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

TEST REPORT

For

Everex Communications, Inc.

1045 Mission Ct.
Fremont, CA 94539

FCC ID: TF7M90-1000
IC: 27830-M90IC1000

Report Type:	**Model:**
Original Report	M90

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Report Number:	R2106281-247
Report Date:	2021-11-03
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ACCREDITED
CERTIFICATE #3297.02

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R2106281-247	Original Report	2021-11-03

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test report was prepared on behalf of *Everex Communications, Inc.* and their product model: *M90, FCC ID: TF7M90-1000, IC: 27830-M90IC1000,* or the "EUT" as referred to in this report. The EUT is a PTAC Electronic Controller and has 802.15.4 and BLE radios.

1.2 Objective

This report was prepared on behalf of *Everex Communications, Inc.*, in accordance with Part 2, Subpart J, and Part 15, Subparts B and C of the Federal Communication Commission's rules and ISEDC RSS-247 Issue 2, February 2017.

The objective was 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.

1.3 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 v05r02: 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 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: (Innovation, Science and Economic development Canada - ISEDC) 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:

  - EMC Directive 2014/30/EU US-EU EMC & Telecom MRA CAB (NB)
  - Radio Equipment (RE) Directive 2014/53/EU US-EU EMC & Telecom MRA CAB (NB)
  - 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:
  - ENERGY STAR Recognized Test Laboratory – US EPA
  - Telecommunications Certification Body (TCB) – US FCC;
  - 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 used was Putty. The software is compliant with the standard requirements being tested against.

Modulation	Frequency (MHz)	Power Setting
802.15.4	2405	B
	2440	B
	2475	B
BLE	2402	Max
	2440	Max
	2480	Max

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	0.598	1.249	47.88	3.199

Duty Cycle = On Time (ms)/ Period (ms)
Duty Cycle Correction Factor (dB) = 10*log(1/Duty Cycle)

According to KDB 558074 D01 DTS Meas Guidance v05r02 section 11.0, Answer 3(c):

Taking a RMS average measurement while EUT is transmitting continuously, i.e., greater than 98%, and correcting for operational duty cycle – When greater than 98% duty cycle is achieved for testing purposes, applying average measurement techniques (e.g., average detector / reduced VBW) then adjusting for the protocol limited duty factor to determine the average emission is acceptable. If the 558074 D01 15.247 Meas Guidance v05r02 Page 13 EUT supports more than one operational duty cycle the worst-case value should be used, i.e., the highest operational duty cycle. This measurement refers to spectrum analyzer settings 11.12.2.5.1 (Trace averaging with continuous EUT transmission at full power) in ANSI C63.10.

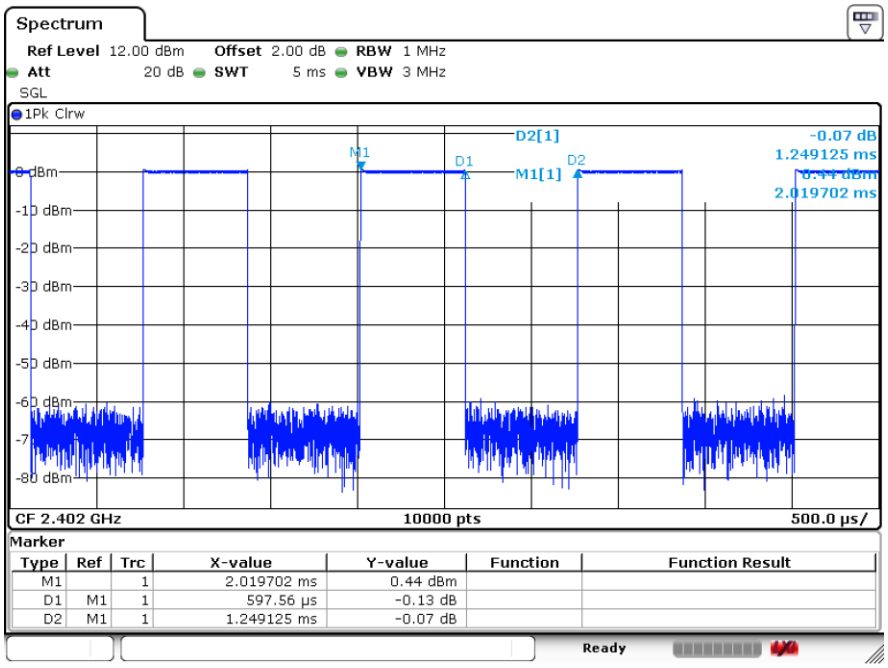
Protocol Limited Duty Cycle/Factor:

Radio Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
802.15.4	37.168	100	37.17	8.5966

Duty Cycle = On Time (ms)/ Period (ms)
Duty Cycle Correction Factor (dB) = 20*log(1/Duty Cycle)

Please refer to the following plots.

BLE



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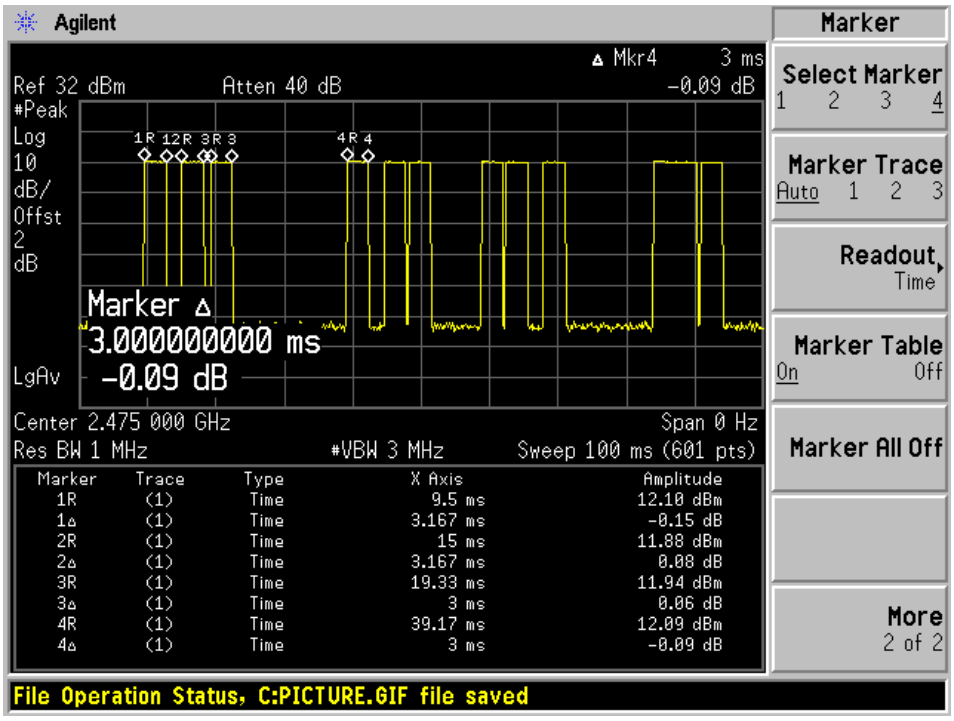
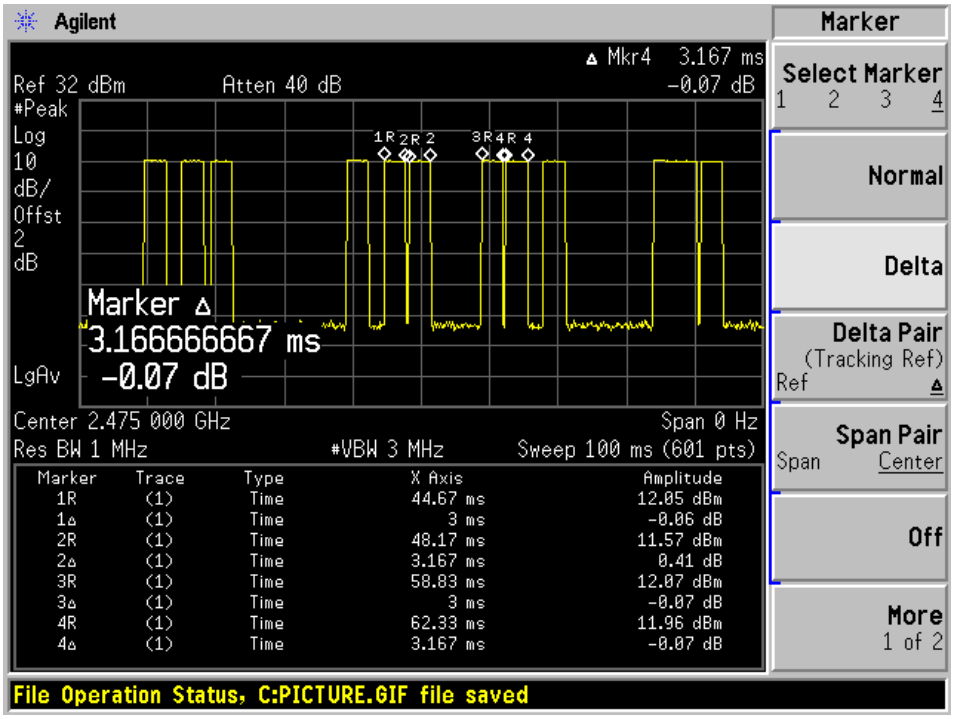
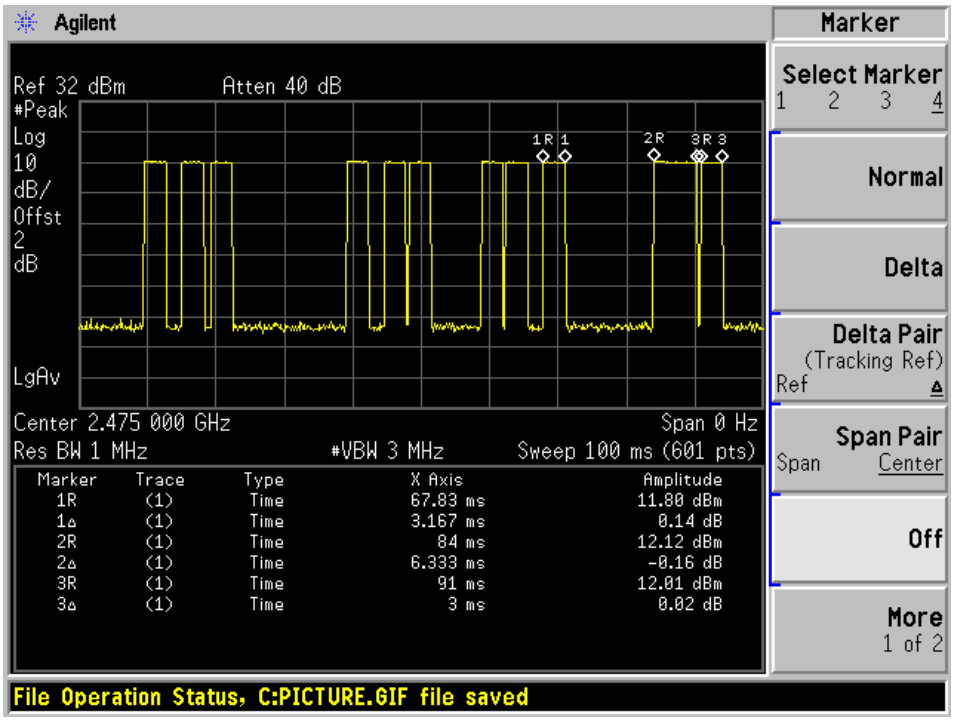
802.15.4(Protocol Limited Duty Cycle)



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Marker
Ref 32 dBm
Atten 40 dB
#Peak
Log
10
dB/
Offst
2
dB
1R 1
2R
3R 3
LgAv
Center 2.475 000 GHz
Span 0 Hz
Res BW 1 MHz
#VBW 3 MHz
Sweep 100 ms (601 pts)
Marker Trace Type X Axis Amplitude
1R (1) Time 67.83 ms 11.80 dBm
1Δ (1) Time 3.167 ms 0.14 dB
2R (1) Time 84 ms 12.12 dBm
2Δ (1) Time 6.333 ms -0.16 dB
3R (1) Time 91 ms 12.01 dBm
3Δ (1) Time 3 ms 0.02 dB
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref
Span Pair
Span Center
Off
More
1 of 2
File Operation Status, C:PICTURE.GIF file saved

2.4 Equipment Modifications

N/A

2.5 Local Support Equipment

Manufacturer	Description	Model	Serial Number
Dell	Laptop	Latitude E6410	3CKRAQ1

2.6 Remote Support Equipment

N/A

2.7 Power Supply/Adapter

Manufacturer	Description	Model
MG Electronics	Plug in Class 2 Transformer	MGT2420

2.8 Interface Ports and Cabling

Description	Length (m)	To	From
Power cables	< 1	EUT	Power Supply

3 Summary of Test Results

Results reported relate only to the product tested.

FCC and ISEDC Rules	Description of Test	Results
FCC §15.203 ISEDC RSS-Gen §6.8	Antenna Requirement	Compliant
FCC §15.207 ISEDC RSS-Gen §8.8	AC Line Conducted Emissions	Compliant
FCC §2.1091, §15.247(i) ISEDC RSS-102	RF Exposure	Compliant
FCC §2.1051, §15.247 (d) ISEDC RSS-247 §5.5	Spurious Emissions at Antenna Port	Compliant
FCC §2.1053, §15.205, §15.209, §15.247 (d) ISEDC RSS-247 §5.5 ISEDC RSS-Gen §8.9 and §8.10	Radiated Spurious Emissions	Compliant
FCC §15.247(a)(2) ISEDC RSS-247 §5.2 (1)	6 dB and 99% Emission Bandwidth	Compliant
FCC §15.247(b)(3) ISEDC RSS-247 §5.4 (4)	Maximum Peak Output Power	Compliant
FCC §15.247(d) ISEDC RSS-247 §5.5	100 kHz Bandwidth of Frequency Band Edge	Compliant
FCC §15.247(e) ISEDC RSS-247 §5.2 (2)	Power Spectral Density	Compliant

4 FCC §15.203 & ISEDC RSS-Gen §6.8 - 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 §6.8: Transmitter Antenna

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotopically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

For license-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

This radio transmitter [enter the device's ISED certification number] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

4.2 Antenna Description

Antenna usage	Frequency Range (MHz)	Maximum Antenna Gain (dBi)	Antenna Type
802.15.4	2400-2483.5	3.5	PCB
BLE	2400-2483.5	1.6	PCB

Note: The antenna gain was provided by the manufacturer.

5 FCC §2.1091, §15.247(i) & ISED 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 ISED RSS-102 Issue 5:

2.5.2 Exemption Limits for Routine Evaluation – RF Exposure Evaluation

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz[6] and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

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

BLE Standalone

Maximum power including turn up power (dBm):	1
Maximum power including turn up power (mW):	1.26
Prediction distance (cm):	20
Prediction frequency (MHz):	2402
Maximum Antenna Gain, typical (dBi):	1.6
Maximum Antenna Gain (numeric):	1.45
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.000363
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 20 cm is 0.000363 mW/cm^2. Limit is 1.0 mW/cm^2.

802.15.4 Standalone

Maximum power including turn up power (dBm):	15
Maximum power including turn up power (mW):	31.62
Prediction distance (cm):	20
Prediction frequency (MHz):	2440
Maximum Antenna Gain, typical (dBi):	3.5
Maximum Antenna Gain (numeric):	2.24
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.014
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 20 cm is 0.014 mW/cm^2. Limit is 1.0 mW/cm^2.

Worst Case Co-location MPE Calculation: BLE and 802.15.4

Radio	EIRP (dBm)	Evaluated Distance (cm)	Worst-Case Exposure Level	Limit	Worst-Case Ratios	Sum of Ratios	Limit
Worst Case							
BLE	2.6	20	0.000363 mW/cm^2	1.0 mW/cm^2	0.0363%	1.44%	100%
802.15.4	18.5	20	0.014 mW/cm^2	1.0 mW/cm^2	1.4%		

5.4 RF exposure evaluation exemption for IC

BLE
Maximum EIRP power = 1 dBm + 1.6 dBi = 2.6 dBm which is lesser than $1.31\times10^{-2}f^{0.6834}$ = 2.6764 W = 34.276 dBm.

802.15.4
Maximum EIRP power = 15 dBm + 3.5 dBi = 18.5 dBm which is lesser than $1.31\times10^{-2}f^{0.6834}$ = 2.705 W = 34.322 dBm.

Therefore, the RF exposure Evaluation is exempt.

6 FCC §15.207 & ISEDC RSS-Gen §8.8 - AC Power Line Conducted Emissions

6.1 Applicable Standards

As per FCC §15.207 and ISEDC RSS GEN §8.8

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 frequencies ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 Note1	56 to 46 Note2
0.5-5	56	46
5-30	60	50

Note1: Decreases with the logarithm of the frequency.
Note2: A linear average detector is required

6.2 Test Setup

The measurement was performed at shield room, using the setup per ANSI C63.10-2013 measurement procedure. The specification used was FCC §15.207 limits and and ISEDC RSS GEN §8.8.

External I/O cables were draped along the edge of the test table and bundle when necessary.
The AC/DC power adapter of the EUT was connected with LISN-1 which provided 120 V / 60 Hz AC power.

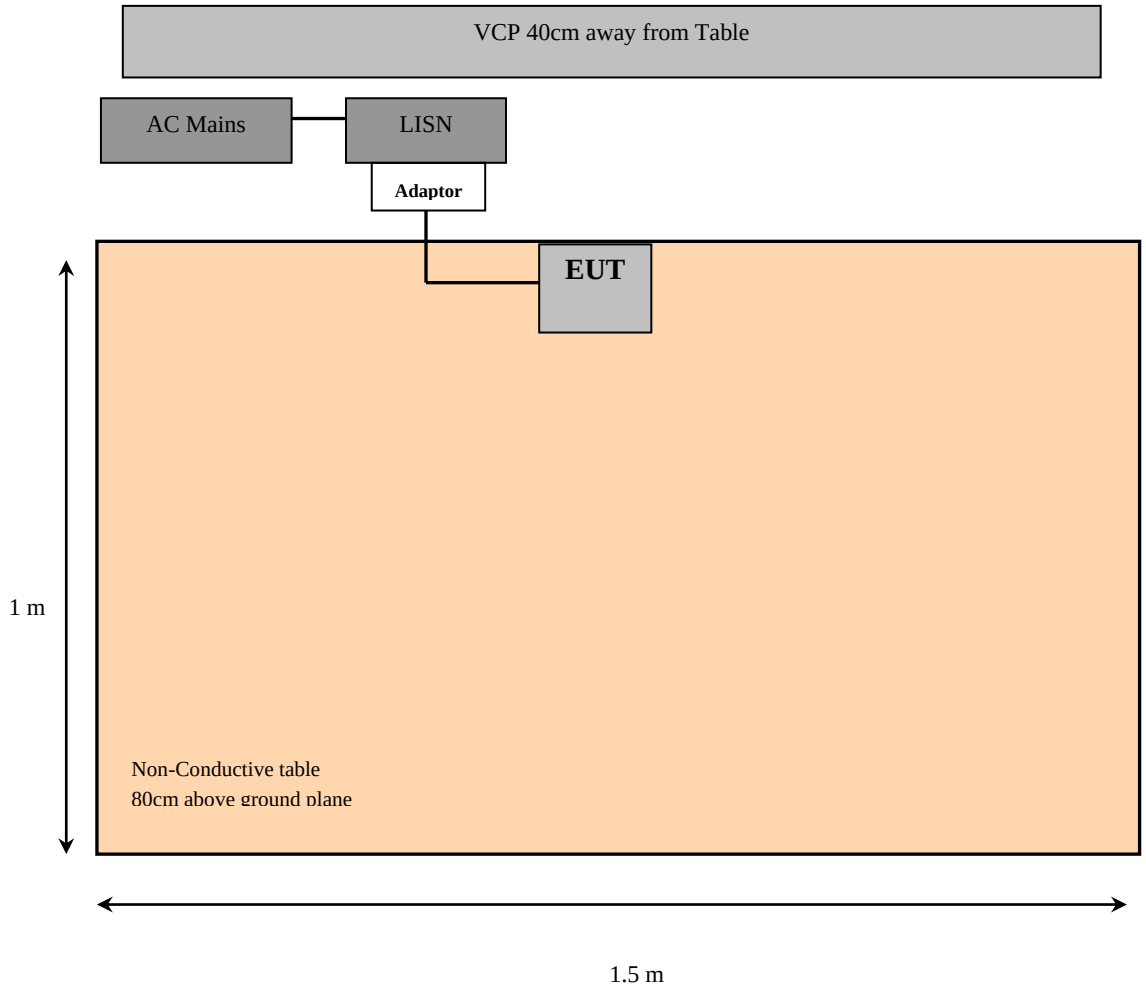
6.3 Test Procedure

During the conducted emissions test, the power cord of the EUT host system was connected to the mains outlet of the LISN-1 and the power cords of support equipment were connected to LISN-2.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All data was recorded in the peak, quasi-peak, and average detection mode. Quasi-Peak readings are distinguished with a “QP.” Average readings are distinguished with an “Ave”.

6.4 Test Setup Block Diagram



6.5 Corrected Amplitude and Margin Calculation

The Corrected Amplitude (CA) is calculated by adding the Correction Factor (CF) to indicated Amplitude (Ai) reading. The basic equation is as follows:

CA = Ai + CF

For example, a corrected amplitude of 46.2 dBuV = Indicated Reading (32.5 dBuV) + Correction Factor (13.7 dB)

The Correction Factor is calculated by adding Cable loss (CL), LISN calibration factor, and attenuation of the impulse limiter and the high pass filter. The basic equation is as follows:

CF= CL + LISN calibration factor + Attenuation

For example, a corrected amplitude of 46.2 dBuV = Indicated Reading (32.5 dBuV) + Cable Loss (3.5 dB) + LISN calibration factor (0.2 dB) + Attenuator (10 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

6.6 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
0322	Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100337	2021-03-09	2 years
0680	Rohde and Schwarz	Impulse Limiter	ESH3-Z2	101964	2021-07-07	1 year
0726	Solar Electronics Company	High Pass Filter	Type 7930-100	7930150204	2020-11-12	1 year
1226	Generic	Conductive emission cable	-	2109241	2021-09-24	1 year
0733	FCC	LISN	FCC-LISN-50-25-2-10-CISPR16	160130	2020-10-13	13 months
-	Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

Note[1]: equipment 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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

6.7 Test Environmental Conditions

Temperature:	20º C
Relative Humidity:	55 %
ATM Pressure:	102.1 kPa

The testing was performed by Christian McCaig on 2021-10-13 in the Ground Plane test site.

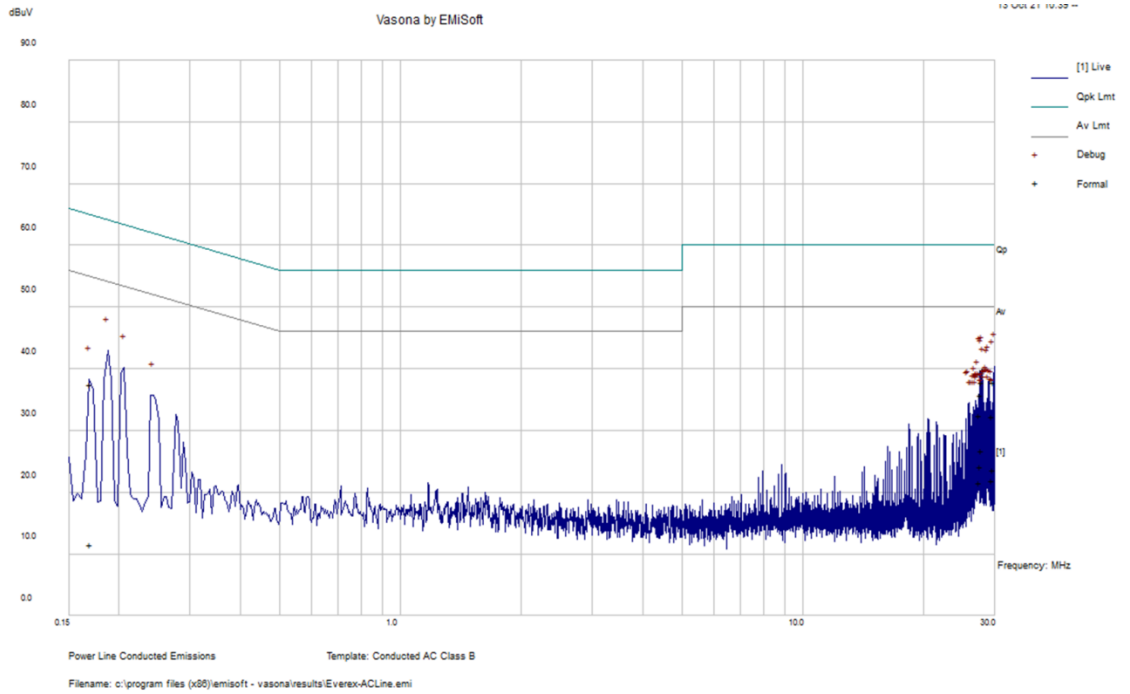
6.8 Summary of Test Results

According to the recorded data in following table, the EUT complied with the FCC Part 15 and RSS-Gen standards' conducted emissions limits, with the margin reading of:

Connection: AC/DC adapter connected to 120 V/60 Hz, AC			
Margin (dB)	**Frequency (MHz)**	**Conductor Mode (Live/Neutral)**	**Range (MHz)**
-22.24	29.896087	Line	0.15-30

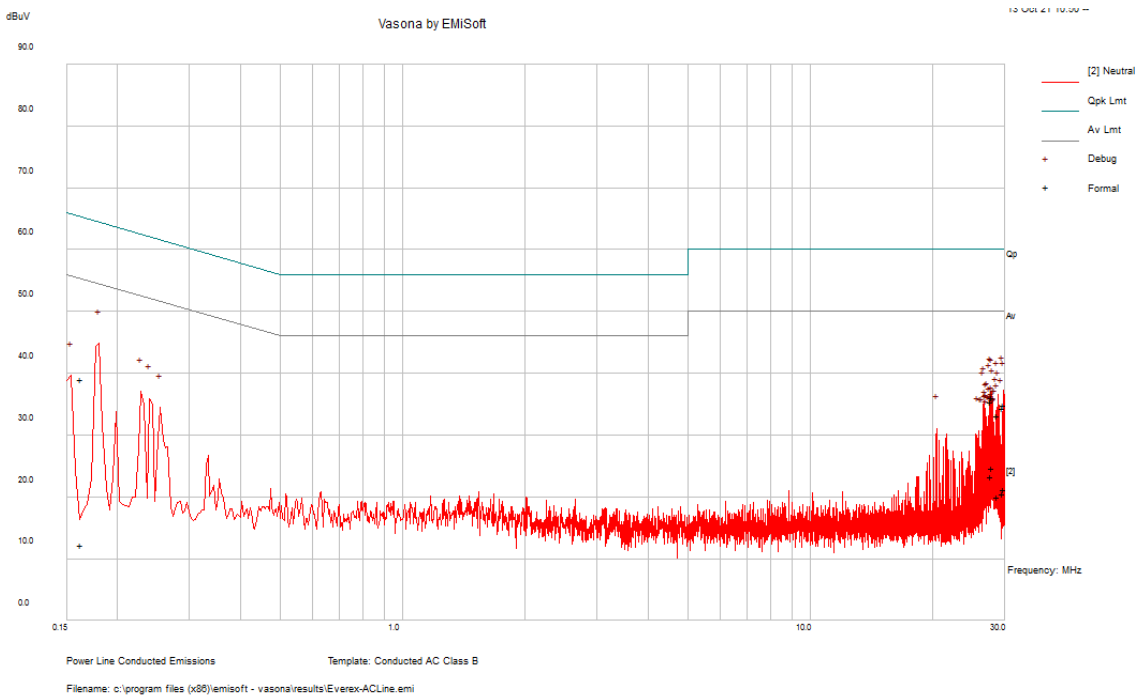
6.9 Conducted Emissions Test Plots and Data

120 V, 60 Hz – Line



Frequency (MHz)	Ai. Reading (dBuV)	Correction Factor (dB)	Corrected Amplitude (dBµV)	Limit (dBµV)	Margin (dB)	Detector
29.896087	**27.25**	**10.51**	**37.76**	**60**	**-22.24**	**QP**
27.859794	27.28	10.48	37.76	60	-22.24	QP
27.486375	22.03	10.48	32.51	60	-27.49	QP
27.673339	25.32	10.49	35.81	60	-24.19	QP
29.702643	21.74	10.51	32.25	60	-27.75	QP
0.169819	27.77	9.76	37.53	64.97	-27.44	QP
29.896087	13.15	10.52	23.67	50	-26.33	Ave
27.859794	16.33	10.49	26.82	50	-23.18	Ave
27.486375	11.1	10.49	21.59	50	-28.41	Ave
27.673339	13.6	10.49	24.09	50	-25.91	Ave
29.702643	11.42	10.51	21.93	50	-28.07	Ave
0.169819	1.84	9.75	11.59	54.97	-43.38	Ave

120 V, 60 Hz – Neutral



Frequency (MHz)	Ai. Reading (dBuV)	Correction Factor (dB)	Corrected Amplitude (dBµV)	Limit (dBµV)	Margin (dB)	Detector
0.16286	29.35	9.74	39.09	65.32	-26.23	QP
29.694099	23.91	10.5	34.41	60	-25.59	QP
27.665384	24.88	10.49	35.37	60	-24.63	QP
27.850512	25.67	10.49	36.16	60	-23.84	QP
28.771282	22.67	10.49	33.16	60	-26.84	QP
29.879654	24.39	10.51	34.9	60	-25.10	QP
0.16286	2.57	9.75	12.32	55.32	-43.00	Ave
29.694099	9.97	10.51	20.48	50	-29.52	Ave
27.665384	12.85	10.49	23.34	50	-26.66	Ave
27.850512	14.27	10.48	24.75	50	-25.25	Ave
28.771282	9.47	10.5	19.97	50	-30.03	Ave
29.879654	10.76	10.51	21.27	50	-28.73	Ave

7 FCC §15.209, §15.247(d) & ISEDC RSS-247 §5.5, RSS-Gen §8.9, §8.10 - Spurious Radiated Emissions

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

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

* Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for license-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a 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 specific 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.

7.2 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 and ISEDC RSS-247 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.

7.3 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 meters 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

7.4 Corrected Amplitude and Margin Calculation

For emissions below 1 GHz,

The Corrected Amplitude (CA) is calculated by adding the Correction Factor to the S.A. Reading. The basic equation is as follows:

CA = S.A. Reading + Correction Factor

For example, a corrected amplitude of 40.3 dBuV/m = S.A. Reading (32.5 dBuV) + Correction Factor (7.8 dB/m)

The Correction Factor is calculated by adding the Antenna Factor (AF), the Cable Loss (CL), the Attenuator Factor (Atten) and subtracting the Amplifier Gain (Ga) together. This calculation is done in the measurement software, and reported in the test result section. The basic equation is as follows:

Correction Factor = AF + CL + Atten – Ga

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

For emission above 1 GHz,

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:

$$CA = Ai + AF + CL + Atten - Ga$$

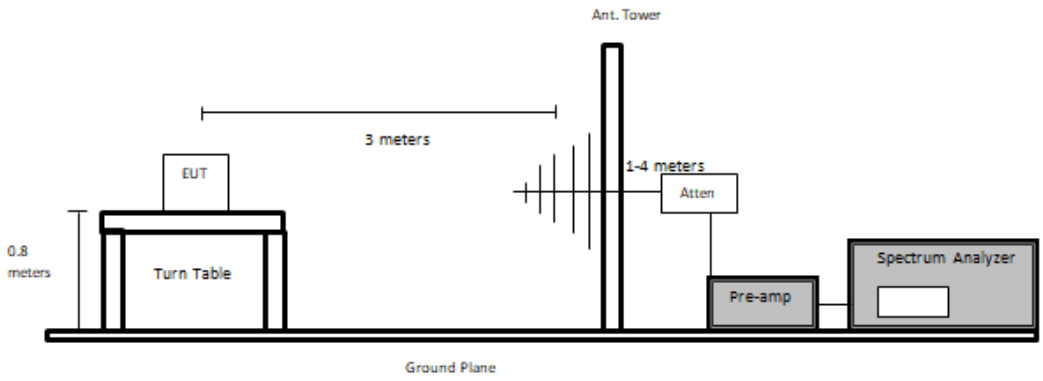
For example, a corrected amplitude of 40.3 dBuV/m = Indicated Reading (32.5 dBuV) + Antenna Factor (+23.5dB/m) + Cable Loss (3.7 dB) + Attenuator (10 dB) - Amplifier Gain (29.4 dB)

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:

$$Margin = Corrected\ Amplitude - Limit$$

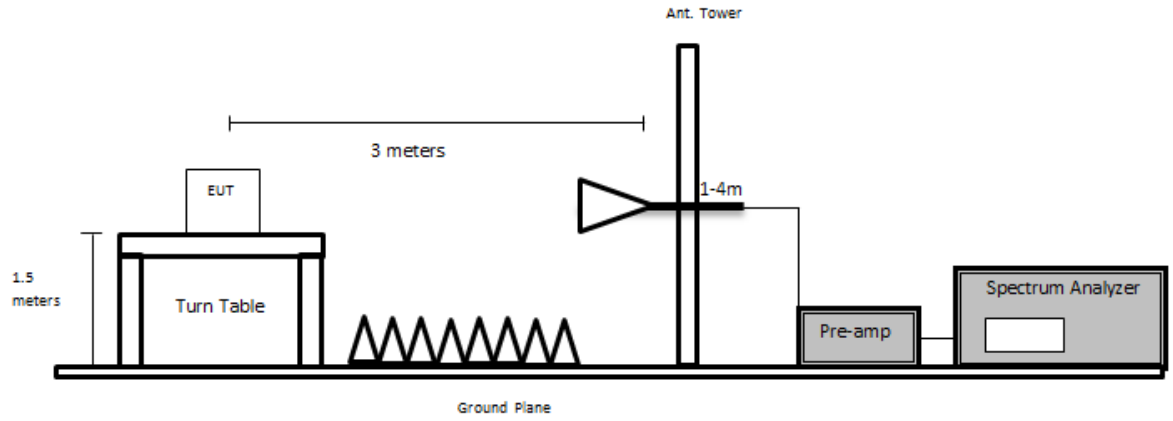
7.5 Test Setup Block Diagram

Below 1GHz:

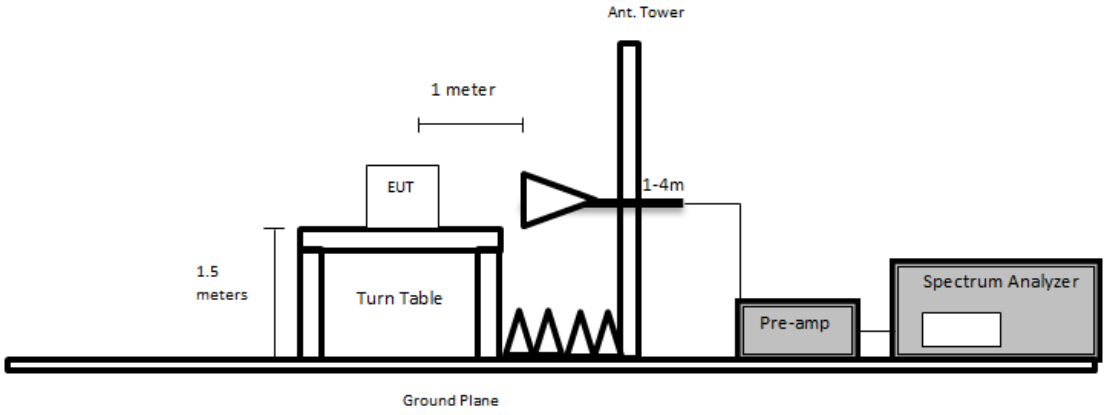


Above 1GHz:

At 3 meters:



At 1 meter:



7.6 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
0310	Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950.03	100338	2020-03-17	19 months
0811	Keysight Technologies	RF Limiter	11867A	MY42243 052	2020-10-27	1 year
0287	Agilent	Spectrum Analyzer	E4446A	US443003 86	2021-04-27	1 year
-	Sunol Science Corp	System Controller	SC110V	122303-1	N/R	N/A
0105	HP	Pre-Amplifier	8449B	3147A004 00	2021-03-02	1 year
0827	AH Systems	Preamplifier	PAM 1840 VH	170	2021-08-03	1 year
0090	Wisewave	Horn Antenna	ARH-4223-02	10555-01	2021-04-12	1 year
0187	A.R.A	Antenna, Horn	DRG-118/A	1132	2020-02-25	2 years
0321	Sunol Sciences	Biconilog Antenna	JB3	A020106-2	2019-11-20	2 years
0459	HP	Pre Amplifier	8447D	2443A043 74	2020-08-17	14 months
1077	Insulted Wire Corp.	157 Series 2.92 SM (x2) Armored 33 ft. Cable	KPS-1571AN-3960-KPS	DC 1917	2021-03-03	1 year
1081	MDP Digital	Times Microwave LMR 400 UltraFex Coaxial Cable 35\'	LMR400UF	BACL190 4161	2021-06-18	1 year
1101	IW Microwave	157 Series Cable Armored with 2.92mm Male Plugs	KPS-1571AN-2400	DC 1922	2021-07-06	1 year
1151	BACL	5m3 Sensitivity Box	1	2	2020-10-27	1 year
-	-	RF cable	-	-	Each time[1]	N/A
-	-	Notch Filter	-	-	Each time[1]	N/A

Note[1]: equipment 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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

7.7 Test Environmental Conditions

Temperature:	23.7 ºC
Relative Humidity:	50 %
ATM Pressure:	101.3 kPa

The testing was performed by Allen Huang and Christian McCaig from 2021-08-16 to 2021-10-11 in 5m chamber 3.

7.8 Summary of Test Results

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

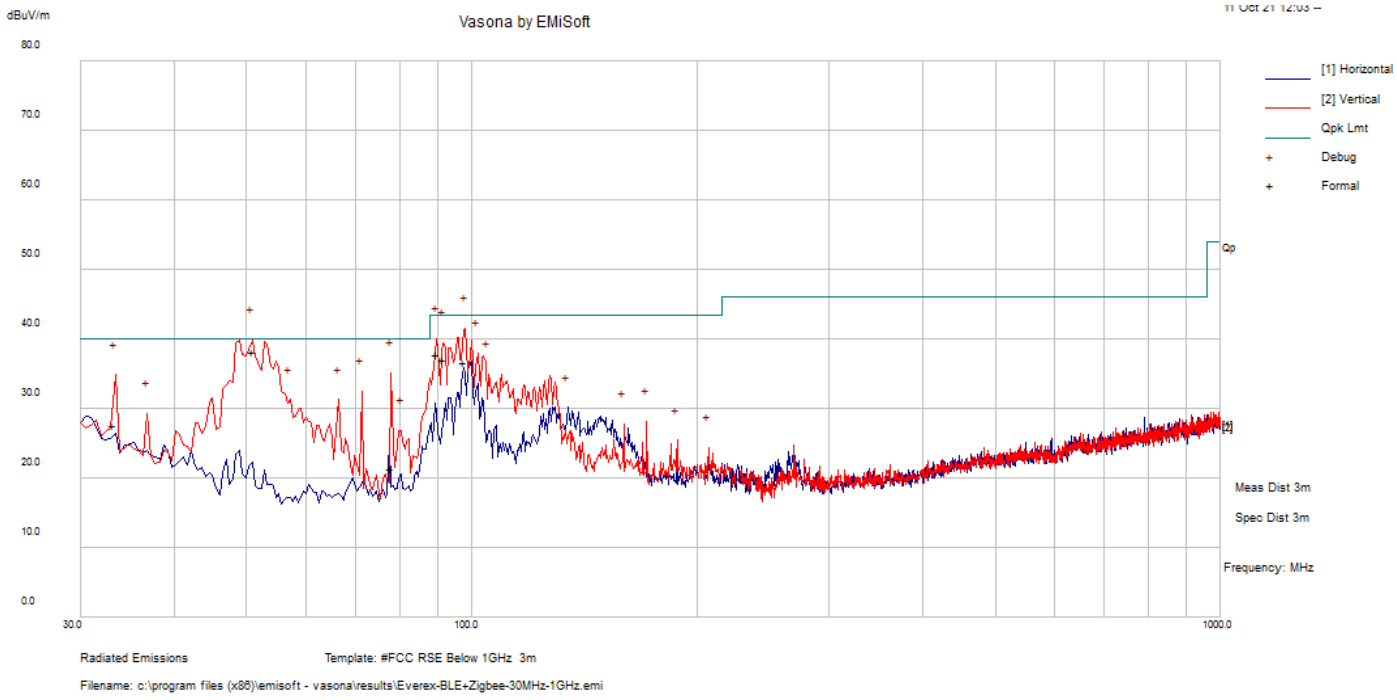
Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Mode, channel**
-1.76	51.01375	Vertical	802.15.4, Mid Channel + BLE, Low Channel

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

7.9 Radiated Emissions Test Results

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

Worst Case: 802.15.4, Mid Channel + BLE, Low Channel



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
51.01375	49.16	-10.92	38.24	132	V	48	40	-1.76	Pass
97.78875	45.09	-8.45	36.64	160	V	300	43.5	-6.86	Pass
89.717	48.35	-10.58	37.77	118	V	192	43.5	-5.73	Pass
91.5385	47.23	-10.2	37.03	122	V	216	43.5	-6.47	Pass
78.11425	32.12	-10.68	21.44	124	V	313	40	-18.56	Pass
33.2215	27.67	-0.03	27.64	201	V	275	40	-12.36	Pass

2) 1–18 GHz Measured at 3 meters

802.15.4

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2405 MHz											
2390	56.09	125	120	H	32.228	5.293	39.359	54.25	74	-19.75	Peak
2390	58.52	100	230	V	32.228	5.293	39.359	56.68	74	-17.32	Peak
2390	38.43	125	120	H	32.228	5.293	39.359	36.59	54	-17.41	Ave
2390	40.04	100	230	V	32.228	5.293	39.359	38.20	54	-15.80	Ave
4804	53.37	315	150	H	34.702	8.336	38.379	58.03	74	-15.97	Peak
4804	53.89	5	130	V	34.702	8.336	38.379	58.55	74	-15.45	Peak
4804	38.02	315	150	H	34.702	8.336	38.379	42.68	54	-11.32	Ave
4804	38.99	5	130	V	34.702	8.336	38.379	43.64	54	-10.36	Ave
Middle Channel 2440 MHz											
4880	52.56	310	150	H	35.3	8.336	35.707	60.489	74	-13.51	Peak
4880	53.72	200	112	V	35.3	8.336	35.707	61.649	74	-12.35	Peak
4880	35.46	310	150	H	35.3	8.336	35.707	43.3854	54	-10.615	Ave
4880	35.34	200	112	V	35.3	8.336	35.707	43.2724	54	-10.73	Ave
High Channel 2475 MH											
2483.5	65.69	350	150	H	32.665	5.523	39.359	64.52	74	-9.48	Peak
2483.5	68.61	100	190	V	32.665	5.523	39.359	67.44	74	-6.56	Peak
2483.5	49.06	350	150	H	32.665	5.523	39.359	47.89	54	-6.11	Ave
2483.5	52.44	100	190	V	32.665	5.523	39.359	51.27	54	-2.73	Ave
4950	52.00	294	115	H	34.678	8.336	38.379	56.64	74	-17.37	Peak
4950	52.43	192	100	V	34.678	8.336	38.379	57.07	74	-16.94	Peak
4950	36.26	294	115	H	34.678	8.336	38.379	40.90	54	-13.10	Ave
4950	37.37	192	100	V	34.678	8.336	38.379	42.00	54	-12.00	Ave

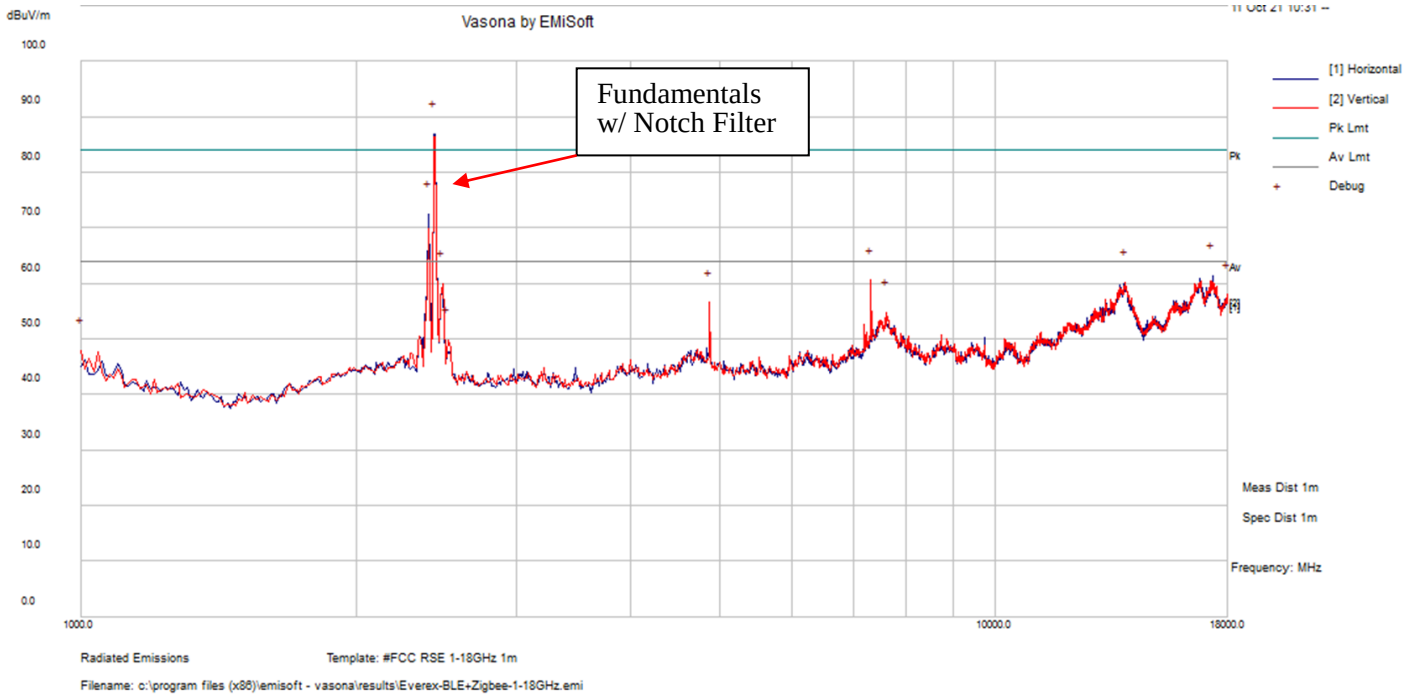
Note: Procedure outlined in KDB 558074 D01 DTS Meas Guidance v05r02 section 11.0, Answer 3(c) was used for measuring Average measurements for 802.15.4 radio.(i.e. " When greater than 98% duty cycle is achieved for testing purposes, applying average measurement techniques then adjusting for the protocol limited duty factor to determine the average emission is acceptable"). This adjustment is described in section 2.3 under "Protocol Limited Duty Cycle/Factor".

BLE

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2402 MHz											
2402	93.56	110	155	H	32.6	4.913	36.863	94.21	-	-	Peak
2402	93.65	192	105	V	32.6	4.913	36.863	94.3	-	-	Peak
2390	49.80	115	135	H	32.6	4.913	36.863	50.45	74	-23.55	Peak
2390	48.70	205	115	V	32.6	4.913	36.863	49.35	74	-24.65	Peak
2390	40.42	115	135	H	32.6	4.913	36.863	41.07	54	-12.93	Ave
2390	40.09	205	115	V	32.6	4.913	36.863	40.74	54	-13.26	Ave
4804	49.85	325	150	H	35	8.336	35.707	57.48	74	-16.52	Peak
4804	48.04	220	150	V	35	8.336	35.707	55.67	74	-18.33	Peak
4804	44.07	325	150	H	35	8.336	35.707	51.70	54	-2.30	Ave
4804	40.57	220	150	V	35	8.336	35.707	48.20	54	-5.80	Ave
7206	46.57	210	150	H	36.1	10.779	36.388	57.06	74.21	-17.15	Peak
7206	46.31	185	155	V	36.1	10.779	36.388	56.80	74.3	-17.50	Peak
Middle Channel 2440 MHz											
4880	47.61	335	260	H	35.3	8.336	35.707	55.54	74	-18.46	Peak
4880	46.65	215	260	V	35.3	8.336	35.707	54.58	74	-19.42	Peak
4880	40.62	335	260	H	35.3	8.336	35.707	48.55	54	-5.45	Ave
4880	38.35	215	260	V	35.3	8.336	35.707	46.28	54	-7.72	Ave
7326	45.25	155	150	H	36.1	10.779	36.483	55.65	74	-18.35	Peak
7326	45.06	360	150	V	36.1	10.779	36.483	55.46	74	-18.54	Peak
7326	37.07	155	150	H	36.1	10.779	36.483	47.46	54	-6.54	Ave
7326	37.24	360	150	V	36.1	10.779	36.483	47.63	54	-6.37	Ave
High Channel 2480 MHz											
2483.5	60.91	170	150	H	33	4.913	36.863	61.96	74	-12.04	Peak
2483.5	59.36	245	245	V	33	4.913	36.863	60.41	74	-13.59	Peak
2483.5	42.27	170	150	H	33	4.913	36.863	43.32	54	-10.68	Ave
2483.5	41.32	245	245	V	33	4.913	36.863	42.37	54	-11.63	Ave
4960	46.40	330	150	H	35.4	8.336	35.707	54.43	74	-19.57	Peak
4960	46.88	0	200	V	35.4	8.336	35.707	54.91	74	-19.09	Peak
4960	39.11	330	150	H	35.4	8.336	35.707	47.14	54	-6.86	Ave
4960	39.41	0	200	V	35.4	8.336	35.707	47.44	54	-6.56	Ave
7440	40.11	240	150	H	36.1	10.779	36.483	50.51	74	-23.49	Peak
7440	46.52	330	150	V	36.1	10.779	36.483	56.92	74	-17.08	Peak
7440	37.91	240	150	H	36.1	10.779	36.483	48.30	54	-5.70	Ave
7440	38.06	330	150	V	36.1	10.779	36.483	48.45	54	-5.55	Ave

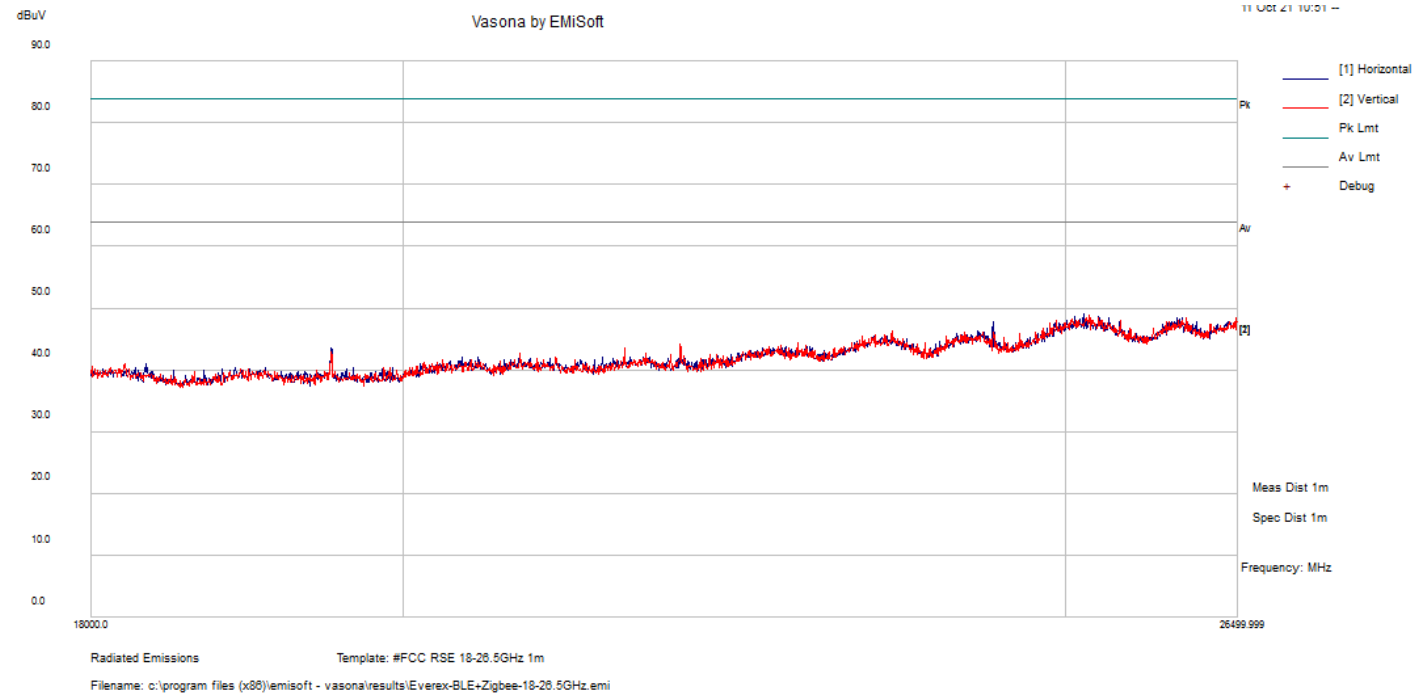
3) 1–18 GHz Measured at 1 meter

Worst case: 802.15.4 Mid Channel + BLE Low Channel



4) 18 – 26.5 GHz Measured at 1 meter

Worst case: 802.15.4, Mid Channel + BLE, Low Channel



8 FCC §15.247(a) (2) & ISEDC RSS-247 §5.2 -Emission Bandwidth

8.1 Applicable Standards

According to ECFR §15.247(a) (2) and ISEDC RSS-247 §5.2, 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

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 8: DTS bandwidth

8.3 Test Equipment List and Details

Bacl No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
0912	Rhode & Schwarz	Spectrum Analyzer	FSV40	101203	2021-04-26	1 year
-	-	RF cable	-	-	Each time[1]	N/A

Note[1]: cable 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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

8.4 Test Environmental Conditions

Temperature:	23.6º C
Relative Humidity:	53 %
ATM Pressure:	101.3 KPa

The testing was performed by Christian McCaig on 2021-10-13 in RF site.

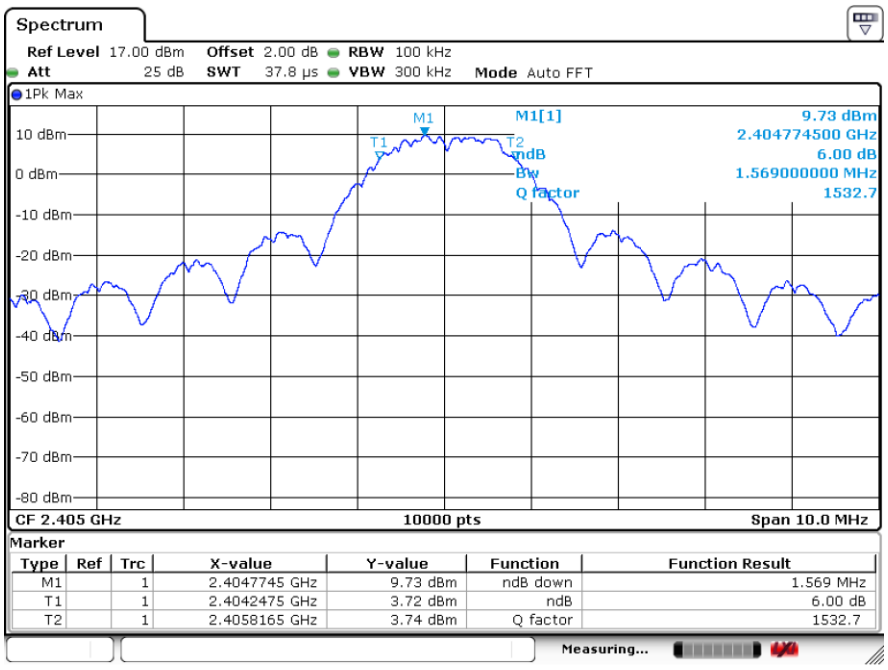
8.5 Test Results

Mode	Channel	Frequency (MHz)	6 dB OBW (MHz)	99% OBW (MHz)	6 dB OBW Limit (kHz)	Result
802.15.4	Low	2405	1.569	2.368	≥ 500	Pass
	Middle	2440	1.583	2.418	≥ 500	Pass
	High	2475	1.604	2.437	≥ 500	Pass
BLE	Low	2402	0.741	1.046	≥ 500	Pass
	Middle	2440	0.744	1.055	≥ 500	Pass
	High	2480	0.748	1.055	≥ 500	Pass

Please refer to the following plots for detailed test results:

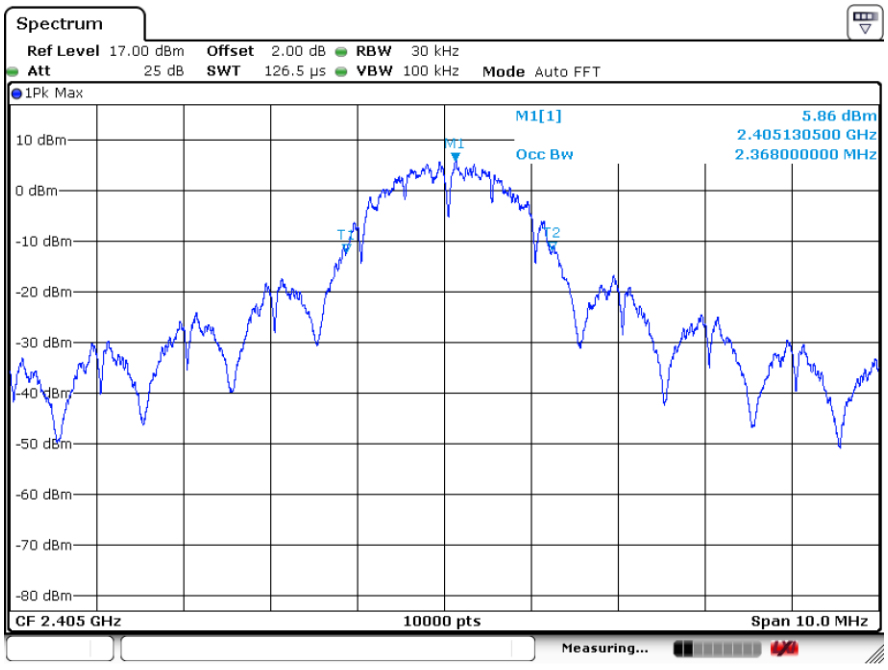
802.15.4

Low Channel 6 dB OBW



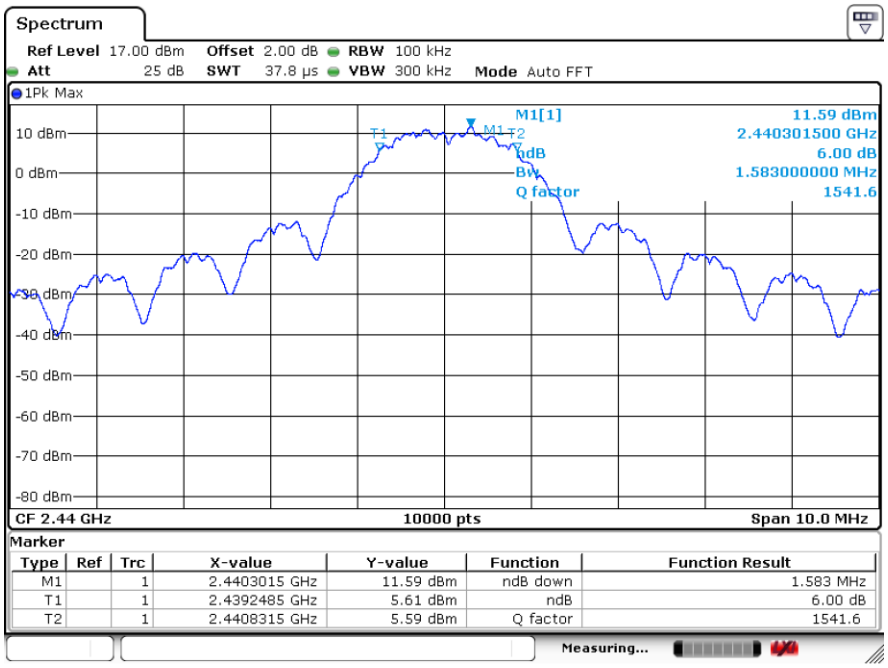
Date: 13.OCT.2021 09:11:25

Low Channel 99% dB OBW



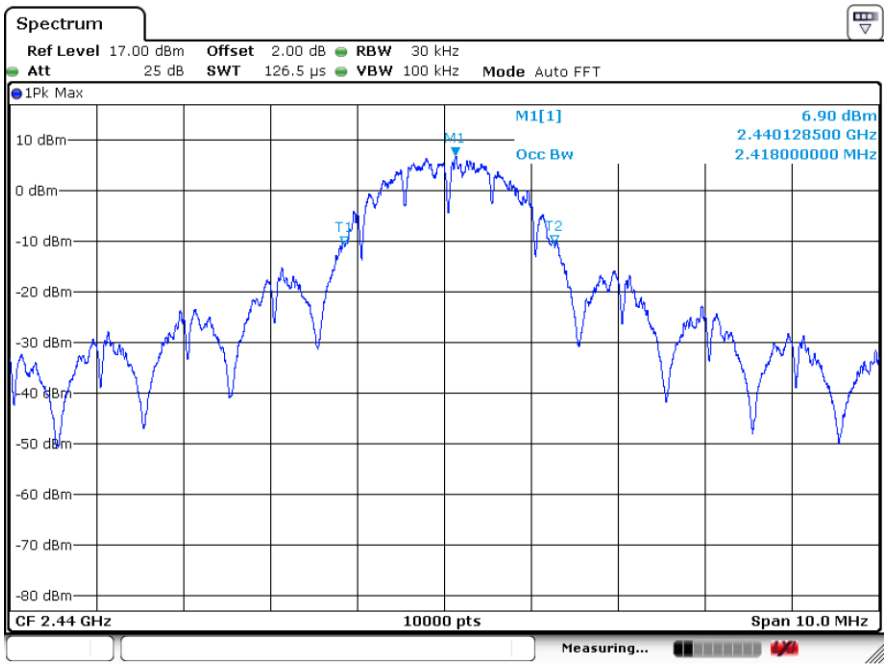
Date: 13.OCT.2021 09:12:34

Mid Channel 6 dB OBW



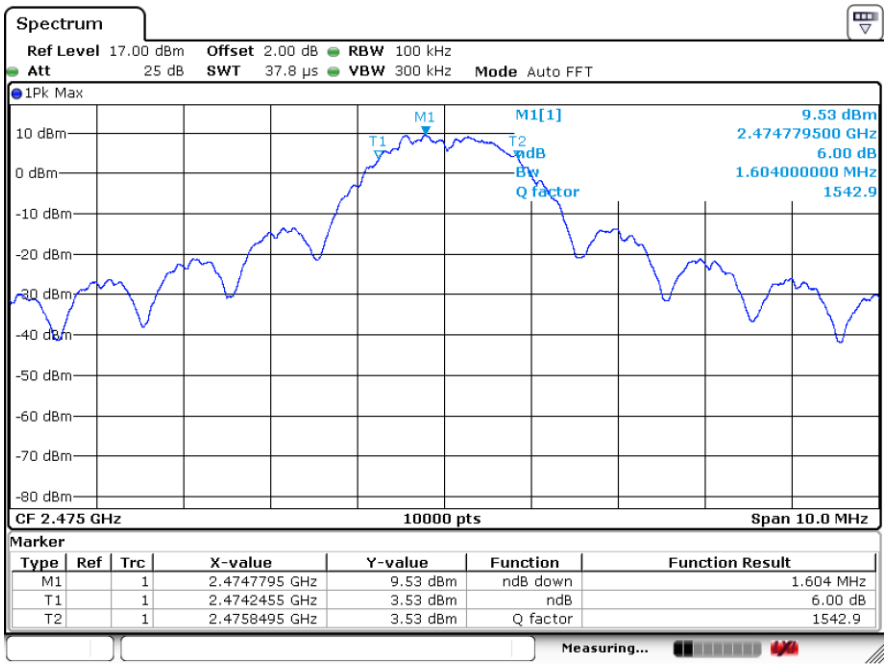
Date: 13.OCT.2021 09:16:10

Mid Channel 99% dB OBW



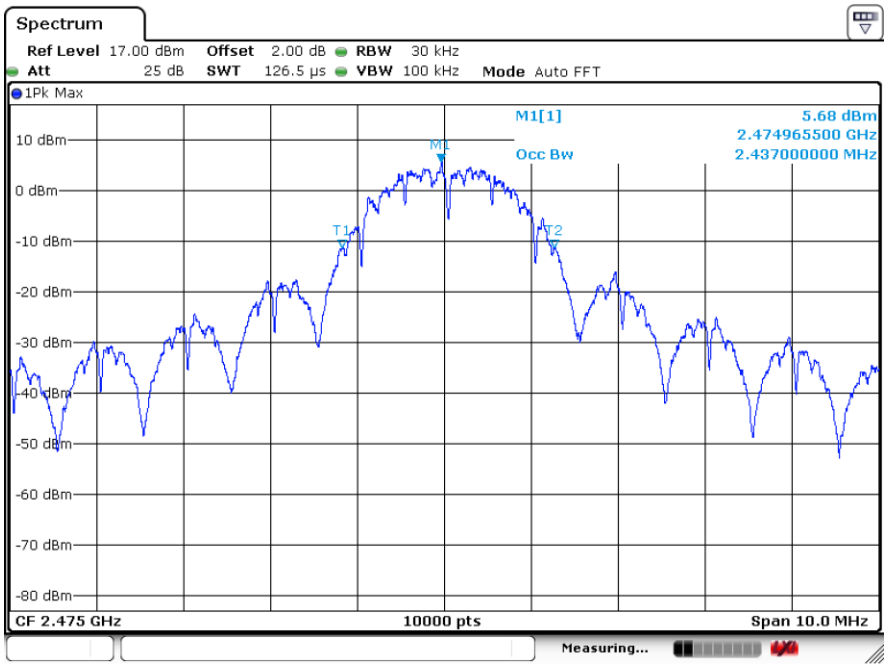
Date: 13.OCT.2021 09:14:57

High Channel 6 dB OBW



Date: 13.OCT.2021 09:26:11

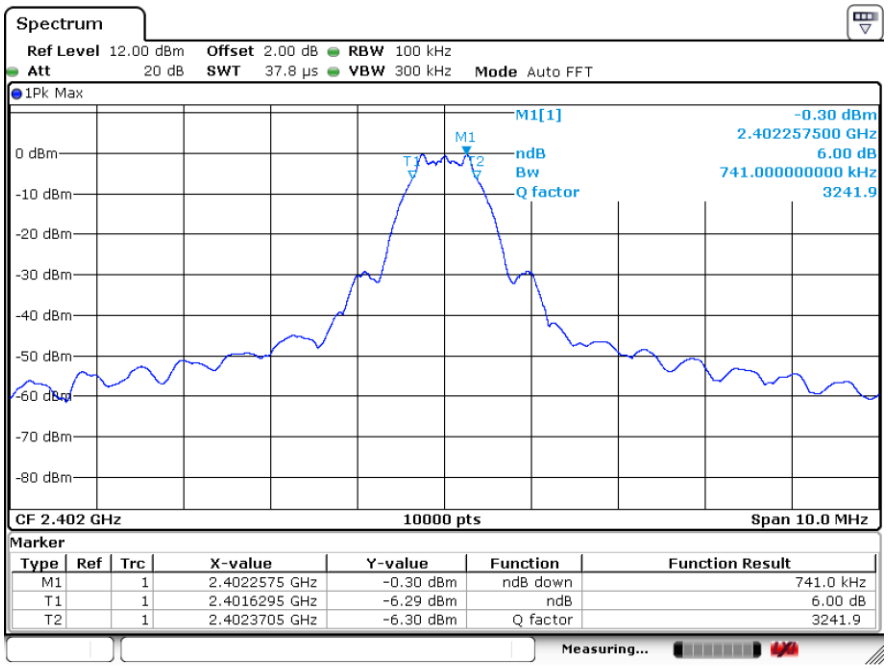
High Channel 99% dB OBW



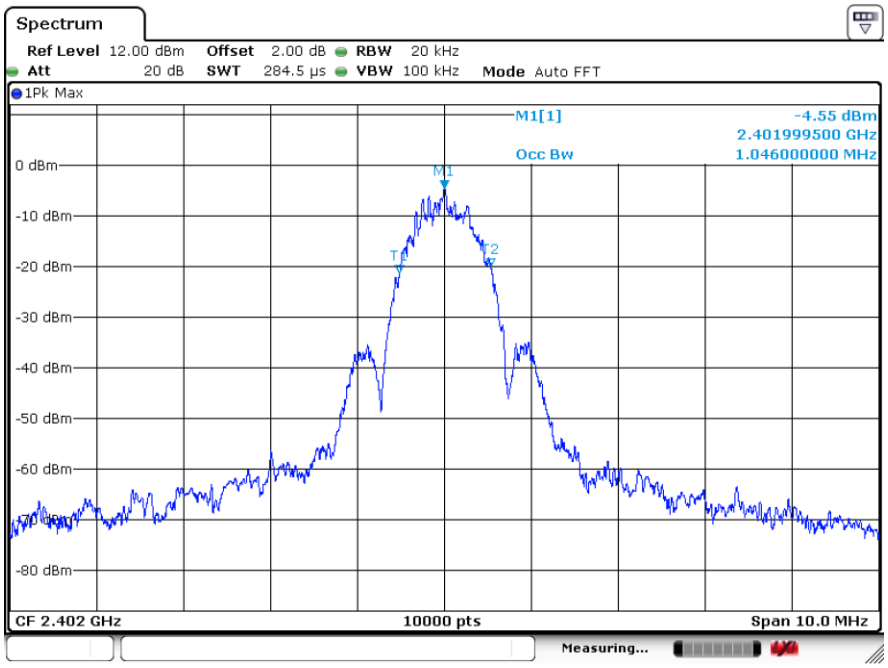
Date: 13.OCT.2021 09:26:47

BLE

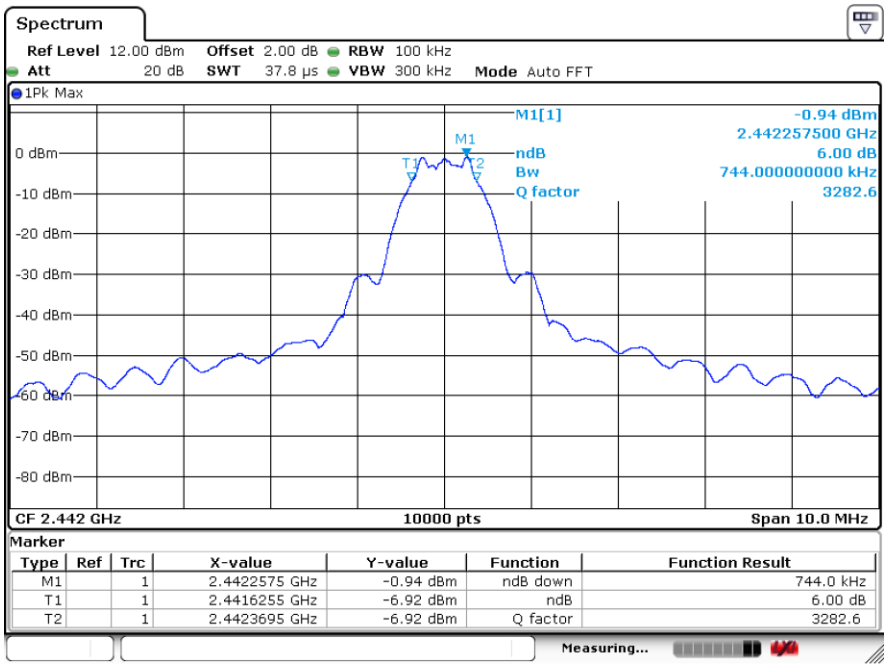
Low Channel 6 dB OBW



Low Channel 99% dB OBW

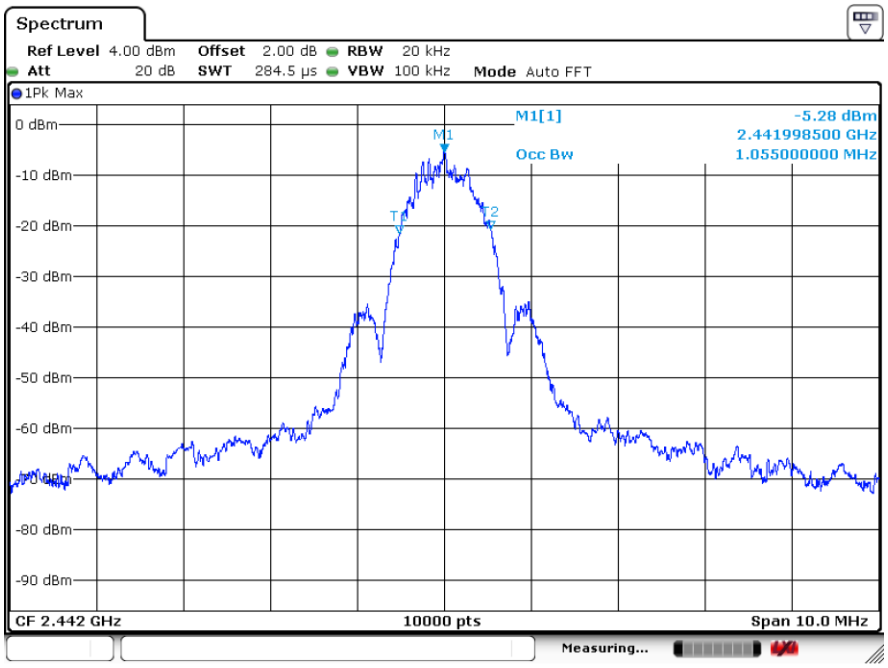


Mid Channel 6 dB OBW



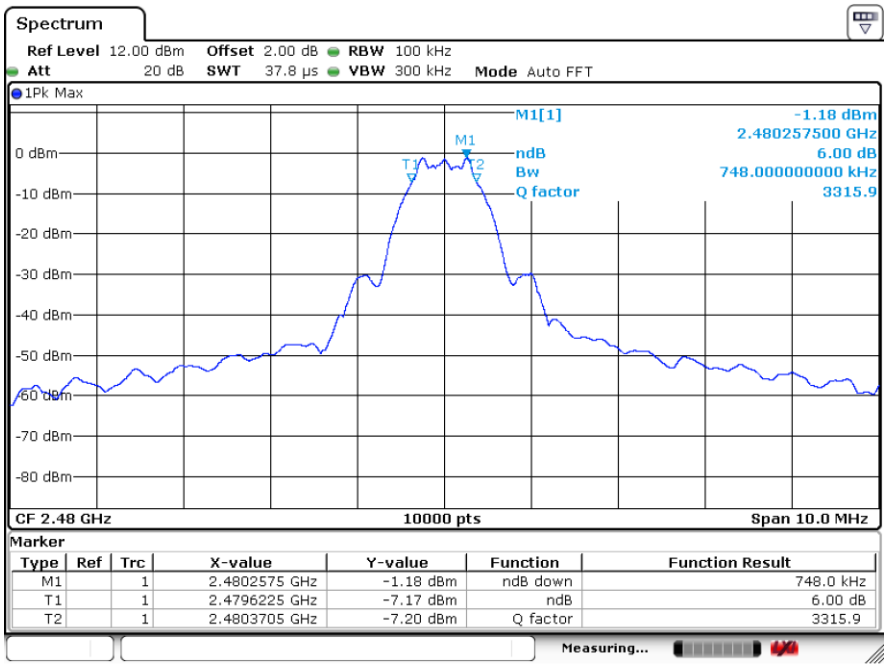
Date: 13.OCT.2021 08:32:05

Mid Channel 99% dB OBW

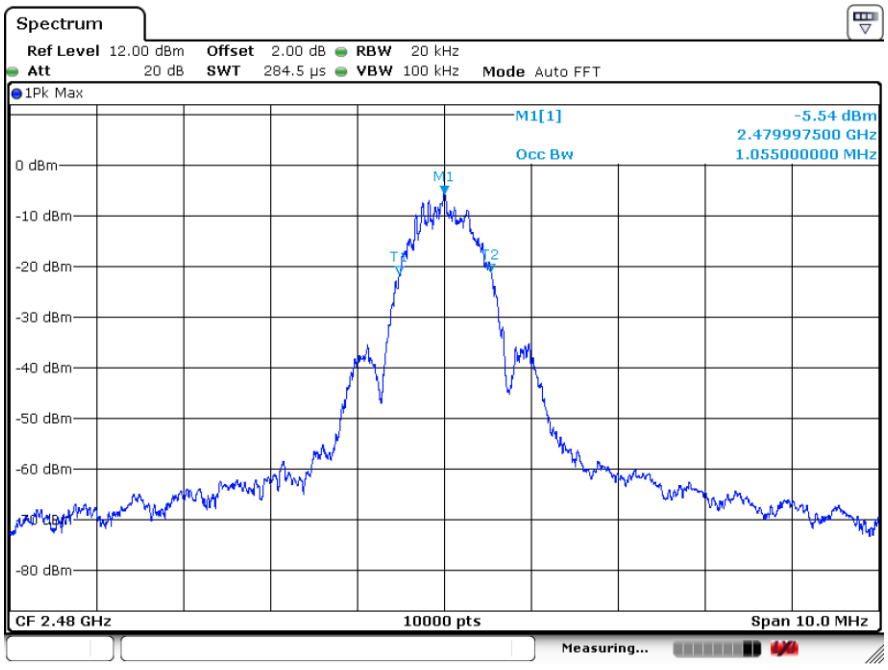


Date: 13.OCT.2021 08:31:21

High Channel 6 dB OBW



High Channel 99% dB OBW



9 FCC §15.247(b) (3) & ISEDC RSS-247 §5.4 (4) - Output Power Measurement

9.1 Applicable Standards

According to ECFR §15.247(b) (3) and ISEDC RSS-247 §5.4 (4) for systems using digital modulation in the 902~928 MHz, 2400~2483.5 MHz, and 5725~5850 MHz bands: 1 Watt.

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 9: Fundamental emission output power

9.3 Test Equipment List and Details

Bacl No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
0624	Agilent	Spectrum Analyzer	E4446A	MY48250238	2021-02-12	1 year
-	-	RF cable	-	-	Each time[1]	N/A

Note[1]: cable 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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

9.4 Test Environmental Conditions

Temperature:	22º C
Relative Humidity:	55 %
ATM Pressure:	102.1 KPa

The testing was performed by Christian McCaig on 2021-10-11 at RF site.

9.5 Test Results

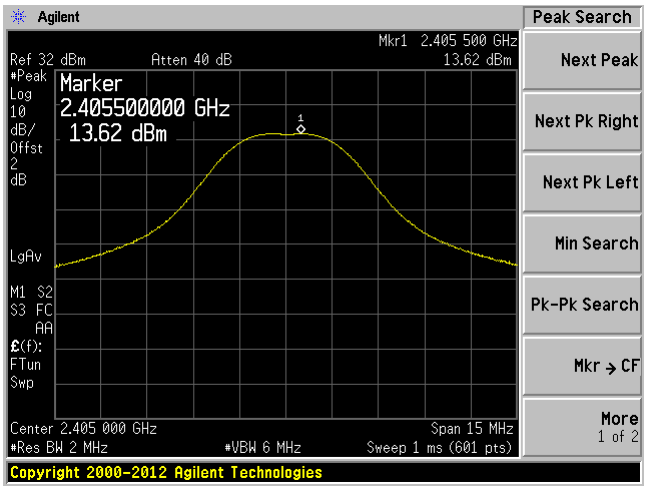
Peak Output Power

Mode	Channel	Frequency (MHz)	Conducted Output Power (dBm)	Output Power Limit (dBm)	Result
802.15.4	Low	2405	13.62	30	Pass
	Middle	2440	14.66	30	Pass
	High	2475	13.41	30	Pass
BLE	Low	2402	0.51	30	Pass
	Middle	2440	0.06	30	Pass
	High	2480	-0.07	30	Pass

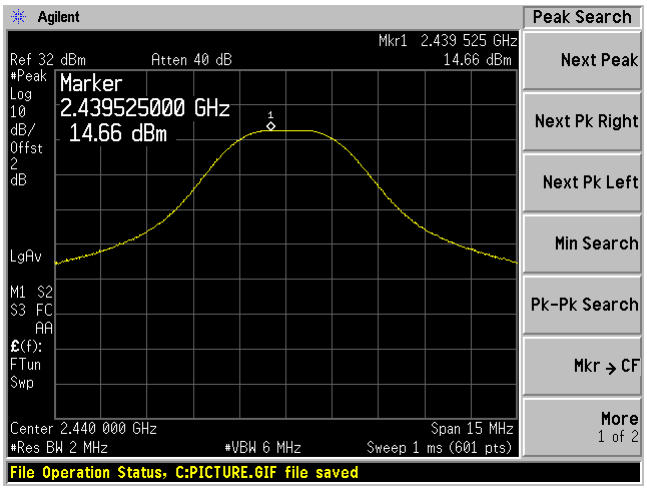
Please refer to the following plots for detailed test results:

802.15.4

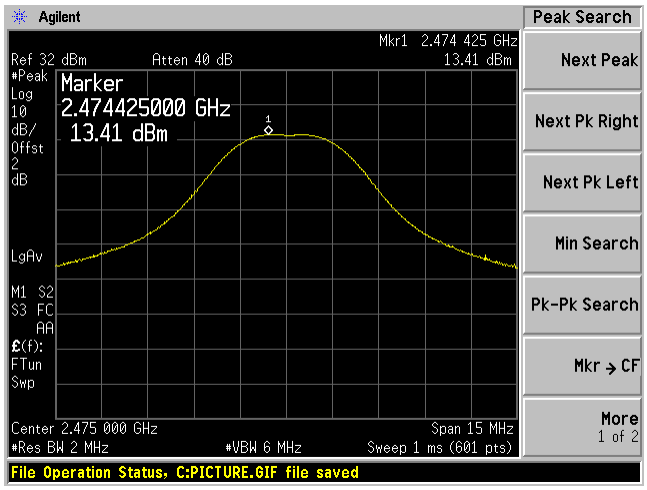
Low Channel



Mid Channel

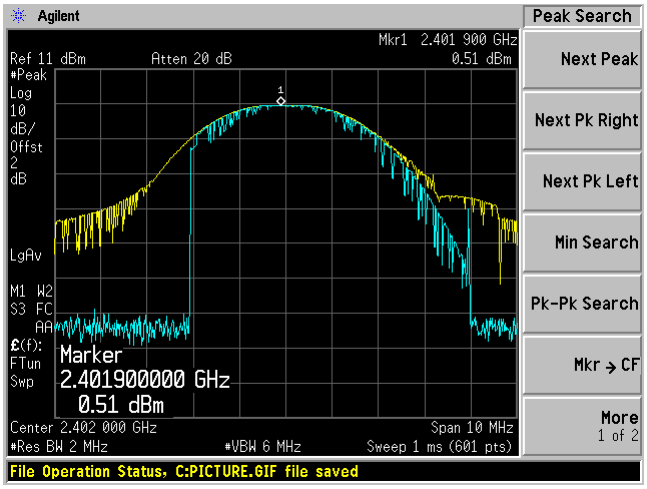


High Channel

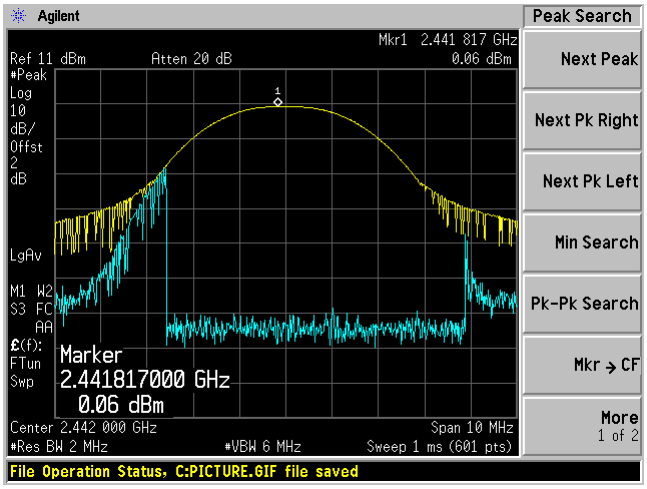


BLE

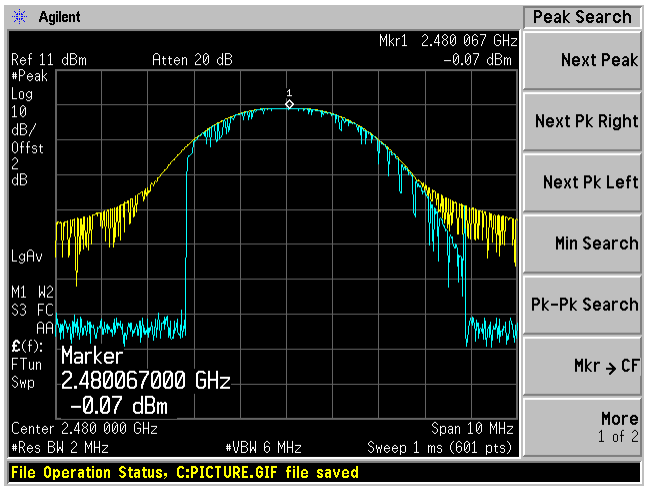
Low Channel



Mid Channel



High Channel



10 FCC §15.247(d) and ISEDC RSS-247 §5.5 – 100 kHz Bandwidth of Band Edges

10.1 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).

According to 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.

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 13: Band-edge measurements

10.3 Test Equipment List and Details

Bacl No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
0912	Rhode & Schwarz	Spectrum Analyzer	FSV40	101203	2021-04-26	1 year
-	-	RF cable	-	-	Each time[1]	N/A

Note[1]: cable 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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

10.4 Test Environmental Conditions

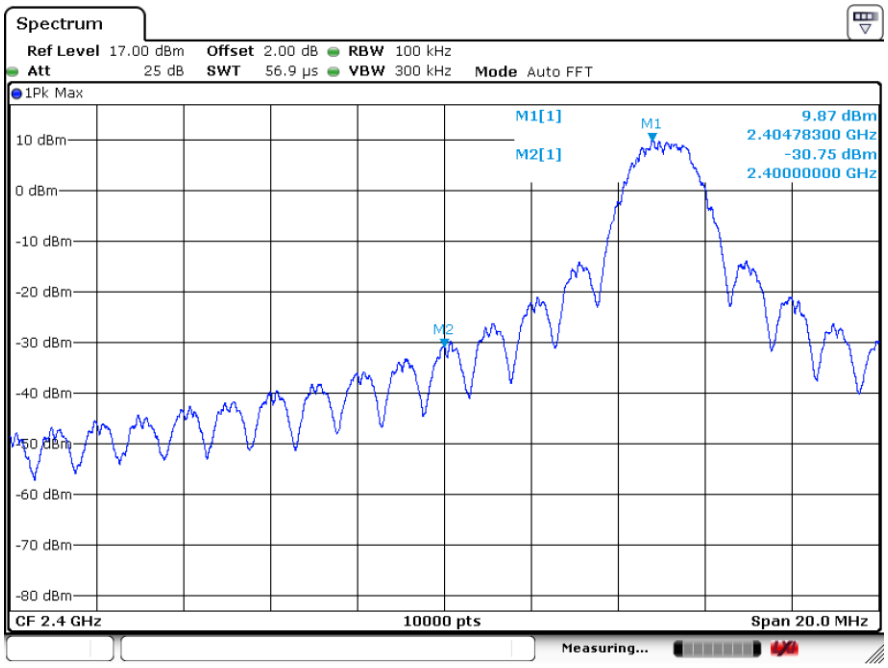
Temperature:	23.6º C
Relative Humidity:	53 %
ATM Pressure:	101.1 KPa

The testing was performed by Christian McCaig on 2021-10-13 at RF site.

10.5 Test Results

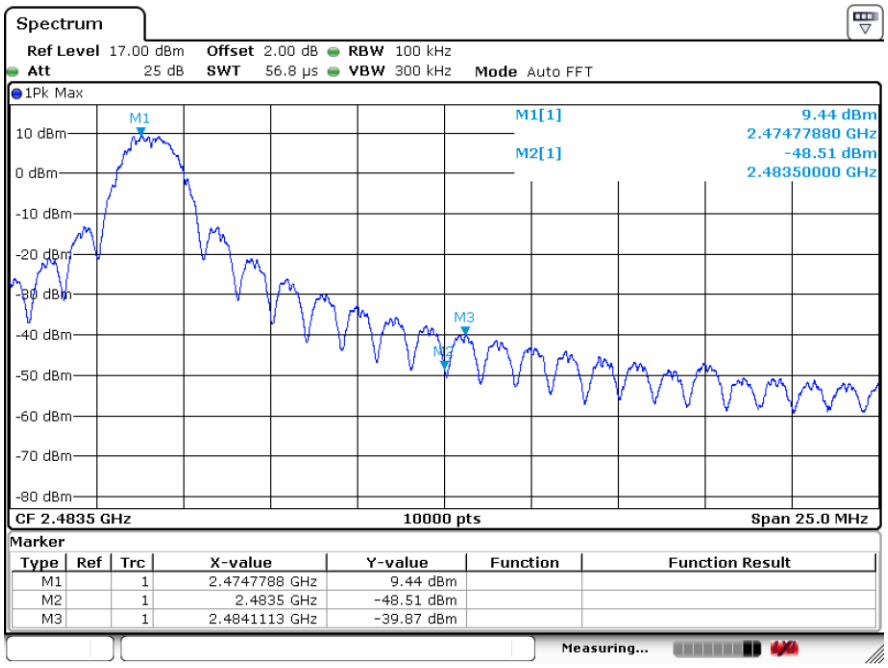
802.15.4

Low Channel



Date: 13.OCT.2021 09:06:03

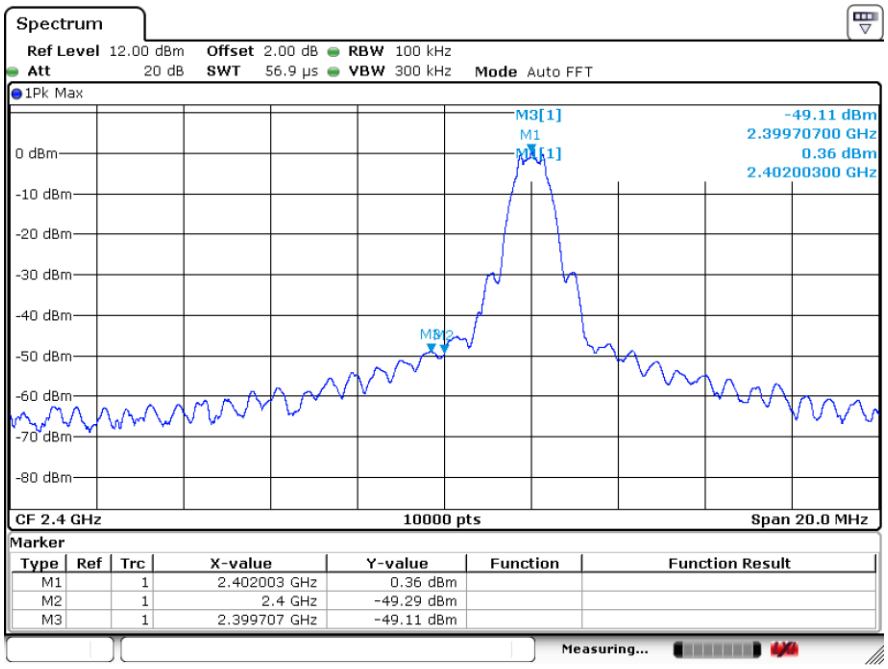
High Channel



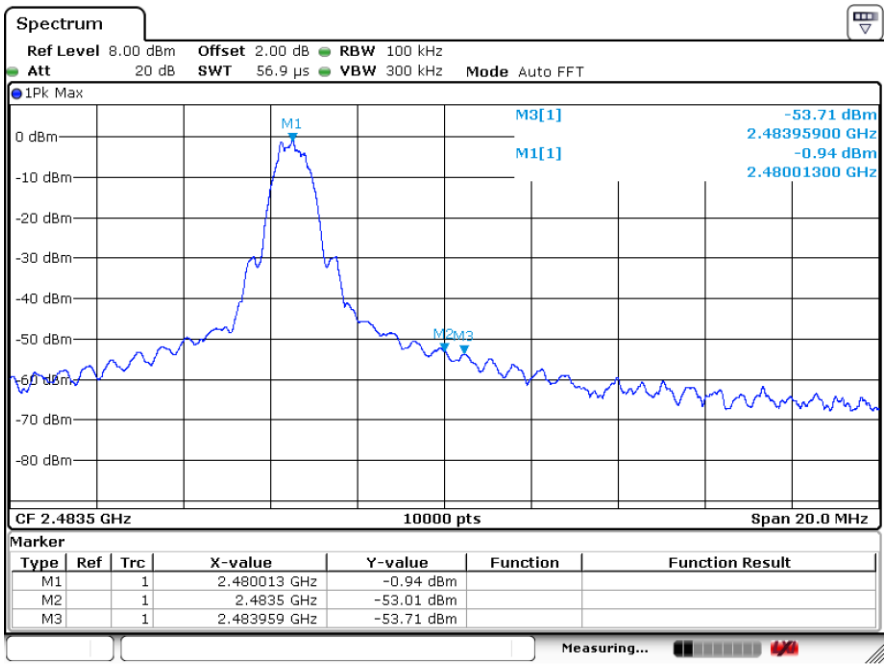
Date: 13.OCT.2021 09:25:31

BLE

Low Channel



High Channel



11 FCC §15.247(e) & ISEDC RSS-247 §5.2(2) – Power Spectral Density

11.1 Applicable Standards

According to ECFR §15.247(e) and RSS-247 §5.2 (2), 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.

11.2 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.

11.3 Test Equipment List and Details

Bacl No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
0912	Rhode & Schwarz	Spectrum Analyzer	FSV40	101203	2021-04-26	1 year
-	-	RF cable	-	-	Each time[1]	N/A

Note[1]: cable 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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

11.4 Test Environmental Conditions

Temperature:	23.6º C
Relative Humidity:	53 %
ATM Pressure:	101.1 KPa

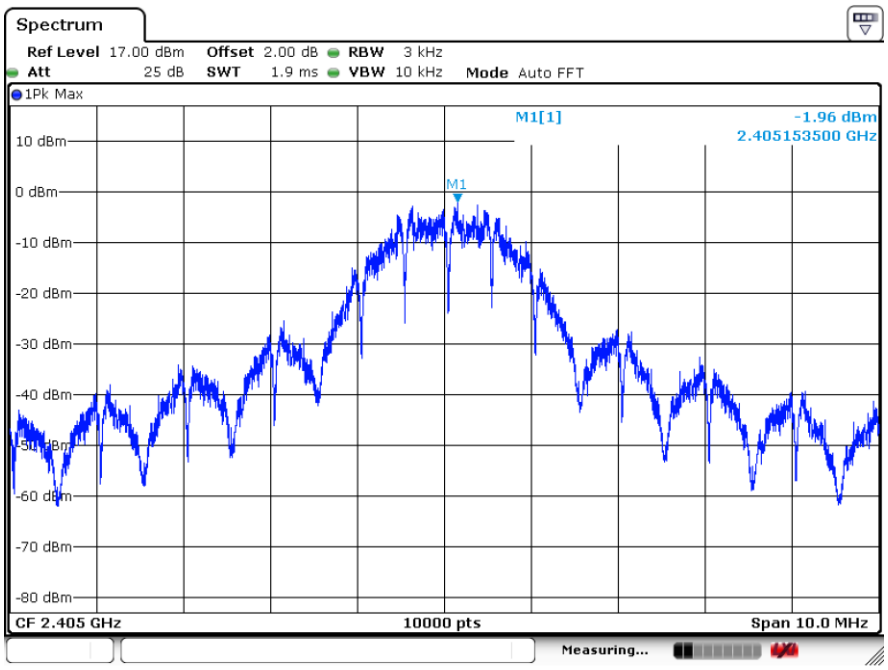
The testing was performed by Christian McCaig on 2021-10-13 at RF site.

11.5 Test Results

Mode	Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
802.15.4	Low	2405	-1.96	8
	Middle	2440	-1.86	8
	High	2475	-2.88	8
BLE	Low	2402	-14.95	8
	Middle	2440	-15.69	8
	High	2480	-15.92	8

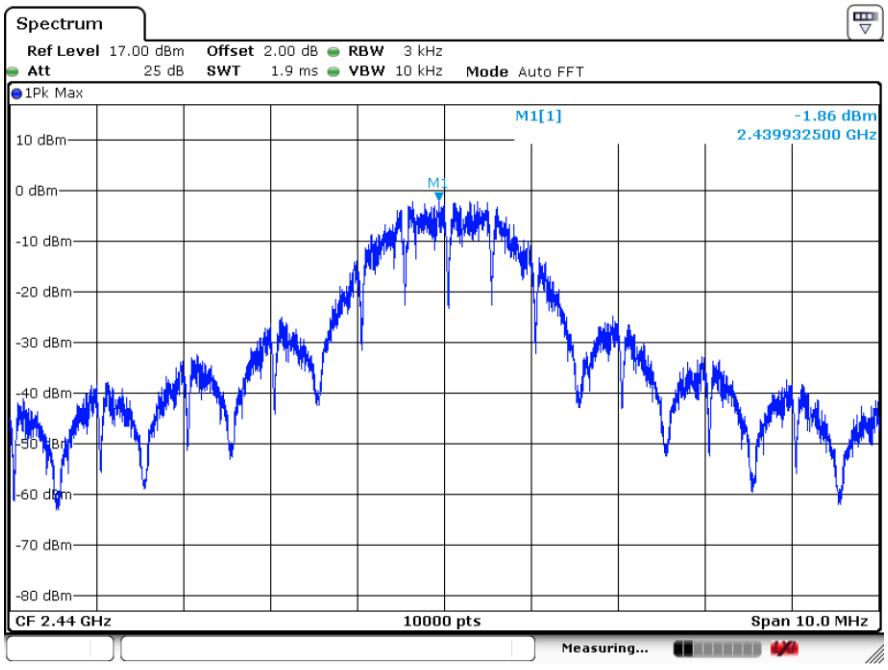
802.15.4

Low Channel



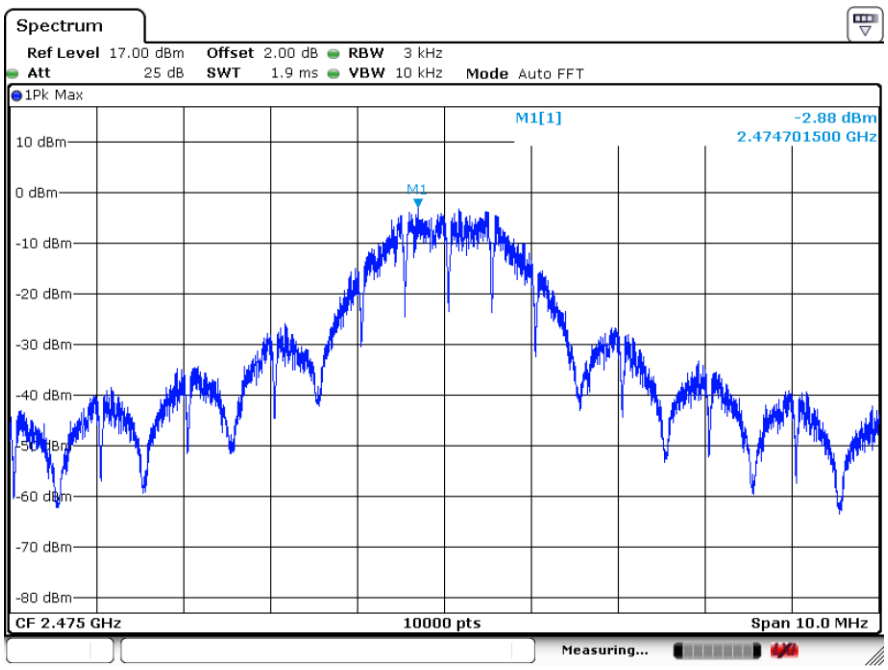
Date: 13.OCT.2021 09:13:04

Mid Channel



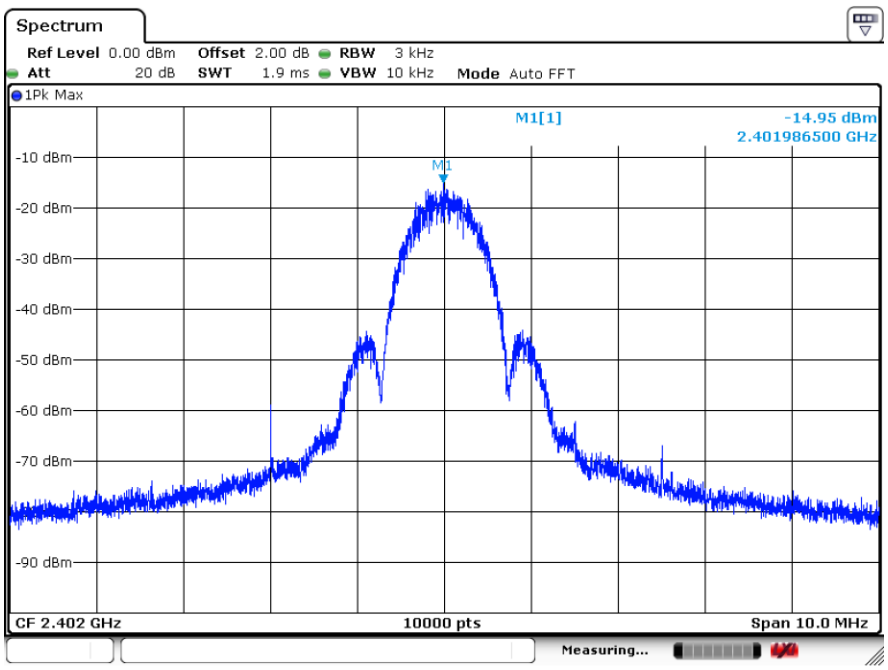
Date: 13.OCT.2021 09:14:12

High Channel



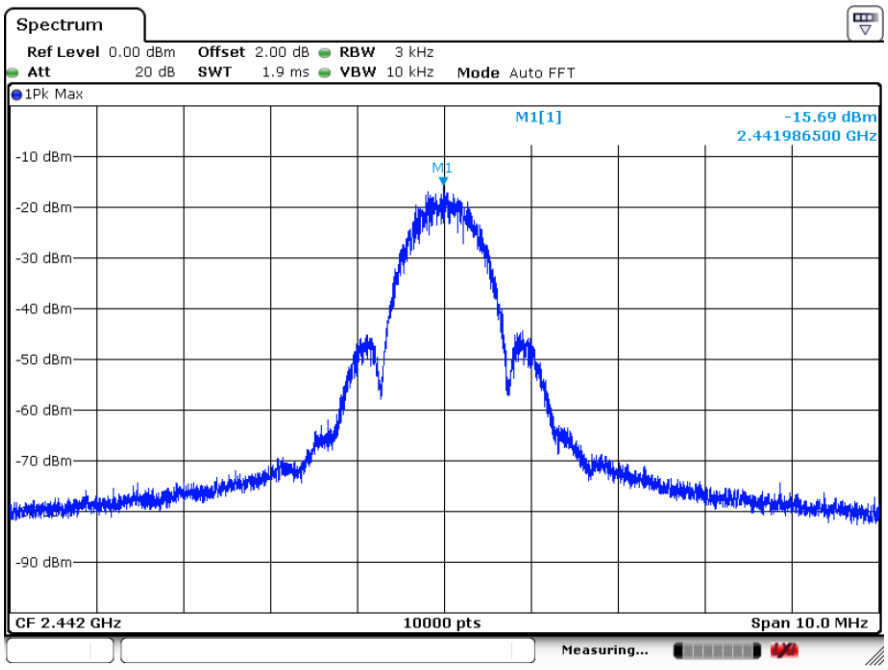
BLE

Low Channel



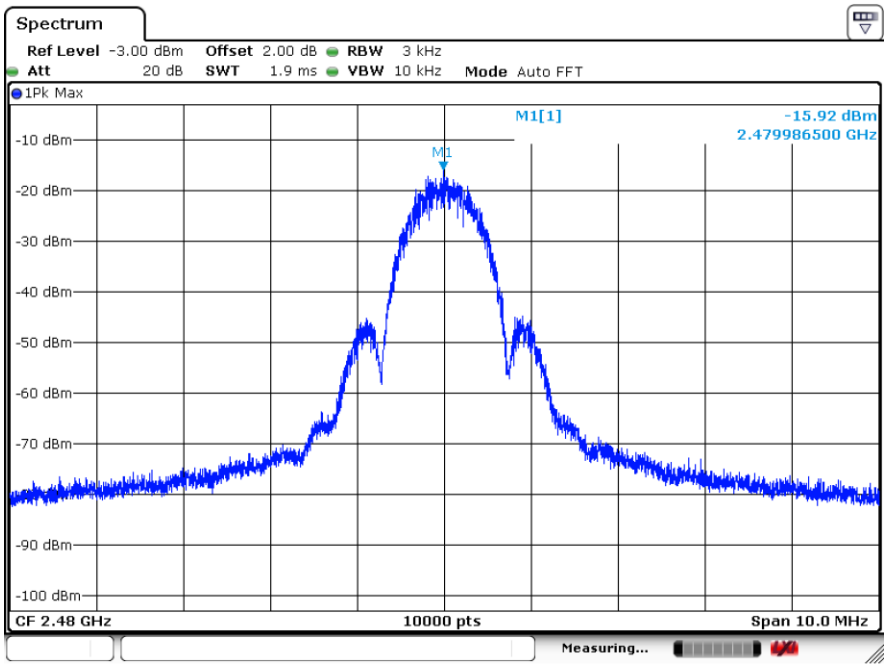
Date: 13.OCT.2021 09:00:29

Mid Channel



Date: 13.OCT.2021 08:30:37

High Channel



12 FCC §15.247(d) & ISEDC RSS-247 §5.5, RSS-GEN §8.9 – Spurious Emissions at Antenna Terminals

12.1 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)).

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.

12.2 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.

12.3 Test Equipment List and Details

Bacl No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
0912	Rhode & Schwarz	Spectrum Analyzer	FSV40	101203	2021-04-26	1 year
-	-	RF cable	-	-	Each time[1]	N/A

Note[1]: cable 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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

12.4 Test Environmental Conditions

Temperature:	23.6º C
Relative Humidity:	53 %
ATM Pressure:	101.3 KPa

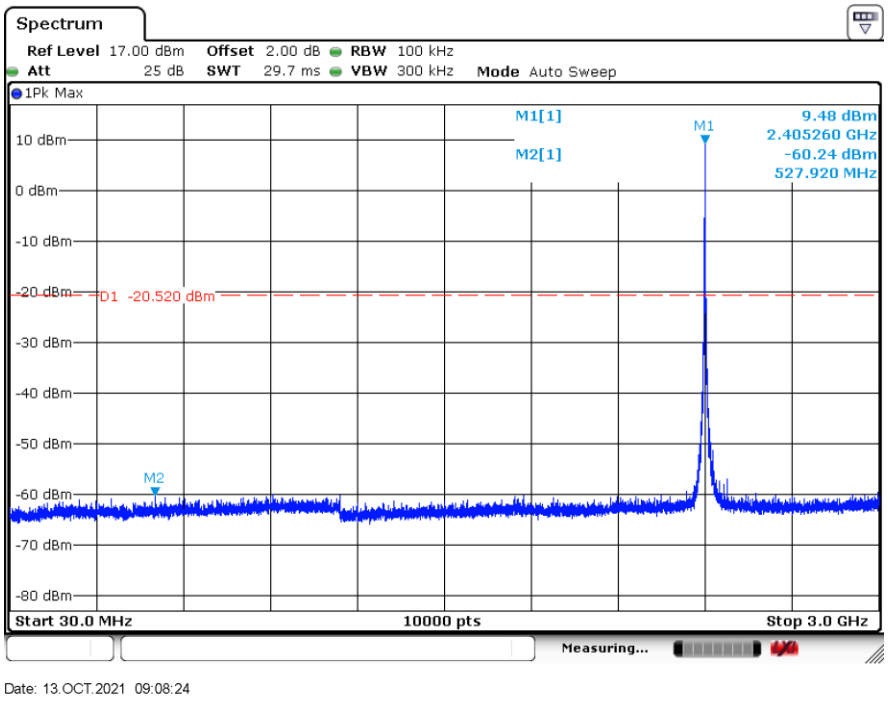
The testing was performed by Christian McCaig on 2021-10-13 in RF site.

12.5 Test Results

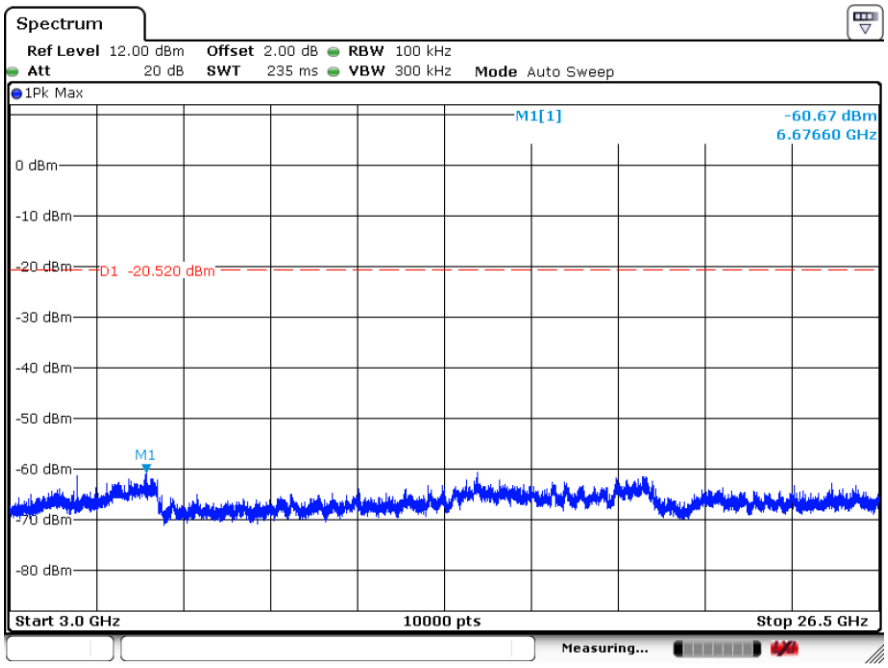
802.15.4

Low Channel

30MHz – 3GHz



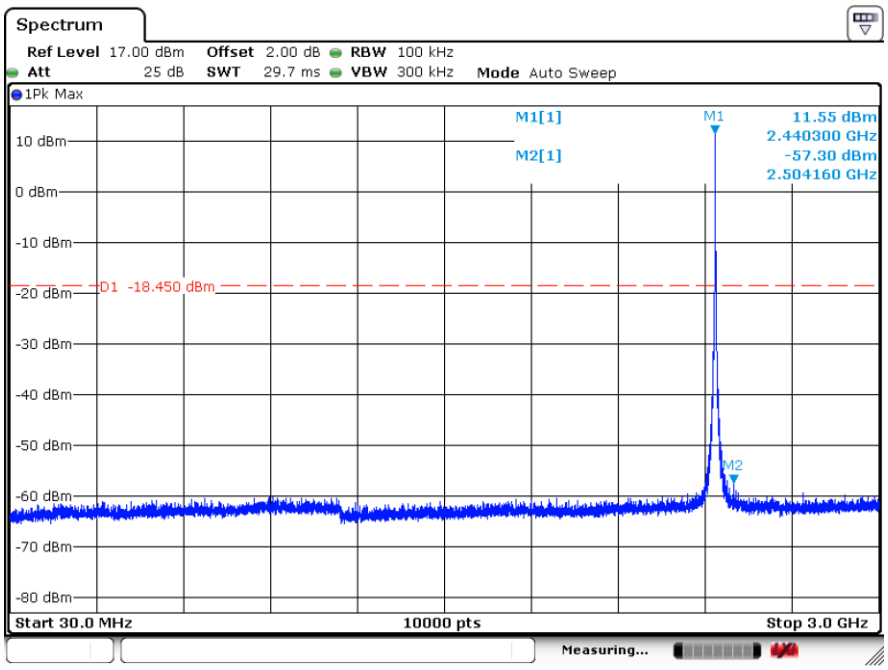
3GHz – 26GHz



Date: 13.OCT.2021 09:10:04

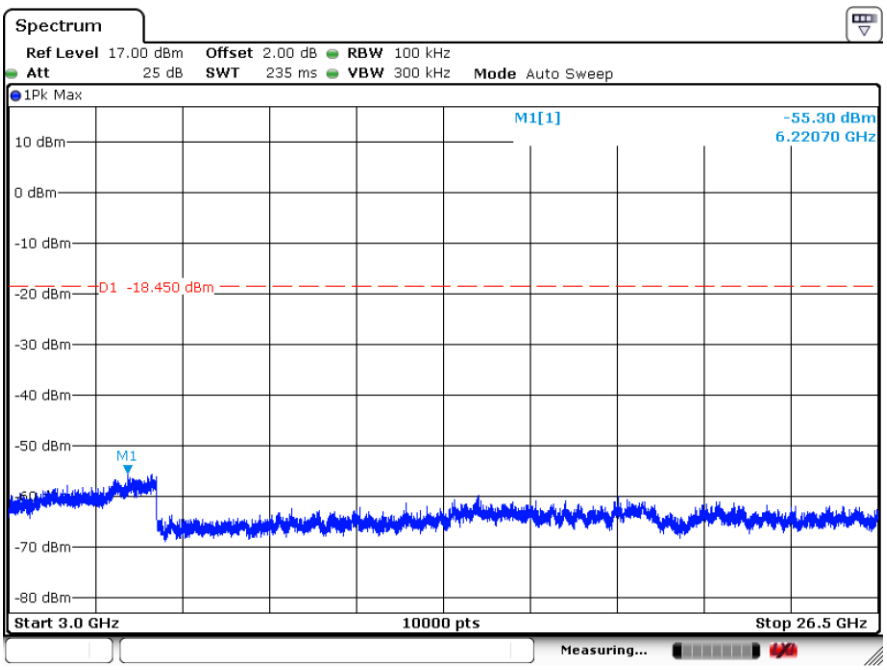
Mid Channel

30MHz – 3GHz



Date: 13.OCT.2021 09:18:03

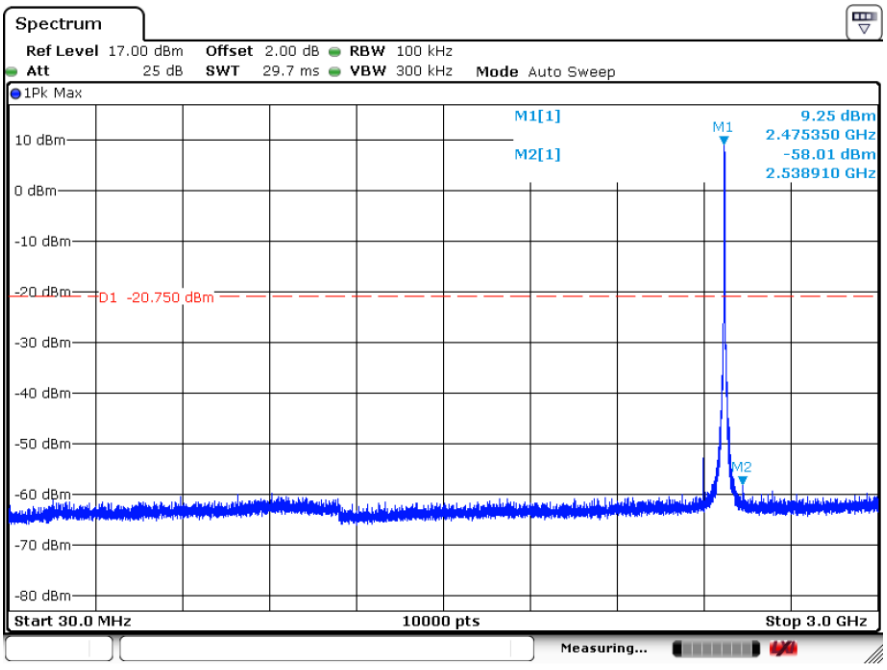
3GHz – 26GHz



Date: 13.OCT.2021 09:18:42

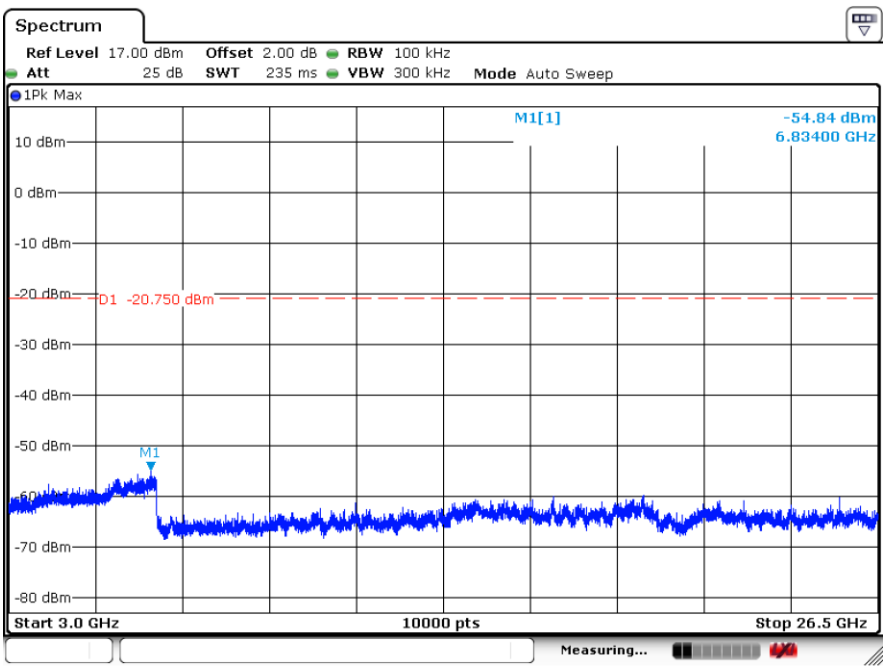
High Channel

30MHz – 3GHz



Date: 13.OCT.2021 09:23:33

3GHz – 26GHz

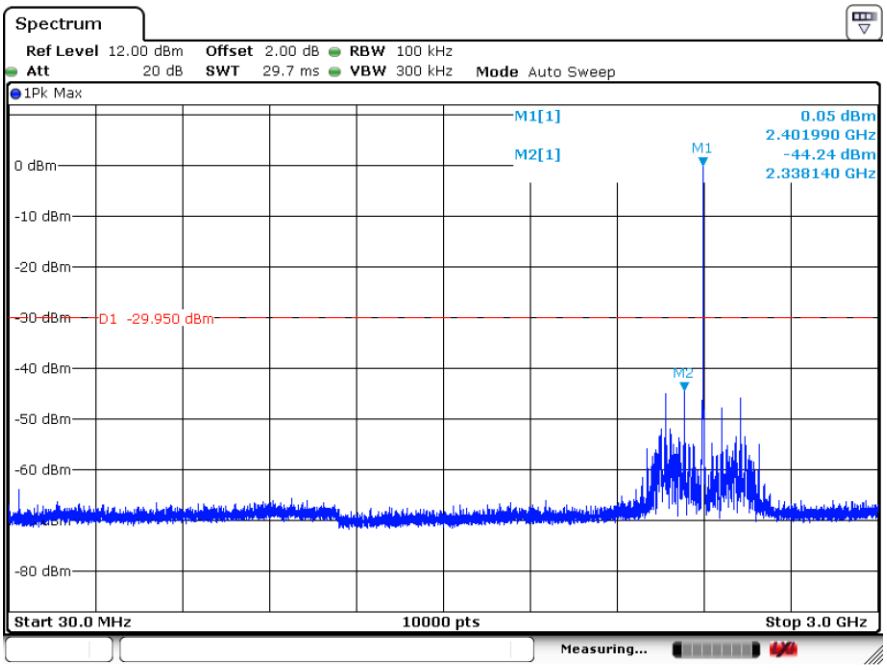


Date: 13.OCT.2021 09:24:18

BLE

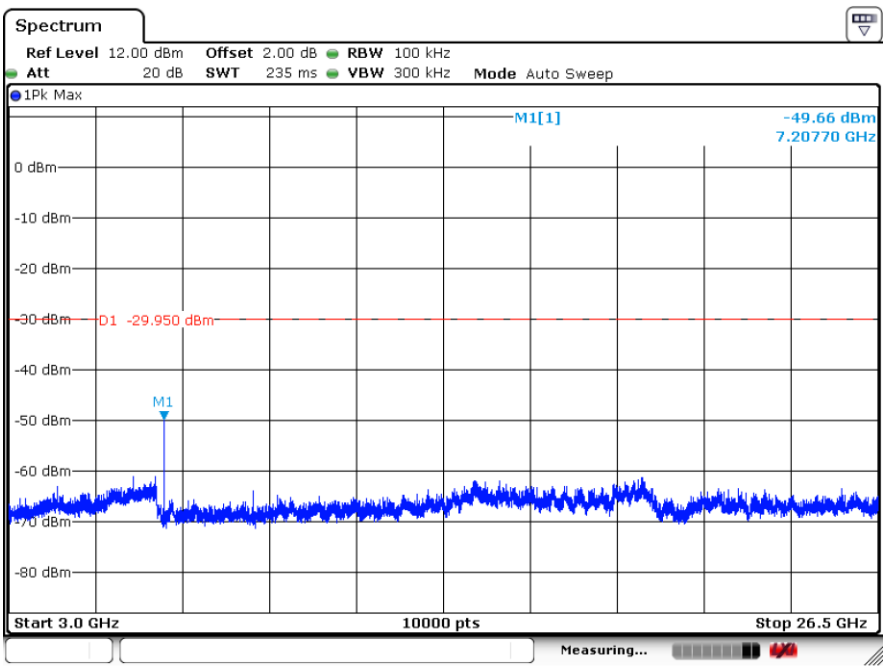
Low Channel

30MHz – 3GHz



Date: 13.OCT.2021 08:56:19

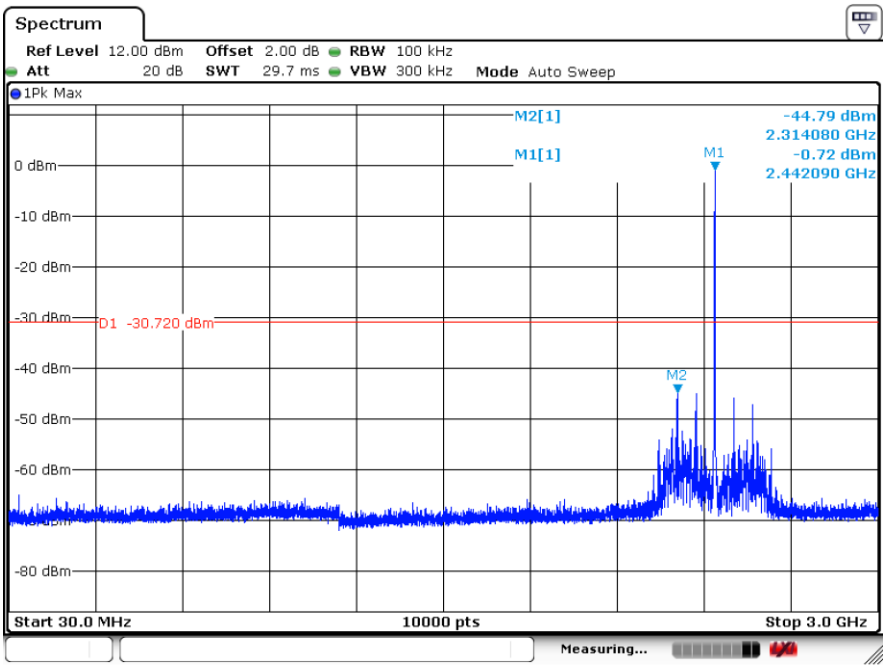
3GHz – 26GHz



Date: 13.OCT.2021 08:57:07

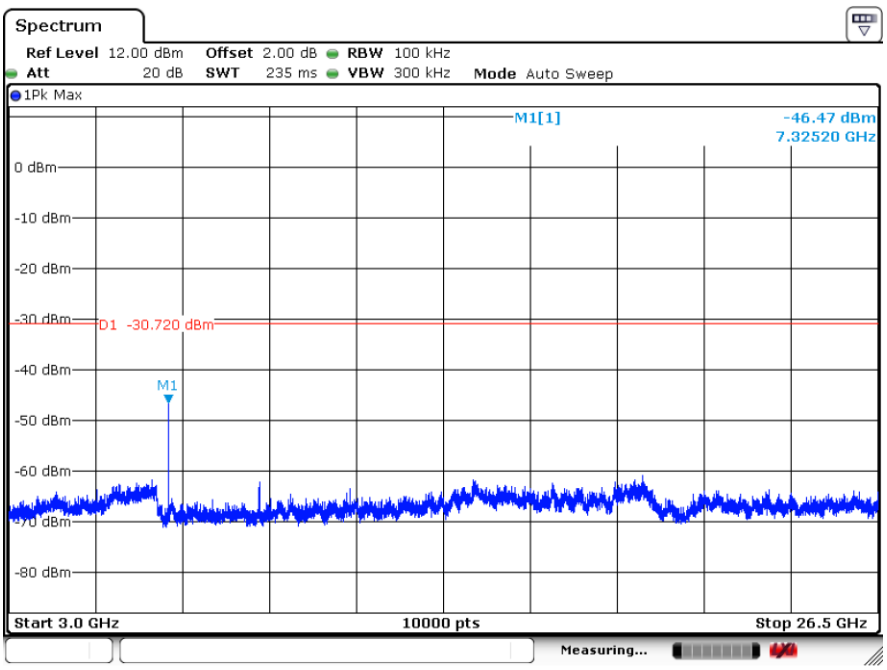
Mid Channel

30MHz – 3GHz



Date: 13.OCT.2021 08:28:13

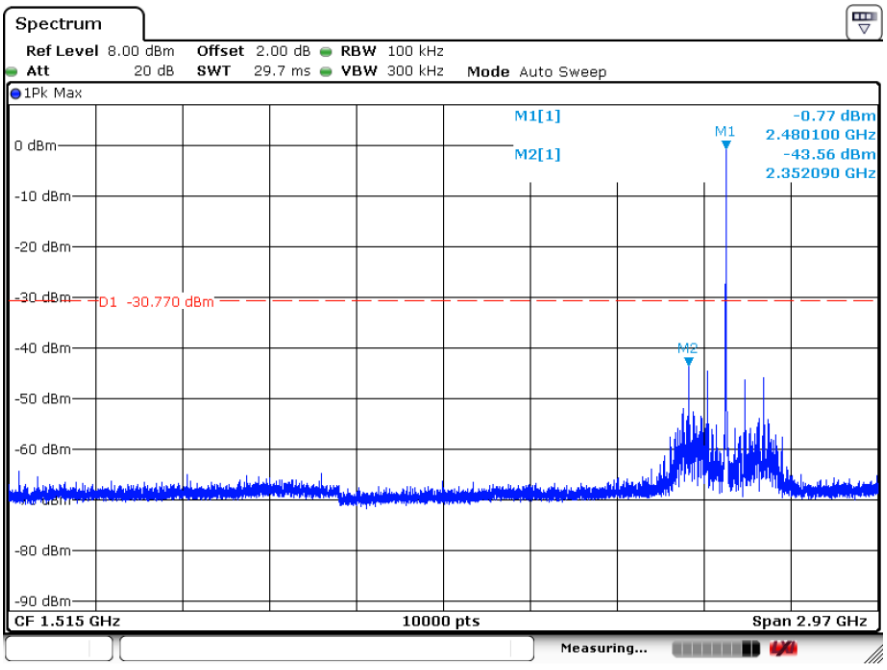
3GHz – 26GHz



Date: 13.OCT.2021 08:28:56

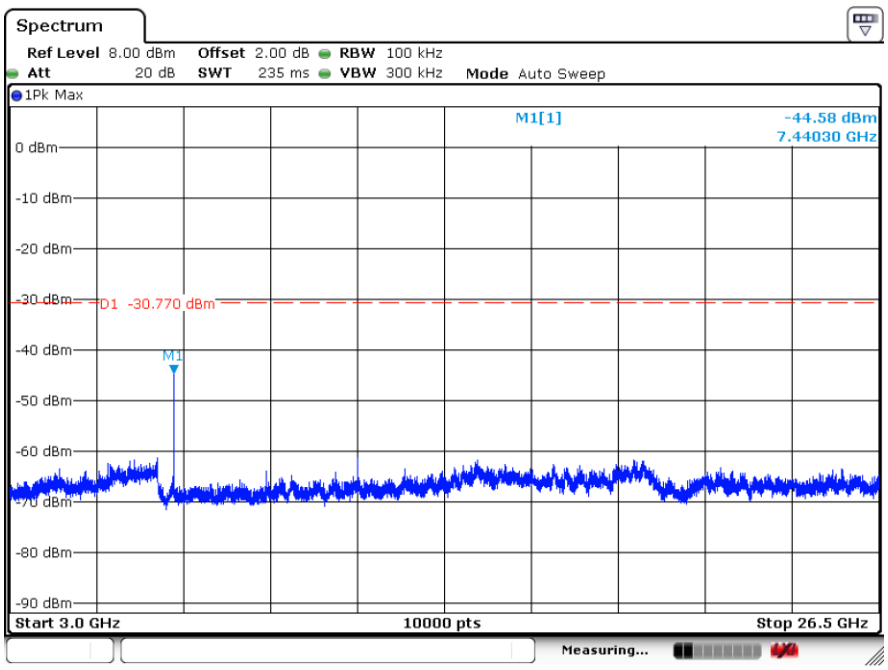
High Channel

30MHz – 3GHz



Date: 13.OCT.2021 08:38:22

3GHz – 26GHz



Date: 13.OCT.2021 08:38:52

13 Annex A (Normative) – EUT Test Setup Photographs

Please refer to the attachment.

14 Annex B (Normative) – EUT External Photographs

Please refer to the attachment.

15 Annex C (Normative) – EUT Internal Photographs

Please refer to the attachment.

16 Annex D (Normative) - A2LA Electrical Testing Certificate

Accredited Laboratory

A2LA has accredited

BAY AREA COMPLIANCE LABORATORIES CORP.

Sunnyvale, CA

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets A2LA *R222 - Specific Requirements EPA ENERGY STAR Accreditation Program*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated April 2017*).

Presented this 10th day of March 2021.

Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3297.02
Valid to September 30, 2022

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

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

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

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