CERTIFICATION TEST REPORT

Report Number. : 12563734-E3V2

Applicant	:	Samsung Electronics Co., Ltd. 129 Samsung-Ro, Yeongtong-Gu, Suwon-Si, Gyeonggi-Do, 16677, Korea
Model	:	SM-G970F/DS and SM-G970F
FCC ID	:	A3LSMG970F
EUT Description	:	GSM/WCDMA/LTE phone with BT, DTS/UNII a/b/g/n/ac/11ax HE 20/40/80, ANT+ and NFC
Test Standard(s)	:	FCC 47 CFR PART 15 SUBPART C

Date Of Issue:
January 17, 2019

Prepared by:
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NVLAP TESTING
ilac-MRA
NVLAP Lab code: 200065-0

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	12/19/2018	Initial Issue	
V2	1/14/2019	Updated per reviewer's comments (Sections 5.1, 5.2, 8.3, 8.4, and 8.5)	Steven Tran
V3	1/17/2019	Updated per reviewer's comments (Section 1)	Steven Tran

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Samsung Electronics Co., Ltd.
129 Samsung-Ro, Yeongtong-Gu,
Suwon-Si, Gyeonggi-Do, 16677, Korea

EUT DESCRIPTION: GSM/WCDMA/LTE phone with BT, DTS/UNII a/b/g/n/ac/11ax HE 20/40/80, ANT+ and NFC

MODEL: SM-G970F/DS and SM-G970F

SERIAL NUMBER: Conducted: R38KA0H49TL
Radiated: R38KB05BJQB

DATE TESTED: OCTOBER 30, 2018 TO JANUARY 7, 2019

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C	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.

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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, and KDB 558074 D01 15.247 Meas Guidance v05.

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	3.15 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	5.36 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.32 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.45 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.24 dB

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

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5. EQUIPMENT UNDER TEST

5.1. EUT DESCRIPTION

The EUT is a GSM/WCDMA/LTE phone with BT, DTS/UNII a/b/g/n/ac/11ax HE 20/40/80, ANT+ and NFC. The model SM-G970F was used for final testing and is representative of the test results in this report.

5.2. MAXIMUM OUTPUT POWER

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

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2402 - 2480	BLE (125kbps)	7.20	5.25
2402 - 2480	BLE (500kbps)	7.15	5.19
2402 - 2480	BLE (1Mbps)	7.34	5.42
2402 - 2480	BLE (2Mbps)	8.62	7.28

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an FPCB antenna, with a maximum gain of –1.21 dBi.

5.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was G970F.001

5.5. WORST-CASE CONFIGURATION AND MODE

Radiated emissions below 1GHz, above 18GHz, and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

Band edge and radiated emissions between 1GHz and 18GHz were performed with the EUT set to transmit at the highest power on low, middle and high channels.

The fundamental of the EUT was investigated in three orthogonal orientations X,Y,Z, it was determined that X orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in X orientation.

All radios that can be transmitted simultaneously have been evaluated for radiated for all possible combinations of transmission and found to be in compliance.

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5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
AC Adapter	Samsung	EP-TA300	R3KB5B01S1SE3	N/A
USB Data Cabe	Samsung	N/A	N/A	N/A
Earphone	Samsung	N/A	N/A	N/A

I/O CABLES (CONDUCTED TEST)

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

I/O CABLES (RADIATED AND CONDUCTED EMISSIONS)

I/O Cable List						
Cable No	**Port**	**# of identical ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	USB	1	USB	Shielded	1	N/A
2	earphone	1	3.5mm	Un-shielded	1	N/A

TEST SETUP

The EUT is a stand alone. Test software exercised the radio card.

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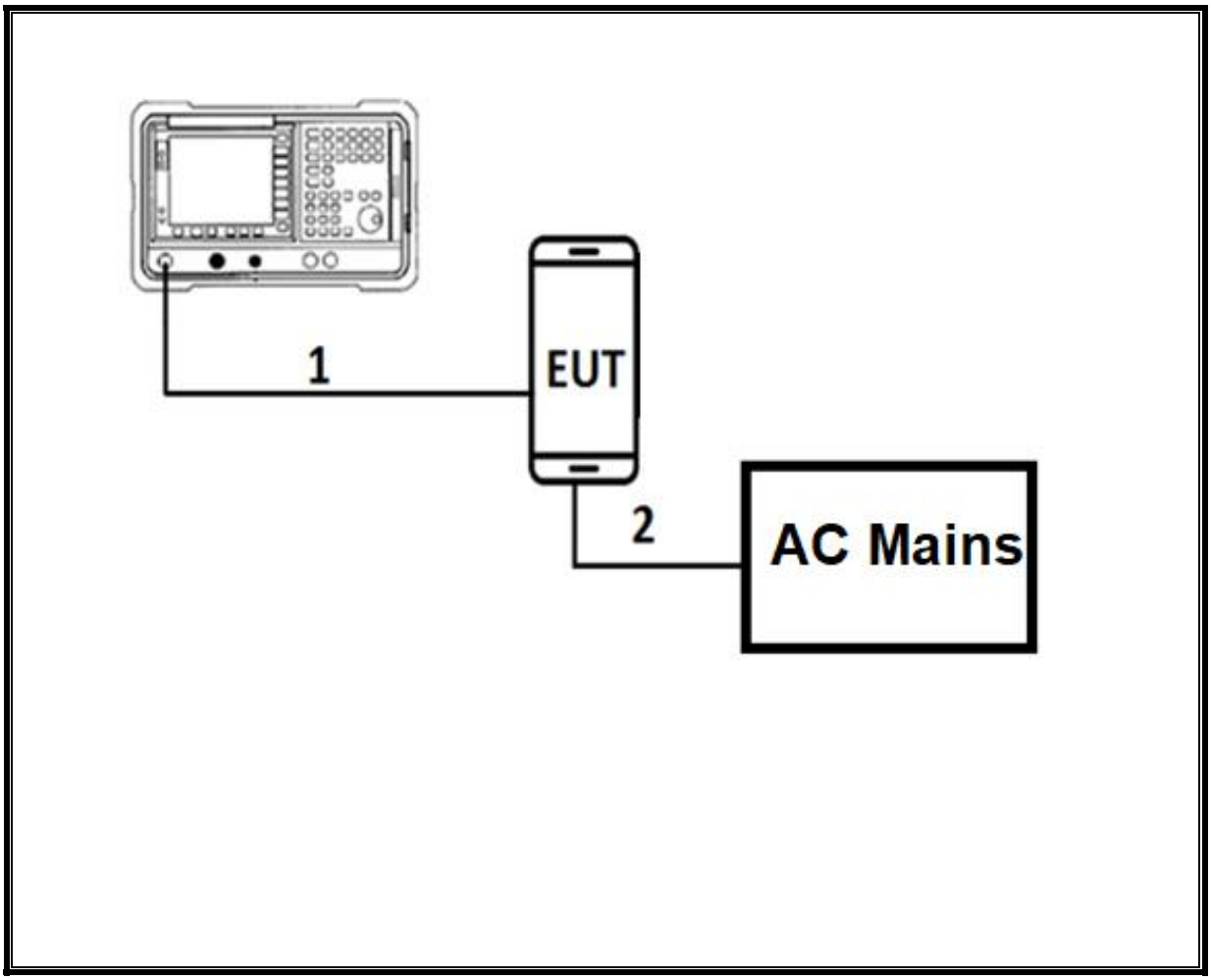
CONDCUTED TEST SETUP DIAGRAM



TEST SETUP

For conducted tests: the EUT was stand alone. The test software exercises the radio.

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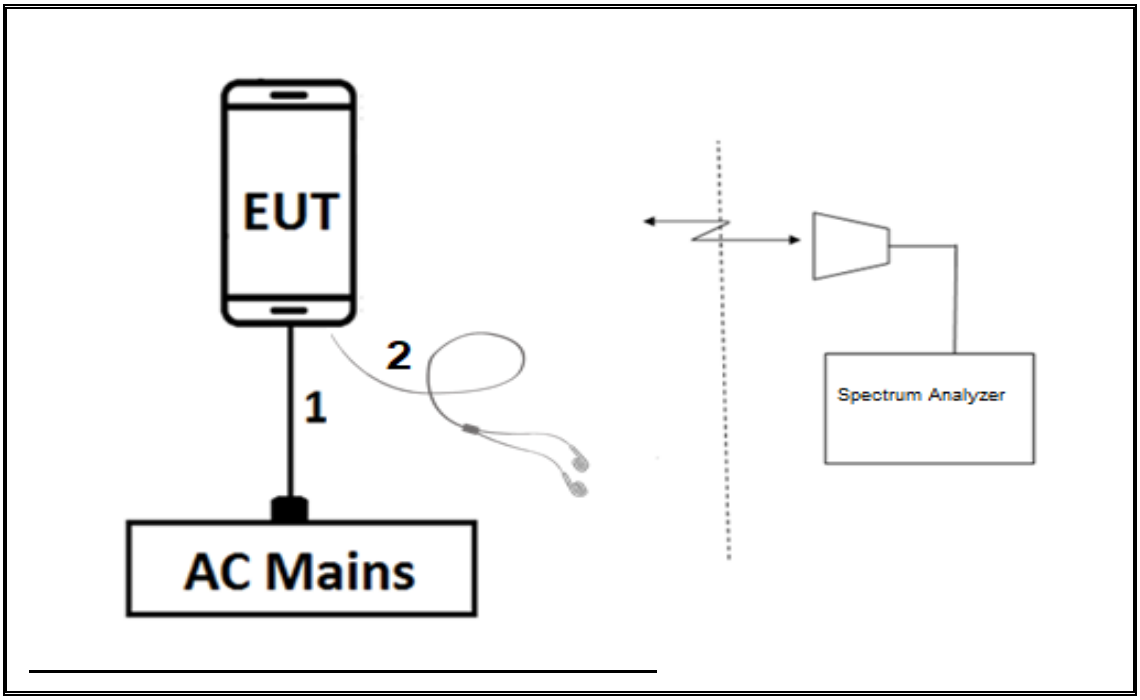
RADIATED AND AC LINE CONDUCTED EMISSIONS SETUP DIAGRAM



TEST SETUP

For radiated tests: EUT is Stand alone. The test software exercises the radio.

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6. MEASUREMENT METHOD

6 dB BW: ANSI C63.10 Subclause -11.8.1

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

Output Power : ANSI C63.10 Subclause -11.9.1.3 Method Peak Power Meter (Measurement using a broadband peak RF power meter)

Average Power: ANSI C63.10 Subclause -11.9.2.3.2 Method AVGPM-G (Measurement using a gated RF average-reading 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 -11.13.3.4 Trace averaging across ON and OFF times of the EUT transmissions followed by duty cycle correction

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

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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**
Amplifier, 100KHz to 1GHz,32dB	Agilent (Keysight) Technologies	8447D	T15	10/20/2019	10/20/2018
RF Amplifier	MITEQ	AFS42-00101800-25-S-42	T493	10/13/2019	10/13/2018
RF Amplifier, 1-18GHz	MITEQ	AFS42-00101800-25-S-42	T1165	10/20/2019	10/20/2018
Pre-Amp 1-26.5 GHz	Agilent	8449B	T404	03/09/2019	023/09/2018
Antenna, Broadband Hybrid, 30MHz to 3000MHz	Sunol Sciences Corp.	JB3	PRE0181574	08/01/2019	08/01/2018
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T345	04/25/2019	04/25/2018
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T863	06/21/2019	06/21/2018
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T862	05/24/2019	05/24/2018
Antenna, Active Loop 9kHz-30MHz	Com-Power Corp.	AL-130R	PRE0165308	12/13/2018	12/13/2017
18 - 26.5 GHz Horn Antenna	ARA	MWH-1826/B	T477	06/16/2019	06/16/2018
Power Meter, P-series single channel	Agilent (Keysight) Technologies	N1911A	T1271	07/26/2019	07/26/2018
Power Sensor, P-series, 50MHz to 18GHz, Wideband	Agilent (Keysight) Technologies	N1921A	T1224	10/09/2019	10/09/2018
EMI Reciever	Rohde & Schwarz	ESR	T1436	02/21/2019	02/21/2018
L.I.S.N.	FCC INC.	FCC LISN 50/250	T1310	06/15/2019	06/15/2018
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T1113	12/21/2018	12/21/2017
Spectrum Analyzer	Agilent (Keysight) Technologies	E4446A	T146	08/13/2019	08/13/2018
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T1466	04/16/2019	04/16/2018
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T1454	01/08/2019	01/08/2018

Test Software List			
Description	**Manufacturer**	**Model**	**Version**
Radiated Software	UL	UL EMC	Ver 9.5, Dec 01, 2016
Antenna Port Software	UL	UL RF	Ver 9.0, Oct 31, 2018

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8. ANTENNA PORT TEST RESULTS

8.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

PROCEDURE

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 (125kbps)	3.105	3.750	0.828	82.80%	0.82	0.322
BLE (500kbps)	1.050	1.876	0.560	55.97%	2.52	0.952
BLE (1Mbps)	0.378	0.626	0.604	60.38%	2.19	2.646
BLE(2Mbps)	0.194	0.624	0.311	31.09%	5.07	5.155

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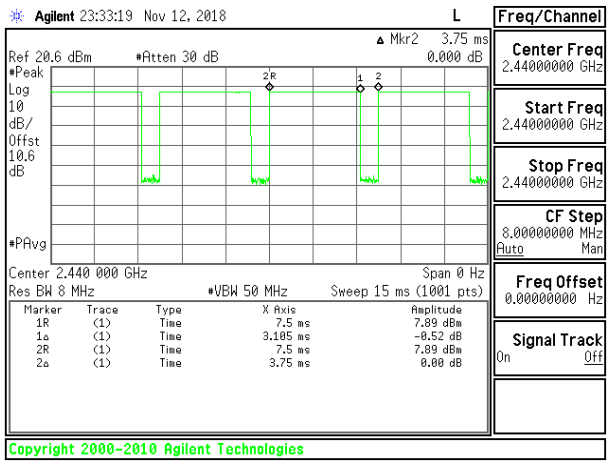
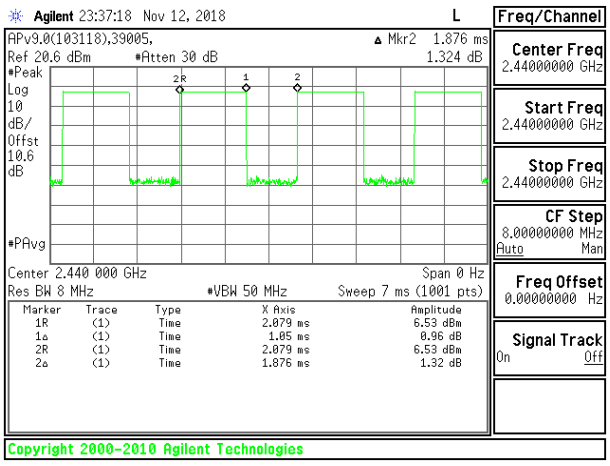
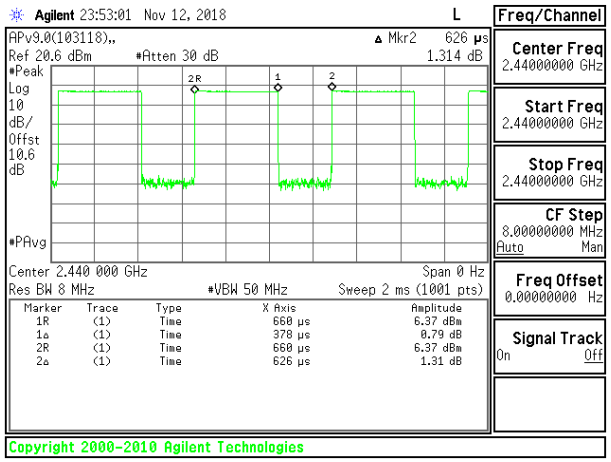
DUTY CYCLE PLOTS



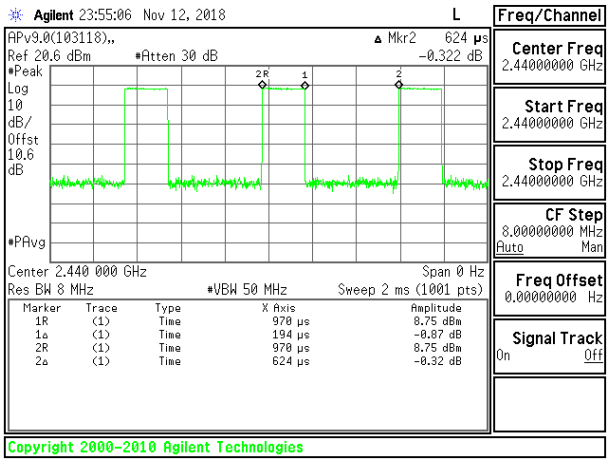
BLE (125kbps)



BLE (500kbps)



BLE (1Mbps)



BLE (2Mbps)

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8.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

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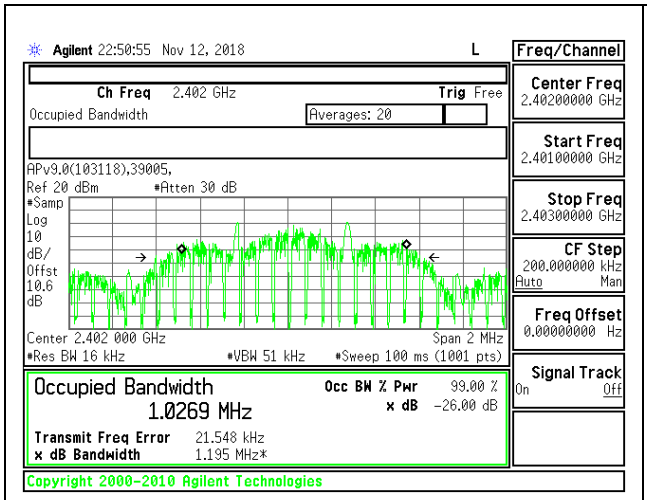
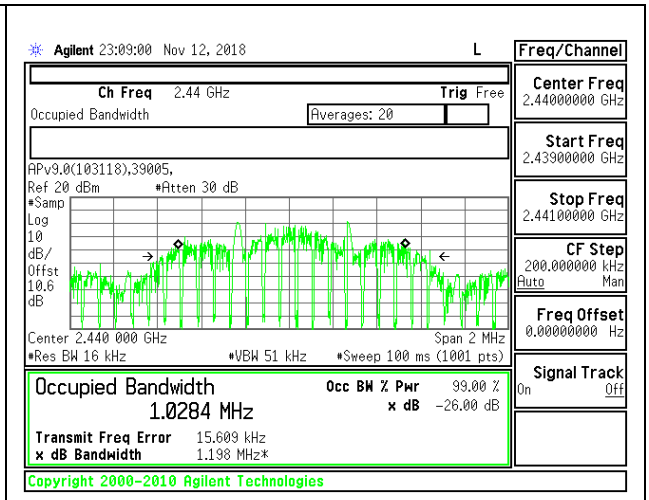
8.2.1. BLE (125kbps)

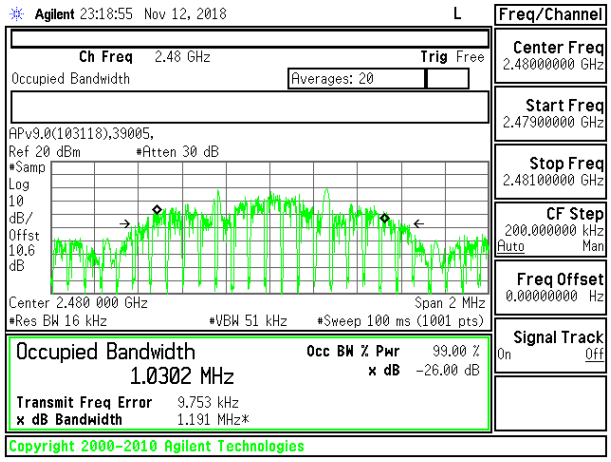
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0269
Middle	2440	1.0284
High	2480	1.0302



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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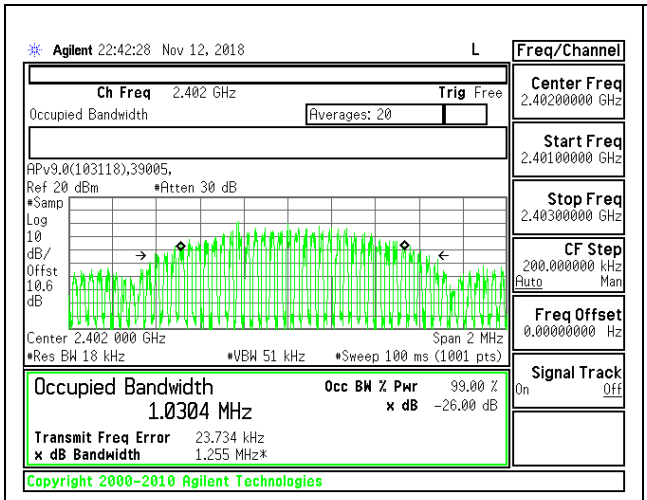
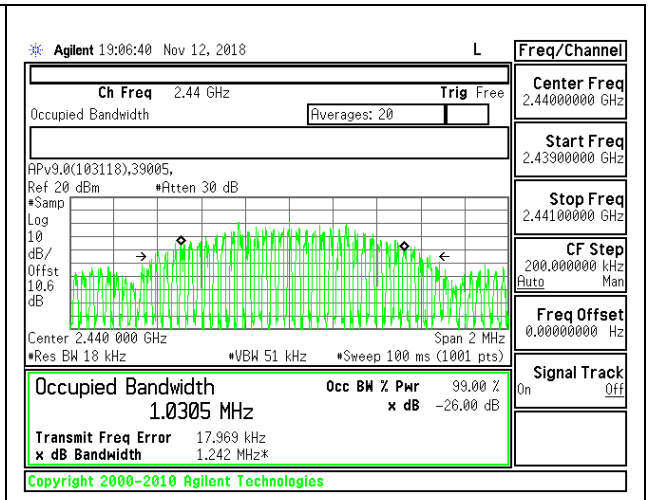
8.2.2. BLE (500kbps)

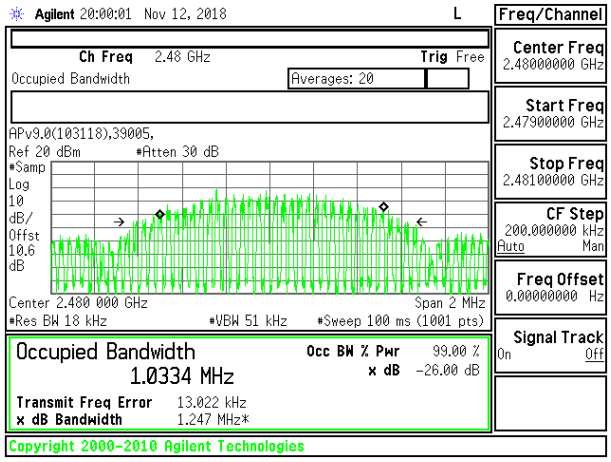
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0304
Middle	2440	1.0305
High	2480	1.0334



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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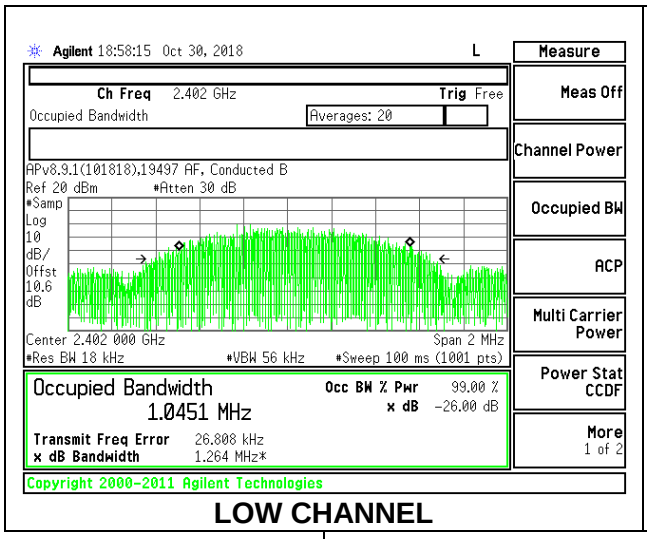
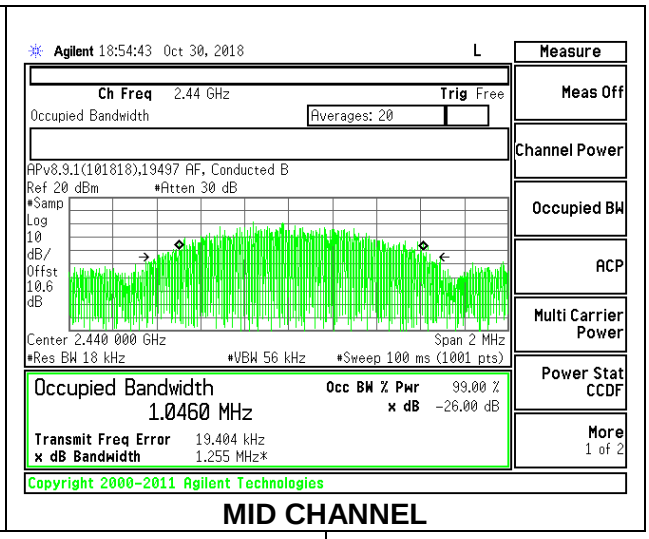
8.2.3. BLE (1Mbps)

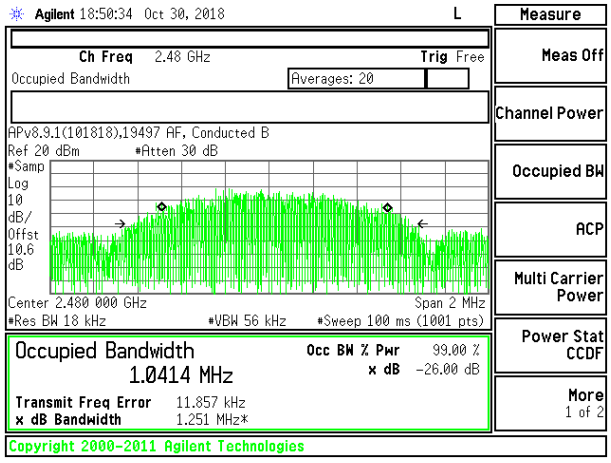
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0451
Middle	2440	1.0460
High	2480	1.0414



LOW CHANNEL



MID CHANNEL



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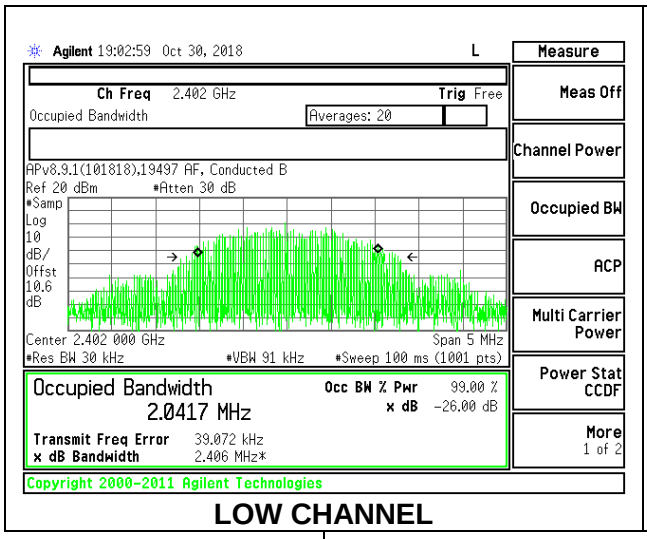
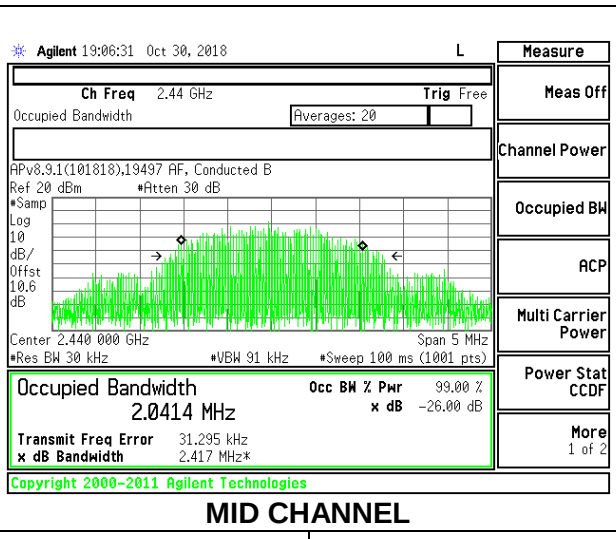
8.2.4. BLE (2Mbps)

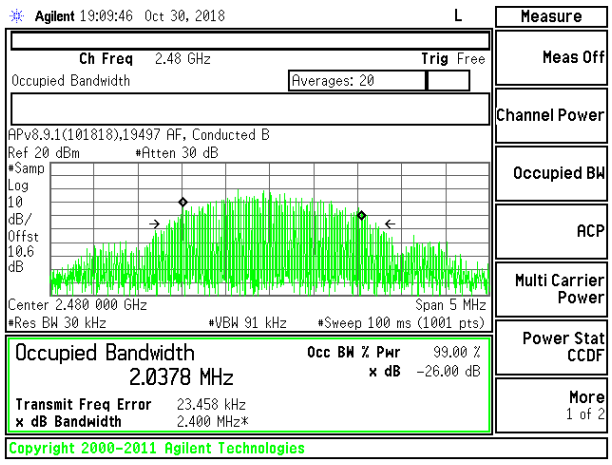
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	2.0417
Middle	2440	2.0414
High	2480	2.0378



LOW CHANNEL



MID CHANNEL



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8.3. 6 dB BANDWIDTH

LIMITS

FCC §15.407 (e)

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

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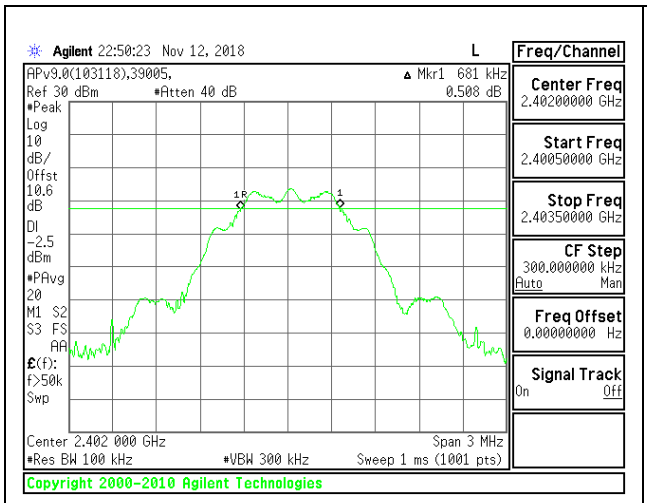
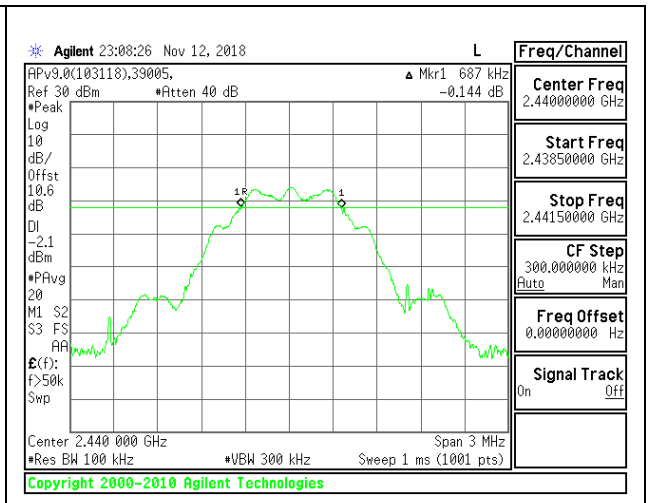
8.3.1. BLE (125kbps)

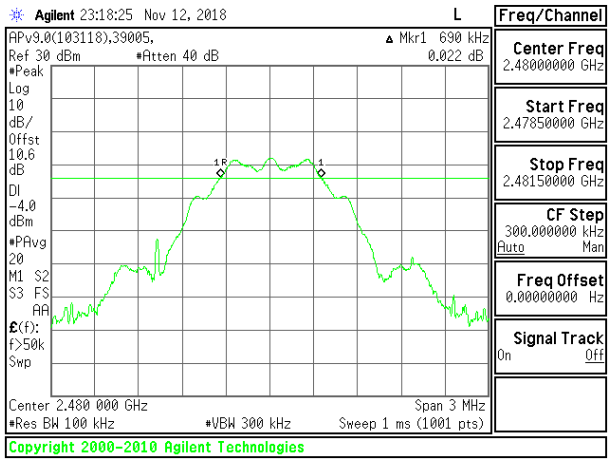
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.6810	0.5
Middle	2440	0.6870	0.5
High	2480	0.6900	0.5



LOW CHANNEL



MID CHANNEL



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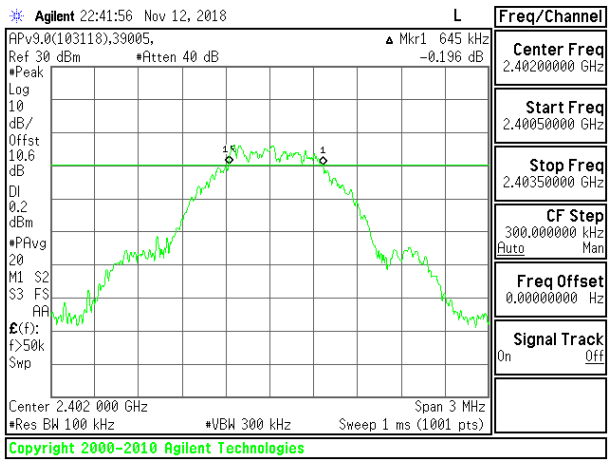
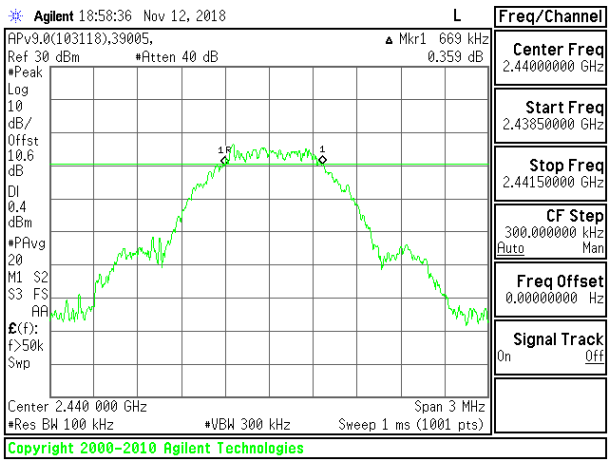
8.3.2. BLE (500kbps)

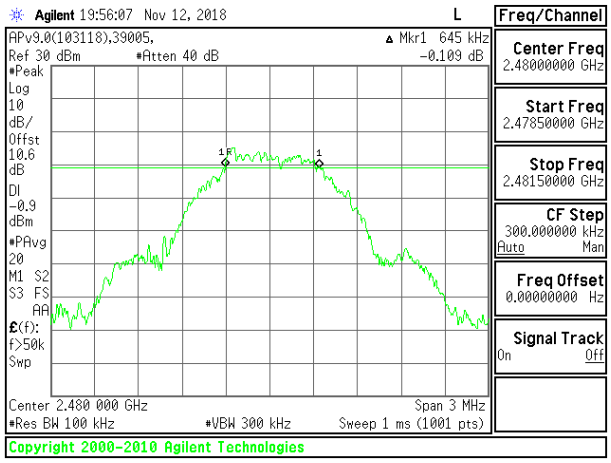
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.6450	0.5
Middle	2440	0.6690	0.5
High	2480	0.6450	0.5



LOW CHANNEL



MID CHANNEL



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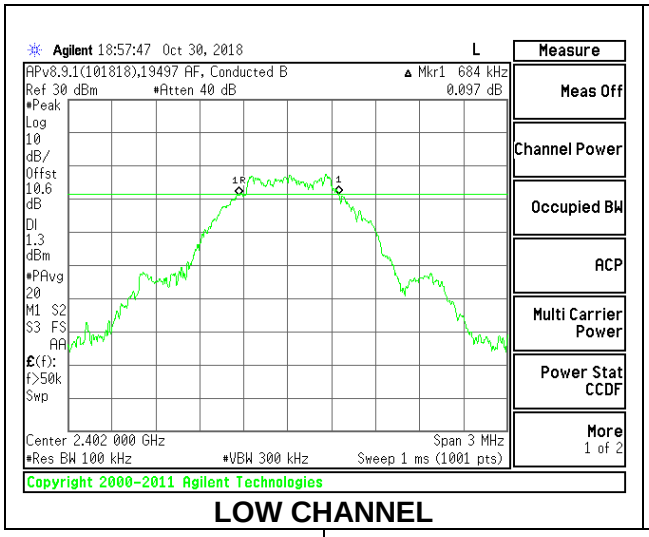
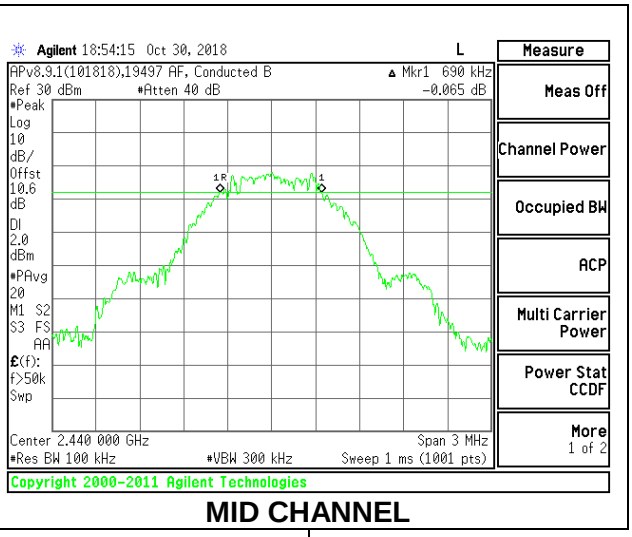
8.3.3. BLE (1Mbps)

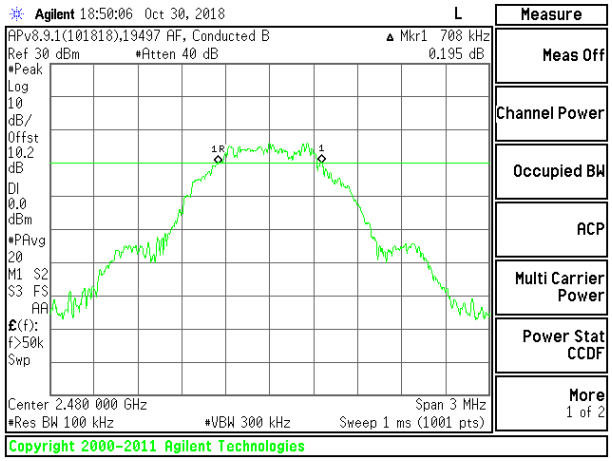
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.6840	0.5
Middle	2440	0.6900	0.5
High	2480	0.7080	0.5



LOW CHANNEL



MID CHANNEL



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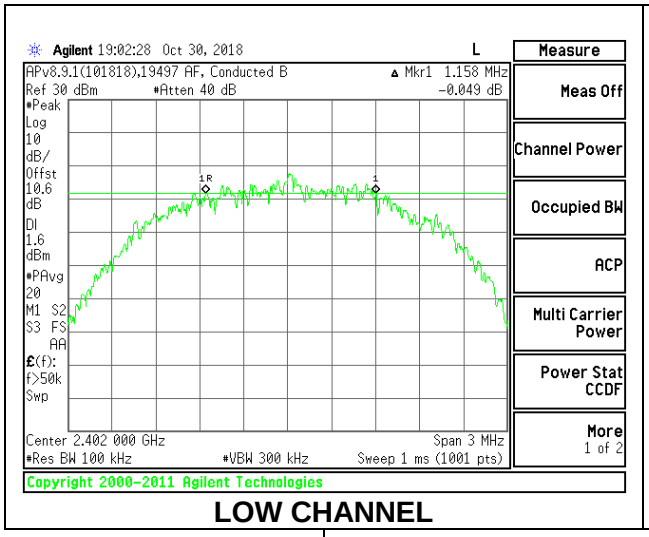
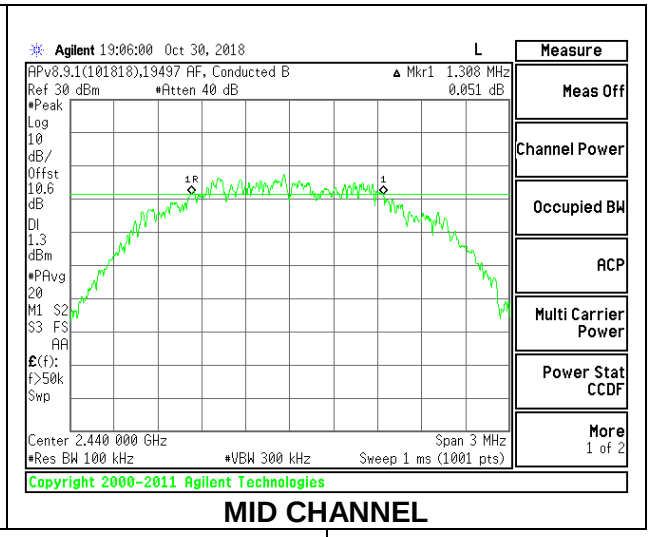
8.3.4. BLE (2Mbps)

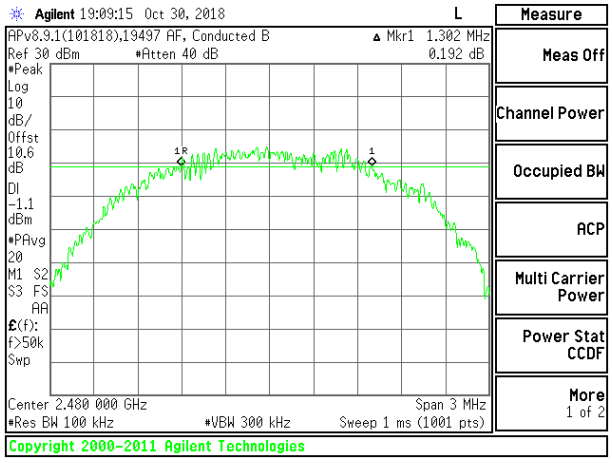
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	1.1580	0.5
Middle	2440	1.3080	0.5
High	2480	1.3020	0.5



LOW CHANNEL



MID CHANNEL



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8.4. OUTPUT POWER

LIMITS

FCC §15.247 (b) (3)

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 was entered as an offset in the power meter to allow for a gated peak reading of power.

RESULTS

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8.4.1. BLE (125kbps)

Tested By:	39005 RA
Date:	11/20/2018

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	6.260	30	-23.740
Middle	2440	7.200	30	-22.800
High	2480	5.600	30	-24.400

8.4.1. BLE (500kbps)

Tested By:	39005 RA
Date:	11/20/2018

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	6.650	30	-23.350
Middle	2440	7.150	30	-22.850
High	2480	6.770	30	-23.230

8.4.1. BLE (1Mbps)

Tested By:	39005 RA
Date:	11/20/2018

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	6.750	30	-23.250
Middle	2440	7.340	30	-22.660
High	2480	5.500	30	-24.500

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8.4.2. BLE (2Mbps)

Tested By:	39005 RA
Date:	11/20/2018

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	7.950	30	-22.050
Middle	2440	8.620	30	-21.380
High	2480	7.010	30	-22.990

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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 was entered as an offset in the power meter to allow for a gated average reading of power.

RESULTS

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8.5.1. BLE (125kbps)

Tested By:	39005 RA
Date:	11/20/2018

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	5.96
Middle	2440	6.91
High	2480	5.30

8.5.2. BLE (500kbps)

Tested By:	39005 RA
Date:	1/7/2018

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	6.34
Middle	2440	6.85
High	2480	6.14

8.5.3. BLE (1Mbps)

Tested By:	39005 RA
Date:	11/20/2018

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	6.40
Middle	2440	7.07
High	2480	5.18

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8.5.4. BLE (2Mbps)

Tested By:	39005 RA
Date:	11/20/2018

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	7.23
Middle	2440	7.92
High	2480	6.25

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8.6. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247 (e)

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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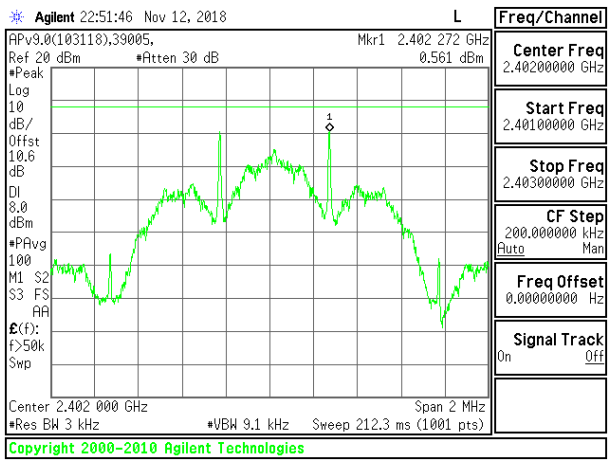
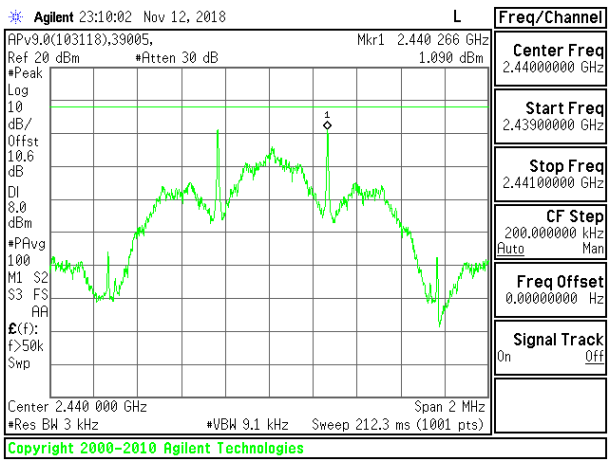
8.6.1. BLE (125kbps)

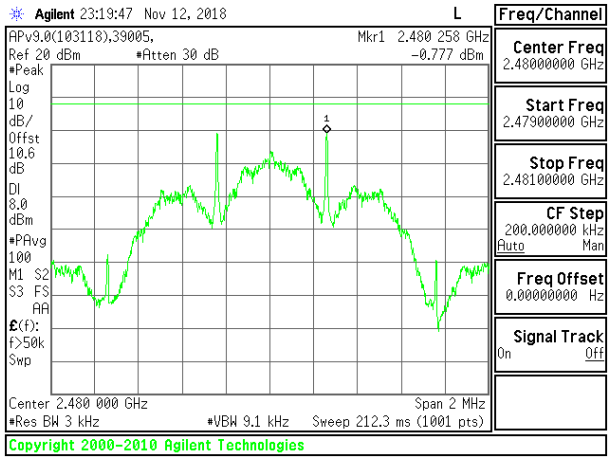
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	0.56	8	-7.44
Middle	2440	1.09	8	-6.91
High	2480	-0.78	8	-8.78



LOW CHANNEL



MID CHANNEL



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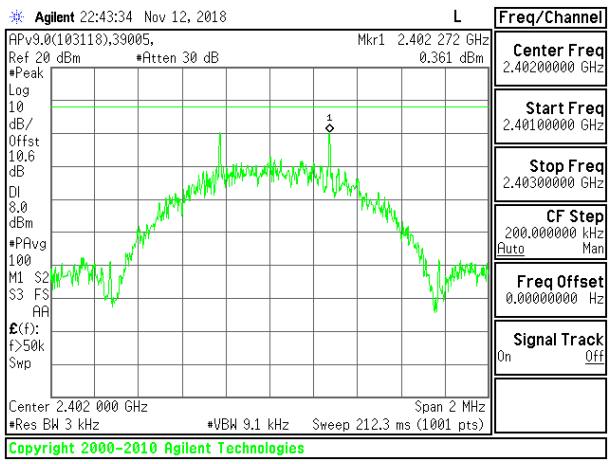
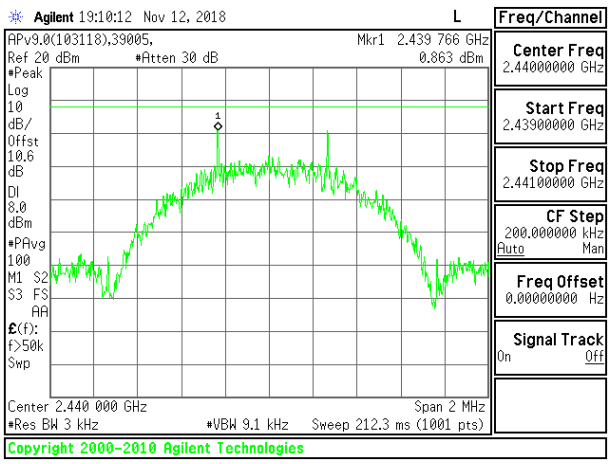
8.6.2. BLE (500kbps)

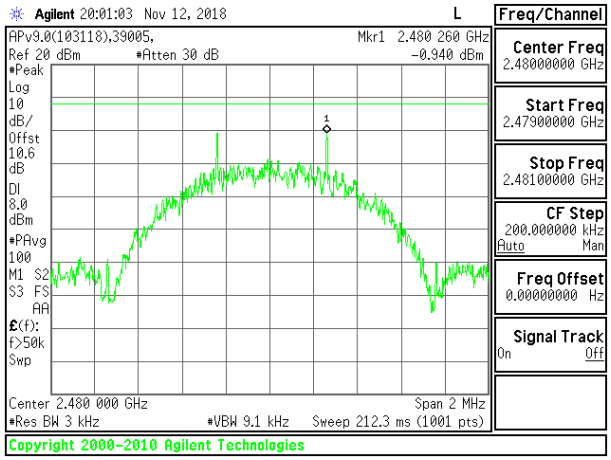
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	0.36	8	-7.64
Middle	2440	0.86	8	-7.14
High	2480	-0.94	8	-8.94



LOW CHANNEL



MID CHANNEL



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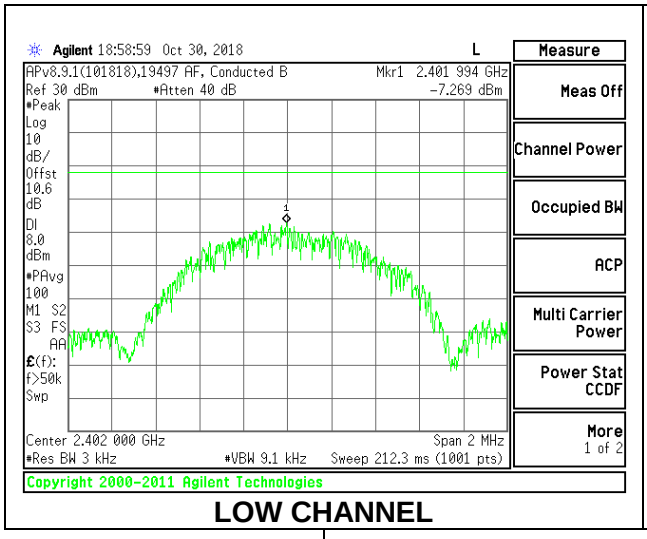
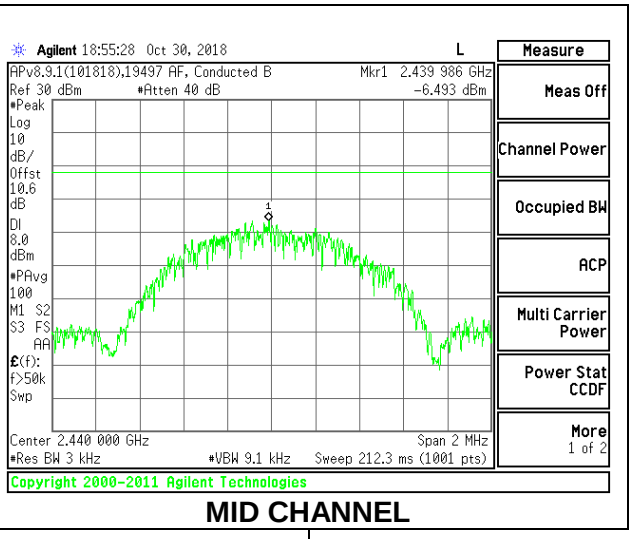
8.6.1. BLE (1Mbps)

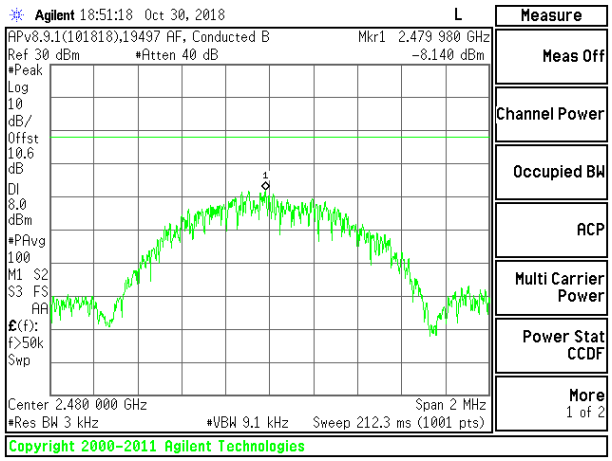
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	-7.27	8	-15.27
Middle	2440	-6.49	8	-14.49
High	2480	-8.14	8	-16.14



LOW CHANNEL



MID CHANNEL



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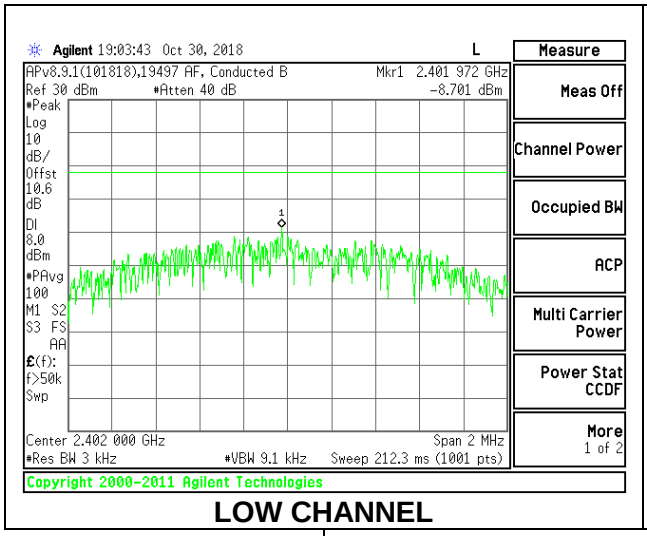
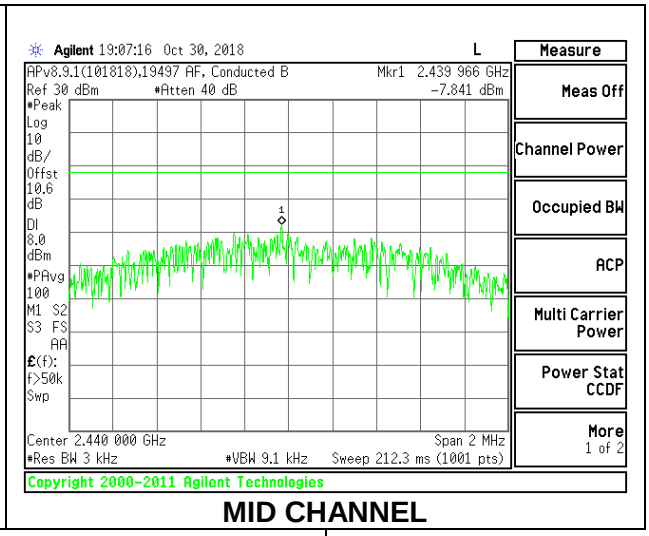
8.6.2. BLE (2Mbps)

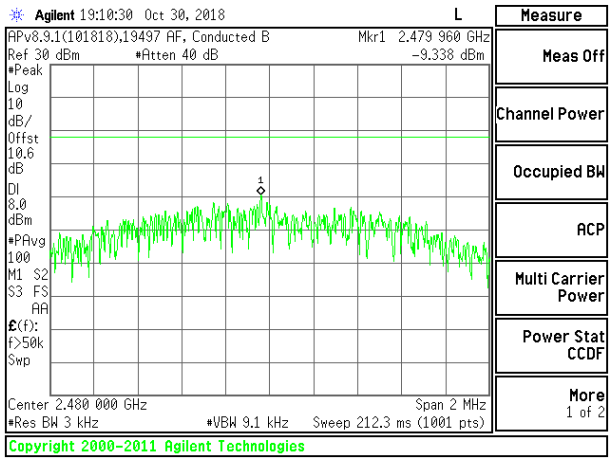
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	-8.70	8	-16.70
Middle	2440	-7.84	8	-15.84
High	2480	-9.34	8	-17.34



LOW CHANNEL



MID CHANNEL



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8.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

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

RESULTS

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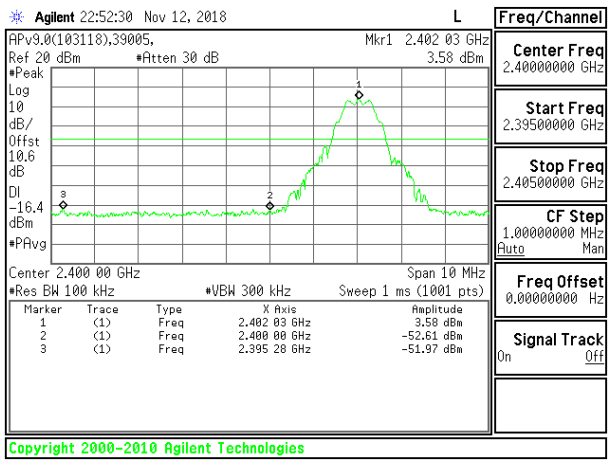
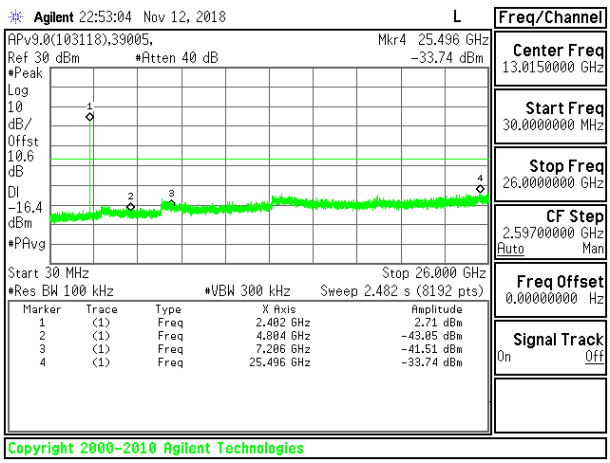
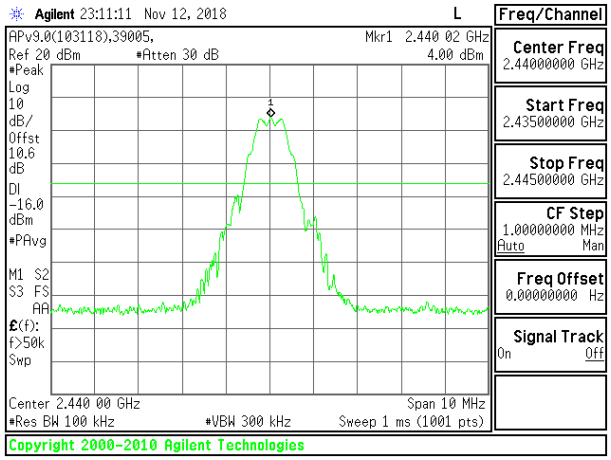
8.7.1. BLE (125kbps)



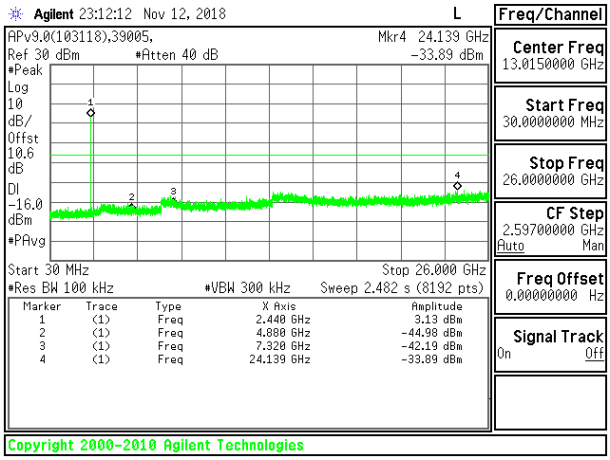
LOW CHANNEL BANDEDGE



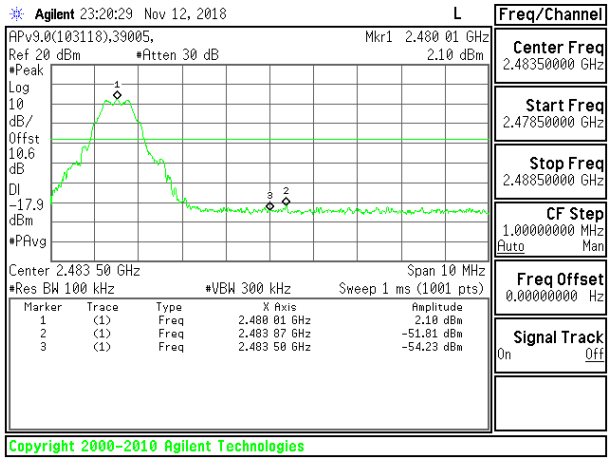
OUT-OF-BAND LOW CHANNEL



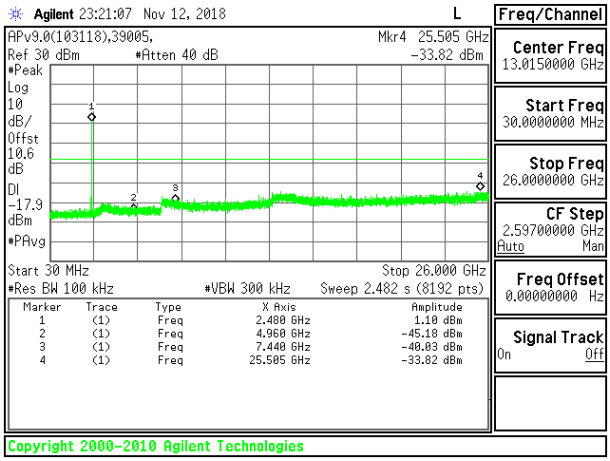
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



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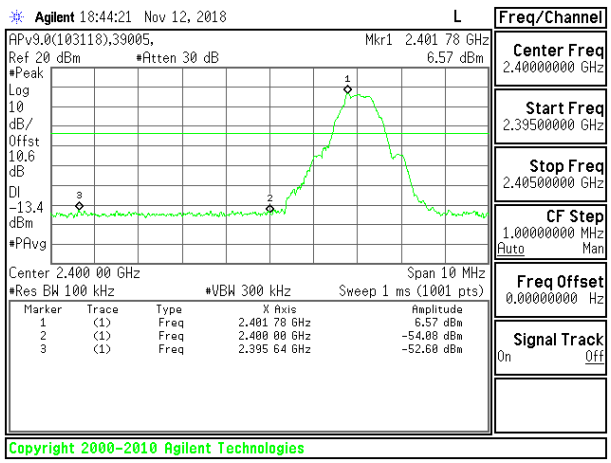
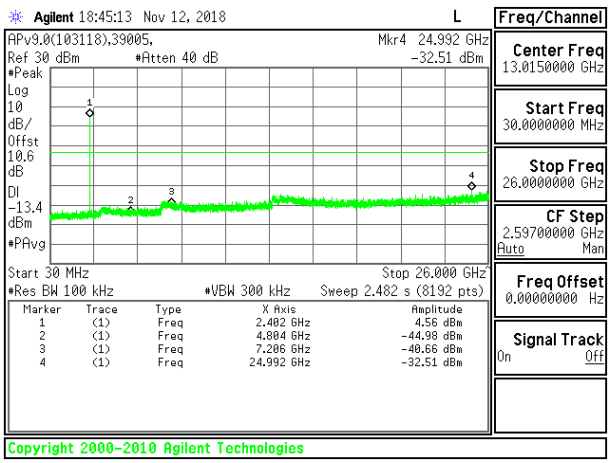
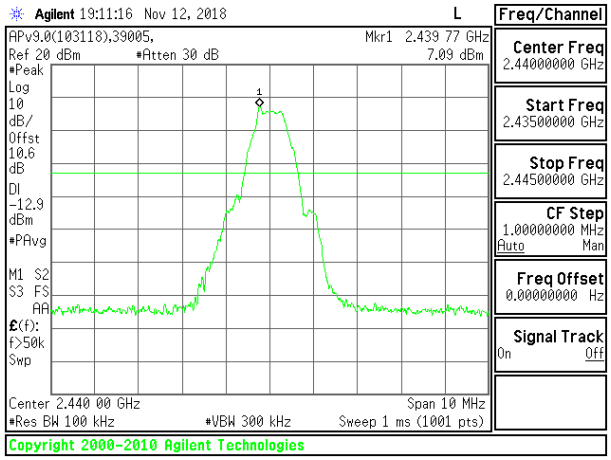
8.7.2. BLE (500kbps)



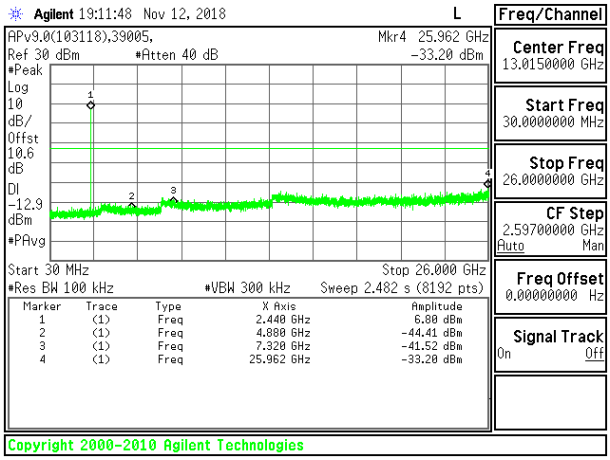
LOW CHANNEL BANDEDGE



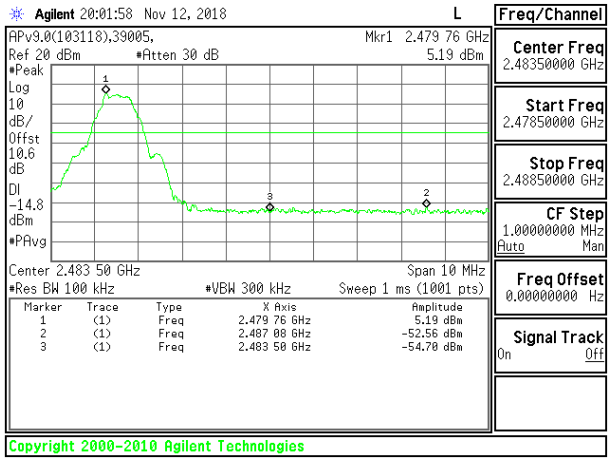
OUT-OF-BAND LOW CHANNEL



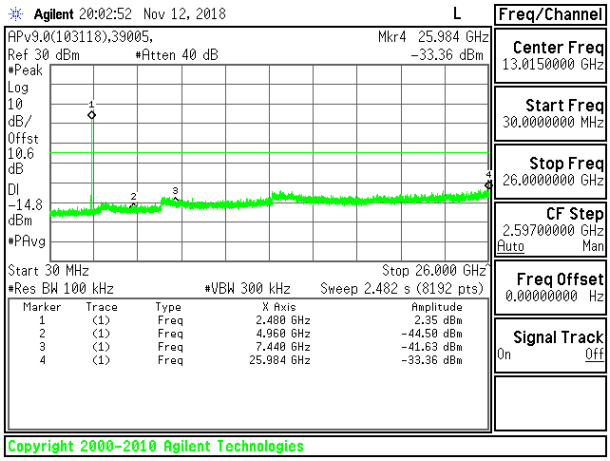
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



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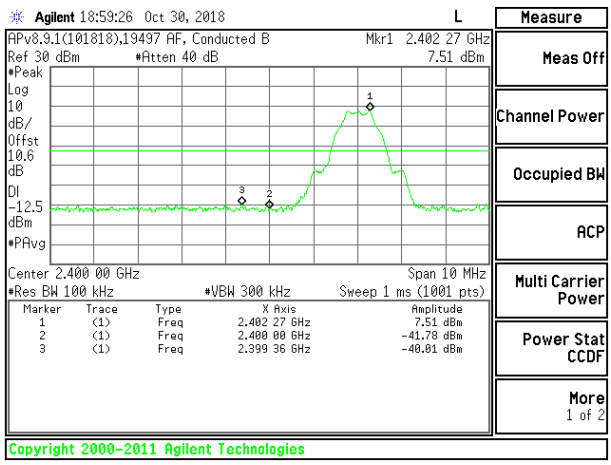
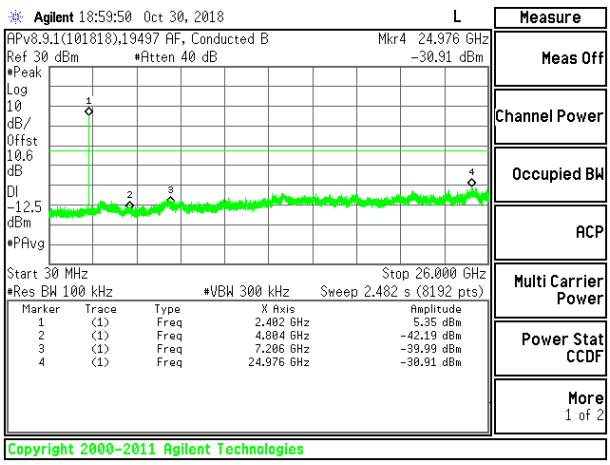
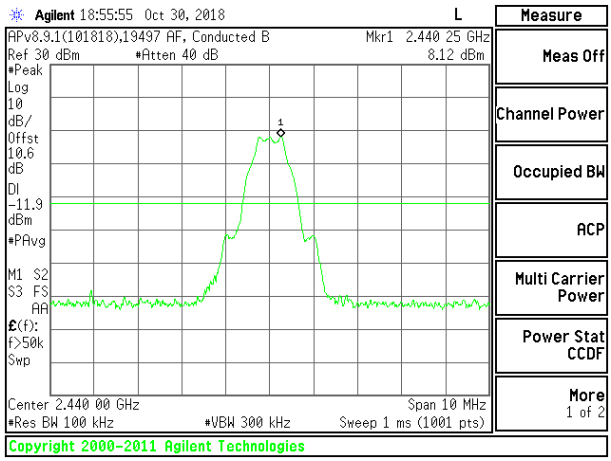
8.7.3. BLE (1Mbps)



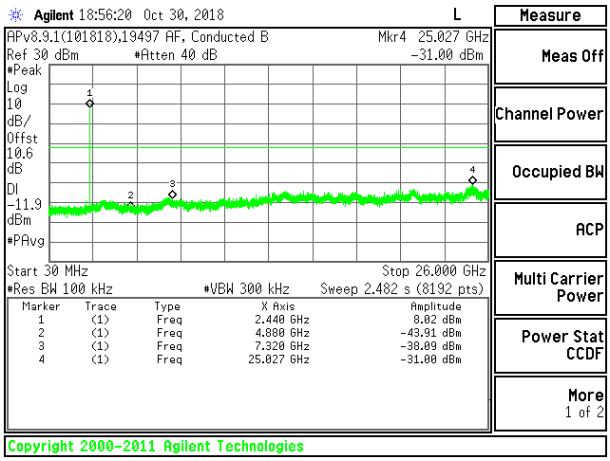
LOW CHANNEL BANDEDGE



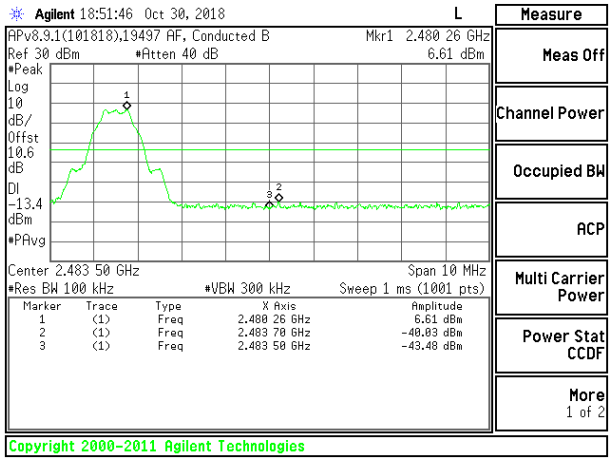
OUT-OF-BAND LOW CHANNEL



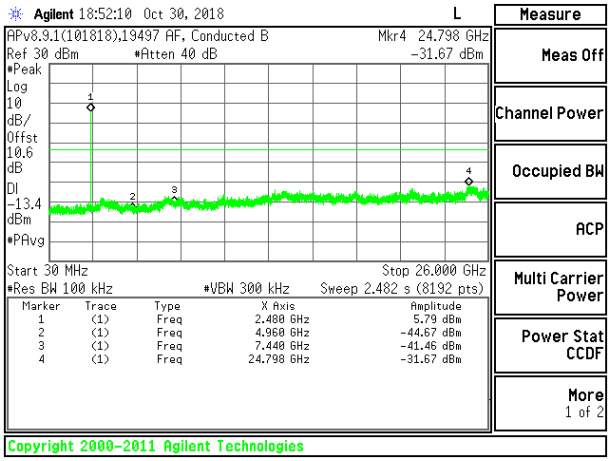
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



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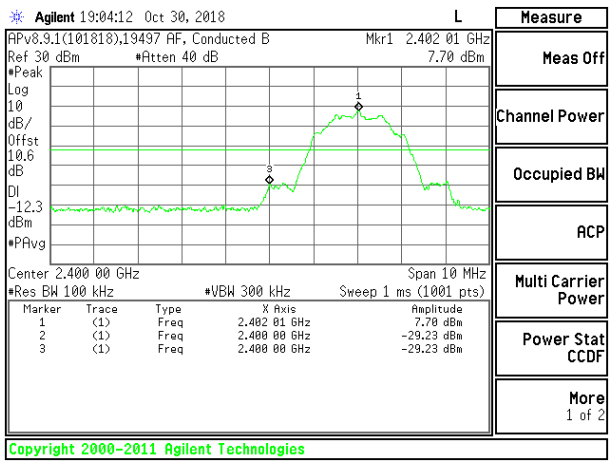
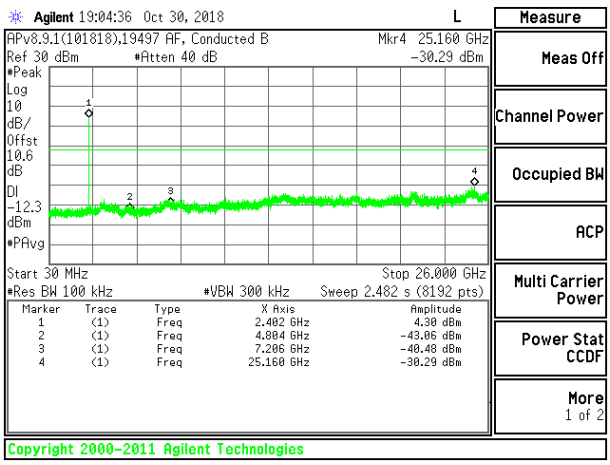
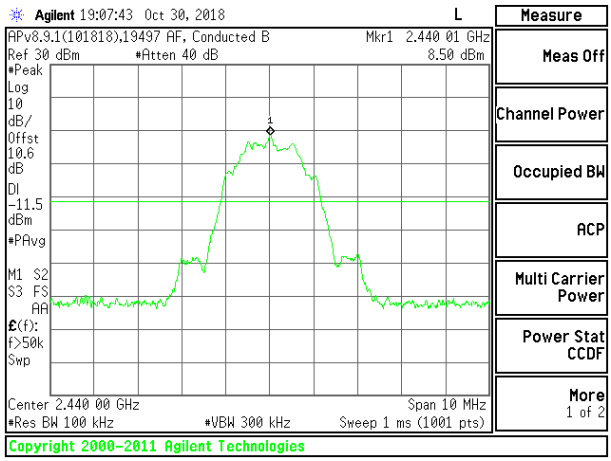
8.7.4. BLE (2Mbps)



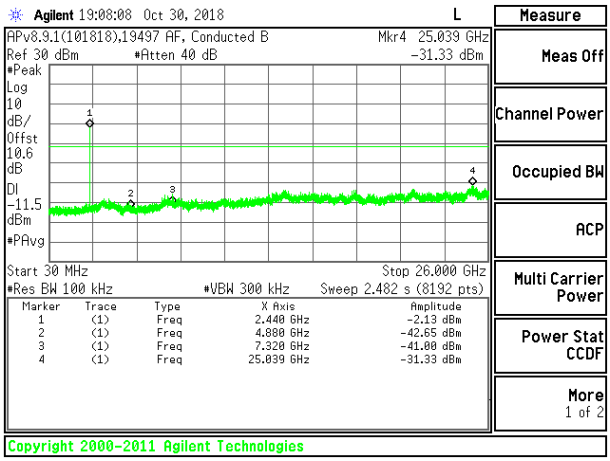
LOW CHANNEL BANDEDGE



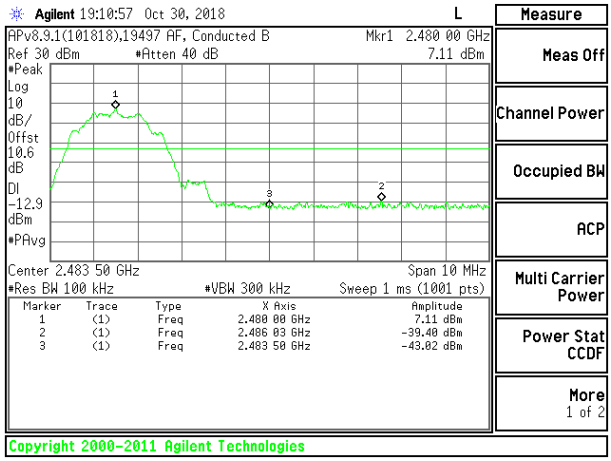
OUT-OF-BAND LOW CHANNEL



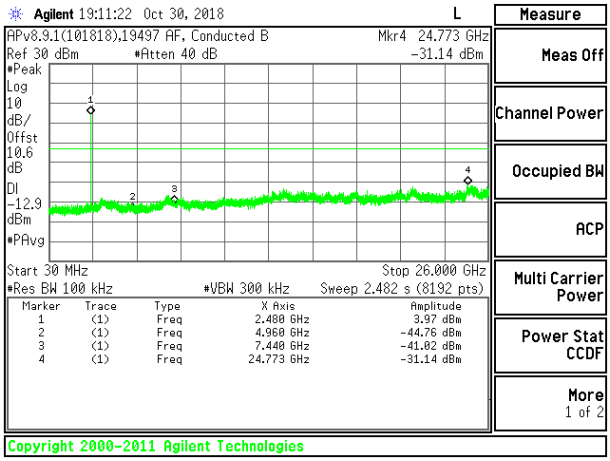
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



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