FCC PART 15, SUBPART C
ISEDC RSS-247, ISSUE 2, FEBRUARY 2017

TEST AND MEASUREMENT REPORT

For

Pratt & Whitney Engine Services, Inc.

249 Vanderbilt Avenue, Norwood, MA 02062, USA

Model: FAST-A-010-3_E

Report Type:	**Product Type:**
Original Report	FAST (Flight-data Acquisition, Storage & Transmission)

Prepared By:	Rudy Sun Test Engineer
Report Number:	R1705231-247
Report Date:	2017-06-20
Reviewed By:	Jin Yang RF Engineer

Bay Area Compliance Laboratories Corp.
1274 Anvilwood Avenue,
Sunnyvale, CA 94089, USA
Tel: (408) 732-9162
Fax: (408) 732-9164

TABLE OF CONTENTS

DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1705231-247 DTS	Original Report	-

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test and measurement report was prepared on behalf of *Pratt & Whitney Engine Services, Inc.* and their product model: FAST-A-010-3_E, The device used TiWi's Module TiWi- R1, FCC ID: TFB-TIWI1-01; IC: 5969A-TIWI10, which support Wi-Fi radio (2400-2483.5MHz). The EUT is a FAST (Flight-data Acquisition, Storage & Transmission) and contains a cellular radio (GSM 850/1900 and UMTS 850/1900) and a Wi-Fi radio (2400-2483.5MHz).

1.2 Mechanical Description of EUT

The EUT measures approximately 152.4 mm (L) x 68.6 mm (W) x 94.0 mm (H).

The test data gathered are from typical production sample, serial number: R1705231assigned by Pratt & Whitney Engine Services, Inc.

1.3 Objective

This report is prepared on behalf of *Pratt & Whitney Engine Services, Inc.,* in accordance with Part 2, Subpart J, and Part 15, Subparts A and C of the Federal Communication Commission's rules and ISEDC RSS-247 Issue 2, FEBRUARY 2017.

The objective is to determine compliance with FCC Part 15.247 and ISEDC RSS-247 rules for Output Power, Antenna Requirements, 6 dB Bandwidth, Power Spectral Density, 100 kHz Bandwidth of Band Edges Measurement, Conducted and Radiated Spurious Emissions.

1.4 Related Submittal(s)/Grant(s)

R1705231-22, RS132/24,RS133

1.5 Test Methodology

All measurements contained in this report were conducted in accordance with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and FCC KDB 558074 D01 DTS Meas Guidance v04: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.

1.6 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in the field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Parameter	Measurement uncertainty
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±0.57 dB
Power Spectral Density, conducted	±1.48dB
Unwanted Emissions, conducted	±1.57dB
All emissions, radiated	±4.0 dB
AC power line Conducted Emission	±2.0 dB
Temperature	±2 ^{o} C
Humidity	±5 %
DC and low frequency voltages	±1.0 %
Time	±2 %
Duty Cycle	±3 %

1.7 Test Facility Registrations

BACLs test facilities that are used to perform Radiated and Conducted Emissions tests are currently recognized by the Federal Communications Commission as Accredited with NIST Designation Number US1129.

BACL's test facilities that are used to perform Radiated and Conducted Emissions tests are currently registered with Industry Canada under Registration Numbers: 3062A-1, 3062A-2, and 3062A-3.

BACL is a Chinese Taipei Bureau of Standards Metrology and Inspection (BSMI) validated Conformity Assessment Body (CAB), under Appendix B, Phase I Procedures of the APEC Mutual Recognition Arrangement (MRA). BACL's BSMI Lab Code Number is: SL2-IN-E-1002R

BACL's test facilities that are used to perform AC Line Conducted Emissions, Telecommunications Line Conducted Emissions, Radiated Emissions from 30 MHz to 1 GHz, and Radiated Emissions from 1 GHz to 6 GHz are currently recognized as Accredited in accordance with the Voluntary Control Council for Interference [VCCI] Article 15 procedures under Registration Number A-0027.

1.8 Test Facility Accreditations

Bay Area Compliance Laboratories Corp. (BACL) is:

A- ***An independent, 3rd-Party, Commercial Test Laboratory accredited to ISO/IEC 17025:2005 by A2LA (Test Laboratory Accreditation Certificate Number 3297.02),*** in the fields of: Electromagnetic Compatibility and Telecommunications. Unless noted by an Asterisk (*) in the Compliance Matrix (See Section 3 of this Test Report), BACL's ISO/IEC 17025:2005 Scope of Accreditation includes all of the Test Method Standards and/or the Product Family Standards detailed in this Test Report..

BACL's ISO/IEC 17025:2005 Scope of Accreditation includes a comprehensive suite of EMC Emissions, EMC Immunity, Radio, RF Exposure, Safety and wireline Telecommunications test methods applicable to a wide range of product categories. These product categories include Central Office Telecommunications Equipment [including NEBS - Network Equipment Building Systems], Unlicensed and Licensed Wireless and RF devices, Information Technology Equipment (ITE); Telecommunications Terminal Equipment (TTE); Medical Electrical Equipment; Industrial, Scientific and Medical Test Equipment; Professional Audio and Video Equipment; Industrial and Scientific Instruments and Laboratory Apparatus; Cable Distribution Systems, and Energy Efficient Lighting.

B- ***A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3297.03)*** to certify

- For the USA (Federal Communications Commission):
  - 1- All Unlicensed radio frequency devices within FCC Scopes A1, A2, A3, and A4;
  - 2- All Licensed radio frequency devices within FCC Scopes B1, B2, B3, and B4;
  - 3- All Telephone Terminal Equipment within FCC Scope C.
- For the Canada (Industry Canada):
  - 1 All Scope 1-Licence-Exempt Radio Frequency Devices;
  - 2 All Scope 2-Licensed Personal Mobile Radio Services;
  - 3 All Scope 3-Licensed General Mobile & Fixed Radio Services;
  - 4 All Scope 4-Licensed Maritime & Aviation Radio Services;
  - 5 All Scope 5-Licensed Fixed Microwave Radio Services
  - 6 All Broadcasting Technical Standards (BETS) in the Category I Equipment Standards List.
- For Singapore (Info-Communications Development Authority (IDA)):
  - 1 All Line Terminal Equipment: All Technical Specifications for Line Terminal Equipment – Table 1 of IDA MRA Recognition Scheme: 2011, Annex 2
  - 2. All Radio-Communication Equipment: All Technical Specifications for Radio-Communication Equipment – Table 2 of IDA MRA Recognition Scheme: 2011, Annex 2
- For the Hong Kong Special Administrative Region:
  - 1 All Radio Equipment, per KHCA 10XX-series Specifications;
  - 2 All GMDSS Marine Radio Equipment, per HKCA 12XX-series Specifications;
  - 3 All Fixed Network Equipment, per HKCA 20XX-series Specifications.
- For Japan:
  - 1 MIC Telecommunication Business Law (Terminal Equipment):
    - All Scope A1 - Terminal Equipment for the Purpose of Calls;
    - All Scope A2 - Other Terminal Equipment
  - 2 Radio Law (Radio Equipment):
    - All Scope B1 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 1 of the Radio Law
    - All Scope B2 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 2 of the Radio Law
    - All Scope B3 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 3 of the Radio Law

C- ***A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3297.01)*** to certify Products to USA's Environmental Protection Agency (EPA) ENERGY STAR Product Specifications for:

1 Electronics and Office Equipment:
- for Telephony (ver. 3.0)
- for Audio/Video (ver. 3.0)
- for Battery Charging Systems (ver. 1.1)
- for Set-top Boxes & Cable Boxes (ver. 4.1)
- for Televisions (ver. 6.1)
- for Computers (ver. 6.0)
- for Displays (ver. 6.0)
- for Imaging Equipment (ver. 2.0)
- for Computer Servers (ver. 2.0)

2 Commercial Food Service Equipment
- for Commercial Dishwashers (ver. 2.0)
- for Commercial Ice Machines (ver. 2.0)
- for Commercial Ovens (ver. 2.1)
- for Commercial Refrigerators and Freezers

3 Lighting Products
- For Decorative Light Strings (ver. 1.5)
- For Luminaires (including sub-components) and Lamps (ver. 1.2)
- For Compact Fluorescent Lamps (CFLs) (ver. 4.3)
- For Integral LED Lamps (ver. 1.4)

4 Heating, Ventilation, and AC Products
- for Residential Ceiling Fans (ver. 3.0)
- for Residential Ventilating Fans (ver. 3.2)

5 Other
- For Water Coolers (ver. 3.0)

D. A NIST Designated Phase-I and Phase-II Conformity Assessment Body (CAB) for the following economies and regulatory authorities under the terms of the stated MRAs/Treaties:

- Australia: ACMA (Australian Communication and Media Authority) – APEC Tel MRA -Phase I;
- Canada: (Industry Canada - IC) Foreign Certification Body – FCB – APEC Tel MRA -Phase I & Phase II;
- Chinese Taipei (Republic of China – Taiwan):
  - BSMI (Bureau of Standards, Metrology and Inspection) APEC Tel MRA -Phase I;
  - NCC (National Communications Commission) APEC Tel MRA -Phase I;
- European Union:
  - Radio & Teleterminal Equipment (R&TTE) Directive 1995/5/EC
    US -EU EMC & Telecom MRA CAB
- Hong Kong Special Administrative Region: (Office of the Telecommunications Authority – OFTA)
  APEC Tel MRA -Phase I & Phase II
- Israel – US-Israel MRA Phase I
- Republic of Korea (Ministry of Communications - Radio Research Laboratory) APEC Tel MRA -Phase I
- Singapore: (Infocomm Development Authority - IDA) APEC Tel MRA -Phase I & Phase II;
- Japan: VCCI - Voluntary Control Council for Interference US-Japan Telecom Treaty VCCI Side Letter-
- USA:
  - ENERGY STAR Recognized Test Laboratory – US EPA
  - Telecommunications Certification Body (TCB) – US FCC;
- Vietnam: APEC Tel MRA -Phase I;

2 System Test Configuration

2.1 Justification

The EUT was configured for testing according to ANSI C63.10-2013 and FCC KDB 558074 D01 DTS Meas Guidance v04.

The EUT was tested in a testing mode to represent worst-case results during the final qualification test.

The worst-case data rates are determined to be as follows for each mode based upon investigation by measuring the average power, peak power and PSD across all data rates bandwidths, and modulations.

2.2 EUT Exercise Software

N/A

2.3 Channel Plan

Channel #s	Frequency (MHz)	Channel #s	Frequency (MHz)	Channel #s	Frequency (MHz)	Channel #s	Frequency (MHz)
1	2412	4	2427	7	2442	10	2457
2	2417	5	2432	8	2447	11	2462
3	2422	6	2437	9	2452		

2.4 Equipment Modifications

N/A

2.5 Local Support Equipment

Manufacturer/Product Type	Description	Model No.	Serial No.
Dell	Windows Laptop	E6410	-

2.6 Support Equipment

There was no support equipment included, or intended for use with EUT during these tests.

2.7 Interface Ports and Cabling

Cable Description	Length (m)	To	From
RF Cable	< 1 m	PSA	EUT

3 Summary of Test Results

Results reported relate only to the product tested.

FCC/ ISEDC Rules	Description of Test	Results
FCC §15.203 ISEDC RSS-Gen §8.3	Antenna Requirement	Compliant
FCC §2.1091, §15.247(i) ISEDC RSS-102	RF Exposure	Compliant
FCC §2.1053, §15.205, §15.209, §15.247 (d) ISEDC RSS-247 §5.5 ISEDC RSS-Gen §8.9 & §8.10	Radiated Spurious Emissions	Compliant

4 FCC §15.203 & ISEDC RSS-Gen §8.3 - Antenna Requirements

4.1 Applicable Standards

According to FCC §15.203:

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.

And according to FCC §15.247 (b) (4), if transmitting antennas of directional gain greater than 6 dBi are used the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

According to ISEDC RSS-Gen §8.3: Transmitter Antenna

The applicant for equipment certification, as per RSP-100, must provide a list of all antenna types that may be used with the license-exempt transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna.

License-exempt transmitters that have received equipment certification may operate with different types of antennas. However, it is not permissible to exceed the maximum equivalent isotropically radiated power (e.i.r.p.) limits specified in the applicable standard (RSS) for the license-exempt apparatus.

Testing shall be performed using the highest gain antenna of each combination of license-exempt transmitter and antenna type, with the transmitter output power set at the maximum level. [9] When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

User manuals for transmitters equipped with detachable antennas shall also contain the following notice in a conspicuous location:

This radio transmitter (identify the device by certification number) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types approved for use with the transmitter, indicating the maximum permissible antenna gain (in dBi).

4.2 Antenna Description

The antennas used by the EUT are not permanent attached antennas.

Antenna usage	Frequency Range (MHz)	Maximum Antenna Gain (dBi)
RF	2400-2483.5	4.3

5 FCC § 2.1091, §15.247(i) & ISEDC RSS-102 – RF Exposure

5.1 Applicable Standards

According to FCC §15.247(i) and §1.1307(b)(1), 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 level in excess of the Commission's guidelines.

Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	* (100)	30
1.34-30	824/f	2.19/f	* ($180/f^2$)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

According to RSS-102 § 4:

RF Field Strength Limits for Uncontrolled Use Devices (Uncontrolled Environment)

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142f^{0.3417}$	$0.008335f^{0.3417}$	$0.02619f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

5.2 MPE Prediction

Predication of MPE limit at a given distance, Equation from OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: S = power density
P = power input to antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

5.3 MPE Results For FCC

Maximum peak output power at antenna input terminal (dBm):	19.67
Maximum peak output power at antenna input terminal (mW):	92.683
Prediction distance (cm):	30
Prediction frequency (MHz):	2412
Maximum Antenna Gain, typical (dBi):	4.3
Maximum Antenna Gain (numeric):	2.692
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.011
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 30 cm is 0.011 mW/cm^2. Limit is 1.0 mW/cm^2, so the percentage is 0.011/1= 1.10%. The total percentage is 77.0% (WWAN) + 1.10% (WLAN) = 78.10%.

5.4 RF exposure evaluation exemption for IC

Maximum peak output power at antenna input terminal (dBm):	19.67
Maximum peak output power at antenna input terminal (W):	0.927
Prediction distance (m):	0.4
Prediction frequency (MHz):	2412
Antenna Gain, typical (dBi):	4.3
Maximum Antenna Gain (numeric):	2.692
Power density at predication frequency at 0.4m (W/m^2):	0.124
MPE limit for uncontrolled exposure at predication frequency (W/m^2):	5.366

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 40 cm is 0.124 $mW/cm^{2.}$ Limit is 5.366 mW/cm^2. The percentage is 0.124/5.366= 2.31%. The total percentage is 92.4% (WWAN) + 2.31% (WLAN) = 94.71%.

6 FCC §15.205, §15.209, §15.247(d), ISEDC RSS-247 §5.5, & ISEDC RSS-GEN §8.9 & §8.10 - Spurious Radiated Emissions

6.1 Applicable Standards

As per FCC §15.35(d): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz.

As Per FCC §15.205(a) except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423		4. 5 – 5. 15
0.495 – 0.505	16.69475 – 16.69525	960 – 1240	5. 35 – 5. 46
2.1735 – 2.1905	25.5 – 25.67	1300 – 1427	7.25 – 7.75
4.125 – 4.128	37.5 – 38.25	1435 – 1626.5	8.025 – 8.5
4.17725 – 4.17775	73 – 74.6	1645.5 – 1646.5	9.0 – 9.2
4.20725 – 4.20775	74.8 – 75.2	1660 – 1710	9.3 – 9.5
6.215 – 6.218	108 – 121.94	1718.8 – 1722.2	10.6 – 12.7
6.26775 – 6.26825	123 – 138	2200 – 2300	13.25 – 13.4
6.31175 – 6.31225	149.9 – 150.05	2310 – 2390	14.47 – 14.5
8.291 – 8.294	156.52475 – 156.52525	2483.5 – 2500	15.35 – 16.2
8.362 – 8.366	156.7 – 156.9	2690 – 2900	17.7 – 21.4
8.37625 – 8.38675	162.0125 –167.17	3260 – 3267	22.01 – 23.12
8.41425 – 8.41475	167.72 – 173.2	3.332 – 3.339	23.6 – 24.0
12.29 – 12.293	240 – 285	3 3458 – 3 358	31.2 – 31.8
12.51975 – 12.52025	322 – 335.4	3.600 – 4.400	36.43 – 36.5
12.57675 – 12.57725	399.9 – 410		Above 38.6
13.36 – 13.41	608 – 614		

As per FCC §15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table

Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz.

However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

As per FCC §15.247 (d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c).

As per ISEDC RSS-Gen 8.9,

> Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 4 or Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Table 4 – General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Above 30 MHz

Frequency (MHz)	Field Strength (µv/m at 3 metres)
30-88	100
88-216	150
216-960	200
Above 960*	500

linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.

Note: Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the specifISEDC RSS.

As per ISEDC RSS-247 §5.5, in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

6.2 Test Setup

The radiated emissions tests were performed in the 5-meter Chamber, using the setup in accordance with ANSI C63.10-2013. The specification used was the FCC 15 Subpart limits.

The spacing between the peripherals was 10 centimeters.

External I/O cables were draped along the edge of the test table and bundle when necessary.

6.3 Test Procedure

For the radiated emissions test, the EUT host, and all support equipment power cords were connected to the AC floor outlet.

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

The EUT was set 3 meter away from the testing antenna, which was varied from 1-4 meter, and the EUT was placed on a turntable, which was 0.8 meter and 1.5 meter above the ground plane for below and above 1000 MHz measurements, the table shall be rotated for 360 degrees to find out the highest emission. The receiving antenna's polarity should be changed between horizontal and vertical.

The spectrum analyzer or receiver was set as:

Below 1000 MHz:

RBW = 100 kHz / VBW = 300 kHz / Sweep = Auto

Above 1000 MHz:

(1) Peak: RBW = 1MHz / VBW = 1MHz / Sweep = Auto
(2) Average: RBW = 1MHz / VBW = 10Hz / Sweep = Auto

6.4 Corrected Amplitude & Margin Calculation

The Corrected Amplitude (CA) is calculated by adding the Antenna Factor (AF), the Cable Loss (CL), the Attenuator Factor (Atten) and subtracting the Amplifier Gain (Ga) to indicated Amplitude (Ai) reading. The basic equation is as follows:

CA = Ai + AF + CL + Atten – Ga

For example, a corrected amplitude of 40.3 dBuV/m = Indicated Reading (32.5 dBuV) + Antenna Factor (+23.5dB) + Cable Loss (3.7 dB) + Attenuator (10 dB) - Amplifier Gain (29.4 dB)

The "**Margin**" column of the following data tables indicates the degree of compliance within the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the maximum limit. The equation for margin calculation is as follows:

Margin = Corrected Amplitude – Limit

6.5 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100338	2016-02-04	2 year
Agilent	Analyzer, Spectrum	E4440A	US 42221851	2016-06-10	1 year
Sunol Science Corp	System Controller	SC99V	011003-1	N/R	N/R
Sunol Sciences	Antenna, Biconi-Log	JB3	A020106-2	2015-07-11	2 Years
EMCO	Antenna, Horn	3115	9511-4627	2016-01-28	2 years
HP	Amplifier, Pre	8447D	2944A06639	2016-06-28	1 year
IW	Yellow High Frequency Cable	DC 1531	SPS-2303-3840-SPS	2016-08-05	1 Year
Suirong	30 ft conductive emission cable	LMR400	C0013	2017-03-21	1 Year
Suirong	30 ft conductive emission cable	LMR400	C0014	2017-03-21	1 Year
Wainwright Instruments	Band Reject Filter	WRCGV900/930-880/950-40/8SS	-	Each time1	1 year
-	SMA cable	-	C0002	Each time1	N/A
HP	Pre-Amplifier	8449B OPT HO2	3008A0113	2016-05-23	1 year
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: BACL *attests that all calibrations have been performed per the A2LA requirements, traceable to NIST.*

6.6 Test Environmental Conditions

Temperature:	20-22 ºC
Relative Humidity:	37-40 %
ATM Pressure:	101 kPa

The testing was performed by Rudy Sun from 2017-05-25 in 5m chamber 3.

6.7 Summary of Test Results

According to the data hereinafter, the EUT complied with FCC Title 47, Part 15C, ISEDC RSS-GEN, and ISEDC RSS-247 standards' radiated emissions limits, and had the worst margin of:

2400 – 2483.5MHz Wi-Fi

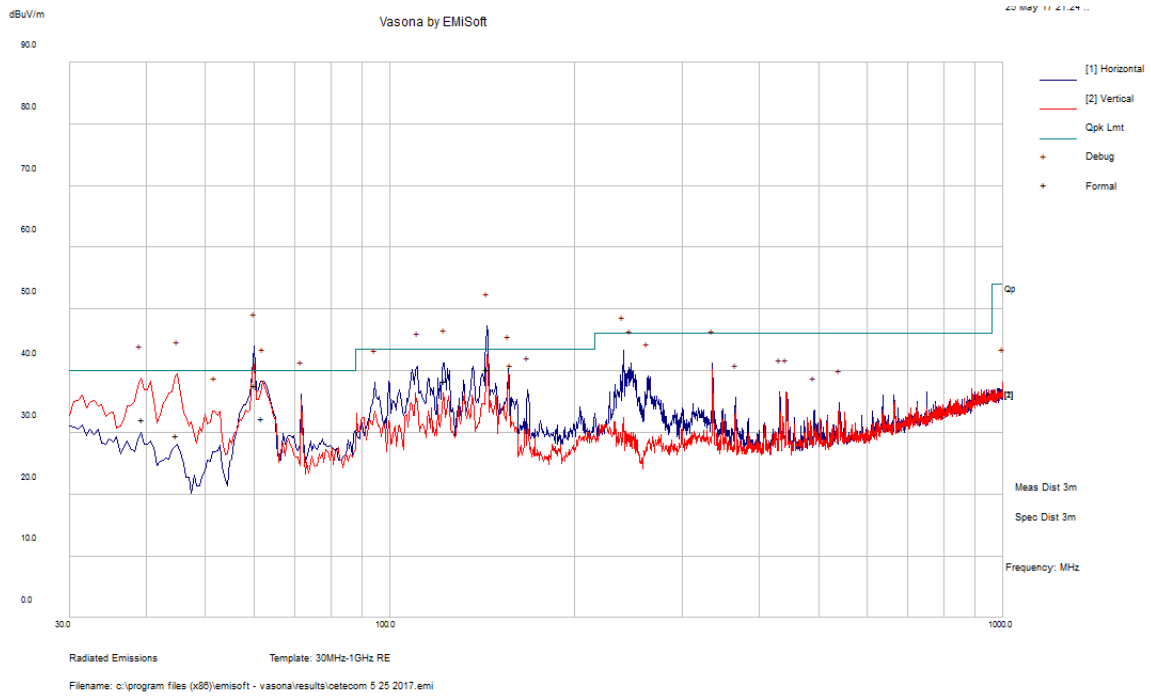
Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Mode, channel**
-2.26	60.01925	Horizontal	n20, 2437MHz

Please refer to the following table and plots for specific test result details

6.8 Radiated Emissions Test Results

1) 30 MHz – 1 GHz Worst Case, Measured at 3 meters

2400 – 2483.5 MHz



Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
60.01925	37.74	289	H	94	40	-2.26	QP
144.0288	40.2	175	H	202	43.5	-3.3	QP
44.95075	29.57	191	V	290	40	-10.43	QP
39.42075	32.17	144	V	46	40	-7.83	QP
61.782	32.33	245	V	115	40	-7.67	QP
122.8763	38.43	161	H	99	43.5	-5.07	QP

2) 1–10 GHz Measured at 3 meters

b mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2412	61.84	360	218	H	29.042	6.259	0	97.141	-	-	Peak
2412	65.44	233	265	V	29.042	6.259	0	100.741	-	-	Peak
2412	31.03	360	218	H	29.042	6.259	0	66.331	-	-	Ave
2412	32.61	233	265	V	29.042	6.259	0	67.911	-	-	Ave
2390	26.05	360	218	H	29.042	6.237	0	61.329	74	-12.671	Peak
2390	25.51	233	265	V	29.042	6.237	0	60.789	74	-13.211	Peak
2390	12.39	360	218	H	29.042	6.237	0	47.669	54	-6.331	Ave
2390	12.37	233	265	V	29.042	6.237	0	47.649	54	-6.351	Ave
4824	45.80	360	218	H	32.472	8.416	38.54	48.148	74	-25.852	Peak
4824	46.03	233	265	V	32.472	8.416	38.54	48.378	74	-25.622	Peak
4824	33.03	360	218	H	32.472	8.416	38.54	35.378	54	-18.622	Ave
4824	33.04	233	265	V	32.472	8.416	38.54	35.388	54	-18.612	Ave
7236	44.63	360	218	H	36.692	10.348	37.9	53.77	74	-20.23	Peak
7236	43.51	233	265	V	36.692	10.348	37.9	52.65	74	-21.35	Peak
7236	32.04	360	218	H	36.692	10.348	37.9	41.18	54	-12.82	Ave
7236	32.02	233	265	V	36.692	10.348	37.9	41.16	54	-12.84	Ave

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Middle Channel 2437 MHz											
2437	64.83	264	248	V	29.413	6.241	0	100.484	-	-	Peak
2437	60.72	360	177	H	29.413	6.241	0	96.374	-	-	Peak
2437	31.55	264	248	V	29.413	6.241	0	67.204	-	-	Ave
2437	30.67	360	177	H	29.413	6.241	0	66.324	-	-	Ave
4874	44.88	264	248	V	32.638	8.386	38.54	47.364	74	-26.636	Peak
4874	45.10	360	177	H	32.638	8.386	38.54	47.584	74	-26.416	Peak
4874	32.47	264	248	V	32.638	8.386	38.54	34.954	54	-19.046	Ave
4874	32.50	360	177	H	32.638	8.386	38.54	34.984	54	-19.016	Ave

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
High Channel 2462 MHz											
2462	65.12	232	275	V	29.3	6.229	0	100.649	-	-	Peak
2462	61.48	331	177	H	29.3	6.229	0	97.009	-	-	Peak
2462	32.62	232	275	V	29.3	6.229	0	68.149	-	-	Ave
2462	31.17	331	177	H	29.3	6.229	0	66.699	-	-	Ave
2483.5	25.39	232	275	V	29.34	6.223	0	60.953	74	-13.047	Peak

2483.5	25.73	331	177	H	29.34	6.223	0	61.293	74	-12.707	Peak
2483.5	12.66	232	275	V	29.34	6.223	0	48.223	54	-5.777	Ave
2483.5	12.62	331	177	H	29.34	6.223	0	48.183	54	-5.817	Ave
4924	45.63	232	275	V	32.638	8.386	38.54	48.114	74	-25.886	Peak
4924	46.01	331	177	H	32.638	8.386	38.54	48.494	74	-25.506	Peak
4924	33.36	232	275	V	32.638	8.386	38.54	35.844	54	-18.156	Ave
4924	33.38	331	177	H	32.638	8.386	38.54	35.864	54	-18.136	Ave

g mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2412	65.52	333	177	H	29.042	6.259	0	100.821	-	-	Peak
2412	69.02	229	265	V	29.042	6.259	0	104.321	-	-	Peak
2412	52.48	333	177	H	29.042	6.259	0	87.781	-	-	Ave
2412	55.88	229	265	V	29.042	6.259	0	91.181	-	-	Ave
2390	25.29	333	177	H	29.042	6.237	0	60.569	74	-13.431	Peak
2390	24.7	229	265	V	29.042	6.237	0	59.979	74	-14.021	Peak
2390	14.77	333	177	H	29.042	6.237	0	50.049	54	-3.951	Ave
2390	14.85	229	265	V	29.042	6.237	0	50.129	54	-3.871	Ave
4824	45.66	333	177	H	32.472	8.416	38.54	48.008	74	-25.992	Peak
4824	45.45	229	265	V	32.472	8.416	38.54	47.798	74	-26.202	Peak
4824	35.69	333	177	H	32.472	8.416	38.54	38.038	54	-15.962	Ave
4824	35.64	229	265	V	32.472	8.416	38.54	37.988	54	-16.012	Ave
7236	44.41	333	177	H	36.692	10.348	38	53.45	74	-20.55	Peak
7236	44.81	229	265	V	36.692	10.348	38	53.85	74	-20.15	Peak
7236	34.94	333	177	H	36.692	10.348	38	43.98	54	-10.02	Ave
7236	34.70	229	265	V	36.692	10.348	38	43.74	54	-10.26	Ave
Frequency (MHz)	**S.A. Reading (dBµV)**	**Turntable Azimuth (degrees)**	**Test Antenna**			**Cable Loss (dB)**	**Pre-Amp. (dB)**	**Cord. Reading (dBµV/m)**	**FCC**		**Comments**
			Height (cm)	**Polarity (H/V)**	**Factor (dB/m)**				**Limit (dBµV/m)**	**Margin (dB)**	
Middle Channel 2437 MHz											
2437	68.81	219	251	V	29.413	6.241	0	104.464	-	-	Peak
2437	66.33	360	180	H	29.413	6.241	0	101.984	-	-	Peak
2437	54.76	219	251	V	29.413	6.241	0	90.414	-	-	Ave
2437	51.3	360	180	H	29.413	6.241	0	86.954	-	-	Ave
4874	45.68	219	251	V	32.638	8.386	38.54	48.164	74	-25.836	Peak
4874	45.09	360	180	H	32.638	8.386	38.54	47.574	74	-26.426	Peak
4874	35.58	219	251	V	32.638	8.386	38.54	38.064	54	-15.936	Ave
4874	35.57	360	180	H	32.638	8.386	38.54	38.054	54	-15.946	Ave

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
High Channel 2462 MHz											
2462	68.65	311	272	V	29.413	6.229	0	104.292	-	-	Peak
2462	63.06	360	209	H	29.413	6.229	0	98.702	-	-	Peak
2462	54.01	311	272	V	29.413	6.229	0	89.652	-	-	Ave
2462	50.26	360	209	H	29.413	6.229	0	85.902	-	-	Ave
2483.5	25.26	311	272	V	29.413	6.223	0	60.896	74	-13.104	Peak
2483.5	25.77	360	209	H	29.413	6.223	0	61.406	74	-12.594	Peak
2483.5	15.15	311	272	V	29.413	6.223	0	50.786	54	-3.214	Ave
2483.5	15.1	360	209	H	29.413	6.223	0	50.736	54	-3.264	Ave
4924	45.55	311	272	V	32.638	8.386	38.54	48.034	74	-25.966	Peak
4924	44.61	360	209	H	32.638	8.386	38.54	47.094	74	-26.906	Peak
4924	35.87	311	272	V	32.638	8.386	38.54	38.354	54	-15.646	Ave
4924	35.88	360	209	H	32.638	8.386	38.54	38.364	54	-15.636	Ave

n20 mode

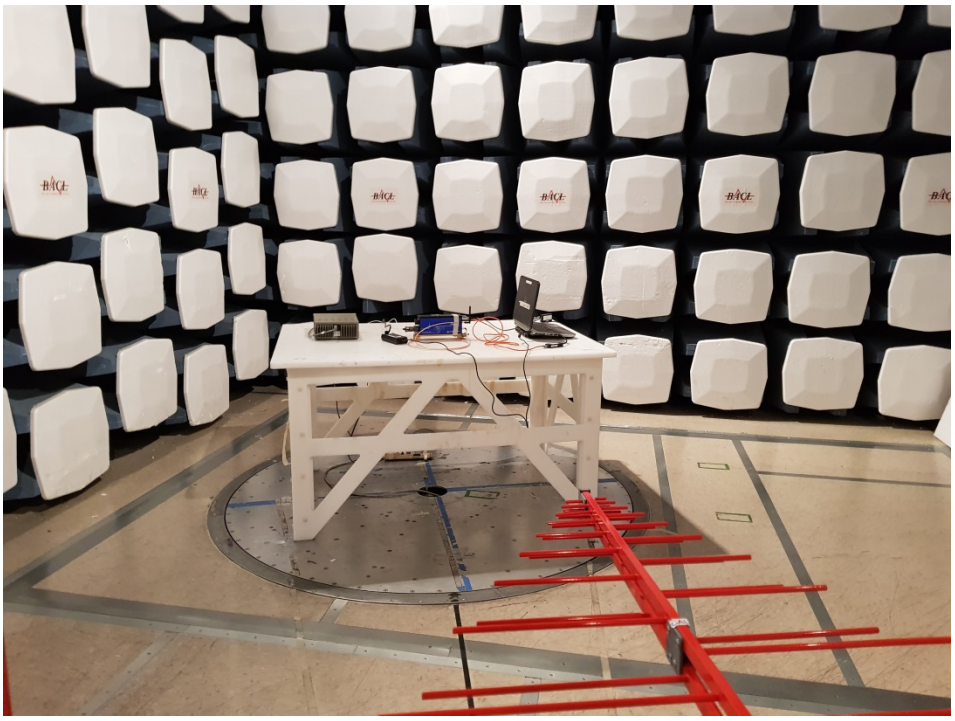
Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2412	65.08	360	237	V	29.042	6.259	0	100.38	-	-	Peak
2412	65.99	360	226	H	29.042	6.259	0	101.29	-	-	Peak
2412	45.25	360	237	V	29.042	6.259	0	80.55	-	-	Ave
2412	46.04	360	226	H	29.042	6.259	0	81.34	-	-	Ave
2390	25.05	360	237	V	29.042	6.237	0	60.33	74	-13.67	Peak
2390	26.41	360	226	H	29.042	6.237	0	61.69	74	-12.31	Peak
2390	14.65	360	237	V	29.042	6.237	0	49.93	54	-4.07	Ave
2390	14.79	360	226	H	29.042	6.237	0	50.07	54	-3.93	Ave
4824	45.25	360	237	V	32.472	8.416	38.54	47.60	74	-26.40	Peak
4824	45.27	360	226	H	32.472	8.416	38.54	47.62	74	-26.38	Peak
4824	35.64	360	237	V	32.472	8.416	38.54	37.99	54	-16.01	Ave
4824	35.63	360	226	H	32.472	8.416	38.54	37.98	54	-16.02	Ave
7236	44.95	360	226	H	36.692	10.211	37.9	53.953	74	-20.047	Peak
7236	44.66	360	237	V	36.692	10.211	37.9	53.663	74	-20.337	Peak
7236	34.64	360	226	H	36.692	10.211	37.9	43.643	54	-10.357	Ave
7236	34.62	360	237	V	36.692	10.211	37.9	43.623	54	-10.377	Ave
Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Middle Channel 2437 MHz											
2437	69.23	319	280	V	29.413	6.241	0	104.88	-	-	Peak
2437	64.78	360	224	H	29.413	6.241	0	100.43	-	-	Peak

2437	50.38	319	280	V	29.413	6.241	0	86.03	-	-	Ave
2437	45.09	360	224	H	29.413	6.241	0	80.74	-	-	Ave
4874	45.16	319	280	V	32.638	8.386	38.54	47.64	74	-26.36	Peak
4874	45.70	360	224	H	32.638	8.386	38.54	48.18	74	-25.82	Peak
4874	35.84	319	280	V	32.638	8.386	38.54	38.32	54	-15.68	Ave
4874	35.85	360	224	H	32.638	8.386	38.54	38.33	54	-15.67	Ave

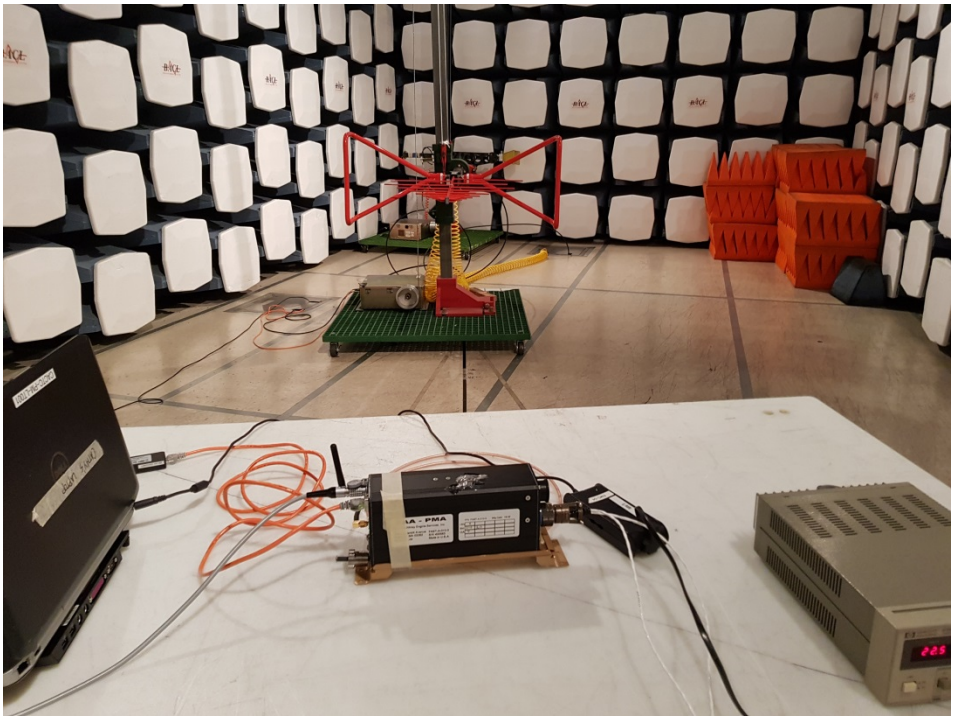
Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
High Channel 2462 MHz											
2462	67.3	318	258	V	29.413	6.229	0	102.94	-	-	Peak
2462	64.72	360	208	H	29.413	6.229	0	100.36	-	-	Peak
2462	48.78	318	258	V	29.413	6.229	0	84.42	-	-	Ave
2462	44.58	360	208	H	29.413	6.229	0	80.22	-	-	Ave
2483.5	25.76	318	258	V	29.413	6.223	0	61.40	74	-12.60	Peak
2483.5	25.81	360	208	H	29.413	6.223	0	61.45	74	-12.55	Peak
2483.5	15.12	318	258	V	29.413	6.223	0	50.76	54	-3.24	Ave
2483.5	15.1	360	208	H	29.413	6.223	0	50.74	54	-3.26	Ave
4924	47.17	318	258	V	32.638	8.386	38.54	49.65	74	-24.35	Peak
4924	44.50	360	208	H	32.638	8.386	38.54	46.98	74	-27.02	Peak
4924	35.89	318	258	V	32.638	8.386	38.54	38.37	54	-15.63	Ave
4924	35.89	360	208	H	32.638	8.386	38.54	38.37	54	-15.63	Ave

7 Exhibit B - Test Setup Photographs

7.1 Radiated Emission below 1 GHz Front View

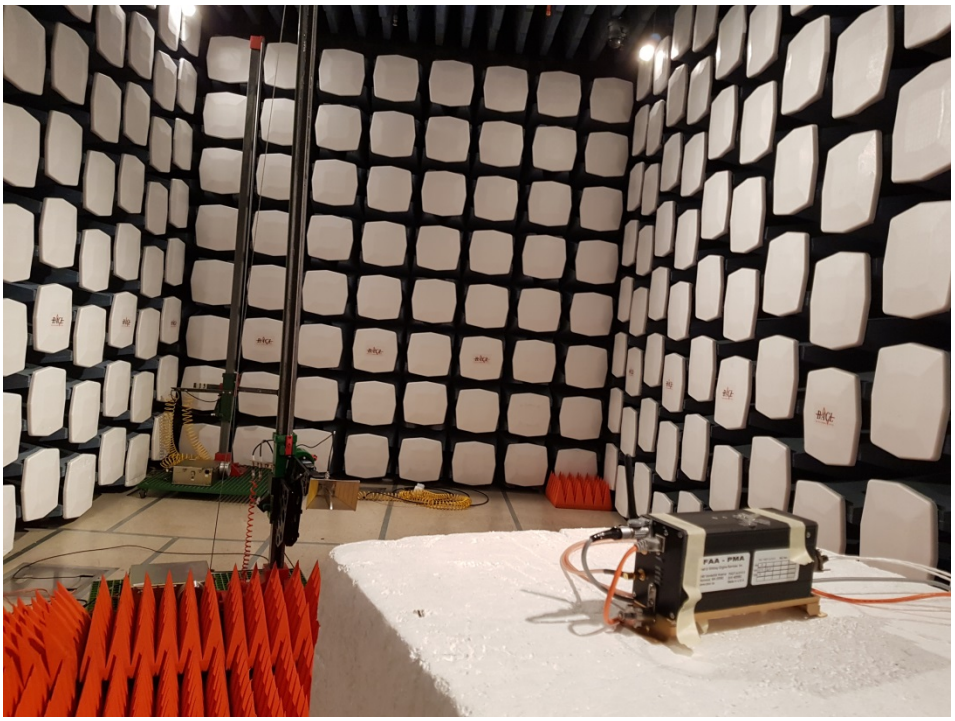


7.2 Radiated Emission below 1 GHz Rear View



7.3 Radiated Emission above 1 GHz Front View

7.4 Radiated Emission above 1 GHz Rear View



--- END OF REPORT ---