FCC 47 CFR PART 15 SUBPART C
INDUSTRY CANADA RSS-247 ISSUE 1

CERTIFICATION TEST REPORT

FOR

WIRELESS HEADSET

MODEL NUMBER: AI1

FCC ID: A94AI1
IC: 3232A-AI1

REPORT NUMBER: R11043795-E1

ISSUE DATE: 2016-06-09

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Revision History

Version	Issue Date	Revisions	Revised By
1	2016-04-19	Initial Issue	Ron Reichard
2	2016-05-12	Added below 30 MHz data.	Jeff Moser
3	2016-05-17	Clarified Radiated measurement mode 'V1TR', added statement regarding chamber characterizartion for below 30 MHz on page 113.	Jeff Moser
4	2016-05-20	Included below 30 MHz limits on page 97.	Jeff Moser
5	2016-06-09	Revised informative average power measurements (DQPSK and 8PSK).	Jeff Moser

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Bose Corp.
100 The Mountain Rd.
Framingham, Massachusetts, 01701, USA

EUT DESCRIPTION: Wireless Headset

MODEL: AI1

SERIAL NUMBER: ID 2305610-EMC (Radiated sample);
ID EB77B5 (Conducted sample)

DATE TESTED: 2016-02-22 to 2016-03-31, 2016-05-05, 2016-06-08

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C	PASS
INDUSTRY CANADA RSS-247 Issue 1	PASS
INDUSTRY CANADA RSS-GEN Issue 4	PASS

UL LLC tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL LLC based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL LLC and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC 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 any government.

Approved & Released
For UL LLC By:

Jeff Moser
EMC Program Manager
UL – Consumer Technology Division

Prepared By:

Ron Reichard
EMC Project Lead
UL – Consumer Technology Division

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, RSS-GEN Issue 4, RSS-247 Issue 1.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 12 Laboratory Dr., Research Triangle Park, NC 27709, USA and 2800 Suite B, Perimeter Park Drive, Morrisville, NC 27560.

12 Laboratory Dr., RTP, NC 27709
☐ Chamber A
☐ Chamber C

2800 Suite B Perimeter Park Dr., Morrisville, NC 27560
☒ Chamber NORTH
☒ Chamber SOUTH

The onsite chambers are covered under Industry Canada company address code 2180C with site numbers 2180C -1 through 2180C-4, respectively.

UL LLC (RTP) is accredited by NVLAP, Laboratory Code 200246-0. The full scope of accreditation can be viewed at http://www.nist.gov/nvlap/.

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

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

4.3. MEASUREMENT UNCERTAINTY

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

PARAMETER		UNCERTAINTY
Total RF power, conducted	+/-	0.45
RF power density, conducted	+/-	1.50
Spurious emissions, conducted	+/-	2.94
All emissions, radiated up to 26 GHz	+/-	5.36
Temperature	+/-	0.07
Humidity	+/-	2.26
DC and low frequency voltages	+/-	1.27
Conducted Emissions (0.150-30MHz)	+/-	2.37

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

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a Wireless Headset that contains a Bluetooth transceiver.

The radio module is manufactured by Cambridge Silicon Radio, CSR8670.

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	Basic GFSK	9.21	8.34
2402 - 2480	DQPSK	8.10	6.46
2402 - 2480	Enhanced 8PSK	8.30	6.76

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a meander printed etch antenna, with a maximum gain of +0.6 dBi.

5.4. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was version 0.2.0.84.

The test utility and driver software used during testing was Polycomm, ver. 0.1.5.0 and CSR BlueSuite ver 2.5.8

5.5. WORST-CASE CONFIGURATION AND MODE

Radiated emissions were performed with the EUT set to transmit at the channel with the highest output power as the worst-case scenario.

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

For Enhanced Data rate modes, 8DPSK is considered worst-case and only select tests were performed for the DQPSK mode. Additionally, unless noted in the test report, all tests were performed with the DH5 packet size as this was considered worst-case.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
Laptop PC (for commissioning the EUT)	Lenovo	20BU-S04K00	PC-0A2UQS	N/A
AC Adapter (for laptop PC)	Lenovo	ADLX65NLC2A	54DE1T	N/A

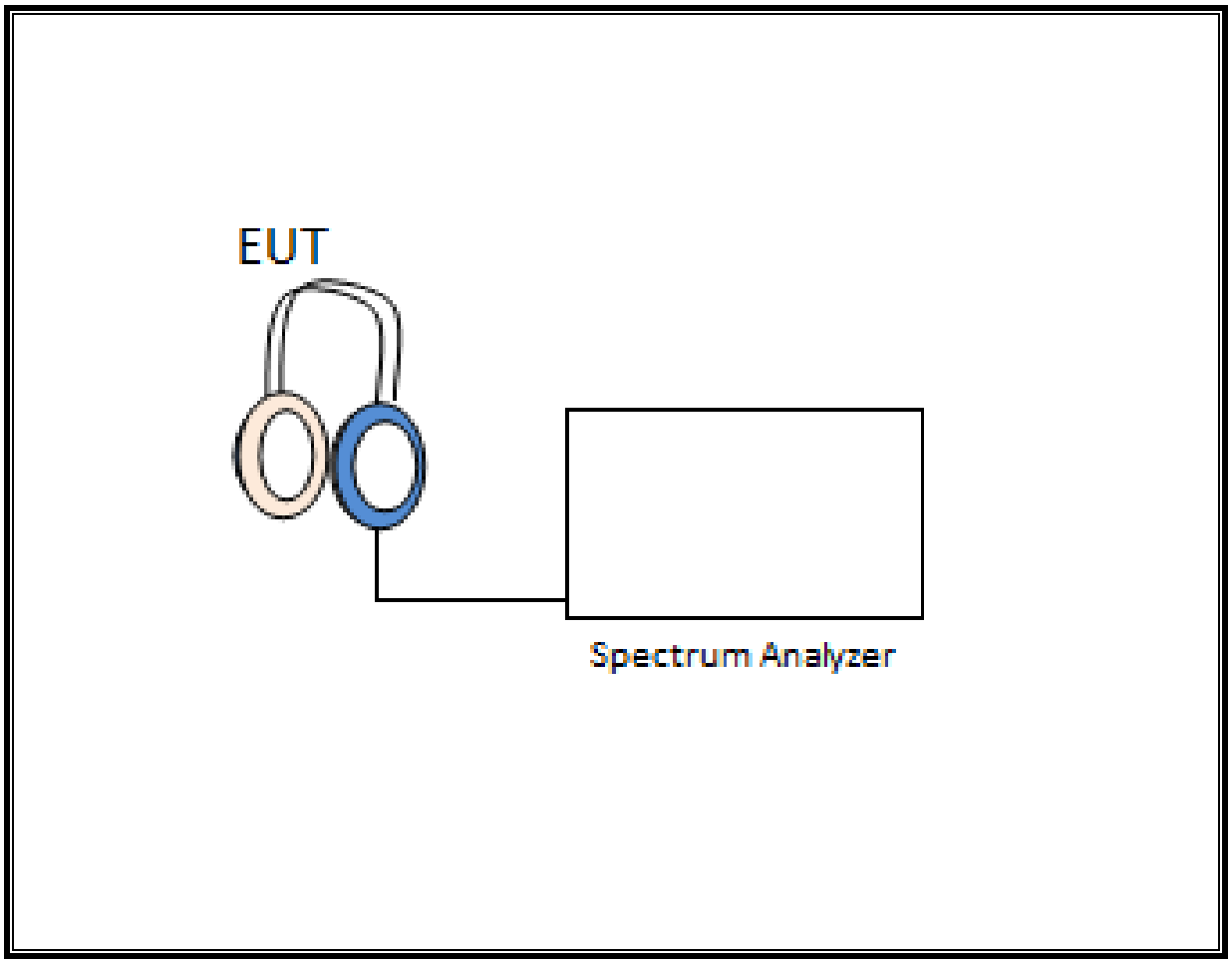
I/O CABLES

I/O Cable List						
Cable No	**Port**	**# of identical ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	USB	1	Micro USB	Unshielded	0.33	For USB charging cable.

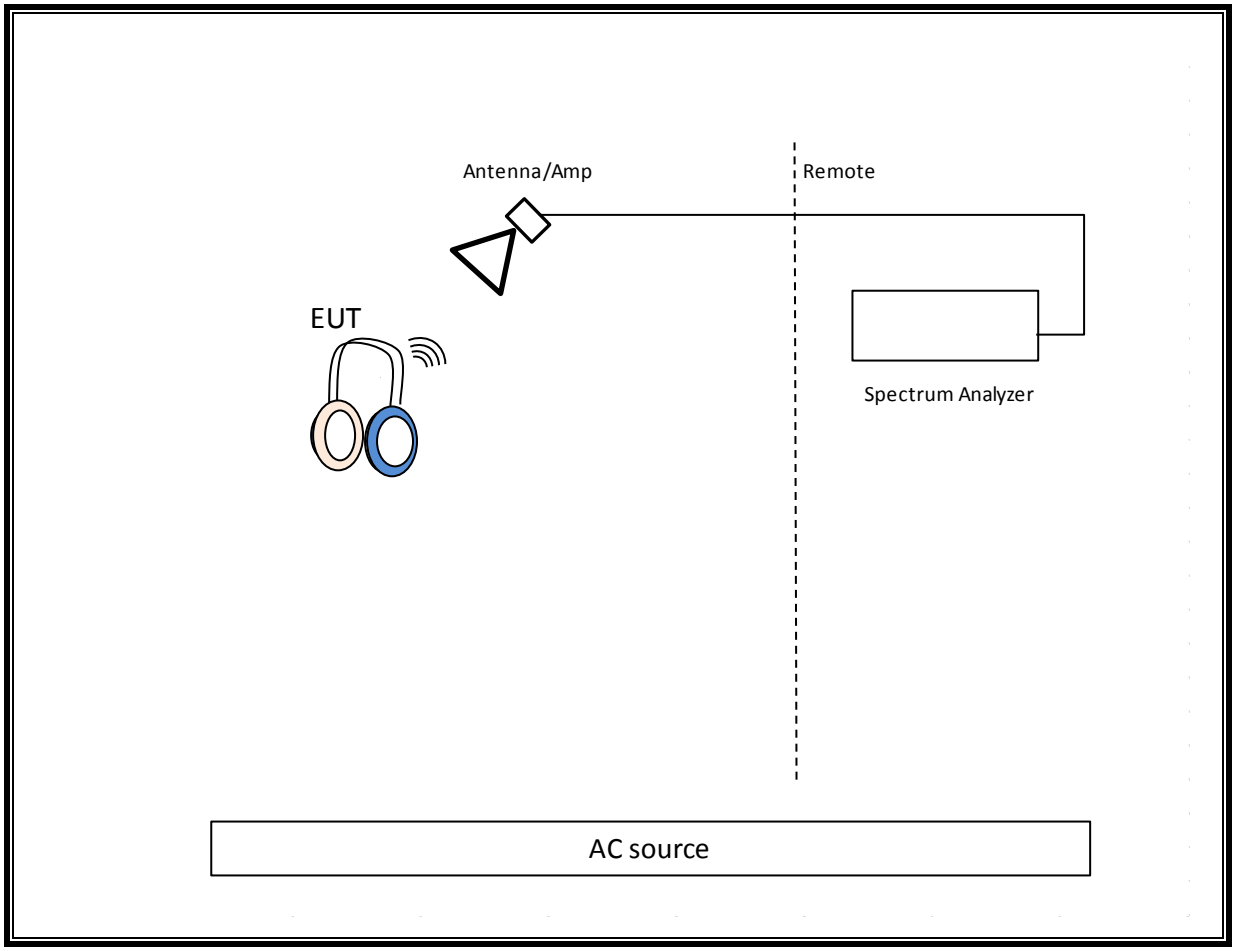
TEST SETUP

The EUT is set up as a stand-alone device during radiated-emissions testing. For convenience, the device is connected to a laptop PC via a USB cable to configure the device for test during antenna-port measurements. Test software exercised the radio portion of the device.

SETUP DIAGRAM FOR CONDUCTED TESTS



SETUP DIAGRAM FOR RADIATED TESTS



6. TEST AND MEASUREMENT EQUIPMENT

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

Test Equipment Used - Wireless Conducted Measurement Equipment

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	Conducted Room 1				
SA0019	Spectrum Analyzer	Agilent Technologies	E4446A	2015-09-02	2016-09-30
PWM004	RF Power Meter	Keysight Technologies	N1911A	2015-06-08	2016-06-30
PWS004	Peak and Avg Power Sensor, 50MHz to 6GHz	Keysight Technologies	E9323A	2015-06-05	2016-06-30
PRE0128068	RF Power Meter	Anritsu	ML2495A	2015-12-16	2016-12-16
PRE0128067	Pulse Power Sensor, 300MHz to 40GHz	Anritsu	MA2411B	2015-12-16	2016-12-16
HI0079	Temp/Humid/Pressure Meter	Springfield	PreciseTemp	2015-07-01	2016-07-31
MM0167	True RMS Multimeter	Agilent	U1232A	2015-08-17	2016-08-31
76022	DC Regulated Power Supply	CircuitSpecialists.Com	CSI3005X5	N/A	N/A
	Conducted Room 2				
SA0020	Spectrum Analyzer	Agilent Technologies	E4446A	2015-02-26	2016-02-29
PWM003	RF Power Meter	Keysight Technologies	N1911A	2015-06-08	2017-06-08
PWS003	Peak and Avg Power Sensor, 50MHz to 6GHz	Keysight Technologies	E9323A	2015-06-05	2016-06-05
1100502	Temp/Humid Chamber	Cincinnati Sub-Zero	ZPH-8-3.5-SCT/AC	2015-05-13	2016-05-31
43733	Temp/Humid/Pressure Meter	Cole-Parmer	99760-00	2014-03-24	2016-03-24
MM0168	True RMS Multimeter	Agilent	U1232A	2015-08-17	2016-08-31
76021	DC Regulated Power Supply	CircuitSpecialists.Com	CSI3005X5	N/A	N/A

Note – All testing in Conducted Room 2 was performed prior to 2016-02-29.

Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville - North Chamber)

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
AT0073	Hybrid Broadband Antenna, 30-1000MHz	Sunol Sciences Corp.	JB3	2015-06-10	2016-06-30
AT0072	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2015-02-17	2016-02-29
N-SAC02	Gain-loss string: 30-1000MHz	Various	Various	2015-06-04	2016-06-30
N-SAC03	Gain-loss string: 1-18GHz	Various	Various	2015-09-29	2016-09-30
SA0026	Spectrum Analyzer	Agilent	N9030A	2015-03-27	2016-03-31
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA
HI0079	Temp/Humid/Pressure Meter	Springfield Precision	PreciseTemp	2015-07-01	2016-07-31

Note – All testing in this chamber was performed prior to 2016-02-29

Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville - South Chamber)

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
AT0079	Active Loop Antenna	ETS-Lindgren	6502	2015-12-08	2016-12-31
AT0076	Horn Antenna, 18-26.5GHz	ARA	MWH-1826/B	2015-08-27	2016-08-31
S-SAC01	Gain-loss string: 0.009-30MHz	Various	Various	2015-10-07	2016-10-31
S-SAC04	Gain-loss string: 18-40GHz	Various	Various	2016-02-29	2017-02-28
SA0018	Spectrum Analyzer	Agilent	N9030A	2015-11-07	2016-11-30
SA0025	Spectrum Analyzer	Agilent	N9030A	2016-03-17	2017-03-31
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA
HI0050	Temp/Humid/Pressure Meter	Cole-Parmer	99760-00	2015-07-01	2016-07-31

7. ANTENNA PORT TEST RESULTS

7.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

PROCEDURE

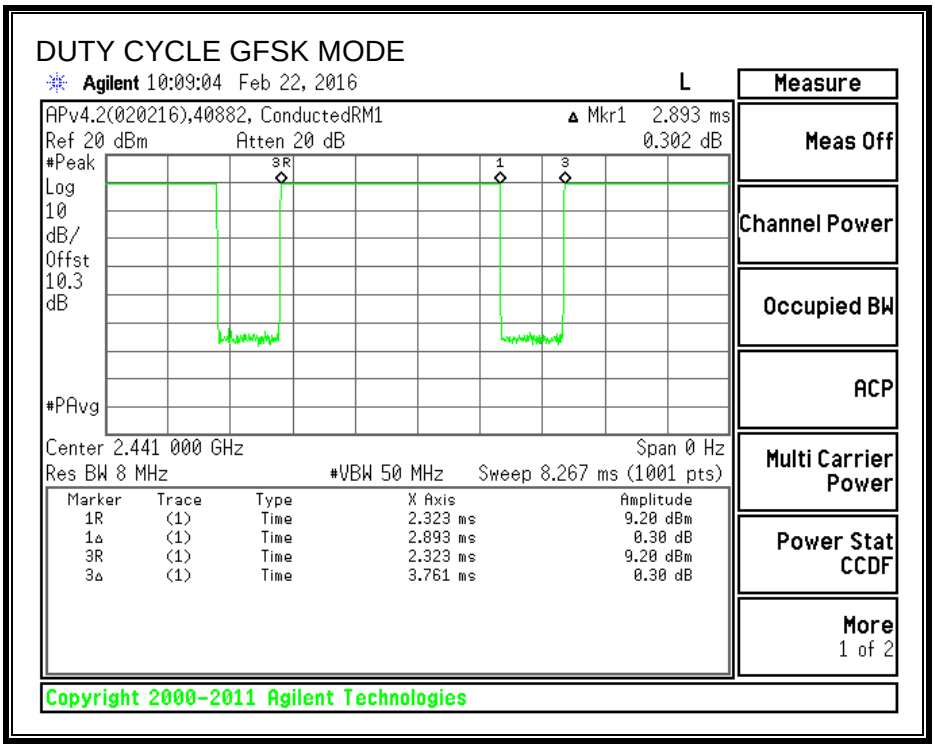
KDB 558074 Zero-Span Spectrum Analyzer Method.

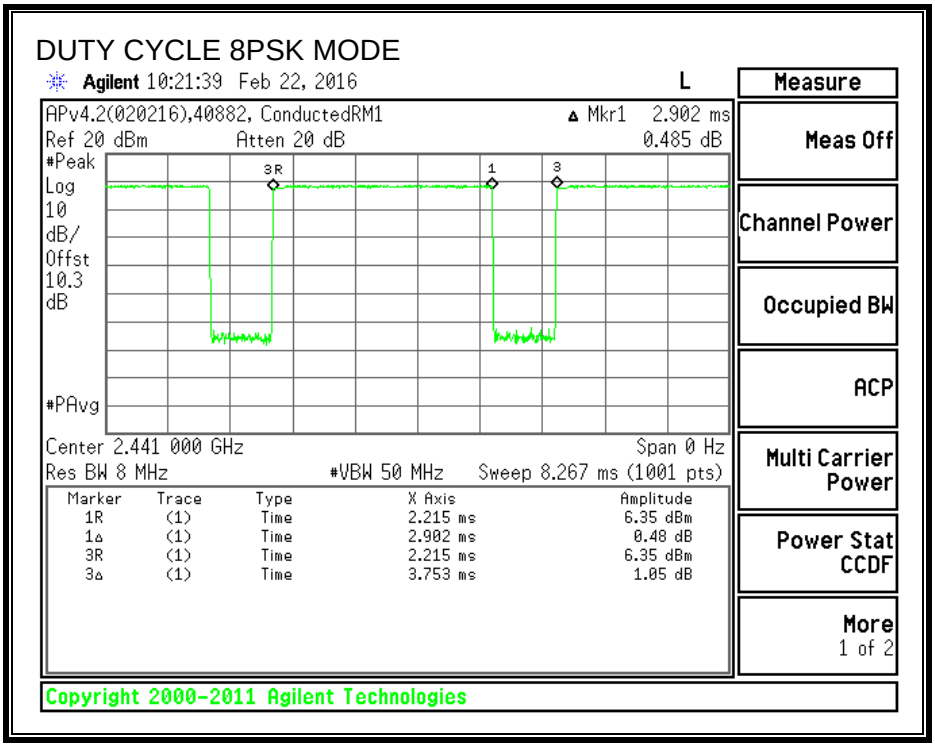
ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
2.4 GHz band (Hopping OFF)						
Bluetooth GFSK	2.893	3.761	0.769	76.92%	1.14	0.346
Bluetooth 8PSK	2.902	3.753	0.773	77.32%	1.12	0.345

DUTY CYCLE PLOTS

HOPPING OFF





7.2. BASIC DATA RATE GFSK MODULATION

7.2.1. 20 dB AND 99% BANDWIDTH

LIMIT

None; for reporting purposes only.

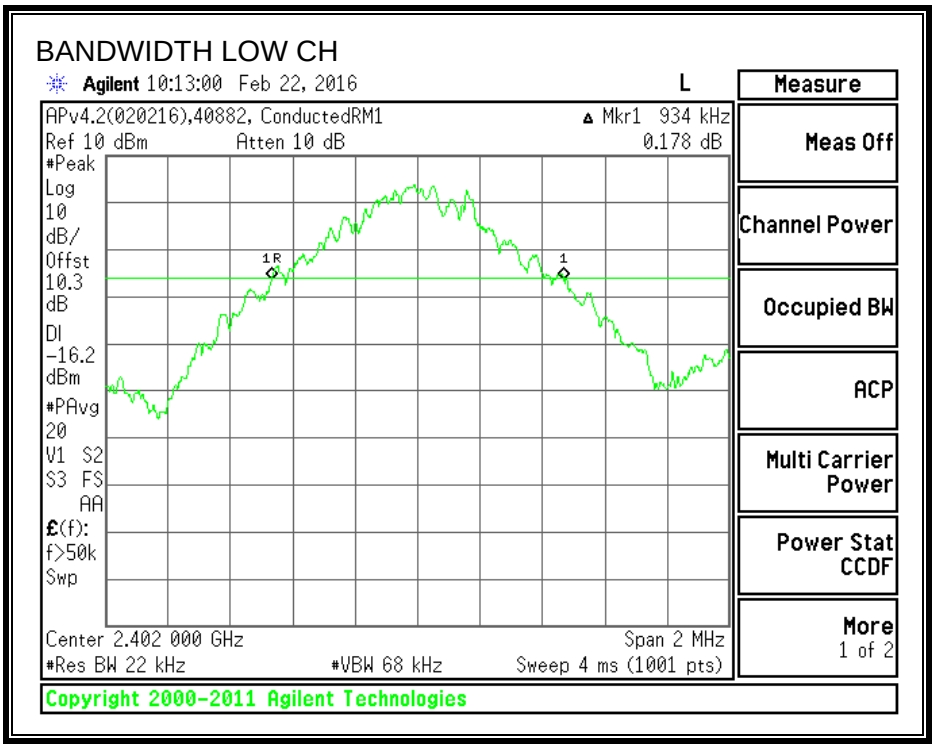
TEST PROCEDURE

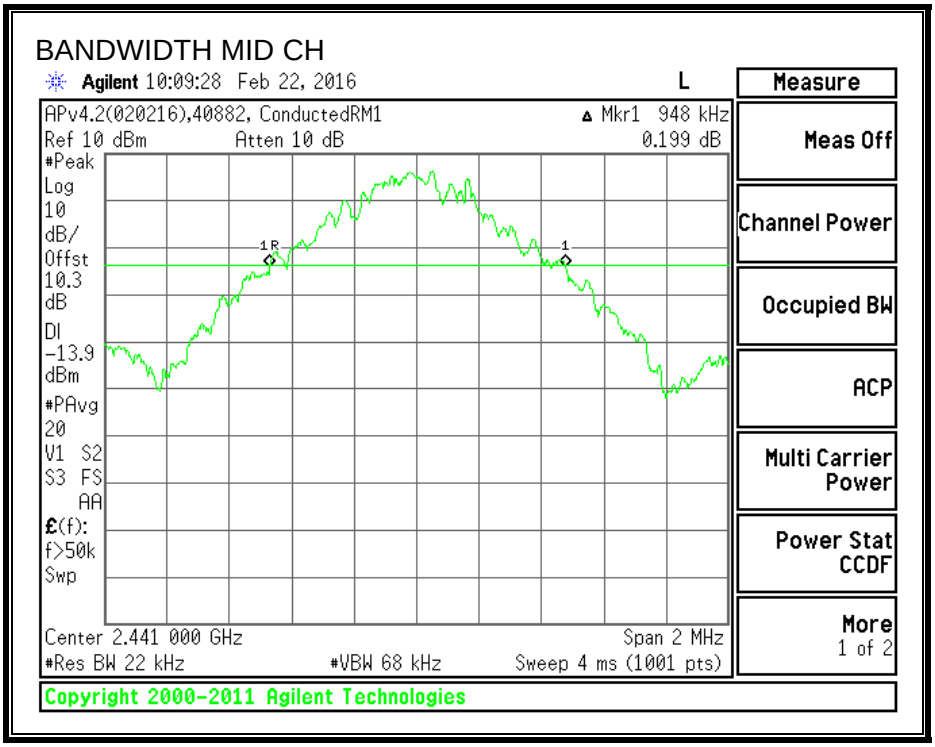
The transmitter output is connected to a spectrum analyzer. The RBW is set to 1-5% of the 20 dB bandwidth and 99% Occupied Bandwidth. The VBW is set to ≥ RBW. The sweep time is coupled.

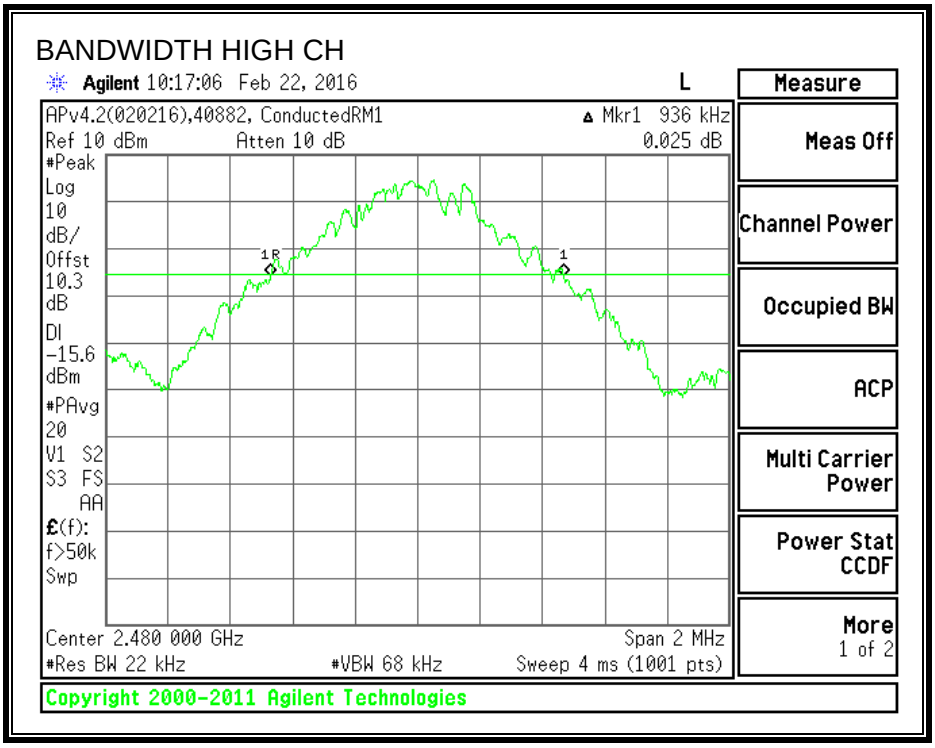
RESULTS

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)	99% Bandwidth (kHz)
Low	2402	934	883.3763
Middle	2441	948	879.7397
High	2480	936	871.9877

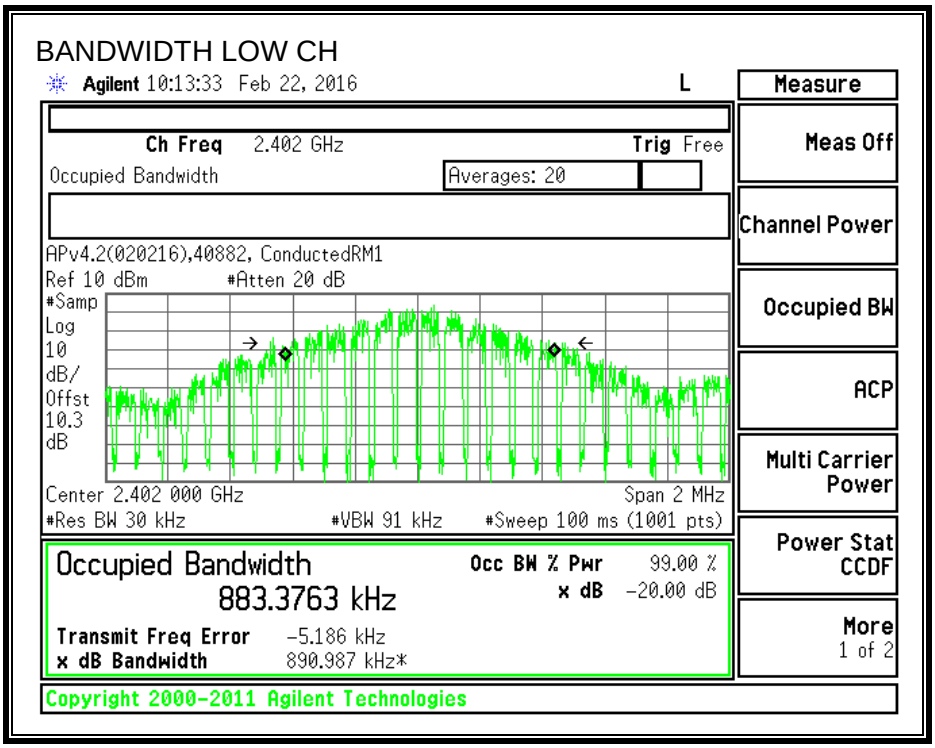
20 dB BANDWIDTH

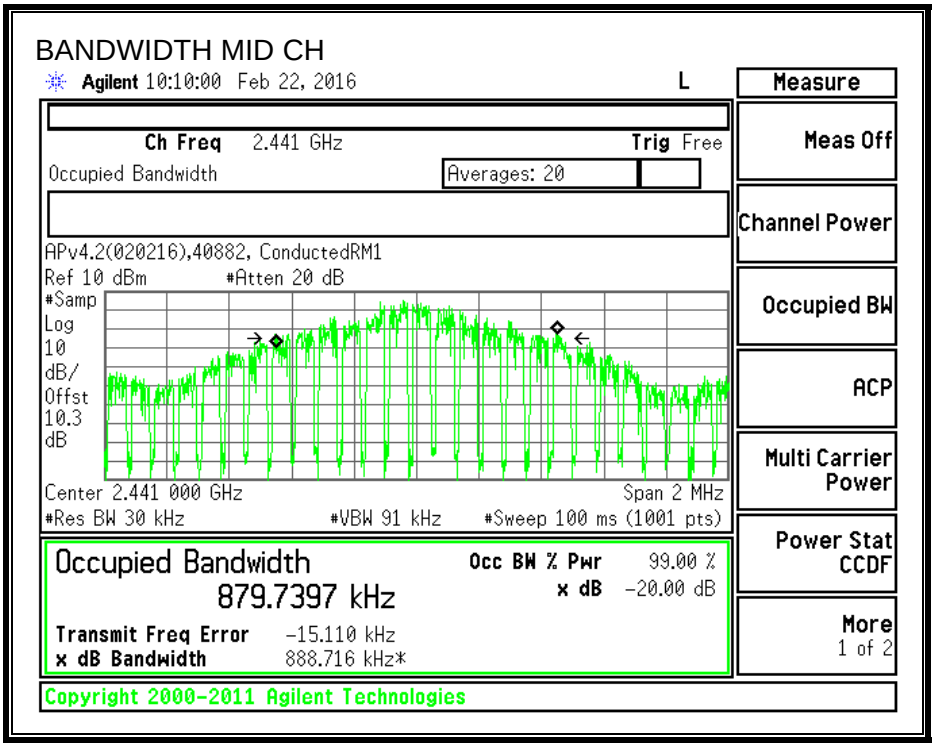


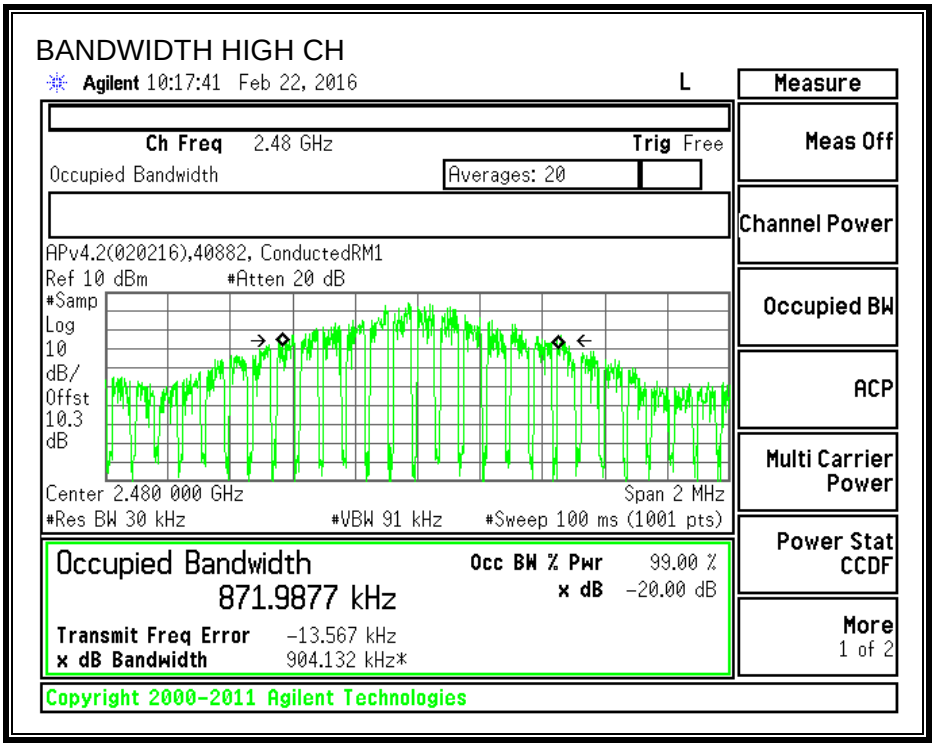




99% BANDWIDTH







7.2.2. HOPPING FREQUENCY SEPARATION

LIMIT

FCC §15.247 (a) (1)

IC RSS-247 5.1 (2)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hoping channel, whichever is greater.

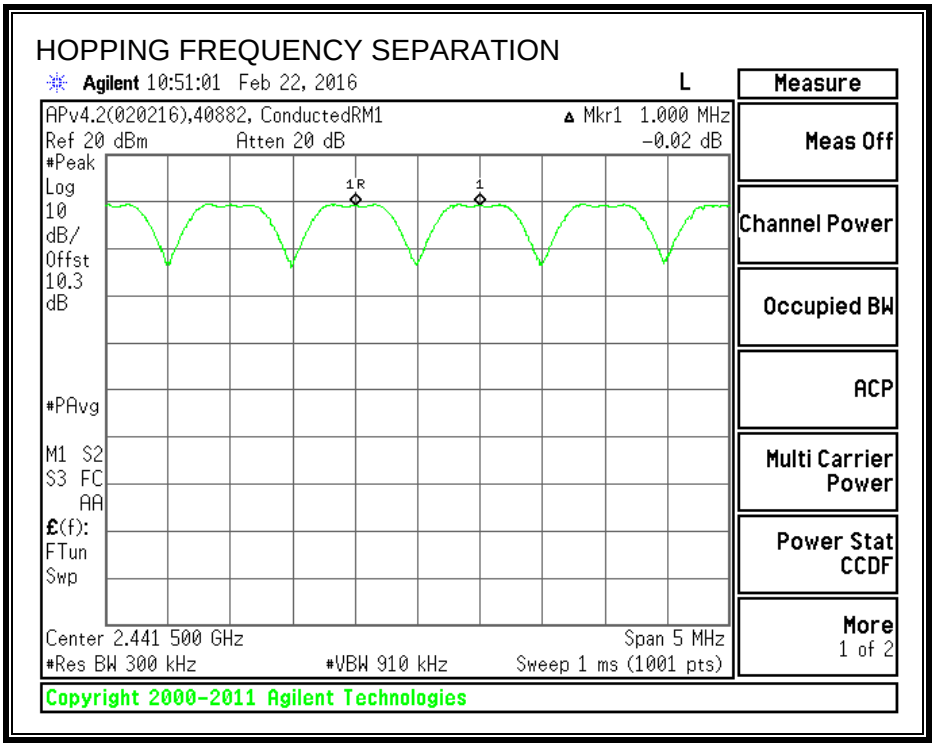
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The RBW is set to 300 kHz and the VBW is set to 3x RBW. The sweep time is coupled.

RESULTS

HOPPING FREQUENCY SEPARATION



7.2.3. NUMBER OF HOPPING CHANNELS

LIMIT

FCC §15.247 (a) (1) (iii)

IC RSS-247 5.1 (4)

Frequency hopping systems in the 2400 – 2483.5 MHz band shall use at least 15 non-overlapping channels.

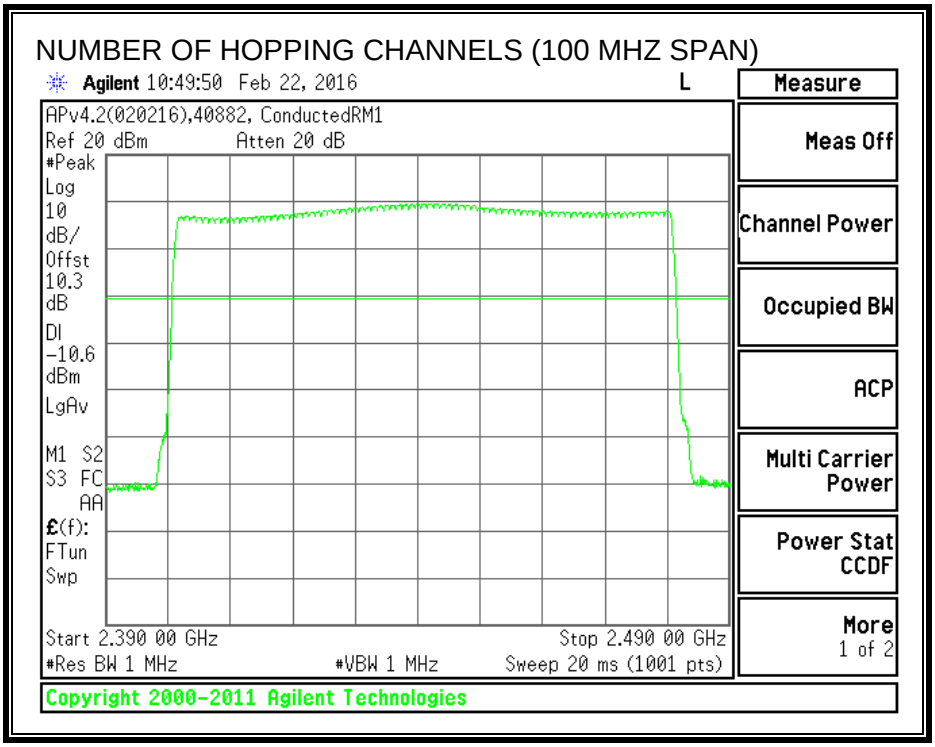
TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps for visibility of the entire span. Then, smaller spans are set to more clearly identify the channels. The RBW is set to 30% of the channel spacing (approx. 300 kHz). The analyzer is set to Max Hold.

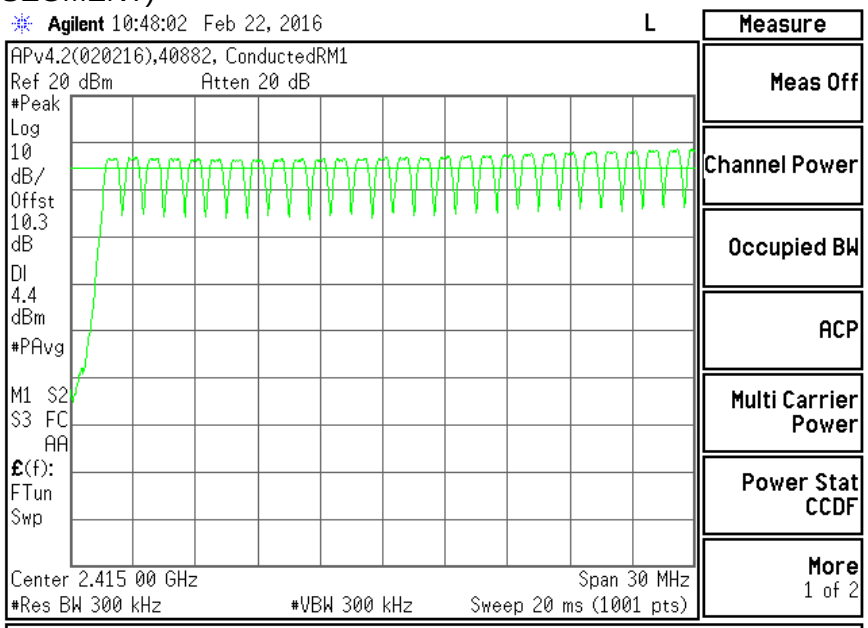
RESULTS

Normal Mode: 79 Channels observed.
AFH Mode: min of 20 Channels declared.

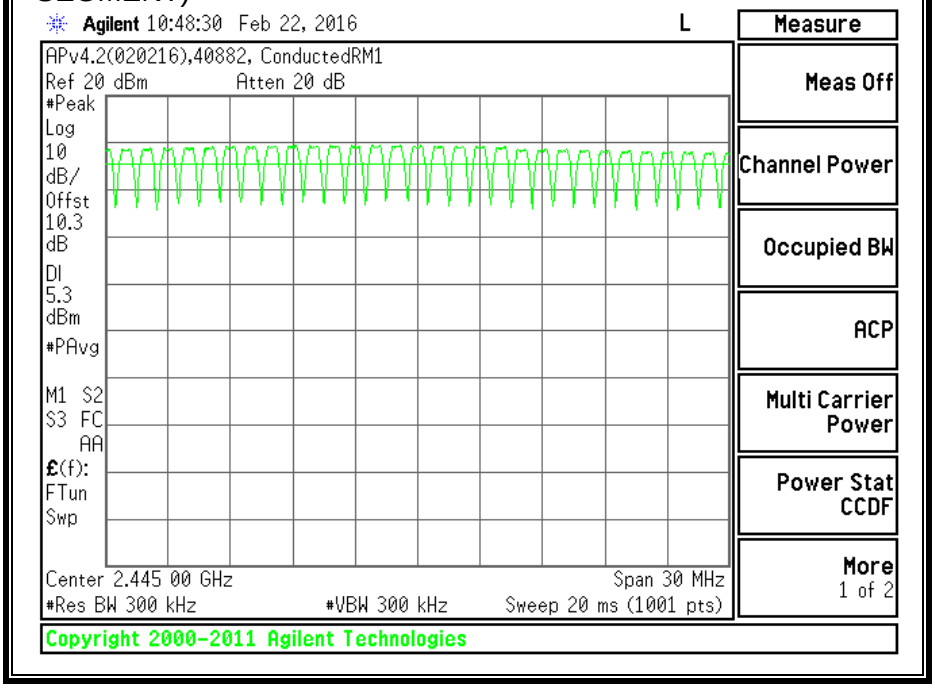
NUMBER OF HOPPING CHANNELS



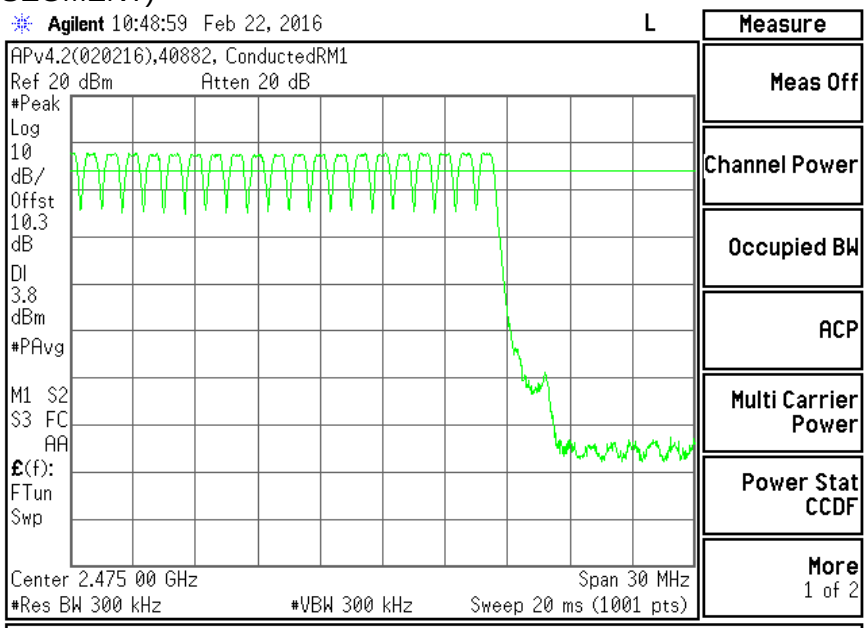
NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, FIRST SEGMENT)



NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, SECOND SEGMENT)



NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, THIRD SEGMENT)



7.2.4. AVERAGE TIME OF OCCUPANCY

LIMIT

FCC §15.247 (a) (1) (iii)

IC RSS-247 5.1 (4)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan. The number of pulses is measured in a 3.16 second scan, to enable resolution of each occurrence.

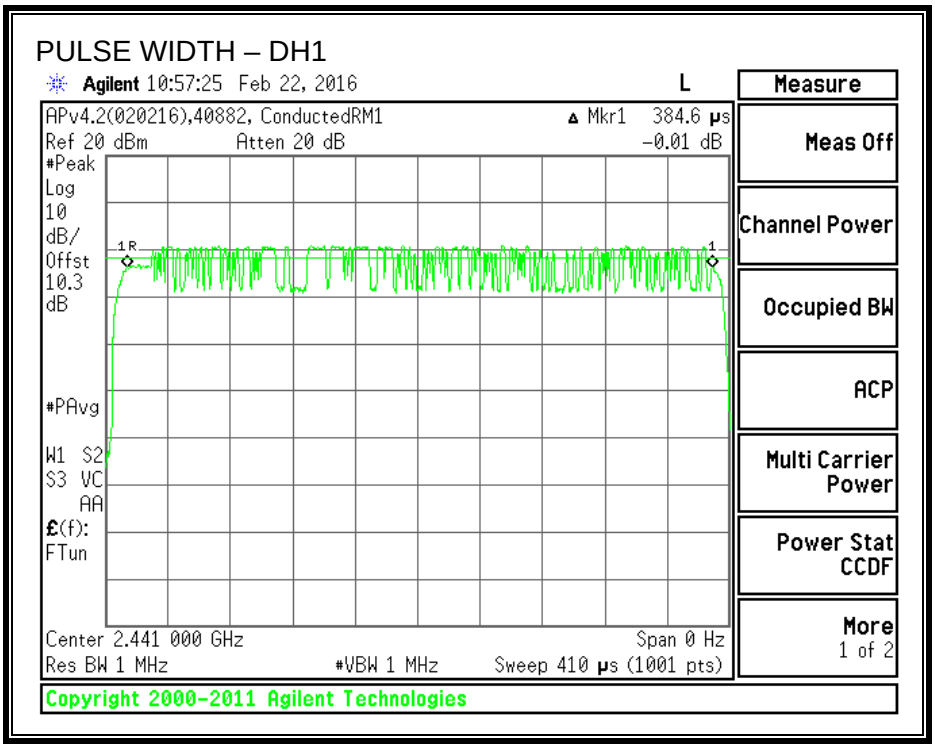
The average time of occupancy in the specified 31.6 second period (79 channels * 0.4 s) is equal to 10 * (# of pulses in 3.16 s) * pulse width.

For AFH mode, the average time of occupancy in the specified 8 second period (20 channels * 0.4 seconds) is equal to 10 * (# of pulses in 0.8 s) * pulse width.

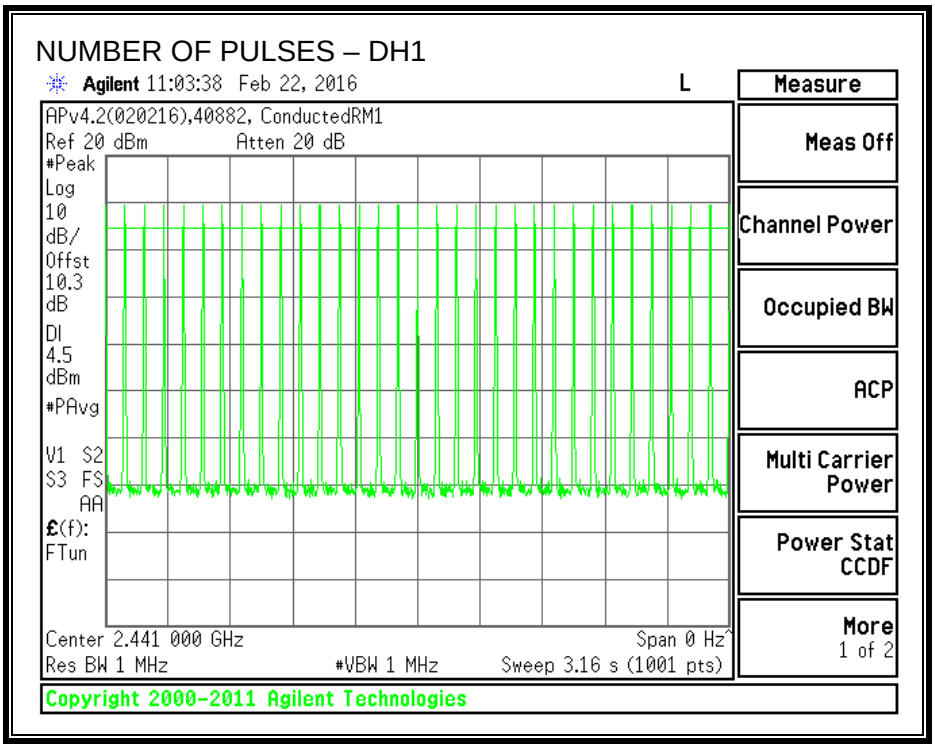
RESULTS

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK Normal Mode					
DH1	0.385	33	0.127	0.4	-0.273
DH3	1.64	16	0.262	0.4	-0.138
DH5	2.892	11	0.318	0.4	-0.082
DH Packet	Pulse Width (msec)	Number of Pulses in 0.8 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK AFH Mode					
DH1	0.385	8.25	0.032	0.4	-0.368
DH3	1.64	4	0.066	0.4	-0.334
DH5	2.892	2.75	0.080	0.4	-0.320

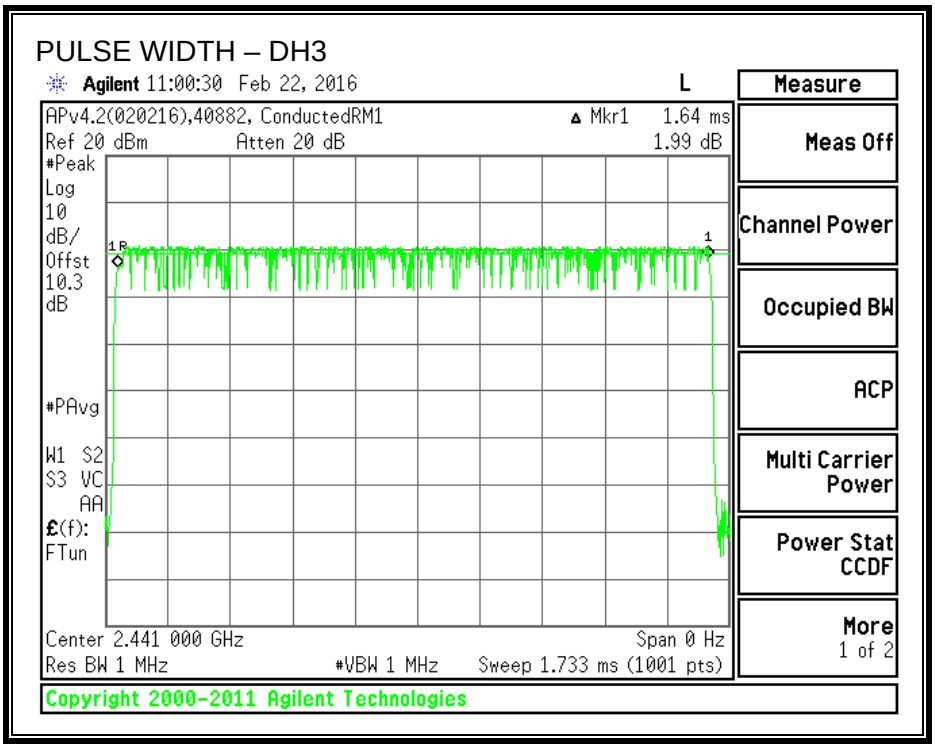
PULSE WIDTH - DH1



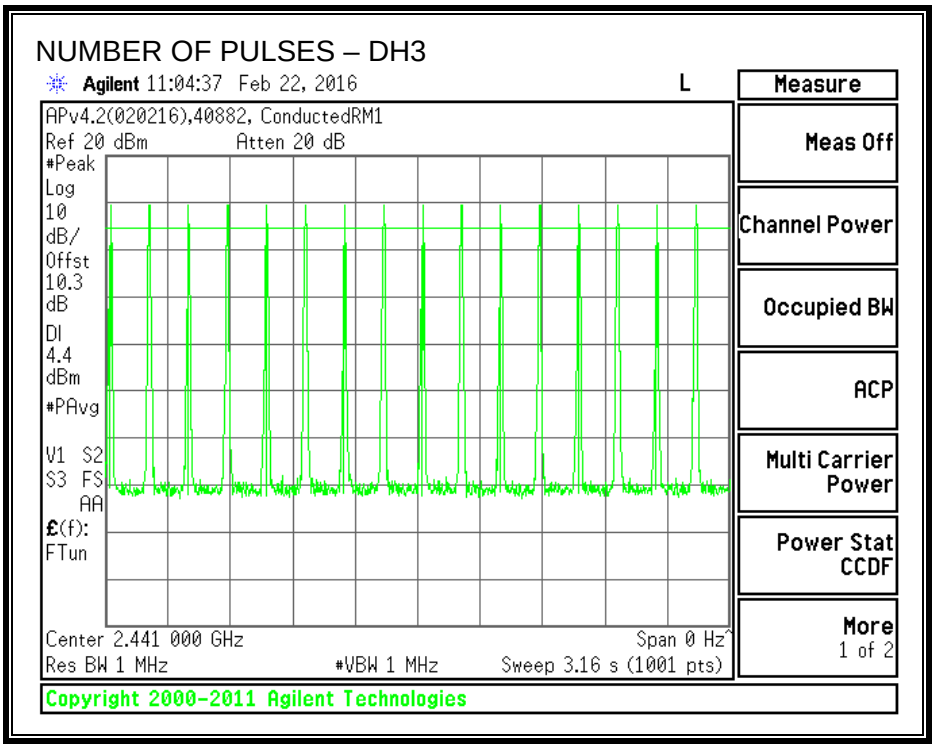
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1



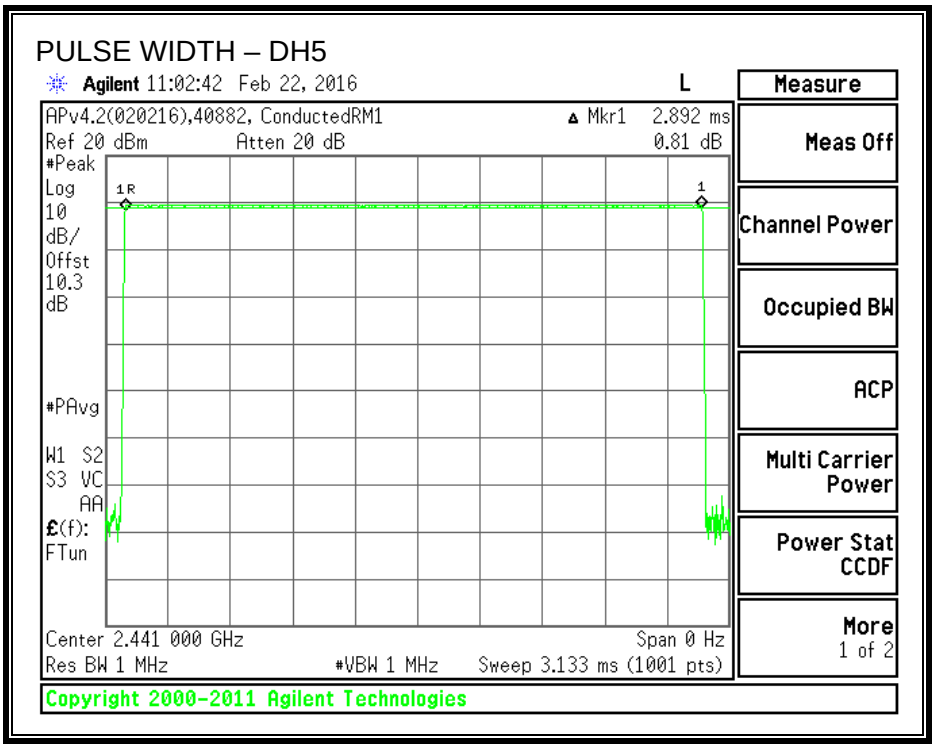
PULSE WIDTH – DH3



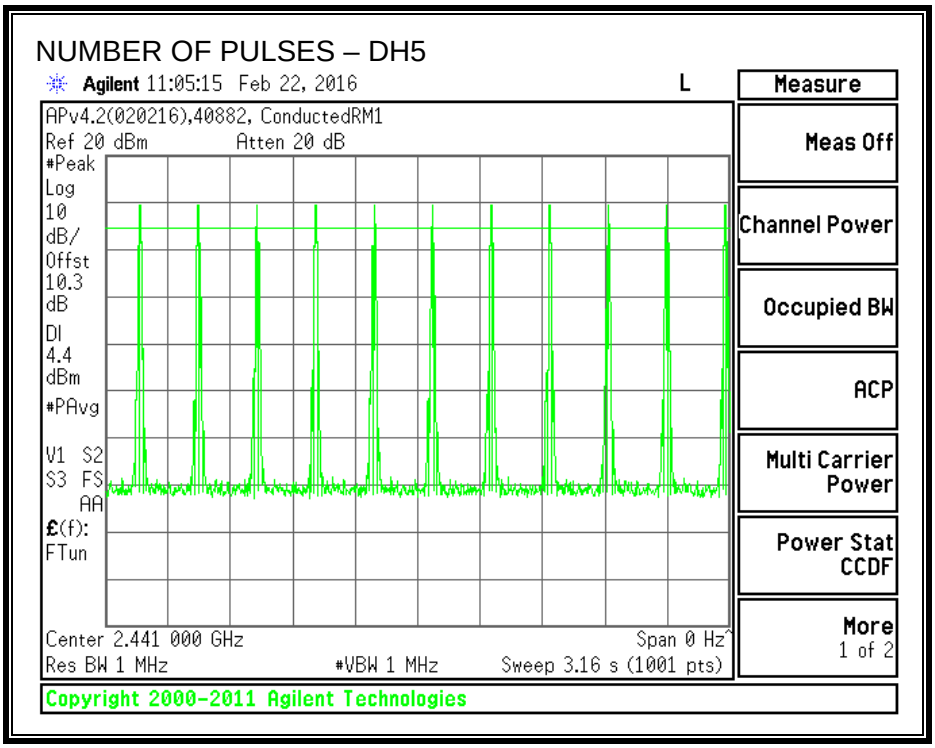
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3



PULSE WIDTH – DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5



7.2.5. OUTPUT POWER

LIMIT

§15.247 (b) (1)

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

RSS-247 5.1 (2)

For frequency hopping systems operating in the band 2400-2483.5 MHz and employing at least 75 hopping channels, the maximum peak conducted output power shall not exceed 1 W; for all other frequency hopping systems in the band, the maximum peak conducted output power shall not exceed 0.125 W.

TEST PROCEDURE

The transmitter output was connected to a power meter equipped with a power sensor capable of measuring peak power. The cable assembly insertion loss of 10.294 dB (including 10 dB pad and 0.294 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

RESULTS

For 75 or more hopping channels

Channel	Frequency (MHz)	Output Power (dBm)	Directional Gain (dBi)	Limit (dBm)	Margin (dB)
Low	2402	6.62	0.60	30	-23.38
Middle	2441	9.21	0.60	30	-20.79
High	2480	7.70	0.60	30	-22.30

7.2.6. AVERAGE POWER

LIMIT

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter and a gated average power measurement was performed. The cable assembly insertion loss of 10.294 dB (including 10 dB pad and 0.294 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

RESULTS

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	6.33
Middle	2441	9.02
High	2480	7.47

7.2.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

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)).

IC RSS-247 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section A8.4 (4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

TEST PROCEDURE

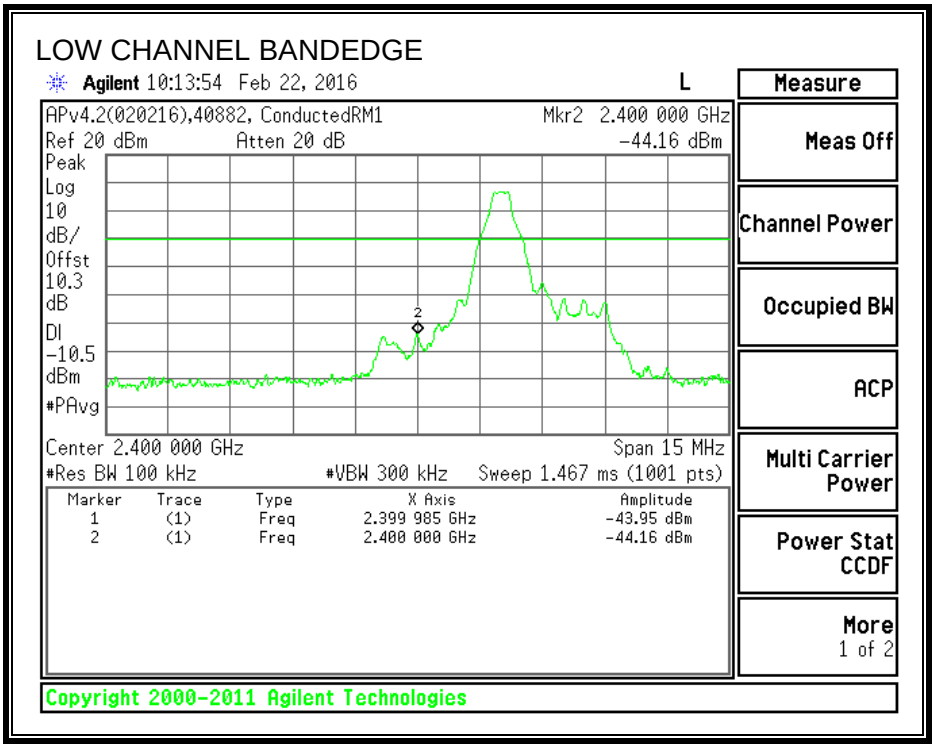
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

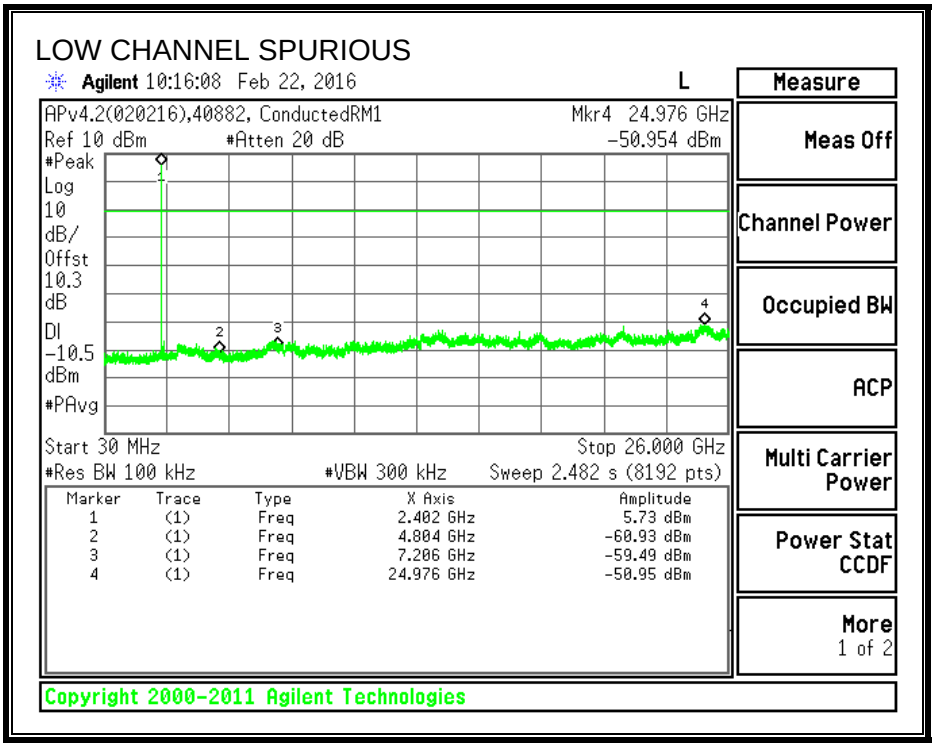
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

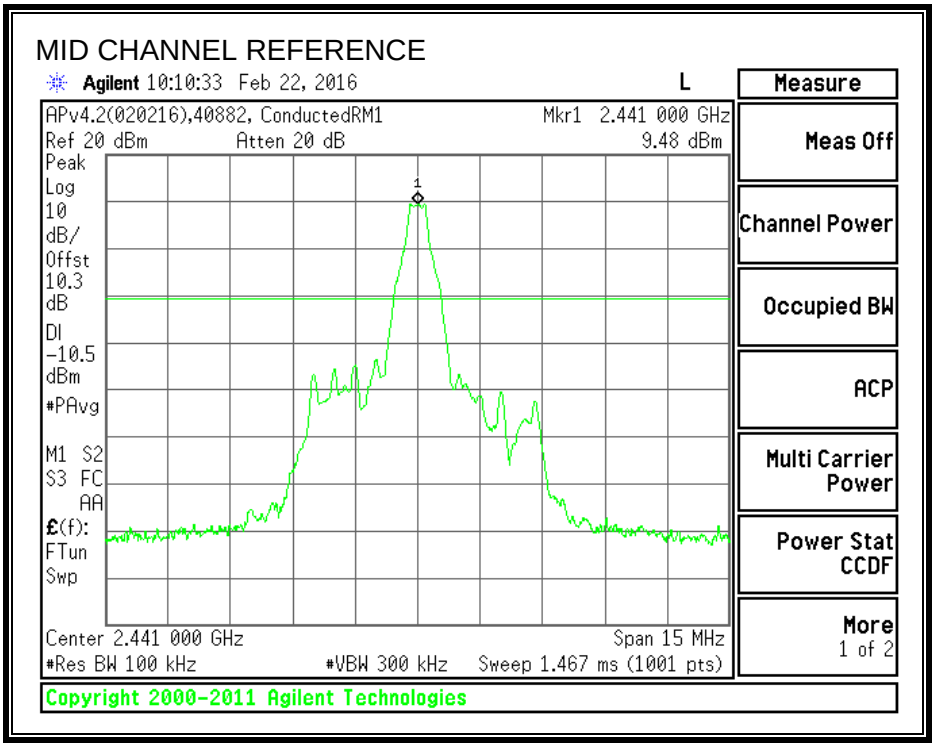
RESULTS

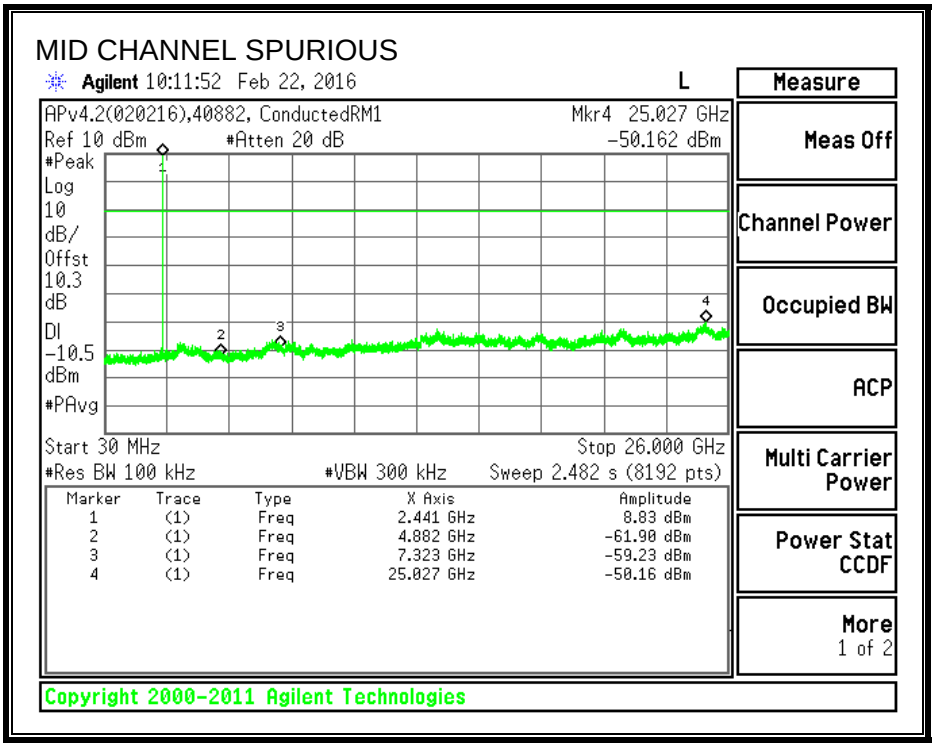
SPURIOUS EMISSIONS, LOW CHANNEL



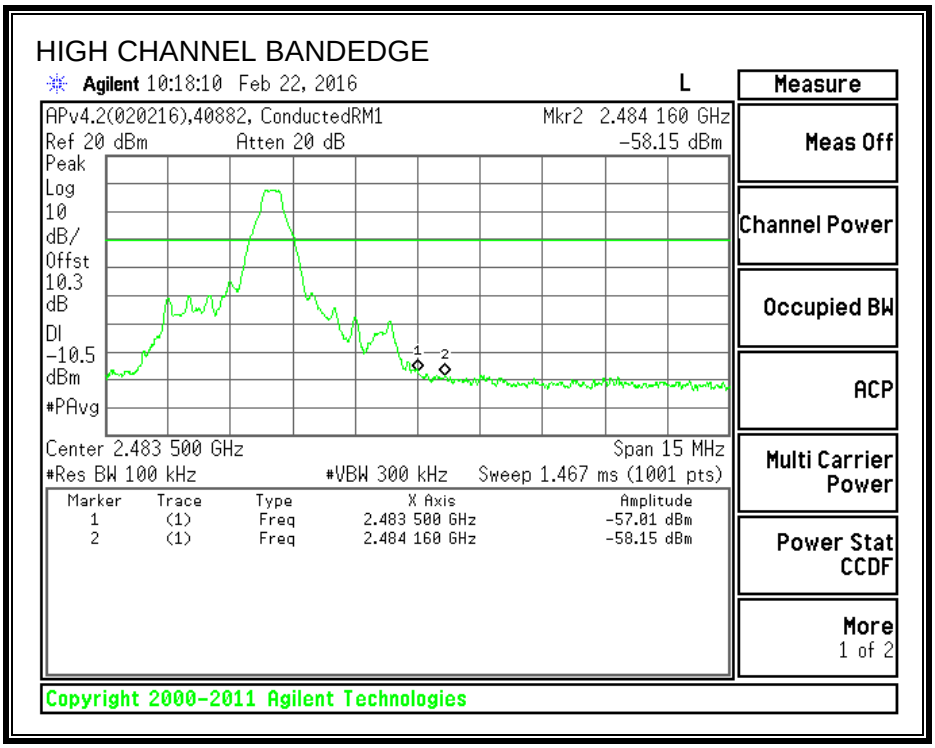


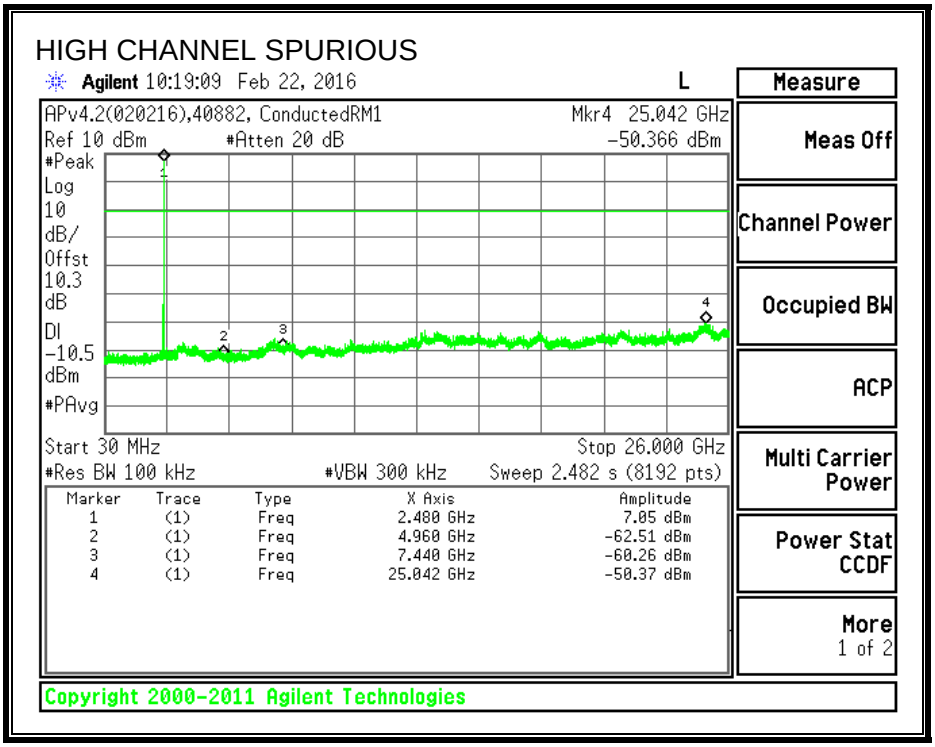
SPURIOUS EMISSIONS, MID CHANNEL



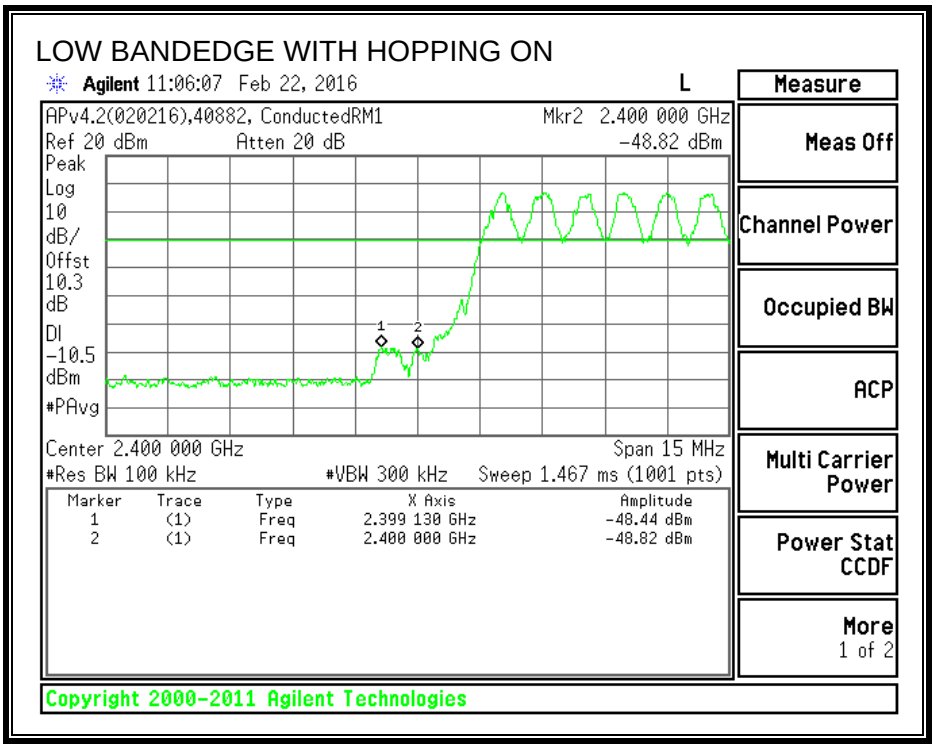


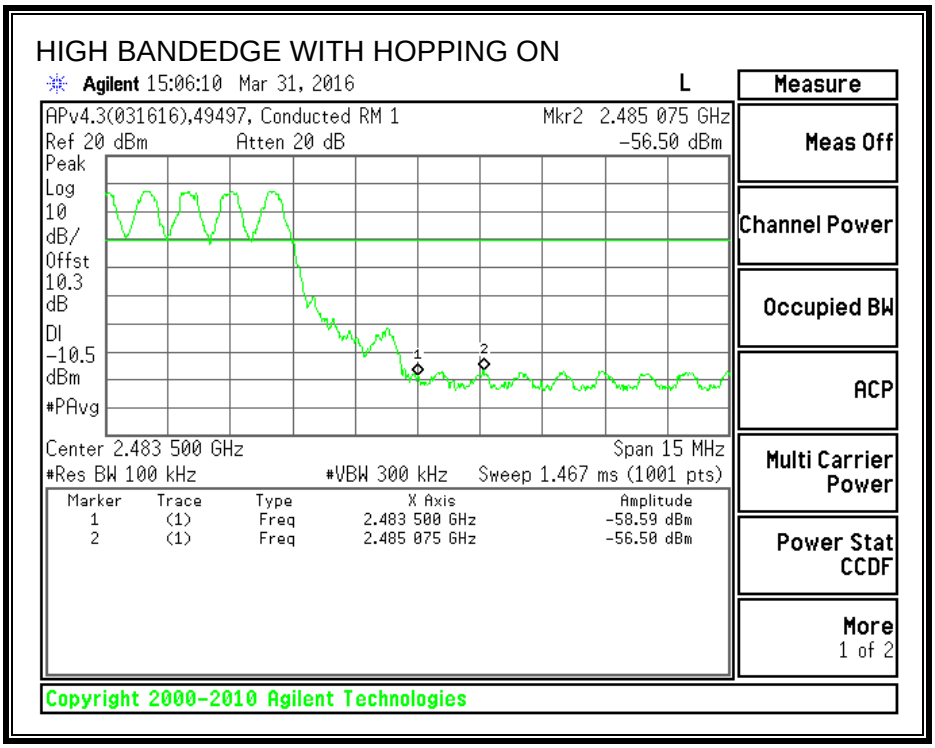
SPURIOUS EMISSIONS, HIGH CHANNEL





SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON





7.3. ENHANCED DATA RATE QPSK MODULATION

7.3.1. 20 dB AND 99% BANDWIDTH

LIMIT

None; for reporting purposes only.

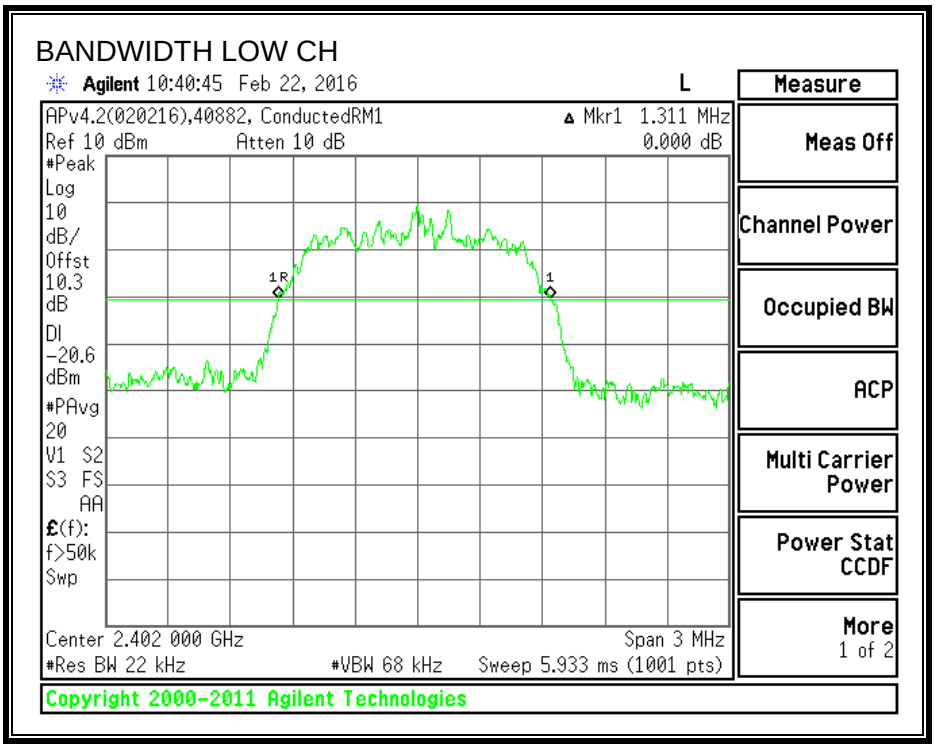
TEST PROCEDURE

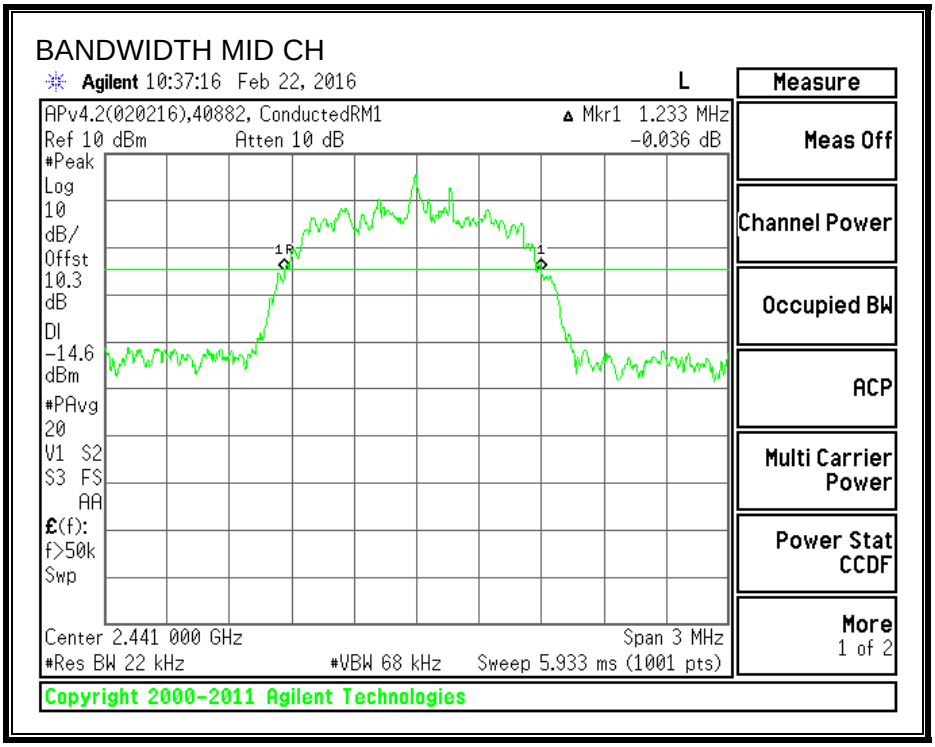
The transmitter output is connected to a spectrum analyzer. The RBW is set to 1-5% of the 20 dB bandwidth and 99% Occupied Bandwidth. The VBW is set to ≥ RBW. The sweep time is coupled.

RESULTS

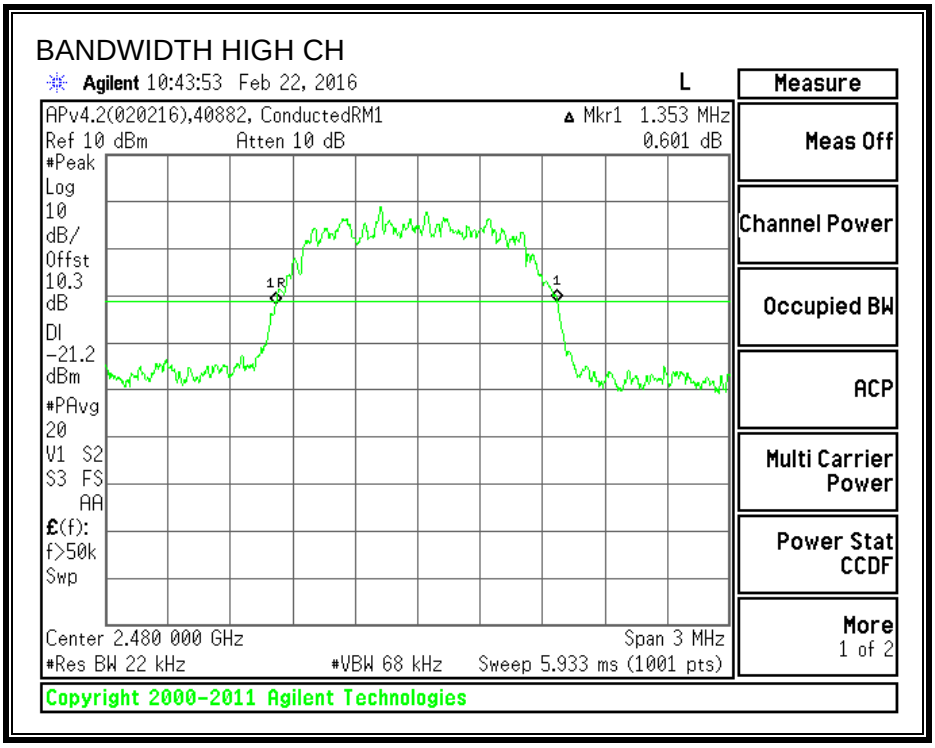
Channel	Frequency (MHz)	20 dB Bandwidth (kHz)	99% Bandwidth (kHz)
Low	2402	1311	1199.9
Middle	2441	1233	1213.1
High	2480	1353	1212.7

20 dB BANDWIDTH

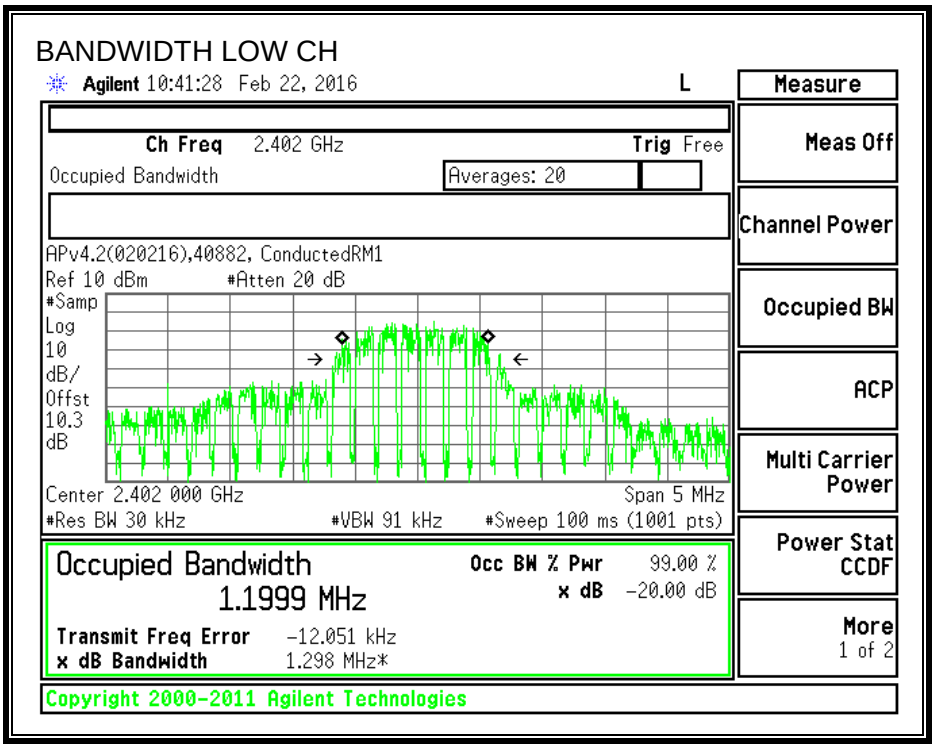


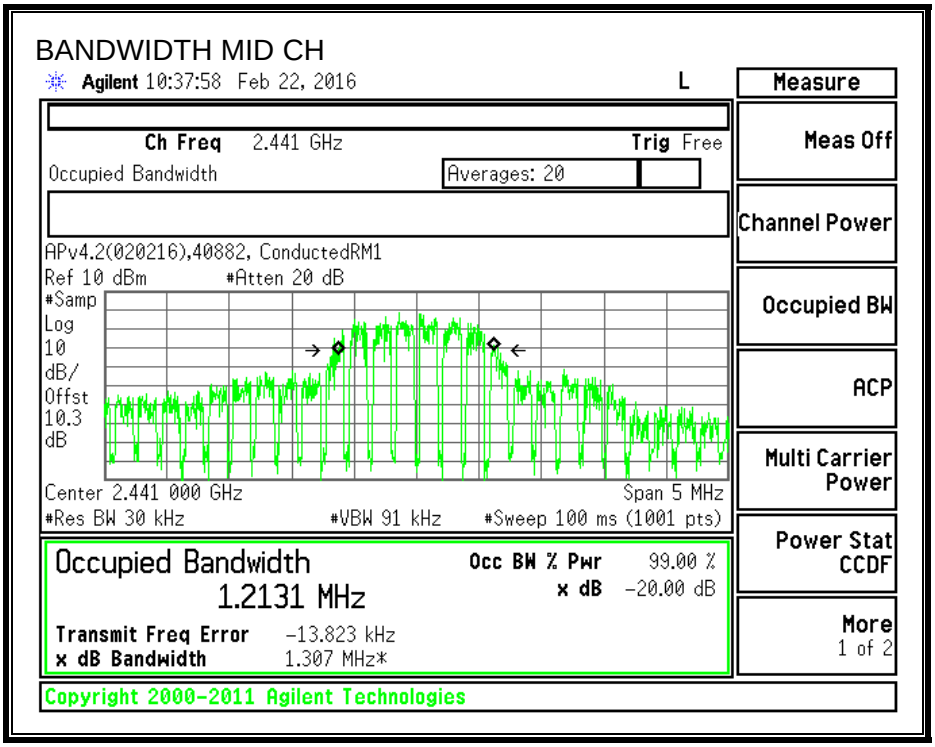


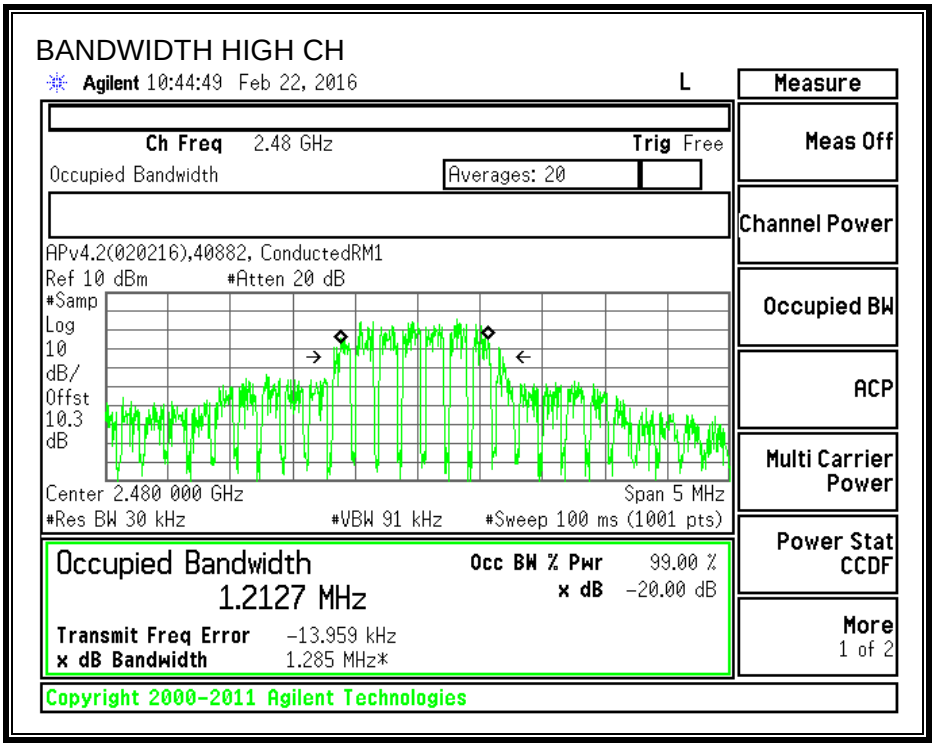
BANDWIDTH HIGH CH



99% BANDWIDTH







7.3.2. AVERAGE TIME OF OCCUPANCY

LIMIT

FCC §15.247 (a) (1) (iii)

IC RSS-247 5.1 (4)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan. The number of pulses is measured in a 3.16 second scan, to enable resolution of each occurrence.

The average time of occupancy in the specified 31.6 second period (79 channels * 0.4 s) is equal to 10 * (# of pulses in 3.16 s) * pulse width.

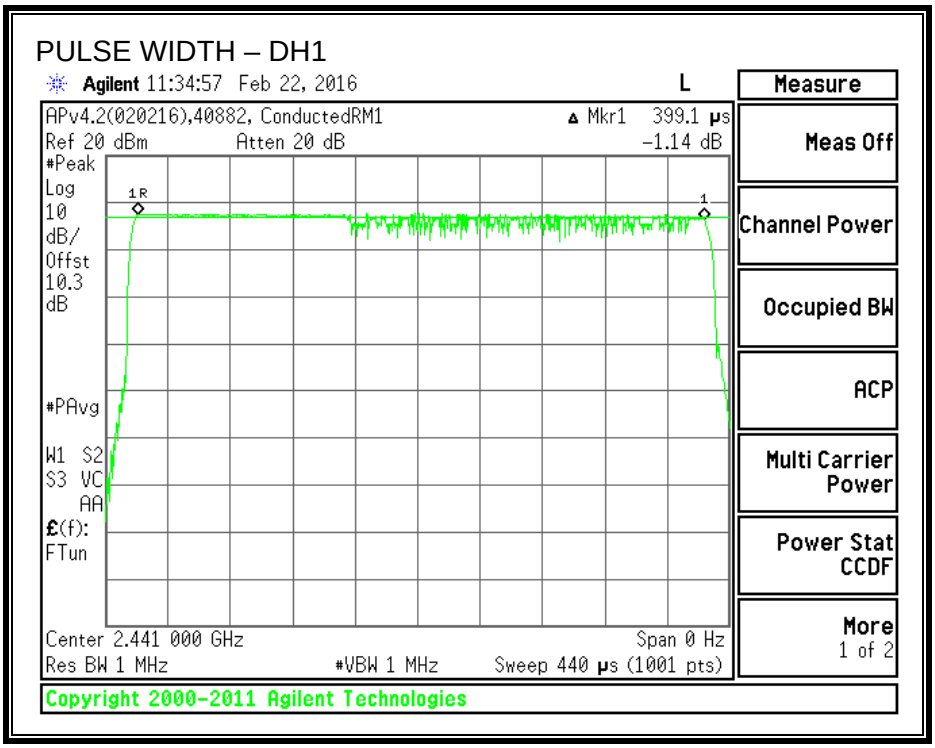
RESULTS

DQPSK Mode

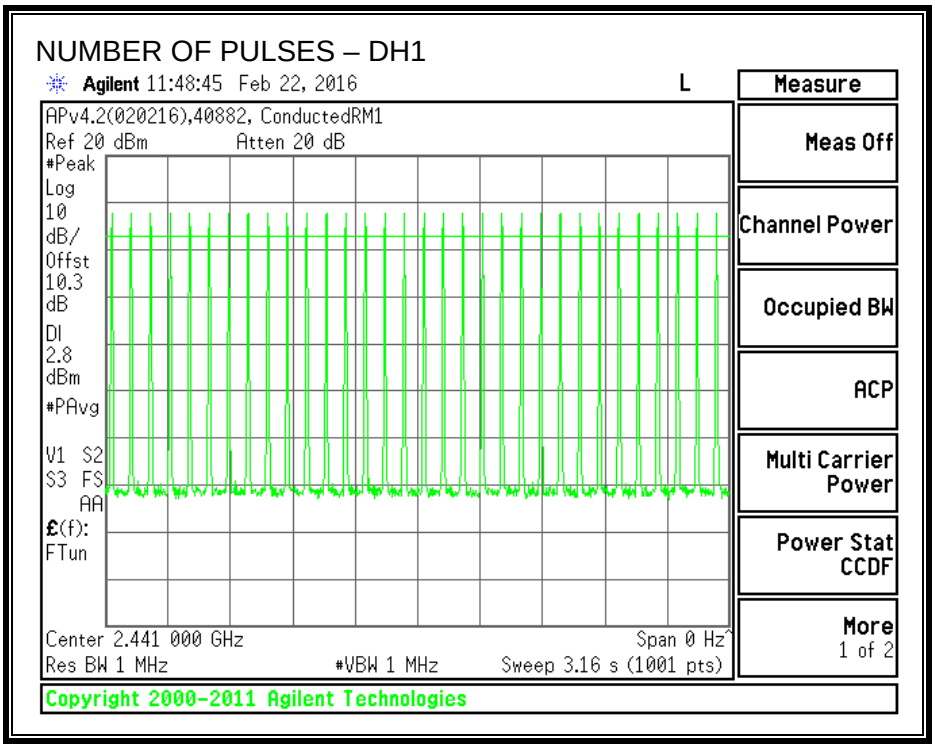
DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of (sec)	Limit (sec)	Margin (sec)
DH1	0.399	32	0.128	0.4	-0.272
DH3	1.651	16	0.264	0.4	-0.136
DH5	2.886	11	0.317	0.4	-0.083

Note: for AFH (DQPSK) mode, please refer to the results of AFH (GFSK) mode; the channel selection and hopping rate are the same for both EDR and Basic Rate operation, data for Basic Rate on page 31 demonstrates compliance with channel occupancy when AFH is employed.

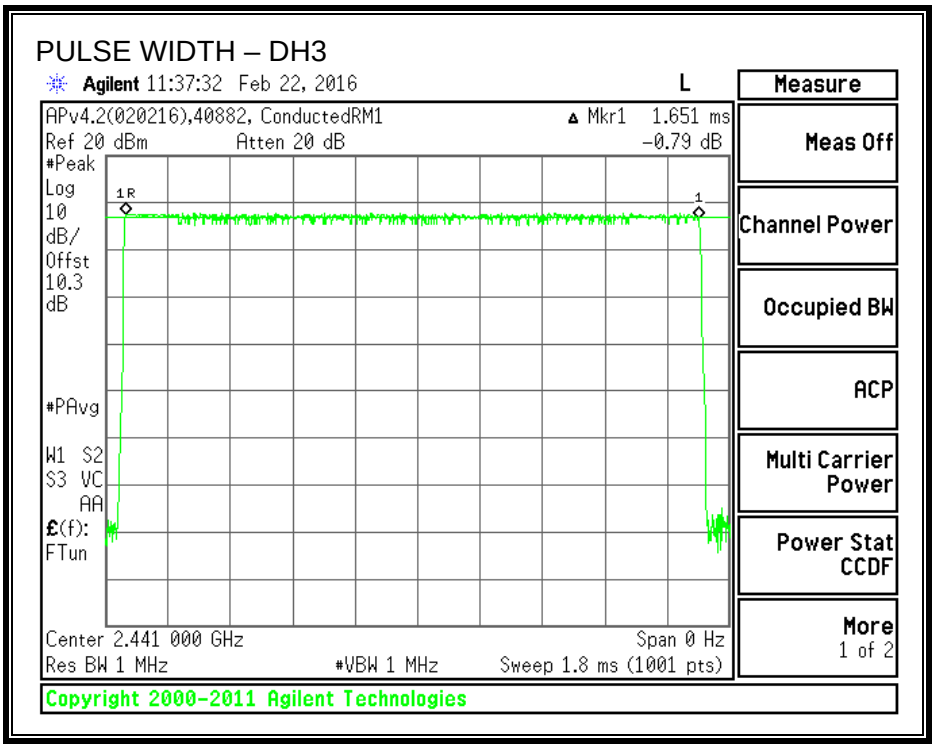
PULSE WIDTH - DH1



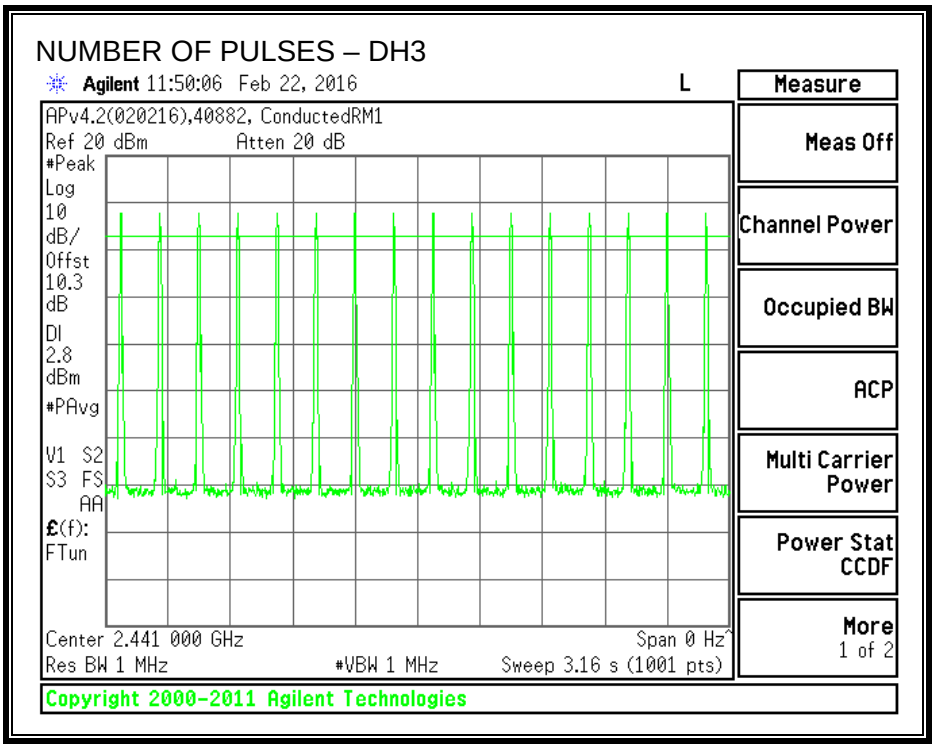
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1



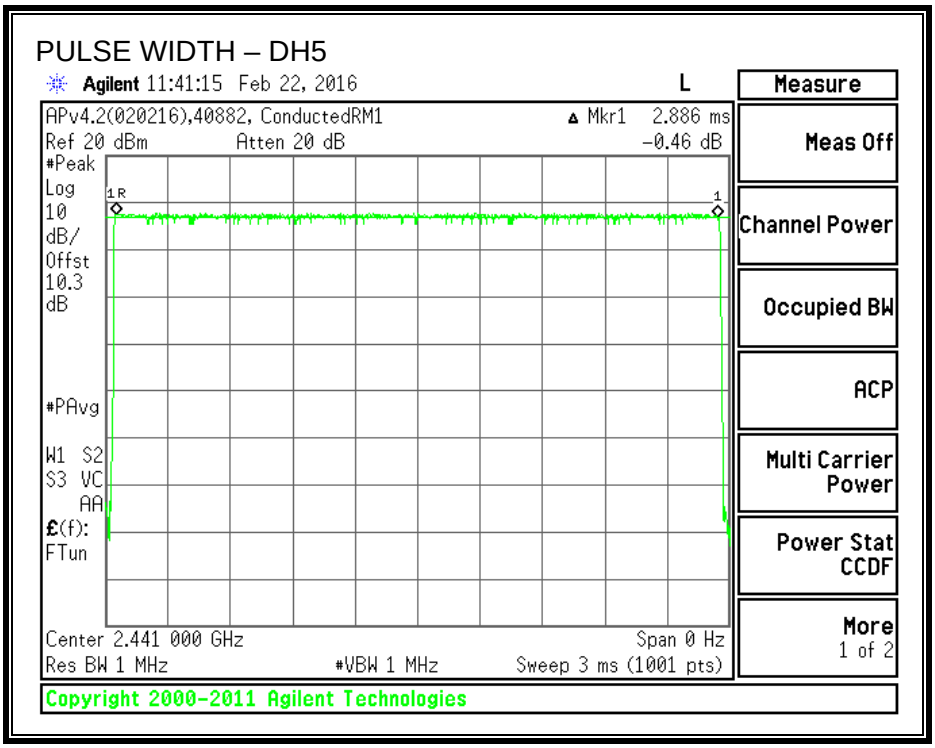
PULSE WIDTH – DH3



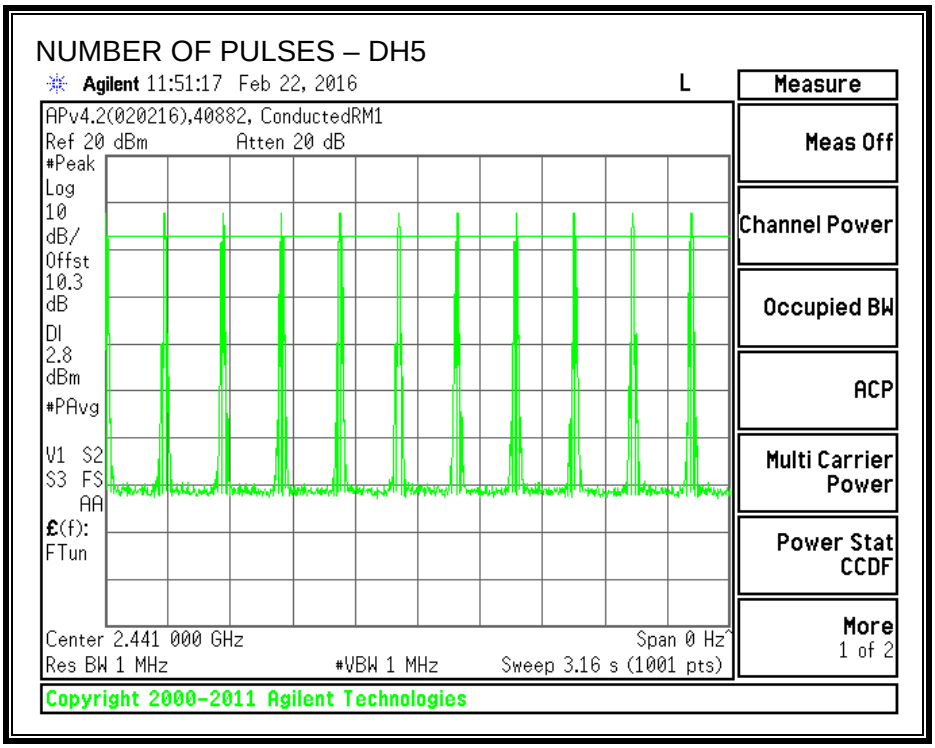
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3



PULSE WIDTH – DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5



7.3.3. OUTPUT POWER

LIMIT

§15.247 (b) (1)

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

RSS-247 5.1 (2)

For frequency hopping systems operating in the band 2400-2483.5 MHz and employing at least 75 hopping channels, the maximum peak conducted output power shall not exceed 1 W; for all other frequency hopping systems in the band, the maximum peak conducted output power shall not exceed 0.125 W.

TEST PROCEDURE

The transmitter output was connected to a power meter equipped with a power sensor capable of measuring peak power. The cable assembly insertion loss of 10.294 dB (including 10 dB pad and 0.294 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

RESULTS

For DQPSK mode, the channel separation was limited to 2/3 the 20 dB bandwidth. Therefore, the output power was limited to 125 mW. This was based on the channel separation measurements for the 8PSK mode.

Channel	Frequency (MHz)	Output Power (dBm)	Directional Gain (dBi)	Limit (dBm)	Margin (dB)
Low	2402	4.92	0.60	21	-16.08
Middle	2441	8.10	0.60	21	-12.90
High	2480	6.22	0.60	21	-14.78

7.3.4. AVERAGE POWER

LIMIT

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter and a gated average power measurement was performed. The cable assembly insertion loss of 10.294 dB (including 10 dB pad and 0.294 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

RESULTS

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	2.56
Middle	2441	5.92
High	2480	4.10

7.4. ENHANCED DATA RATE 8PSK MODULATION

7.4.1. 20 dB AND 99% BANDWIDTH

LIMIT

None; for reporting purposes only.

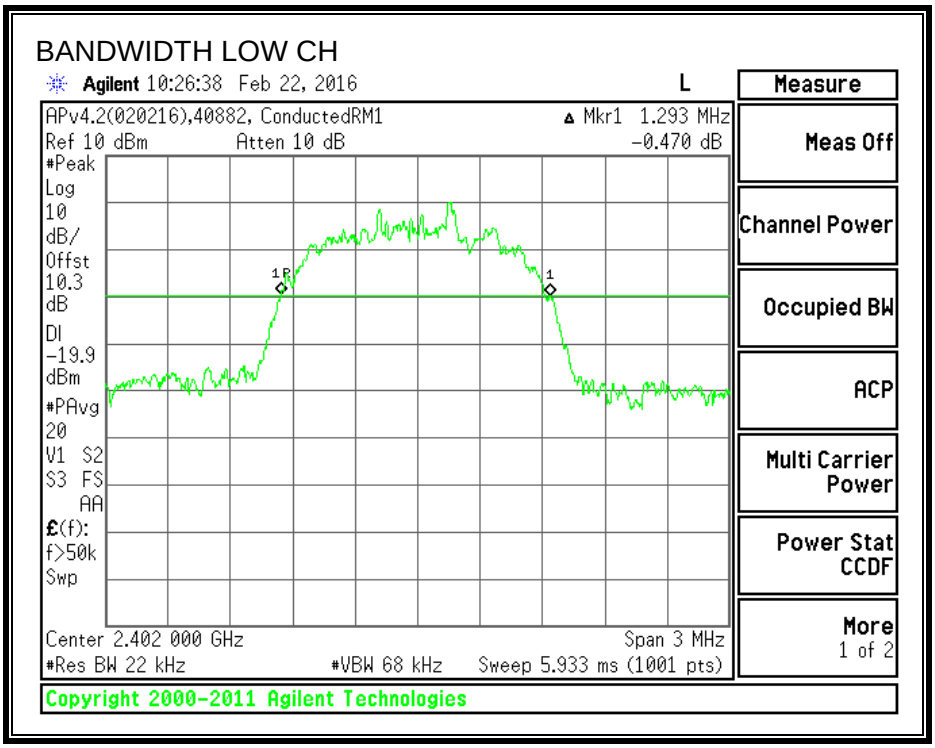
TEST PROCEDURE

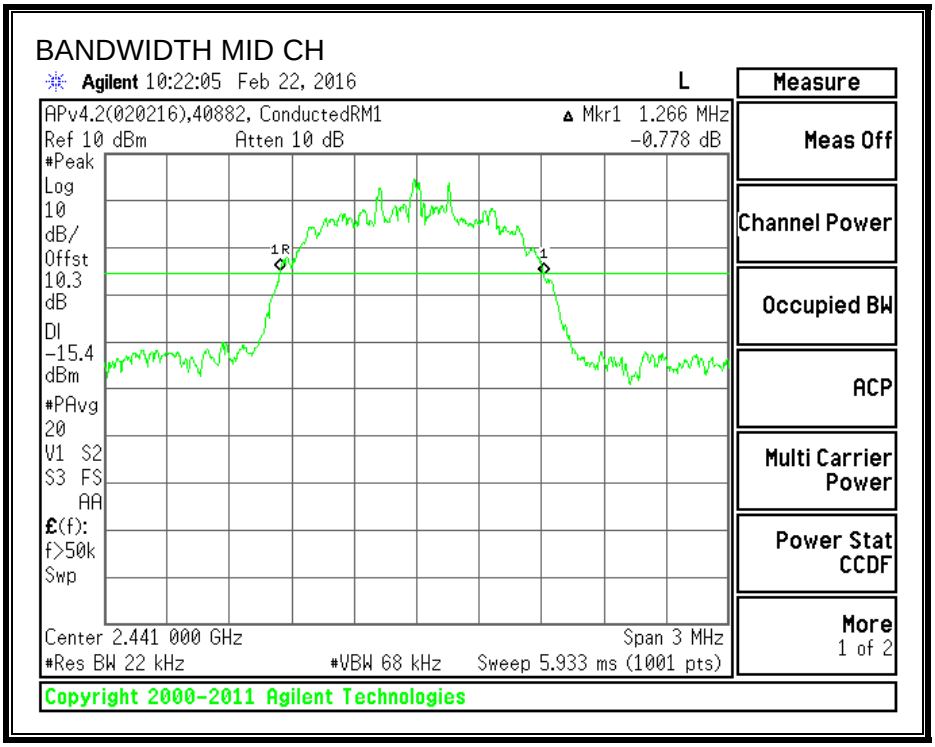
The transmitter output is connected to a spectrum analyzer. The RBW is set to 1-5% of the 20 dB bandwidth and 99% Occupied Bandwidth. The VBW is set to ≥ RBW. The sweep time is coupled.

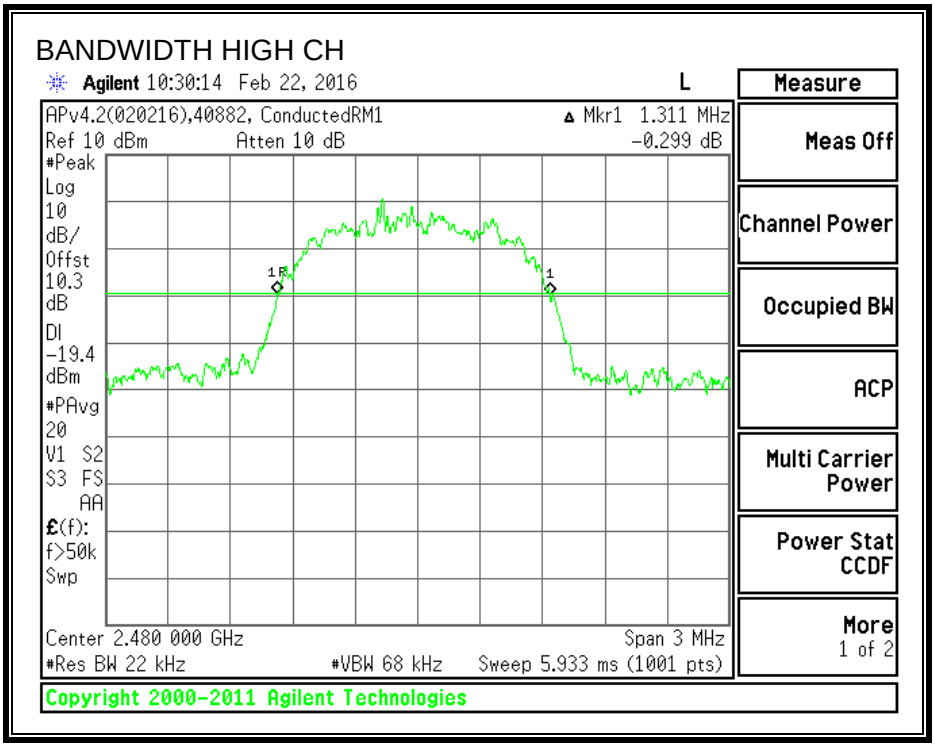
RESULTS

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)	99% Bandwidth (kHz)
Low	2402	1293	1211.1
Middle	2441	1266	1214.5
High	2480	1311	1216

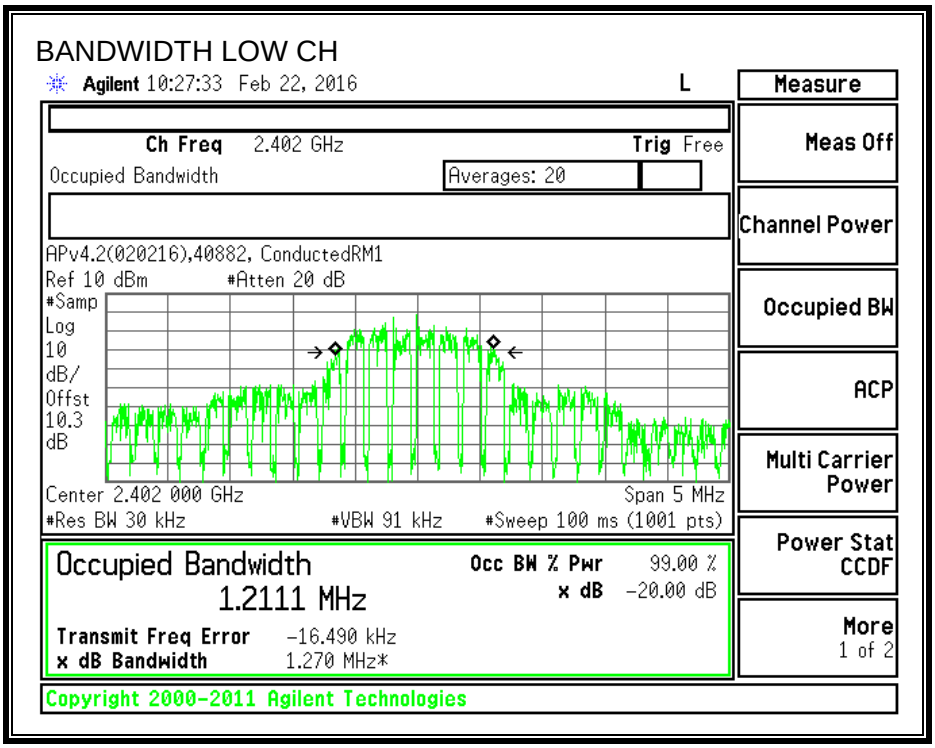
20 dB BANDWIDTH

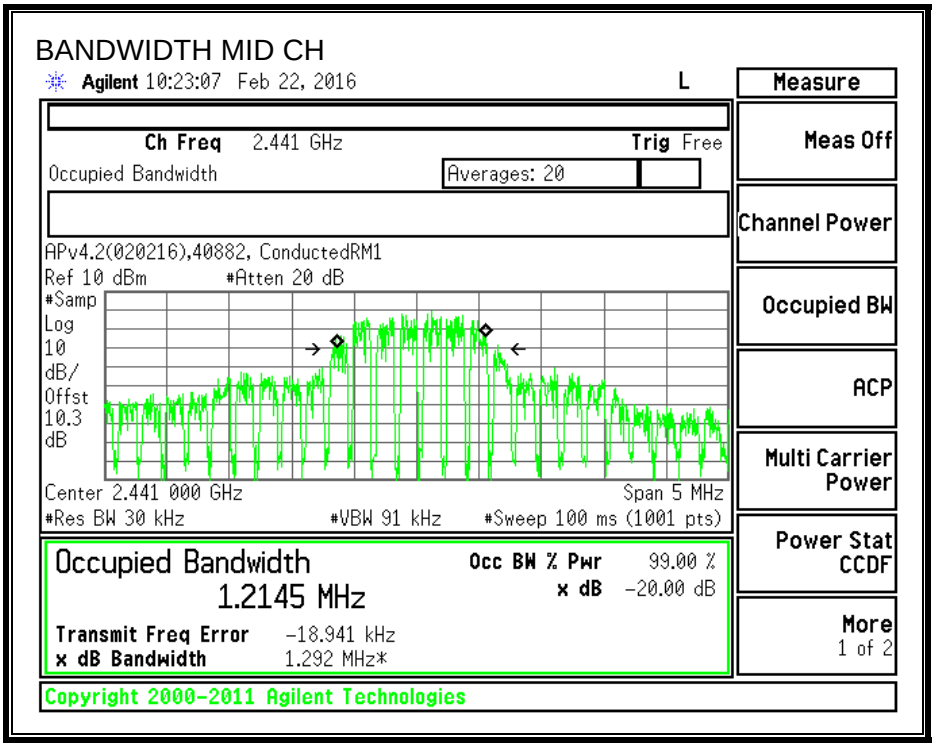


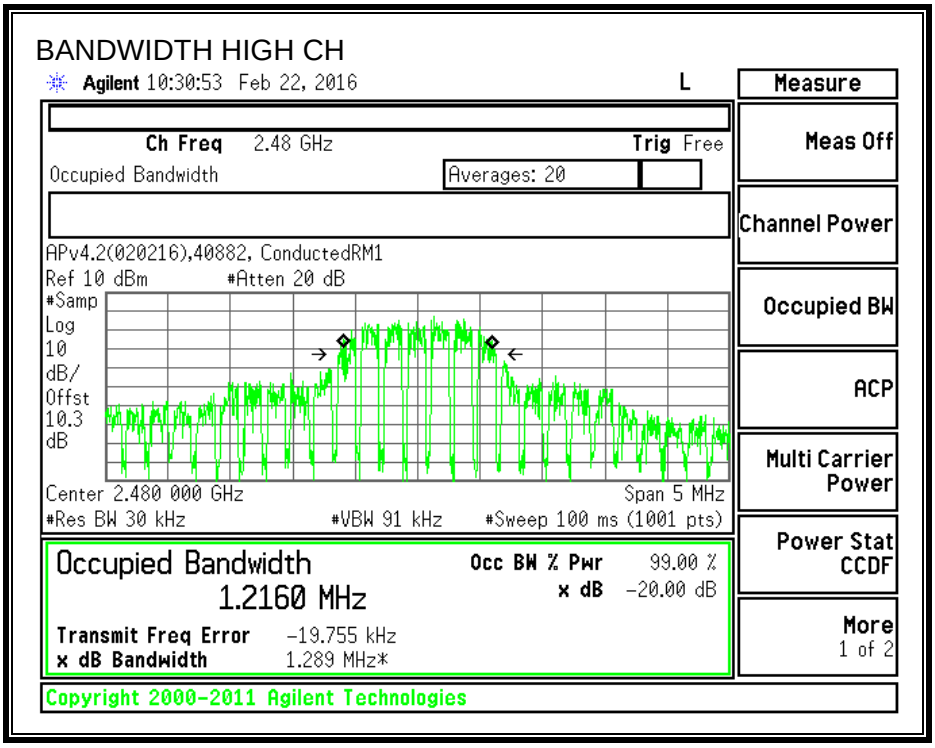




99% BANDWIDTH







7.4.2. HOPPING FREQUENCY SEPARATION

LIMIT

FCC §15.247 (a) (1)

IC RSS-247 5.1 (2)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hoping channel, whichever is greater.

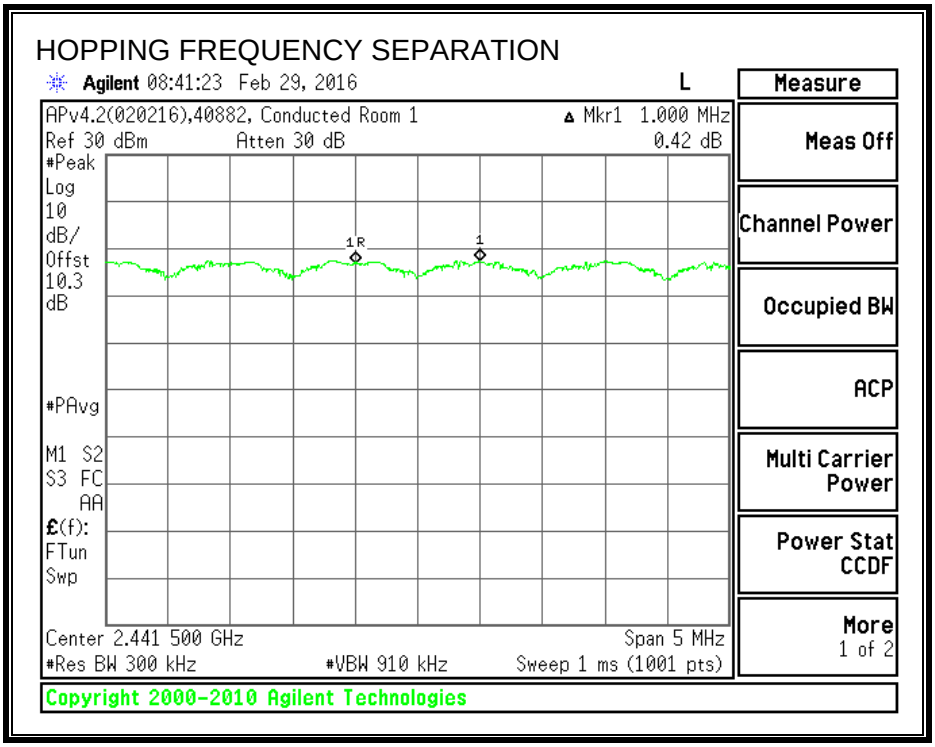
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The RBW is set to 300 kHz and the VBW is set to ≥ RBW. The sweep time is coupled.

RESULTS

HOPPING FREQUENCY SEPARATION



Note – The channel hopping separation of 1MHz is less than the 20 dB bandwidth (approx. 1.3 MHz). However, the output power is less than 125 mW and the channel separation is greater than 2/3 the 20 dB bandwidth (approx. 875 kHz).

7.4.3. NUMBER OF HOPPING CHANNELS

LIMIT

FCC §15.247 (a) (1) (iii)

IC RSS-247 5.1 (4)

Frequency hopping systems in the 2400 – 2483.5 MHz band shall use at least 15 non-overlapping channels.

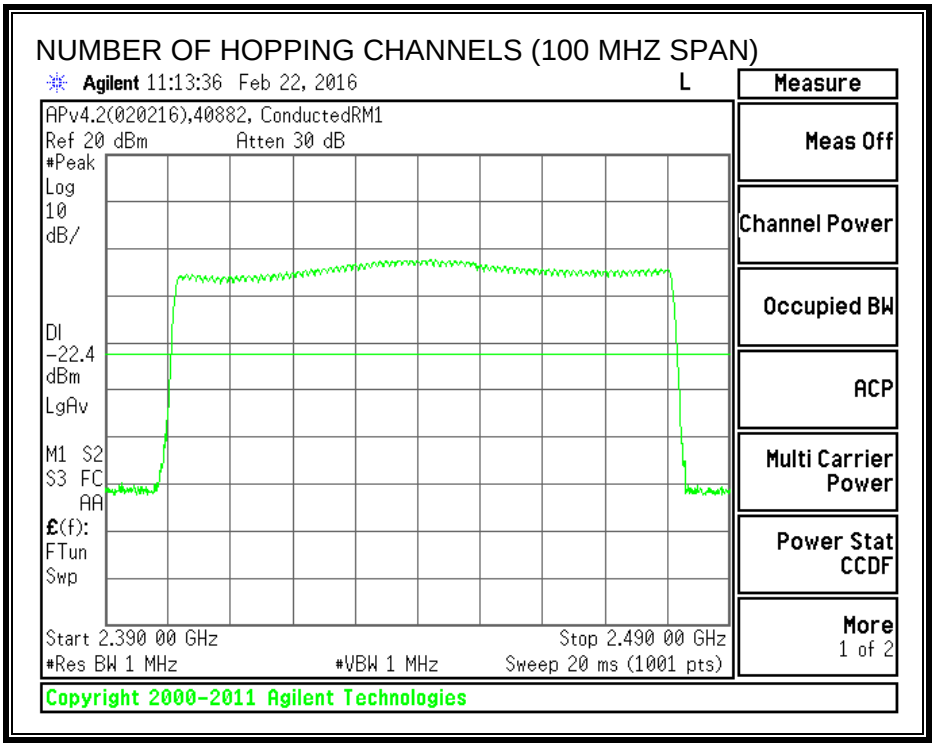
TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps for visibility of the entire span. Then, smaller spans are set to more clearly identify the channels. The RBW is set to 30% of the channel spacing (approx. 300 kHz). The analyzer is set to Max Hold.
.

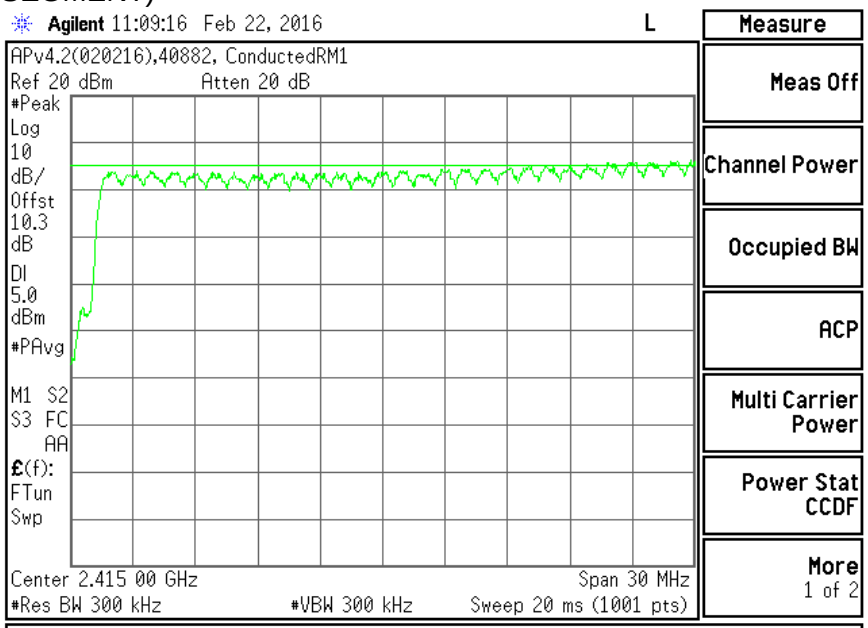
RESULTS

Normal Mode: 79 Channels observed.
AFH Mode: min of 20 Channels declared.

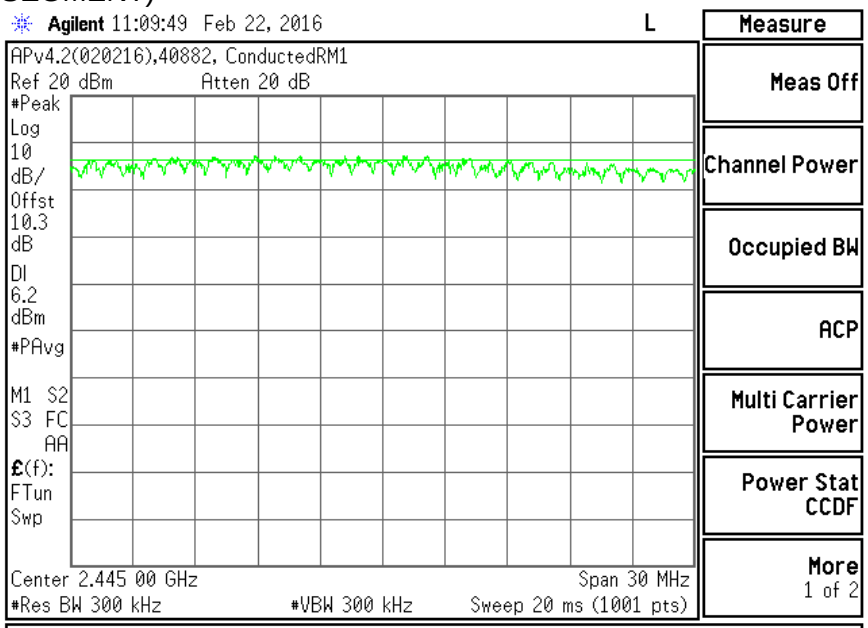
NUMBER OF HOPPING CHANNELS



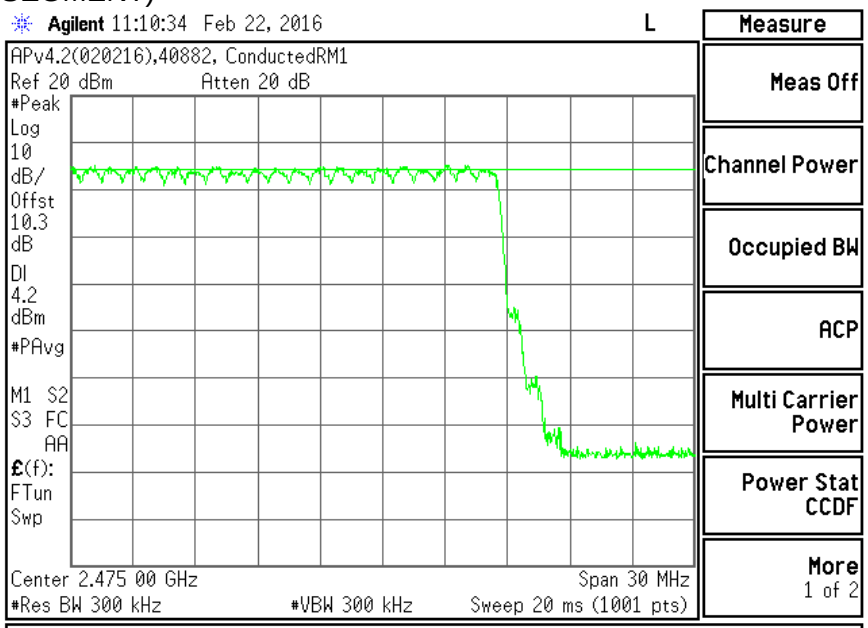
NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, FIRST SEGMENT)



NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, SECOND SEGMENT)



NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, THIRD SEGMENT)



7.4.4. AVERAGE TIME OF OCCUPANCY

LIMIT

FCC §15.247 (a) (1) (iii)

IC RSS-247 5.1 (4)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan. The number of pulses is measured in a 3.16 second scan, to enable resolution of each occurrence.

The average time of occupancy in the specified 31.6 second period (79 channels * 0.4 s) is equal to 10 * (# of pulses in 3.16 s) * pulse width.

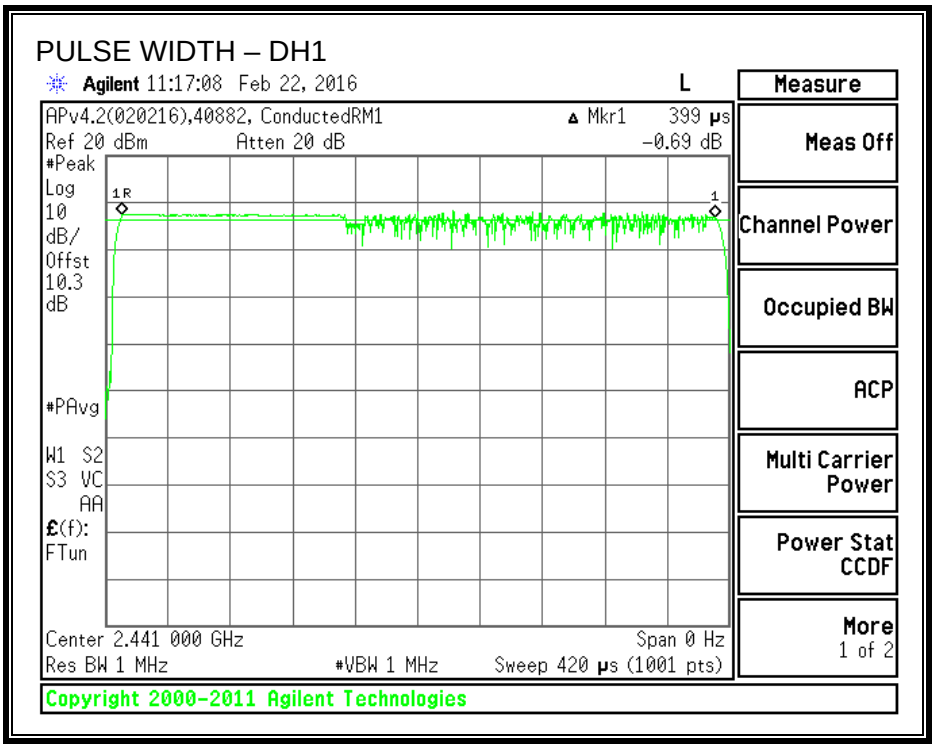
RESULTS

8PSK (EDR) Mode

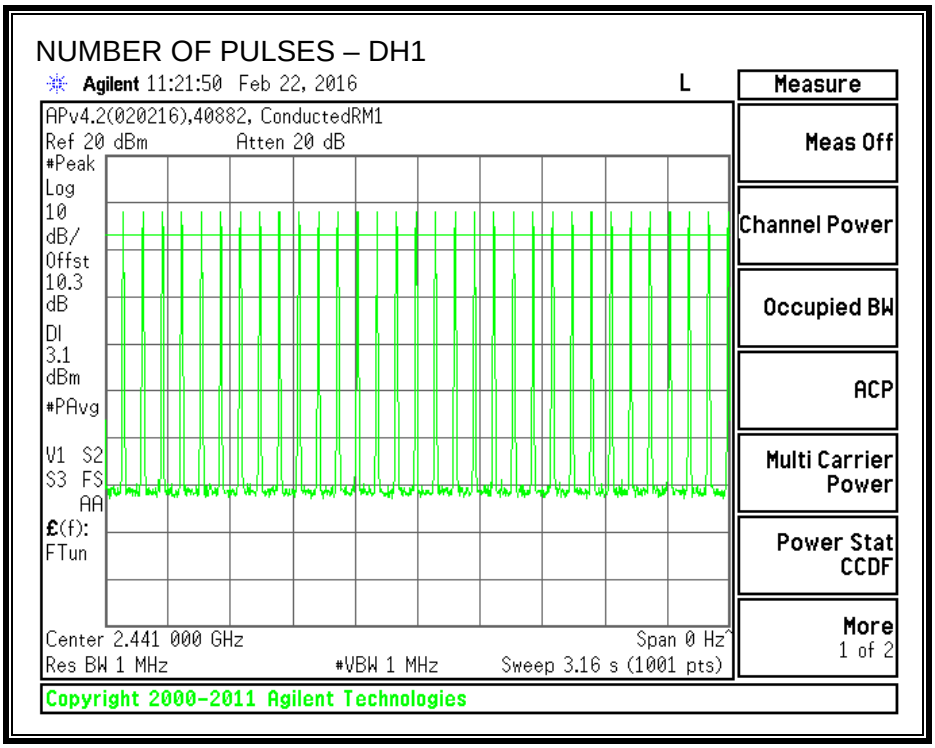
DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of (sec)	Limit (sec)	Margin (sec)
DH1	0.399	32	0.128	0.4	-0.272
DH3	1.641	16	0.263	0.4	-0.137
DH5	2.898	11	0.319	0.4	-0.081

Note: for AFH (8PSK) mode, please refer to the results of AFH (GFSK) mode; the channel selection and hopping rate are the same for both EDR and Basic Rate operation, data for Basic Rate on page 31 demonstrates compliance with channel occupancy when AFH is employed.

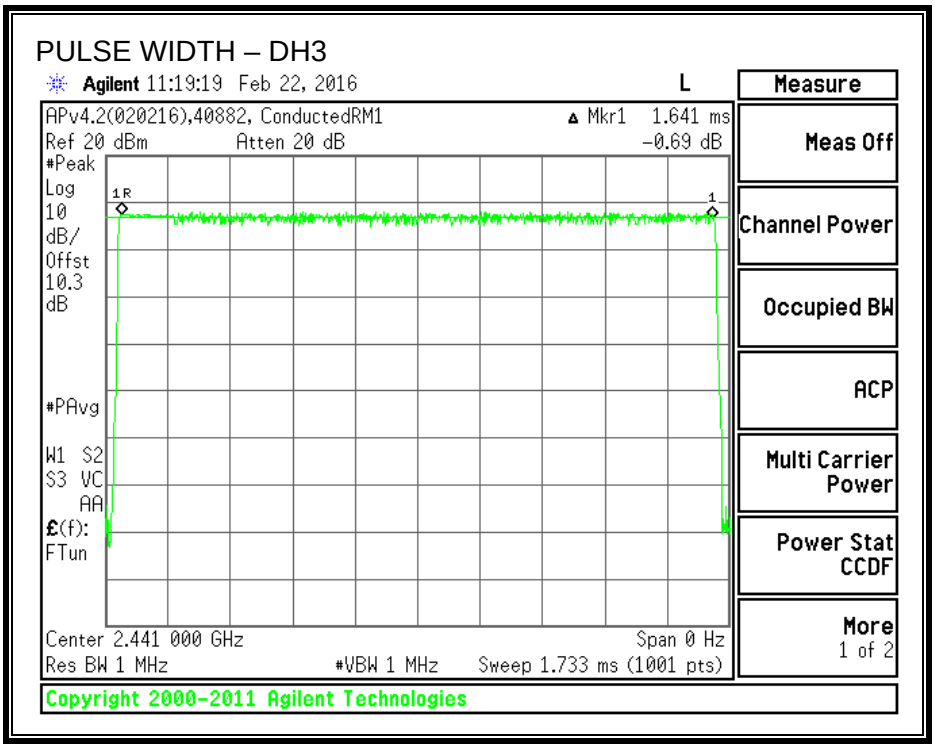
PULSE WIDTH - DH1



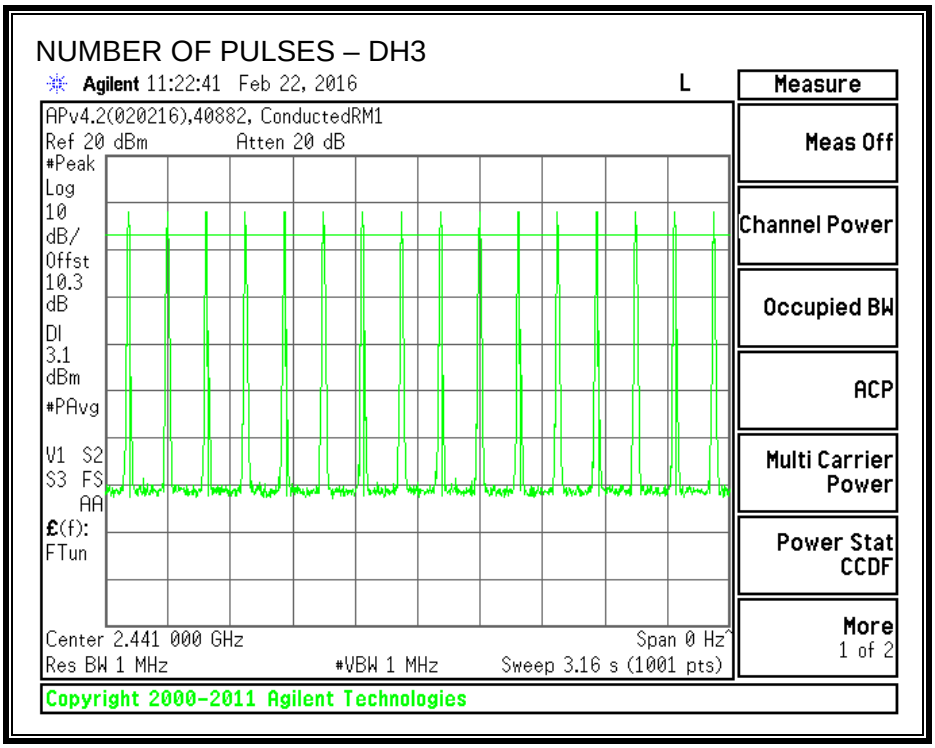
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1



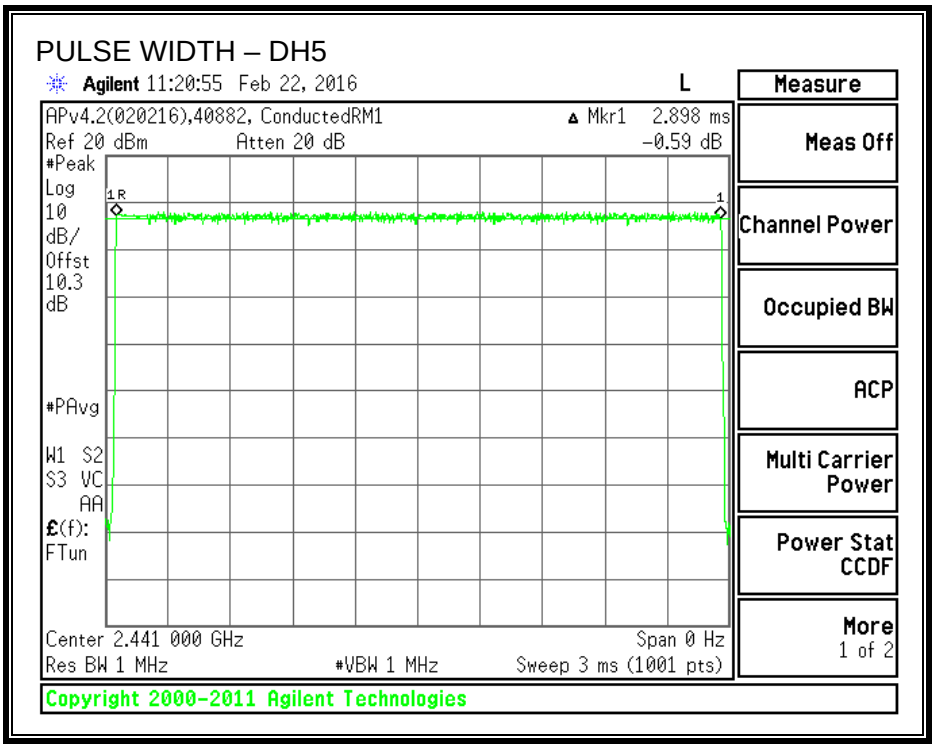
PULSE WIDTH – DH3



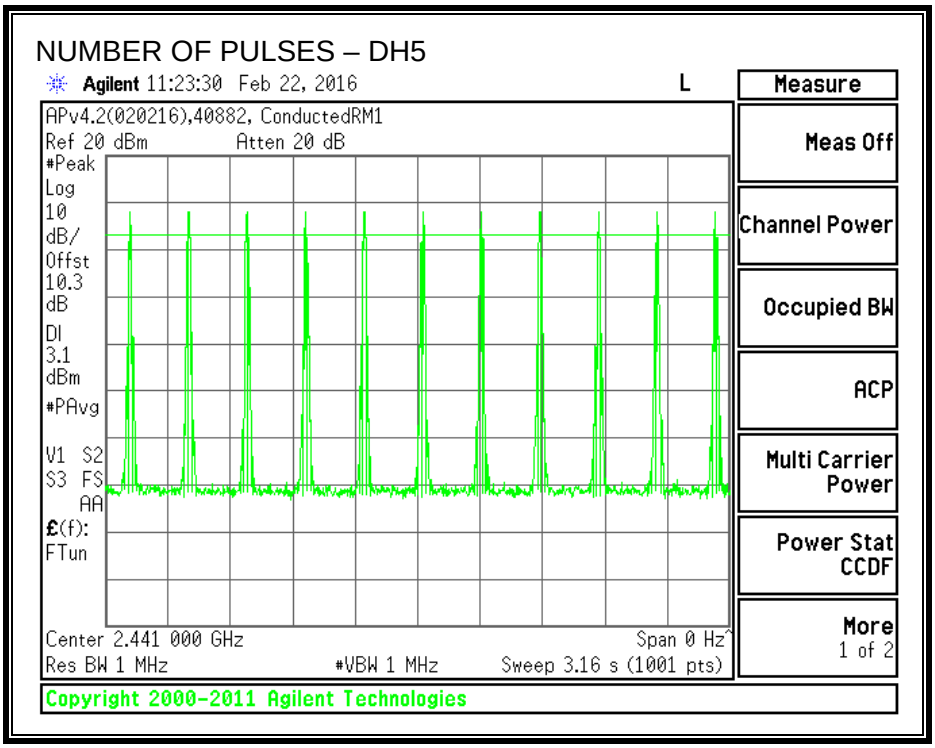
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3



PULSE WIDTH – DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5



7.4.5. OUTPUT POWER

LIMIT

§15.247 (b) (1)

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

RSS-247 5.1 (2)

For frequency hopping systems operating in the band 2400-2483.5 MHz and employing at least 75 hopping channels, the maximum peak conducted output power shall not exceed 1 W; for all other frequency hopping systems in the band, the maximum peak conducted output power shall not exceed 0.125 W.

TEST PROCEDURE

The transmitter output was connected to a power meter equipped with a power sensor capable of measuring peak power. The cable assembly insertion loss of 10.294 dB (including 10 dB pad and 0.294 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

RESULTS

For 8PSK mode, the channel separation was limited to 2/3 the 20 dB bandwidth. Therefore, the output power was limited to 125 mW.

Channel	Frequency (MHz)	Output Power (dBm)	Directional Gain (dBi)	Limit (dBm)	Margin (dB)
Low	2402	5.20	0.60	21	-15.80
Middle	2441	8.30	0.60	21	-12.70
High	2480	6.56	0.60	21	-14.44

7.4.6. AVERAGE POWER

LIMIT

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter and a gated average power measurement was performed. The cable assembly insertion loss of 10.294 dB (including 10 dB pad and 0.294 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

RESULTS

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	2.46
Middle	2441	5.86
High	2480	4.06

7.4.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

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)).

IC RSS-247 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section A8.4 (4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

TEST PROCEDURE

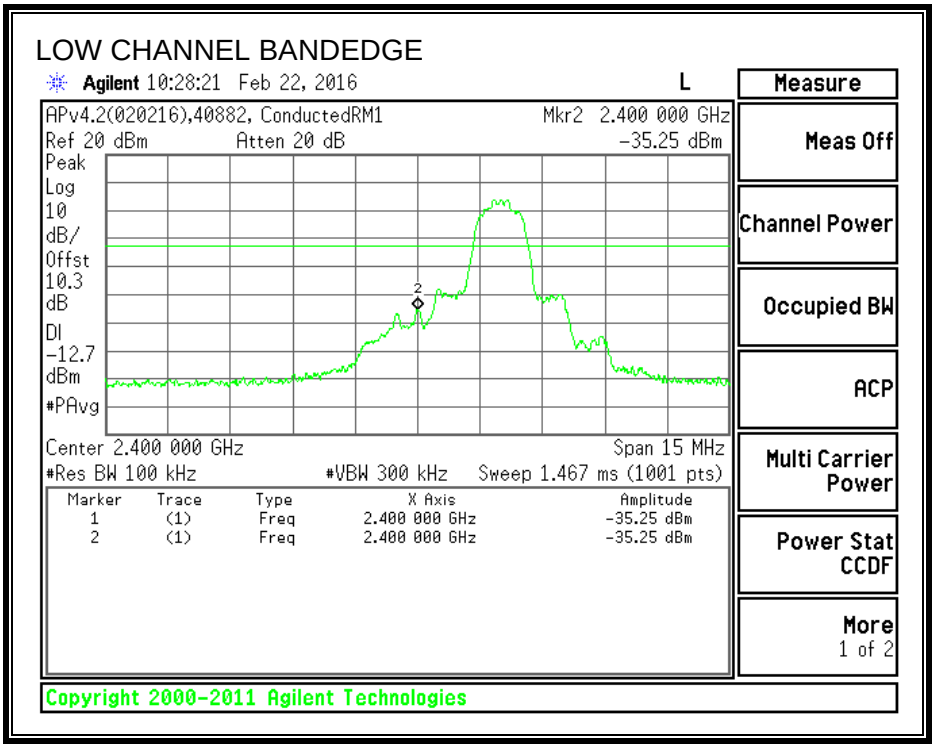
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

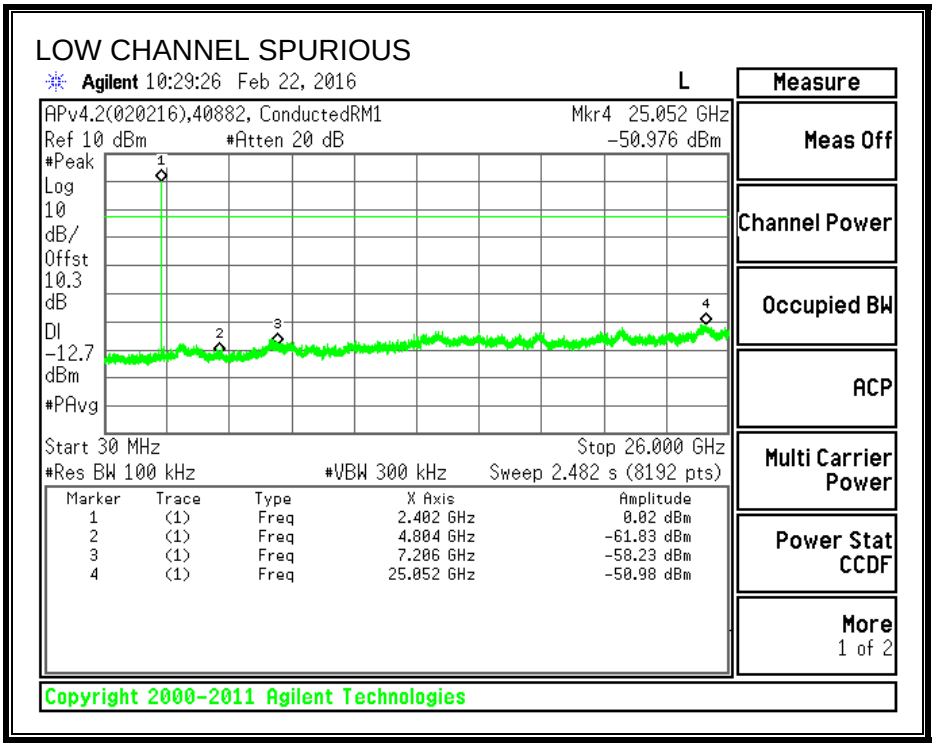
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

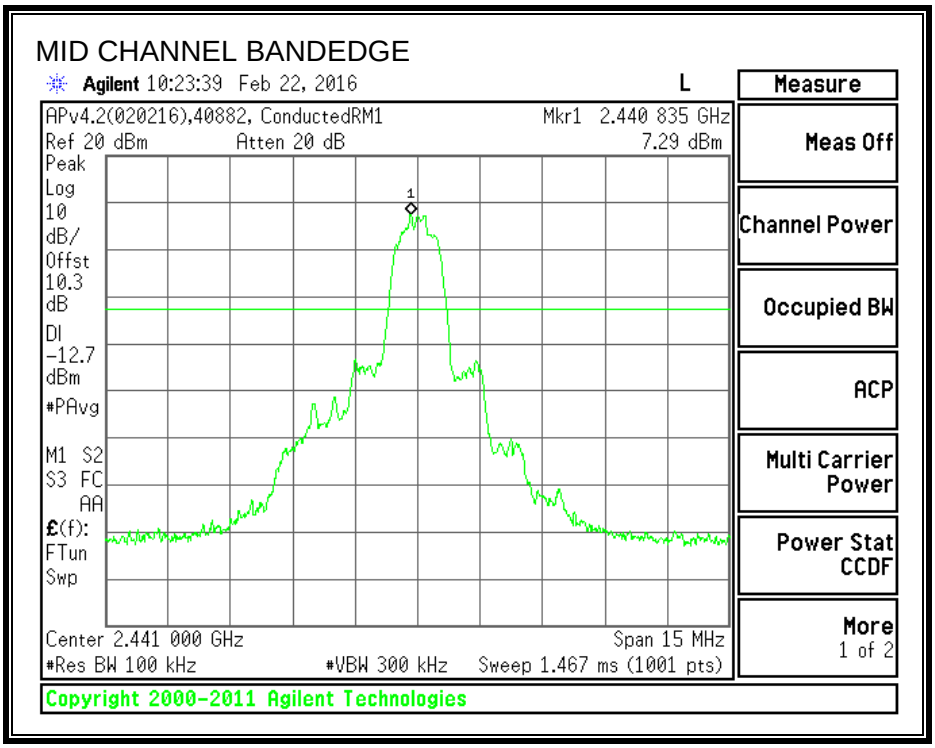
RESULTS

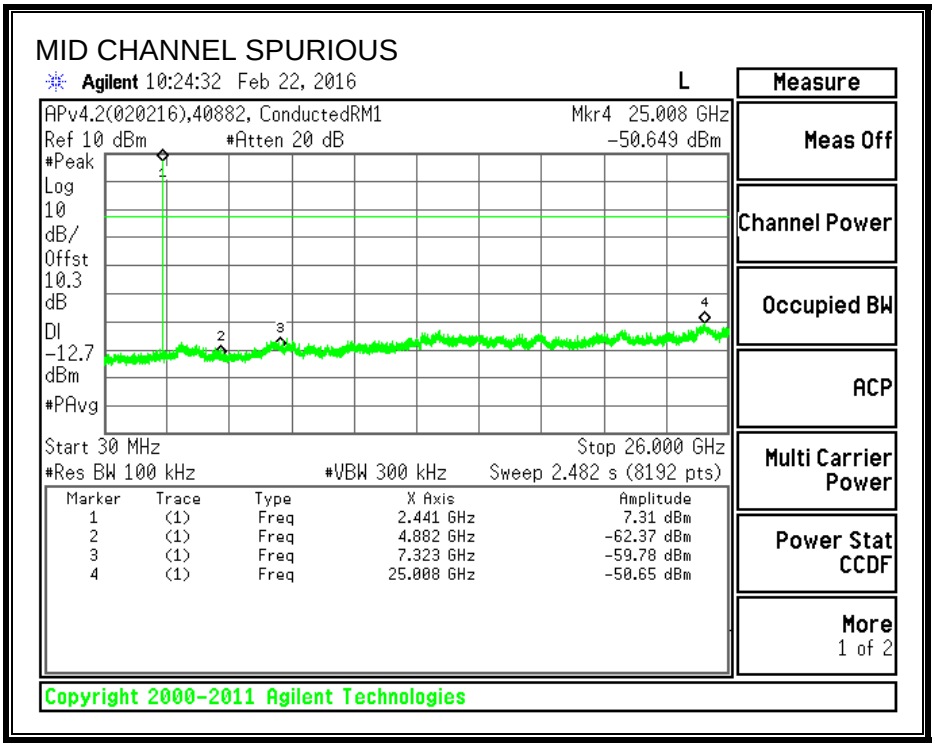
SPURIOUS EMISSIONS, LOW CHANNEL



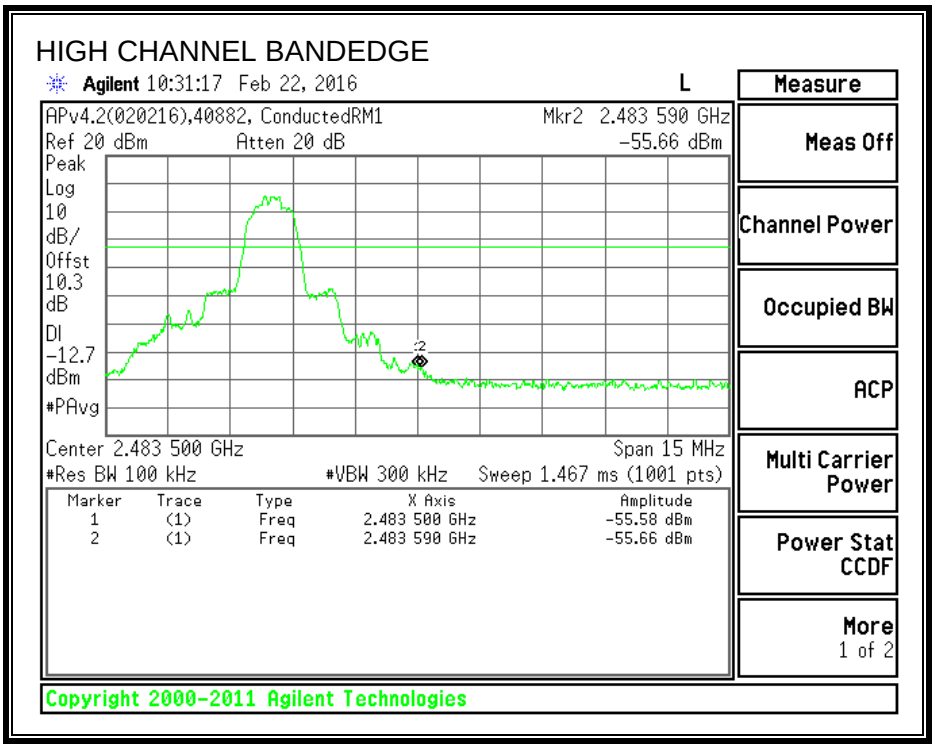


SPURIOUS EMISSIONS, MID CHANNEL

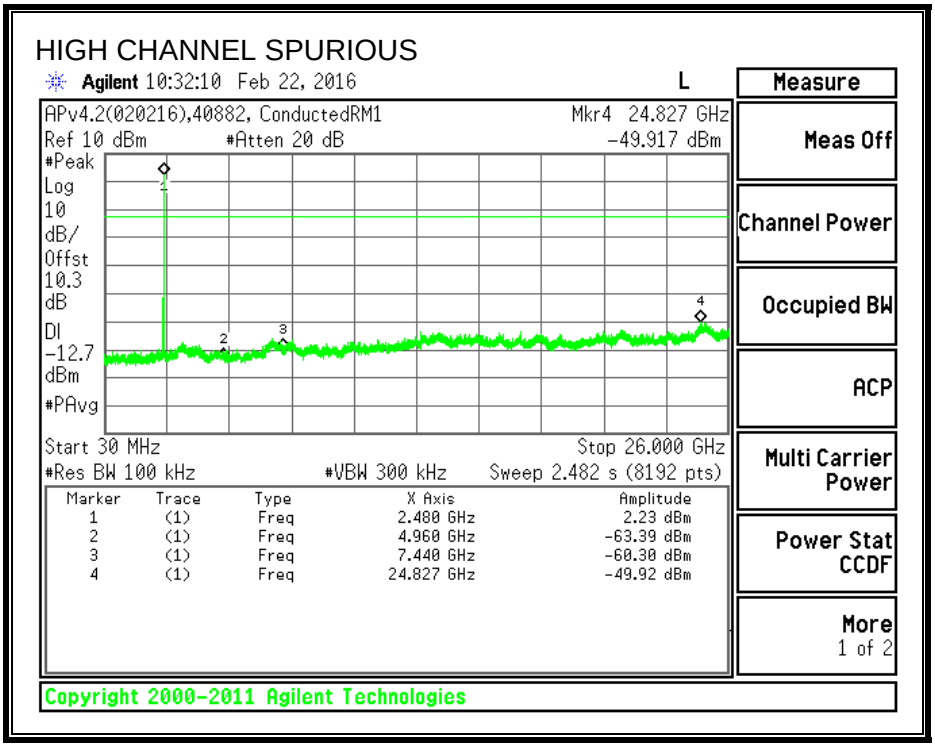




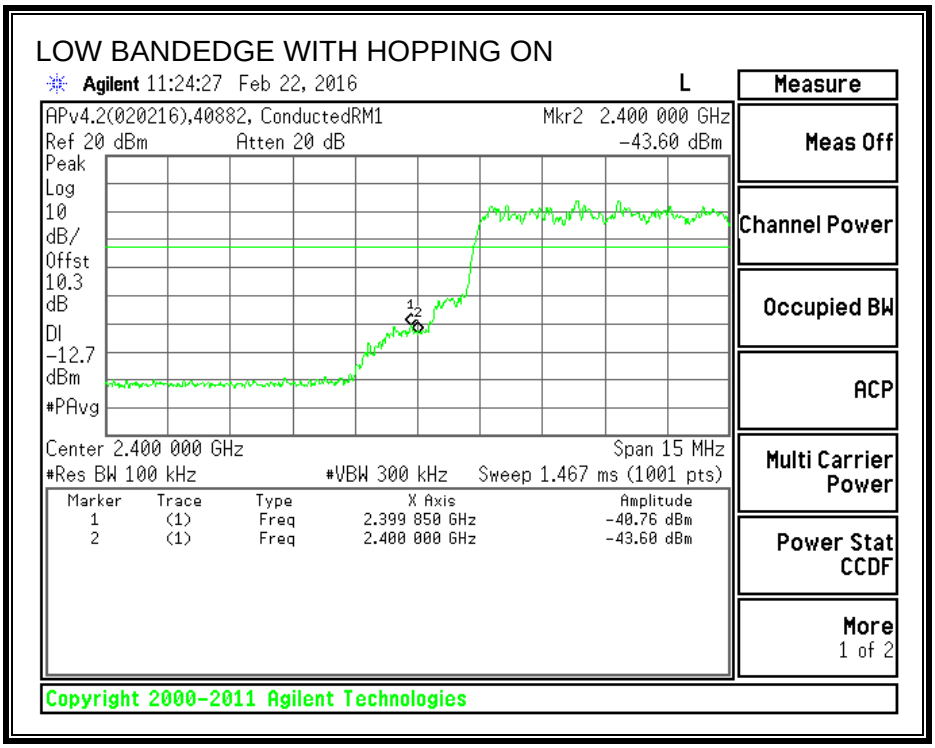
SPURIOUS EMISSIONS, HIGH CHANNEL

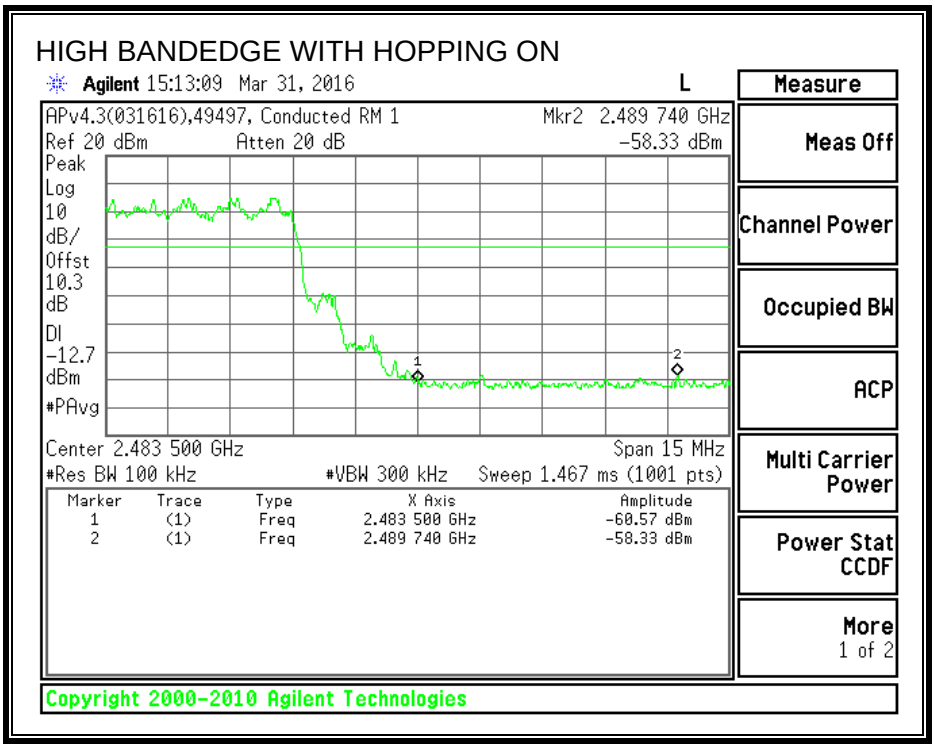


HIGH CHANNEL SPURIOUS



SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON





8. RADIATED TEST RESULTS

8.1. LIMITS AND PROCEDURE

LIMITS

FCC §15.205 and §15.209

IC RSS-GEN Clause 8.9 (Transmitter)

IC RSS-GEN Clause 7.1.2 (Receiver)

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
0.009-0.490	2400/F(kHz) @ 300 m	-
0.490-1.705	24000/F(kHz) @ 30 m	-
1.705 - 30	30 @ 30m	-
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane for below 1GHz measurements and 1.5 m above the ground plane for above 1GHz measurements. The antenna to EUT distance is 3 meters.

For measurements below 1 GHz the resolution bandwidth is set to 120 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements for the 30-1000 MHz range, 9 kHz for peak detection measurements or 9 kHz for quasi-peak detection measurements for the 0.15-30 MHz range and 200 Hz for peak detection measurements or 200 Hz for quasi-peak detection measurements for the 9 to 150 kHz range. Peak detection is used unless otherwise noted as quasi-peak.

For peak measurements above 1 GHz, the resolution bandwidth is set to 1 MHz and the video bandwidth is set to 3 MHz. For average measurements above 1GHz, the resolution bandwidth and video bandwidth are set as described in ANSI C63.10:2013 for the applicable measurement. The particular averaging method used for this test program was by measuring using a Peak detector with the resolution bandwidth set to 1MHz and a reduced video bandwidth, based on $1/T_{on}$ where T_{on} is the transmit on time.

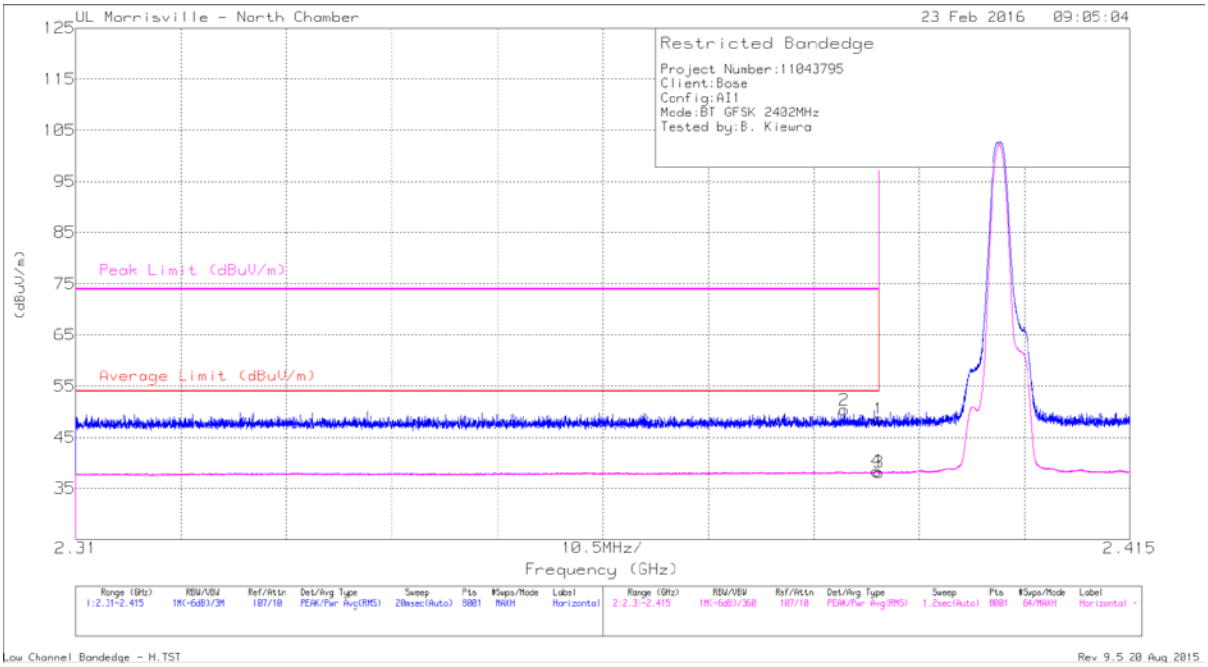
The spectrum from 9 kHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each applicable band.

The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

8.2. TRANSMITTER ABOVE 1 GHz

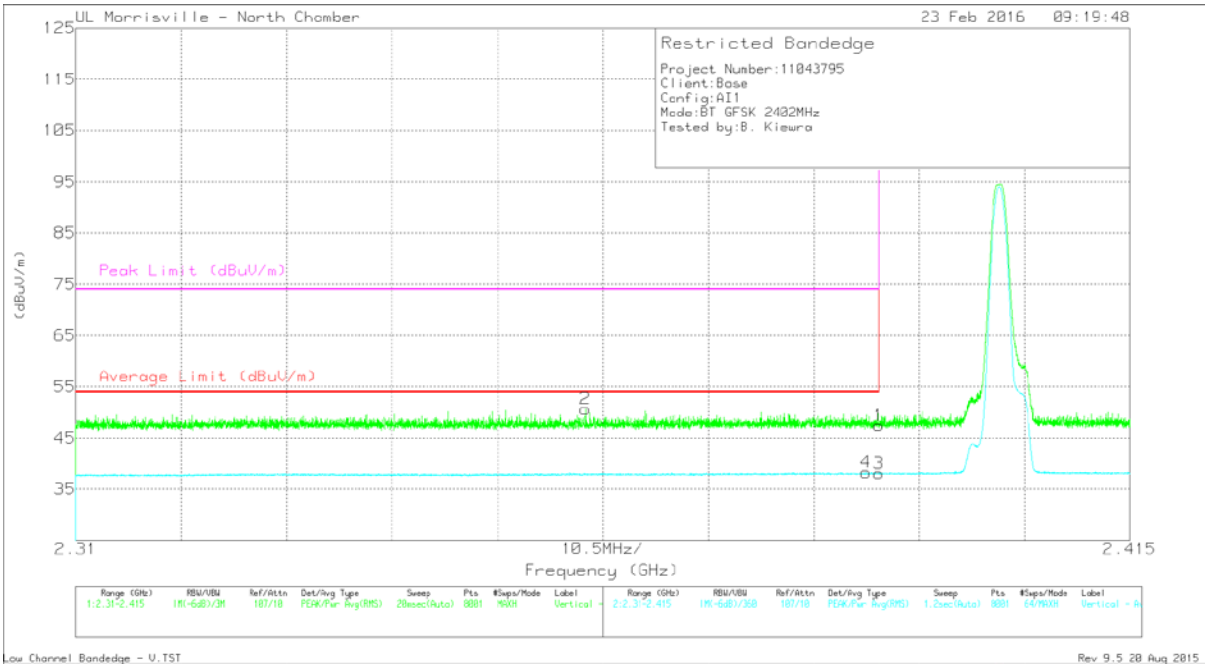
8.2.1. BASIC DATA RATE GFSK MODULATION

RESTRICTED BANDEDGE (LOW CHANNEL)



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0072 (dB/m)	Amp/Cbl /Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	41.78	Pk	31.9	-25.1	48.58	-	-	74	-25.42	334	215	H
2	* 2.387	43.51	Pk	31.9	-25.1	50.31	-	-	74	-23.69	334	215	H
3	* 2.39	31.4	V1TR	31.9	-25.1	38.2	54	-15.8	-	-	334	215	H
4	* 2.39	31.65	V1TR	31.9	-25.1	38.45	54	-15.55	-	-	334	215	H

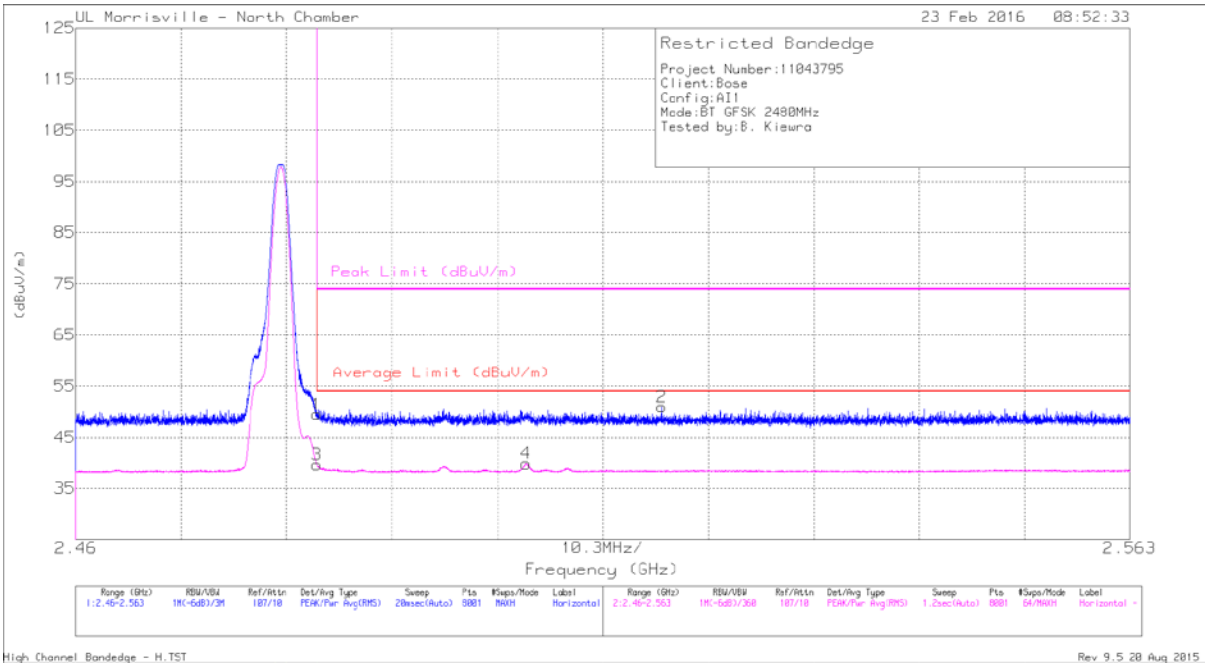
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
V1TR: VB=1/Ton, where: Ton is packet duration



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0072 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	40.6	Pk	31.9	-25.1	47.4	-	-	74	-26.6	354	353	V
2	* 2.361	43.98	Pk	31.8	-25.1	50.68	-	-	74	-23.32	354	353	V
3	* 2.39	31.32	V1TR	31.9	-25.1	38.12	54	-15.88	-	-	354	353	V
4	* 2.389	31.51	V1TR	31.9	-25.1	38.31	54	-15.69	-	-	354	353	V

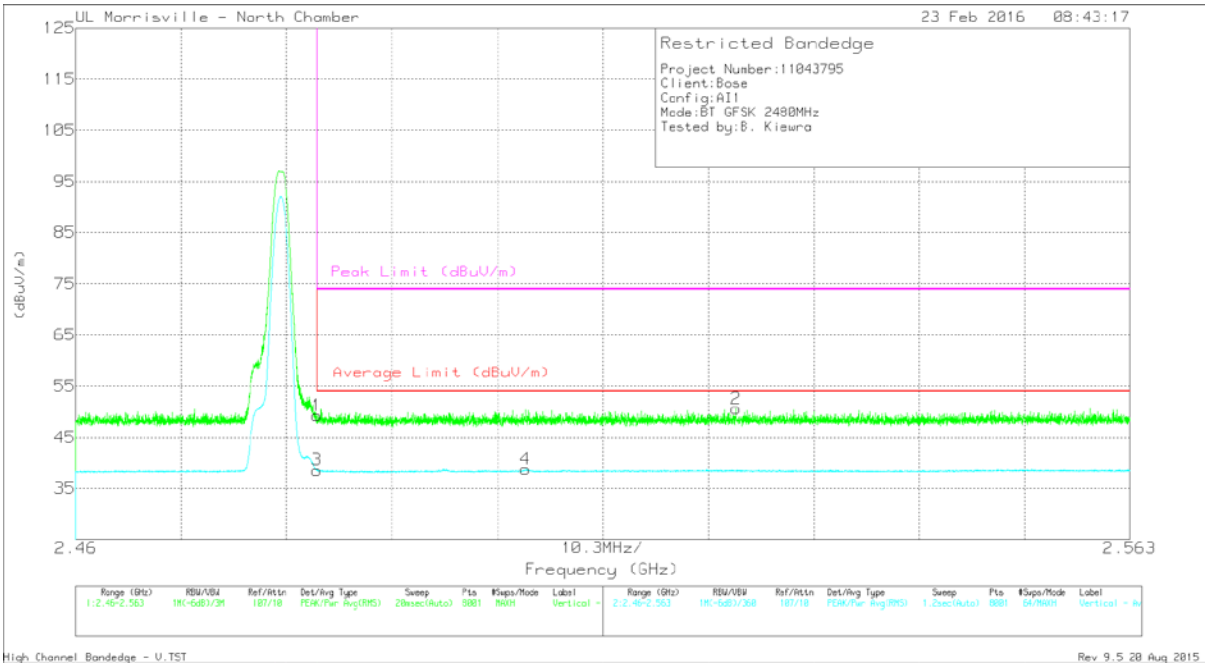
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
V1TR: VB=1/Ton, where: Ton is packet duration

RESTRICTED BANDEDGE (HIGH CHANNEL)



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0072 (dB/m)	Amp/Cbl /Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	42.26	Pk	32.1	-24.9	49.46	-	-	74	-24.54	78	194	H
2	2.517	43.65	Pk	32.1	-24.8	50.95	-	-	74	-23.05	78	194	H
3	* 2.484	32.44	V1TR	32.1	-24.9	39.64	54	-14.36	-	-	78	194	H
4	2.504	32.65	V1TR	32.1	-24.9	39.85	54	-14.15	-	-	78	194	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
V1TR: VB=1/Ton, where: Ton is packet duration



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0072 (dB/m)	Amp/Cbl /Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	42.07	Pk	32.1	-24.9	49.27	-	-	74	-24.73	61	244	V
2	2.525	43.42	Pk	32.1	-24.9	50.62	-	-	74	-23.38	61	244	V
3	* 2.484	31.41	V1TR	32.1	-24.9	38.61	54	-15.39	-	-	61	244	V
4	2.504	31.62	V1TR	32.1	-24.9	38.82	54	-15.18	-	-	61	244	V

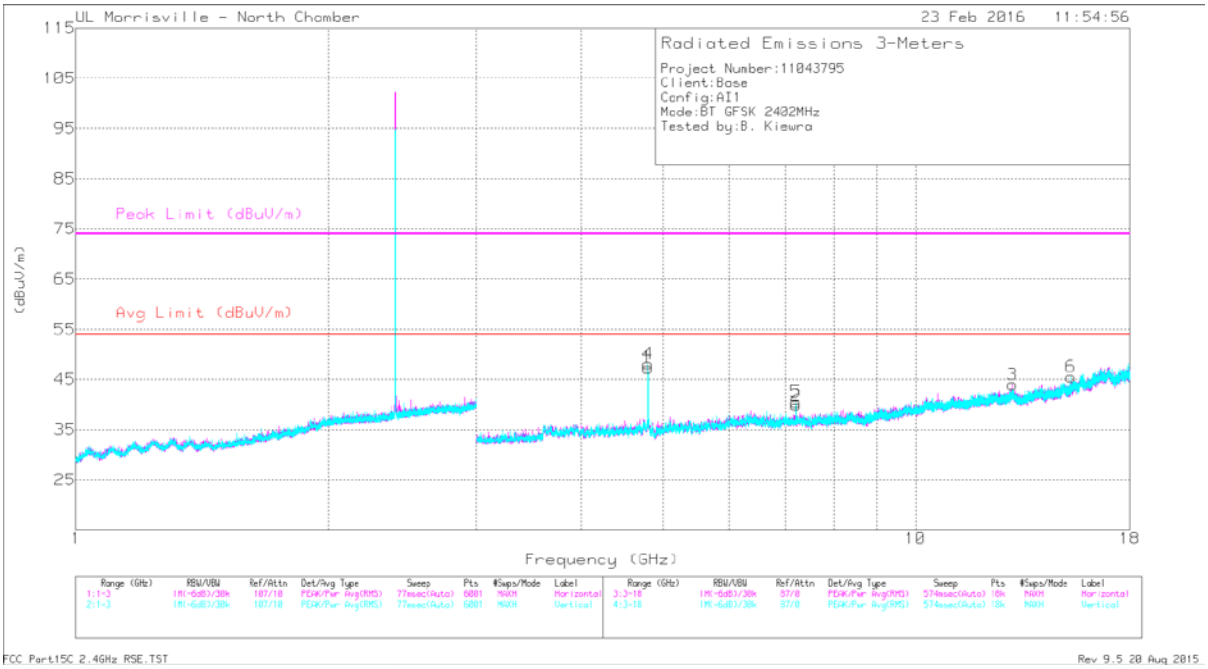
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

V1TR: VB=1/Ton, where: Ton is packet duration

HARMONICS AND SPURIOUS EMISSIONS

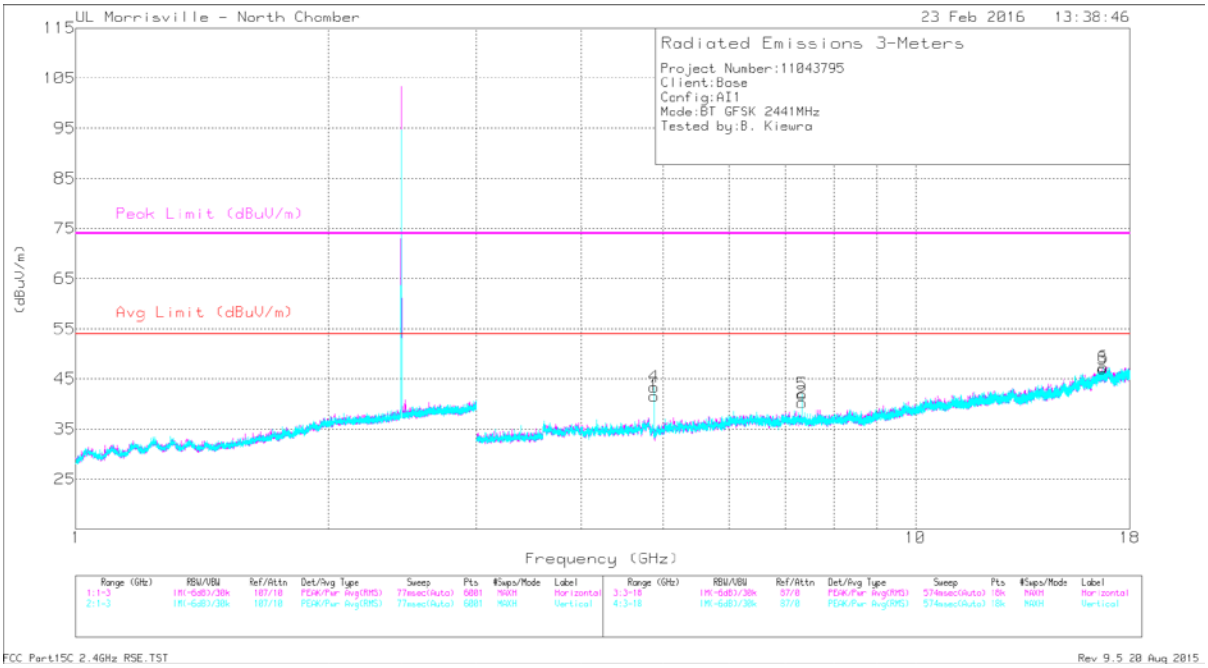
1-18 GHz Low Channel



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0072 (dB/m)	Amp/Cbl /Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 4.804	48.13	PK-U	34.1	-32.3	49.93	-	-	74	-24.07	245	106	H
	* 4.804	43.56	V1TR	34.1	-32.3	45.36	54	-8.64	-	-	245	106	H
4	* 4.804	48.88	PK-U	34.1	-32.3	50.68	-	-	74	-23.32	345	101	V
	* 4.804	44.27	V1TR	34.1	-32.3	46.07	54	-7.93	-	-	345	101	V
2	7.206	35.01	Pk	35.7	-30.9	39.81	-	-	74	-34.19	0-360	101	H
3	13.058	30.95	Pk	39.3	-26.3	43.95	-	-	74	-30.05	0-360	101	H
5	7.206	35.71	Pk	35.7	-30.9	40.51	-	-	74	-33.49	0-360	101	V
6	15.327	33.04	Pk	40.2	-27.7	45.54	-	-	74	-28.46	0-360	101	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
PK-U: Maximum Peak
V1TR: VB=1/Ton, where: Ton is packet duration

1-18 GHz Mid Channel



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0072 (dB/m)	Amp/Cbl /Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 4.88	36.46	PK-U	34.1	-32.4	38.16	-	-	74	-35.84	339	118	H
	* 4.881	25.37	V1TR	34.1	-32.4	27.07	54	-26.93	-	-	339	118	H
2	* 7.323	40.73	PK-U	35.7	-30	46.43	-	-	74	-27.57	220	109	H
	* 7.323	31.66	V1TR	35.7	-30	37.36	54	-16.64	-	-	220	109	H
4	* 4.882	45.04	PK-U	34.1	-32.4	46.74	-	-	74	-27.26	349	133	V
	* 4.882	39.12	V1TR	34.1	-32.3	40.92	54	-13.08	-	-	349	133	V
5	* 7.322	40.66	PK-U	35.7	-30	46.36	-	-	74	-27.64	349	102	V
	* 7.323	31.64	V1TR	35.7	-30	37.34	54	-16.66	-	-	349	102	V
3	16.705	29.13	Pk	42.2	-24.3	47.03	-	-	74	-26.97	0-360	200	H
6	16.748	30.88	Pk	42.3	-25.8	47.38	-	-	74	-26.62	0-360	200	V

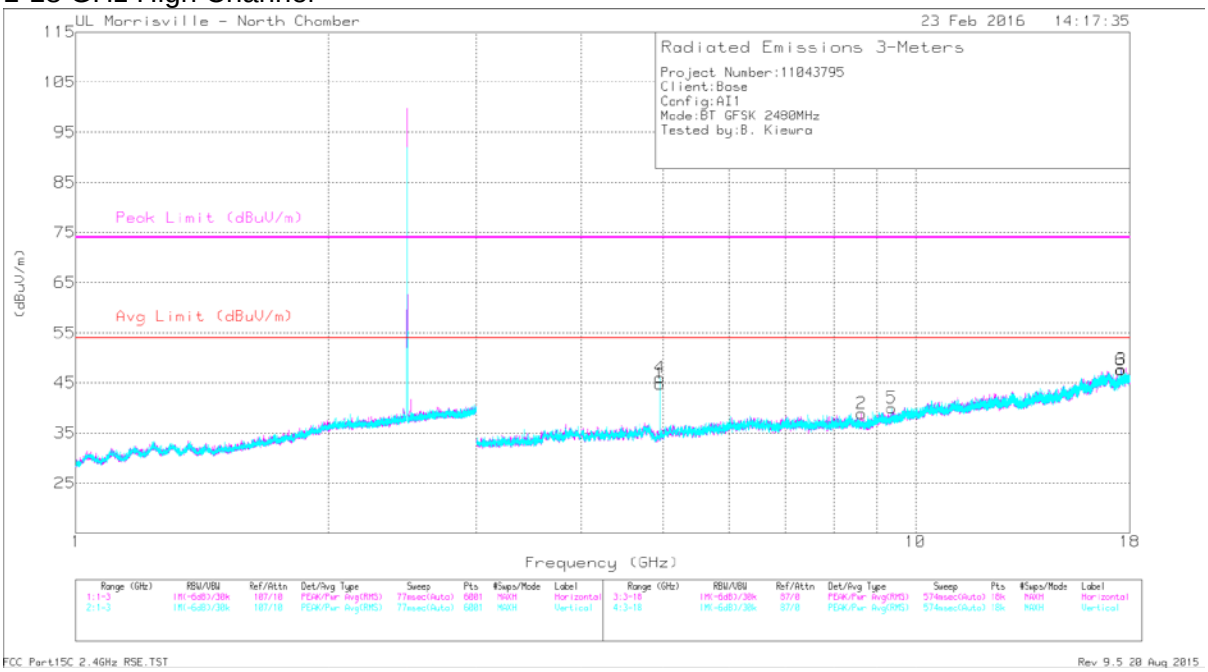
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

PK-U: Maximum Peak

V1TR: VB=1/Ton, where: Ton is packet duration

1-18 GHz High Channel

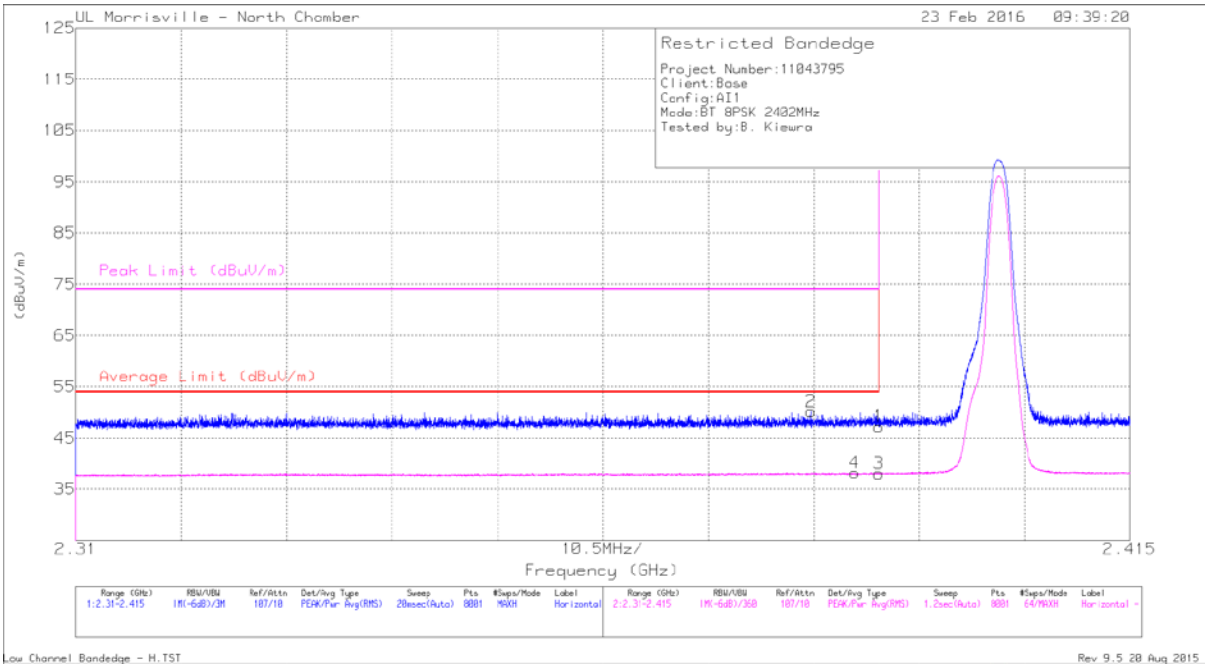


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0072 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 4.96	46.92	PK-U	34.1	-33.2	47.82	-	-	74	-26.18	251	113	H
	* 4.96	42.29	V1TR	34.1	-33.2	43.19	54	-10.81	-	-	251	113	H
4	* 4.961	46.87	PK-U	34.1	-33.2	47.77	-	-	74	-26.23	331	105	V
	* 4.96	42.11	V1TR	34.1	-33.2	43.01	54	-10.99	-	-	331	105	V
5	* 9.38	36.83	PK-U	36.6	-29.1	44.33	-	-	74	-29.67	330	140	V
	* 9.38	25.88	V1TR	36.6	-29.1	33.38	54	-20.62	-	-	330	140	V
2	8.633	32.5	Pk	36	-29.6	38.9	-	-	74	-35.1	0-360	200	H
3	17.591	31.16	Pk	41.8	-25.2	47.76	-	-	74	-26.24	0-360	101	H
6	17.568	30.98	Pk	41.8	-25.2	47.58	-	-	74	-26.42	0-360	101	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
PK-U: Maximum Peak
V1TR: VB=1/Ton, where: Ton is packet duration

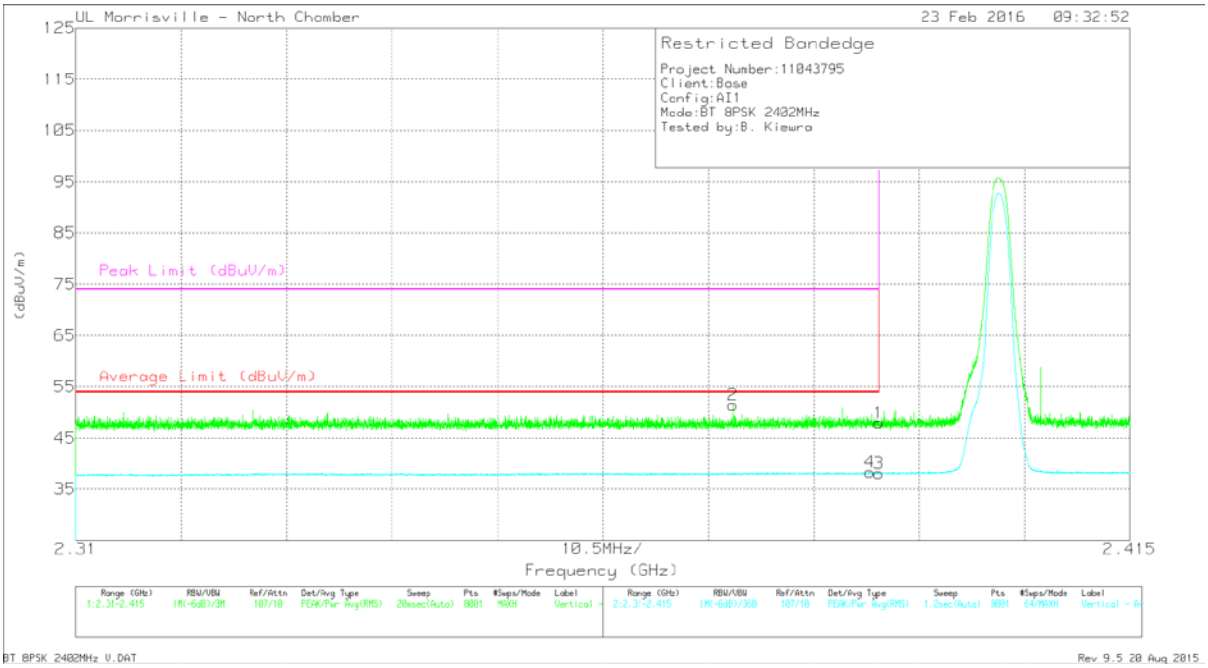
8.2.2. ENHANCED DATA RATE 8PSK MODULATION

RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0072 (dB/m)	Amp/Cbl /Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	40.44	Pk	31.9	-25.1	47.24	-	-	74	-26.76	309	137	H
2	* 2.383	43.38	Pk	31.9	-25.1	50.18	-	-	74	-23.82	309	137	H
3	* 2.39	31.27	V1TR	31.9	-25.1	38.07	54	-15.93	-	-	309	137	H
4	* 2.388	31.44	V1TR	31.9	-25.1	38.24	54	-15.76	-	-	309	137	H

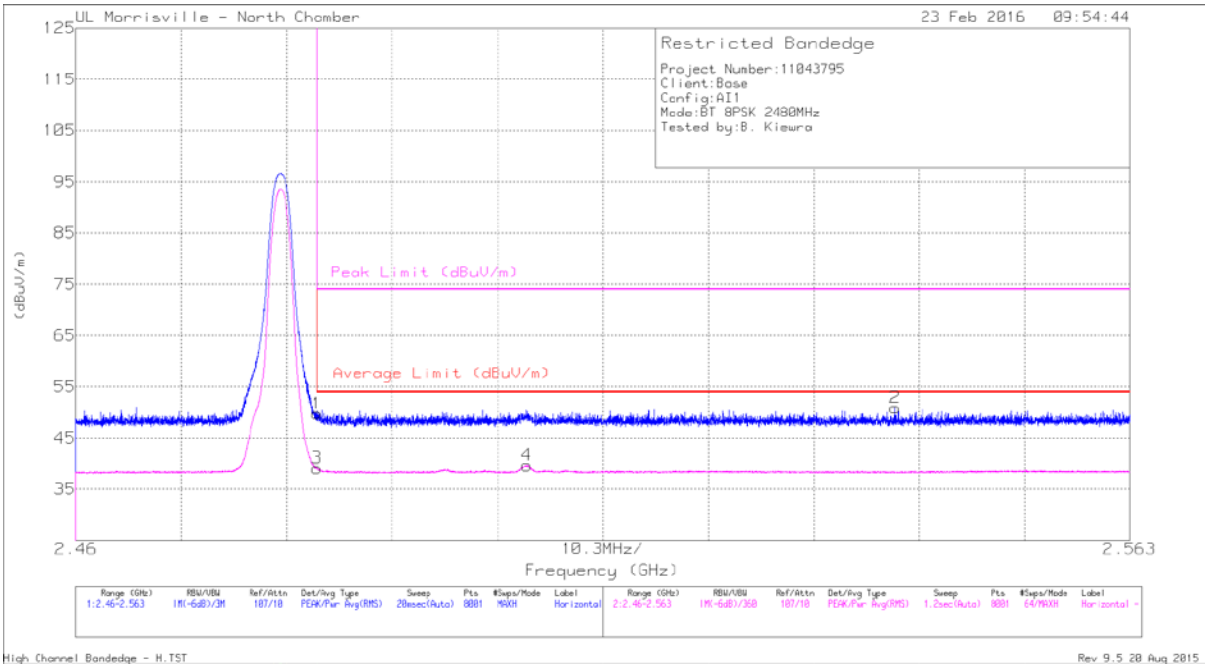
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
V1TR: VB=1/Ton, where: Ton is packet duration



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0072 (dB/m)	Amp/Cbl /Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	41.09	Pk	31.9	-25.1	47.89	-	-	74	-26.11	9	396	V
2	* 2.375	44.64	Pk	31.9	-25.1	51.44	-	-	74	-22.56	9	396	V
3	* 2.39	31.3	V1TR	31.9	-25.1	38.1	54	-15.9	-	-	9	396	V
4	* 2.389	31.55	V1TR	31.9	-25.1	38.35	54	-15.65	-	-	9	396	V

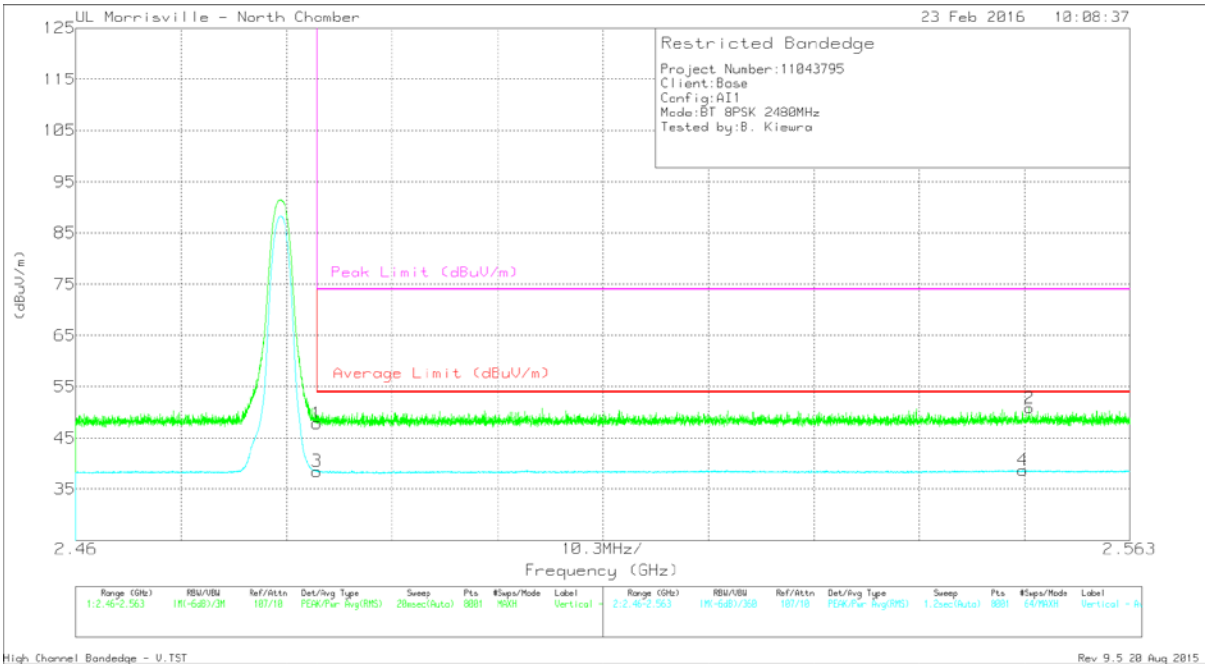
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
V1TR: VB=1/Ton, where: Ton is packet duration

RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0072 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	42.54	Pk	32.1	-24.9	49.74	-	-	74	-24.26	343	164	H
3	* 2.484	31.94	V1TR	32.1	-24.9	39.14	54	-14.86	-	-	343	164	H
4	2.504	32.46	V1TR	32.1	-24.9	39.66	54	-14.34	-	-	343	164	H
2	2.54	43.83	Pk	32.1	-25	50.93	-	-	74	-23.07	343	164	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
V1TR: VB=1/Ton, where: Ton is packet duration

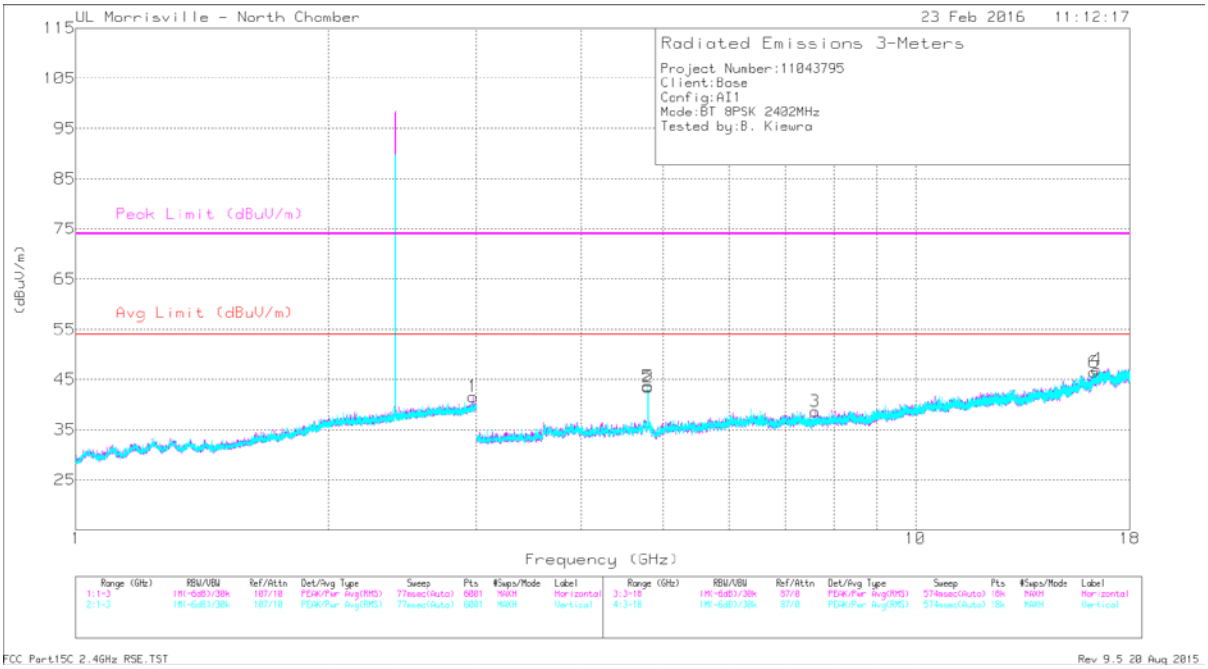


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0072 (dB/m)	Amp/Cbl /Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	40.68	Pk	32.1	-24.9	47.88	-	-	74	-26.12	359	370	V
3	* 2.484	31.32	V1TR	32.1	-24.9	38.52	54	-15.48	-	-	359	370	V
2	2.553	43.54	Pk	32.2	-24.9	50.84	-	-	74	-23.16	359	370	V
4	2.553	31.45	V1TR	32.2	-24.9	38.75	54	-15.25	-	-	359	370	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
V1TR: VB=1/Ton, where: Ton is packet duration

HARMONICS AND SPURIOUS EMISSIONS

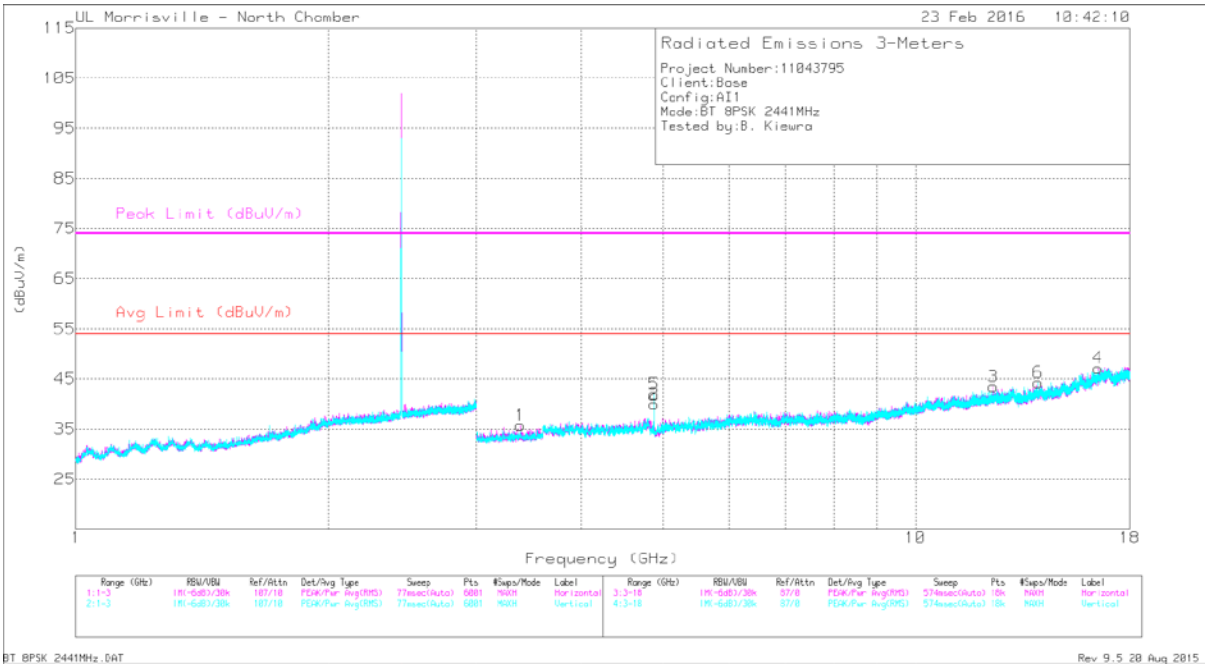
1-18 GHz Low Channel



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0072 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	* 4.804	44.97	PK-U	34.1	-32.3	46.77	-	-	74	-27.23	244	364	H
	* 4.804	35.86	V1TR	34.1	-32.3	37.66	54	-16.34	-	-	244	364	H
3	* 7.597	38.03	PK-U	35.8	-30.3	43.53	-	-	74	-30.47	32	192	H
	* 7.596	26.84	V1TR	35.8	-30.3	32.34	54	-21.66	-	-	32	192	H
5	* 4.804	46.26	PK-U	34.1	-32.3	48.06	-	-	74	-25.94	1	114	V
	* 4.804	38.43	V1TR	34.1	-32.3	40.23	54	-13.77	-	-	1	114	V
1	2.973	32.82	Pk	32.4	-23.6	41.62	-	-	74	-32.38	0-360	199	H
6	16.318	30.15	Pk	41.4	-25.1	46.45	-	-	74	-27.55	0-360	101	V
4	16.45	32.73	Pk	41.7	-27.4	47.03	-	-	74	-26.97	0-360	101	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
PK-U: Maximum Peak
V1TR: VB=1/Ton, where: Ton is packet duration

1-18 GHz Mid Channel



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0072 (dB/m)	Amp/Cbl /Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	* 4.882	44.75	PK-U	34.1	-32.4	46.45	-	-	74	-27.55	247	108	H
	* 4.882	35.77	V1TR	34.1	-32.4	37.47	54	-16.53	-	-	247	108	H
3	* 12.382	36.12	PK-U	39.1	-27.2	48.02	-	-	74	-25.98	359	226	H
	* 12.384	24.9	V1TR	39.1	-27.2	36.8	54	-17.2	-	-	359	226	H
5	* 4.882	44.6	PK-U	34.1	-32.4	46.3	-	-	74	-27.7	351	104	V
	* 4.882	36.56	V1TR	34.1	-32.3	38.36	54	-15.64	-	-	351	104	V
1	3.384	35.82	Pk	33	-33.1	35.72	-	-	74	-38.28	0-360	199	H
6	14.002	32.56	Pk	39.2	-27.5	44.26	-	-	74	-29.74	0-360	199	V
4	16.504	32.07	Pk	41.8	-26.7	47.17	-	-	74	-26.83	0-360	101	H

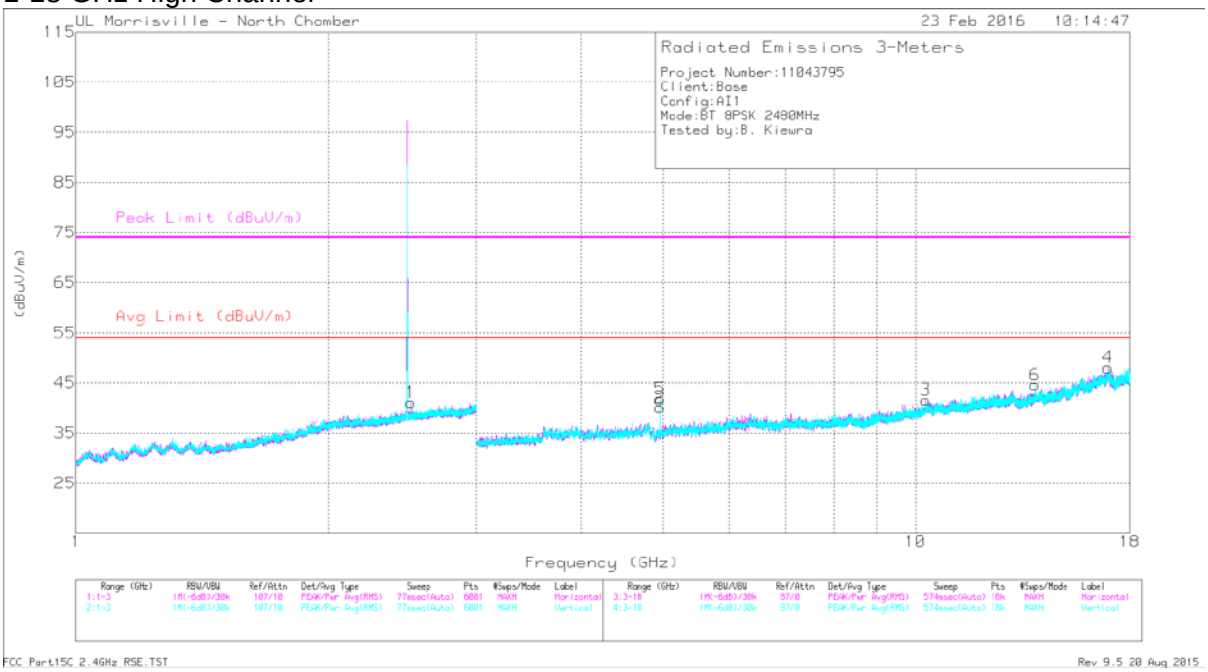
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

PK-U: Maximum Peak

V1TR: VB=1/Ton, where: Ton is packet duration

1-18 GHz High Channel

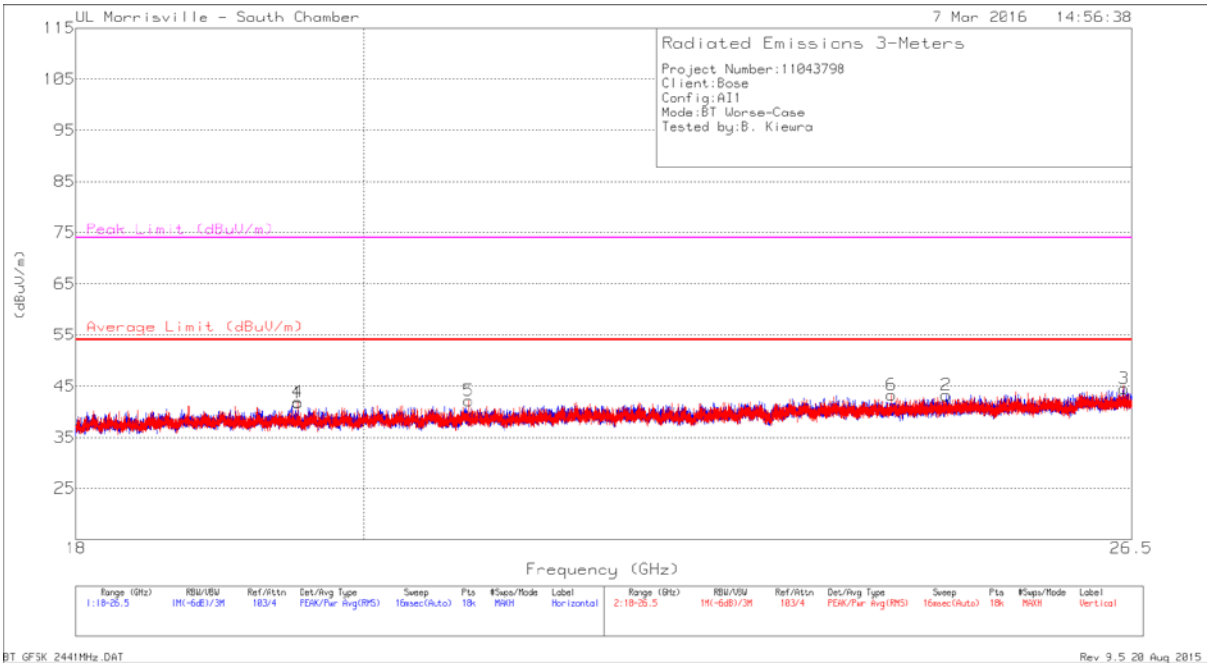


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0072 (dB/m)	Amp/Cbl /Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	* 4.96	44.44	PK-U	34.1	-33.2	45.34	-	-	74	-28.66	257	115	H
	* 4.96	35.91	V1TR	34.1	-33.2	36.81	54	-17.19	-	-	257	115	H
5	* 4.96	45.4	PK-U	34.1	-33.2	46.3	-	-	74	-27.7	330	109	V
	* 4.96	36.96	V1TR	34.1	-33.2	37.86	54	-16.14	-	-	330	109	V
1	2.504	33.72	Pk	32.1	-24.7	41.12	-	-	74	-32.88	0-360	200	H
3	10.29	31.13	Pk	37.5	-27	41.63	-	-	74	-32.37	0-360	101	H
6	13.89	33.38	Pk	39.2	-28	44.58	-	-	74	-29.42	0-360	101	V
4	16.967	31.17	Pk	42.2	-25.3	48.07	-	-	74	-25.93	0-360	101	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
PK-U: Maximum Peak
V1TR: VB=1/Ton, where: Ton is packet duration

8.3. WORST-CASE 18-26GHz

SPURIOUS EMISSIONS 18 TO 26GHz (WORST-CASE CONFIGURATION)



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0076 (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 19.524	51.89	PK-U	32.9	-40.4	44.39	54	-9.61	74	-29.61	337	123	H
4	* 19.524	52.98	PK-U	32.9	-40.4	45.48	54	-8.52	74	-28.52	62	110	V
5	* 20.785	48.32	PK-U	33.5	-40.3	41.52	54	-12.48	74	-32.48	201	291	V
2	24.762	47.05	Pk	34.6	-38.4	43.25	-	-	74	-30.75	0-360	199	H
3	26.428	46.79	Pk	35.1	-37.4	44.49	-	-	74	-29.51	0-360	102	H
6	24.267	47.58	Pk	34.4	-38.7	43.28	-	-	74	-30.72	0-360	299	V

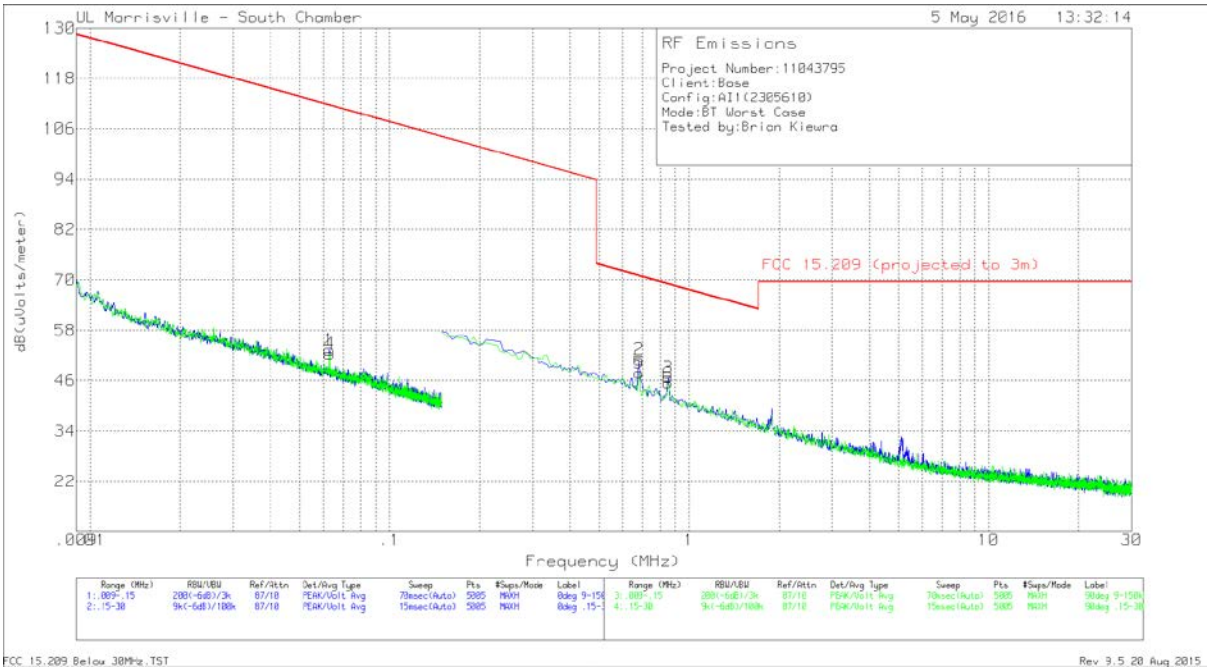
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
PK-U: Maximum Peak
V1TR: VB=1/Ton, where: Ton is packet duration

8.4. WORST-CASE BELOW 1 GHz

SPURIOUS EMISSIONS 9kHz-30 MHz (WORST-CASE CONFIGURATION)

Note: All measurements were made at a test distance of 3 m. The limits in the plots and tabular data are the FCC/IC limits extrapolated from the specification distance (300 m from 9-490 kHz and 30 m from 490 kHz – 30 MHz) to the measurement distance to clearly show the relative levels of fundamental and spurious emissions and demonstrate compliance with the requirement that the level of any spurious emissions be below the level of the intentionally transmitted signal. The extrapolation factor for the limits were 40*Log (specification distance / test distance).

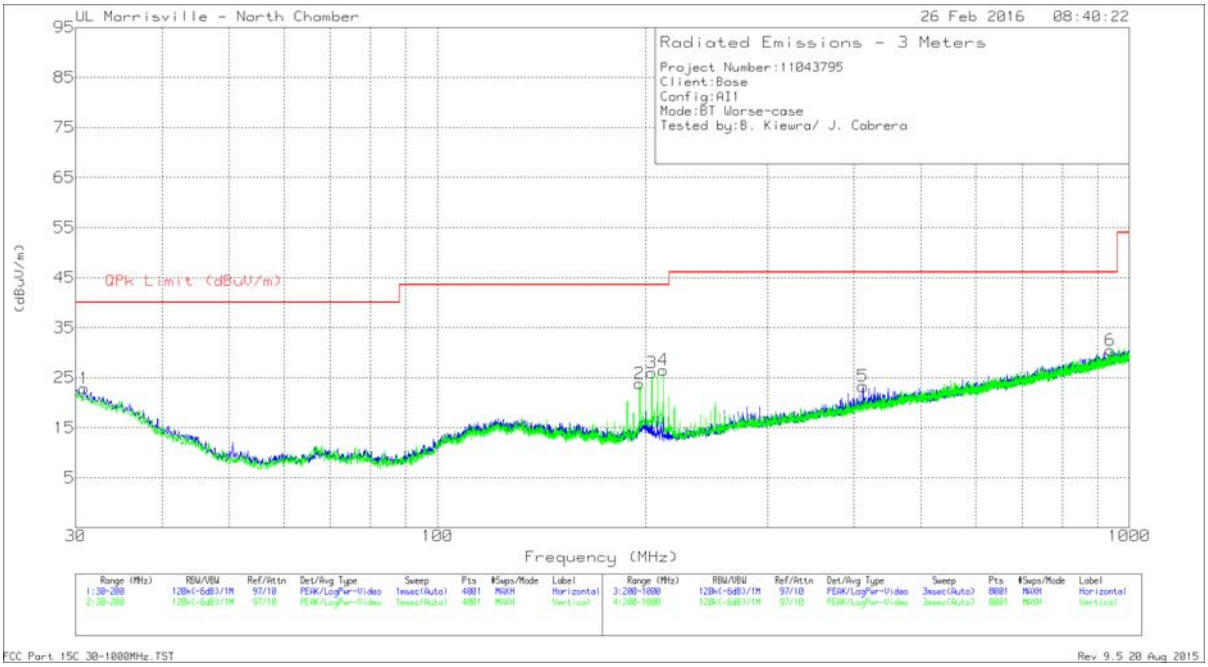
The anechoic chamber has been properly calibrated so that the measurement results correspond to what would be obtained from an open field sites.



Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0079 AF (dB/m)	Cbl (dB)	Corrected Reading dB(uVolts/meter)	FCC 15.209 (projected to 3m)	Margin (dB)	Azimuth (Degs)
1	.06293	41.02	Pk	12.2	.1	53.32	111.63	-58.31	0-360
4	.06293	40.06	Pk	12.2	.1	52.36	111.63	-59.27	0-360
2	.68089	39.04	Pk	11.9	.1	51.04	70.94	-19.9	0-360
5	.68089	35.79	Pk	11.9	.1	47.79	70.94	-23.15	0-360
3	.84791	34.76	Pk	11.9	.1	46.76	69.04	-22.28	0-360
6	.84791	33.44	Pk	11.9	.1	45.44	69.04	-23.6	0-360

Pk - Peak detector
FCC 15.209 Below 30MHz.TST
Rev 9.5 20 Aug 2015

SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION)



Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0073 AF (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	30.85	28.91	Pk	25.5	-31.6	22.81	40	-17.19	0-360	399	H
5	412	31.57	Pk	20.7	-29	23.27	46.02	-22.75	0-360	199	H
2	196.005	37.05	Pk	16.9	-30.1	23.85	43.52	-19.67	0-360	102	V
3	204	40.04	Pk	16	-30.1	25.94	43.52	-17.58	0-360	102	V
4	212	41.31	Pk	15.2	-30	26.51	43.52	-17.01	0-360	199	V
6	938.2	29.4	Pk	27.3	-26.2	30.5	46.02	-15.52	0-360	199	V

Pk - Peak detector

9. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

RSS-Gen 7.2.2

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

* Decreases with the logarithm of the frequency.

TEST PROCEDURE

The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.10.

The receiver is set to a resolution bandwidth of 9 kHz. Peak detection is used unless otherwise noted as quasi-peak or average.

Line conducted data is recorded for both NEUTRAL and HOT lines.

RESULTS

Line conducted testing was considered but deemed not applicable because the EUT does not transmit or receive when the EUT is plugged in for charging. The Bluetooth radio is disabled when the USB is connected to a laptop or charger.