FCC 47 CFR PART 15 SUBPART C
INDUSTRY CANADA RSS-210 ISSUE 8

CERTIFICATION TEST REPORT

FOR

CELLULAR PHONE WITH BLUETOOTH AND WLAN RADIOS

MODEL NUMBER: A1524

FCC ID: BCG-E2817A
IC: 579C-E2817A

REPORT NUMBER: 14U17676-E1 Revision C

ISSUE DATE: AUGUST 05, 2014

Prepared for
APPLE, INC.
1 INFINITE LOOP
CUPERTINO, CA 95014, U.S.A.

Prepared by
UL VERIFICATION SERVICES INC.
47173 BENICIA STREET
FREMONT, CA 94538, U.S.A.
TEL: (510) 771-1000
FAX: (510) 661-0888

NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	7/23/14	Initial Issue	F. de Anda
A	7/30/14	Updated sections 1, 2 and 5	F. de Anda
B	08/02/14	Address TCB Questions	T. Lee
C	08/05/14	Update section 1	D. Garcia

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: APPLE, INC.
1 INFINITE LOOP
CUPERTINO, CA 95014, U.S.A.

EUT DESCRIPTION: CELLULAR PHONE WITH BLUETOOTH AND WLAN RADIOS

MODEL: A1524

SERIAL NUMBER: C39MV097G1G3 (Conducted), C39NV00FG2YF (Radiated)

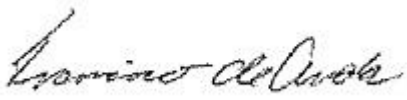
DATE TESTED: JUNE 07, 2014 - JULY 21, 2014

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C	Pass
INDUSTRY CANADA RSS-210 Issue 8 Annex 8	Pass
INDUSTRY CANADA RSS-GEN Issue 3	Pass

UL Verification Services Inc. 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 Verification Services Inc. 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.

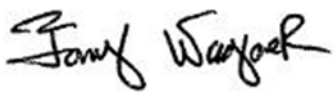
Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released For
UL Verification Services Inc. By:



Francisco de Anda
PROJECT LEADER
UL VERIFICATION SERVICES INC.

Tested By:



Tony Wagoner
EMC ENGINEER
UL VERIFICATION SERVICES INC.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10-2009, FCC CFR 47 Part 2, FCC CFR 47 Part 15, RSS-GEN Issue 3, and RSS-210 Issue 8.

Per FCC guidance, radiated tests are performed to ensure there is no deviation in EM fields between Model 1522 and Model 1524.

3. FACILITIES AND ACCREDITATION

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

47173 Benicia Street	47266 Benicia Street
☐ Chamber A	☐ Chamber D
☐ Chamber B	☐ Chamber E
☐ Chamber C	☒ Chamber F
	☐ Chamber G
	☐ Chamber H

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://ts.nist.gov/standards/scopes/2000650.htm.

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
Conducted Disturbance, 0.15 to 30 MHz	±3.52 dB
Radiated Disturbance, 30 to 1000 MHz	±4.94 dB

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

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

Model A1524 is a mobile phone with multimedia functions (music, application support, and video), Cellular GSM/GPRS/EGPRS/CDMA2000/EVDO Rev.A/ EVDO Rev.B /WCDMA/HSPA+/DC-HSDPA/LTE FDD & Carrier Aggregation radio, IEEE 802.11a/b/g/n/ac radio, Bluetooth radio and NFC. The rechargeable battery is not user accessible.

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	11.93	15.60
2402 - 2480	Enhanced 8PSK	11.56	14.32

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a PiFA antenna, with a maximum gain of 0.81 dBi.

5.4. SOFTWARE AND FIRMWARE

The test utility software used during testing was Bluetool 1.8.5

5.5. WORST-CASE CONFIGURATION AND MODE

The worst-position was the EUT with highest emissions. To determine the worst-case, the EUT is a portable device that has three orientations; therefore X, Y and Z orientations have been investigated with AC adapter and Headset, and the worst case was found to be at X (Flatbed) position without AC adapter and headset.

The worst-case mode and channel used for 30-1000 MHz radiated and power line conducted emissions was including headset, AC charger and the mode and channel with the highest output power.

There are three vendors of the WiFi/Bluetooth radio modules: variant 1, variant 2 and variant 3 and they have the same mechanical outline, same on board antenna, matching circuit, antenna structure and same specification. Baseline testing was performed on all three variants to determine the worst case on all conducted power and radiated emissions.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
AC/DC adapter	Apple	A1401	60812	NA
Earphone	Apple	NA	NA	NA
Laptop	Apple	A1278	C02HJ0A7DTY4	NA
DC power supply	Sorensen	XT 15-4	1319A02780	NA

I/O CABLES (CONDUCTED TEST)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	Antenna	1	SMA	Un-shielded	0.1	N/A
2	USB	1	USB	Shielded	1	N/A
3	DC	1	DC	Un-shielded	0.8	N/A

I/O CABLES (RADIATED ABOVE 1 GHZ)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
None used						

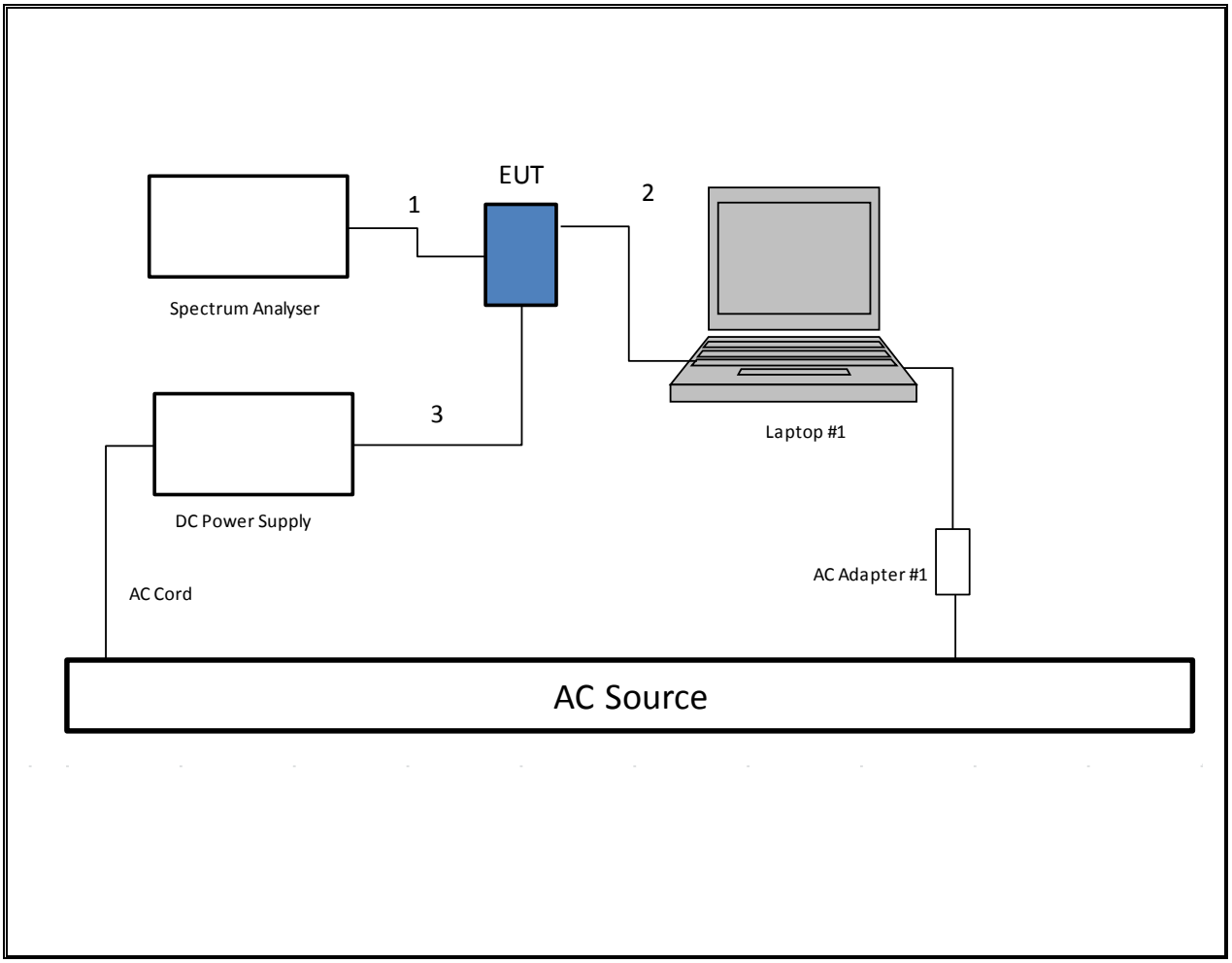
I/O CABLES (BELOW 1GHZ & AC LINE CONDUCTED TESTS)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	1	US115	Un-Shielded	80cm	NA
2	DC	1	USB	Un-Shielded	1m	NA
3	Audio	1	Jack	Un-Shielded	0.5m	NA

TEST SETUP- CONDUCTED PORT

The EUT was tested connected to a host Laptop via USB cable adapter and spectrum analyzer to antenna port. Test software exercised the EUT.

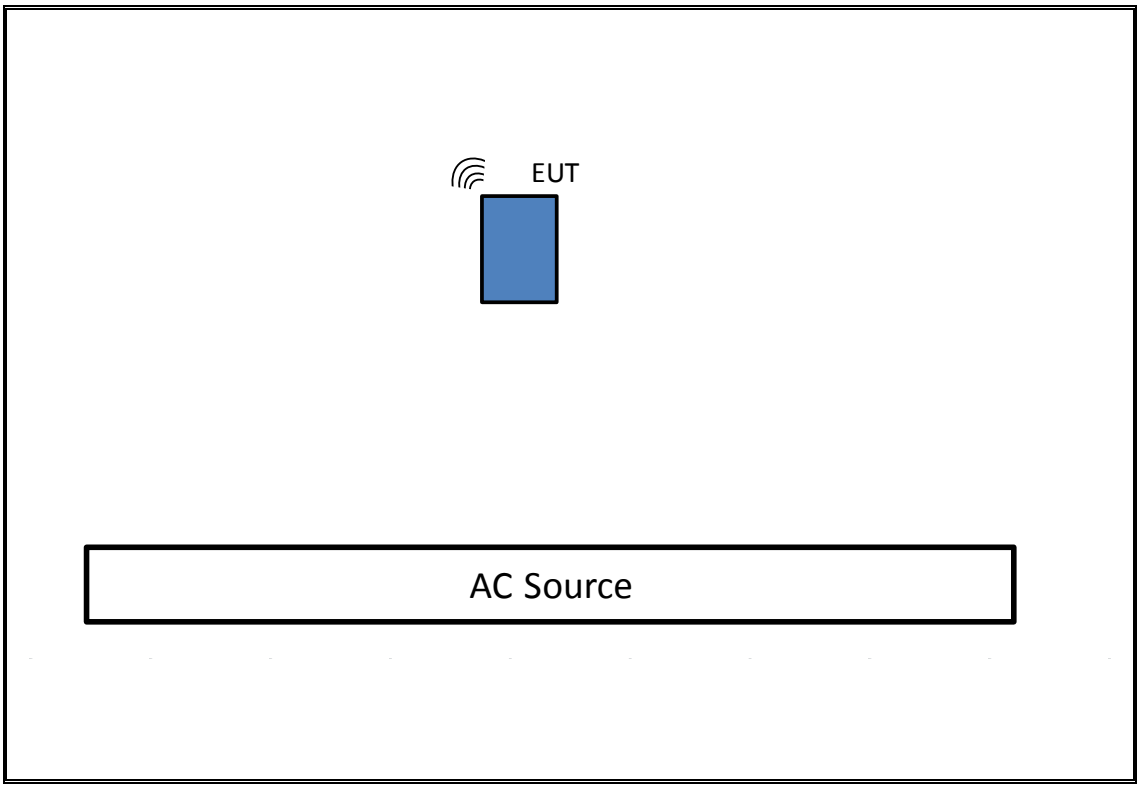
SETUP DIAGRAM



TEST SETUP- RADIATED-ABOVE 1 GHZ

The EUT was tested battery powered. Test software exercised the EUT.

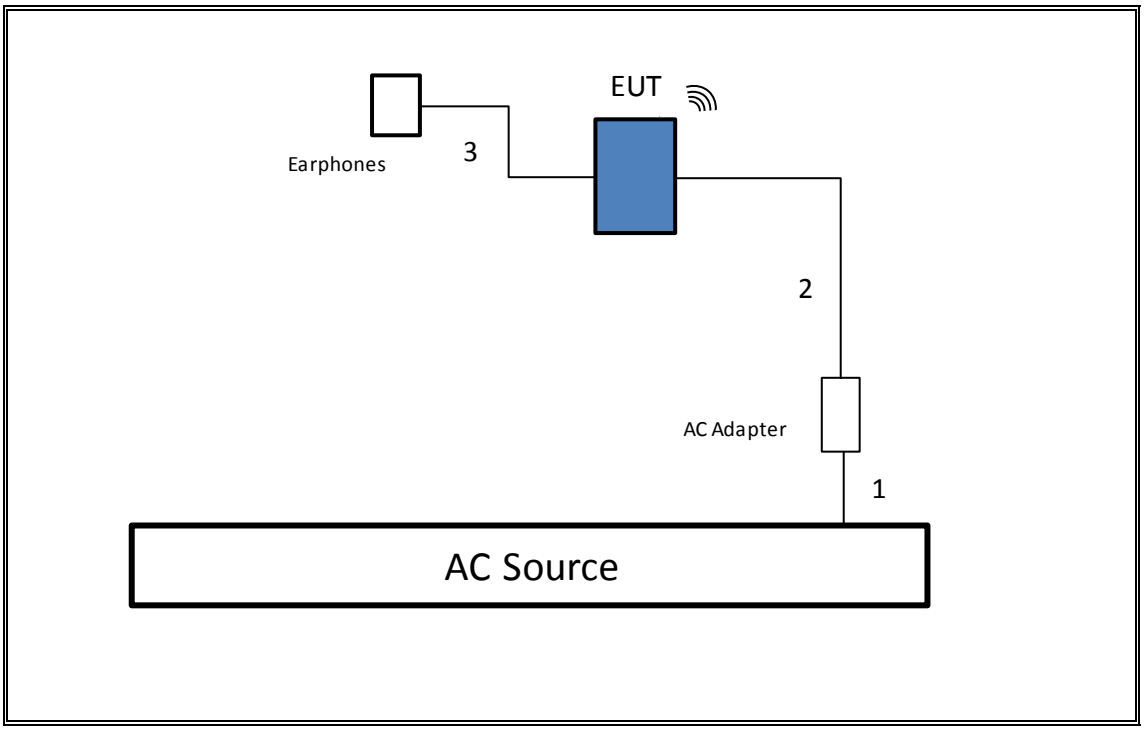
SETUP DIAGRAM



TEST SETUP- BELOW 1GHZ & AC LINE CONDUCTED TESTS

The EUT was tested with earphones connected and powered by AC adapter. Test software exercised the EUT.

SETUP DIAGRAM



6. TEST AND MEASUREMENT EQUIPMENT

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

TEST EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Asset**	**Cal Due**
Antenna, Horn, 18 GHz	ETS Lindgren	3117	F00131	02/18/15
Antenna, Horn, 26.5 GHz	ARA	MWH-1826/B	C00589	11/28/14
Peak / Average Power Sensor	Agilent / HP	N1911A	F00153	03/06/15
Wideband Power Sensor	Agilent	N1921A	F00361	10/02/14
Peak Power Meter	Agilent / HP	E9323A	F00025	04/03/15
Spectrum Analyzer, 44 GHz	Agilent / HP	N9030A	F00129	02/22/15
Antenna, Bilog, 2 GHz	Sunol Sciences	JB1	F00168	03/28/15
Preamplifier, 1300 MHz	Sonoma	310	F00008	05/27/15
Preamplifier, 26.5 GHz	Agilent / HP	8449B	F00165	03/25/15
EMI Test Receiver, 9 kHz-7 GHz	R & S	ESCI 7	F00092	09/05/14
LISN, 30 MHz	FCC	LISN-50/250-25-2	C00626	01/14/15

7. ON TIME, DUTY CYCLE AND MEASUREMENT METHODS

LIMITS

None; for reporting purposes only.

PROCEDURE

KDB 789033 Zero-Span Spectrum Analyzer Method.

7.1. 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)
GFSK	2.880	3.760	0.766	76.6%	1.158	0.347
8PSK	2.890	3.750	0.771	77.1%	1.131	0.346

7.2. MEASUREMENT METHODS

6 dB BW: KDB 558074 D01.

Output Power: KDB 558074 D01.

Power Spectral Density: KDB 558074 D01.

Out-of-band emissions in non-restricted bands: KDB 558074 D01.

Out-of-band emissions in restricted bands: KDB 558074 D01.

DUTY CYCLE PLOTS

DUTY CYCLE BLE MODE GFSK

DUTY CYCLE PLOTS

DUTY CYCLE BLE MODE 8PSK

8. ANTENNA PORT TEST RESULTS

8.1. BASIC DATA RATE GFSK MODULATION

8.1.1. 20 dB AND 99% BANDWIDTH

LIMIT

None; for reporting purposes only.

TEST PROCEDURE

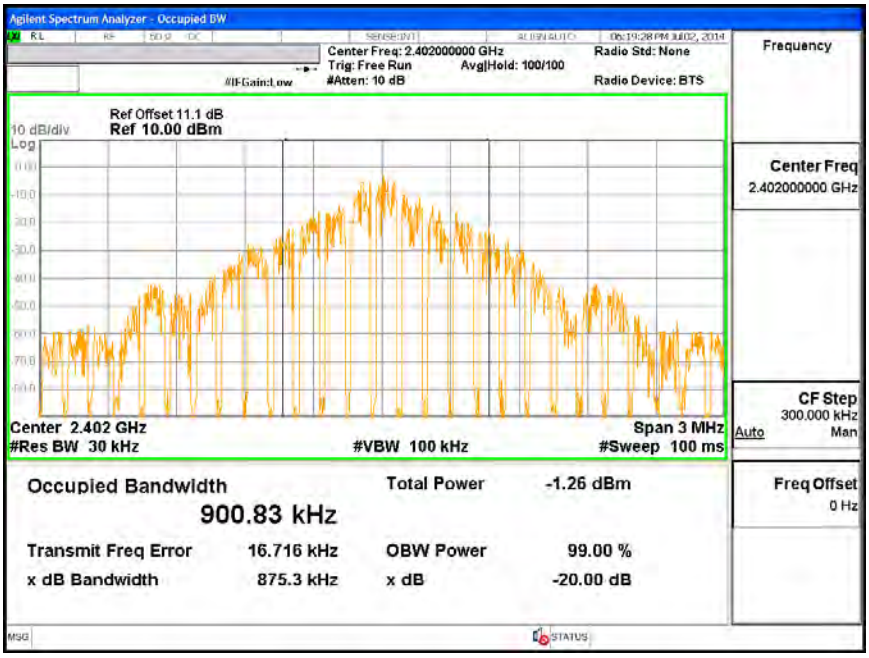
The transmitter output is connected to a spectrum analyzer. The RBW is set to ≥ 1% of the 20 dB bandwidth. The VBW is set to ≥ RBW. The sweep time is coupled.

RESULTS

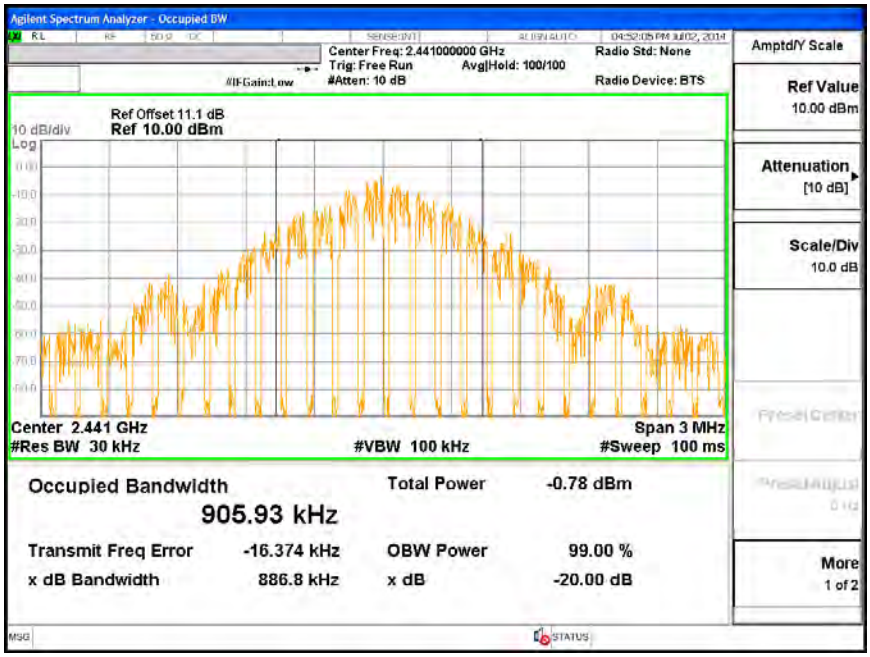
Channel	Frequency (MHz)	20 dB Bandwidth (kHz)	99% Bandwidth (kHz)
Low	2402	875.3	900.83
Middle	2441	886.8	905.93
High	2480	850.8	896.66

20 dB AND 99% BANDWIDTH

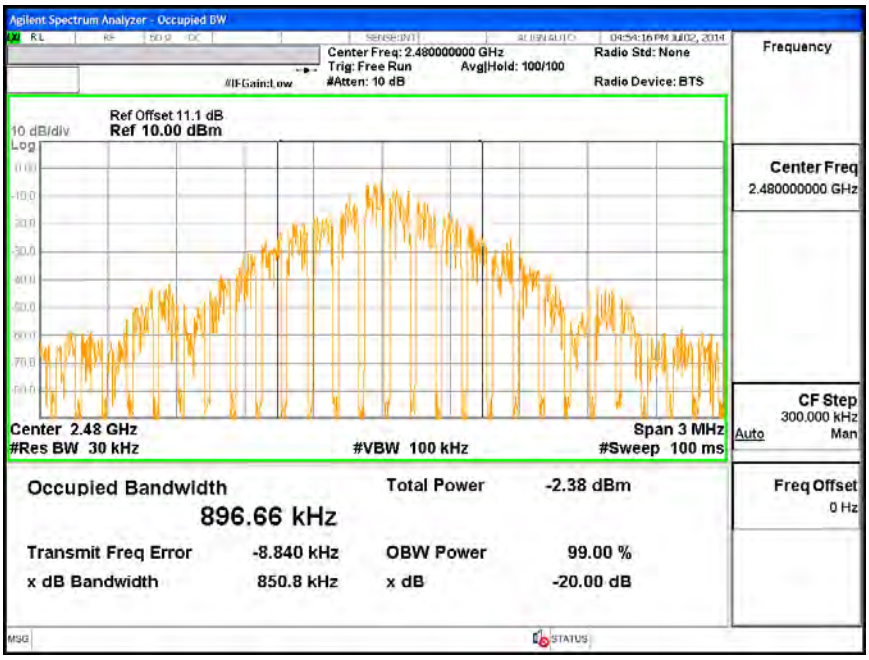
BANDWIDTH LOW CH



BANDWIDTH MID CH



BANDWIDTH HIGH CH



8.1.2. HOPPING FREQUENCY SEPARATION

LIMIT

FCC §15.247 (a) (1)

IC RSS-210 A8.1 (b)

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 100 kHz and the VBW is set to 100 kHz. The sweep time is coupled.

RESULTS

HOPPING FREQUENCY SEPARATION

HOPPING FREQUENCY SEPARATION

8.1.3. NUMBER OF HOPPING CHANNELS

LIMIT

FCC §15.247 (a) (1) (iii)

IC RSS-210 A8.1 (d)

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. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

RESULTS

Normal Mode: 79 Channels observed.

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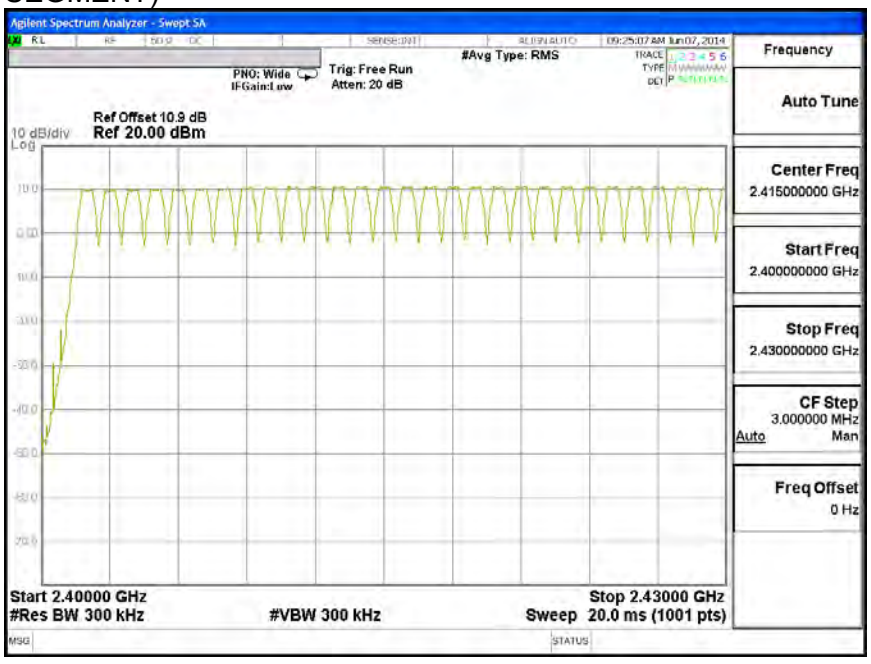
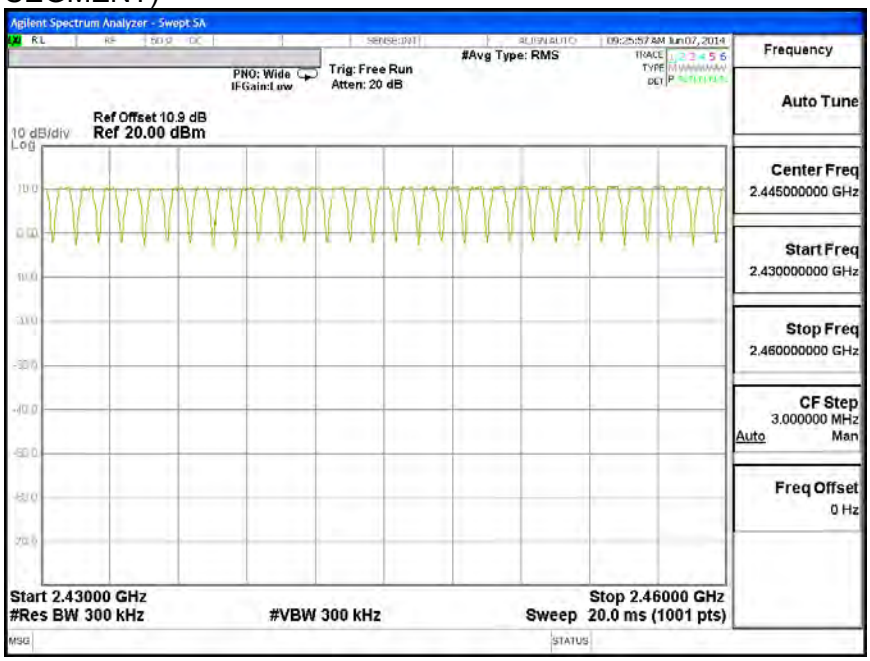
NUMBER OF HOPPING CHANNELS

NUMBER OF HOPPING CHANNELS (100 MHZ SPAN)

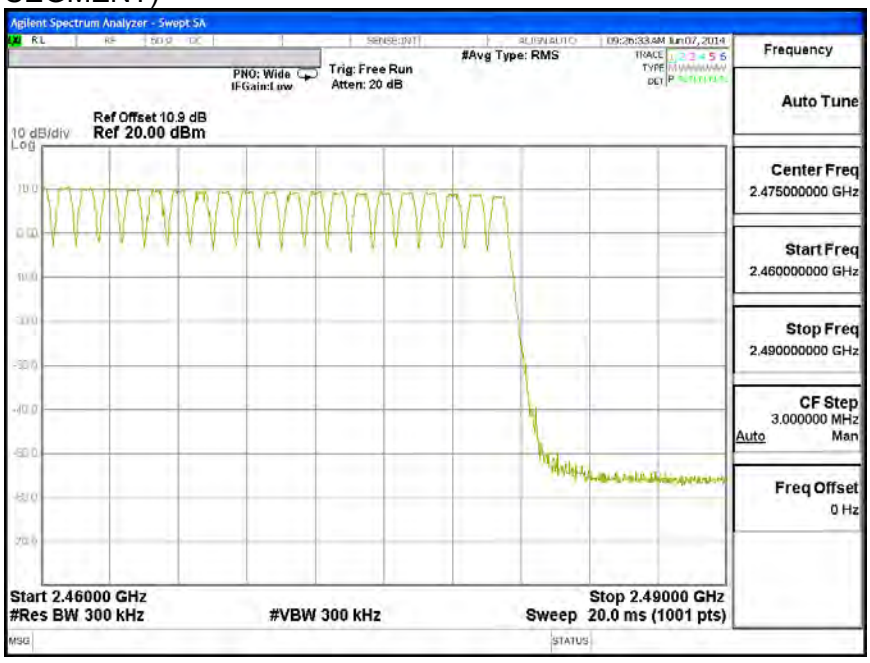
NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, FIRST SEGMENT)



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



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



8.1.4. AVERAGE TIME OF OCCUPANCY

LIMIT

FCC §15.247 (a) (1) (iii)

IC RSS-210 A8.1 (d)

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.

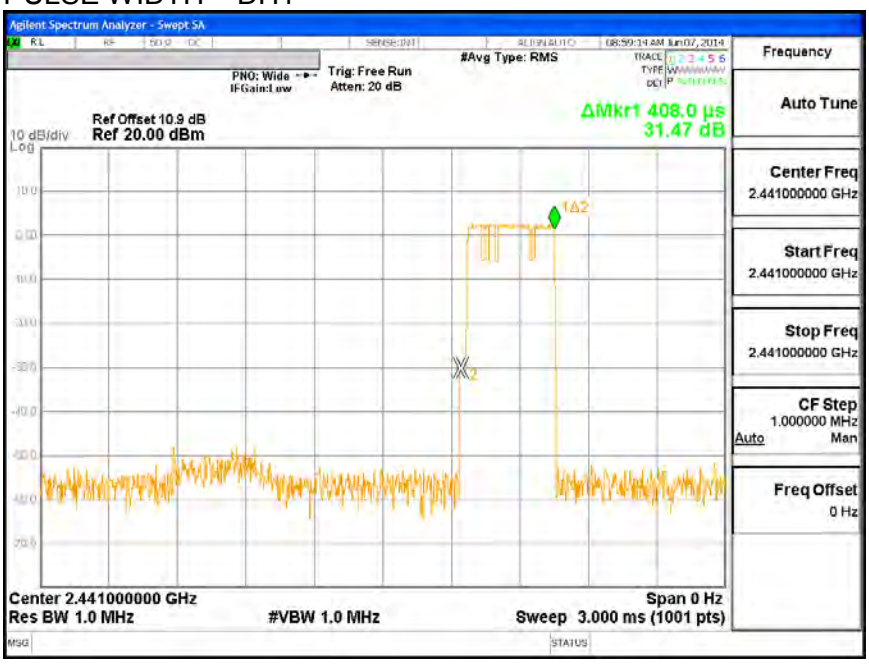
The average time of occupancy in the specified 31.6 second period (79 channels * 0.4 s) is equal to 10 * (# of pulses in 3.16 s) * pulse width.

RESULTS

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	0.408	32	0.131	0.4	-0.269
DH3	1.638	19	0.311	0.4	-0.089
DH5	2.900	11	0.319	0.4	-0.081

PULSE WIDTH - DH1

PULSE WIDTH – DH1

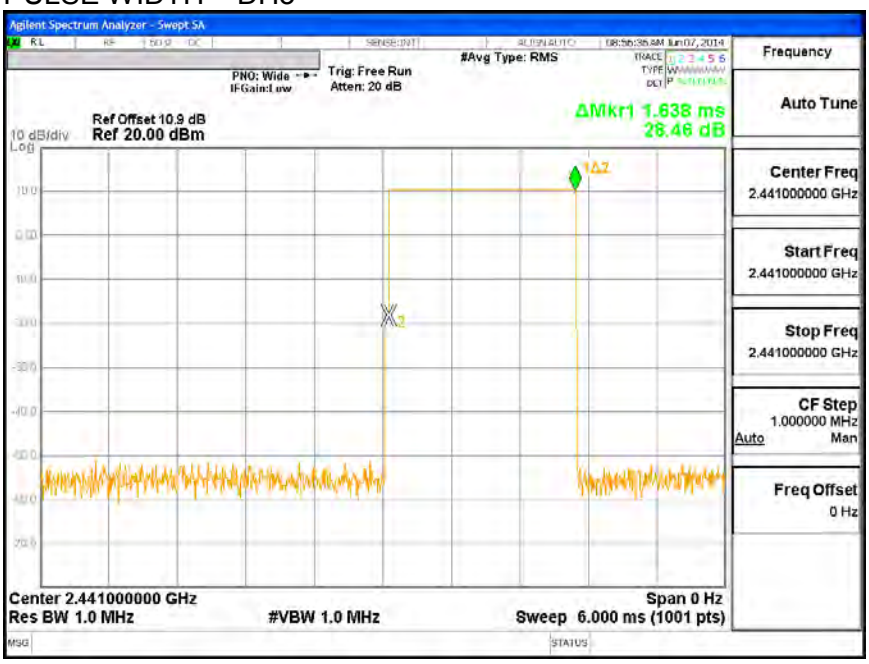


NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1

NUMBER OF PULSES – DH1

PULSE WIDTH – DH3

PULSE WIDTH – DH3

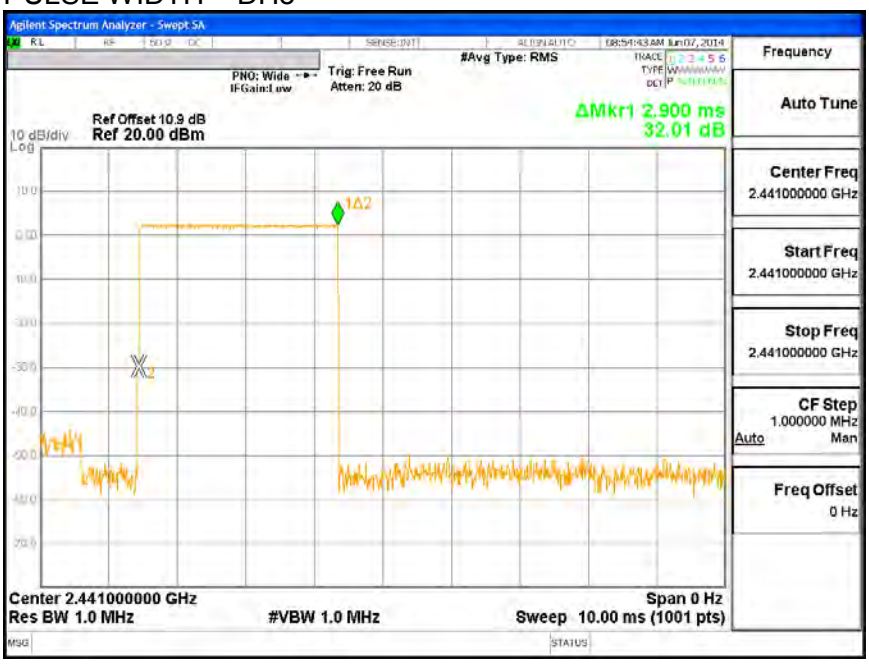


NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3

NUMBER OF PULSES – DH3

PULSE WIDTH – DH5

PULSE WIDTH – DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5

NUMBER OF PULSES – DH5

8.1.1. OUTPUT POWER

LIMIT

§15.247 (b) (1)

RSS-210 Issue 7 Clause A8.4

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

TEST PROCEDURE

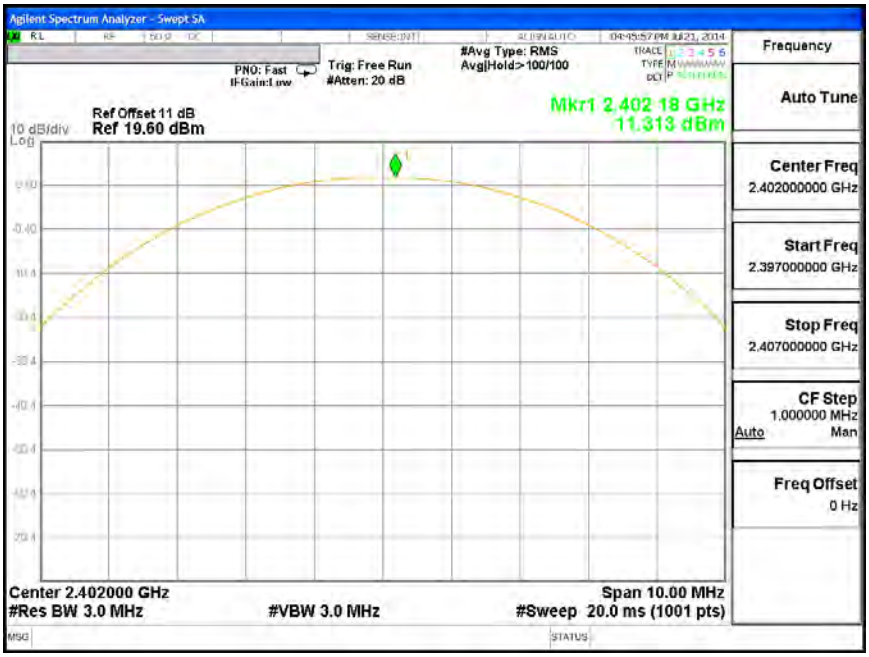
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

RESULTS

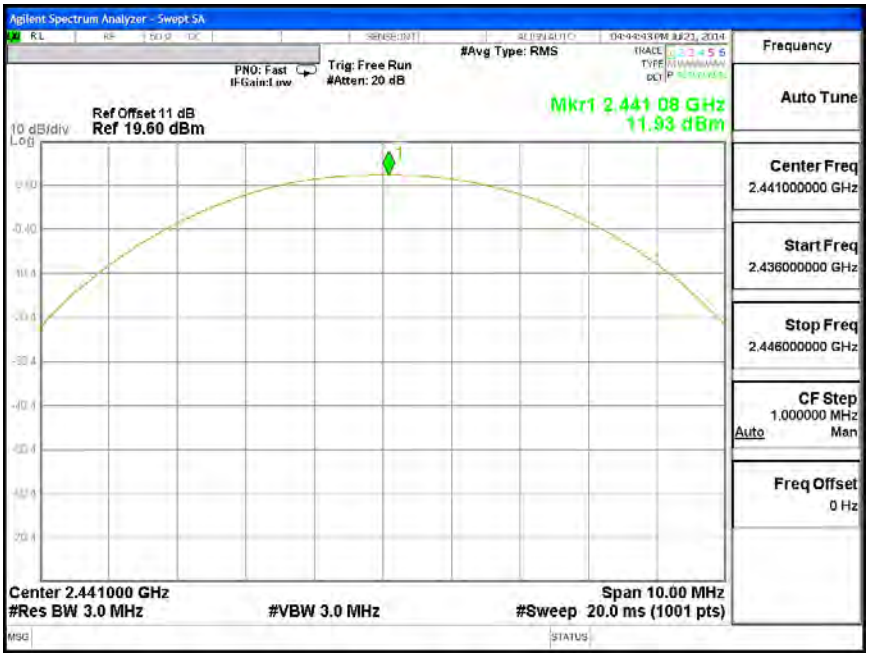
Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	11.31	30	-18.69
Middle	2441	11.93	30	-18.07
High	2480	9.92	30	-20.08

OUTPUT POWER

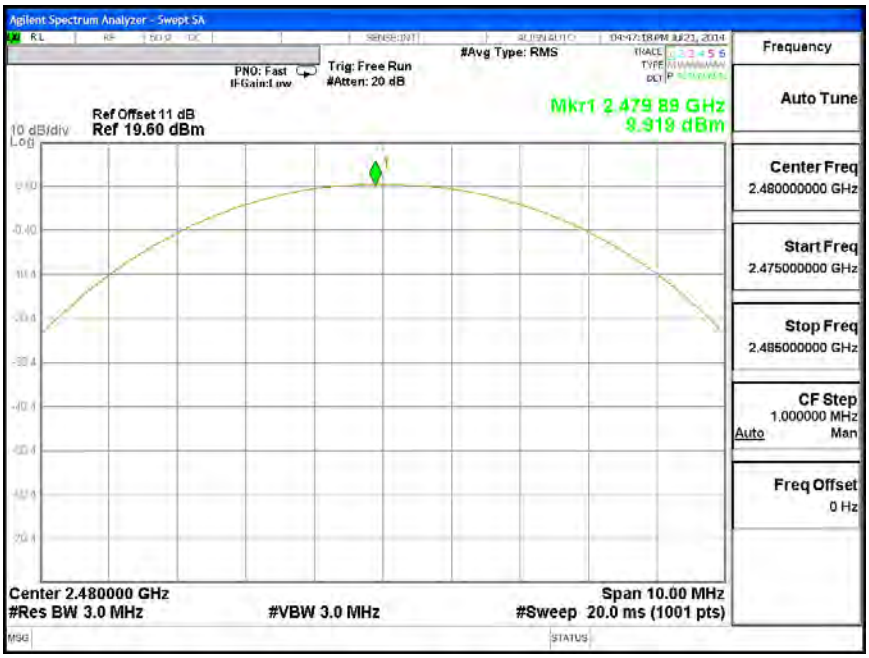
PEAK POWER LOW CH



PEAK POWER MID CH



PEAK POWER HIGH CH



8.1.2. 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 11 dB (including 10 dB pad and 1 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	11.21
Middle	2441	11.96
High	2480	9.83

8.1.3. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

Limit = -20 dBc

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.

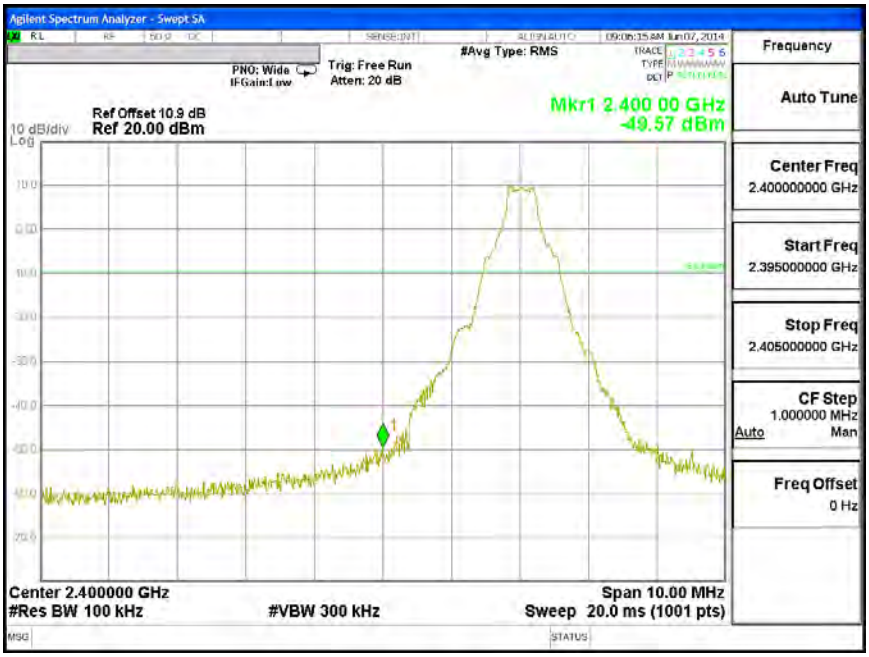
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

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

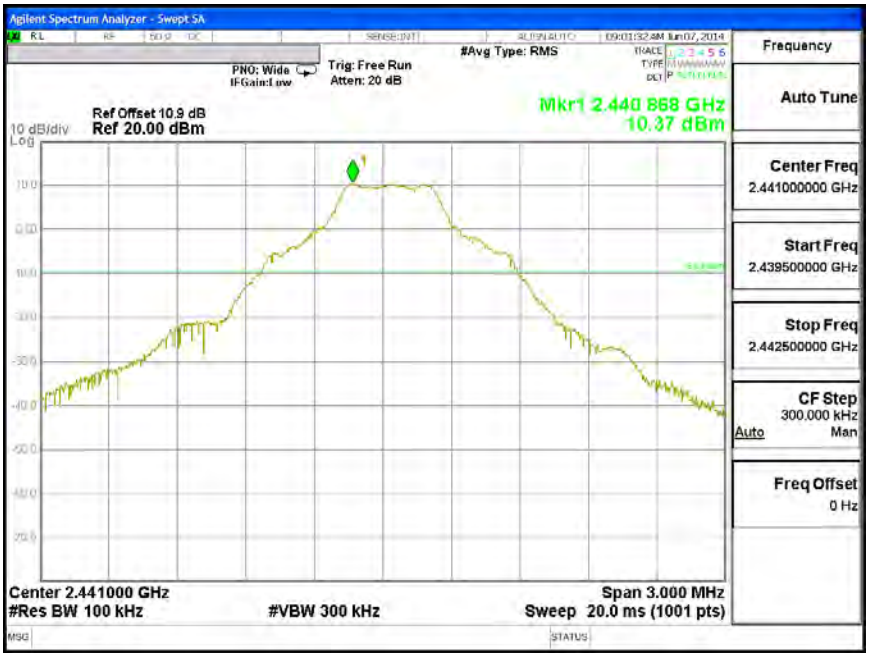
LOW CHANNEL BANDEDGE



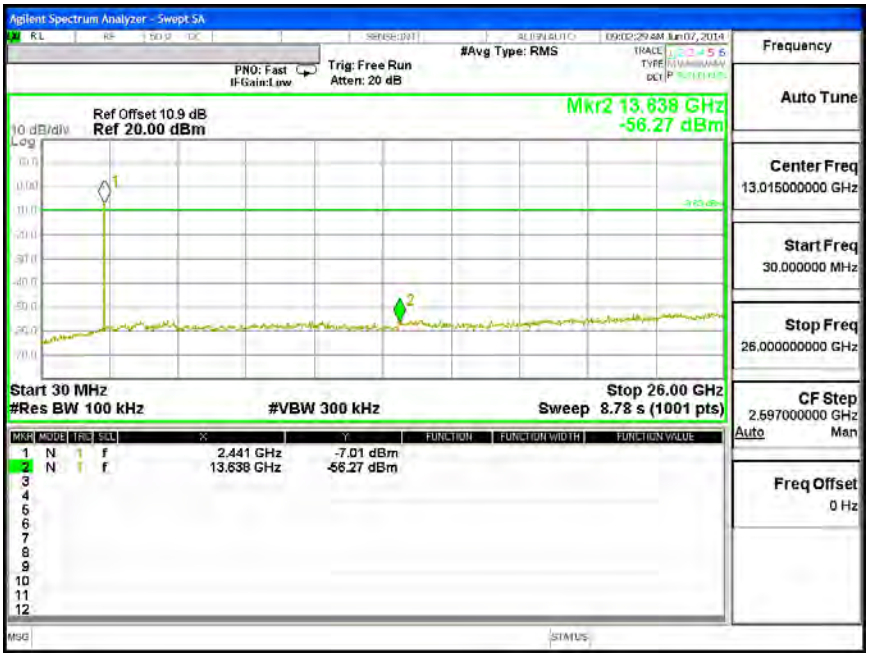
LOW CHANNEL SPURIOUS

SPURIOUS EMISSIONS, MID CHANNEL

MID CHANNEL REFERENCE

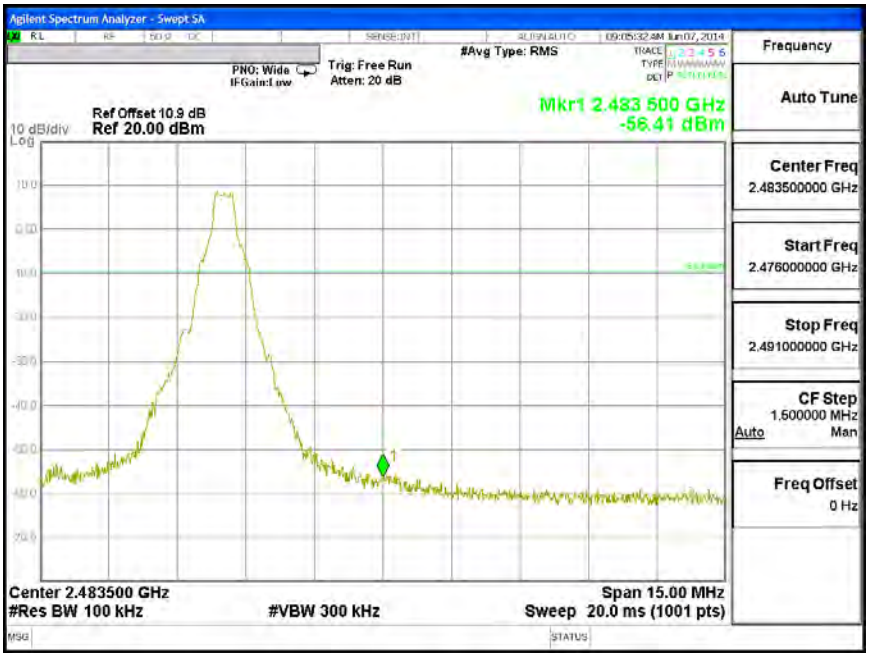


MID CHANNEL SPURIOUS

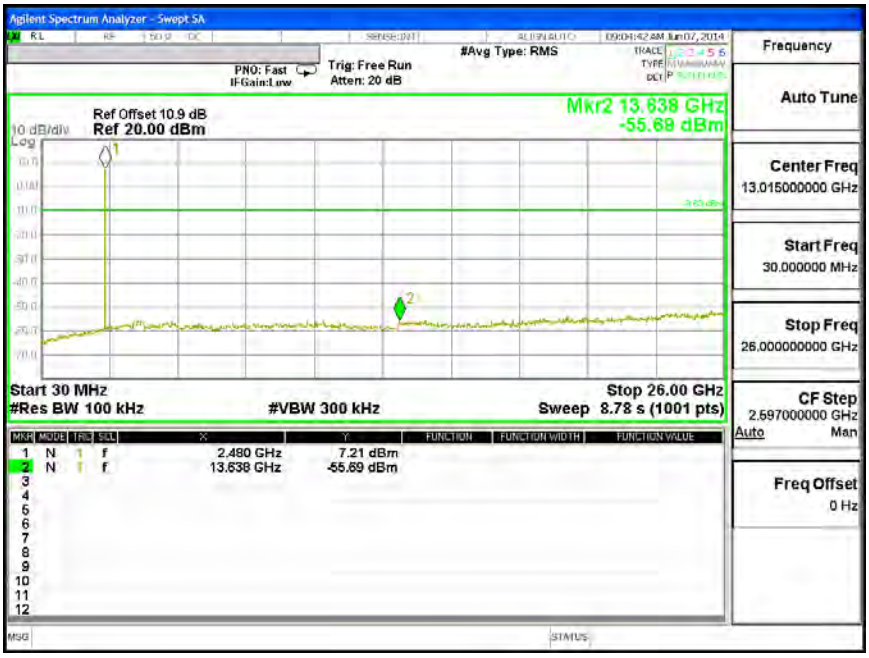


SPURIOUS EMISSIONS, HIGH CHANNEL

HIGH CHANNEL BANDEDGE

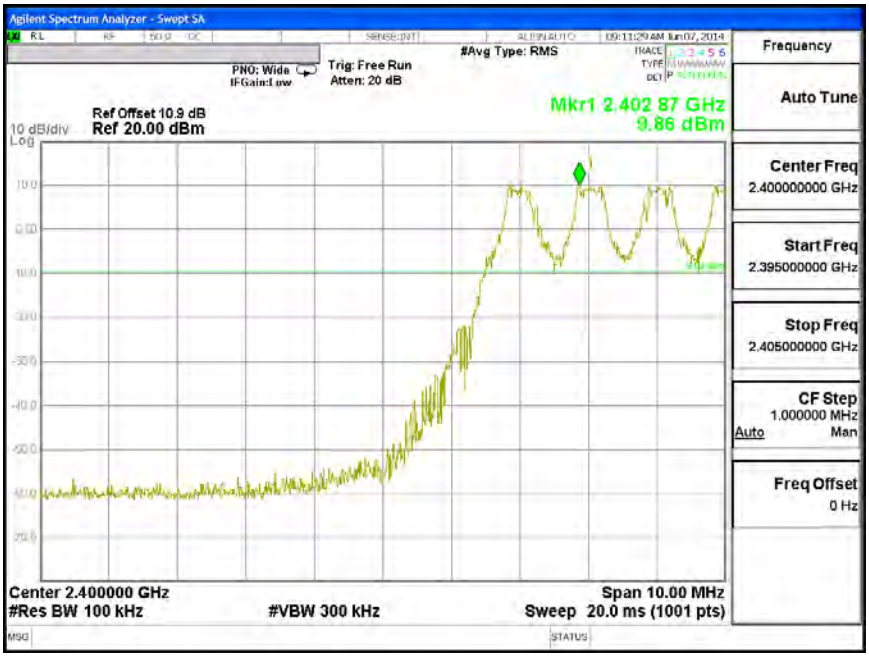


HIGH CHANNEL SPURIOUS

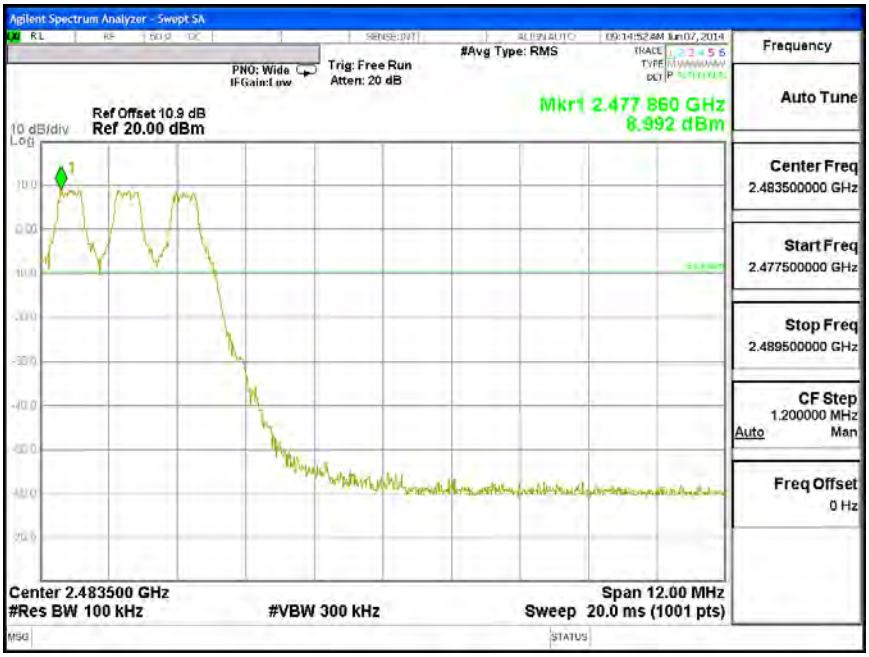


SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON

LOW BANDEDGE WITH HOPPING ON



HIGH BANDEDGE WITH HOPPING ON



8.2. ENHANCED DATA RATE 8PSK MODULATION

8.2.1. 20 dB AND 99% BANDWIDTH

LIMIT

None; for reporting purposes only.

TEST PROCEDURE

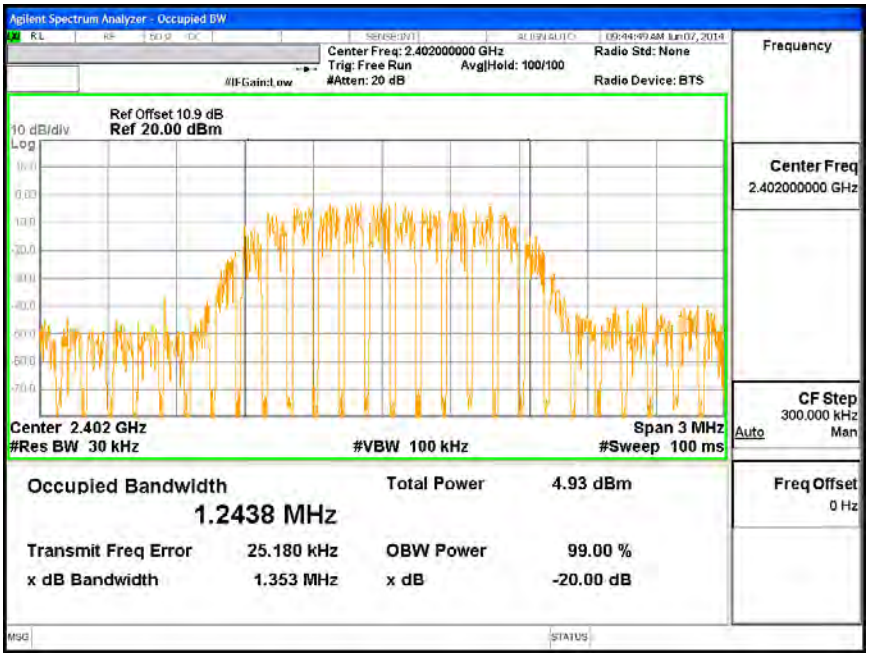
The transmitter output is connected to a spectrum analyzer. The RBW is set to ≥ 1% of the 20 dB bandwidth. The VBW is set to ≥ RBW. The sweep time is coupled.

RESULTS

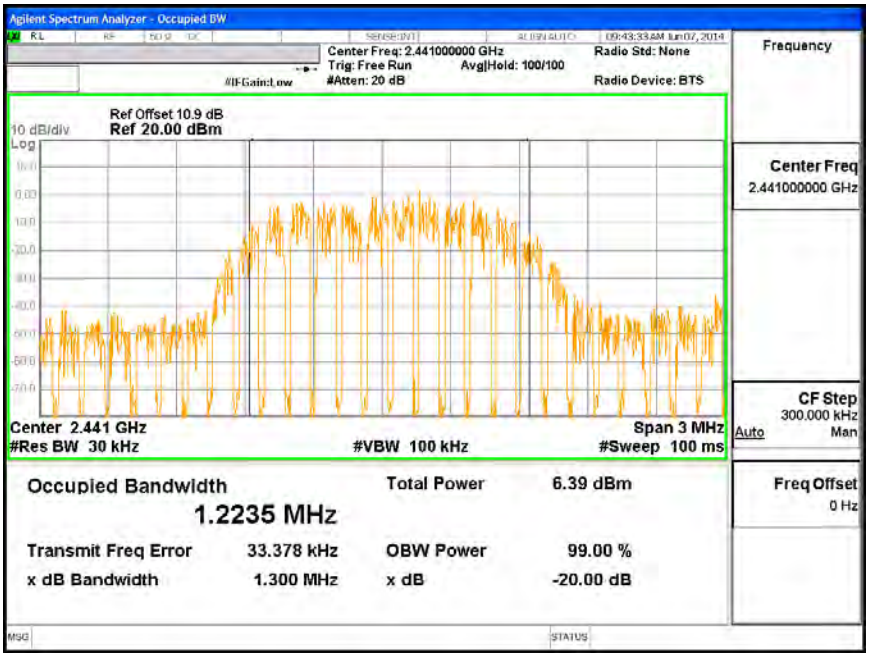
Channel	Frequency (MHz)	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.353	1.244
Middle	2441	1.300	1.224
High	2480	1.350	1.235

20 dB AND 99% BANDWIDTH

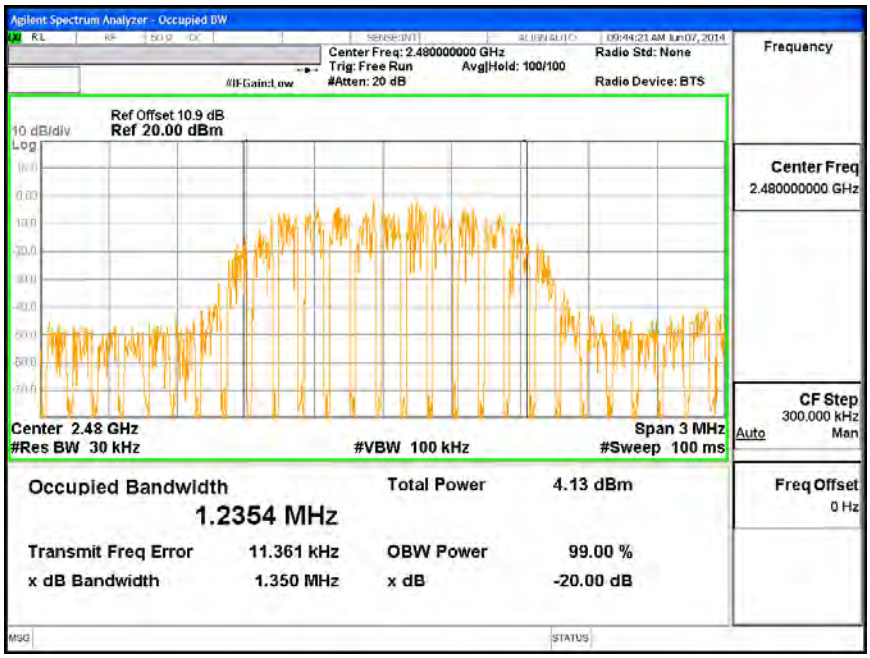
BANDWIDTH LOW CH



BANDWIDTH MID CH



BANDWIDTH HIGH CH



8.2.2. HOPPING FREQUENCY SEPARATION

LIMIT

FCC §15.247 (a) (1)

IC RSS-210 A8.1 (b)

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.

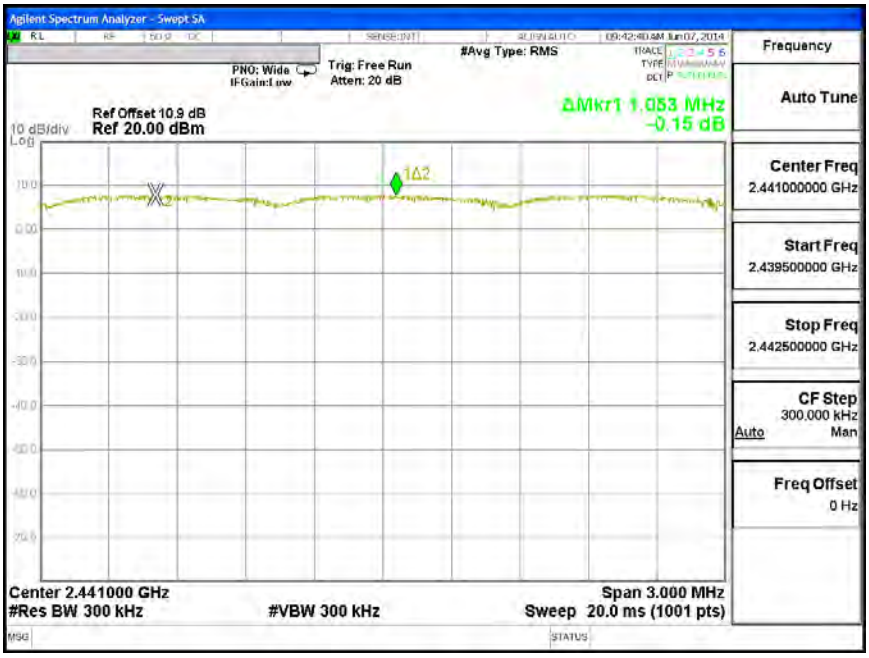
TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 100 kHz. The sweep time is coupled.

RESULTS

HOPPING FREQUENCY SEPARATION

HOPPING FREQUENCY SEPARATION



8.2.3. NUMBER OF HOPPING CHANNELS

LIMIT

FCC §15.247 (a) (1) (iii)

IC RSS-210 A8.1 (d)

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. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

RESULTS

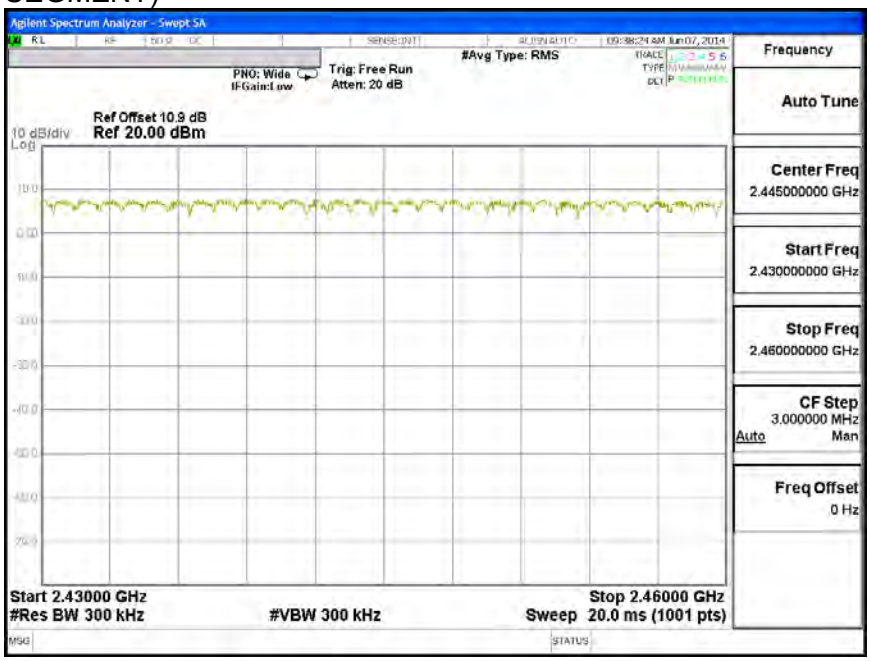
Normal Mode: 79 Channels observed.

NUMBER OF HOPPING CHANNELS

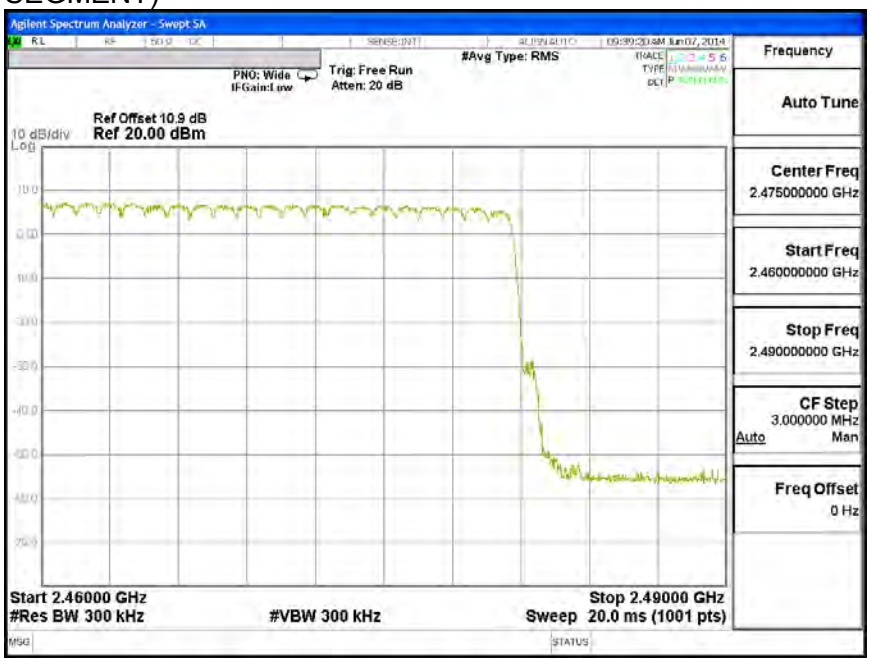
NUMBER OF HOPPING CHANNELS (100 MHZ SPAN)

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)



8.2.4. AVERAGE TIME OF OCCUPANCY

LIMIT

FCC §15.247 (a) (1) (iii)

IC RSS-210 A8.1 (d)

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

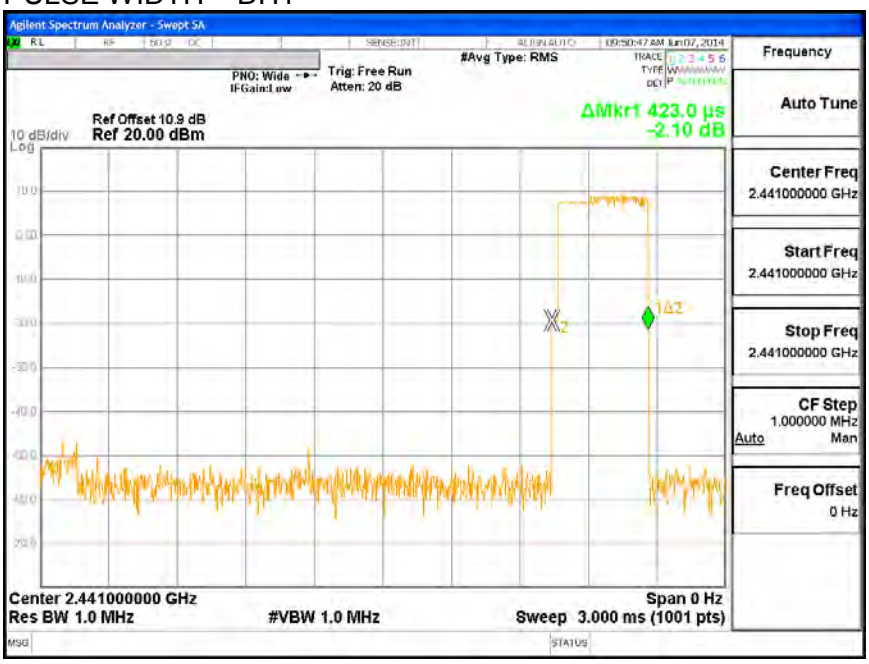
Time Of Occupancy = 10 * xx pulses * yy msec = zz msec

8PSK (EDR) Mode

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of (sec)	Limit (sec)	Margin (sec)
3DH1	0.423	32	0.135	0.4	-0.265
3DH3	1.675	12	0.201	0.4	-0.199
3DH5	2.920	12	0.350	0.4	-0.050

PULSE WIDTH - DH1

PULSE WIDTH – DH1

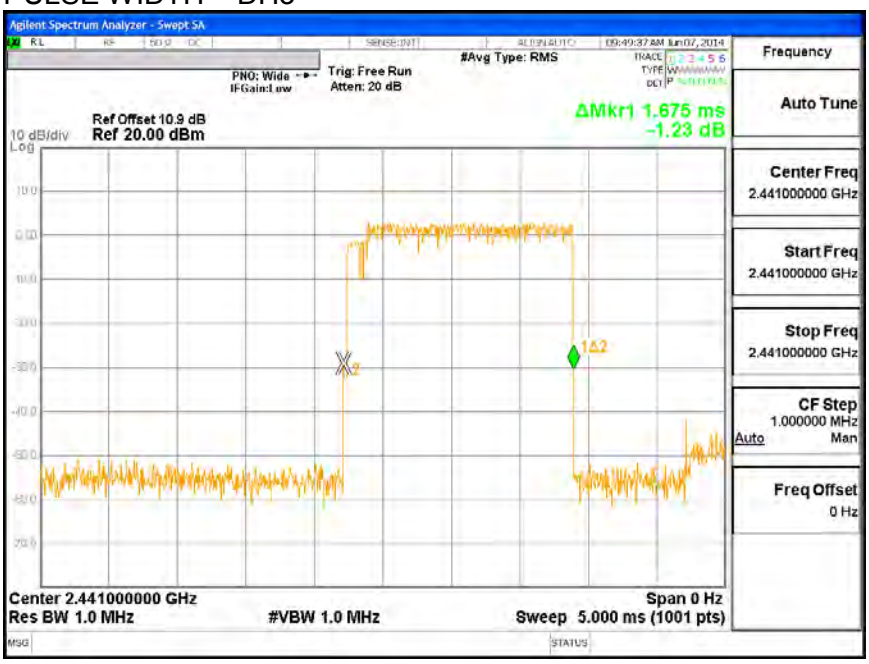


NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1

NUMBER OF PULSES – DH1

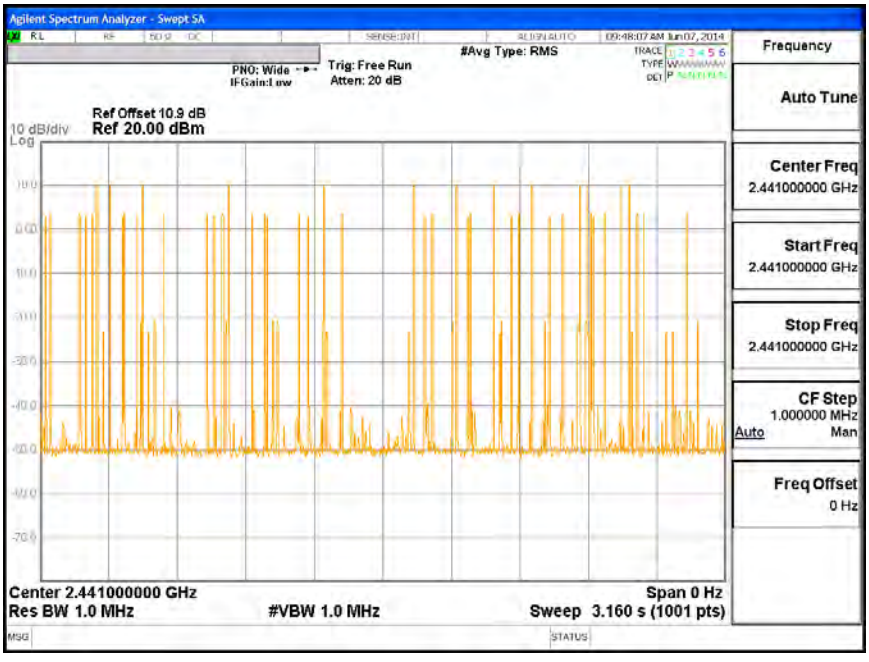
PULSE WIDTH – DH3

PULSE WIDTH – DH3



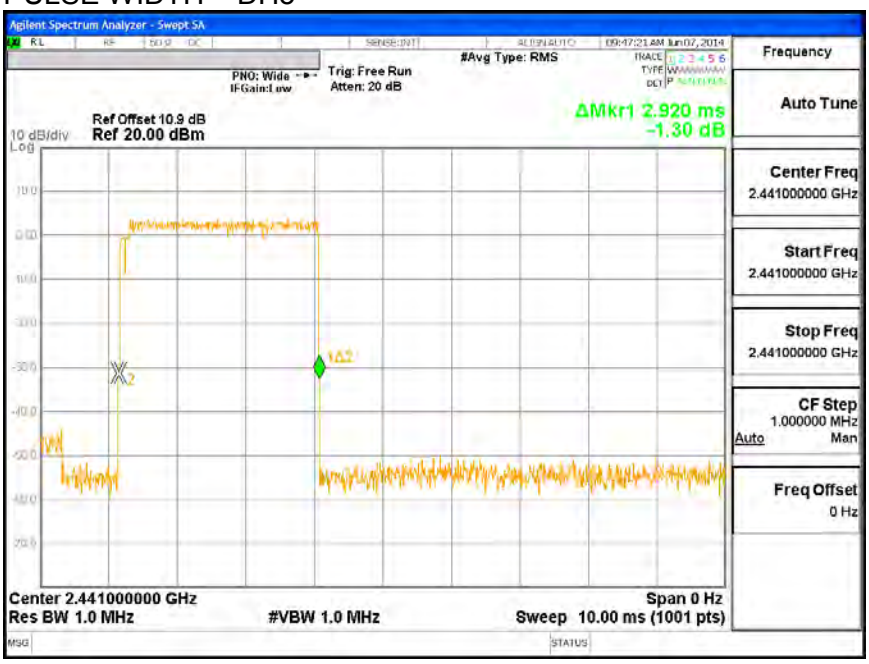
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3

NUMBER OF PULSES – DH3



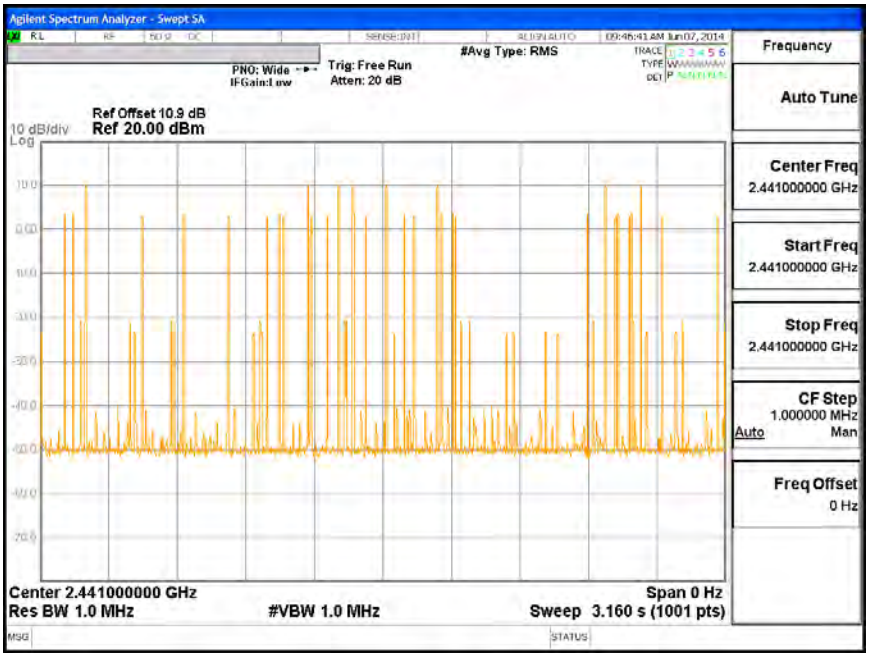
PULSE WIDTH – DH5

PULSE WIDTH – DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5

NUMBER OF PULSES – DH5



8.2.5. OUTPUT POWER

LIMIT

§15.247 (b) (1)

RSS-210 Issue 7 Clause A8.4

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

TEST PROCEDURE

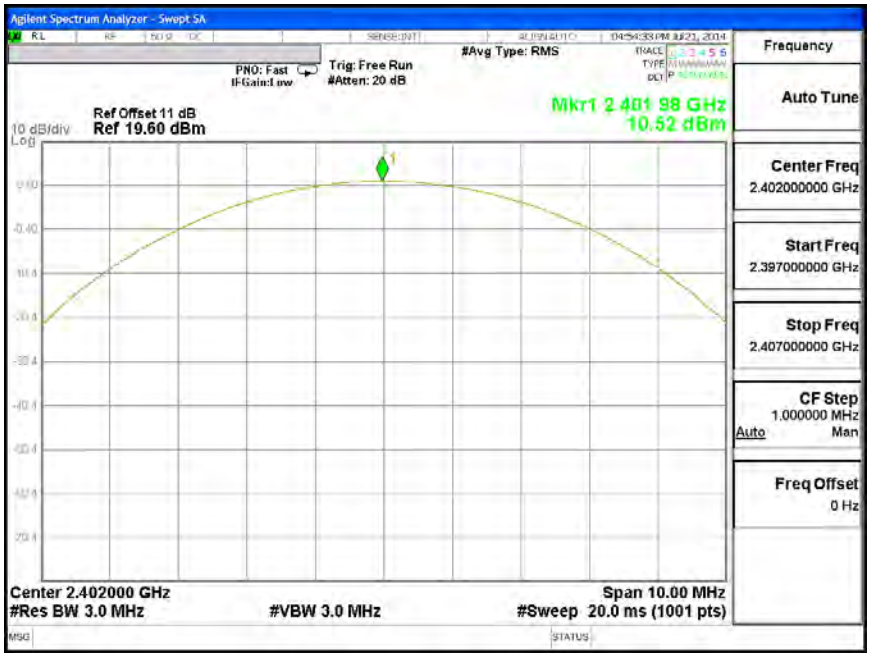
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

RESULTS

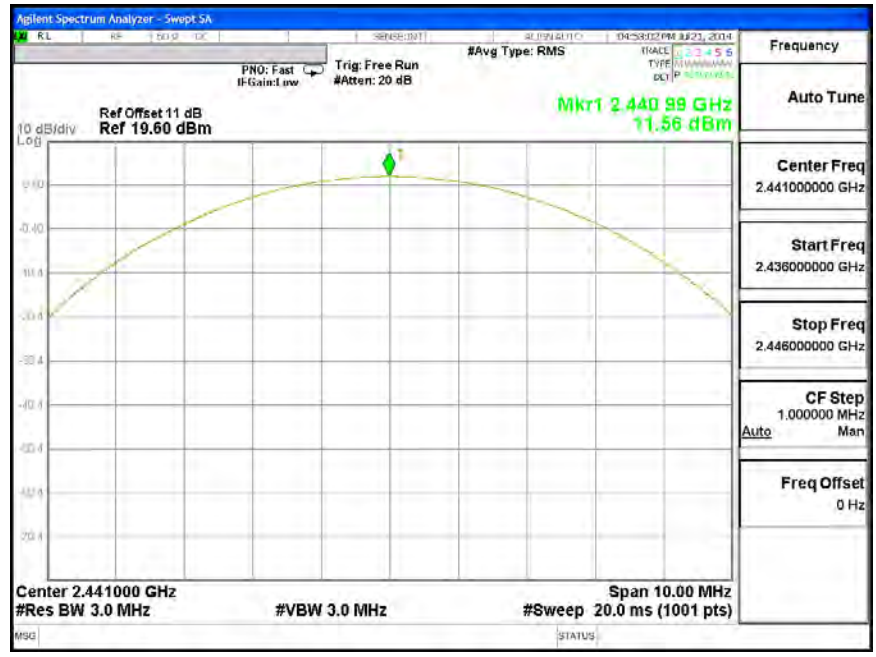
Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	10.52	30	-19.48
Middle	2441	11.56	30	-18.44
High	2480	9.26	30	-20.74

OUTPUT POWER

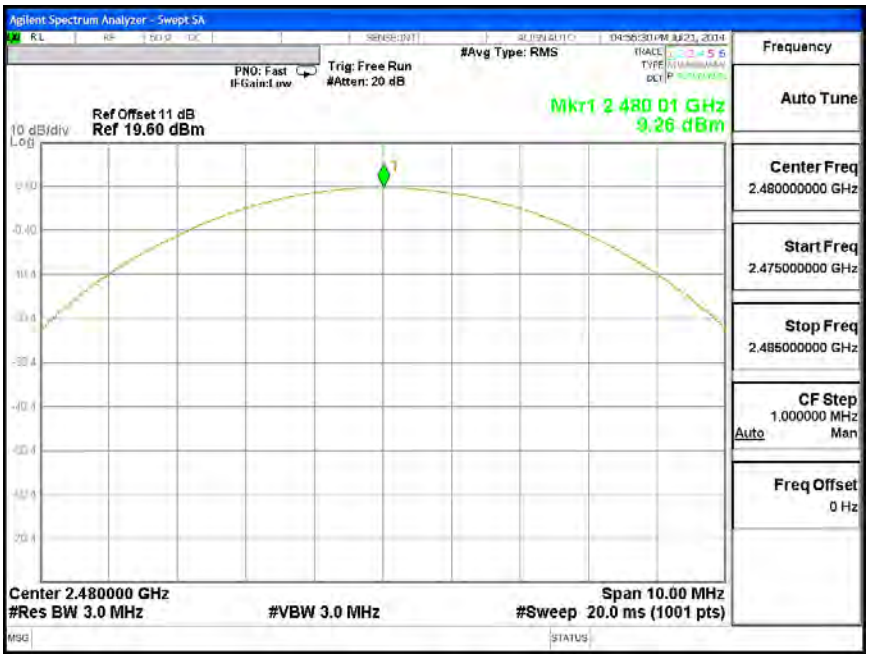
PEAK POWER LOW CH



PEAK POWER MID CH



PEAK POWER HIGH CH



8.2.6. 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 11 dB (including 10 dB pad and 1 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	9.12
Middle	2441	9.92
High	2480	7.75

8.2.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

Limit = -20 dBc

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.

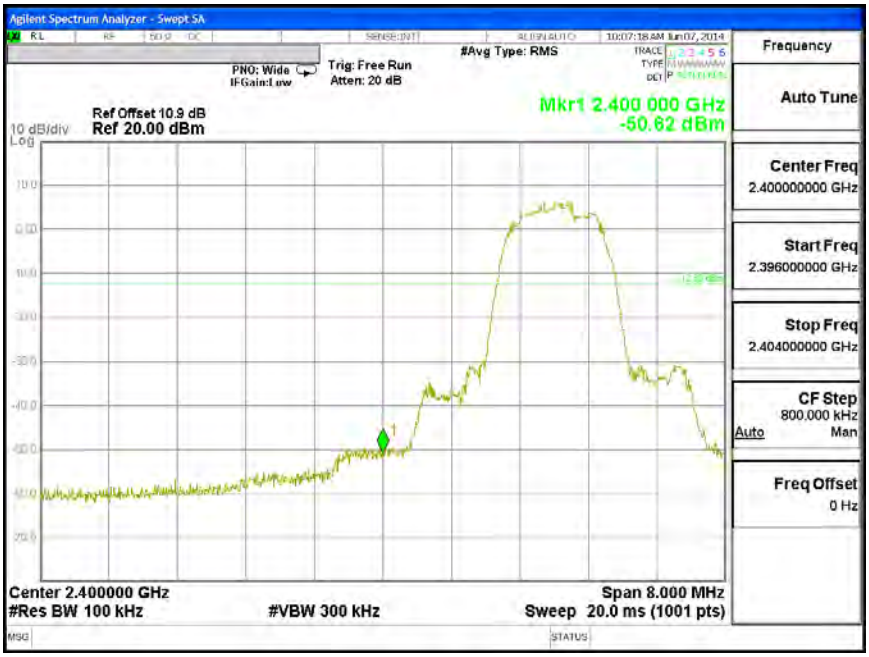
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

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

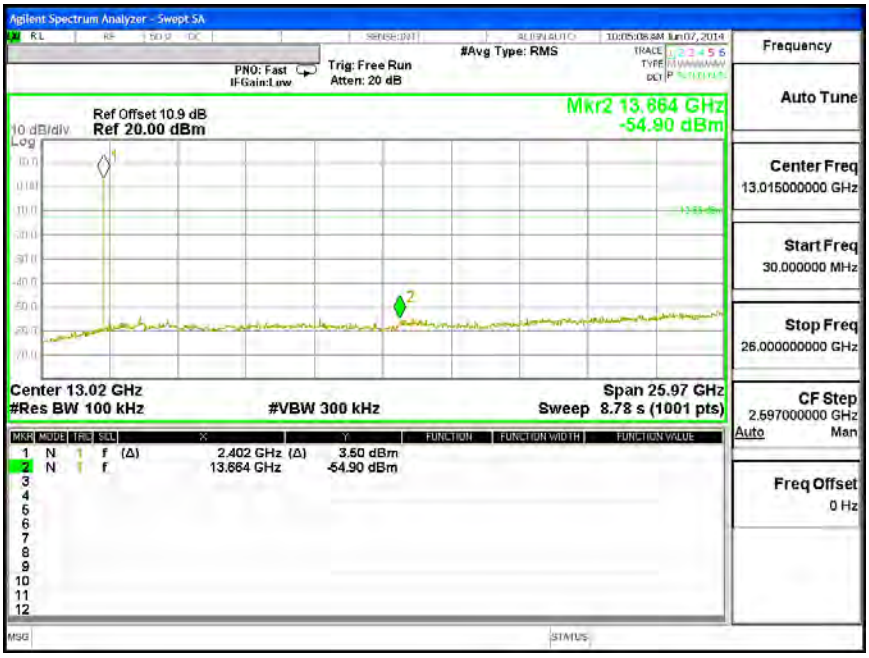
RESULTS

SPURIOUS EMISSIONS, LOW CHANNEL

LOW CHANNEL BANDEDGE

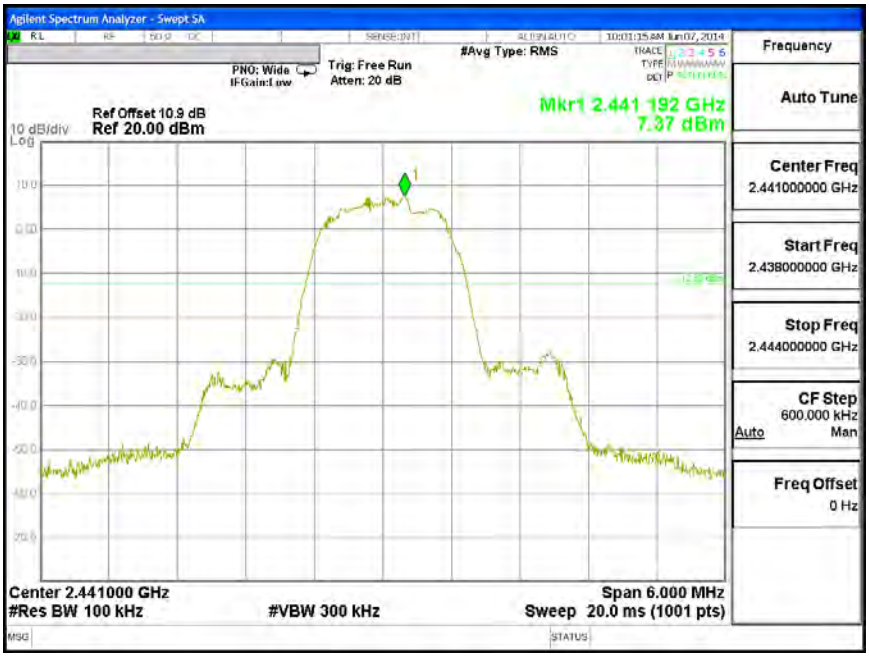


LOW CHANNEL SPURIOUS



SPURIOUS EMISSIONS, MID CHANNEL

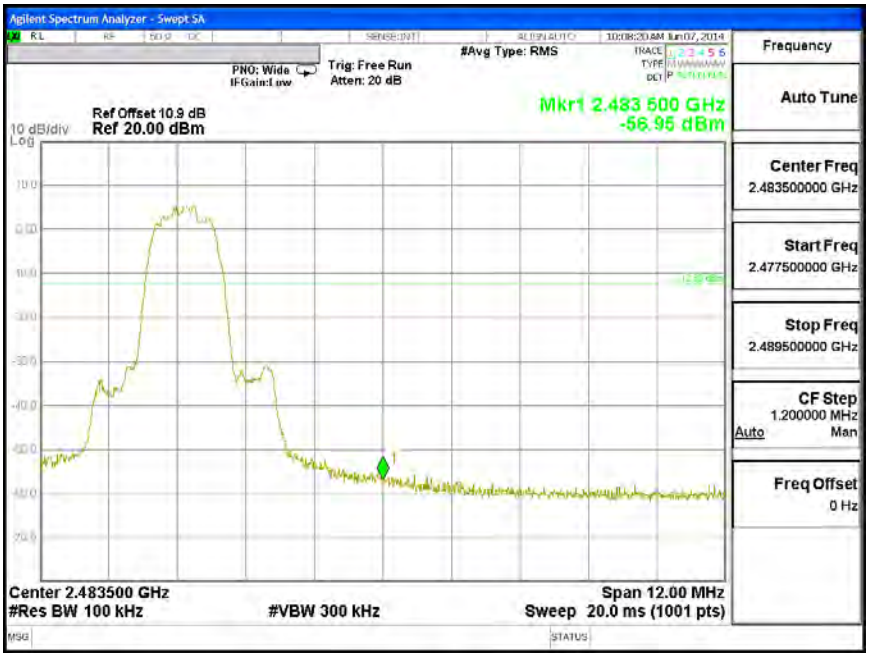
MID CHANNEL REFERENCE



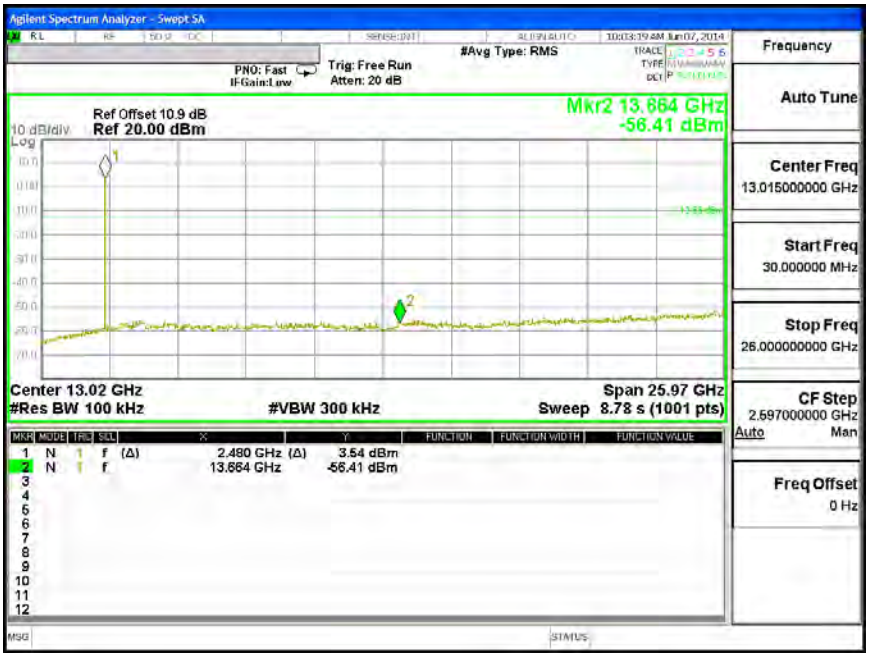
MID CHANNEL SPURIOUS

SPURIOUS EMISSIONS, HIGH CHANNEL

HIGH CHANNEL BANDEDGE

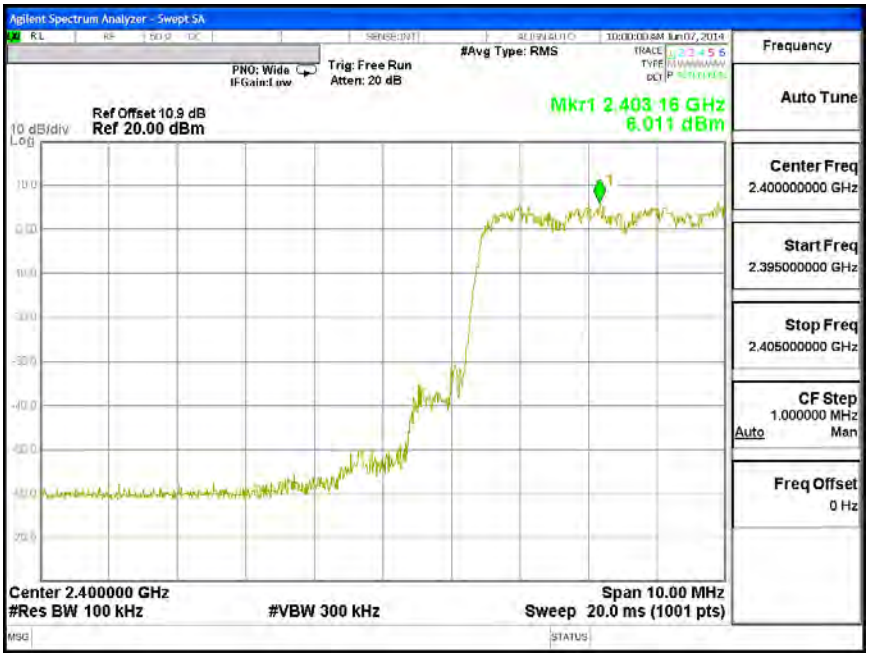


HIGH CHANNEL SPURIOUS

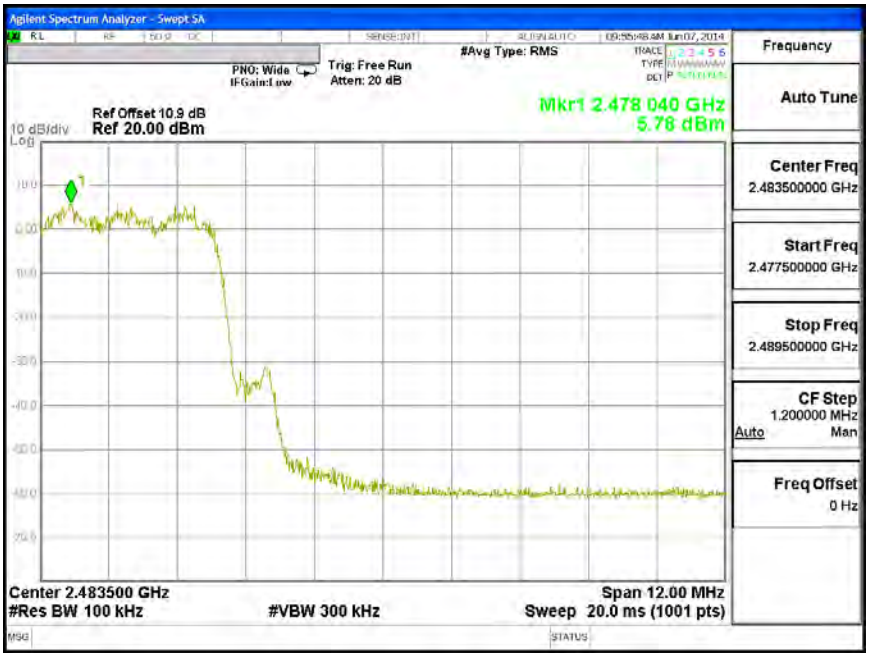


SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON

LOW BANDEDGE WITH HOPPING ON



HIGH BANDEDGE WITH HOPPING ON



9. RADIATED TEST RESULTS

9.1. LIMITS AND PROCEDURE

LIMITS

FCC §15.205 and §15.209

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
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. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.4. The EUT is set to transmit in a continuous mode.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 3 MHz for peak measurements and 10 Hz for average measurements.

The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 2.4 GHz band.

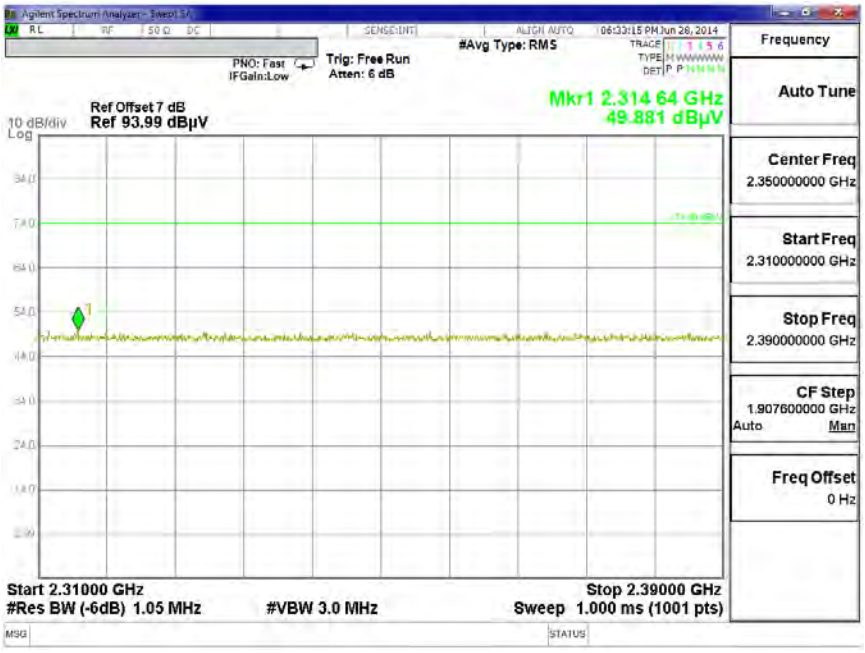
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized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

9.2. TRANSMITTER ABOVE 1GHz

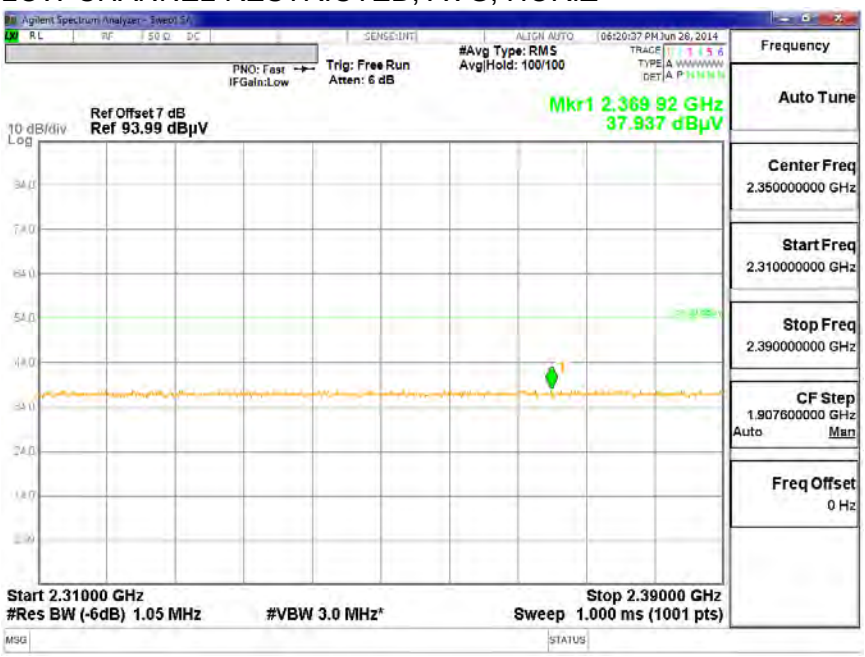
9.2.1. BASIC DATA RATE GFSK MODULATION

RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)

LOW CHANNEL RESTRICTED, PEAK, HORIZ

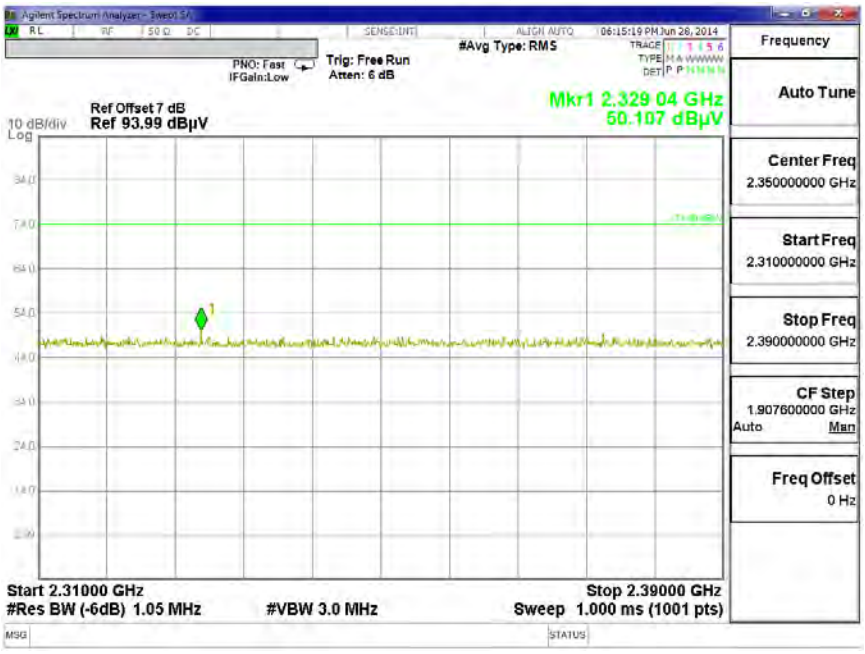


LOW CHANNEL RESTRICTED, AVG, HORIZ



RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)

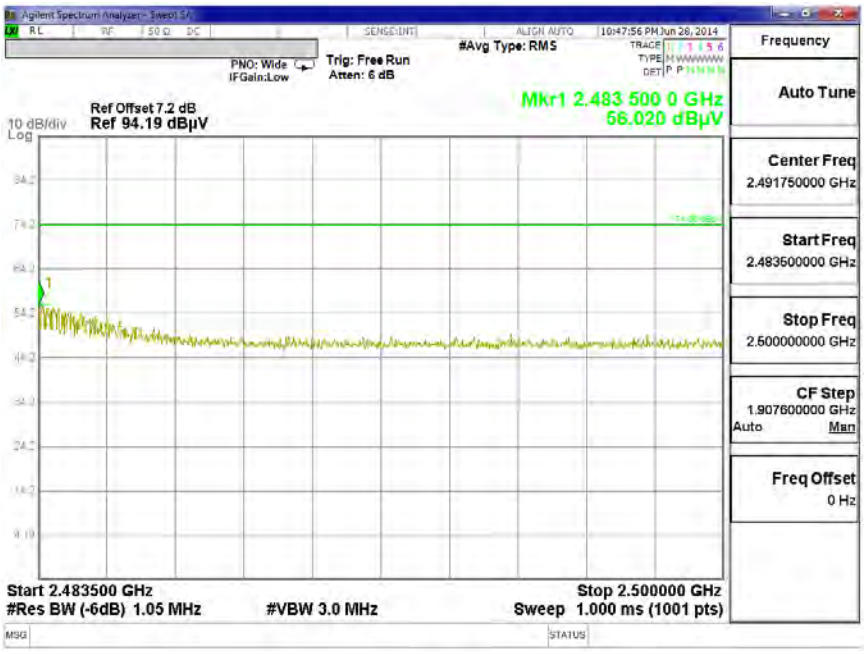
LOW CHANNEL RESTRICTED, PEAK, VERT



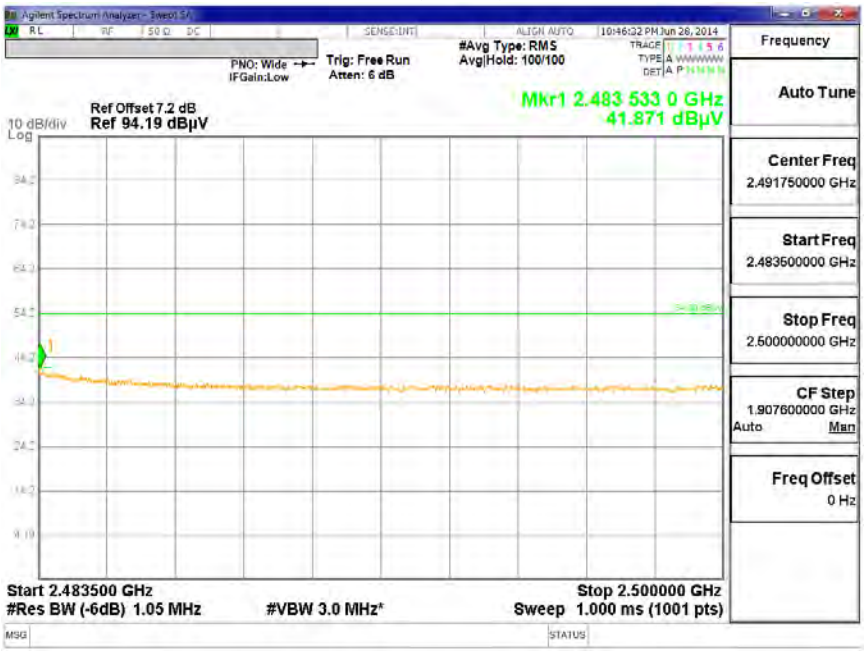
LOW CHANNEL RESTRICTED, AVG, VERT

RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)

HIGH CHANNEL RESTRICTED, PEAK, HORIZ

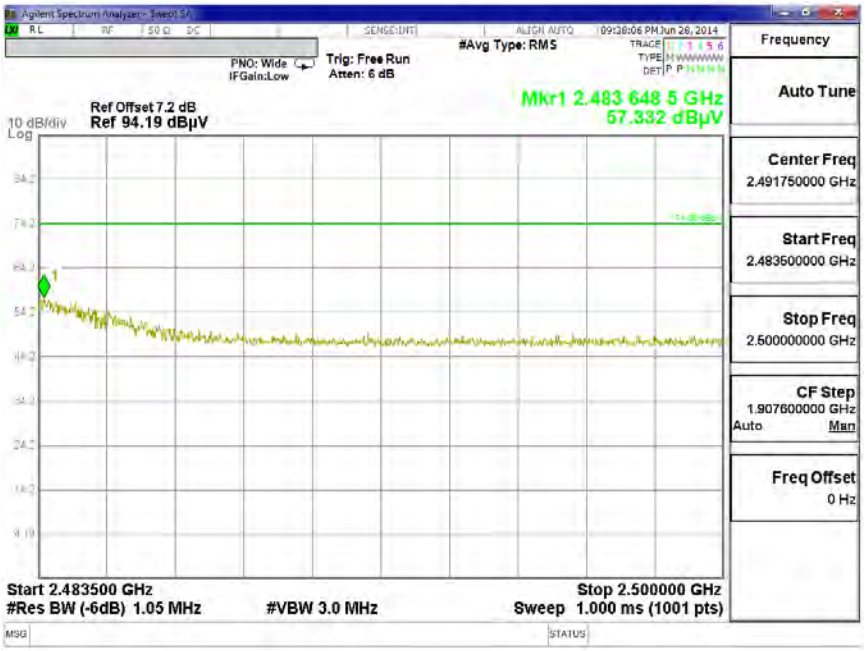


HIGH CHANNEL RESTRICTED, AVG, HORIZ



RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)

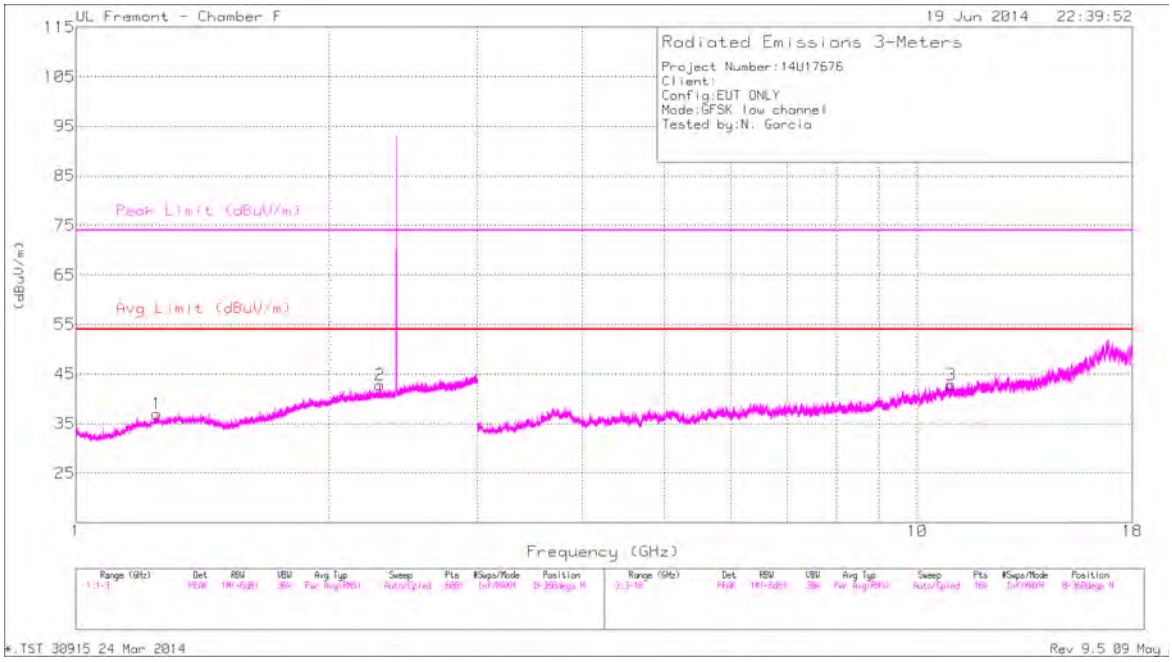
HIGH CHANNEL RESTRICTED, PEAK, VERT



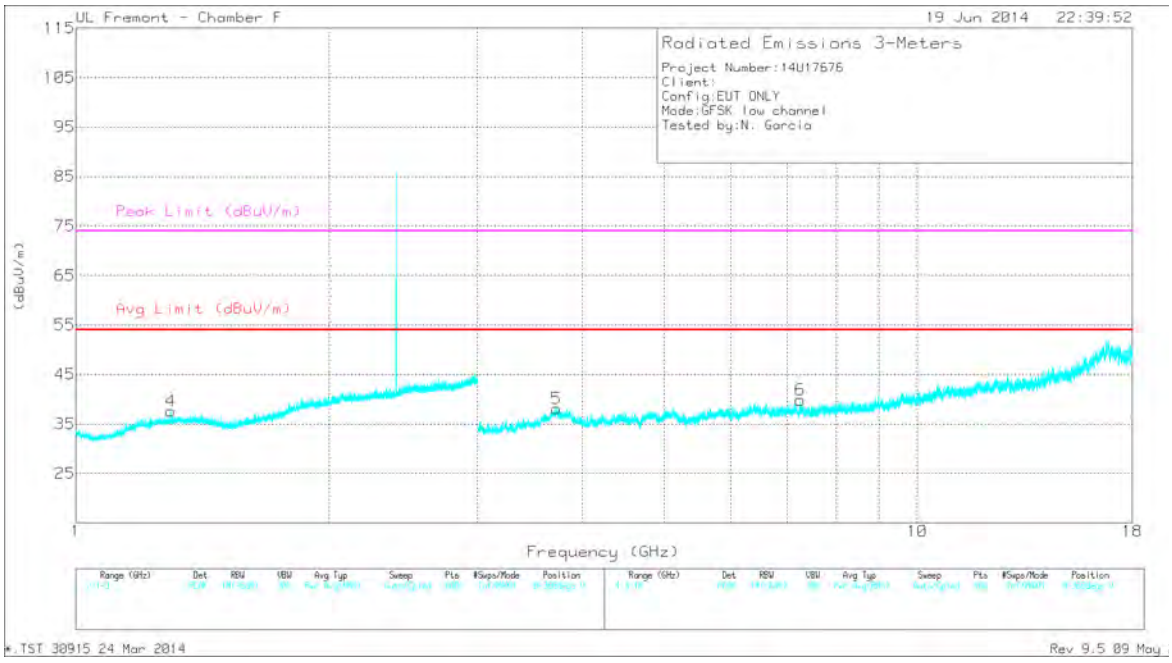
HIGH CHANNEL RESTRICTED, AVG, VERT

LOW CHANNEL HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL HORIZONTAL PLOT



LOW CHANNEL VERTICAL PLOT



DATA

Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
* 1.25	41.91	PK3	29.5	-26.6	0	44.81	-	-	74	-29.19	191	150	H
* 1.25	29.4	VB1T	29.5	-26.6	1.1	33.4	54	-20.6	-	-	191	150	H
* 2.296	41.64	PK3	31.8	-23.4	0	50.04	-	-	74	-23.96	200	178	H
* 2.296	28.84	VB1T	31.8	-23.4	1.1	38.34	54	-15.66	-	-	200	178	H
* 1.292	41.15	PK3	30	-27.1	0	44.05	-	-	74	-29.95	150	202	V
* 1.298	28.23	VB1T	30	-27	1.1	32.33	54	-21.67	-	-	150	202	V
* 10.966	33.84	PK3	38.1	-22.3	0	49.64	-	-	74	-24.36	267	211	H
* 10.967	21.97	VB1T	38.1	-22.3	1.1	38.87	54	-15.13	-	-	267	211	H
* 3.726	38.89	PK3	34.7	-29.5	0	44.09	-	-	74	-29.91	249	107	V
* 3.725	26.99	VB1T	34.7	-29.5	1.1	33.29	54	-20.71	-	-	249	107	V
* 7.257	37.58	PK3	35.5	-26.4	0	46.68	-	-	74	-27.32	260	208	V
* 7.257	25.13	VB1T	35.5	-26.4	1.1	35.33	54	-18.67	-	-	260	208	V

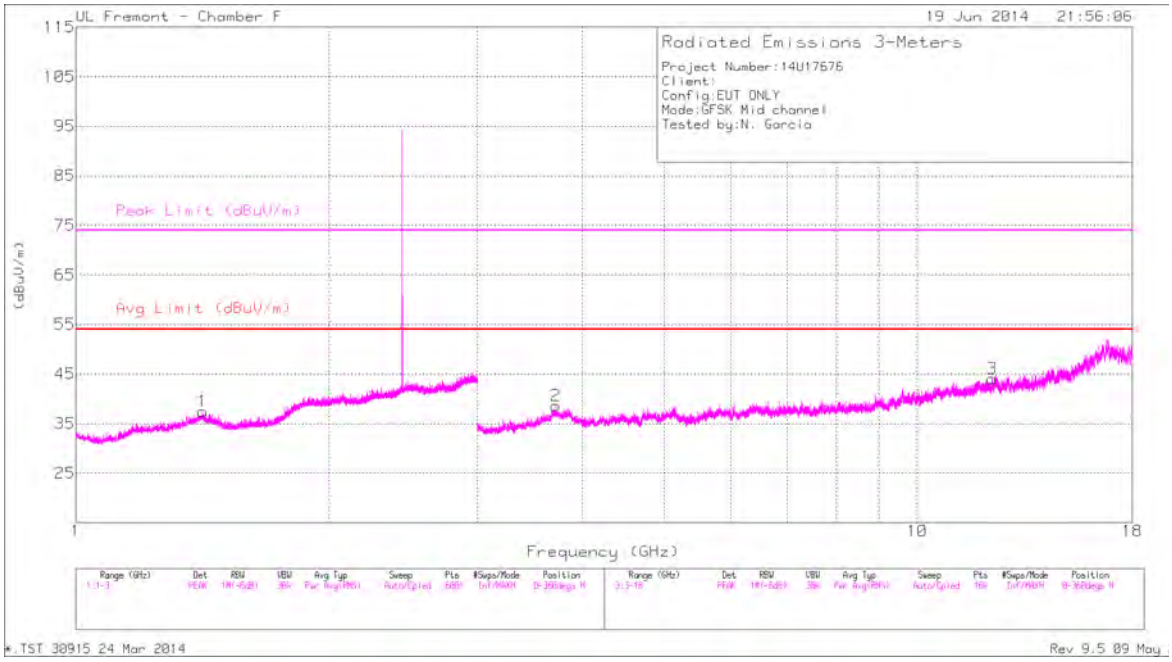
* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band

PK3 - FHSS Method: Maximum Peak

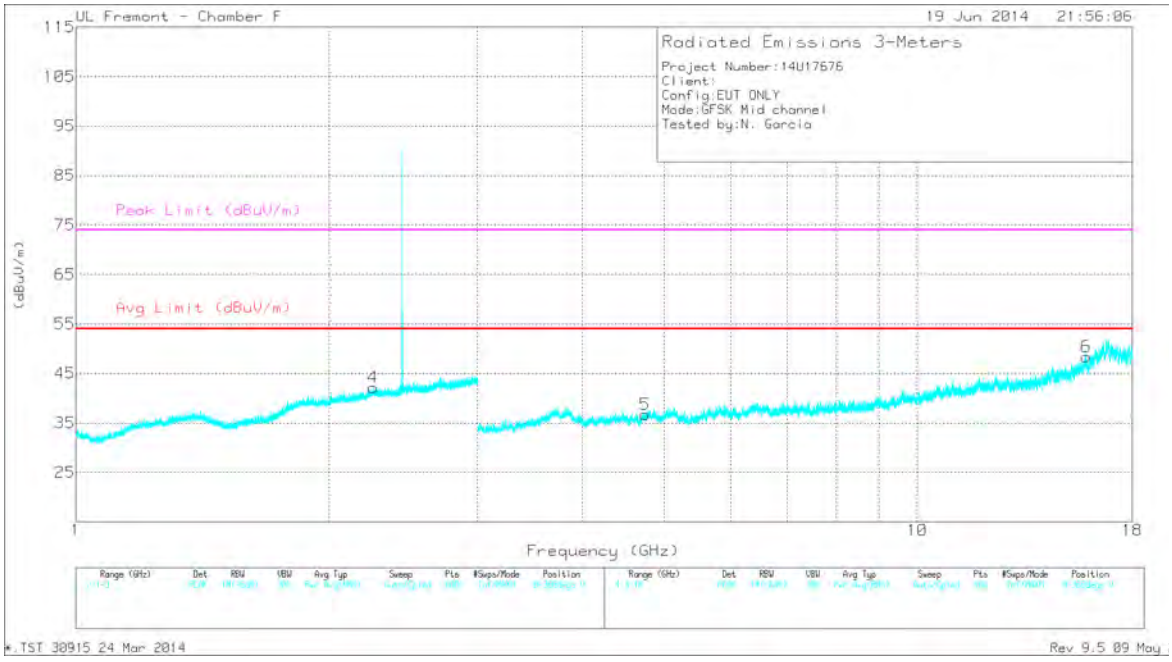
VB1T - FHSS Method: VB=1/Ton, Voltage Averaging Max Hold where: Ton is the duration of the packet

MID CHANNEL HARMONICS AND SPURIOUS EMISSIONS

MID CHANNEL HORIZONTAL PLOT



MID CHANNEL VERTICAL PLOT



DATA

Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
* 1.416	41.58	PK3	29.1	-25.4	0	45.28	-	-	74	-28.72	226	111	H
* 1.42	28.92	VB1T	29.1	-25.5	1.1	33.62	54	-20.38	-	-	226	111	H
* 2.255	40.86	PK3	31.8	-23.3	0	49.36	-	-	74	-24.64	240	113	V
* 2.25	28.86	VB1T	31.8	-23.4	1.1	38.36	54	-15.64	-	-	240	113	V
* 3.717	39.17	PK3	34.8	-29.5	0	44.47	-	-	74	-29.53	289	102	H
* 3.713	26.94	VB1T	34.8	-29.4	1.1	33.44	54	-20.56	-	-	289	102	H
* 12.273	35.47	PK3	38.9	-22.8	0	51.57	-	-	74	-22.43	225	106	H
* 12.269	23.04	VB1T	38.9	-22.8	1.1	40.24	54	-13.76	-	-	225	106	H
* 4.749	38.57	PK3	34.1	-28.5	0	44.17	-	-	74	-29.83	270	201	V
* 4.744	26.66	VB1T	34.1	-28.4	1.1	33.46	54	-20.54	-	-	270	201	V
* 15.859	35.77	PK3	40.4	-19.5	0	56.67	-	-	74	-17.33	221	205	V
* 15.863	23.65	VB1T	40.4	-19.5	1.1	45.65	54	-8.35	-	-	221	205	V

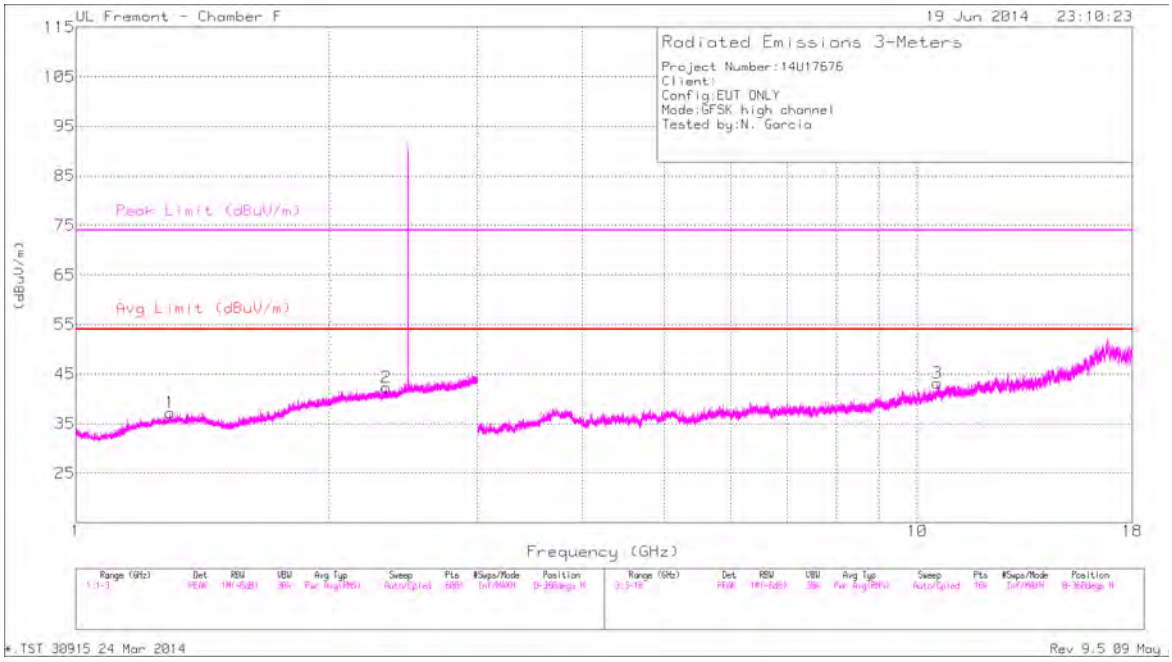
* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band

PK3 - FHSS Method: Maximum Peak

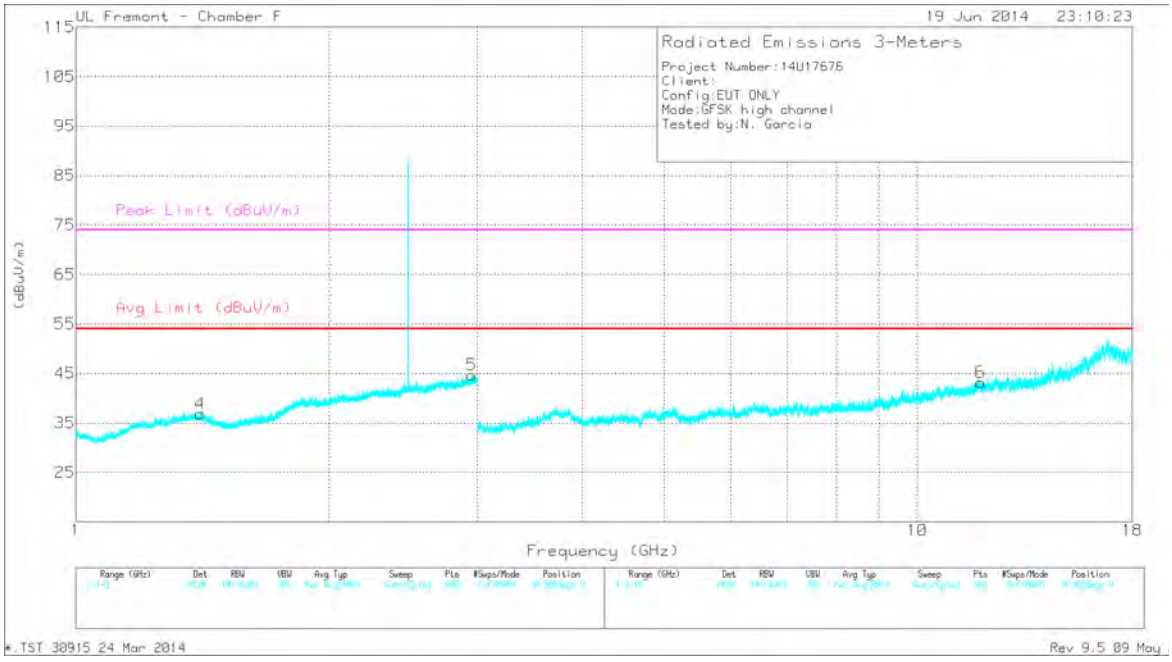
VB1T - FHSS Method: VB=1/Ton, Voltage Averaging Max Hold where: Ton is the duration of the packet

HIGH CHANNEL HARMONICS AND SPURIOUS EMISSIONS

HIGH CHANNEL HORIZONTAL PLOT



HIGH CHANNEL VERTICAL PLOT



DATA

Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
* 1.298	41.4	PK3	30	-27	0	44.4	-	-	74	-29.6	117	101	H
* 1.295	29.4	VB1T	30	-27.1	1.1	33.4	54	-20.6	-	-	117	101	H
* 2.336	41.29	PK3	31.9	-23.5	0	49.69	-	-	74	-24.31	111	101	H
* 2.342	29.05	VB1T	32	-23.6	1.1	38.55	54	-15.45	-	-	111	101	H
* 1.405	41.6	PK3	29.2	-25.5	0	45.3	-	-	74	-28.7	106	111	V
* 1.409	28.73	VB1T	29.2	-25.4	1.1	33.63	54	-20.37	-	-	106	111	V
2.955	41.12	PK3	33.3	-21.9	0	52.52	-	-	-	-	108	102	V
2.952	28.79	VB1T	33.3	-22	1.1	41.19	-	-	-	-	108	102	V
10.566	33.63	PK3	37.8	-20.9	0	50.53	-	-	-	-	149	205	H
10.562	21.57	VB1T	37.8	-20.9	1.1	39.57	-	-	-	-	149	205	H
* 11.89	34.92	PK3	38.9	-22.8	0	51.02	-	-	74	-22.98	120	110	V
* 11.886	22.51	VB1T	38.9	-22.8	1.1	39.71	54	-14.29	-	-	120	110	V

* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band

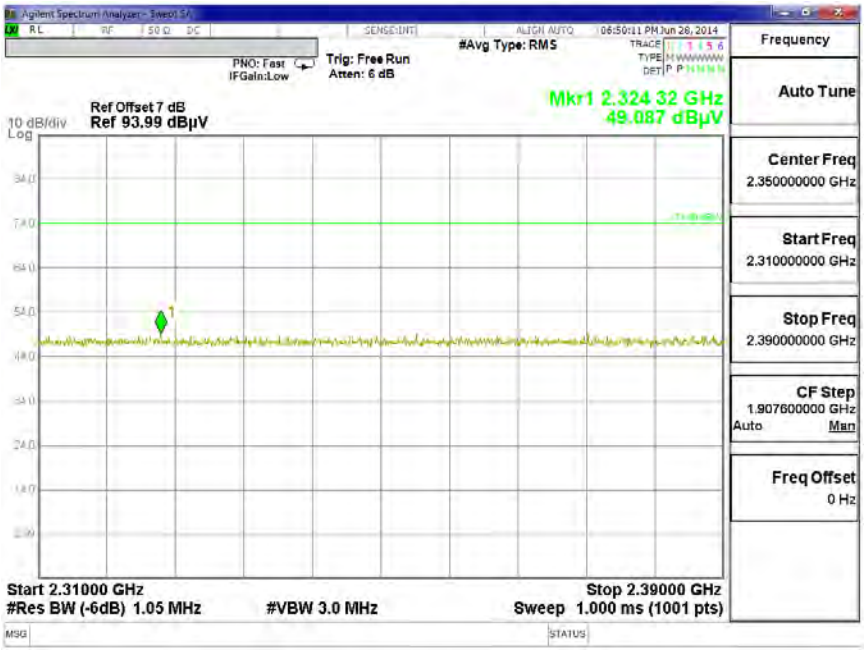
PK3 - FHSS Method: Maximum Peak

VB1T - FHSS Method: VB=1/Ton, Voltage Averaging Max Hold where: Ton is the duration of the packet

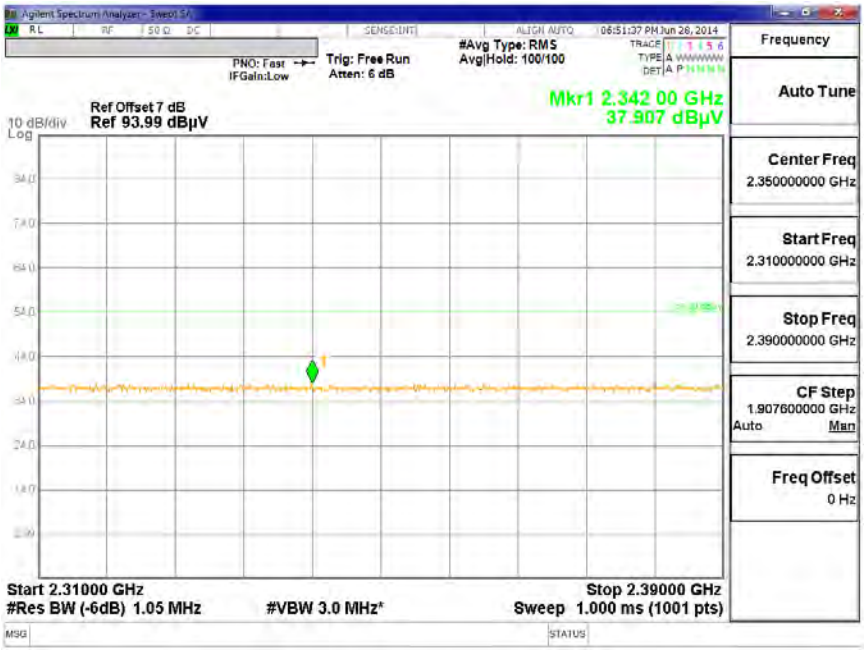
9.2.2. ENHANCED DATA RATE 8PSK MODULATION

RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)

LOW CHANNEL RESTRICTED, PEAK, HORIZ

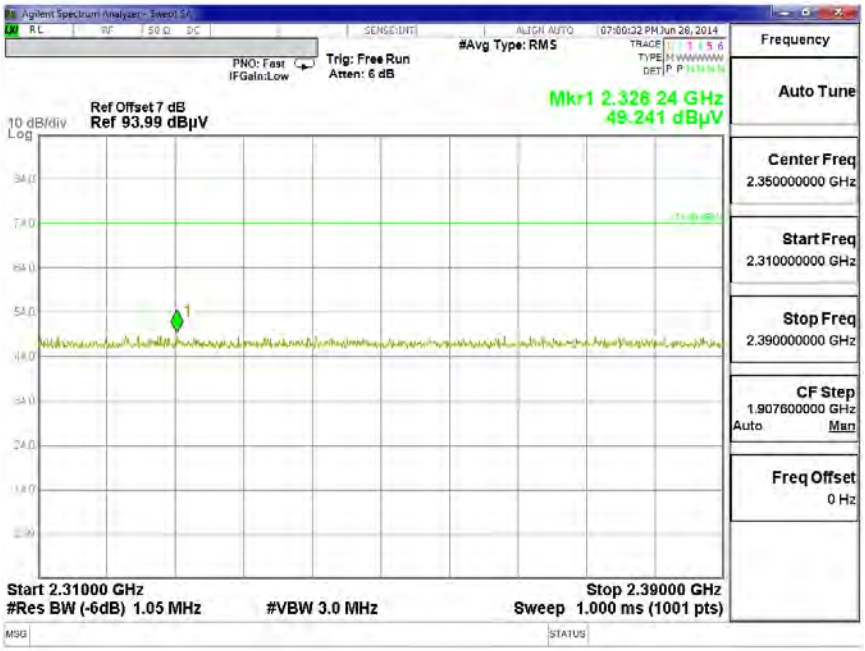


LOW CHANNEL RESTRICTED, AVG, HORIZ



RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)

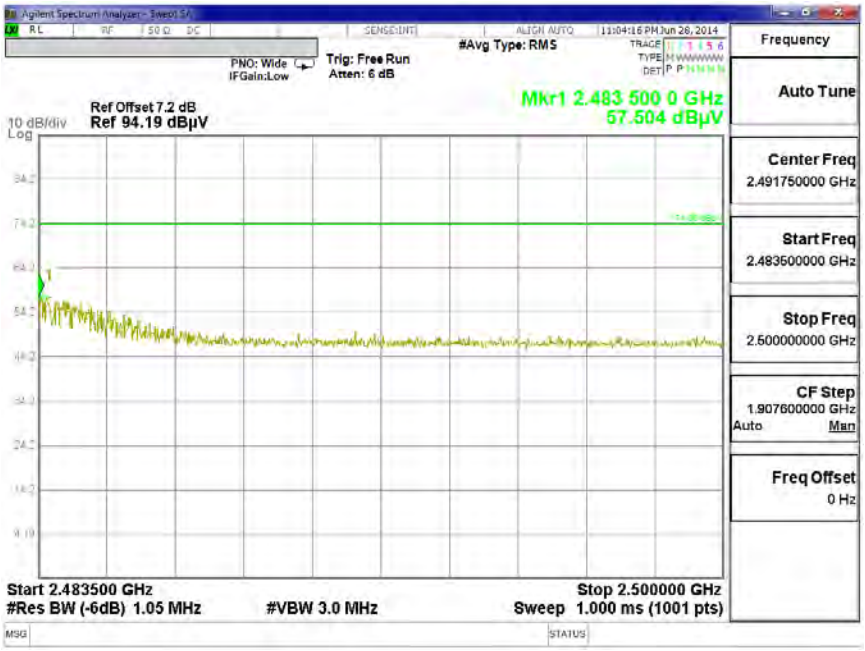
LOW CHANNEL RESTRICTED, PEAK, VERT



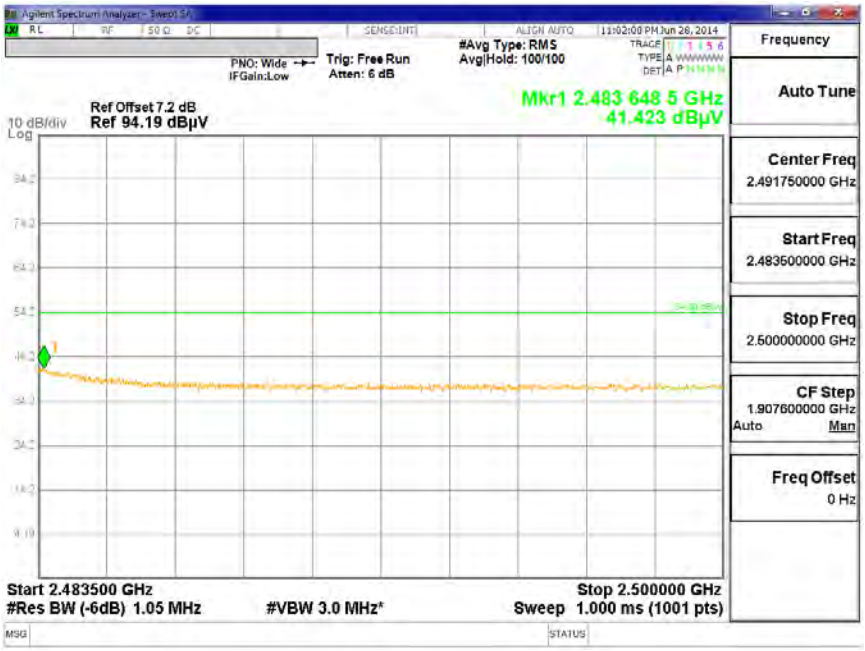
LOW CHANNEL RESTRICTED, AVG, VERT

RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL

HIGH CHANNEL RESTRICTED, PEAK, HORIZ

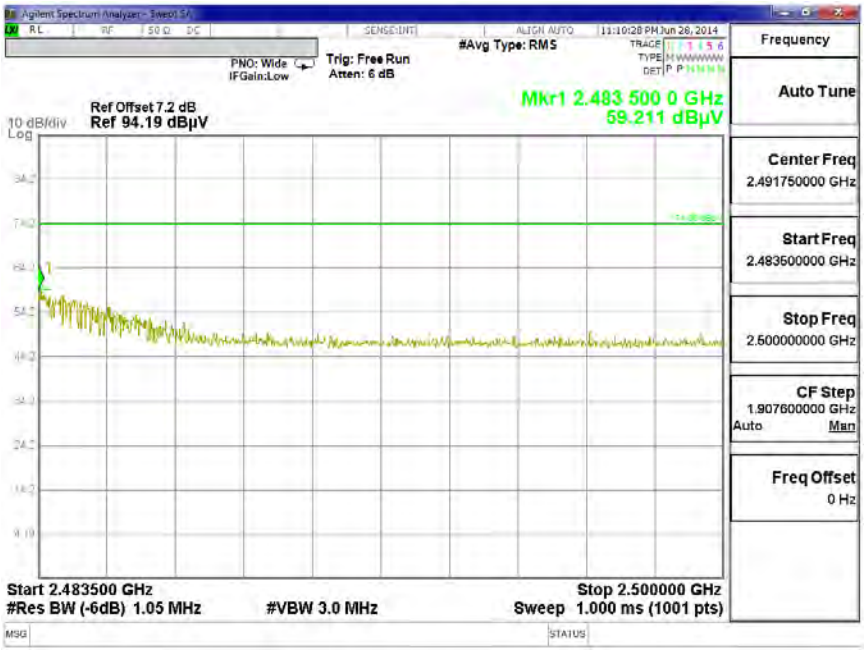


HIGH CHANNEL RESTRICTED, AVG, HORIZ

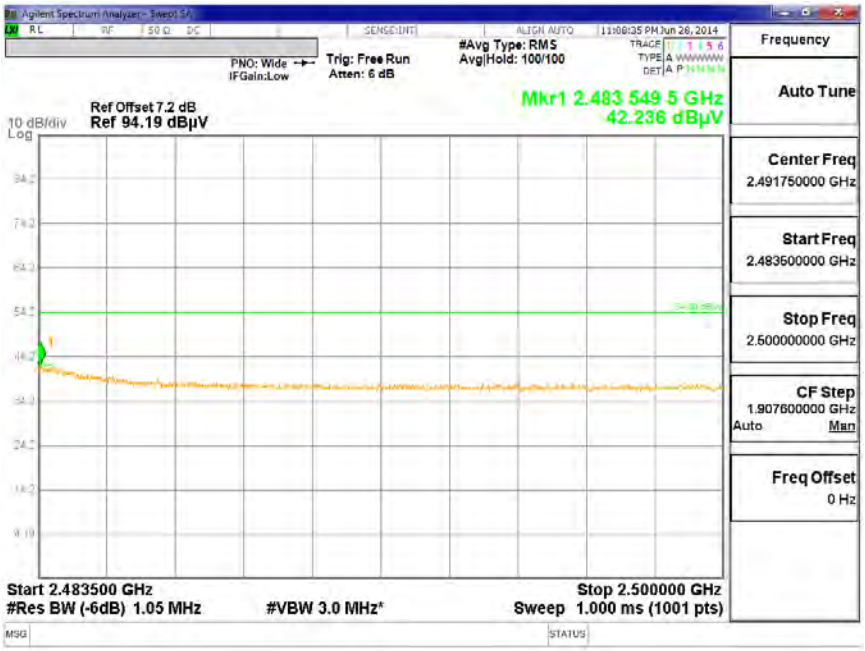


RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)

HIGH CHANNEL RESTRICTED, PEAK, VERT

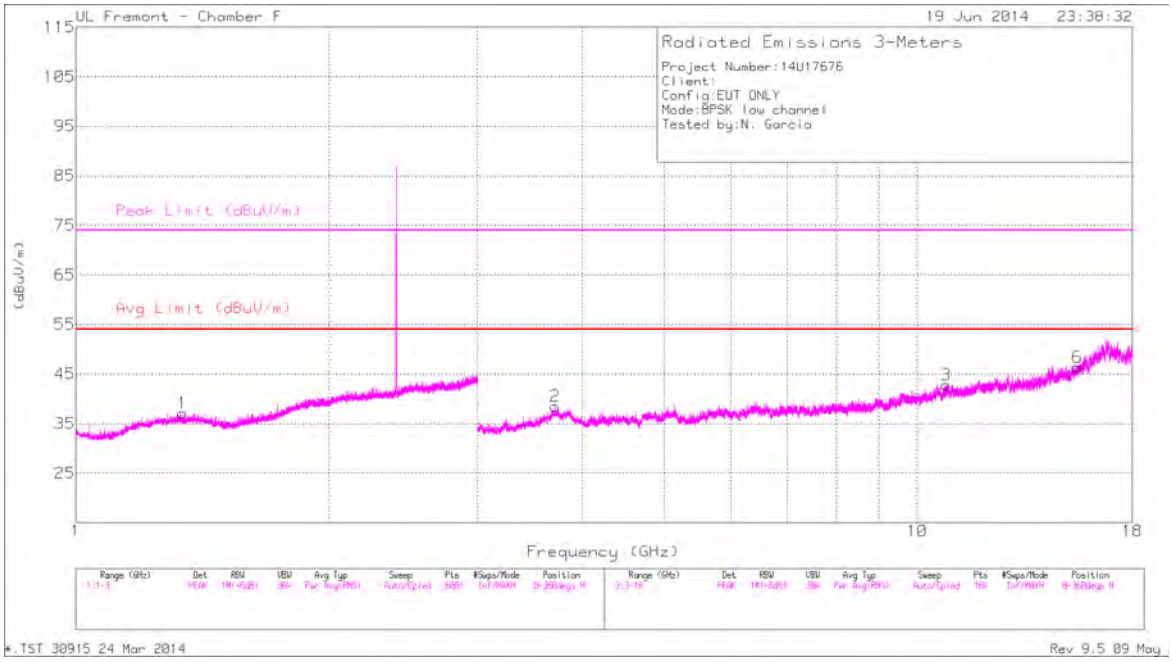


HIGH CHANNEL RESTRICTED, AVG, VERT

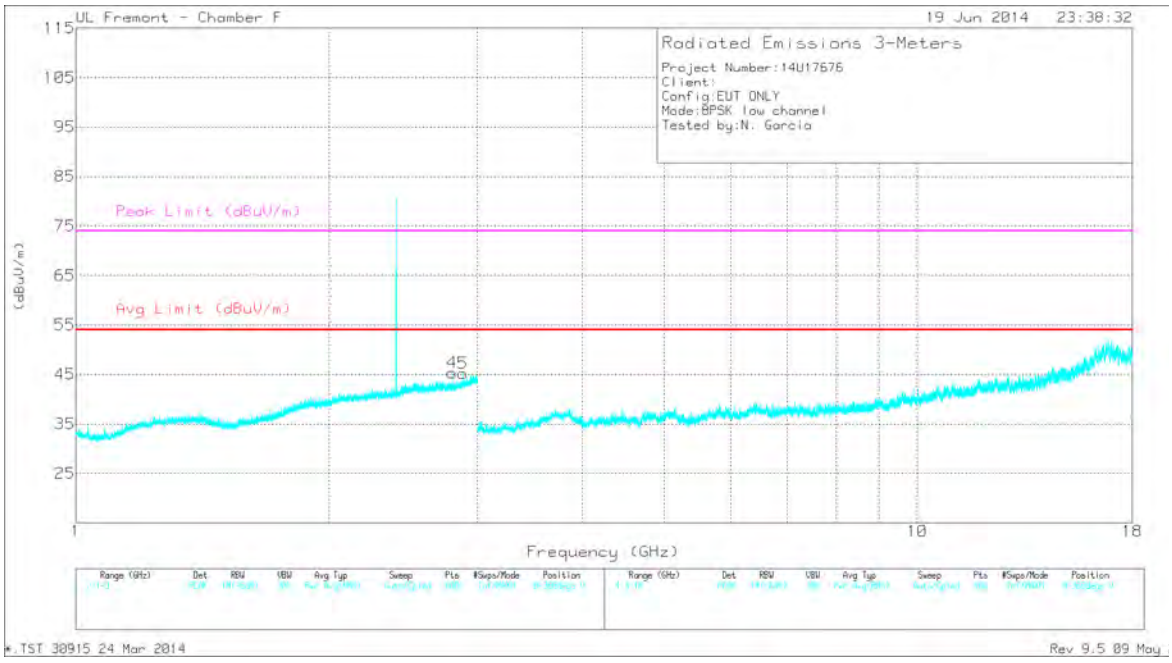


LOW CHANNEL HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL HORIZONTAL PLOT



LOW CHANNEL VERTICAL PLOT



DATA

Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
* 1.341	42.32	PK3	29.7	-26.6	0	45.42	-	-	74	-28.58	135	201	H
* 1.337	29.37	VB1T	29.8	-26.6	1.1	33.67	54	-20.33	-	-	135	201	H
* 2.798	41.07	PK3	32.9	-22.9	0	51.07	-	-	74	-22.93	187	257	V
* 2.806	29.01	VB1T	32.9	-22.8	1.1	40.21	54	-13.79	-	-	187	257	V
* 2.882	42.2	PK3	33.2	-22.4	0	53	-	-	74	-21	135	348	V
* 2.889	28.75	VB1T	33.2	-22.4	1.1	40.65	54	-13.35	-	-	135	348	V
* 3.71	39.75	PK3	34.8	-29.4	0	45.15	-	-	74	-28.85	111	205	H
* 3.717	27.14	VB1T	34.8	-29.5	1.1	33.54	54	-20.46	-	-	111	205	H
* 10.814	33.67	PK3	38	-22	0	49.67	-	-	74	-24.33	109	189	H
* 10.81	21.81	VB1T	38	-22	1.1	38.91	54	-15.09	-	-	109	189	H
* 15.497	35.53	PK3	40.4	-21.7	0	54.23	-	-	74	-19.77	111	178	H
* 15.493	23.54	VB1T	40.4	-21.7	1.1	43.34	54	-10.66	-	-	111	178	H

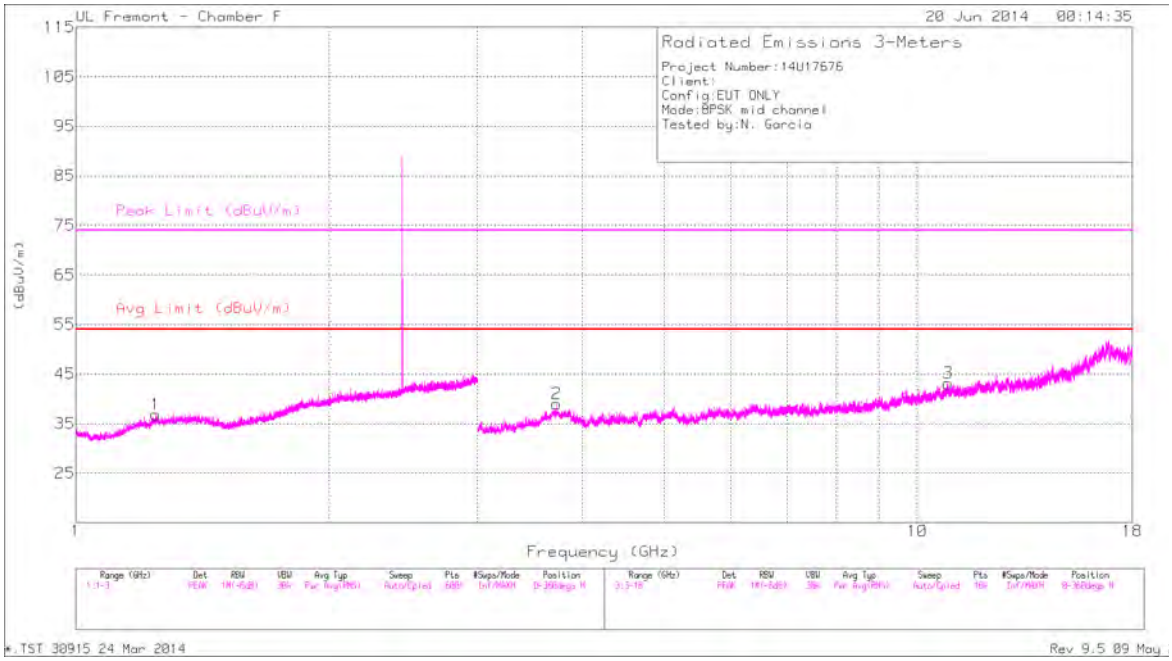
* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band

PK3 - FHSS Method: Maximum Peak

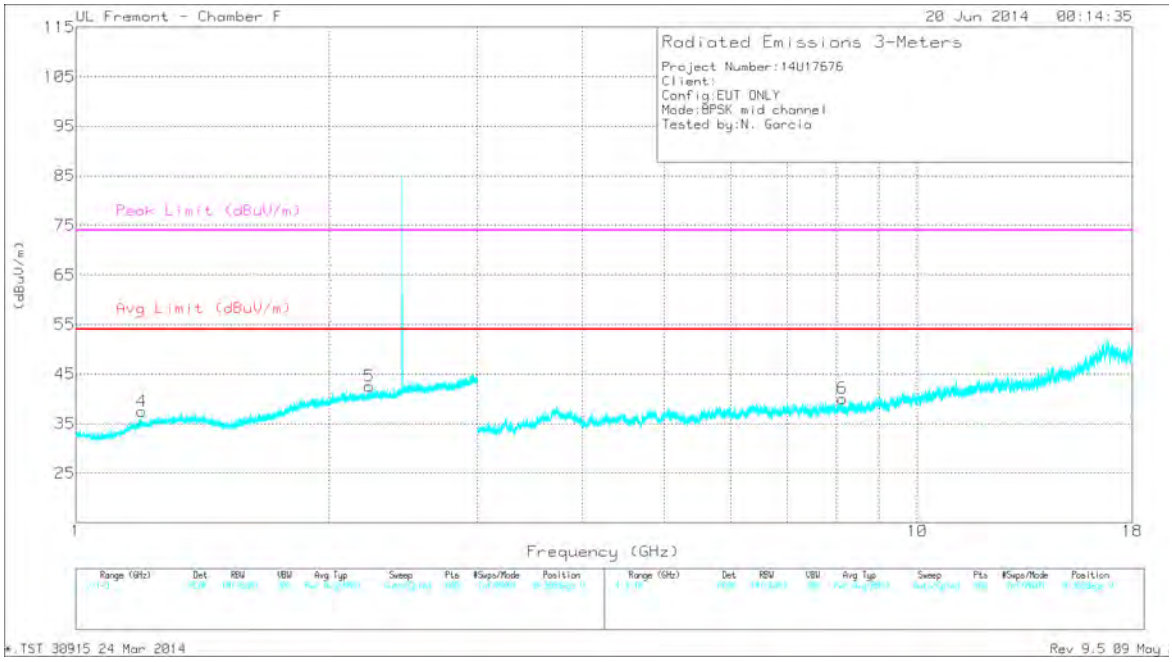
VB1T - FHSS Method: VB=1/Ton, Voltage Averaging Max Hold where: Ton is the duration of the packet

MID CHANNEL HARMONICS AND SPURIOUS EMISSIONS

MID CHANNEL HORIZONTAL PLOT



MID CHANNEL VERTICAL PLOT



DATA

Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
* 1.242	41.62	PK3	29.4	-26.5	0	44.52	-	-	74	-29.48	102	107	H
* 1.246	29.36	VB1T	29.5	-26.6	1.1	33.36	54	-20.64	-	-	102	107	H
* 1.199	40.61	PK3	28.9	-26.5	0	43.01	-	-	74	-30.99	229	168	V
* 1.202	27.9	VB1T	29	-26.6	1.1	31.4	54	-22.6	-	-	229	168	V
* 2.228	41.09	PK3	31.8	-23.7	0	49.19	-	-	74	-24.81	201	155	V
* 2.23	28.4	VB1T	31.8	-23.7	1.1	37.6	54	-16.4	-	-	201	155	V
* 3.724	39.14	PK3	34.7	-29.5	0	44.34	-	-	74	-29.66	194	283	H
* 3.723	28.21	VB1T	34.7	-29.5	1.1	34.51	54	-19.49	-	-	194	283	H
* 10.871	34.18	PK3	38.1	-21.8	0	50.48	-	-	74	-23.52	154	215	H
* 10.875	22.11	VB1T	38.1	-21.9	1.1	39.41	54	-14.59	-	-	154	215	H
* 8.149	38.07	PK3	35.7	-25.6	0	48.17	-	-	74	-25.83	154	215	H
* 8.152	24.54	VB1T	35.7	-25.6	1.1	35.74	54	-18.26	-	-	154	215	H

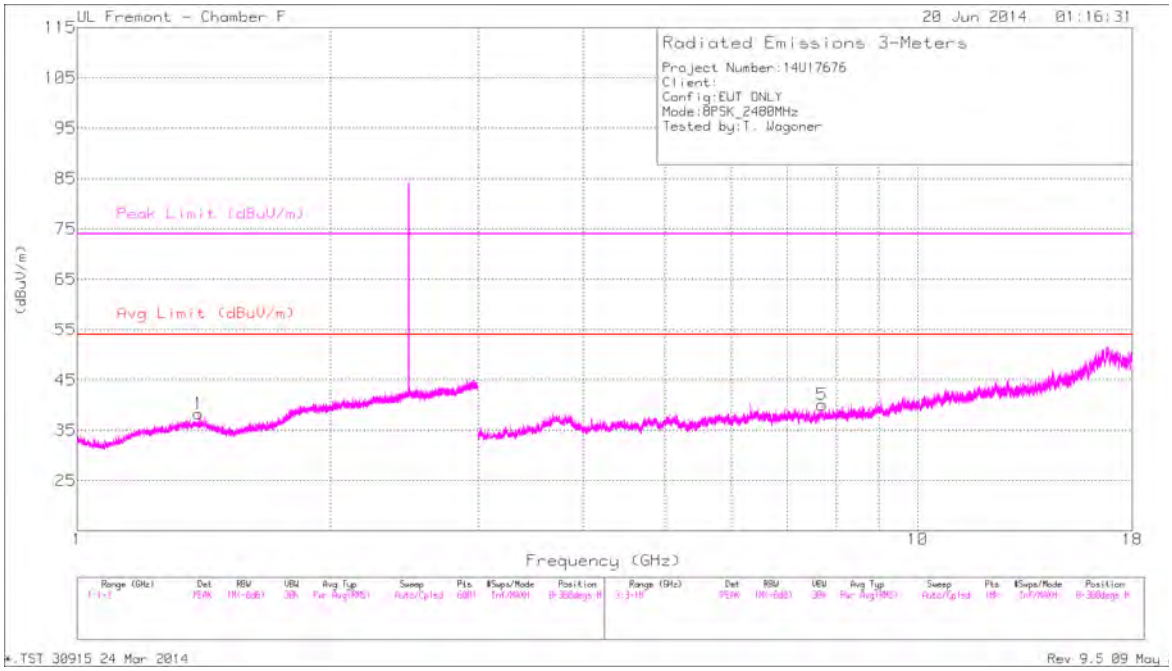
* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band

PK3 - FHSS Method: Maximum Peak

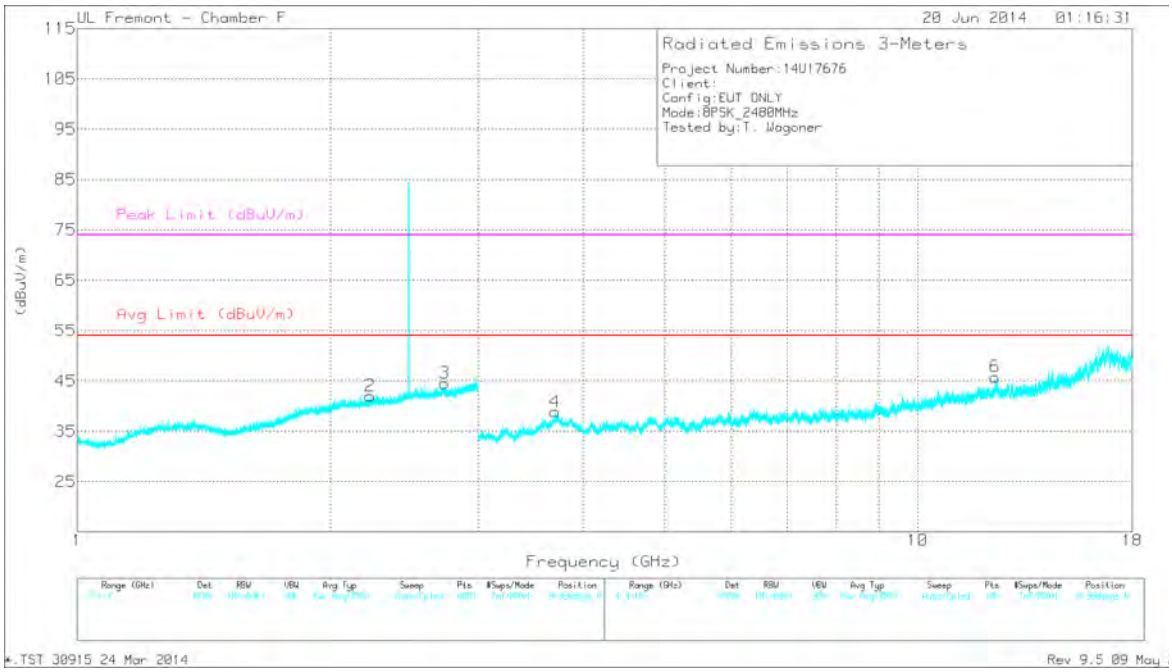
VB1T - FHSS Method: VB=1/Ton, Voltage Averaging Max Hold where: Ton is the duration of the packet

HIGH CHANNEL HARMONICS AND SPURIOUS EMISSIONS

HIGH CHANNEL HORIZONTAL PLOT



HIGH CHANNEL VERTICAL PLOT



DATA

Radiated Emissions

Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
* 1.393	35.84	PK3	29.3	-25.7	0	39.44	-	-	74	-34.56	302	328	H
* 1.394	29.16	VB1T	29.3	-25.7	1.1	33.86	54	-20.14	-	-	302	328	H
* 2.737	35.36	PK3	32.8	-22.5	0	45.66	-	-	74	-28.34	215	268	V
* 2.738	28.88	VB1T	32.8	-22.5	1.1	40.28	54	-13.72	-	-	215	268	V
* 2.228	36.78	PK3	31.8	-23.7	0	44.88	-	-	74	-29.12	215	268	V
* 2.228	29.1	VB1T	31.8	-23.7	1.1	38.3	54	-15.7	-	-	215	268	V
* 7.695	32.4	PK3	35.6	-25.7	0	42.3	-	-	74	-31.7	100	119	H
* 7.695	24.3	VB1T	35.6	-25.7	1.1	35.3	54	-18.7	-	-	100	119	H
* 3.703	34.5	PK3	34.8	-29.4	0	39.9	-	-	74	-34.1	309	121	V
* 3.701	26.96	VB1T	34.8	-29.5	1.1	33.36	54	-20.64	-	-	309	121	V
* 12.364	31.62	PK3	38.9	-21.4	0	49.12	-	-	74	-24.88	10	121	V
* 12.371	22.78	VB1T	38.9	-21.1	1.1	41.68	54	-12.32	-	-	10	121	V

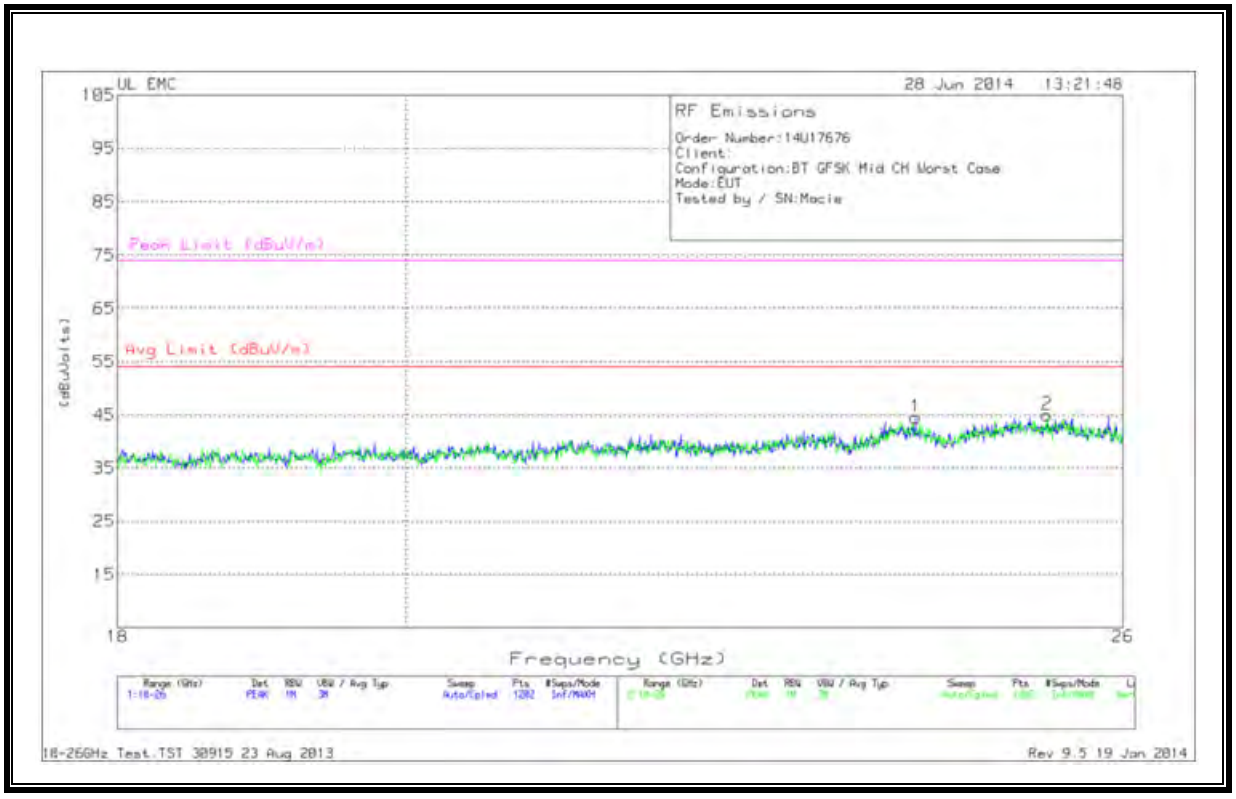
* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band

PK3 - FHSS Method: Maximum Peak

VB1T - FHSS Method: VB=1/Ton, Voltage Averaging Max Hold where: Ton is the duration of the packet

9.3. WORST-CASE ABOVE 18 GHz

SPURIOUS EMISSIONS 18 TO 26 GHz (WORST-CASE CONFIGURATION, HORIZONTAL & VERTICAL)



DATA

Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T89 (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuVolts)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)
1	24.102	43.4	PK	33.6	-23	-9.5	44.5	54	-9.5	74	-29.5
2	25.287	43.1	PK	33.9	-22.5	-9.5	45	54	-9	74	-29

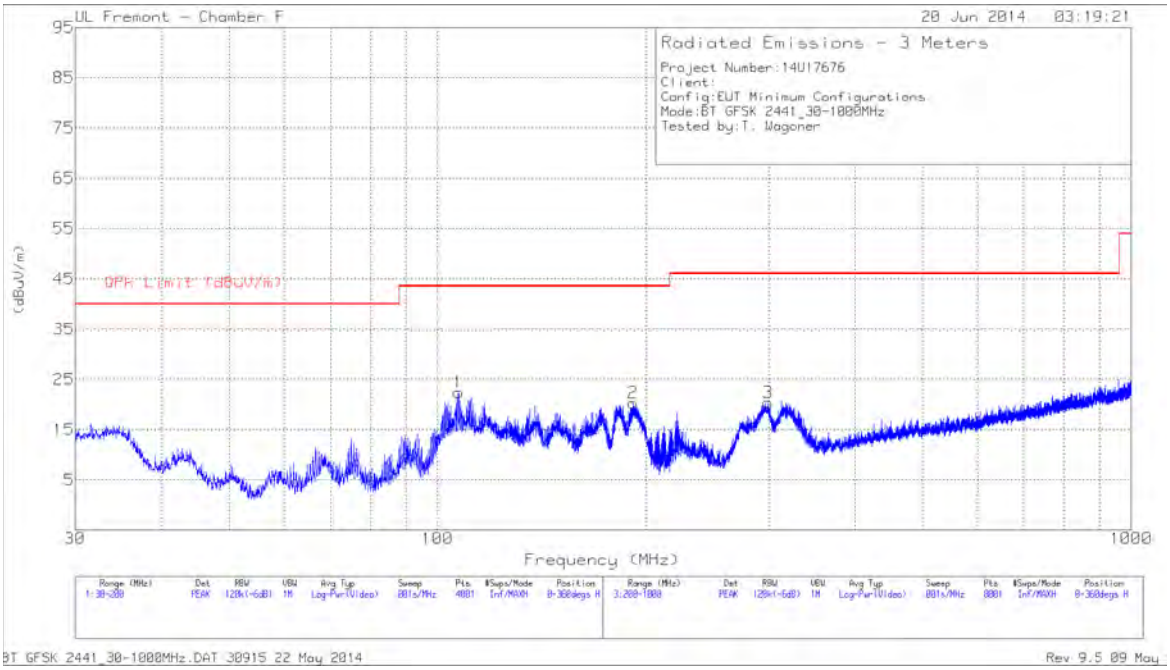
PK - Peak detector

Note: GFSK, highest power mode used for test.

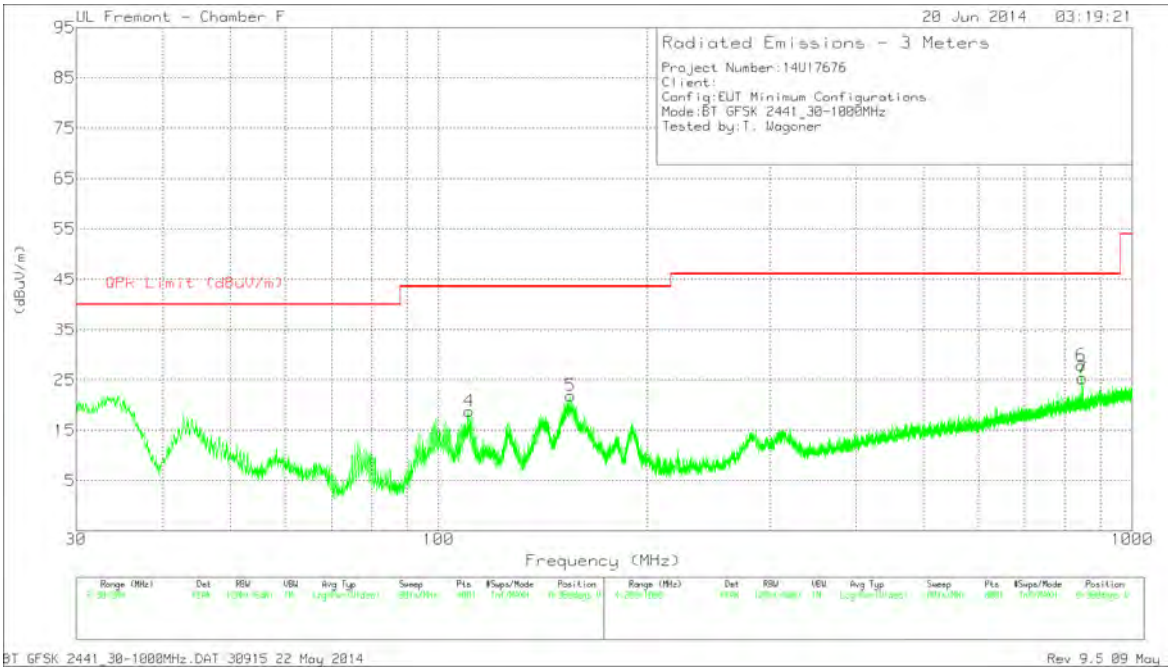
WORST-CASE BELOW 1 GHz

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

HORIZONTAL PLOT



VERTICAL PLOT



DATA

Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF T122 (dB/m)	Amp/Cbl (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	107.1375	41.78	PK	12.1	-31.5	0	22.38	43.52	-21.14	0-360	301	H
2	191.415	40.03	PK	11.4	-31.1	0	20.33	43.52	-23.19	0-360	100	H
4	* 110.7075	37.53	PK	12.8	-31.5	0	18.83	43.52	-24.69	0-360	101	V
5	154.865	40.74	PK	12.5	-31.3	0	21.94	43.52	-21.58	0-360	101	V
3	299.4	37.68	PK	13.4	-30.7	0	20.38	46.02	-25.64	0-360	101	H
6	844.1	35.12	PK	21.8	-29	0	27.92	46.02	-18.1	0-360	301	V
7	848	32.56	PK	21.8	-29	0	25.36	46.02	-20.66	0-360	200	V

* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band

PK - Peak detector

Note: GFSK, highest power mode used for test.

10. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

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 C63.4.

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

WORST EMISSIONS

Line-L1 .15 - 30MHz

Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	T24 IL L1 (dB)	LC Cables 1&3 (dB)	Corrected Reading dBuV	CISPR 22 Class B QP	Margin to Limit (dB)	CISPR 22 Class B Avg	Margin to Limit (dB)
1	.168	45.13	PK	1.2	0	46.33	65.1	-18.77	-	-
2	.168	27.32	Av	1.2	0	28.52	-	-	55.1	-26.58
3	.7665	46.71	PK	.3	0	47.01	56	-8.99	-	-
4	.7665	32.82	Av	.3	0	33.12	-	-	46	-12.88
5	18.537	33.02	PK	.3	.2	33.52	60	-26.48	-	-
6	18.537	19.92	Av	.3	.2	20.42	-	-	50	-29.58

Line-L2 .15 - 30MHz

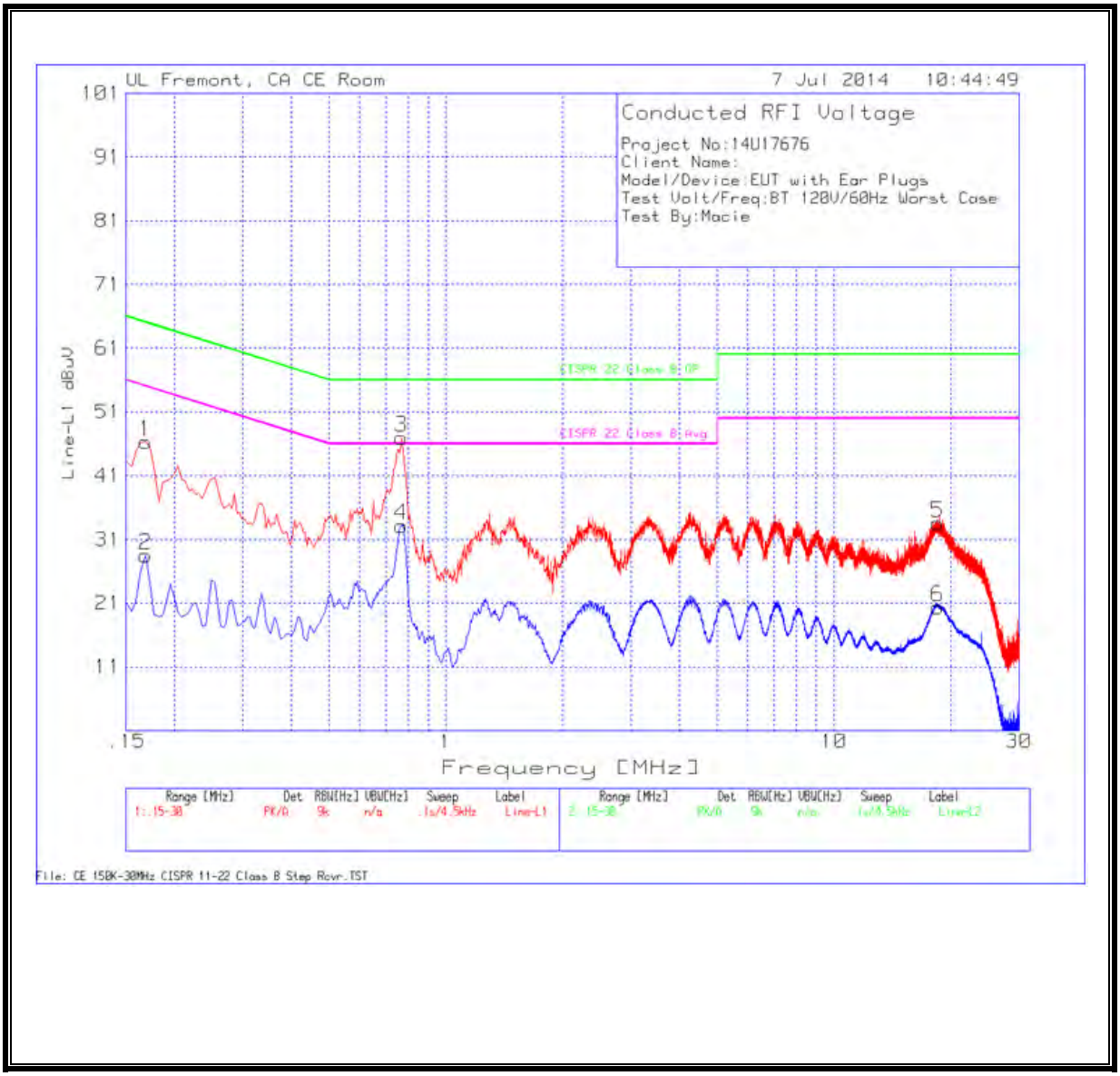
Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	T24 IL L2 (dB)	LC Cables 2&3 (dB)	Corrected Reading dBuV	CISPR 22 Class B QP	Margin to Limit (dB)	CISPR 22 Class B Avg	Margin to Limit (dB)
7	.168	44.24	PK	1.3	0	45.54	65.1	-19.56	-	-
8	.168	23.85	Av	1.3	0	25.15	-	-	55.1	-29.95
9	.7665	43.42	PK	.3	0	43.72	56	-12.28	-	-
10	.7665	27.73	Av	.3	0	28.03	-	-	46	-17.97
11	24.5355	32.32	PK	.3	.3	32.92	60	-27.08	-	-
12	24.5355	17.39	Av	.3	.3	17.99	-	-	50	-32.01

PK - Peak detector

Av - average detection

LINE 1 RESULTS



LINE 2 RESULTS