313 West 12800 South, Suite 311
Draper, UT 84020
(801) 260-4040

Test Report

Certification

FCC ID	MZR-YRHCPZW4FM
Equipment Under Test	AYR-MOD-ZW4-USA
Test Report Serial No	V067192_02
Dates of Test	February 15 and 16, 2023
Report Issue Date	February 24, 2023

Test Specifications:	Applicant:
FCC Part 15, Subpart C Sections 15.203, 15.207, and 15.249	Master Lock Company 6744 S. Howell Avenue Oak Creek, WI 53154 U.S.A.

NVLAP LAB CODE 100272-0

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Certification of Engineering Report

This report has been prepared by VPI Laboratories, 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	Master Lock Company
Manufacturer	Master Lock Company
Brand Name	Yale
Model Name	AYR-MOD-ZW4-USA
FCC ID	MZR-YRHCPZW4FM

On this 24th day of February 2023, I, individually and for VPI Laboratories, 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 Laboratories, 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 federal government.

VPI Laboratories, Inc.

Tested by: Benjamin N. Antczak

Reviewed by: Jason Stewart

Revision History		
Revision	**Description**	**Date**
01	Original Report Release	February 24, 2023
02	Corrected FCC ID	May 28, 2024

Table of Contents

1 Client Information

1.1 Applicant

Company Name	Master Lock Company 6744 S. Howell Avenue Oak Creek, WI 53154 U.S.A.
Contact Name	Sidnei Stifelmann
Title	Senior Global Product Regulatory Compliance Manager

1.2 Manufacturer

Company Name	Master Lock Company 6744 S. Howell Avenue Oak Creek, WI 53154 U.S.A.
Contact Name	Sidnei Stifelmann
Title	Senior Global Product Regulatory Compliance Manager

2 Equipment Under Test (EUT)

2.1 Identification of EUT

Brand Name	Yale
Model Number	AYR-MOD-ZW4-USA
Serial Number	None
Dimensions (cm)	5 x 2 x 2

2.2 Description of EUT

The AYR-MOD-ZW4-USA is module containing a Z-wave LR transceiver that is used in Yale door locks. The AYR-MOD-ZW4-USA is powered by the batteries in the lock. For testing purposes, a Phihong PSA 05A-050QL6 power supply was used to power the AYR-MOD-ZW4-USA. The transceiver uses 3 channel in the 902 MHz – 928 MHz ISM frequency band. The transceiver uses a PCB trace as an antenna with a gain of -1.26 as provided by the Manufacturer. The maximum power settings for the transceiver channels are shown below. Testing was performed using these settings.

Frequency (MHz)	Power Setting	Data Rate (kb/s)	Modulation
908.40	3 raw	40	GFSK
908.42	3 raw	9.6	GFSK
916.00	3 raw	100	GFSK

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 in VPI Laboratories, Inc. report V067190_1. Transceiver can transmit at one additional channel subject to §15.247 and found to be compliant in VPI Laboratories, Inc. report V067195_1.

2.3 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: Yale MN: AYR-MOD-ZW4-USA (Note 1) SN: None	Z-wave module for door locks	See Section 2.4

Notes: (1) EUT

2.4 Interface Ports on EUT

Name of Ports	No. of Ports Fitted to EUT	Cable Description/Length
Lock Interface	1	The EUT connects directly to the lock via an 8 pin header connector

2.5 Modification Incorporated/Special Accessories on EUT

The following modifications were made to the EUT by the Client during testing to comply with the specification. This report is not complete without an accompanying signed attestation, that the product will have all of the documented modifications incorporated into the product when manufactured and placed on the market.

- The transmit power was reduced to “3 raw” to comply with §15.249(a) field strength of the fundamental.

2.6 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 15.249 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 §15.249 Operation within the bands 902 – 928 MHz, 2400 – 2483.5 MHz, and 5725 – 5850 MHz

a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental Frequency	Field Strength of Fundamental (millivolts/meter)	Field Strength of Harmonics (microvolts/meter)
902-928 MHz	50	500
2400-2483.5 MHz	50	500
5725-5875 MHz	50	500
24.0-24.25 GHz	250	2500

b) Fixed, point-to-point operation as referred to in this paragraph shall be limited to systems employing a fixed transmitter transmitting to a fixed remote location. Point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information are not allowed. Fixed, point-to-point operation is permitted in the 24.05-24.25 GHz band subject to the following conditions.
   1. The field strength of emissions in this band shall not exceed 2500 millivolts/meter.
   2. The frequency tolerance of the carrier signal shall be maintained within ±0.001% of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.
   3. Antenna gain must be at least 33 dBi. Alternatively, the main lobe beamwidth must not exceed 3.5 degrees. The beamwidth limit shall apply to both the azimuth and elevation planes. At antenna gains over 33 dBi or beamwidths narrower than 3.5 degrees, power must be reduced to ensure that the field strength does not exceed 2500 millivolts/meter.

c) Field strength limits are specified at a distance of 3 meters.

d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.

e) (e) As shown in § 15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.

3.3 Test Procedure

VPI Laboratories, Inc. is accredited by National Voluntary Laboratory Accreditation Program (NVLAP); NVLAP Lab Code: 100272-0, which is effective until September 30, 2023. VPI Laboratories, Inc. carries FCC Accreditation Designation Number US5263. VPI Laboratories 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 and 47 CFR Part 15.

4 Operation of EUT During Testing

4.1 Operating Environment

Power Supply	5 VDC from batteries in normal use, for testing, an external DC power supply was used operating from 120 VAC/60 Hz

4.2 Operating Modes

The EUT was tested on 3 orthogonal axes and with the EUT constantly transmitting a modulated signal at the maximum power setting. The worst-case fundamental emissions were with the EUT standing on its long edge, and worst-case harmonic emissions were with the EUT place flat on the table. See Section 8 for reference photos.

4.3 EUT Exercise Software

CA Engineering software was used to control and exercise the transmitter.

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
15.249(a)	Field Strength of the Fundamental Frequency	902-928 (Center Frequencies 908.4, 908.42, and 916.0)	Complied
15.249(a)	Field Strength of the Harmonics	0.009 – 10000	Complied
15.249(d)	Field Strength of Spurious Emissions	0.009 – 10000	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.

6.2 Test Results

6.2.1 §15.203 Antenna Requirements

The EUT uses a meandering trace on the PCB as an antenna.

Result

The EUT complied with the specification.

6.2.2 §15.207 Conducted Emissions at AC Mains Ports

Hot Lead

Frequency (MHz)	Detector	Receiver Reading (dBµV)	Correction Factor (dB)	Measured Level (dBµV)	Class B Limit (dBµV)	Margin (dB)
0.24	Peak (Note 1)	29.1	9.8	39.0	52.0	-13.1
0.43	Peak (Note 1)	27.7	9.8	37.5	47.3	-9.8
0.53	Quasi-Peak (Note 2)	32.6	10.0	42.6	56.0	-13.5
0.53	Average (Note 2)	28.6	10.0	38.6	46.0	-7.5
0.94	Peak (Note 1)	25.1	9.8	35.0	46.0	-11.0
1.1	Peak (Note 1)	23.6	9.8	33.5	46.0	-12.5
1.7	Peak (Note 1)	22.6	9.9	32.5	46.0	-13.5
2.4	Peak (Note 1)	22.8	9.9	32.7	46.0	-13.3
3.0	Peak (Note 1)	21.7	9.9	31.6	46.0	-14.5
3.7	Peak (Note 1)	22.4	9.9	32.3	46.0	-13.7
4.4	Peak (Note 1)	22.0	9.9	31.9	46.0	-14.1
5.1	Peak (Note 1)	21.5	9.9	31.4	50.0	-18.6
18.6	Peak (Note 1)	15.6	10.4	26.0	50.0	-24.0

Note 1: The reference detector used for the measurements was Quasi-Peak or Peak and the data was compared to the average limit; therefore, the EUT was deemed to meet both the average and quasi-peak limits.
Note 2: The reference detector used for the measurements was quasi-peak and average and the data was compared to the respective limits.

Neutral Lead

Frequency (MHz)	Detector	Receiver Reading (dBµV)	Correction Factor (dB)	Measured Level (dBµV)	Class B Limit (dBµV)	Margin (dB)
0.44	Peak (Note 1)	24.5	9.8	34.3	47.1	-12.8
0.52	Peak (Note 1)	30.7	9.8	40.5	46.0	-5.5
0.90	Peak (Note 1)	21.5	9.8	31.4	46.0	-14.6
1.1	Peak (Note 1)	20.2	9.8	30.0	46.0	-16.0
1.5	Peak (Note 1)	19.1	9.9	28.9	46.0	-17.1
2.3	Peak (Note 1)	19.5	9.9	29.4	46.0	-16.6
3.8	Peak (Note 1)	19.5	9.9	29.4	46.0	-16.6
5.8	Peak (Note 1)	18.5	10.0	28.5	50.0	-21.6
9.4	Peak (Note 1)	16.4	10.1	26.5	50.0	-23.6

Note 1: The reference detector used for the measurements was Quasi-Peak or Peak and the data was compared to the average limit; therefore, the EUT was deemed to meet both the average and quasi-peak limits.
Note 2: The reference detector used for the measurements was quasi-peak and average and the data was compared to the respective limits.

Result

The EUT complied with the specification limit by a margin of 5.5 dB.

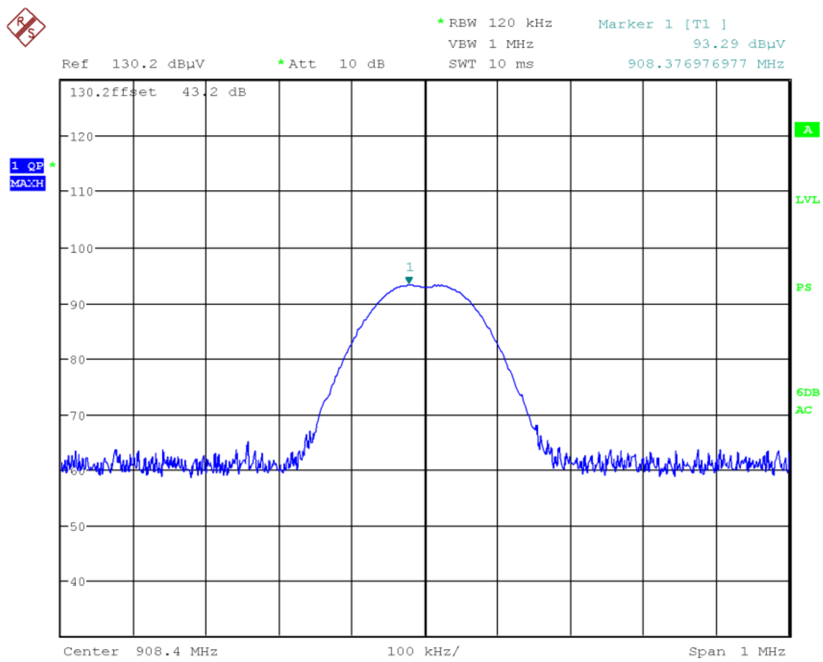
6.2.3 §15.249(a) Fundamental Field Strength

The table below shows the fundamental emission, measured at 3 meters using quasi-peak detection.

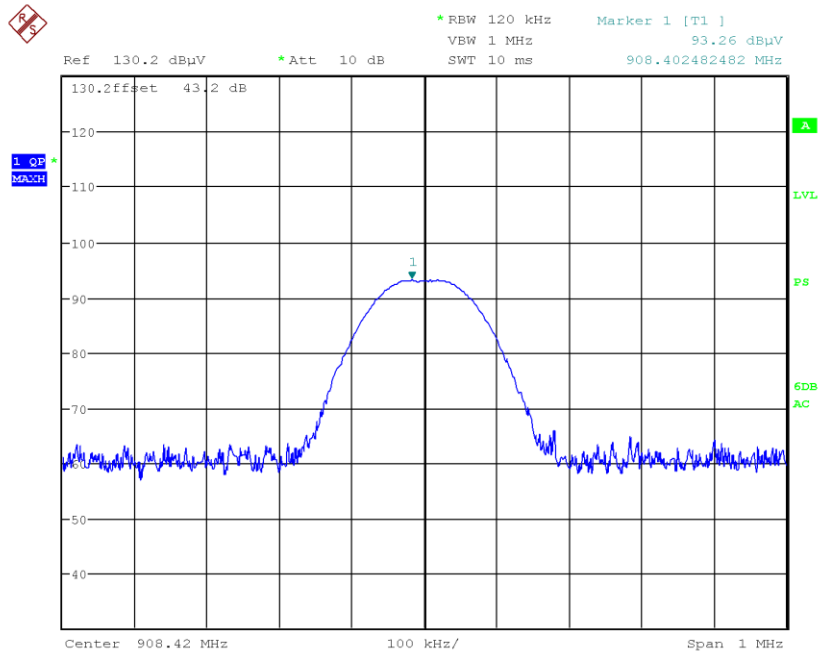
Frequency (MHz)	Detector	Receiver Reading (dBμV)	Correction Factor (dB/m)	Field Strength (dBμV/m)	3 m Limit (dBμV/m)	Margin (dB)
908.40	Quasi-Peak	50.1	43.2	93.3	94.0	-0.7
908.42	Quasi-Peak	50.1	43.2	93.3	94.0	-0.7
916.00	Quasi-Peak	49.1	43.4	92.5	94.0	-1.5

Result

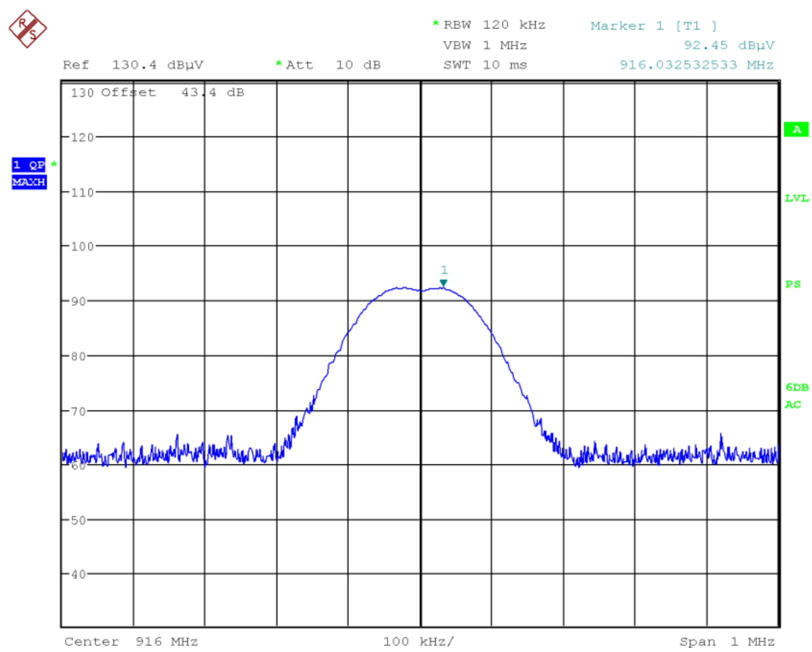
The EUT complied with the specification.



Graph 1: 908.40 MHz Fundamental Field Strength



Graph 2: 908.42 MHz Fundamental Field Strength



Graph 3: 916.0 MHz Fundamental Field Strength

6.2.4 §15.249(a) and §15.249(d) Field Strength of Harmonics and Spurious Emissions

The spurious emissions and harmonic emissions were measured from the lowest frequency used in the device to the 10th harmonic of the highest frequency while transmitting at the maximum possible power level of "155 raw." The table below shows the emissions from the transmitter. Emissions from the digital circuitry and receivers of the EUT was evaluated and found compliant in VIP Laboratories, Inc. report V067190.

Transmitting at 908.40 MHz

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1816.80	Peak	Vertical	37.4	3.7	41.1	74.0	-32.9
1816.80	Average	Vertical	34.7	3.7	38.4	54.0	-15.6
1816.80	Peak	Horizontal	42.7	3.7	46.4	74.0	-27.6
1816.80	Average	Horizontal	41.1	3.7	44.8	54.0	-9.2
2725.20	Peak	Vertical	31.5	5.9	37.4	74.0	-36.6
2725.20	Average	Vertical	27.4	5.9	33.3	54.0	-20.7
2725.20	Peak	Horizontal	32.7	5.9	38.6	74.0	-35.4
2725.20	Average	Horizontal	30.4	5.9	36.3	54.0	-17.7
3633.60	Peak	Vertical	30.9	8.6	39.5	74.0	-34.5
3633.60	Average	Vertical	27.2	8.6	35.7	54.0	-18.3
3633.60	Peak	Horizontal	31.3	8.6	39.8	74.0	-34.2
3633.60	Average	Horizontal	25.8	8.6	34.4	54.0	-19.6
4542.00	Peak	Vertical	31.6	9.5	41.1	74.0	-32.9
4542.00	Average	Vertical	26.8	9.5	36.2	54.0	-17.8
4542.00	Peak	Horizontal	30.3	9.5	39.8	74.0	-34.2
4542.00	Average	Horizontal	26.2	9.5	35.7	54.0	-18.3
5450.40	Peak	Vertical	31.2	11.2	42.4	74.0	-31.6
5450.40	Average	Vertical	27.4	11.2	38.6	54.0	-15.4
5450.40	Peak	Horizontal	30.7	11.2	41.9	74.0	-32.1
5450.40	Average	Horizontal	28.1	11.2	39.4	54.0	-14.6
6358.80	Peak	Vertical	29.5	12.3	41.8	74.0	-32.2
6358.80	Average	Vertical	26.0	12.3	38.3	54.0	-15.7
6358.80	Peak	Horizontal	30.5	12.3	42.8	74.0	-31.2
6358.80	Average	Horizontal	27.3	12.3	39.6	54.0	-14.4

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
7267.20	Peak	Vertical	28.7	15.3	44.0	74.0	-30.0
7267.20	Average	Vertical	25.4	15.3	40.6	54.0	-13.4
7267.20	Peak	Horizontal	30.0	15.3	45.2	74.0	-28.8
7267.20	Average	Horizontal	25.8	15.3	41.1	54.0	-12.9
8175.60	Peak	Vertical	30.2	17.4	47.6	74.0	-26.4
8175.60	Average	Vertical	28.7	17.4	46.1	54.0	-7.9
8175.60	Peak	Horizontal	28.5	17.4	45.9	74.0	-28.1
8175.60	Average	Horizontal	24.5	17.4	41.9	54.0	-12.1
9084.00	Peak	Vertical	26.0	19.4	45.4	74.0	-28.6
9084.00	Average	Vertical	21.2	19.4	40.6	54.0	-13.4
9084.00	Peak	Horizontal	26.4	19.4	45.8	74.0	-28.2
9084.00	Average	Horizontal	21.4	19.4	40.8	54.0	-13.2

Transmitting at 908.42 MHz

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1816.84	Peak	Vertical	42.3	3.7	46.0	74.0	-28.0
1816.84	Average	Vertical	41.9	3.7	45.6	54.0	-8.4
1816.84	Peak	Horizontal	43.6	3.7	47.3	74.0	-26.7
1816.84	Average	Horizontal	42.2	3.7	45.9	54.0	-8.1
2725.26	Peak	Vertical	30.2	5.9	36.1	74.0	-37.9
2725.26	Average	Vertical	27.4	5.9	33.3	54.0	-20.7
2725.26	Peak	Horizontal	32.0	5.9	37.9	74.0	-36.1
2725.26	Average	Horizontal	29.2	5.9	35.1	54.0	-18.9
3633.68	Peak	Vertical	29.7	8.6	38.3	74.0	-35.7
3633.68	Average	Vertical	26.5	8.6	35.1	54.0	-18.9
3633.68	Peak	Horizontal	30.0	8.6	38.6	74.0	-35.4
3633.68	Average	Horizontal	26.1	8.6	34.6	54.0	-19.4
4542.10	Peak	Vertical	30.1	9.5	39.6	74.0	-34.4
4542.10	Average	Vertical	27.6	9.5	37.1	54.0	-16.9

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4542.10	Peak	Horizontal	31.0	9.5	40.4	74.0	-33.6
4542.10	Average	Horizontal	25.9	9.5	35.4	54.0	-18.6
5450.52	Peak	Vertical	30.4	11.2	41.6	74.0	-32.4
5450.52	Average	Vertical	27.9	11.2	39.1	54.0	-14.9
5450.52	Peak	Horizontal	30.9	11.2	42.1	74.0	-31.9
5450.52	Average	Horizontal	27.1	11.2	38.3	54.0	-15.7
6358.94	Peak	Vertical	30.5	12.3	42.8	74.0	-31.2
6358.94	Average	Vertical	27.0	12.3	39.3	54.0	-14.7
6358.94	Peak	Horizontal	30.6	12.3	42.9	74.0	-31.1
6358.94	Average	Horizontal	29.1	12.3	41.4	54.0	-12.6
7267.36	Peak	Vertical	28.1	15.3	43.4	74.0	-30.6
7267.36	Average	Vertical	23.8	15.3	39.1	54.0	-14.9
7267.36	Peak	Horizontal	28.9	15.3	44.2	74.0	-29.8
7267.36	Average	Horizontal	25.9	15.3	41.2	54.0	-12.8
8175.78	Peak	Vertical	28.1	17.4	45.5	74.0	-28.5
8175.78	Average	Vertical	25.9	17.4	43.3	54.0	-10.7
8175.78	Peak	Horizontal	28.8	17.4	46.2	74.0	-27.8
8175.78	Average	Horizontal	25.6	17.4	43.0	54.0	-11.0
9084.20	Peak	Vertical	25.0	19.4	44.3	74.0	-29.7
9084.20	Average	Vertical	21.9	19.4	41.3	54.0	-12.7
9084.20	Peak	Horizontal	24.2	19.4	43.5	74.0	-30.5
9084.20	Average	Horizontal	20.8	19.4	40.2	54.0	-13.8

Transmitting at 916.00 MHz

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1832.00	Peak	Vertical	36.7	3.8	40.5	74.0	-33.5
1832.00	Average	Vertical	34.8	3.8	38.5	54.0	-15.5
1832.00	Peak	Horizontal	43.5	3.8	47.2	74.0	-26.8
1832.00	Average	Horizontal	42.5	3.8	46.3	54.0	-7.7

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2748.00	Peak	Vertical	32.6	5.9	38.5	74.0	-35.5
2748.00	Average	Vertical	27.4	5.9	33.4	54.0	-20.6
2748.00	Peak	Horizontal	31.7	5.9	37.6	74.0	-36.4
2748.00	Average	Horizontal	28.2	5.9	34.1	54.0	-19.9
3664.00	Peak	Vertical	32.0	8.7	40.7	74.0	-33.3
3664.00	Average	Vertical	27.6	8.7	36.4	54.0	-17.6
3664.00	Peak	Horizontal	30.5	8.7	39.2	74.0	-34.8
3664.00	Average	Horizontal	26.2	8.7	34.9	54.0	-19.1
4580.00	Peak	Vertical	30.8	9.6	40.4	74.0	-33.6
4580.00	Average	Vertical	26.6	9.6	36.2	54.0	-17.8
4580.00	Peak	Horizontal	30.2	9.6	39.8	74.0	-34.2
4580.00	Average	Horizontal	24.7	9.6	34.3	54.0	-19.7
5496.00	Peak	Vertical	30.6	11.2	41.8	74.0	-32.2
5496.00	Average	Vertical	27.1	11.2	38.3	54.0	-15.7
5496.00	Peak	Horizontal	31.5	11.2	42.7	74.0	-31.3
5496.00	Average	Horizontal	28.0	11.2	39.2	54.0	-14.8
6412.00	Peak	Vertical	29.9	12.3	42.2	74.0	-31.8
6412.00	Average	Vertical	26.7	12.3	39.0	54.0	-15.0
6412.00	Peak	Horizontal	31.4	12.3	43.7	74.0	-30.3
6412.00	Average	Horizontal	27.9	12.3	40.2	54.0	-13.8
7328.00	Peak	Vertical	28.7	15.5	44.2	74.0	-29.8
7328.00	Average	Vertical	25.3	15.5	40.8	54.0	-13.2
7328.00	Peak	Horizontal	27.9	15.5	43.5	74.0	-30.5
7328.00	Average	Horizontal	24.2	15.5	39.7	54.0	-14.3
8244.00	Peak	Vertical	31.2	17.6	48.9	74.0	-25.1
8244.00	Average	Vertical	30.0	17.6	47.6	54.0	-6.4
8244.00	Peak	Horizontal	30.7	17.6	48.4	74.0	-25.6
8244.00	Average	Horizontal	28.6	17.6	46.2	54.0	-7.8
9160.00	Peak	Vertical	25.6	19.4	45.0	74.0	-29.0
9160.00	Average	Vertical	22.6	19.4	42.0	54.0	-12.0

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
9160.00	Peak	Horizontal	25.5	19.4	44.9	74.0	-29.1
9160.00	Average	Horizontal	23.4	19.4	42.8	54.0	-11.2

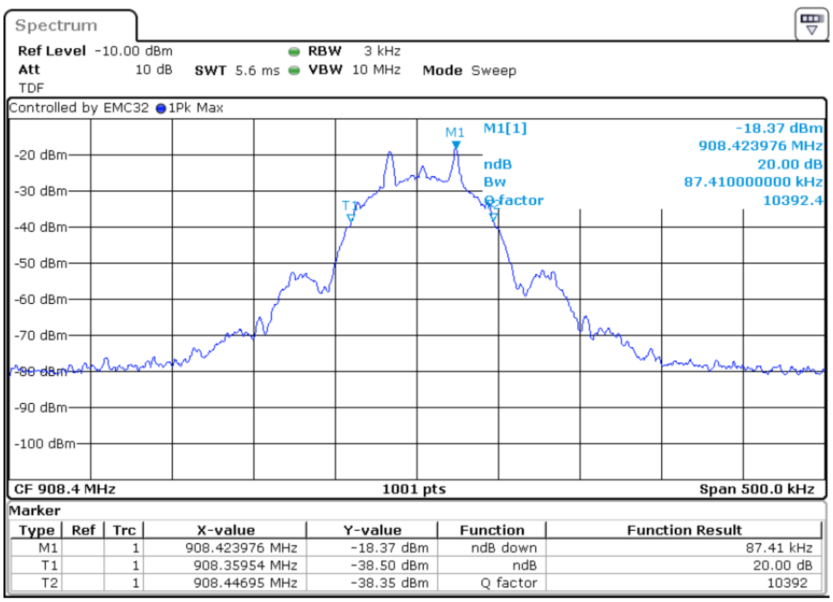
Result

The EUT complied with the specification.

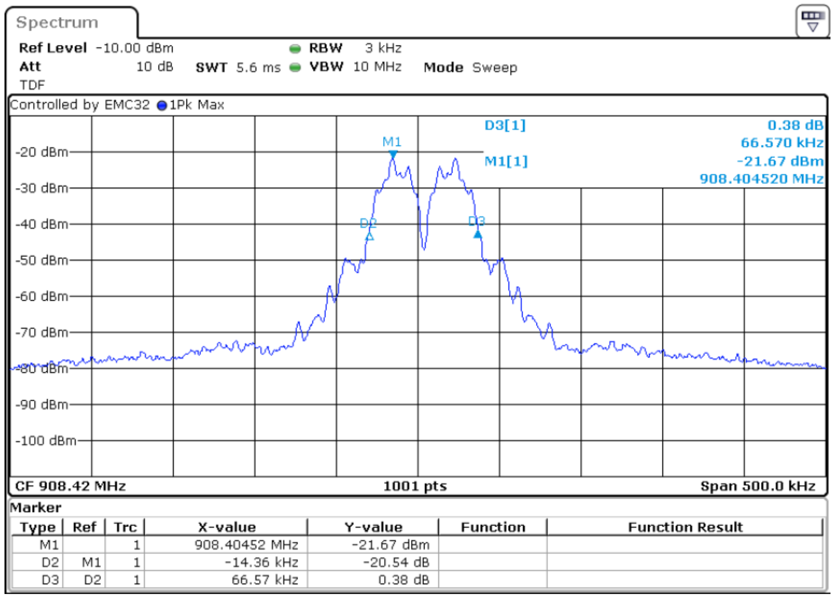
6.2.5 Channel Bandwidth

The 20 dB bandwidths of the channels are shown in the table and plots below. The plots show the fundamental emission contained totally within the 902 – 928 MHz frequency band.

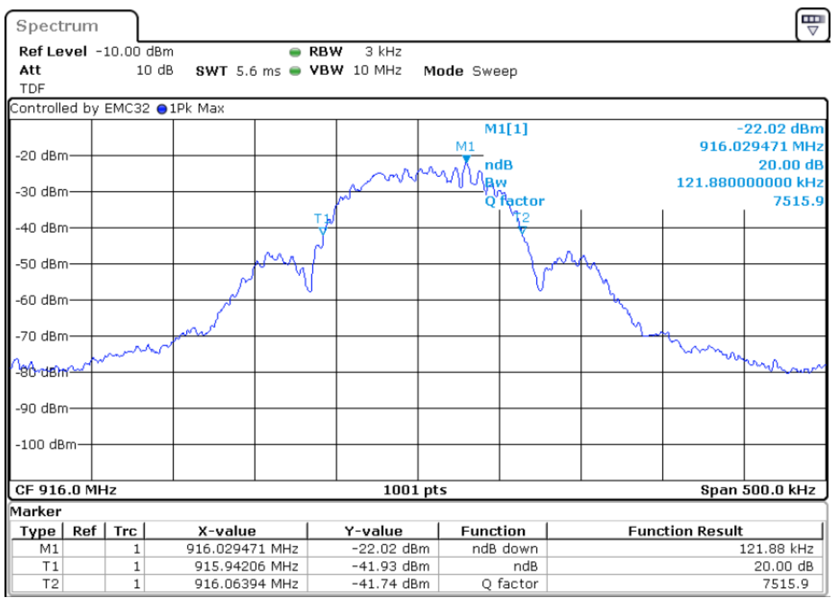
Frequency (MHz)	20 dB Bandwidth (kHz)
908.40	87.4
908.42	66.6
916.00	121.9



Graph 4: 908.40 MHz 20 dB Channel Bandwidth



Graph 5: 908.42 MHz 20 dB Channel Bandwidth



Graph 6: 916.0 MHz Channel 20 dB Bandwidth

6.3 Sample Field Strength Calculation

6.3.1 Field 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. The basic equation with a sample calculation is shown below:

$$Receiver\ Amplitude\ Reading = Receiver\ Reading - Amplifier\ Gain$$
$$Correction\ Factor = Antenna\ Factor\ +\ Cable\ Factor$$
$$Field\ Strength = Receiver\ Amplitude\ Reading\ +\ Correction\ Factor$$

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.

$$Receiver\ Amplitude\ Reading\ =\ 42.5 - 26.5\ =\ 16.0\ \text{dB}\mu\text{V/m}$$
$$Correction\ Factor\ =\ 4.5 + 4.0\ =\ 8.5\ \text{dB}$$
$$Field\ Strength\ =\ 16.0 + 8.5\ =\ 24.5\ \text{dB}\mu\text{V/m}$$

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.

$$Receiver\ Amplitude\ Reading\ =\ 20.8\ \text{dB}\mu\text{V}$$
$$Correction\ Factor\ =\ 10.1 + 0.3\ =\ 10.4\ \text{dB}$$
$$Conducted\ Emissions\ Value\ =\ 20.8 + 10.4\ =\ 31.2\ \text{dB}\mu\text{V}$$

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	08/24/2022	08/24/2023
Spectrum Analyzer/ Signal Analyzer	Rohde & Schwarz	FSV40	V044352	03/08/2022	03/08/2023
LISN	Teseq	NNB 51	V045406	12/05/2022	12/05/2023
Conductance Cable Wanship Upper Site	VPI Labs	Cable J	V034832	12/23/2022	12/23/2023
EMC32 Test Software	Rohde & Schwarz	10.60.20	N/A	N/A	N/A

Table 2: List of equipment used for conducted emissions testing at mains ports.

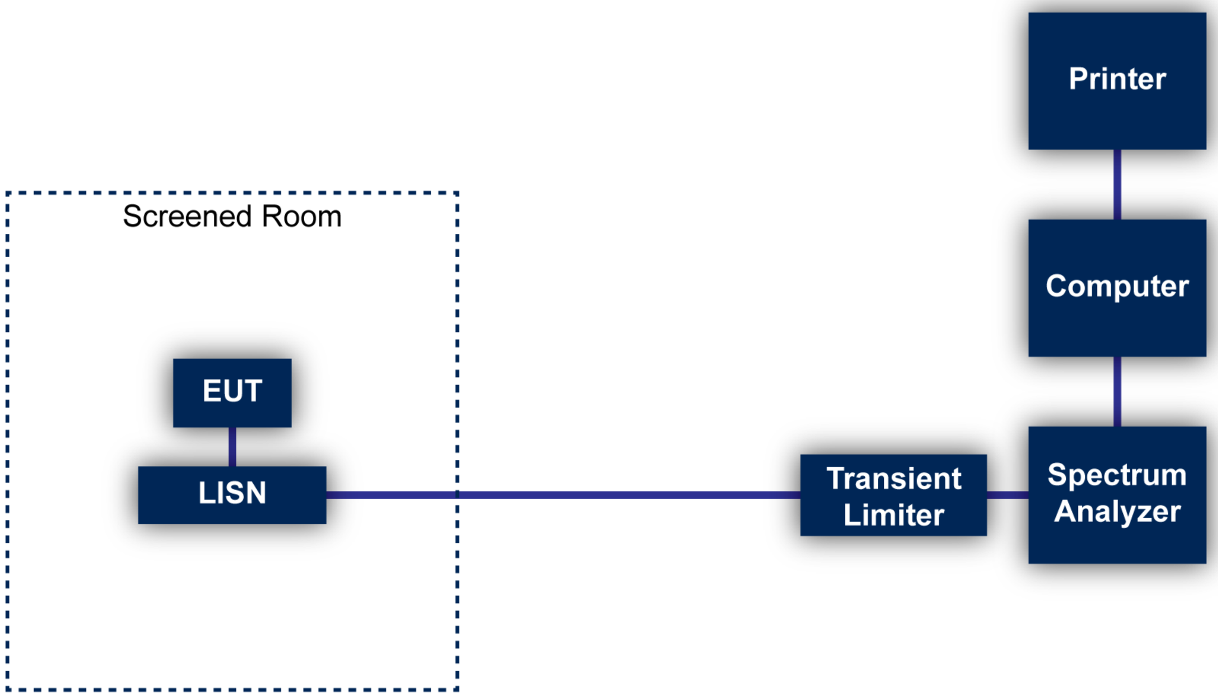


Figure 1: Conducted Emissions Test

7.2 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 meters 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	08/24/2022	08/24/2023
Spectrum Analyzer/ Signal Analyzer	Rohde & Schwarz	FSV40	V044352	03/08/2022	03/08/2024
Biconilog Antenna	EMCO	3142E	V057461	07/21/2021	07/21/2023
3142E Power Amplifier	EMCO	3142E-PA	V036056	05/19/2022	05/19/2023
Double Ridged Guide Antenna	EMCO	3115	V034413	01/25/2023	01/25/2025
High Frequency Amplifier	Miteq	AFS4-001018000-35-10P-4	V033997	12/23/2022	12/23/2023
6' High Frequency Cable	Microcoax	UFB197C-0-0720-000000	V033638	12/23/2022	12/23/2023
20' High Frequency Cable	Microcoax	UFB197C-1-3120-000000	V033979	12/23/2022	12/23/2023
3 Meter Radiated Emissions Cable Wanship Upper Site	Microcoax	UFB205A-0-4700-000000	V033639	12/23/2022	12/23/2023
10 Meter Radiated Emissions Cable Wanship Upper Site	VPI Labs	Cable L	V033649	12/23/2022	12/23/2023
EMC32 Test Software	Rohde & Schwarz	10.60.20	N/A	N/A	N/A

Table 3: List of equipment used for radiated emissions testing.

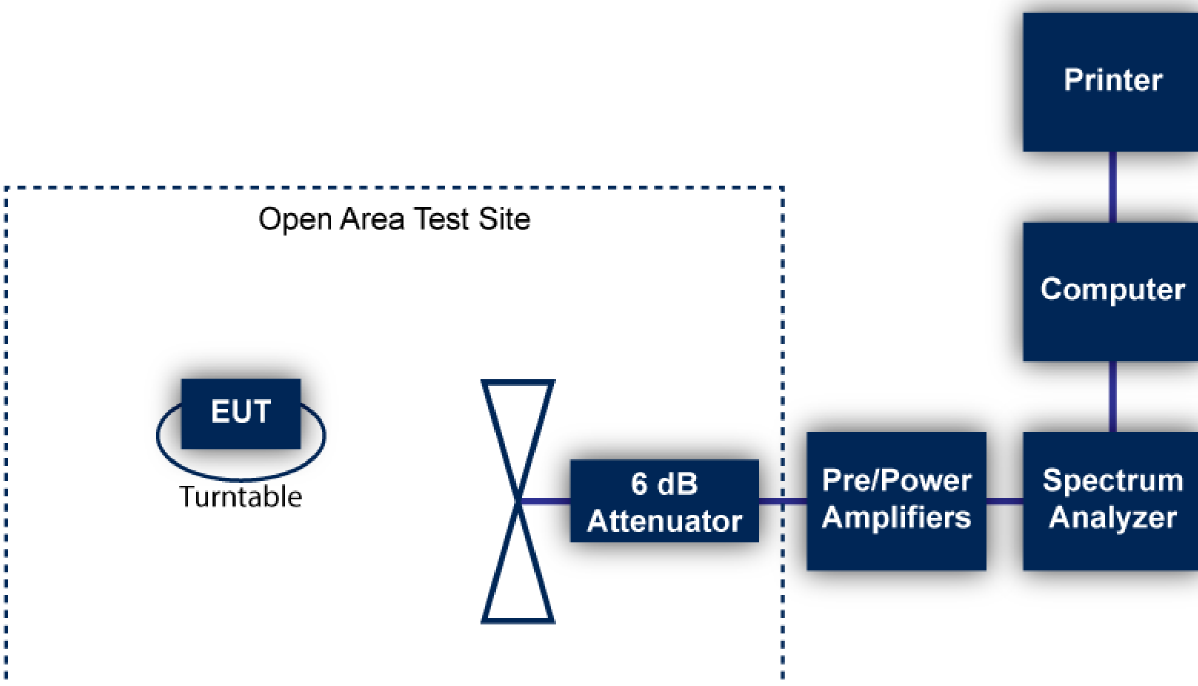


Figure 2: Radiated Emissions Test

7.3 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/ Signal Analyzer	Rohde & Schwarz	FSV40	V044352	03/08/2022	03/08/2023
6 dB Attenuator	Pasternack	PE7004-6	V033645	12/23/2022	12/23/2023
"DUT 5" Cable	N/A	N/A	V034173	12/23/2022	12/23/2023

7.3.1 Test Configuration Block Diagram

Figure 3: Direct Connection at the Antenna Port Test

7.4 Equipment Calibration

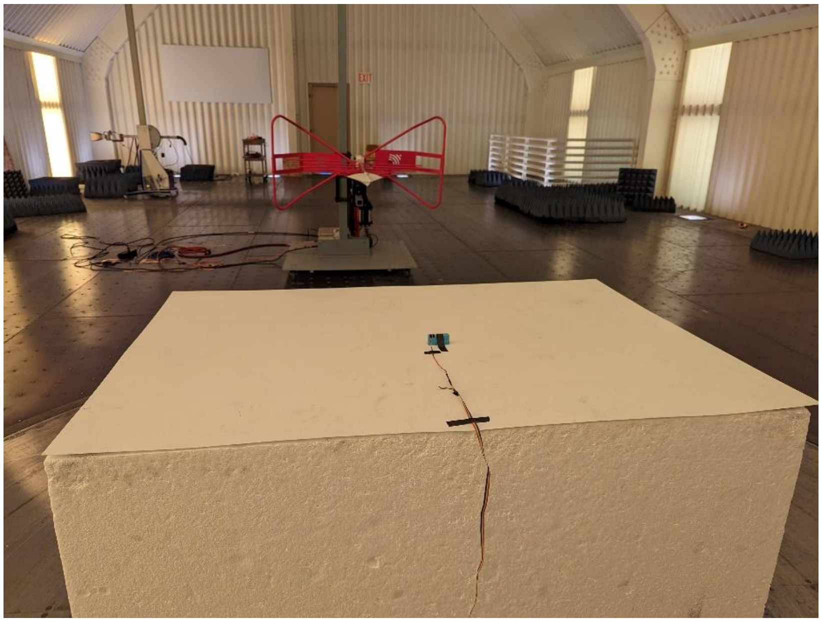
All applicable equipment is calibrated using either an independent calibration laboratory or VPI Laboratories, Inc. personnel at intervals defined in ANSI C63.4:2014 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology (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

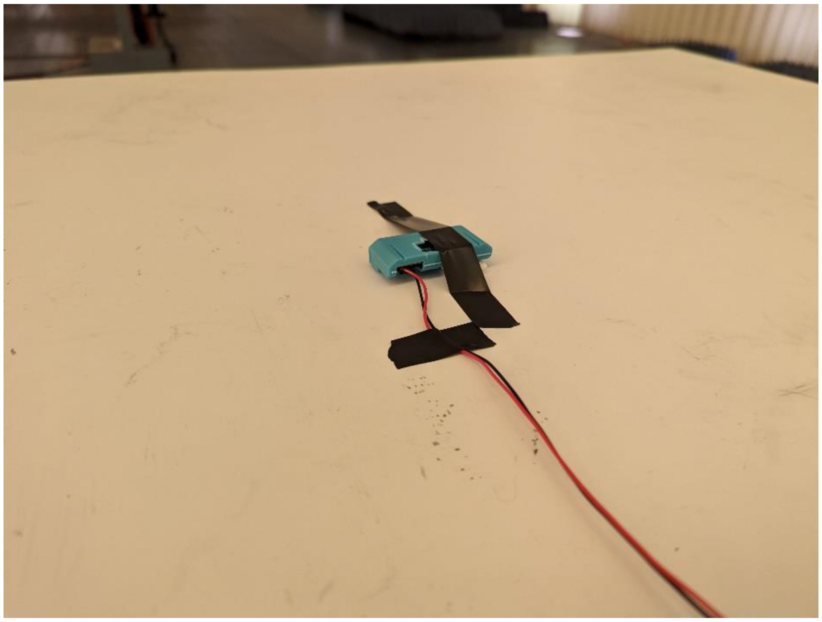
Photograph 1: Front View Radiated Emissions Worst-Case Configuration – 30 to 1000 MHz



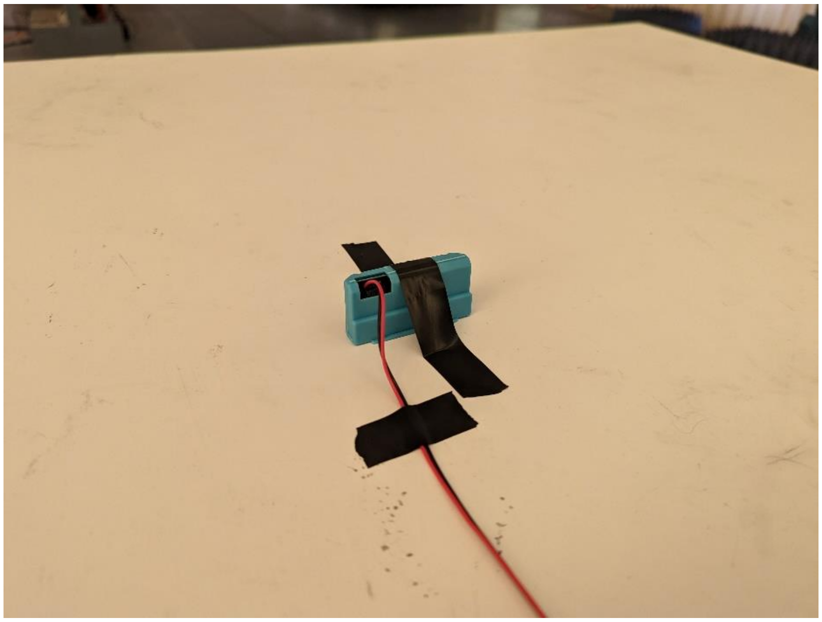
Photograph 2: Back View Radiated Emissions Worst-Case Configuration – 30 to 1000 MHz

Photograph 3: Front View Radiated Emissions Worst-Case Configuration – Above 1000 MHz

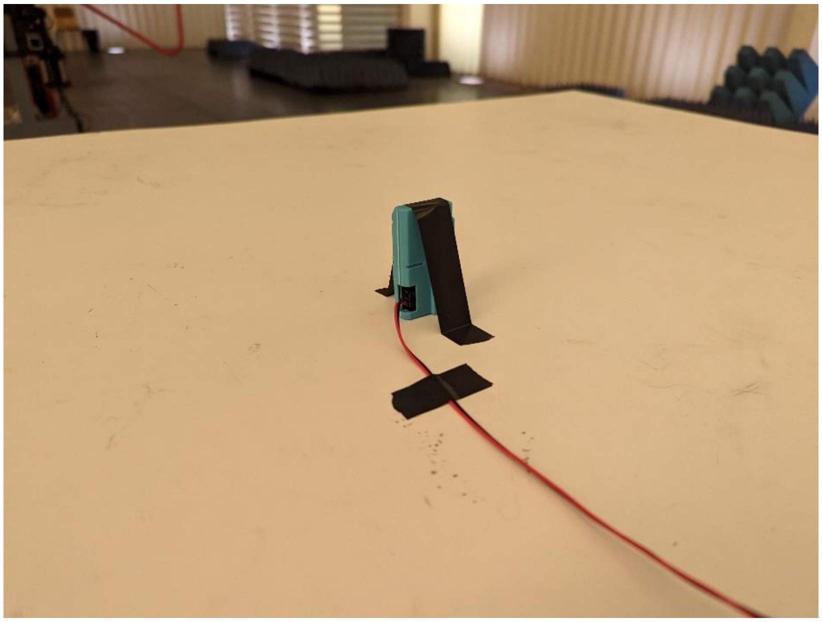
Photograph 4: Back View Radiated Emissions Worst-Case Configuration – Above 1000 MHz



Photograph 5: Laying Flat Placement on the Table

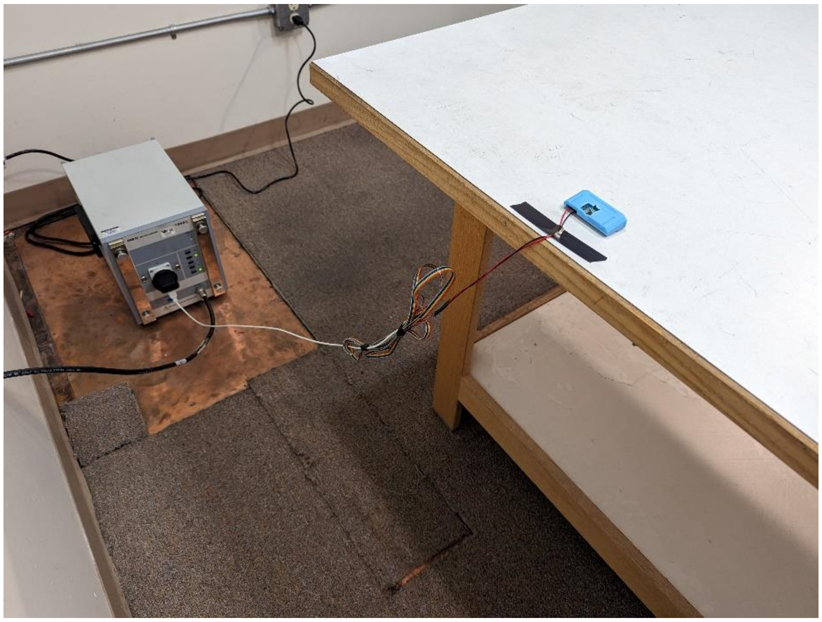


Photograph 6: On Long Edge Placement on the Table

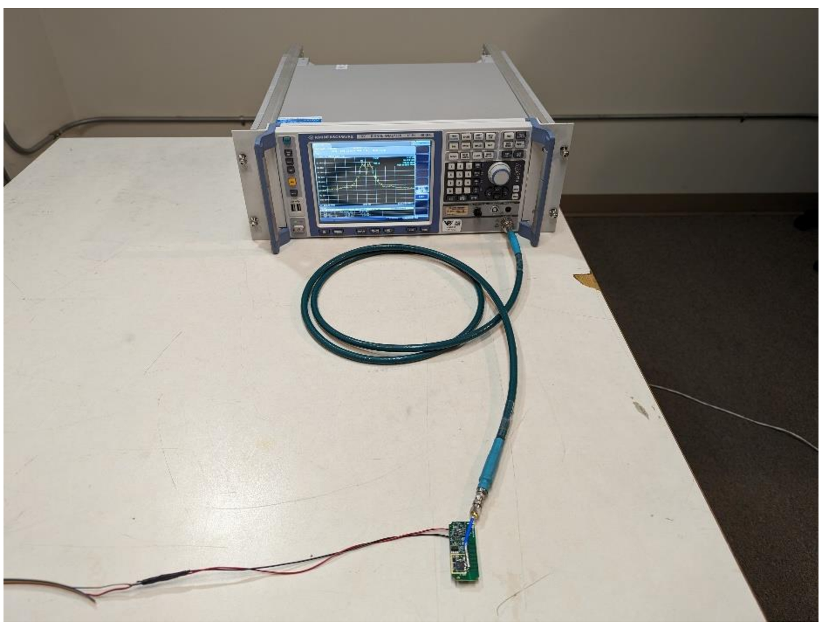


Photograph 7: On Short Edge Placement on the Table

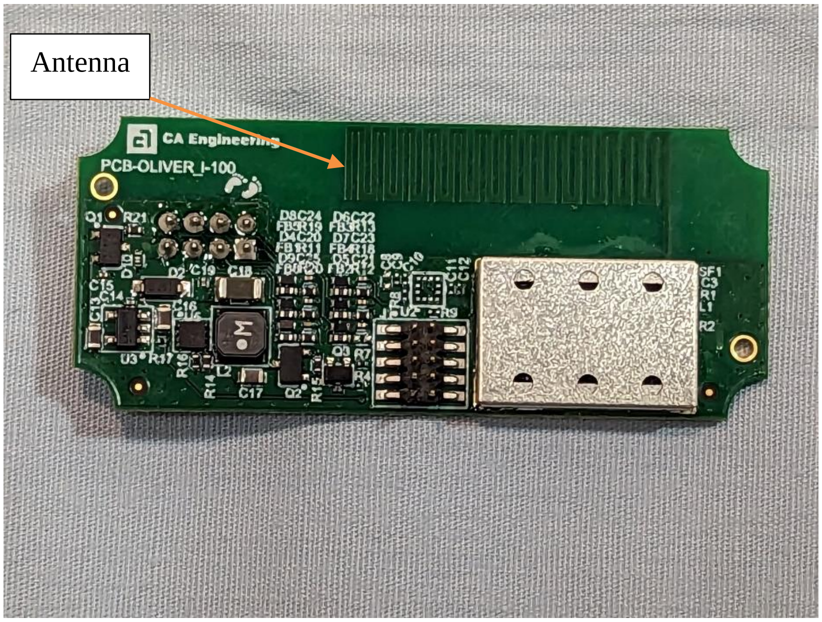
Photograph 8: Front View Conducted Emissions Worst-Case Configuration



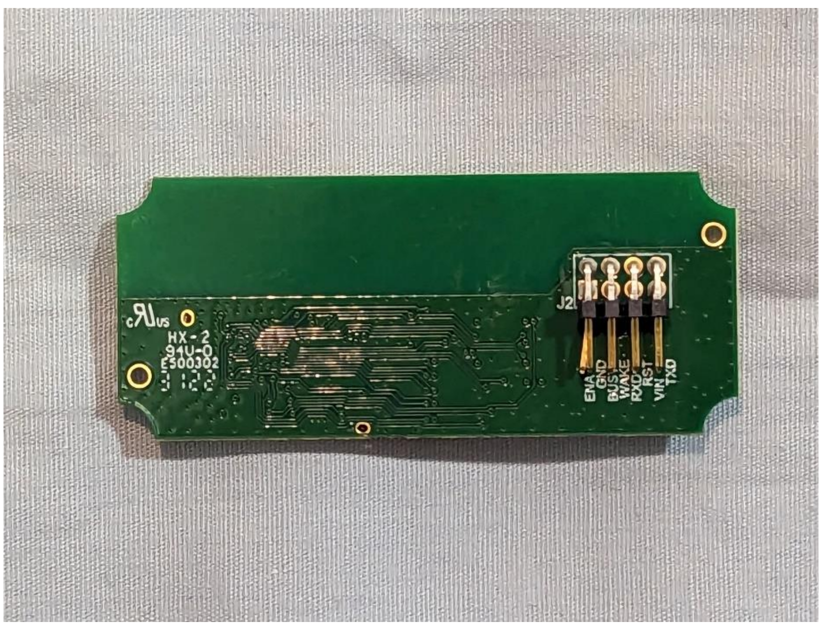
Photograph 9: Back View Conducted Emissions Worst-Case Configuration



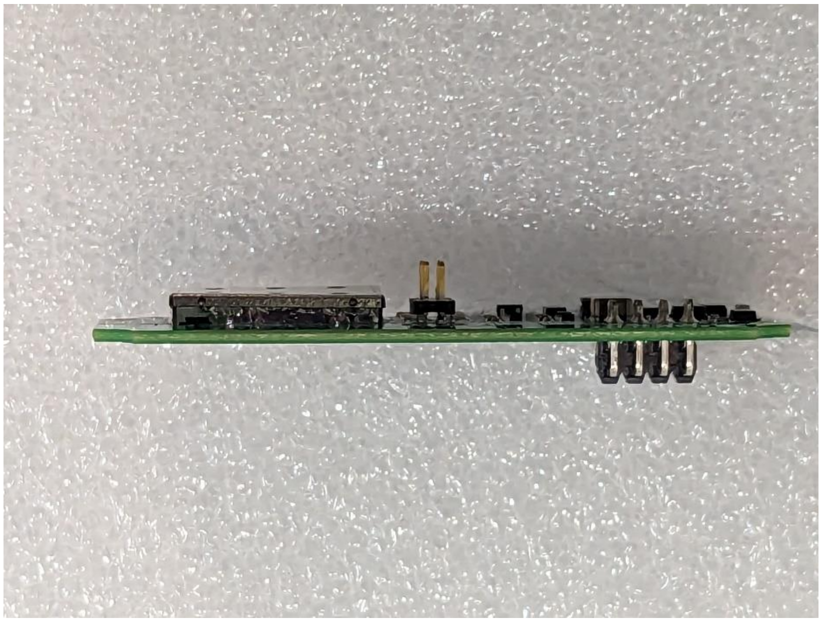
Photograph 10: View of Conducted Measurements Test Setup at the Antenna Port



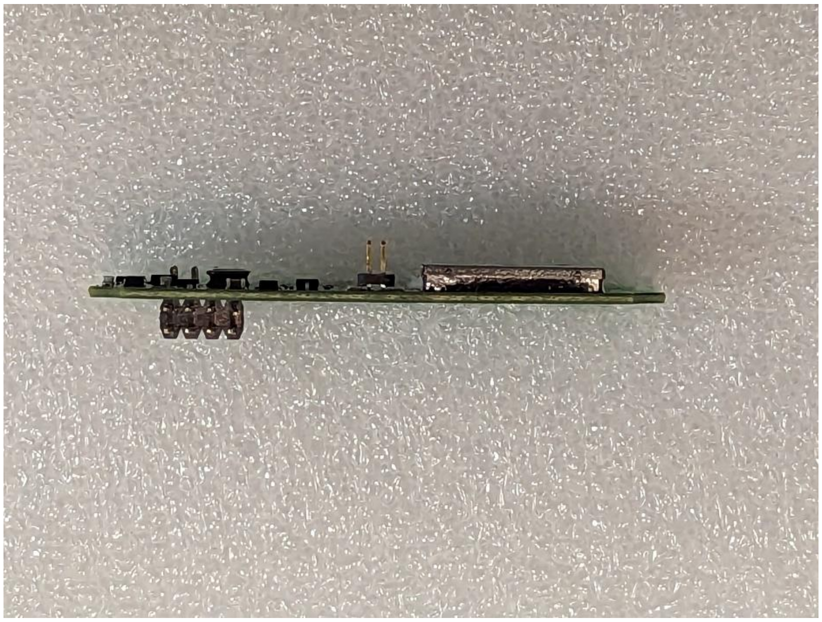
Photograph 11: Top View of the EUT with RF Shield In Place



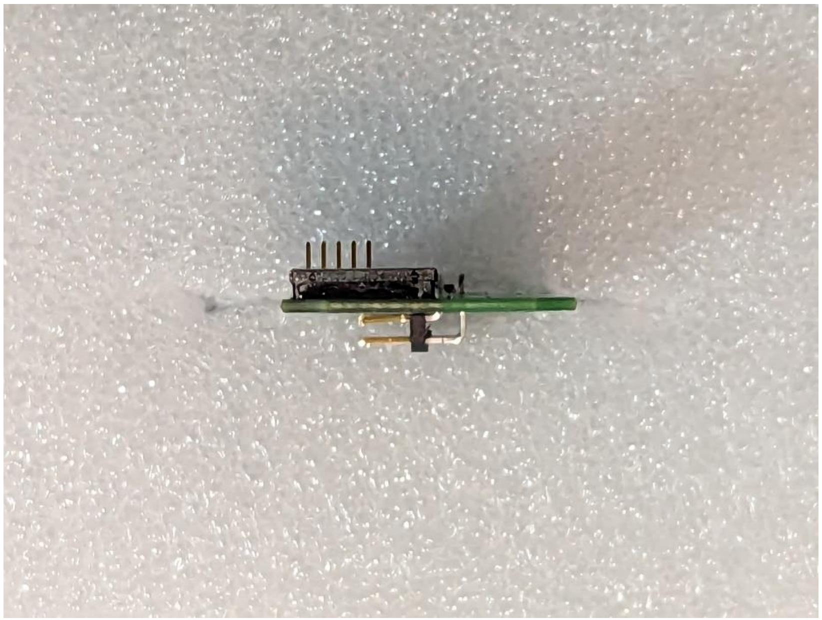
Photograph 12: Bottom View of the EUT



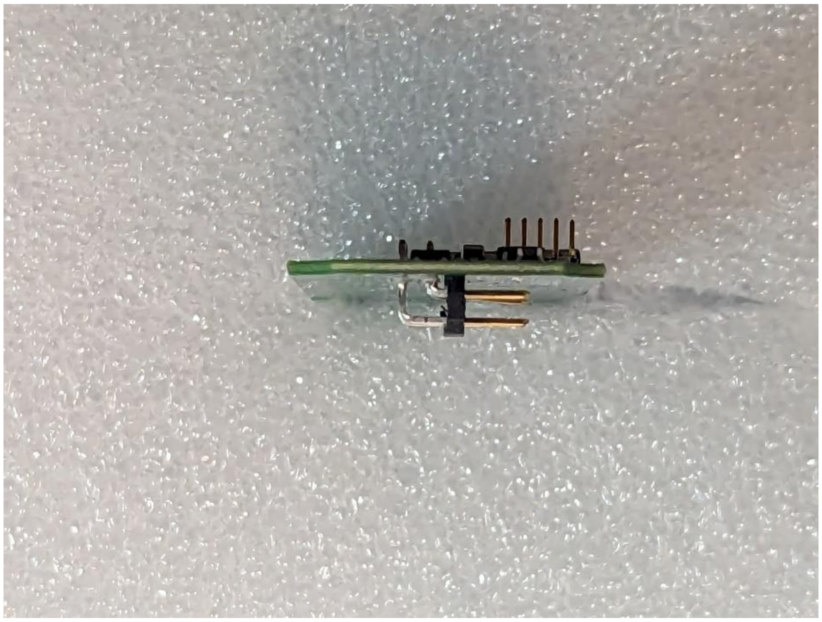
Photograph 13: Long Edge View 1



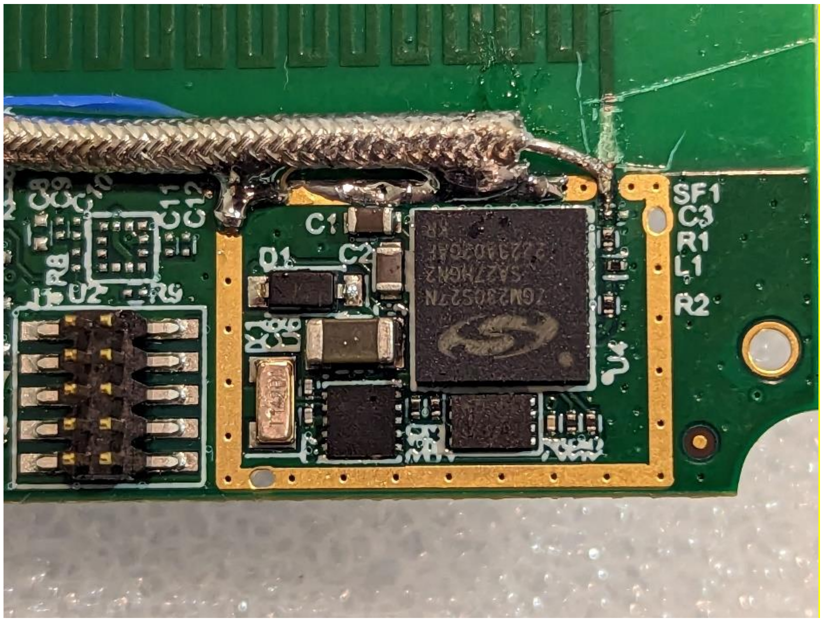
Photograph 14: Long Edge View 2



Photograph 15: Short Edge View 1

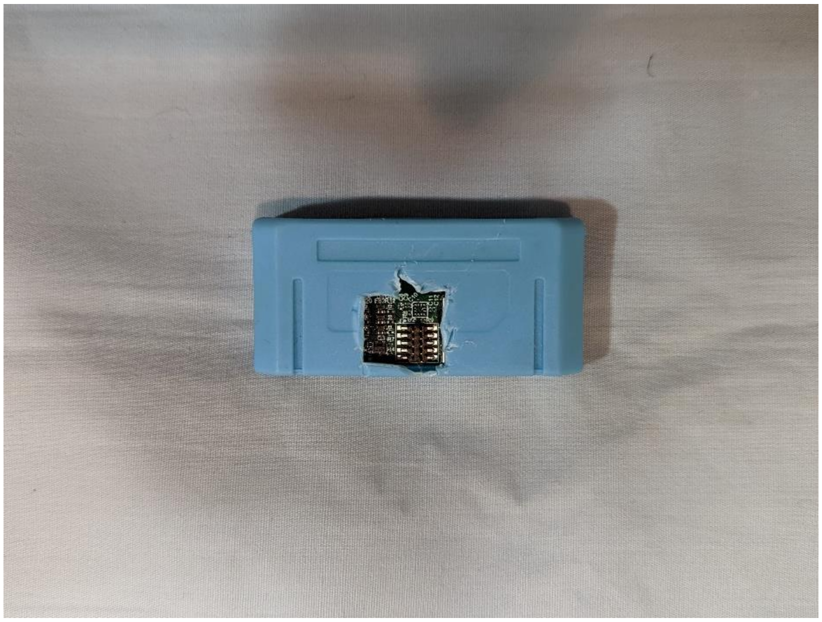


Photograph 16: Short Edge View 2

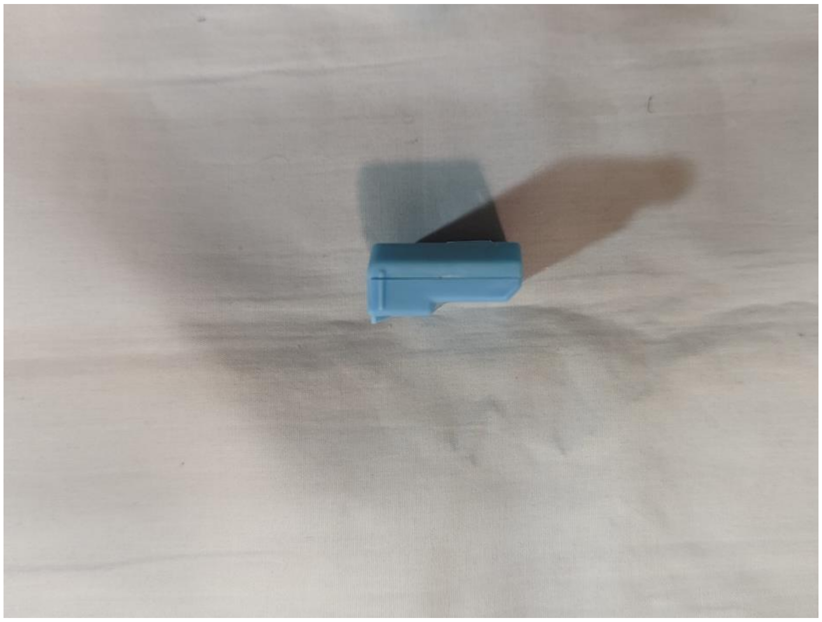


Photograph 17: View of the Circuitry Under the RF Shield

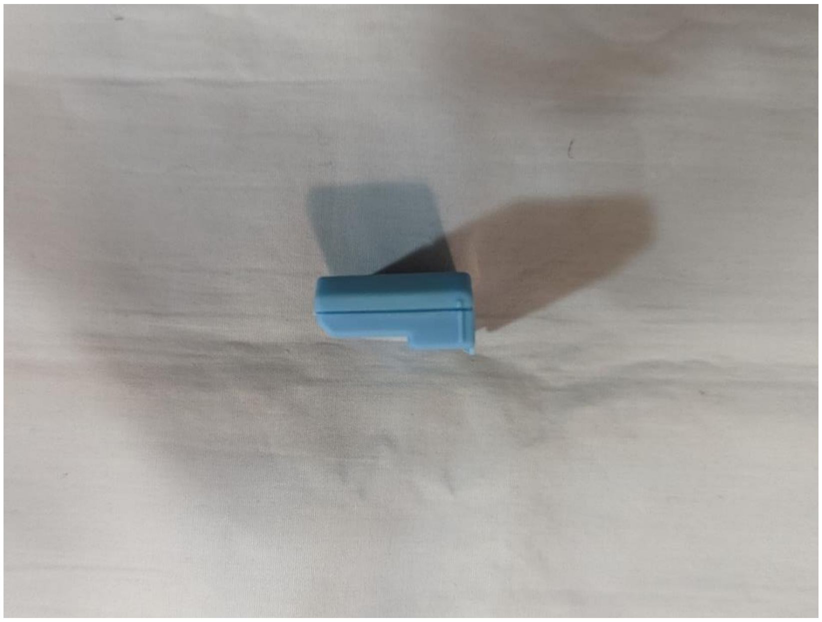
Photograph 18: Front View of the EUT in the Housing



Photograph 19: Back View of the EUT in the Housing

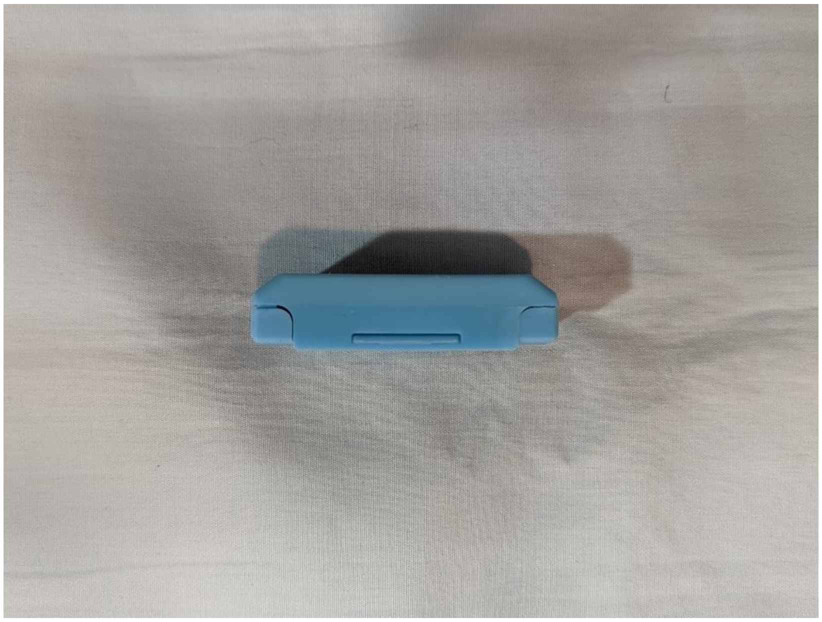


Photograph 20: Side View of the EUT in the Housing

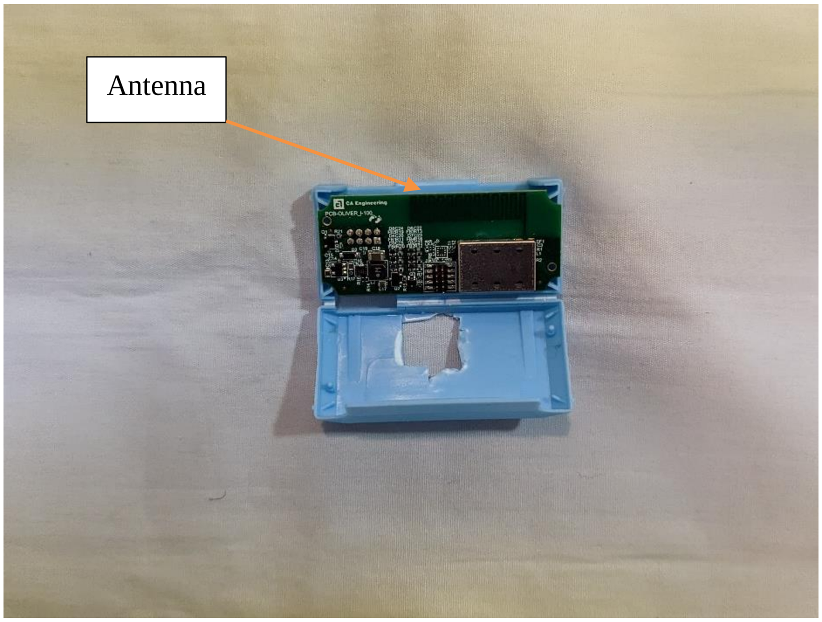


Photograph 21: Side View of the EUT in the Housing

Photograph 22: Side View of the EUT in the Housing

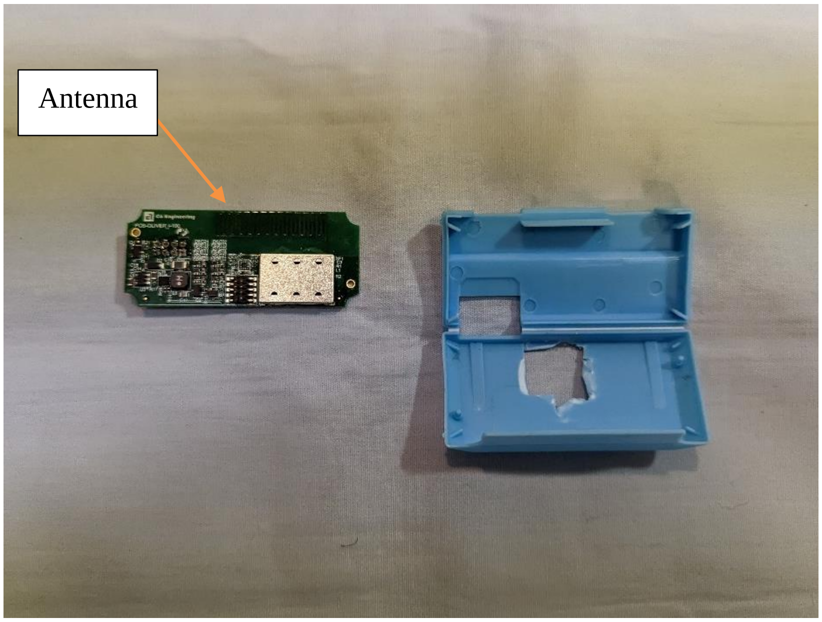


Photograph 23: Side View of the EUT in the Housing



Photograph 24: View 1 of the EUT in the Housing

Photograph 25: View 2 of the EUT in the Housing



Photograph 26: View of the EUT and the Housing

--- End of Report ---