



FCC PART 15, SUBPART C
TEST REPORT
For
Nectar, Inc.

517 Byron Street, Palo Alto, CA 94301, USA

FCC ID: 2AVAD0001A

| | |
|--|-----------------------------------|
| Report Type: Original Report | Product Type: Smart Cap |
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| Report Number: | R1911275-247 (DTS) |
| Report Date: | 2020-02-19 |
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Note: This test report is prepared for the customer shown above and for the device described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. This report **must not** be used by the customer to claim product certification, approval, or endorsement by A2LA*, NIST, or any agency of the Federal Government.

* This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "*" Rev.10

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DOCUMENT REVISION HISTORY

| Revision Number | Report Number | Description of Revision | Date of Revision |
|------------------------|----------------------|--------------------------------|-------------------------|
| 0 | R1911275-247 (DTS) | Original Report | 2020-02-19 |

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test and measurement report was prepared on behalf of *Nectar, Inc.*, and their product model: 0001A, FCC ID: 2AVAD0001A or the “EUT” as referred to in this report. It is a smart cap (IoT device) measures the remaining liquid level at the bar.

The EUT product measures approximately 150 mm (L) x 50 mm (W) x 50 mm (H) and weighs approximately 50 g.

1.2 Objective

This report is prepared on behalf of *Nectar, Inc.*, in accordance with Part 2, Subpart J, and Part 15, Subparts B and C of the Federal Communication Commission’s rules.

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

1.3 Related Submittal(s)/Grant(s)

N/A

1.4 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 v05r2: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.

1.5 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 ° C |
| Humidity | ±5 % |
| DC and low frequency voltages | ±1.0 % |
| Time | ±2 % |
| Duty Cycle | ±3 % |

1.6 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.

1.7 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 3279.02), 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 3279.03) 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 3279.01) 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: (Innovation, Science and Economic development Canada - ISED) Foreign Certification Body – FCB – APEC Tel MRA -Phase I & Phase II;
- Chinese Taipei (Republic of China – Taiwan):
 - o BSMI (Bureau of Standards, Metrology and Inspection) APEC Tel MRA -Phase I;
 - o NCC (National Communications Commission) APEC Tel MRA -Phase I;
- European Union:
 - o EMC Directive 2014/30/EU US-EU EMC & Telecom MRA CAB (NB)
 - o Radio Equipment (RE) Directive 2014/53/EU US-EU EMC & Telecom MRA CAB (NB)
 - o Low Voltage Directive (LVD) 2014/35/EU
- 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 Media Development Authority - IMDA) APEC Tel MRA -Phase I & Phase II;
- Japan: VCCI - Voluntary Control Council for Interference US-Japan Telecom Treaty VCCI Side Letter-
- USA:
 - o ENERGY STAR Recognized Test Laboratory – US EPA
 - o Telecommunications Certification Body (TCB) – US FCC;
 - o Nationally Recognized Test Laboratory (NRTL) – US OSHA
- 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 v05r02.

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 PPSD across all data rates bandwidths, and modulations.

2.2 EUT Exercise Software

The test software was provided by Nectar, Inc., the software is compliant with the standard requirements being tested against.

| Modulation | Frequency (MHz) | Power Setting |
|------------|-----------------|---------------|
| BLE | 2402 | 0 |
| | 2440 | 0 |
| | 2480 | 0 |

Data Rates Tested:
BLE: 1Mbps

2.3 Duty Cycle Correction Factor

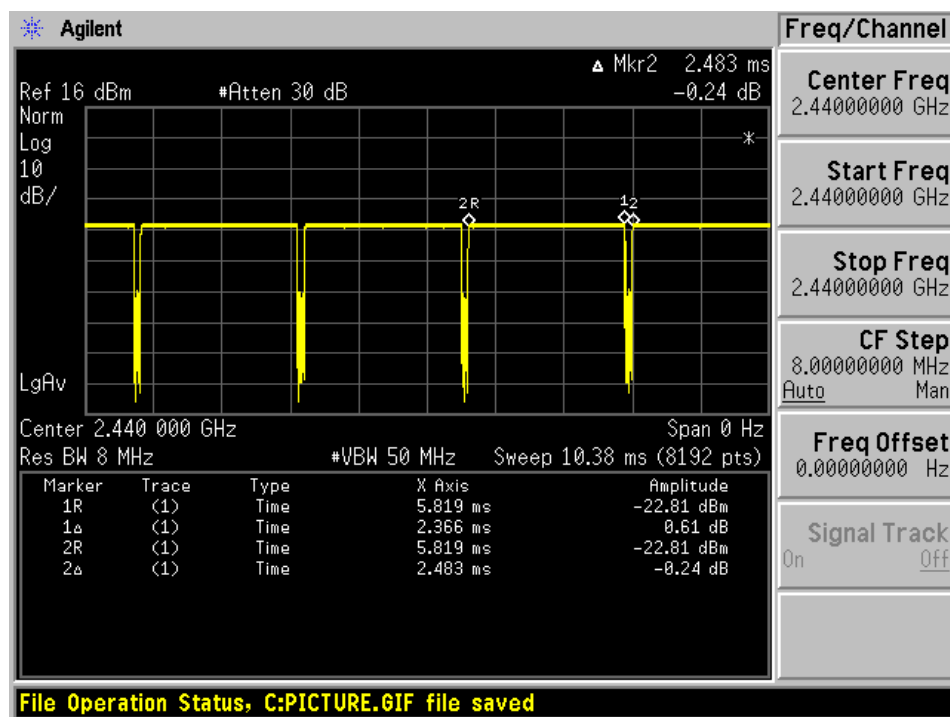
According to KDB 558074 D01 DTS Meas Guidance v05r02 section 6.0:

Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (i.e., with a duty cycle of greater than or equal to 98%). When continuous operation cannot be realized, then the use of sweep triggering/signal gating techniques can be utilized to ensure that measurements are made only during transmissions at the maximum power control level. Such sweep triggering/signal gating techniques will require knowledge of the minimum transmission duration (T) over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation. Sweep triggering/signal gating techniques can then be used if the measurement/sweep time of the analyzer can be set such that it does not exceed T at any time that data is being acquired (i.e., no transmitter off-time is to be considered).

| Radio Mode | On Time (ms) | Period (ms) | Duty Cycle (%) | Duty Cycle Correction Factor (dB) |
|------------|--------------|-------------|----------------|-----------------------------------|
| BLE | 2.366 | 2.483 | 95.29 | 0.21 |

Duty Cycle = On Time (ms)/ Period (ms)
Duty Cycle Correction Factor (dB) = $10 \cdot \log(1/\text{Duty Cycle})$

Please refer to the following plots.



2.4 Equipment Modifications

A hole was cut in the side of the EUT with a RF cable coming out to connect antenna ports to power spectrum analyzer.

2.5 Local Support Equipment

| Manufacturer | Description | Model |
|--------------|-------------|---------|
| Dell | Laptop | unknown |

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 |
|-------------------|------------|--------|------|
| Micro USB Cable | < 1 m | Laptop | EUT |
| RF Cable | < 1 m | EUT | PSA |

3 Summary of Test Results

Results reported relate only to the product tested.

| FCC Rules | Description of Test | Results |
|---|--|------------------|
| §15.203 | Antenna Requirement | Compliant |
| §15.207 | AC Line Conducted Emissions | N/A ¹ |
| §2.1091, §15.247(i) | RF Exposure | Compliant |
| §2.1051, §15.247 (d) | Spurious Emissions at Antenna Port | Compliant |
| §2.1053, §15.205, §15.209, §15.247 (d) | Radiated Spurious Emissions | Compliant |
| §15.247(a)(2) | 6 dB and 99% Emission Bandwidth | Compliant |
| §15.247(b)(3) | Maximum Peak Output Power | Compliant |
| §15.247(d) | 100 kHz Bandwidth of Frequency Band Edge | Compliant |
| §15.247(e) | Power Spectral Density | Compliant |

Note¹: The EUT is DC powered; therefore, AC Line Conducted Emissions is not required.

4 FCC §15.203 - 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.

4.2 Antenna Description

The antennas used by the EUT are permanent attached antennas.

| Antenna usage | Frequency Range (MHz) | Maximum Antenna Gain (dBi) | Antenna Type |
|---------------|-----------------------|----------------------------|--------------|
| BLE | 2400-2483.5 | 1.5 | spherical |

5 FCC §2.1091 & §15.247(i) - RF Exposure

5.1 Applicable Standards

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 (minute) |
|--|-------------------------------|-------------------------------|-------------------------------------|-------------------------|
| 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 |

Note: f = frequency in MHz

* = Plane-wave equivalent power density

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 Test Results

The device is compliant with the requirement MPE limit for uncontrolled exposure. The tuned up power density at the distance of 20 cm is 0.0037 mW/cm². Limit is 1.0 mW/cm².

| | |
|---|--------|
| Maximum peak output power at antenna input terminal (dBm): | -1.11 |
| Maximum peak output power at antenna input terminal (mW): | 0.77 |
| Prediction distance (cm): | 20 |
| Predication frequency (MHz): | 2402 |
| Maximum Antenna Gain, typical (dBi): | 1.50 |
| Maximum Antenna Gain (numeric): | 1.41 |
| Power density of prediction frequency at prediction distance (mW/cm ²): | 0.0002 |
| FCC limit (mW/cm ²): | 1.00 |

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.0002 mW/cm². Limit is 1.0 mW/cm².

6 FCC §15.209 & §15.247(d) - 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 | 960 – 1240 | 4. 5 – 5. 15 |
| 0.495 – 0.505 | 16.69475 – 16.69525 | 1300 – 1427 | 5. 35 – 5. 46 |
| 2.1735 – 2.1905 | 25.5 – 25.67 | 1435 – 1626.5 | 7.25 – 7.75 |
| 4.125 – 4.128 | 37.5 – 38.25 | 1645.5 – 1646.5 | 8.025 – 8.5 |
| 4.17725 – 4.17775 | 73 – 74.6 | 1660 – 1710 | 9.0 – 9.2 |
| 4.20725 – 4.20775 | 74.8 – 75.2 | 1718.8 – 1722.2 | 9.3 – 9.5 |
| 6.215 – 6.218 | 108 – 121.94 | 2200 – 2300 | 10.6 – 12.7 |
| 6.26775 – 6.26825 | 123 – 138 | 2310 – 2390 | 13.25 – 13.4 |
| 6.31175 – 6.31225 | 149.9 – 150.05 | 2483.5 – 2500 | 14.47 – 14.5 |
| 8.291 – 8.294 | 156.52475 – 156.52525 | 2690 – 2900 | 15.35 – 16.2 |
| 8.362 – 8.366 | 156.7 – 156.9 | 3260 – 3267 | 17.7 – 21.4 |
| 8.37625 – 8.38675 | 162.0125 – 167.17 | 3.332 – 3.339 | 22.01 – 23.12 |
| 8.41425 – 8.41475 | 167.72 – 173.2 | 3 3458 – 3 358 | 23.6 – 24.0 |
| 12.29 – 12.293 | 240 – 285 | 3.600 – 4.400 | 31.2 – 31.8 |
| 12.51975 – 12.52025 | 322 – 335.4 | | 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)).

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 C 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 or 1/T / Sweep = Auto

6.4 Corrected Amplitude and 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:

$$\text{Margin} = \text{Corrected Amplitude} - \text{Limit}$$

6.5 Test Equipment List and Details

| Manufacturer | Description | Model No. | Serial No. | Calibration Date | Calibration Interval |
|--------------------|---|-------------------------|------------|------------------------|----------------------|
| Rohde and Schwarz | Receiver, EMI Test | ESCI 1166.5950K03 | 100338 | 2018-07-05 | 2 years |
| Rohde & Schwarz | Signal Analyzer | FSQ26 | 200749 | 2019-11-07 | 2 years |
| Sunol Sciences | System Controller | SC99V | 011003-1 | N/R | N/A |
| Sunol Sciences | Antenna, Biconi-Log | JB1 | A013105-3 | 2018-02-26 | 2 years |
| Sunol Sciences | Antenna, Horn | DRH-118 | A052704 | 2019-04-02 | 2 years |
| HP/Agilent | Amplifier, Pre | 8449B OPT HO2 | 3008A0113 | 2019-09-30 | 1 year |
| Insulated Wire INC | 157 Series 2.92 SM (x2) Armored 33 ft. Cable | KPS-1571AN- 3960-KPS | DC 1917 | 2019-05-08 | 1 year |
| - | SMA cable | - | C0002 | Each time ¹ | N/A |
| Agilent | Pre-Amplifier | 8447D | 2944A10187 | 2019-04-11 | 1 year |
| AH Systems | Preamplifier | PAM 1840 VH | 170 | 2019-09-24 | 1 year |
| Wisewave | Antenna, Horn | ARH-4223-02 | 10555-02 | 2017-12-15 | 2 years |
| Vasona | Test software | V6.0 build 11 | 10400213 | N/R | N/R |

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: *BACL Corp.* attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 02 October 2018) “A2LA Policy on Metrological Traceability”.

6.6 Test Environmental Conditions

| | |
|---------------------------|------------------|
| Temperature: | 20-22 °C |
| Relative Humidity: | 42-50 % |
| ATM Pressure: | 101.9 -102.7 kPa |

The testing was performed by Frank Wang and Matthew Riego de Dios 2019-11-26 to 2019-11-27 in 5m chamber 3.

6.7 Summary of Test Results

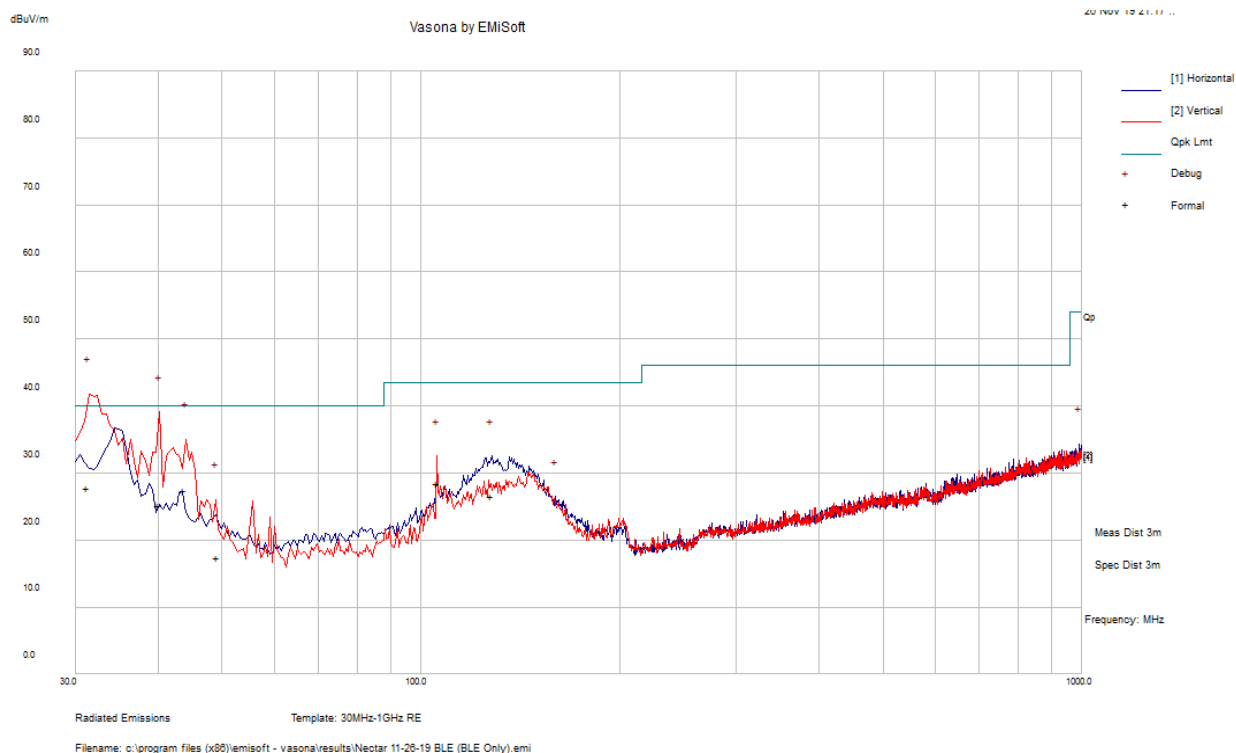
According to the data hereinafter, the EUT complied with FCC Title 47, Part 15C and standard's radiated emissions limits, and had the worst margin of:

| Mode: Transmitting | | | |
|---------------------------|----------------------------|---|---------------------|
| Margin (dB) | Frequency (MHz) | Polarization (Horizontal/Vertical) | channel |
| -12.19 | 31.276 | Vertical | 2402MHz low channel |

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

6.8 Radiated Emissions Test Results

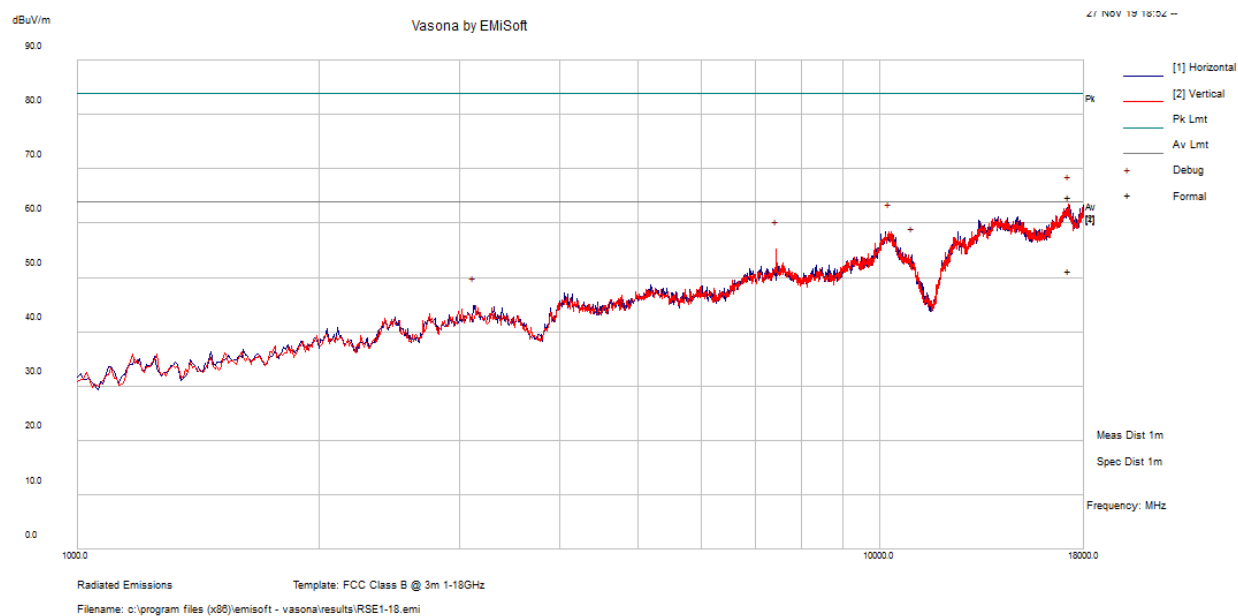
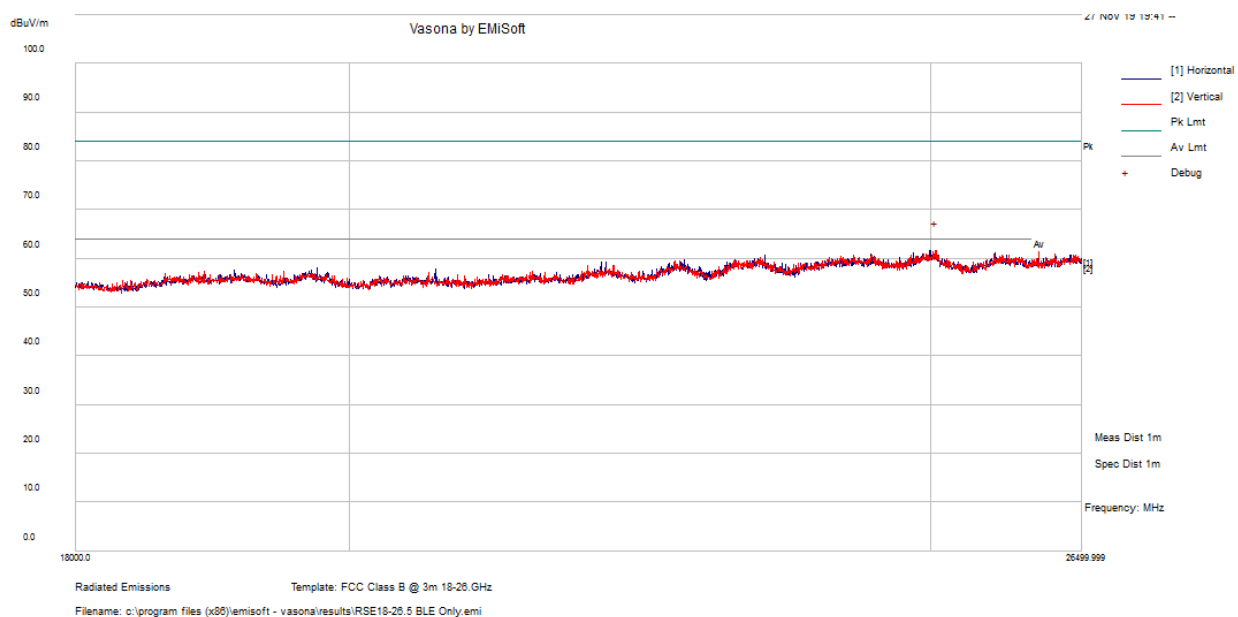
1) 30 MHz -1 GHz Worst Case



| Frequency (MHz) | Corrected Amplitude (dBμV/m) | Antenna Height (cm) | Antenna Polarity (H/V) | Turntable Azimuth (degrees) | Limit (dBμV/m) | Margin (dB) | Comment |
|-----------------|------------------------------|---------------------|------------------------|-----------------------------|----------------|-------------|---------|
| 31.276 | 27.81 | 274 | V | 97 | 40 | -12.19 | QP |
| 40.089 | 25.23 | 235 | V | 72 | 40 | -14.77 | QP |
| 43.85275 | 27.39 | 124 | V | 282 | 40 | -12.61 | QP |
| 105.7745 | 28.58 | 299 | V | 226 | 43.5 | -14.92 | QP |
| 127.9285 | 26.68 | 233 | H | 197 | 43.5 | -16.82 | QP |
| 49.13575 | 17.5 | 100 | V | 52 | 40 | -22.5 | QP |

2) 1–25 GHz

| 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 2402 MHz | | | | | | | | | | | |
| 2383 | 58.92 | 56 | 120 | H | 28.07 | 6.31 | 39.33 | 53.97 | 74.00 | -20.03 | PK |
| 2383 | 40.02 | 56 | 120 | H | 28.07 | 6.31 | 39.33 | 35.07 | 54.00 | -18.93 | AV |
| 2383 | 53.96 | 91 | 232 | V | 28.64 | 6.31 | 39.33 | 49.58 | 74.00 | -24.42 | PK |
| 2383 | 38.27 | 91 | 232 | V | 28.64 | 6.31 | 39.33 | 33.89 | 54.00 | -20.11 | AV |
| 4804 | 48.66 | 0 | 100 | H | 32.46 | 9.10 | 37.598 | 52.62 | 74.00 | -21.38 | PK |
| 4804 | 36.96 | 0 | 100 | H | 32.46 | 9.10 | 37.598 | 40.92 | 54.00 | -13.08 | AV |
| 4804 | 47.63 | 0 | 100 | V | 32.46 | 9.10 | 37.598 | 51.59 | 74.00 | -22.41 | PK |
| 4804 | 37.76 | 0 | 100 | V | 32.46 | 9.10 | 37.598 | 41.72 | 54.00 | -12.28 | AV |
| Middle Channel 2440 MHz | | | | | | | | | | | |
| 4880 | 47.81 | 0 | 100 | H | 32.77 | 9.10 | 37.598 | 52.08 | 74.00 | -21.92 | PK |
| 4880 | 35.11 | 0 | 100 | H | 32.77 | 9.10 | 37.598 | 39.38 | 54.00 | -14.62 | AV |
| 4880 | 48.62 | 0 | 100 | V | 32.77 | 9.10 | 37.598 | 52.89 | 74.00 | -21.11 | PK |
| 4880 | 35.51 | 0 | 100 | V | 32.77 | 9.10 | 37.598 | 39.78 | 54.00 | -14.22 | AV |
| High Channel 2480 MHz | | | | | | | | | | | |
| 2483.5 | 54.50 | 54 | 213 | H | 28.47 | 6.60 | 39.27 | 50.30 | 74.00 | -23.70 | PK |
| 2483.5 | 39.61 | 54 | 213 | H | 28.47 | 6.60 | 39.27 | 35.41 | 54.00 | -18.59 | AV |
| 2483.5 | 50.66 | 100 | 100 | V | 28.64 | 6.60 | 39.27 | 46.63 | 74.00 | -27.37 | PK |
| 2483.5 | 40.10 | 100 | 100 | V | 28.64 | 6.60 | 39.27 | 36.07 | 54.00 | -17.93 | AV |
| 4960 | 47.64 | 0 | 100 | H | 32.73 | 9.10 | 37.598 | 51.88 | 74.00 | -22.12 | PK |
| 4960 | 35.43 | 0 | 100 | H | 32.73 | 9.10 | 37.598 | 39.67 | 54.00 | -14.33 | AV |
| 4960 | 48.23 | 0 | 100 | V | 32.73 | 9.10 | 37.598 | 52.47 | 74.00 | -21.53 | PK |
| 4960 | 36.66 | 0 | 100 | V | 32.73 | 9.10 | 37.598 | 40.90 | 54.00 | -13.10 | AV |

1 GHz – 18 GHz 2.4 GHz Worst Case Scan at 1 Meter**18 GHz – 26.5 GHz Worst Case GHz Scan at 1 Meter**

Note: No emission found above 18 GHz

7 FCC §15.247(a) (2) -Emission Bandwidth

7.1 Applicable Standards

According to ECFR §15.247(a) (2), systems using digital modulation techniques may operate in the 902~928 MHz, 2400~2483.5 MHz, and 5725~5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz

7.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 8: DTS bandwidth

7.3 Test Equipment List and Details

| Manufacturer | Description | Model No. | Serial No. | Calibration Date | Calibration Interval |
|--------------|--------------------|-----------|------------|------------------------|----------------------|
| Agilent | Analyzer, Spectrum | E4446A | MY48250238 | 2019-06-26 | 1 year |
| - | RF cable | - | - | Each time ¹ | N/A |
| - | 20dB attenuator | - | - | Each time ¹ | N/A |

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: *BACL Corp.* attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 02 October 2018) "A2LA Policy on Metrological Traceability".

7.4 Test Environmental Conditions

| | |
|--------------------|-----------|
| Temperature: | 23° C |
| Relative Humidity: | 42 % |
| ATM Pressure: | 101.9 KPa |

The testing was performed by Zhao Zhao on 2019-11-27 in RF site.

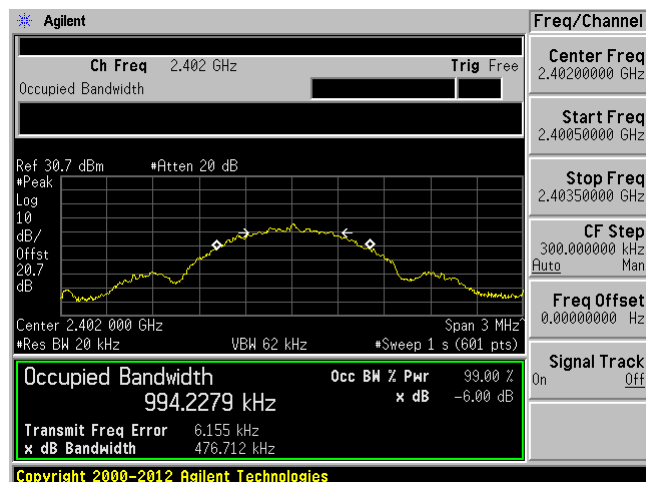
7.5 Test Results

| Channel | Frequency (MHz) | 99% OBW (kHz) | 6 dB OBW (kHz) | 6 dB OBW Limit (kHz) |
|---------|-----------------|---------------|----------------|----------------------|
| Low | 2402 | 985.6954 | 620.324 | 500 |
| Middle | 2440 | 989.7636 | 617.682 | 500 |
| High | 2480 | 966.5087 | 633.208 | 500 |

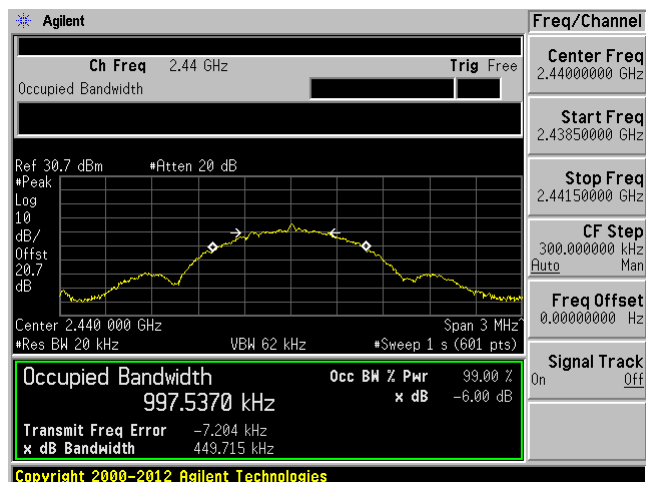
Please refer to the following plots for detailed test results.

99% OBW

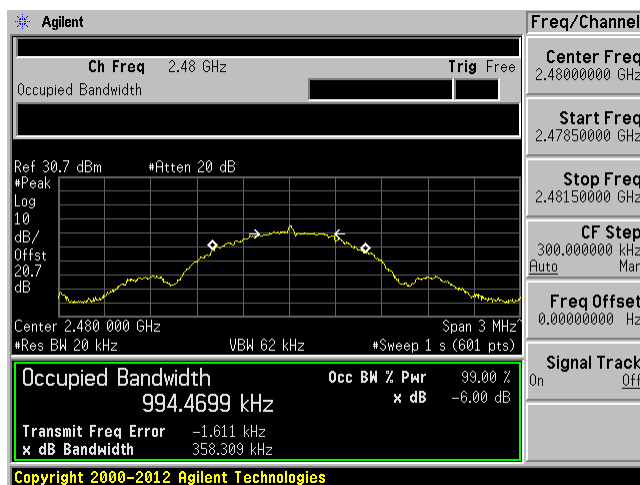
Low Channel 2402 MHz



Middle Channel 2440 MHz

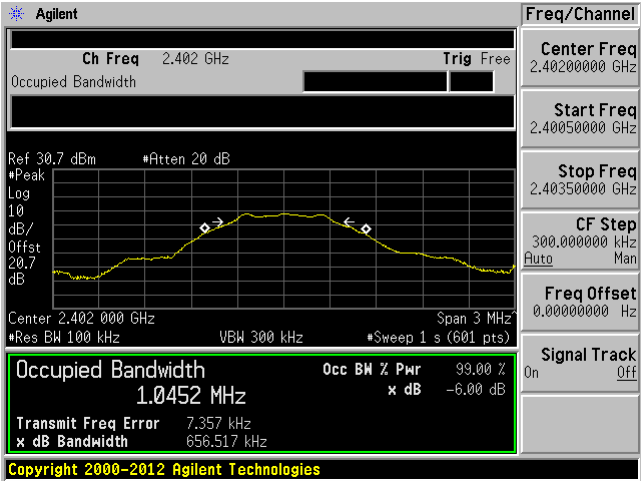


High Channel 2480 MHz

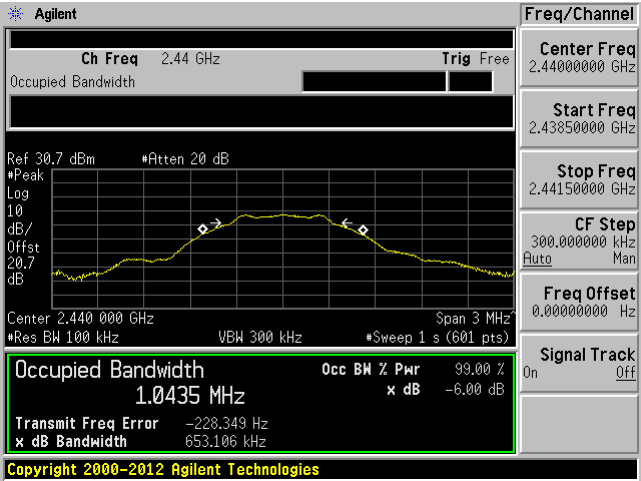


6 dB OBW

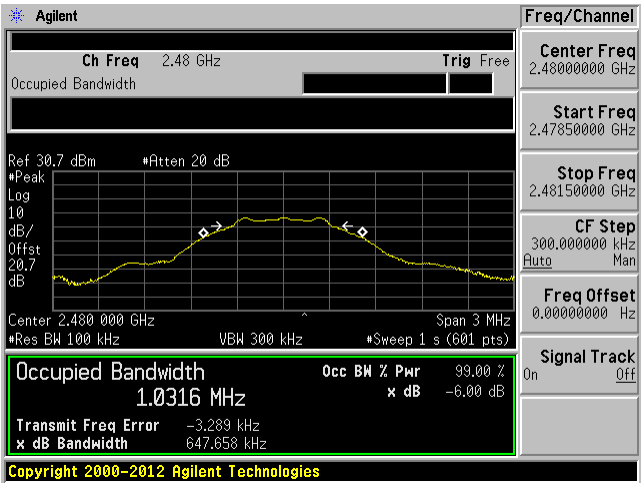
Low Channel 2402 MHz



Middle Channel 2440 MHz



High Channel 2480 MHz



8 FCC §15.247(b) (3) - Output Power Measurement

8.1 Applicable Standards

According to ECFR §15.247(b) (3) for systems using digital modulation in the 902~928 MHz, 2400~2483.5 MHz, and 5725~5850 MHz bands: 1 Watt.

8.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 9: Fundamental emission output power

8.3 Test Equipment List and Details

| Manufacturer | Description | Model No. | Serial No. | Calibration Date | Calibration Interval |
|---------------|--------------------|-----------|------------|------------------------|----------------------|
| Agilent | Analyzer, Spectrum | E4446A | MY48250238 | 2019-06-26 | 1 year |
| ETS- Lingerin | Power Sensor | 7002-006 | 160097 | 2018-12-31 | 2 years |
| - | RF Cable | - | - | Each time ¹ | N/A |
| - | 20dB attenuator | - | - | Each time ¹ | N/A |

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: *BACL Corp.* attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 02 October 2018) "A2LA Policy on Metrological Traceability".

8.4 Test Environmental Conditions

| | |
|---------------------------|-----------|
| Temperature: | 23° C |
| Relative Humidity: | 42 % |
| ATM Pressure: | 101.9 KPa |

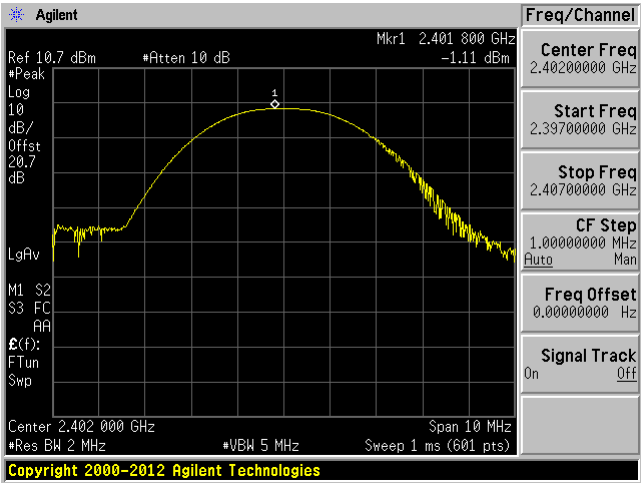
The testing was performed by Zhao Zhao 2019-11-27- in RF site.

8.5 Test Results

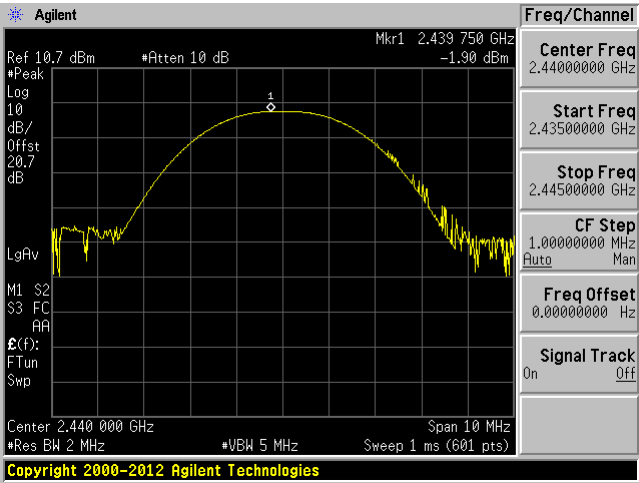
| Channel | Frequency (MHz) | Conducted Peak Power (dBm) | Limit (dBm) |
|---------|-----------------|----------------------------|-------------|
| Low | 2402 | -1.11 | 30 |
| Middle | 2440 | -1.90 | 30 |
| High | 2480 | -2.79 | 30 |

Please refer to the following plots for detailed test results.

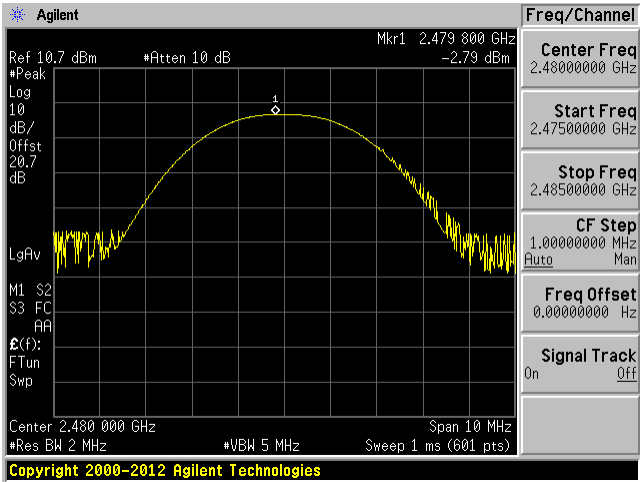
Low Channel 2402 MHz



Middle Channel 2440 MHz



High Channel 2480 MHz



9 FCC §15.247(d) - 100 kHz Bandwidth of Band Edges

9.1 Applicable Standards

According to ECFR §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum 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. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emissions limits specified in §15.209(a) see §15.205(c).

9.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 13: Band-edge measurements

9.3 Test Equipment List and Details

| Manufacturer | Description | Model No. | Serial No. | Calibration Date | Calibration Interval |
|--------------|--------------------|-----------|------------|------------------------|----------------------|
| Agilent | Analyzer, Spectrum | E4446A | MY48250238 | 2019-06-26 | 1 year |
| - | RF Cable | - | - | Each time ¹ | N/A |
| - | 20dB attenuator | - | - | Each time ¹ | N/A |

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: *BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 02 October 2018) "A2LA Policy on Metrological Traceability".*

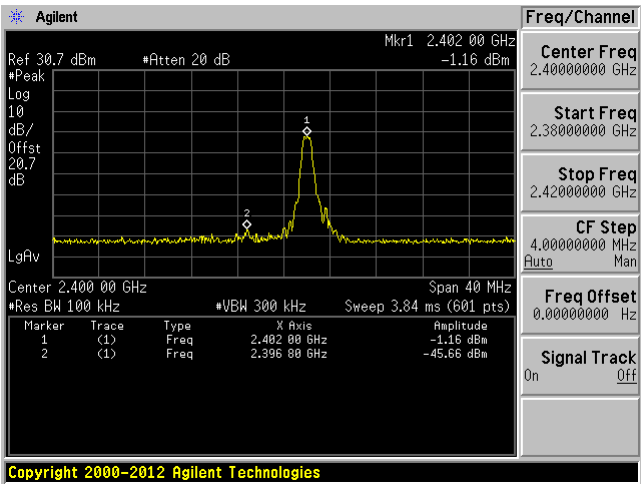
9.4 Test Environmental Conditions

| | |
|--------------------|-----------|
| Temperature: | 23° C |
| Relative Humidity: | 42 % |
| ATM Pressure: | 101.9 KPa |

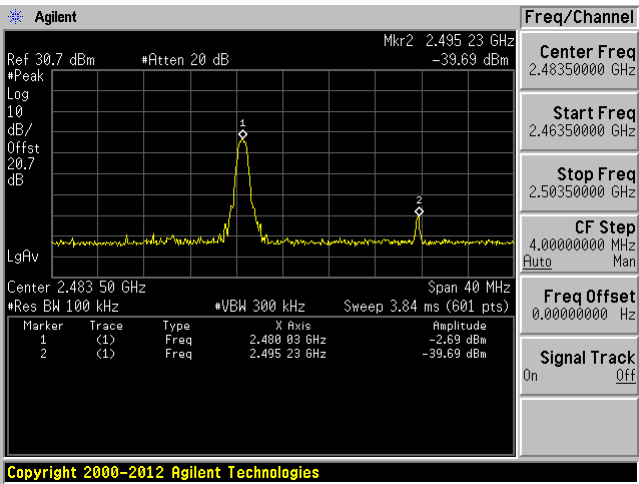
The testing was performed by Zhao Zhao 2019-11-27 in RF site.

9.5 Test Results

Low Channel 2402 MHz



High Channel 2480 MHz



10 FCC §15.247(e) - Power Spectral Density

10.1 Applicable Standards

According to ECFR §15.247(e), for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

10.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 10: Maximum power spectral density level in the fundamental emission.

10.3 Test Equipment List and Details

| Manufacturer | Description | Model No. | Serial No. | Calibration Date | Calibration Interval |
|--------------|--------------------|-----------|------------|------------------------|----------------------|
| Agilent | Analyzer, Spectrum | E4446A | MY48250238 | 2019-06-26 | 1 year |
| - | RF Cable | - | - | Each time ¹ | N/A |
| - | 20dB attenuator | - | - | Each time ¹ | N/A |

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: *BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 02 October 2018) "A2LA Policy on Metrological Traceability".*

10.4 Test Environmental Conditions

| | |
|--------------------|-----------|
| Temperature: | 23° C |
| Relative Humidity: | 42 % |
| ATM Pressure: | 101.9 KPa |

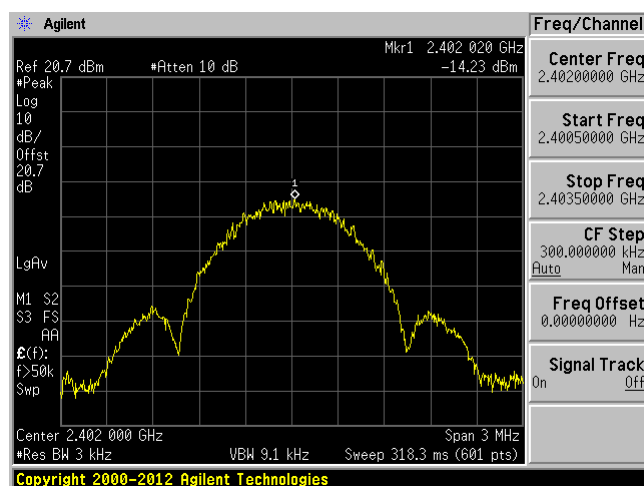
The testing was performed by Zhao Zhao on 2019-11-27 in RF site.

10.5 Test Results

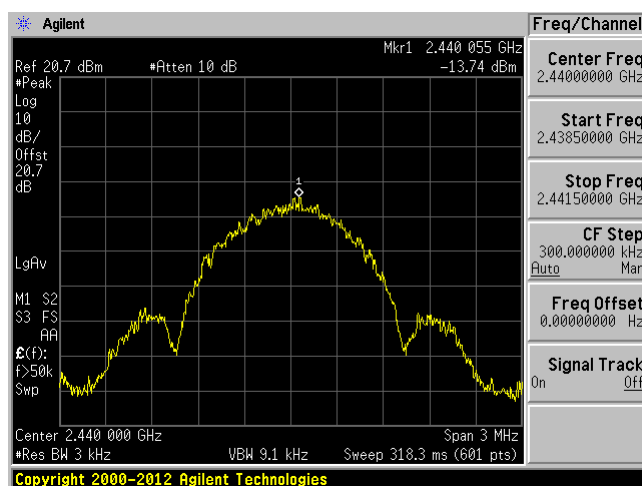
| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) |
|---------|-----------------|----------------|------------------|
| Low | 2402 | -14.23 | 8 |
| Middle | 2440 | -13.74 | 8 |
| High | 2480 | -15.46 | 8 |

Please refer to the following plots for detailed test results

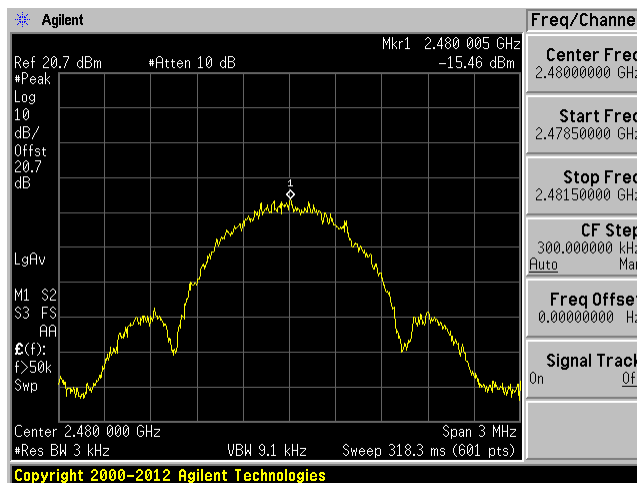
Low Channel 2402 MHz



Middle Channel 2440 MHz



High Channel 2480 MHz



11 FCC §15.247(d) - Spurious Emissions at Antenna Terminals

11.1 Applicable Standards

For ECFR §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)).

11.2 Test Procedure

The RF output of the EUT was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz. Sufficient scans were taken to show any out of band emissions up to 10th harmonic.

11.3 Test Equipment List and Details

| Manufacturer | Description | Model No. | Serial No. | Calibration Date | Calibration Interval |
|--------------|--------------------|-----------|------------|------------------------|----------------------|
| Agilent | Analyzer, Spectrum | E4446A | MY48250238 | 2019-06-26 | 1 year |
| - | RF Cable | - | - | Each time ¹ | N/A |
| - | 20dB attenuator | - | - | Each time ¹ | N/A |

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: *BACL Corp.* attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 02 October 2018) "A2LA Policy on Metrological Traceability".

11.4 Test Environmental Conditions

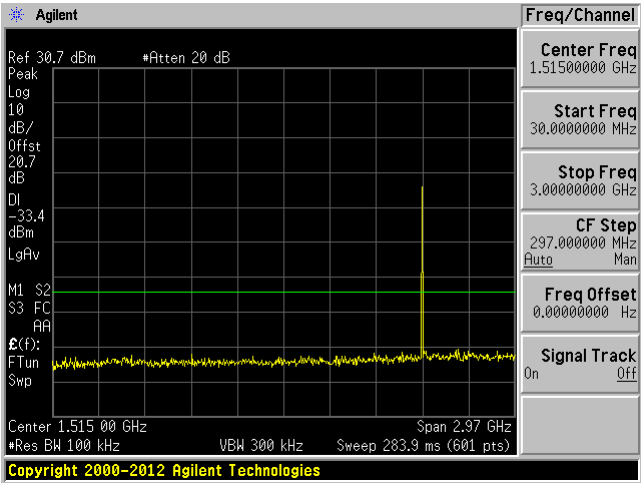
| | |
|--------------------|-----------|
| Temperature: | 23° C |
| Relative Humidity: | 42 % |
| ATM Pressure: | 101.9 KPa |

The testing was performed by Zhao Zhao on 2019-11-27 in RF site.

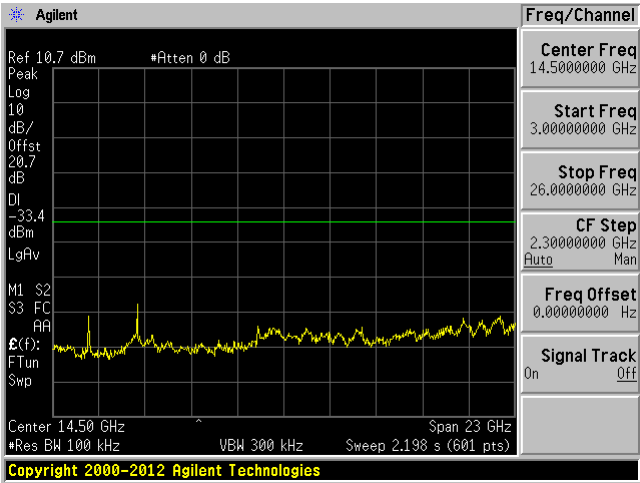
11.5 Test Results

Please refer to following plots.

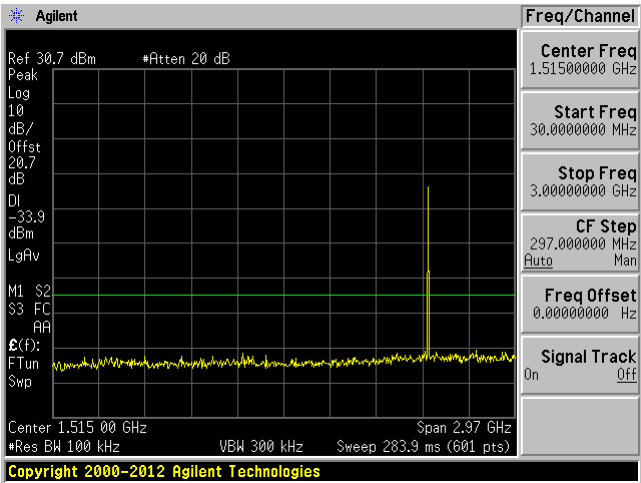
Low Channel 30 MHz – 3 GHz



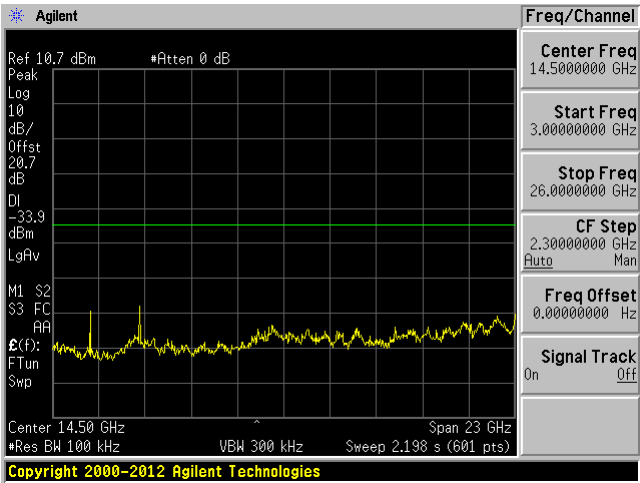
Low Channel 3 GHz – 26 GHz



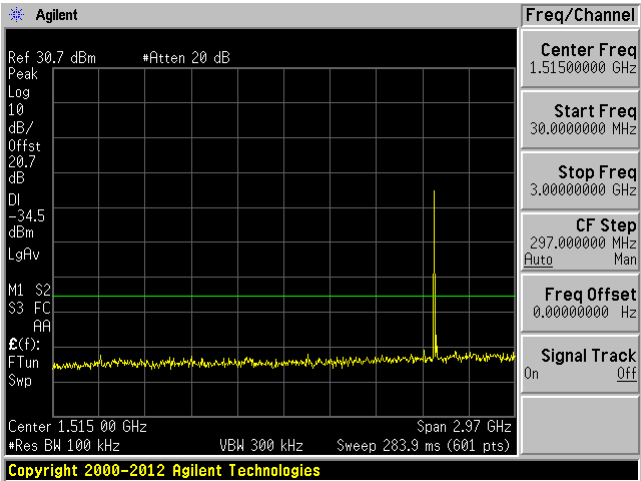
Middle Channel 30 MHz – 3 GHz



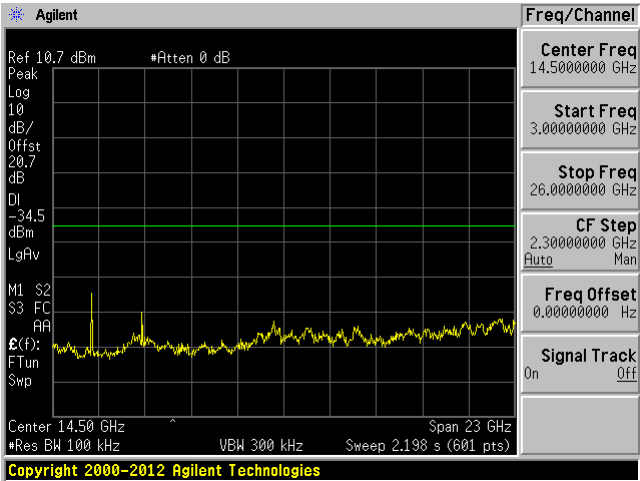
Middle Channel 3 GHz – 26 GHz



High Channel 30 MHz – 3 GHz



High Channel 3 GHz – 26 GHz



12 Annex A (Normative) – EUT Setup Photographs

Please refer to the attachment.

13 Annex B (Normative) – EUT Photographs

Please refer to the attachment.

14 Annex C (Normative) – EUT Internal Photographs

Please refer to the attachment.

15 Annex D (Normative) - A2LA Electrical Testing Certificate



Please follow the web link below for a full ISO 17025 scope

<https://www.a2la.org/scopepdf/3297-02.pdf>

--- END OF REPORT ---