CERTIFICATION TEST REPORT

Report Number. : 12696946-E2V2

Applicant	:	APPLE, INC. 1 APPLE PARK WAY CUPERTINO, CA 95014, U.S.A.
Model	:	A2111, A2222 AND A2223
FCC ID	:	BCG-E3309A
IC	:	579C-E3309A
EUT Description	:	SMARTPHONE
Test Standard(s)	:	FCC 47 CFR PART 15 SUBPART C ISED RSS-247 ISSUE 2 ISED RSS-GEN ISSUE 5

Date Of Issue:
July 25, 2019

Prepared by:
UL Verification Services Inc.
47173 Benicia Street
Fremont, CA 94538 U.S.A.
TEL: (510) 319-4000
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NVLAP Lab code: 200065-0

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	7/18/2019	Initial Issue	Tony Li
V2	7/25/2019	Address TCB's Questions	Chin Pang

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: APPLE, INC.
1 APPLE PARK WAY
CUPERTINO, CA 95014, U.S.A.

EUT DESCRIPTION: SMARTPHONE

MODEL: A2111, A2222 AND A2223

SERIAL NUMBER: C7CYQ004MT74, C7CYP0L2MT5Q

DATE TESTED: FEBRUARY 21, 2019 – JULY 03, 2019

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C	Complies
ISED RSS-247 Issue 2	Complies
ISED RSS-GEN Issue 5	Complies

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of the U.S. government.

Approved & Released For
UL Verification Services Inc. By:

Chin Pang
Senior Engineer
Consumer Technology Division
UL Verification Services Inc.

Prepared By:

Tony Li
Test Engineer
Consumer Technology Division
UL Verification Services Inc.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, ANSI C63.10-2013, KDB 558074 D01 15.247 Meas Guidance v05r02, RSS-GEN Issue 5, and RSS-247 Issue 2.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, and 47658 Kato Road, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

47173 Benicia Street	47266 Benicia Street	47658 Kato Rd
☒ Chamber A (ISED:2324B-1)	☐ Chamber D (ISED:22541-1)	☐ Chamber I (ISED:2324A-5)
☐ Chamber B (ISED:2324B-2)	☐ Chamber E (ISED:22541-2)	☐ Chamber J (ISED:2324A-6)
☐ Chamber C (ISED:2324B-3)	☒ Chamber F (ISED:22541-3)	☐ Chamber K (ISED:2324A-1)
	☐ Chamber G (ISED:22541-4)	☐ Chamber L (ISED:2324A-3)
	☒ Chamber H (ISED:22541-5)	

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers above are covered under Industry Canada company address and respective code

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0

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4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

RADIATED EMISSIONS

Where relevant, the following sample calculation is provided:
Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)
36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

MAINS CONDUCTED EMISSIONS

Where relevant, the following sample calculation is provided:
Final Voltage (dBuV) = Measured Voltage (dBuV) + Cable Loss (dB) + Limiter Factor (dB) + LISN Insertion Loss.
36.5 dBuV + 0 dB +10.1 dB+ 0 dB = 46.6 dBuV

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Worst Case Conducted Disturbance, 9KHz to 0.15 MHz	3.84 dB
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.65 dB
Worst Case Radiated Disturbance, 9KHz to 30 MHz	2.52 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	4.88 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.24 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.37 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.17 dB

Uncertainty figures are valid to a confidence level of 95%.

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5. EQUIPMENT UNDER TEST

5.1. EUT DESCRIPTION

EUT is a smartphone with multimedia functions (music, application support, and video), cellular GSM, GPRS, EGPRS, UMTS, LTE, TD-SCDMA, CDMA, IEEE 802.11a/b/g/n/ac/ax, Bluetooth, Ultra-Wide band, GPS and NFC. All models support at least one UICC based SIM. The second SIM, if present, is either UICC based pSIM (physical SIM) or e-SIM (electronic SIM). The device has a built-in inductive charging receiver. The rechargeable battery is also not user accessible.

5.2. DIFFERENCE IN MODEL NUMBER

Model A2111, A2222 and A2223 is electrically identical to Model A2111. Three model numbers are allocated for marketing and logistic purposes only. A2111 was used to perform all final tests.

5.3. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak conducted output power as follows:

Antenna	Configuration	Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
Ant 2	High Power	2402 - 2480	BLE 1M	19.26	84.33
	Low Power			12.48	17.70
	High Power		BLE 2M	19.39	86.90
	Low Power			12.47	17.66
Ant 5	High Power	2402 - 2480	BLE 1M	20.10	102.33
	Low Power			12.69	18.58
	High Power		BLE 2M	20.23	105.44
	Low Power			12.76	18.88
BF, Ant 2 + Ant 5	High Power	2402 - 2480	BLE 1M	20.42	110.15
	Low Power			15.59	36.22
	High Power		BLE 2M	20.46	111.17
	Low Power			15.64	36.64

5.4. DESCRIPTION OF AVAILABLE ANTENNAS

Frequency Range (GHz)	Ant. 2 (dBi)	Ant. 5 (dBi)
2.4	-4.5	-2.6

5.5. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was BT FW version: 17.1.140.1283.

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5.6. WORST-CASE CONFIGURATION AND MODE

The EUT was investigated in three orthogonal orientations X, Y and Z on Ant 2 (Antenna 2) and Ant 5 (Antenna 5). It was determined that X (Flatbed) orientation was the worst-case orientation for Ant 2, Ant 5 and beamforming 2TX.

Radiated band edge, harmonic, and spurious emissions from 1GHz to 18GHz were performed with the EUT set to transmit at highest power on Low/Middle/High channels.

Radiated emissions below 30MHz, below 1GHz, 18-26GHz and power line conducted emissions were performed with the EUT transmitting at the channel with the highest output power as worst-case scenario.

For below 1GHz tests, EUT was connected to AC power adapter as the worst case; and for above 1GHz tests, the worst-case configuration reported was with EUT only. For AC line conducted emission, test was investigated with AC power adapter and with laptop.

For simultaneous transmission of multiple channels in the 2.4GHz BLE and 5GHz bands. No noticeable new emission was found.

Radiated band edge, harmonic, and spurious emissions from 1GHz to 18GHz were performed with the EUT set to transmit at highest power on Low/Middle/High channels.

Radiated emissions below 30MHz, below 1GHz, 18-26GHz and power line conducted emissions were performed with the EUT transmitting at the channel with the highest output power as worst-case scenario.

For below 1GHz tests, EUT was connected to AC power adapter as the worst case; and for above 1GHz tests, the worst-case configuration reported was with EUT only. There was no emission found below 30MHz within 20dB of the limit. For AC line conducted emission, test was investigated with AC power adapter and with laptop.

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5.7. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
laptop	Apple	A1502	HRP003436	QDS-BRCM1080
Laptop AC/DC adapter	Liteon Technology	PA-1450-BA1	B123	NA
EUT AC Adapter	Apple	A1385	D29325SM03XDHLHC9	NA

I/O CABLES

I/O Cable List						
Cable No	**Port**	**# of identical ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	Antenna	1	SMA	Un-Shielded	0.2	To spectrum Analyzer
2	USB	1	USB	Shielded	1	N/A
3	AC	1	AC	Un-shielded	2	N/A

I/O CABLES (BELOW 1GHz AND AC POWER LINE TEST WITH ADAPTER AND LAPTOP)

I/O Cable List						
Cable No	**Port**	**# of identical**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	AC	1	AC	Un-shielded	2	N/A
2	USB	1	USB	Un-shielded	1	N/A

TEST SETUP

The EUT is connected to a test laptop during the tests. Test software exercised the radio card.

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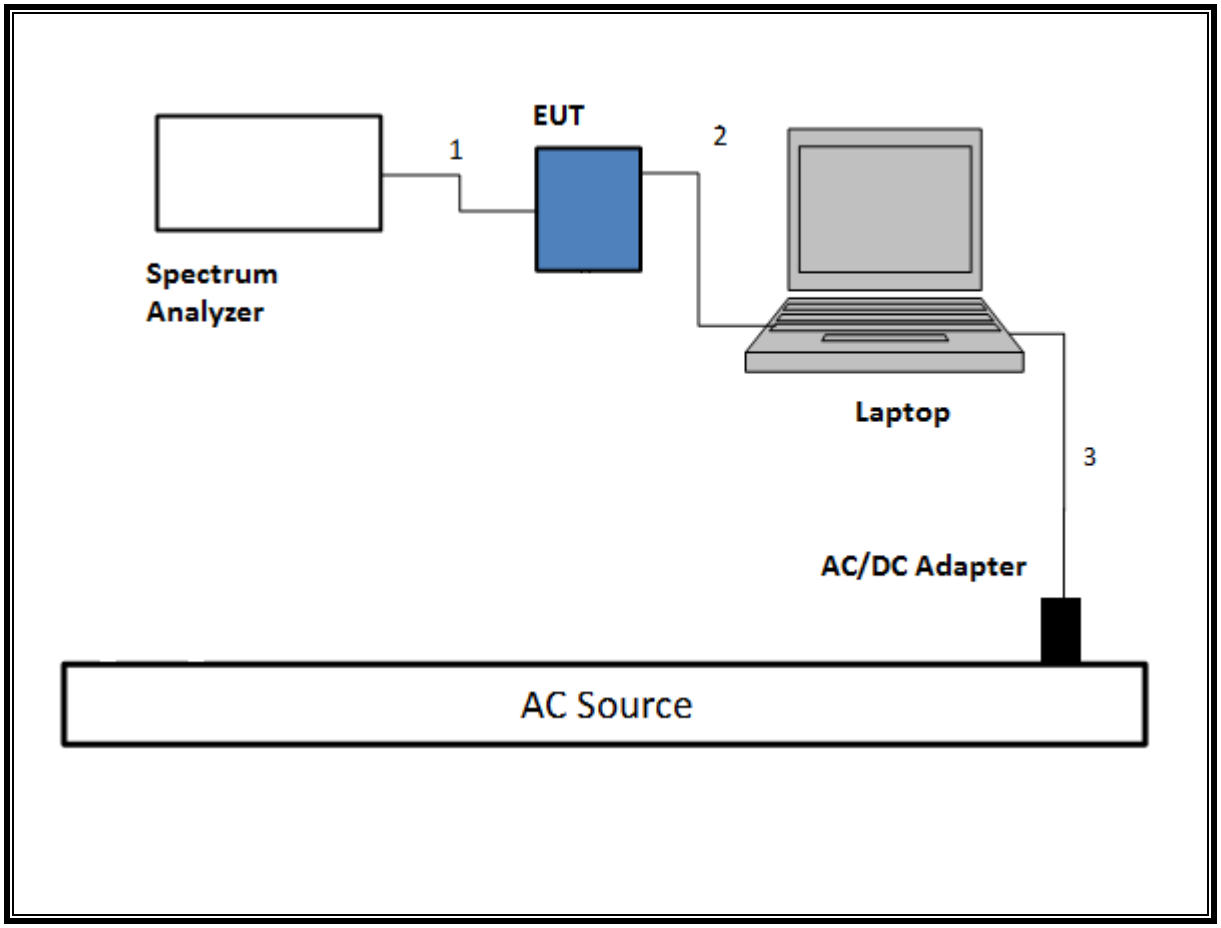
SETUP DIAGRAM FOR CONDUCTED TESTS



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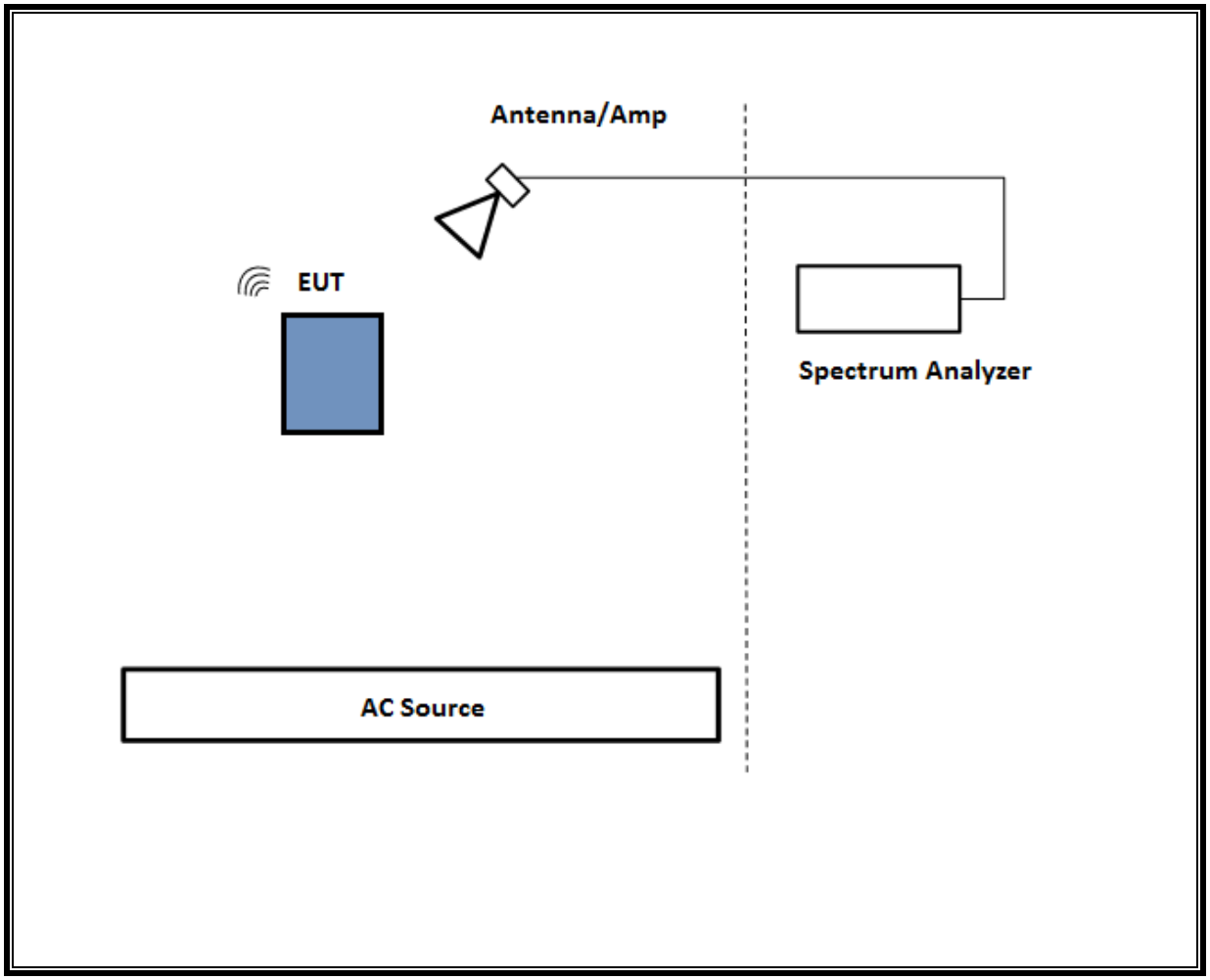
SETUP DIAGRAM FOR RADIATED TESTS Above 1 GHz



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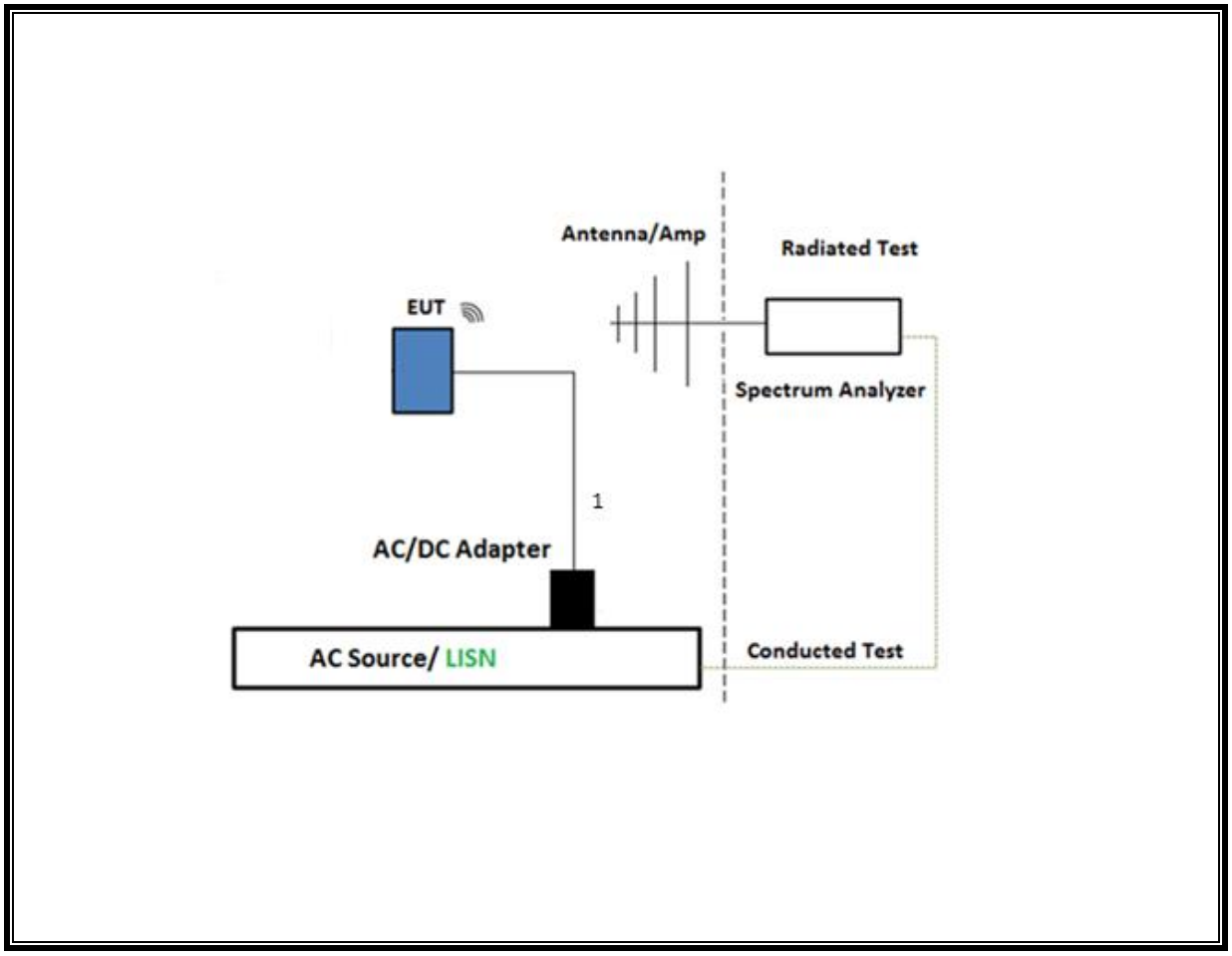
SETUP DIAGRAM FOR Below 1GHz and AC LINE CONDUCTED TEST



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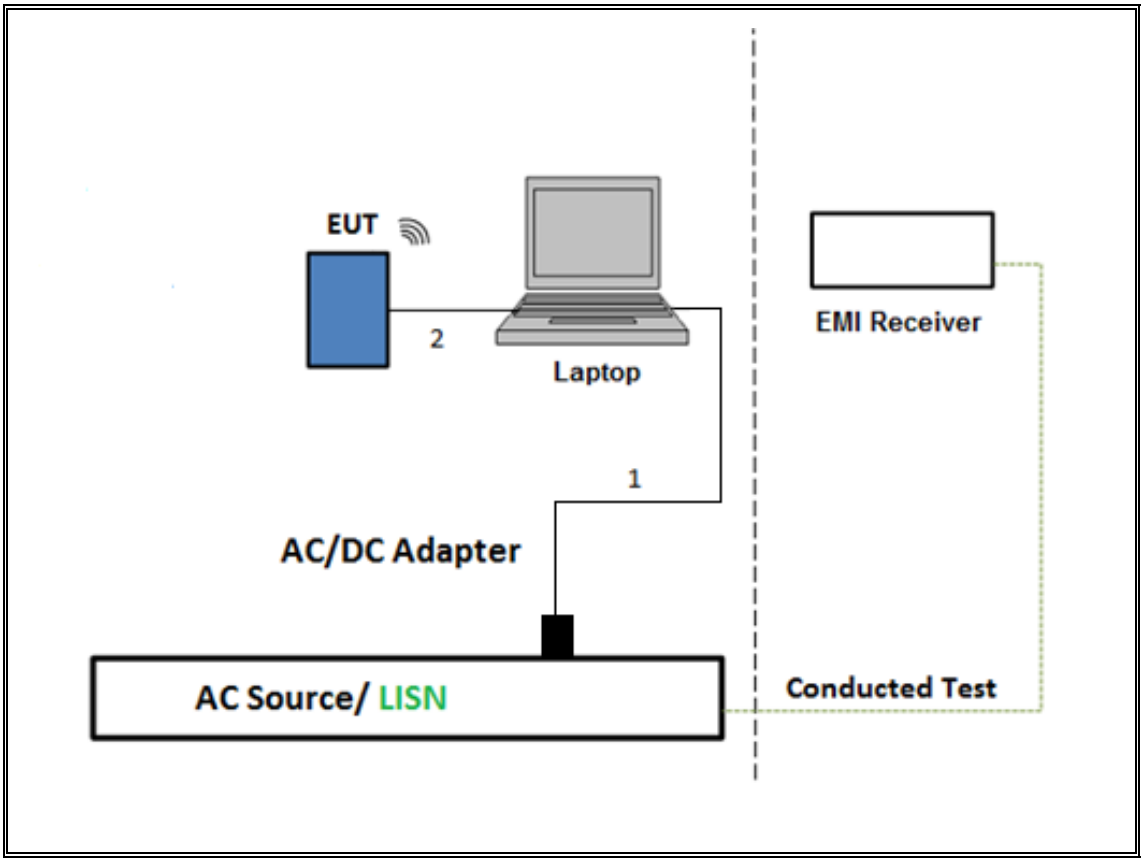
TEST SETUP- AC LINE CONDUCTED: LAPTOP CONFIGURATION



6. MEASUREMENT METHOD

6 dB BW: ANSI C63.10 Subclause -11.8.1 RBW ≥ DTS BW

Occupied BW (99%): ANSI C63.10-2013 Section 6.9.3

Output Power: ANSI C63.10 Subclause -11.9.1.3 Method PKPM1 Peak-reading power meter

Output Power: ANSI C63.10 Subclause -11.9.2.3.1 Measurement using average power meter

PSD: ANSI C63.10 Subclause -11.10.2 Method PKPSD (peak PSD)

Radiated emissions non-restricted frequency bands: ANSI C63.10 Subclause -11.11

Radiated emissions restricted frequency bands: ANSI C63.10 Subclause -11.12.1

Conducted emissions in restricted frequency bands: ANSI C63.10 Subclause -11.12.2

Band-edge: ANSI C63.10 Subclause -11.13.3.2 Integration method -Peak detection

Band-edge: ANSI C63.10 Subclause -11.13.3.3 Integration method -Trace averaging with continuous transmission at full power

AC Power Line Conducted Emissions: ANSI C63.10-2013, Section 6.2.

Radiated Spurious Emissions Below 30MHz: ANSI C63.10-2013 Section 6.4

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7. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

TEST EQUIPMENT LIST					
Description	**Manufacturer**	**Model**	**ID Num**	**Cal Due**	**Last Cal**
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T908	01/23/2020	01/23/2019
Thermometer	Control Company	14-650-118, 15557603	T1817	02/26/2020	02/26/2019
Horn Antenna 1-18GHz	ETS-Lindgren	3117	T136	07/02/2019	07/02/2018
Horn Antenna 1-18GHz	ETS-Lindgren	3117	T345	04/20/2020	04/25/2019
*Horn Antenna 1-18GHz	ETS-Lindgren	3117	T345	04/25/2019	04/25/2018
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T346	05/14/2020	05/14/2019
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T931	05/11/2020	05/11/2019
Amplifier, 10KHz to 1GHz, 32dB	Sonoma Instrument Co.	310N	T15	10/20/2019	10/20/2018
Antenna, Active Loop 9KHz to 30MHz	ETS-Lindgren	6502	T1616	10/18/2019	10/18/2018
Hybrid Antenna, 30-3Ghz	SunAR rf Motion	JB3	PRE0181574	08/01/2019	08/01/2018
*Antenna, Horn 18 to 26.5GHz	ARA	MWH-1826/B	T447	06/16/2019	06/16/2018
Amplifier, 1 - 18GHz	Miteq	AFS42-00101800-25	T1165	02/02/2020	02/02/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T340	01/22/2020	01/22/2019
Amplifier, 1 - 18GHz	Miteq	AFS42-00101800-25	T1567	01/26/2020	01/26/2019
*Pre-Amp 18-26GHz	Agilent Technology	8449B	T404	03/23/2020	03/23/2019
Power Meter, P-series single channel	Agilent (Keysight) Technologies	N1911A	T227	10/29/2019	10/29/2018
Filter, HPF 3GHz	Micro-Tronics	HPM17543	T1014	01/26/2020	01/26/2019
Power Sensor	Power Sensor	Keysight	T1226	02/06/2020	02/06/2019
AC Line Conducted					
*EMI Test Receiver 9Khz-7GHz	Rohde & Schwarz	ESCI7	T1436	02/14/2020	
Power Cable, Line Conducted Emissions	UL	PG1	T861	08/31/2019	
*LISN for Conducted Emissions CISPR-16	Fischer	50/250-25-2-01	T1310	06/19/2019	
UL AUTOMATION SOFTWARE					
Radiated Software	UL	UL EMC	Ver 9.5, April 26, 2016		
Conducted Software	UL	UL EMC	Ver 5.4, October 13, 2016		
AC Line Conducted Software	UL	UL EMC	Ver 9.5, May 26, 2015		

*Testing is completed before equipment expiration date.

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8. ANTENNA PORT TEST RESULTS

8.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

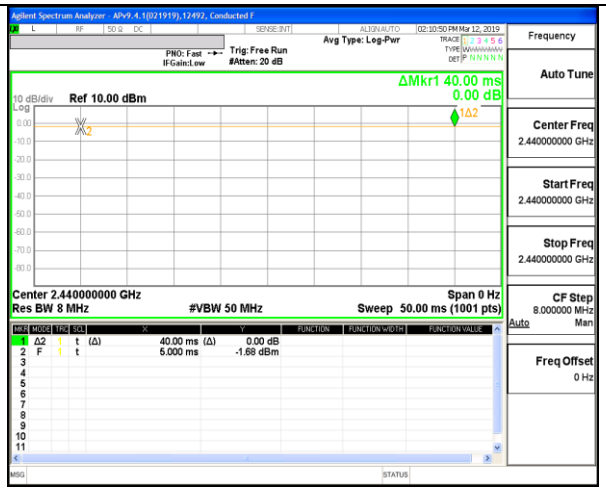
PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

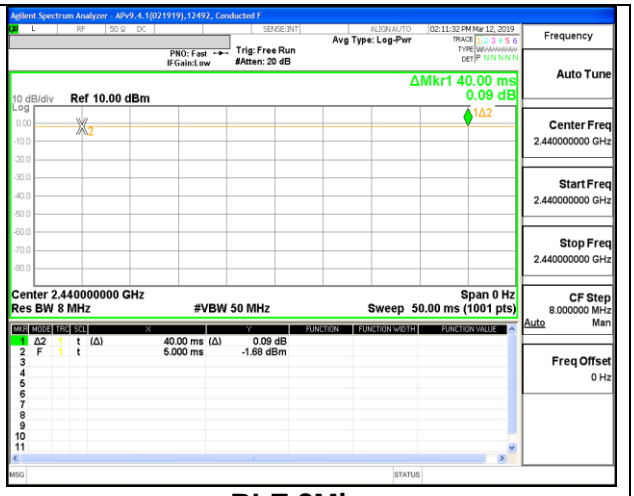
ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
2.4GHz Band						
BLE, 1Mbps	1.000	1.000	1.000	100.00%	0.00	0.010
BLE, 2Mbps	1.000	1.000	1.000	100.00%	0.00	0.010
BLE, TXBF, 1Mbps	1.000	1.000	1.000	100.00%	0.00	0.010
BLE, TXBF, 2Mbps	1.000	1.000	1.000	100.00%	0.00	0.010

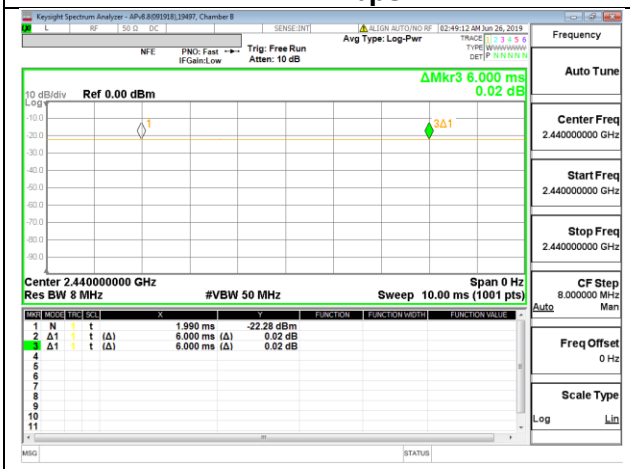
DUTY CYCLE PLOTS



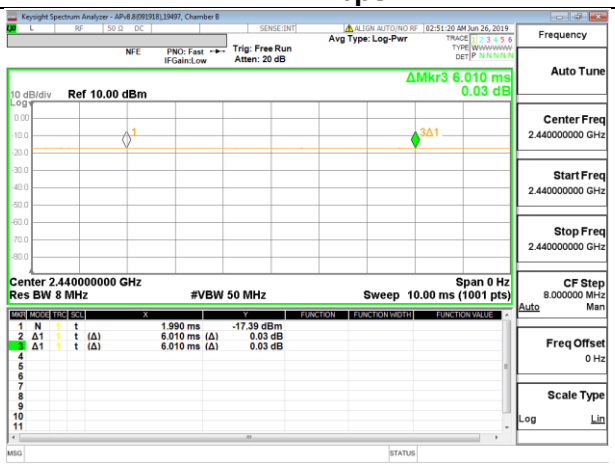
BLE 1Mbps



BLE 2Mbps



BLE TXBF 1Mbps



BLE TXBF 2Mbps

8.2. 99% BANDWIDTH

LIMITS

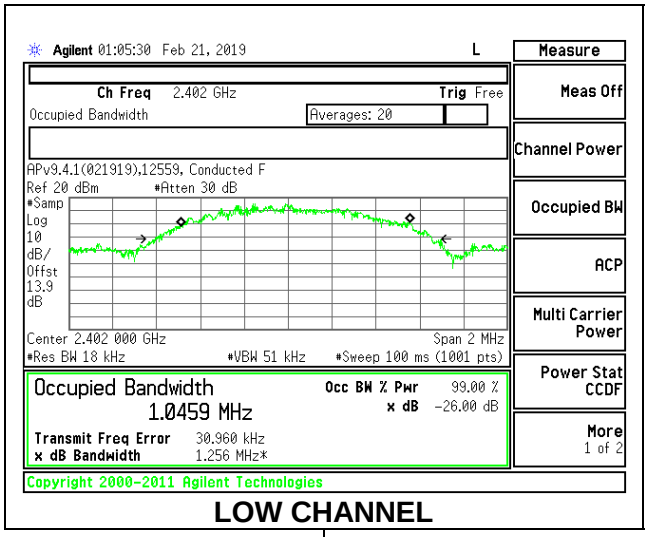
None; for reporting purposes only.

RESULTS

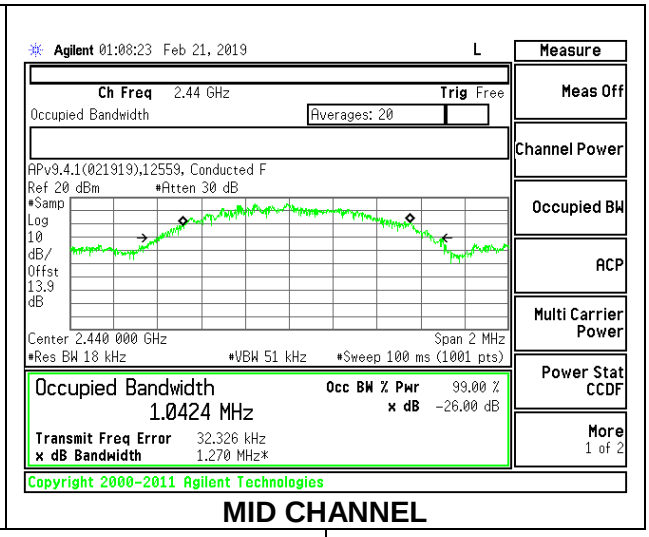
8.2.1. HIGH POWER BLE (1Mbps)

Antenna 2

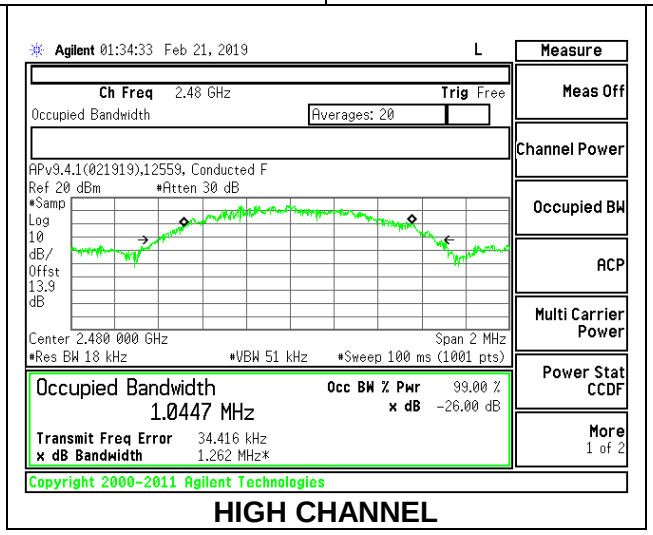
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0459
Middle	2440	1.0424
High	2480	1.0447



LOW CHANNEL



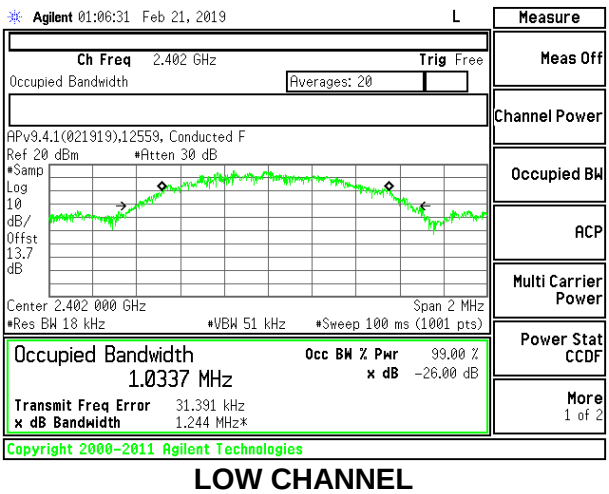
MID CHANNEL



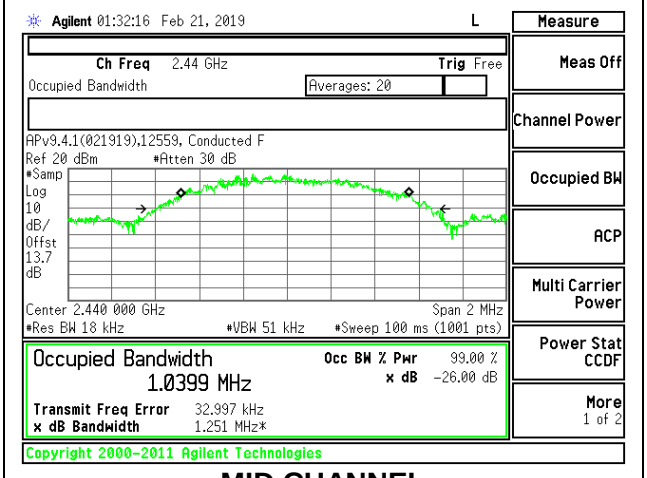
HIGH CHANNEL

Antenna 5

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0337
Middle	2440	1.0399
High	2480	1.0305



LOW CHANNEL



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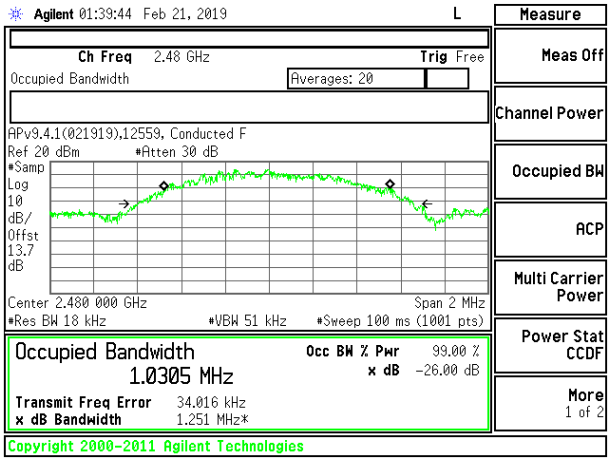
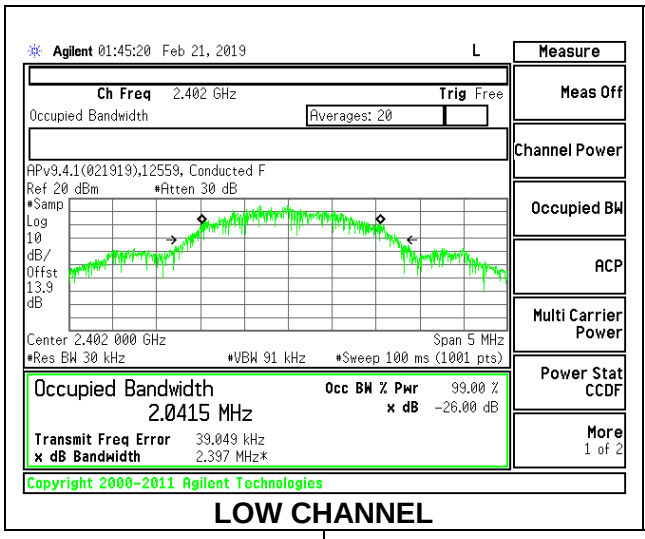


HIGH CHANNEL

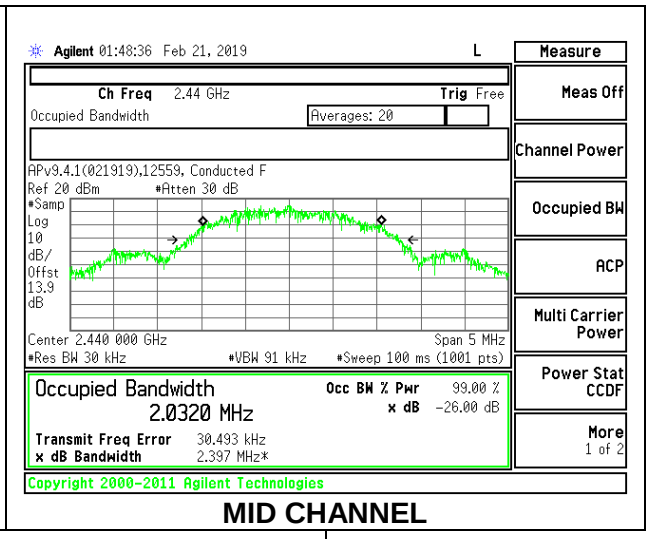
8.2.2. HIGH POWER BLE (2Mbps)

Antenna 2

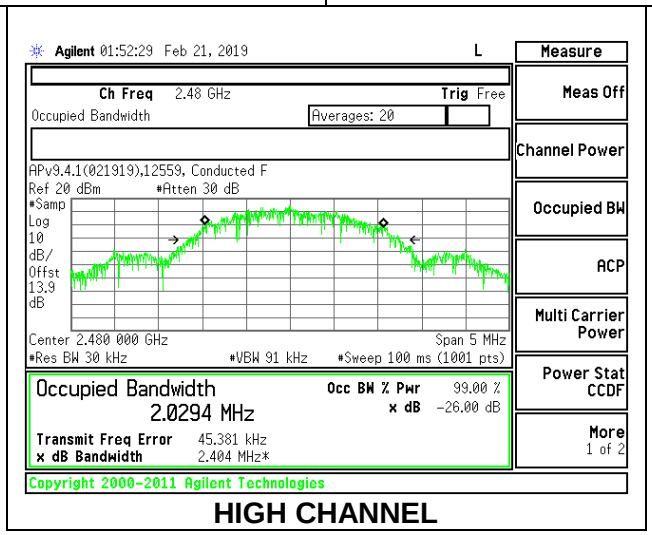
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	2.0415
Middle	2440	2.0320
High	2480	2.0294



LOW CHANNEL



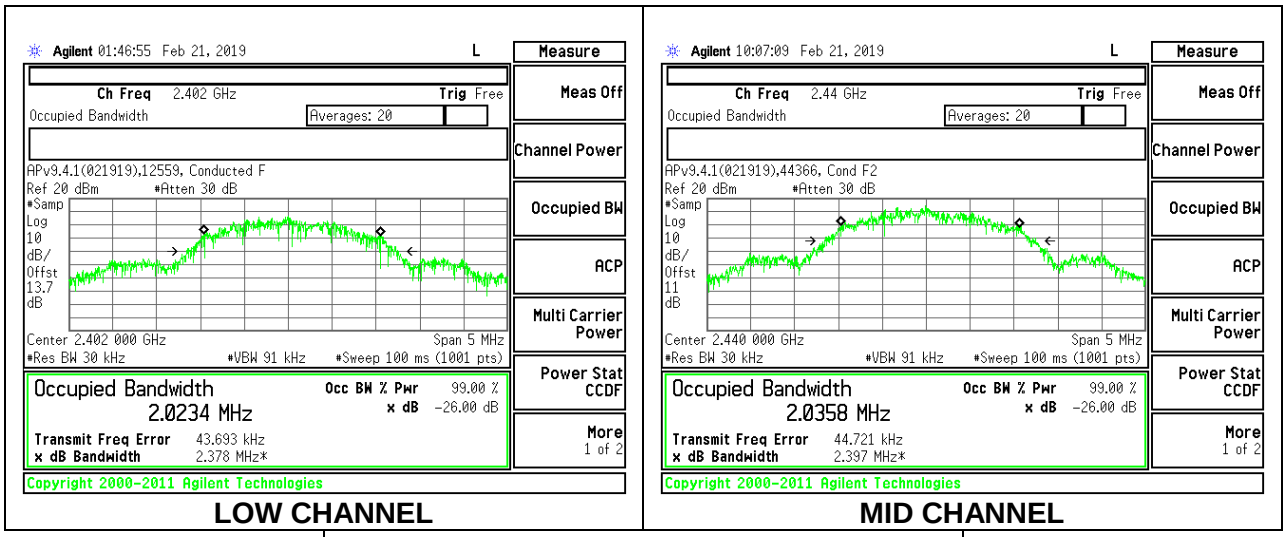
MID CHANNEL



HIGH CHANNEL

Antenna 5

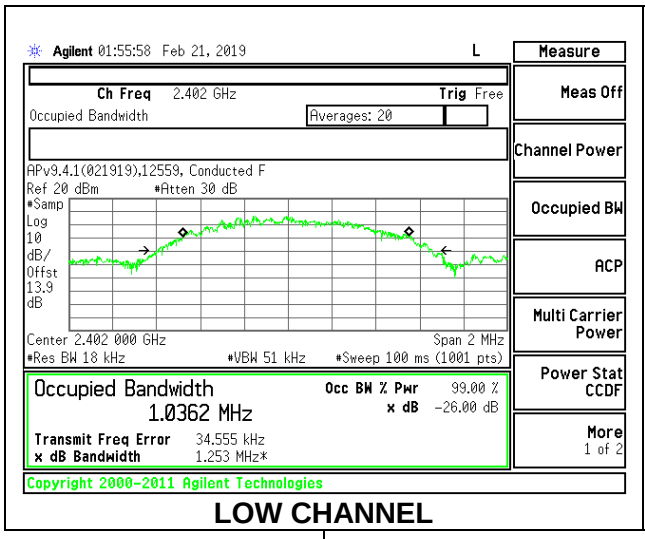
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	2.0234
Middle	2440	2.0358
High	2480	2.0185



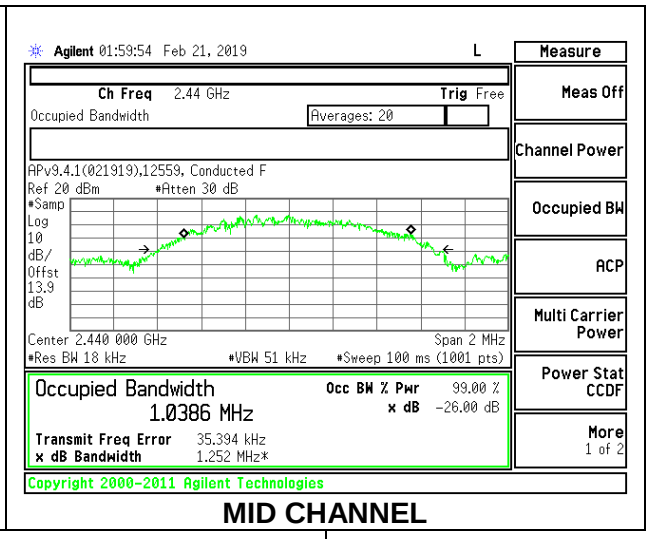
8.2.3. LOW POWER BLE (1Mbps)

Antenna 2

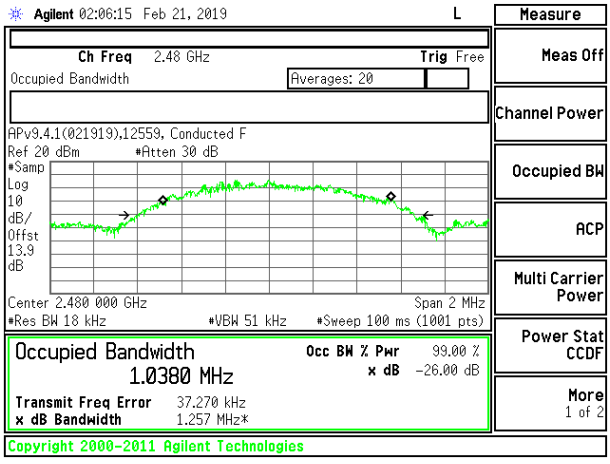
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0362
Middle	2440	1.0386
High	2480	1.0380



LOW CHANNEL



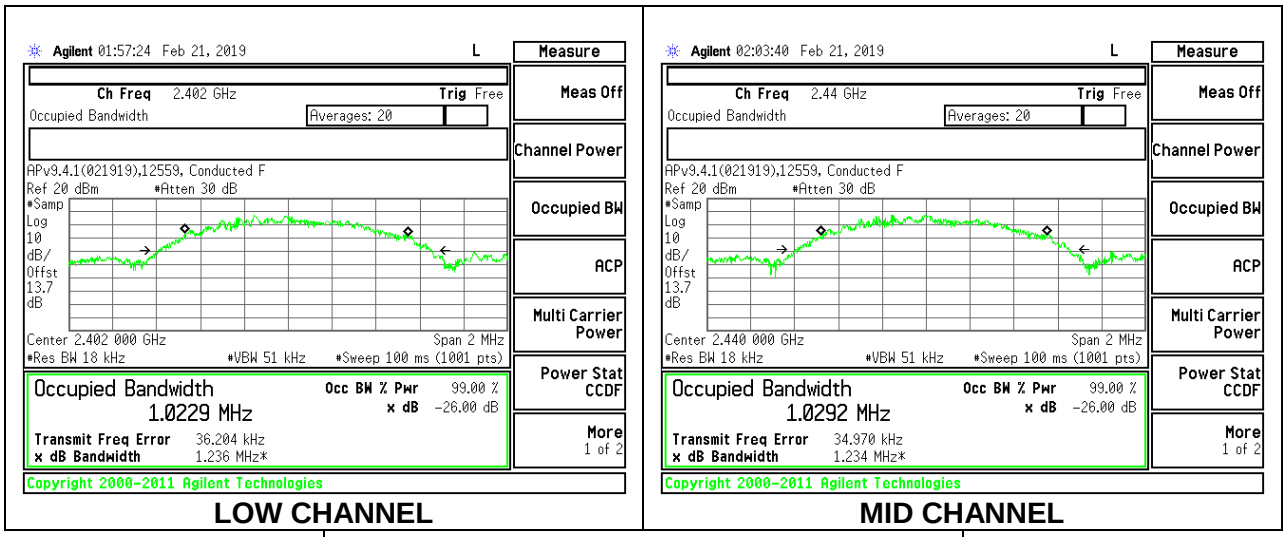
MID CHANNEL



HIGH CHANNEL

Antenna 5

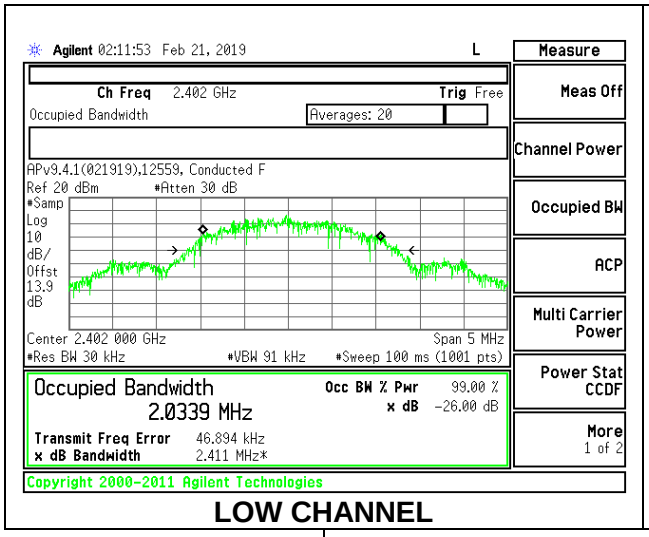
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0229
Middle	2440	1.0292
High	2480	1.0336



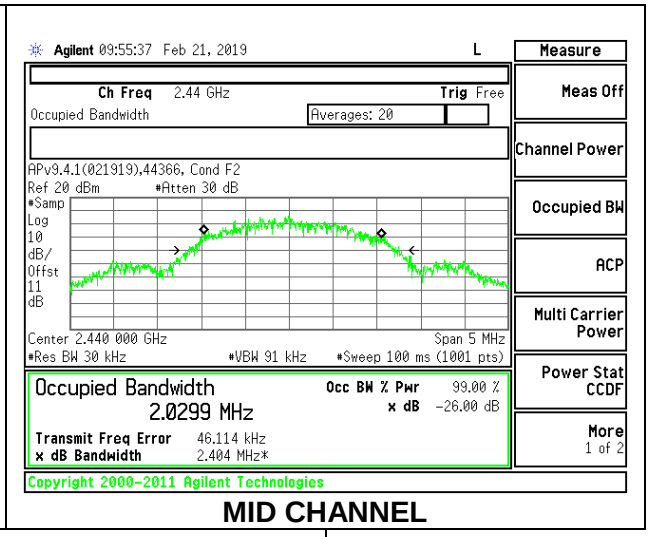
8.2.4. LOW POWER BLE (2Mbps)

Antenna 2

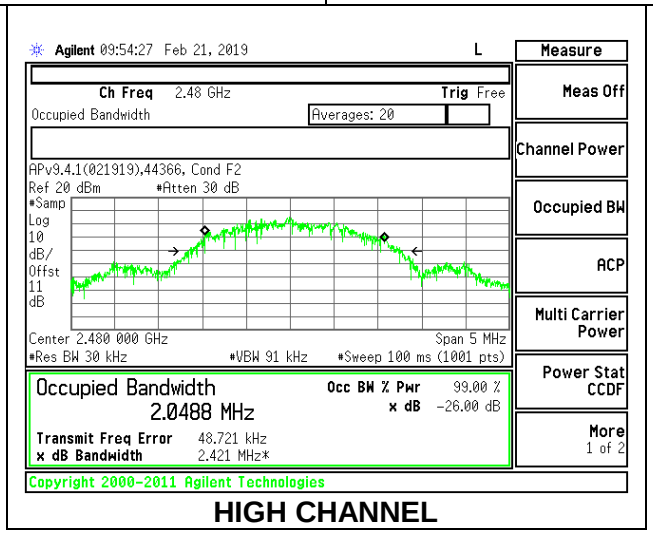
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	2.0339
Middle	2440	2.0299
High	2480	2.0488



LOW CHANNEL



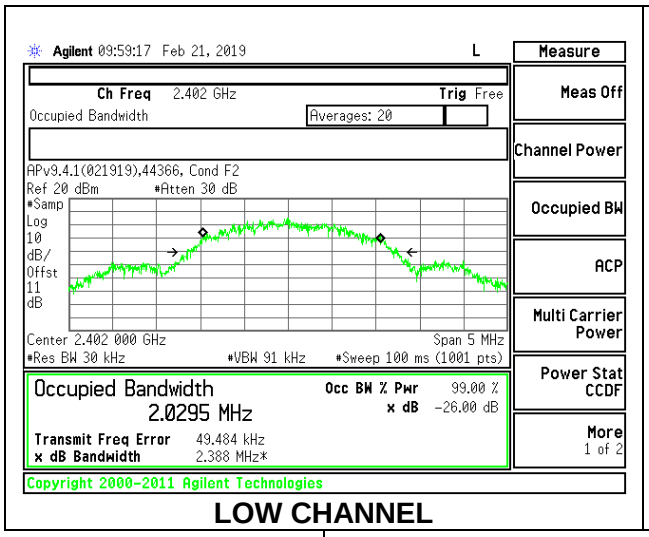
MID CHANNEL



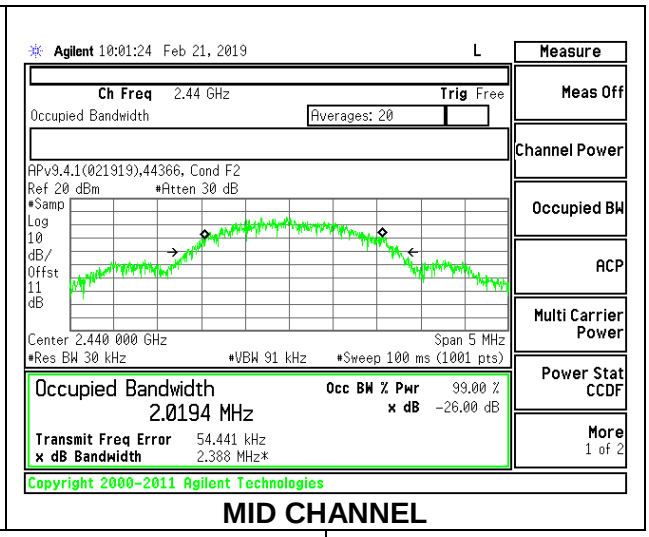
HIGH CHANNEL

Antenna 5

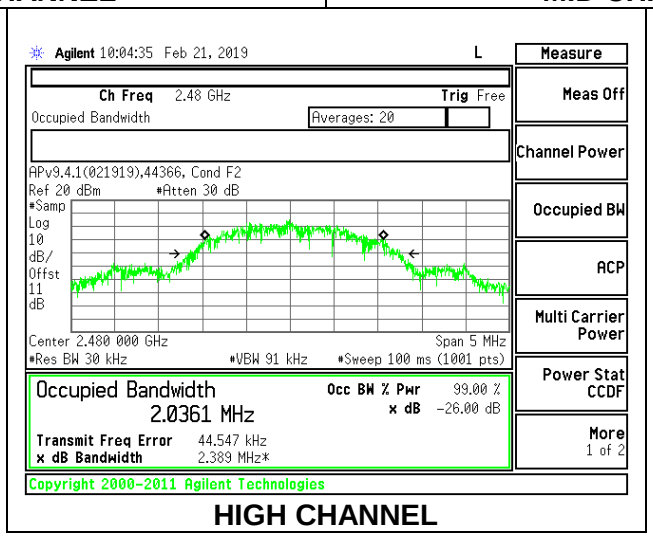
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	2.0295
Middle	2440	2.0194
High	2480	2.0361



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

8.3. 6 dB BANDWIDTH

LIMITS

FCC §15.407 (e)

RSS-247 5.2 (a)

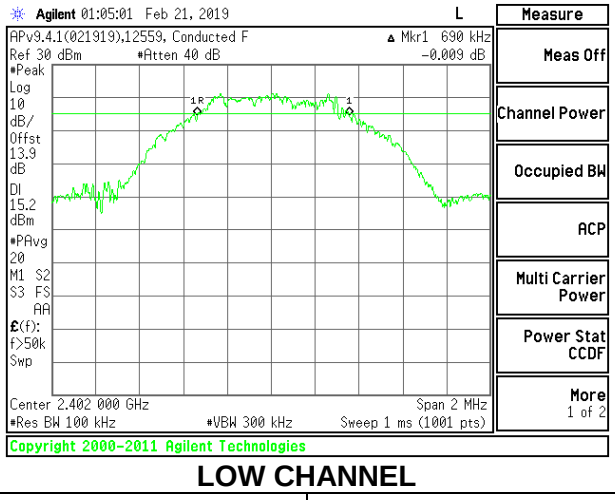
The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS

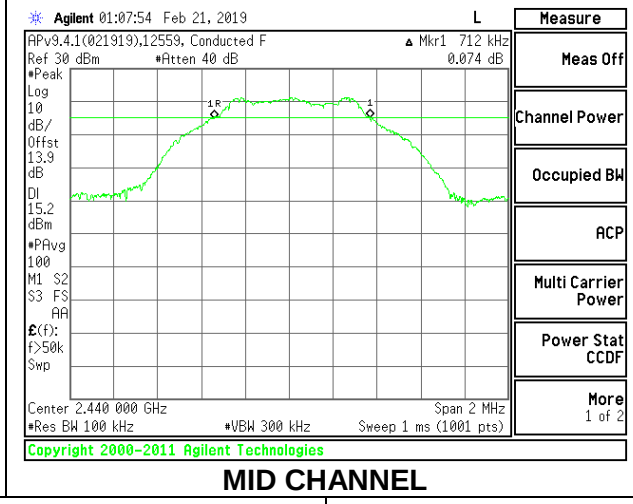
8.3.1. HIGH POWER BLE (1Mbps)

Antenna 2

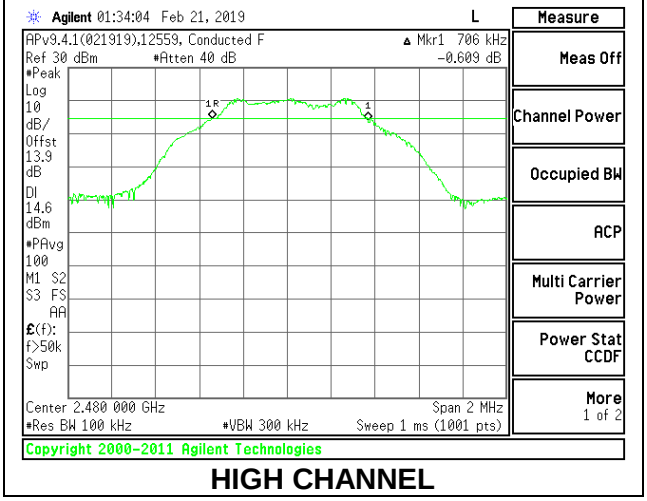
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.6900	0.5
Middle	2440	0.7120	0.5
High	2480	0.7060	0.5



LOW CHANNEL



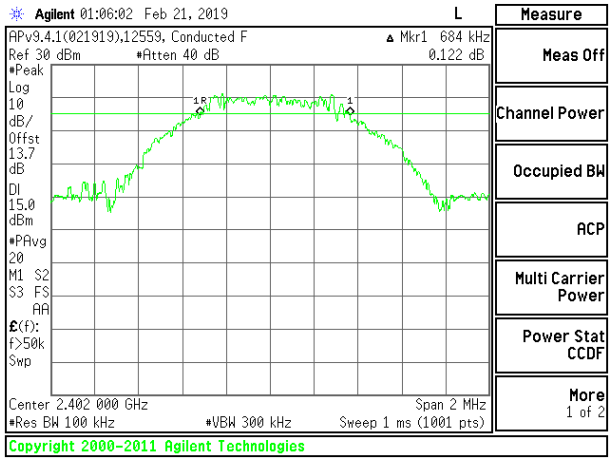
MID CHANNEL



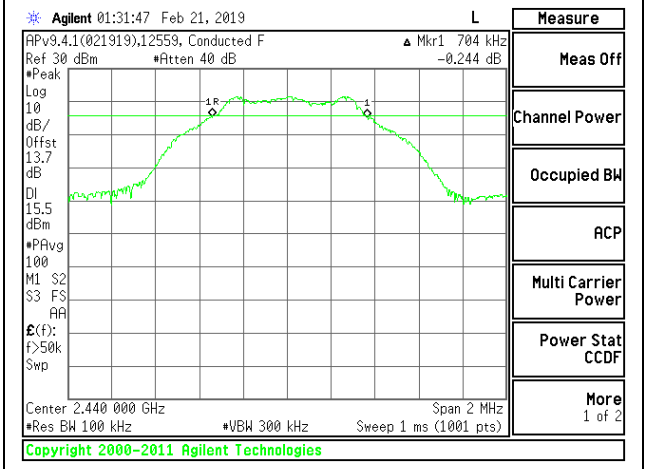
HIGH CHANNEL

Antenna 5

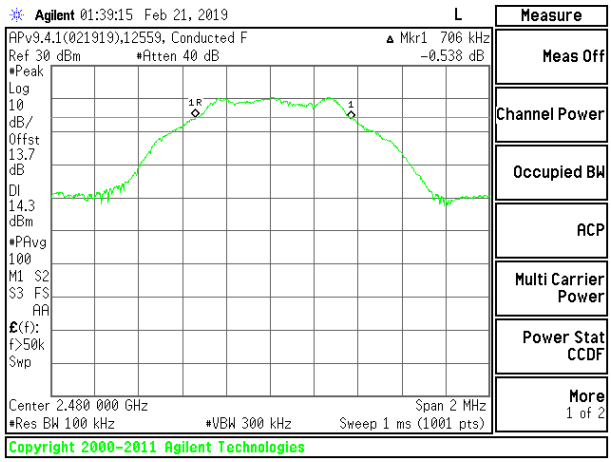
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.6840	0.5
Middle	2440	0.7040	0.5
High	2480	0.7060	0.5



LOW CHANNEL



MID CHANNEL

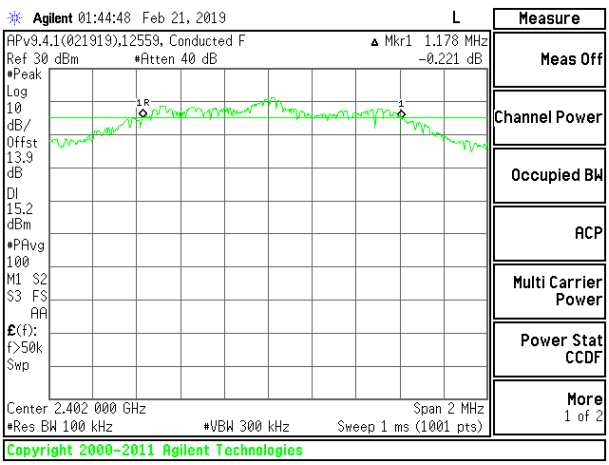


HIGH CHANNEL

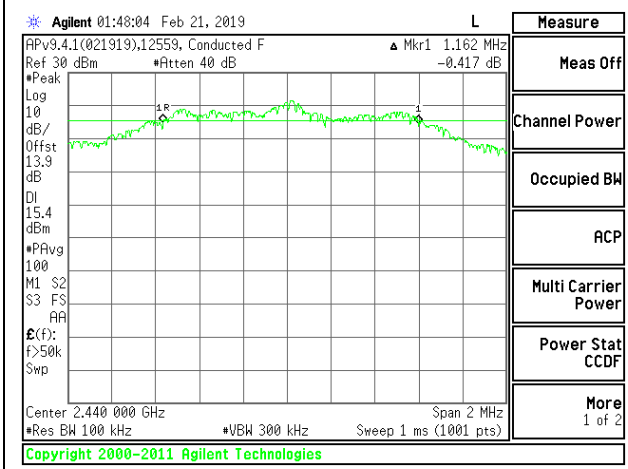
8.3.2. HIGH POWER BLE (2Mbps)

Antenna 2

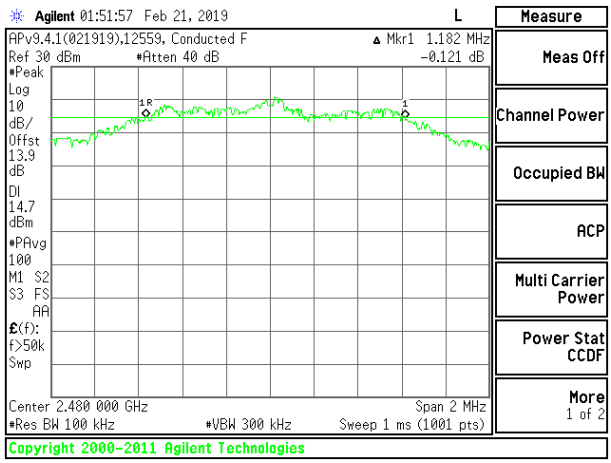
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	1.1780	0.5
Middle	2440	1.1620	0.5
High	2480	1.1820	0.5



LOW CHANNEL



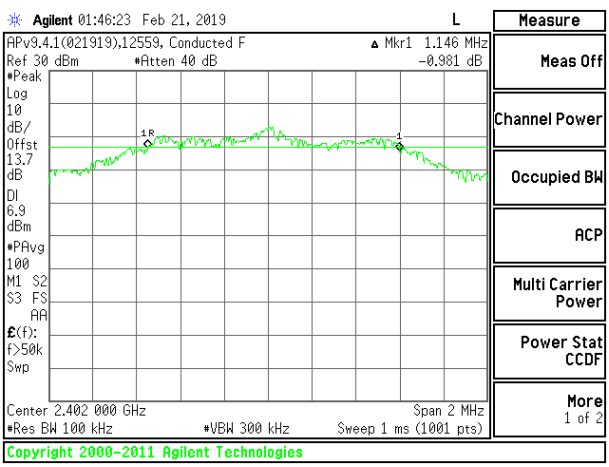
MID CHANNEL



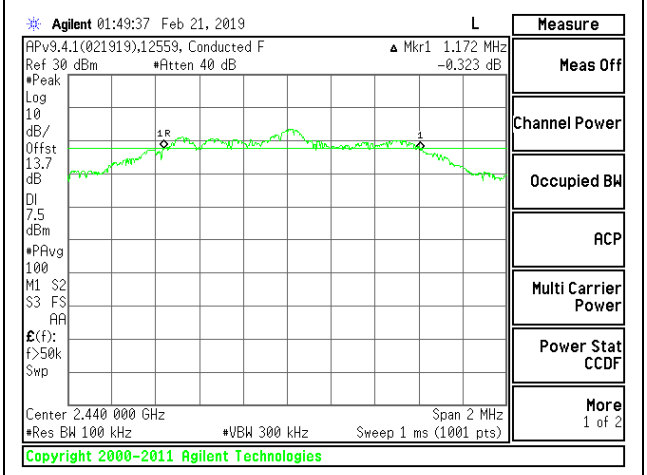
HIGH CHANNEL

Antenna 5

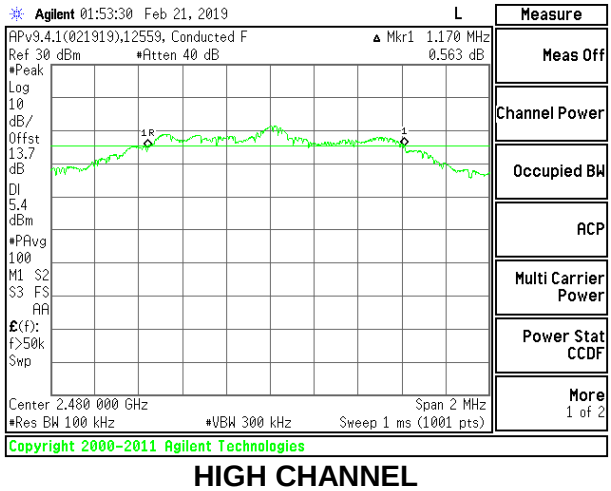
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	1.1460	0.5
Middle	2440	1.1720	0.5
High	2480	1.1700	0.5



LOW CHANNEL



MID CHANNEL

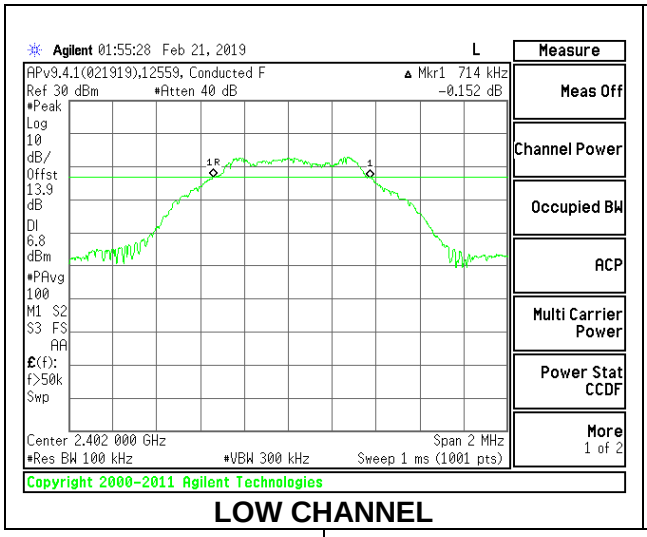


HIGH CHANNEL

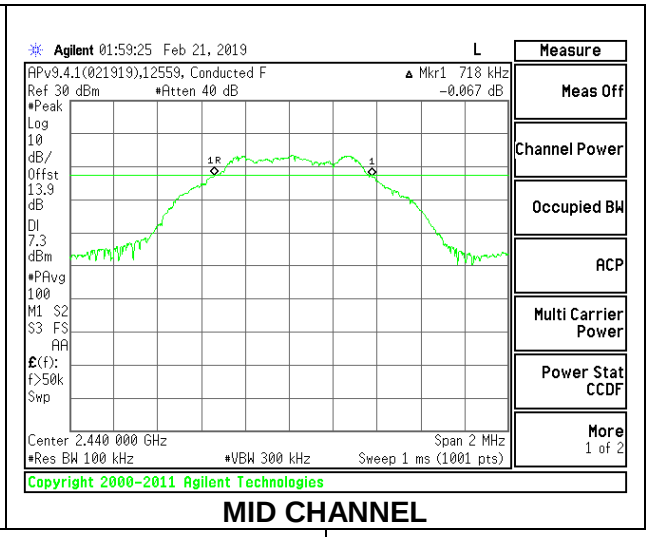
8.3.3. LOW POWER BLE (1Mbps)

Antenna 2

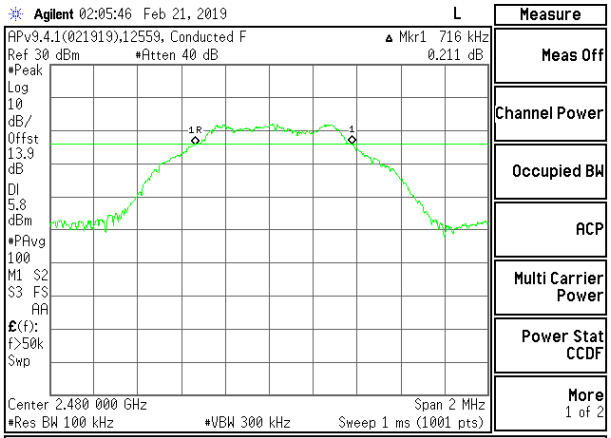
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.7140	0.5
Middle	2440	0.7180	0.5
High	2480	0.7160	0.5



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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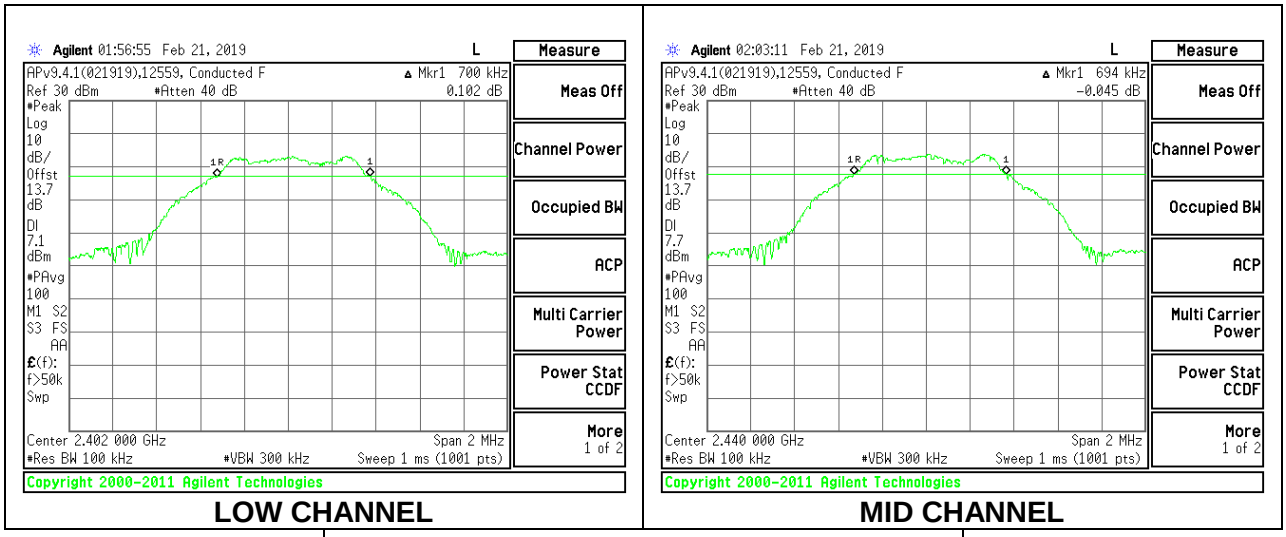
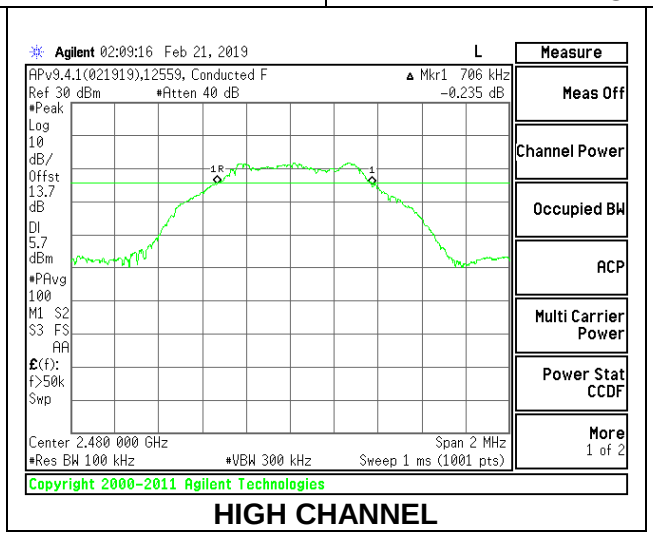
Antenna 5

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.7000	0.5
Middle	2440	0.6940	0.5
High	2480	0.7060	0.5





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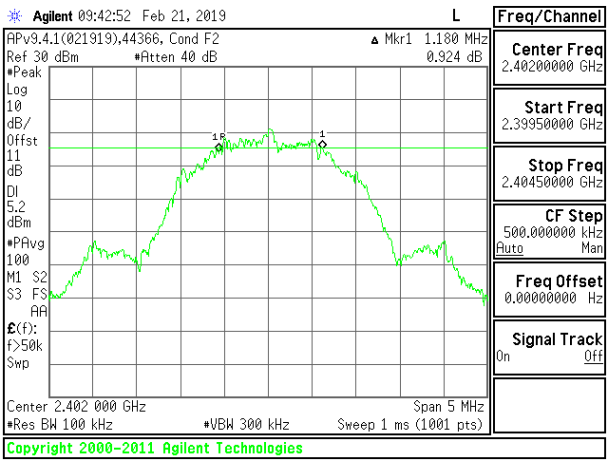
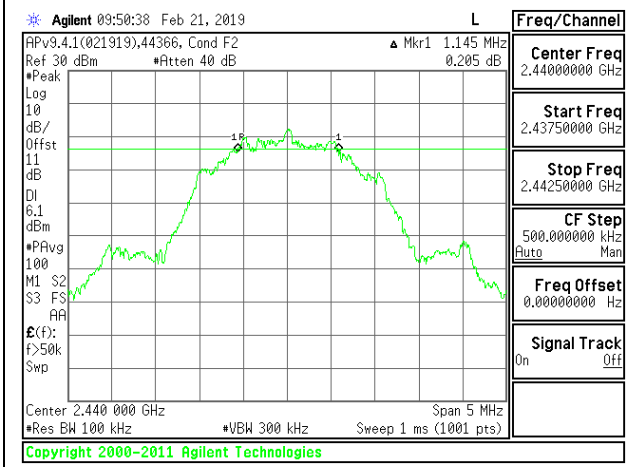
8.3.4. LOW POWER BLE (2Mbps)

Antenna 2

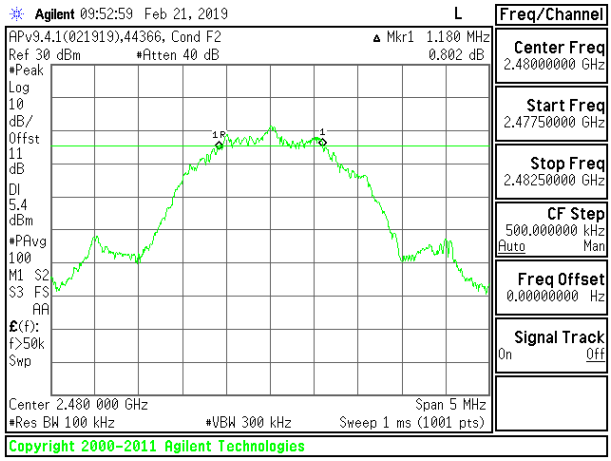
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	1.1800	0.5
Middle	2440	1.1450	0.5
High	2480	1.1800	0.5



LOW CHANNEL



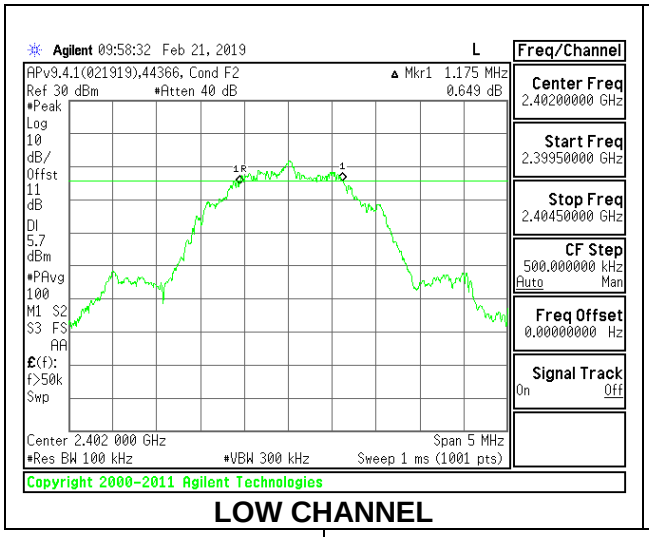
MID CHANNEL



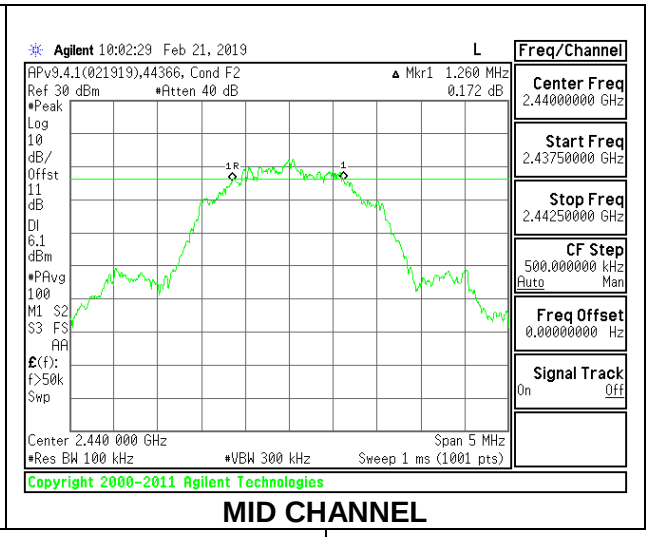
HIGH CHANNEL

Antenna 5

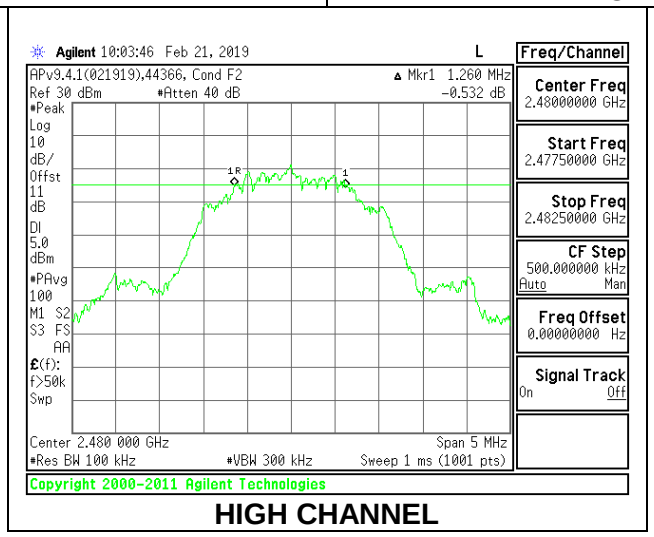
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	1.1750	0.5
Middle	2440	1.2600	0.5
High	2480	1.2600	0.5



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

8.4. OUTPUT POWER

LIMITS

FCC §15.247 (b) (3)

RSS-247 5.4 (d)

The maximum antenna gain is less than or equal to 6 dBi, therefore the limit is 30 dBm.

TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 10.5 dB (including 10 dB pad and 0.5 dB cable) was entered as an offset in the power meter to allow for a gated peak reading of power.

RESULTS

UL VERIFICATION SERVICES INC.
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8.4.1. HIGH POWER BLE (1Mbps)

Antenna 2

Tested By:	39316
Date:	6/25/2019

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	19.13	30	-10.87
Middle	2440	19.26	30	-10.74
High	2480	19.11	30	-10.89

Antenna 5

Tested By:	39316
Date:	6/25/2019

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	20.04	30	-9.96
Middle	2440	20.10	30	-9.90
High	2480	19.95	30	-10.05

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8.4.2. HIGH POWER BLE (2Mbps)

Antenna 2

Tested By:	39316
Date:	6/25/2019

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	19.20	30	-10.80
Middle	2440	19.39	30	-10.61
High	2480	19.36	30	-10.64

Antenna 5

Tested By:	39316
Date:	6/25/2019

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	20.18	30	-9.82
Middle	2440	20.23	30	-9.77
High	2480	20.15	30	-9.85

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8.4.3. LOW POWER BLE (1Mbps)

Antenna 2

Tested By:	39316
Date:	6/25/2019

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	12.45	30	-17.55
Middle	2440	12.48	30	-17.52
High	2480	12.42	30	-17.58

Antenna 5

Tested By:	39316
Date:	6/25/2019

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	12.61	30	-17.39
Middle	2440	12.69	30	-17.31
High	2480	12.55	30	-17.45

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8.4.4. LOW POWER BLE (2Mbps)

Antenna 2

Tested By:	39316
Date:	6/25/2019

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	12.42	30	-17.58
Middle	2440	12.47	30	-17.53
High	2480	12.30	30	-17.70

Antenna 5

Tested By:	39316
Date:	6/25/2019

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	12.64	30	-17.36
Middle	2440	12.76	30	-17.24
High	2480	12.67	30	-17.33

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8.5. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 10.5 dB (including 10 dB pad and 0.5 dB cable) was entered as an offset in the power meter to allow for a gated average reading of power.

RESULTS

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

8.5.1. HIGH POWER BLE (1Mbps)

Antenna 2

Tested By:	39316
Date:	6/25/2019

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	18.75
Middle	2440	18.87
High	2480	18.80

Antenna 5

Tested By:	39316
Date:	6/25/2019

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	19.61
Middle	2440	19.68
High	2480	19.53

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8.5.2. HIGH POWER BLE (2Mbps)

Antenna 2

Tested By:	39316
Date:	6/25/2019

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	18.64
Middle	2440	18.73
High	2480	18.71

Antenna 5

Tested By:	39316
Date:	6/25/2019

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	19.65
Middle	2440	19.71
High	2480	19.62

8.5.3. LOW POWER BLE (1Mbps)

Antenna 2

Tested By:	39316
Date:	6/25/2019

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	12.23
Middle	2440	12.25
High	2480	12.18

Antenna 5

Tested By:	39316
Date:	6/25/2019

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	12.14
Middle	2440	12.25
High	2480	12.08

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8.5.4. LOW POWER BLE (2Mbps)

Antenna 2

Tested By:	39316
Date:	6/25/2019

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	12.23
Middle	2440	12.25
High	2480	12.12

Antenna 5

Tested By:	39316
Date:	6/25/2019

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	12.18
Middle	2440	12.25
High	2480	12.21

8.6. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247 (e)

RSS-247 (5.2) (b)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

RESULTS

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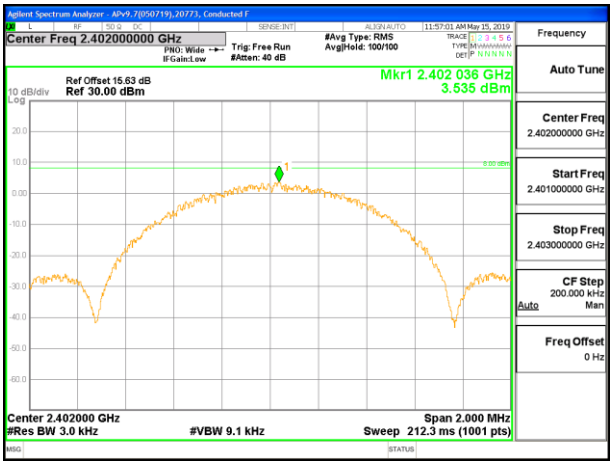
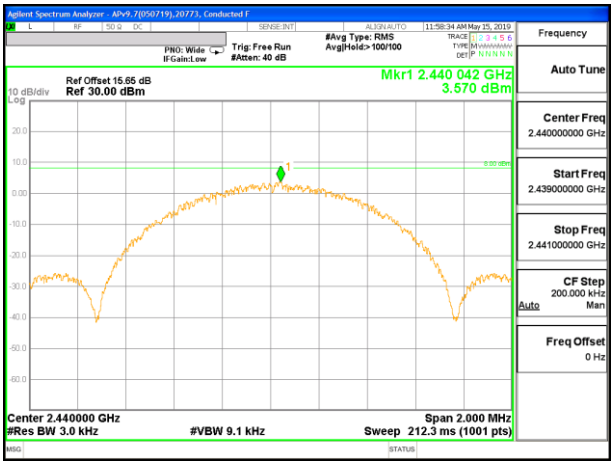
8.6.1. HIGH POWER BLE (1Mbps)

Antenna 2

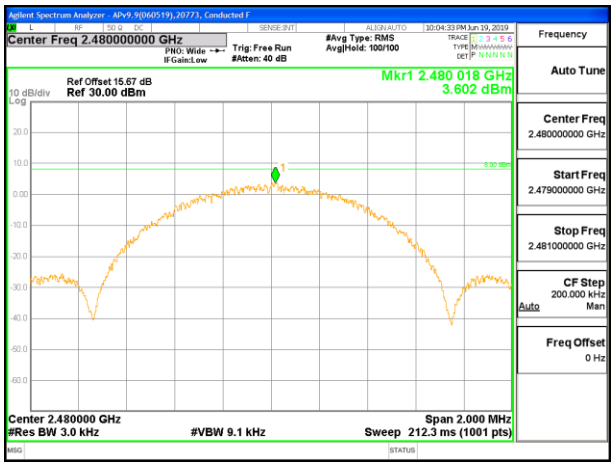
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	3.535	8	-4.465
Middle	2440	3.570	8	-4.430
High	2480	3.602	8	-4.398



LOW CHANNEL



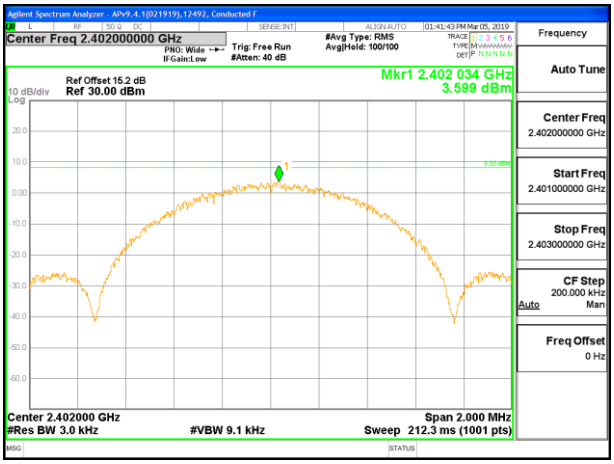
MID CHANNEL



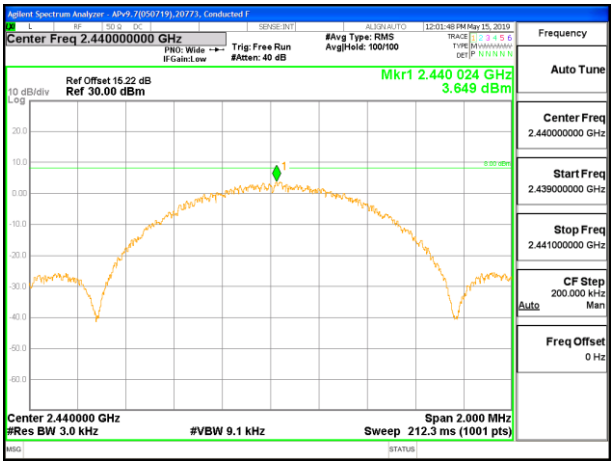
HIGH CHANNEL

Antenna 5

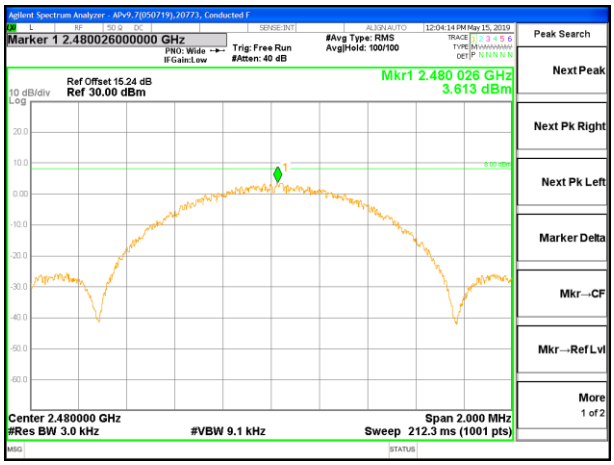
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	3.599	8	-4.401
Middle	2440	3.649	8	-4.351
High	2480	3.613	8	-4.387



LOW CHANNEL



MID CHANNEL

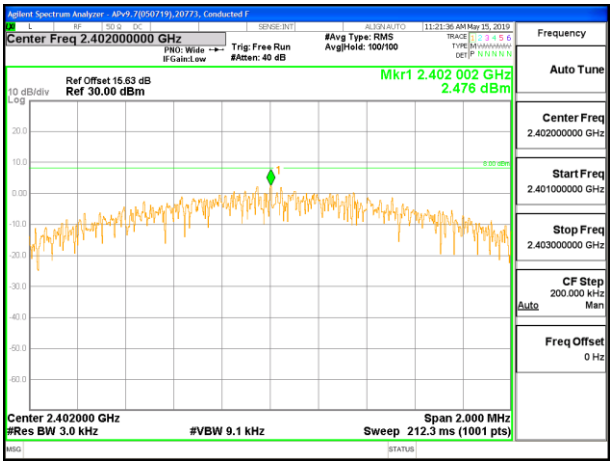


HIGH CHANNEL

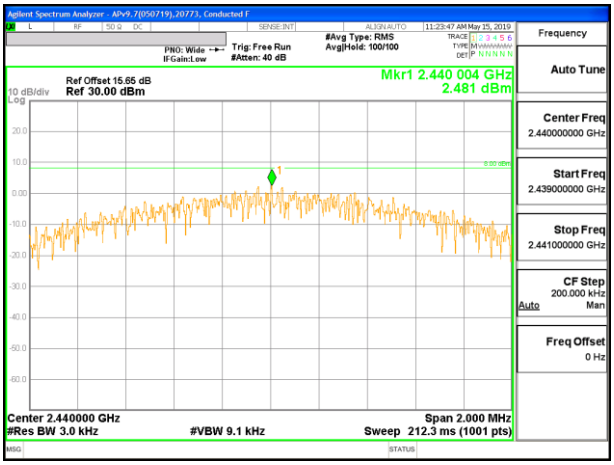
8.6.2. HIGH POWER BLE (2Mbps)

Antenna 2

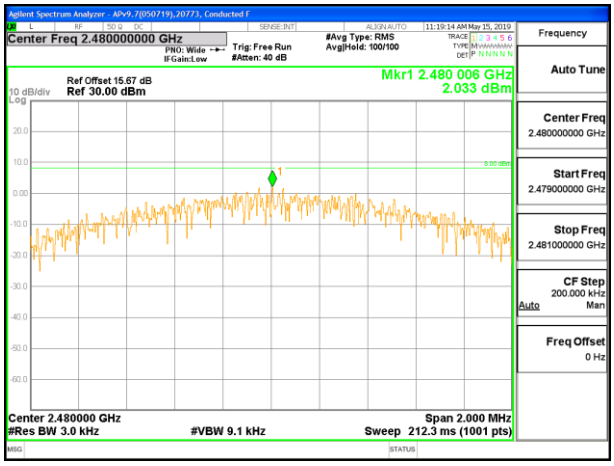
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	2.476	8	-5.524
Middle	2440	2.481	8	-5.519
High	2480	2.033	8	-5.967



LOW CHANNEL



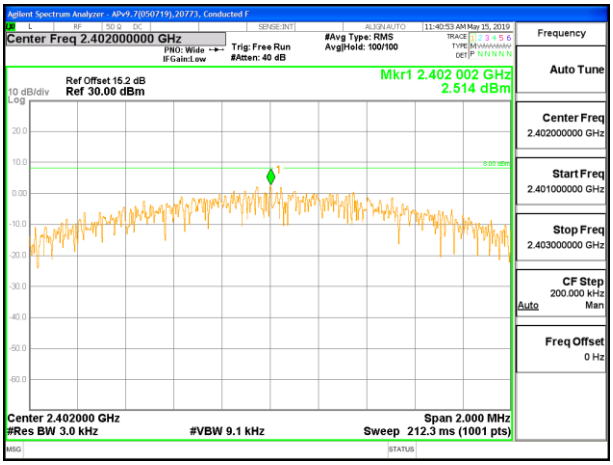
MID CHANNEL



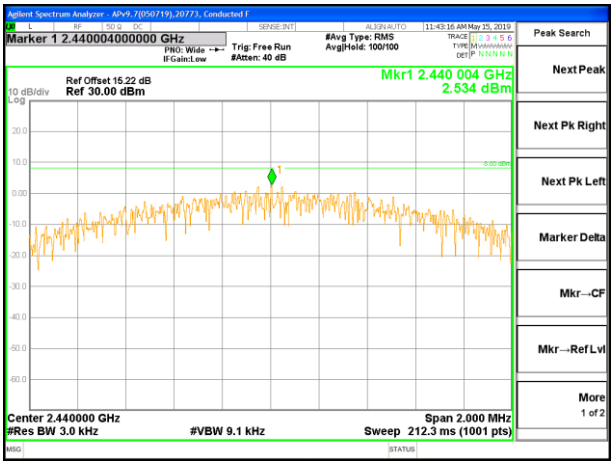
HIGH CHANNEL

Antenna 5

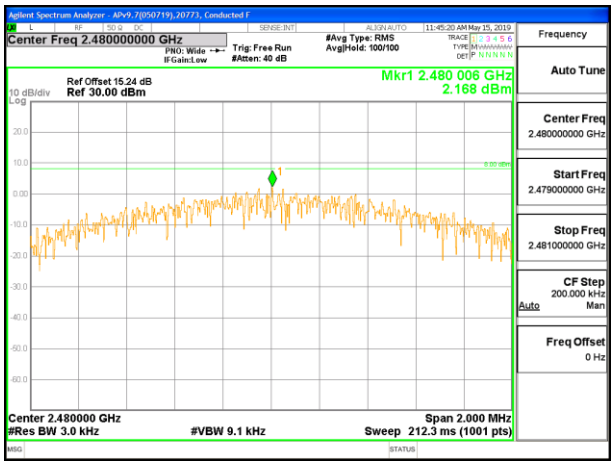
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	2.514	8	-5.486
Middle	2440	2.534	8	-5.466
High	2480	2.168	8	-5.832



LOW CHANNEL



MID CHANNEL

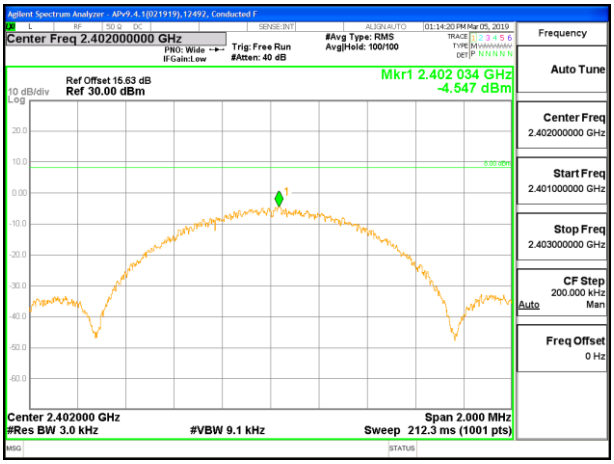


HIGH CHANNEL

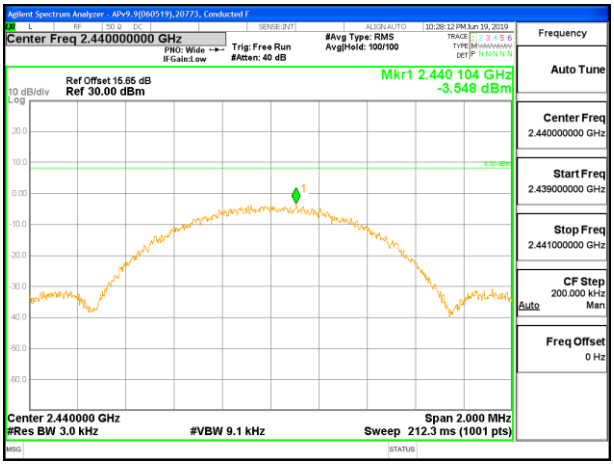
8.6.3. LOW POWER BLE (1Mbps)

Antenna 2

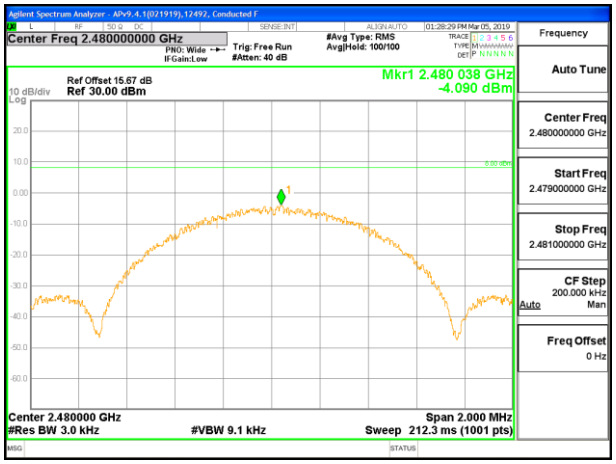
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	-4.547	8	-12.547
Middle	2440	-3.548	8	-11.548
High	2480	-4.090	8	-12.090



LOW CHANNEL



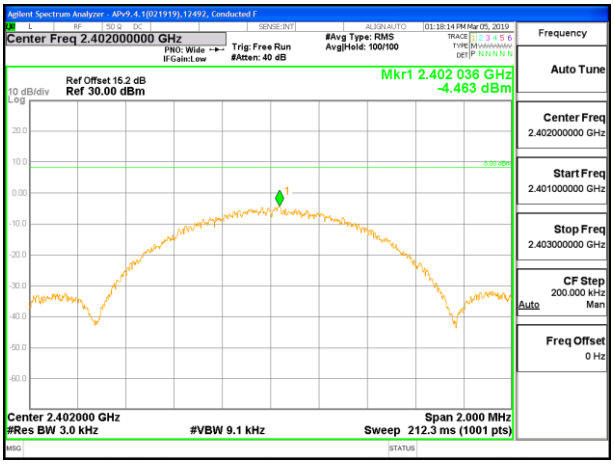
MID CHANNEL



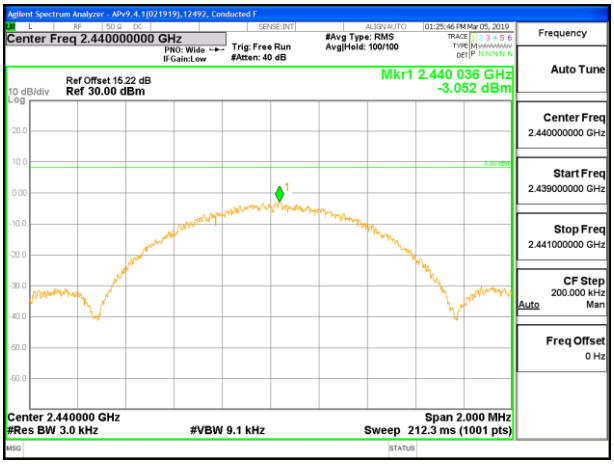
HIGH CHANNEL

Antenna 5

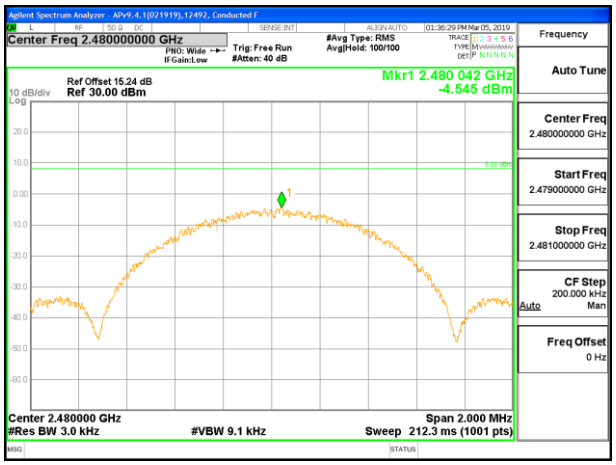
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	-4.463	8	-12.463
Middle	2440	-3.052	8	-11.052
High	2480	-4.545	8	-12.545



LOW CHANNEL



MID CHANNEL

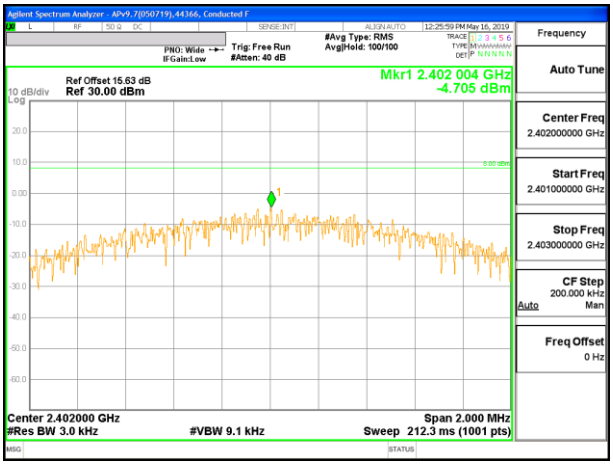


HIGH CHANNEL

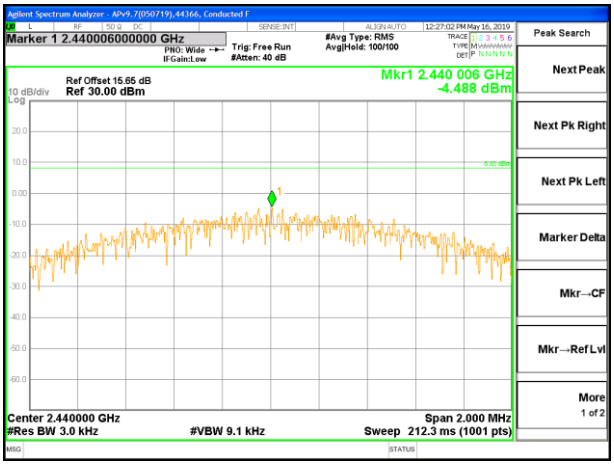
8.6.4. LOW POWER BLE (2Mbps)

Antenna 2

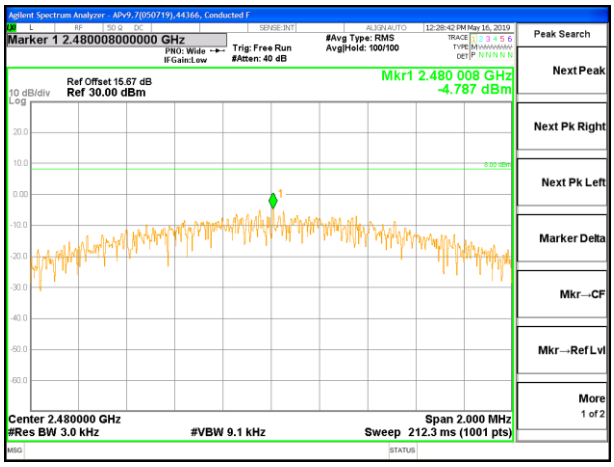
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	-4.705	8	-12.705
Middle	2440	-4.488	8	-12.488
High	2480	-4.787	8	-12.787



LOW CHANNEL



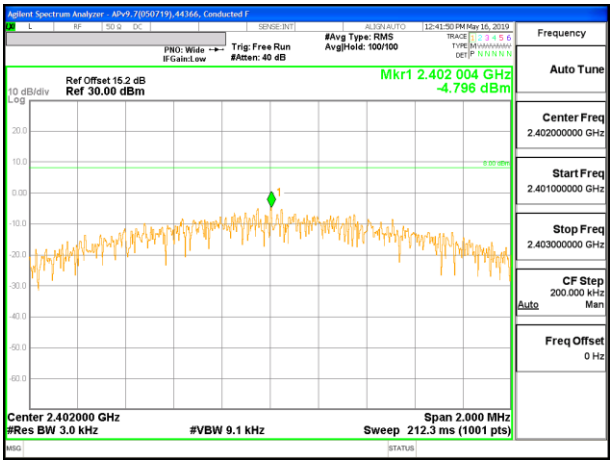
MID CHANNEL



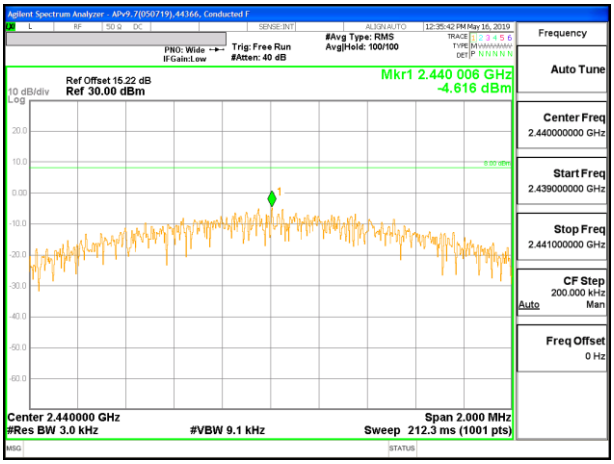
HIGH CHANNEL

Antenna 5

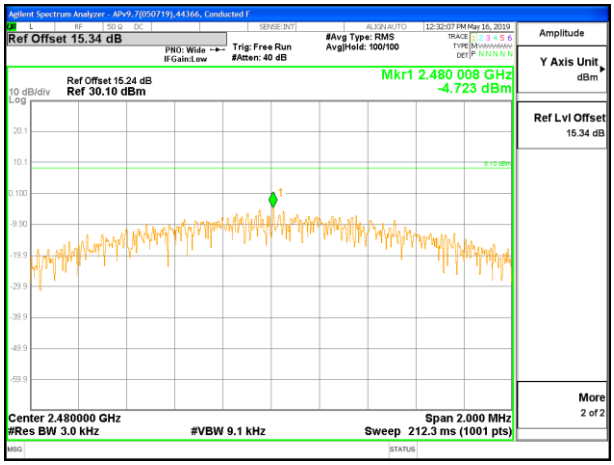
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	-4.796	8	-12.796
Middle	2440	-4.616	8	-12.616
High	2480	-4.723	8	-12.723



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

8.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

RSS-247 5.5

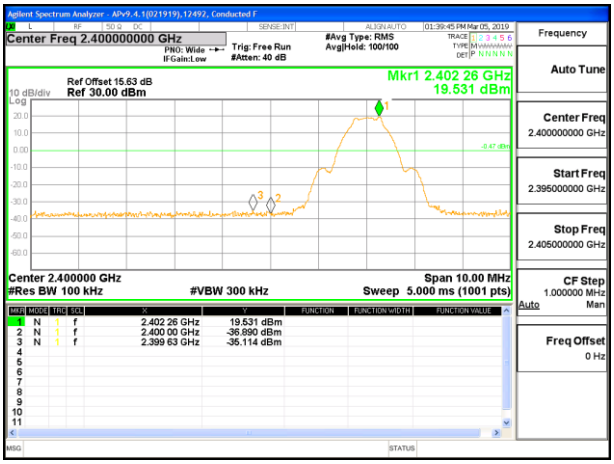
Output power was measured based on the use of a peak measurement, therefore the required attenuation is 20 dB.

Note: Test procedures and setting on beamforming are same as BLE normal mode

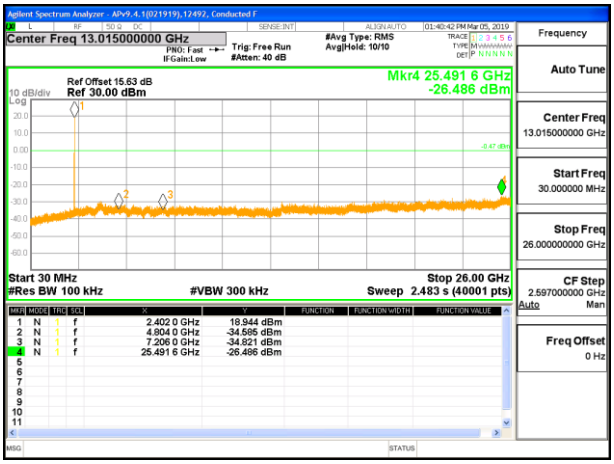
RESULTS

8.7.1. HIGH POWER BLE (1Mbps)

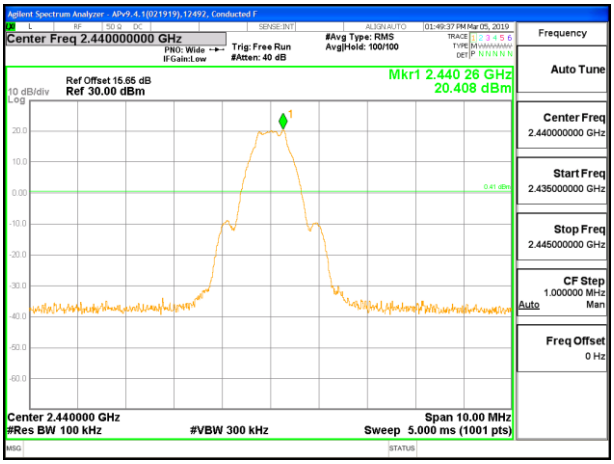
Antenna 2



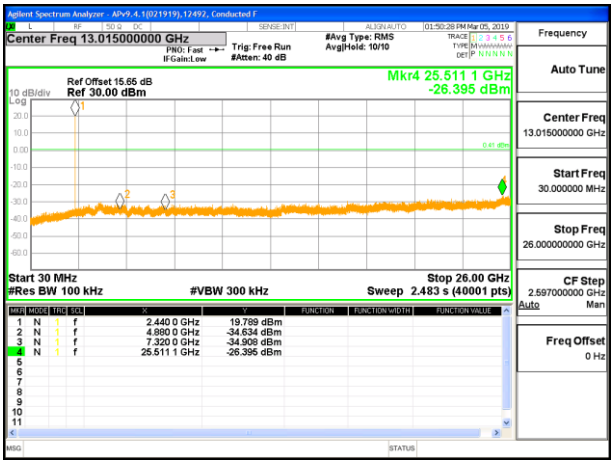
LOW CHANNEL BANDEDGE



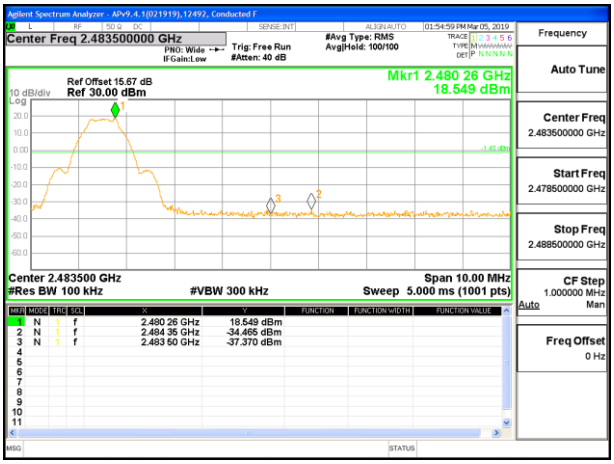
OUT-OF-BAND LOW CHANNEL



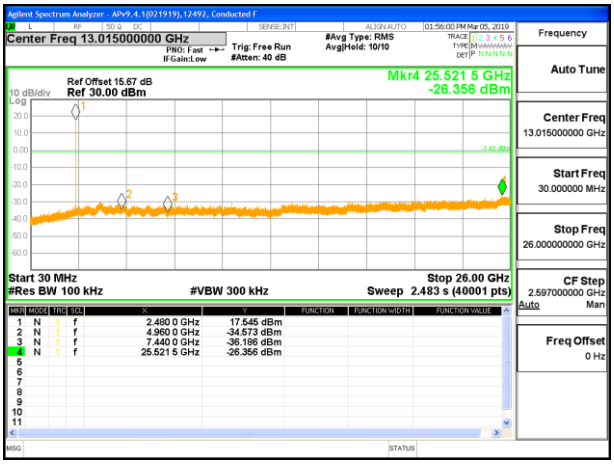
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL

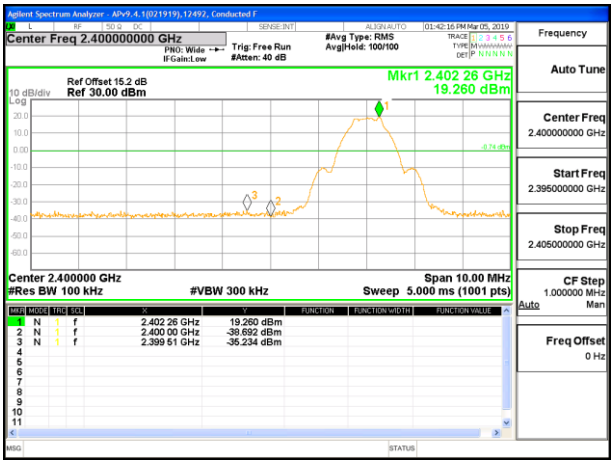


HIGH CHANNEL BANDEDGE

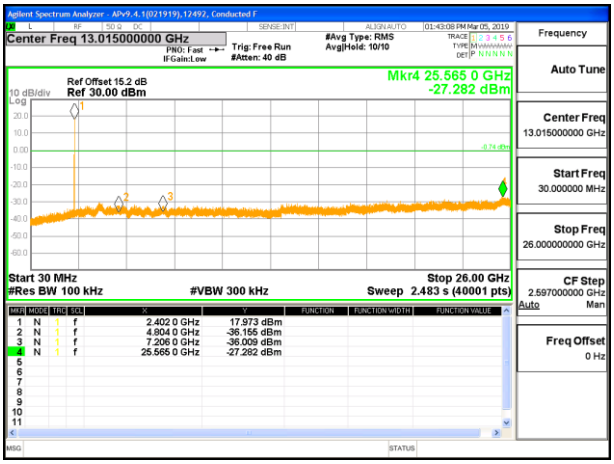


OUT-OF-BAND HIGH CHANNEL

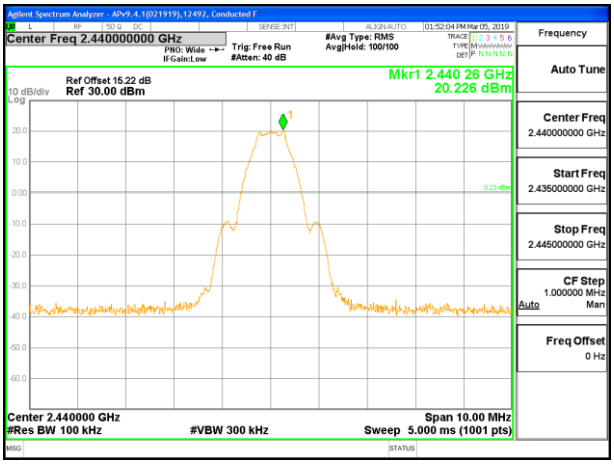
Antenna 5



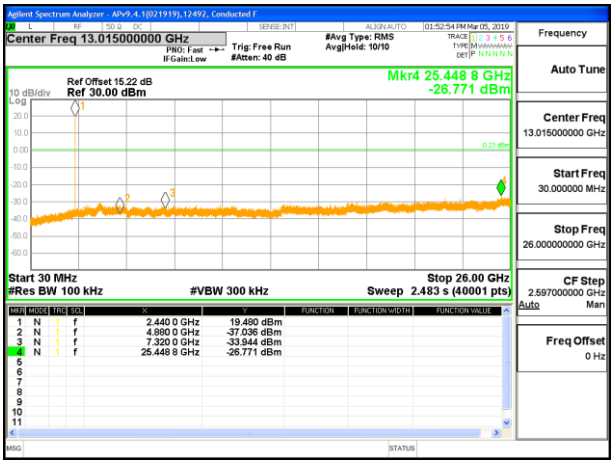
LOW CHANNEL BANDEDGE



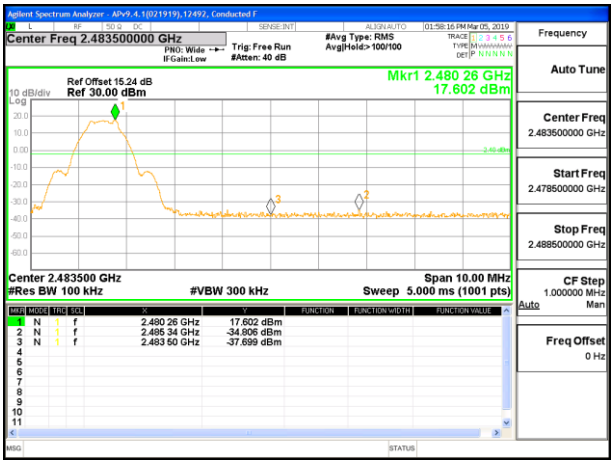
OUT-OF-BAND LOW CHANNEL



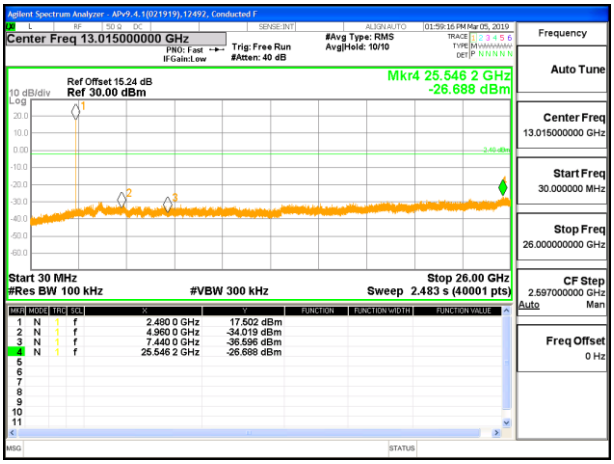
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE

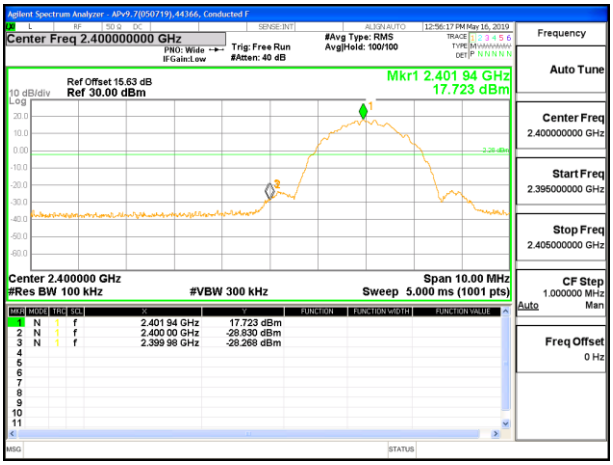


OUT-OF-BAND HIGH CHANNEL

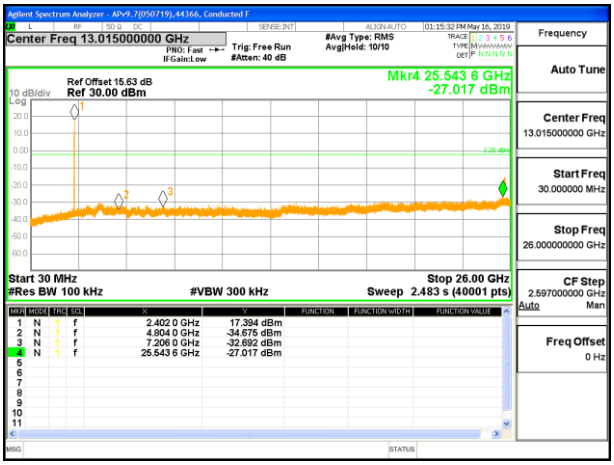
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

8.7.2. HIGH POWER BLE (2Mbps)

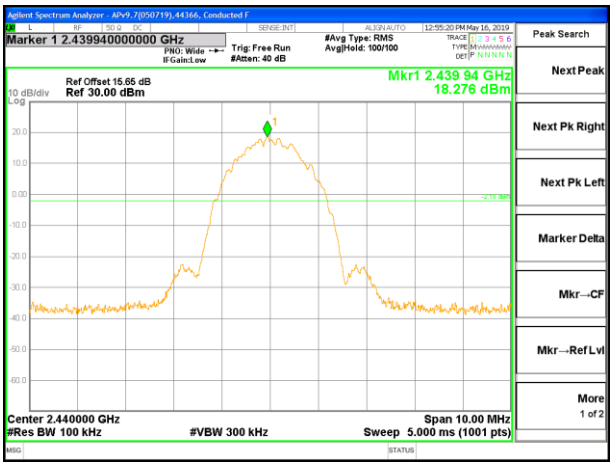
Antenna 2



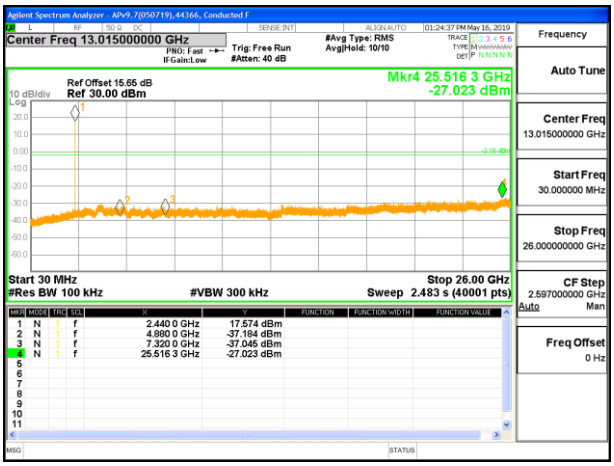
LOW CHANNEL BANDEDGE



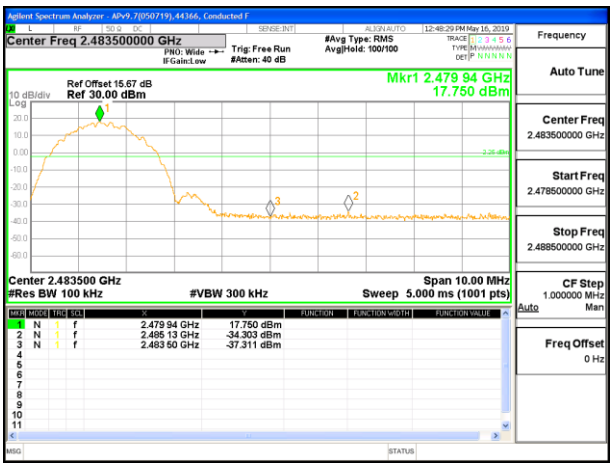
OUT-OF-BAND LOW CHANNEL



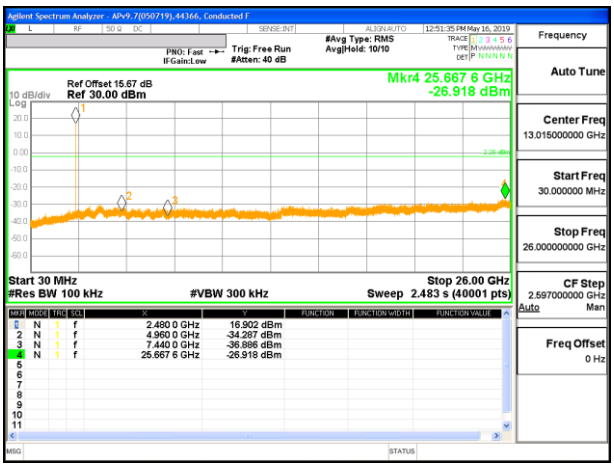
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

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47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888