FCC PART 15, SUBPART C

TEST AND MEASUREMENT REPORT

For

Nexkey Inc.

245 South Railroad Ave
San Mateo, CA 94401, USA

FCC ID: 2AO3ASOL01

Report Type:	**Product Type:**
Original Report	Electronic Lock for Access Control

Prepared By:	Deepak Mishra Test Technician
Report Number	R2110275-247
Report Issue Date:	2021-12-17
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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	R2110275-247	Original Report	2021-12-17

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test report was prepared on behalf of *Nexkey Inc.* and their product model: SOL01, FCC ID: 2AO3ASOL01 or the "EUT" as referred to in this report. It is an Electronic Lock for Access Control using low energy Bluetooth (BLE) operating within the 2400-2483.5 MHz frequency range and supporting 1 Mbps and 2 Mbps.

1.2 Mechanical Description of EUT

SOL01 measures approximately 12.38 cm (Length), 3.18 cm (Width), and 3.56 cm (Height) and weighs approximately 0.5 kg.

The data gathered are from production samples provided by Nexkey Inc. with BACL assigned serial numbers: R2110275-1 and R2110275-2.

1.3 Objective

This report was prepared on behalf of *Nexkey Inc.* in accordance with Part 2, Subpart J, and Part 15, Subpart C of the Federal Communication Commission's rules.

The objective was to determine compliance with FCC Part 15.247 for Antenna Requirement, RF Exposure, AC Line Conducted Emissions, Emission Bandwidth, Radiated & Conducted Spurious Emissions, 100 kHz Band Edges, Maximum Output Power, and Peak Power Spectrum Density

1.4 Related Submittal(s)/Grant(s)

N/A

1.5 Test Methodology

All measurements contained in this report were conducted in accordance with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

1.6 Measurement Uncertainty

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

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

1.7 Test Facility Registrations

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

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

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

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

1.8 Test Facility Accreditations

Bay Area Compliance Laboratories Corp. (BACL) is:

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

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

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

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

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

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

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

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

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

5 Other
- For Water Coolers (ver. 3.0)

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

- Australia: ACMA (Australian Communication and Media Authority) – APEC Tel MRA -Phase I;
- Canada: (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 in accordance to ANSI C63.10.

2.2 EUT Exercise Software

The test software used was CoolTerm. The software is compliant with the standard requirements being tested against.

Data Rate	Channel Frequency (MHz)	Power Setting
1 Mbps	2402	0
	2440	0
	2480	0
2 Mbps	2402	0
	2440	0
	2480	0

2.3 Duty Cycle Correction Factor

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

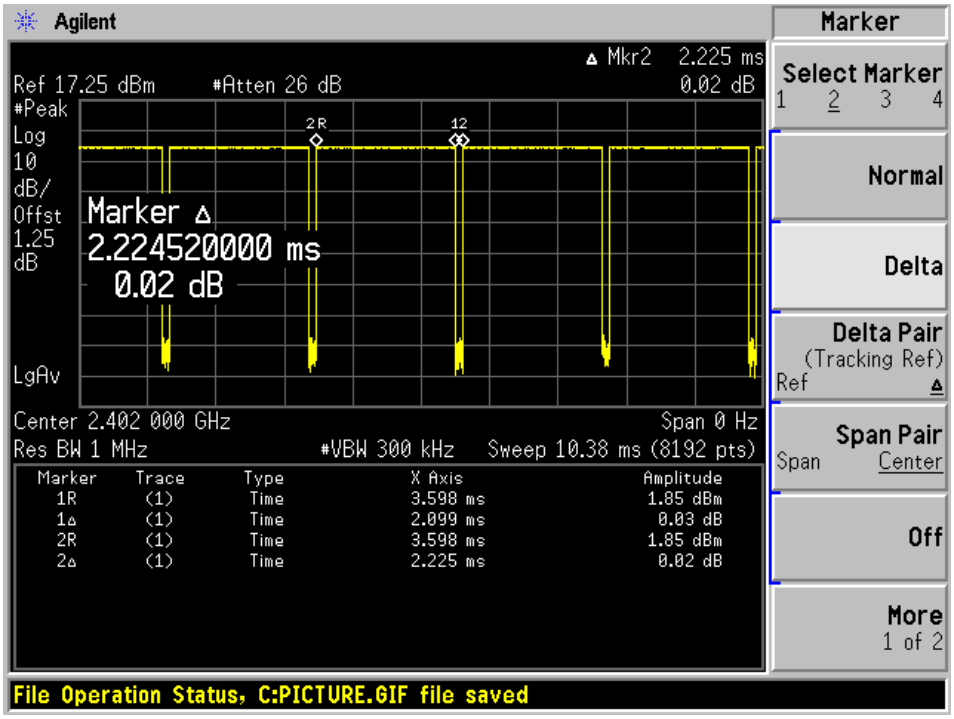
Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (i.e., with a duty cycle of greater than or equal to 98%). When continuous operation cannot be realized, then the use of sweep triggering/signal gating techniques can be utilized 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).

Data Rate	Radio frequency (MHz)	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
1 Mbps	2402	2.099	2.225	94.34	0.253
2 Mbps	2402	1.056	1.177	89.72	0.471

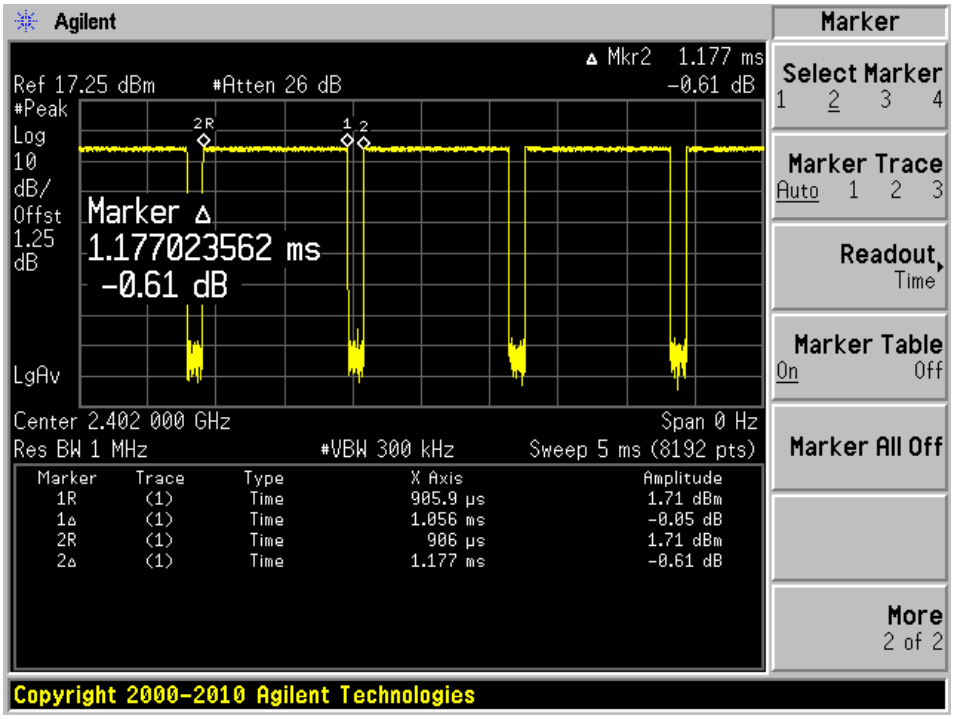
Duty Cycle = On Time (ms)/ Period (ms)
Duty Cycle Correction Factor (dB) = 10*log(1/Duty Cycle)

Please refer to the following plots.

1 Mbps


Agilent
Marker
Mkr2 2.225 ms
0.02 dB
Ref 17.25 dBm
#Atten 26 dB
#Peak
Log
10
dB/
Offst
1.25
dB
2R
12
Marker Δ
2.224520000 ms
0.02 dB
LgAv
Center 2.402 000 GHz
Span 0 Hz
Res BW 1 MHz
#VBW 300 kHz
Sweep 10.38 ms (8192 pts)
Marker Trace Type X Axis Amplitude
1R (1) Time 3.598 ms 1.85 dBm
1Δ (1) Time 2.099 ms 0.03 dB
2R (1) Time 3.598 ms 1.85 dBm
2Δ (1) Time 2.225 ms 0.02 dB
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref Δ
Span Pair
Span Center
Off
More
1 of 2
File Operation Status, C:PICTURE.GIF file saved

2 Mbps


Agilent
Marker
Mkr2 1.177 ms
-0.61 dB
Ref 17.25 dBm
#Atten 26 dB
#Peak
Log
10
dB/
Offst
1.25
dB
2R
1 2
Marker Δ
1.177023562 ms
-0.61 dB
LgAv
Center 2.402 000 GHz
Span 0 Hz
Res BW 1 MHz
#VBW 300 kHz
Sweep 5 ms (8192 pts)
Marker Trace Type X Axis Amplitude
1R (1) Time 905.9 µs 1.71 dBm
1Δ (1) Time 1.056 ms -0.05 dB
2R (1) Time 906 µs 1.71 dBm
2Δ (1) Time 1.177 ms -0.61 dB
Select Marker
1 2 3 4
Marker Trace
Auto 1 2 3
Readout
Time
Marker Table
On Off
Marker All Off
More
2 of 2
Copyright 2000-2010 Agilent Technologies

2.4 Equipment Modifications

N/A

2.5 Local Support Equipment

Manufacturer	Description	Model	Serial No.
Dell	Laptop	Latitude E6410	-
Volteq	DC Power Supply	HY5003D	-

2.6 Remote Support Equipment

N/A

2.7 Interface Ports and Cabling

Cable Descriptions	Length (m)	From	To
Alligator Jumper Wires	< 1m	Power Supply	EUT
USB	< 1m	EUT	Laptop

3 Summary of Test Results

Results reported relate only to the product tested.

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

Note[1]: Device is powered by batteries

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

External/Internal/ Integral	Frequency Range (MHz)	Antenna Type	Maximum Antenna Gain (dBi)
Integral	2400-2483.5 MHz	Stamped Metal Antenna	- 1.3 dBi

Antenna gain is information provided by customer.

5 FCC §2.1091, §15.247(i) - 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

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

Maximum peak output power at antenna input terminal (dBm):	1.61
Maximum peak output power at antenna input terminal (mW):	1.448771854
Prediction distance (cm):	20
Prediction frequency (MHz):	2440
Maximum Antenna Gain, typical (dBi):	-1.3
Maximum Antenna Gain (numeric):	0.741310241
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.00021366
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 0.00021366 mW/cm^2. Limit is 1.0 mW/cm^2.

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) 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).

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 was 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 should be changed the polarization both of horizontal and vertical.

The spectrum analyzer or receiver is set as:

Below 1000 MHz:

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

Above 1000 MHz:

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

6.4 Corrected Amplitude & Margin Calculation

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:

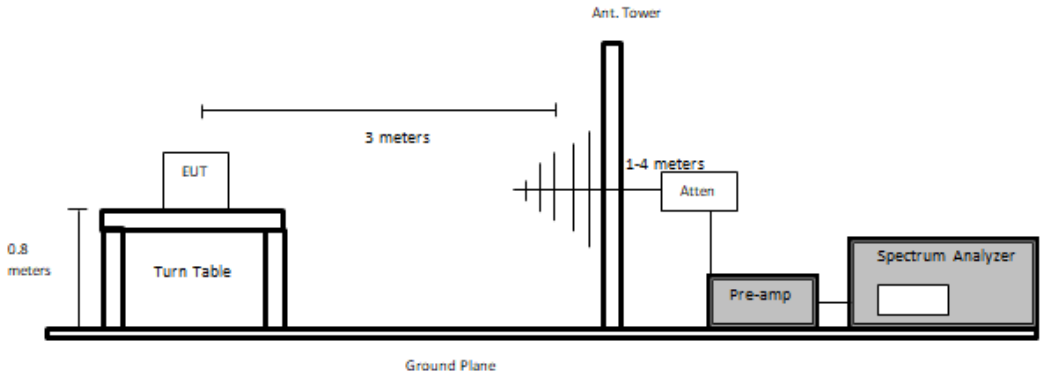
CA = Ai + AF + CL + Atten – Ga

For example, a corrected amplitude of 40.3 dBuV/m = Indicated Reading (32.5 dBuV) + Antenna Factor (+23.5dB) + Cable Loss (3.7 dB) + Attenuator (10 dB) - Amplifier Gain (29.4 dB)
The "**Margin**" column of the following data tables indicates the degree of compliance within the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the maximum limit. The equation for margin calculation is as follows:

Margin = Corrected Amplitude – Limit

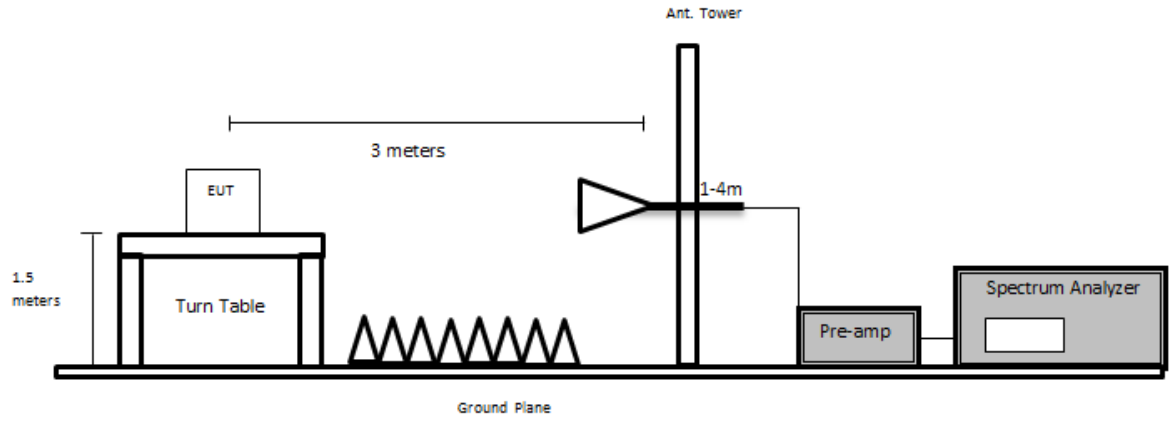
6.5 Test Setup Block Diagram

Below 1 GHz:

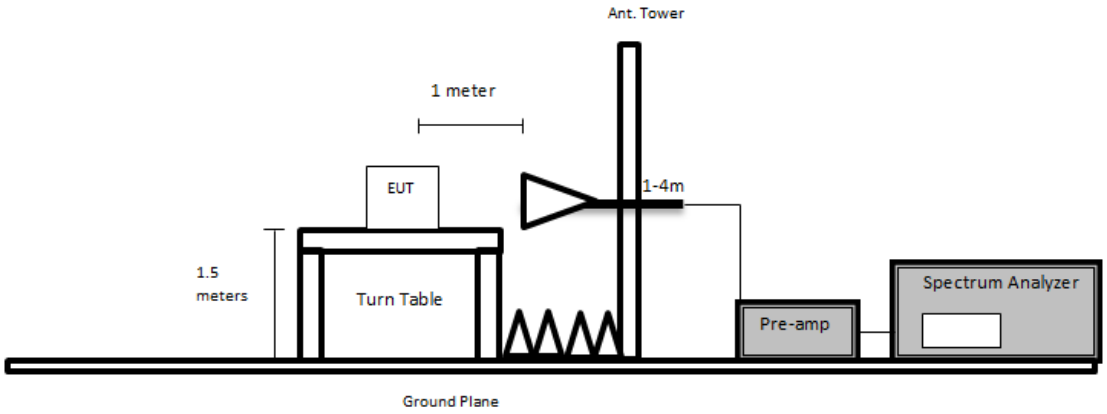


Above 1 GHz:

At 3 meters:



At 1 meter:


Ant. Tower
1 meter
EUT
1-4m
1.5
meters
Turn Table
Spectrum Analyzer
Pre-amp
Ground Plane

6.6 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
287	HP	Spectrum Analyzer 46 GHz	E4446A	US44300386	2021-04-27	1 year
124	Rhode & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100044	2021-05-14	2 years
	Sunol Science Corp	System Controller	SC99V	122303-1	N/R	N/R
1192	ETS Lindgren	Antenna, Horn	3117	00218973	2021-09-14	2 years
90	Wisewave	Antenna, Horn	ARH-4223-02	10555-01	2021-04-12	2 years
321	Sunol Sciences Corp	Biconilog Antenna	JB3	A020106-2	2021-11-22	2 years
658	HP	Preamplifier	8449B OPT HO2	3008A0113	2021-05-06	1 year
459	HP	Pre Amplifier	8447D	2443A04374	2021-11-02	1 year
827	AH Systems	Pre-Amplifier	PAM 1840 VH	170	2021-08-03	1 year
1077	IW Microwave	157 Series 2.92 SM (x2) Armored 33 ft. Cable	KPS-1571AN-3960-KPS	DC 1917	2021-03-03	1 year
1081	Fairview Microwave	Times Microwave LMR 400 UltraFex Coaxial Cable 35'	FMC0101405-420	BACL1904161	2021-06-18	1 year
1101	IW Microwave	157 Series Cable Armored with 2.92mm Male Plugs on Both Sides	KPS-1571AN-2400	DC 1922	2021-07-06	1 year
-	-	Notch Filter	-	-	Each Time[1]	Each Time[1]
-	-	SMA cable	-	C0006	Each Time[1]	Each Time[1]

Note[1]: cable and notch filter 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:	20 ºC
Relative Humidity:	38 %
ATM Pressure:	102.1 kPa

The testing was performed by Deepak Mishra from 2021-12-01 to 2021-12-10 at 5 meter chamber 3.

6.8 Summary of Test Results

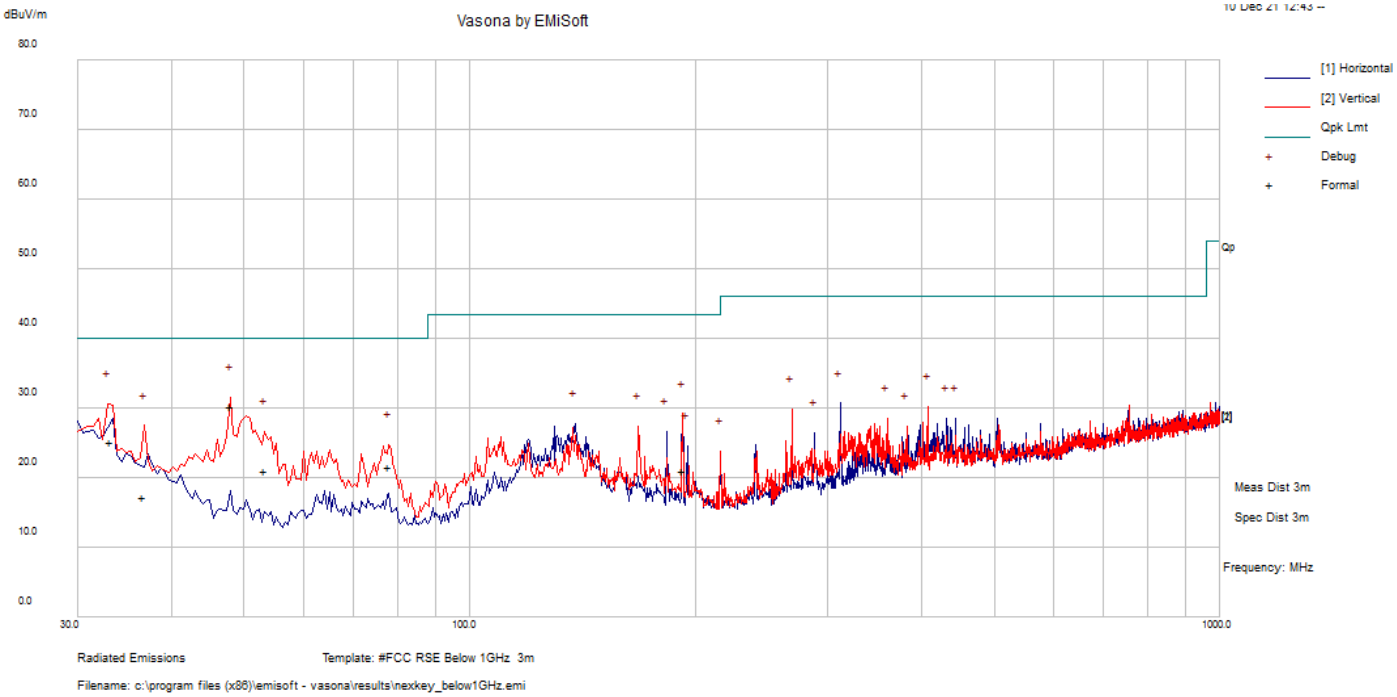
According to the data hereinafter, the EUT complied with FCC Part 15C standard's radiated emissions limits, and had the worst margin of:

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Transmitting Channel (MHz)**
-4.23	4960	H	2480, 1 Mbps

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

6.9 Radiated Emissions Test Results

1) 30 MHz – 1 GHz Worst Case (2440 MHz, 1 Mbps), Measured at 3 meters



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
47.999	40.32	-10.04	30.28	105	V	26	40	-9.72	Pass
33.159	25.14	0.03	25.16	187	V	49	40	-14.84	Pass
36.6785	19.85	-2.65	17.2	143	V	128	40	-22.8	Pass
53.3465	32.25	-11.27	20.98	147	V	136	40	-19.02	Pass
191.99175	27.64	-6.6	21.04	135	V	155	43.5	-22.46	Pass
78.05125	32.22	-10.67	21.55	101	V	265	40	-18.45	Pass

2) 1–26.5 GHz, Measured at 3 Meters

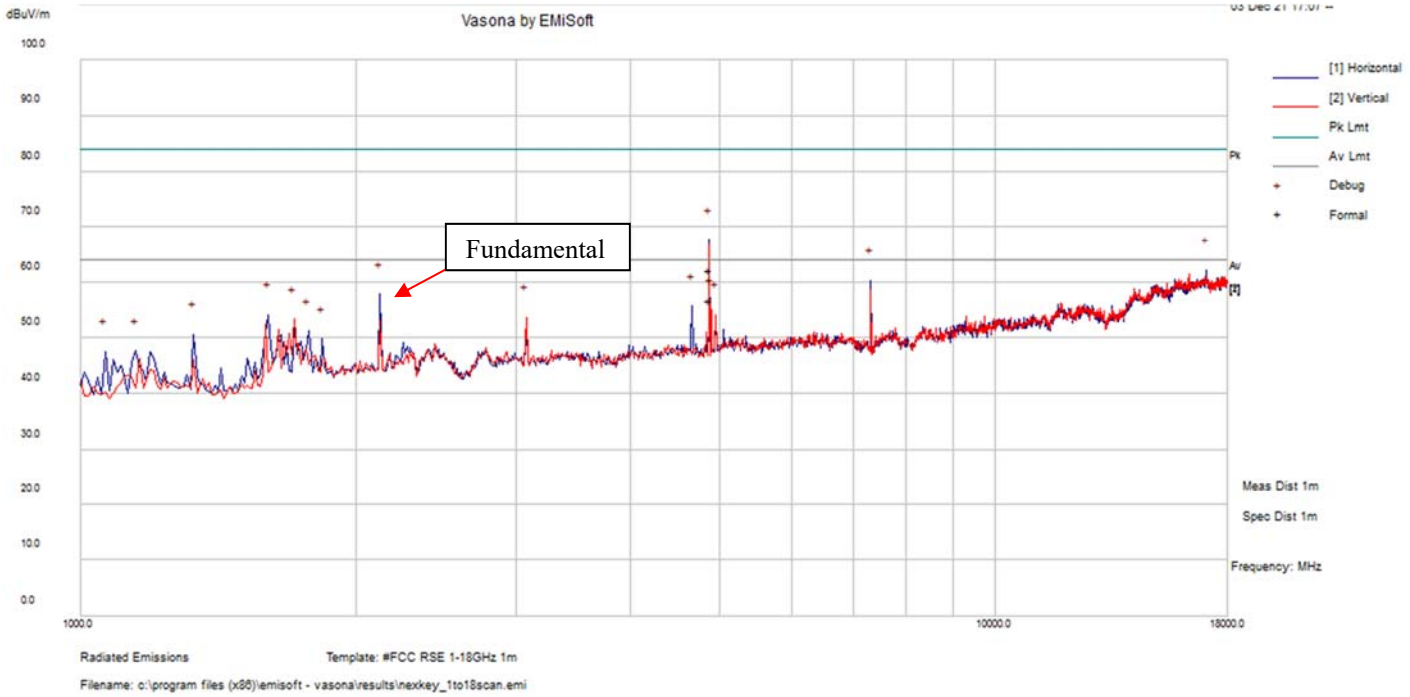
2 Mbps

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/ISEDC		Note
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel Frequency: 2402 MHz											
2390	50.120	216	109	H	27.92	4.91	39.359	43.60	74	-30.40	Peak
2390	50.980	97	300	V	27.92	4.91	39.359	44.46	74	-29.54	Peak
2390	38.147	216	109	H	27.92	4.91	39.359	31.62	54	-22.38	Ave
2390	36.909	97	300	V	27.92	4.91	39.359	30.39	54	-23.61	Ave
4804	50.720	264	278	V	34.70	8.33	38.302	55.46	74	-18.54	Peak
4804	43.431	264	278	V	34.70	8.33	38.302	48.17	54	-5.83	Ave
4804	50.110	306	150	H	34.70	8.33	38.302	54.85	74	-19.15	Peak
4804	41.115	306	150	H	34.70	8.33	38.302	45.85	54	-8.15	Ave
Middle Channel Frequency: 2440 MHz											
4880	49.320	127	174	V	34.68	8.33	38.25	54.08	74	-19.92	Peak
4880	39.641	127	174	V	34.68	8.33	38.25	44.41	54	-9.60	Ave
4880	49.870	100	118	H	34.68	8.33	38.25	54.63	74	-19.37	Peak
4880	43.411	100	118	H	34.68	8.33	38.25	48.18	54	-5.83	Ave
High Channel Frequency: 2480 MHz											
2483.5	54.990	157	150	H	28.75	4.913	39.359	49.30	74	-24.70	Peak
2483.5	53.660	182	114	V	28.75	4.913	39.359	47.97	74	-26.03	Peak
2483.5	39.136	157	150	H	28.75	4.913	39.359	33.44	54	-20.56	Ave
2483.5	39.705	182	114	V	28.75	4.913	39.359	34.01	54	-19.99	Ave
4960	51.220	150	150	V	34.68	8.336	38.25	55.98	74	-18.02	Peak
4960	43.080	150	150	V	34.68	8.336	38.25	47.84	54	-6.16	Ave
4960	50.880	110	130	H	34.68	8.336	38.25	55.64	74	-18.36	Peak
4960	45.010	110	130	H	34.68	8.336	38.25	49.77	54	-4.23	Ave

1 Mbps

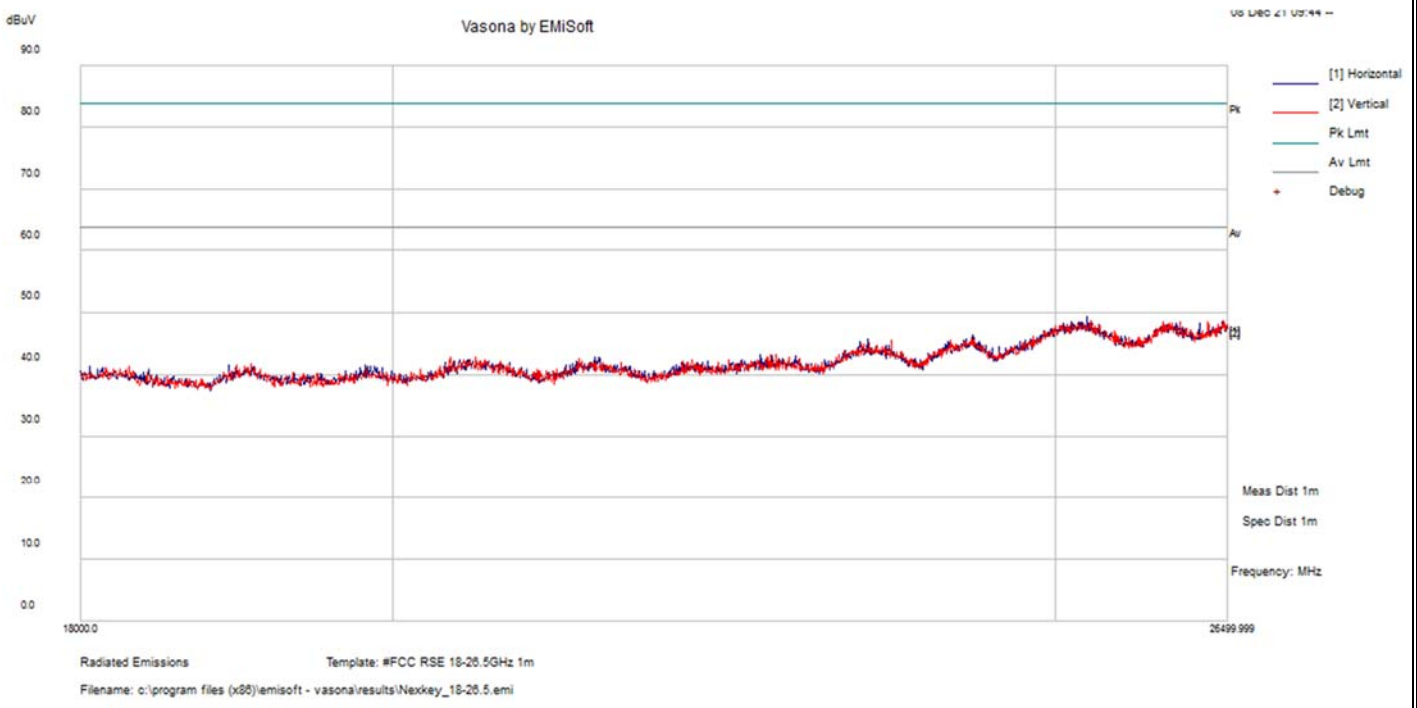
Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/ISEDC		Note
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel Frequency: 2402 MHz											
2390	50.000	327	150	H	27.923	4.913	39.359	43.48	74	-30.52	Peak
2390	49.930	258	150	V	27.923	4.913	39.359	43.41	74	-30.59	Peak
2390	38.114	327	150	H	27.923	4.913	39.359	31.59	54	-22.41	Ave
2390	37.407	258	150	V	27.923	4.913	39.359	30.88	54	-23.12	Ave
4804	49.560	57	150	V	34.70	8.336	38.302	54.30	74	-19.70	Peak
4804	36.975	57	150	V	34.70	8.336	38.302	41.71	54	-12.29	Ave
4804	50.510	314	150	H	34.70	8.336	38.302	55.25	74	-18.75	Peak
4804	43.507	314	150	H	34.70	8.336	38.302	48.24	54	-5.76	Ave
Middle Channel Frequency: 2440 MHz											
4880	47.880	65	150	V	34.68	8.336	38.25	52.64	74	-21.36	Peak
4880	39.783	65	150	V	34.68	8.336	38.25	44.55	54	-9.45	Ave
4880	49.880	326	206	H	34.68	8.336	38.25	54.64	74	-19.36	Peak
4880	42.133	326	206	H	34.68	8.336	38.25	46.90	54	-7.10	Ave
High Channel Frequency: 2480 MHz											
2483.5	53.830	259	150	H	28.752	4.913	39.359	48.14	74	-25.86	Peak
2483.5	50.960	148	295	V	28.752	4.913	39.359	45.27	74	-28.73	Peak
2483.5	38.165	259	150	H	28.752	4.913	39.359	32.47	54	-21.53	Ave
2483.5	38.453	148	295	V	28.752	4.913	39.359	32.76	54	-21.24	Ave
4960	49.810	30	150	V	34.68	8.336	38.25	54.57	74	-19.43	Peak
4960	42.050	30	150	V	34.68	8.336	38.25	46.81	54	-7.19	Ave
4960	50.090	300	200	H	34.68	8.336	38.25	54.85	74	-19.15	Peak
4960	43.170	300	200	H	34.68	8.336	38.25	47.93	54	-6.07	Ave

3) 1 – 18 GHz Worst Case (2440 MHz, 1 Mbps), Measured at 1 meter



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
4879.398	60.53	1.53	62.06	116	H	158	84	-21.94	Pass
4879.398	55.28	1.53	56.81	116	H	158	64	-7.19	Pass

4) 18 – 26.5 GHz Worst Case (2440 MHz, 1 Mbps), Measured at 1 meter



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

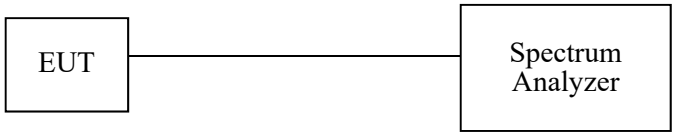
7.1 Applicable Standards

According to FCC §15.247(a) (2): the minimum 6 dB bandwidth shall be 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 Setup Diagram



7.4 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
912	Rhode & Schwarz	Signal Analyzer	FSV40	101203	2021-04-26	1 year
655	Rohde & Schwarz	Signal Analyzer	FSQ26	200749	2019-11-07	25 months
-	-	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".*

7.5 Test Environmental Conditions

Temperature:	21º C
Relative Humidity:	39 %
ATM Pressure:	102.0 KPa

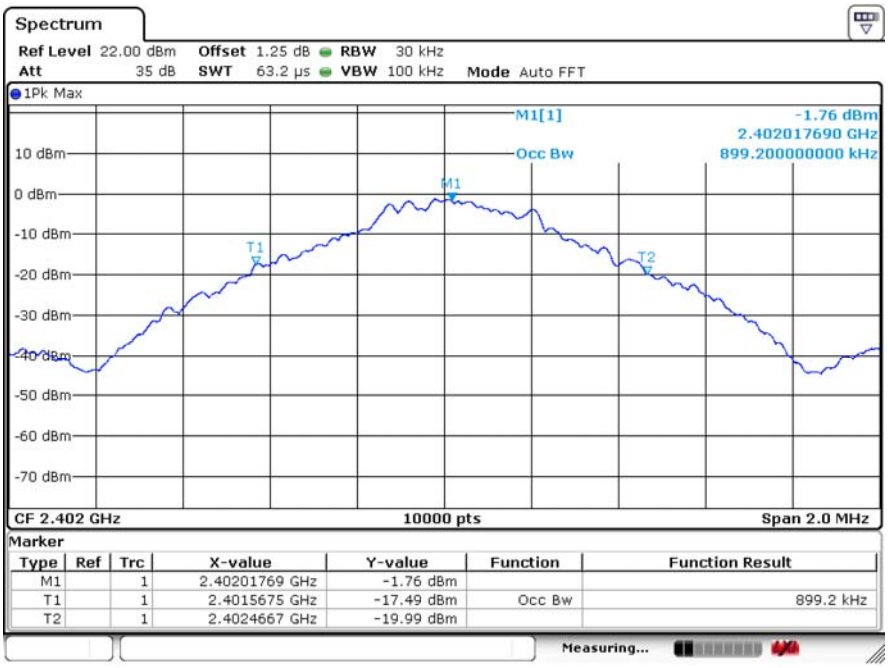
The testing was performed by Rita Yang on 2021-12-03 at RF test site.

7.6 Test Results

Rate	Channel	Frequency (MHz)	99% OBW (kHz)	-6 dB BW (kHz)	-6 dB BW Limit (kHz)
1 Mbps	Low	2402	899.2	507.6	≥ 500
	Middle	2440	919	510	≥ 500
	High	2480	923.33	502.5	≥ 500
2 Mbps	Low	2402	1803.2	973.5	≥ 500
	Middle	2440	1753.2	822.9	≥ 500
	High	2480	1800	847.5	≥ 500

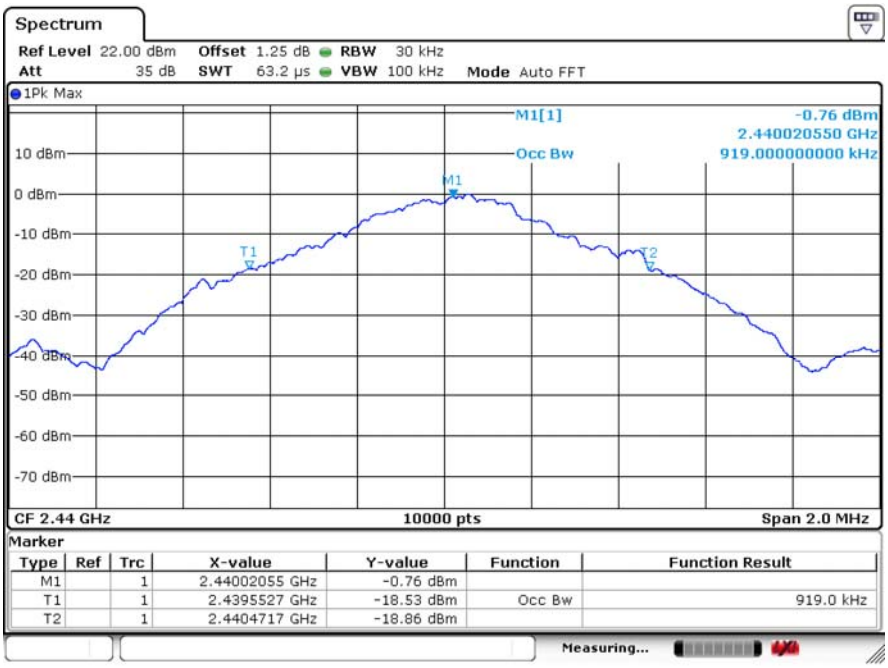
Please refer to the following plots for detailed test results.

99% OBW, Low Channel: 2402 MHz 1 Mbps



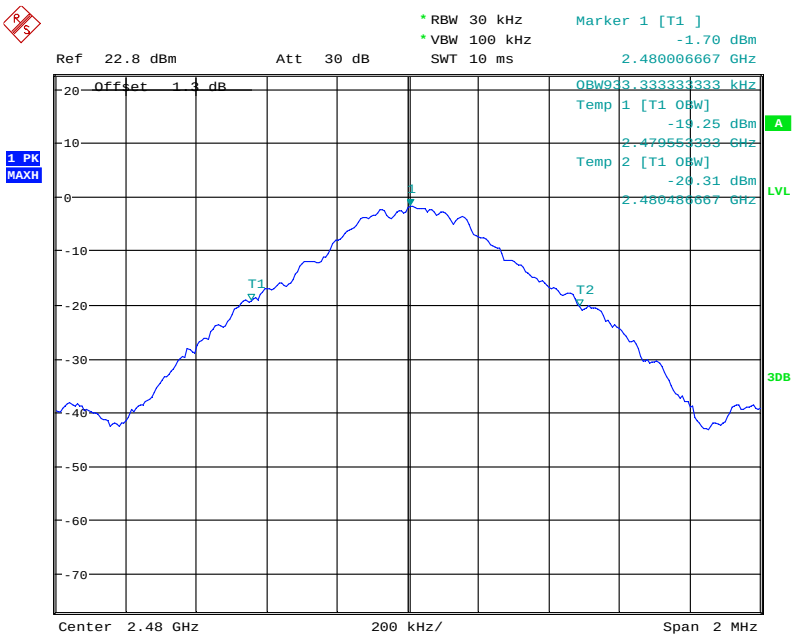
Date: 3.DEC.2021 11:37:32

99% OBW, Mid Channel: 2440 MHz 1 Mbps

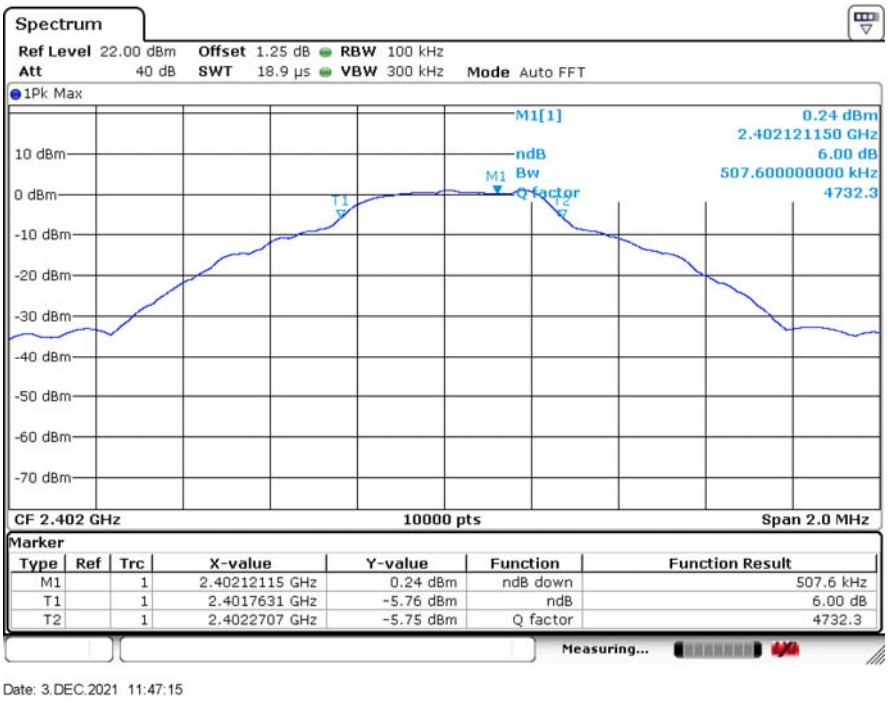


Date: 3.DEC.2021 11:55:38

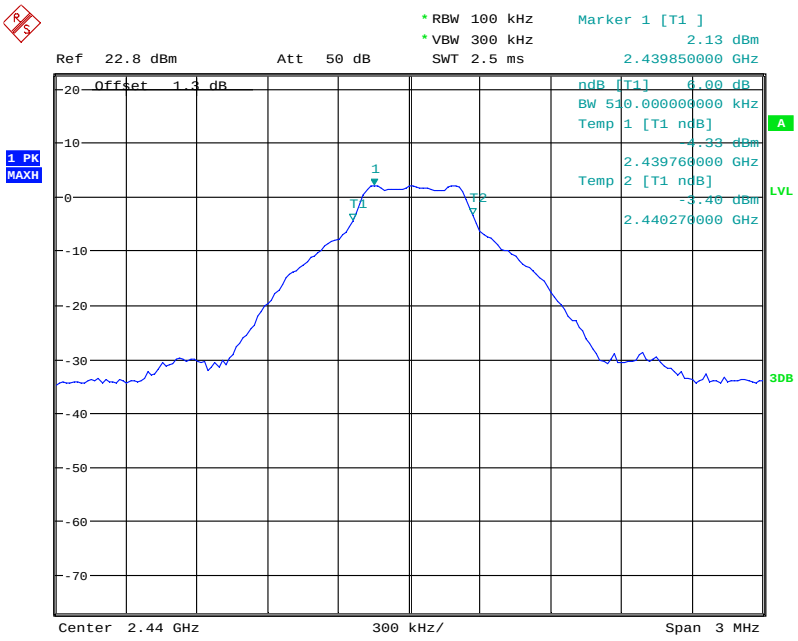
99% OBW, High Channel: 2480 MHz 1 Mbps



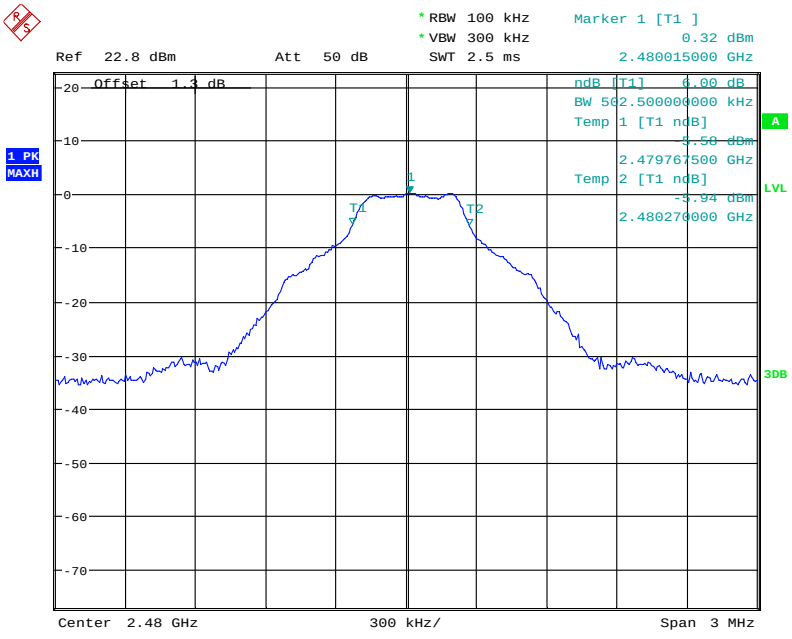
-6 dB BW, Low Channel: 2402 MHz 1 Mbps



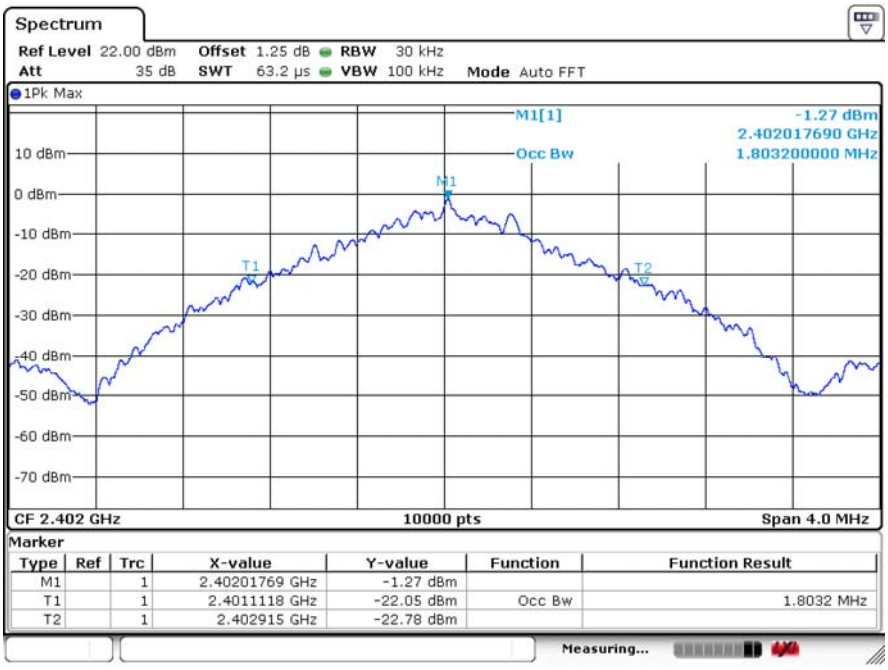
-6 dB BW, Mid Channel: 2440 MHz 1 Mbps



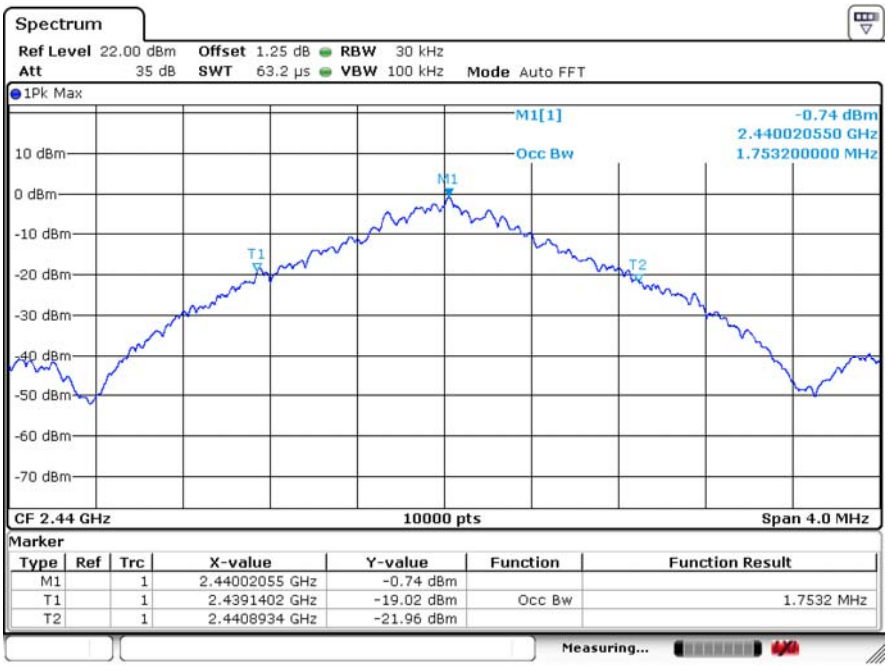
-6 dB BW, High Channel: 2480 MHz 1 Mbps



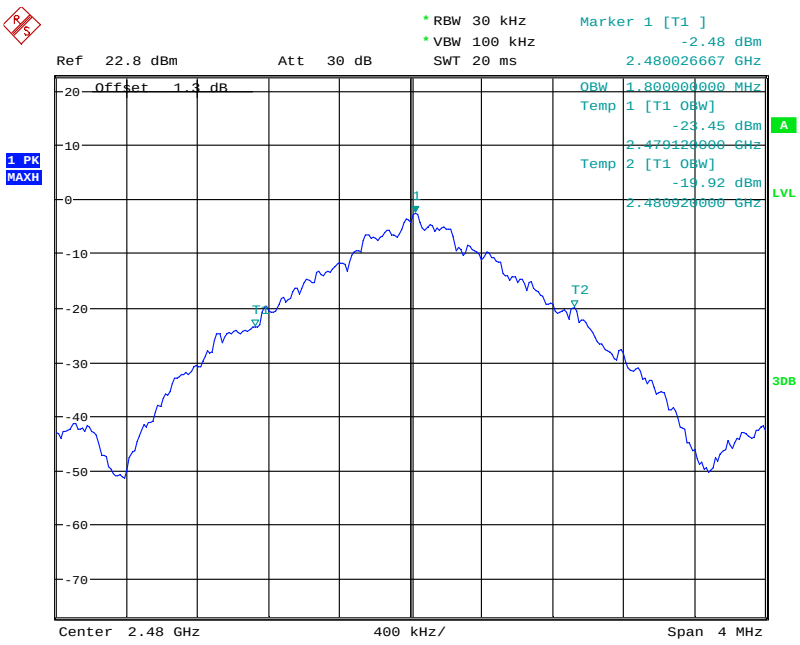
99% OBW, Low Channel: 2402 MHz 2 Mbps



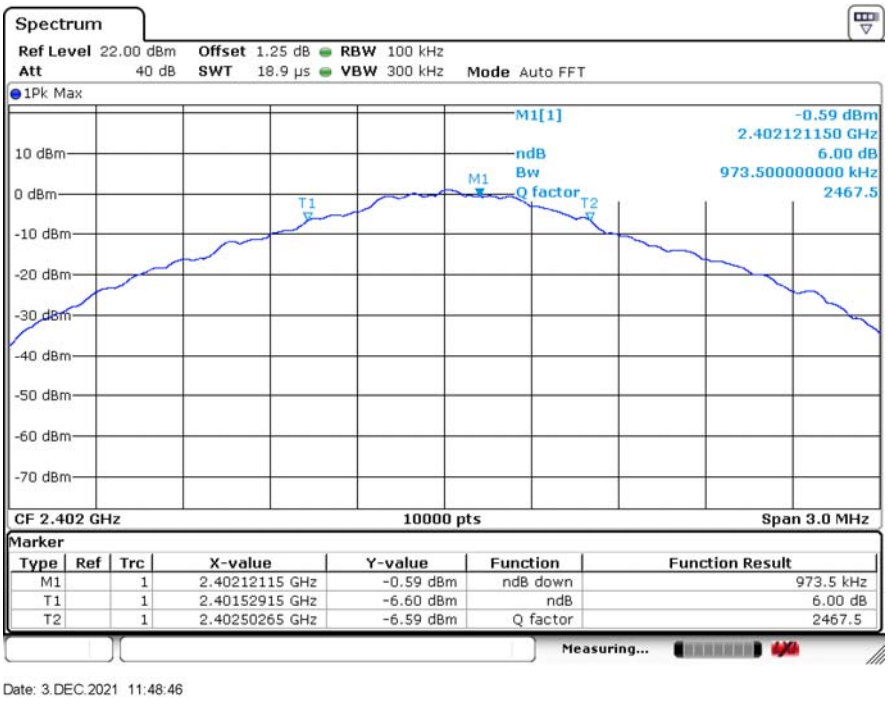
99% OBW, Mid Channel: 2440 MHz 2 Mbps



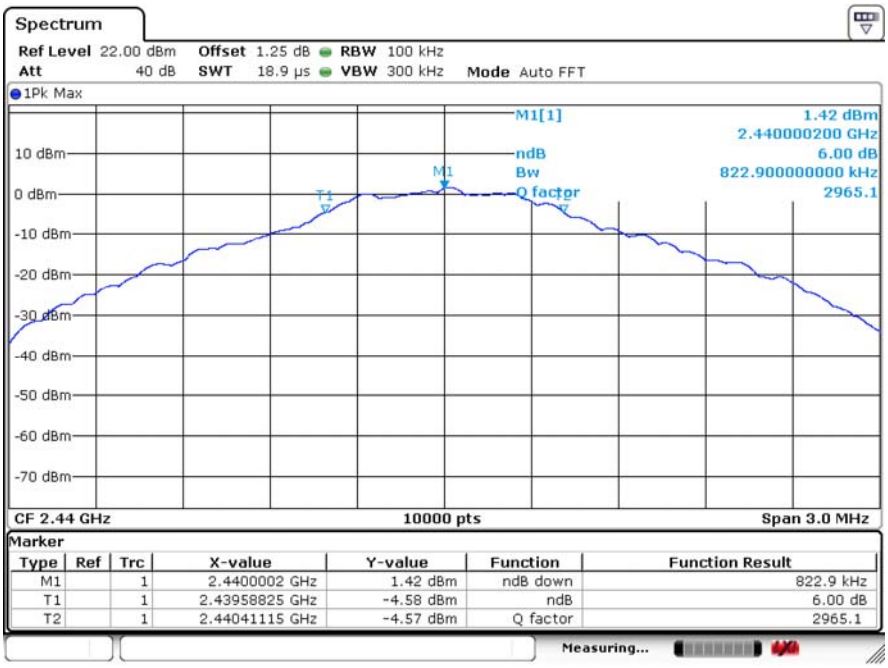
99% OBW, High Channel: 2480 MHz 2 Mbps



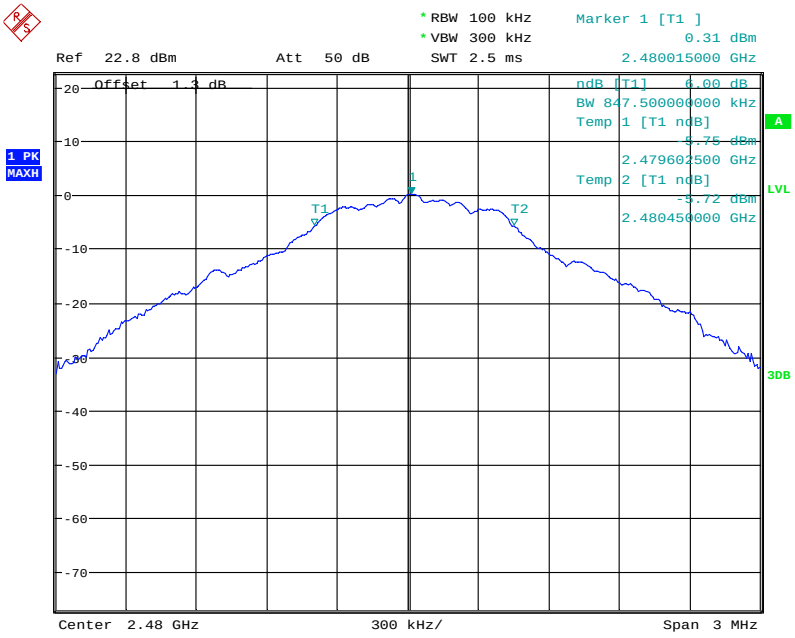
-6 dB BW, Low Channel: 2402 MHz 2 Mbps



-6 dB BW, Mid Channel: 2440 MHz 2 Mbps



-6 dB BW, High Channel: 2480 MHz 2 Mbps



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

8.1 Applicable Standards

According to FCC §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. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

8.2 Measurement Procedure

The measurements are based on ANSI C63.10-2013, Section 11.9.2.2.2.

8.3 Test Setup Diagram

8.4 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
912	Rhode & Schwarz	Signal 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".*

8.5 Test Environmental Conditions

Temperature:	21º C
Relative Humidity:	39 %
ATM Pressure:	102.0 KPa

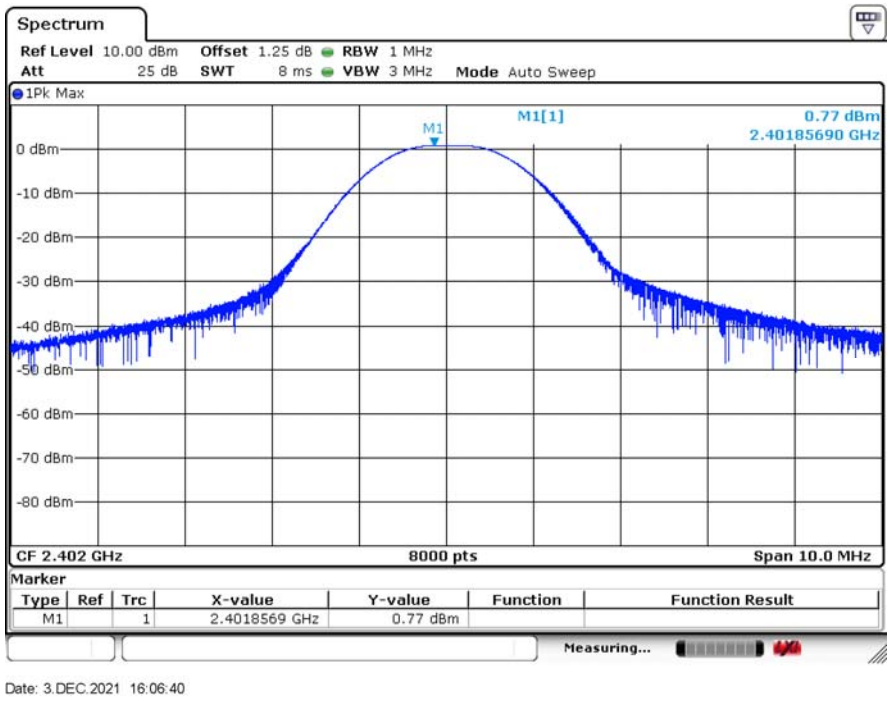
The testing was performed by Rita Yang on 2021-12-03 at RF test site.

8.6 Test Results

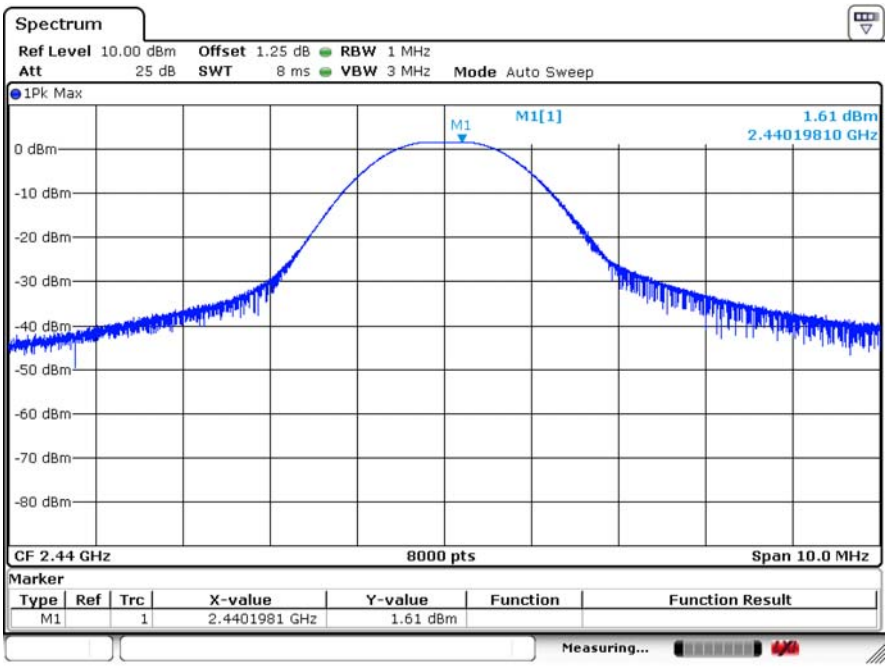
Data Rate	Channel	Frequency (MHz)	Conducted Output Power (dBm)	FCC Limit (dBm)
1 Mbps	Low	2402	0.77	< 30
	Middle	2440	1.61	< 30
	High	2480	0.20	< 30
2 Mbps	Low	2402	0.78	< 30
	Middle	2440	1.56	< 30
	High	2480	0.20	< 30

Please refer to the following plots for detailed test results.

Low Channel: 2402 MHz 1 Mbps

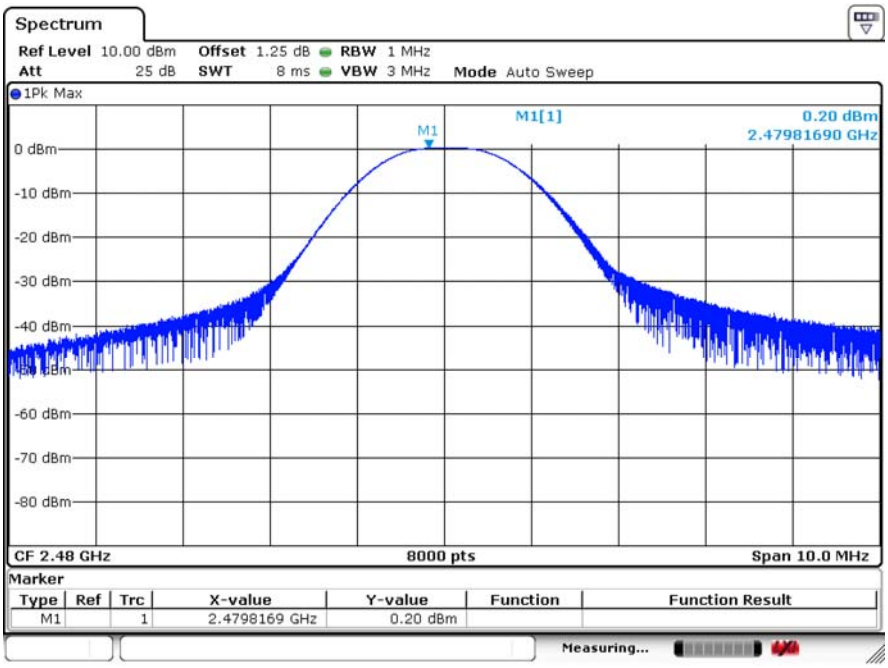


Mid Channel: 2440 MHz 1 Mbps



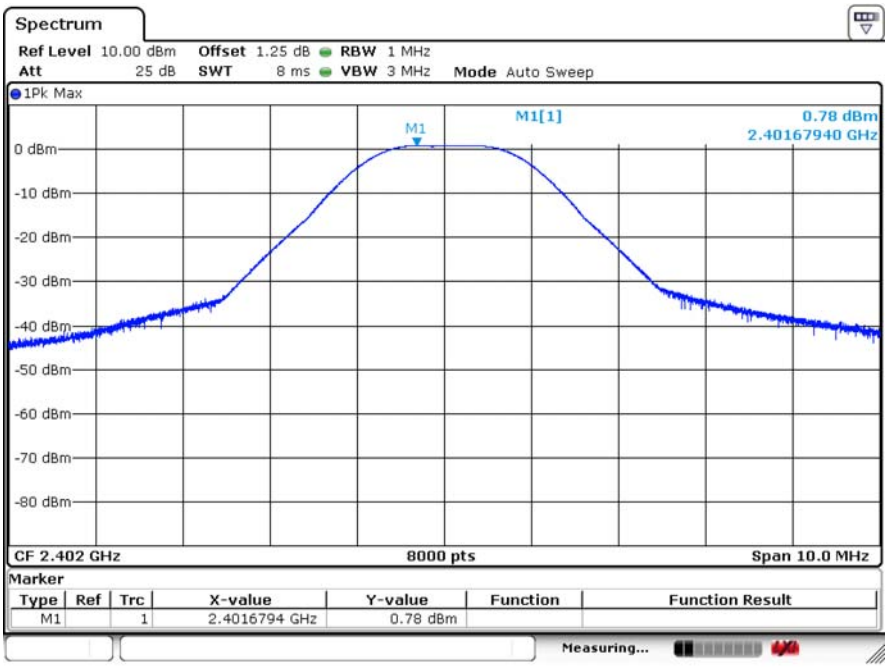
Date: 3.DEC.2021 16:08:11

High Channel: 2480 MHz 1 Mbps



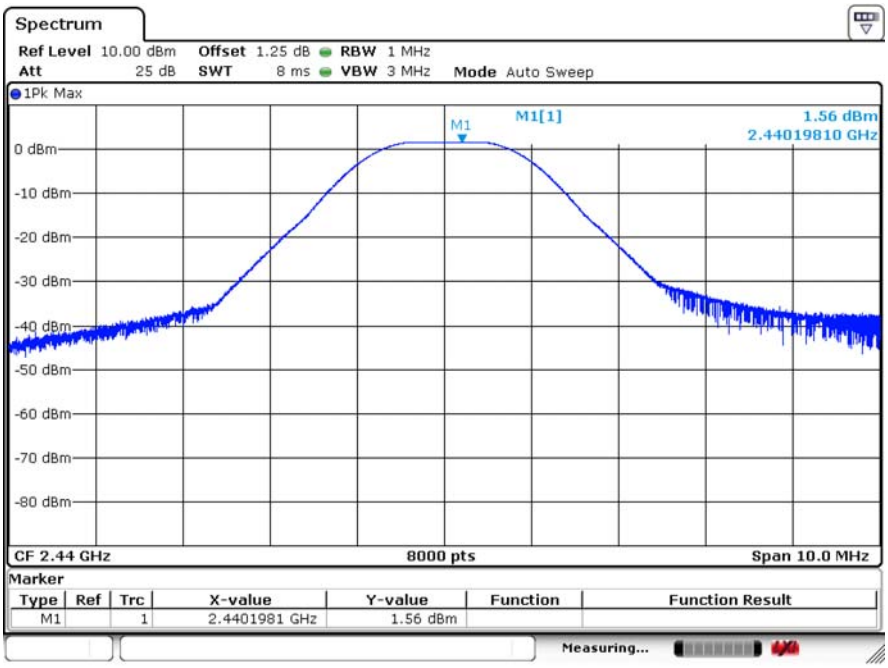
Date: 3.DEC.2021 16:11:35

Low Channel: 2402 MHz 2 Mbps



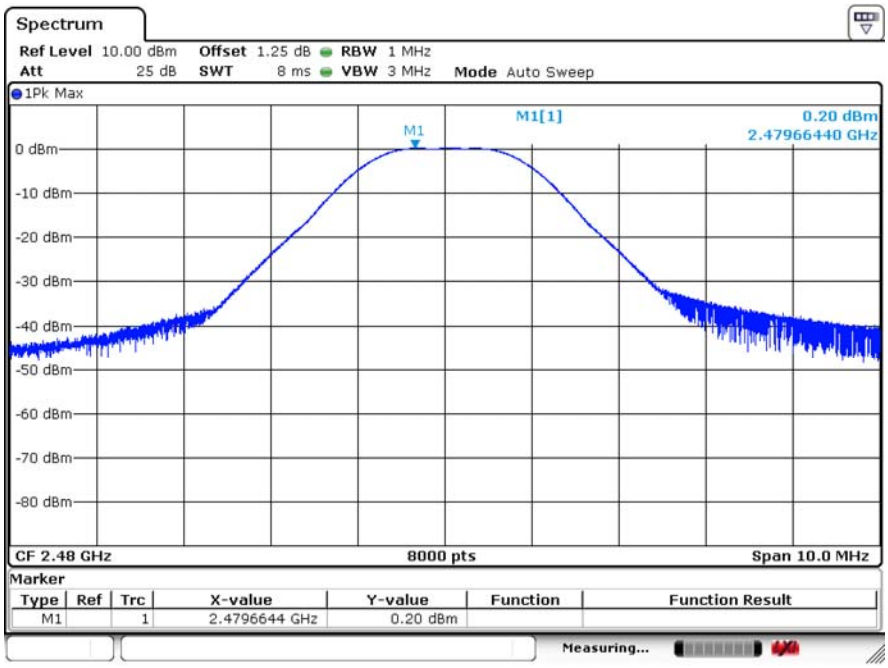
Date: 3.DEC.2021 16:04:45

Mid Channel: 2440 MHz 2 Mbps



Date: 3.DEC.2021 16:09:22

High Channel: 2480 MHz 2 Mbps



9 FCC §15.247(e) - Peak Power Spectral Density

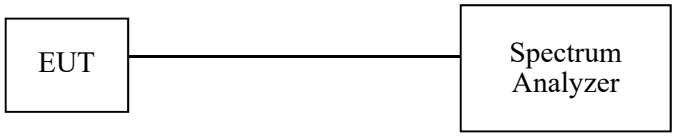
9.1 Applicable Standards

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.

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 10: Maximum power spectral density level in the fundamental emission.

9.3 Test Setup Diagram



9.4 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
912	Rhode & Schwarz	Signal 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".*

9.5 Test Environmental Conditions

Temperature:	21° C
Relative Humidity:	39 %
ATM Pressure:	102.0 KPa

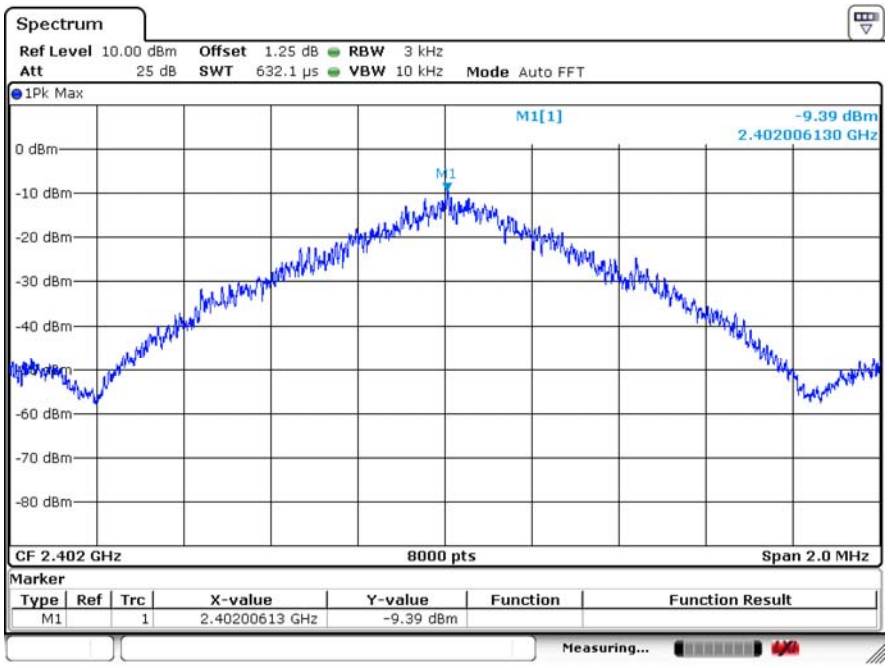
The testing was performed by Rita Yang on 2021-12-03 at RF test site.

9.6 Test Results

Rate	Channel	Frequency (MHz)	Conducted PSD (dBm/3 kHz)	FCC Limit (dBm/3 kHz)
1 Mbps	Low	2402	-9.39	< 8
	Middle	2440	-9.01	< 8
	High	2480	-10.48	< 8
2 Mbps	Low	2402	-12.75	< 8
	Middle	2440	-10.24	< 8
	High	2480	-12.98	< 8

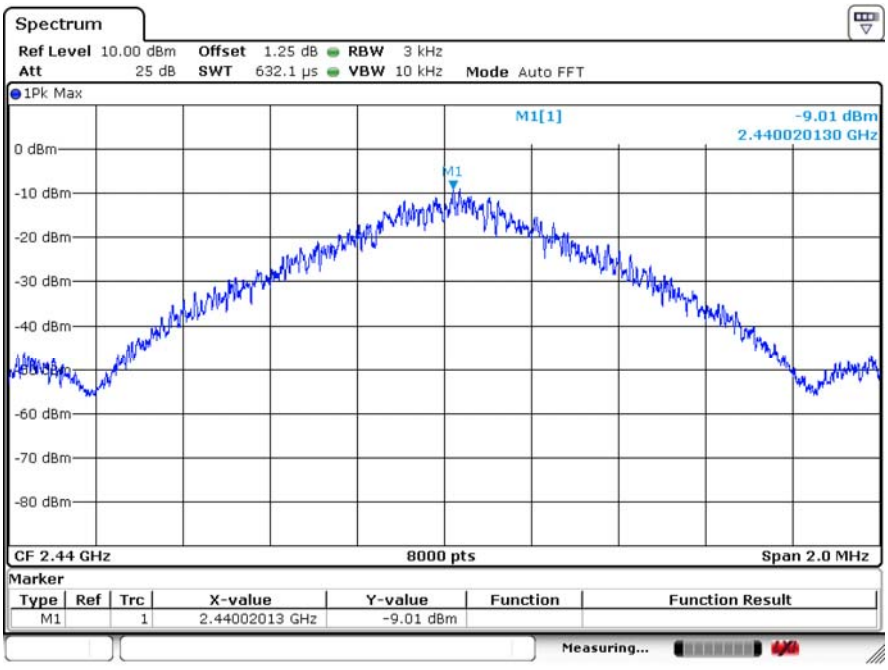
Please refer to the following plots for detailed test results.

Low Channel: 2402 MHz 1 Mbps



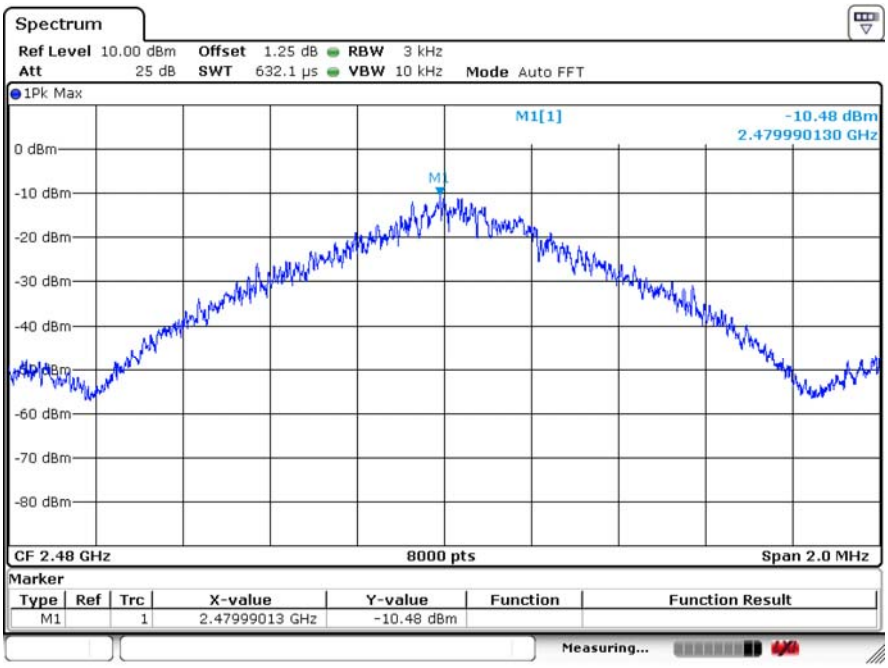
Date: 3.DEC.2021 16:27:59

Mid Channel: 2440 MHz 1 Mbps



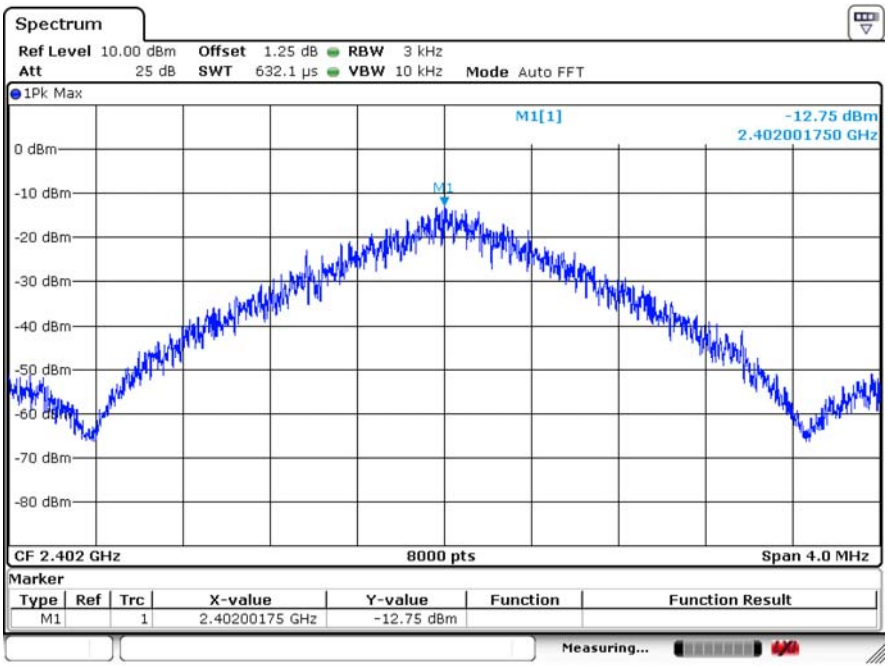
Date: 3.DEC.2021 16:26:26

High Channel: 2480 MHz 1 Mbps



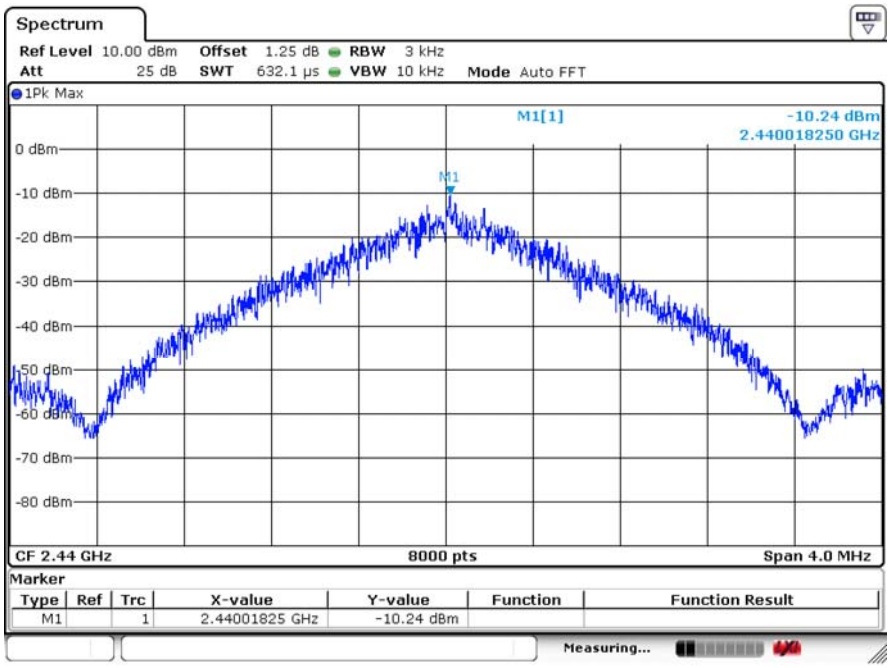
Date: 3.DEC.2021 16:21:50

Low Channel: 2402 MHz 2 Mbps



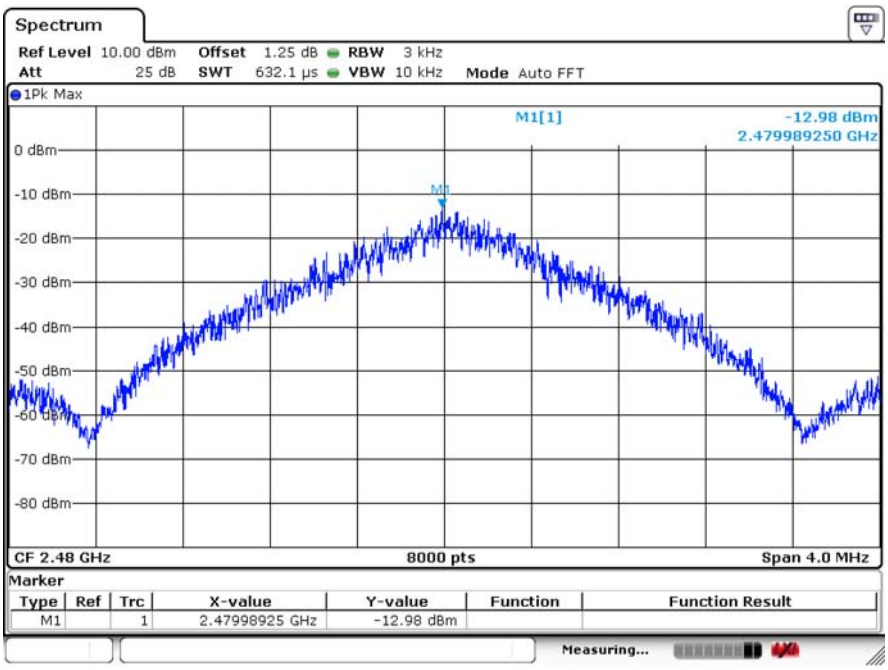
Date: 3.DEC.2021 16:29:04

Mid Channel: 2440 MHz 2 Mbps



Date: 3.DEC.2021 16:23:56

High Channel: 2480 MHz 2 Mbps



Date: 3.DEC.2021 16:22:58

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

10.1 Applicable Standards

According to FCC §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).

10.2 Measurement Procedure

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation

RBW = 100 kHz
VBW = 300 kHz
Sweep = coupled
Detector function = peak
Trace = max hold

10.3 Test Setup Diagram

10.4 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
912	Rhode & Schwarz	Signal 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".*

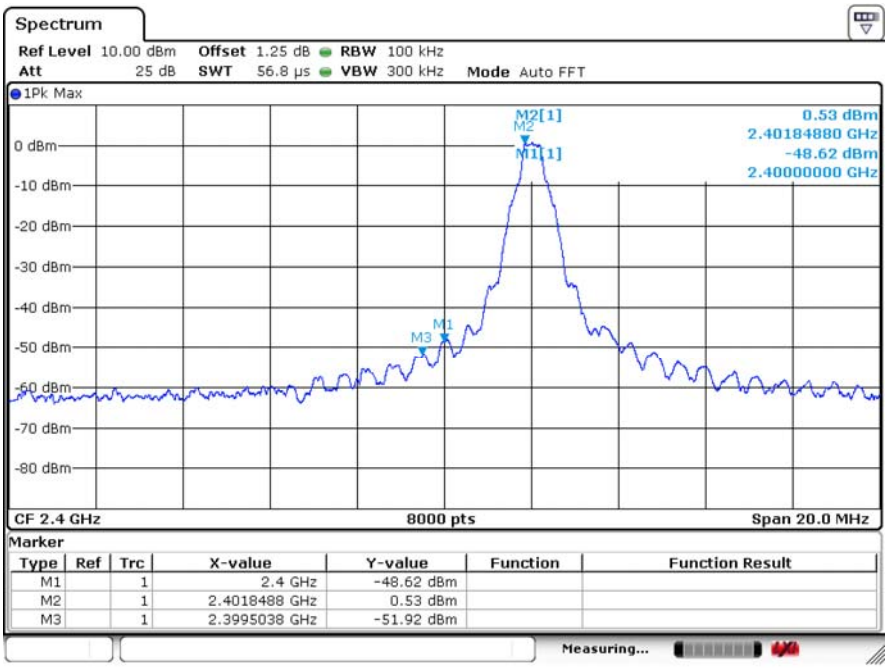
10.5 Test Environmental Conditions

Temperature:	21º C
Relative Humidity:	39 %
ATM Pressure:	102.0 KPa

The testing was performed by Rita Yang on 2021-12-03 at RF test site.

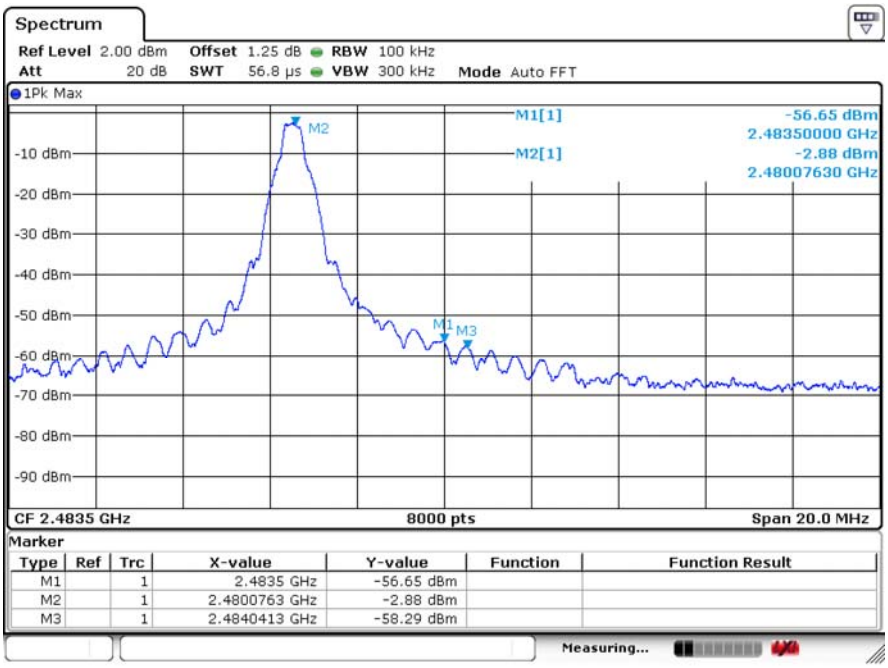
10.6 Test Results

Low Channel: 2402 MHz 1 Mbps



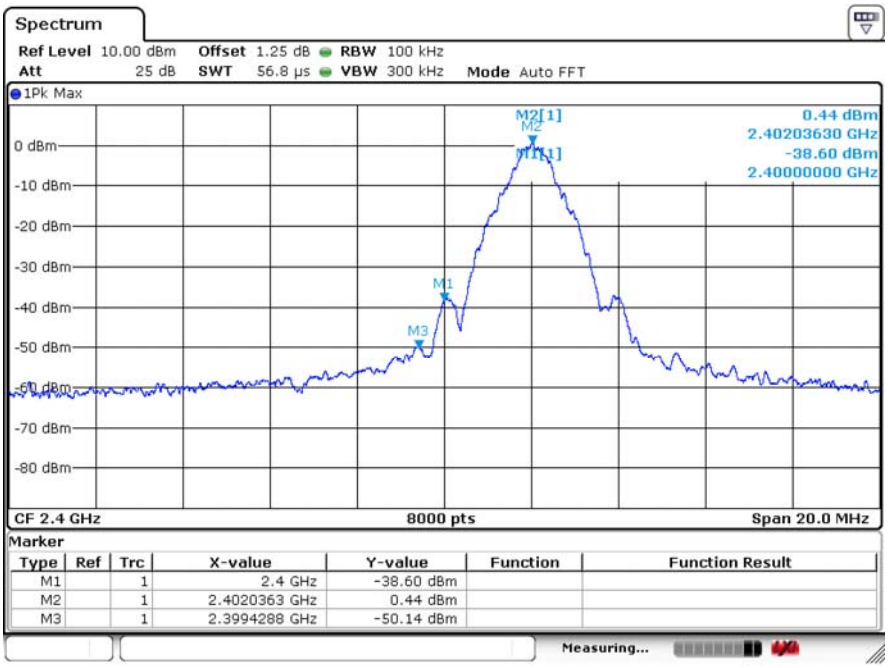
Date: 3.DEC.2021 15:49:57

High Channel: 2480 MHz 1 Mbps



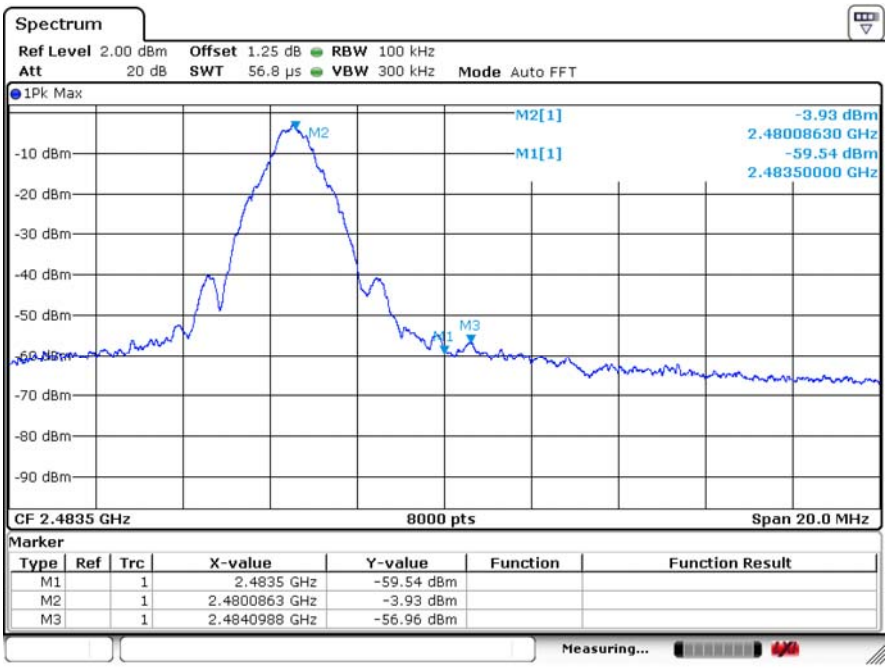
Date: 3.DEC.2021 15:46:16

Low Channel: 2402 MHz 2 Mbps



Date: 3.DEC.2021 15:51:47

High Channel: 2440 MHz 2 Mbps



Date: 3.DEC.2021 15:39:53

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

11.1 Applicable Standards

For 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)).

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 Setup Diagram

11.4 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
287	Agilent	Signal Analyzer	E446A	US44300386	2021-04-27	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".*

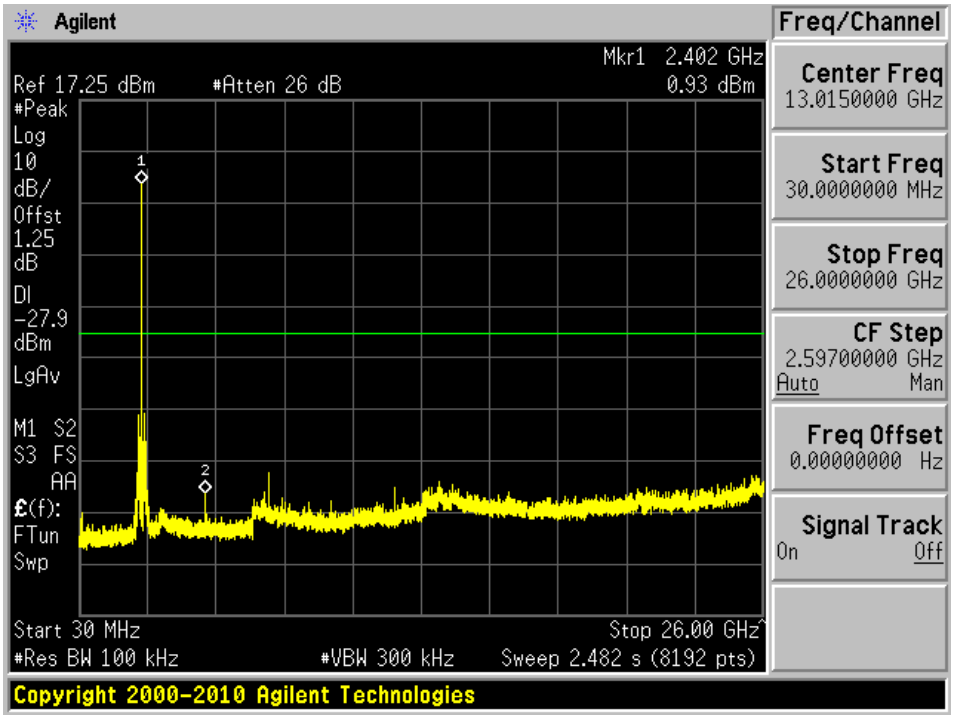
11.5 Test Environmental Conditions

Temperature:	21º C
Relative Humidity:	39 %
ATM Pressure:	102.0 KPa

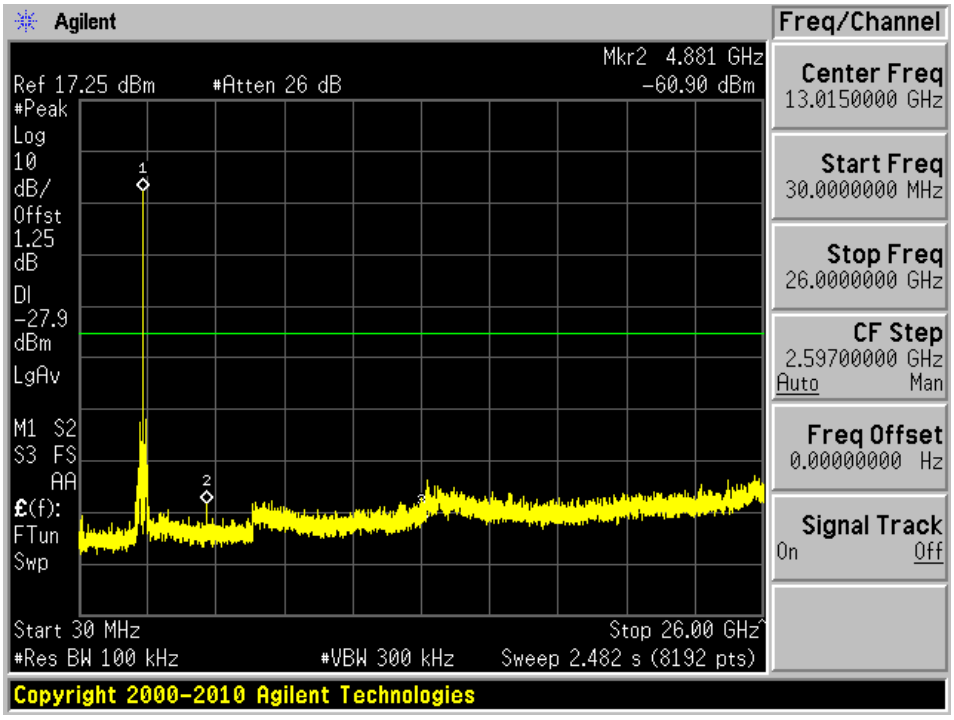
The testing was performed by Rita Yang on 2021-12-03 at RF test site.

11.6 Test Results

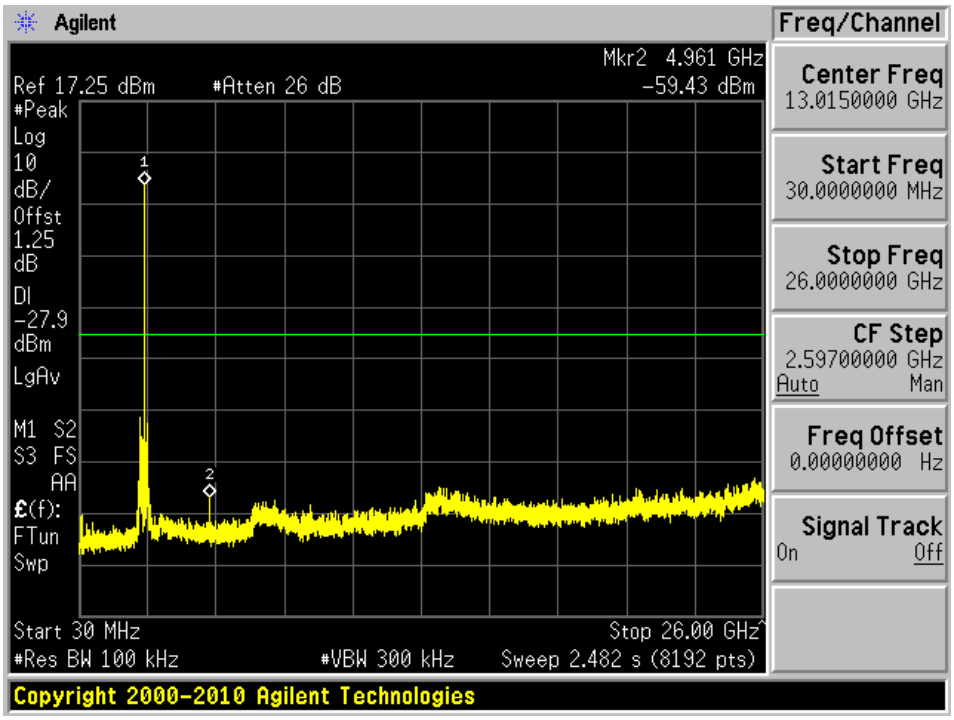
Low Channel: 2402 MHz 1 Mbps



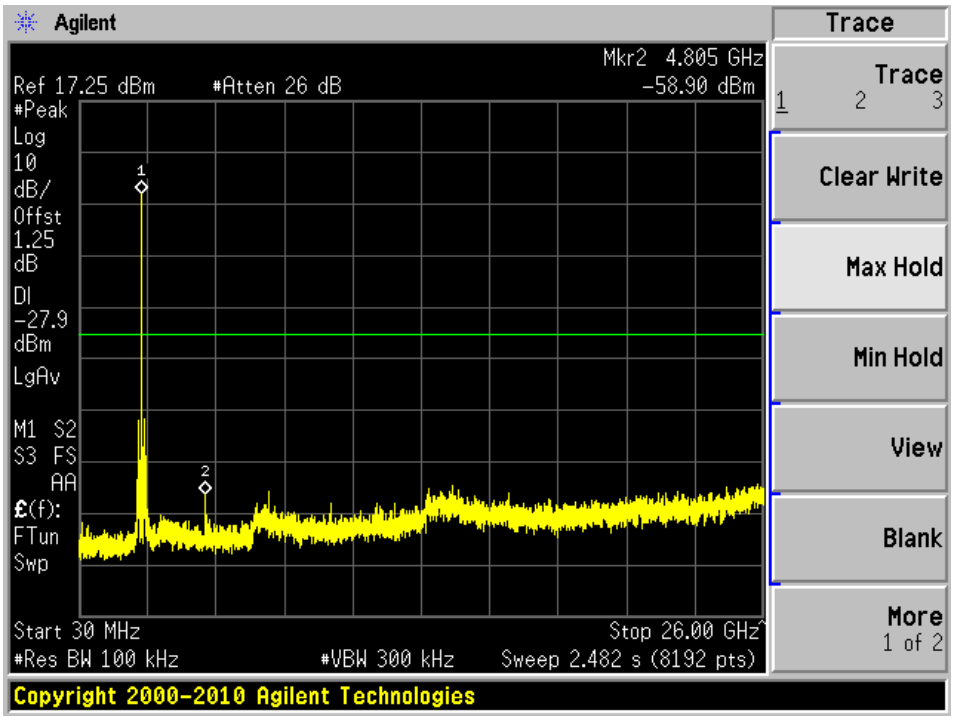
Mid Channel: 2440 MHz 1 Mbps



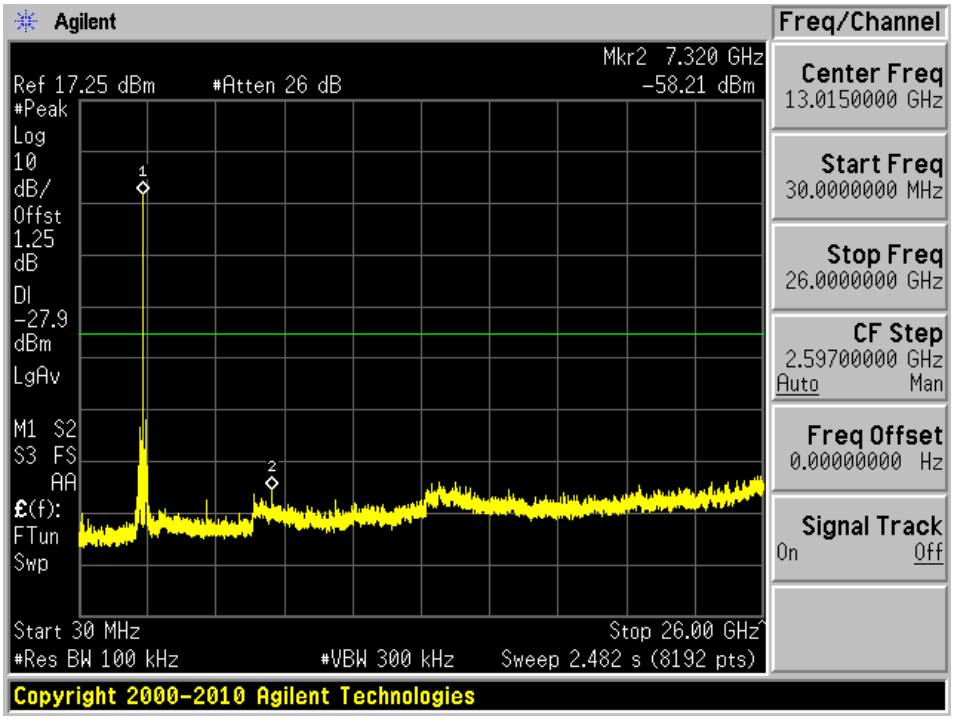
High Channel: 2480 MHz 1 Mbps



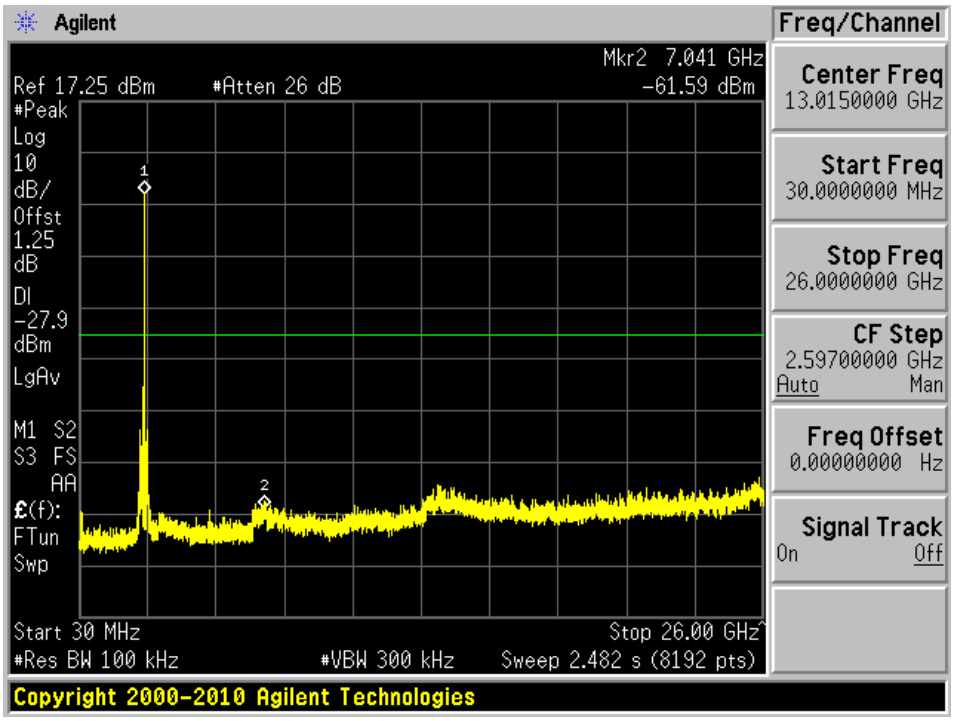
Low Channel: 2402 MHz 2 Mbps



Mid Channel: 2440 MHz 2 Mbps



High Channel: 2480 MHz 2 Mbps



12 Annex A (Normative) - Test Setup Photographs

Please refer to the attachment

13 Annex B (Normative) - EUT External 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

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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