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

Test Report

Certification

FCC ID	U4A-YRHCPZW1FM
Equipment Under Test	AYR-MOD-ZW3-USA
Test Report Serial No	V050705_01
Date of Test	January 14, 2020
Report Issue Date	January 22, 2020

Test Specifications:	**Applicant:**
FCC Part 15, Subpart C	Assa Abloy, Inc. 110 Sargent Drive New Haven, CT 06511 U.S.A.

Testing
NVLAP Lab Code 100272-0

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

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	Assa Abloy, Inc.
Manufacturer	Assa Abloy, Inc.
Brand Name	Yale
Model Number	AYR-MOD-ZW3-USA
FCC ID	U4A-YRHCPZW1FM

On this 22nd day of January 2020, 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: Norman P. Hansen

Reviewed by: Benjamin N. Antczak

Revision History		
Revision	**Description**	**Date**
01	Original Report Release	January 22, 2020

Table of Contents

1 Client Information

1.1 Applicant

Company Name	Assa Abloy, Inc. 110 Sargent Drive New Haven, CT 06511 U.S.A.
Contact Name	Andrea Waterman
Title	Compliance Specialist

1.2 Manufacturer

Company Name	Assa Abloy, Inc. 110 Sargent Drive New Haven, CT 06511 U.S.A.
Contact Name	Andrea Waterman
Title	Compliance Specialist

2 Equipment Under Test (EUT)

2.1 Identification of EUT

Brand Name	Yale
Model Number	AYR-MOD-ZW3-USA
Serial Number	5019000184
Dimensions (cm)	5.5 x 2.5 x 1.5

2.2 Description of EUT

The AYR-MOD-ZW3-USA is a Z-wave module that is typically used in Yale lock assemblies. Power is provided by batteries powering the lock. To meet RSS-Gen requirements should the module ever be placed in a device that connects to the AC mains, a Triad WS2U059-2000 power supply was used to provide power for testing conducted emissions at the AC mains.

The Z-wave transceiver operates at one of 3 frequencies, 916 MHz (100 kbps), 908.4 MHz (40 kbps), or 908.42 MHz (906 kbps). The antenna is a trace on the PCB.

This report covers the circuitry of the devices subject to FCC §15.249. The circuitry of the device subject to FCC Part 15, Subpart B was found to be compliant and is covered in VPI Laboratories, Inc. report V050704.

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-ZW3-USA (Note 1) SN: 5019000184	Z-wave transceiver module	See Section 2.4
BN: Triad MN: WS2U059-2000 SN: None	Power supply	DC out/ USB A to 2 conductors (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.

2.4 Interface Ports on EUT

Name of Ports	No. of Ports Fitted to EUT	Cable Description/Length
Device Interface	1	2 pins of the header that connects directly to the host was extended 1 meter to either the power supply or a battery pack.

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 power was set in firmware to 15. This setting will be incorporated into production firmware and will not be user accessible.

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, 2019. 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. Testing was performed at the VPI Laboratories, Inc. Wanship Upper Open Area Test Site, located at 29145 Old Lincoln Highway, Wanship, UT. This location is listed on NVLAP scope under the lines for C63.4 and C63.10.

4 Operation of EUT During Testing

4.1 Operating Environment

Power Supply	6 VDC from 4 AA batteries

4.2 Operating Modes

The EUT was tested on 3 orthogonal axes while transmitting constantly at the set channel. Duty cycle was >98%.

4.3 EUT Exercise Software

Internal firmware configured by an external computer and interface card was used to exercise the EUT. Once the firmware was configured, the computer and interface card were removed for testing.

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	Complied
15.249(a)	Field Strength of the Harmonics	0.009 - 9160	Complied
15.249(d)	Field Strength of Spurious Emissions	0.009 - 9160	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 trace on the PCB for the antenna. It is not user accessible or replaceable.

Result

The EUT complied with the specification.

6.2.2 §15.207 Conducted Emissions at AC Mains Ports

Frequency (MHz)	AC Mains Lead	Detector	Measured Level (dBμV)	Limit (dBμV)	Margin (dB)
0.16	Hot Lead	Peak (Note 1)	39.9	55.7	-15.8
0.26	Hot Lead	Peak (Note 1)	33.5	51.5	-18.0
0.46	Hot Lead	Peak (Note 1)	30.0	46.7	-16.7
0.74	Hot Lead	Peak (Note 1)	31.6	46.0	-14.4
0.82	Hot Lead	Peak (Note 1)	33.7	46.0	-12.3
4.56	Hot Lead	Peak (Note 1)	30.4	46.0	-15.6
0.17	Neutral Lead	Peak (Note 1)	37.8	55.0	-17.2
0.27	Neutral Lead	Peak (Note 1)	34.2	51.2	-17.0
0.33	Neutral Lead	Peak (Note 1)	31.8	49.6	-17.8
0.44	Neutral Lead	Peak (Note 1)	29.2	47.0	-17.8
0.70	Neutral Lead	Peak (Note 1)	31.3	46.0	-14.7
0.81	Neutral Lead	Peak (Note 1)	31.6	46.0	-14.4
4.56	Neutral Lead	Peak (Note 1)	30.5	46.0	-15.5

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 12.3 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)	Antenna Polarity
908.40	Quasi-Peak	56.0	37.4	93.4	94.0	-0.6	Vertical
908.40	Quasi-Peak	52.8	37.4	90.2	94.0	-3.8	Horizontal
908.42	Quasi-Peak	56.2	37.4	93.6	94.0	-0.4	Vertical
908.42	Quasi-Peak	52.9	37.4	90.3	94.0	-3.7	Horizontal
916.00	Quasi-Peak	55.7	37.9	93.6	94.0	-0.4	Vertical
916.00	Quasi-Peak	52.5	37.9	90.4	94.0	-3.6	Horizontal

Result

The EUT complied with the specification.

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. The table below shows the worst-case emissions from the transmitter. Emissions from the digital circuitry and receivers of the EUT are shown in VPI Laboratories, Inc. report V050704.

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	7.5	30.1	37.6	74.0	-36.4
1816.80	Average	Vertical	0.8	30.1	30.9	54.0	-23.1
1816.80	Peak	Horizontal	7.5	30.1	37.6	74.0	-36.4
1816.80	Average	Horizontal	1.8	30.1	31.9	54.0	-22.1
2725.20	Peak	Vertical	6.5	33.4	39.9	74.0	-34.1
2725.20	Average	Vertical	-0.2	33.4	33.2	54.0	-20.8
2725.20	Peak	Horizontal	7.7	33.4	41.1	74.0	-32.9
2725.20	Average	Horizontal	0.4	33.4	33.8	54.0	-20.2
3633.60	Peak	Vertical	6.4	36.5	42.9	74.0	-31.1
3633.60	Average	Vertical	-4.3	36.5	32.2	54.0	-21.8
3633.60	Peak	Horizontal	7.5	36.5	44.0	74.0	-30.0
3633.60	Average	Horizontal	-0.9	36.5	35.6	54.0	-18.4
4542.00	Peak	Vertical	6.8	38.2	45.0	74.0	-29.0
4542.00	Average	Vertical	-4.4	38.2	33.8	54.0	-20.2

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4542.00	Peak	Horizontal	6.3	38.2	44.5	74.0	-29.5
4542.00	Average	Horizontal	-4.2	38.2	34.0	54.0	-20.0
5450.40	Peak	Vertical	6.2	40.3	46.5	74.0	-27.5
5450.40	Average	Vertical	-3.9	40.3	36.4	54.0	-17.6
5450.40	Peak	Horizontal	6.5	40.3	46.8	74.0	-27.2
5450.40	Average	Horizontal	-0.9	40.3	39.4	54.0	-14.6
6358.80	Peak	Vertical	4.8	40.8	45.6	74.0	-28.4
6358.80	Average	Vertical	-5.6	40.8	35.2	54.0	-18.8
6358.80	Peak	Horizontal	5.4	40.8	46.2	74.0	-27.8
6358.80	Average	Horizontal	-5.4	40.8	35.4	54.0	-18.6
7267.20	Peak	Vertical	5.1	42.9	48.0	74.0	-26.0
7267.20	Average	Vertical	-5.4	42.9	37.5	54.0	-16.5
7267.20	Peak	Horizontal	5.6	42.9	48.5	74.0	-25.5
7267.20	Average	Horizontal	-5.2	42.9	37.7	54.0	-16.3
8175.60	Peak	Vertical	4.8	44.4	49.2	74.0	-24.8
8175.60	Average	Vertical	-5.9	44.4	38.5	54.0	-15.5
8175.60	Peak	Horizontal	4.2	44.4	48.6	74.0	-25.4
8175.60	Average	Horizontal	-5.8	44.4	38.6	54.0	-15.4
9084.00	Peak	Vertical	5.3	45.5	50.8	74.0	-23.2
9084.00	Average	Vertical	-5.7	45.5	39.8	54.0	-14.2
9084.00	Peak	Horizontal	4.7	45.5	50.2	74.0	-23.8
9084.00	Average	Horizontal	-5.9	45.5	39.6	54.0	-14.4

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	7.8	30.1	37.9	74.0	-36.1
1816.84	Average	Vertical	0.7	30.1	30.8	54.0	-23.2
1816.84	Peak	Horizontal	7.6	30.1	37.7	74.0	-36.3
1816.84	Average	Horizontal	1.2	30.1	31.3	54.0	-22.7

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2725.26	Peak	Vertical	6.7	33.4	40.1	74.0	-33.9
2725.26	Average	Vertical	0.1	33.4	33.5	54.0	-20.5
2725.26	Peak	Horizontal	7.5	33.4	40.9	74.0	-33.1
2725.26	Average	Horizontal	0.0	33.4	33.4	54.0	-20.6
3633.68	Peak	Vertical	6.1	36.5	42.6	74.0	-31.4
3633.68	Average	Vertical	-4.2	36.5	32.3	54.0	-21.7
3633.68	Peak	Horizontal	7.8	36.5	44.3	74.0	-29.7
3633.68	Average	Horizontal	0.1	36.5	36.6	54.0	-17.4
4542.10	Peak	Vertical	6.2	38.2	44.4	74.0	-29.6
4542.10	Average	Vertical	-4.3	38.2	33.9	54.0	-20.1
4542.10	Peak	Horizontal	6.5	38.2	44.7	74.0	-29.3
4542.10	Average	Horizontal	-4.2	38.2	34.0	54.0	-20.0
5450.52	Peak	Vertical	6.6	40.3	46.9	74.0	-27.1
5450.52	Average	Vertical	-2.6	40.3	37.7	54.0	-16.3
5450.52	Peak	Horizontal	7.4	40.3	47.7	74.0	-26.3
5450.52	Average	Horizontal	-0.3	40.3	40.0	54.0	-14.0
6358.94	Peak	Vertical	5.3	40.8	46.1	74.0	-27.9
6358.94	Average	Vertical	-5.1	40.8	35.7	54.0	-18.3
6358.94	Peak	Horizontal	5.4	40.8	46.2	74.0	-27.8
6358.94	Average	Horizontal	-5.3	40.8	35.5	54.0	-18.5
7267.36	Peak	Vertical	5.4	42.9	48.3	74.0	-25.7
7267.36	Average	Vertical	-5.1	42.9	37.8	54.0	-16.2
7267.36	Peak	Horizontal	5.1	42.9	48.0	74.0	-26.0
7267.36	Average	Horizontal	-5.1	42.9	37.8	54.0	-16.2
8175.78	Peak	Vertical	4.3	44.4	48.7	74.0	-25.3
8175.78	Average	Vertical	-5.9	44.4	38.5	54.0	-15.5
8175.78	Peak	Horizontal	5.0	44.4	49.4	74.0	-24.6
8175.78	Average	Horizontal	-5.5	44.4	38.9	54.0	-15.1
9084.20	Peak	Vertical	5.1	45.5	50.6	74.0	-23.4
9084.20	Average	Vertical	-5.7	45.5	39.8	54.0	-14.2

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
9084.20	Peak	Horizontal	4.2	45.5	49.7	74.0	-24.3
9084.20	Average	Horizontal	-6.1	45.5	39.4	54.0	-14.6

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	7.6	30.2	37.8	74.0	-36.2
1832.00	Average	Vertical	0.4	30.2	30.6	54.0	-23.4
1832.00	Peak	Horizontal	7.4	30.2	37.6	74.0	-36.4
1832.00	Average	Horizontal	0.4	30.2	30.6	54.0	-23.4
2748.00	Peak	Vertical	6.8	33.5	40.3	74.0	-33.7
2748.00	Average	Vertical	-0.1	33.5	33.4	54.0	-20.6
2748.00	Peak	Horizontal	6.8	33.5	40.3	74.0	-33.7
2748.00	Average	Horizontal	-0.4	33.5	33.1	54.0	-20.9
3664.00	Peak	Vertical	6.4	36.5	42.9	74.0	-31.1
3664.00	Average	Vertical	-4.1	36.5	32.4	54.0	-21.6
3664.00	Peak	Horizontal	7.1	36.5	43.6	74.0	-30.4
3664.00	Average	Horizontal	-0.5	36.5	36.0	54.0	-18.0
4580.00	Peak	Vertical	6.1	38.3	44.4	74.0	-29.6
4580.00	Average	Vertical	-4.5	38.3	33.8	54.0	-20.2
4580.00	Peak	Horizontal	6.2	38.3	44.5	74.0	-29.5
4580.00	Average	Horizontal	-4.7	38.3	33.6	54.0	-20.4
5496.00	Peak	Vertical	6.2	40.4	46.6	74.0	-27.4
5496.00	Average	Vertical	-4.1	40.4	36.3	54.0	-17.7
5496.00	Peak	Horizontal	7.0	40.4	47.4	74.0	-26.6
5496.00	Average	Horizontal	0.0	40.4	40.4	54.0	-13.6
6412.00	Peak	Vertical	5.9	40.9	46.8	74.0	-27.2
6412.00	Average	Vertical	-4.8	40.9	36.1	54.0	-17.9
6412.00	Peak	Horizontal	6.0	40.9	46.9	74.0	-27.1
6412.00	Average	Horizontal	-5.1	40.9	35.8	54.0	-18.2

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
7328.00	Peak	Vertical	5.1	43.0	48.1	74.0	-25.9
7328.00	Average	Vertical	-5.4	43.0	37.6	54.0	-16.4
7328.00	Peak	Horizontal	5.2	43.0	48.2	74.0	-25.8
7328.00	Average	Horizontal	-5.4	43.0	37.6	54.0	-16.4
8244.00	Peak	Vertical	4.8	44.5	49.3	74.0	-24.7
8244.00	Average	Vertical	-6.0	44.5	38.5	54.0	-15.5
8244.00	Peak	Horizontal	4.7	44.5	49.2	74.0	-24.8
8244.00	Average	Horizontal	-5.9	44.5	38.6	54.0	-15.4
9160.00	Peak	Vertical	5.1	45.6	50.7	74.0	-23.3
9160.00	Average	Vertical	-5.9	45.6	39.7	54.0	-14.3
9160.00	Peak	Horizontal	2.7	45.6	48.3	74.0	-25.7
9160.00	Average	Horizontal	-5.8	45.6	39.8	54.0	-14.2

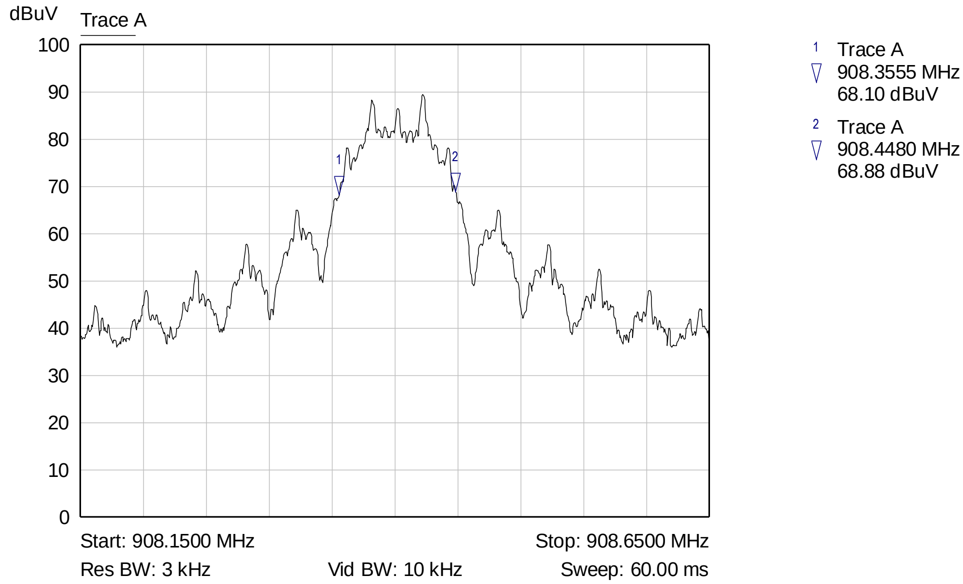
Result

The EUT complied with the specification.

6.2.5 Channel Bandwidth

The 99% occupied bandwidth of the channels are shown in the plots below. These plots show the fundamental emission is contained totally within the 902 – 928 MHz frequency band.

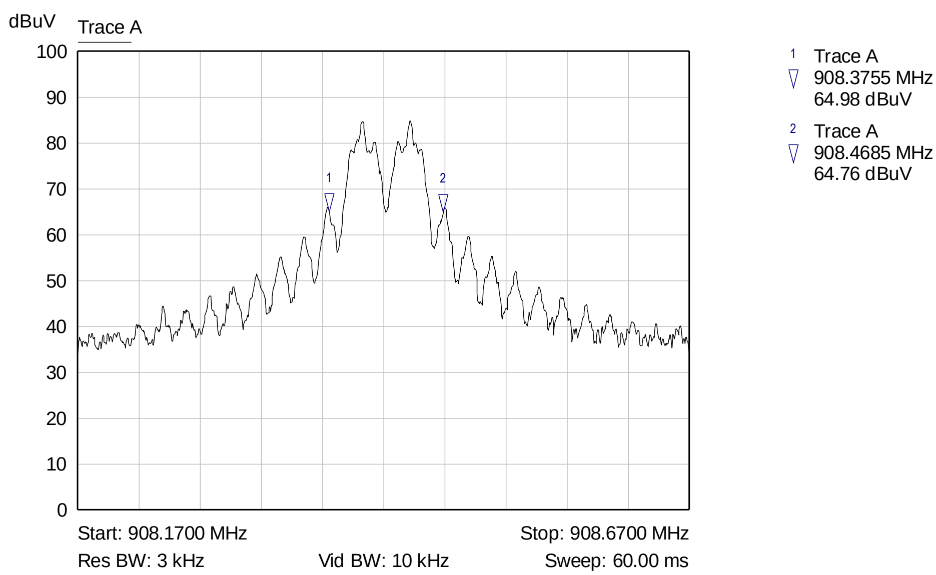
Frequency (MHz)	99% Bandwidth (kHz)
908.40	92.5
908.42	93.0
916.00	113.5



Trace A

Measurement Parameter	Value
Occupied Power Bandwidth	92.50 kHz

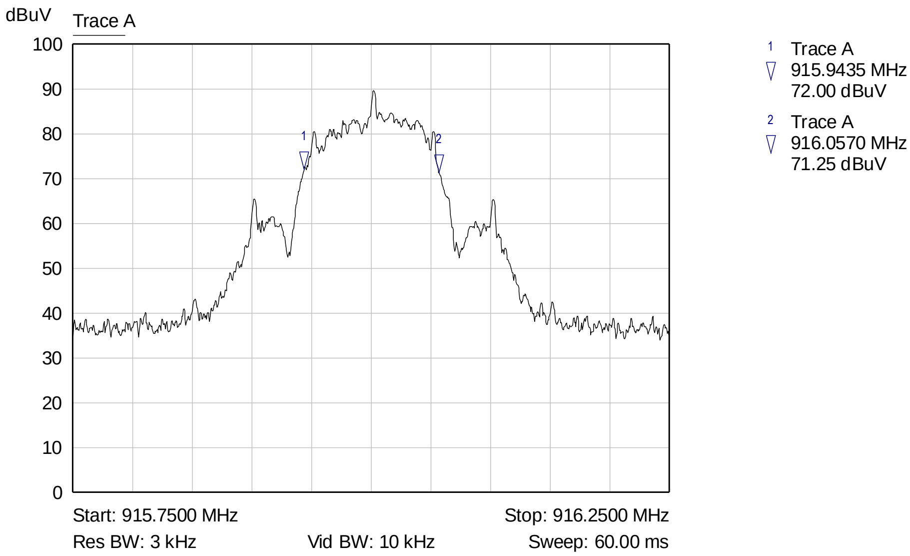
Graph 1: Channel Bandwidth



Trace A

Measurement Parameter	Value
Occupied Power Bandwidth	93.00 kHz

Graph 2: Channel Bandwidth



Trace A

Measurement Parameter	Value
Occupied Power Bandwidth	113.50 kHz

Graph 3: Channel Bandwidth

Result

The EUT complies as the fundamental emission remains fully with in the 902 – 928 MHz frequency band.

6.3 Sample Field Strength Calculation

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.

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

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

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

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	Hewlett Packard	8566B	V048078	05/26/2019	05/26/2020
Quasi-Peak Detector	Hewlett Packard	85650A	V039474	05/02/2018	05/02/2020
LISN	Teseq	NNB 51	V045406	07/13/2018	07/13/2020
Conductance Cable Wanship Upper Site	VPI Labs	Cable J	V034832	01/09/2020	01/09/2021
Filter	VPI Labs	47038	V047038	01/09/2020	01/09/2021
Test Software (AC)	VPI Labs	Revision 01	V035674	N/A	N/A

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

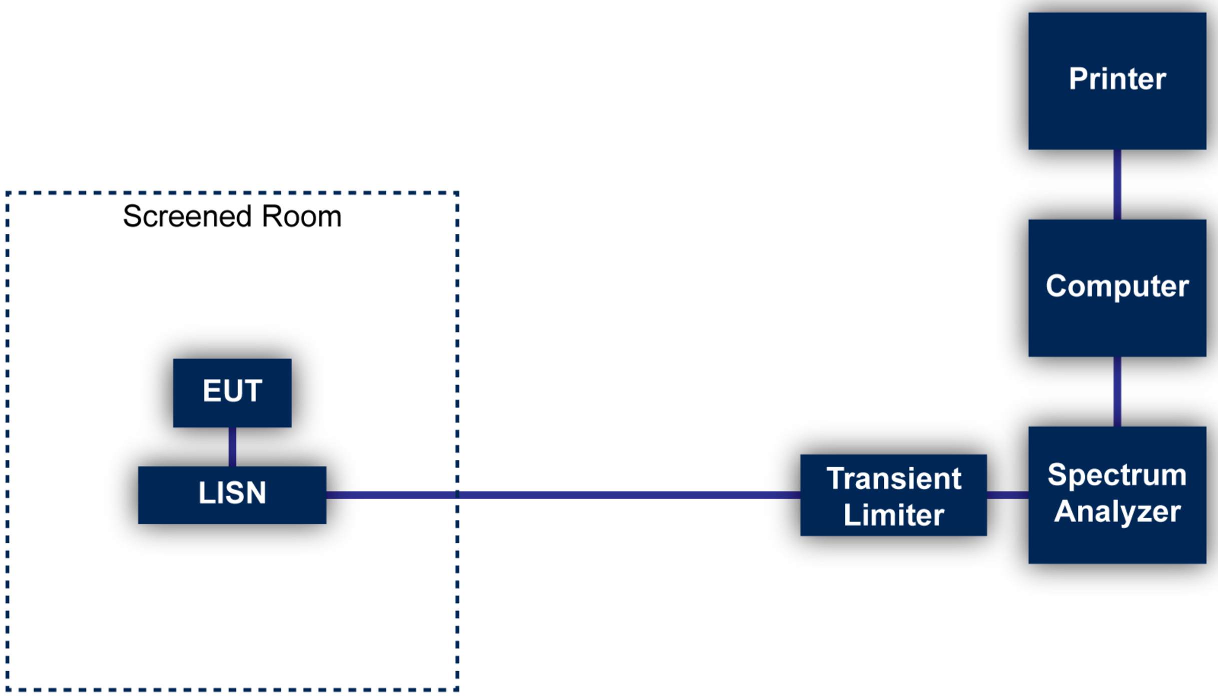


Figure 1: Conducted Emissions Test

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	08/01/2019	08/01/2020
Spectrum Analyzer	Hewlett Packard	8566B	V048078	05/26/2019	05/26/2020
Quasi-Peak Detector	Hewlett Packard	85650A	V039474	05/02/2018	05/02/2020
Loop Antenna	EMCO	6502	V034216	02/11/2019	02/11/2021
Biconilog Antenna	EMCO	3142E-PA	V035736	07/05/2018	07/05/2020
Double Ridged Guide Antenna	EMCO	3115	V033469	04/13/2018	04/13/2020
900 MHz High Pass Filter	Microtronics	HPM50108-03	V034185	01/09/2020	01/09/2021
High Frequency Amplifier	Miteq	AFS4-001018000-35-10P-4	V033997	01/09/2020	01/09/2021
6’ High Frequency Cable	Microcoax	UFB197C-0-0720-000000	V033638	01/09/2020	01/09/2021
20’ High Frequency Cable	Microcoax	UFB197C-1-3120-000000	V033979	01/09/2020	01/09/2021
3 Meter Radiated Emissions Cable Wanship Upper Site	Microcoax	UFB205A-0-4700-000000	V033639	01/09/2020	01/09/2021
Test Software (FCC)	VPI Labs	Revision 01	V035673	N/A	N/A

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

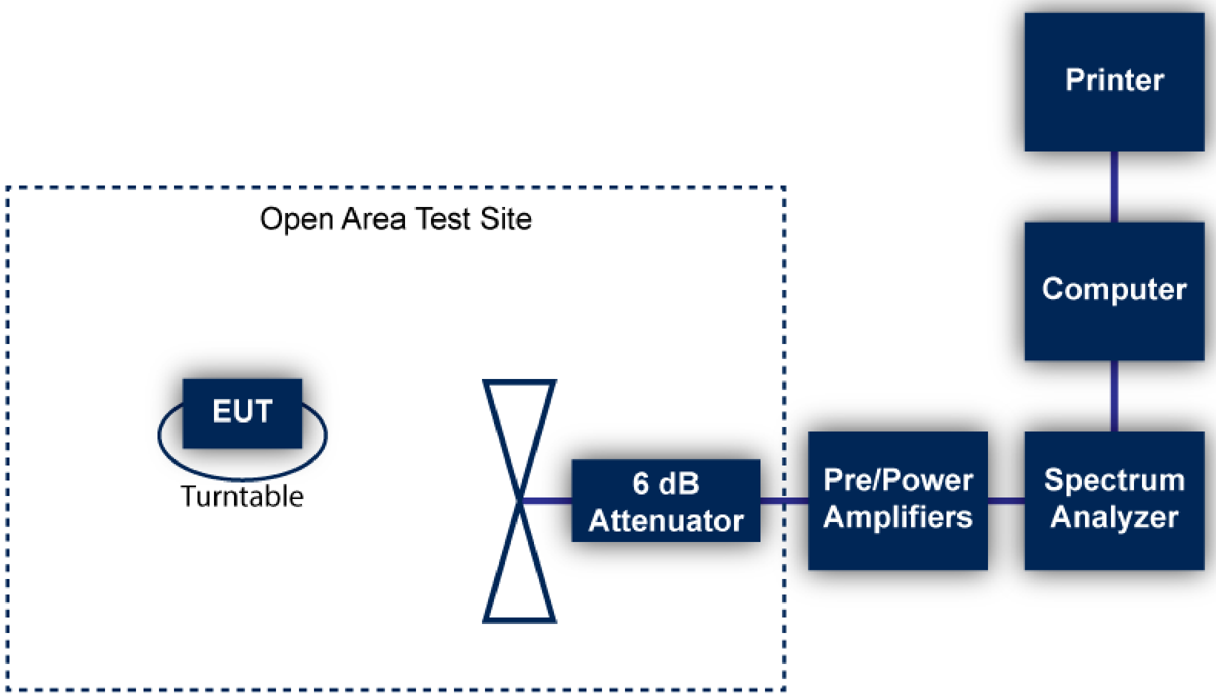


Figure 2: Radiated Emissions Test

7.3 Equipment Calibration

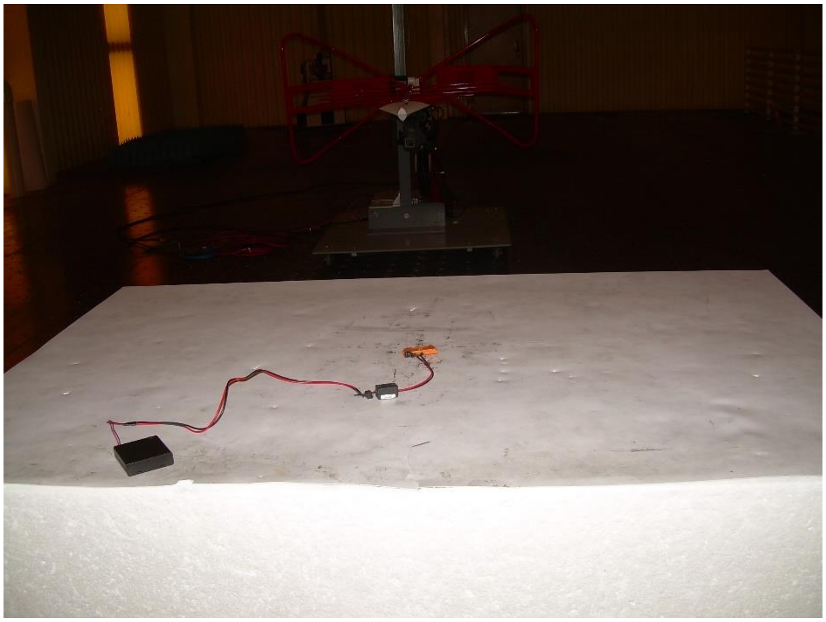
All applicable equipment is calibrated using either an independent calibration laboratory or VPI Laboratories, Inc. personnel at intervals defined in ANSI C63.4:2014 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology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

7.4 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

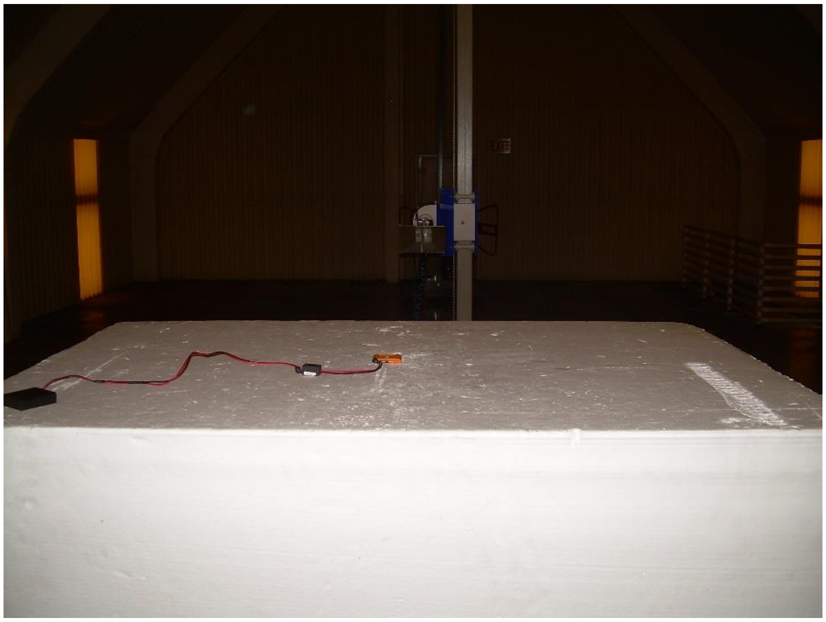
8 Photographs

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



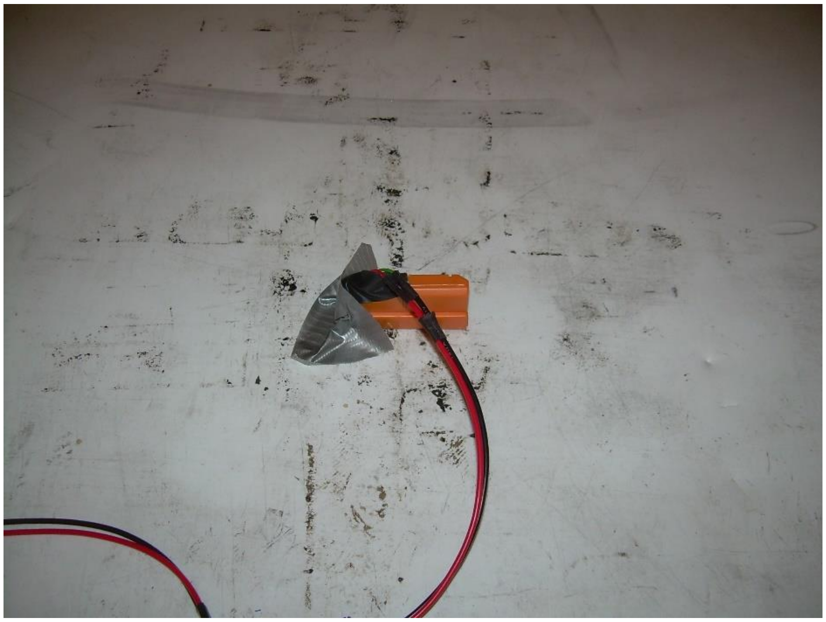
Photograph 2: Back View Radiated Emissions Worst-Case Configuration – 30 – 1000 MHz

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

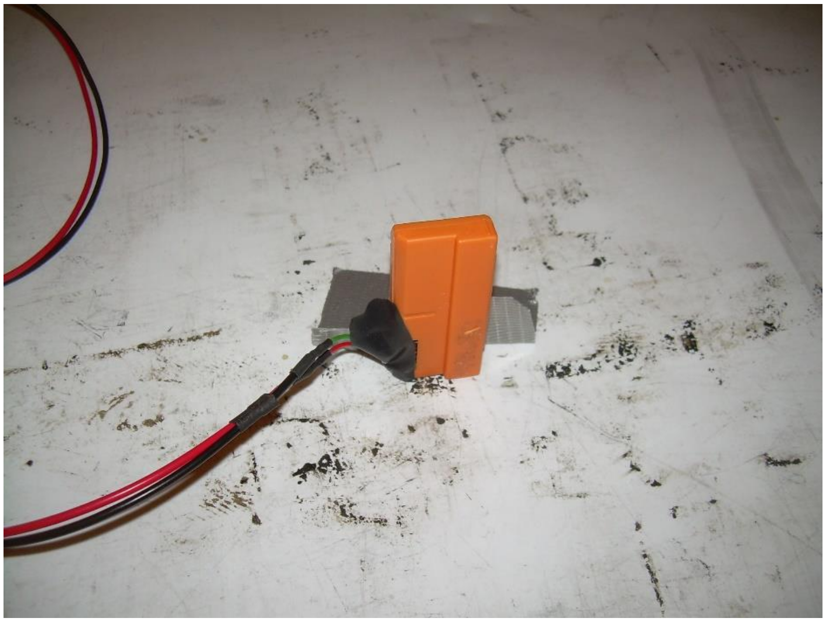


Photograph 4: Back View Radiated Emissions Worst-Case Configuration – Above 1000 MHz

Photograph 5: Flat Placement – Worst-Case



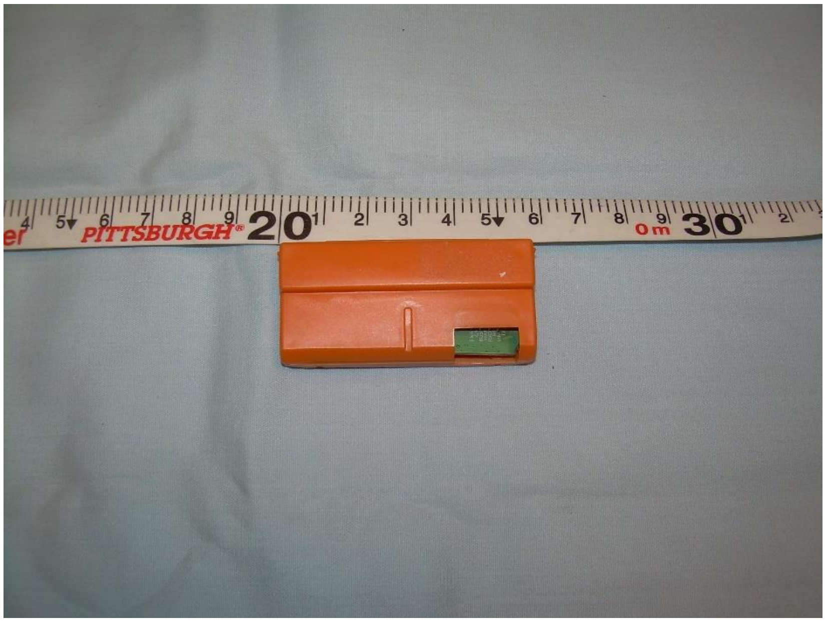
Photograph 6: On Edge Placement



Photograph 7: Vertical Placement

Photograph 8: Front View Conducted Emissions Worst-Case Configuration

Photograph 9: Back View Conducted Emissions Worst-Case Configuration



Photograph 10: Top View of the EUT

Photograph 11: Bottom View of the EUT

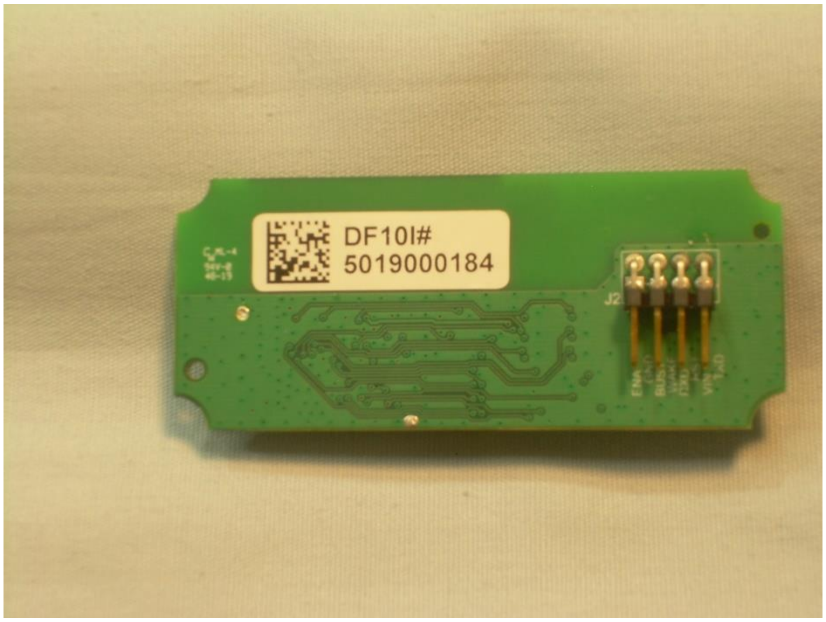
Photograph 12: Left Side View of the EUT

Photograph 13: Right Side View of the EUT

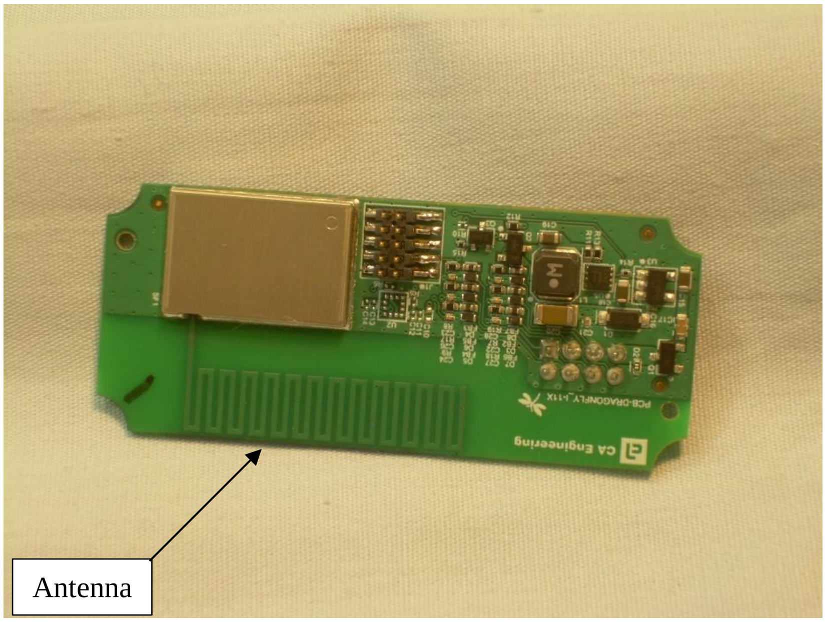
Photograph 14: Back View of the EUT

Photograph 15: Front View of the EUT

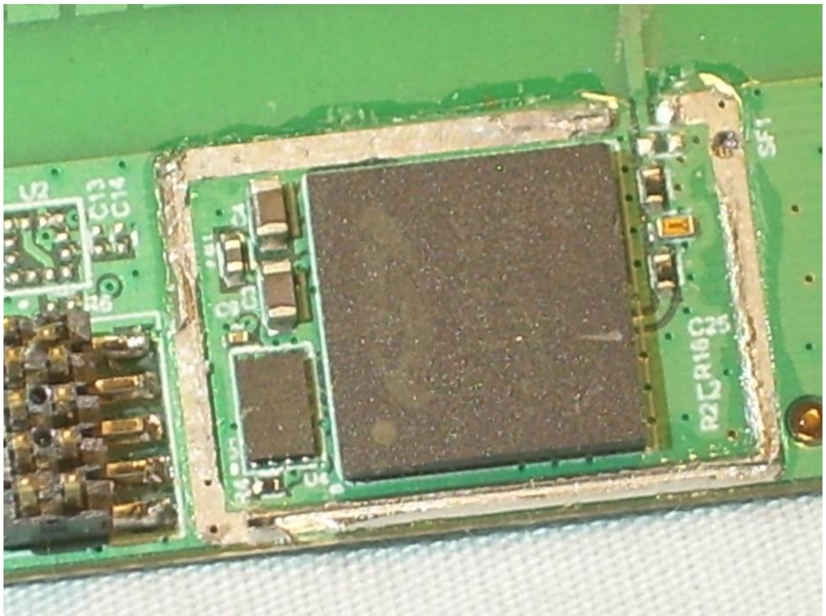
Photograph 16: EUT in Housing



Photograph 17: Trace Side of the PCB



Photograph 18: Component Side of the PCB



Photograph 19: Circuity Under the RF Shield – Shield Removed

--- End of Report ---