313 West 12800 South, Suite 311
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Test Report

Certification

FCC ID	2BF5N-SENS247
Equipment Under Test	SmartSensor
Test Report Serial No	V076289_01
Dates of Test	May 14, July 29, and August 8, 2024
Report Issue Date	September 30, 2024

Test Specifications:	Applicant:
FCC Part 15, Subpart C	ZealaCare 4262 W 4000 N Cedar City, Utah 84721 U.S.A.

TESTING
NVLAP LAB CODE 100272-0

Certification of Engineering Report

This report has been prepared by VPI Technology, Inc. to document compliance of the device described below with the requirements of Federal Communications Commission (FCC) Part 15, Subpart C. This report may be reproduced in full. Partial reproduction of this report may only be made with the written consent of the laboratory. The results in this report apply only to the sample tested.

Applicant	Zealacare
Manufacturer	Zealacare
Brand Name	Zealacare
Model Number	SmartSensor
FCC ID	2BF5N-SENS247

On this 30th day of September 2024, I, individually and for VPI Technology, Inc., certify that the statements made in this engineering report are true, complete, and correct to the best of my knowledge, and are made in good faith.

Although NVLAP has accredited the VPI Technology, Inc. EMC testing facilities, this report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the US government.

VPI Technology, Inc.

Emissions Tested by: Benjamin N. Antczak

Reviewed by: Jason Stewart

Revision History		
Revision	**Description**	**Date**
01	Original Report Release	September 30, 2024

Table of Contents

1 Client Information

1.1 Applicant

Company Name	ZealaCare 4262 W 4000 N Cedar City, Utah 84721 U.S.A.
Contact Name	Aaron Collette
Title	CEO

1.2 Manufacturer

Company Name	ZealaCare 4262 W 4000 N Cedar City, Utah 84721 U.S.A.
Contact Name	Aaron Collette
Title	CEO

2 Equipment Under Test (EUT)

2.1 Identification of EUT

Brand Name	ZealaCare
Model Number	SmartSensor
Revision	V2
Serial Number	Engineering Test Unit
Dimensions (cm)	5.5 x 3.5 x 1.5
Mfr. Declared Antenna Gain (dBi)	2.0

2.2 Customer Supplied Data (if applicable)

2.2.1 Disclaimer

This test report contains customer supplied data that may have an affect on the validity of the results presented. The customer maintains responsibility for the accuracy of these results.

2.3 Description of EUT

The SmartSensor is a WiFi and BLE enabled moisture sensor for use in the Zealacare Smart Incontinence System. It is internally powered by a rechargeable 3.7VDC 1.18Wh Lithium-Ion Battery battery with limited charge voltage of 4.7VDC. It is charged via standard Qi chargers. To test charging mode, an Anker 313 Wireless Charger (Pad) and Samsung ETA-U90JWE PSU were used. EUT contains pre-certified wireless module containing CE mark and FCCID 2ATUB-WIZFI360PA for WiFi transmissions and operates only in the 2.4 GHz ISM band. EUT also transmits with BLE, which is evaluated in this report. The cannel map is shown below, and tested channels are emphasized.

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	***2402***	11	2422	21	2442	31	2462
2	2404	12	2424	22	2444	32	2464
3	2406	13	2426	23	2446	33	2466
4	2408	14	2428	24	2448	34	2468
5	2410	15	2430	25	2450	35	2470
6	2412	16	2432	26	2452	36	2472
7	2414	17	2434	27	2454	37	2474
8	2416	18	2436	28	2456	38	2476
9	2418	19	2438	29	2458	39	2478
10	2420	***20***	***2440***	30	2460	***40***	***2480***

This report covers the circuitry of the devices subject to FCC Part 15, Subpart C. The circuitry of the device subject to FCC Subpart B was found to be compliant and is covered in a separate VPI Technology, Inc. report.

2.4 EUT and Support Equipment

The EUT and support equipment used during the test are listed below.

Brand Name Model Number Serial Number	Description	Name of Interface Ports / Interface Cables
BN: Zealacare MN: SmartSensor (Note 1) SN: Production Engineering Unit E	Wireless Moisture Detection Sensor	See Section 2.4
BN: Zealacare MN: Briefs SN: N/A	S/M Super Absorbent Briefs	Direct Snap Connection (Monitoring Mode Only) (Note 2)

Notes: (1) EUT

(2) Interface port connected to EUT (See Section 2.4)

The support equipment listed above was not modified in order to achieve compliance with this standard.

2.5 Interface Ports on EUT

Name of Ports	No. of Ports Fitted to EUT	Cable Description/Length
Briefs Connection	1 of 1	No Cable, 2x Direct Snaps
Micro-USB Port for FCC Test Mode Setup	0 of 1 (Note 1)	N/A
Note 1: Service port is not accessible to end users.		

2.6 Modification Incorporated/Special Accessories on EUT

There were no modifications or special accessories required to comply with the specification.

2.7 Deviation from Test Standard

There were no deviations from the test specification.

3 Test Specification, Methods and Procedures

3.1 Test Specification

Title	FCC PART 15, Subpart C (47 CFR 15) 15.203, 15.207, and 15.247 Limits and methods of measurement of radio interference characteristics of radio frequency devices.
Purpose of Test	The tests were performed to demonstrate initial compliance

3.2 Methods & Procedures

3.2.1 §15.203 Antenna Requirement

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

3.2.2 §15.207 Conducted Limits

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency range (MHz)	**Limit (dBμV)**	
	Quasi-peak	**Average**
0.15 to 0.50*	66 to 56*	56 to 46*
0.50 to 5	56	46
5 to 30	60	50

*Decreases with the logarithm of the frequency.

Table 1: Limits for conducted emissions at mains ports of Class B ITE.

3.2.3 §15.247 Operation within the bands 902 – 928 MHz, 2400 – 2483.5 MHz, and 5725 – 5850 MHz

a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions.

1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400 – 2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

    i. For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

    ii. Frequency hopping systems operating in the 5725-5850 MHz band shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

    iii. Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 non-overlapping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 non-overlapping channels are used.

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 output power of the intentional radiator shall not exceed the following:

1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

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 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.

4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

c) Operation with directional antenna gains greater than 6 dBi.

1) Fixed point-to-point operation:

i. Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

ii. Systems operating in the 5725-5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

iii. Fixed, point-to-point operation, as used in paragraphs (b)(4)(i) and (b)(4)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum or digitally modulated intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400-2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

i. Different information must be transmitted to each receiver.

ii. If the transmitter employs an antenna system that emits multiple directional beams but does not emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna /antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:

A. The directional gain shall be calculated as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

B. A lower value for the directional gain than that calculated in paragraph (c)(2)(ii)(A) of this section will be accepted if sufficient evidence is presented, e.g., due to shading of the array or coherence loss in the beamforming.

iii. If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the power limit specified in paragraph (c)(2)(ii) of this section. If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the limit specified in paragraph (c)(2)(ii) of this section. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the limit specified in paragraph (c)(2)(ii) of this section by more than 8 dB.

iv. Transmitters that emit a single directional beam shall operate under the provisions of paragraph (c)(1) of this section.

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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 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.

f) For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. The digital modulation operation of the hybrid system, with the frequency hopping turned off, shall comply with the power density requirements of paragraph (d) of this section.

g) Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

h) The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

i) Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See § 1.1307(b)(1) of this Chapter.

Note: Spread spectrum systems are sharing these bands on a noninterference basis with systems supporting critical Government requirements that have been allocated the usage of these bands, secondary only to ISM equipment operated under the provisions of Part 18 of this Chapter. Many of these Government systems are airborne radiolocation systems that emit a high EIRP which can cause interference to other users. Also, investigations of the effect of spread spectrum interference to U. S. Government operations in the 902-928 MHz band may require a future decrease in the power limits allowed for spread spectrum operation.

3.3 Test Procedure

VPI Technology, Inc. is accredited by National Voluntary Laboratory Accreditation Program (NVLAP); NVLAP Lab Code: 100272-0, which is effective until September 30, 2025. VPI Technology, Inc. carries FCC Accreditation Designation Number US5263. VPI Technology main office is located at 313 W 12800 S, Suite 311, Draper, UT 84020. The testing was performed according to the procedures in ANSI C63.10-2013, KDB 558074, and 47 CFR Part 15.

4 Operation of EUT During Testing

4.1 Operating Environment

Power Supply	Internally Powered
AC Mains Frequency	N/A

4.2 Operating Modes

The transmitter was tested on 3 orthogonal axes while in a constant transmit mode at the upper, middle, and lower channels. The internal battery was fully charged for testing.

4.3 EUT Exercise Software

Serial port was used to control the radio circuitry via Micro-USB port.

5 Summary of Test Results

5.1 FCC Part 15, Subpart C

5.1.1 Summary of Tests

Section	Environmental Phenomena	Frequency Range (MHz)	Result
15.203	Antenna Requirements	Structural requirement	Complied
15.207	Conducted Disturbance at Mains Ports	0.15 to 30	Complied
15.247(a)	Bandwidth Requirement	2400 to 2483.5	Complied
15.247(b)	Peak Output Power	2400 to 2483.5	Complied
15.247(d)	Antenna Conducted Spurious Emissions	0.009 - 25000	Complied
15.247(d)	Radiated Spurious Emissions	0.009 - 25000	Complied
15.247(e)	Peak Power Spectral Density	2400 to 2483.5	Complied

5.2 Result

In the configuration tested, the EUT complied with the requirements of the specification.

6 Measurements, Examinations and Derived Results

6.1 General Comments

This section contains the test results only. Details of the test methods used and a list of the test equipment used during the measurements can be found in Section 7 of this report.

When calculations in this report require EUT antenna gains, those values have been provided by the manufacturer unless otherwise noted.

6.2 Test Results

6.2.1 §15.203 Antenna Requirements

The EUT uses a Walsin RFANT3216120A5T chip antenna with a peak in-band gain of 2.0 dBi.

Result

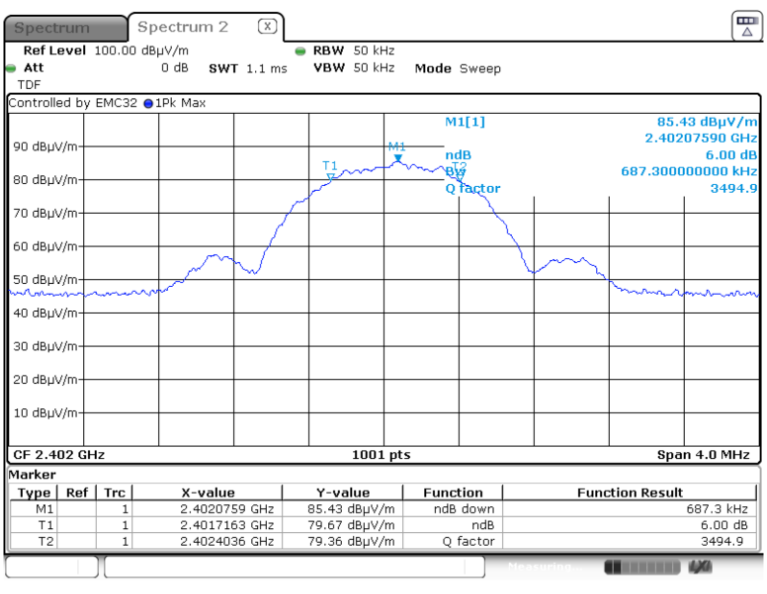
The EUT complied with the specification.

6.2.2 §15.247(a)(2) Emissions Bandwidth

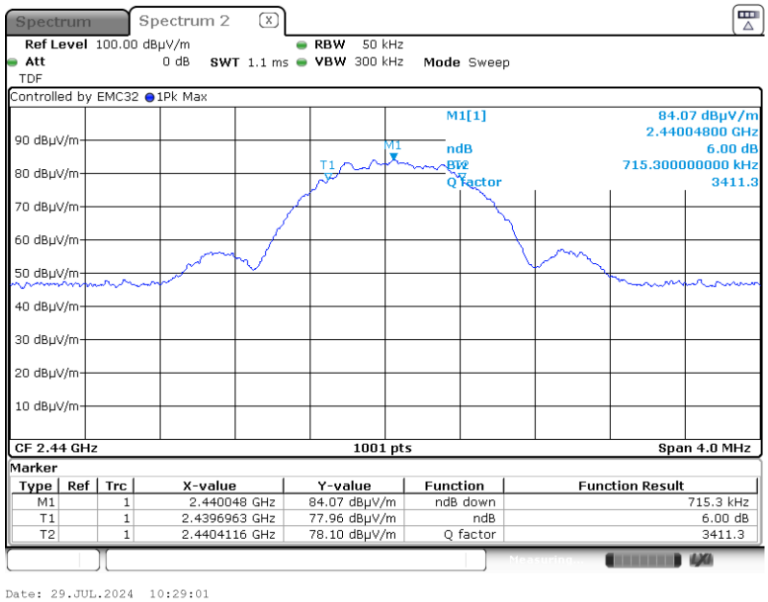
Frequency (MHz)	Emissions 6 dB bandwidth (kHz)
2402	687.3
2440	715.3
2480	703.3

Result

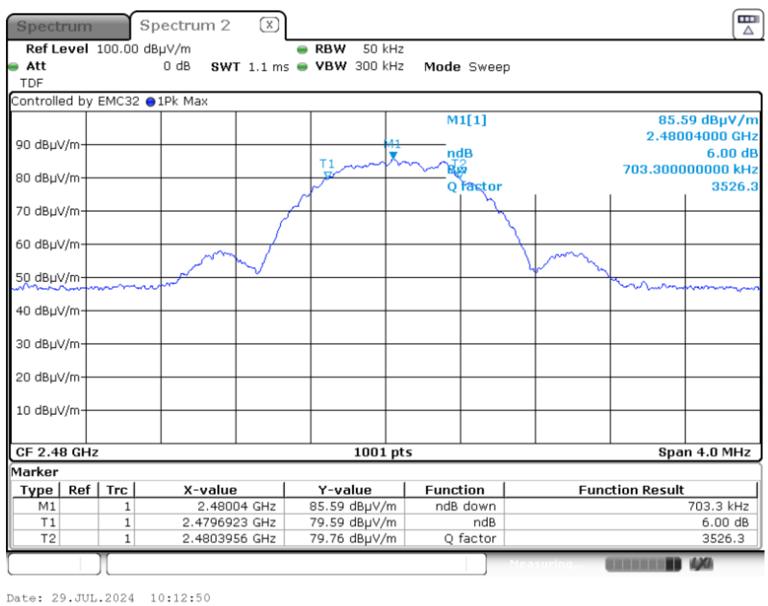
In the configuration tested, the 6 dB bandwidth was greater than 500 kHz; therefore, the EUT complied with the requirements of the specification (see spectrum analyzer plots below).



Graph 1: Lowest Channel Bandwidth



Graph 2: Middle Channel Bandwidth



Graph 3: Highest Channel Bandwidth

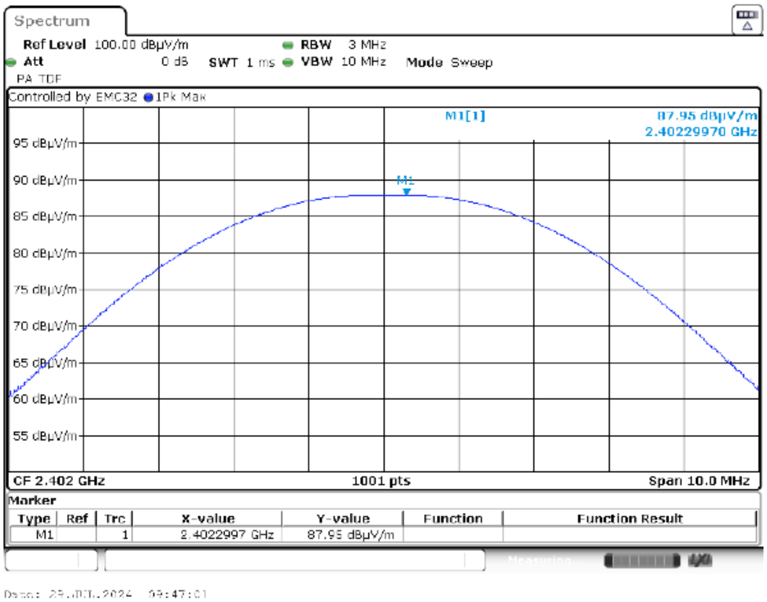
6.2.3 §15.247(b)(3) Peak Output Power

The maximum peak RF Conducted output power measured for this device was -8.98 dBm or 0.13 mW. The limit is 30 dBm or 1 Watt when using antennas with 6 dBi or less gain. The antenna has a gain of 2.0 dBi.

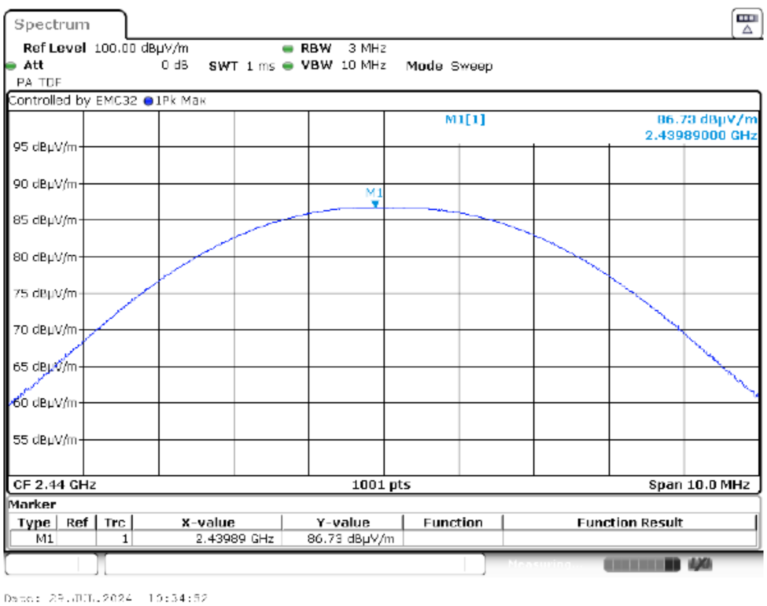
Frequency (MHz)	Measured 3m Radiated Field (dBµV/m)	EIRP (dBm)	Conducted Output Power (dBm)	Output Power (mW)
2402	87.95	-7.28	-9.28	0.12
2440	86.73	-8.50	-10.50	0.09
2480	88.25	-6.98	-8.98	0.13

Result

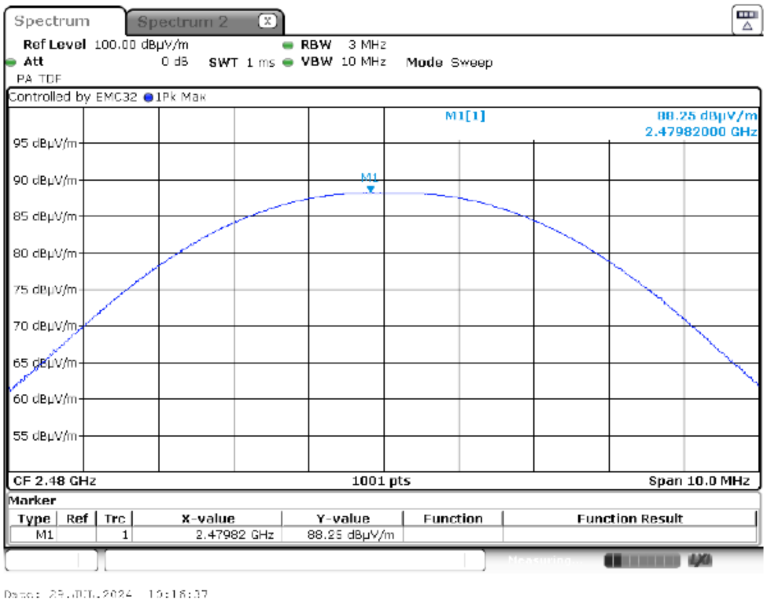
In the configuration tested, the RF peak output power was less than 1 Watt; therefore, the EUT complied with the requirements of the specification (see spectrum analyzer plots below).



Graph 4: Lowest Channel Output Power Plot



Graph 5: Middle Channel Output Power



Graph 6: Highest Channel Output Power Plot

6.2.4 §15.247(d) Spurious Emissions

Radiated Spurious Emissions in the Restricted Bands of §15.205

The frequency range from the lowest frequency generated or used in the device to the tenth harmonic of the highest fundamental emission was investigated to measure any radiated emissions in the restricted bands. The following tables show measurements of any emission that fell into the restricted bands of §15.205. The tables show the worst-case emission measured from the EUT. For frequencies above 18.0 GHz, a measurement distance of 1 meter was used. The noise floor was a minimum of 6 dB below the limit. The emissions in the restricted bands must meet the limits specified in §15.209. Tabular data for each of the spurious emissions is shown below for each of the units. Plots of the band edges are also shown.

Result

All emissions in the restricted bands of §15.205 met the limits specified in §15.209; therefore, the EUT complies with the specification.

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
4804.6	Peak	Vertical	45.6	6.1	51.8	74.0	-22.3
4803.9	Average	Vertical	41.7	6.1	47.8	54.0	-6.2
4804.2	Peak	Horizontal	42.5	6.1	48.7	74.0	-25.4
4803.9	Average	Horizontal	37.5	6.1	43.6	54.0	-10.4
7206.6	Peak	Vertical	40.5	10.5	51.0	74.0	-23.0
7206.2	Average	Vertical	32.8	10.5	43.3	54.0	-10.7
7206.6	Peak	Horizontal	41.8	10.5	52.3	74.0	-21.7
7205.8	Average	Horizontal	34.8	10.5	45.3	54.0	-8.7
9607.1	Peak	Vertical	34.0	12.8	46.8	74.0	-27.2

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
9609.9	Average	Vertical	21.7	12.8	34.5	54.0	-19.5
9606.7	Peak	Horizontal	34.8	12.8	47.6	74.0	-26.4
9606.7	Average	Vertical	22.0	12.8	34.8	54.0	-19.2
12009.0	Peak	Vertical	32.6	16.2	48.9	74.0	-25.1
12009.0	Average	Vertical	21.1	16.2	37.3	54.0	-16.7
12008.6	Peak	Horizontal	33.5	16.2	49.7	74.0	-24.3
12009.0	Average	Horizontal	21.1	16.2	37.3	54.0	-16.7
14410.8	Peak	Vertical	32.0	20.6	52.6	74.0	-21.4
14410.8	Average	Vertical	19.2	20.6	39.7	54.0	-14.3
14396.7	Peak	Horizontal	32.3	20.6	52.9	74.0	-21.1
14395.2	Average	Horizontal	19.4	20.6	39.9	54.0	-14.1
16812.7	Peak	Vertical	31.8	18.8	50.5	74.0	-23.5
16813.6	Average	Vertical	18.5	18.8	37.2	54.0	-16.8
16815.8	Peak	Horizontal	31.4	18.8	50.2	74.0	-23.8
16814.9	Average	Horizontal	18.7	18.8	37.5	54.0	-16.5

Table 2: Transmitting at the Lowest Frequency

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4880.4	Peak	Vertical	46.4	6.1	52.5	74.0	-21.5
4880.0	Average	Vertical	42.3	6.1	48.4	54.0	-5.6
4880.4	Peak	Horizontal	42.9	6.1	49.0	74.0	-25.0
4880.0	Average	Horizontal	37.5	6.1	43.7	54.0	-10.3
7321.0	Peak	Vertical	40.9	10.9	51.8	74.0	-22.2
7320.6	Average	Vertical	32.8	10.9	43.7	54.0	-10.3
7319.3	Peak	Horizontal	42.9	10.9	53.8	74.0	-20.2
7320.2	Average	Horizontal	35.3	10.9	46.2	54.0	-7.8
9760.2	Peak	Vertical	35.2	12.6	47.8	74.0	-26.2
9759.7	Average	Vertical	22.7	12.6	35.3	54.0	-18.7
9760.2	Peak	Horizontal	35.3	12.6	47.9	74.0	-26.1
9759.3	Average	Vertical	23.4	12.6	36.0	54.0	-18.0
12199.4	Peak	Vertical	35.1	16.2	51.4	74.0	-22.7
12198.9	Average	Vertical	21.9	16.2	38.2	54.0	-15.9
12199.4	Peak	Horizontal	34.0	16.2	50.2	74.0	-23.8
12201.3	Average	Horizontal	22.0	16.2	38.2	54.0	-15.8
14637.3	Peak	Vertical	32.6	20.7	53.4	74.0	-20.7

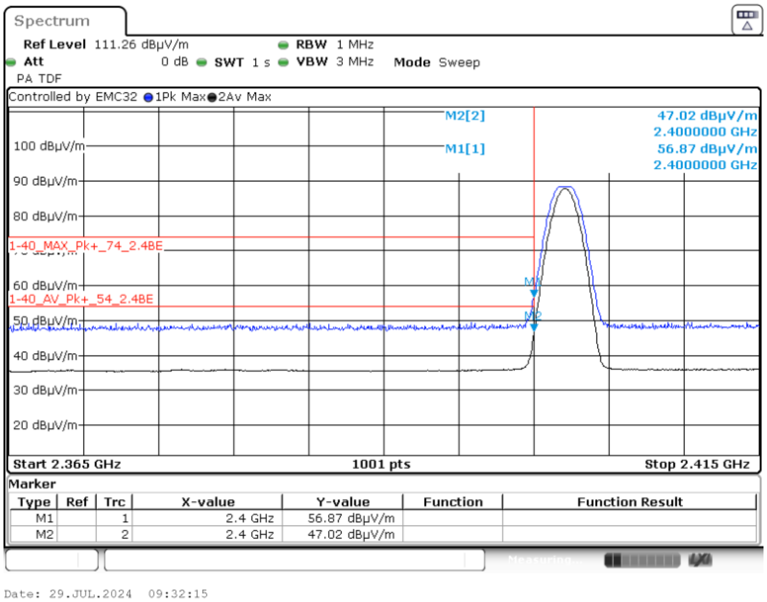
Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
14639.2	Average	Vertical	19.5	20.7	40.3	54.0	-13.7
14641.2	Peak	Horizontal	33.1	20.7	53.9	74.0	-20.1
14642.6	Average	Horizontal	20.3	20.7	41.1	54.0	-12.9
17079.6	Peak	Vertical	31.0	19.7	50.7	74.0	-23.3
17078.3	Average	Vertical	18.9	19.7	38.7	54.0	-15.3
17083.5	Peak	Horizontal	32.0	19.7	51.7	74.0	-22.3
17083.1	Average	Horizontal	19.4	19.7	39.1	54.0	-14.9

Table 3: Transmitting at the Middle Frequency

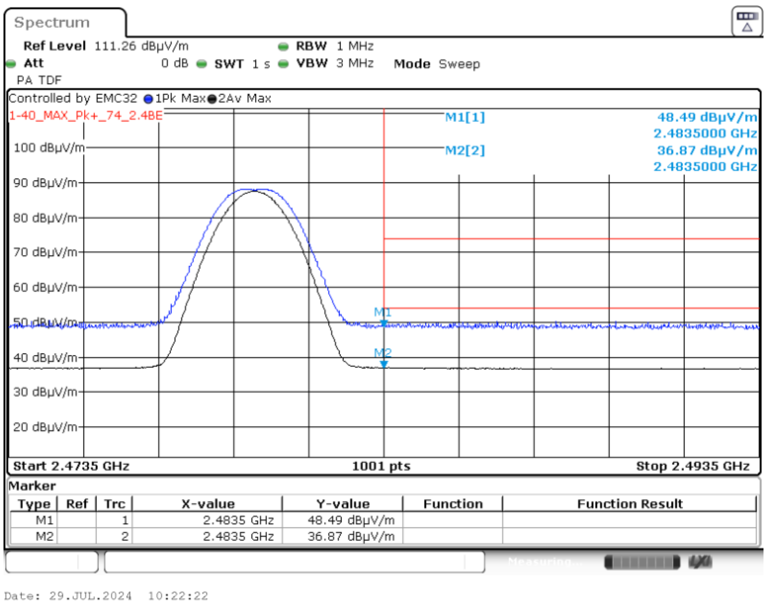
Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4960.8	Peak	Vertical	44.3	6.6	50.8	74.0	-23.2
4960.1	Average	Vertical	40.1	6.6	46.7	54.0	-7.3
4959.7	Peak	Horizontal	41.9	6.6	48.4	74.0	-25.6
4960.1	Average	Horizontal	37.0	6.6	43.6	54.0	-10.4
7440.8	Peak	Vertical	41.6	11.1	52.7	74.0	-21.3
7440.4	Average	Vertical	34.5	11.1	45.6	54.0	-8.4
7441.2	Peak	Horizontal	41.6	11.1	52.7	74.0	-21.3
7440.8	Average	Horizontal	34.0	11.1	45.1	54.0	-8.9
9918.4	Peak	Vertical	34.8	13.5	48.2	74.0	-25.8
9919.8	Average	Vertical	21.9	13.5	35.4	54.0	-18.6
9920.2	Peak	Horizontal	34.4	13.5	47.9	74.0	-26.1
9921.2	Average	Vertical	22.1	13.5	35.6	54.0	-18.4
12401.8	Peak	Vertical	32.7	16.3	49.1	74.0	-25.0
12399.0	Average	Vertical	20.5	16.3	36.8	54.0	-17.2
12401.4	Peak	Horizontal	32.6	16.3	49.0	74.0	-25.0
12401.4	Average	Horizontal	21.2	16.3	37.5	54.0	-16.5
14877.9	Peak	Vertical	30.4	20.4	50.8	74.0	-23.2
14878.4	Average	Vertical	18.3	20.4	38.7	54.0	-15.3
14882.8	Peak	Horizontal	30.8	20.4	51.2	74.0	-22.8
14881.8	Average	Horizontal	18.3	20.4	38.7	54.0	-15.3
17360.4	Peak	Vertical	28.9	22.0	50.9	74.0	-23.2
17360.4	Average	Vertical	17.1	22.0	39.1	54.0	-14.9
17360.9	Peak	Horizontal	29.0	22.0	51.0	74.0	-23.0
17360.4	Average	Horizontal	17.3	22.0	39.3	54.0	-14.7

Table 4: Transmitting at the Highest Frequency

No other emissions were seen in the restricted bands



Graph 7: Radiated Lower Band Edge Plot



Graph 8: Radiated Upper Band Edge Plot

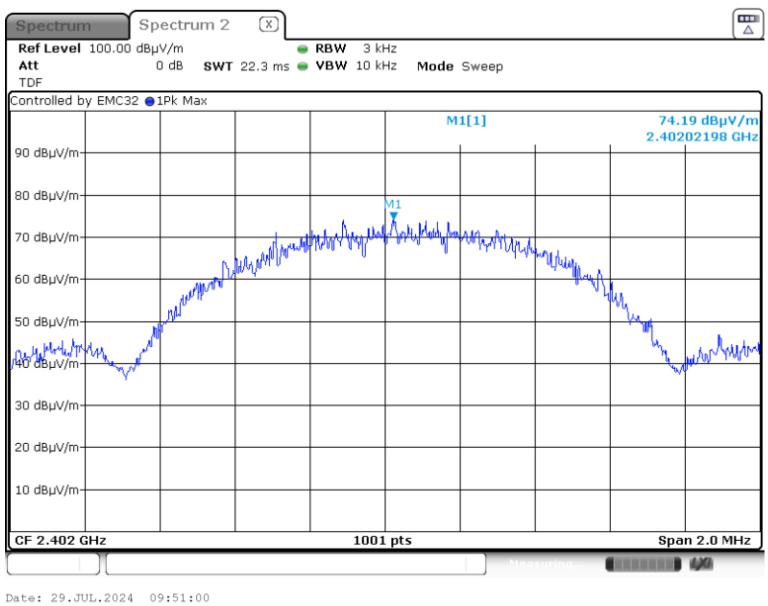
6.2.5 §15.247(e) Peak Power Spectral Density

The peak 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. Results of this testing are summarized.

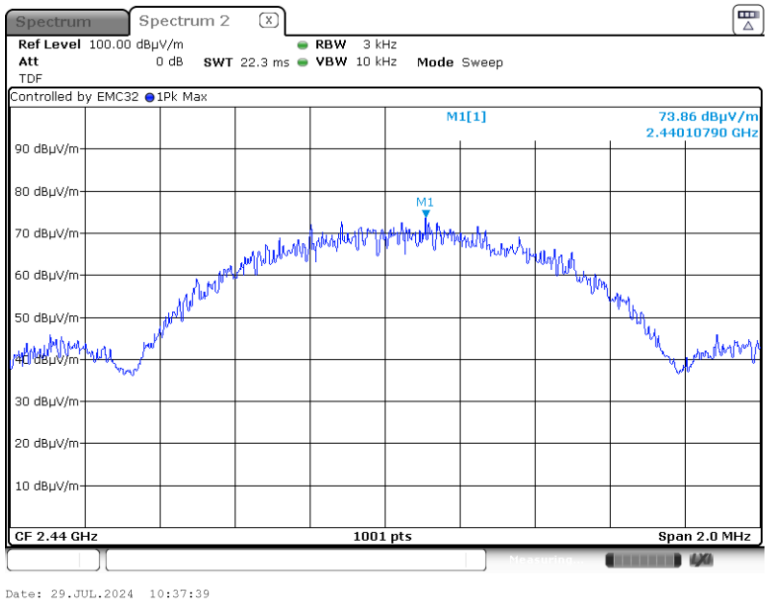
Frequency (MHz)	Measured 3m Radiated Field (dBµV/m)	EIRP (dBm)	Conducted PSD (dBm)	Criteria (dBm)
2402	74.19	-21.04	-19.04	8.0
2440	73.86	-21.37	-19.37	8.0
2480	75.23	-20.00	-18.0	8.0

Result

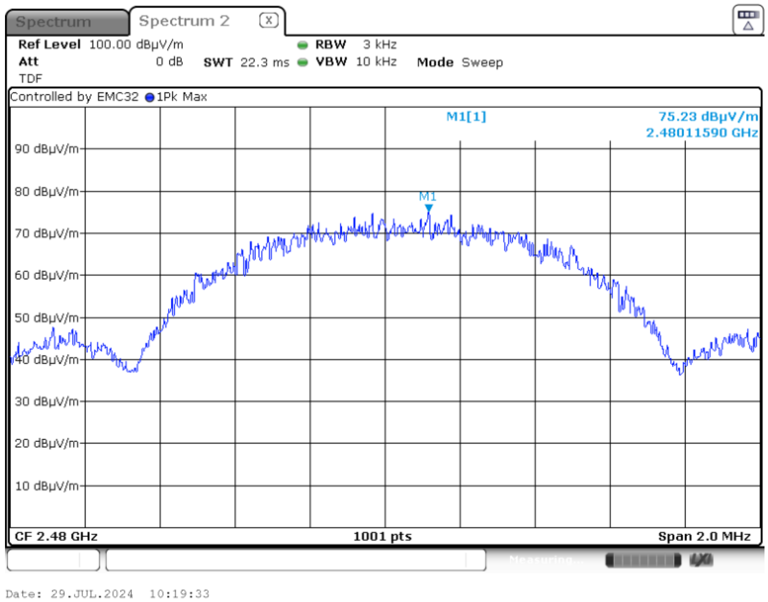
The maximum peak power spectral density was less than the limit of 8 dBm; therefore, the EUT complies with the specification.



Graph 9: Lowest Channel 3 kHz PSD Plot



Graph 10: Middle Channel 3 kHz PSD Plot



Graph 11: Highest Channel Output 3 kHz PSD Plot

6.3 Sample Measurement Calculations

6.3.1 Filed Strength Calculations

The field strength is calculated by adding the *Correction Factor* (*Antenna Factor* + *Cable Factor*), to the measured level from the receiver. The receiver amplitude reading is compensated for any amplifier gain. When an average measurement requires an average measurement correction value, it is also accounted for. The basic equation with a sample calculation is shown below:

Receiver Amplitude Reading=Receiver Reading-Amplifier Gain

Correction Factor=Antenna Factor + Cable Factor

Field Strength=Receiver Amplitude Reading + Correction Factor [+Average Correction Value]

Example

Assuming a *Receiver Reading* of 42.5 dBμV is obtained from the receiver, the *Amplifier Gain* is 26.5 dB the *Antenna Factor* is 4.5 dB, and the *Cable Factor* is 4.0 dB. The *Field Strength* is calculated by subtracting the *Amplifier Gain* and adding the *Correction Factor*, giving a *Field Strength* of 24.5 dBμV/m.

$$Receiver\ Amplitude\ Reading\ =\ 42.5 - 26.5\ =\ 16.0\ \mathrm{dB\mu V/m}$$

$$Correction\ Factor\ =\ 4.5 + 4.0\ =\ 8.5\ \mathrm{dB}$$

$$Field\ Strength\ =\ 16.0 + 8.5\ =\ 24.5\ \mathrm{dB\mu V/m}$$

6.3.2 Conducted Measurement Value Calculations

A conducted emission value is calculated by adding the *Correction Factor* (*LISN Transducer Factor* + *Cable Factor*) to the measured value from the receiver. The LISN contains an internal 10dB (nominal) attenuation accounted for in the LISN Transducer Factor. Amplifiers are not utilized for this measurement. The basic equation with a sample calculation is shown below:

Correction Factor = LISN Transducer Factor + Cable Factor

Conducted Emission Value = Receiver Amplitude Reading + Correction Factor

Example

Assuming a *Receiver Reading* of 20.8 dBμV is obtained from the receiver, *LISN Transducer Factor* is 10.1 dB, and the *Cable Factor* is 0.3 dB. The *Conducted Emissions Value* is calculated by adding the *Correction Factor*, giving a *Conducted Emissions Value* of 31.2 dBμV.

$$Receiver\ Amplitude\ Reading\ =\ 20.8\ \mathrm{dB\mu V}$$

$$Correction\ Factor\ =\ 10.1 + 0.3\ =\ 10.4\ \mathrm{dB}$$

$$Conducted\ Emissions\ Value\ =\ 20.8 + 10.4\ =\ 31.2\ \mathrm{dB\mu V}$$

7 Test Procedures and Test Equipment

7.1 Conducted Emissions at Mains Ports

The conducted emissions at mains and telecommunications ports from the EUT were measured using a spectrum analyzer with a quasi-peak adapter for peak, quasi-peak and average readings. The quasi-peak adapter uses a bandwidth of 9 kHz, with the spectrum analyzer's resolution bandwidth set at 100 kHz, for readings in the 150 kHz to 30 MHz frequency ranges.

The conducted emissions at mains ports measurements are performed in a screen room using a (50 Ω/50 μH) Line Impedance Stabilization Network (LISN).

Where mains flexible power cords are longer than 1 m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0.4 m in length.

Where the EUT is a collection of devices with each device having its own power cord, the point of connection for the LISN is determined from the following rules:

- Each power cord, which is terminated in a mains supply plug, shall be tested separately.
- Power cords, which are not specified by the manufacturer to be connected via a host unit, shall be tested separately.
- Power cords which are specified by the manufacturer to be connected via a host unit or other power supplying equipment shall be connected to that host unit and the power cords of that host unit connected to the LISN and tested.
- Where a special connection is specified, the necessary hardware to effect the connection is supplied by the manufacturer for the testing purpose.
- When testing equipment with multiple mains cords, those cords not under test are connected to an artificial mains network (AMN) different than the AMN used for the mains cord under test.

For testing, desktop EUT are placed on a non-conducting table at least 0.8 meters from the metallic floor and placed 40 cm from the vertical coupling plane (copper plating in the wall behind EUT table). Floor standing equipment is placed directly on the earth grounded floor.

Type of Equipment	Manufacturer	Model Number	Asset Number	Date of Last Calibration	Due Date of Calibration
Spectrum Analyzer/Receiver	Rohde & Schwarz	ESU40	V033119	10/26/2022	10/26/2024
Spectrum Analyzer/ Signal Analyzer	Rohde & Schwarz	FSV40	V044352	03/08/2023	03/08/2025
LISN	Teseq	NNB 51	V045406	08/10/2024	08/10/2025
Conductance Cable Wanship Upper Site	VPI Labs	Cable J	V034832	01/10/2024	01/10/2025
Filter	VPI Labs	47038	V047038	01/10/2024	01/10/2025
EMC32 Measurement Software	Rohde & Schwarz	10.60.20	N/A	N/A	N/A

Table 5: List of equipment used for conducted emissions testing at mains ports.

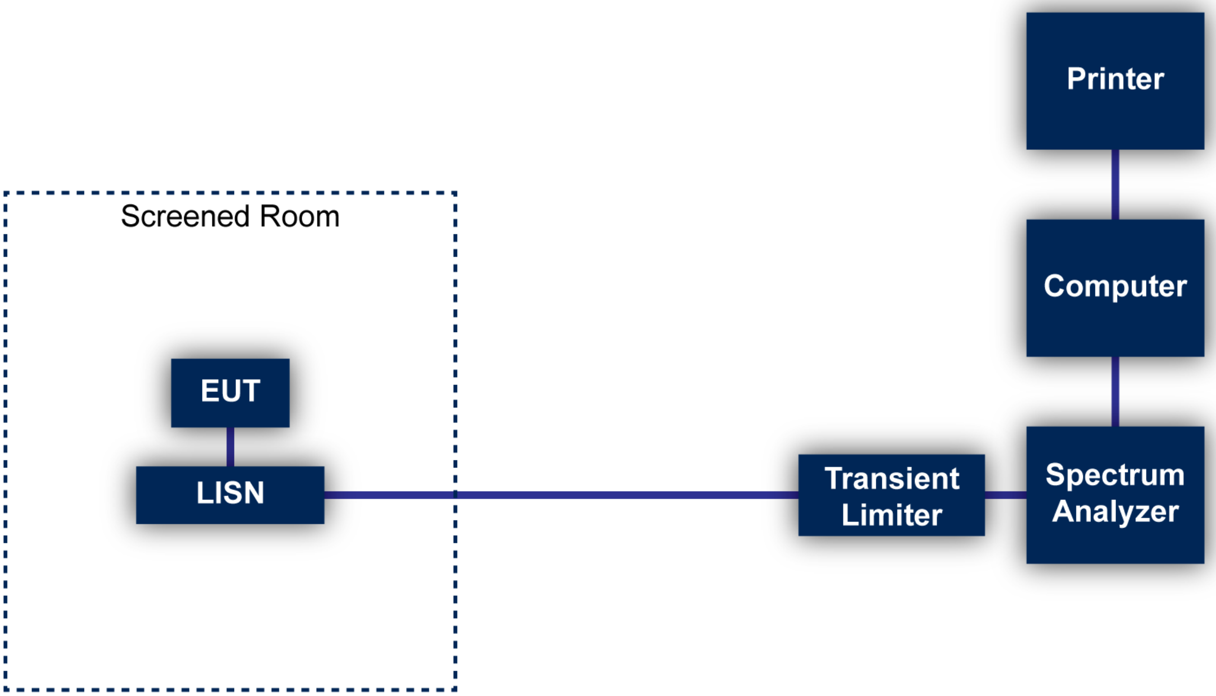


Figure 1: Conducted Emissions Test

7.2 Direct Connection at the Antenna Port Tests

Type of Equipment	Manufacturer	Model Number	Asset Number	Date of Last Calibration	Due Date of Calibration
Spectrum Analyzer/Receiver	Rohde & Schwarz	ESU40	V033119	10/26/2022	10/26/2024
Spectrum Analyzer/ Signal Analyzer	Rohde & Schwarz	FSV40	V044352	03/08/2023	03/08/2025
6 dB Attenuator	Pasternack	PE7004-6	V033645	01/10/2024	01/10/2025
Low Loss Cable	N/A	N/A	V034173	01/10/2022	01/10/2023

7.2.1 Test Configuration Block Diagram

Figure 2: Direct Connection at the Antenna Port Test

7.3 Radiated Emissions

The radiated emissions from the EUT were measured using a spectrum analyzer with a quasi-peak adapter for peak and quasi-peak readings.

A preamplifier with a fixed gain of 51 dB was used to increase the sensitivity of the measuring instrumentation. The quasi-peak adapter uses a bandwidth of 120 kHz, with the spectrum analyzer's resolution bandwidth set at 1 MHz, for readings in the 30 to 1000 MHz frequency ranges. For frequencies below 30 MHz, a 9 kHz resolution Bandwidth was used.

A loop antenna was used to measure frequencies below 30 MHz. A biconilog antenna was used to measure the frequency range of 30 to 1000 MHz, at a distance of 3 meters from the EUT. The readings obtained by these antennas are correlated to the levels obtained with a tuned dipole antenna by adding antenna factors. A double-ridged guide antenna was used to measure the emissions at frequencies above 1000 MHz at a distance of 3 and/or 1 meter from the EUT.

The configuration of the EUT was varied to find the maximum radiated emission. The EUT was connected to the peripherals listed in Section 2.3 via the interconnecting cables listed in Section 2.4. A technician manually manipulated these interconnecting cables to obtain worst-case radiated emissions. The EUT was rotated 360 degrees, and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission. Where there were multiple interface ports all of the same type, cables are either placed on all of the ports or cables added to these ports until the emissions do not increase by more than 2 dB.

Desktop EUT are measured on a non-conducting table 0.8 meters above the ground plane. For frequencies above 1000 MHz, the EUT is placed on a table 1.5 meters above the ground plane. The table is placed on a turntable, which is level with the ground plane. For equipment normally placed on floors, the equipment shall be placed directly on the turntable.

For radiated emissions testing that is performed at distances closer than the specified distance; an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

Type of Equipment	Manufacturer	Model Number	Asset Number	Date of Last Calibration	Due Date of Calibration
Spectrum Analyzer/Receiver	Rohde & Schwarz	ESU40	V033119	10/26/2022	10/26/2024
Spectrum Analyzer/ Signal Analyzer	Rohde & Schwarz	FSV40	V044352	03/08/2023	03/08/2025
Loop Antenna	EMCO	6502	V034216	02/03/2023	02/03/2025
Biconilog Antenna	EMCO	3142E	V057461	7/21/2023	07/21/2025
3142E Power Amplifier	EMCO	3142E-PA	V036056	05/19/2024	05/19/2025
Double Ridged Guide Antenna	EMCO	3115	V033469	01/25/2023	01/25/2025
Standard Gain Horn	ETS-Lindgren	3160-09	V034223	ICO	ICO
High Frequency Amplifier	Miteq	AFS4-001018000-35-10P-4	V033997	01/10/2024	01/10/2025
900 MHz High Pass Filter	Micro-Tronics	HPM50108-03	V034185	01/10/2024	01/10/2025

Type of Equipment	Manufacturer	Model Number	Asset Number	Date of Last Calibration	Due Date of Calibration
2.4 GHz High Pass Filter	Micro-Tronics	HPM50111-03	V034183	01/10/2024	01/10/2025
2.4 GHz Notch Filter	Micro-Tronics	BRM50702-03	V034213	01/10/2024	01/10/2025
6' High Frequency Cable	Microcoax	UFB197C-0-0720-000000	V033638	01/10/2024	01/10/2025
20' High Frequency Cable	Microcoax	UFB197C-1-3120-000000	V033979	01/10/2024	01/10/2025
3 Meter Radiated Emissions Cable Wanship Upper Site	Microcoax	UFB205A-0-4700-000000	V033639	01/10/2024	01/10/2025
EMC32 Test Software	Rohde & Schwarz	10.60.20	N/A	N/A	N/A

Table 6: List of equipment used for radiated emissions testing.

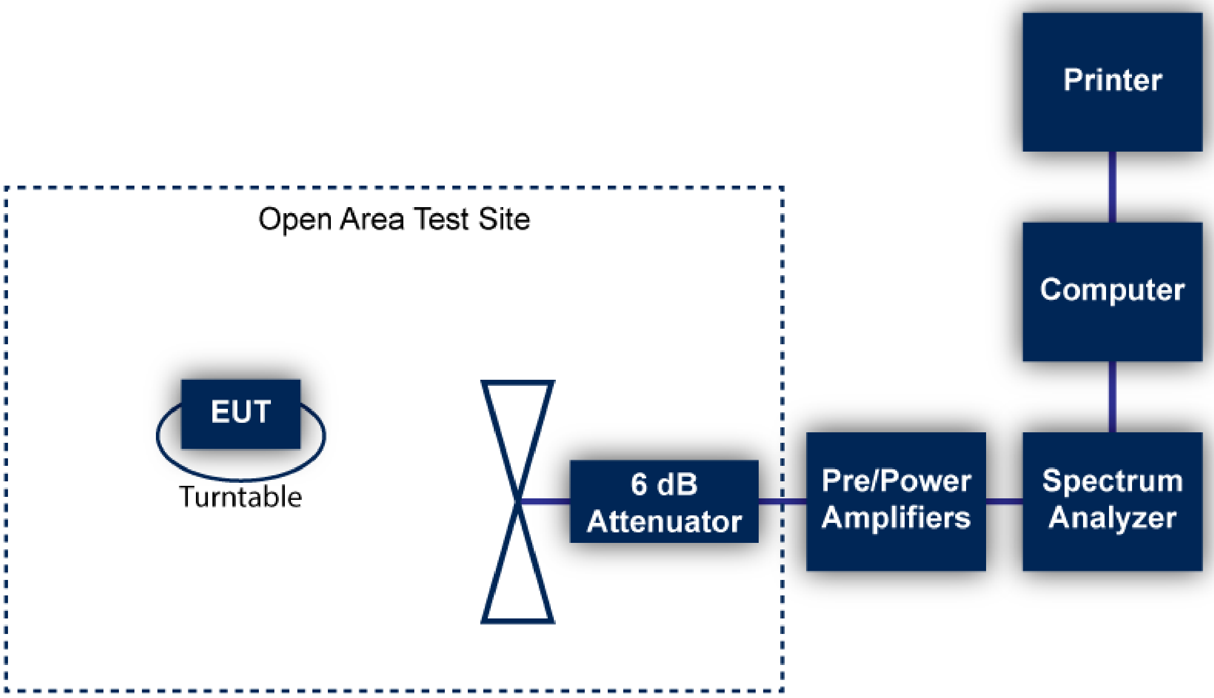


Figure 3: Radiated Emissions Test

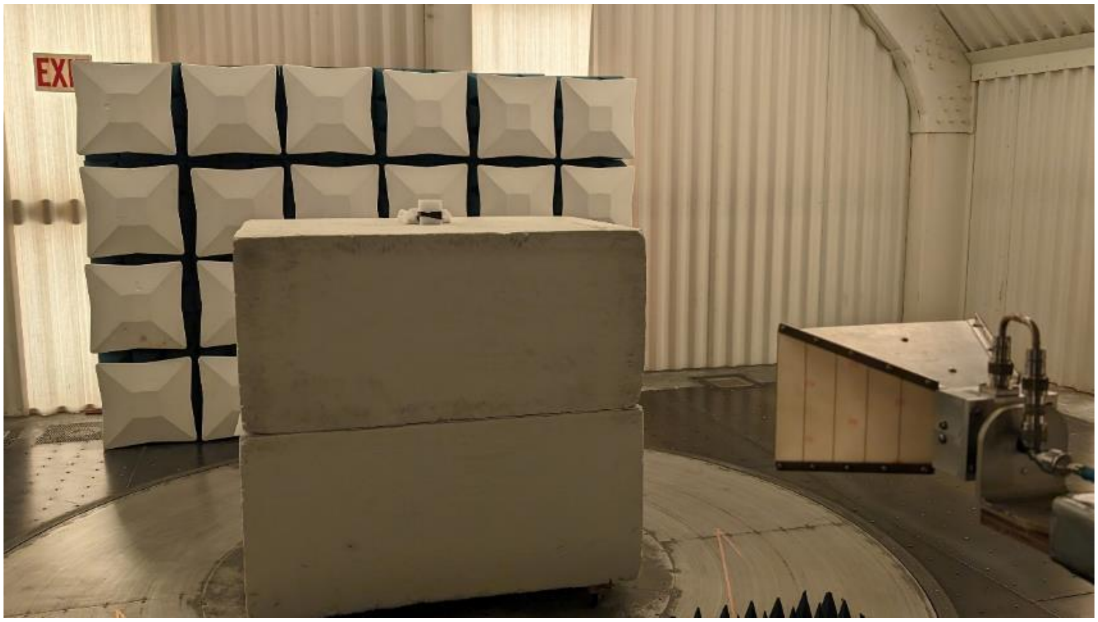
7.4 Equipment Calibration

All applicable equipment is calibrated using either an independent calibration laboratory or VPI Technology, Inc. personnel at intervals defined in ANSI C63.4:2014 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to tractability is on file and is available for examination upon request.

7.5 Measurement Uncertainty

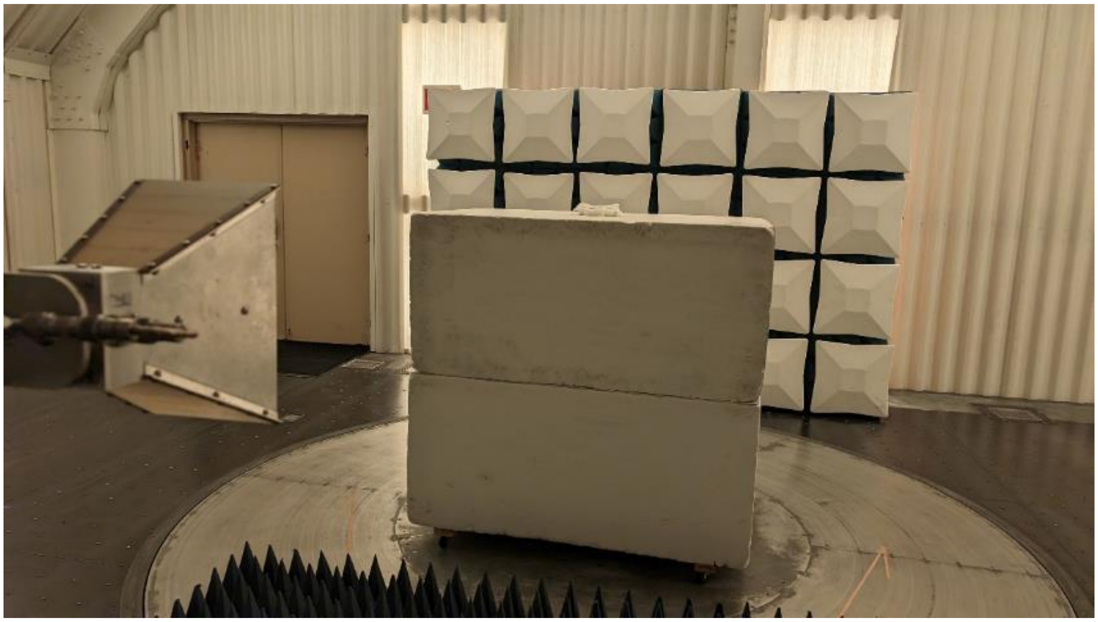
Test	Uncertainty (±dB)	Confidence (%)
Conducted Emissions	2.8	95
Radiated Emission (9 kHz to 30 MHz)	3.3	95
Radiated Emissions (30 MHz to 1 GHz)	3.4	95
Radiated Emissions (1 GHz to 18 GHz)	5.0	95
Radiated Emissions (18 GHz to 40 GHz)	4.1	95

8 Photographs



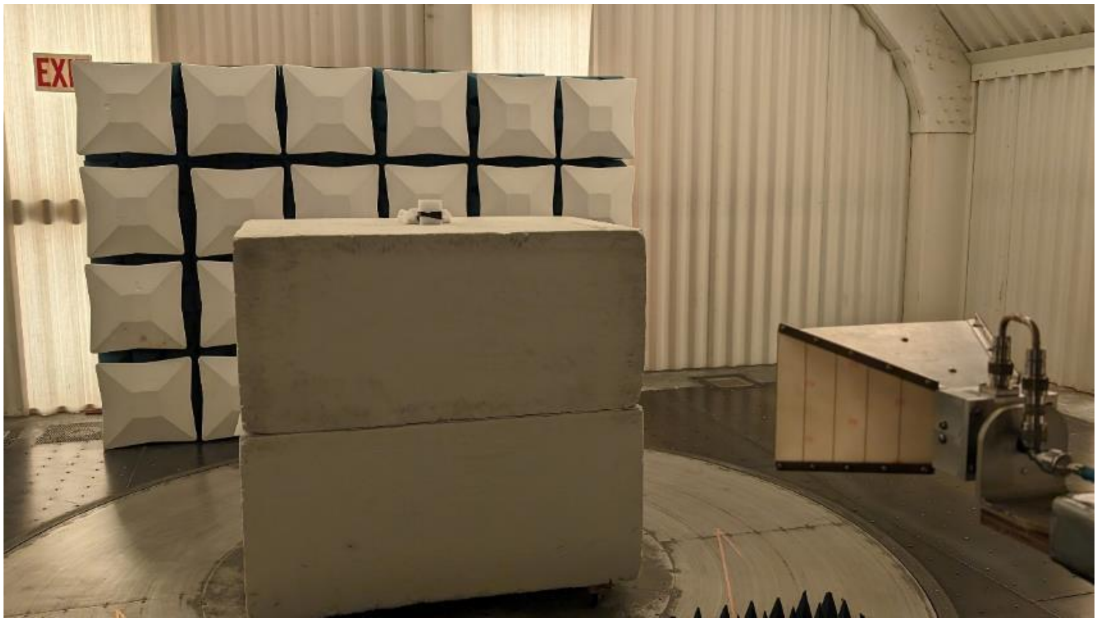
Photograph 1: Front View Radiated Emissions Worst-Case Configuration "Standing on Short Edge"

Photograph 2: Back View Radiated Emissions Worst-Case Configuration "Standing on Short Edge"



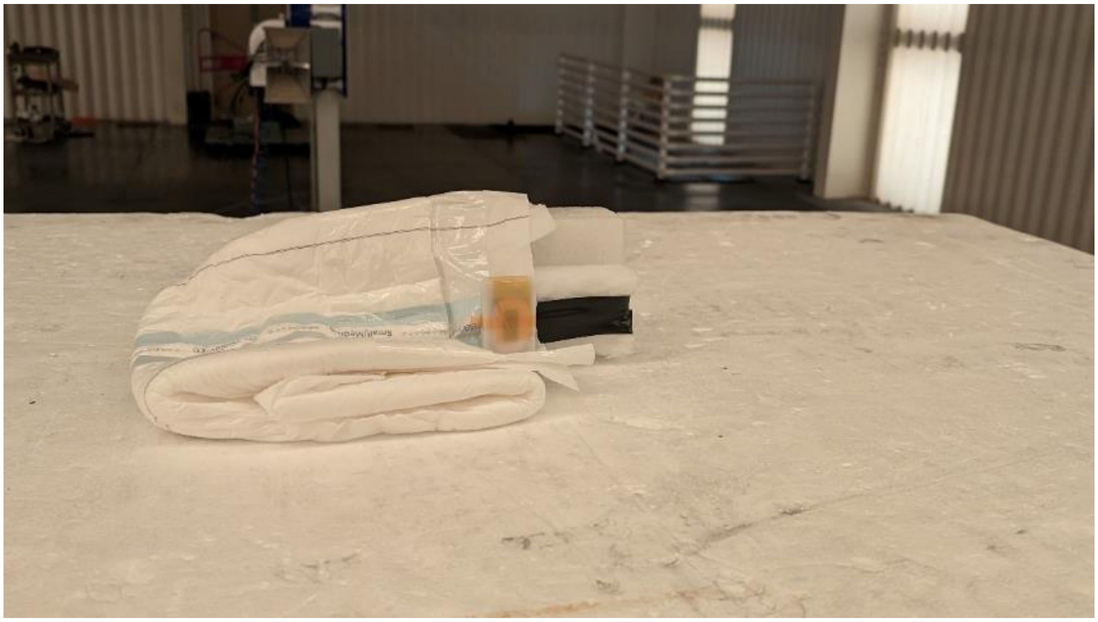
Photograph 3: Front View "Laying Flat" Configuration

Photograph 4: Back View "Laying Flat" Configuration



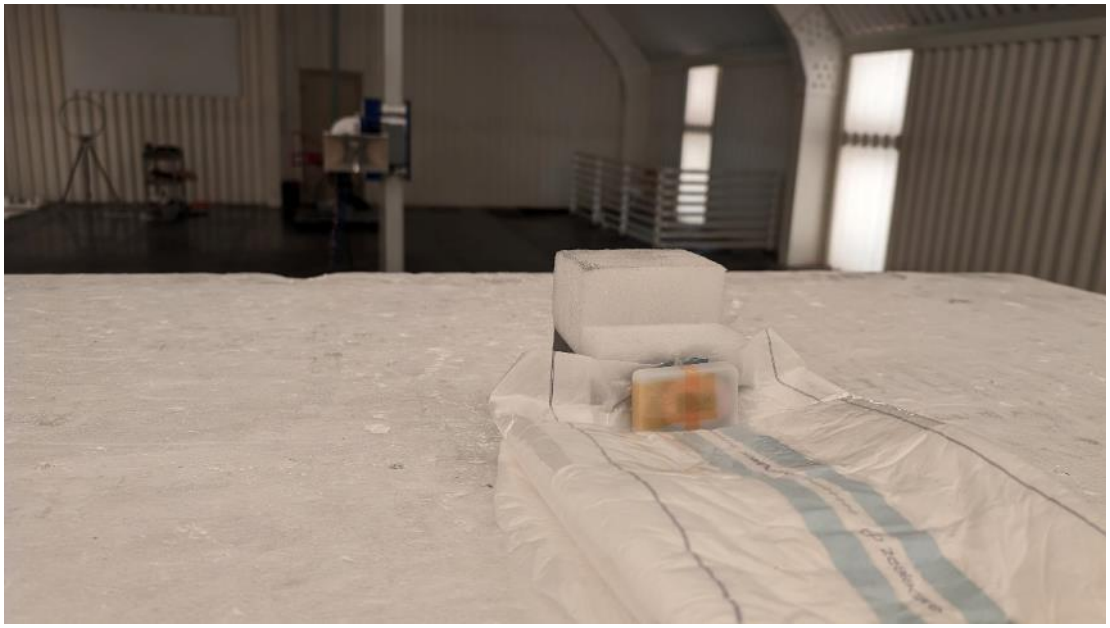
Photograph 5: Front View "Standing on Long Edge" Configuration

Photograph 6: Back View "Standing on Long Edge" Configuration



Photograph 7: Close-up View of Worst-Case Orientation (“Standing on Short Edge”)

Photograph 8: Close-up View of “Laying Flat” Orientation



Photograph 9: Close-up View of "Standing on Long Edge" Orientation

Photograph 10: Front View of the EUT

Photograph 11: Back View of the EUT

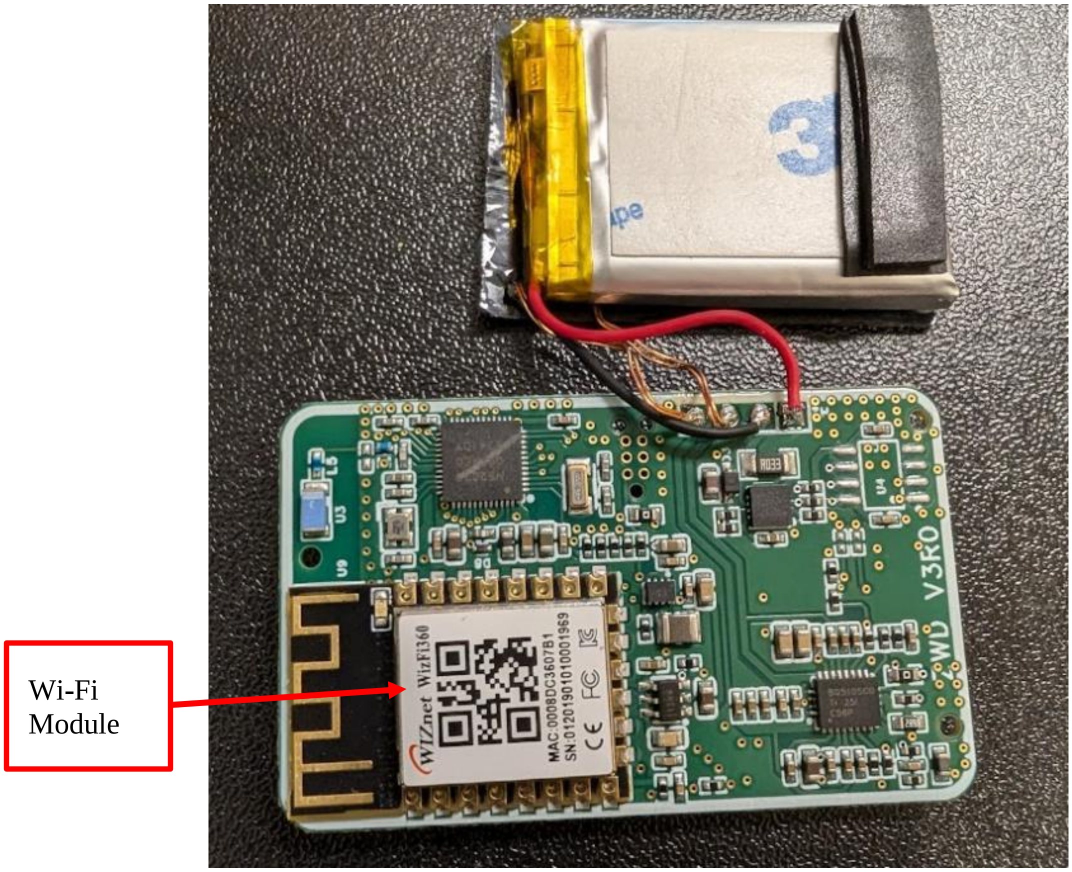
Photograph 12: Top View of the EUT

Photograph 13: Bottom View of the EUT

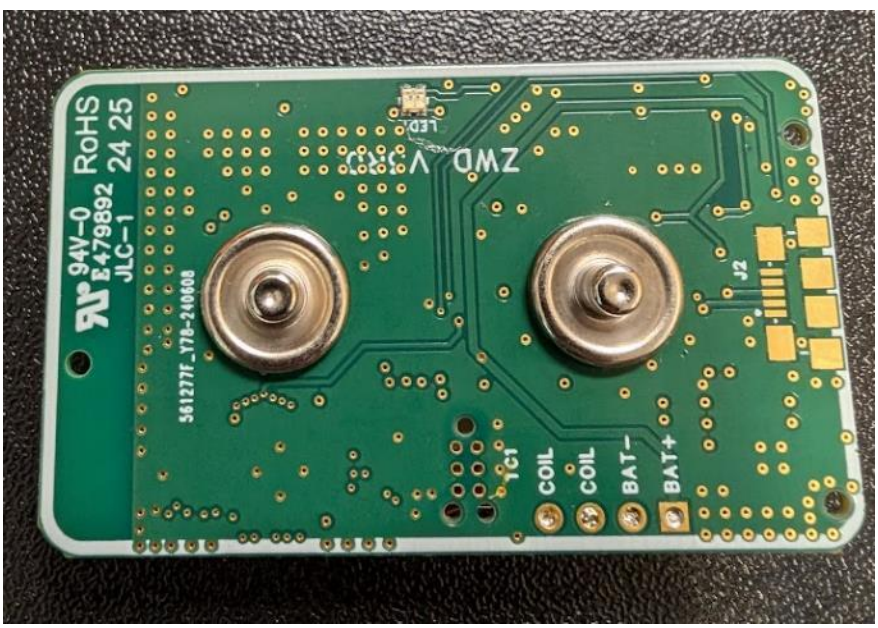
Photograph 14: Side 1 View of the EUT

Photograph 15: Side 2 View of the EUT

Photograph 16: View of the EUT Placement in Enclosure



Photograph 17: Front View of the PCB



Photograph 18: Back View of the PCB

Photograph 19: Close-up View of the RF Circuitry

--- End of Report ---