 36.2 | 49.1 | 36.3 | 54.0 | -17.8 | -17.7 |
| 4874.0 | 50.2 | 36.3 | 49.3 | 36.4 | 54.0 | -17.7 | -17.6 |
| 4924.0 | 49.9 | 36.4 | 49.5 | 36.5 | 54.0 | -17.6 | -17.5 |
| 7236.0 | 53.4 | 40.4 | 53.3 | 40.4 | 54.0 | -13.6 | -13.6 |
| 7311.0 | 53.3 | 40.5 | 53.7 | 40.5 | 54.0 | -13.5 | -13.5 |
| 7386.0 | 53.3 | 40.5 | 53.6 | 40.5 | 54.0 | -13.5 | -13.5 |
| 12060.0 | 59.9 | 47.0 | 59.7 | 47.1 | 54.0 | -7.0 | -6.9 |
| 12185.0 | 61.8 | 49.0 | 61.3 | 47.9 | 54.0 | -5.0 | -6.1 |
| 12310.0 | 60.9 | 47.8 | 60.9 | 48.1 | 54.0 | -6.2 | -5.9 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

### *Summary of Results for Radiated Emissions in Restricted Bands*

The EUT demonstrated compliance with the radiated emissions requirements of 47CFR Paragraph 15, Subpart 15C, RSS-247 Issue 2, and RSS-GEN Issue 5 emission requirements. The EUT worst-case operations demonstrated a minimum radiated emission margin of -1.2 dB below the requirements in restricted frequency bands. Peak, Quasi-peak, and average amplitudes were checked for compliance with the regulations. Worst-case emissions are reported with other emissions found in the restricted frequency bands at least 20 dB below the requirements.

### *AC Line Conducted EMI Procedure*

The EUT was arranged in typical equipment configurations operating from AC power adapter. Testing was performed with the EUT placed on a 1 x 1.5-meter wooden bench 80 cm above the conducting ground plane, floor of a screen room. The bench was positioned 40 cm away from the wall of the screen room. The LISN was positioned on the floor of the screen room 80-cm from the rear of the EUT. Testing for the AC line-conducted emissions were the procedures of ANSI C63.10-2013 paragraph 6. The AC power adapter or CPU providing power to the EUT was connected to the LISN for AC line-conducted emissions testing. A second LISN was positioned on the floor of the screen room 80-cm from the rear of the supporting equipment of the EUT. All power cords except those providing power to the EUT were then powered from the second LISN. EMI was coupled to the spectrum analyzer through a 0.1 µF capacitor, internal to the LISN. Power line conducted emissions testing was carried out individually for each current carrying conductor of the EUT. The excess length of lead between the system and the LISN receptacle was folded back and forth to form a bundle not exceeding 40 cm in length. The screen room, conducting ground plane, analyzer, and LISN were bonded together to the protective earth ground. Preliminary testing was performed to identify the frequencies of each of the emissions, which demonstrated the highest amplitudes. The cables were repositioned to obtain maximum amplitude of measured EMI level. Once the worst-case configuration was identified, plots were made of the EMI from 0.15 MHz to 30 MHz then data was recorded with maximum conducted emissions levels.

Refer to figures one and two for plots of configuration #2, EUT – USB-A AC Power Adapter Line conducted emissions.

Refer to figures three and four for plots of configuration #2, EUT – USB-C AC Power Adapter Line conducted emissions.

Refer to figures five and six for plots of configuration #3, EUT – USB Computer interface AC Line conducted emissions.

**Figure 1 AC Line Conducted emissions of EUT line 1 (EUT – USB-A AC Adapter)**

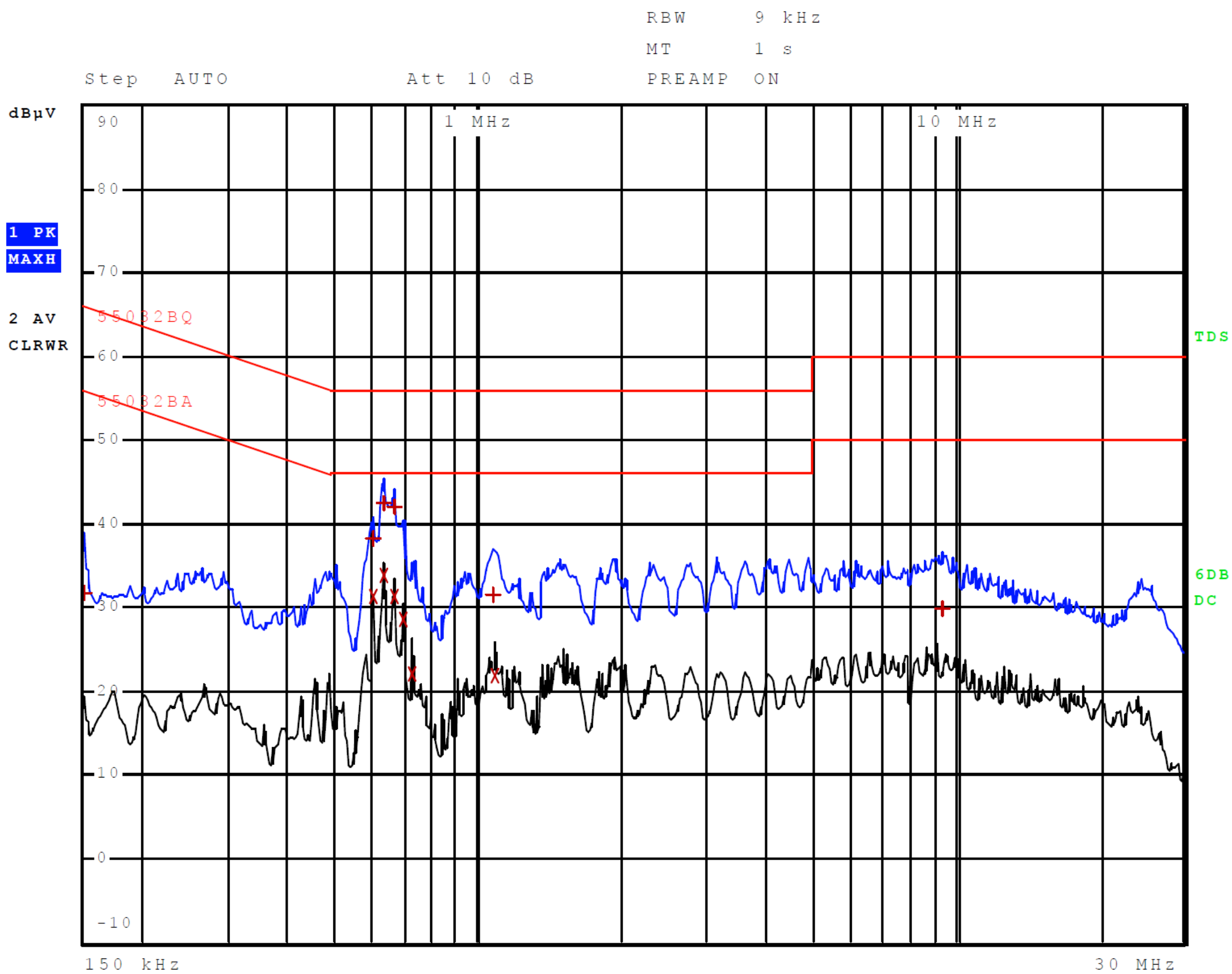


**Figure 2 AC Line Conducted emissions of EUT line 2 (EUT – USB-A AC Adapter)**

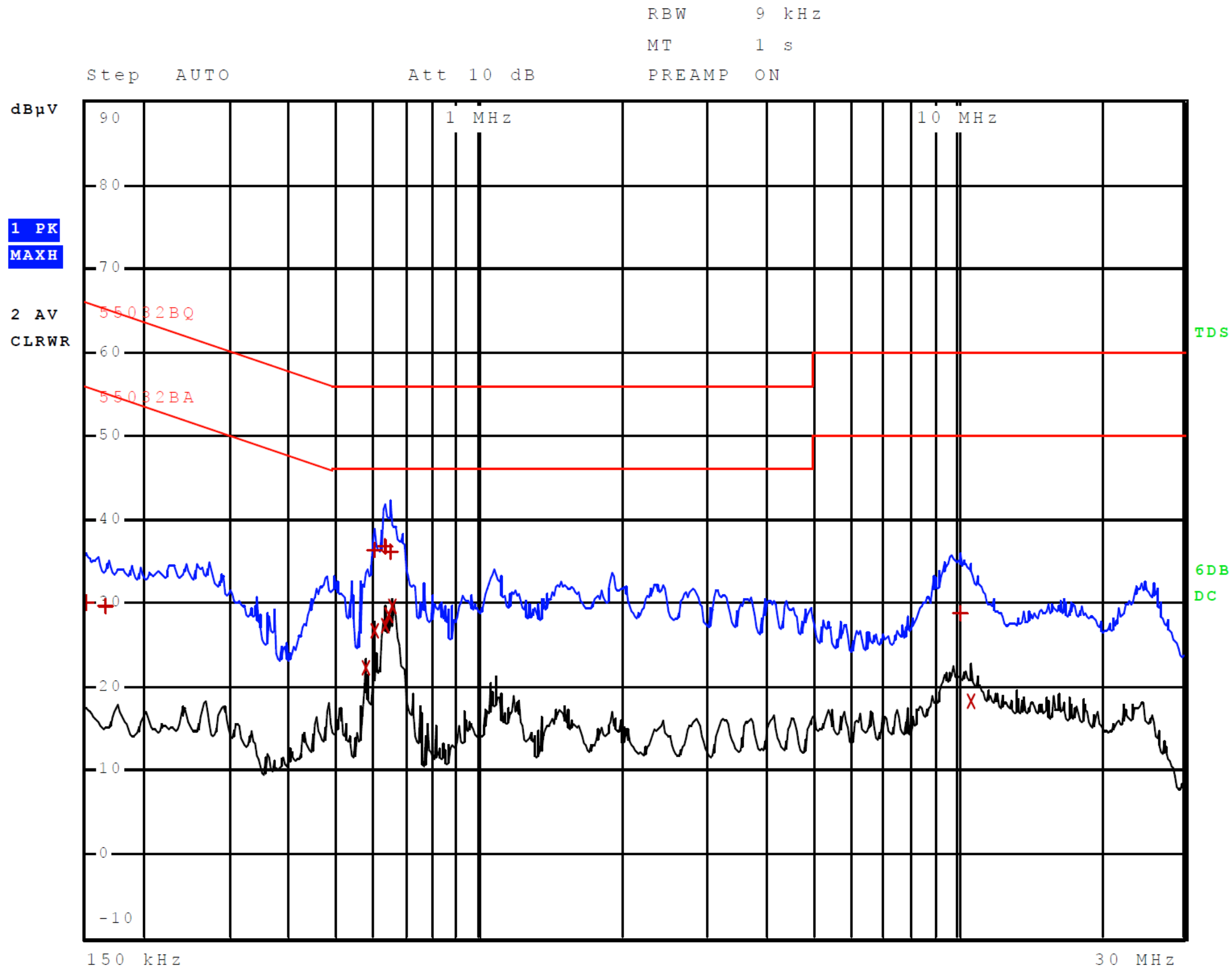


**Figure 3 AC Line Conducted emissions of EUT line 1 (EUT – USB-C AC Adapter)**

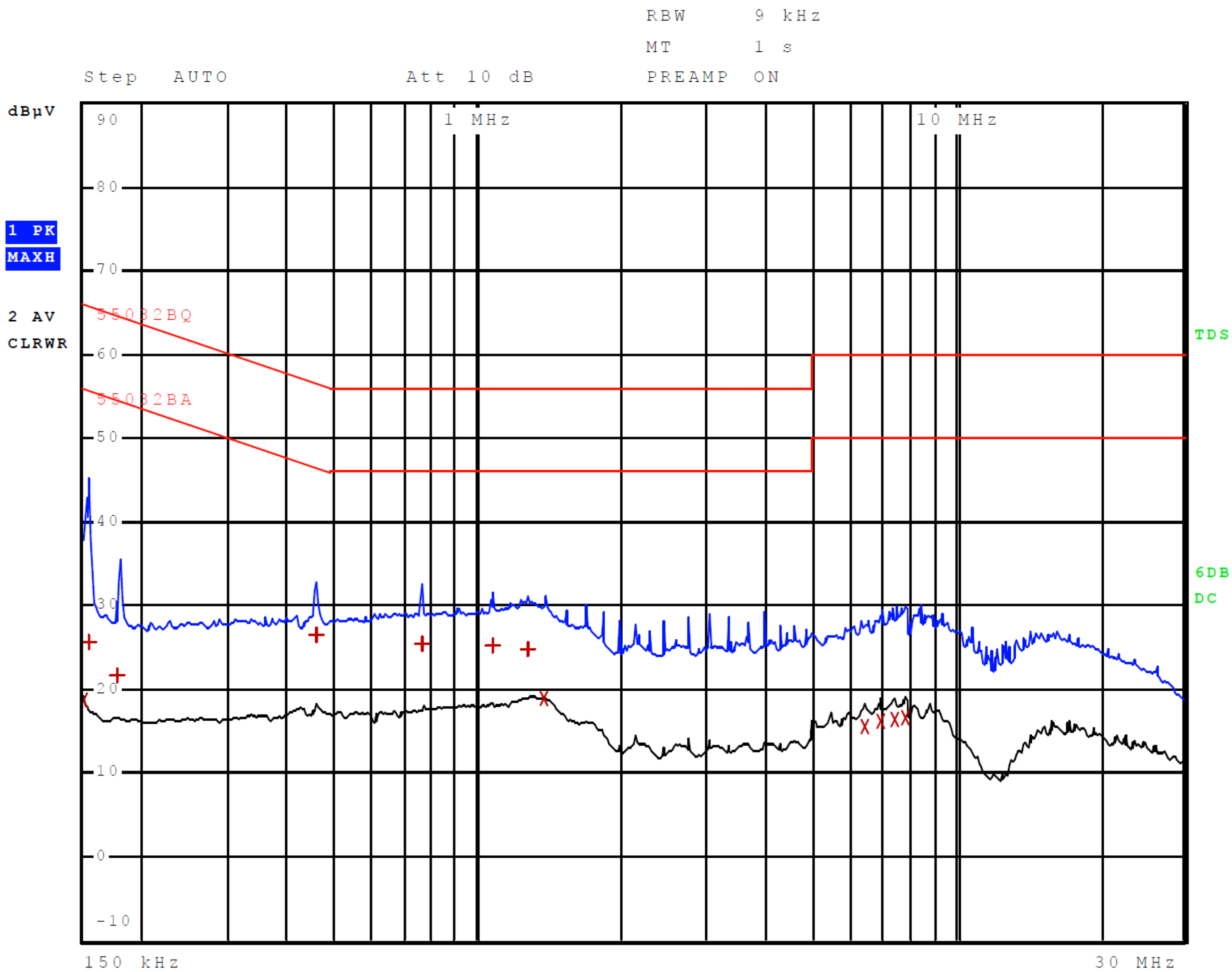


**Figure 4 AC Line Conducted emissions of EUT line 2 (EUT – USB-C AC Adapter)**

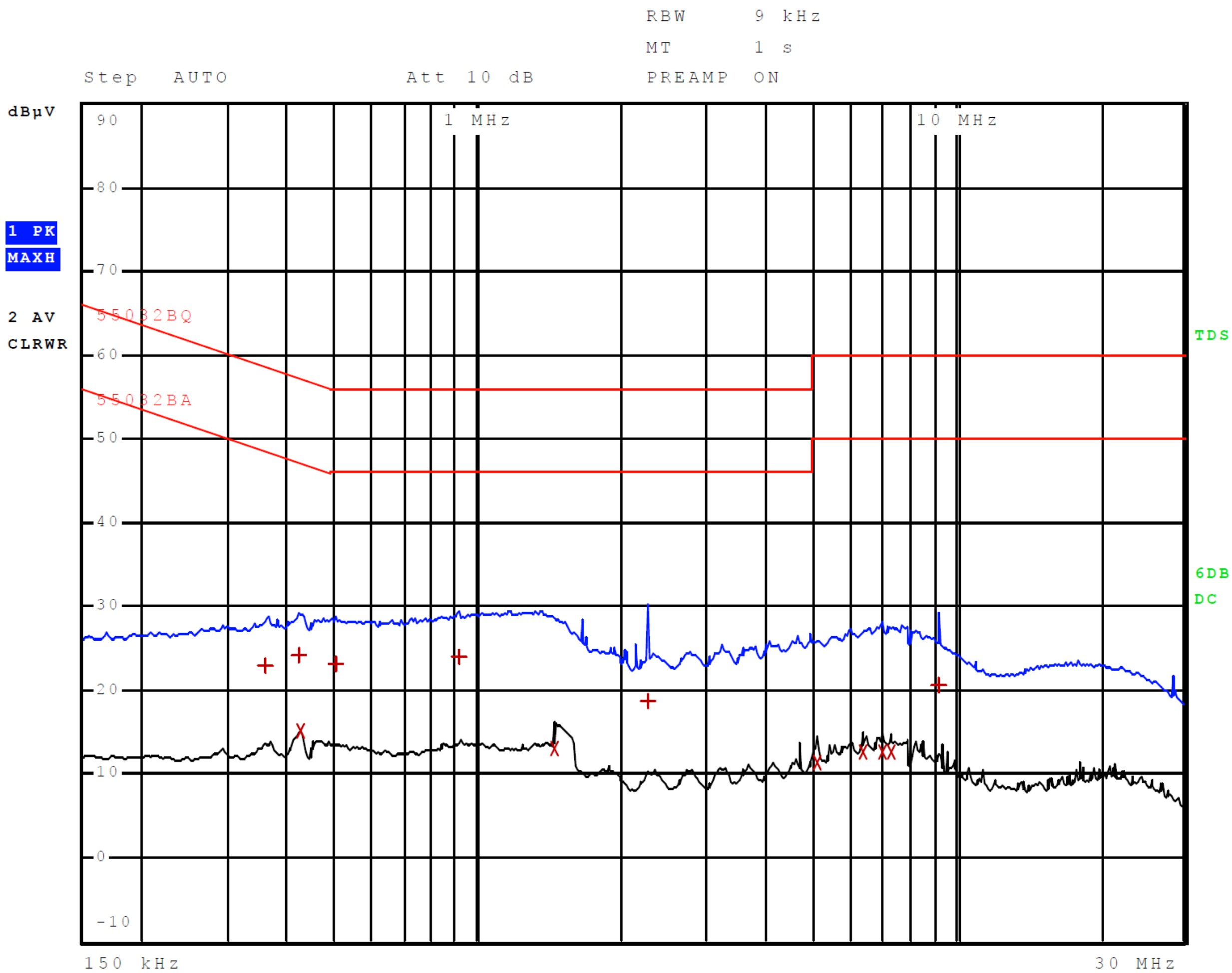


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**Figure 5 AC Line Conducted emissions of EUT line 1 (EUT – Computer)**

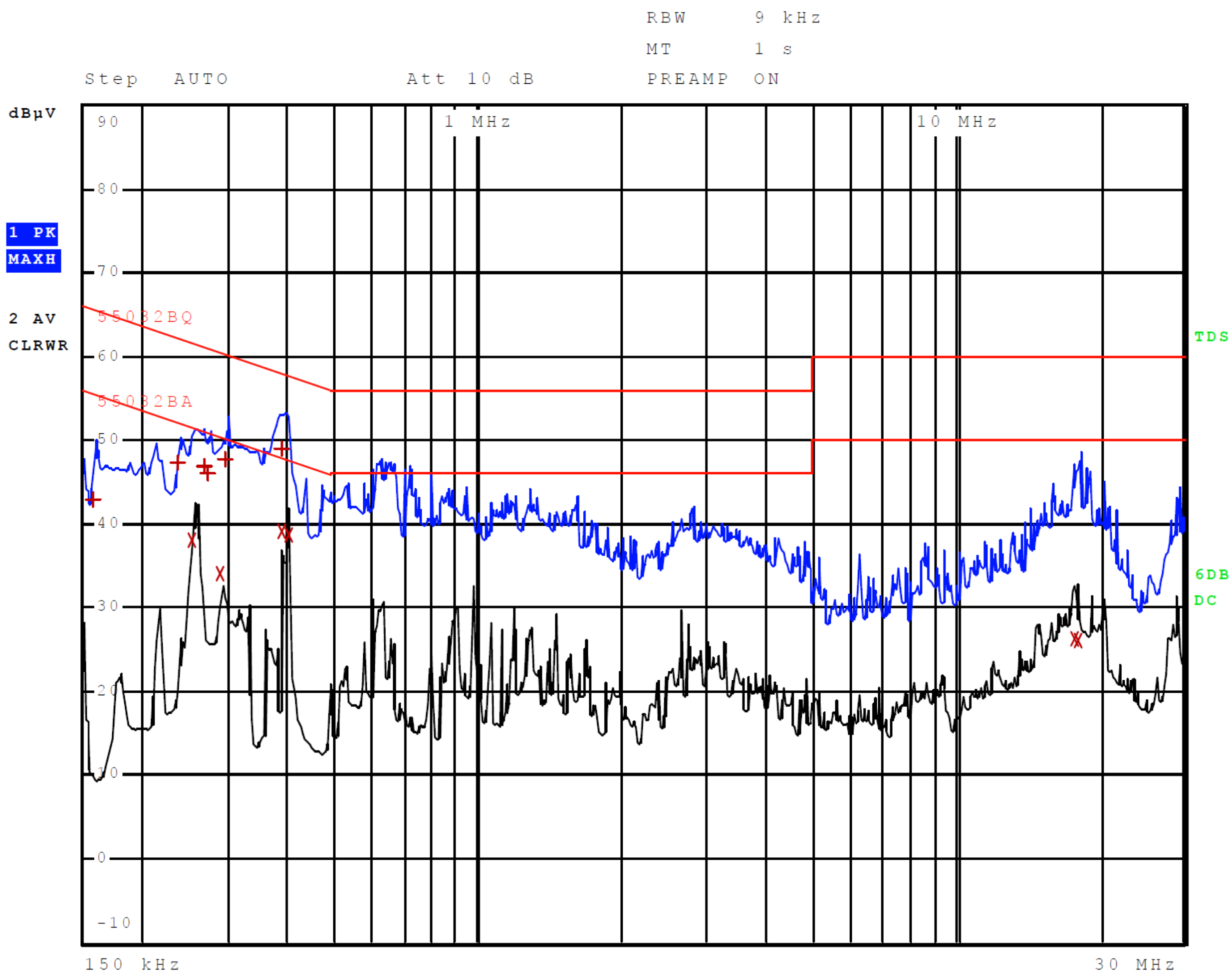


**Figure 6 AC Line Conducted emissions of EUT line 2 (EUT – Computer)**

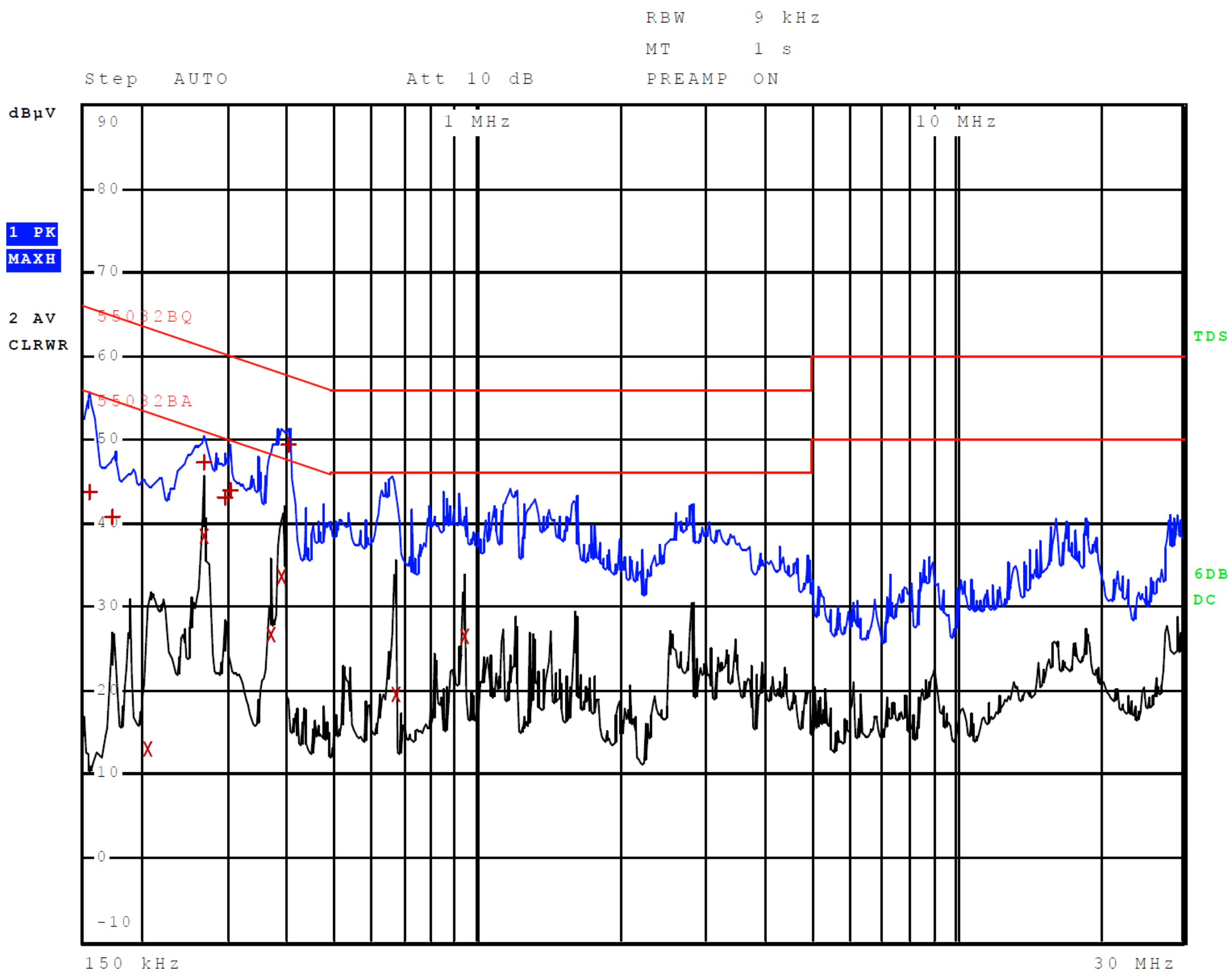


**Table 6 AC Line Conducted Emissions Data L1 (EUT – USB-A AC Adapter)**

| Trace | Frequency | Level (dBµV) | Detector | Delta Limit/dB |
|---|---|---|---|---|
| 1 | 150.000000000 kHz | 31.70 | Quasi Peak | -34.30 |
| 2 | 598.000000000 kHz | 31.25 | Average | -14.75 |
| 1 | 602.000000000 kHz | 38.25 | Quasi Peak | -17.75 |
| 2 | 630.000000000 kHz | 33.79 | Average | -12.21 |
| 1 | 630.000000000 kHz | 42.49 | Quasi Peak | -13.51 |
| 1 | 662.000000000 kHz | 42.06 | Quasi Peak | -13.94 |
| 2 | 666.000000000 kHz | 31.24 | Average | -14.76 |
| 2 | 694.000000000 kHz | 28.46 | Average | -17.54 |
| 2 | 726.000000000 kHz | 22.14 | Average | -23.86 |
| 1 | 1.074000000 MHz | 31.53 | Quasi Peak | -24.47 |
| 2 | 1.082000000 MHz | 21.73 | Average | -24.27 |
| 1 | 9.407900000 MHz | 29.82 | Quasi Peak | -30.18 |

Other emissions present had amplitudes at least 20 dB below the limit.

**Table 7 AC Line Conducted Emissions Data L2 ( EUT – USB-A AC Adapter)**

| Trace | Frequency | Level (dBµV) | Detector | Delta Limit/dB |
|---|---|---|---|---|
| 1 | 150.000000000 kHz | 30.04 | Quasi Peak | -35.96 |
| 1 | 166.000000000 kHz | 29.70 | Quasi Peak | -35.46 |
| 2 | 574.000000000 kHz | 22.19 | Average | -23.81 |
| 2 | 598.000000000 kHz | 26.67 | Average | -19.33 |
| 1 | 602.000000000 kHz | 36.31 | Quasi Peak | -19.69 |
| 2 | 630.000000000 kHz | 27.30 | Average | -18.70 |
| 1 | 630.000000000 kHz | 36.78 | Quasi Peak | -19.22 |
| 2 | 642.000000000 kHz | 28.48 | Average | -17.52 |
| 1 | 650.000000000 kHz | 36.20 | Quasi Peak | -19.80 |
| 2 | 654.000000000 kHz | 29.61 | Average | -16.39 |
| 1 | 10.179900000 MHz | 28.75 | Quasi Peak | -31.25 |
| 2 | 10.739900000 MHz | 18.32 | Average | -31.68 |

Other emissions present had amplitudes at least 20 dB below the limit.

**Table 8 AC Line Conducted Emissions Data L1 (EUT – USB-C AC Adapter)**

| Trace | Frequency | Level (dBµV) | Detector | Delta Limit/dB |
|---|---|---|---|---|
| 2 | 150.000000000 kHz | 18.68 | Average | -37.32 |
| 1 | 154.000000000 kHz | 25.70 | Quasi Peak | -40.08 |
| 1 | 178.000000000 kHz | 21.62 | Quasi Peak | -42.96 |
| 1 | 458.000000000 kHz | 26.55 | Quasi Peak | -30.18 |
| 1 | 762.000000000 kHz | 25.35 | Quasi Peak | -30.65 |
| 1 | 1.070000000 MHz | 25.28 | Quasi Peak | -30.72 |
| 1 | 1.274000000 MHz | 24.73 | Quasi Peak | -31.27 |
| 2 | 1.374000000 MHz | 18.83 | Average | -27.17 |
| 2 | 6.455900000 MHz | 15.58 | Average | -34.42 |
| 2 | 6.943900000 MHz | 16.07 | Average | -33.93 |
| 2 | 7.431900000 MHz | 16.37 | Average | -33.63 |
| 2 | 7.847900000 MHz | 16.53 | Average | -33.47 |

Other emissions present had amplitudes at least 20 dB below the limit.

**Table 9 AC Line Conducted Emissions Data L2 ( EUT – USB-C AC Adapter)**

| Trace | Frequency | Level (dBµV) | Detector | Delta Limit/dB |
|---|---|---|---|---|
| 1 | 362.000000000 kHz | 22.94 | Quasi Peak | -35.75 |
| 1 | 418.000000000 kHz | 24.13 | Quasi Peak | -33.36 |
| 2 | 422.000000000 kHz | 15.07 | Average | -32.34 |
| 1 | 502.000000000 kHz | 23.17 | Quasi Peak | -32.83 |
| 1 | 910.000000000 kHz | 24.01 | Quasi Peak | -31.99 |
| 2 | 1.446000000 MHz | 13.05 | Average | -32.95 |
| 1 | 2.258000000 MHz | 18.74 | Quasi Peak | -37.26 |
| 2 | 5.135900000 MHz | 11.43 | Average | -38.57 |
| 2 | 6.407900000 MHz | 12.51 | Average | -37.49 |
| 2 | 7.031900000 MHz | 12.55 | Average | -37.45 |
| 2 | 7.319900000 MHz | 12.58 | Average | -37.42 |
| 1 | 9.235900000 MHz | 20.63 | Quasi Peak | -39.37 |

Other emissions present had amplitudes at least 20 dB below the limit.

**Table 10 AC Line Conducted Emissions Data L1 (EUT – Computer)**

| Trace | Frequency | Level (dBµV) | Detector | Delta Limit/dB |
|---|---|---|---|---|
| 1 | 158.000000000 kHz | 42.86 | Quasi Peak | -22.71 |
| 1 | 238.000000000 kHz | 47.26 | Quasi Peak | -14.90 |
| 2 | 254.000000000 kHz | 38.11 | Average | -13.52 |
| 1 | 266.000000000 kHz | 46.78 | Quasi Peak | -14.46 |
| 1 | 274.000000000 kHz | 46.05 | Quasi Peak | -14.94 |
| 2 | 290.000000000 kHz | 33.92 | Average | -16.61 |
| 1 | 298.000000000 kHz | 47.57 | Quasi Peak | -12.73 |
| 2 | 386.000000000 kHz | 38.96 | Average | -9.19 |
| 1 | 390.000000000 kHz | 48.99 | Quasi Peak | -9.07 |
| 2 | 398.000000000 kHz | 38.64 | Average | -9.25 |
| 2 | 17.651900000 MHz | 26.27 | Average | -23.73 |
| 2 | 17.955900000 MHz | 25.96 | Average | -24.04 |

Other emissions present had amplitudes at least 20 dB below the limit.

**Table 11 AC Line Conducted Emissions Data L2 ( EUT – Computer)**

| Trace | Frequency | Level (dBµV) | Detector | Delta Limit/dB |
|---|---|---|---|---|
| 1 | 154.000000000 kHz | 43.69 | Quasi Peak | -22.09 |
| 1 | 174.000000000 kHz | 40.80 | Quasi Peak | -23.97 |
| 2 | 206.000000000 kHz | 12.95 | Average | -40.41 |
| 2 | 266.000000000 kHz | 38.38 | Average | -12.86 |
| 1 | 266.000000000 kHz | 47.32 | Quasi Peak | -13.92 |
| 1 | 294.000000000 kHz | 43.01 | Quasi Peak | -17.40 |
| 1 | 302.000000000 kHz | 43.95 | Quasi Peak | -16.24 |
| 2 | 366.000000000 kHz | 26.59 | Average | -22.00 |
| 2 | 390.000000000 kHz | 33.57 | Average | -14.50 |
| 1 | 398.000000000 kHz | 49.43 | Quasi Peak | -8.46 |
| 2 | 670.000000000 kHz | 19.46 | Average | -26.54 |
| 2 | 934.000000000 kHz | 26.44 | Average | -19.56 |

Other emissions present had amplitudes at least 20 dB below the limit.

### *Summary of Results for AC Line Conducted Emissions Results*

The EUT demonstrated compliance with the AC Line Conducted Emissions requirements of 47CFR Part 15C and other applicable emissions requirements. The EUT-AC adapter configuration #2 worst-case configuration demonstrated a minimum margin of -12.1 dB below the requirement. The EUT-CPU configurations #3 worst-case configuration demonstrated a minimum margin of -8.4 dB below the requirement. Other emissions were present with amplitudes at least 20 dB below the limit and worst-case amplitudes recorded.

### *General Radiated Emissions Procedure*

The EUT was arranged in a typical equipment configuration and operated through all available mode during testing. Preliminary testing was performed in a screen room with the EUT positioned 1 meter from the FSM. Radiated emissions measurements were performed to identify the frequencies, which produced the highest emissions. Each radiated emission was then maximized at the OATS location before final radiated measurements were performed. Final data was taken with the EUT located on the OATS at 3 meters distance between the EUT and the receiving antenna. The frequency spectrum from 9 kHz to 25,000 MHz was searched for general radiated emissions. Measured emission levels were maximized by EUT placement on the table, rotating the turntable through 360 degrees, varying the antenna height between 1 and 4 meters above the ground plane and changing antenna position between horizontal and vertical polarization. Antennas used were Loop from 9 kHz to 30 MHz, Broadband Biconical from 30 to 200 MHz, Biconilog from 30 to 1000 MHz, Log Periodic from 200 MHz to 1 GHz and or double Ridge or pyramidal horns and mixers above 1 GHz, notch filters and appropriate amplifiers and external mixers were utilized.

**Table 12 General Radiated Emissions Data**

| Frequency (MHz) | Horizontal Peak (dBµV/m) | Horizontal Quasi-Peak (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Quasi-Peak (dBµV/m) | Limit @ 3m (dBµV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 77.6 | 38.2 | 32.7 | 36.9 | 30.8 | 40.0 | -7.3 | -9.2 |
| 96.0 | 39.8 | 36.6 | 43.2 | 35.0 | 40.0 | -3.4 | -5.0 |
| 110.6 | 40.2 | 34.1 | 35.1 | 31.0 | 40.0 | -5.9 | -9.0 |
| 115.3 | 38.2 | 33.4 | 34.9 | 31.4 | 40.0 | -6.6 | -8.6 |
| 129.3 | 41.4 | 32.8 | 33.8 | 28.7 | 40.0 | -7.2 | -11.3 |
| 132.4 | 41.3 | 27.4 | 36.4 | 30.9 | 40.0 | -12.6 | -9.1 |
| 134.1 | 40.2 | 28.7 | 30.3 | 25.2 | 40.0 | -11.3 | -14.8 |
| 480.0 | 43.1 | 39.9 | 41.9 | 39.0 | 47.0 | -7.1 | -8.0 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency range below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

### *Summary of Results for General Radiated Emissions*

The EUT demonstrated compliance with the radiated emissions requirements of 47CFR Paragraph 15.209, RSS-247 Issue 2 and RSS-GEN Issue 5 emission requirements. The EUT demonstrated a minimum margin of -3.4 dB below the requirements. Other emissions were present with amplitudes at least 20 dB below the Limits.

### *Operation in the Band 2400 – 2483.5 MHz*

Test procedures of ANSI C63.10-2013 paragraph 6, and KDB 558074 v05r02 were used during transmitter testing. Test sample #2 was provided for testing antenna port conducted emissions. This sample was modified by replacing the internal antenna with a 50-ohm antenna port connector and attenuator for testing purposes. The transmitter peak and average power was measured at the antenna port using a wideband RF power meter as described in ANSI C63.10-2013 and KDB 558074. Average power measured did not include any time intervals during which the transmitter was off or transmitting at a reduced power level. The Power Spectral Density (PSD) was measured as required in ANSI C63.10-2013 and KDB 558074. DTS Emission bandwidth was measured as required in ANSI C63.10-2013 and KDB 558074. The amplitude of each harmonic and general radiated emission was measured on the OATS at distance of 3 meters from the FSM antenna (radiated emission testing was performed on sample #1 representative of production equipment with integral antenna). The EUT was positioned on supporting turntable elevated as required above the ground plane, at a distance of 3 meters from the FSM antenna. Radiated emission investigations were performed from 9 kHz to 25,000 MHz. Each radiated emission was maximized by varying the FSM antenna height and polarization, and by rotating the turntable. The worst-case amplitude of each emission was then recorded from the analyzer display. The peak and quasi-peak amplitude of frequencies below 1000 MHz were measured using a spectrum analyzer. The peak and average amplitude of frequencies above 1000 MHZ were measured using a spectrum analyzer. A Loop antenna was used for measuring emissions from 0.009 to 30 MHz, Biconilog Antenna for 30 to 1000 MHz, Double-Ridge, and/or Pyramidal Horn Antennas from 1 GHz to 25 GHz. Radiated Emissions were measured in dBμV/m @ 3 meters.

Plots were taken of transmitter performance (using sample #2) for reference in this and other documentation displaying compliance with the specifications.

**Figure 7 Plot of Transmitter Emissions Operation in 2402-2480 MHz Mode 1 ANT**

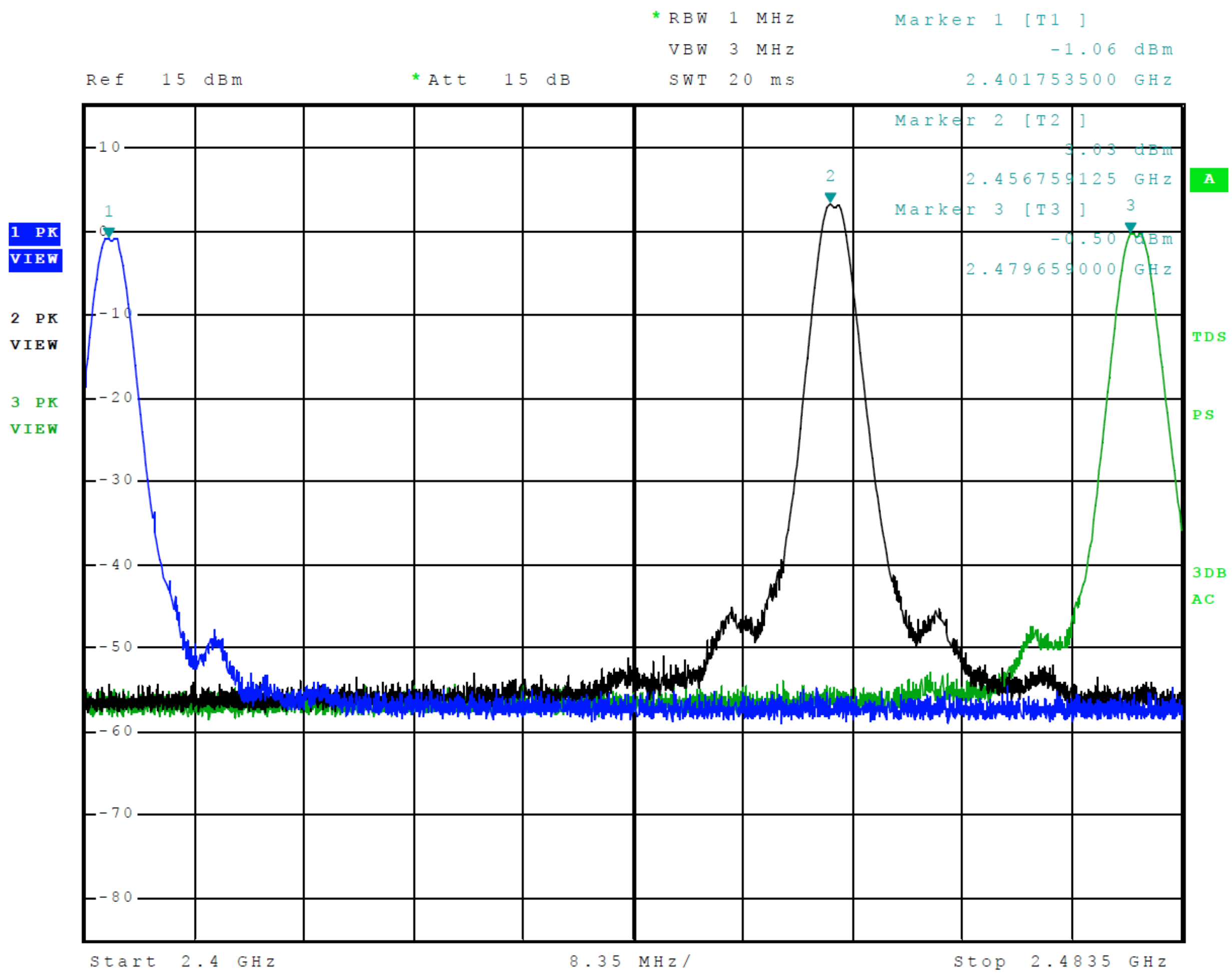


**Figure 8 Plot of Transmitter Emissions Operation in 2402-2480 MHz Mode 2 BLE**

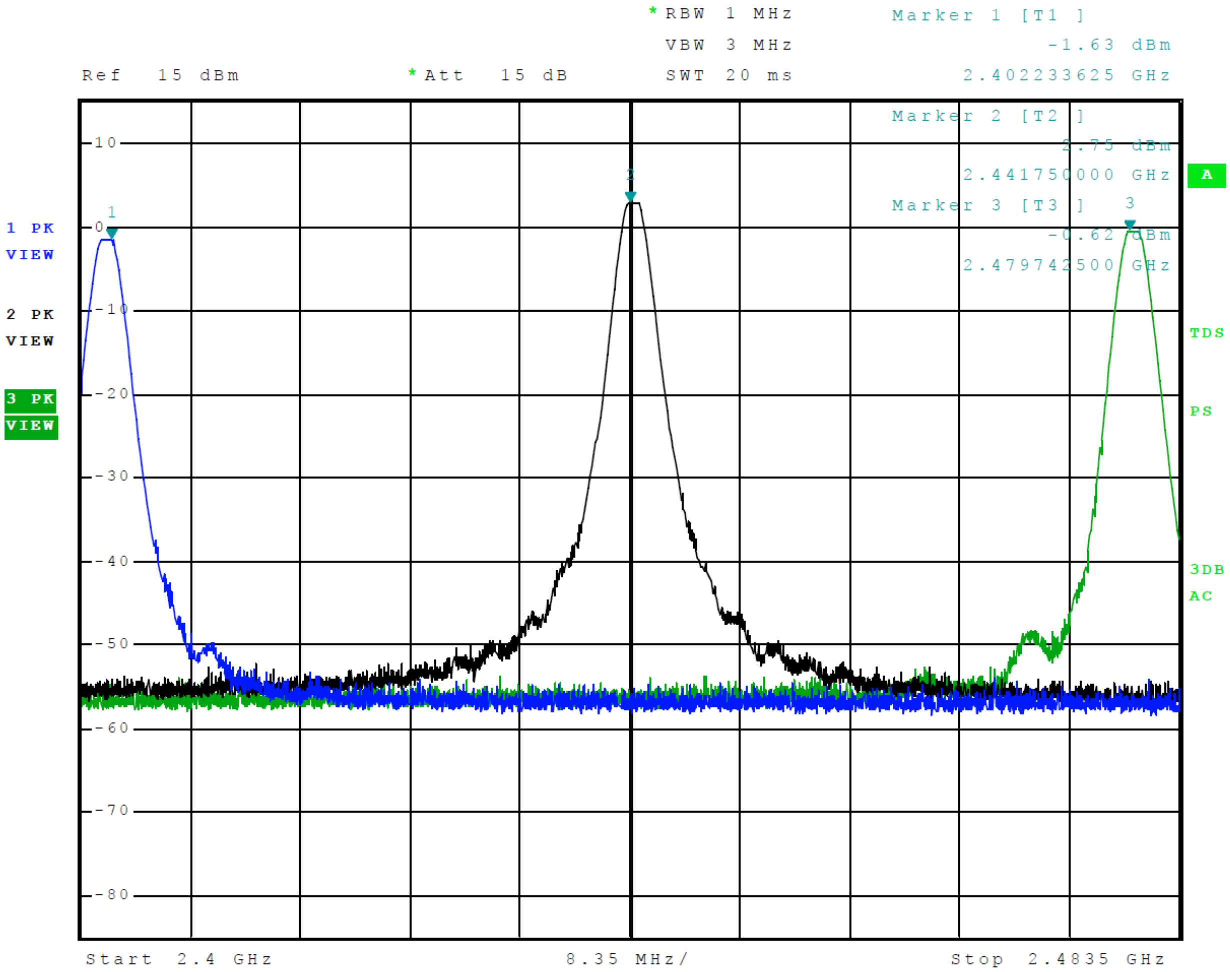


**Figure 9 Plot of Transmitter Operation in 2412-2462 MHz Mode 3 802.11b**

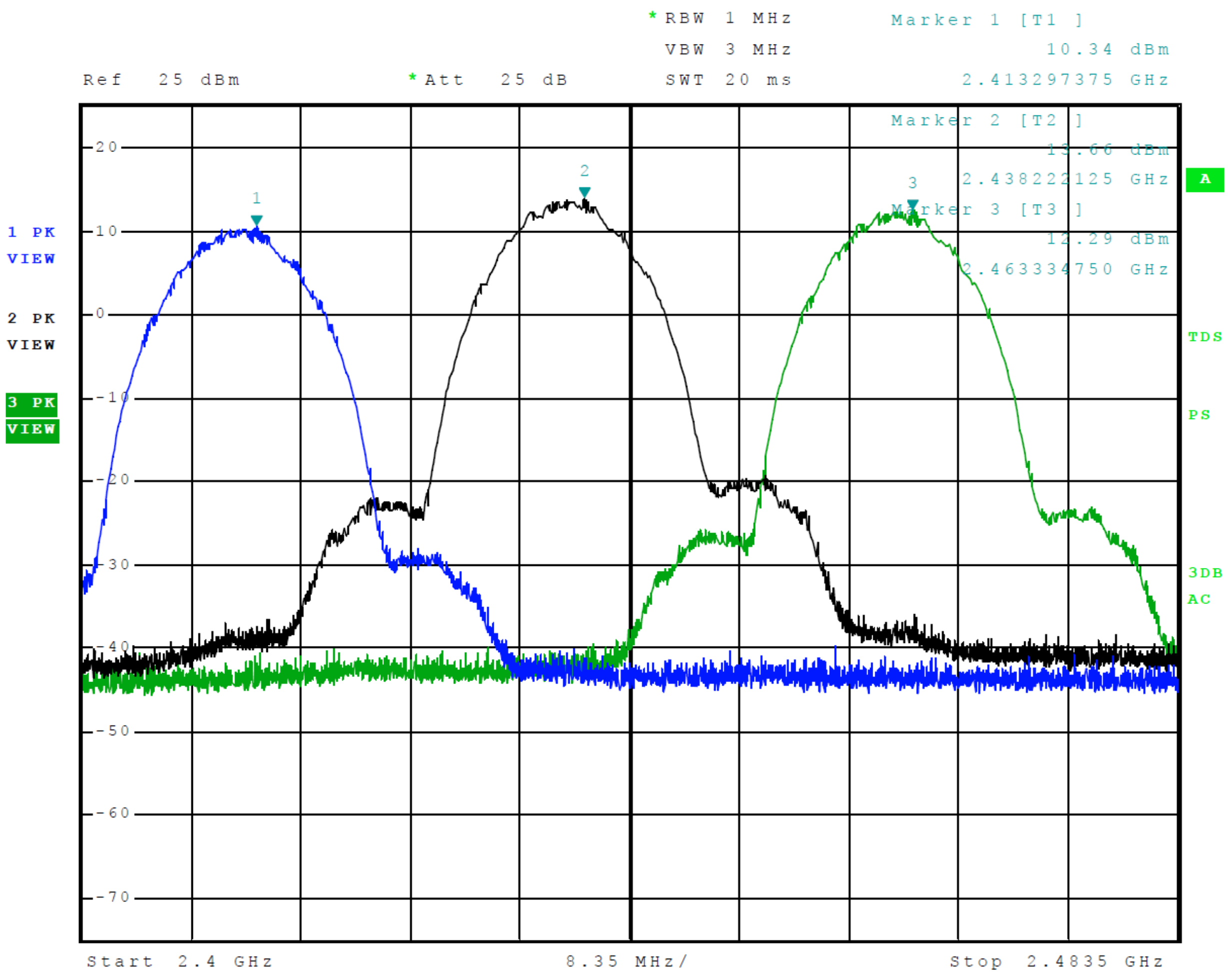
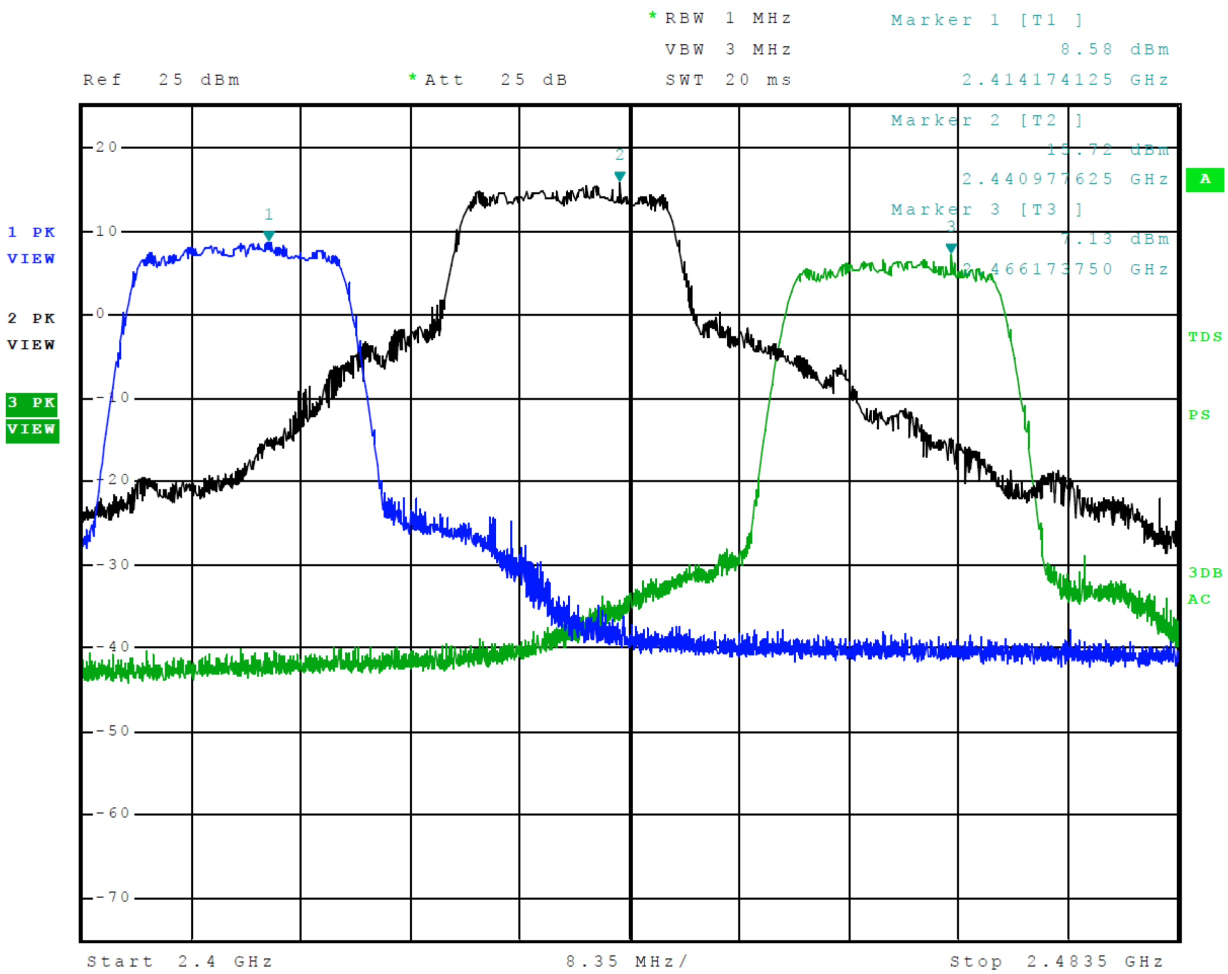


**Figure 10 Plot of Transmitter Operation in 2412-2462 MHz Mode 4 802.11g**



# Figure 11 Plot of Transmitter Operation in 2412-2462 MHz Mode 5 802.11n

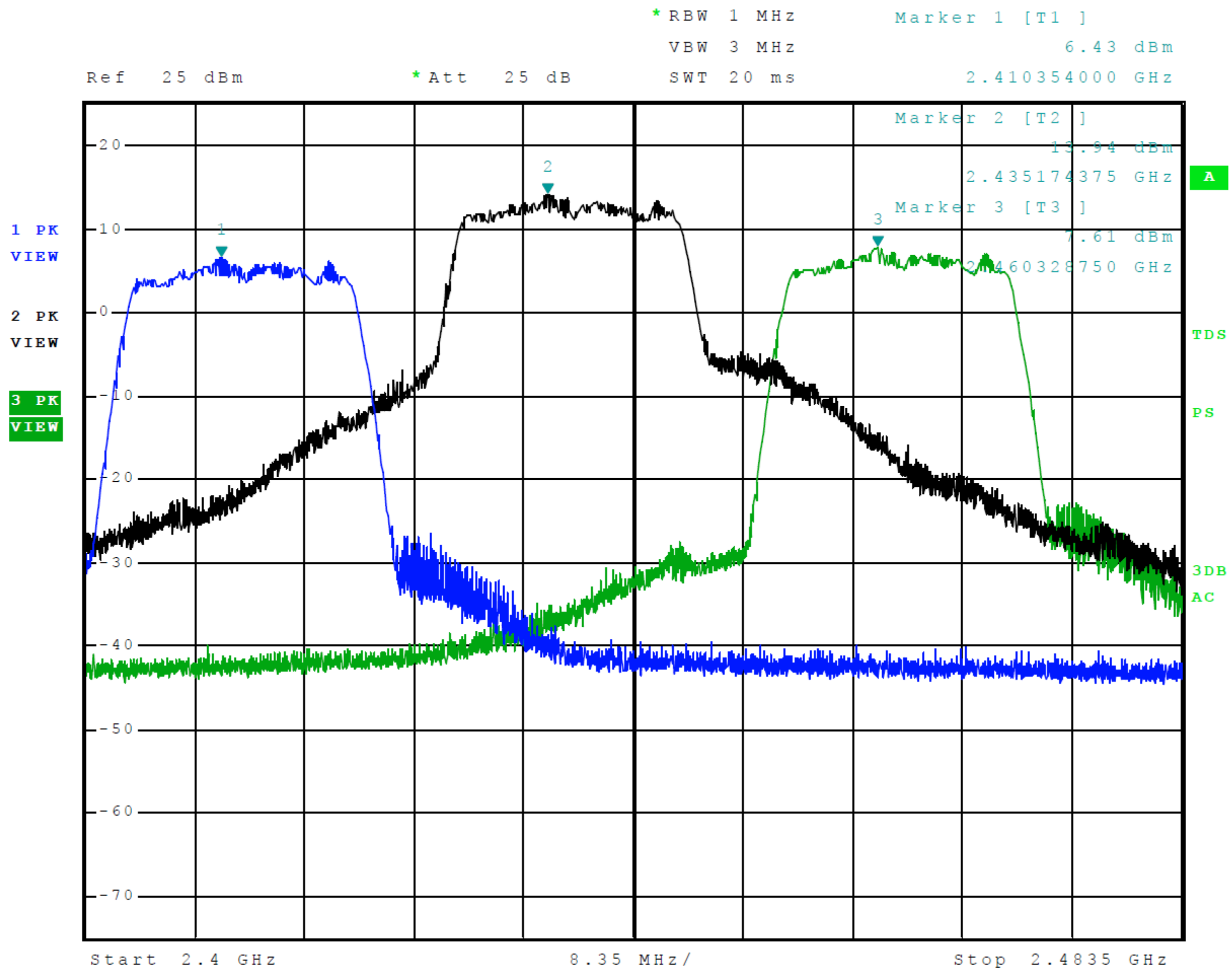


**Figure 12 Plot of Transmitter Emissions Low Band Edge Mode 1 ANT**

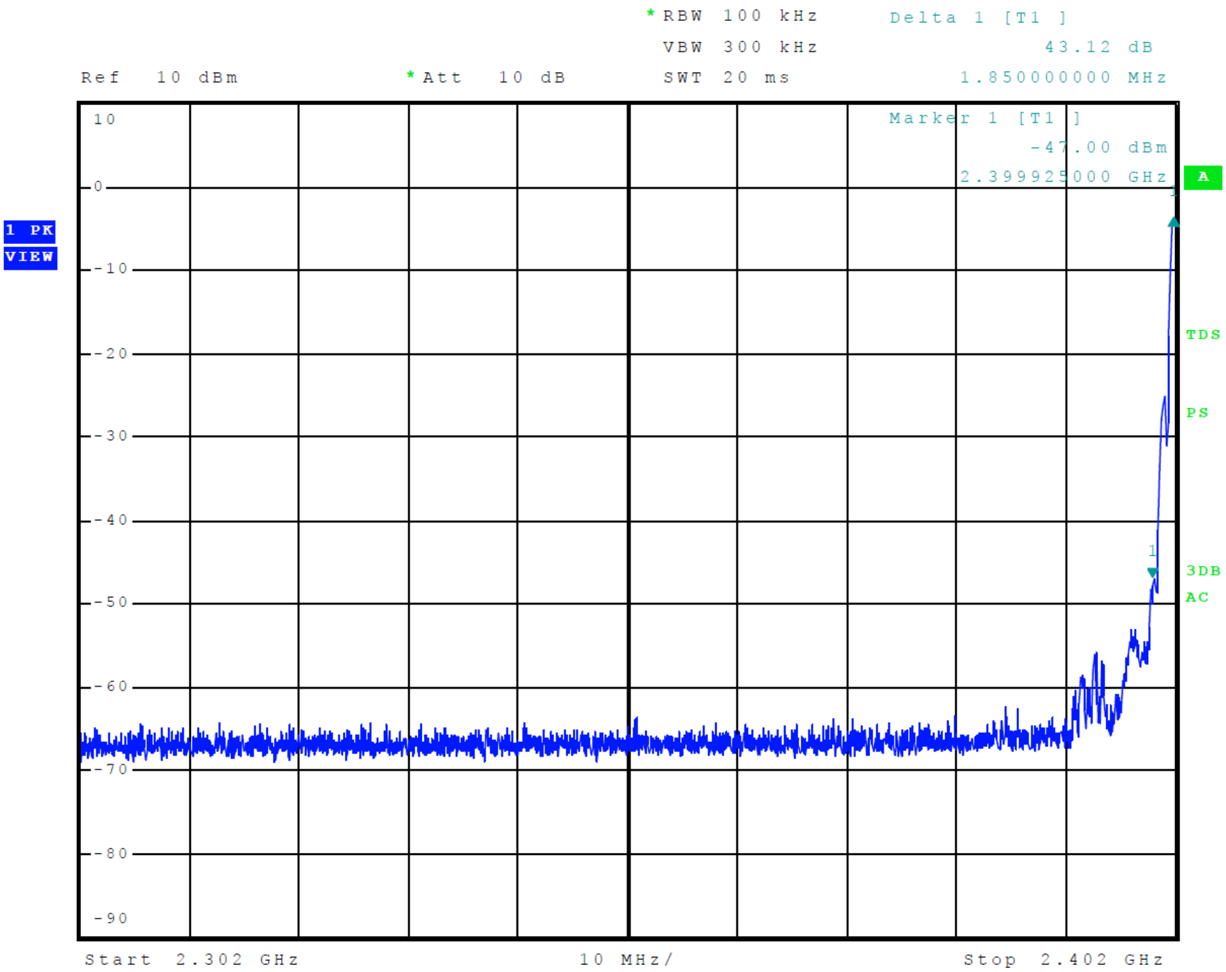


**Figure 13 Plot of Transmitter Emissions Low Band Edge Mode 2 BLE**

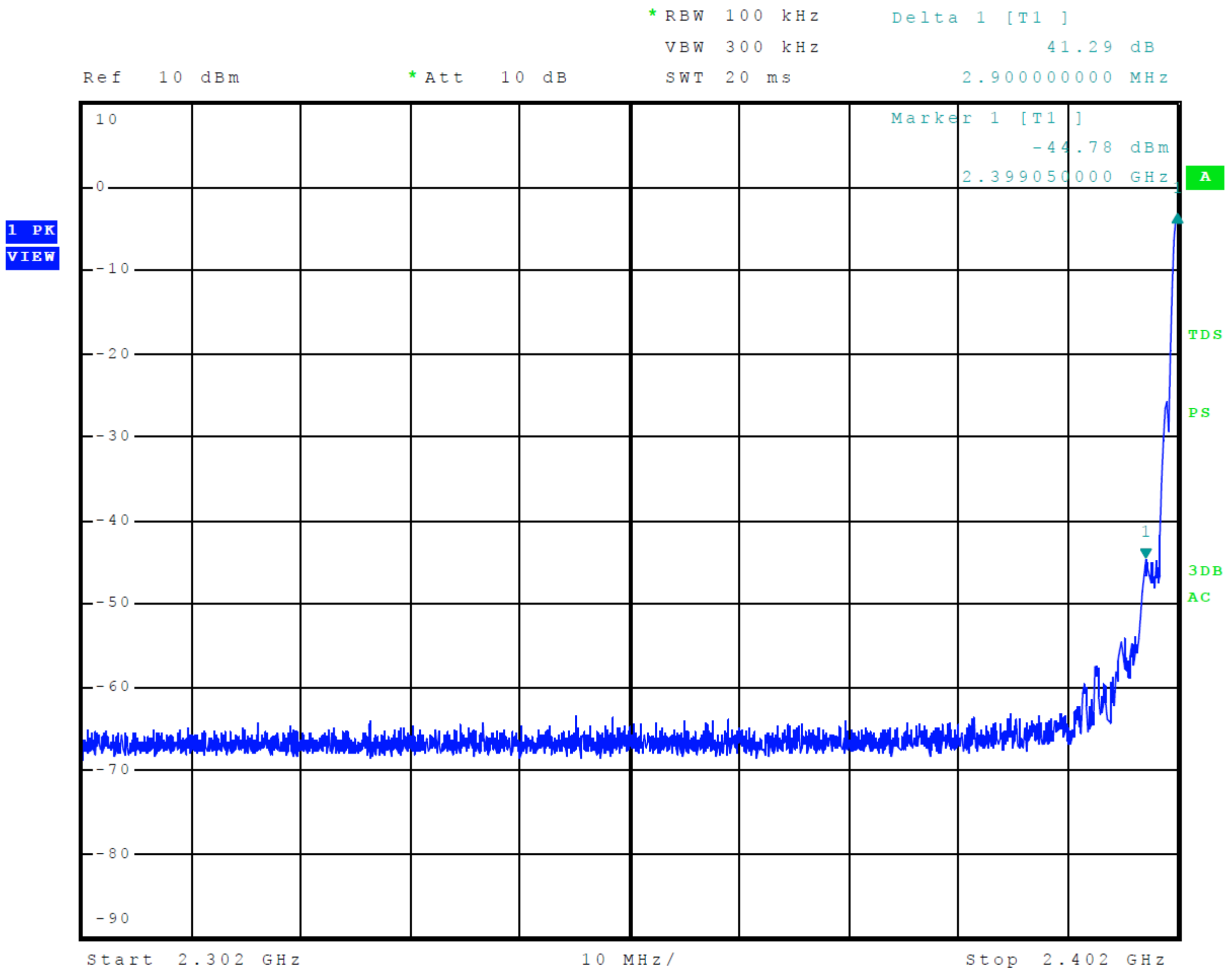


**Figure 14 Plot of Transmitter Emissions Low Band Edge Mode 3 802.11b**

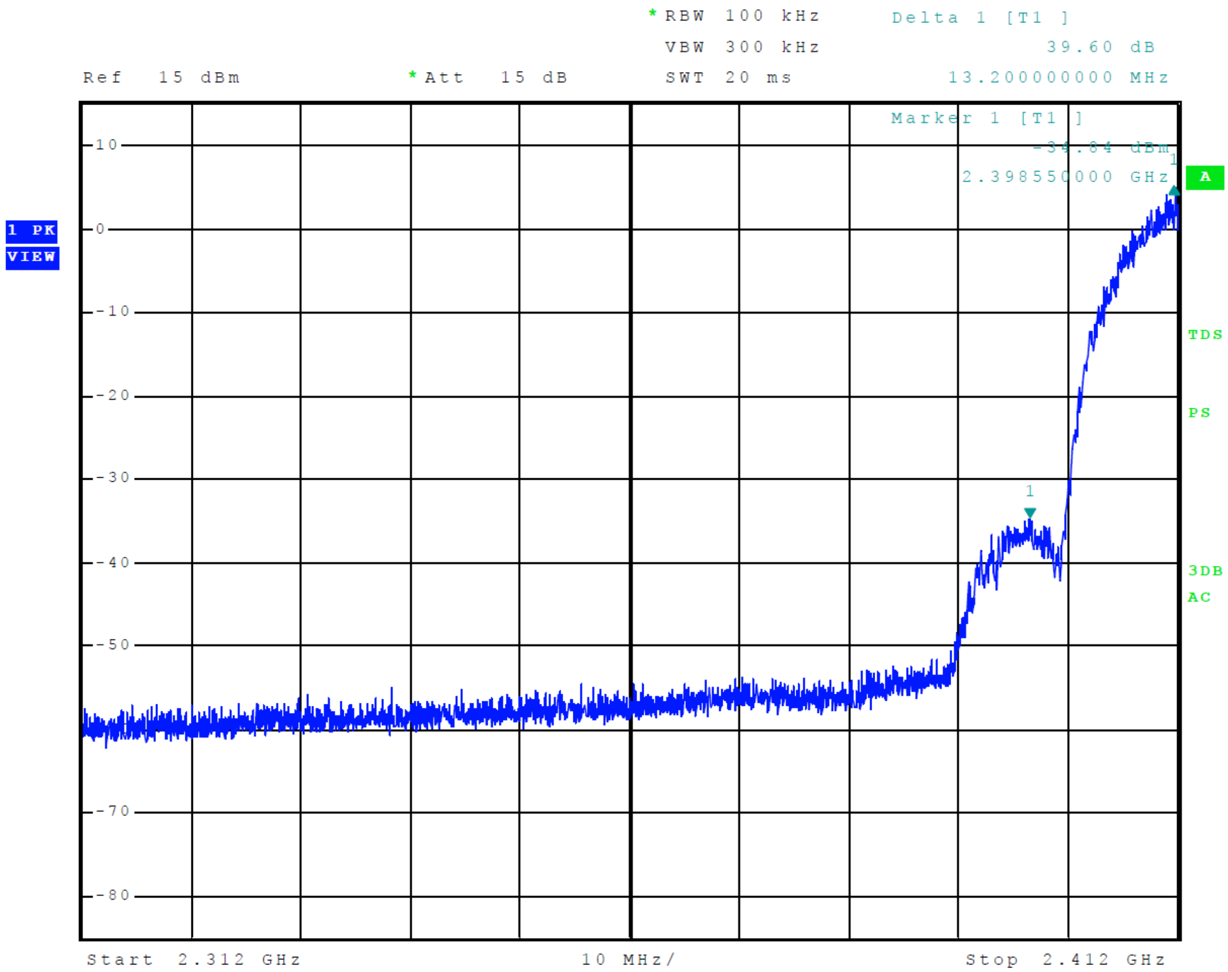


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**Figure 15 Plot of Transmitter Emissions Low Band Edge Mode 4 802.11g**

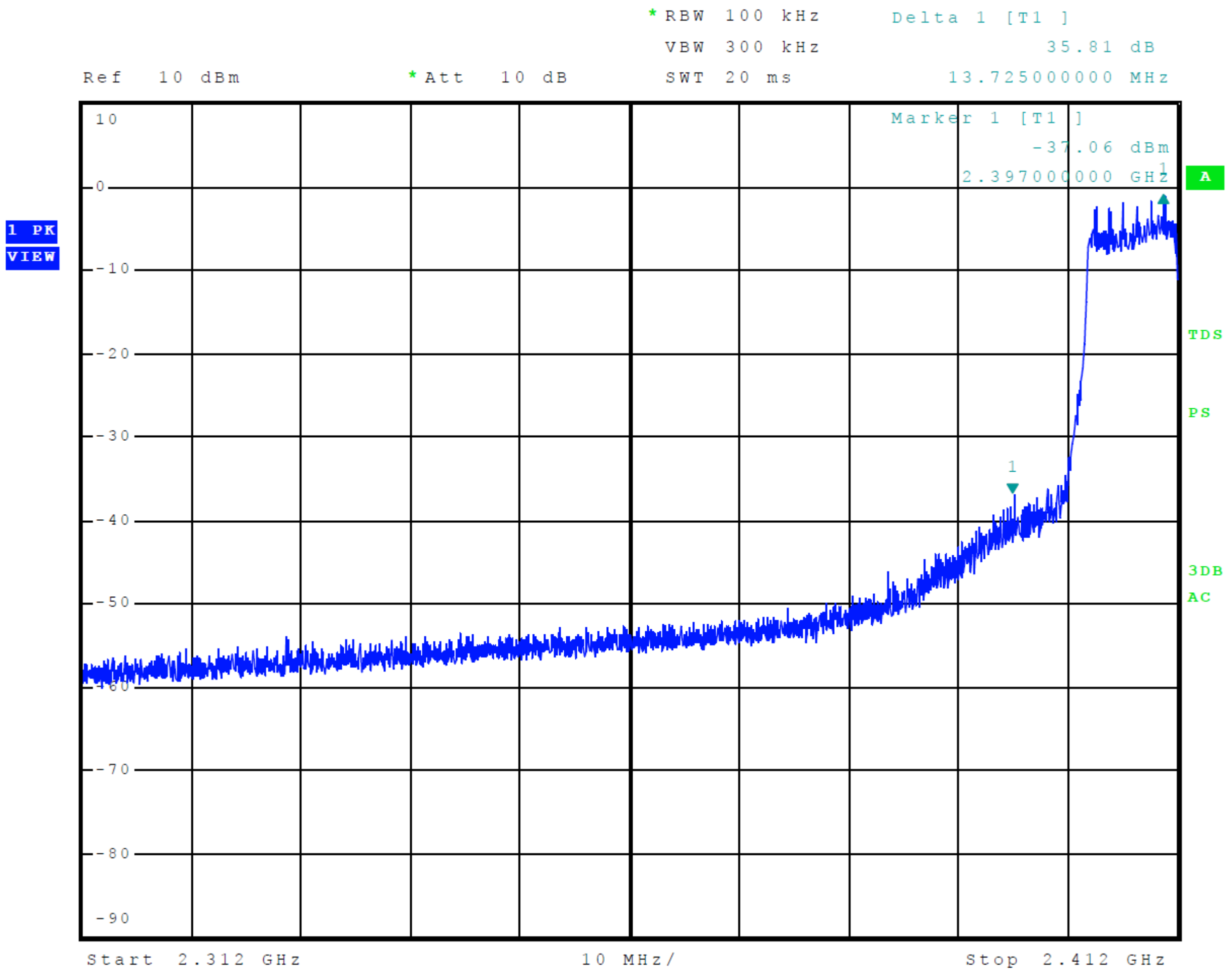
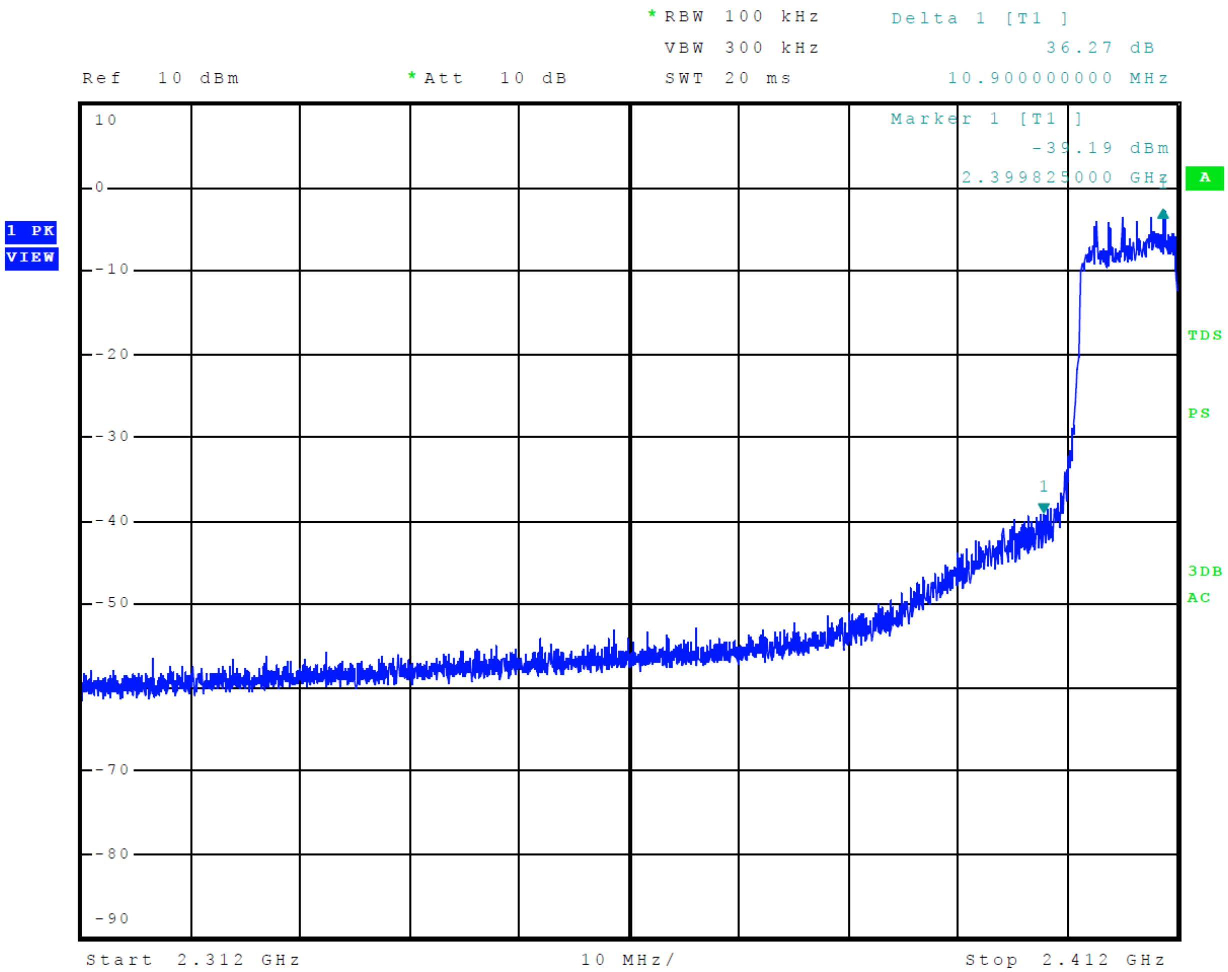


**Figure 16 Plot of Transmitter Emissions Low Band Edge Mode 5 802.11n**



## Figure 17 Plot of Transmitter Emissions High Band Edge Mode 1 ANT

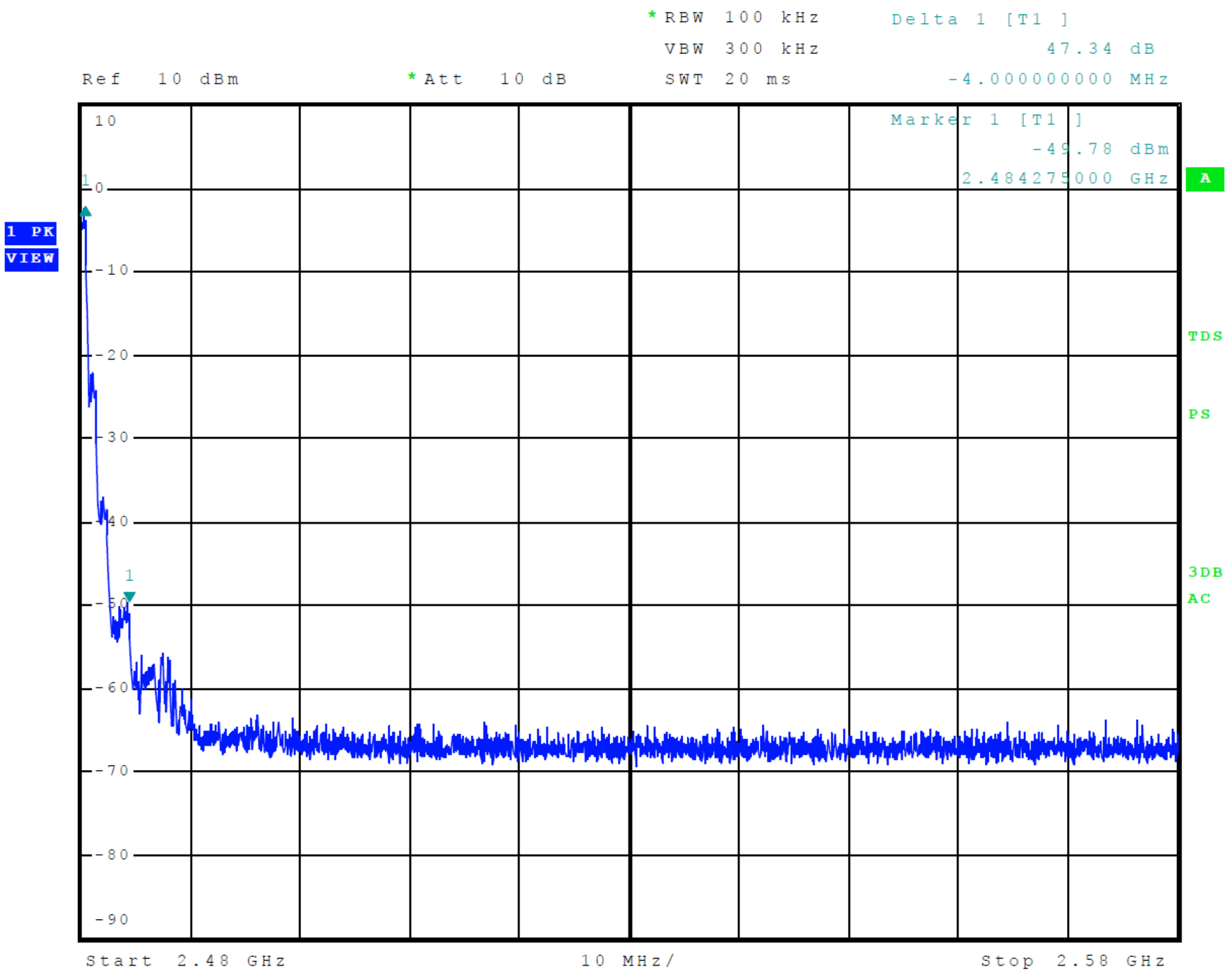


**Figure 18 Plot of Transmitter Emissions High Band Edge Mode 2 BLE**

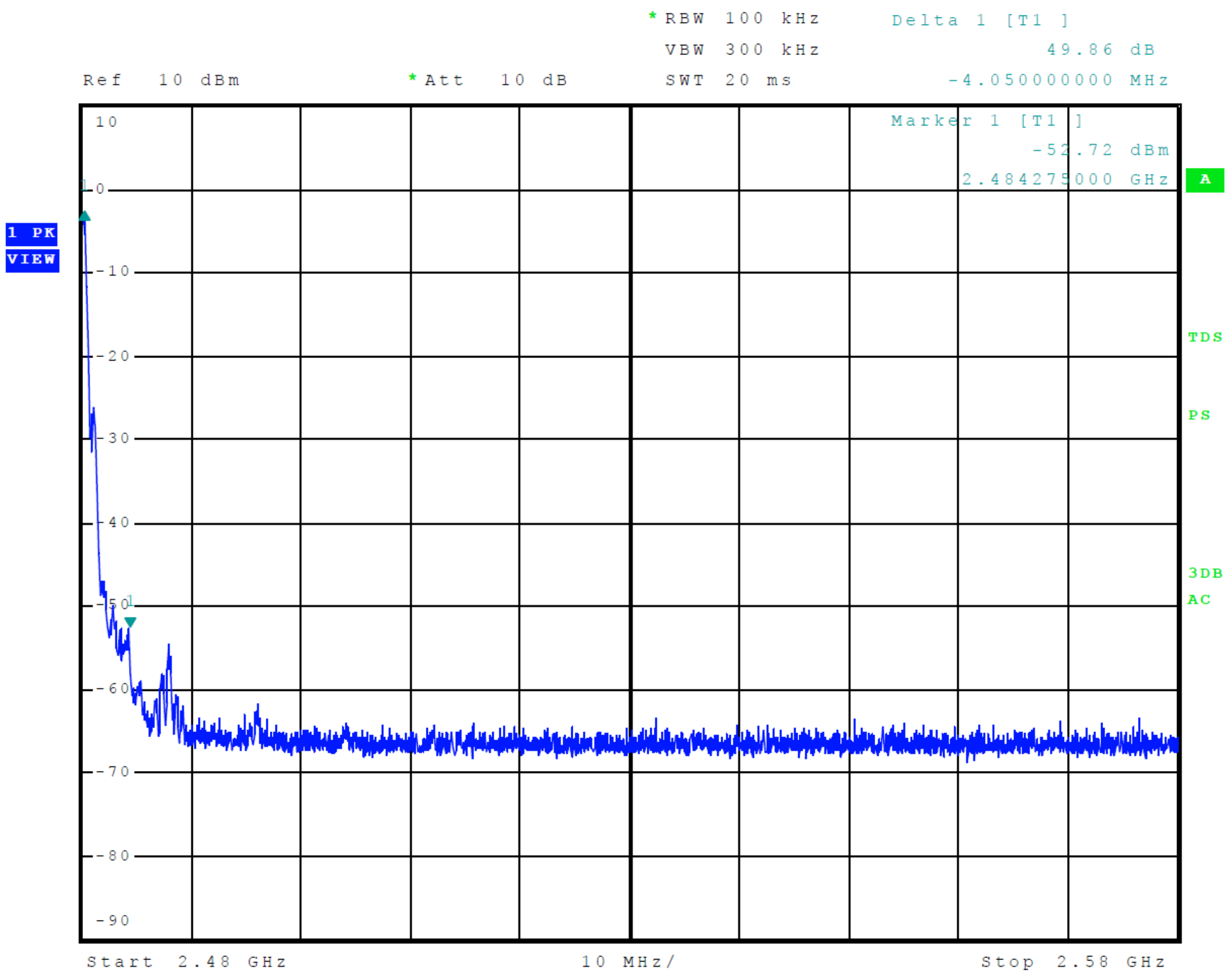


**Figure 19 Plot of Transmitter Emissions High Band Edge Mode 3 802.11b**

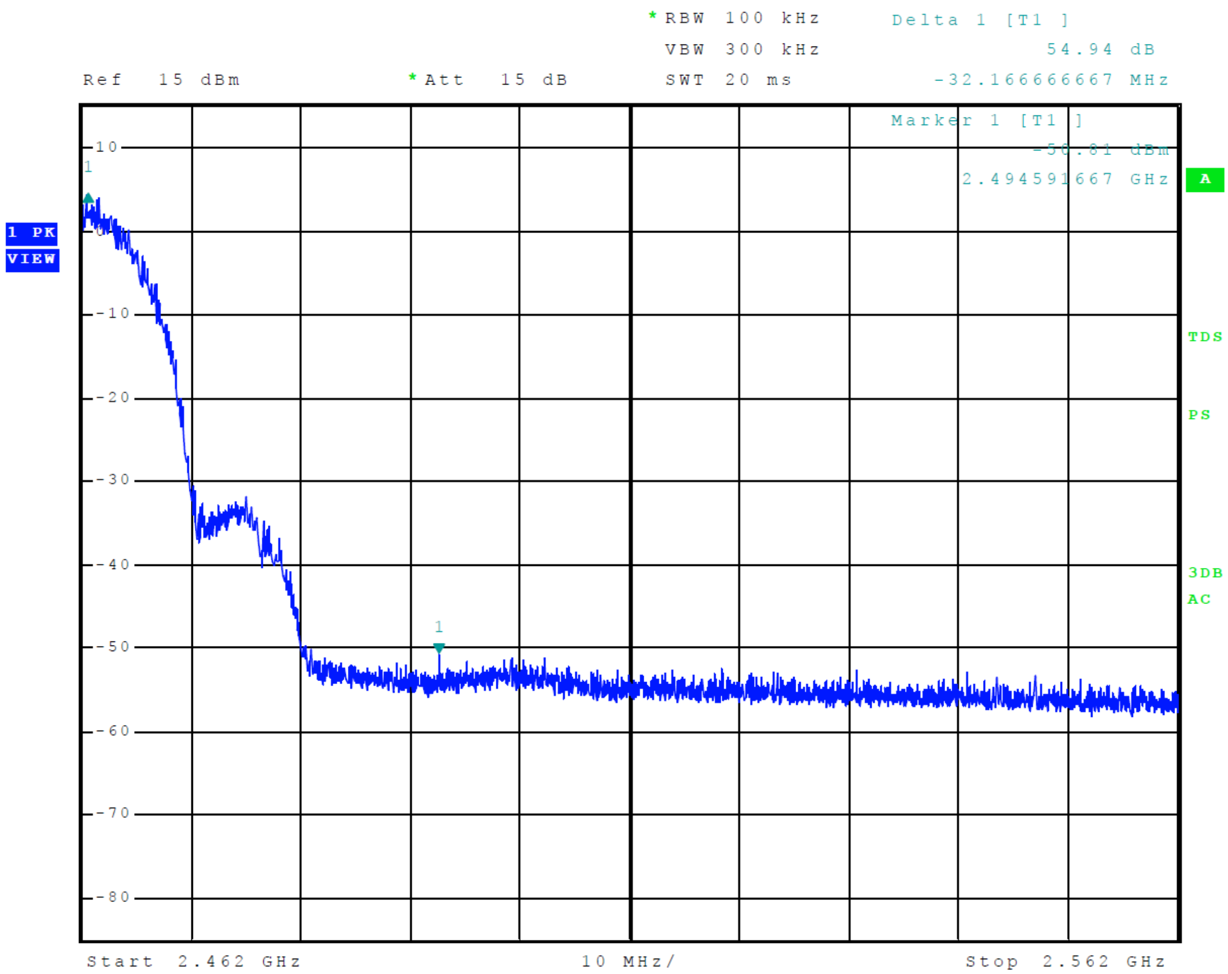
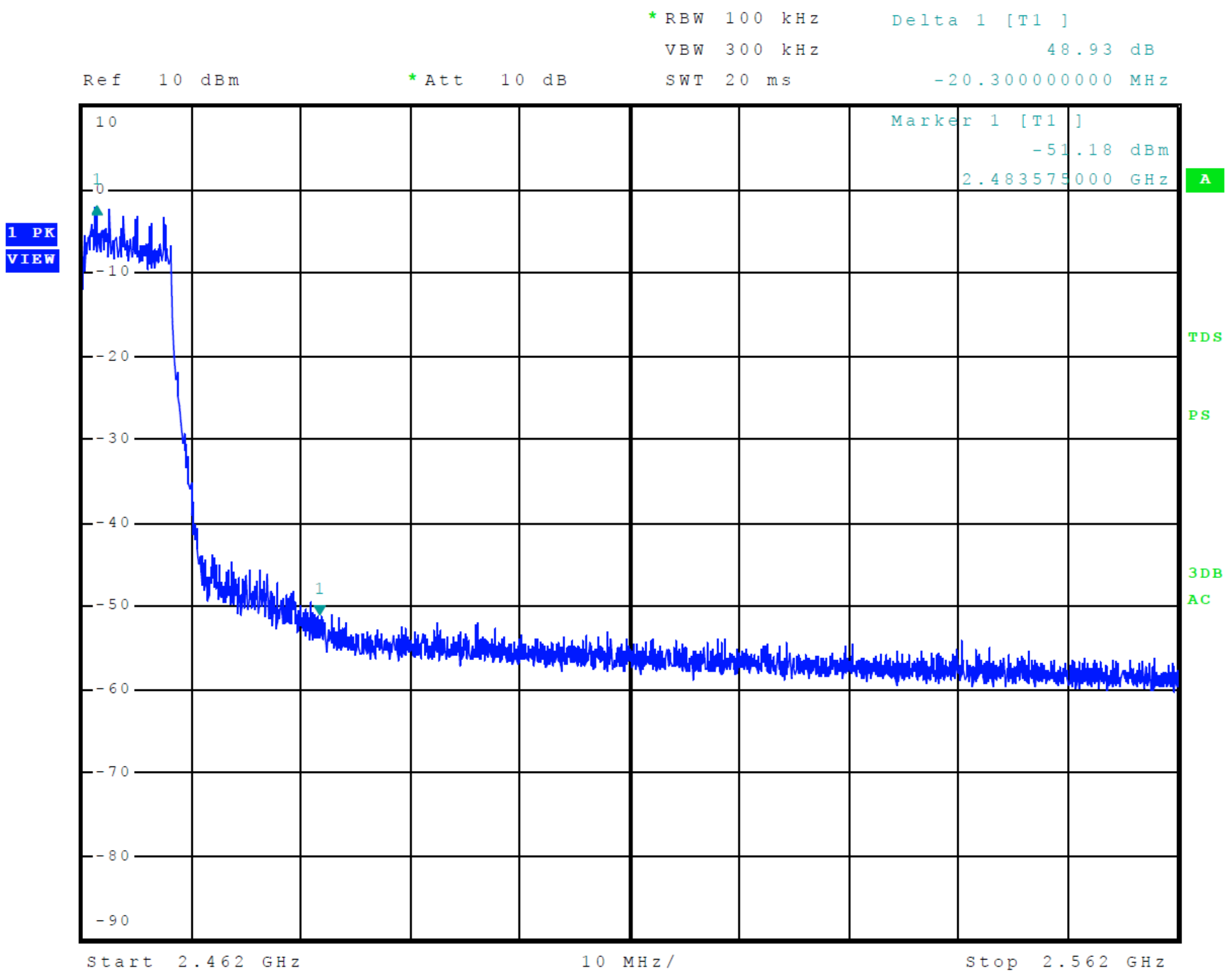


**Figure 20 Plot of Transmitter Emissions High Band Edge Mode 4 802.11g**



## Figure 21 Plot of Transmitter Emissions High Band Edge Mode 5 802.11n

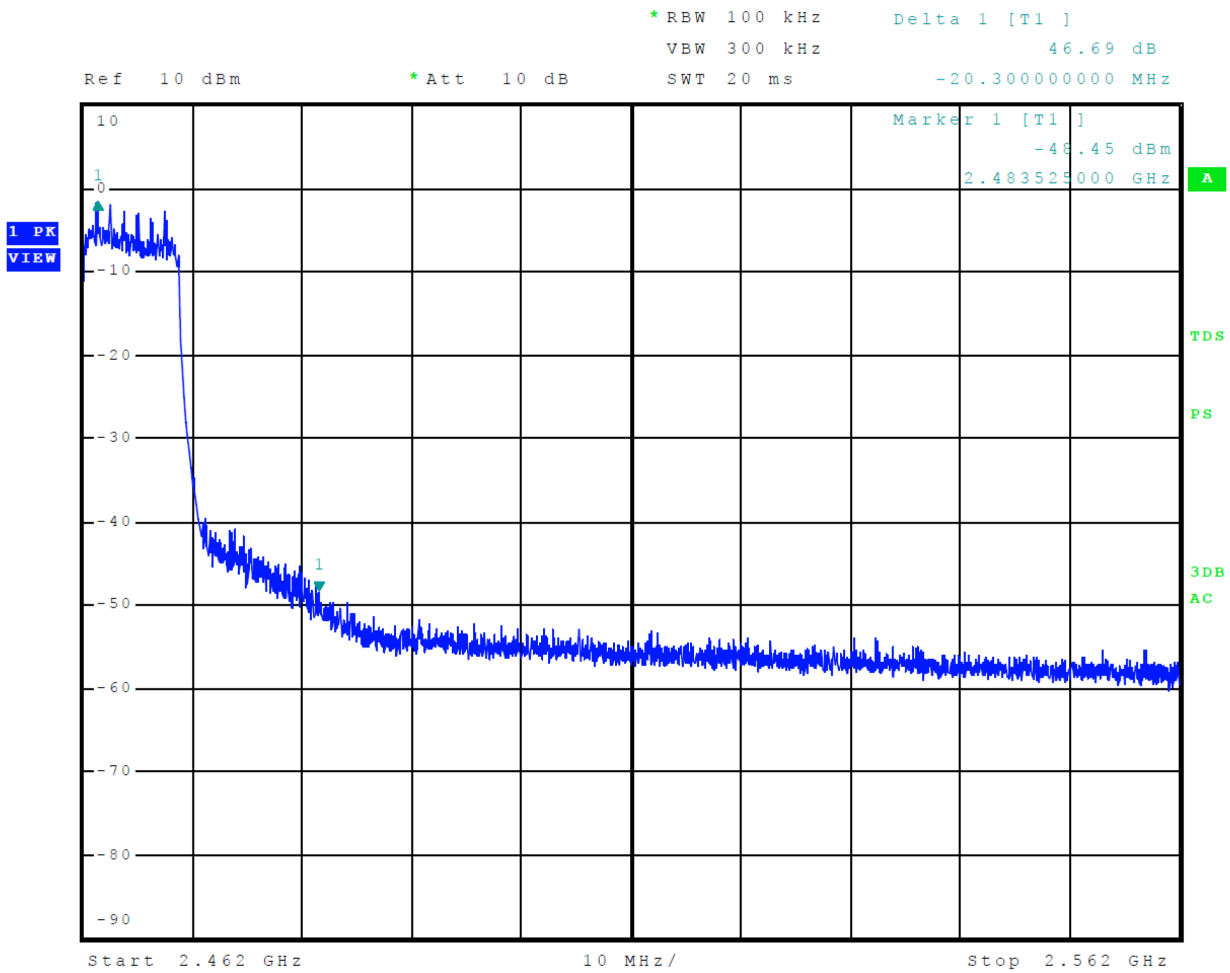


**Figure 22 Plot of 6-dB Occupied Bandwidth Mode 1 ANT**

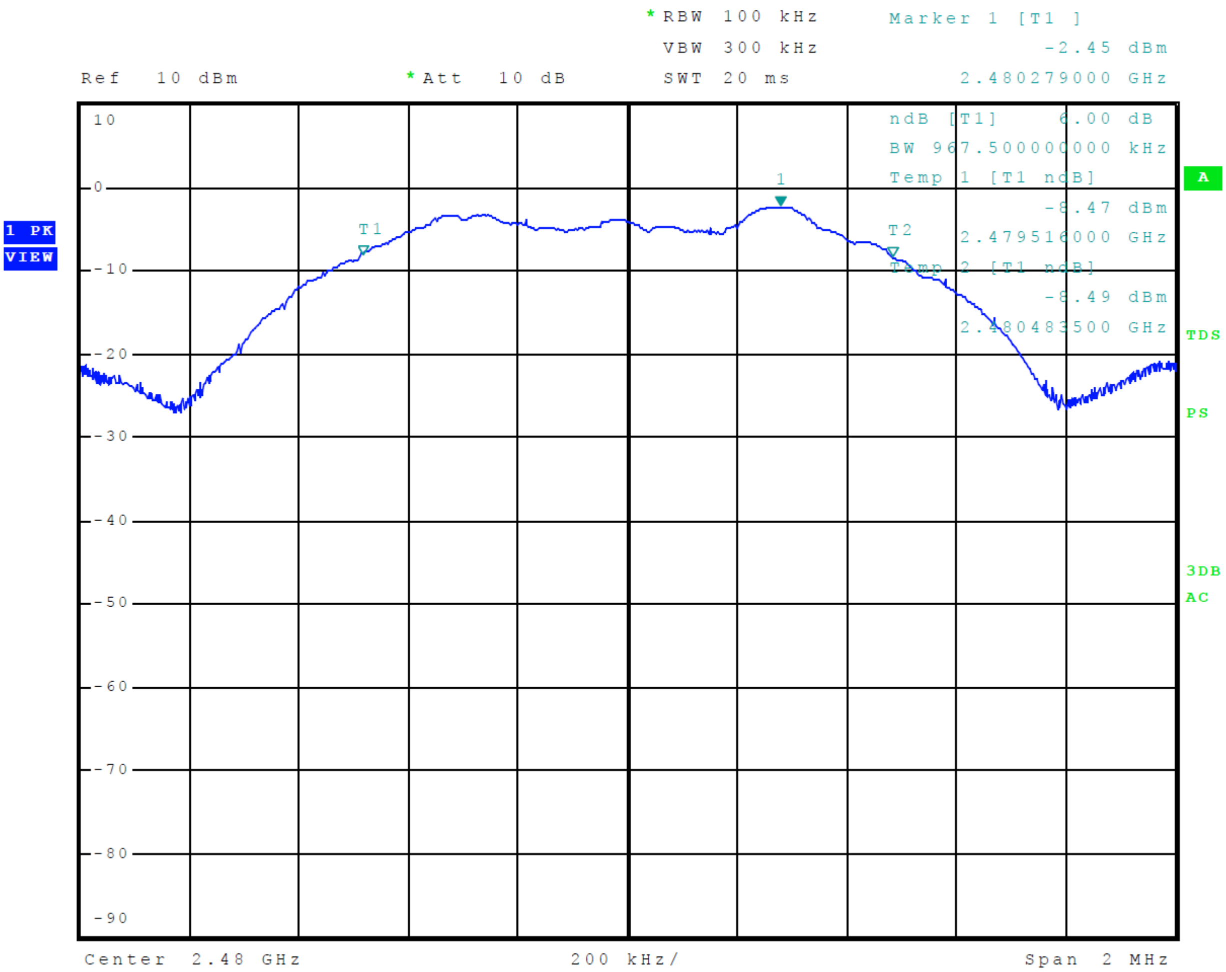
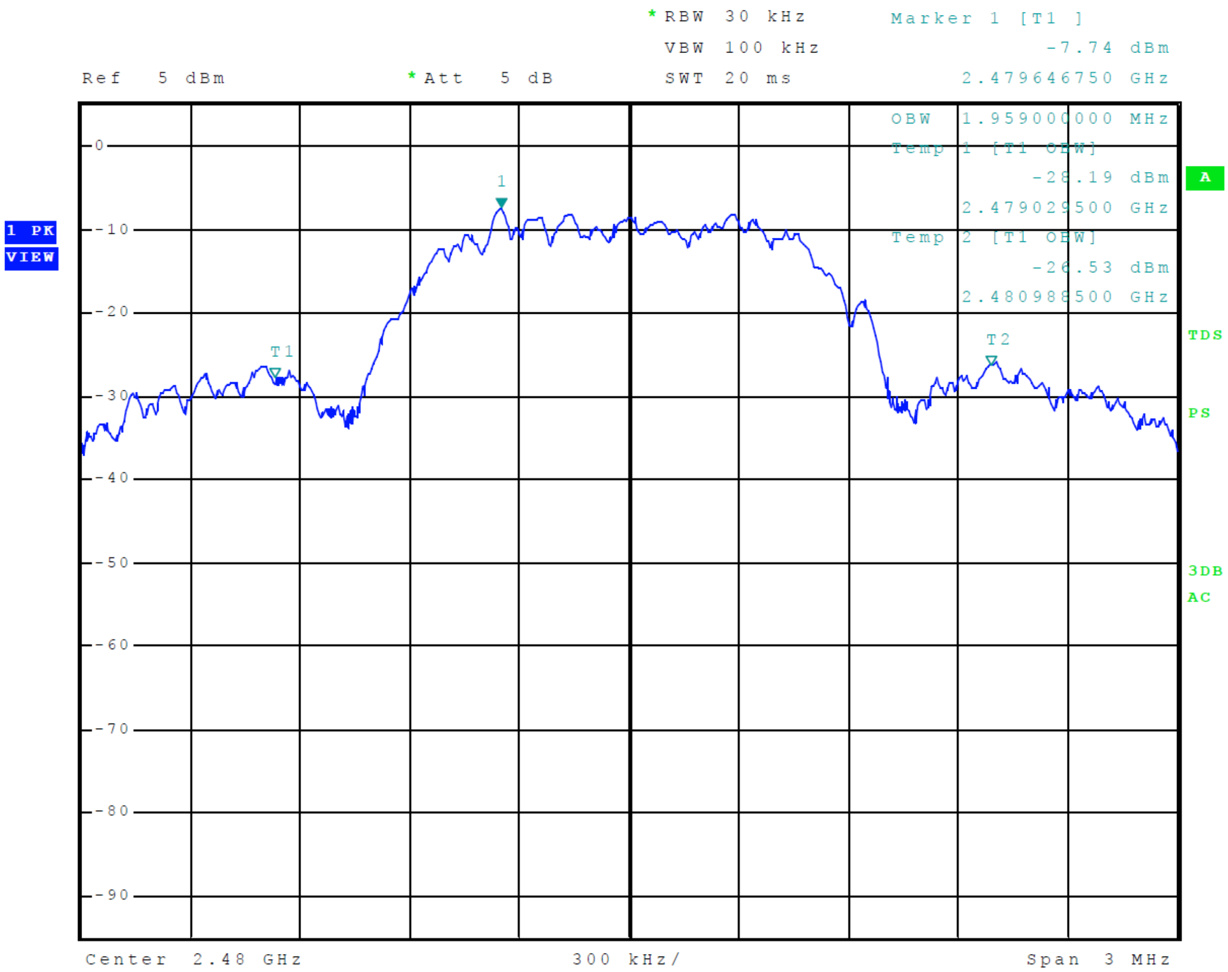


**Figure 23 Plot of 99% Occupied Bandwidth Mode 1 ANT**



NVLAP Lab Code 200087-0

**Figure 24 Plot of 6-dB Occupied Bandwidth Mode 2 BLE**

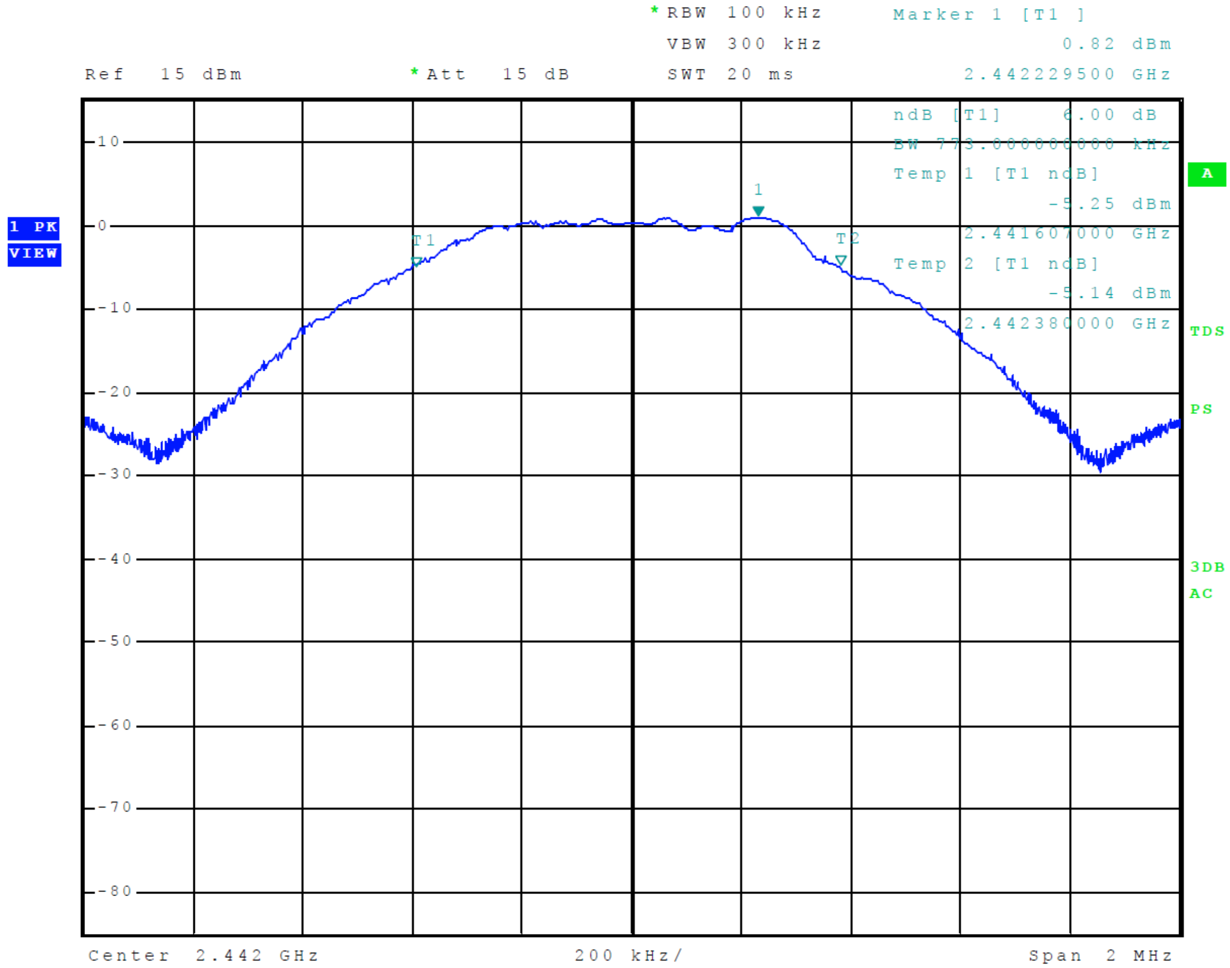
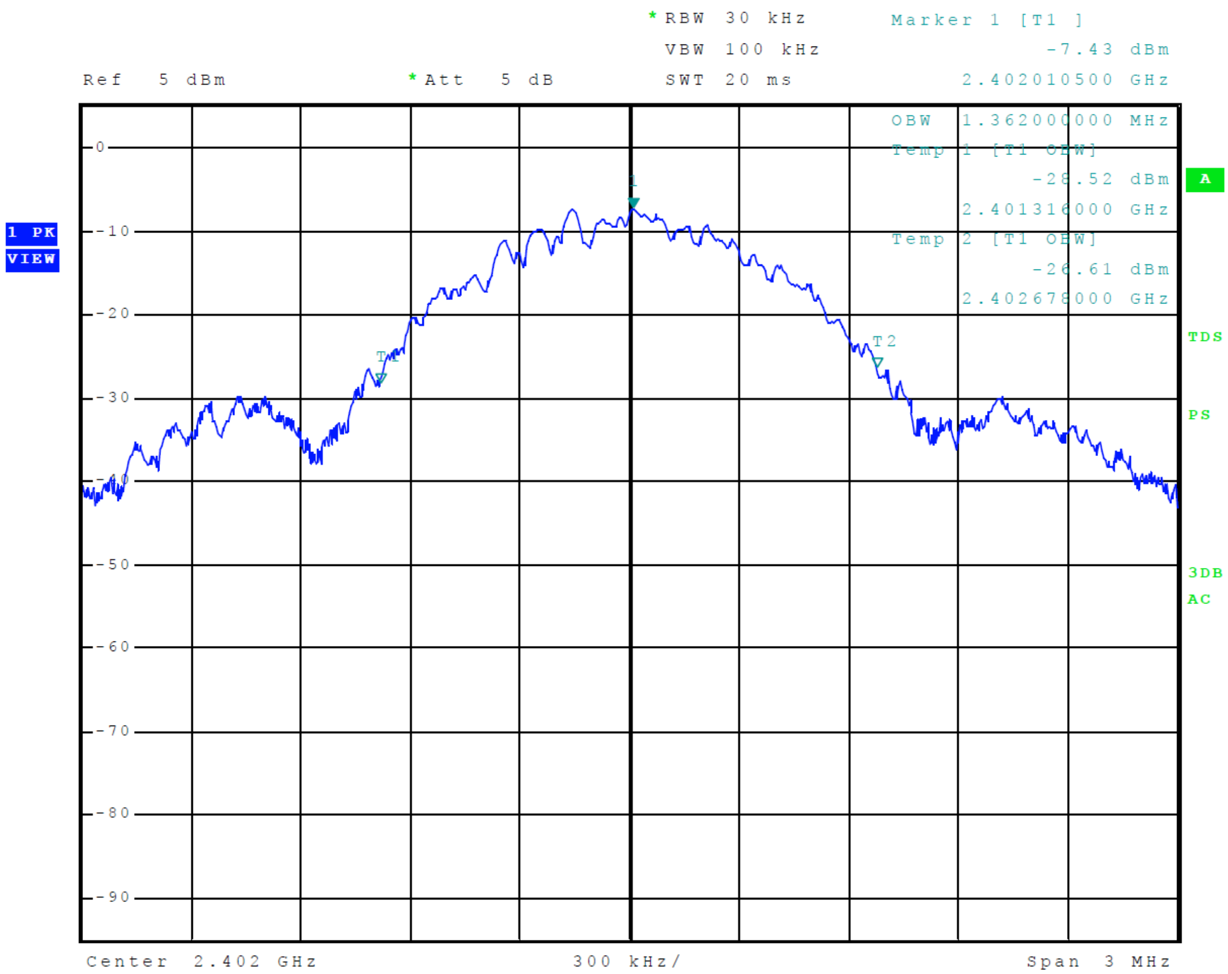


**Figure 25 Plot of 99% Occupied Bandwidth Mode 2 BLE**



## Figure 26 Plot of 6-dB Occupied Bandwidth Mode 3 802.11b

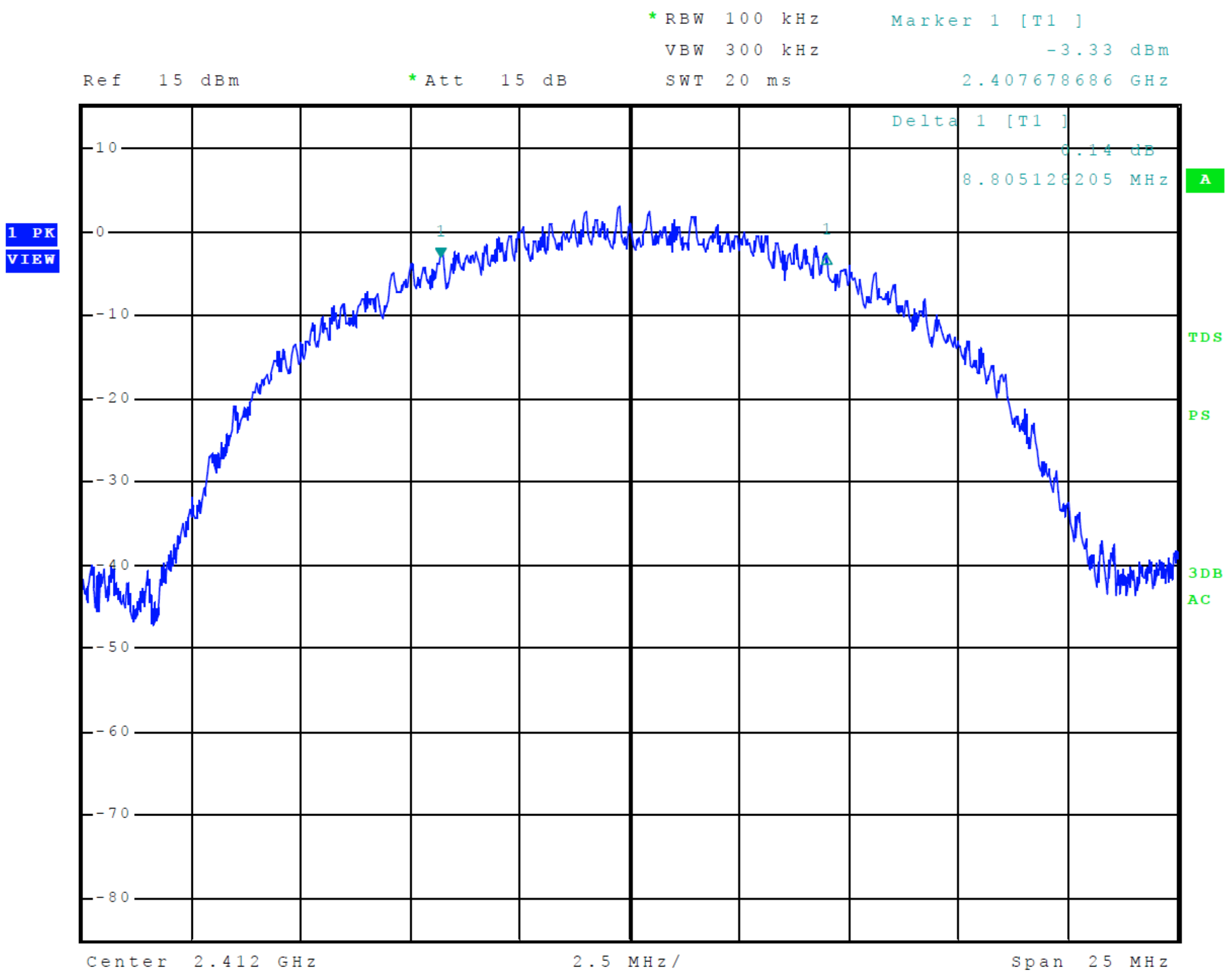


**Figure 27 Plot of 99% Occupied Bandwidth Mode 3 802.11b**

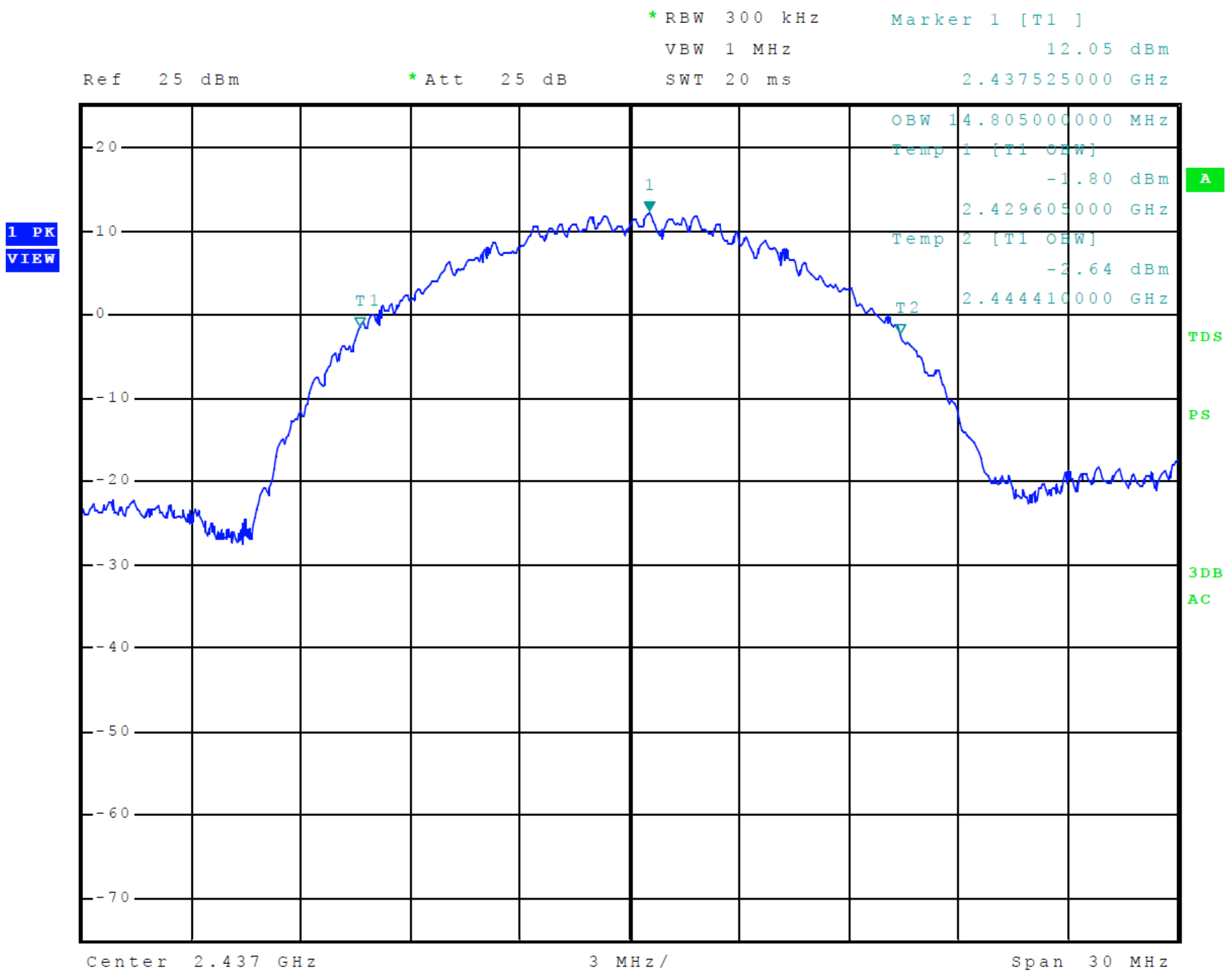


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**Figure 28 Plot of 6-dB Occupied Bandwidth Mode 4 802.11g**

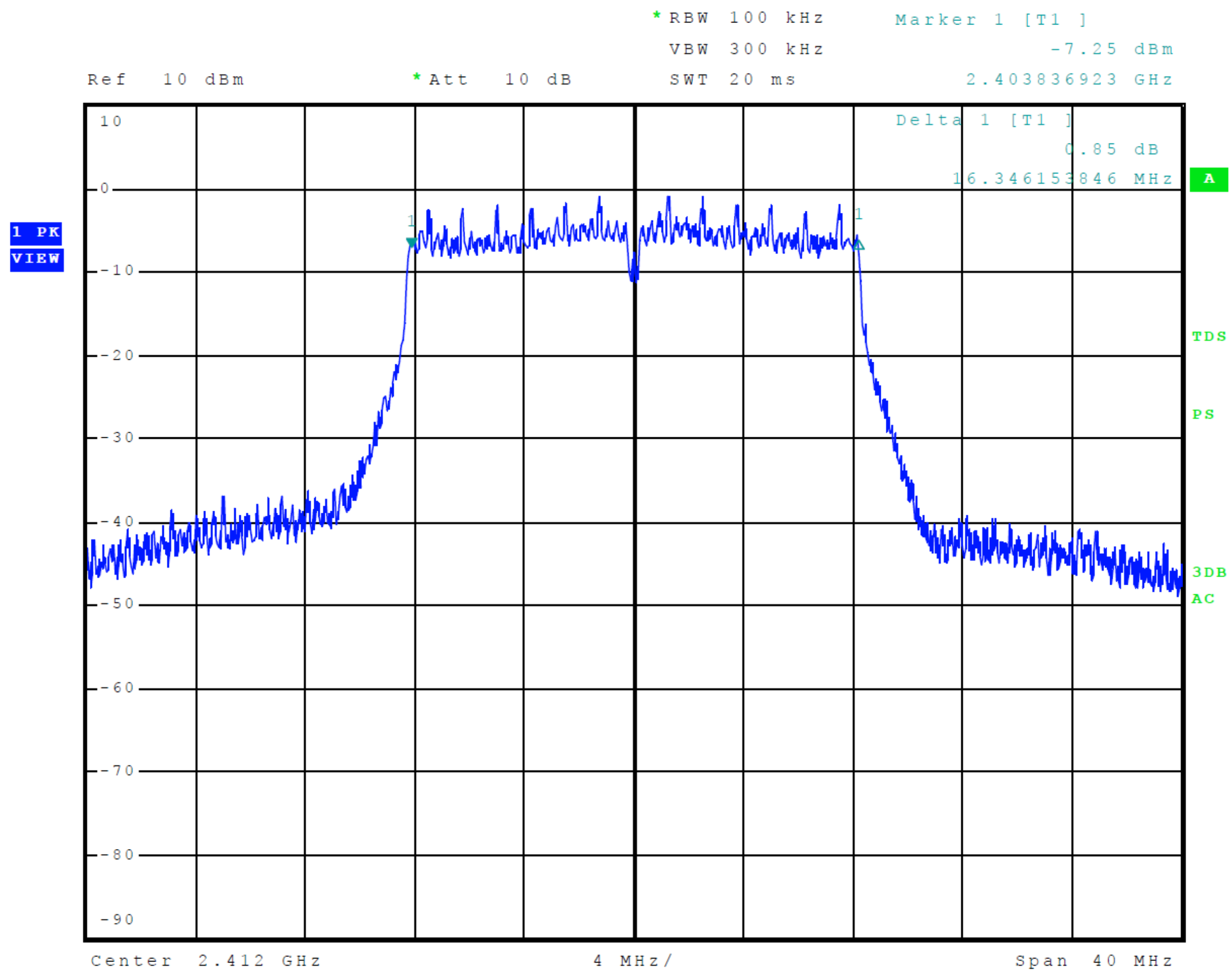

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**Figure 29 Plot of 99% Occupied Bandwidth Mode 4 802.11g**

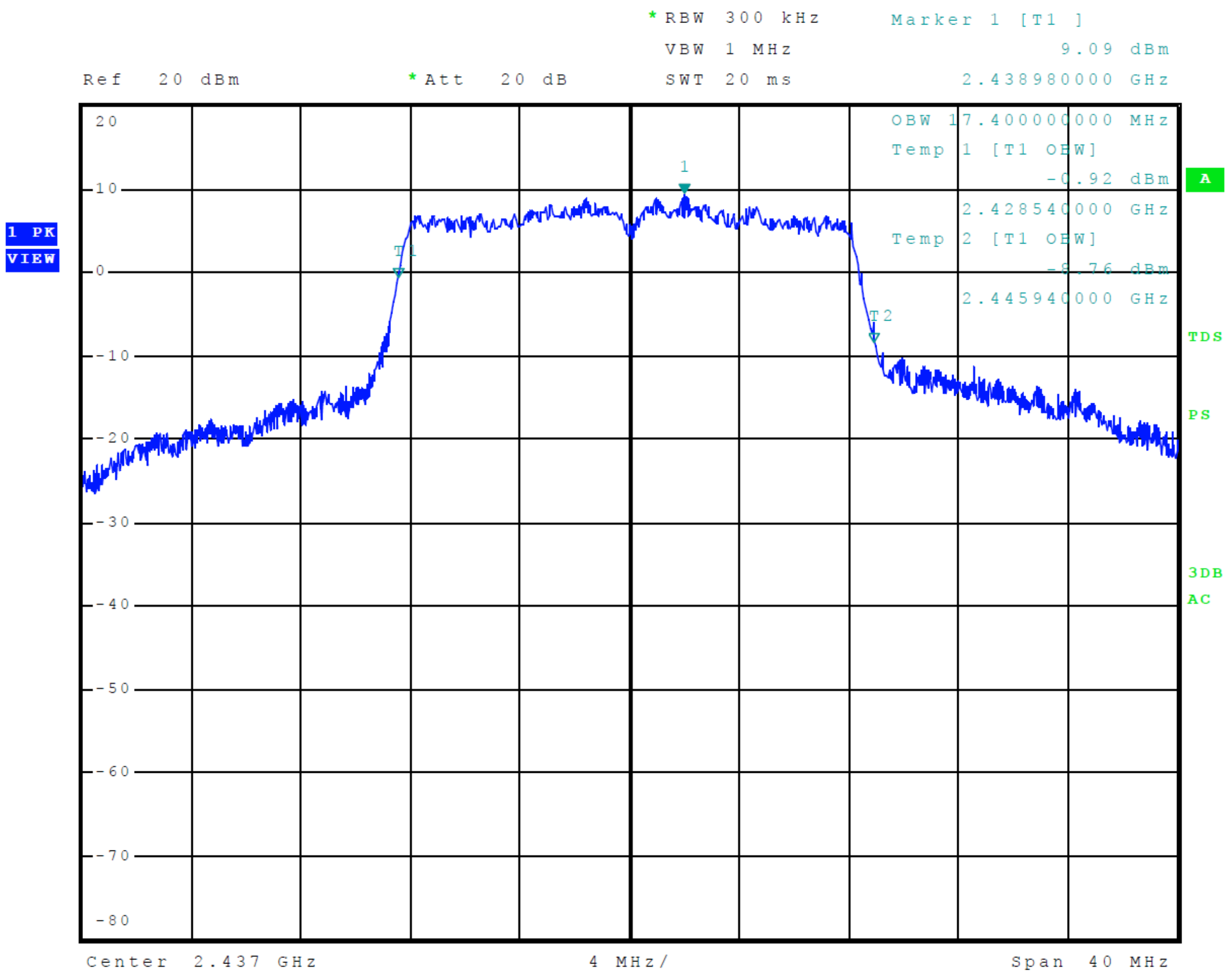


**Figure 30 Plot of 6-dB Occupied Bandwidth Mode 5 802.11n**

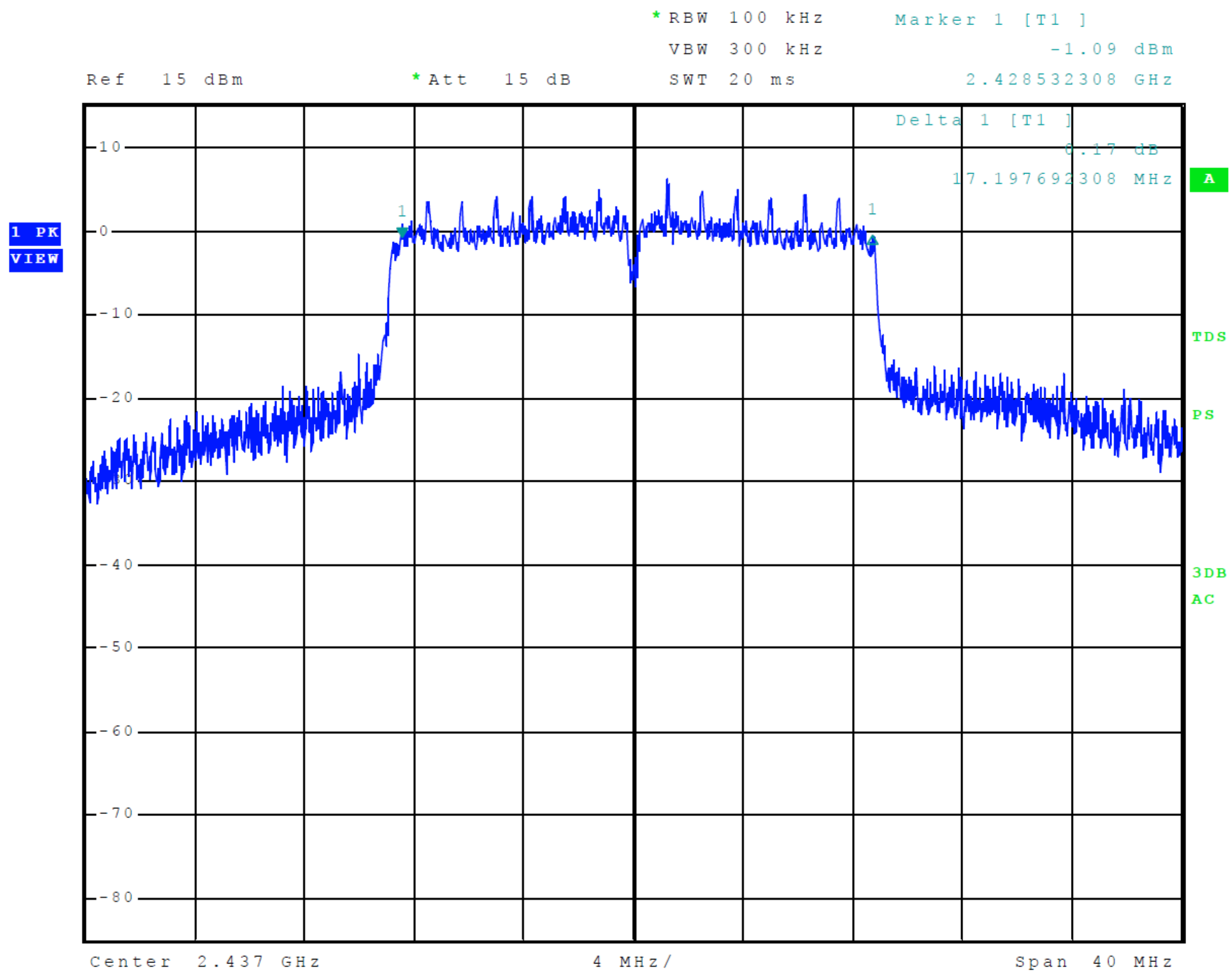


**Figure 31 Plot of 99% Occupied Bandwidth Mode 5 802.11n**

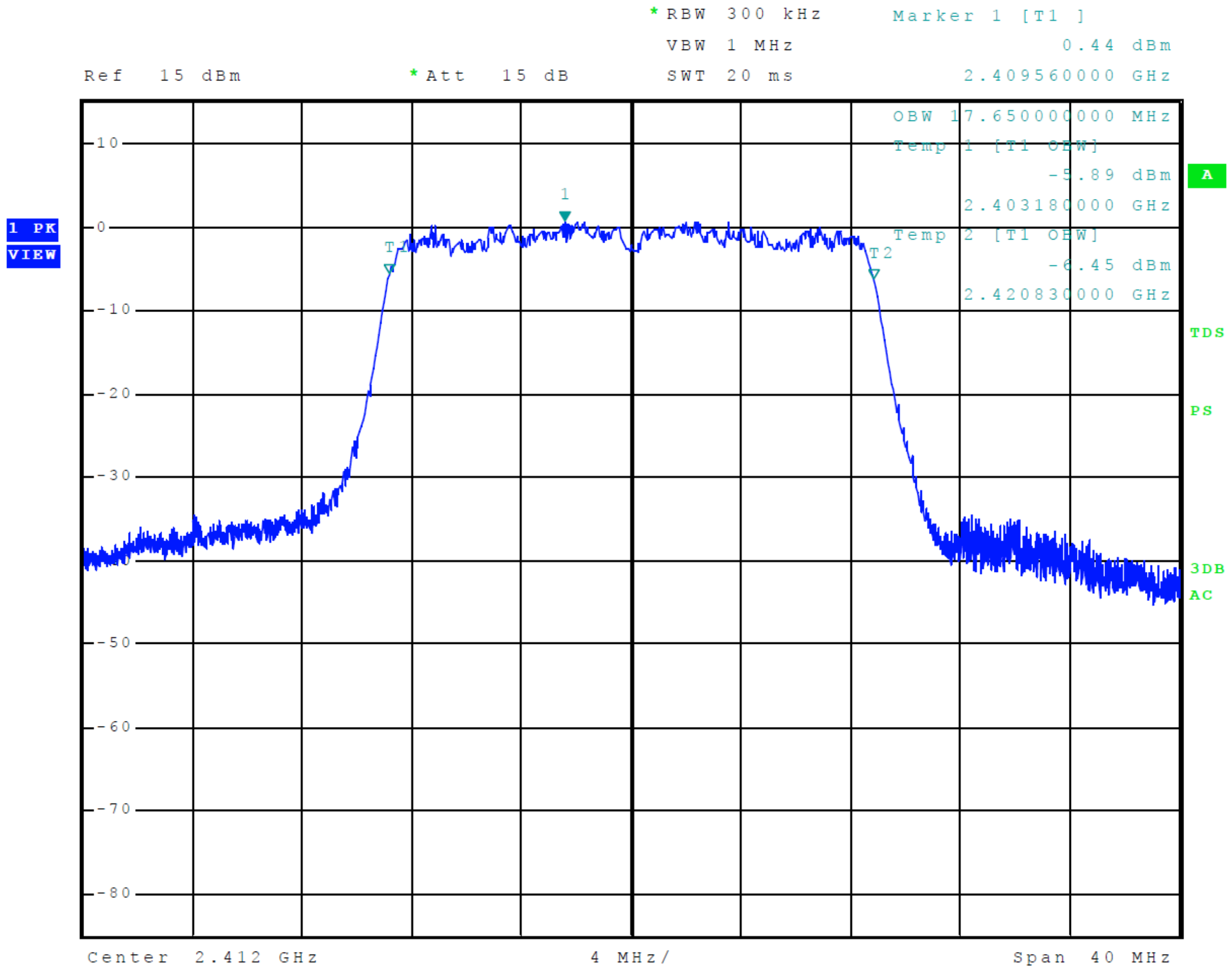


**Figure 32 Plot of Transmitter Power Spectral Density Mode 1 ANT**

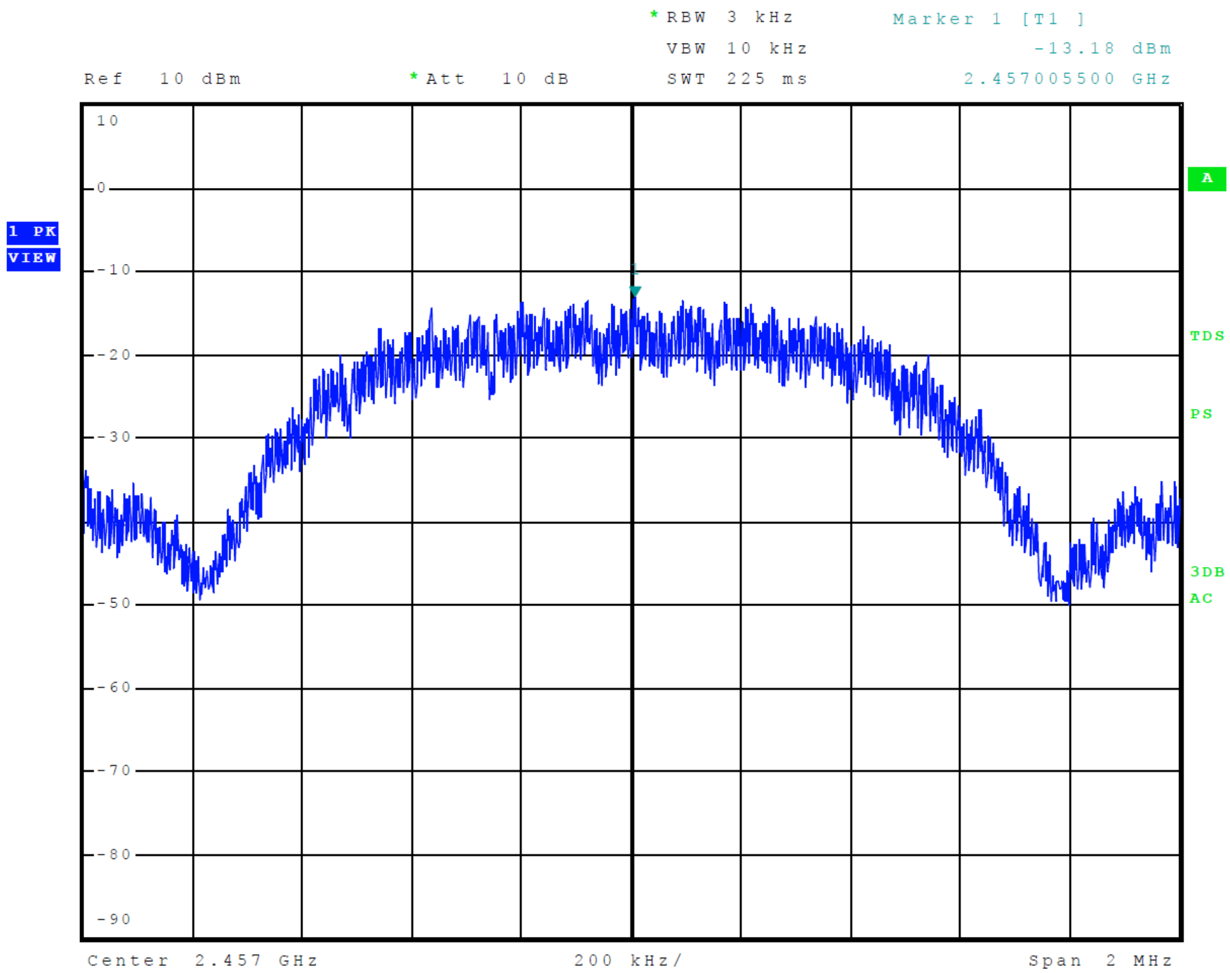


**Figure 33 Plot of Transmitter Power Spectral Density Mode 2 BLE**

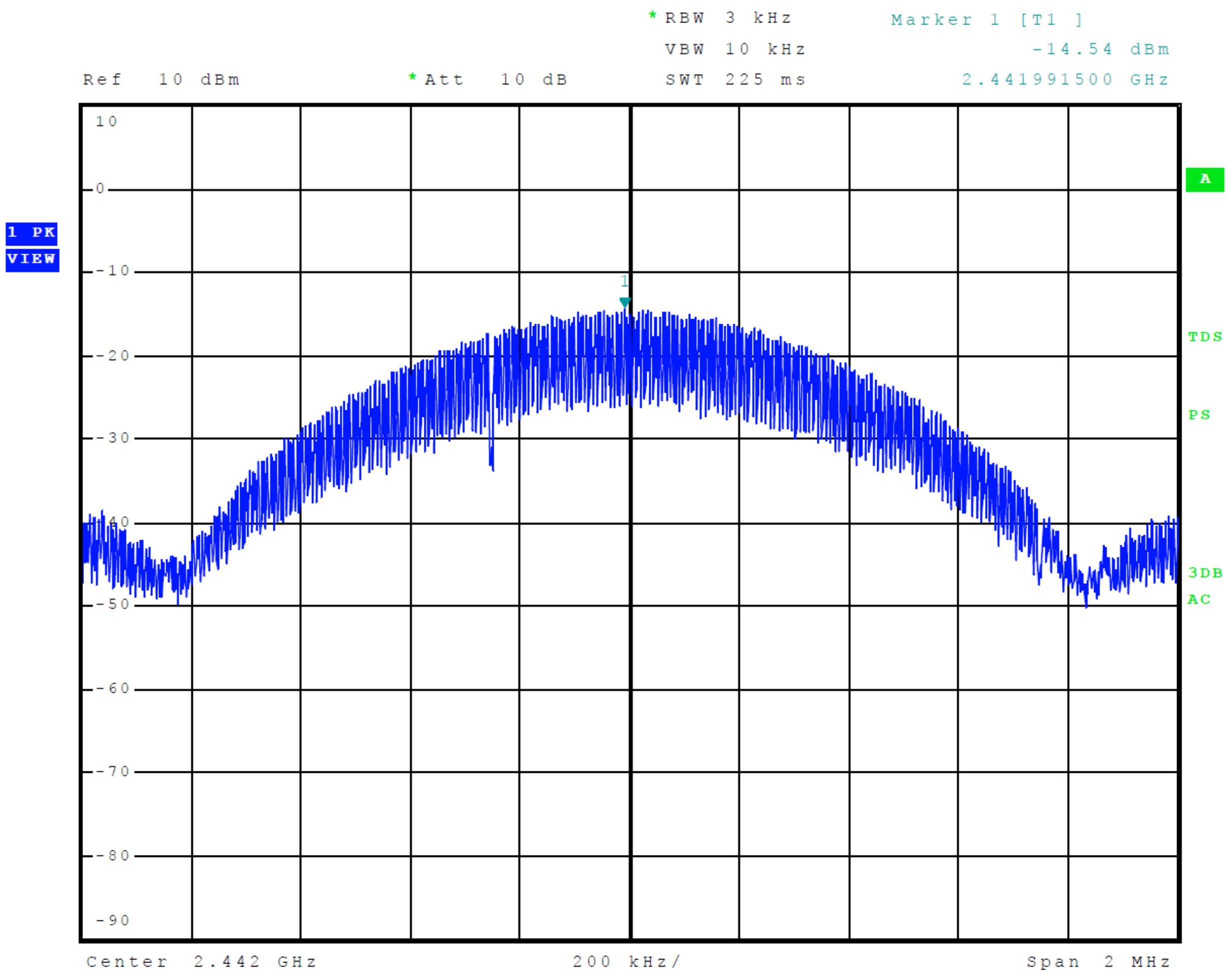


**Figure 34 Plot of Transmitter Power Spectral Density Mode 3 802.11b**

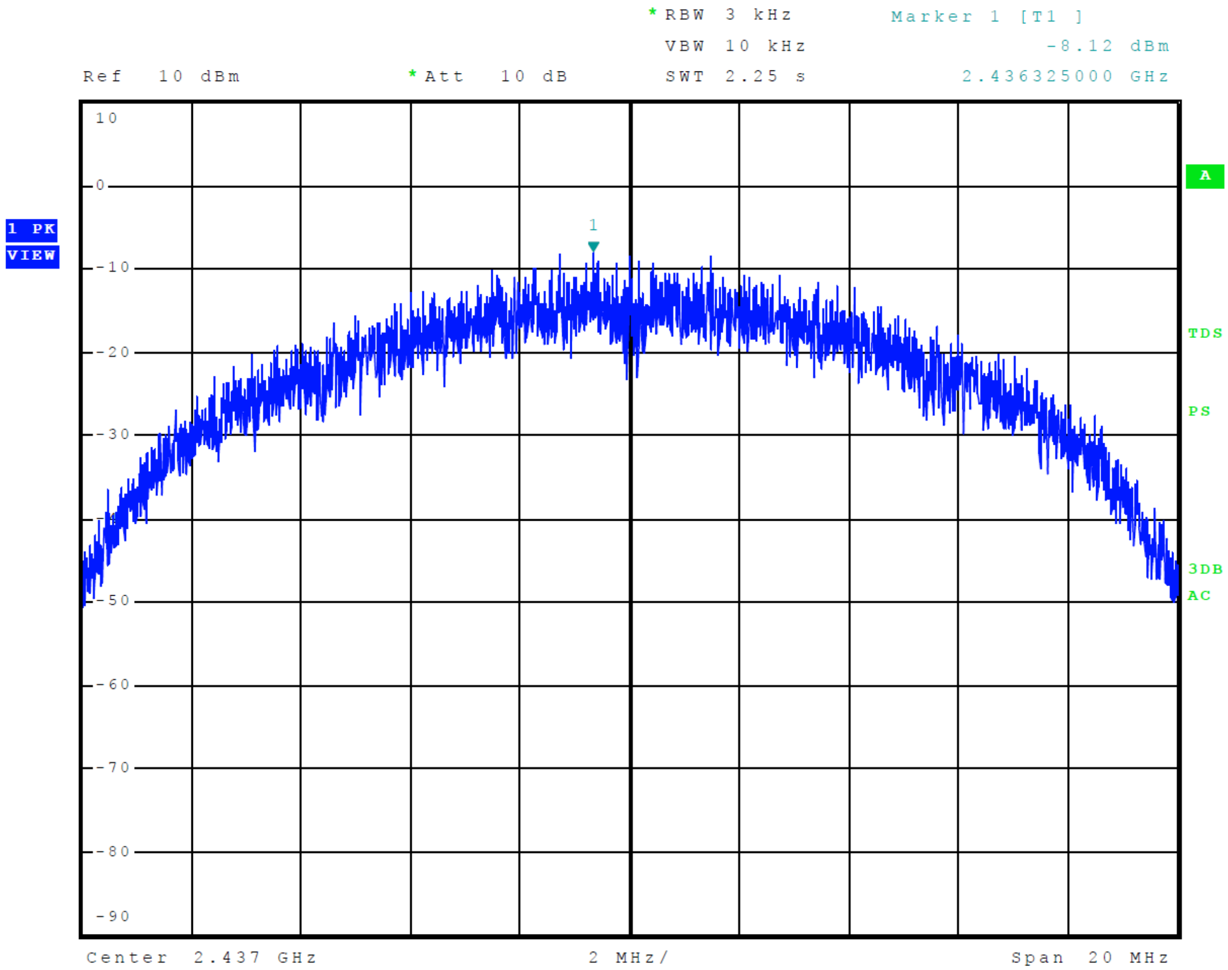


**Figure 35 Plot of Transmitter Power Spectral Density Mode 4 802.11g**

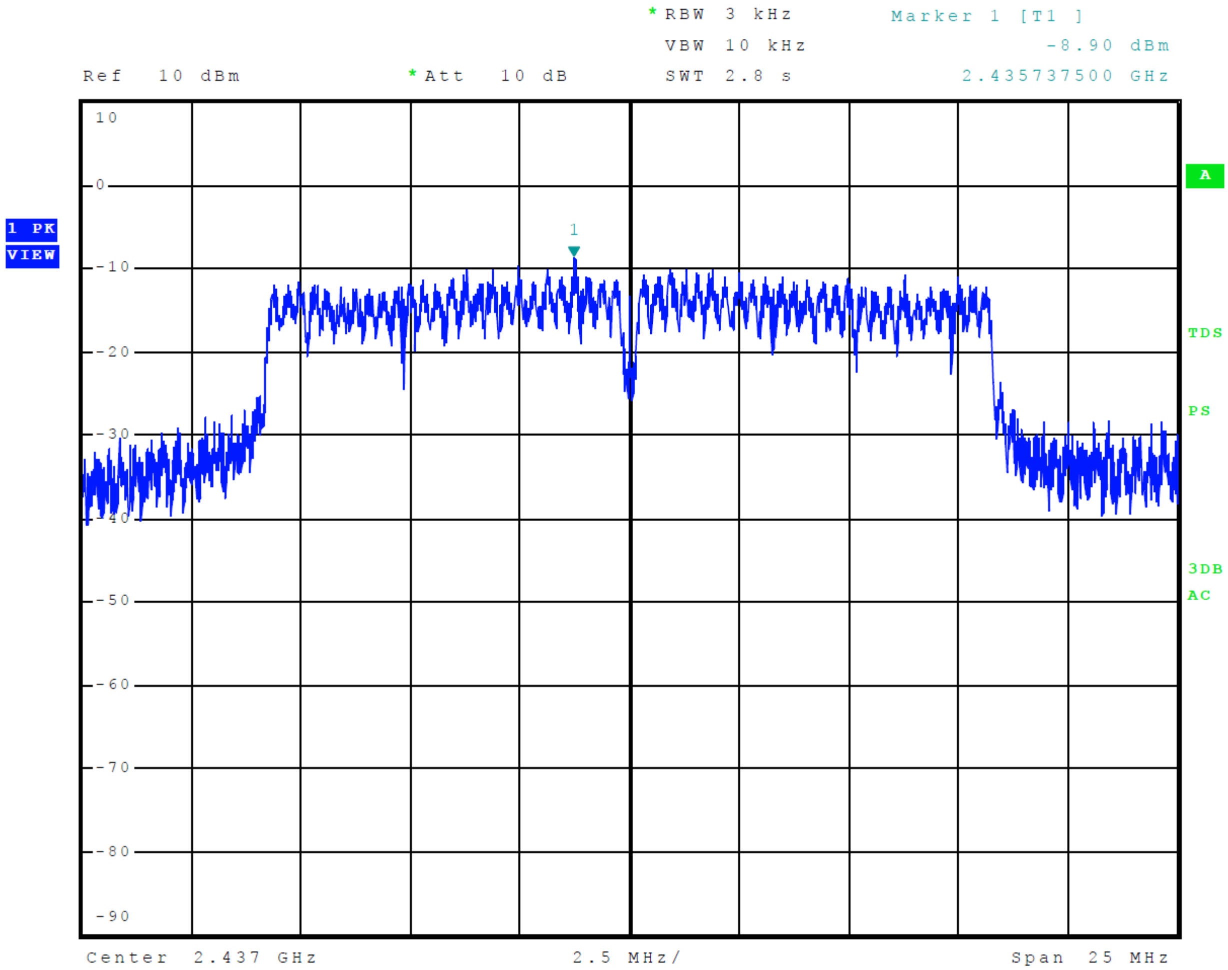
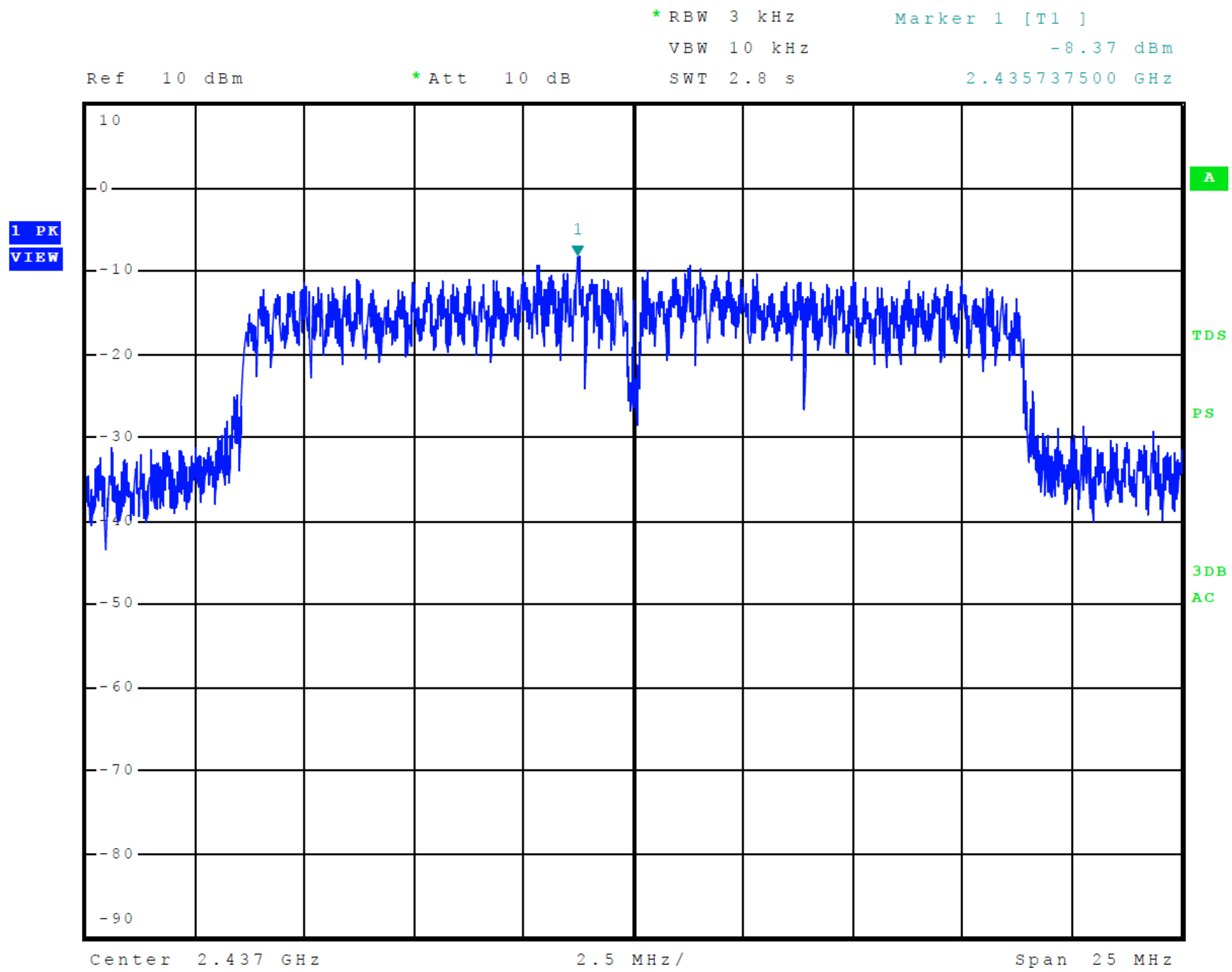


**Figure 36 Plot of Transmitter Power Spectral Density Mode 5 802.11n**



## *Transmitter Emissions Data*

**Table 13 Transmitter Radiated Emissions Mode 1 ANT**

| Frequency in MHz | Horizontal Peak (dBμV/m) | Horizontal Average (dBμV/m) | Vertical Peak (dBμV/m) | Vertical Average (dBμV/m) | Limit @ 3m (dBμV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2402.0 | -- | -- | -- | -- | -- | -- | -- |
| 4804.0 | 49.8 | 36.5 | 49.7 | 36.6 | 54.0 | -17.5 | -17.4 |
| 7206.0 | 54.0 | 40.7 | 53.3 | 40.6 | 54.0 | -13.3 | -13.4 |
| 9608.0 | 56.6 | 44.1 | 57.1 | 44.0 | 54.0 | -9.9 | -10.0 |
| 12010.0 | 60.5 | 47.9 | 60.0 | 47.4 | 54.0 | -6.1 | -6.6 |
| 14412.0 | 61.9 | 48.8 | 62.0 | 49.0 | 54.0 | -5.2 | -5.0 |
| 16814.0 | 65.3 | 51.3 | 65.5 | 51.6 | 54.0 | -2.7 | -2.4 |
| 2457.0 | -- | -- | -- | -- | -- | -- | -- |
| 4914.0 | 49.5 | 36.5 | 50.0 | 36.5 | 54.0 | -17.5 | -17.5 |
| 7371.0 | 53.4 | 40.5 | 53.4 | 40.6 | 54.0 | -13.5 | -13.4 |
| 9828.0 | 56.5 | 44.4 | 57.2 | 44.4 | 54.0 | -9.6 | -9.6 |
| 12285.0 | 60.8 | 48.0 | 61.2 | 48.0 | 54.0 | -6.0 | -6.0 |
| 14742.0 | 62.7 | 49.7 | 62.4 | 49.7 | 54.0 | -4.3 | -4.3 |
| 17199.0 | 64.4 | 51.9 | 64.2 | 51.9 | 54.0 | -2.1 | -2.1 |
| 2480.0 | -- | -- | -- | -- | -- | -- | -- |
| 4960.0 | 51.1 | 36.6 | 50.2 | 36.6 | 54.0 | -17.4 | -17.4 |
| 7440.0 | 53.9 | 40.8 | 53.7 | 40.8 | 54.0 | -13.2 | -13.2 |
| 9920.0 | 57.2 | 44.3 | 56.5 | 43.9 | 54.0 | -9.7 | -10.1 |
| 12400.0 | 60.7 | 47.7 | 61.4 | 48.0 | 54.0 | -6.3 | -6.0 |
| 14880.0 | 61.5 | 49.1 | 62.3 | 49.1 | 54.0 | -4.9 | -4.9 |
| 17360.0 | 65.0 | 52.1 | 65.6 | 52.1 | 54.0 | -1.9 | -1.9 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency range below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

**Table 14 Transmitter Radiated Emissions Mode 2 BLE**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2402.0 | -- | -- | -- | -- | -- | -- | -- |
| 4804.0 | 50.2 | 36.6 | 49.9 | 36.6 | 54.0 | -17.4 | -17.4 |
| 7206.0 | 53.8 | 40.7 | 53.6 | 40.6 | 54.0 | -13.3 | -13.4 |
| 9608.0 | 56.9 | 44.1 | 57.2 | 43.9 | 54.0 | -9.9 | -10.1 |
| 12010.0 | 60.1 | 47.4 | 60.2 | 47.5 | 54.0 | -6.6 | -6.5 |
| 14412.0 | 62.1 | 49.0 | 62.7 | 49.0 | 54.0 | -5.0 | -5.0 |
| 16814.0 | 64.7 | 51.7 | 64.5 | 51.6 | 54.0 | -2.3 | -2.4 |
| 2442.0 | -- | -- | -- | -- | -- | -- | -- |
| 4884.0 | 50.0 | 36.7 | 50.1 | 36.5 | 54.0 | -17.3 | -17.5 |
| 7326.0 | 53.5 | 40.8 | 54.3 | 40.7 | 54.0 | -13.2 | -13.3 |
| 9768.0 | 57.0 | 44.2 | 57.5 | 44.1 | 54.0 | -9.8 | -9.9 |
| 12210.0 | 61.2 | 48.1 | 61.5 | 48.1 | 54.0 | -5.9 | -5.9 |
| 14652.0 | 52.3 | 49.6 | 63.1 | 49.7 | 54.0 | -4.4 | -4.3 |
| 17094.0 | 64.2 | 51.4 | 64.1 | 51.4 | 54.0 | -2.6 | -2.6 |
| 2480.0 | -- | -- | -- | -- | -- | -- | -- |
| 4960.0 | 50.1 | 36.8 | 50.1 | 36.6 | 54.0 | -17.2 | -17.4 |
| 7440.0 | 53.9 | 40.6 | 53.8 | 40.7 | 54.0 | -13.4 | -13.3 |
| 9920.0 | 57.2 | 44.2 | 56.9 | 44.0 | 54.0 | -9.8 | -10.0 |
| 12400.0 | 60.4 | 47.3 | 59.8 | 47.3 | 54.0 | -6.7 | -6.7 |
| 14880.0 | 61.5 | 48.4 | 61.3 | 48.5 | 54.0 | -5.6 | -5.5 |
| 17360.0 | 64.4 | 51.2 | 64.5 | 51.3 | 54.0 | -2.8 | -2.7 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency range below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

**Table 15 Transmitter Radiated Emissions Mode 3 802.11b**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2412.0 | -- | -- | -- | -- | -- | -- | -- |
| 4824.0 | 50.0 | 36.3 | 49.9 | 36.3 | 54.0 | -17.7 | -17.7 |
| 7236.0 | 53.2 | 40.4 | 53.9 | 40.4 | 54.0 | -13.6 | -13.6 |
| 9648.0 | 57.1 | 44.4 | 57.0 | 44.1 | 54.0 | -9.6 | -9.9 |
| 12060.0 | 60.4 | 47.7 | 60.2 | 47.3 | 54.0 | -6.3 | -6.7 |
| 14472.0 | 61.6 | 48.8 | 61.9 | 48.9 | 54.0 | -5.2 | -5.1 |
| 16884.0 | 66.2 | 53.2 | 65.8 | 53.1 | 54.0 | -0.8 | -0.9 |
| 2437.0 | -- | -- | -- | -- | -- | -- | -- |
| 4874.0 | 49.8 | 36.5 | 49.6 | 36.4 | 54.0 | -17.5 | -17.6 |
| 7311.0 | 53.8 | 40.5 | 53.9 | 40.5 | 54.0 | -13.5 | -13.5 |
| 9748.0 | 57.0 | 44.0 | 56.8 | 44.1 | 54.0 | -10.0 | -9.9 |
| 12185.0 | 60.7 | 48.1 | 61.1 | 48.0 | 54.0 | -5.9 | -6.0 |
| 14622.0 | 62.6 | 49.9 | 63.1 | 49.9 | 54.0 | -4.1 | -4.1 |
| 17059.0 | 65.3 | 52.5 | 65.4 | 52.5 | 54.0 | -1.5 | -1.5 |
| 2462.0 | -- | -- | -- | -- | -- | -- | -- |
| 4924.0 | 49.4 | 36.5 | 49.6 | 36.5 | 54.0 | -17.5 | -17.5 |
| 7386.0 | 54.1 | 40.6 | 53.8 | 40.6 | 54.0 | -13.4 | -13.4 |
| 9848.0 | 57.7 | 44.5 | 56.9 | 44.5 | 54.0 | -9.5 | -9.5 |
| 12310.0 | 61.2 | 48.1 | 61.5 | 48.2 | 54.0 | -5.9 | -5.8 |
| 14772.0 | 62.7 | 49.6 | 62.7 | 49.7 | 54.0 | -4.4 | -4.3 |
| 17234.0 | 64.1 | 51.5 | 64.2 | 51.5 | 54.0 | -2.5 | -2.5 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

**Table 16 Transmitter Radiated Emissions Mode 4 802.11g**

| Frequency in MHz | Horizontal Peak (dBμV/m) | Horizontal Average (dBμV/m) | Vertical Peak (dBμV/m) | Vertical Average (dBμV/m) | Limit @ 3m (dBμV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2412.0 | -- | -- | -- | -- | -- | -- | -- |
| 4824.0 | 49.3 | 36.2 | 49.7 | 36.2 | 54.0 | -17.8 | -17.8 |
| 7236.0 | 53.4 | 40.2 | 52.9 | 40.2 | 54.0 | -13.8 | -13.8 |
| 9648.0 | 57.5 | 44.1 | 57.0 | 44.1 | 54.0 | -9.9 | -9.9 |
| 12060.0 | 60.0 | 47.3 | 61.0 | 47.2 | 54.0 | -6.7 | -6.8 |
| 14472.0 | 61.3 | 48.5 | 61.5 | 48.5 | 54.0 | -5.5 | -5.5 |
| 16884.0 | 66.0 | 52.7 | 65.3 | 52.7 | 54.0 | -1.3 | -1.3 |
| 2437.0 | -- | -- | -- | -- | -- | -- | -- |
| 4874.0 | 49.7 | 36.4 | 49.4 | 36.4 | 54.0 | -17.6 | -17.6 |
| 7311.0 | 53.3 | 40.5 | 53.8 | 40.5 | 54.0 | -13.5 | -13.5 |
| 9748.0 | 56.5 | 44.0 | 57.0 | 44.0 | 54.0 | -10.0 | -10.0 |
| 12185.0 | 61.0 | 48.5 | 60.7 | 47.9 | 54.0 | -5.5 | -6.1 |
| 14622.0 | 62.2 | 49.7 | 62.9 | 49.8 | 54.0 | -4.3 | -4.2 |
| 17059.0 | 65.4 | 52.5 | 65.5 | 52.5 | 54.0 | -1.5 | -1.5 |
| 2462.0 | -- | -- | -- | -- | -- | -- | -- |
| 4924.0 | 50.0 | 36.5 | 49.6 | 36.5 | 54.0 | -17.5 | -17.5 |
| 7386.0 | 53.6 | 41.0 | 53.1 | 40.5 | 54.0 | -13.0 | -13.5 |
| 9848.0 | 57.5 | 44.6 | 57.4 | 44.6 | 54.0 | -9.4 | -9.4 |
| 12310.0 | 60.4 | 48.1 | 60.9 | 48.1 | 54.0 | -5.9 | -5.9 |
| 14772.0 | 63.3 | 49.6 | 62.7 | 49.6 | 54.0 | -4.4 | -4.4 |
| 17234.0 | 64.3 | 51.5 | 64.3 | 51.5 | 54.0 | -2.5 | -2.5 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

**Table 17 Transmitter Radiated Emissions Mode 5 802.11n**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2412.0 | -- | -- | -- | -- | -- | -- | -- |
| 4824.0 | 49.9 | 36.2 | 49.1 | 36.3 | 54.0 | -17.8 | -17.7 |
| 7236.0 | 53.4 | 40.4 | 53.3 | 40.4 | 54.0 | -13.6 | -13.6 |
| 9648.0 | 56.7 | 44.0 | 57.2 | 44.0 | 54.0 | -10.0 | -10.0 |
| 12060.0 | 59.9 | 47.0 | 59.7 | 47.1 | 54.0 | -7.0 | -6.9 |
| 14472.0 | 61.7 | 48.6 | 61.5 | 48.7 | 54.0 | -5.4 | -5.3 |
| 16884.0 | 65.4 | 52.5 | 66.4 | 53.0 | 54.0 | -1.5 | -1.0 |
| 2437.0 | -- | -- | -- | -- | -- | -- | -- |
| 4874.0 | 50.2 | 36.3 | 49.3 | 36.4 | 54.0 | -17.7 | -17.6 |
| 7311.0 | 53.3 | 40.5 | 53.7 | 40.5 | 54.0 | -13.5 | -13.5 |
| 9748.0 | 56.4 | 43.9 | 56.9 | 43.9 | 54.0 | -10.1 | -10.1 |
| 12185.0 | 61.8 | 49.0 | 61.3 | 47.9 | 54.0 | -5.0 | -6.1 |
| 14622.0 | 62.5 | 49.7 | 62.5 | 49.7 | 54.0 | -4.3 | -4.3 |
| 17059.0 | 65.5 | 52.6 | 65.2 | 52.5 | 54.0 | -1.4 | -1.5 |
| 2462.0 | -- | -- | -- | -- | -- | -- | -- |
| 4924.0 | 49.9 | 36.4 | 49.5 | 36.5 | 54.0 | -17.6 | -17.5 |
| 7386.0 | 53.3 | 40.5 | 53.6 | 40.5 | 54.0 | -13.5 | -13.5 |
| 9848.0 | 57.1 | 44.5 | 58.2 | 44.5 | 54.0 | -9.5 | -9.5 |
| 12310.0 | 60.9 | 47.8 | 60.9 | 48.1 | 54.0 | -6.2 | -5.9 |
| 14772.0 | 62.2 | 49.3 | 62.3 | 49.6 | 54.0 | -4.7 | -4.4 |
| 17234.0 | 64.1 | 51.3 | 64.2 | 51.5 | 54.0 | -2.7 | -2.5 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

**Table 18 Transmitter Antenna Port Conducted Data modes 1 and 2**

| Frequency MHz | Antenna Port Average Output Power (Watts) | 99% Occupied Bandwidth (kHz) | 6-dB Occupied Bandwidth (kHz) | Peak Power Spectral Density (dBm) |
|---|---|---|---|---|
| Mode 1 ANT | | | | |
| 2402 | 0.001 | 1,356.0 | 888.0 | -18.6 |
| 2457 | 0.002 | 1,359.0 | 920.0 | -13.2 |
| 2480 | 0.001 | 1,959.0 | 967.5 | -17.4 |
| Mode 2 BLE | | | | |
| 2402 | 0.001 | 1,362.0 | 772.0 | -18.7 |
| 2442 | 0.002 | 1,276.5 | 773.0 | -14.5 |
| 2480 | 0.001 | 1,284.0 | 771.5 | -17.6 |

**Table 19 Transmitter Antenna Port Conducted Data modes 3, 4, and 5**

| Frequency MHz | Antenna Port Average Output Power (Watts) | 99% Occupied Bandwidth (kHz) | 6-dB Occupied Bandwidth (kHz) | Peak Power Spectral Density (dBm) |
|---|---|---|---|---|
| Mode 3 802.11b | | | | |
| 2412 | 0.022 | 14,647.5 | 8,805.1 | -11.3 |
| 2437 | 0.050 | 14,805.0 | 8,768.4 | -6.0 |
| 2462 | 0.031 | 14,692.5 | 8,752.6 | -8.3 |
| Mode 4 802.11g | | | | |
| 2412 | 0.012 | 16,650.0 | 16,346.2 | -14.5 |
| 2437 | 0.054 | 17,400.0 | 16,331.3 | -8.9 |
| 2462 | 0.008 | 16,650.0 | 16,346.0 | -16.9 |
| Mode 5 802.11n | | | | |
| 2412 | 0.007 | 17,650.0 | 16,884.2 | -16.4 |
| 2437 | 0.047 | 18,200.0 | 17,197.7 | -8.4 |
| 2462 | 0.008 | 17,650.0 | 17,135.9 | -16.2 |

### *Summary of Results for Transmitter Radiated Emissions of Intentional Radiator*

The EUT demonstrated compliance with the radiated and conducted emission requirements of 47CFR Subpart 15C Paragraph 15.247, RSS-247 Issue 2 and RSS-GEN Issue 5 emission requirements for Digital Transmission Systems. Highest average output power measured at the antenna port was 0.054 Watts. The highest peak power spectral density measured at the antenna port presented a minimum margin of -14.0 dB below the requirements. The EUT demonstrated a minimum margin of -0.8 dB below the harmonic emissions requirements. There were no other significantly measurable emissions in the restricted bands other than those recorded in this report. Other emissions were present with amplitudes at least 20 dB below the requirements. There were no other deviations or exceptions to the requirements.

## Annex

- Annex A Measurement Uncertainty Calculations
- Annex B Test Equipment
- Annex C Rogers Qualifications
- Annex D Rogers Labs Certificate of Accreditation

## *Annex A Measurement Uncertainty Calculations*

The measurement uncertainty was calculated for all measurements listed in this test report according To CISPR 16–4. Result of measurement uncertainty calculations are recorded below. Component and process variability of production devices similar to those tested may result in additional deviations. The manufacturer has the sole responsibility of continued compliance.

| Measurement | Expanded Measurement Uncertainty $U_{(lab)}$ |
|---|---|
| 3 Meter Horizontal 0.009-1000 MHz Measurements | 4.16 |
| 3 Meter Vertical 0.009-1000 MHz Measurements | 4.33 |
| 3 Meter Measurements 1-18 GHz | 5.14 |
| 3 Meter Measurements 18-40 GHz | 5.16 |
| 10 Meter Horizontal Measurements 0.009-1000 MHz | 4.15 |
| 10 Meter Vertical Measurements 0.009-1000 MHz | 4.32 |
| AC Line Conducted | 1.75 |
| Antenna Port Conducted power | 1.17 |
| Frequency Stability | 1.00E-11 |
| Temperature | 1.6˚C |
| Humidity | 3% |

## *Annex B Test Equipment*

| Equipment | Manufacturer | Model (SN) | Band | Cal Date(m/d/y) | Due |
|---|---|---|---|---|---|
| ☒ LISN | FCC | FCC-LISN-50-25-10(1PA) (160611) | .15-30MHz | 3/29/2022 | 3/29/2023 |
| ☒ LISN: Fischer Custom Communications Model: FCC-LISN-50-16-2-08 | | | | 3/29/2022 | 3/29/2023 |
| ☒ Cable | Huber & Suhner Inc. | Sucoflex102ea(L10M)(303073) | 9kHz-40 GHz | 10/14/2021 | 10/14/2022 |
| ☐ Cable | Huber & Suhner Inc. | Sucoflex102ea(1.5M)(303069) | 9kHz-40 GHz | 10/14/2021 | 10/14/2022 |
| ☒ Cable | Huber & Suhner Inc. | Sucoflex102ea(1.5M)(303070) | 9kHz-40 GHz | 10/14/2021 | 10/14/2022 |
| ☒ Cable | Belden | RG-58 (L1-CAT3-11509) | 9kHz-30 MHz | 10/14/2021 | 10/14/2022 |
| ☐ Cable | Belden | RG-58 (L2-CAT3-11509) | 9kHz-30 MHz | 10/14/2021 | 10/14/2022 |
| ☒ Antenna | Com Power | AL-130 (121055) | .001-30 MHz | 10/14/2021 | 10/14/2022 |
| ☒ Antenna: | EMCO | 6509 | .001-30 MHz | 10/14/2020 | 10/14/2022 |
| ☐ Antenna | ARA | BCD-235-B (169) | 20-350MHz | 10/14/2021 | 10/14/2022 |
| ☐ Antenna: | Schwarzbeck Model | VHBB 9124 (1468) | 30-200MHz | 10/14/2020 | 10/14/2022 |
| ☒ Antenna | Sunol | JB-6 (A100709) | 30-1000 MHz | 10/14/2021 | 10/14/2022 |
| ☐ Antenna | ETS-Lindgren | 3147 (40582) | 200-1000MHz | 10/14/2020 | 10/14/2022 |
| ☐ Antenna: | Schwarzbeck Model: | VULP 9118 (A-534) | 200-1000MHz | 10/14/2020 | 10/14/2022 |
| ☒ Antenna | ETS-Lindgren | 3117 (200389) | 1-18 GHz | 3/29/2022 | 3/29/2024 |
| ☐ Antenna | Com Power | AH-118 (10110) | 1-18 GHz | 10/14/2020 | 10/14/2022 |
| ☒ Antenna | Com Power | AH-840 (101046) | 18-40 GHz | 4/6/2021 | 4/6/2023 |
| ☒ Analyzer | Rohde & Schwarz | ESU40 (100108) | 20Hz-40GHz | 3/9/2022 | 3/9/2023 |
| ☒ Analyzer | Rohde & Schwarz | ESW44 (101534) | 20Hz-44GHz | 1/18/2022 | 1/18/2023 |
| ☐ Analyzer | Rohde & Schwarz | FS-Z60, 90, 140, and 220 | 40GHz-220GHz | 12/22/2017 | 12/22/2027 |
| ☒ Amplifier | Com-Power | PA-010 (171003) | 100Hz-30MHz | 10/14/2021 | 10/14/2022 |
| ☒ Amplifier | Com-Power | CPPA-102 (01254) | 1-1000 MHz | 10/14/2021 | 10/14/2022 |
| ☒ Amplifier | Com-Power | PAM-118A (551014) | 0.5-18 GHz | 10/14/2021 | 10/14/2022 |
| ☒ Amplifier | Com-Power | PAM-840A (461328) | 18-40 GHz | 10/14/2021 | 10/14/2022 |
| ☐ Power Meter | Agilent | N1911A with N1921A | 0.05-40 GHz | 3/29/2022 | 3/29/2023 |
| ☐ Generator | Rohde & Schwarz | SMB100A6 (100150) | 20Hz-6 GHz | 3/29/2022 | 3/29/2023 |
| ☐ Generator | Rohde & Schwarz | SMBV100A6 (260771) | 20Hz-6 GHz | 3/29/2022 | 3/29/2023 |
| ☐ RF Filter | Micro-Tronics | BRC50722 (009).9G notch | 30-18000 MHz | 4/6/2021 | 4/6/2023 |
| ☐ RF Filter | Micro-Tronics | HPM50114 (017)1.5G HPF | 30-18000 MHz | 4/6/2021 | 4/6/2023 |
| ☐ RF Filter | Micro-Tronics | HPM50117 (063) 3G HPF | 30-18000 MHz | 4/6/2021 | 4/6/2023 |
| ☐ RF Filter | Micro-Tronics | HPM50105 (059) 6G HPF | 30-18000 MHz | 4/6/2021 | 4/6/2023 |
| ☐ RF Filter | Micro-Tronics | BRM50702 (172) 2G notch | 30-18000 MHz | 4/6/2021 | 4/6/2023 |
| ☐ RF Filter | Micro-Tronics | BRC50703 (G102) 5G notch | 30-18000 MHz | 4/6/2021 | 4/6/2023 |
| ☐ RF Filter | Micro-Tronics | BRC50705 (024) 5G notch | 30-18000 MHz | 4/6/2021 | 4/6/2023 |
| ☐ Attenuator | Fairview | SA6NFNF100W-40 (1625) | 30-18000 MHz | 3/29/2022 | 3/29/2023 |
| ☐ Attenuator | Mini-Circuits | VAT-3W2+ (1436) | 30-6000 MHz | 3/29/2022 | 3/29/2023 |
| ☐ Attenuator | Mini-Circuits | VAT-3W2+ (1445) | 30-6000 MHz | 3/29/2022 | 3/29/2023 |
| ☐ Attenuator | Mini-Circuits | VAT-3W2+ (1735) | 30-6000 MHz | 3/29/2022 | 3/29/2023 |
| ☐ Attenuator | Mini-Circuits | VAT-6W2+ (1438) | 30-6000 MHz | 3/29/2022 | 3/29/2023 |
| ☐ Attenuator | Mini-Circuits | VAT-6W2+ (1736) | 30-6000 MHz | 3/29/2022 | 3/29/2023 |
| ☒ Weather station | Davis | 6312 (A81120N075) | | 11/4/2021 | 11/4/2022 |

List of Test Equipment — Calibration Date (m/d/y) Due

| Equipment | | | Calibration Date (m/d/y) | Due |
|---|---|---|---|---|
| ☐ Antenna: | Schwarzbeck Model VHBB 9124 (01468) | | 10/14/2020 | 10/14/2022 |
| ☐ Antenna: | Schwarzbeck Model: VULP 9118 A (VULP 9118 A-856) | | 10/14/2020 | 10/14/2022 |
| ☐ Frequency Counter: Leader LDC-825 (8060153 | | | 3/29/2022 | 3/29/2023 |
| ☐ ISN: Com-Power Model ISN T-8 | | | 3/29/2022 | 3/29/2023 |
| ☐ LISN | Compliance Design | FCC-LISN-2.Mod.cd,(126) .15-30MHz | 10/14/2021 | 10/14/2022 |
| ☐ LISN: Com-Power Model LI-220A | | | 3/29/2022 | 3/29/2024 |
| ☐ LISN: Com-Power Model LI-550C | | | 10/14/2020 | 10/14/2022 |
| ☐ Cable | Huber & Suhner Inc. | Sucoflex102ea(1.5M)(303072) 9kHz-40 GHz | 10/14/2021 | 10/14/2022 |
| ☐ Cable | Huber & Suhner Inc. | Sucoflex102ea(L1M)(281183) 9kHz-40 GHz | 10/14/2021 | 10/14/2022 |
| ☐ Cable | Huber & Suhner Inc. | Sucoflex102ea(L4M)(281184) 9kHz-40 GHz | 10/14/2021 | 10/14/2022 |
| ☐ Cable | Huber & Suhner Inc. | Sucoflex102ea(L10M)(317546)9kHz-40 GHz | 10/14/2021 | 10/14/2022 |
| ☐ Cable | Time Microwave | 4M-750HF290-750 (4M) 9kHz-24 GHz | 10/14/2021 | 10/14/2022 |
| ☐ RF Filter | Micro-Tronics | BRC17663 (001) 9.3-9.5 notch 30-1800 MHz | 4/6/2021 | 4/6/2023 |
| ☐ RF Filter | Micro-Tronics | BRC19565 (001) 9.2-9.6 notch 30-1800 MHz | 10/14/2021 | 10/14/2023 |
| ☐ Analyzer | HP | 8562A (3051A05950) 9kHz-125GHz | 3/29/2022 | 3/29/2023 |
| ☐ Wave Form Generator Keysight | | 33512B (MY57400128) | 3/29/2022 | 3/29/2023 |
| ☐ Antenna: Solar 9229-1 & 9230-1 | | | 2/22/2022 | 2/22/2023 |
| ☐ CDN: Com-Power Model CDN325E | | | 10/14/2021 | 10/14/2022 |
| ☐ Injection Clamp Luthi Model EM101 | | | 10/14/2021 | 10/14/2022 |
| ☐ Oscilloscope Scope: Tektronix MDO 4104 | | | 2/22/2022 | 2/22/2023 |
| ☐ EMC Transient Generator HVT TR 3000 | | | 2/22/2022 | 2/22/2023 |
| ☐ AC Power Source (Ametech, California Instruments) | | | 2/22/2022 | 2/22/2023 |
| ☐ Field Intensity Meter: EFM-018 | | | 2/22/2022 | 2/22/2023 |
| ☐ ESD Simulator: MZ-15 | | | 2/22/2022 | 2/22/2023 |
| ☐ R.F. Power Amp ACS 230-50W | | | not required | |
| ☐ R.F. Power Amp EIN Model: A301 | | | not required | |
| ☐ R.F. Power Amp A.R. Model: 10W 1010M7 | | | not required | |
| ☐ R.F. Power Amp A.R. Model: 50U1000 | | | not required | |
| ☐ Temperature Chamber | | | not required | |
| ☒ Shielded Room | | | not required | |

# *Annex C Rogers Qualifications*

***Scot D. Rogers, Engineer***

**Rogers Labs, Inc.**

Mr. Rogers has approximately 35 years' experience in the field of electronics. Working experience includes six years working in the automated controls industry and 6 years working with the design, development and testing of radio communications and electronic equipment.

Positions Held:

| | |
|---|---|
| Systems Engineer: | A/C Controls Mfg. Co., Inc. |
| Electrical Engineer: | Rogers Consulting Labs, Inc. |
| Electrical Engineer: | Rogers Labs, Inc. Current |

Educational Background:

Bachelor of Science Degree in Electrical Engineering from Kansas State University

Bachelor of Science Degree in Business Administration Kansas State University

Several Specialized Training courses and seminars pertaining to Microprocessors and Software programming

## *Annex D Laboratory Certificate of Accreditation*

**United States Department of Commerce**
**National Institute of Standards and Technology**

# Certificate of Accreditation to ISO/IEC 17025:2017

**NVLAP LAB CODE: 200087-0**

**Rogers Labs, Inc.**
Louisburg, KS

*is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:*

**Electromagnetic Compatibility & Telecommunications**

*This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).*

2022-03-22 through 2023-03-31
*Effective Dates*

DEPARTMENT OF COMMERCE · UNITED STATES OF AMERICA

*For the National Voluntary Laboratory Accreditation Program*

Celltech
Testing and Engineering Services Lab

| | |
|---|---|
| Test Report Serial Number: | 45461762 R2.0 |
| Test Report Date: | 19 Decemberr 2022 |
| Project Number: | 1602 |

# SAR Test Report - New Application

Applicant:

GARMIN

**Garmin International Inc.**
**1200 East 151 St.**
**Olathe, KS, 66062**
**USA**

| Maximum *reported* SAR | | |
|---|---|---|
| Body (1g): | 0.80 | W/kg |
| General Pop. Limit: | 1.60 | |

| Maximum *reported* SAR | | |
|---|---|---|
| Extremity (10g): | 0.35 | W/kg |
| General Pop. Limit: | 4.00 | |

| FCC ID: | IC Registration Number |
|---|---|
| **IPH-04394** | |
| Product Model Number / HVIN | Product Name / PMN |
| **A04394** | **A04394** |

In Accordance With:

**FCC 47 CFR §2.1093**
Radiofrequency Radiation Exposure Evaluation: Portable Devices

Approved By:

**Ben Hewson, President**
Celltech Labs Inc.
21-364 Lougheed Rd.
Kelowna, BC, V1X 7R8
Canada

**Test Lab Certificate: 2470.01** **IC Registration 3874A** **FCC Registration: CA3874**

## Table of Contents



# 1.0 REVISION HISTORY

| Revision History | | | | | |
|---|---|---|---|---|---|
| **Samples Tested By:** | | Ben Hewson | **Date(s) of Evaluation:** | | 14-15 September 2022 |
| **Report Prepared By:** | | Art Voss | **Report Reviewed By:** | | Art Voss |
| **Report Revision** | **Description of Revision** | | **Revised Section** | **Revised By** | **Revision Date** |
| 0.1 | Draft | | n/a | Art Voss | 21 October 2022 |
| 1.0 | Initial Release | | n/a | Ben Hewson | 31 October 2022 |
| 2.0 | Revised for Extremity Evaluation | | 10, 11 | Art Voss | 19 December 2022 |

## 2.0 CLIENT AND DEVICE INFORMATION

| Client Information | | |
|---|---|---|
| Applicant Name | **Garmin International Inc.** | |
| Applicant Address | 1200 East 151 St | |
| | Olathe, KS, 66062 | |
| | USA | |
| **DUT Information** | | |
| Device Identifier(s): | FCC ID: | IPH-04394 |
| | ISED ID: | |
| Device Model(s) / HVIN: | A04394 | |
| Device Marketing Name / PMN: | A04394 | |
| Test Sample Serial No.: | Conducted: 3401137001 OTA: 3403386857 | |
| Device Type: | Low Power Digital Device Transmitter | |
| FCC Equipment Class: | Digital Transmission System (DTS), Part 15 Spread Spectrum Transmitter (DSS), Unlicensed National Information Infrastructure TX (NII) | |
| Transmit Frequency Range: | WiFi (DTS): 2412-2462MHz | |
| | BT/BLE (DTS, DSS): 2402-2480MHz | |
| Manuf. Max. Rated Output Power: | BT LE (DXX): 2mW (3dBm) | |
| | ANT (DXX): 2mW (3dBm) | |
| | 802.11 (DTS): 54mW (17.32dBm) | |
| Modulation: | WiFi: DSSS, OFDM, CCK, MCS0-7 | |
| Modulation: | BLE: GMSK | |
| Modulation: | ANT: GFSK: | |
| DUT Power Source: | 4.35 VDC Internal Li-Ion Battery | |
| DUT Dimensions [LxWxH] | L x W x H: 80mm x 60mm x 20mm | |
| Deviation(s) from standard/procedure: | None | |
| Modification of DUT: | None | |

## 3.0 SCOPE OF EVALUATION

This Certification Report was prepared on behalf of:

**Garmin International Inc.**

The A04394 is a Low Power Digital Transmitter that may be mounted or handheld, with a Wi-Fi transceiver that is capable of operating in the 2.4GHz WiFi/ BT and 5GHz U-NII frequency bands. The device is capable of operating simultaneously on the BT and U-NII bands. The device is intended for General Population Use. The product operates from an internal proprietary Li-ion rechargeable battery which can be connected to a compliant USB interface port, AC or DC adapter for charging. Test samples provided by the manufacturer were capable of transmitting at select frequencies and modulations preset by the manufacturer. An additional antenna modification was prepared for one sample allowing the ability to connect test equipment for antenna port conducted power analysis.

**Application:**

This is an application for a new device certification.

**Scope:**

The scope of this evaluation limited to the evaluation of SAR for intended and non-intended applications. It will include evaluation of the 2.4 GHz WiFi/BT and U-NII transmitters for all required RF exposure configurations including Extremity and Body Configuration as the device may be operational while in hand or on person (lap).

The Test Plan developed for this evaluation is based on the required test channels and configurations which produced the highest worst case SAR and where applicable, SAR test reduction and/or SAR test exclusion may be utilized. The DUT was evaluated for SAR at the maximum tune up tolerance and conducted output power level, preset by the manufacturer and in accordance with the procedures described in IEC/IEEE 62209-1528, FCC KDB 447498 and FCC KDB 248227.

# 4.0 NORMATIVE REFERENCES

| Normative References* | |
|---|---|
| ANSI / ISO 17025:2005 | General Requirements for competence of testing and calibration laboratories |
| FCC CFR Title 47 Part 2 | Code of Federal Regulations |
| Title 47: | Telecommunication |
| Part 2.1093: | Radiofrequency Radiation Exposure Evaluation: Portable Devices |
| IEEE International Committee on Electromagnetic Safety | |
| IEEE 1528-2013: | IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques |
| IEC International Standard | |
| IEC 62209-2 2010 | Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Part 2 |
| IEC International Standard /IEEE International Committee on Electromagnetic Safety | |
| IEC/IEEE 62209-1528 | Measurement procudeure for the assessment of sepcific absorption rate of human expoure to radio frequency fields from hand-held and body-mounted wireless communication devices - Part 1528; Human models, insturmentation, and procedures (Frequency range of 4 MHz to 10 GHz) |
| FCC KDB | |
| KDB 865664 D01v01r04 | SAR Measurement Requirements for 100MHz to 6GHz |
| FCC KDB | |
| KDB 447498 D01v06 | Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies |
| FCC KDB | |
| KDB 248227 D01v02r02 | SAR Guidance for IEEE 802.11 (WiFi) Transmitters |
| * When the issue number or issue date is omitted, the latest version is assumed. | |

# 5.0 STATEMENT OF COMPLIANCE

This measurement report demonstrates that samples of the product model(s) were evaluated for Specific Absorption Rate (SAR) on the date(s) shown, in accordance with the Measurement Procedures cited and were found to comply with the Standard(s) Applied based on the Exposure Limits of the Use Group indicated for which the product is intended to be used.

| | | |
|---|---|---|
| **Applicant:** Garmin International Inc. | **Model / HVIN:** A04394 | |
| **Standard(s) Applied:** FCC 47 CFR §2.1093 | **Measurement Procedure(s):** FCC KDB 865664, FCC KDB 447498, FCC KDB 248227<br>IEC/IEEE Standard 62209-1528, IEC 62209-2 | |
| **Reason For Issue:**<br>[x] New Certification<br>[ ] Class I Permissive Change<br>[ ] Class II Permissive Change | **Use Group:**<br>[x] General Population / Uncontrolled<br>[ ] Occupational / Controlled | **Limits Applied:**<br>[x] 1.6W/kg - 1g Volume<br>[ ] 8.0W/kg - 1g Volume<br>[x] 4.0W/kg - 10g Volume |
| **Reason for Change:** | | **Date(s) Evaluated:** 14 - 15 September 2022 |

The results of this investigation are based solely on the test sample(s) provided by the applicant which was not adjusted, modified or altered in any manner whatsoever except as required to carry out specific tests or measurements. A description of the device, operating configuration, detailed summary of the test results, methodologies and procedures used during this evaluation, the equipment used and the various provisions of the rules are included in this test report.

| | |
|---|---|
| I attest that the data reported herein is true and accurate w ithin the tolerance of the Measurement Instrument Uncertainty; that all tests and measurements w ere performed in accordance w ith accepted practices or procedures; and that all tests and measurements w ere performed by me or by trained personnel under my direct supervision. The results of this investigation are based solely on the test sample(s) provided by the client w hich w ere not adjusted, modified or altered in any manner w hatsoever, except as required to carry out specific tests or measurements. This test report has been completed in accordance w ith ISO/IEC 17025. | Art Voss, P.Eng.<br>Technical Manager<br>Celltech Labs Inc.<br>21 October 2022<br>Date |

## 6.0 SAR MEASUREMENT SYSTEM

### SAR Measurement System

Celltech Labs Inc. SAR measurement facility employs a Dosimetric Assessment System (DASY™) manufactured by Schmid & Partner Engineering AG (SPEAG™) of Zurich, Switzerland. The DASY6 measurement system is comprised of the measurement server, a robot controller, a computer, a near-field probe, a probe alignment sensor, an Elliptical Planar Phantom (ELI) phantom and a specific anthropomorphic mannequin (SAM) phantom for Head and/or Body SAR evaluations. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF). A cell controller system contains the power supply, robot controller and a teach pendant (Joystick) to control the robot's servo motors. The Staubli robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical form the DAE to digital electronic signal and transfers data to the DASY6 measurement server. The DAE4 utilizes a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16-bit AD-converter, a command decoder and a control logic unit. Transmission to the DASY6 measurement server is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe-mounting device includes two different sensor systems for frontal and sidewise probe contacts. The sensor systems are also used for mechanical surface detection and probe collision detection. The robot utilizes a controller with built in VME-bus computer.


DASY 6 SAR System


DASY 6 Measurement Controller

# 7.0 RF CONDUCTED POWER MEASUREMENT

**Table 7.1 Conducted Power Measurements, WiFi/BT**

| Conducted Power Measurements | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Band | Mode | Bandwidth (MHz) | Channel | Frequency (MHz) | Modulation | Bit Rate (Mbps) | Measured Power (dBm) | Rated Power (dBm) | Rated Power (W) | Delta (dB) | SAR Test Channel (Y/-) | Duty Cycle (%) | Crest Factor (1/DC) |
| WLAN 2.4G | 802.11b | 20 | 6 | 2437 | CCK | 1 | 16.34 | 17.32 | 0.054 | -0.98 | - | - | - |
| | | | 6 | 2437 | CCK | 2 | 16.52 | 17.32 | 0.054 | -0.80 | - | - | - |
| | | | 6 | 2437 | DSSS | 5.5 | 16.86 | 17.32 | 0.054 | -0.46 | - | - | - |
| | | | 6 | 2437 | | 11 | 16.85 | 17.32 | 0.054 | -0.47 | - | - | - |
| | | | **1** | **2412** | | 5.5 | **12.74** | **17.32** | **0.054** | **-4.58** | **Y** | **89.3** | **1.12** |
| | | | 2 | 2417 | | | 14.84 | 17.32 | 0.054 | -2.48 | - | - | - |
| | | | 3 | 2422 | | | 15.71 | 17.32 | 0.054 | -1.61 | - | - | - |
| | | | 4 | 2427 | | | 16.71 | 17.32 | 0.054 | -0.61 | - | - | - |
| | | | 5 | 2432 | | | 16.89 | 17.32 | 0.054 | -0.43 | - | - | - |
| | | | **6** | **2437** | | | **16.84** | **17.32** | **0.054** | **-0.48** | **Y** | **89.3** | **1.12** |
| | | | **7** | **2442** | | | **17.04** | **17.32** | **0.054** | **-0.28** | **Y** | **89.3** | **1.12** |
| | | | 8 | 2447 | | | 16.90 | 17.32 | 0.054 | -0.42 | - | - | - |
| | | | 9 | 2452 | | | 16.18 | 17.32 | 0.054 | -1.14 | - | - | - |
| | | | 10 | 2457 | | | 14.40 | 17.32 | 0.054 | -2.92 | - | - | - |
| | | | **11** | **2462** | | | **16.90** | **17.32** | **0.054** | **-0.42** | **Y** | **89.3** | **1.12** |
| WLAN 2.4G | 802.11g | 20 | 6 | 2437 | OFDM | 6 | 15.07 | 17.32 | 0.054 | -2.25 | - | - | - |
| | | | | | | 9 | 14.99 | 17.32 | 0.054 | -2.33 | - | - | - |
| | | | | | | 12 | 14.97 | 17.32 | 0.054 | -2.35 | - | - | - |
| | | | | | | 36 | 13.58 | 17.32 | 0.054 | -3.74 | - | - | - |
| | | | | | | 54 | 12.87 | 17.32 | 0.054 | -4.45 | - | - | - |
| | | | 1 | 2412 | | 6 | 9.93 | 17.32 | 0.054 | -7.39 | - | - | - |
| | | | 2 | 2417 | | | 10.44 | 17.32 | 0.054 | -6.88 | - | - | - |
| | | | 3 | 2422 | | | 14.49 | 17.32 | 0.054 | -2.83 | - | - | - |
| | | | 4 | 2427 | | | 14.44 | 17.32 | 0.054 | -2.88 | - | - | - |
| | | | 5 | 2432 | | | 14.44 | 17.32 | 0.054 | -2.88 | - | - | - |
| | | | 6 | 2437 | | | 15.07 | 17.32 | 0.054 | -2.25 | - | - | - |
| | | | 7 | 2442 | | | 14.78 | 17.32 | 0.054 | -2.54 | - | - | - |
| | | | 8 | 2447 | | | 13.34 | 17.32 | 0.054 | -3.98 | - | - | - |
| | | | 9 | 2452 | | | 11.54 | 17.32 | 0.054 | -5.78 | - | - | - |
| | | | 10 | 2457 | | | 7.26 | 17.32 | 0.054 | -10.06 | - | - | - |
| | | | 11 | 2462 | | | 7.26 | 17.32 | 0.054 | -10.06 | - | - | - |

### Table 7.1 Conducted Power Measurements, WiFi/BT (Cont.)

| Band | Mode | Bandwidth (MHz) | Channel | Frequency (MHz) | Modulation | Bit Rate (Mbps) | Measured Power (dBm) | Rated Power (dBm) | Rated Power (W) | Delta (dB) | SAR Test Channel (Y/-) | Duty Cycle (%) | Crest Factor (1/DC) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WLAN 2.4G | 802.11n | 20 | 6 | 2437 | MCS0 | - | 14.45 | 16.72 | 0.047 | -2.27 | - | - | - |
| | | | | | MCS3 | | 13.91 | 16.72 | 0.047 | -2.81 | - | - | - |
| | | | | | MCS7 | | 10.18 | 16.72 | 0.047 | -6.54 | - | - | - |
| | | | 1 | 2412 | MCS0 | | 7.77 | 16.72 | 0.047 | -8.95 | - | - | - |
| | | | 2 | 2417 | | | 10.20 | 16.72 | 0.047 | -6.52 | - | - | - |
| | | | 3 | 2422 | | | 11.57 | 16.72 | 0.047 | -5.15 | - | - | - |
| | | | 4 | 2427 | | | 11.56 | 16.72 | 0.047 | -5.16 | - | - | - |
| | | | 5 | 2432 | | | 13.35 | 16.72 | 0.047 | -3.37 | - | - | - |
| | | | 6 | 2437 | | | 14.45 | 16.72 | 0.047 | -2.27 | - | - | - |
| | | | 7 | 2442 | | | 14.42 | 16.72 | 0.047 | -2.30 | - | - | - |
| | | | 8 | 2447 | | | 13.35 | 16.72 | 0.047 | -3.37 | - | - | - |
| | | | 9 | 2452 | | | 12.43 | 16.72 | 0.047 | -4.29 | - | - | - |
| | | | 10 | 2457 | | | 11.58 | 16.72 | 0.047 | -5.14 | - | - | - |
| | | | 11 | 2462 | | | 8.87 | 16.72 | 0.047 | -7.85 | - | - | - |
| BT | LE | 1 | **2** | **2402** | GMSK | - | **3.00** | **3.00** | **0.002** | **0.00** | **Y** | **100** | **1** |
| | | | 17 | 2440 | | | 3.00 | 3.00 | 0.002 | 0.00 | - | - | - |
| | | | 39 | 2480 | | | -0.08 | 3.00 | 0.002 | -3.08 | - | - | - |
| ANT | ANT | 1 | 2 | 2402 | GFSK | - | -1.35 | 3.00 | 0.002 | -4.35 | - | - | - |
| | | | 41 | 2441 | | | 2.21 | 3.00 | 0.002 | -0.79 | - | - | - |
| | | | 80 | 2480 | | | -1.19 | 3.00 | 0.002 | -4.19 | - | - | - |

The rated power and tolerance are stated for typical transmission modes and data rates. Some modes and data rates may produce lower than rated conducted power levels. Power measurements taken across the various channels, modes and data rates did not produce levels in excess of the Rated Power plus Tolerance. SAR was evaluated using the power level setting specified by the manufacture to be the max output power and produce the most conservative SAR. SAR was evaluated at the *maximum average* tune up tolerance. See section 2.0 Client and Device Information for details. The *reported* SAR was not scaled down.

## 8.0 NUMBER OF TEST CHANNELS (*Nc*)

**Table 8.1 Number of Test Channels**

The intended use of the device is to be mounted on a vehicle' dashboard; however, the device could transmit while held in hand or on person. As such the device was evaluated for both Body and Extremity use.

Wi-FI SAR Evaluation:

SAR was evaluated in DSSS mode at the maximum duty cycle. The power level setting selected was specified by the manufacturer to be the max output power and produce the most conservative SAR.

As per FCC KDB 248227, the required 802.11 test channels are Ch1, Ch 6 and Ch 11; The highest conducted output power was found on Channel 7. As a result, this channel was selected for initial SAR evaluation.

SAR test reduction methodology was applied to reduce the total number of required test channels from the SAR test evaluation.

When applicable, SAR test reduction methods may be utilized.

802.11b DSSS SAR test reduction is determined according to the following:

a) When the *reported* SAR of the highest measured maximum output power channel is ≤ to 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.

b) When the *reported* SAR is > 0.8 W/kg, SAR is required for that exposure configuration using the next highest output power channel. When any *reported* SAR is > 1.2 W/Kg, SAR is required for the third channel.

2.4 GHz 802.11g/n OFDM SAR Test Exclusion Requirements

a) When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration.

b) When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.

The initial test configuration for 2.4 GHz and 5 GHz OFDM transmission modes is determined by the 802.11 configuration with the highest maximum output power specified for production units, including tune-up tolerance, in each standalone and aggregated frequency band. An initial test position was established for Both UNII1 and UNII 3 bands.

When the reported SAR of the initial test configuration is > 0.8 W/kg, SAR measurement is required for subsequent next highest measured output power channel(s) in the initial test configuration until reported SAR is ≤ 1.2 W/kg or all required channels are tested.

NOTE: The Bluetooth transmitter is capable of simultaneous transmission with the 5GHz WiFi Transmitter. The Bluetooth SAR was evaluated for simultaneous SAR.

As per KDB 447498 D01V06, where appropriate SAR test exclusion based on antenna test separation distances may be applied.

1. When the distance is < 50mm exclusion threshold is "Ratio" , when the distance is >50 mm exclusion is in "mW"
2. Maximum power is the source-based-time-average power and represents the maximum RF output power among production units.
3. Per KDB 447498 D01v06, for larger devices, the test separation distance of adjacent edge configuration is determined by the closest separation between the antenna and the user
4. Per KDB 447498 D01v06, standalone SAR test exclusion threshold is applied; If the test separation distance is < 5mm, 5mm is used to determine SAR exclusion threshold
5. Per KDB 447498 D01v06, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separaton distances ≤ 50mm are determined by; (step a)
   [(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]*[√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR
   - f(GHz) is the f channel transmit frequency in GHz
   - power and distance are rounded to the nearest MW and mm before calculation
   - result is rounded to one decimal place for comparison
   - the values 3.0 and 7.5 are referred to as numeric thresholds in step b
6. Per KDB 447498 D01v06, at 100 MHz to 6 GHz and for test separation distance > 50mm, the SAR test exclusion threshold is determined according to t the following; (step b)
   a) [Power allowed at numeric threshold for 50 mm in step a) + test separation distance - 50mm)*(f(MHz)/150)] mW, at 100 MHz to 1500 MHz
   b)[Power allowed at numeric threshold for 50 mm in step a) + (test separation distance -50mm)* 10] mW at > 1500MHz and ≤ 6GHz

## 9.0 ACCESSORIES EVALUATED

**Table 9.1 Manufacturer's Accessory List**

There are no manufacturer's accessories available when used in a portable application.

# 10.0 SAR MEASUREMENT SUMMARY

**Table 10.1: Measured Results – BODY**

| Measured 1g SAR Results - BODY Configuration | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Plot ID | Test Frequency (MHz) | DUT Configuration | | | | | Accessories | | | | DUT Spacing | | Measured SAR (W/kg) | SAR Drift (dB) |
| | | | Pos | Mode | BW | Mod | BR | Antenna ID | Battery ID | Body ID | Audio ID | DUT (mm) | Antenna (mm) | | |
| 14 Sep 2022 | B1 | 2442 | Front Side | 802.11B | 20MHz | DSSS | 5.5mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.496 | 0.130 |
| 14 Sep 2022 | B3 | 2442 | Right Edge | 802.11B | 20MHz | DSSS | 5.5mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.084 | 0.610 |
| 14 Sep 2022 | B4 | 2442 | Left Edge | 802.11B | 20MHz | DSSS | 5.5mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.305 | 0.450 |
| 15 Sep 2022 | B5 | 2442 | Top Edge | 802.11B | 20MHz | DSSS | 5.5mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.619 | -0.130 |
| 15 Sep 2022 | B6 | 2442 | Bottom Edge | 802.11B | 20MHz | DSSS | 5.5mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.077 | 0.300 |
| 15 Sep 2022 | B7 | 2442 | Back Side | 802.11B | 20MHz | DSSS | 5.5mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.537 | -0.060 |
| 15 Sep 2022 | B8 | 2402 | Top Edge | BLE | 2MHz | GMSK | 2mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.002 | 1.830 |
| 15 Sep 2022 | B9 | 2402 | Back Side | BLE | 2MHz | GMSK | 2mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.004 | 1.210 |
| 15 Sep 2022 | B10 | 2442 | Back Side | 802.11B | 20MHz | DSSS | 5.5mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.681 | -0.420 |
| Applicable SAR Limit | | | | | | | | Use Group | | | | | | Limit | |
| FCC CFR 2.1093 | | | Health Canada Safety Code 6 | | | | | General Population/User Unaware | | | | | | 1.6 W/kg | |

**Table 10.2: Measured Results – Extremity**

| Measured 10g SAR Results - EXTREMITY Configuration | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Plot ID | Test Frequency (MHz) | DUT Configuration | | | | | Accessories | | | | DUT Spacing | | Measured SAR (W/kg) | SAR Drift (dB) |
| | | | Pos | Mode | BW | Mod | BR | Antenna ID | Battery ID | Body ID | Audio ID | DUT (mm) | Antenna (mm) | | |
| 14 Sep 2022 | E1 | 2442 | Front Side | 802.11B | 20MHz | DSSS | 5.5mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.216 | 0.130 |
| 14 Sep 2022 | E3 | 2442 | Right Edge | 802.11B | 20MHz | DSSS | 5.5mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.042 | 0.610 |
| 14 Sep 2022 | E4 | 2442 | Left Edge | 802.11B | 20MHz | DSSS | 5.5mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.136 | 0.450 |
| 15 Sep 2022 | E5 | 2442 | Top Edge | 802.11B | 20MHz | DSSS | 5.5mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.277 | -0.130 |
| 15 Sep 2022 | E6 | 2442 | Bottom Edge | 802.11B | 20MHz | DSSS | 5.5mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.037 | 0.300 |
| 15 Sep 2022 | E7 | 2442 | Back Side | 802.11B | 20MHz | DSSS | 5.5mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.254 | -0.060 |
| 15 Sep 2022 | E8 | 2402 | Top Edge | BLE | 2MHz | GMSK | 2mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.000 | 1.830 |
| 15 Sep 2022 | E9 | 2402 | Back Side | BLE | 2MHz | GMSK | 2mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.001 | 1.210 |
| 15 Sep 2022 | E10 | 2442 | Back Side | 802.11B | 20MHz | DSSS | 5.5mbps | n/a | n/a | n/a | n/a | 0 | 0 | 0.299 | -0.420 |
| Applicable SAR Limit | | | | | | | | Use Group | | | | | | Limit | |
| FCC CFR 2.1093 | | | Health Canada Safety Code 6 | | | | | General Population/User Unaware | | | | | | 4 W/kg | |

# 11.0 SCALING OF MAXIMUM MEASURE SAR

**Table 11.1 SAR Scaling 1g**

| Scaling of Maximum Measured SAR (1g) | | | | | |
|---|---|---|---|---|---|
| Measured Parameters | | Configuration | | | |
| | | Body | | | |
| Plot ID | | B10 | | | |
| Maximum Measured $SAR_M$ | | 0.681 | | | (W/kg) |
| Frequency | | 2442 | | | (MHz) |
| Drift | Power Drift | -0.420 | | | (dB) |
| Conducted Power | | 17.040 | | | (dBm) |
| DC | Transmit Duty Cycle | 100.000 | | | (%) |
| Fluid Deviation from Target | | | | | |
| Δe | Permitivity | -6.84% | | | |
| Δσ | Conductivity | 6.25% | | | |

| Fluid Sensitivity Calculation (1g) IEC/IEEE 62209-1528 7.8.2 | | | | | |
|---|---|---|---|---|---|
| Delta SAR = Ce * Δe + Cσ * Δσ (8) | | | | | |
| $Ce = (-0.0007854*f^3) + (0.009402*f^2) - (0.02742*f) - 0.2026$ (9) | | | | | |
| $C\sigma = (0.009804*f^3) - (0.08661*f^2) + (0.02981*f) + 0.7829$ (10) | | | | | |
| f | Frequency (GHz) | 2.442 | | | |
| Ce | | -0.225 | | | |
| Cσ | | 0.482 | | | |
| Ce * Δe | | 0.015 | | | |
| Cσ * Δσ | | 0.030 | | | |
| ΔSAR | | 0.046 (3) | | | (%) |

Note(3): Delta SAR is Positive, SAR Adjustment for Fluid Sensitivity is not Required, in accordance with ISED Notice 2012-DRS0529

| Manufacturer's Tuneup Tolerance | | | | |
|---|---|---|---|---|
| Measured Conducted Power | 17.040 | | | (dBm) |
| Rated Conducted Power | 17.320 | | | (dBm) |
| ΔP | -0.280 | | | (dB) |

| Crest Factor | | | | |
|---|---|---|---|---|
| Transmit Duty Cycle (DC) | 100.000 | | | (%) |
| CF (1/DC) | 1.000 (5) | | | |

Note(5): Crest Factor = 1 (100% Duty Cycle), Crest Factor Adjustment not Required.

**Table 11.1 SAR Scaling 1g (Cont.)**

| Scaling of Maximum Measured SAR (1g) | | | | |
|---|---|---|---|---|
| Measured Parameters | Configuration | | | |
| | Body | | | |
| Plot ID | B10 | | | |
| Maximum Measured $SAR_M$ | 0.681 | | | (W/kg) |
| Frequency | 2442 | | | (MHz) |
| **SAR Adjustment for Fluid Sensitivity** | | | | |
| $SAR_1 = SAR_M$ X [ΔSAR] | [redacted] | | | (W/kg) |
| **SAR Adjustment for Tuneup Tolerance** | | | | |
| $SAR_2 = SAR_1$ + [ΔP] | 0.726 | | | (W/kg) |
| **SAR Adjustment for Drift** | | | | |
| $SAR_3 = SAR_2$ + [Drift] | 0.800 | | | (W/kg) |
| **SAR Adjustment for Crest Factor** | | | | |
| $SAR_4 = SAR_3$ x [CF] | [redacted] | | | (W/kg) |
| ***reported*** **1g SAR** | | | | |
| $SAR_4$ | **0.80** | | | (W/kg) |

**Table 11.2 SAR Scaling 10g**

| Scaling of Maximum Measured SAR (10g) | | | | | |
|---|---|---|---|---|---|
| Measured Parameters | | Configuration | | | |
| | | Extremity | | | |
| Plot ID | | E10 | | | |
| Maximum Measured $SAR_M$ | | 0.299 | | | (W/kg) |
| Frequency | | 2442 | | | (MHz) |
| Drift | Power Drift | -0.420 | | | (dB) |
| Conducted Power | | 17.040 | | | (dBm) |
| DC | Transmit Duty Cycle | 100.000 | | | (%) |
| Fluid Deviation from Target | | | | | |
| Δe | Permitivity | -6.84% | | | |
| Δσ | Conductivity | 6.25% | | | |

| Fluid Sensitivity Calculation (10g) IEC/IEEE 62209-1528 7.8.2 | | | | | |
|---|---|---|---|---|---|
| Delta SAR = Ce * Δe + Cσ * Δσ (8) | | | | | |
| Ce = $(0.003456*f^3) - (0.03531*f^2) + (0.07675*f) - 0.186$ (11) | | | | | |
| Cσ = $(0.004479*f^3) - (0.01586*f^2) - (0.1972*f) + 0.7717$ (12) | | | | | |
| f | Frequency (GHz) | 2.442 | | | |
| Ce | | -0.225 | | | |
| Cσ | | 0.482 | | | |
| Ce * Δe | | 0.015 | | | |
| Cσ * Δσ | | 0.030 | | | |
| ΔSAR | | 0.046 (3) | | | (%) |

Note(3): Delta SAR is Positive, SAR Adjustment for Fluid Sensitivity is not Required, in accordance with ISED Notice 2012-DRS0529

| Manufacturer's Tuneup Tolerance | | | | |
|---|---|---|---|---|
| Measured Conducted Power | 17.040 | | | (dBm) |
| Rated Conducted Power | 17.320 | | | (dBm) |
| ΔP | -0.280 | | | (dB) |

| Crest Factor | | | | |
|---|---|---|---|---|
| Transmit Duty Cycle (DC) | 100.000 | | | (%) |
| CF (1/DC) | 1.000 (5) | | | |

Note(5): Crest Factor = 1 (100% Duty Cycle), Crest Factor Adjustment not Required.

**Table 11.2 SAR Scaling 10g (Cont.)**

| Scaling of Maximum Measured SAR (10g) | | | | |
|---|---|---|---|---|
| Measured Parameters | Configuration | | | |
| | Extremity | | | |
| Plot ID | E10 | | | |
| Maximum Measured $SAR_M$ | 0.299 | | | (W/kg) |
| Frequency | 2442 | | | (MHz) |
| **SAR Adjustment for Fluid Sensitivity** | | | | |
| $SAR_1 = SAR_M$ X [ΔSAR] | 0.299 | | | (W/kg) |
| **SAR Adjustment for Tuneup Tolerance** | | | | |
| $SAR_2 = SAR_1$ + [ΔP] | 0.319 | | | (W/kg) |
| **SAR Adjustment for Drift** | | | | |
| $SAR_3 = SAR_2$ + [Drift] | 0.351 | | | (W/kg) |
| **SAR Adjustment for Crest Factor** | | | | |
| $SAR_4 = SAR_3$ x [CF] | 0.351 | | | (W/kg) |
| ***reported*** **10g SAR** | | | | |
| $SAR_4$ | **0.35** | | | (W/kg) |

| NOTES to Table |
|---|
| Scaling of the Maximum Measured SAR is based on the highest Face, Body and/or Head SAR measured of ALL test channels, configurations and accessories used during THIS evaluation. The Measured Fluid Deviation parameters apply only to deviation of the tissue equivalent fluids used at the frequencies which produced the highest measured SAR. The Measured Conducted Power applies to the Conducted Power measured at the frequencies producing the highest Face, Body and/or Head SAR. The Measured Drift is the SAR drift associated with that specific SAR measurement. The Reported SAR is the accumulation of all SAR Adjustments from the applicable Steps 1 through 4. The Plot ID is for indentification of the SAR Measurement Plots in the Annexes of this report.<br><br>NOTE: Some of the scaling factors in Steps 1 through 4may not apply and are identified by grayed fields. |
| **Step 1** |
| Per IEC/IEEE 62209-1528, FCC KDB 865664, ISED RSS-102 and ISED Notice 2012-DRS0529 . Scaling required only when Measured Fluid Deviation is greater than 5%. If the Measured Fluid Deviation is greater than 5%,<br>Table 10.1 will be shown and will indicate the SAR scaling factor in percent (%). SAR is MULTIPLIED by this scaling factor only when the scaling factor is positive (+). |
| **Step 2** |
| Per IEC/IEEE 62209-1528, FCC KDB 865664 and ISED RSS-102. Scaling required only when the difference (Delta) between the Measured Conducted Power and the Manufacturer's Rated Conducted Power is (-) Negative.<br>The absolute value of Delta is ADDED to the SAR. |
| **Step 3** |
| Per IEC/IEEE 62209-1528, FCC KDB 865664 and ISED RSS-102. Scaling required only when Measured Drift is (-) Negative. The absolute value of Measured Drift is added to Reported. |
| **Step 4** |
| Per IEC/IEEE 62209-1528, FCC KDB 865664 and ISED RSS-102. When the transmit Duty Cyle (DC) is less than 100%, the *reported* SAR must be scaled to 100% by the Crest Factor (CF). CF = 1/DC where DC is in decimal. |
| **Step 5** |
| The Reported SAR is the Maximum Final Adjusted SAR from the applicable Steps 1 through 4and are reported on Page 1 of this report. |

### 11.3 Simultaneous Transmission SAR Analysis

There are no simultaneous transmission conditions.

## 12.0 SAR EXPOSURE LIMITS

**Table 12.1 Exposure Limits**

| SAR RF EXPOSURE LIMITS | | | |
|---|---|---|---|
| FCC 47 CFR§2.1093 | Health Canada Safety Code 6 | General Population / Uncontrolled Exposure(4) | Occupational / Controlled Exposure(5) |
| Spatial Average(1) (averaged over the whole body) | | 0.08 W/kg | 0.4 W/kg |
| Spatial Peak(2) (Head and Trunk averaged over any 1 g of tissue) | | **1.6 W/kg** | 8.0 W/kg |
| Spatial Peak(3) (Hands/Wrists/Feet/Ankles averaged over 10 g) | | **4.0 W/kg** | 20.0 W/kg |
| (1) The Spatial Average value of the SAR averaged over the whole body. | | | |
| (2) The Spatial Peak value of the SAR averaged over any 1 gram of tissue, defined as a tissue volume in the shape of a cube and over the appropriate averaging time. | | | |
| (3) The Spatial Peak value of the SAR averaged over any 10 grams of tissue, defined as a tissue volume in the shape of a cube and over the appropriate averaging time. | | | |
| (4) Uncontrolled environments are defined as locations where there is potential exposure to individuals who have no knowledge or control of their potential exposure. | | | |
| (5) Controlled environments are defined as locations where there is potential exposure to individuals who have knowledge of their potential exposure and can exercise control over their exposure. | | | |

# 13.0 DETAILS OF SAR EVALUATION

## 13.1 Day Log

| DAY LOG | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Date | Ambient Temp (° C) | Fluid Temp (° C) | Relative Humidity (%) | Barometric Pressure (kPa) | Fluid Dielectric | SPC | Test | Task |
| 14 Sep 2022 | 25.2 | 23.8 | 19% | 100.6 | X | X | X | 2450H Fluid, SPC, SAR Testing |
| 15 Sep 2022 | 23.6 | 23.5 | 20% | 101.5 | | | X | 2450H SAR Testing |

## 13.2 DUT Setup and Configuration

| DUT Setup and Configuration |
|---|
| **Overview** |
| The A04394 was evaluated for Body SAR at the maximum conducted output power level, preset by the manufacturer, with a fully charged battery in unmodulated continuous transmit operation ( Maximum duty cycle), as provided by the manufacturer with a unit set up and pre-installed with Compliance Test Mode. |

## 13.3 DUT Positioning

| DUT Positioning |
|---|
| **Positioning** |
| The DUT Positioner was securely fastened to the Phantom Platform to ensure consistent positioning of the DUT for each test evaluation. |
| **FACE Configuration** |
| This device is not capable of voice communication and was not tested in the FACE configuration. |
| **BODY Configuration** |
| There are no Body-Worn and Audio Accessories for this device and was not evaluated for BODY configuration. |
| **HEAD Configuration** |
| This device is not intended to be held to the ear and was not tested in the HEAD configuration. |
| **EXTREMITY Configuration** |
| The DUT, was securely clamped into the device holder with the surface of the DUT normally in contact with the body (hand) in direct contact with the bottom of the phantom, or 0mm separation from the DUT to the phantom resembling that for which it was intended to be used. |

## 13.4 General Procedures and Report

| General Procedures and Reporting |
|---|
| **General Procedures** |
| The fluid dielectric parameters of the Active Tissue Simulating Liquid (TSL) were measured as described in this Section, recorded and entered into the DASY Measurement Server. Active meaning the TSL used during the SAR evaluation of the DUT. The temperature of the Active TSL was measured and recorded prior to performing a System Performance Check (SPC). An SPC was performed with the Active TSL prior to the start of the test series. The temperature of the Active TSL was measured throughout the day and the Active TSL temperature was maintained to ± 0.5°C. The Active TSL temperature was maintained to within ±2.0°C throughout the test series. The liquid parameters shall be measured within 24 hours before the start of a test series and if it takes longer than 48 hours, the liquid parameters shall also be measured at the end of the test series.<br><br>An Area Scan exceeding the length and width of the DUT projection was performed and the locations of all maximas within 2dB of the Peak SAR recorded. A Zoom Scan centered over the Peak SAR location(s) was performed and the 1g and 10g SAR values recorded. The resolutions of the Area Scan and Zoom Scan are described in the Scan Resolution table(s) in this Section. A Power Reference Measurement was taken at the phantom reference point immediately prior to the Area Scan. A Power Drift measurement was taken at the phantom reference point immediately following the Zoom Scan to determine the power drift. A Z-Scan from the *Maximum Distance to Phantom Surface* to the fluid surface was performed following the power drift measurement. |
| **Reporting** |
| The 1g SAR, 10g SAR and power drift measurements are recorded in the SAR Measurement Summary tables in the SAR Measurement Summary Section of this report. The SAR values shown in the SAR column are the SAR values reported by the SAR Measurement Server with the DUT operating at maximum transmit duty cycle. These tables also include other information such as transmit channel and frequency, modulation, accessories tested and DUT-phantom separation distance.<br><br>In the Scaling of Maximum Measured SAR Section of this report, the highest measured SAR in the BODY configuration, within the entire scope of this assessment, are, when applicable, scaled for Fluid Sensitivity, Manufacturer's Tune-Up Tolerance, Simultaneous Transmission and Drift. With the exception of Duty Cycle correction/compensation, SAR values are ONLY scaled up, not down. The final results of this scaling is the *reported SAR* which appears on the Cover Page of this report. |

## 13.5 Fluid Dielectric and Systems Performance Check

| Fluid Dielectric and Systems Performance Check |
|---|
| **Fluid Dielectric Measurement Procedure** |
| The fluid dielectric parameters of the Tissue Simulating Liquid (TSL) are measured using the Open-Ended Coax Method connected to an Agilent 8753ET Network Analyzer connected to a measurement server running Aprel Dielectric Property Measurement System. A frequency range of ± 100MHz for frequencies > 300MHz and ± 50MHz for frequencies ≤ 300MHz with frequency step size of 10MHz is used. The center frequency is centered around the SAR measurement probe's calibration point for that TSL frequency range. A calibration of the setup is performed using a short-open-deionized water (at 23°C in a 300ml beaker) method. A sample of the TSL is placed in a 300ml beaker and the open-ended coax is submerged approximately 8mm below the fluid surface in the approximate center of the beaker. A check of the setup is made to ensure no air is trapped under the open-ended coax. The sample of TSL is measured and compared to the IEC/IEEE 62209-1528 targets for HEAD or BODY for the entire fluid measurement range. Fluid adjustment are made if the dielectric parameters are > 5% in range that the DUT is to be tested. If the adjustments fail to bring the parameters to ≤ 5% but are < 10%, the SAR Fluid Sensitivity as per IEC/IEEE 62209-1528 and FCC KDB 865664 are applied to the highest measured SAR. A TSL with dielectric parameters > 10% in the DUT test frequency range are not used. |
| **Systems Performance Check** |
| The fluid dielectric parameters of the Active TSL are entered into the DASY Measurement Server at each of the 10MHz step size intervals. Active meaning the TSL used during the SAR evaluation of the DUT. The DASY Measurement System will automatically interpolate the dielectric parameters for DUT test frequencies that fall between the 10MHz step intervals. |
| A Systems Performance Check (SPC) is performed in accordance with IEC/IEEE 62209-1528 "System Check" and FCC KDB 865664 "System Verification". A validation source, dipole or Confined Loop Antenna (CLA), is placed under the geometric center of the phantom and separated from the phantom in accordance to the validation source's Calibration Certificate data. A CW signal set to the frequency of the validate source's and SAR measurement probe's calibration frequency with a forward power set to the validation source's Calibration Certificate data power setting is applied to the validation source. An Area Scan is centered over the projection of the validation source's feed point and an Area Scan is taken. A Zoom Scan centered over the Peak SAR measurement of the Area Scan and the 1g and 10g SAR is measured. The measured 1g and 10g SAR is compared to the 1g and 10g SAR measurements from the validation source's Calibration Certificate. When required, the measured SAR is normalized to 1.0W and compared to the normalized SAR indicated on the validation source's Calibration Certificate. The SPC is considered valid when the measured and normalized SAR is ≤ 10% of the measured and normalize SAR of the validation source's Calibration Certificate. |
| The fluid dielectric parameters of the Active TSL and SPC are repeated when the Active TSL has been in use for greater than 84 hours or if the Active TSL temperature has exceed ± 1°C of the initial fluid analysis. |

## 13.6 Scan Resolution 100MHz to 2GHz

| Scan Resolution 100MHz to 2GHz | |
|---|---|
| **Maximum distance from the closest measurement point to phantom surface: (Geometric Center of Probe Center)** | **4 ± 1 mm** |
| **Maximum probe angle normal to phantom surface. (Flat Section ELI Phantom)** | **5° ± 1°** |
| **Area Scan Spatial Resolution ΔX, ΔY** | **15 mm** |
| **Zoom Scan Spatial Resolution ΔX, ΔY** | **7.5 mm** |
| **Zoom Scan Spatial Resolution ΔZ (Uniform Grid)** | **5 mm** |
| **Zoom Scan Volume X, Y, Z** | **30 mm** |
| **Phantom** | **ELI** |
| **Fluid Depth** | **150 ± 5 mm** |
| An Area Scan with an area extending beyond the device was used to locate the candidate maximas within 2dB of the global maxima. | |
| A Zoom Scan centered over the peak SAR location(s) determined by the Area Scan was used to determine the 1-gram and 10-gram peak spatial-average SAR | |

### 13.7 Scan Resolution 2GHz to 3GHz

| Scan Resolution 2GHz to 3GHz | |
|---|---|
| **Maximum distance from the closest measurement point to phantom surface: (Geometric Center of Probe Center)** | **4 ± 1 mm** |
| **Maximum probe angle normal to phantom surface. (Flat Section ELI Phantom)** | **$5^{o} \pm 1^{o}$** |
| **Area Scan Spatial Resolution ΔX, ΔY** | **12 mm** |
| **Zoom Scan Spatial Resolution ΔX, ΔY** | **5 mm** |
| **Zoom Scan Spatial Resolution ΔZ (Uniform Grid)** | **5 mm** |
| **Zoom Scan Volume X, Y, Z** | **30 mm** |
| **Phantom** | **ELI** |
| **Fluid Depth** | **150 ± 5 mm** |
| An Area Scan with an area extending beyond the device was used to locate the candidate maximas within 2dB of the global maxima. | |
| A Zoom Scan centered over the peak SAR location(s) determined by the Area Scan was used to determine the 1-gram and 10-gram peak spatial-average SAR | |

### 13.8 Scan Resolution 5GHz to 6GHz

| Scan Resolution 5GHz to 6GHz | |
|---|---|
| **Maximum distance from the closest measurement point to phantom surface: (Geometric Center of Probe Center)** | **4 ± 1 mm** |
| **Maximum probe angle normal to phantom surface. (Flat Section ELI Phantom)** | **$5^{o} \pm 1^{o}$** |
| **Area Scan Spatial Resolution ΔX, ΔY** | **10 mm** |
| **Zoom Scan Spatial Resolution ΔX, ΔY** | **4 mm** |
| **Zoom Scan Spatial Resolution ΔZ (Uniform Grid)** | **2 mm** |
| **Zoom Scan Volume X, Y, Z** | **22 mm** |
| **Phantom** | **ELI** |
| **Fluid Depth** | **100 ± 5 mm** |
| An Area Scan with an area extending beyond the device was used to locate the candidate maximas within 2dB of the global maxima. | |
| A Zoom Scan centered over the peak SAR location(s) determined by the Area Scan was used to determine the 1-gram and 10-gram peak spatial-average SAR | |

# 14.0 MEASUREMENT UNCERTAINTIES

**Table 14.1 Measurement Uncertainty**

| UNCERTAINTY BUDGET FOR DEVICE EVALUATION (IEC/IEEE 62209-1528 Table 9) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Source of Uncertainty | Reference | Toler ±% | Prob Dist | Div | $c_i$ | $c_i$ | Stand Unct ±% | Stand Unct ±% | $V_i$ or $V_{eff}$ |
| **Measurement System** | | | | | (1g) | (10g) | (1g) | (10g) | |
| EX3DV4 Probe Calibration** (*k*=1) | E.2.1 | 6.7 | N | 1 | 1 | 1 | **6.7** | **6.7** | ∞ |
| Axial Isotropy** (*k*=1) | E.2.2 | 0.6 | R | √3 | 0.7 | 0.7 | **0.2** | **0.2** | ∞ |
| Hemispherical Isotropy** (*k*=1) | E.2.2 | 3.2 | R | √3 | 0.7 | 0.7 | **1.3** | **1.3** | ∞ |
| Boundary Effect* | E.2.3 | 1.0 | R | √3 | 1 | 1 | 0.6 | 0.6 | ∞ |
| Linearity** (*k*=1) | E.2.4 | **0.5** | R | √3 | 1 | 1 | **0.3** | **0.3** | ∞ |
| System Detection Limits* | E.2.4 | 1.0 | R | √3 | 1 | 1 | 0.6 | 0.6 | ∞ |
| Modulation Response** (*k*=1) | E.2.5 | **8.3** | R | √3 | 1 | 1 | **4.8** | **4.8** | ∞ |
| Readout Electronics* | E.2.6 | 0.3 | N | 1 | 1 | 1 | 0.3 | 0.3 | ∞ |
| Response Time* | E.2.7 | 0.8 | R | √3 | 1 | 1 | 0.5 | 0.5 | ∞ |
| Integration Time* | E.2.8 | 2.6 | R | √3 | 1 | 1 | 1.5 | 1.5 | ∞ |
| RF Ambient Conditions - Noise | E.6.1 | **0.0** | R | √3 | 1 | 1 | 0.0 | 0.0 | **10** |
| RF Ambient Conditions - Reflection | E.6.1 | **0.0** | R | √3 | 1 | 1 | 0.0 | 0.0 | **10** |
| Probe Positioner Mechanical Tolerance* | E.6.2 | 0.0 | R | √3 | 1 | 1 | 0.0 | 0.0 | ∞ |
| Probe Positioning wrt Phantom Shell* | E.6.3 | 0.4 | R | √3 | 1 | 1 | 0.2 | 0.2 | ∞ |
| Post-processing* | E.5 | 2.0 | R | √3 | 1 | 1 | 1.2 | 1.2 | ∞ |
| **Test Sample Related** | | | | | | | | | |
| Test Sample Positioning | E.4.2 | **2.2** | N | 1 | 1 | 1 | 2.2 | 2.2 | **5** |
| Device Holder Uncertainty* | E.4.1 | 3.6 | N | 1 | 1 | 1 | 3.6 | 3.6 | ∞ |
| SAR Drift Measurement(2) | E.2.9 | 0.0 | R | √3 | 1 | 1 | 0.0 | 0.0 | ∞ |
| SAR Power Scaling(3) | E.6.5 | 0.0 | R | √3 | 1 | 1 | 0.0 | 0.0 | ∞ |
| **Phantom and Tissue Parameters** | | | | | | | | | |
| Phantom Uncertainty* | E.3.1 | 6.1 | R | √3 | 1 | 1 | 3.5 | 3.5 | ∞ |
| SAR Correction Uncertainty | E.3.2 | **1.6** | N | 1 | 1 | 0.84 | 1.6 | 1.3 | ∞ |
| Liquid Conductivity (measurement) | E.3.3 | **5.0** | N | 1 | 0.78 | 0.71 | 3.9 | 3.6 | **10** |
| Liquid Permittivity (measurement) | E.3.3 | **5.0** | N | 1 | 0.23 | 0.26 | 1.2 | 1.3 | **10** |
| Liquid Conductivity (Temperature) | E.3.2 | **0.4** | R | √3 | 0.78 | 0.71 | 0.2 | 0.2 | **10** |
| Liquid Permittivity Temperature) | E.3.2 | **0.2** | R | √3 | 0.23 | 0.26 | 0.0 | 0.0 | **10** |
| **Effective Degrees of Freedom(1)** | | | | | | | | $V_{eff}$ = | **1141** |
| **Combined Standard Uncertainty** | | | **RSS** | | | | **11.1** | **11.0** | |
| **Expanded Uncertainty (95% Confidence Interval)** | | | **k=2** | | | | **22.2** | **21.9** | |
| **Measurement Uncertainty Table in accordance with IEC/IEEE 62209-1528** | | | | | | | | | |

(1) The Effective Degrees of Freedom is > 30

Therefore a coverage factor of k=2 represents an approximate confidence level of 95%.

(2) The SAR Value is compensated for Drift

(3) SAR Power Scaling not Required

* Provided by SPEAG for DASY4

**Table 14.2 Calculation of Degrees of Freedom**

| Calculation of the Degrees and Effective Degrees of Freedom | |
|---|---|
| $v_i = n - 1$ | $$v_{eff} = \frac{u_c^4}{\sum_{i=1}^{m} \frac{c_i^4 u_i^4}{v_i}}$$ |

## 15.0 FLUID DIELECTRIC PARAMETERS

**Table 15.1 Fluid Dielectric Parameters 2450MHz HEAD TSL**

```
****************************************************************
                     Aprel Laboratory
           Test Result for UIM Dielectric Parameter
                  Wed 14/Sep/2022 12:40:45
                  Freq      Frequency(GHz)
FCC_eH      FCC OET 65 Supplement C (June 2001) Limits for Head Epsilon
FCC_sH      FCC OET 65 Supplement C (June 2001) Limits for Head Sigma
                  Test_e  Epsilon  of  UIM
                  Test_s  Sigma of UIM
****************************************************************
```

| Freq | FCC_eH | FCC_sH | Test_e | Test_s |
|---|---|---|---|---|
| 2.3500 | 39.38 | 1.71 | 36.91 | 1.80 |
| 2.3600 | 39.36 | 1.72 | 36.66 | 1.82 |
| 2.3700 | 39.34 | 1.73 | 36.49 | 1.80 |
| 2.3800 | 39.32 | 1.74 | 36.62 | 1.81 |
| 2.3900 | 39.31 | 1.75 | 36.54 | 1.84 |
| 2.4000 | 39.29 | 1.76 | 36.51 | 1.84 |
| 2.4100 | 39.27 | 1.76 | 36.62 | 1.86 |
| 2.4200 | 39.25 | 1.77 | 36.59 | 1.89 |
| 2.4300 | 39.24 | 1.78 | 36.60 | 1.87 |
| 2.4400 | 39.22 | 1.79 | 36.57 | 1.90 |
| 2.4500 | 39.20 | 1.80 | 36.38 | 1.92 |
| 2.4600 | 39.19 | 1.81 | 36.48 | 1.92 |
| 2.4700 | 39.17 | 1.82 | 36.41 | 1.93 |
| 2.4800 | 39.16 | 1.83 | 36.42 | 1.95 |
| 2.4900 | 39.15 | 1.84 | 36.30 | 1.95 |
| 2.5000 | 39.14 | 1.85 | 36.22 | 1.98 |
| 2.5100 | 39.12 | 1.87 | 36.18 | 1.97 |
| 2.5200 | 39.11 | 1.88 | 36.16 | 2.00 |
| 2.5300 | 39.10 | 1.89 | 36.17 | 1.99 |
| 2.5400 | 39.09 | 1.90 | 36.07 | 2.01 |
| 2.5500 | 39.07 | 1.91 | 36.29 | 2.04 |

| FLUID DIELECTRIC PARAMETERS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Date: 14 Sep 2022 | | Fluid Temp: 23.8 | | Frequency: 2450MHz | | Tissue: | Head |
| Freq (MHz) | | Test_e | Test_s | Target_e | Target_s | Deviation Permittivity | Deviation Conductivity |
| 2350.0000 | | 36.9100 | 1.8000 | 39.3800 | 1.71 | -6.27% | 5.26% |
| 2360.0000 | | 36.6600 | 1.8200 | 39.3600 | 1.72 | -6.86% | 5.81% |
| 2370.0000 | | 36.4900 | 1.8000 | 39.3400 | 1.73 | -7.24% | 4.05% |
| 2380.0000 | | 36.6200 | 1.8100 | 39.3200 | 1.74 | -6.87% | 4.02% |
| 2390.0000 | | 36.5400 | 1.8400 | 39.3100 | 1.75 | -7.05% | 5.14% |
| 2400.0000 | | 36.5100 | 1.8400 | 39.2900 | 1.76 | -7.08% | 4.55% |
| 2402.0000 | * | 36.5320 | 1.8440 | 39.2860 | 1.76 | -7.01% | 4.77% |
| 2410.0000 | | 36.6200 | 1.8600 | 39.2700 | 1.76 | -6.75% | 5.68% |
| 2412.0000 | * | 36.6140 | 1.8660 | 39.2660 | 1.76 | -6.75% | 5.90% |
| 2420.0000 | | 36.5900 | 1.8900 | 39.2500 | 1.77 | -6.78% | 6.78% |
| 2430.0000 | | 36.6000 | 1.8700 | 39.2400 | 1.78 | -6.73% | 5.06% |
| 2437.0000 | * | 36.5790 | 1.8910 | 39.2260 | 1.79 | -6.75% | 5.82% |
| 2440.0000 | | 36.5700 | 1.9000 | 39.2200 | 1.79 | -6.76% | 6.15% |
| 2442.0000 | * | 36.5320 | 1.9040 | 39.2160 | 1.79 | -6.84% | 6.25% |
| 2450.0000 | | 36.3800 | 1.9200 | 39.2000 | 1.80 | -7.19% | 6.67% |
| 2460.0000 | | 36.4800 | 1.9200 | 39.1900 | 1.81 | -6.92% | 6.08% |
| 2462.0000 | * | 36.4660 | 1.9220 | 39.1860 | 1.81 | -6.94% | 6.07% |
| 2470.0000 | | 36.4100 | 1.9300 | 39.1700 | 1.82 | -7.05% | 6.04% |
| 2480.0000 | | 36.4200 | 1.9500 | 39.1600 | 1.83 | -7.00% | 6.56% |
| 2490.0000 | | 36.3000 | 1.9500 | 39.1500 | 1.84 | -7.28% | 5.98% |
| 2500.0000 | | 36.2200 | 1.9800 | 39.1400 | 1.85 | -7.46% | 7.03% |
| 2510.0000 | | 36.1800 | 1.9700 | 39.1200 | 1.87 | -7.52% | 5.35% |
| 2520.0000 | | 36.1600 | 2.0000 | 39.1100 | 1.88 | -7.54% | 6.38% |
| 2530.0000 | | 36.1700 | 1.9900 | 39.1000 | 1.89 | -7.49% | 5.29% |
| 2540.0000 | | 36.0700 | 2.0100 | 39.0900 | 1.90 | -7.73% | 5.79% |
| 2550.0000 | | 36.2900 | 2.0400 | 39.0700 | 1.91 | -7.12% | 6.81% |

*Channel Frequency Tested

# 16.0 SYSTEM VERIFICATION TEST RESULTS

**Table 16.1 System Verification Results 2450MHz HEAD TSL**

| System Verification Test Results | | | | | |
|---|---|---|---|---|---|
| Date | | Frequency (MHz) | Validation Source | | |
| | | | P/N | | S/N |
| 14 Sep 2022 | | 2450 | D2450V2 | | 825 |
| Fluid Type | Fluid Temp °C | Ambient Temp °C | Ambient Humidity (%) | Forward Power (mW) | Source Spacing (mm) |
| Head | 23.8 | 25 | 19% | 250 | 10 |
| Fluid Parameters | | | | | |
| Permittivity | | | Conductivity | | |
| Measured | Target | Deviation | Measured | Target | Deviation |
| 36.38 | 39.20 | -7.19% | 1.92 | 1.80 | 6.67% |
| Measured SAR | | | | | |
| 1 gram | | | 10 gram | | |
| Measured | Target | Deviation | Measured | Target | Deviation |
| 12.70 | 13.18 | -3.64% | 5.91 | 6.01 | -1.58% |
| Measured SAR Normalized to 1.0W | | | | | |
| 1 gram | | | 10 gram | | |
| Normalized | Target | Deviation | Normalized | Target | Deviation |
| 50.80 | 52.72 | -3.64% | 23.64 | 24.02 | -1.56% |

Prior to the SAR evaluations, system checks were performed on the planar section of the phantom and a SPEAG validation dipole in accordance with the procedures described in IEEE 1528-2013, FCC KDB 846224, IEC 62209-1 and IEC 62209-1528.

The dielectric parameters of the simulated tissue mixture were measured prior to the system performance check using a Dielectric Probe Kit and a Network Analyzer.

The forward power was applied to the dipole and the system was verified to a tolerance of +10% from the system manufacturer's dipole calibration target SAR value.

The forward power applied was same forward power applied by the calibration lab during the calibration of this validation source.

## 17.0 SYSTEM VALIDATION SUMMARY

**Table 17.1 System Validation Summary**

| SAR Validation SummaryChart | | | | | |
|---|---|---|---|---|---|
| Validation Date | Validation Source | Validation Frequency | Linearity | Isotropy | Extrapolation |
| ✓ = Complete | | ✓ = Not Required | | | |
| 3-May-22 | D2450V2 | 2450 | ✓ | ✓ | ✓ |

## 18.0 MEASUREMENT SYSTEM SPECIFICATIONS

**Table 18.1 Measurement System Specifications**

| Measurement System Specification | |
|---|---|
| **Specifications** | |
| **Positioner** | Stäubli Unimation Corp. Robot Model: TX90XL |
| **Repeatability** | +/- 0.035 mm |
| **No. of axis** | 6.0 |
| **Data Acquisition Electronic (DAE) System** | |
| **Cell Controller** | |
| **Processor** | Intel(R) Core(TM) i7-7700 |
| **Clock Speed** | 3.60 GHz |
| **Operating System** | Windows 10 Professional |
| **Data Converter** | |
| **Features** | Signal Amplifier, multiplexer, A/D converter, and control logic |
| **Software** | Measurement Software: DASY6, V 6.4.0.12171 / DASY52 V52.10.0.1446 |
| | Postprocessing Software: SEMCAD X, V14.6.10( Deployment Build ) |
| **Connecting Lines** | Optical downlink for data and status info., Optical uplink for commands and clock |
| **DASY Measurement Server** | |
| **Function** | Real-time data evaluation for field measurements and surface detection |
| **Hardware** | Intel ULV Celeron CPU 400 MHz; 128 MB chip disk; 128 MB RAM |
| **Connections** | COM1, COM2, DAE, Robot, Ethernet, Service Interface |
| **E-Field Probe** | |
| **Model** | EX3DV4 |
| **Serial No.** | 3600 |
| **Construction** | Triangular core fiber optic detection system |
| **Frequency** | 10 MHz to 6 GHz |
| **Linearity** | ±0.2 dB (30 MHz to 3 GHz) |
| **Phantom** | |
| **Type** | ELI Elliptical Planar Phantom |
| **Shell Material** | Fiberglass |
| **Thickness** | 2mm +/- .2mm |
| **Volume** | > 30 Liter |

## Measurement System Specification

### Probe Specification

| | | |
|---|---|---|
| Construction: | Symmetrical design with triangular core;<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, glycol) |  |
| Calibration: | In air from 10 MHz to 2.5 GHz<br>In head simulating tissue at frequencies of 900 MHz<br>and 1.8 GHz (accuracy ± 8%) | |
| Frequency: | 10 MHz to > 6 GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz) | |
| Directivity: | ± 0.2 dB in head tissue (rotation around probe axis)<br>± 0.4 dB in head tissue (rotation normal to probe axis) | |
| Dynamic Range: | 5 µW/g to > 100 mW/g; Linearity: ± 0.2 dB | |
| Surface Detect: | ± 0.2 mm repeatability in air and clear liquids over diffuse reflecting surfaces | |
| Dimensions: | Overall length: 330 mm; Tip length: 16 mm;<br>Body diameter: 12 mm; Tip diameter: 6.8 mm<br>Distance from probe tip to dipole centers: 2.7 mm | |
| Application: | General dosimetry up to 3 GHz; Compliance tests of mobile phone | **EX3DV4 E-Field Probe** |

### Phantom Specification

The ELI V5.0 phantom is an elliptical planar fiberglass shell phantom with a shell thickness of 2.0mm +/- .2mm at the planar area. This phantom conforms to OET Bulletin 65, Supplement C, IEEE 1528-2013, IEC 62209-1, IEC 62209-2 and IEC/IEEE 62209-1528.

**ELI Phantom**

### Device Positioner Specification

The DASY device positioner has two scales for device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear openings). The plane between the ear openings and the mouth tip has a rotation angle of 65°. The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections.

**Device Positioner**

# 19.0 TEST EQUIPMENT LIST

**Table 19.1 Equipment List and Calibration**

| Test Equipment List | | | | |
|---|---|---|---|---|
| DESCRIPTION | ASSET NO. | SERIAL NO. | DATE CALIBRATED | CALIBRATION DUE |
| Schmid & Partner DASY 6 System | - | - | - | - |
| -DASY Measurement Server | 00158 | 1078 | CNR | CNR |
| -Robot | 00046 | 599396-01 | CNR | CNR |
| -DAE4 | 00019 | 353 | 14-Apr-22 | 14-Apr-23 |
| -EX3DV4 E-Field Probe | 00213 | 3600 | 20-Apr-22 | 20-Apr-23 |
| -CLA 30 Validation Dipole | 00300 | 1005 | 18-Mar-20 | 18-Mar-23 |
| -CLA150 Validation Dipole | 00251 | 4007 | 18-Mar-20 | 18-Mar-23 |
| -D450V3 Validation Dipole | 00221 | 1068 | 27-Apr-21 | 27-Apr-24 |
| -D835V2 Validation Dipole | 00217 | 4D075 | 27-Apr-21 | 27-Apr-24 |
| -D900V2 Validation Dipole | 00020 | 54 | 16-Mar-20 | 16-Mar-23 |
| ALS-D-01640-S-2 | 00299 | 207-00102 | 15-Dec-20 | 15-Dec-23 |
| -D1800V2 Validation Dipole | 00222 | 247 | 16-Mar-20 | 16-Mar-23 |
| -D1900V2 Validation Dipole | 00218 | 5d107 | 16-Mar-20 | 16-Mar-23 |
| -D2450V2 Validation Dipole | 00219 | 825 | 24-Apr-21 | 24-Apr-24 |
| -D5GHzV2 Validation Dipole | 00126 | 1031 | 27-Apr-21 | 27-Apr-24 |
| ELI Phantom | 00247 | 1234 | CNR | CNR |
| SAM Phantom | 00154 | 1033 | CNR | CNR |
| HP 85070C Dielectric Probe Kit | 00033 | none | CNR | CNR |
| HP 8753ET Network Analyzer | 00134 | US39170292 | 6-Jan-21 | 6-Jan-24 |
| Rohde & Schwarz SMR20 Signal Generator | 00006 | 100104 | 11-Aug-20 | 11-Aug-23 |
| Amplifier Research 10W1000C Power Amplifier | 00041 | 27887 | CNR | CNR |
| Amplifier Research 5S1G4 Power Amplifier | 00106 | 26235 | CNR | CNR |
| Narda Directional Coupler 3020A | 00064 | - | CNR | CNR |
| Kangaroo VWR Humidity/Thermometer | 00334 | 192385455 | 5-Aug-19 | 6-Aug-22 |
| Digital Multi Meter DMR-1800 | 00250 | TE182 | 23-Jun-20 | 23-Jun-23 |
| Bipolar Power Supply 6299A | 00086 | 1144A02155 | CNR | CNR |
| DC-18G 10W 30db Attenuator | 00102 | - | COU | COU |
| R&S FSP40 Spectrum Analyzer | 00241 | 100500 | 9-Aug-21 | 9-Aug-24 |
| HP 8566B Spectrum Analyzer | 00051 | 2747A055100 | 29-Jun-20 | 29-Jun-23 |
| RF Cable-SMA | 00311 | - | CNR | CNR |
| HP Calibration Kit | 00145 | - | CNR | CNR |

CNR = Calibration Not Required

COU = Calibrate on Use

## 20.0 FLUID COMPOSITION

**Table 20.1 Fluid Composition 2450MHz HEAD TSL**

| Tissue Simulating Liquid (TSL) Composition | | | | 2450MHz Body |
|---|---|---|---|---|
| Component by Percent Weight | | | | |
| Water | Glycol | Salt(1) | HEC(2) | Bacteriacide(3) |
| 69.98 | 30.0 | 0.02 | 0.0 | 0.0 |

(1) Non-Iodinized
(2) **H**ydroxy**E**thyl-**C**ellulose: Sigma-Aldrich P/N 54290-500g
(3) Dow Chemical Dowicil 75 Antimicrobial Perservative

## END OF REPORT

# APPENDIX A – SYSTEM VERIFICATION PLOTS

**DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:825**
**Procedure Name: SPC 2450H_Input=250mw, Target=[11.86]13.18][14.50]W/kg 1G target = 52.719**

Communication System: UID 0, CW (0); Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.92 S/m; $\varepsilon_r$ = 36.38; ρ = 1000 kg/m$^3$
Phantom section: Flat Section

Date/Time: 9/14/2022 4:44:26 PM

DASY5 Configuration:

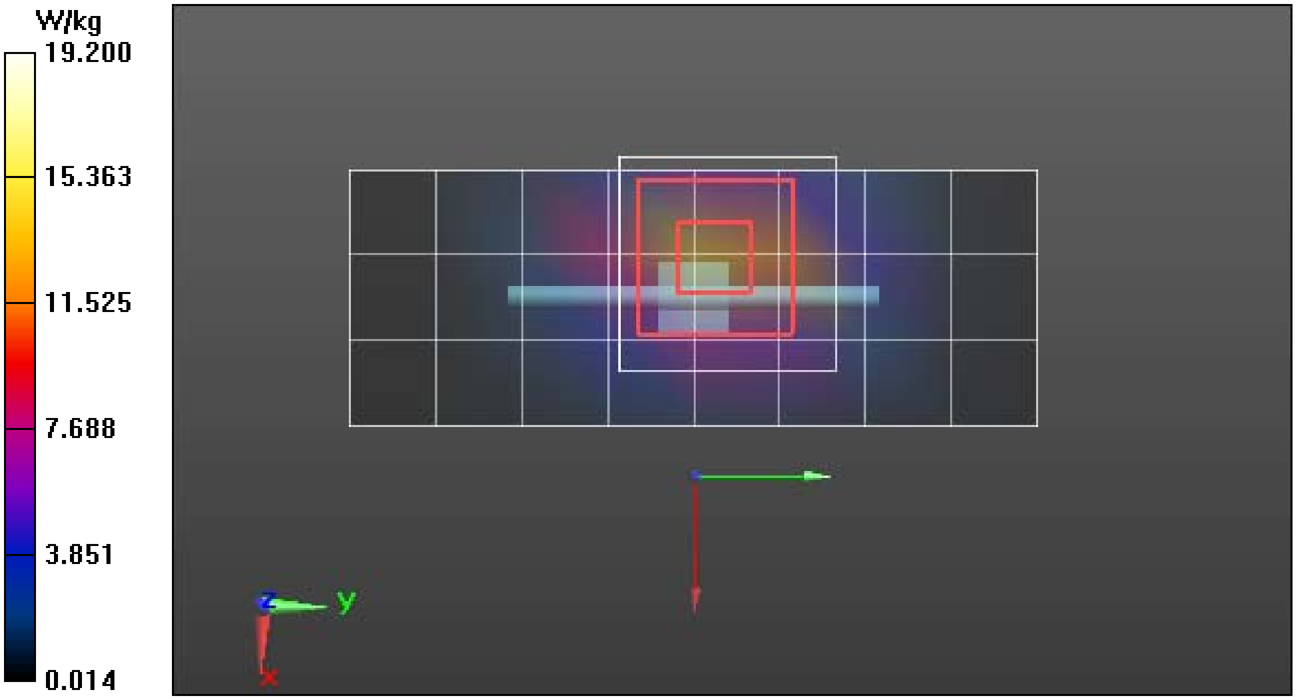
- Probe: EX3DV4 - SN3600; ConvF(6.58, 6.58, 6.58) @ 2450 MHz; Calibrated: 4/20/2022
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn353; Calibrated: 4/14/2022
- Phantom: Twin-SAM V4.0 (30deg probe tilt); Type: QD 000 P40 CC; Serial: xxxx
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

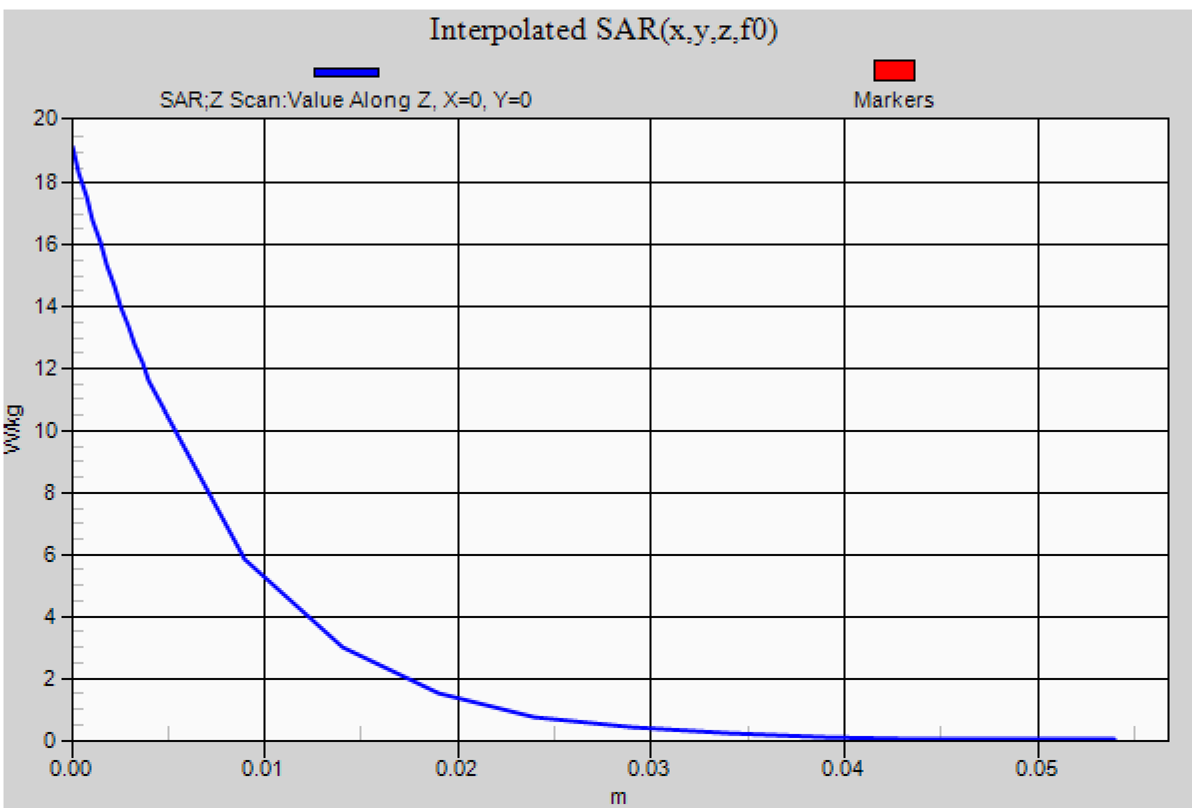
**SPC/SPC 2450H_Input=250mw, Target=[11.86]13.18][14.50]W/kg 1G target = 52.719/Area Scan (4x9x1):** Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (measured) = 13.5 W/kg

**SPC/SPC 2450H_Input=250mw, Target=[11.86]13.18][14.50]W/kg 1G target = 52.719/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 76.68 V/m; Power Drift = 0.22 dB
Peak SAR (extrapolated) = 27.0 W/kg
**SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.91 W/kg**
Smallest distance from peaks to all points 3 dB below = 11 mm
Ratio of SAR at M2 to SAR at M1 = 47.9%
Maximum value of SAR (measured) = 14.2 W/kg

**SPC/SPC 2450H_Input=250mw, Target=[11.86]13.18][14.50]W/kg 1G target = 52.719/Z Scan (1x1x22):** Measurement grid: dx=20mm, dy=20mm, dz=5mm
Penetration depth = 7.408 (7.275, 7.384) [mm]
Maximum value of SAR (interpolated) = 19.2 W/kg


W/kg
19.200
15.363
11.525
7.688
3.851
0.014
z
y
x


Interpolated SAR(x,y,z,f0)
SAR;Z Scan:Value Along Z, X=0, Y=0
Markers
W/kg
m
0
2
4
6
8
10
12
14
16
18
20
0.00
0.01
0.02
0.03
0.04
0.05

# APPENDIX B – MEASUREMENT PLOTS OF MAXIMUM MEASURED SAR

## Plot B10

**DUT: A04394; Type: Transmitter; Serial: Sample Prototype**

**Procedure Name: B10-A04394, Body- Back Side, 2442MHz, 5.5 bits WIFI**

Communication System: UID 0, CW (0); Frequency: 2442 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2442 MHz; $\sigma$ = 1.904 S/m; $\varepsilon_r$ = 36.532; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

Date/Time: 9/15/2022 3:55:30 PM

DASY5 Configuration:

- Probe: EX3DV4 - SN3600; ConvF(6.58, 6.58, 6.58) @ 2442 MHz; Calibrated: 4/20/2022
- Sensor-Surface: 4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn353; Calibrated: 4/14/2022
- Phantom: Twin-SAM V4.0 (30deg probe tilt); Type: QD 000 P40 CC; Serial: xxxx
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**2450H/B10-A04394, Body- Back Side, 2442MHz, 5.5 bits WIFI/Area Scan (8x11x1):** Measurement grid: dx=12mm, dy=12mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.802 W/kg

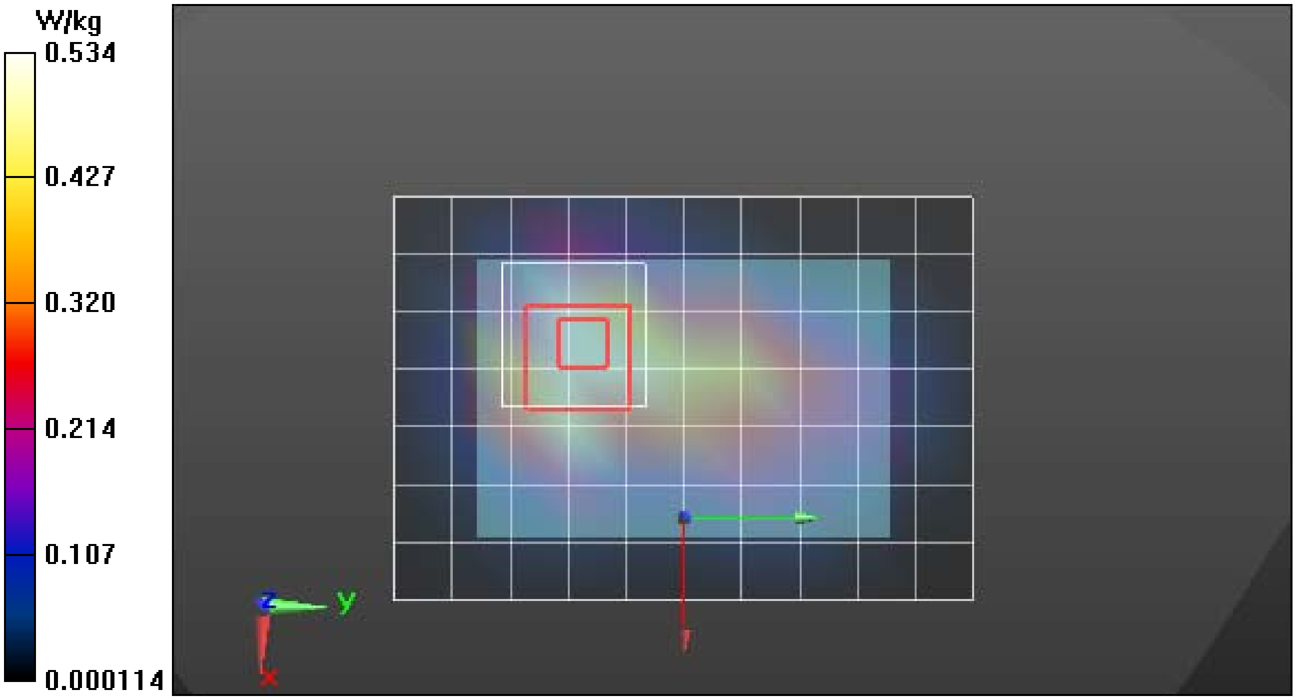
**2450H/B10-A04394, Body- Back Side, 2442MHz, 5.5 bits WIFI/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 13.85 V/m; Power Drift = -0.42 dB
Peak SAR (extrapolated) = 1.68 W/kg
**SAR(1 g) = 0.681 W/kg; SAR(10 g) = 0.299 W/kg**
Smallest distance from peaks to all points 3 dB below = 9.2 mm
Ratio of SAR at M2 to SAR at M1 = 43%

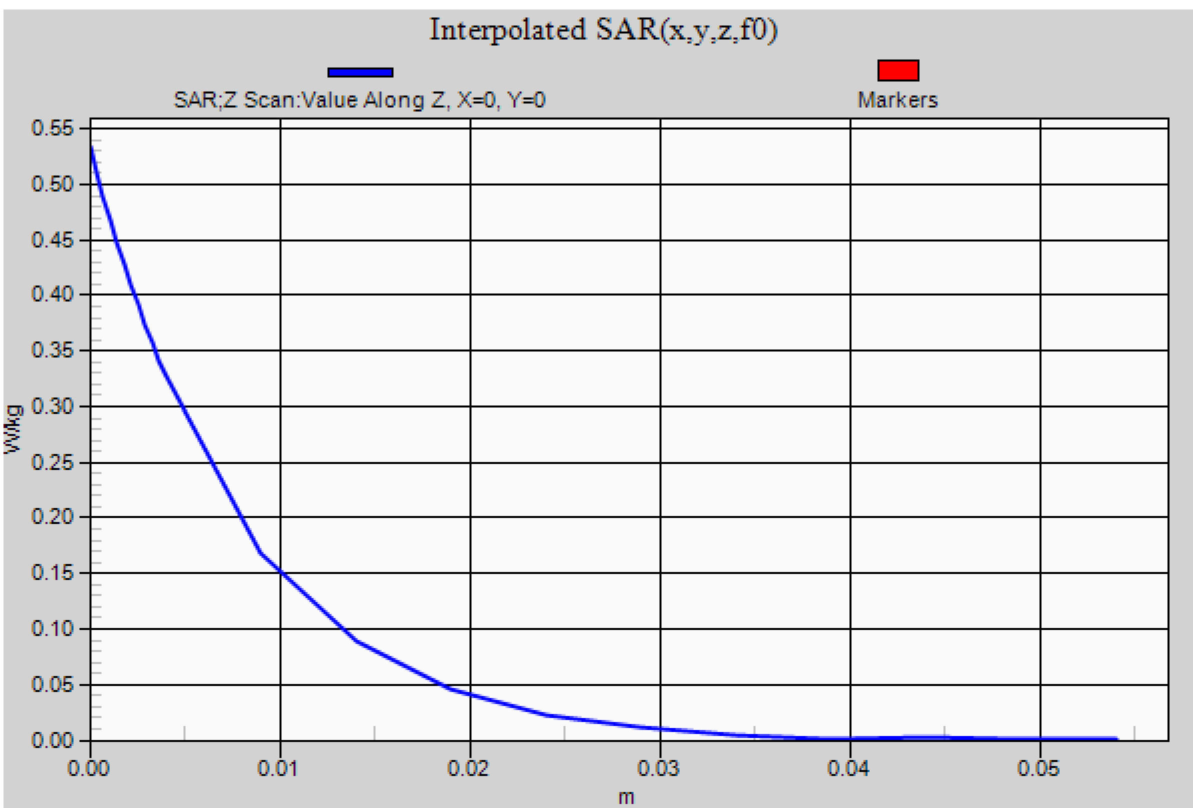
Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (measured) = 0.770 W/kg

**2450H/B10-A04394, Body- Back Side, 2442MHz, 5.5 bits WIFI/Z Scan (1x1x22):** Measurement grid: dx=20mm, dy=20mm, dz=5mm

Info: Interpolated medium parameters used for SAR evaluation.
Penetration depth = 7.773 (7.531, 7.844) [mm]
Maximum value of SAR (interpolated) = 0.534 W/kg


W/kg
0.534
0.427
0.320
0.214
0.107
0.000114
z
y
x


Interpolated SAR(x,y,z,f0)
SAR;Z Scan:Value Along Z, X=0, Y=0
Markers
W/kg
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.00
0.01
0.02
0.03
0.04
0.05
m

## APPENDIX D – PROBE CALIBRATION

**Calibration Laboratory of**
Schmid & Partner
Engineering AG
**Zeughausstrasse 43, 8004 Zurich, Switzerland**

**S** **Schweizerischer Kalibrierdienst**
**C** **Service suisse d'étalonnage**
**S** **Servizio svizzero di taratura**
**Swiss Calibration Service**

Accredited by the Swiss Accreditation Service (SAS)
**The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates**

**Accreditation No.: SCS 0108**

**Client** **Celltech**

**Certificate No: EX3-3600_Apr22**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | EX3DV4 - SN:3600 |
| Calibration procedure(s) | QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v6, QA CAL-23.v5, QA CAL-25.v7<br>Calibration procedure for dosimetric E-field probes |
| Calibration date: | April 20, 2022 |

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter NRP | SN: 104778 | 04-Apr-22 (No. 217-03525/03524) | Apr-23 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-22 (No. 217-03524) | Apr-23 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-22 (No. 217-03525) | Apr-23 |
| Reference 20 dB Attenuator | SN: CC2552 (20x) | 04-Apr-22 (No. 217-03527) | Apr-23 |
| DAE4 | SN: 660 | 13-Oct-21 (No. DAE4-660_Oct21) | Oct-22 |
| Reference Probe ES3DV2 | SN: 3013 | 27-Dec-21 (No. ES3-3013_Dec21) | Dec-22 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| Power meter E4419B | SN: GB41293874 | 06-Apr-16 (in house check Jun-20) | In house check: Jun-22 |
| Power sensor E4412A | SN: MY41498087 | 06-Apr-16 (in house check Jun-20) | In house check: Jun-22 |
| Power sensor E4412A | SN: 000110210 | 06-Apr-16 (in house check Jun-20) | In house check: Jun-22 |
| RF generator HP 8648C | SN: US3642U01700 | 04-Aug-99 (in house check Jun-20) | In house check: Jun-22 |
| Network Analyzer E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-20) | In house check: Oct-22 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Leif Klysner | Laboratory Technician | Leif Klysner |
| Approved by: | Sven Kühn | Deputy Manager | S. K. |

Issued: April 20, 2022

**Calibration Laboratory of**
Schmid & Partner
Engineering AG
**Zeughausstrasse 43, 8004 Zurich, Switzerland**



## Glossary:

| | |
|---|---|
| TSL | tissue simulating liquid |
| NORMx,y,z | sensitivity in free space |
| ConvF | sensitivity in TSL / NORMx,y,z |
| DCP | diode compression point |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A, B, C, D | modulation dependent linearization parameters |
| Polarization $\varphi$ | $\varphi$ rotation around probe axis |
| Polarization $\vartheta$ | $\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis |
| Connector Angle | information used in DASY system to align probe sensor X to the robot coordinate system |

## Calibration is Performed According to the Following Standards:

a) IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

## Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the $E^2$-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z*: *A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3600

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm ($\mu V/(V/m)^2$)[A] | 0.48 | 0.48 | 0.38 | ± 10.1 % |
| DCP (mV)[B] | 101.6 | 98.8 | 101.6 | |

## Calibration Results for Modulation Response

| UID | Communication System Name | | A dB | B dB$\sqrt{\mu V}$ | C | D dB | VR mV | Max dev. | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 147.6 | ± 2.5 % | ± 4.7 % |
| | | Y | 0.0 | 0.0 | 1.0 | | 140.0 | | |
| | | Z | 0.0 | 0.0 | 1.0 | | 146.8 | | |

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

[A] The uncertainties of Norm X,Y,Z do not affect the $E^2$-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3600

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | -124 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 9 mm |
| Tip Diameter | 2.5 mm |
| Probe Tip to Sensor X Calibration Point | 1 mm |
| Probe Tip to Sensor Y Calibration Point | 1 mm |
| Probe Tip to Sensor Z Calibration Point | 1 mm |
| Recommended Measurement Distance from Surface | 1.4 mm |

**Note**: Measurement distance from surface can be increased to 3-4 mm for an *Area Scan* job.

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3600

## Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 30 | 55.0 | 0.75 | 12.25 | 12.25 | 12.25 | 0.00 | 1.00 | ± 13.3 % |
| 150 | 52.3 | 0.76 | 9.65 | 9.65 | 9.65 | 0.00 | 1.00 | ± 13.3 % |
| 450 | 43.5 | 0.87 | 8.78 | 8.78 | 8.78 | 0.16 | 1.30 | ± 13.3 % |
| 750 | 41.9 | 0.89 | 8.23 | 8.23 | 8.23 | 0.46 | 0.86 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 8.11 | 8.11 | 8.11 | 0.51 | 0.80 | ± 12.0 % |
| 900 | 41.5 | 0.97 | 7.99 | 7.99 | 7.99 | 0.47 | 0.80 | ± 12.0 % |
| 1640 | 40.2 | 1.31 | 7.45 | 7.45 | 7.45 | 0.28 | 0.86 | ± 12.0 % |
| 1810 | 40.0 | 1.40 | 7.35 | 7.35 | 7.35 | 0.35 | 0.86 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 7.30 | 7.30 | 7.30 | 0.33 | 0.86 | ± 12.0 % |
| 2300 | 39.5 | 1.67 | 6.79 | 6.79 | 6.79 | 0.36 | 0.90 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 6.58 | 6.58 | 6.58 | 0.33 | 0.90 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 6.49 | 6.49 | 6.49 | 0.38 | 0.90 | ± 12.0 % |
| 5250 | 35.9 | 4.71 | 4.55 | 4.55 | 4.55 | 0.40 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 4.18 | 4.18 | 4.18 | 0.40 | 1.80 | ± 13.1 % |
| 5750 | 35.4 | 5.22 | 4.16 | 4.16 | 4.16 | 0.40 | 1.80 | ± 13.1 % |

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequencies below 3 GHz, the validity of tissue parameters ($\varepsilon$ and $\sigma$) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ($\varepsilon$ and $\sigma$) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3600

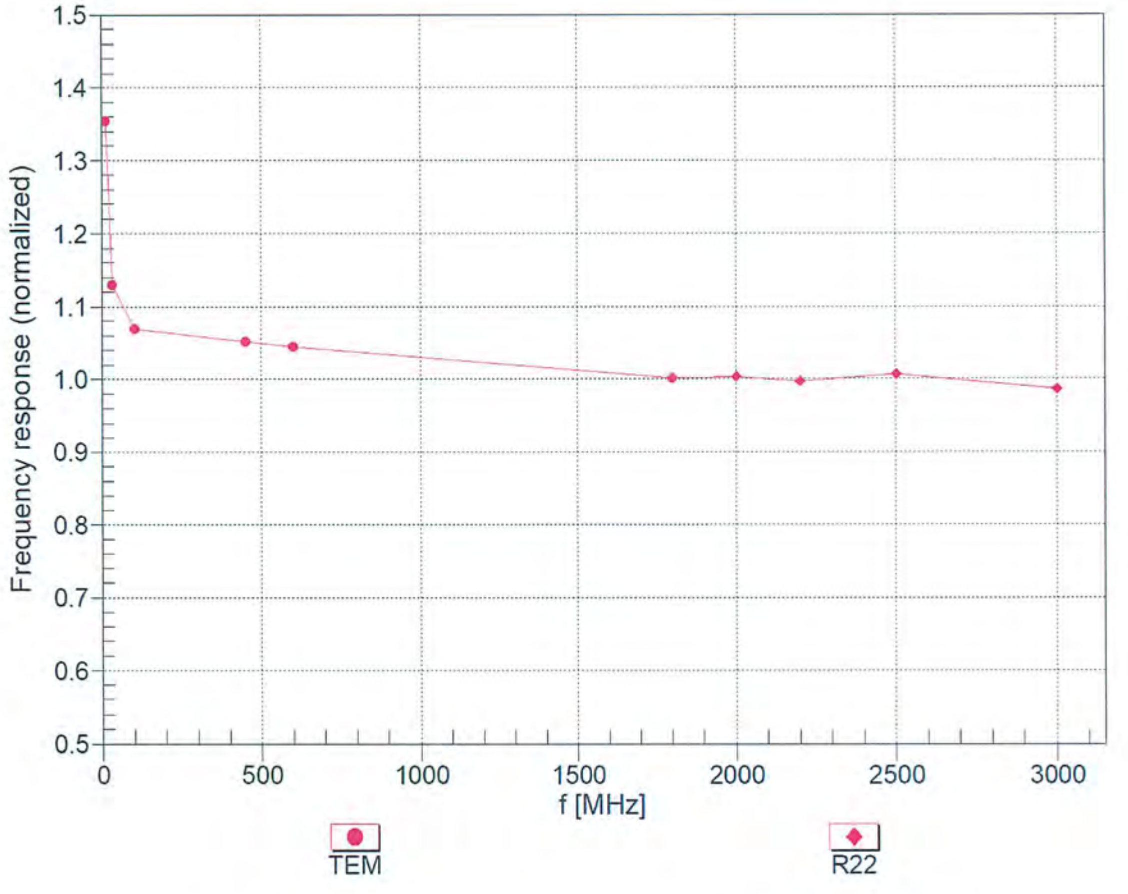
## Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 6500 | 34.5 | 6.07 | 4.75 | 4.75 | 4.75 | 0.20 | 2.50 | ± 18.6 % |

[C] Frequency validity at 6.5 GHz is -600/+700 MHz, and ± 700 MHz at or above 7 GHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies 6-10 GHz, the validity of tissue parameters ($\varepsilon$ and $\sigma$) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz; below ± 2% for frequencies between 3-6 GHz; and below ± 4% for frequencies between 6-10 GHz at any distance larger than half the probe tip diameter from the boundary.

# Frequency Response of E-Field

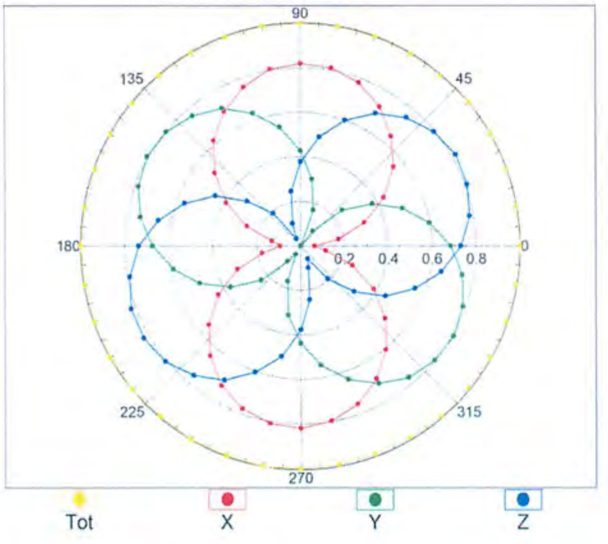
**(TEM-Cell:ifi110 EXX, Waveguide: R22)**



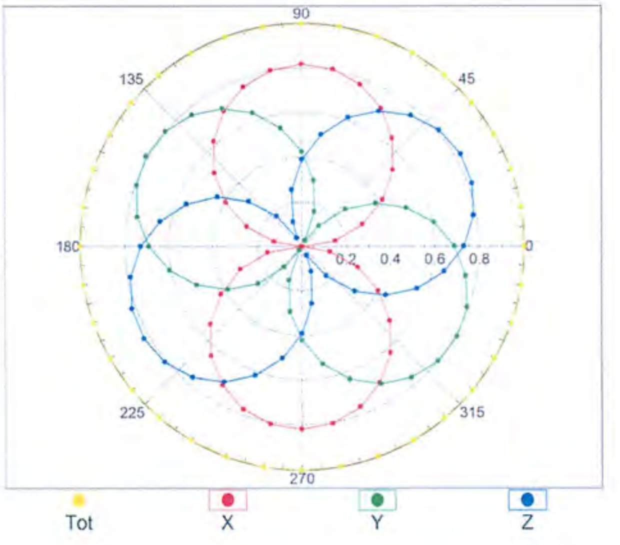

**Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)**

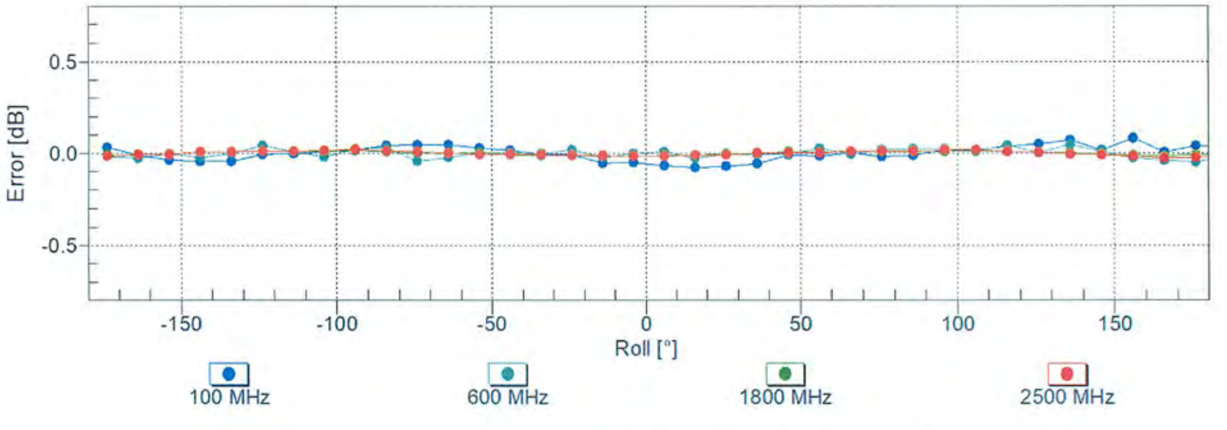
# Receiving Pattern (ϕ), $\vartheta = 0°$

f=600 MHz,TEM



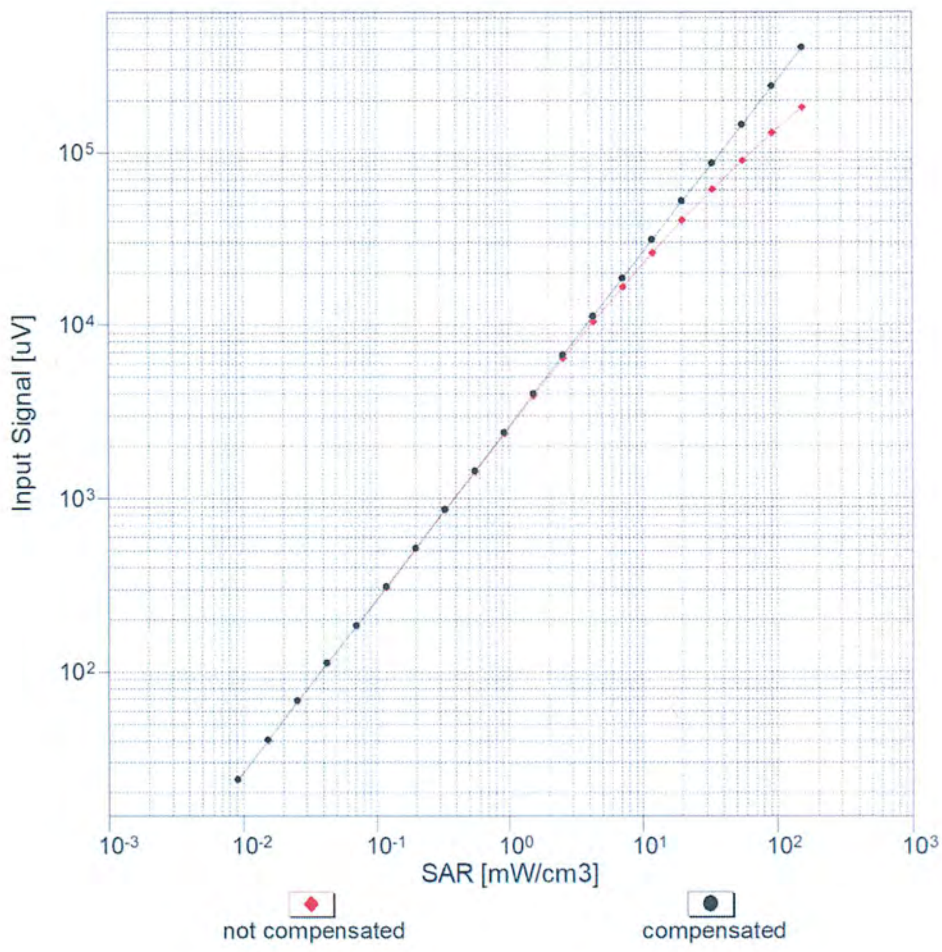

f=1800 MHz,R22

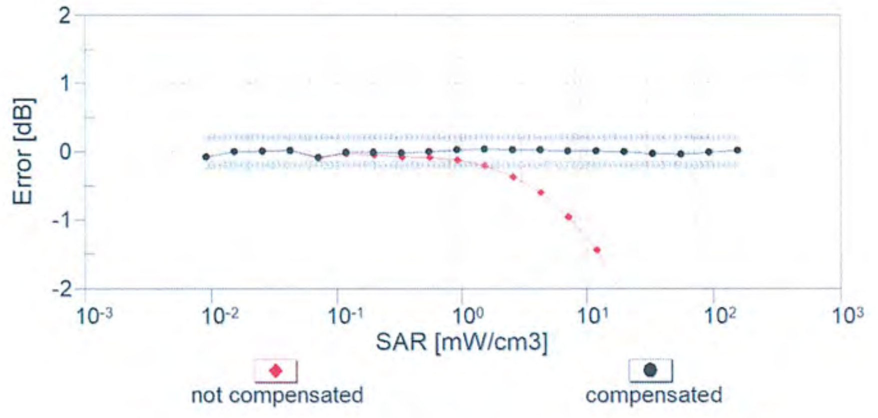



**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

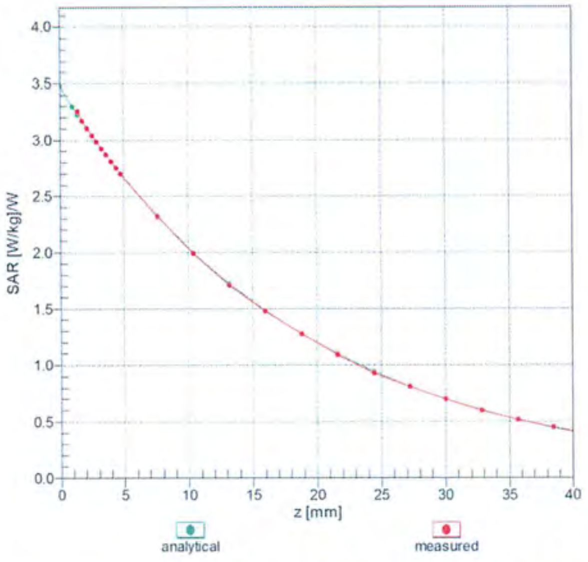
# Dynamic Range f($SAR_{head}$)
**(TEM cell , $f_{eval}$= 1900 MHz)**

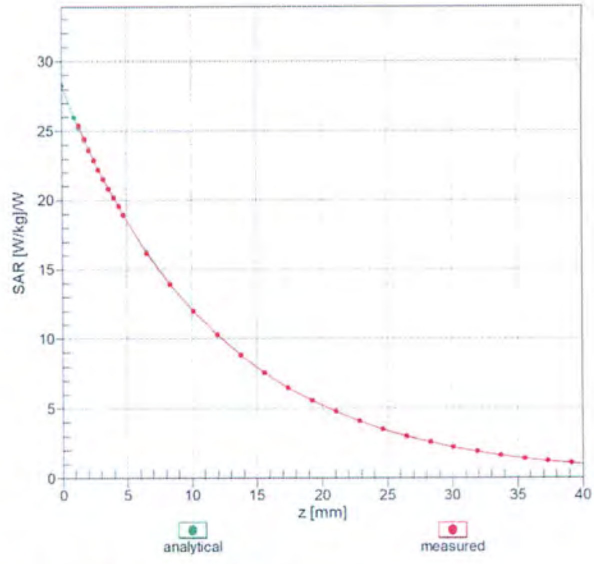



**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

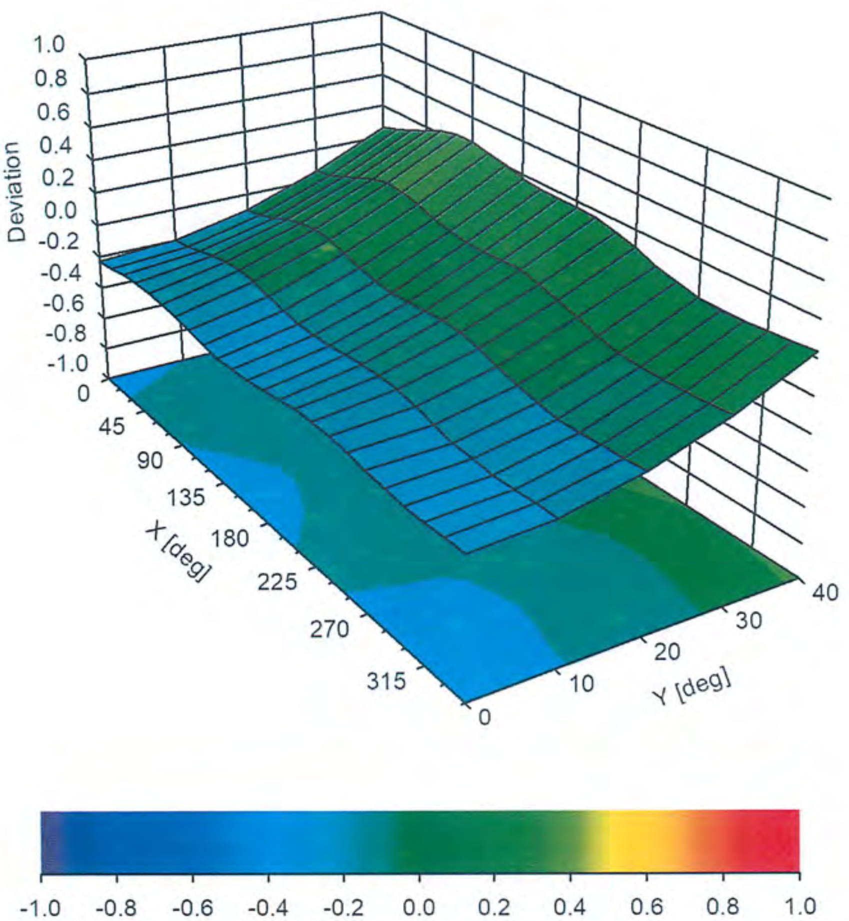
# Conversion Factor Assessment




# Deviation from Isotropy in Liquid

**Error (ϕ, ϑ), f = 900 MHz**




**Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)**

# APPENDIX E – DIPOLE CALIBRATION

# NCL CALIBRATION LABORATORIES

Calibration File No: DC-1904
Project Number: 5921

**Client.: Celltech**

Address: 21 – 364 Lougheed Road, Kelowna, BC V1X 7R8, Canada

# C E R T I F I C A T E   O F   C A L I B R A T I O N

It is certified that the equipment identified below has been calibrated in the **NCL CALIBRATION LABORATORIES** by qualified personnel following recognized procedures and using transfer standards traceable to NRC/NIST.

Validation Dipole (Head)

Manufacturer: SPEAG
Part number: D2450V2
Frequency: 2450 MHz
Serial No: 825

Calibrated: 27/04/2021
Released on: 05/05/2021

This Calibration Certificate is incomplete unless accompanied by the Calibration Results Summary

Released by: ______________________
Pieter Erasmus, Quality Manager

NCL Calibration Laboratories

Suite 102, 303 Terryfox Dr.
Ottawa, Ontario, K2K 3J1
Canada

Division of APREL Lab.
Tel: (613) 435-8300
Fax: (613) 435-8306

## Conditions

Dipole SN 825 was a re-calibration.

**Ambient Temperature of the Laboratory:** 21 °C +/- 0.5°C
**Temperature of the Tissue:** 21 °C +/- 0.5°C

**Primary Measurement Standards**

| Instrument | | Serial Number | | Cal due date |
|---|---|---|---|---|
| Signal Generator | HP | 83640B | 3844A00689 | Sept. 17, 2022 |
| Network Analyzer | Keysight | E5063A | MY54502902 | Mar. 9, 2023 |
| Spectrum Analyzer | Keysight | N9030B | MY57140772 | Apr. 20, 2023 |

**Attestation**

The below named signatories have conducted the calibration and review of the data which is presented in this calibration report.

**We the undersigned attest that to the best of our knowledge the calibration has been accurately conducted and that all information contained within this report has been reviewed for accuracy and any uncertainties if applicable disclosed.**

------------------------------------------------------------
**Pieter Erasmus**
**Quality Manager**

------------------------------------------------------------
**Maryna Nesterova**
**Test and Calibration Engineer**

## Calibration Results Summary

The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

### Tissue Validation

| Tissue | Frequency | Dielectric constant, $\varepsilon_r$ | Conductivity, $\sigma$ [S/m] |
|---|---|---|---|
| Head | 2450 MHz | 40.73 | 1.86 |

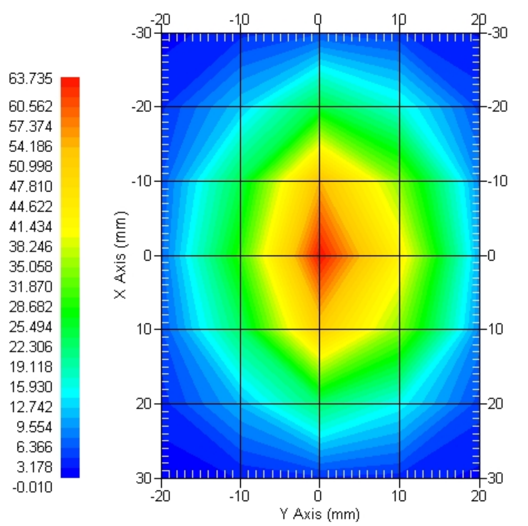
### Electrical Specification

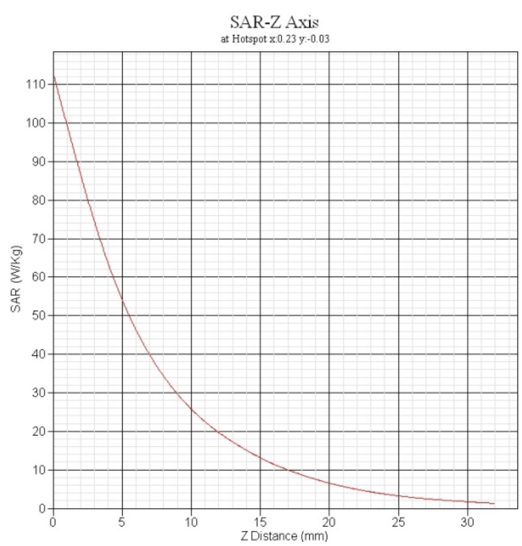
| Tissue | Frequency | Return Loss | Impedance | SWR: |
|---|---|---|---|---|
| Head | 2450 MHz | -19.83 dB | 43.26 Ω | 1.23U |

### System Validation Results

| Tissue | Frequency | 1-Gram SAR | 10-Gram SAR | Uncertainty |
|---|---|---|---|---|
| Head | 2450 MHz | 52.719 W/kg | 24.015 W/kg | 19.8% |

### Head



## Introduction

This Calibration Report has been produced in line with the SSI Dipole Calibration Procedure SSI-TP-018-ALSAS. The results contained within this report are for Validation Dipole SN 825. The calibration routine consisted of a three-step process. Step 1 was a mechanical verification of the dipole to ensure that it meets the mechanical specifications. Step 2 was an Electrical Calibration for the Validation Dipole, where the SWR, Impedance, and the Return loss were assessed. Step 3 involved a System Validation using the ALSAS-10U, along with APREL E-020 30 MHz to 6 GHz E-Field Probe Serial Number 225.

## References

- IEEE Standard 1528:2013
  IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
- EN 62209-1:2016
  Human Exposure to RF Fields from hand-held and body-mounted wireless communication devices - Human models. instrumentation, and procedures - Part 1: Procedure to measure the Specific Absorption Rate (SAR) for hand-held mobile wireless devices
- IEC 62209-2:2019
  Human exposure to RF fields from hand-held and body-mounted wireless devices - Human models, instrumentation, and procedures - Part 2: specific absorption rate (SAR) for wireless communication devices (30 MHz - 6 GHz)
- D22-012-Tissue dielectric tissue calibration procedure
- D28-002-Dipole procedure for validation of SAR system using a dipole
- IEEE 1309 Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9 kHz to 40 GHz

## Conditions

**Ambient Temperature of the Laboratory:** 21 °C +/- 0.5°C
**Temperature of the Tissue:** 21 °C +/- 0.5°C

## Dipole Calibration uncertainty

The calibration uncertainty for the dipole is made up of various parameters presented below.

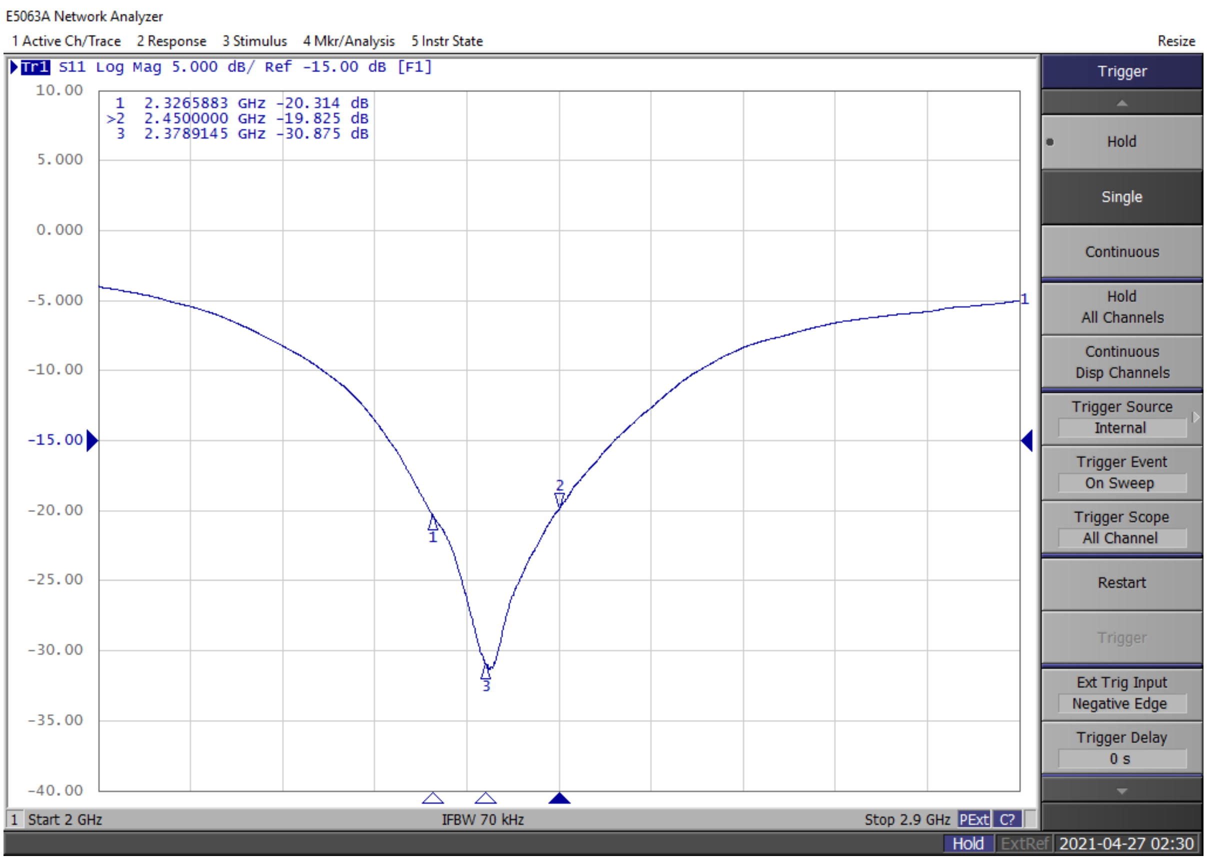
| | Tolerance, % |
|---|---|
| **Mechanical** | 2.00 |
| **Positioning Error** | 0.10 |
| **Electrical** | 0.37 |
| **Tissue Permittivity** | 3.88 |
| **Tissue Conductivity** | 3.56 |
| **Dipole Validation** | 1.70 |
| **Combined Uncertainty, k=2** | **4.81** |

The Following Graphs are the results as displayed on the Vector Network Analyzer.
**Electrical Calibration**

| Test | Head |
|---|---|
| S11 R/L | -19.83 dB |
| Impedance | 43.26 Ω |
| SWR | 1.23 U |

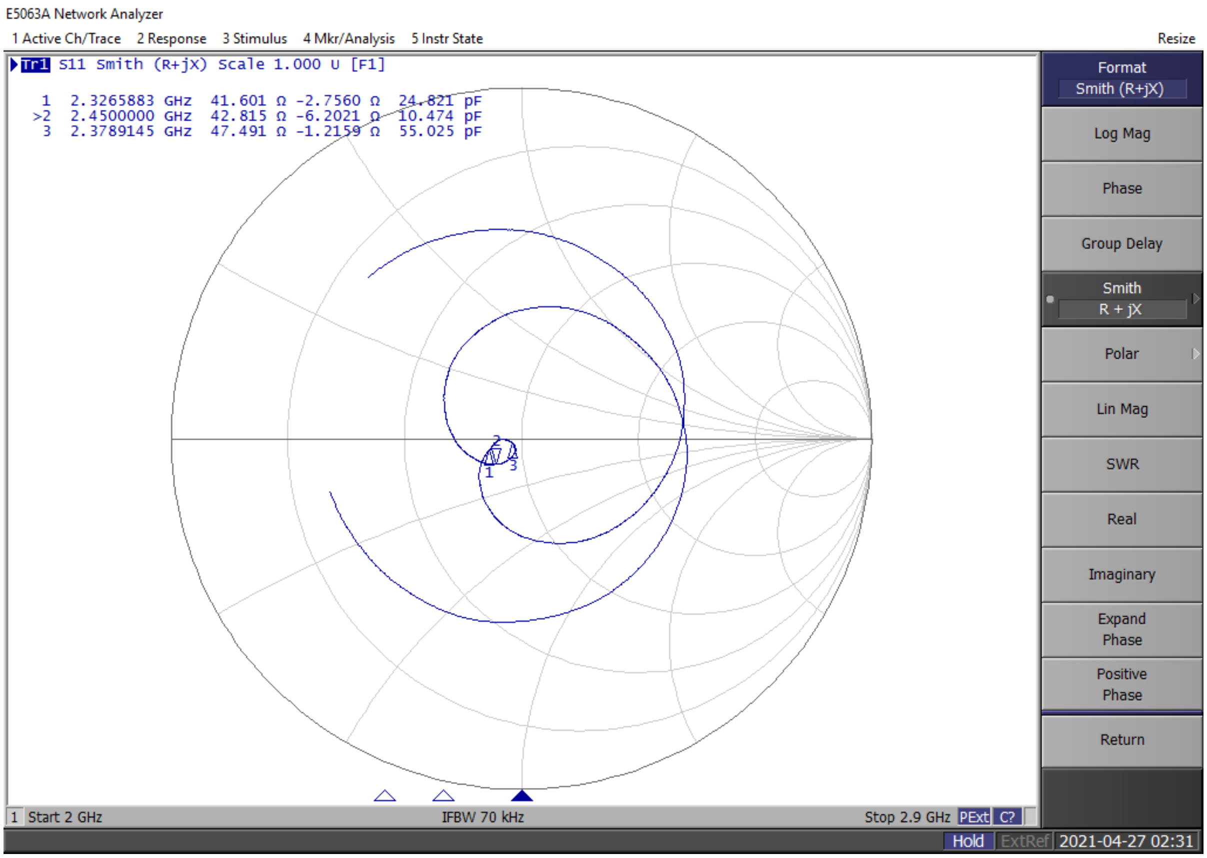
## S11 Parameter Return Loss

### Head
Frequency Range 2326.59 MHz to 2450 MHz



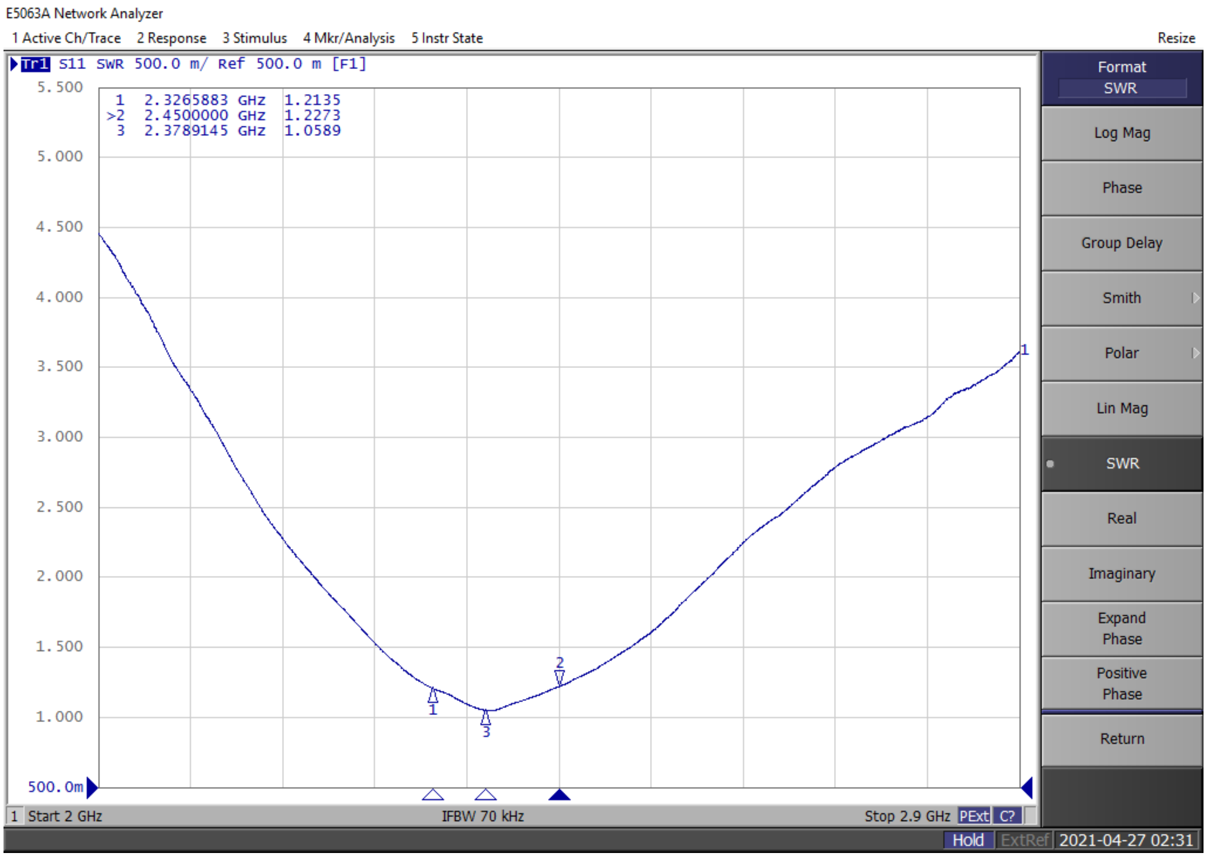
## Smith Chart Dipole Impedance

## Head



## SWR

## Head





This page has been reviewed for content and attested to on Page 2 of this document.

## APPENDIX F - PHANTOM

**Schmid & Partner Engineering AG**

**Zeughausstrasse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fax +41 1 245 97 79**

## Certificate of conformity / First Article Inspection

| | |
|---|---|
| Item | SAM Twin Phantom V4.0 |
| Type No | QD 000 P40 BA |
| Series No | TP-1002 and higher |
| Manufacturer / Origin | Untersee Composites<br>Hauptstr. 69<br>CH-8559 Fruthwilen<br>Switzerland |

### Tests

The series production process used allows the limitation to test of first articles.
Complete tests were made on the pre-series Type No. QD 000 P40 AA, Serial No. TP-1001 and on the series first article Type No. QD 000 P40 BA, Serial No. TP-1006. Certain parameters have been retested using further series units (called samples).

| Test | Requirement | Details | Units tested |
|---|---|---|---|
| Shape | Compliance with the geometry according to the CAD model. | IT'IS CAD File (*) | First article, Samples |
| Material thickness | Compliant with the requirements according to the standards | 2mm +/- 0.2mm in specific areas | First article, Samples |
| Material parameters | Dielectric parameters for required frequencies | 200 MHz – 3 GHz<br>Relative permittivity < 5<br>Loss tangent < 0.05. | Material sample TP 104-5 |
| Material resistivity | The material has been tested to be compatible with the liquids defined in the standards | Liquid type HSL 1800 and others according to the standard. | Pre-series, First article |

### Standards

[1] CENELEC EN 50361
[2] IEEE P1528-200x draft 6.5
[3] IEC PT 62209 draft 0.9
(*) The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of [1] and [3].

### Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of SAR measurements specified in standard [1] and draft standards [2] and [3].

**Date** 18.11.2001

**Signature / Stamp**

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