



**FCC 47 CFR PART 15 SUBPART C
INDUSTRY (ISED) CANADA RSS-247 ISSUE 1**

CERTIFICATION TEST REPORT

FOR

WIRELESS SPEAKER

MODEL NUMBER: 419357

FCC ID: A94419357

IC: 3232A-419357

REPORT NUMBER: R11223360-E1

ISSUE DATE: 2017-04-04

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NVLAP LAB CODE 200246-0

Revision History

Ver.	Issue Date	Revisions	Revised By
1	2016-09-14	Initial Issue	Ron Reichard
2	2017-01-05	Revised note on page 5.	Jeff Moser
3	2017-04-04	Revised Section 5.5 to be more specific and modified the test procedure in Section 9.1.	Jeff Moser

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Bose Corporation
100 The Mountain Road
Framingham, MA, 01701 USA

EUT DESCRIPTION: Wireless Speaker

MODEL: 419357

SERIAL NUMBER: Conducted: B0-0004
Radiated: W0-0039

DATE TESTED: 2016-08-05 to 2016-08-26, 2016-09-13

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C	Pass
INDUSTRY CANADA (ISED CANADA) RSS-247 Issue 1	Pass
INDUSTRY CANADA (ISED 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, or any agency of the U.S. Government.

Approved & Released
For UL LLC By:



Jeffrey 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 (ISED) 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:

$$\begin{aligned} \text{Field Strength (dBuV/m)} &= \text{Measured Voltage (dBuV)} + \text{Antenna Factor (dB/m)} + \\ &\text{Cable Loss (dB)} - \text{Preamp Gain (dB)} \\ 36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} &= 28.9 \text{ dBuV/m} \end{aligned}$$

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 dB
RF power density, conducted	± 1.50 dB
Spurious emissions, conducted	± 2.94 dB
All emissions, radiated up to 26 GHz	± 5.36 dB
Temperature	± 0.07°C
Humidity	± 2.26% RH
DC and low frequency voltages	± 1.27%
Conducted Emissions (0.150-30MHz)	± 3.65 dB

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

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a wireless speaker that contains Bluetooth/BLE transceivers, manufactured by Cambridge Silicon Radio, CSR8675.

The EUT is provided with a Bose model S008AHU0500160 power supply.

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	7.25	5.31
2402 - 2480	DQPSK	5.99	3.97
2402 - 2480	Enhanced 8PSK	6.31	4.28

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a trace antenna formed by printed circuit board etch internal to the product, with a maximum gain of 4.9 dBi.

5.4. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was version 0.6.1.4215

The test utility software used during testing was Polycomm, ver 0.1.9.0 and CSR BlueSuite ver 2.5.8.

5.5. WORST-CASE CONFIGURATION AND MODE

All testing was performed in all modes except as noted below:

For all Radiated Emissions testing, the EUT has an intended orientation and was tested this way (Speaker upright). The fundamental of the EUT was investigated in various configurations:

- Stand alone with music player
- Connected to power charger
- Connected to laptop
- Connected to power charger and music player via 3.5 mm cable

It was determined that connected to the power charger configuration was the worst-case configuration. Therefore, all final radiated testing was performed with the EUT in 'connected to power charger' configuration.

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

For both Conducted and Radiated Emissions, Enhanced Data rate modes, 8DPSK is considered equivalent to DQPSK or worst-case. Therefore, all tests were performed in 8DPSK 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	Lenovo	20BUS04K00	PC0A2UQS	N/A
AC Adapter	Lenovo	ADLX65NLC2A	54DE1T	N/A
AC Adapter	Bose	AFD5V-1C-1U-US	724081-0010	N/A
MP3 Player	Apple	A1387	DNPGL1QEDT9V	N/A
AC Adapter	Bose	S008AHU0500160	745559-0030	N/A

I/O CABLES

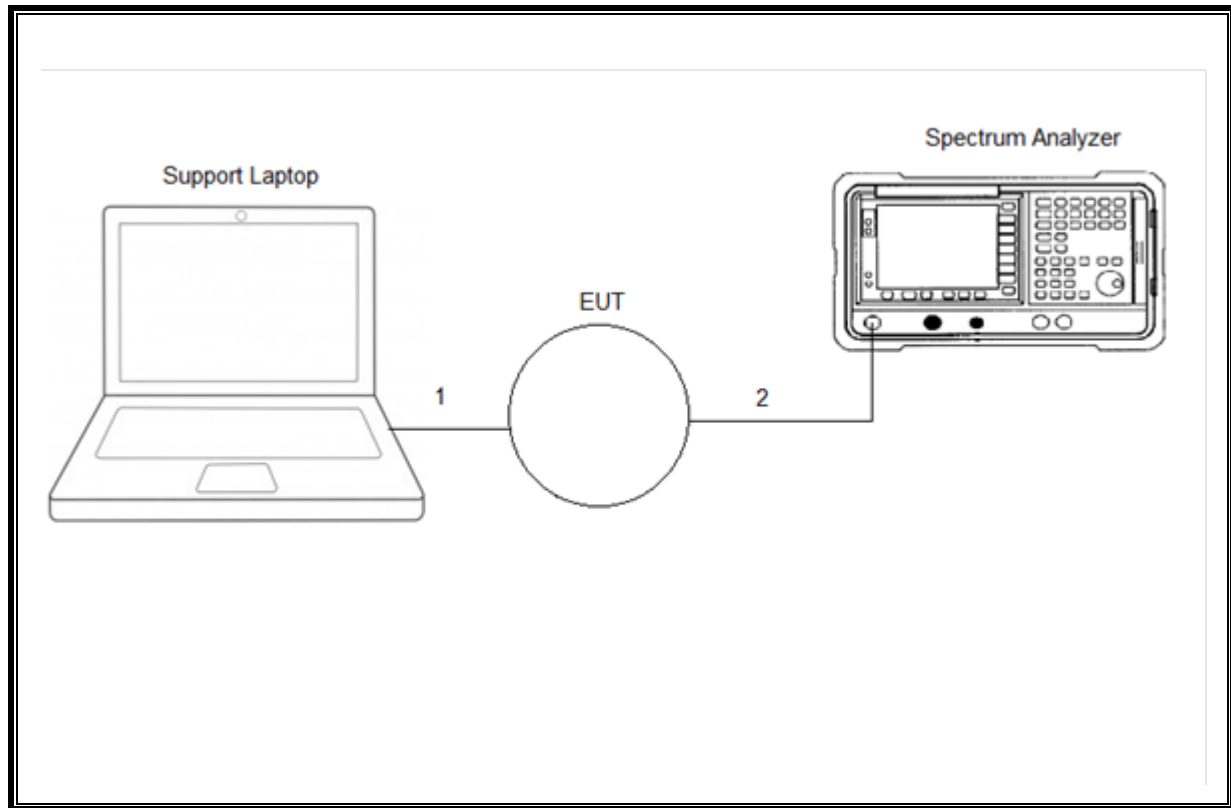
I/O Cable List						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length	Remarks
1	USB	1	Micro USB	Unshielded	<1m	N/A
2	Antenna	1	RF	RF	<1m	N/A
3	DC Mains	1	DC	DC Mains	>1m	N/A
4	3.5mm	1	3.5mm	Audio	<1m	N/A

TEST SETUP

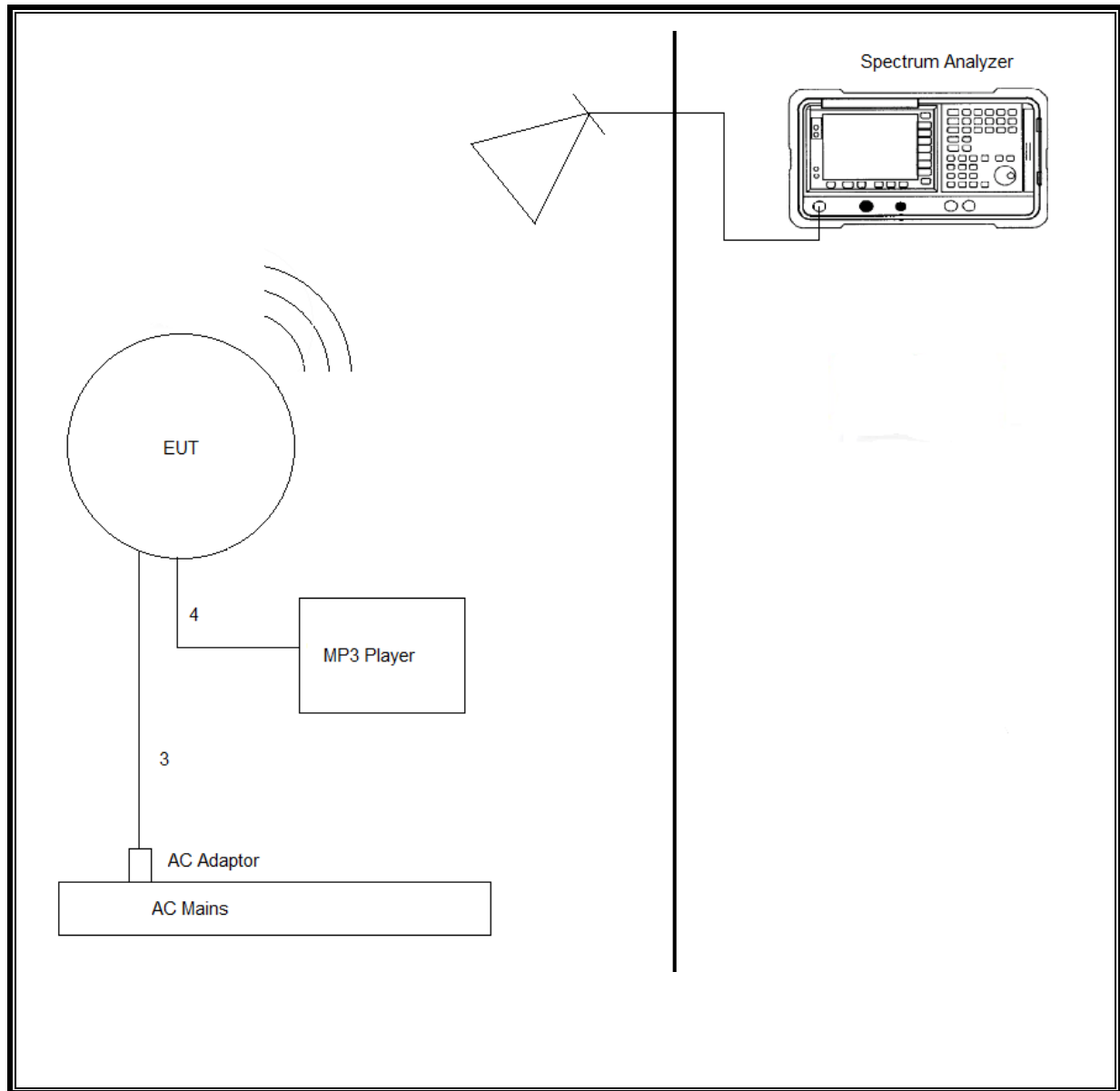
The EUT is set up with its associated AC/DC adapter during radiated-emissions testing. For convenience, the device is connected to a laptop PC via a USB cable to configure the device for test during antenna-port measurements. Test software exercised the radio portion of the device.

SETUP DIAGRAM FOR TESTS

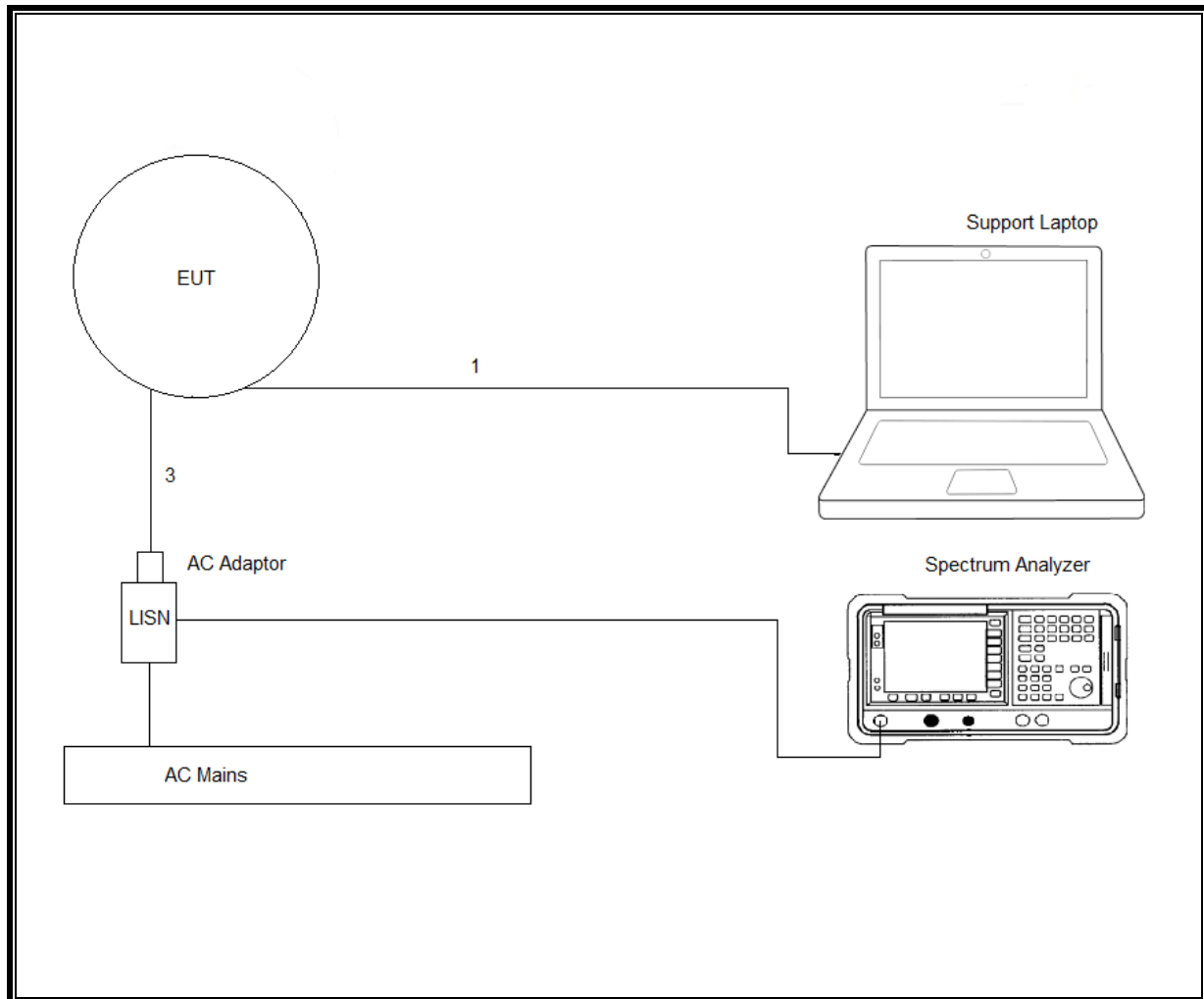
Conducted Setup



Radiated Setup



Line Conducted Setup



6. TEST AND MEASUREMENT EQUIPMENT

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

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

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	0.009-30MHz	(Loop Ant.)			
AT0079	Active Loop Antenna	ETS-Lindgren	6502	2015-12-08	2016-12-31
	30-1000 MHz				
AT0074	Hybrid Broadband Antenna	Sunol Sciences Corp.	JB3	2016-06-07	2017-06-30
	1-18 GHz				
AT0069	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2016-03-07	2017-03-31
	18-26.5 GHz				
AT0076	Horn Antenna, 18-26.5GHz	ARA	MWH-1826/B	2015-08-27	2016-08-31
	Gain-Loss Chains				
S-SAC01	Gain-loss string: 0.009-30MHz	Various	Various	2015-10-07	2016-10-31
S-SAC02	Gain-loss string: 30-1000MHz	Various	Various	2016-06-26	2017-06-30
S-SAC03	Gain-loss string: 1-18GHz	Various	Various	2015-08-22	2016-08-31
S-SAC04	Gain-loss string: 18-40GHz	Various	Various	2016-02-29	2017-02-28
	Receiver & Software				
SA0025	Spectrum Analyzer	Agilent	N9030A	2016-03-17	2017-03-31
SA0026 (18-40GHz RSE)	Spectrum Analyzer	Agilent	N9030A	2016-02-24	2017-02-28
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA
	Additional Equipment used				
HI0078	Temp/Humid/Pressure Meter	Springfield	PreciseTemp	2016-06-13	2017-06-13

Note – This test area was used prior to 2016-08-31.

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	2016-06-22	2017-06-22
PWS004	Peak and Avg Power Sensor, 50MHz to 6GHz	Keysight Technologies	E9323A	2016-06-22	2017-06-22
HI0078	Temp/Humid/Pressure Meter	Springfield	PreciseTemp	2016-06-13	2017-06-13
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	2016-03-22	2017-03-31
PWM003	RF Power Meter	Keysight Technologies	N1911A	2016-06-21	2017-06-21
PWS003	Peak and Avg Power Sensor, 50MHz to 6GHz	Keysight Technologies	E9323A	2016-06-21	2017-06-21
1100502	Temp/Humid Chamber	Cincinnati Sub-Zero	ZPH-8-3.5-SCT/AC	2016-06-06	2017-06-06
HI0078	Temp/Humid/Pressure Meter	Springfield	PreciseTemp	2016-06-13	2017-06-13
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 – These test areas was used prior to 2016-08-31.

Test Equipment Used - Line-Conducted Emissions – Voltage (Morrisville – Conducted 1)

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
CBL077	Coax cable, RG223, N-male to BNC-male, 20-ft.	Pasternack	PE3476-240	2016-06-15	2017-06-30
HI0078	Temp/Humid/Pressure Meter	Springfield	PreciseTemp	2016-06-13	2017-06-30
LISN003	LISN, 50-ohm/50-uH, 2-conductor, 25A	Fischer Custom Com.	FCC-LISN-50-25-2-01-550V	2016-08-24	2017-08-24
LISN008	LISN, 50-ohm/50-uH, 2-conductor, 25A (For support gear only.)	Solar Electronics	8012-50-R-24-BNC	2015-09-03	2016-09-30
PRE0101521 (75141)	EMI Test Receiver 9kHz-7GHz	Rohde & Schwarz	ESCI 7	2016-08-23	2017-08-23
TL001	Transient Limiter, 0.009-30MHz	Com-Power	LIT-930A	2016-06-09	2017-06-30
PS214	AC Power Source	Elgar	CW2501M (s/n 1523A02396)	NA	NA
PS215	AC Power Source	Elgar	CW2501M (s/n 1523A02397)	NA	NA
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA
	Miscellaneous (if needed)				
CDECABLE001	ANSI C63.4 1m extension cable.	UL	Per Annex B of ANSI C63.4	2016-06-04	2017-06-30

7. MEASUREMENT METHODS

Duty Cycle: KDB 558074 Zero-Span Spectrum Analyzer Method

20 dB BW: ANSI C63.10 Section 6.9.2.

99% Occupied Bandwidth: ANSI C63.10-2013, Section 6.9.3

Hopping Frequency Separation: ANSI C63.10 Section 7.8.2

Number of Hopping Channels: ANSI C63.10 Section 7.8.3

Average Time of Occupancy: ANSI C63.10 Section 7.8.4

Output Power: ANSI C63.10 Section 7.8.5

Out-of-band emissions in non-restricted bands: ANSI C63.10 Section 7.8.6 & 7.8.8

Out-of-band emissions in restricted bands: ANSI C63.10:2013 Sections 6.3-6.6

Line Conducted Emissions: ANSI C63.10:2013 Sections 6.2

8. ANTENNA PORT TEST RESULTS

8.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

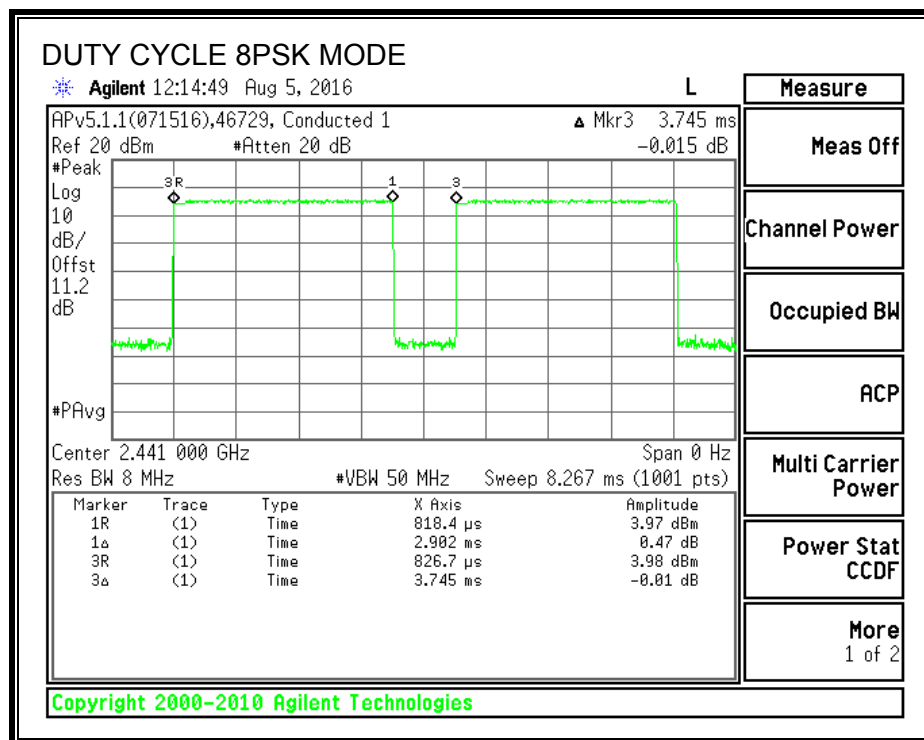
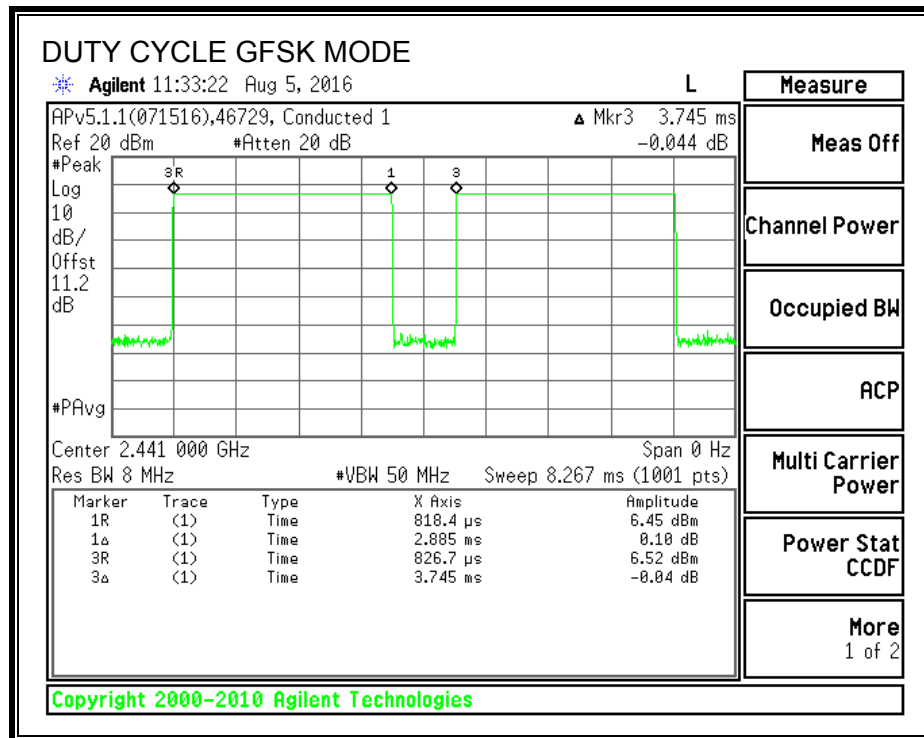
8.2. ON TIME AND DUTY CYCLE RESULTS

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	2.885	3.745	0.770	77.04%	1.13	0.347
Bluetooth 8PSK	2.902	3.745	0.775	77.49%	1.11	0.345

Tested by: Ron Reichard/Jeff Cabrera
Test date: 2016-08-05

8.3. DUTY CYCLE PLOTS

HOPPING OFF



8.4. BASIC DATA RATE GFSK MODULATION

8.4.1. 20 dB AND 99% BANDWIDTH

LIMIT

None; for reporting purposes only. Test per FCC §15.247(a)(1); IC RSS-247 5.1 (1), RSS-Gen 6.6.

TEST PROCEDURE

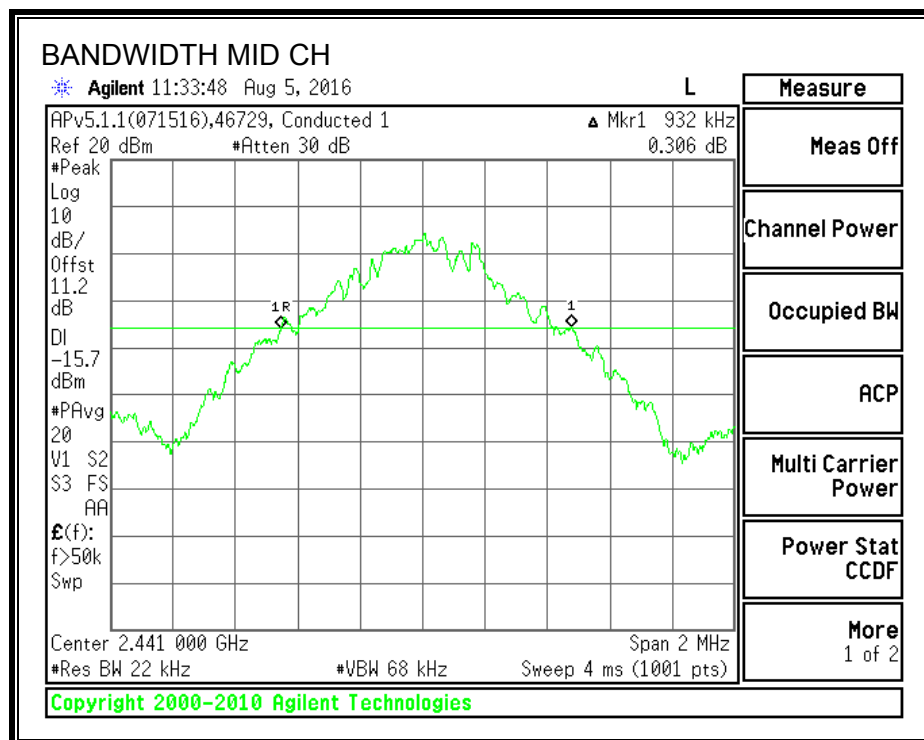
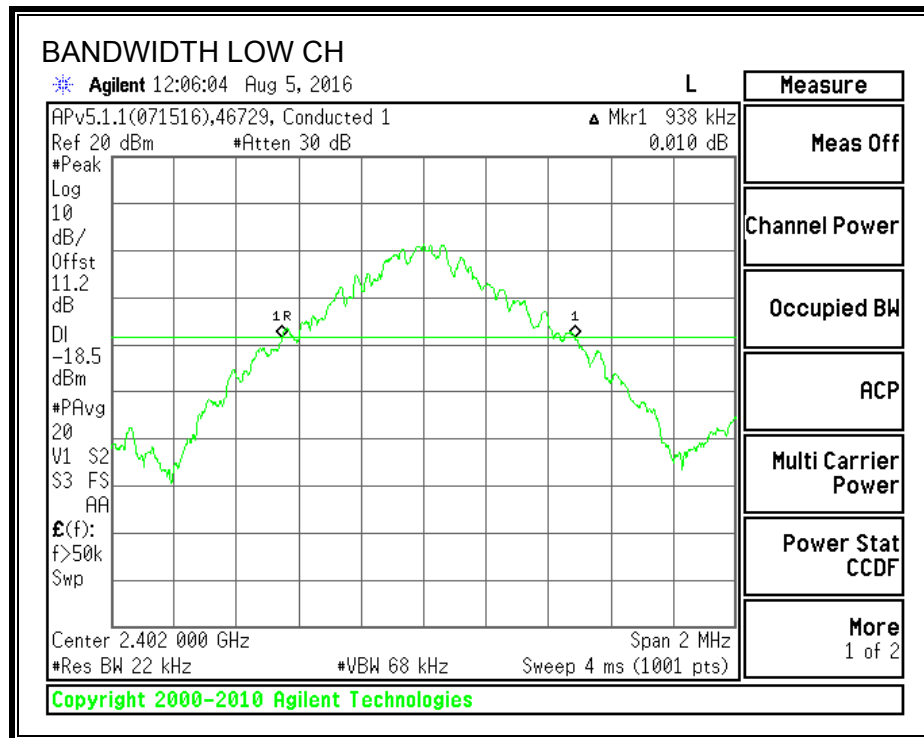
The transmitter output is connected to a spectrum analyzer. The RBW is set to 1-5% of the 20 dB bandwidth and 99% Occupied Bandwidth. The VBW is set to $\geq$ RBW. The sweep time is coupled.

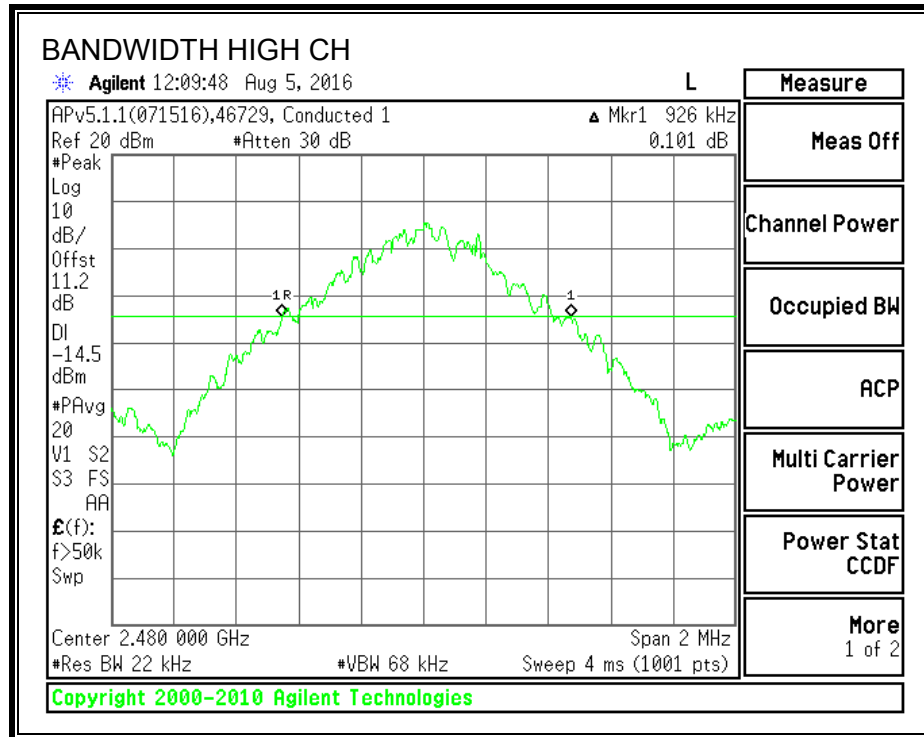
RESULTS

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)	99% Bandwidth (kHz)
Low	2402	938	875.7838
Middle	2441	932	879.7303
High	2480	926	877.9466

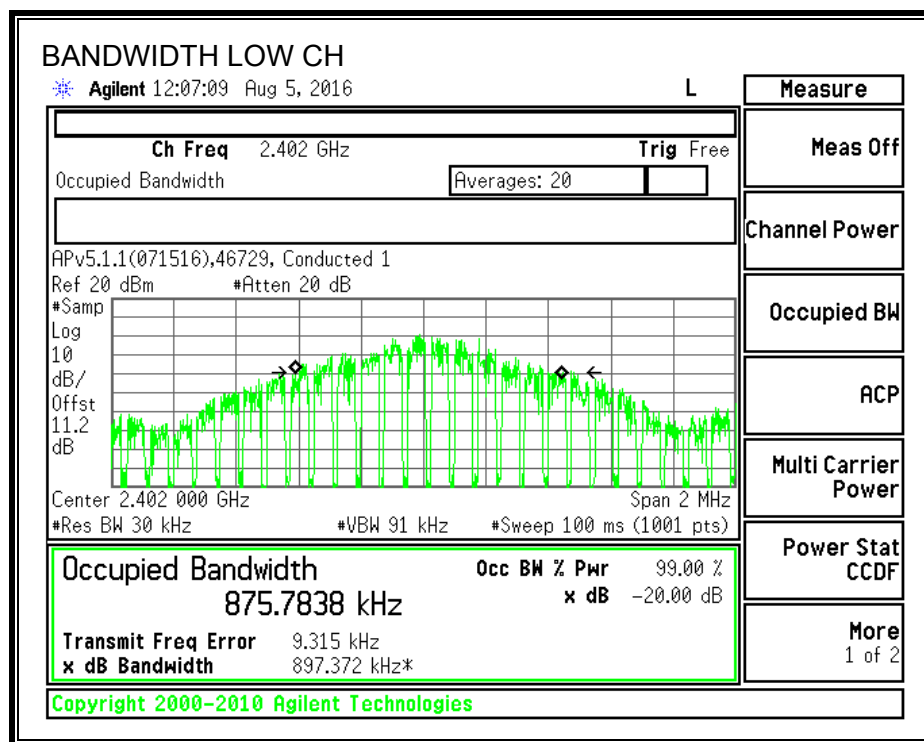
Tested by: Ron Reichard/Jeff Cabrera
Test date: 2016-08-05

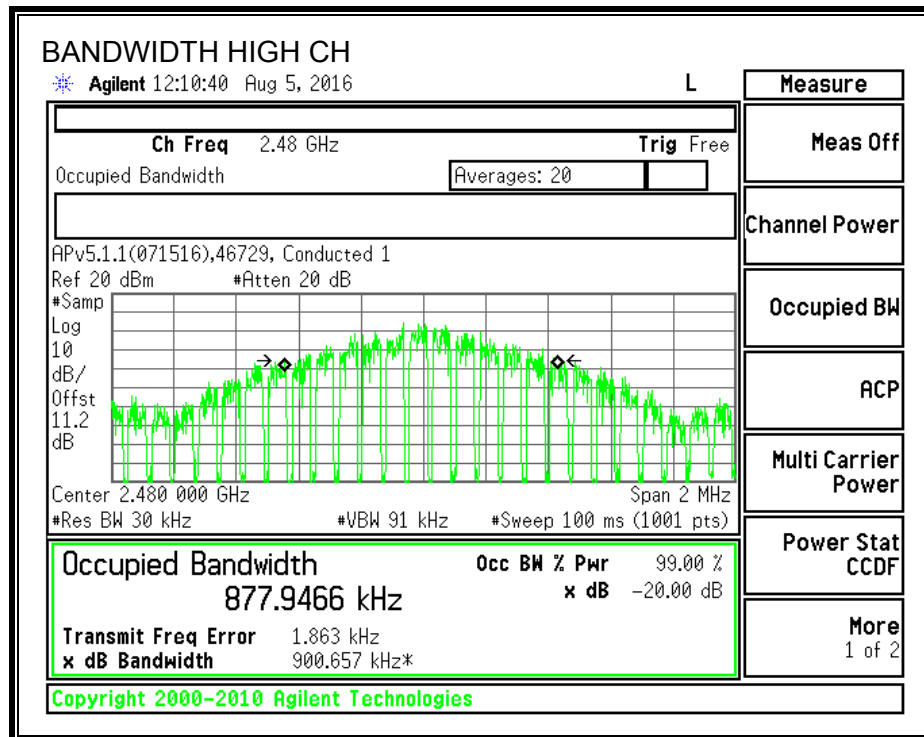
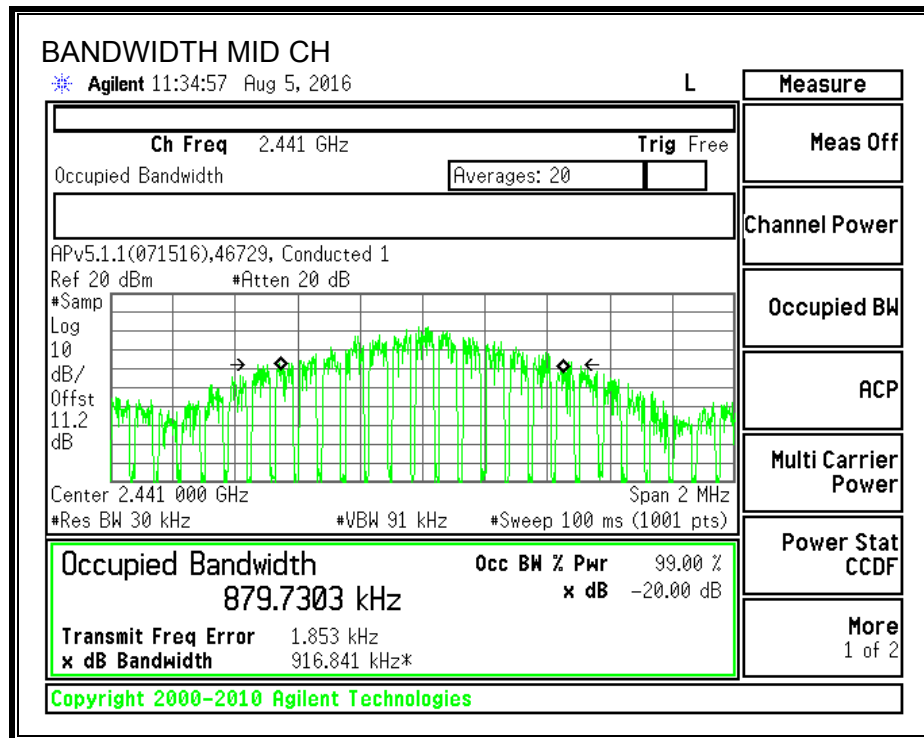
20 dB BANDWIDTH





99% BANDWIDTH





8.4.2. 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 hopping 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.

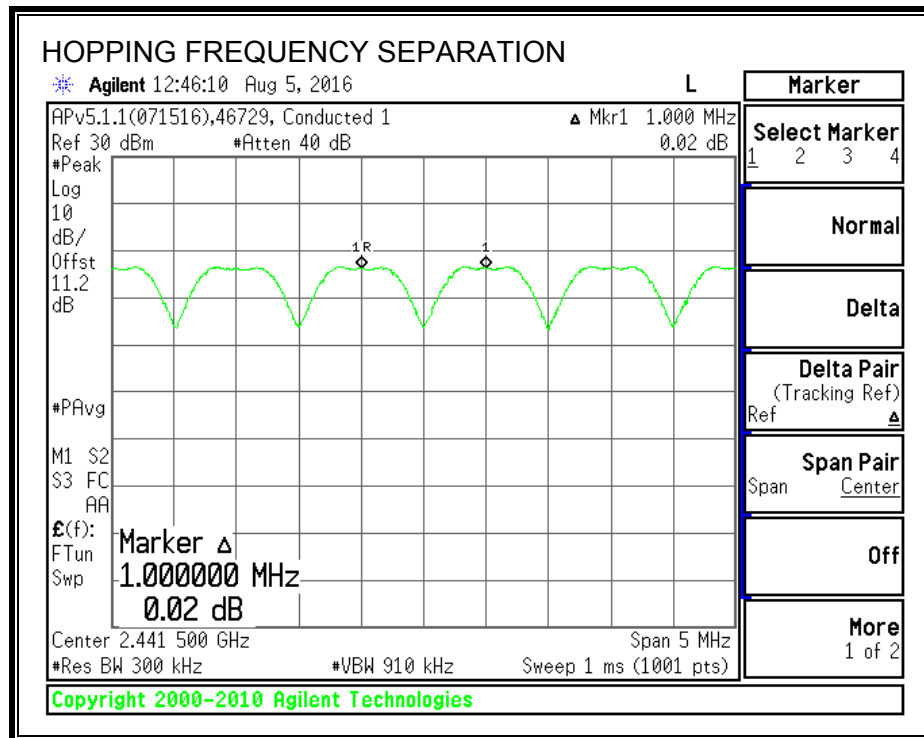
TEST PROCEDURE

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

Tested by: Ron Reichard/Jeff Cabrera
Test date: 2016-08-05

HOPPING FREQUENCY SEPARATION



Ch. A	Ch. B	Ch. 1 to Ch. 2 Sep.	Max. 20 dB BW	2/3 20 dB Margin	Margin
(MHz)	(MHz)	(MHz)	(MHz)	(MHz)	(MHz)
2441	2442	1.000	0.938	0.625	-0.375

Note – The channel hopping separation of 1MHz is greater than the 20 dB bandwidth. Additionally, the output power is less than 125 mW and the channel separation is greater than 2/3 the 20 dB bandwidth (approx. 625 kHz).

8.4.3. 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

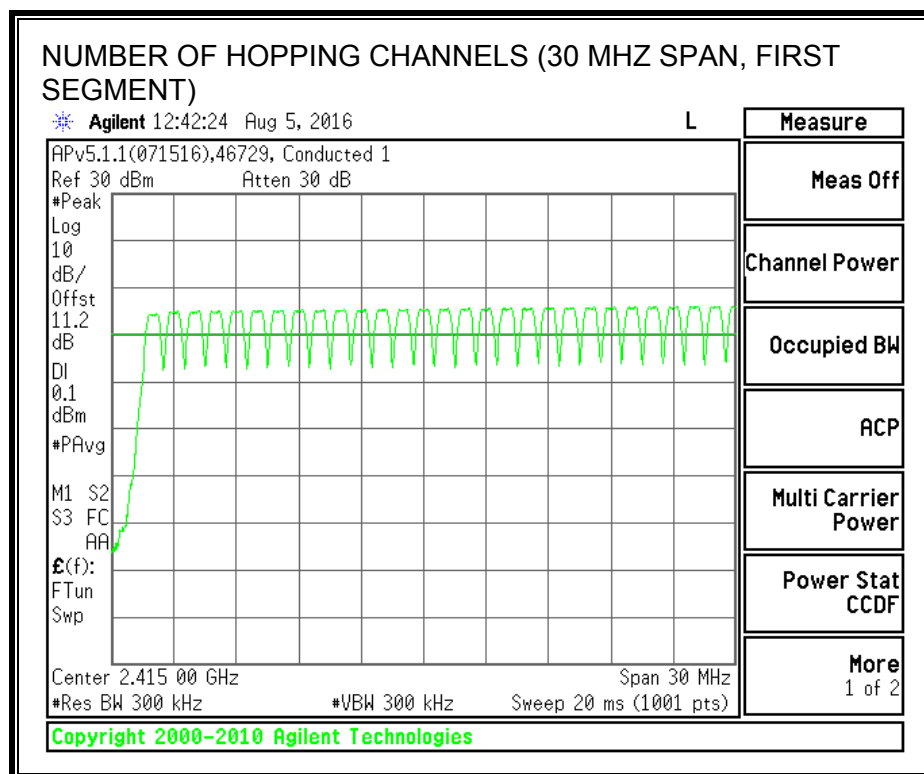
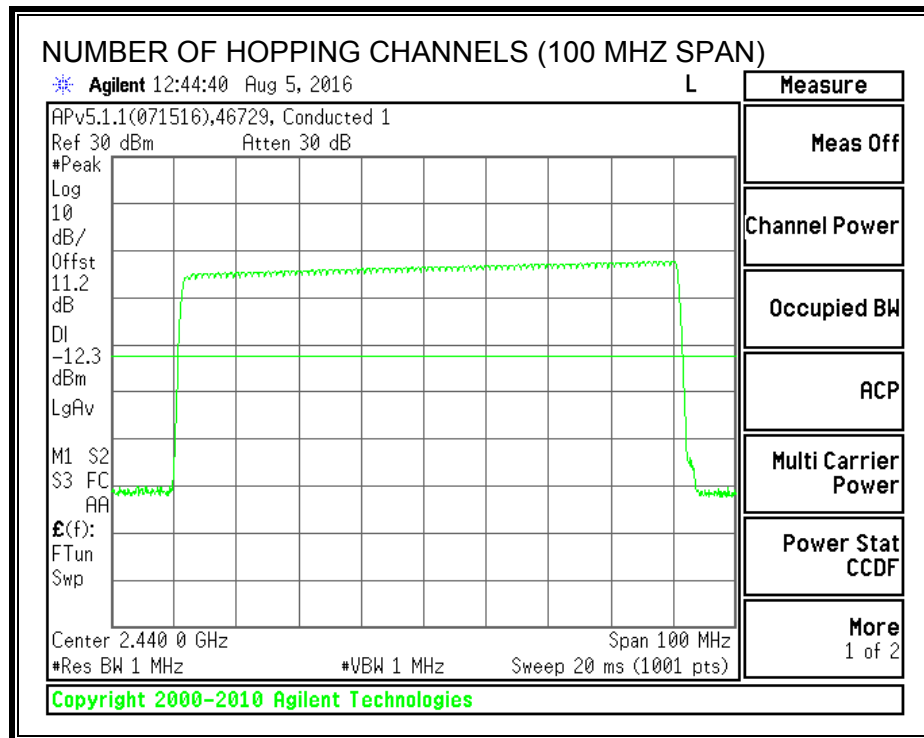
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps for visibility of the entire span. Then, smaller spans are set to more clearly identify the channels. The RBW is set to 30% of the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

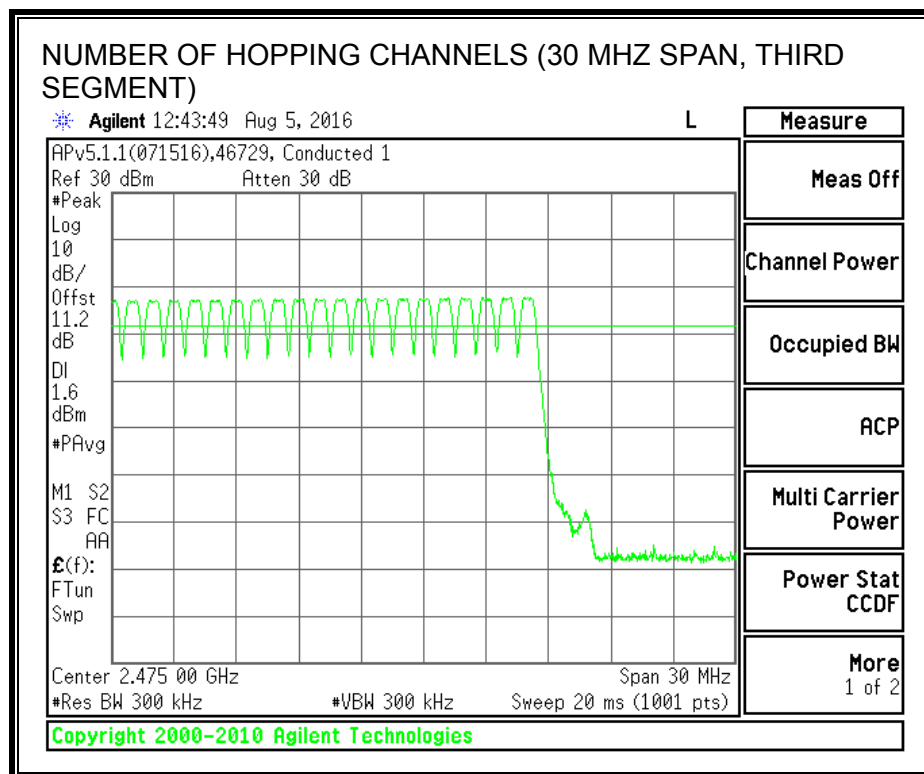
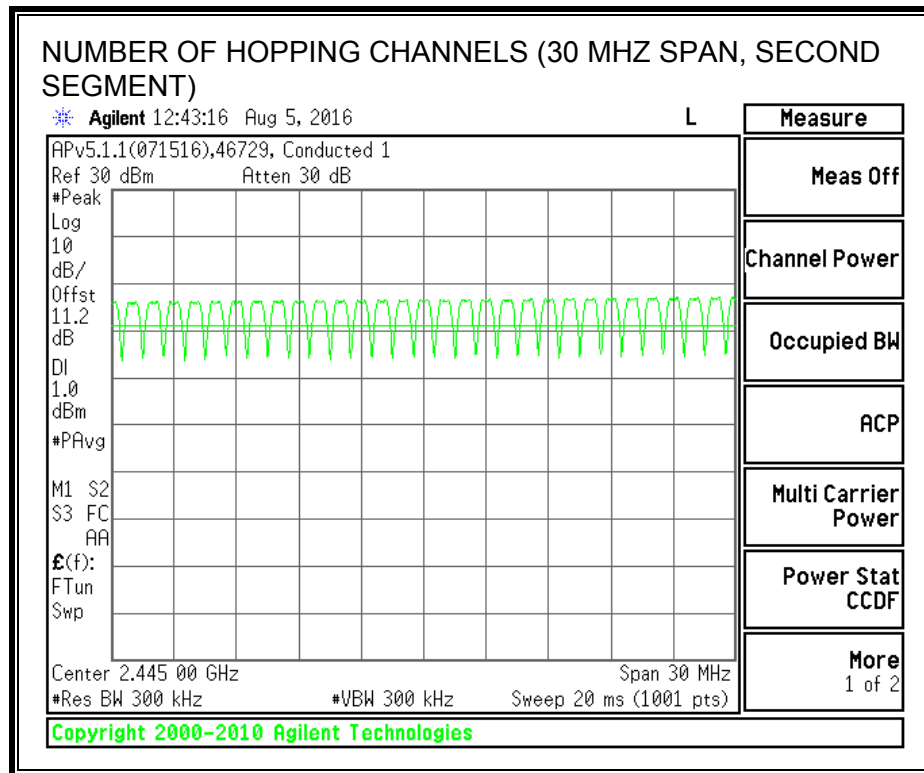
RESULTS

Normal Mode: 79 Channels observed.

Tested by: Ron Reichard/Jeff Cabrera
Test date: 2016-08-05

NUMBER OF HOPPING CHANNELS





8.4.4. 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 $10 * (\# \text{ of pulses in } 3.16 \text{ s}) * \text{pulse width}$.

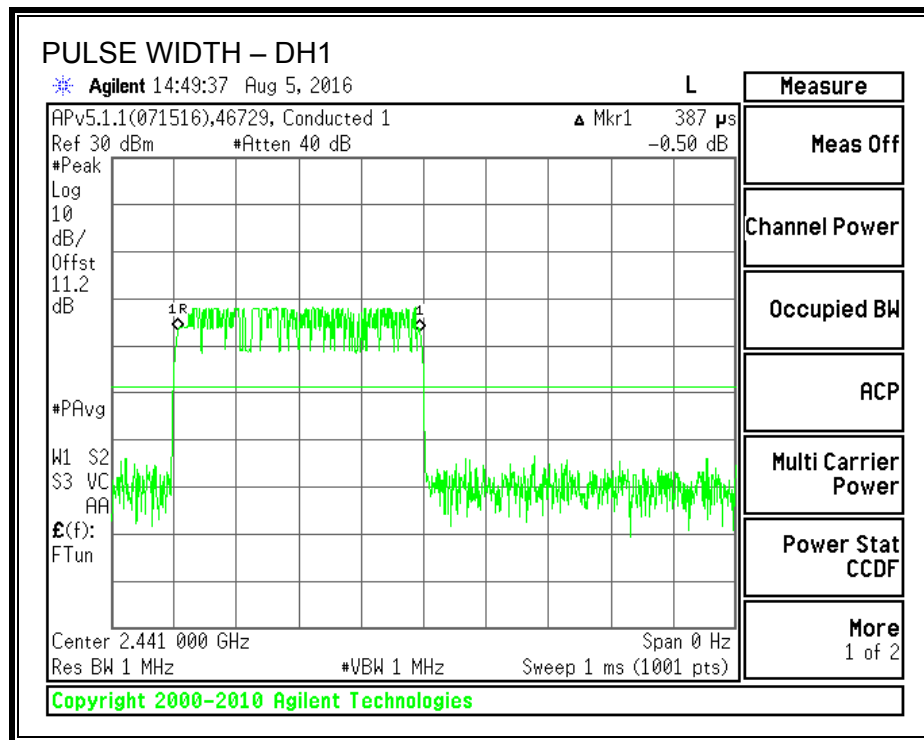
For AFH mode, the average time of occupancy in the specified 8 second period (20 channels * 0.4 seconds) is equal to $10 * (\# \text{ of pulses in } 0.8 \text{ s}) * \text{pulse width}$.

RESULTS

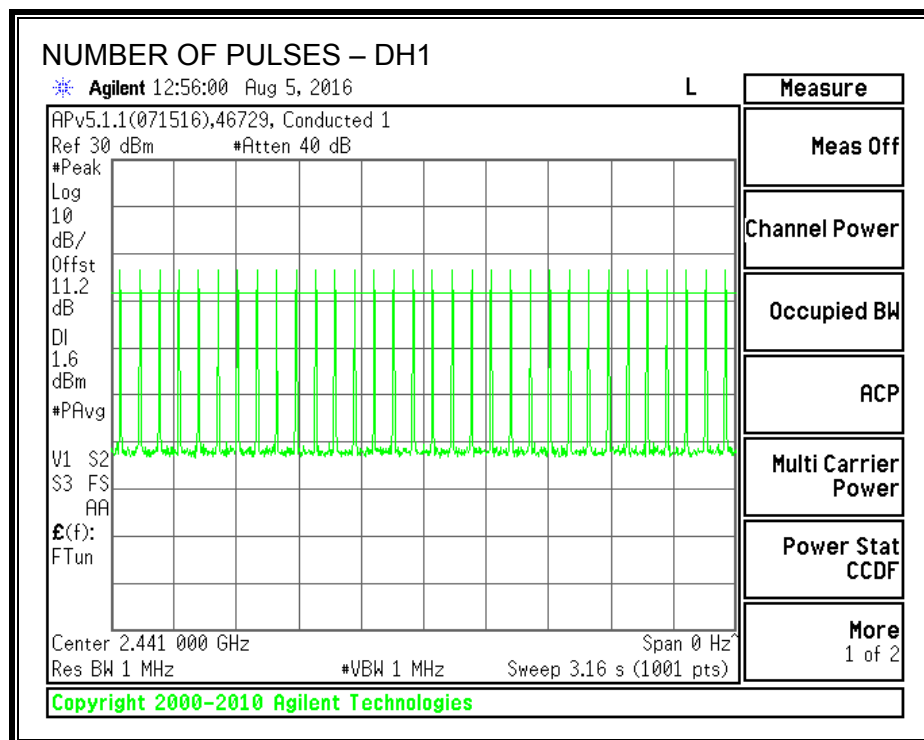
DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK Normal Mode					
DH1	0.387	32	0.124	0.4	-0.276
DH3	1.636	16	0.262	0.4	-0.138
DH5	2.864	10	0.286	0.4	-0.114
DH Packet	Pulse Width (msec)	Number of Pulses in 0.8 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK AFH Mode					
DH1	0.387	8	0.031	0.4	-0.369
DH3	1.636	4	0.065	0.4	-0.335
DH5	2.864	2.5	0.072	0.4	-0.328

Tested by: Ron Reichard/Jeff Cabrera
Test date: 2016-08-05

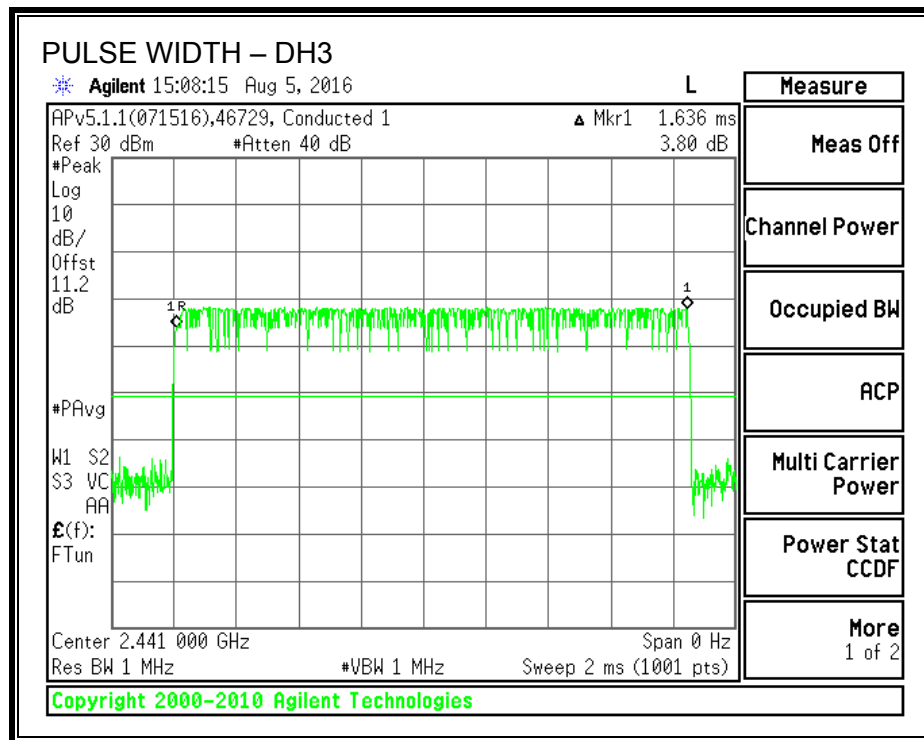
PULSE WIDTH - DH1



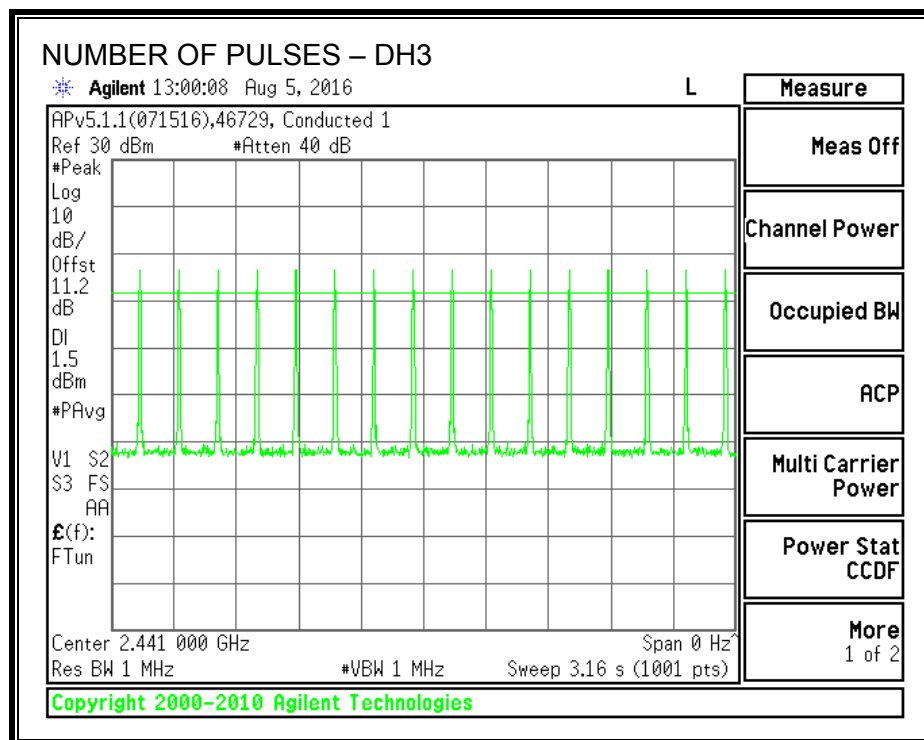
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1



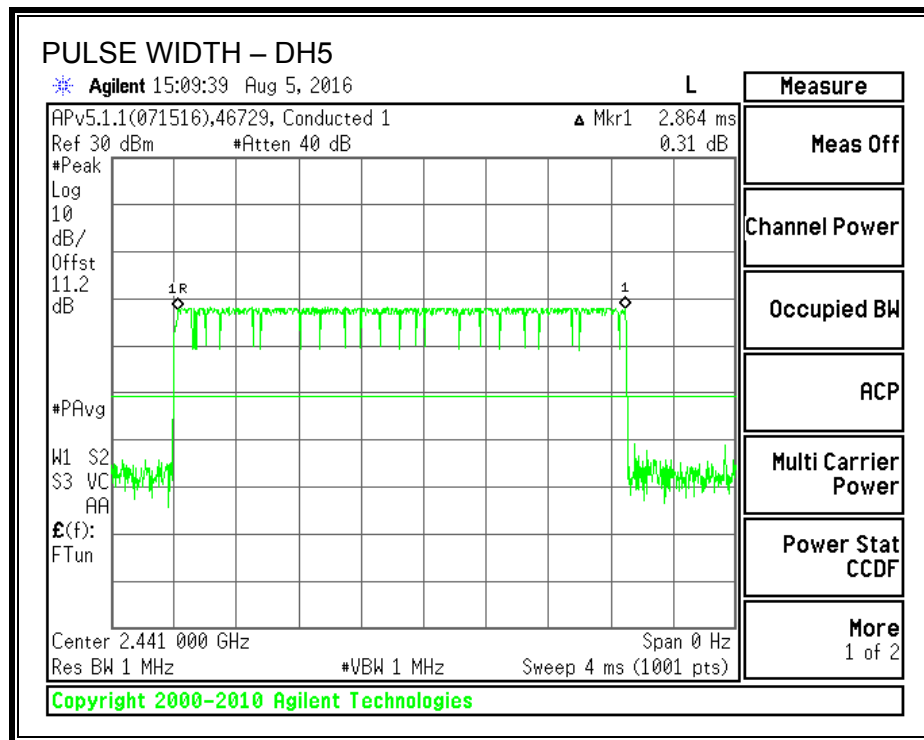
PULSE WIDTH – DH3



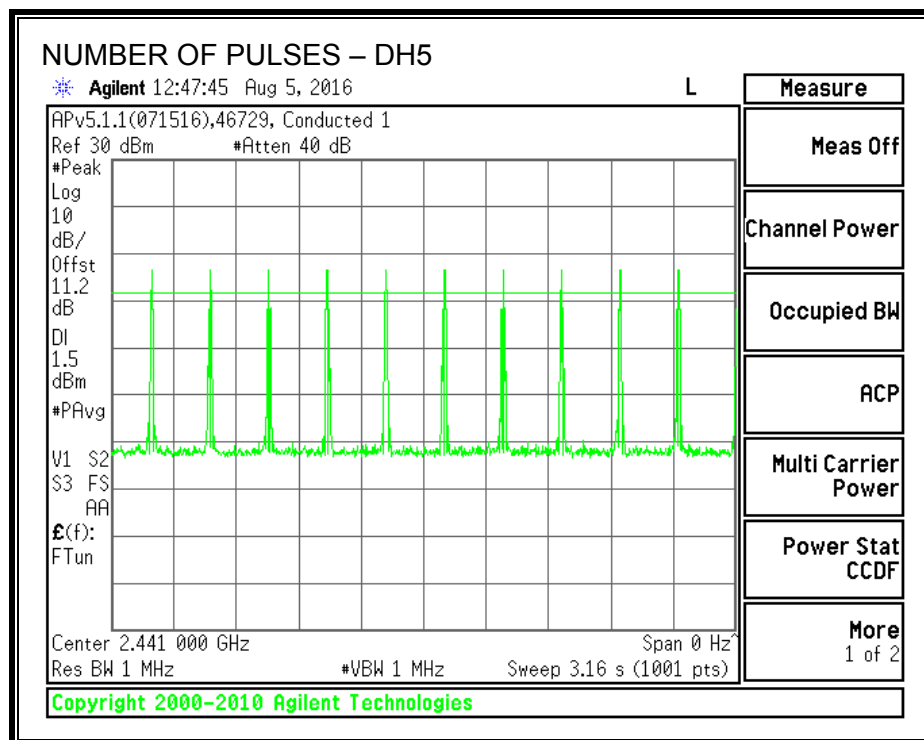
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3



PULSE WIDTH – DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5



8.4.5. 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 5.4 (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 is connected to a power meter.

RESULTS

Channel	Frequency (MHz)	Output Power (dBm)	Directional Gain (dBi)	Limit (dBm)	Margin (dB)
Low	2402	4.12	4.90	30	-25.88
Middle	2441	6.02	4.90	30	-23.98
High	2480	7.25	4.90	30	-22.75

Tested by: Mark Learner
Test date: 2016-08-03

8.4.6. AVERAGE POWER

LIMIT

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

The cable assembly insertion loss of 10.98 dB (including 10 dB pad and 0.98 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	3.88
Middle	2441	5.88
High	2480	7.12

Tested by: Mark Learner
Test date: 2016-08-03

8.4.7. 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.

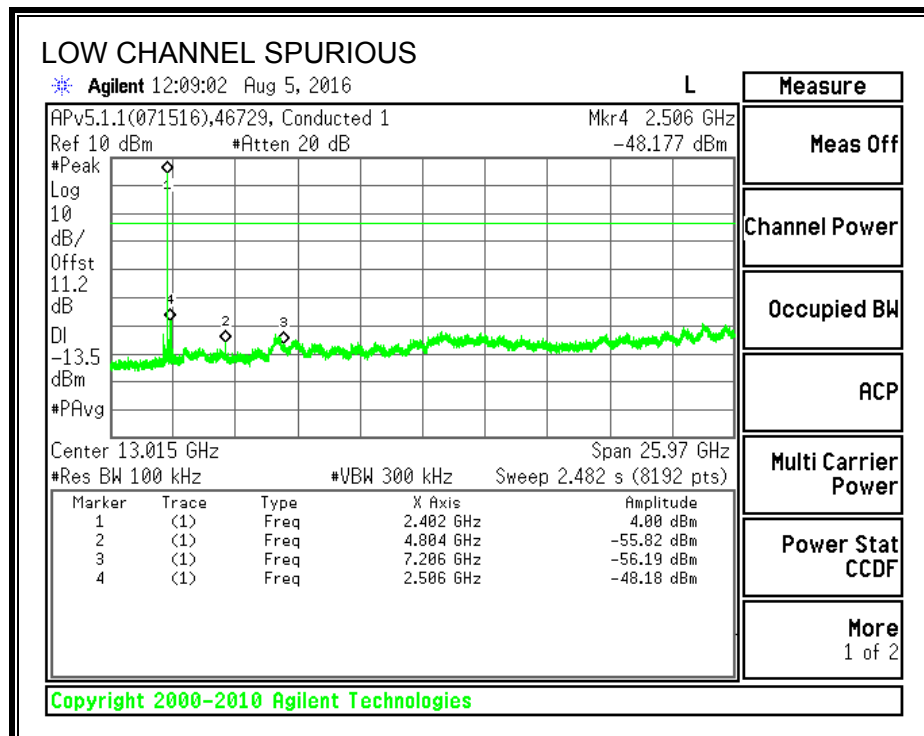
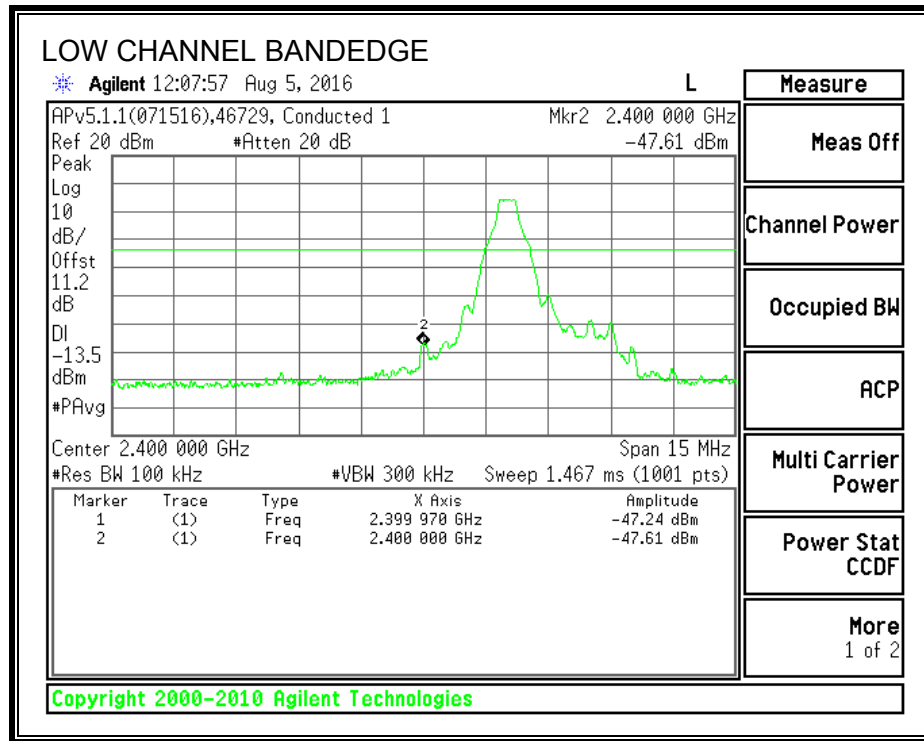
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

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

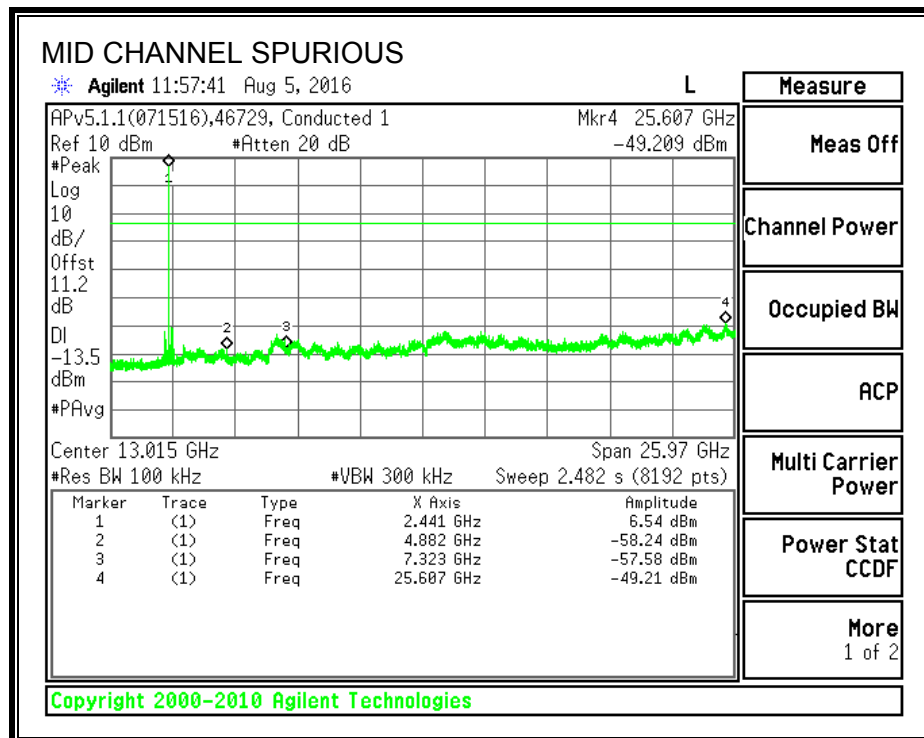
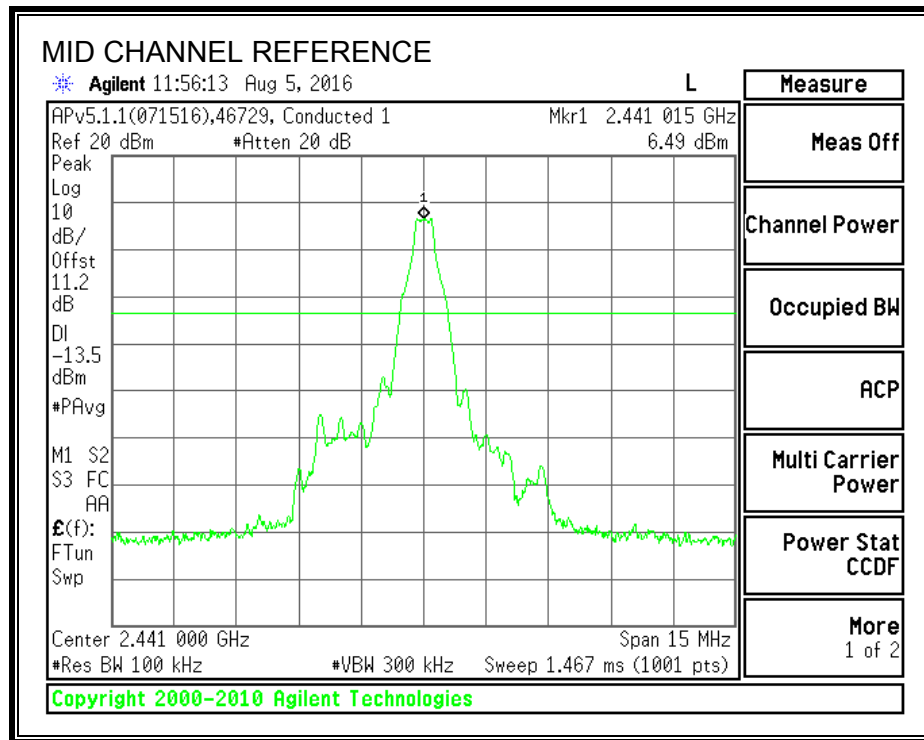
Tested by: Ron Reichard/Jeff Cabrera
Test date: 2016-08-05

RESULTS

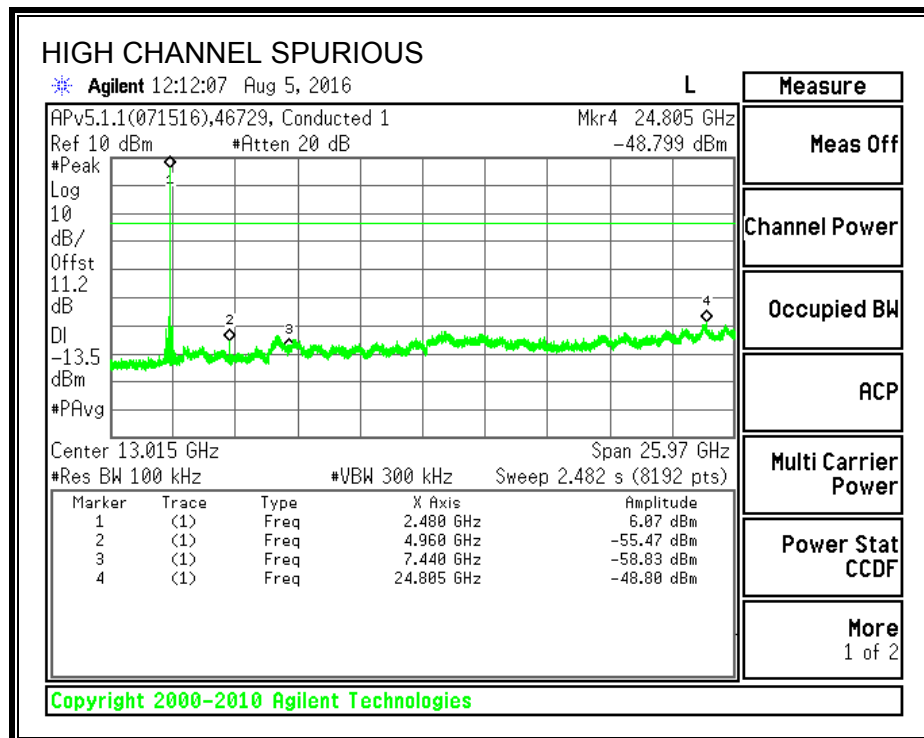
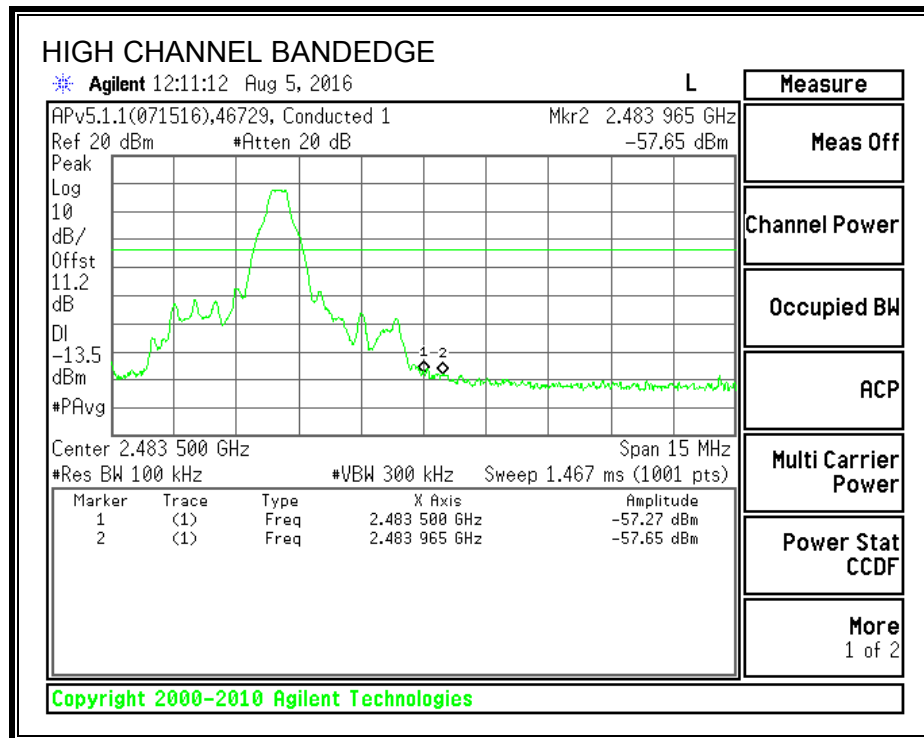
SPURIOUS EMISSIONS, LOW CHANNEL



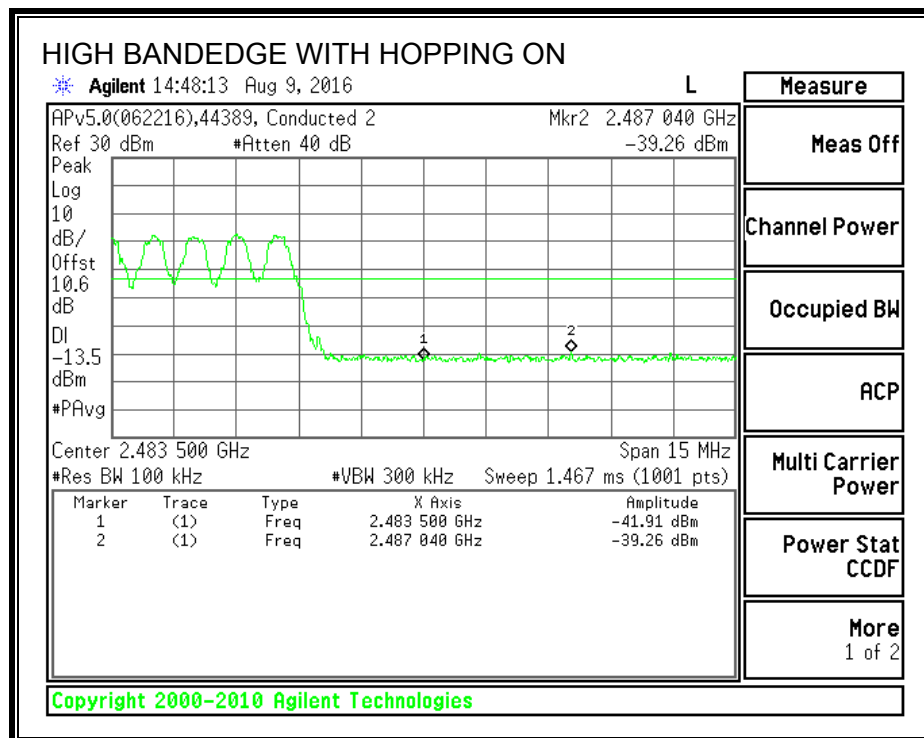
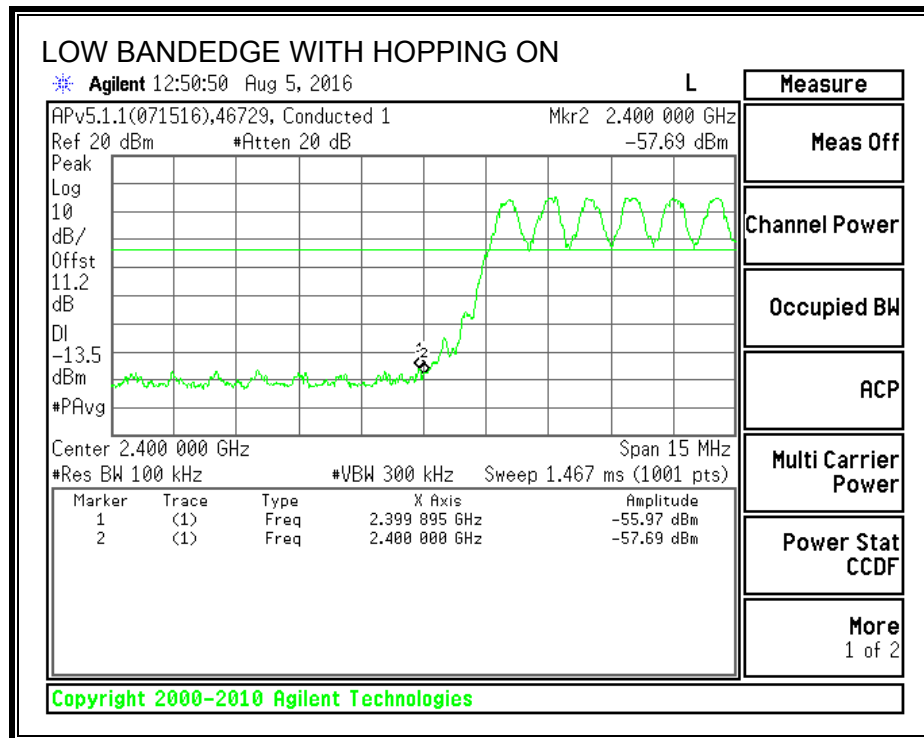
SPURIOUS EMISSIONS, MID CHANNEL



SPURIOUS EMISSIONS, HIGH CHANNEL



SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



8.5. ENHANCED DATA RATE DQPSK MODULATION

8.5.1. 20 dB AND 99% BANDWIDTH

LIMIT

None; for reporting purposes only. Test per FCC §15.247(a)(1); IC RSS-247 5.1 (1), RSS-Gen 6.6.

TEST PROCEDURE

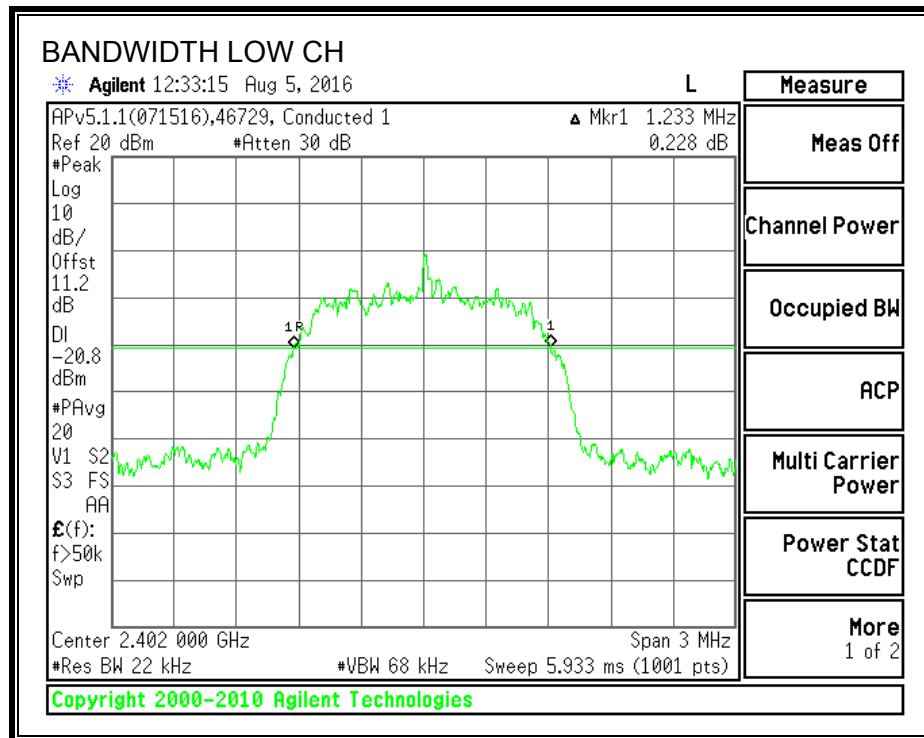
The transmitter output is connected to a spectrum analyzer. The RBW is set to 1-5% of the 20 dB bandwidth and 99% Occupied Bandwidth. The VBW is set to $\geq$ RBW. The sweep time is coupled.

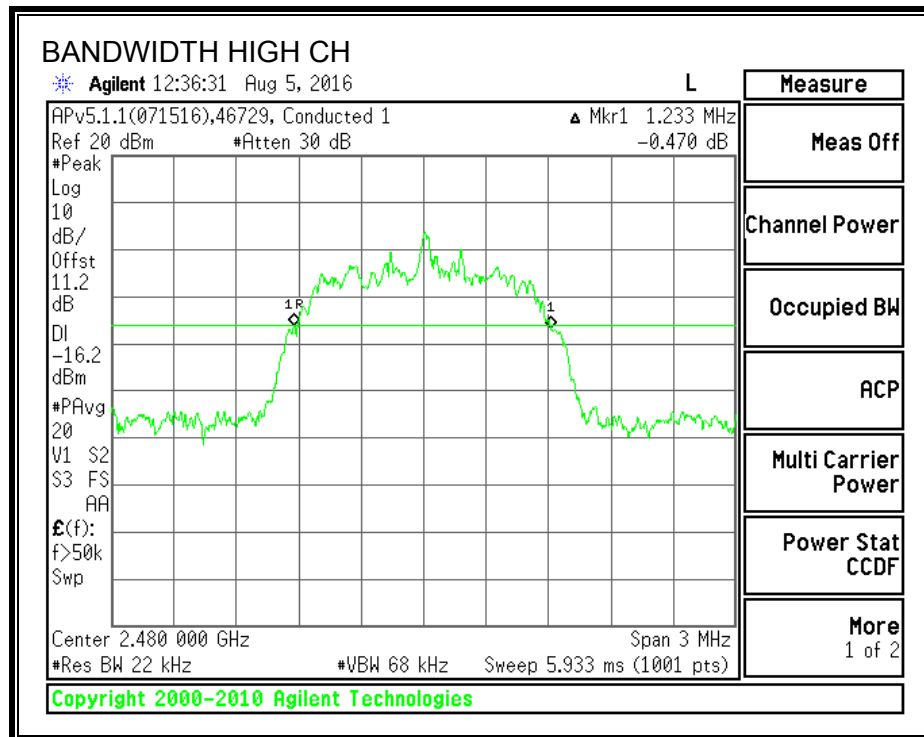
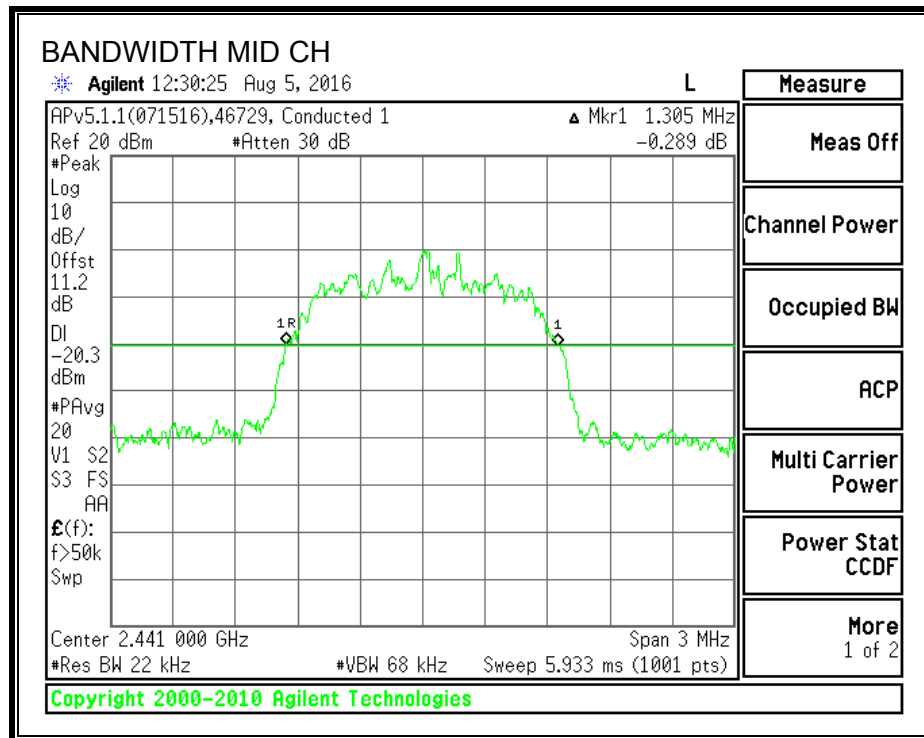
RESULTS

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)	99% Bandwidth (kHz)
Low	2402	1233	1183.2
Middle	2441	1305	1197.8
High	2480	1233	1204.5

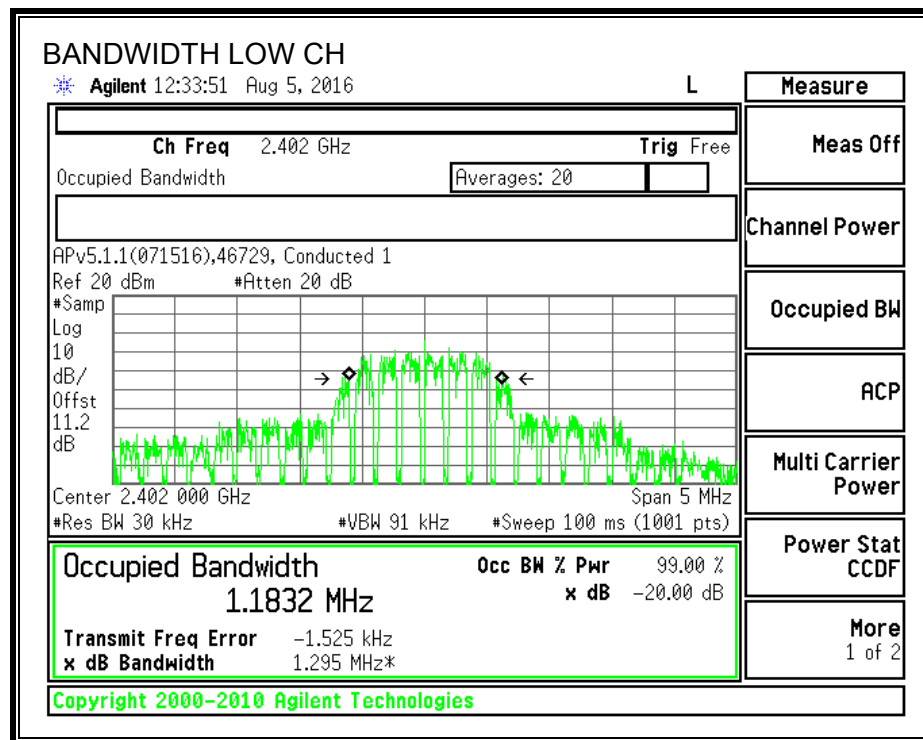
Tested by: Ron Reichard/Jeff Cabrera
Test date: 2016-08-05

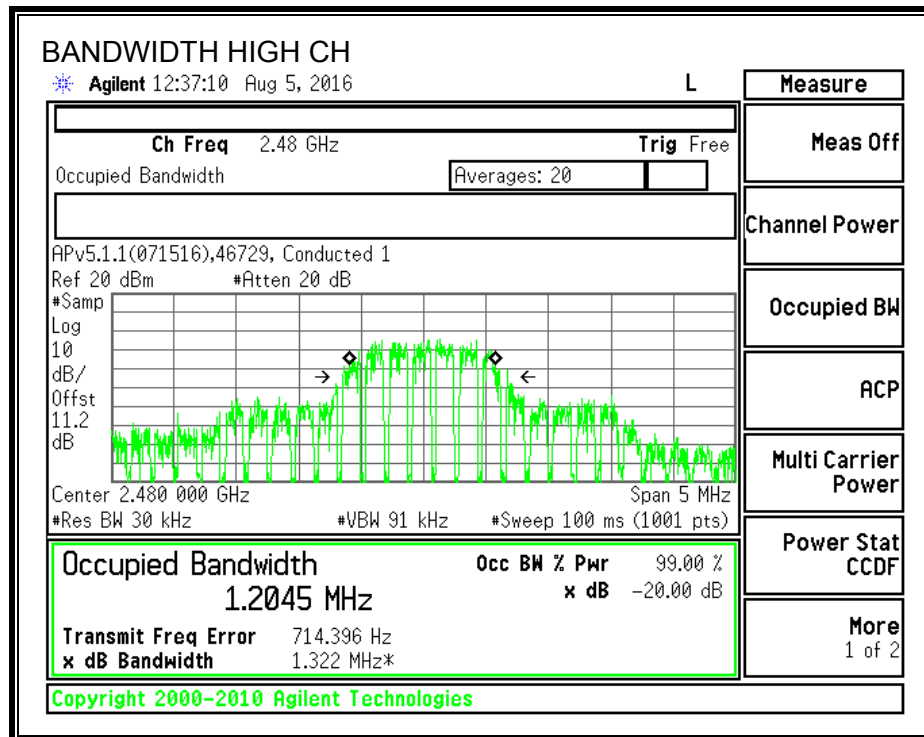
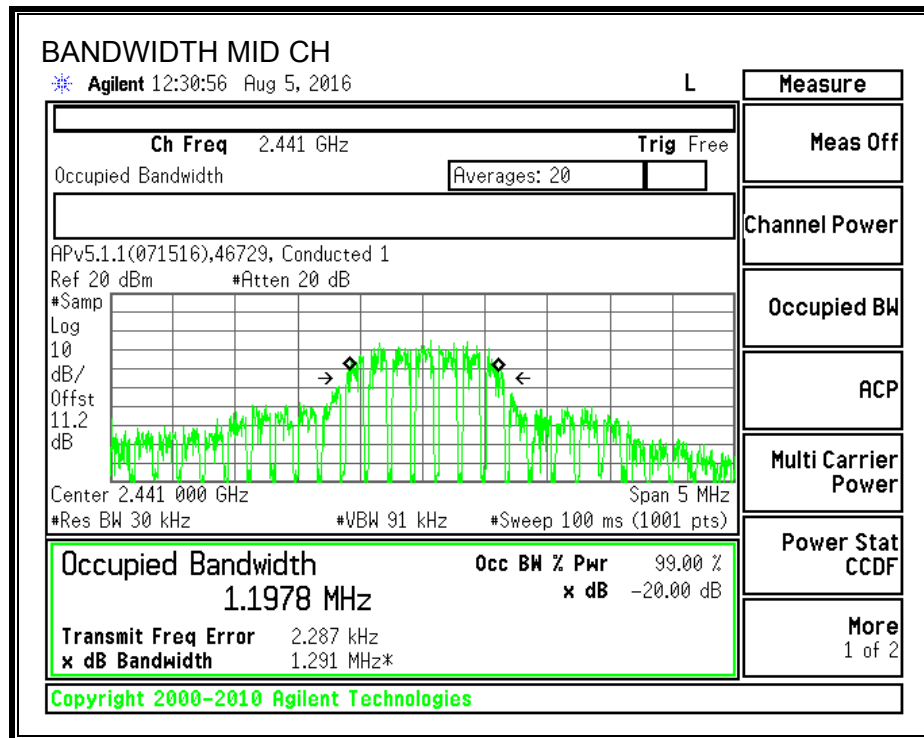
20 dB BANDWIDTH





99% BANDWIDTH





8.5.2. 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 hopping 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.

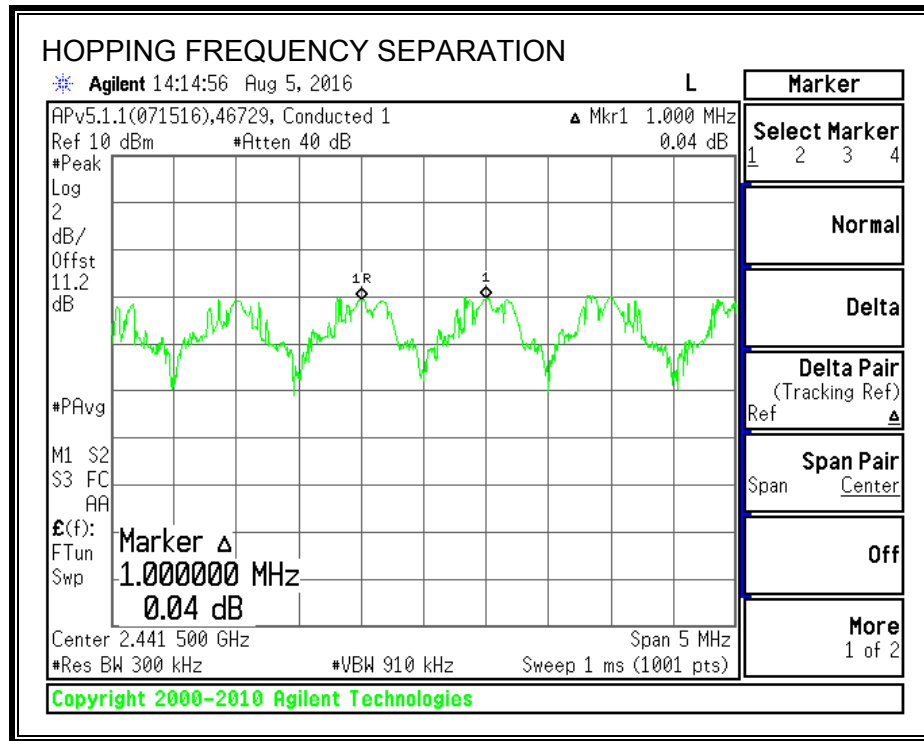
TEST PROCEDURE

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 .

Tested by: Ron Reichard/Jeff Cabrera

Test date: 2016-08-05

RESULTS



Ch. A (MHz)	Ch. B (MHz)	Ch. 1 to Ch. 2 Sep. (MHz)	Max. 20 dB BW (MHz)	2/3 20 dB Margin (MHz)	Margin (MHz)
2441	2442	1.000	1.305	0.870	-0.130

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. 900 kHz).

8.5.3. 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.

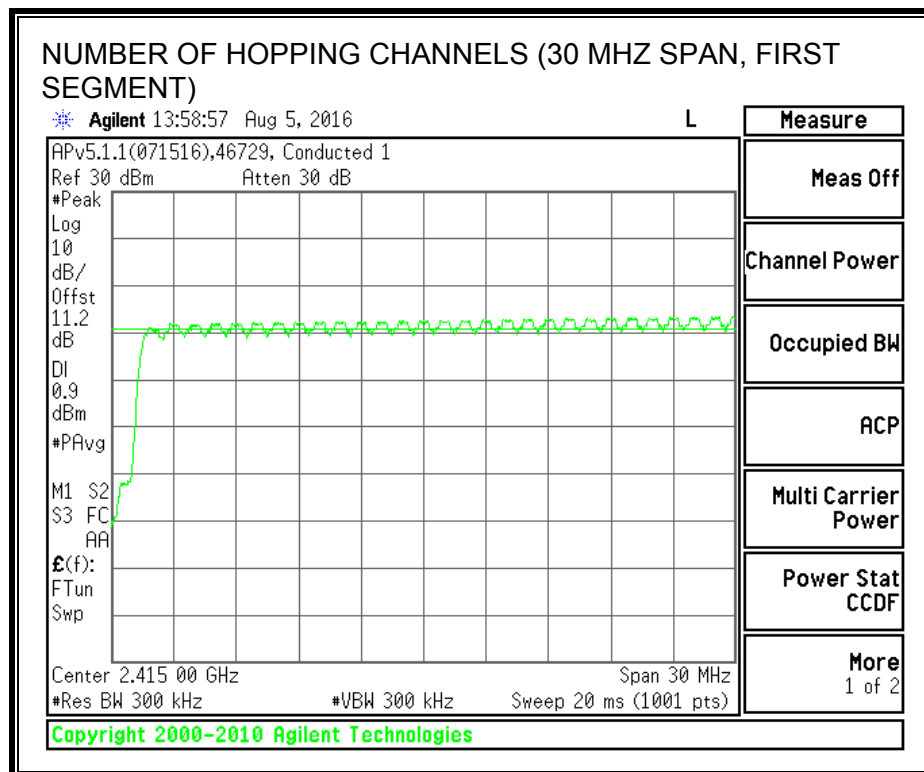
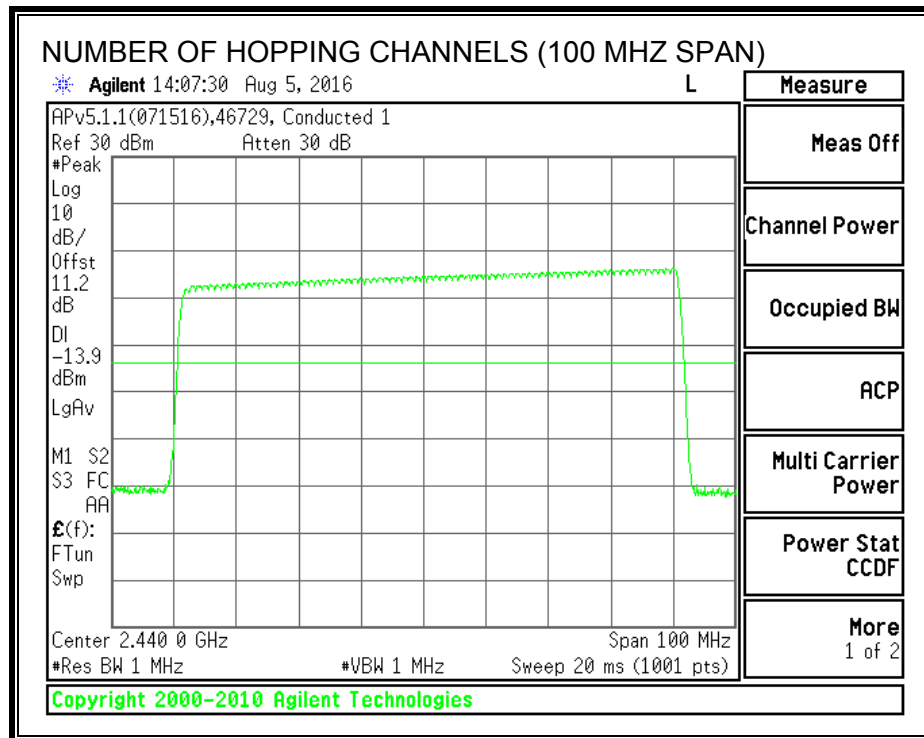
RESULTS

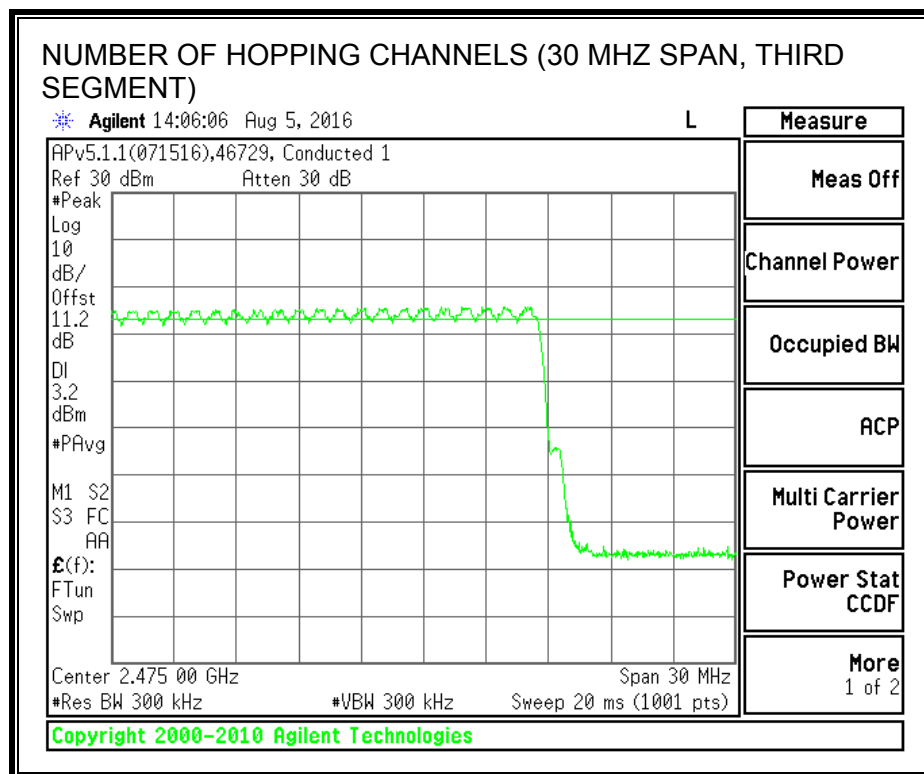
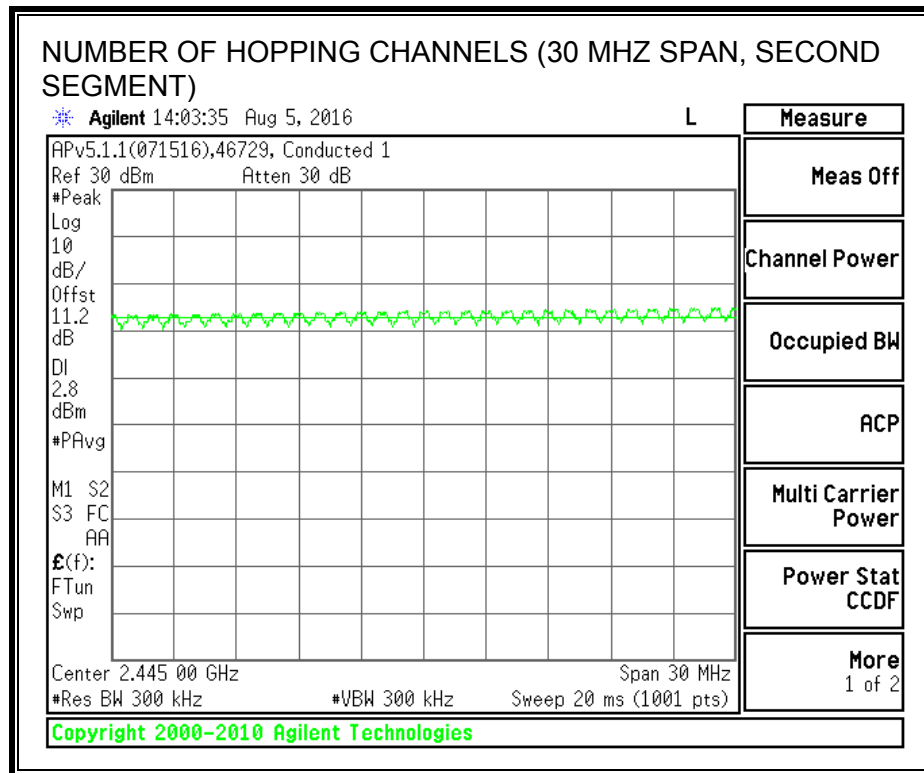
Normal Mode: 79 Channels observed.

Tested by: Ron Reichard/Jeff Cabrera

Test date: 2016-08-05

NUMBER OF HOPPING CHANNELS





8.5.4. 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 $10 * (\# \text{ of pulses in } 3.16 \text{ s}) * \text{pulse width}$.

RESULTS

Time Of Occupancy = $10 * xx \text{ pulses} * yy \text{ msec} = zz \text{ msec}$

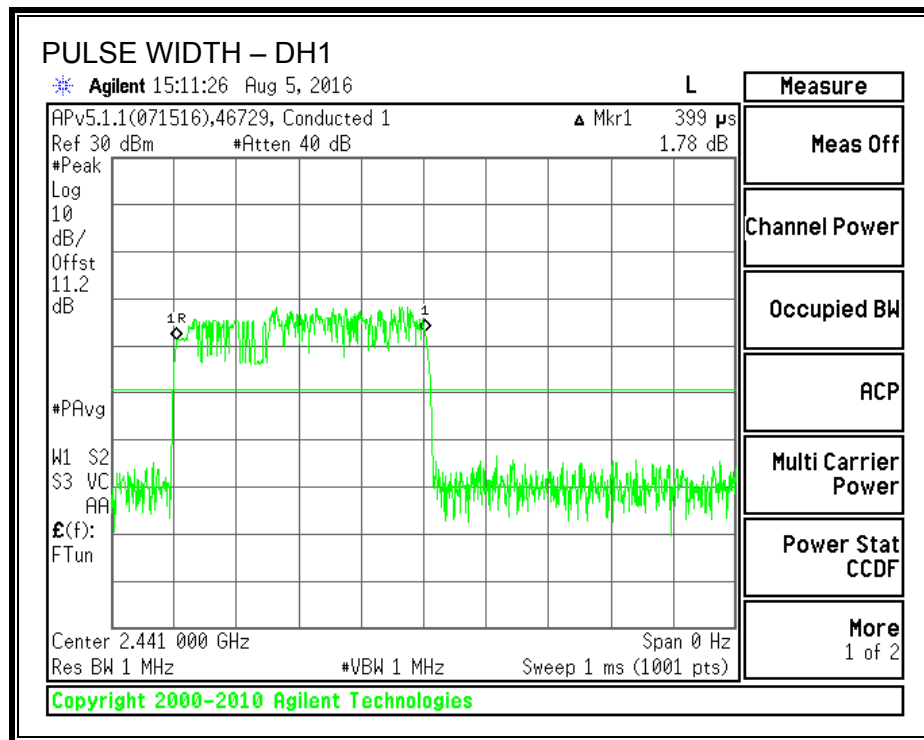
DQPSK Mode

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	1.634	16	0.261	0.4	-0.139
DH5	2.868	11	0.315	0.4	-0.085

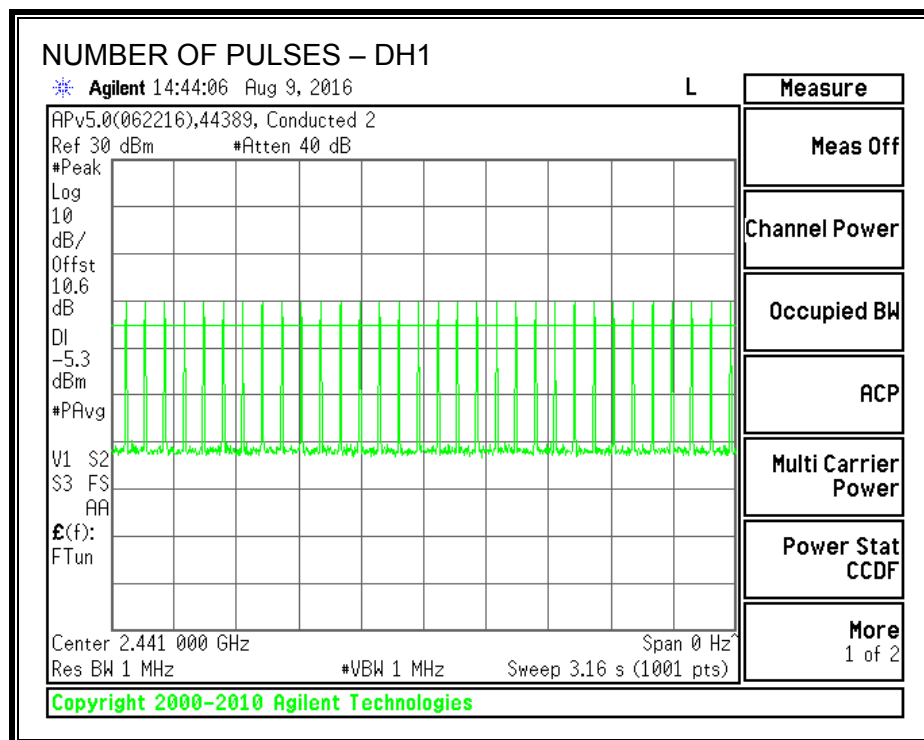
Note: for AFH (DQPSK) mode, please refer to the results of AFH (GFSK) mode; the channel selection and hopping rate are the same for both EDR and Basic Rate operation, data for Basic Rate on page 30 demonstrates compliance with channel occupancy when AFH is employed.

Tested by: Ron Reichard/Niklas Haydon/Jeff Cabrera
Test date: 2016-08-05 to 2016-08-09

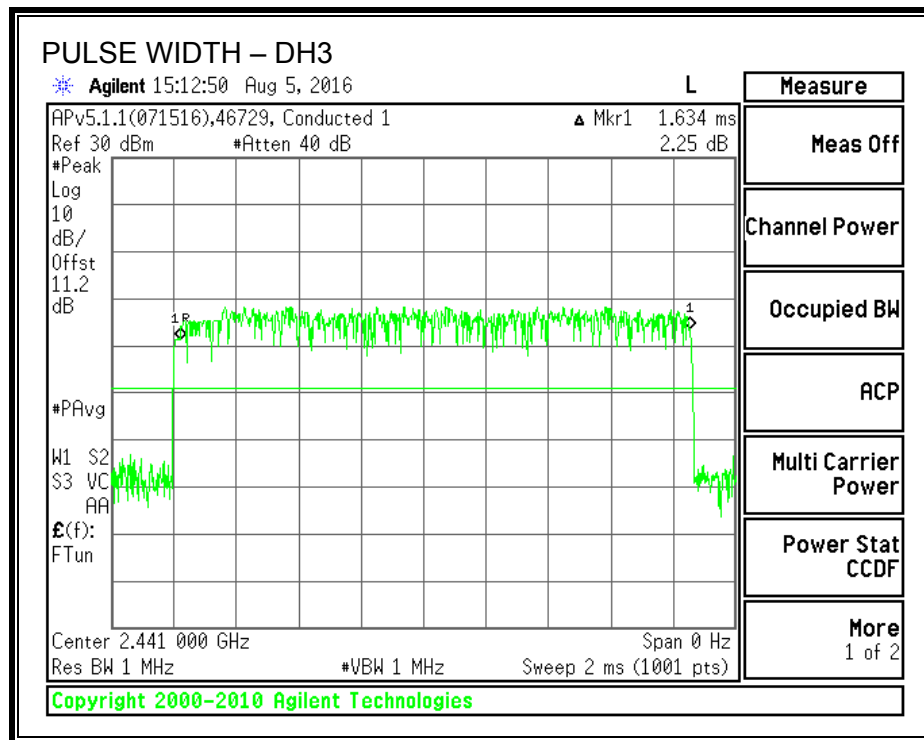
PULSE WIDTH - DH1



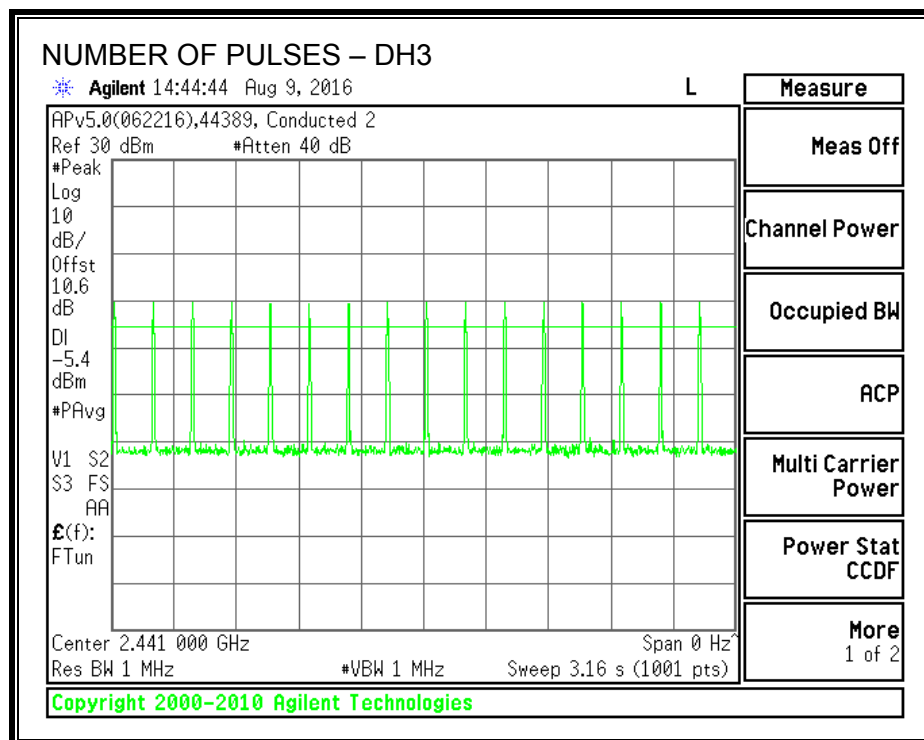
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1



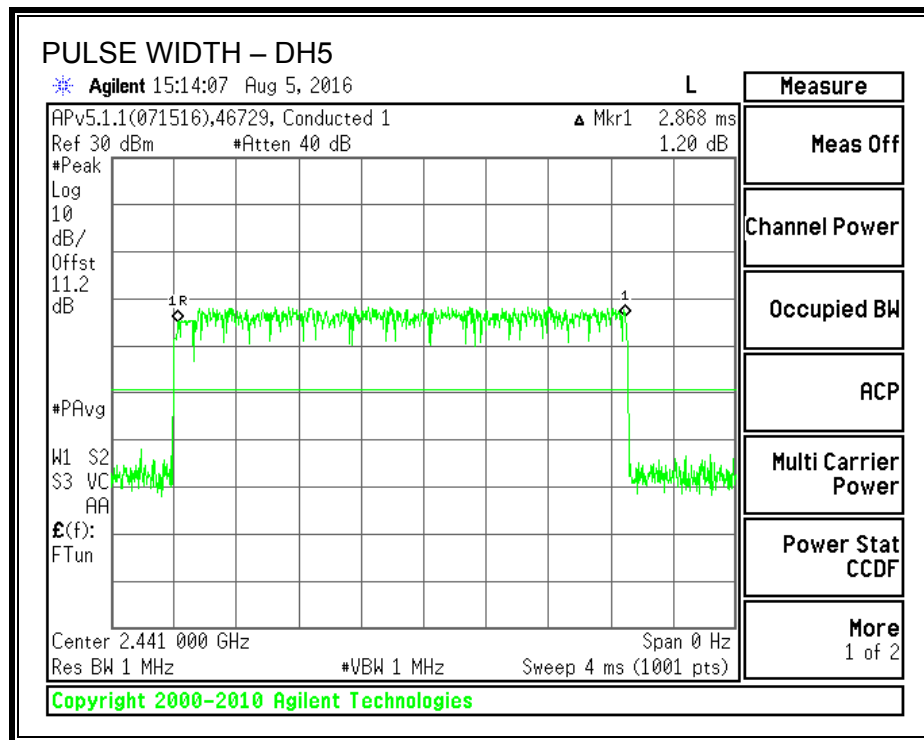
PULSE WIDTH – DH3



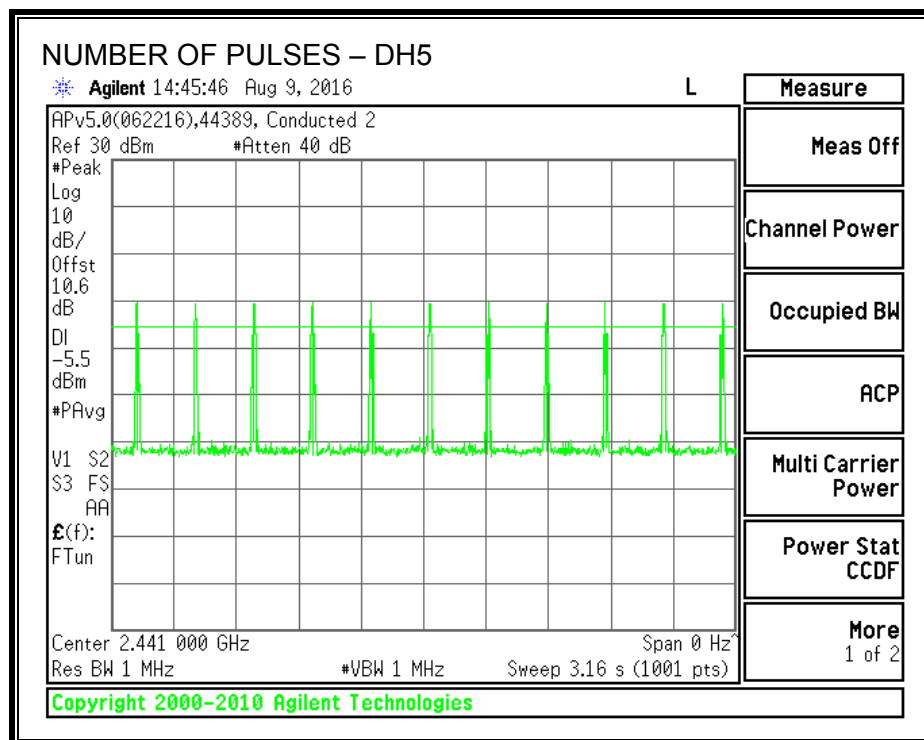
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3



PULSE WIDTH – DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5



8.5.5. 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 5.4 (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 is connected to a power meter.

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.

Channel	Frequency (MHz)	Output Power (dBm)	Directional Gain (dBi)	Limit (dBm)	Margin (dB)
Low	2402	2.03	4.90	21	-18.97
Middle	2441	4.55	4.90	21	-16.45
High	2480	5.99	4.90	21	-15.01

Tested by: Mark Learner
Test date: 2016-08-03

8.5.6. AVERAGE POWER

LIMIT

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

The cable assembly insertion loss of 10.98 dB (including 10 dB pad and 0.98 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	-0.43
Middle	2441	2.10
High	2480	3.78

Tested by: Mark Learner
Test date: 2016-08-03

8.5.7. 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.

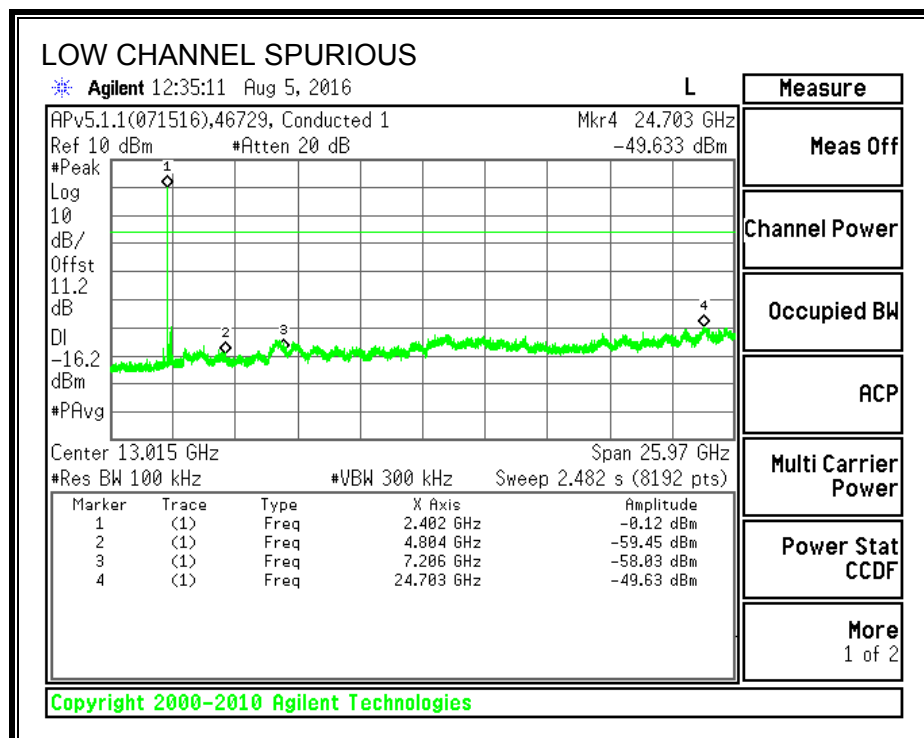
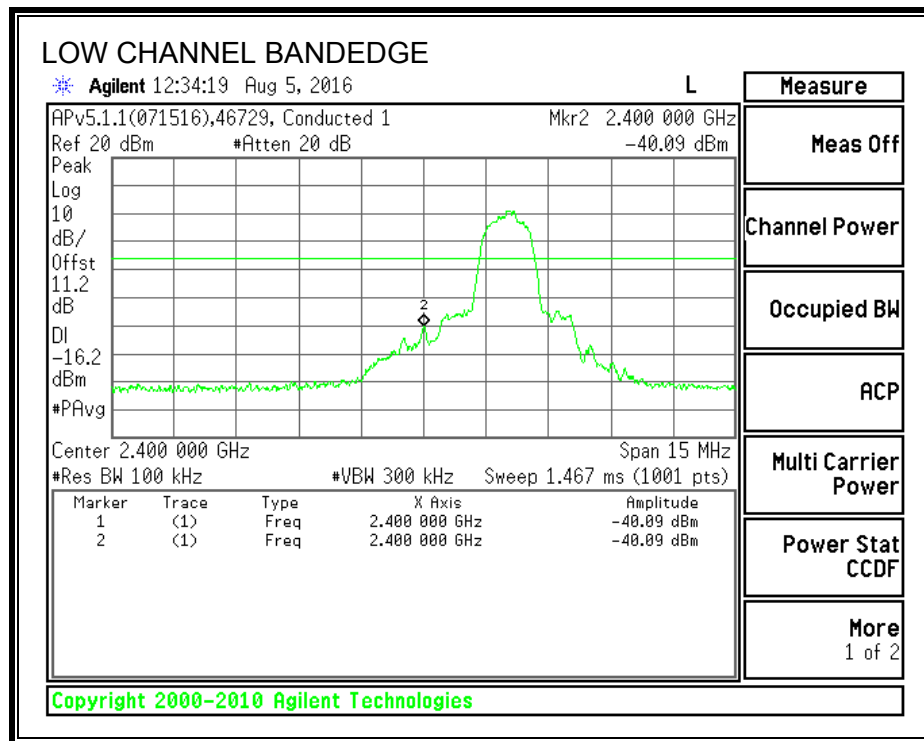
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

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

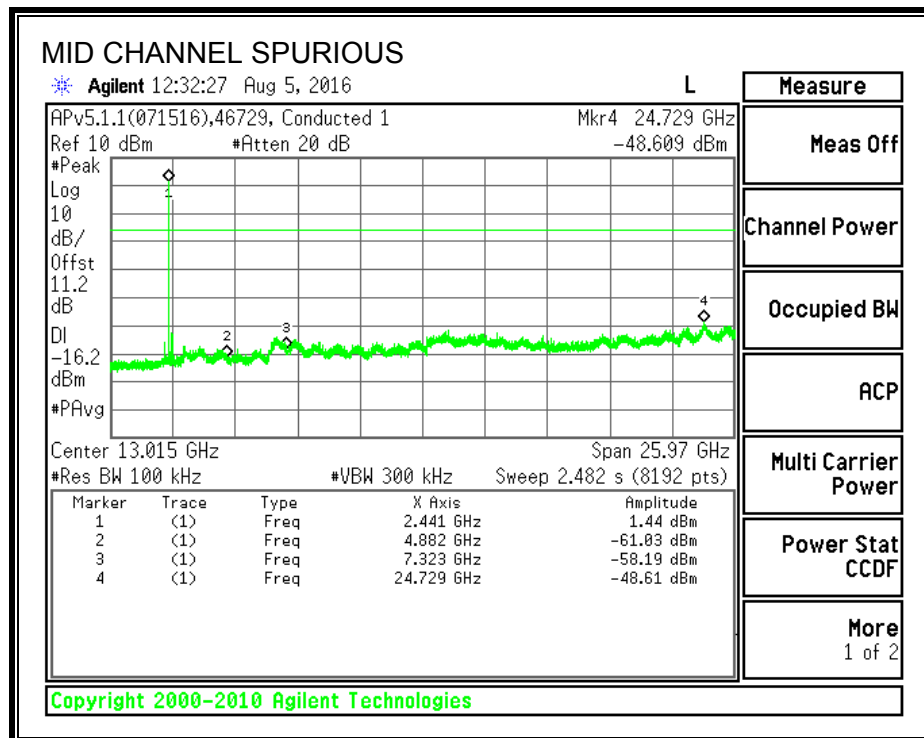
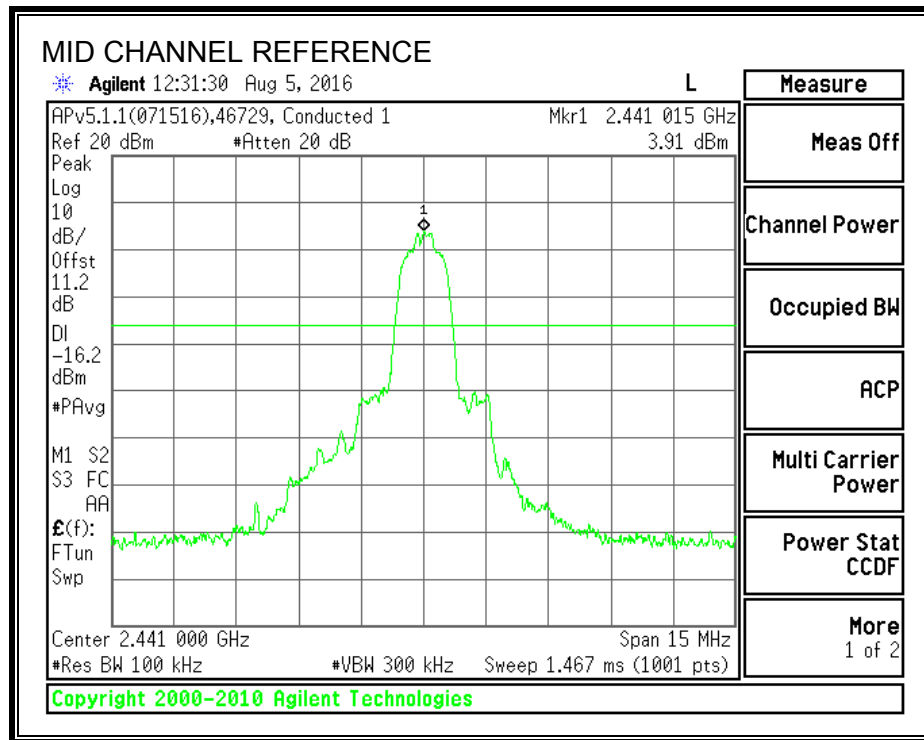
Tested by: Ron Reichard/Niklas Haydon/Jeff Cabrera
Test date: 2016-08-05 to 2016-08-09

RESULTS

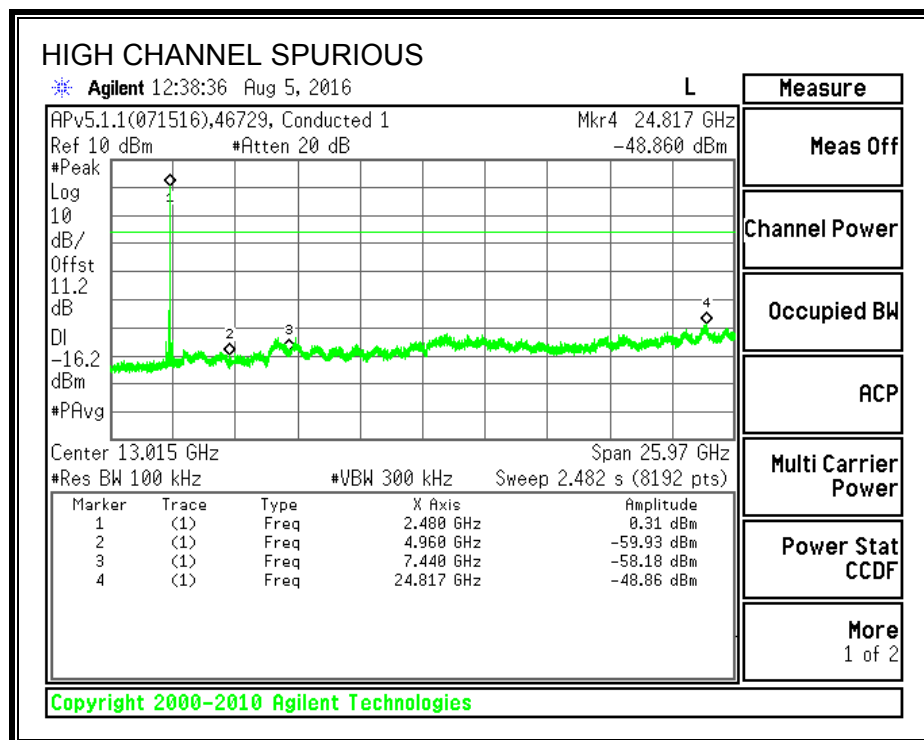
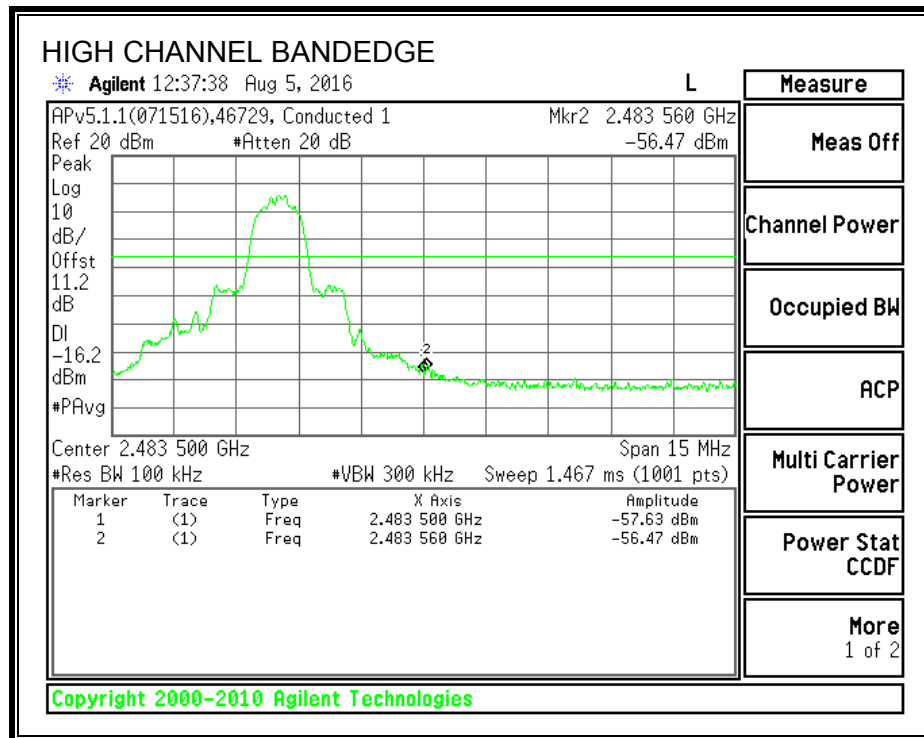
SPURIOUS EMISSIONS, LOW CHANNEL



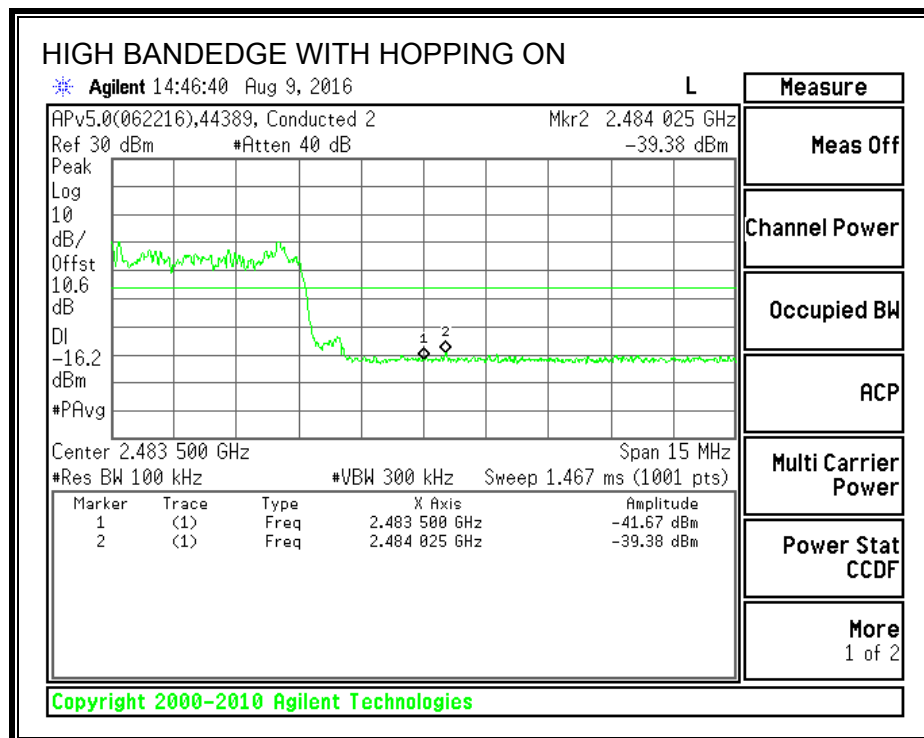
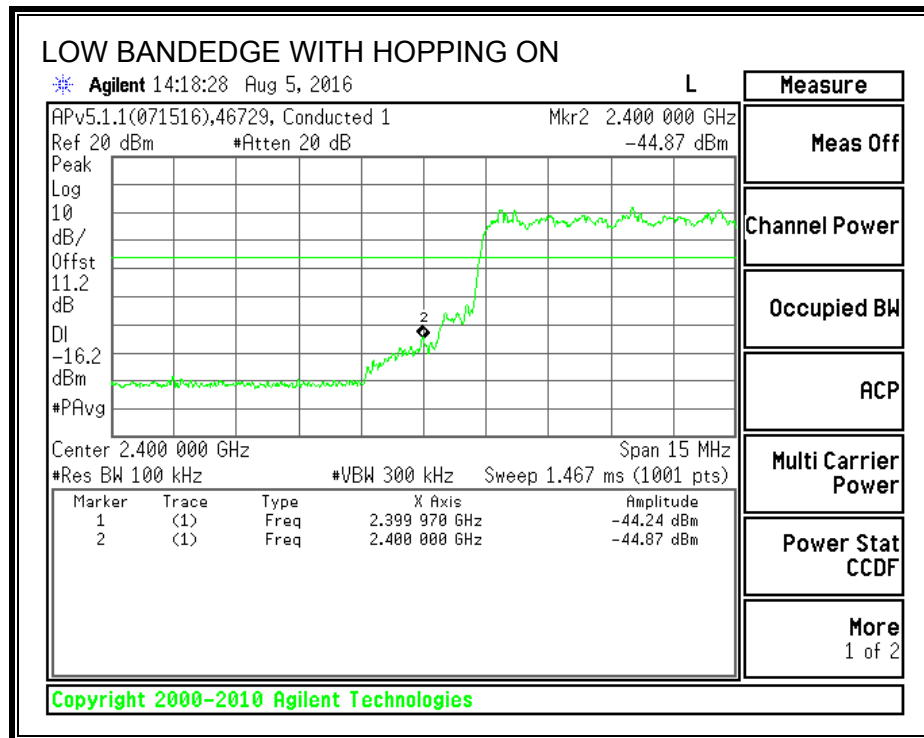
SPURIOUS EMISSIONS, MID CHANNEL



SPURIOUS EMISSIONS, HIGH CHANNEL



SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



8.6. ENHANCED DATA RATE 8PSK MODULATION

8.6.1. 20 dB AND 99% BANDWIDTH

LIMIT

None; for reporting purposes only. Test per FCC §15.247(a)(1); IC RSS-247 5.1 (1), RSS-Gen 6.6.

TEST PROCEDURE

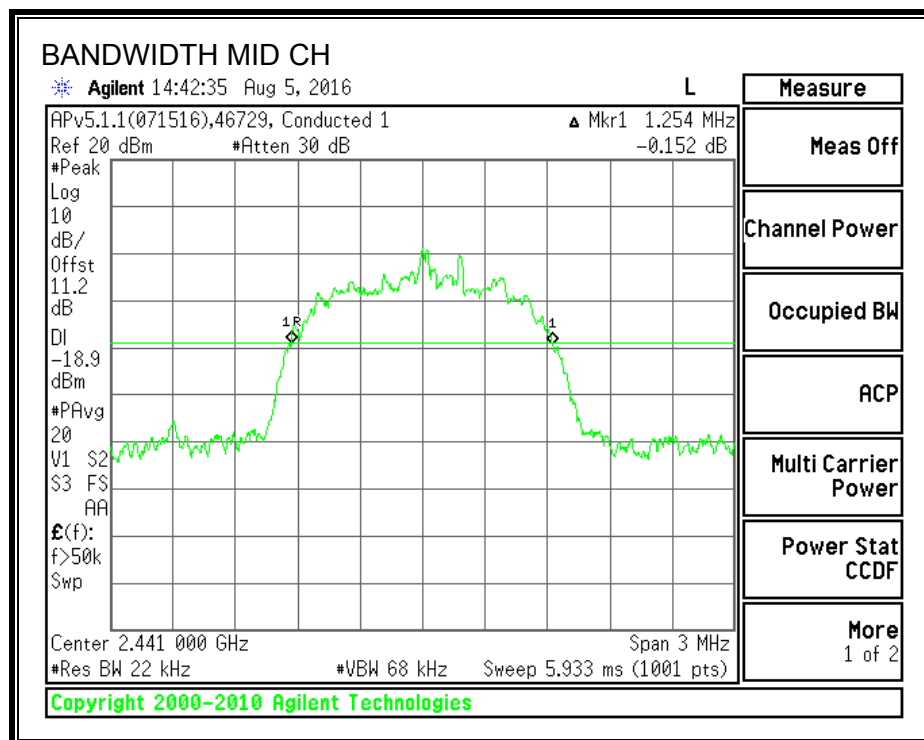
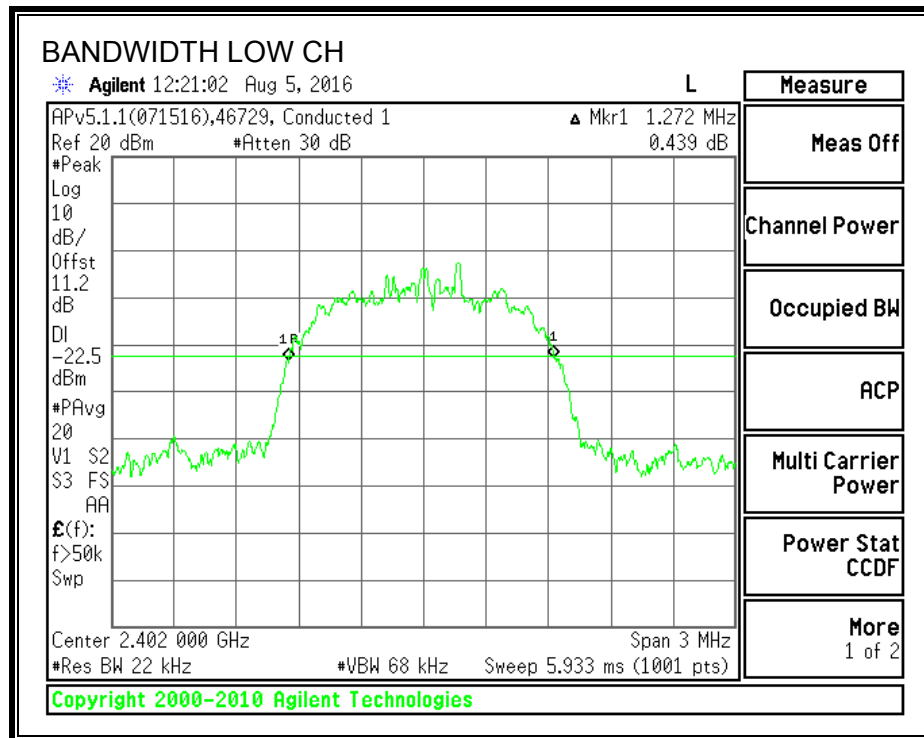
The transmitter output is connected to a spectrum analyzer. The RBW is set to 1-5% of the 20 dB bandwidth and 99% Occupied Bandwidth. The VBW is set to $\geq$ RBW. The sweep time is coupled.

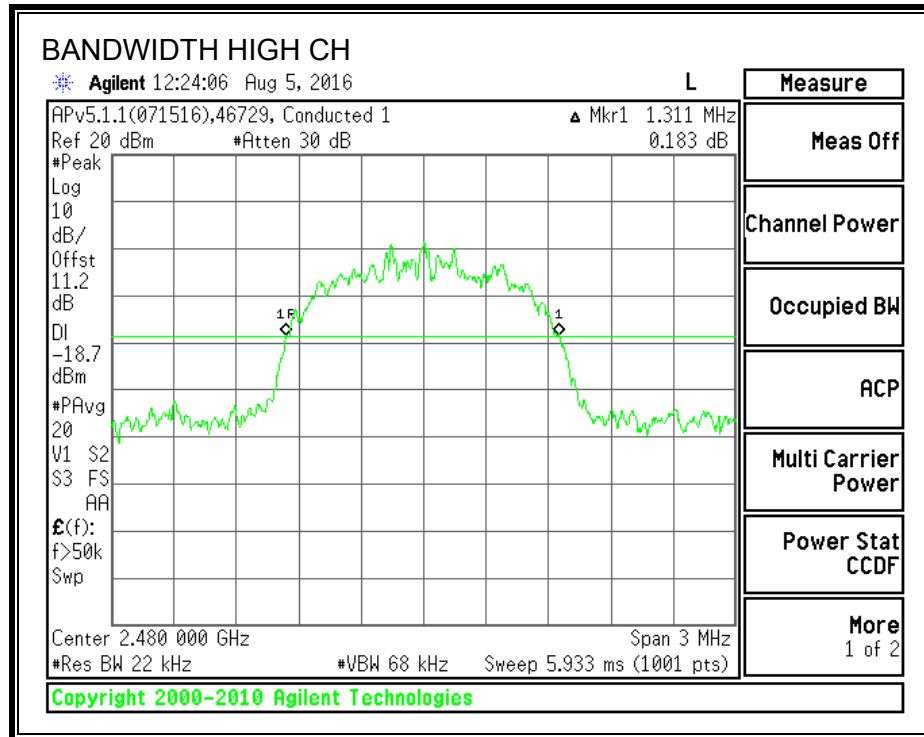
RESULTS

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)	99% Bandwidth (kHz)
Low	2402	1272	1194.4
Middle	2441	1254	1205.4
High	2480	1311	1213.1

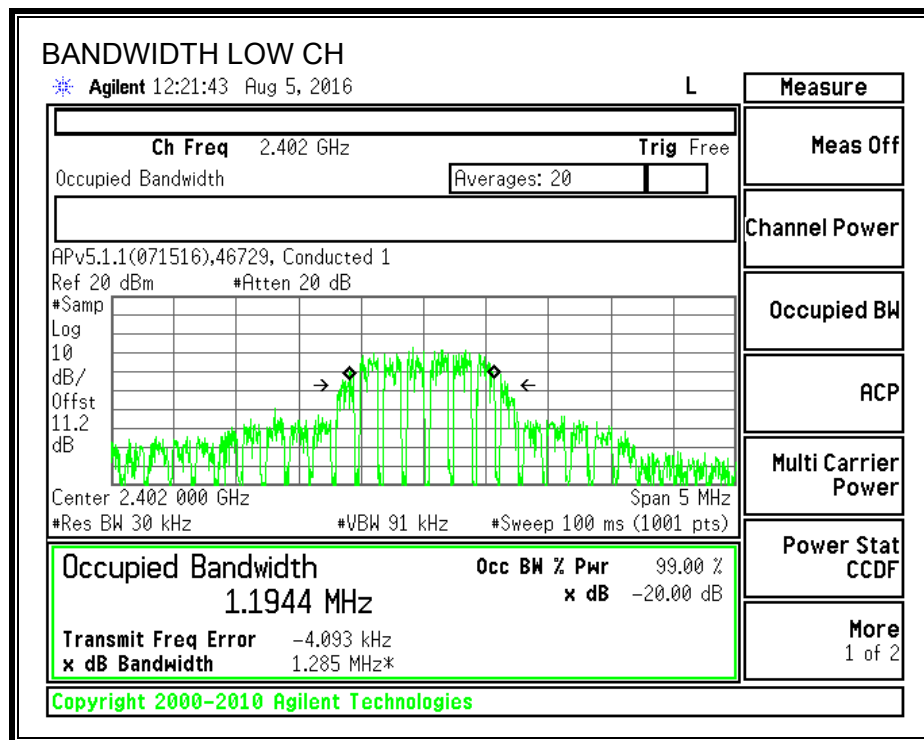
Tested by: Ron Reichard/Jeff Cabrera
Test date: 2016-08-05

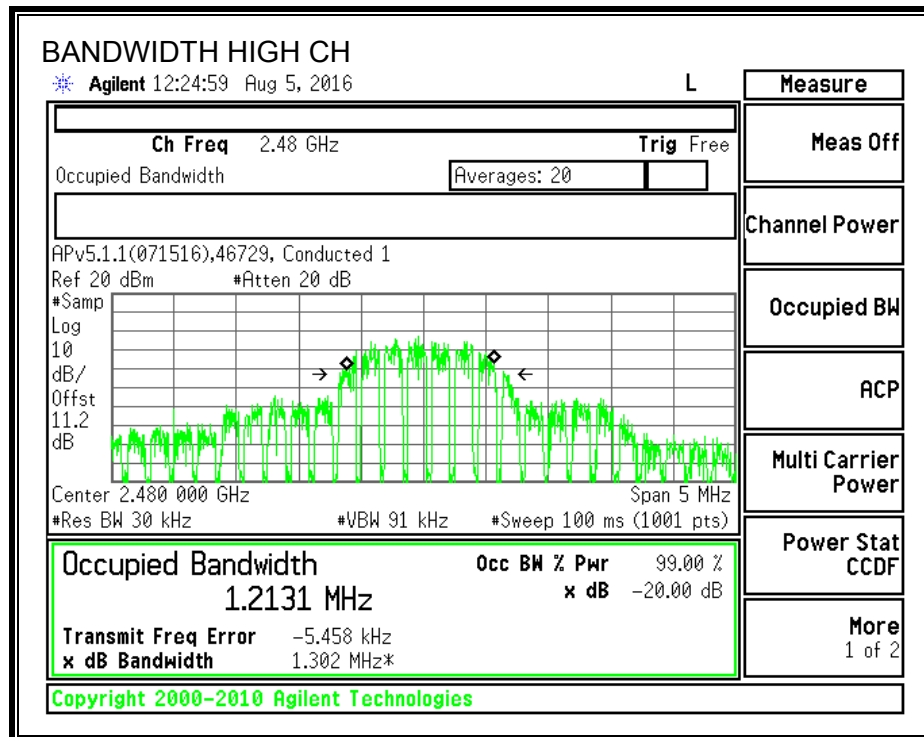
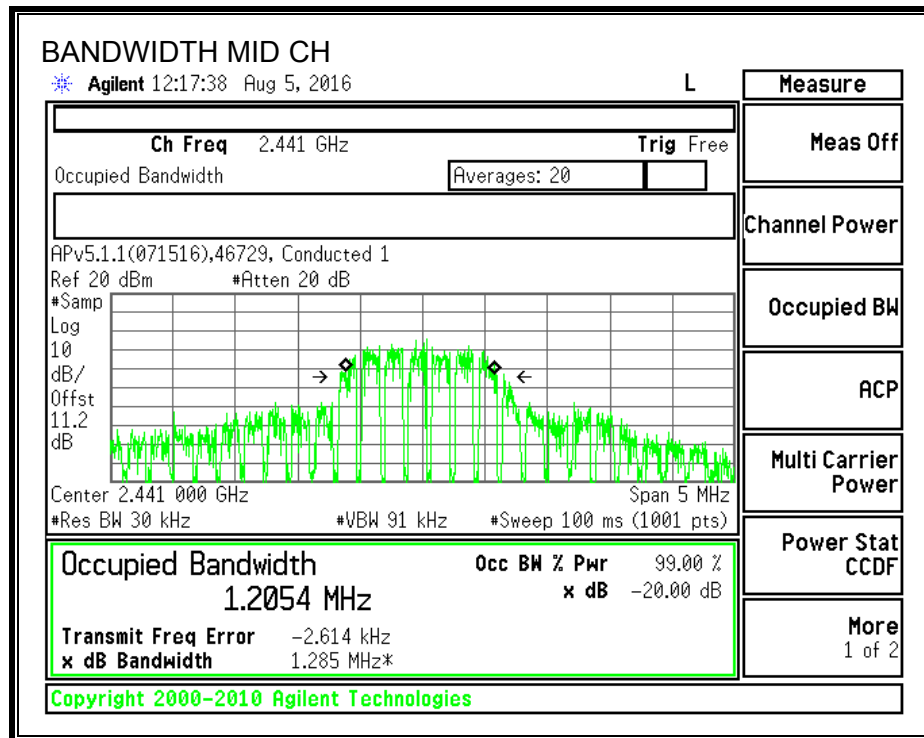
20 dB BANDWIDTH





99% BANDWIDTH





8.6.2. 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 hopping 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.

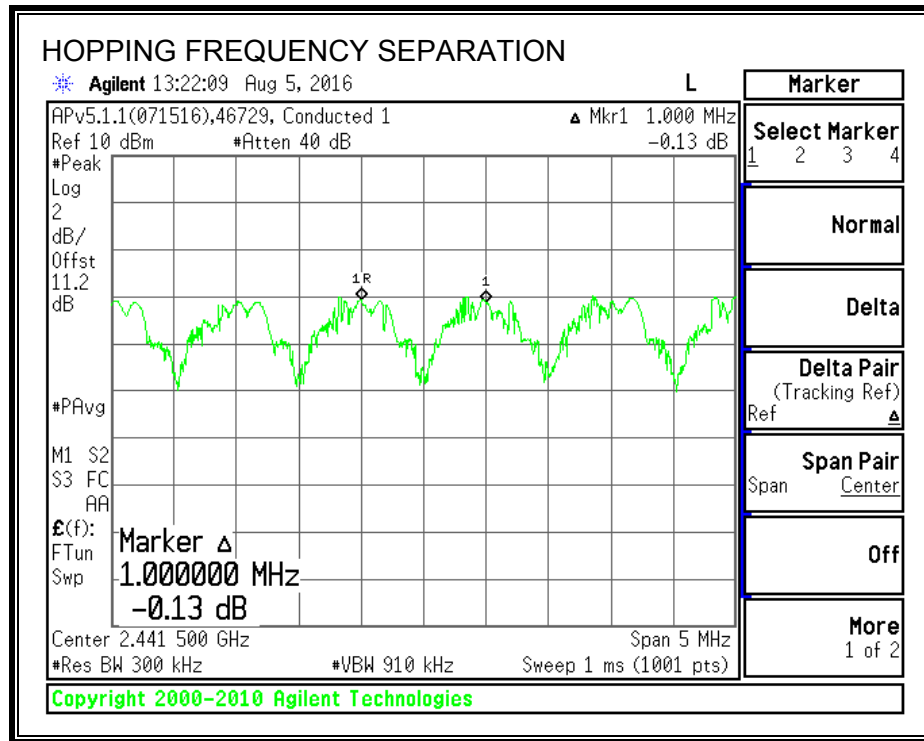
TEST PROCEDURE

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.

Tested by: Ron Reichard/Jeff Cabrera

Test date: 2016-08-05

RESULTS



Ch. A	Ch. B	Ch. 1 to Ch. 2 Sep.	Max. 20 dB BW	2/3 20 dB Margin	Margin
(MHz)	(MHz)	(MHz)	(MHz)	(MHz)	(MHz)
2441	2442	1.000	1.311	0.874	-0.126

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. 900 kHz).

8.6.3. 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.

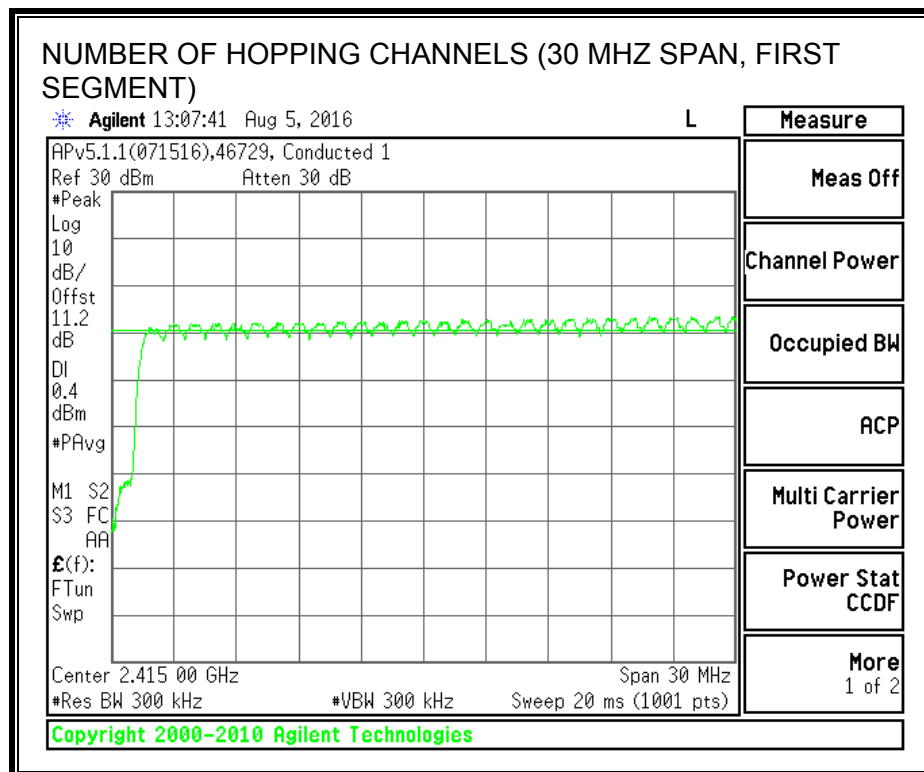
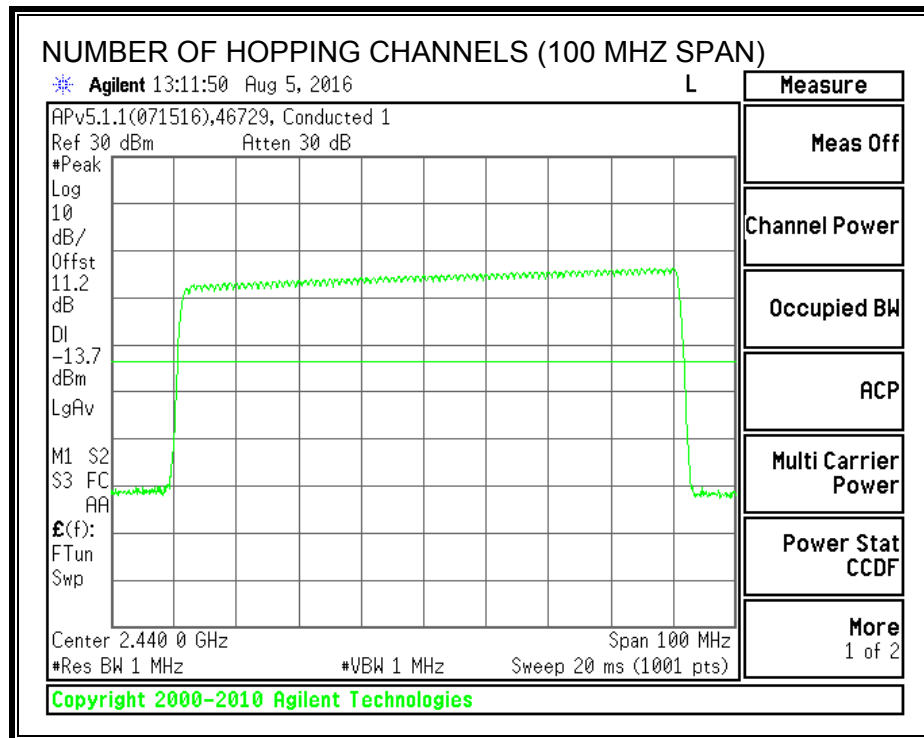
RESULTS

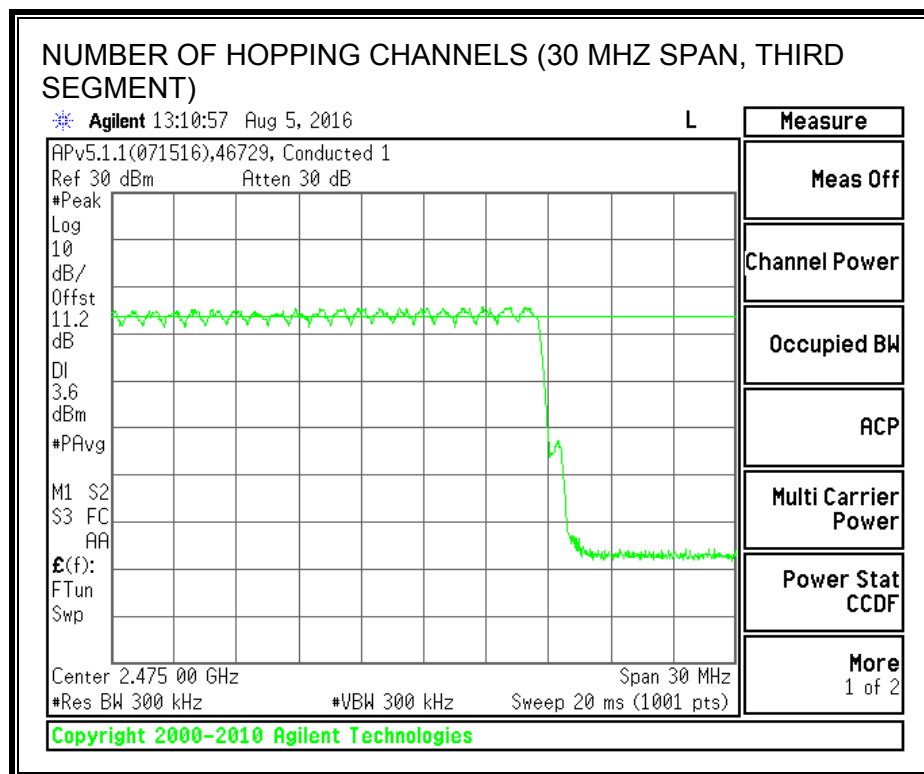
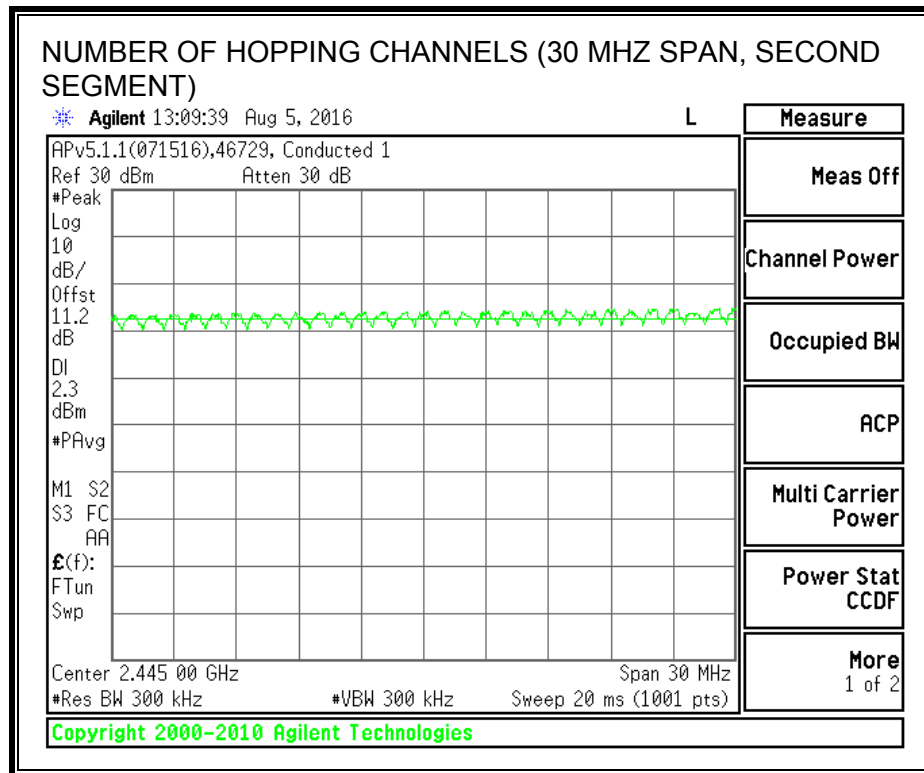
Normal Mode: 79 Channels observed.

Tested by: Ron Reichard/Jeff Cabrera

Test date: 2016-08-05

NUMBER OF HOPPING CHANNELS





8.6.4. 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 $10 * (\# \text{ of pulses in } 3.16 \text{ s}) * \text{pulse width}$.

RESULTS

Time Of Occupancy = $10 * xx \text{ pulses} * yy \text{ msec} = zz \text{ msec}$

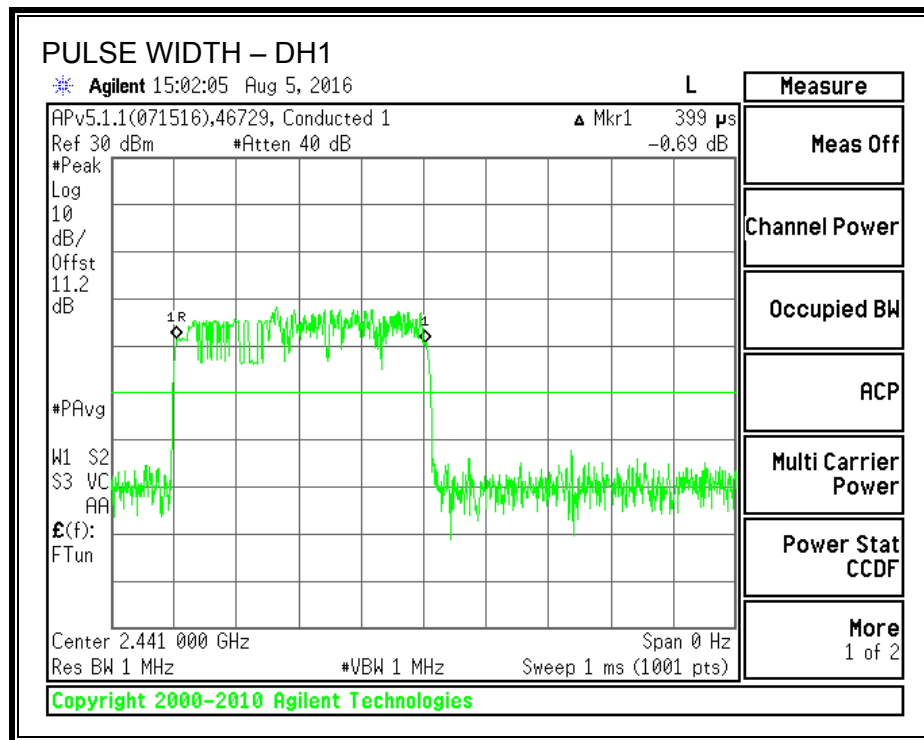
8PSK (EDR) Mode

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	1.622	16	0.260	0.4	-0.140
DH5	2.868	10	0.287	0.4	-0.113

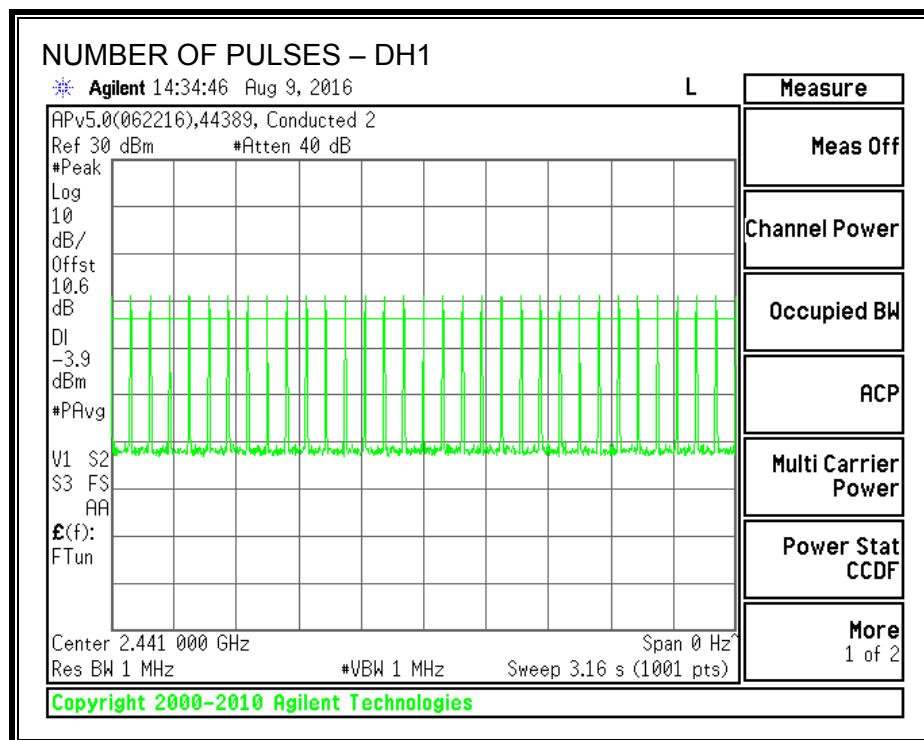
Note: for AFH (8PSK) mode, please refer to the results of AFH (GFSK) mode; the channel selection and hopping rate are the same for both EDR and Basic Rate operation, data for Basic Rate on page 30 demonstrates compliance with channel occupancy when AFH is employed.

Tested by: Ron Reichard/Niklas Haydon/Jeff Cabrera
Test date: 2016-08-05 to 2016-08-09

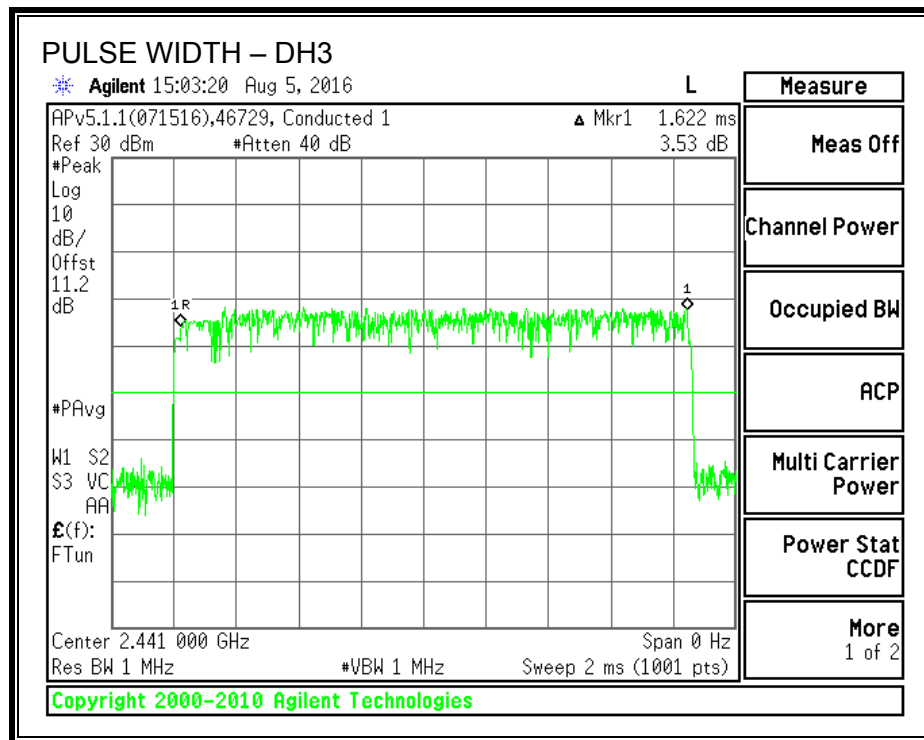
PULSE WIDTH - DH1



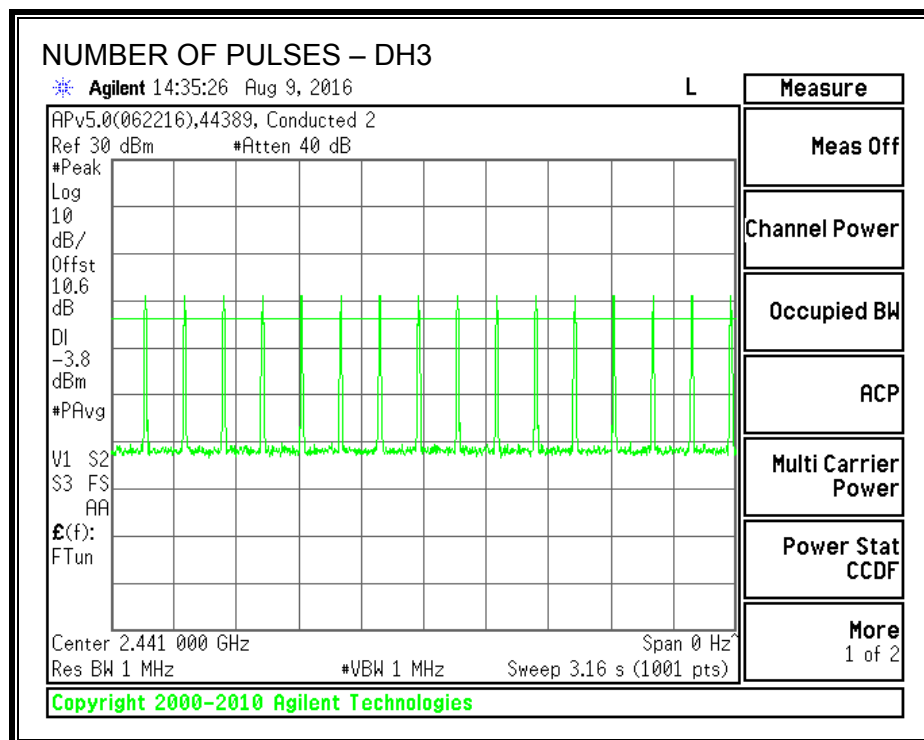
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1



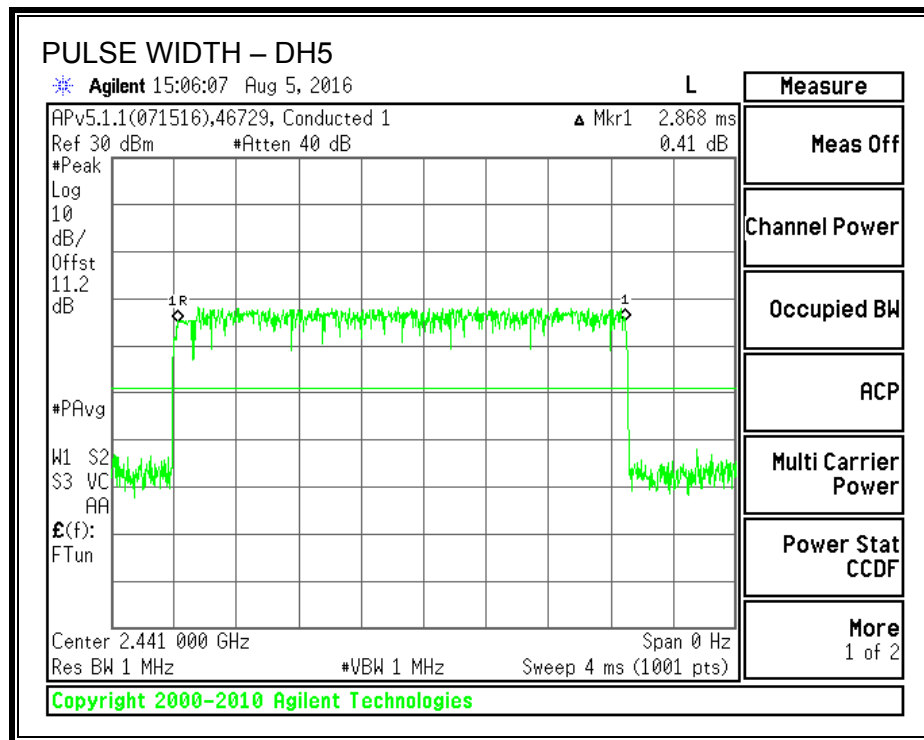
PULSE WIDTH – DH3



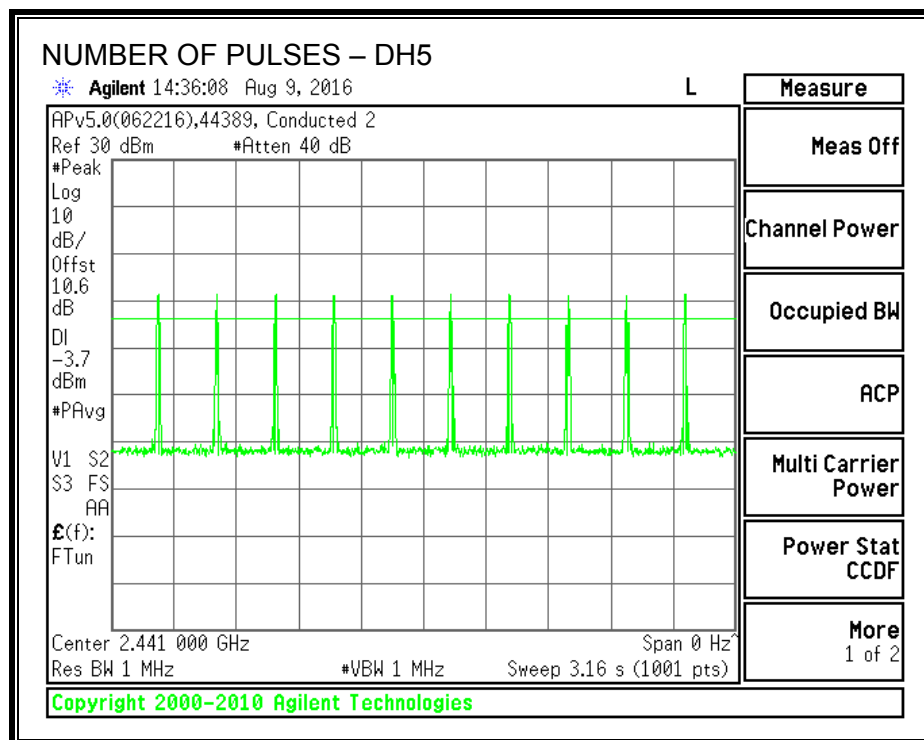
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3



PULSE WIDTH – DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5



8.6.5. 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 5.4 (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 is connected to a power meter.

RESULTS

Channel	Frequency (MHz)	Output Power (dBm)	Directional Gain (dBi)	Limit (dBm)	Margin (dB)
Low	2402	2.42	4.90	21	-18.58
Middle	2441	4.95	4.90	21	-16.05
High	2480	6.31	4.90	21	-14.69

Tested by: Mark Learner

Test date: 2016-08-03

8.6.6. AVERAGE POWER

LIMIT

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

The cable assembly insertion loss of 10.98 dB (including 10 dB pad and 0.98 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	-0.42
Middle	2441	2.19
High	2480	3.76

Tested by: Mark Learner
Test date: 2016-08-03

8.6.7. 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.

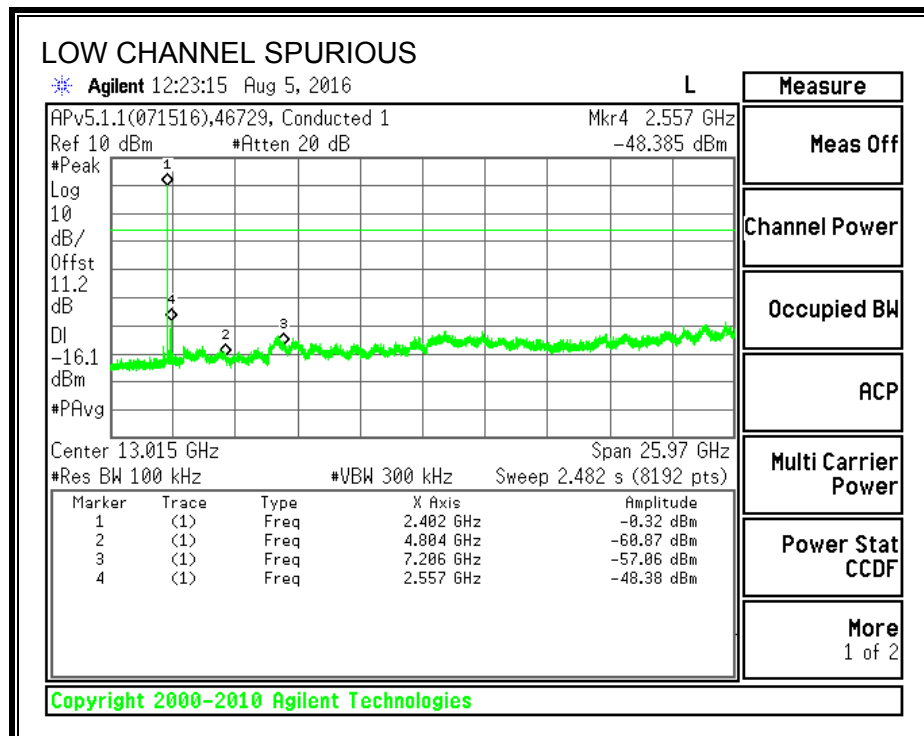
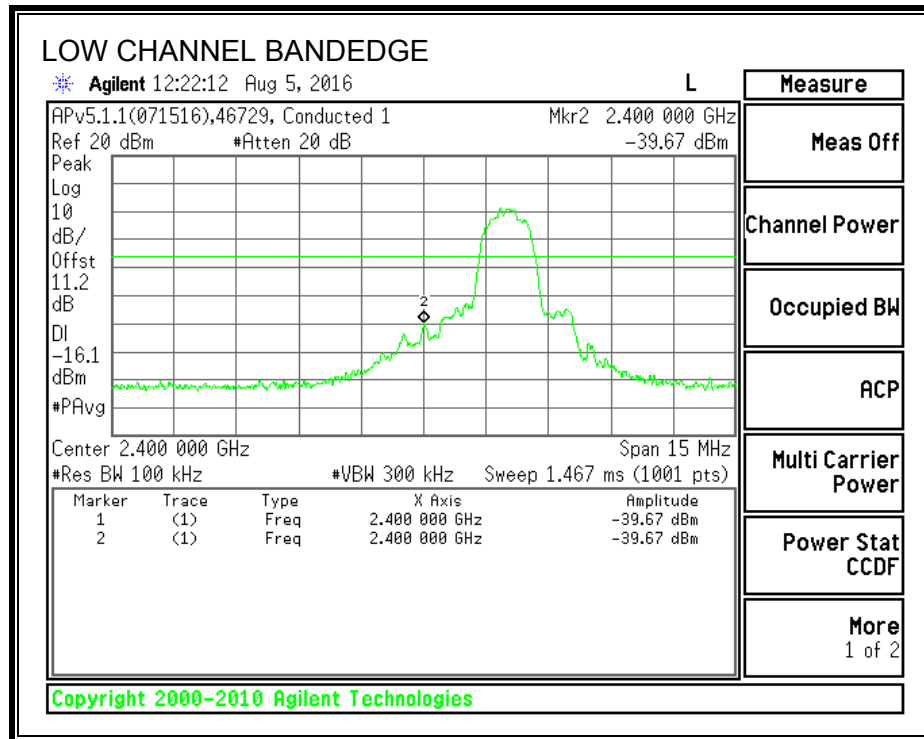
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

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

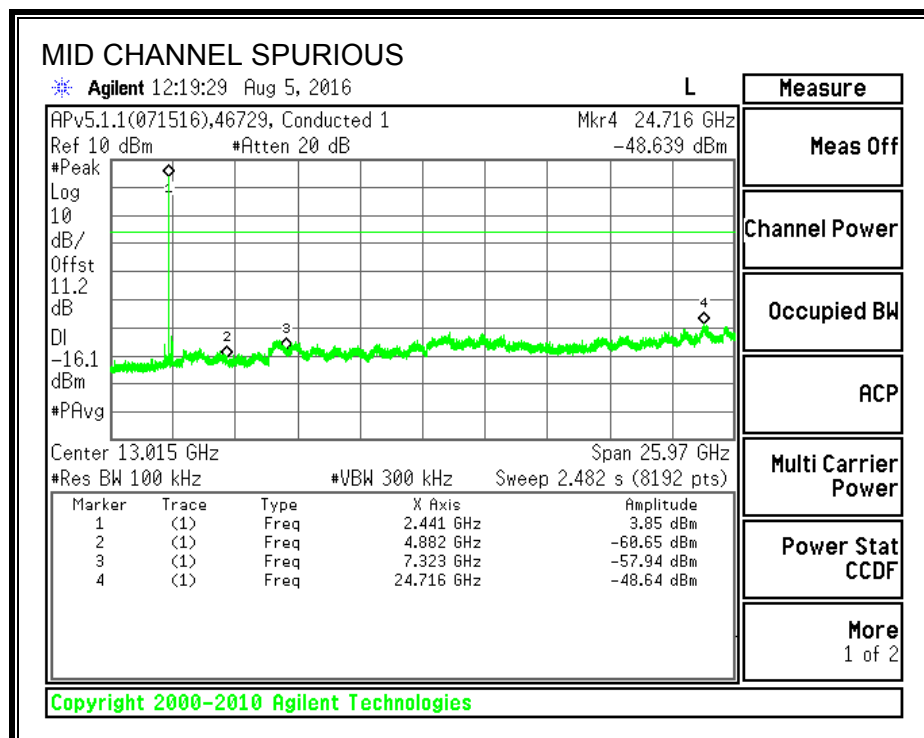
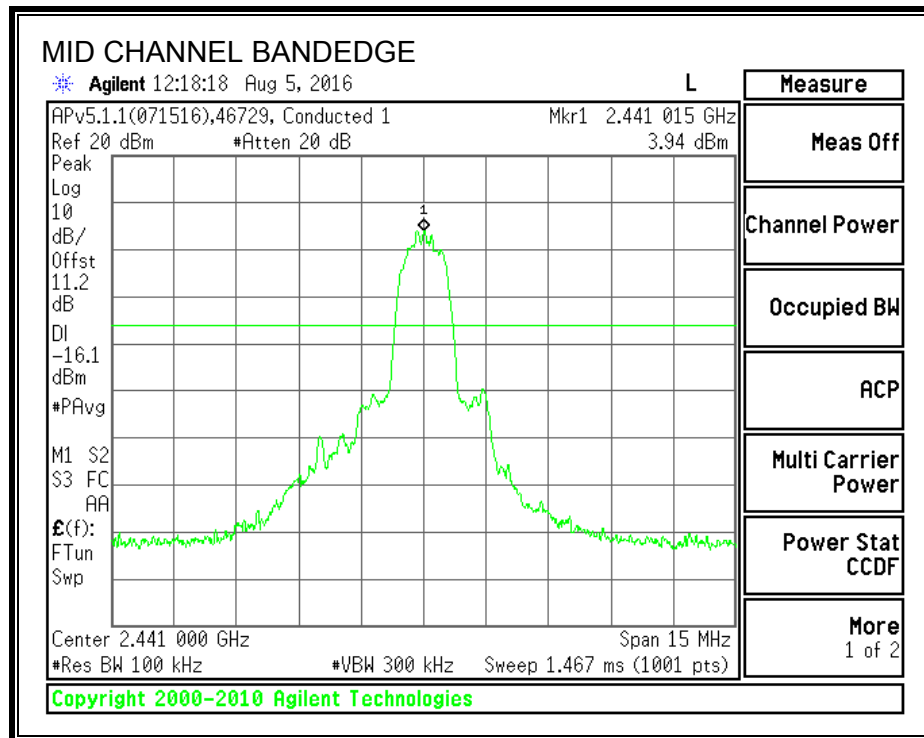
Tested by: Ron Reichard/Jeff Cabrera
Test date: 2016-08-05

RESULTS

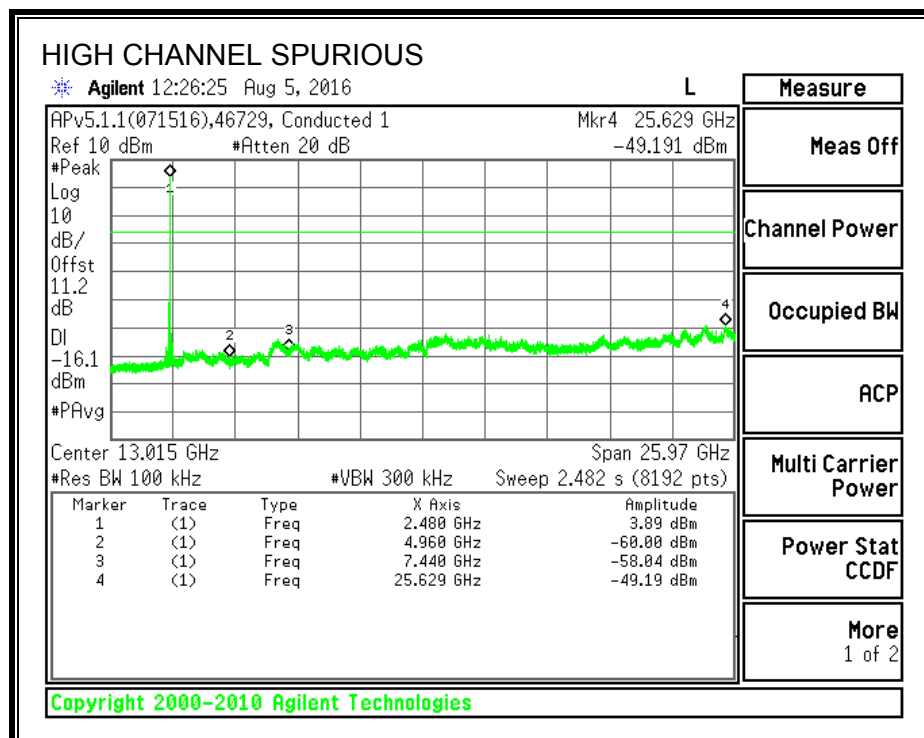
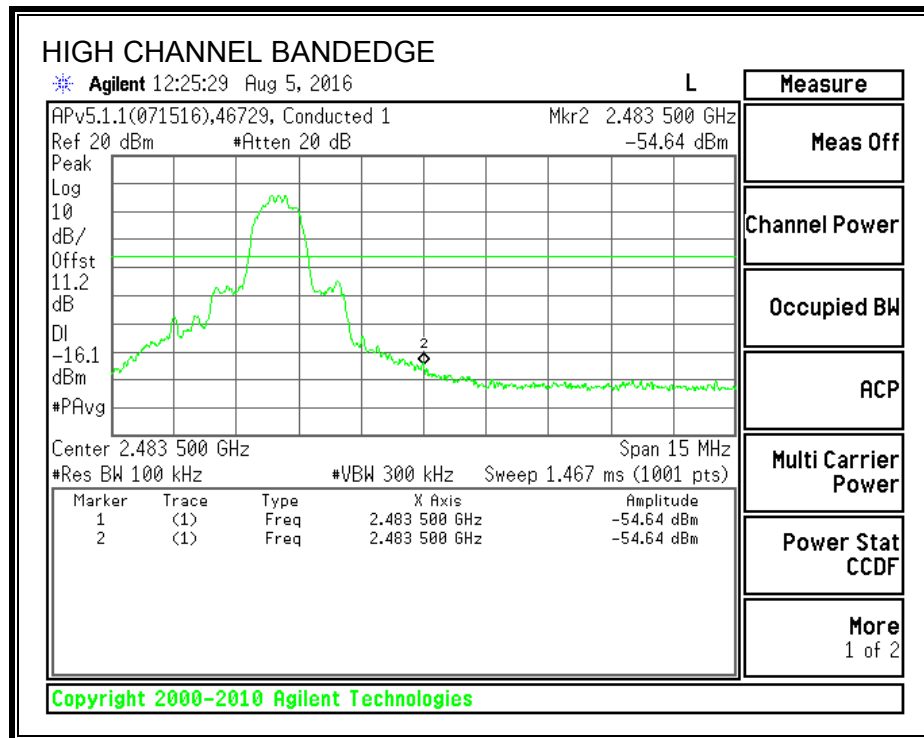
SPURIOUS EMISSIONS, LOW CHANNEL



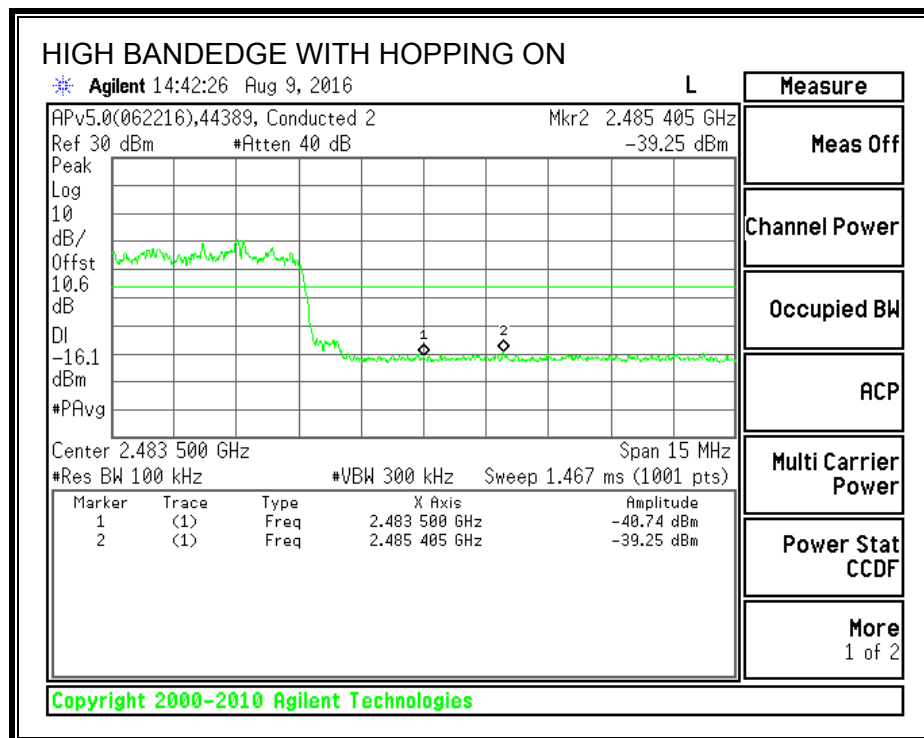
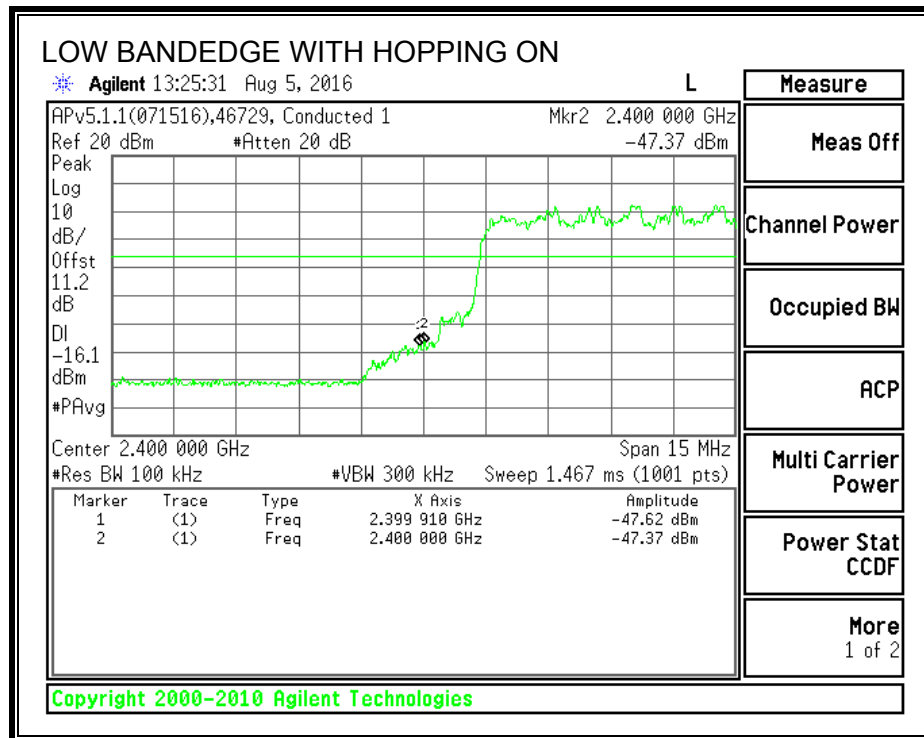
SPURIOUS EMISSIONS, MID CHANNEL



SPURIOUS EMISSIONS, HIGH CHANNEL



SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



9. RADIATED TEST RESULTS

9.1. LIMITS AND PROCEDURE

LIMITS

FCC §15.205, §15.209, §15.247 (d)

IC RSS-GEN Clause 8.9 (Transmitter)

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.

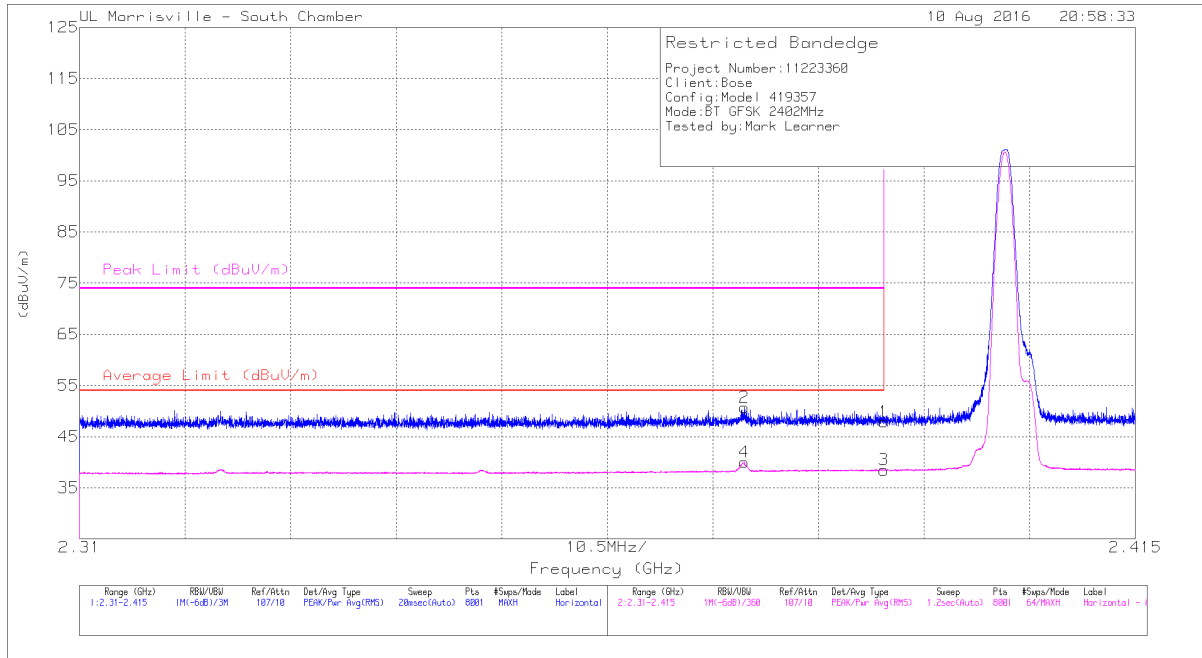
The spectrum from 9 kHz to 26 GHz was investigated. From 1-18 GHz, the transmitter was set to the lowest, middle, and highest channels. For above 18 GHz and below 1GHz, the worst-case channel was set as described in Section 5.5.

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.

9.2. TRANSMITTER ABOVE 1 GHz

9.2.1. BASIC DATA RATE GFSK MODULATION (1-18 GHz)

RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



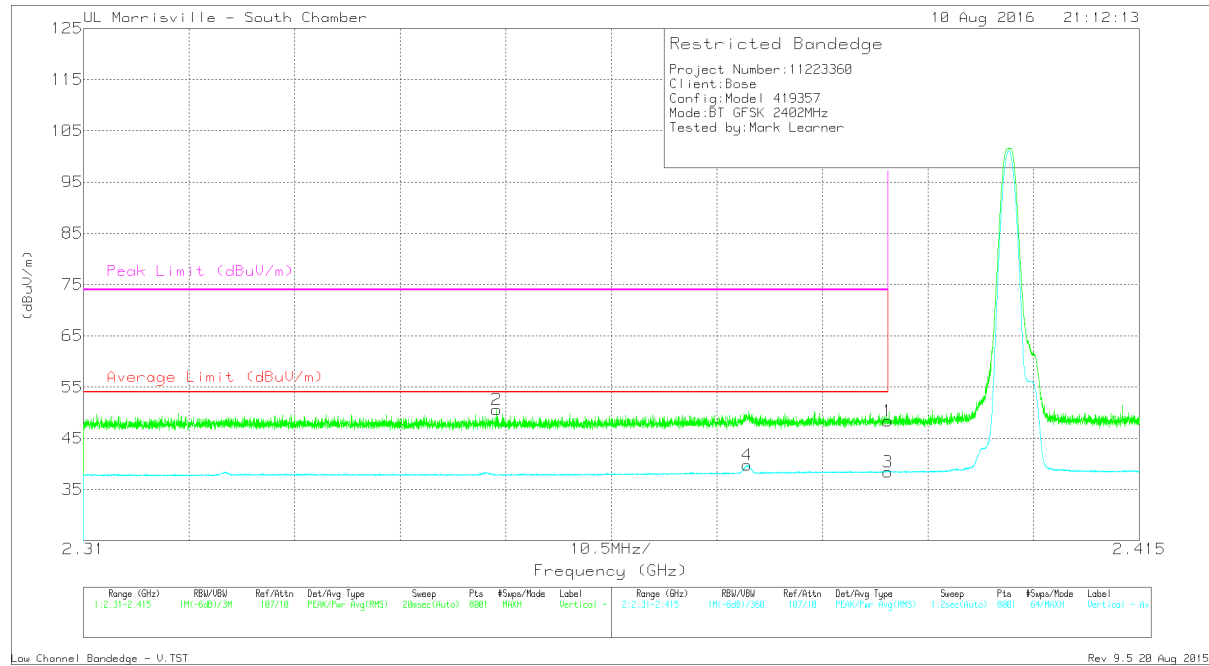
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/Filtr/ Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	40.48	Pk	32.2	-24.8	47.88	-	-	74	-26.12	291	207	H
2	* 2.376	43.39	Pk	32.1	-24.8	50.69	-	-	74	-23.31	291	207	H
3	* 2.39	31.09	V1TR	32.2	-24.8	38.49	54	-15.51	-	-	291	207	H
4	* 2.376	32.72	V1TR	32.1	-24.8	40.02	54	-13.98	-	-	291	207	H

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

Pk - Peak detector

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

RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



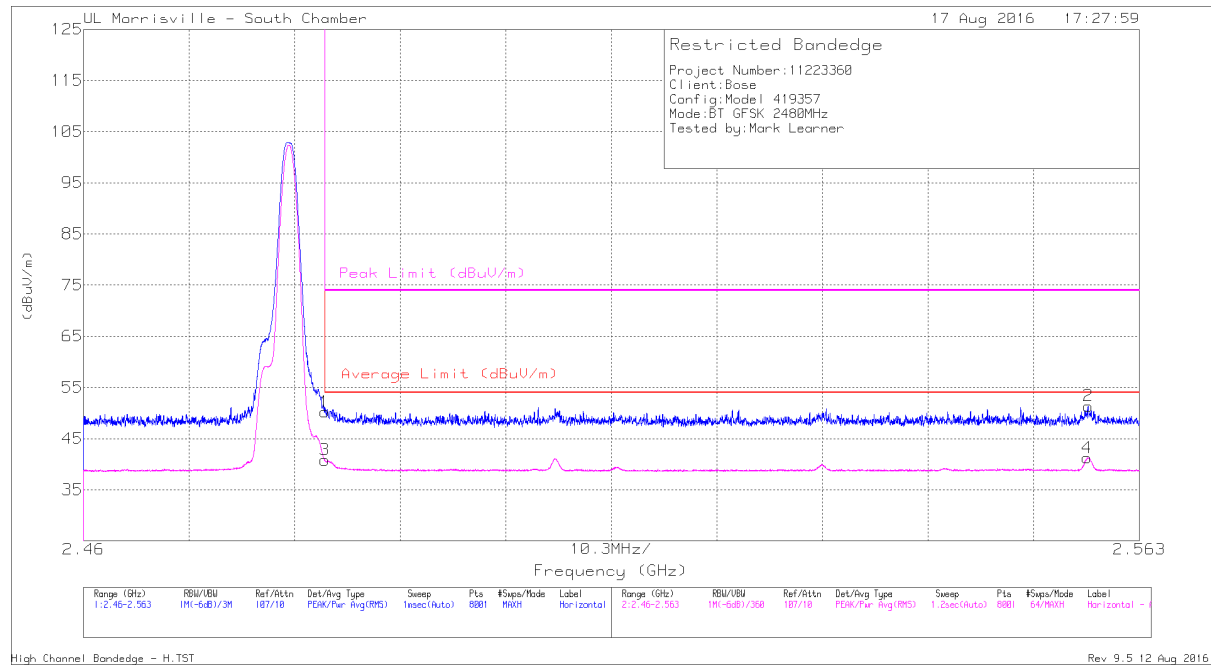
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/Filtr/ Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	41	Pk	32.2	-24.8	48.4	-	-	74	-25.6	337	389	V
2	* 2.351	43.55	Pk	31.8	-24.8	50.55	-	-	74	-23.45	337	389	V
3	* 2.39	31.05	V1TR	32.2	-24.8	38.45	54	-15.55	-	-	337	389	V
4	* 2.376	32.5	V1TR	32.1	-24.8	39.8	54	-14.2	-	-	337	389	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)



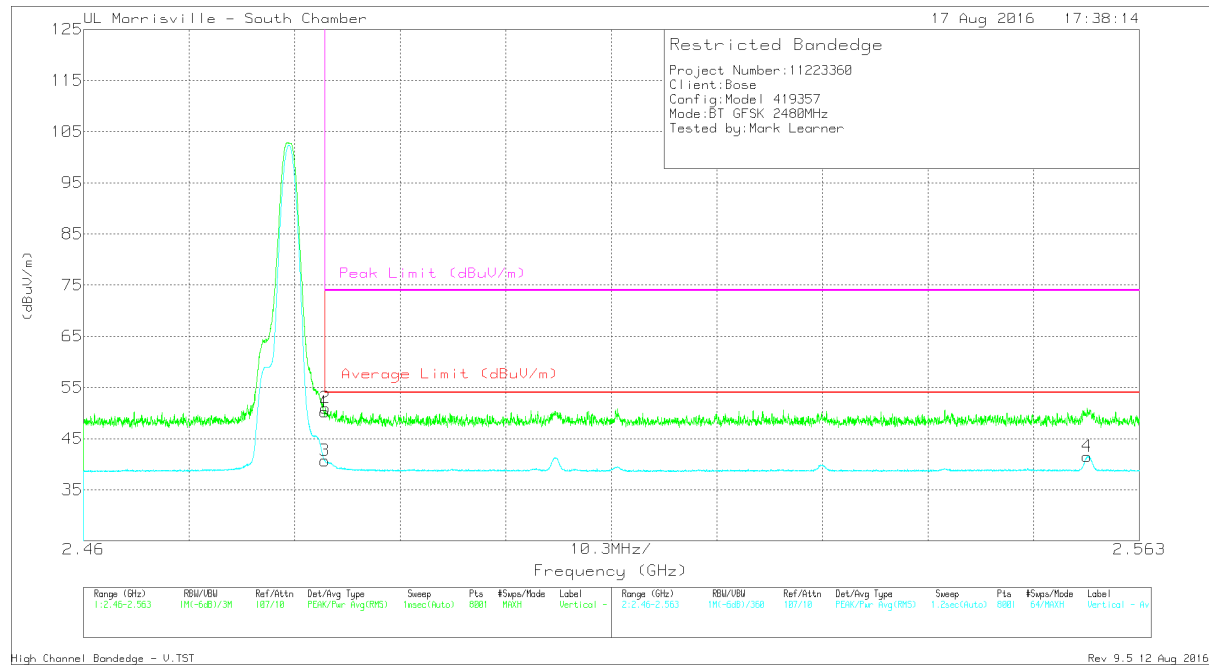
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/Filtr/ Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	42.5	Pk	32.4	-24.7	50.2	-	-	74	-23.8	273	373	H
3	* 2.484	33.13	V1TR	32.4	-24.7	40.83	54	-13.17	-	-	273	373	H
2	2.558	43.69	Pk	32.4	-24.7	51.39	-	-	74	-22.61	273	373	H
4	2.558	33.54	V1TR	32.4	-24.7	41.24	54	-12.76	-	-	273	373	H

* - 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, VERTICAL)



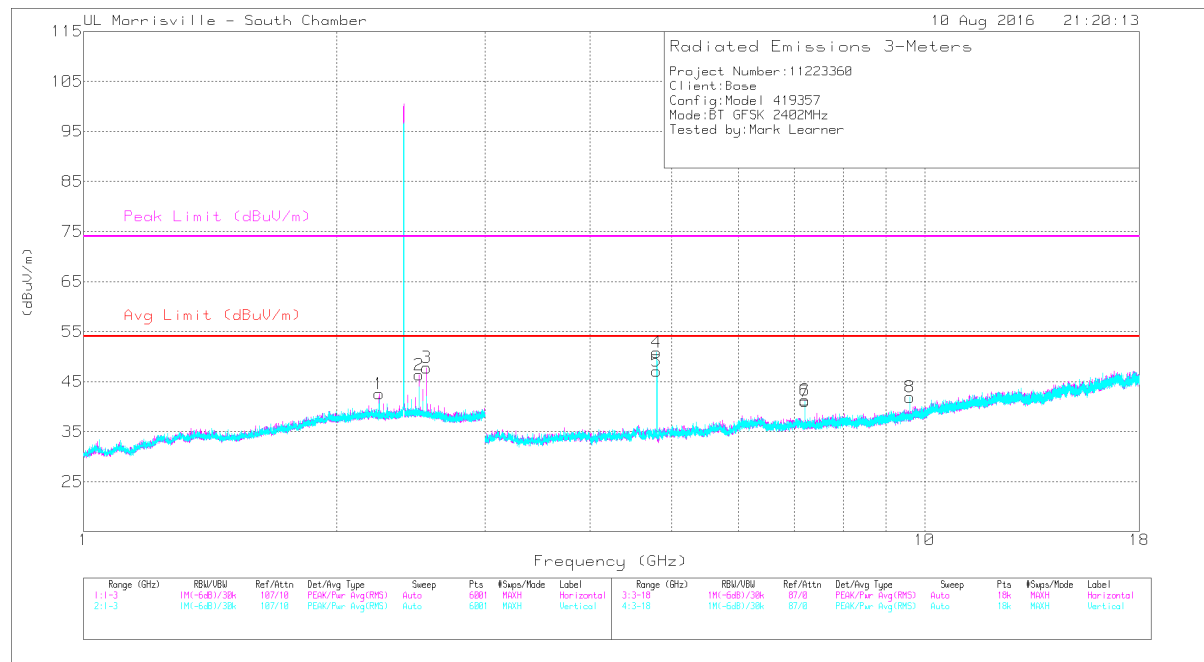
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/Filtr /Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	42.55	Pk	32.4	-24.7	50.25	-	-	74	-23.75	355	364	V
2	* 2.484	43.32	Pk	32.4	-24.7	51.02	-	-	74	-22.98	355	364	V
3	* 2.484	33	V1TR	32.4	-24.7	40.7	54	-13.3	-	-	355	364	V
4	2.558	33.85	V1TR	32.4	-24.7	41.55	54	-12.45	-	-	355	364	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



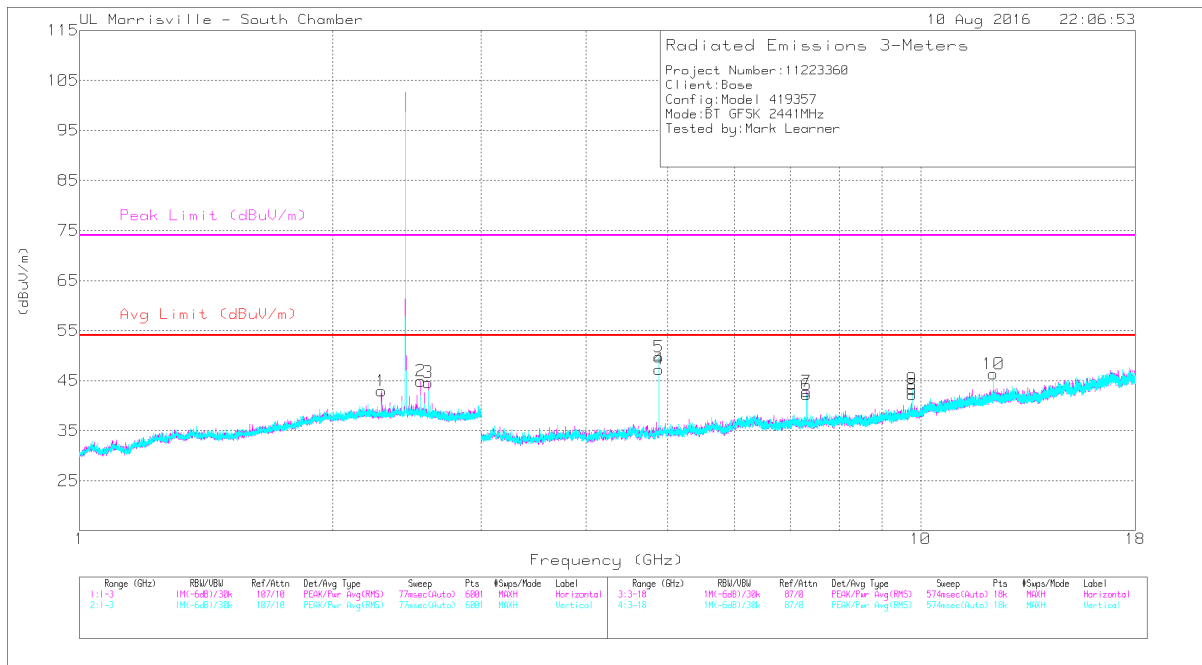
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/Filtr/ Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.246	40.35	PK-U	31.7	-23.6	48.45	-	-	74	-25.55	293	249	H
	* 2.246	33.74	V1TR	31.7	-23.6	41.84	54	-12.16	-	-	293	249	H
5	* 4.804	48.98	PK-U	34	-31.7	51.28	-	-	74	-22.72	329	262	H
	* 4.804	45.06	V1TR	34	-31.7	47.36	54	-6.64	-	-	329	262	H
4	* 4.804	50.5	PK-U	34	-31.7	52.8	-	-	74	-21.2	185	130	V
	* 4.804	47.1	V1TR	34	-31.7	49.4	54	-4.6	-	-	185	130	V
2	2.506	38.61	Pk	32.5	-24.8	46.31	-	-	-	-	0-360	199	H
3	2.558	40.49	Pk	32.4	-25.1	47.79	-	-	-	-	0-360	199	H
6	7.206	34.41	Pk	35.6	-28.7	41.31	-	-	-	-	0-360	199	H
7	7.206	34.17	Pk	35.6	-28.7	41.07	-	-	-	-	0-360	102	V
8	9.607	32.39	Pk	36.6	-27.1	41.89	-	-	-	-	0-360	199	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



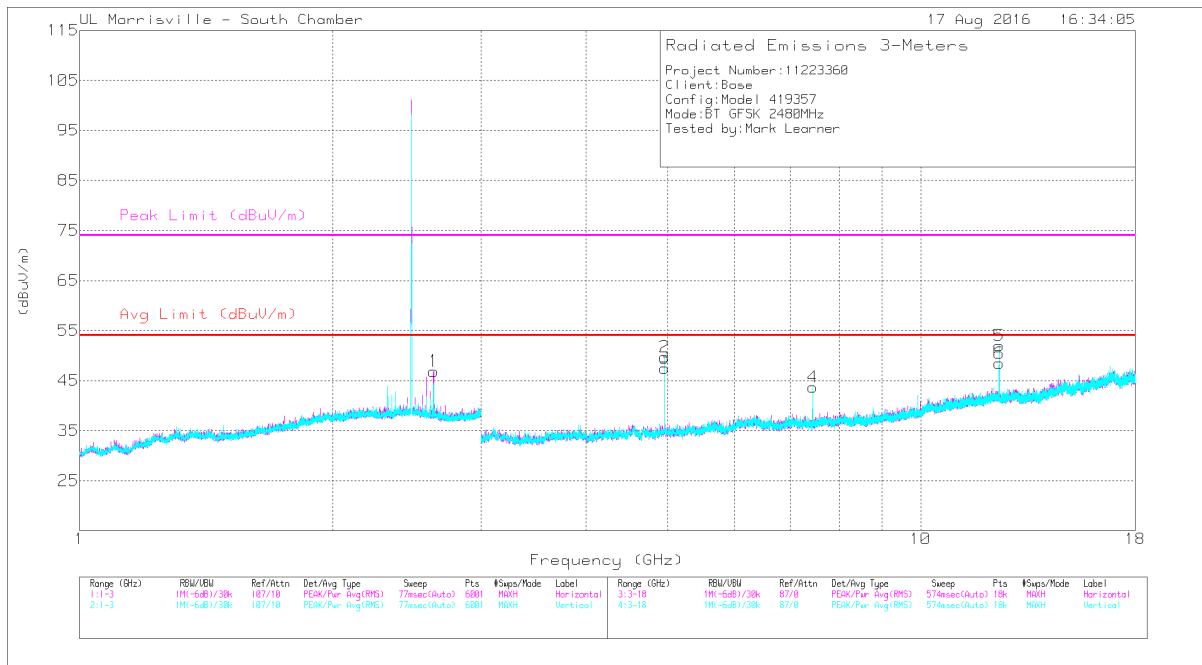
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/Filtr/ Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.285	40.77	PK-U	31.7	-23.9	48.57	-	-	74	-25.43	52	353	H
	* 2.285	34.62	V1TR	31.7	-23.9	42.42	54	-11.58	-	-	52	353	H
4	* 4.882	47.64	PK-U	34.1	-31.5	50.24	-	-	74	-23.76	12	234	H
	* 4.882	43.49	V1TR	34.1	-31.5	46.09	54	-7.91	-	-	12	234	H
7	* 7.322	41.3	PK-U	35.5	-28.4	48.4	-	-	74	-25.6	331	112	H
	* 7.323	33.53	V1TR	35.5	-28.4	40.63	54	-13.37	-	-	331	112	H
5	* 4.882	49.42	PK-U	34.1	-31.5	52.02	-	-	74	-21.98	194	197	V
	* 4.882	45.76	V1TR	34.1	-31.5	48.36	54	-5.64	-	-	194	197	V
6	* 7.322	41.05	PK-U	35.5	-28.4	48.15	-	-	74	-25.85	212	185	V
	* 7.323	33.37	V1TR	35.5	-28.4	40.47	54	-13.53	-	-	212	185	V
10	* 12.206	38.23	PK-U	39	-24.9	52.33	-	-	74	-21.67	109	129	V
	* 12.204	29.6	V1TR	39	-24.9	43.7	54	-10.3	-	-	109	129	V
2	2.545	37.6	Pk	32.4	-25.1	44.9	-	-	-	-	0-360	199	H
3	2.597	37.72	Pk	32.3	-25.4	44.62	-	-	-	-	0-360	199	H
8	9.764	31.76	Pk	36.8	-26.4	42.16	-	-	-	-	0-360	199	H
9	9.765	32.86	Pk	36.8	-26.4	43.26	-	-	-	-	0-360	102	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



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/Filtr/ Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
3	* 4.96	49.9	PK-U	34.1	-31.6	52.4	-	-	74	-21.6	23	271	H
	* 4.96	46	V1TR	34.1	-31.6	48.5	54	-5.5	-	-	23	271	H
6	* 12.4	38.8	PK-U	39	-25	52.8	-	-	74	-21.2	19	108	H
	* 12.399	30.69	V1TR	39	-25	44.69	54	-9.31	-	-	19	108	H
2	* 4.96	50.8	PK-U	34.1	-31.6	53.3	-	-	74	-20.7	193	269	V
	* 4.96	47.33	V1TR	34.1	-31.6	49.83	54	-4.17	-	-	193	269	V
4	* 7.44	41.17	PK-U	35.5	-28.7	47.97	-	-	74	-26.03	61	193	V
	* 7.44	33.87	V1TR	35.5	-28.7	40.67	54	-13.33	-	-	61	193	V
5	* 12.399	42.77	PK-U	39	-25	56.77	-	-	74	-17.23	102	256	V
	* 12.399	35.9	V1TR	39	-25	49.9	54	-4.1	-	-	102	256	V
1	2.636	40.08	Pk	32.5	-25.7	46.88	-	-	-	-	0-360	199	H

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

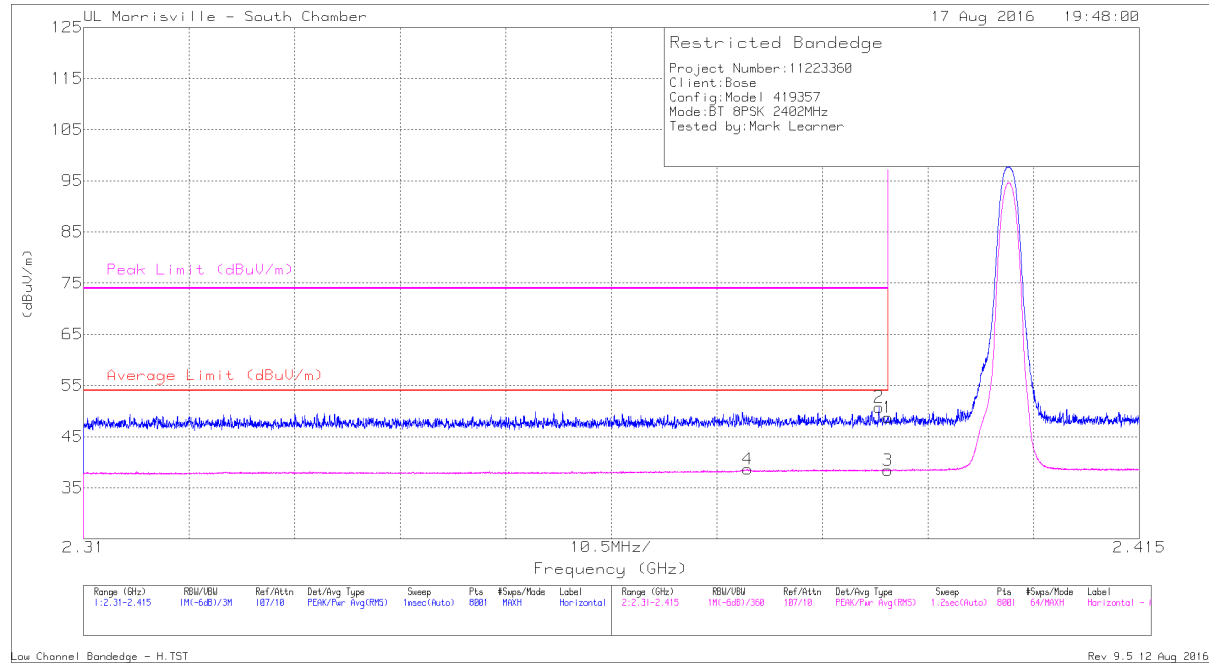
Pk - Peak detector

PK-U: Maximum Peak

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

9.2.2. ENHANCED DATA RATE 8PSK MODULATION (1-18 GHz)

RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



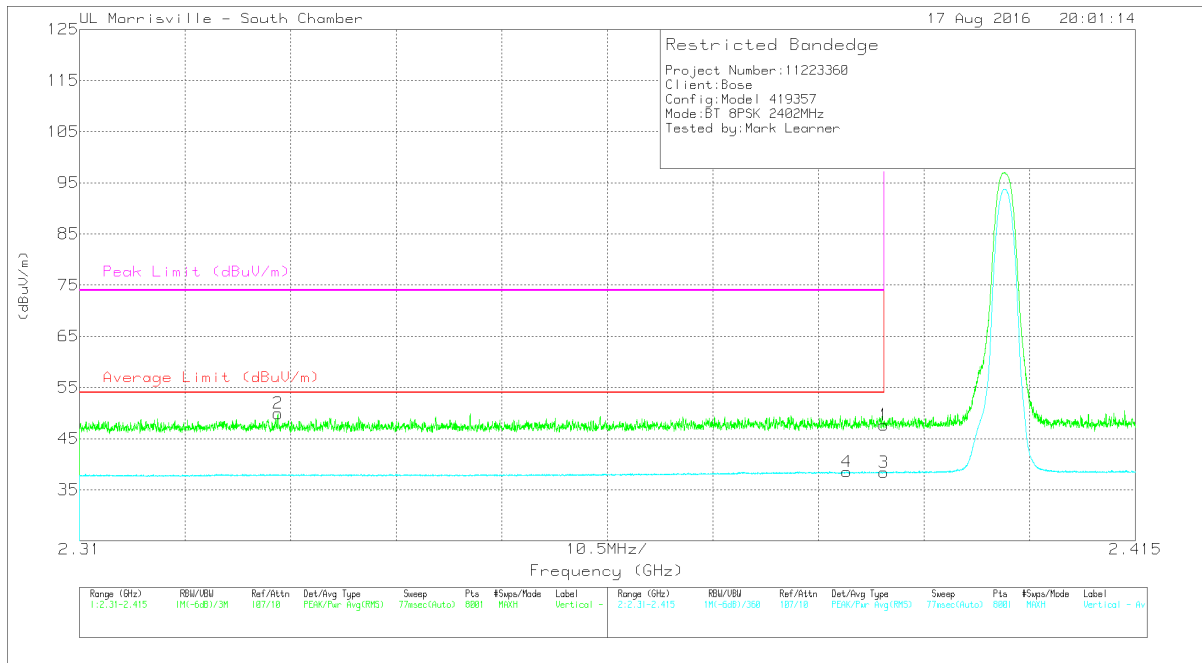
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/Filtr /Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	41.33	Pk	32.2	-24.8	48.73	-	-	74	-25.27	289	390	H
2	* 2.389	43.36	Pk	32.2	-24.8	50.76	-	-	74	-23.24	289	390	H
3	* 2.39	31.03	V1TR	32.2	-24.8	38.43	54	-15.57	-	-	289	390	H
4	* 2.376	31.33	V1TR	32.1	-24.8	38.63	54	-15.37	-	-	289	390	H

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

Pk - Peak detector

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

RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



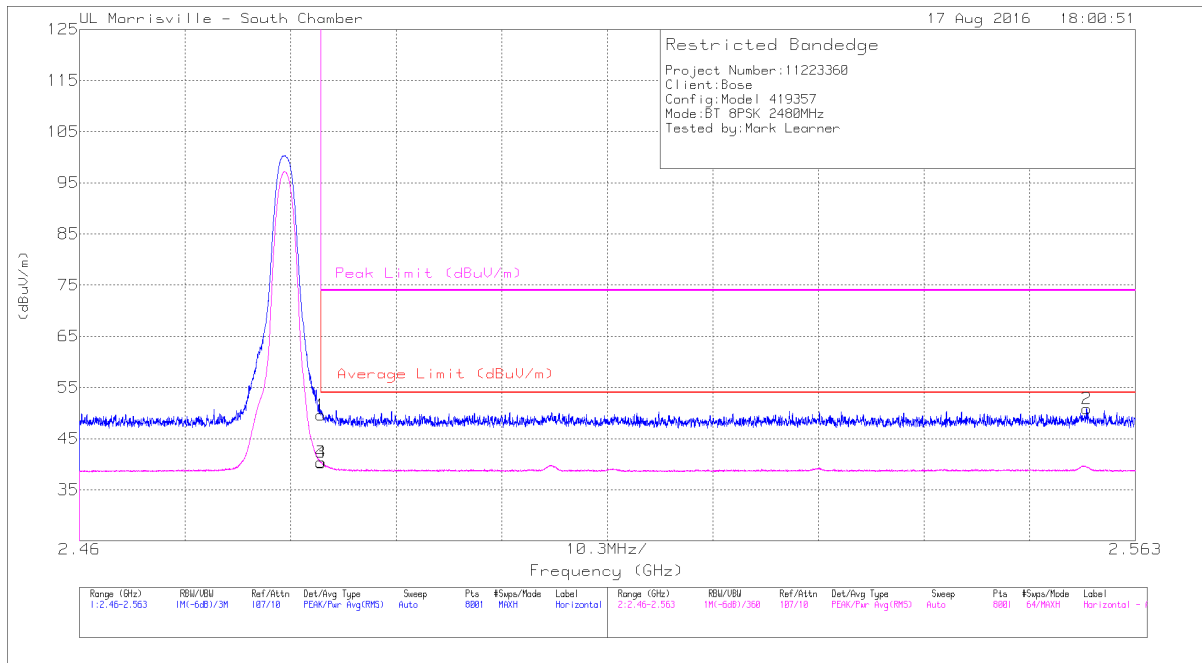
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/Filtr/ Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	40.27	Pk	32.2	-24.8	47.67	-	-	74	-26.33	329	390	V
2	* 2.33	43.02	Pk	31.7	-24.8	49.92	-	-	74	-24.08	329	390	V
3	* 2.39	30.99	V1TR	32.2	-24.8	38.39	54	-15.61	-	-	329	390	V
4	* 2.386	31.15	V1TR	32.2	-24.8	38.55	54	-15.45	-	-	329	390	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)



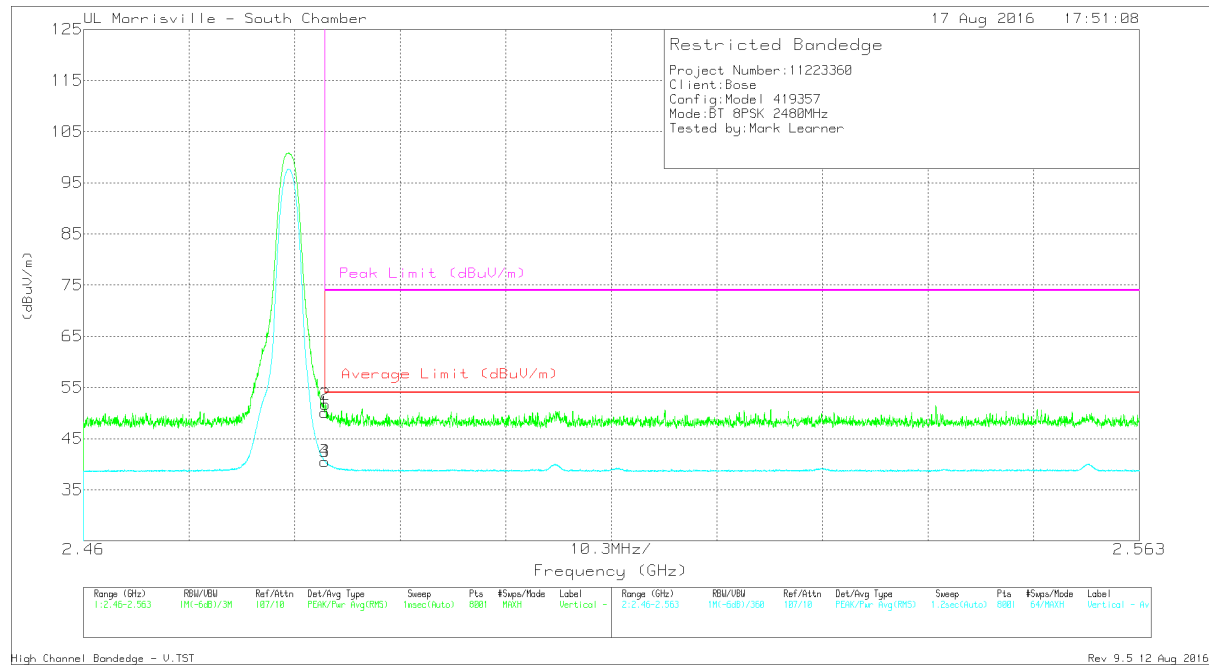
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/Filtr /Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	41.93	Pk	32.4	-24.7	49.63	-	-	74	-24.37	307	375	H
3	* 2.484	32.71	V1TR	32.4	-24.7	40.41	54	-13.59	-	-	307	375	H
4	* 2.484	32.64	V1TR	32.4	-24.7	40.34	54	-13.66	-	-	307	375	H
2	2.558	43.13	Pk	32.4	-24.7	50.83	-	-	74	-23.17	307	375	H

* - 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, VERTICAL)



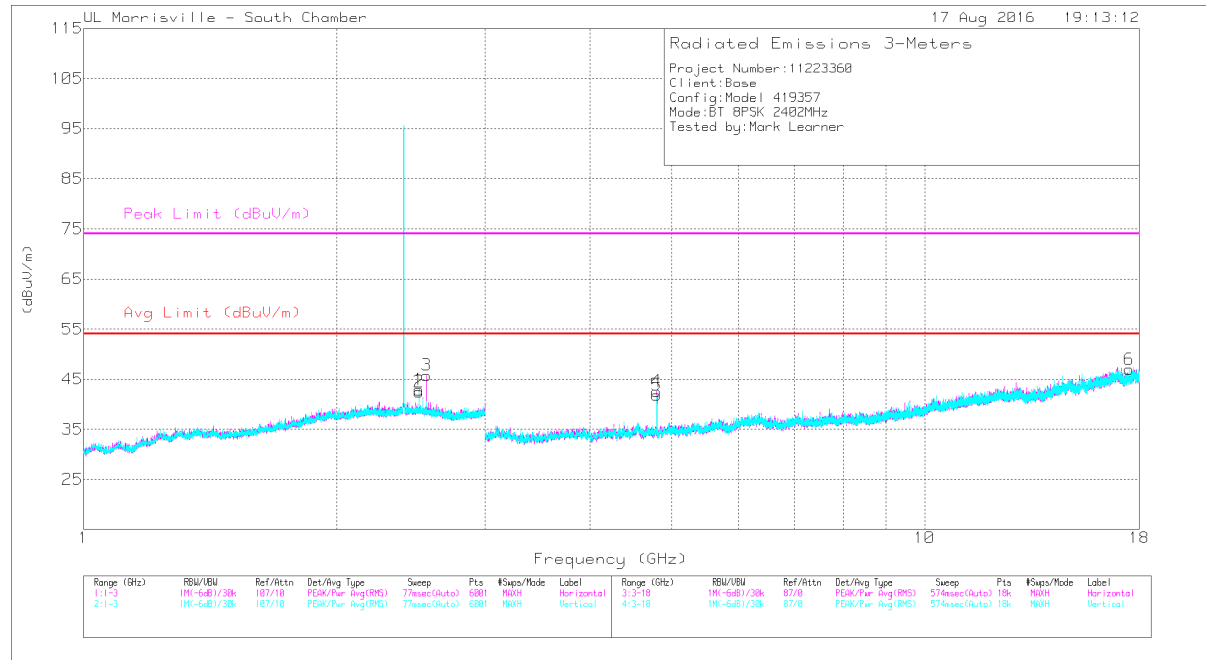
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/Filtr /Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	42.39	Pk	32.4	-24.7	50.09	-	-	74	-23.91	354	365	V
2	* 2.484	43.98	Pk	32.4	-24.7	51.68	-	-	74	-22.32	354	365	V
3	* 2.484	32.86	V1TR	32.4	-24.7	40.56	54	-13.44	-	-	354	365	V
4	* 2.484	32.86	V1TR	32.4	-24.7	40.56	54	-13.44	-	-	354	365	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



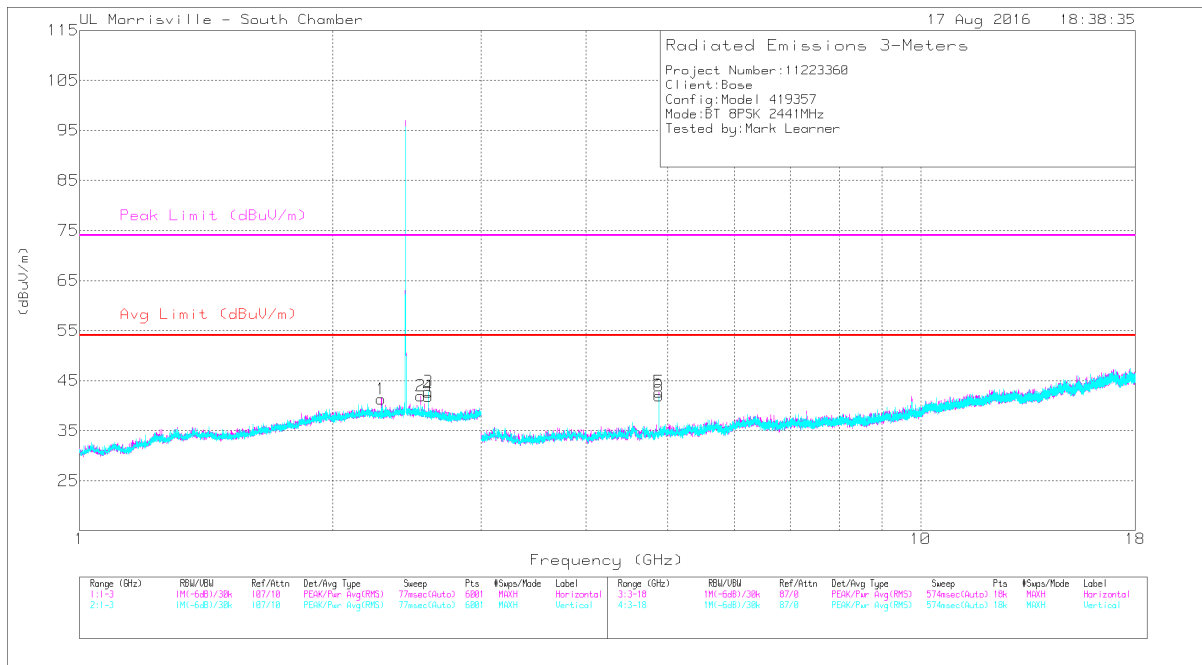
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/Filtr/ Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
4	* 4.804	44.85	PK-U	34	-31.7	47.15	-	-	74	-26.85	342	374	H
	* 4.804	36.89	V1TR	34	-31.7	39.19	54	-14.81	-	-	342	374	H
5	* 4.804	45.14	PK-U	34	-31.7	47.44	-	-	74	-26.56	203	158	V
	* 4.804	37.71	V1TR	34	-31.7	40.01	54	-13.99	-	-	203	158	V
1	2.506	35.2	Pk	32.5	-24.8	42.9	-	-	-	-	0-360	199	H
2	2.506	34.79	Pk	32.5	-24.8	42.49	-	-	-	-	0-360	101	V
3	2.558	38.47	Pk	32.4	-25.1	45.77	-	-	-	-	0-360	199	H
6	17.511	29.78	Pk	41.1	-23.9	46.98	-	-	-	-	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



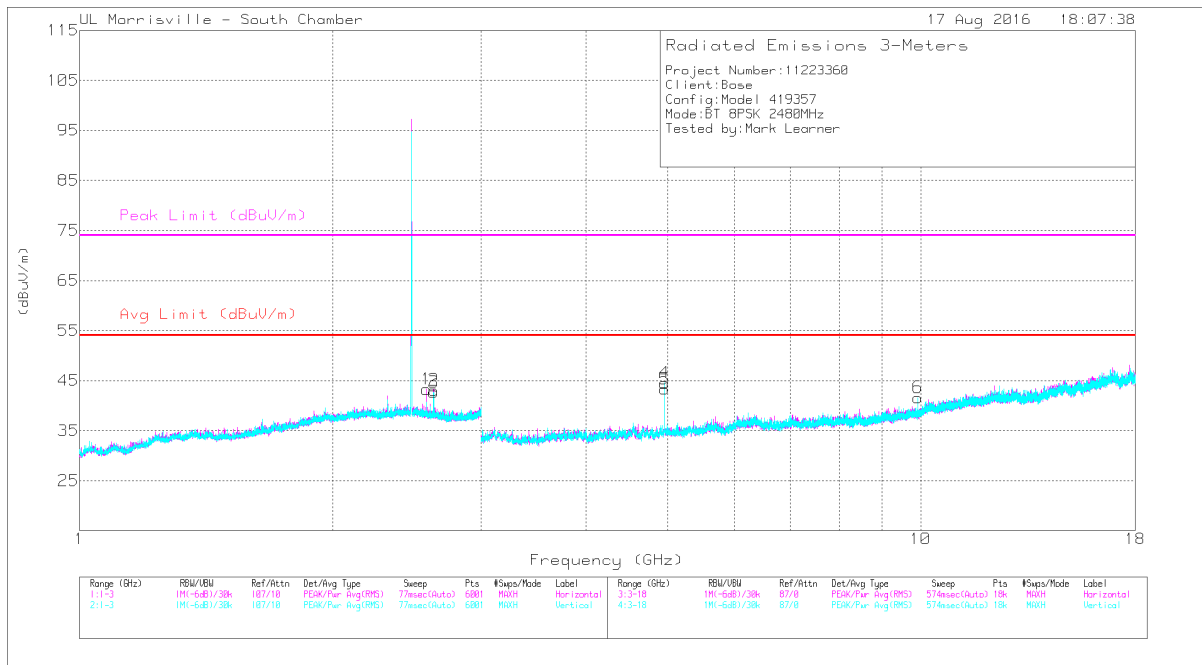
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/Filtr/ Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.285	38.68	PK-U	31.7	-23.9	46.48	-	-	74	-27.52	255	227	H
	* 2.285	29.72	V1TR	31.7	-23.9	37.52	54	-16.48	-	-	255	227	H
5	* 4.882	45.03	PK-U	34.1	-31.5	47.63	-	-	74	-26.37	55	290	H
	* 4.882	37.44	V1TR	34.1	-31.5	40.04	54	-13.96	-	-	55	290	H
6	* 4.882	45.24	PK-U	34.1	-31.5	47.84	-	-	74	-26.16	176	212	V
	* 4.882	37.49	V1TR	34.1	-31.5	40.09	54	-13.91	-	-	176	212	V
2	2.545	34.67	Pk	32.4	-25.1	41.97	-	-	-	-	0-360	199	H
4	2.597	34.89	Pk	32.3	-25.4	41.79	-	-	-	-	0-360	199	H
3	2.597	35.87	Pk	32.3	-25.4	42.77	-	-	-	-	0-360	199	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



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/Filtr/ Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
5	* 4.96	47.08	PK-U	34.1	-31.6	49.58	-	-	74	-24.42	19	269	H
	* 4.96	39.41	V1TR	34.1	-31.6	41.91	54	-12.09	-	-	19	269	H
4	* 4.96	47.86	PK-U	34.1	-31.6	50.36	-	-	74	-23.64	193	298	V
	* 4.96	40.95	V1TR	34.1	-31.6	43.45	54	-10.55	-	-	193	298	V
1	2.584	36.17	Pk	32.4	-25.3	43.27	-	-	-	-	0-360	199	H
2	2.636	36.31	Pk	32.5	-25.7	43.11	-	-	-	-	0-360	199	H
3	2.636	35.88	Pk	32.5	-25.7	42.68	-	-	-	-	0-360	199	V
6	9.918	31.12	Pk	37.1	-26.6	41.62	-	-	-	-	0-360	199	V

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

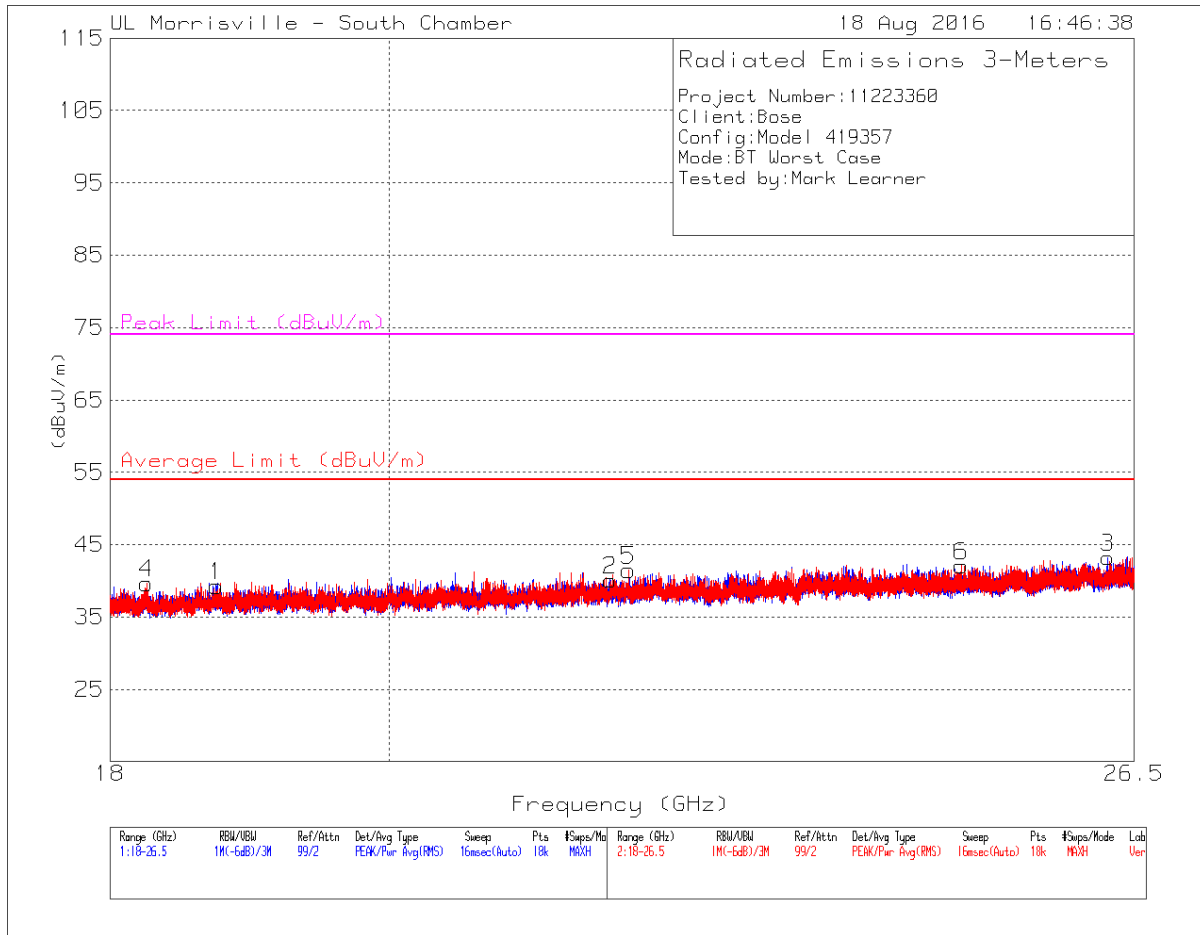
Pk - Peak detector

PK-U: Maximum Peak

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

9.2.3. WORST-CASE 18 - 26 GHz

SPURIOUS EMISSIONS 18 to 26 GHz (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)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 18.739	47.97	PK-U	32.7	-40.8	39.87	54	-14.13	74	-34.13	328	248	H
4	* 18.25	48.2	PK-U	32.5	-41.1	39.6	54	-14.4	74	-34.4	273	203	V
2	21.745	46.3	Pk	33.7	-39.9	40.1	54	-13.9	74	-33.9	0-360	149	H
5	21.894	47.76	Pk	33.6	-39.9	41.46	54	-12.54	74	-32.54	0-360	299	V
6	24.826	45.99	Pk	34.6	-38.5	42.09	54	-11.91	74	-31.91	0-360	201	V
3	26.241	45.95	Pk	34.8	-37.5	43.25	54	-10.75	74	-30.75	0-360	249	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

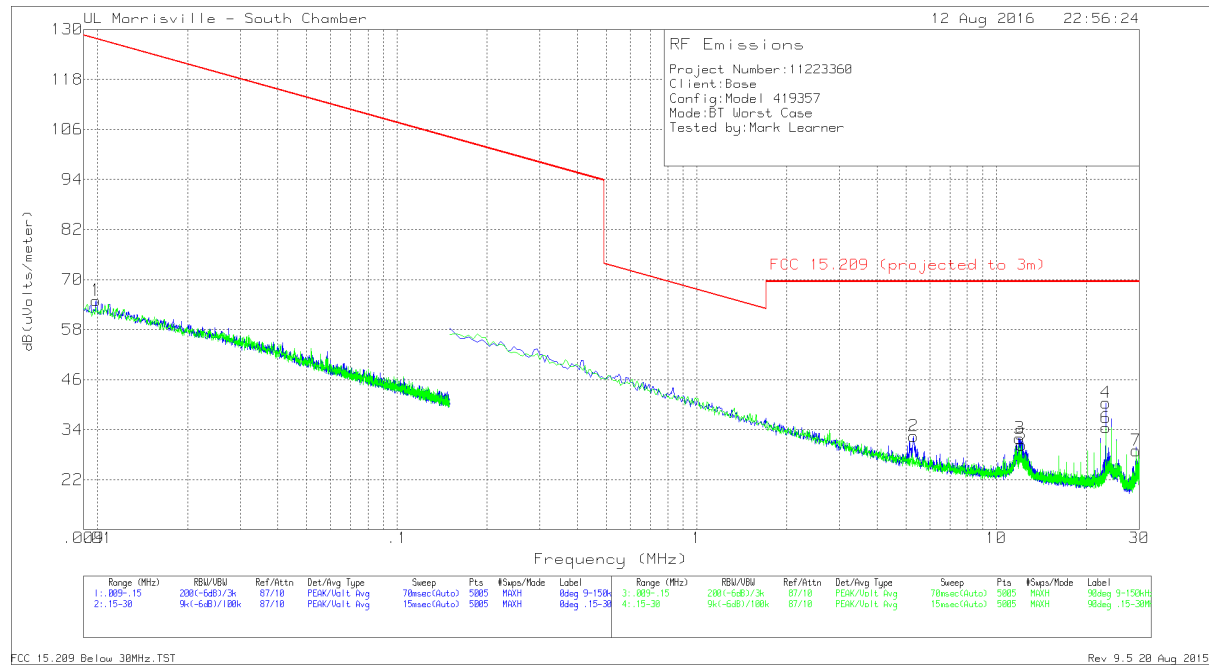
9.3. WORST-CASE BELOW 1 GHz

SPURIOUS EMISSIONS 9kHz to 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 $40 \cdot \log(\text{specification distance} / \text{test distance})$.

Although these tests were performed at a test site other than an open area test site, adequate comparison measurements were confirmed against an open area test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 937606.

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



Loop Antenna Face: ON EUT

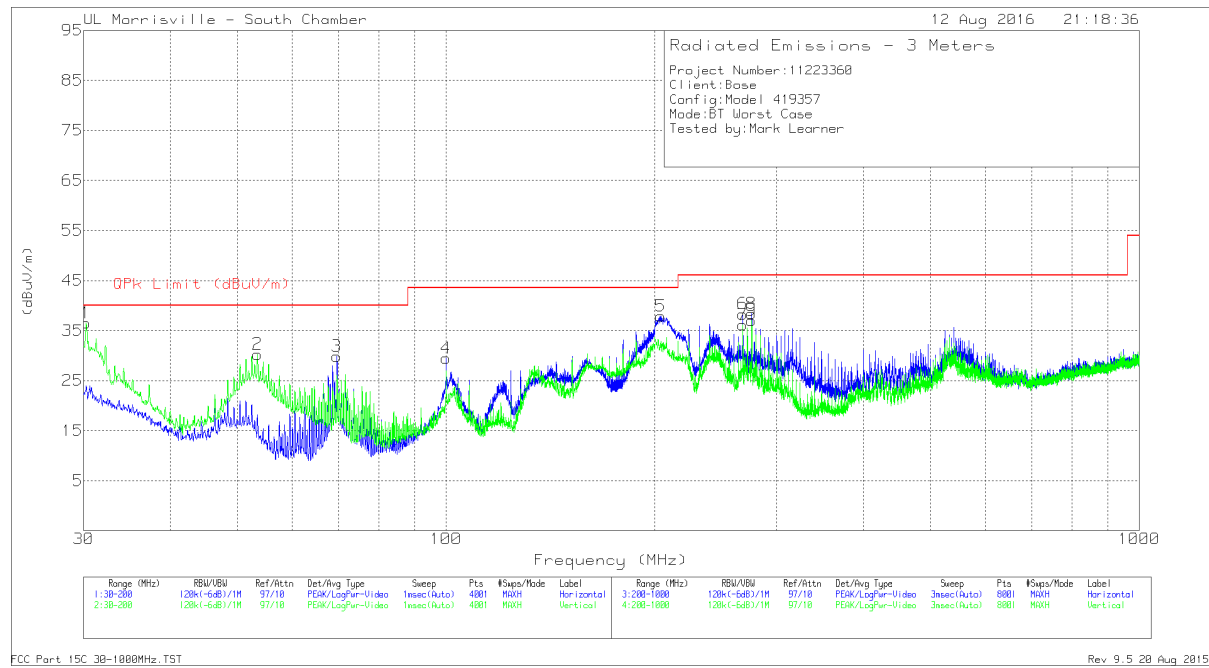
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0079 AF (dB/m)	Cbl (dB)	Corrected Reading dB(uVolts/meter)	FCC 15.209 (projected to 3m)	Margin (dB)	Azimuth (Degs)
1	.00991	45.8	Pk	19.1	.1	65	127.68	-62.68	0-360
2	5.2978	20.76	Pk	11.3	.4	32.46	69.54	-37.08	0-360
3	11.94877	20.48	Pk	10.9	.6	31.98	69.54	-37.56	0-360
4	23.19876	30.15	Pk	9.5	.8	40.45	69.54	-29.09	0-360

Loop Antenna Face: OFF EUT

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)
5	12.12772	18.86	Pk	10.9	.6	30.36	69.54	-39.18	0-360
6	23.19876	24.14	Pk	9.5	.8	34.44	69.54	-35.1	0-360
7	29.23534	19.59	Pk	8.5	.9	28.99	69.54	-40.55	0-360

Pk - Peak detector

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



Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0074 AF (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	30.2664	39.31	Qp	25.8	-31.8	33.31	40	-6.69	236	107	V
2	53.46	49.89	Pk	11.9	-31.5	30.29	40	-9.71	0-360	102	V
3	69.5675	48.79	Pk	12.4	-31.3	29.89	40	-10.11	0-360	199	H
4	99.9975	46.1	Pk	14.4	-31	29.5	43.52	-14.02	0-360	299	H
5	203.9866	49.18	Qp	16.1	-30.2	35.08	43.52	-8.44	132	135	H
6	268	50.54	Pk	17.6	-29.8	38.34	46.02	-7.68	0-360	102	H
7	268	48.36	Pk	17.6	-29.8	36.16	46.02	-9.86	0-360	199	V
8	276	50.37	Pk	17.8	-29.8	38.37	46.02	-7.65	0-360	102	H
9	276	49.06	Pk	17.8	-29.8	37.06	46.02	-8.96	0-360	102	V

Pk - Peak detector

Qp - Quasi-Peak detector

10. 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

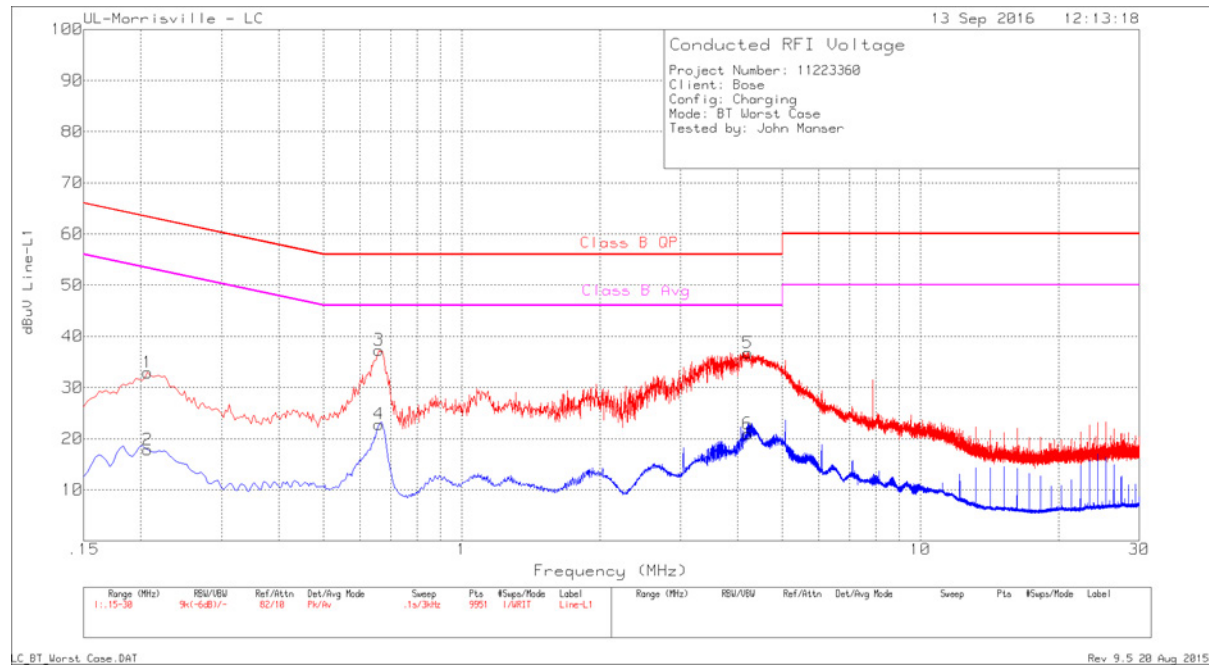
The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.10.

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 1 RESULTS

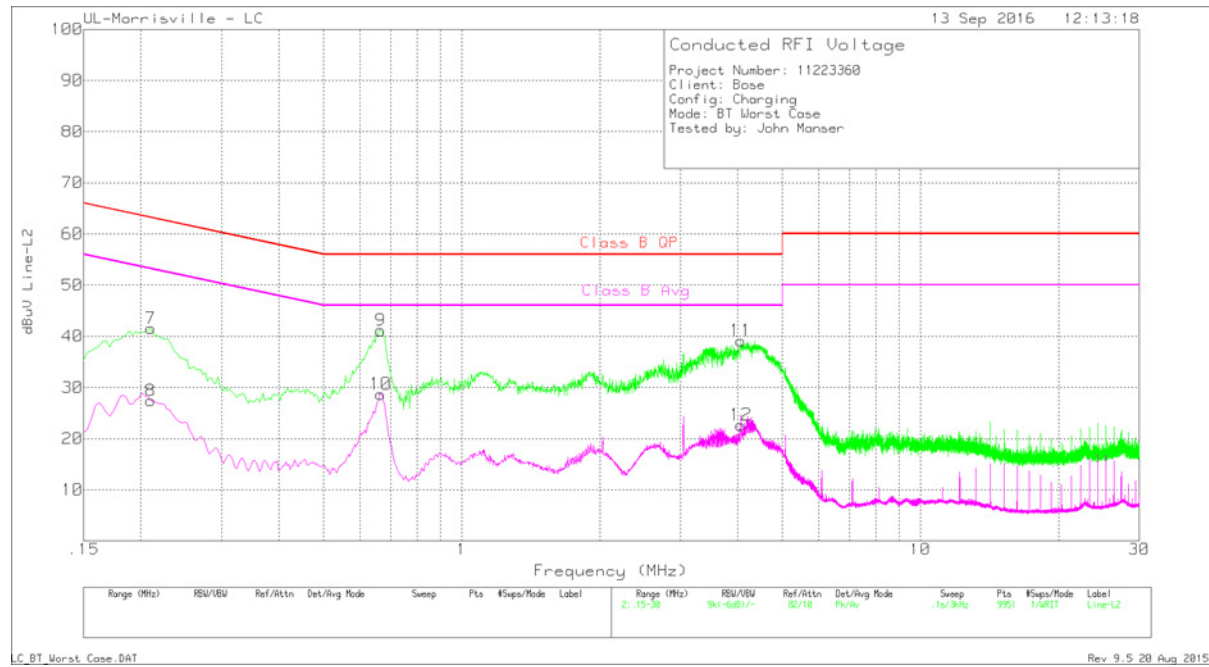


Range 1: Line-L1 .15 - 30MHz										
Marker	Frequency (MHz)	Meter Reading (dBUV)	Det	LISN VCF (dB)	Cbl/Limiter (dB)	Corrected Reading dBUV	QP Limit	Margin (dB)	Avg Limit	Margin (dB)
1	.207	22.82	Pk	.1	10	32.92	63.32	-30.4	-	-
2	.207	7.72	Av	.1	10	17.82	-	-	53.32	-35.5
3	.66	27.32	Pk	0	10	37.32	56	-18.68	-	-
4	.66	12.82	Av	0	10	22.82	-	-	46	-23.18
5	4.203	26.68	Pk	0	10.1	36.78	56	-19.22	-	-
6	4.203	10.86	Av	0	10.1	20.96	-	-	46	-25.04

Pk - Peak detector

Av - Average detection

LINE 2 RESULTS



Range 2: Line-L2 .15 - 30MHz										
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN VCF (dB)	Cbl/Limiter (dB)	Corrected Reading dBuV	QP Limit	Margin (dB)	Avg Limit	Margin (dB)
7	.21	31.43	Pk	.1	10	41.53	63.21	-21.68	-	-
8	.21	17.36	Av	.1	10	27.46	-	-	53.21	-25.75
9	.666	31.15	Pk	0	10	41.15	56	-14.85	-	-
10	.666	18.71	Av	0	10	28.71	-	-	46	-17.29
11	4.065	29.06	Pk	0	10.1	39.16	56	-16.84	-	-
12	4.065	12.59	Av	0	10.1	22.69	-	-	46	-23.31

Pk - Peak detector

Av - Average detection

LC_BT_Worst Case.DAT

Rev 9.5 20 Aug 2015