



FCC 47 CFR PART 15 SUBPART C

CERTIFICATION TEST REPORT

FOR

STB

MODEL NUMBER: 4K JOEY

FCC ID: DKN4KJT

REPORT NUMBER: 10566895A

ISSUE DATE: April 8, 2015

Prepared for
Echostar
90 Inverness Circle East
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Revision History

Rev.	Issue Date	Revisions	Revised By
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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Echostar
90 Inverness Circle East
Englewood, CO 80112

EUT DESCRIPTION: STB

MODEL: 4K JOEY

SERIAL NUMBER: Prototype

DATE TESTED: April 2, 2015 – April 8, 2015

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C	Pass

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

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

Approved & Released For



Bart Mucha
Staff Engineer
UL LLC



MICHAEL FERRER
Program Manager
UL LLC

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4-2009, FCC CFR 47 Part 2, FCC CFR 47 Part 15, 558074 D01 DTS Meas Guidance v03r02.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 333 Pfingsten Road, Northbrook, IL 60062 USA.

UL NBK is accredited by NVLAP, Laboratory Code 100414-0. The full scope of accreditation can be viewed at <http://ts.nist.gov/Standards/scopes/1004140.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

Sample Calculations

Radiated Field Strength and Conducted Emissions data contained within this report is calculated on the following basis:

Field Strength (dBuV/m) = Meter Reading (dBuV) + AF (dB/m) - Gain (dB) + Cable Loss (dB)

Conducted Voltage (dBuV) = Meter Reading (dBuV) + Cable Loss (dB) + LISN IL (dB)

Conducted Current (dBuA) = Meter Reading (dBuV) + Cable Loss (dB) - Transducer Factor (dBohms)

4.3. MEASUREMENT UNCERTAINTY

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

Test	Range	Equipment	Uncertainty k=2
Radiated Emissions	30-200MHz	Bicon 10m Horz	4.27dB
Radiated Emissions	30-200MHz	Bicon 10m Vert	4.28dB
Radiated Emissions	200-1000MHz	LogP 10m Horz	3.33dB
Radiated Emissions	200-1000MHz	LogP 10m Vert	3.39dB
Radiated Emissions	30-200MHz	Bicon 3m Horz	3.30dB
Radiated Emissions	30-130MHz	Bicon 3m Vert	4.84dB
Radiated Emissions	130-200MHz	Bicon 3m Vert	4.94dB
Radiated Emissions	200-1000MHz	LogP 3m Horz	3.46dB
Radiated Emissions	200-1000MHz	LogP 3m Vert	4.98dB
Radiated Emissions	1-6GHz	Horn	5.02dB
Radiated Emissions	6-18GHz	Horn	5.34dB
Radiated Emissions	18-26GHz	Horn	6.60dB
Conducted Ant Port	30MHz-26GHz	Spectrum Analyzer	2.94

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

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a STB tha contains an 802.15.4 Zigbee transceiver. EUT also contains a BT transceiver which is not covered in this report

5.2. MAXIMUM OUTPUT POWER

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

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2425-2475	802.15.4 ZigBee	3.724	2.36

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an inverted F style antenna, with a maximum gain of 0 dBi.

5.4. WORST-CASE CONFIGURATION AND MODE

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

The fundamental of the EUT was investigated in 2 orthogonal orientations Vertical and Horizontal, it was determined that Horizontal orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in Horizontal orientation.

5.5. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List		
Description	Manufacturer	Model
STB	DISH	88
Remote	DISH	20.1 IR
Power Supply	LiteON	PB-1300-1ES1

I/O CABLES

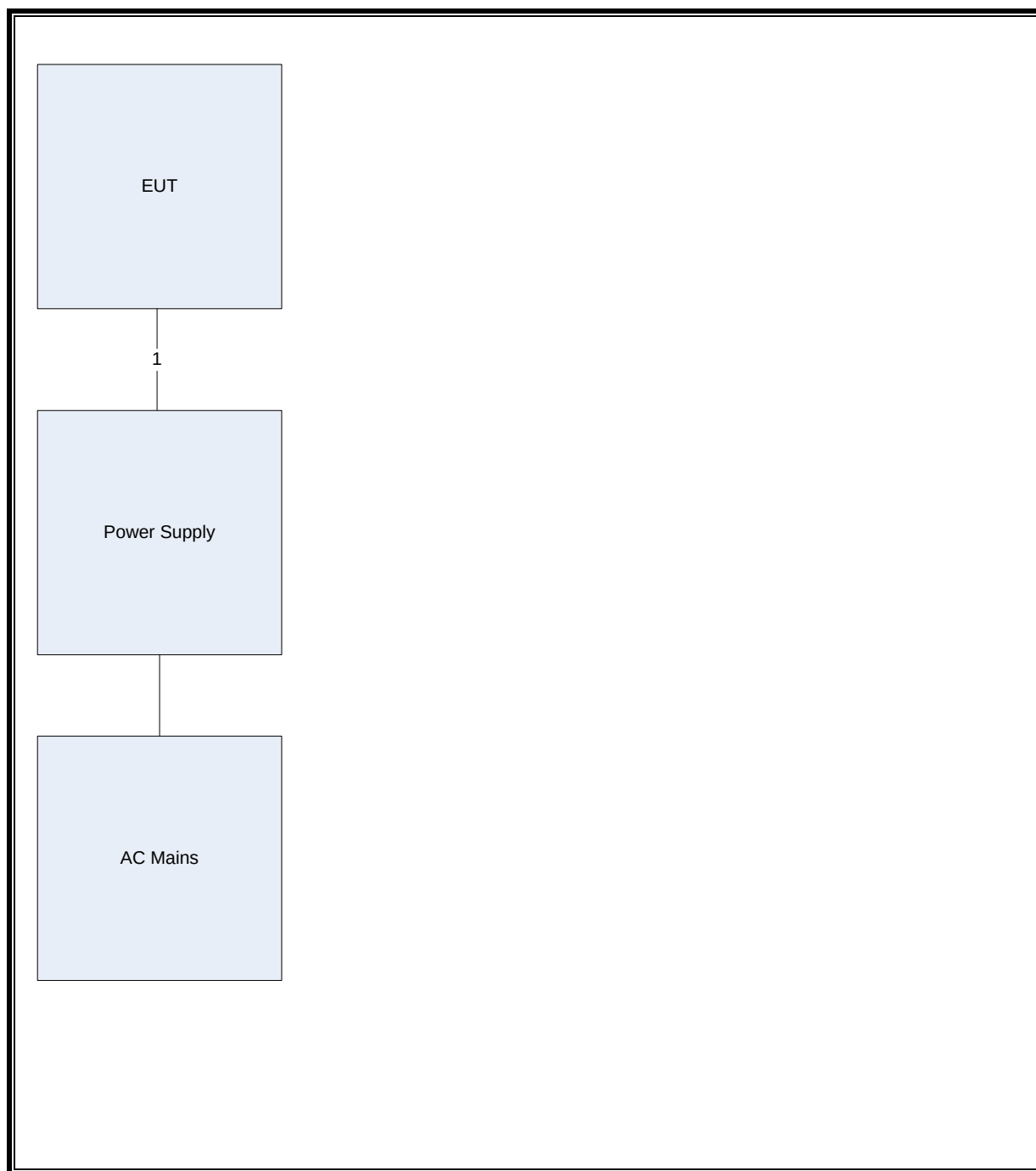
I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	DC	1	DC	2wire	2	None

TEST SETUP

The EUT is a standalone device. The EUT is programmed with a remote control via IR to different transmitter frequencies and modes.

EUT was programmed for 100% duty cycle

SETUP DIAGRAM FOR TESTS



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	T No.	Cal Date	Cal Due
Radiated Software	UL	UL EMC	Ver 9.5, Jan 30, 2015		
Conducted Software	UL	UL EMC	Ver 9.5, Oct 24, 2014		
Receiver	R&S	ESCI	EMC4328	12/18/14	12/31/15
Antenna	Chase	VBA6106A	EMC4078	04/01/14	04/30/15
Antenna	Schaffner	UPA6109	EMC4313	11/16/14	11/30/15
Receiver	R&S	ESU	EMC4323	12/16/14	12/31/15
Antenna	UL	BOMS	EMC4276	12/01/14	12/31/15
Spectrum Analyzer	Agilent	N903A	EMC4360	12/16/14	12/31/15
Power Meter	Agilent	N1912A	EMC4362	12/18/14	12/31/15
Power Sensor	Agilent	N8781A	EMC4363	12/16/14	12/31/15
Receiver	R&S	ESR	EMC4377	04/15/14	04/15/15
LISN	Solar	8602-50-TS-50-N	EMC4052	01/09/15	01/10/16
LISN	Solar	8602-50-TS-50-N	EMC4064	01/09/15	01/10/16

7. ANTENNA PORT TEST RESULTS

7.1. 802.15.4 MODE IN THE 2.4 GHz BAND

7.1.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

IC RSS-210 A8.2 (a)

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

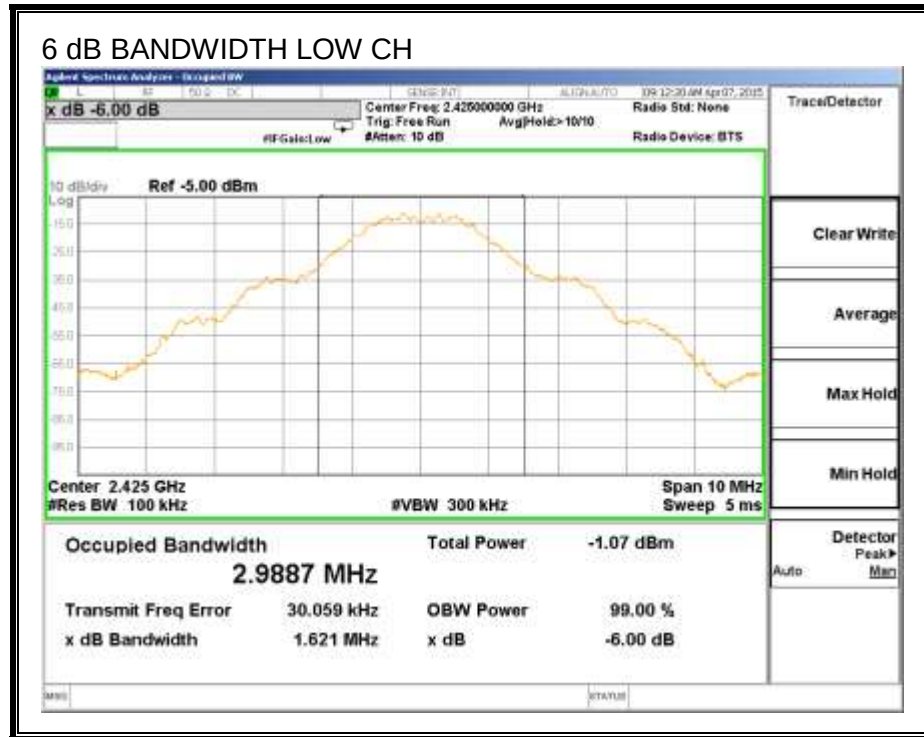
TEST PROCEDURE

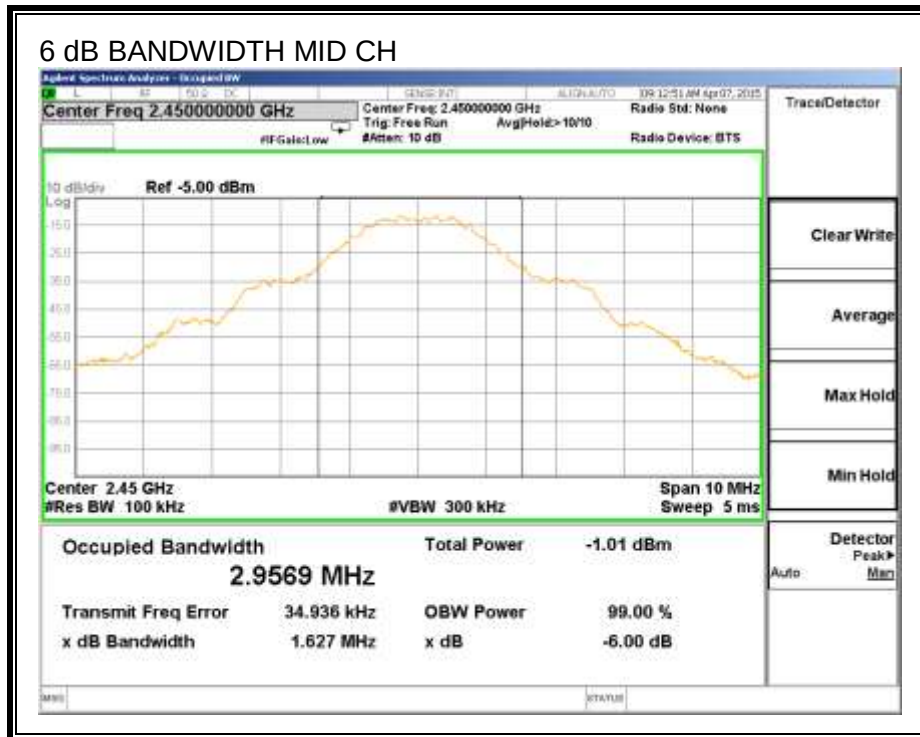
The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

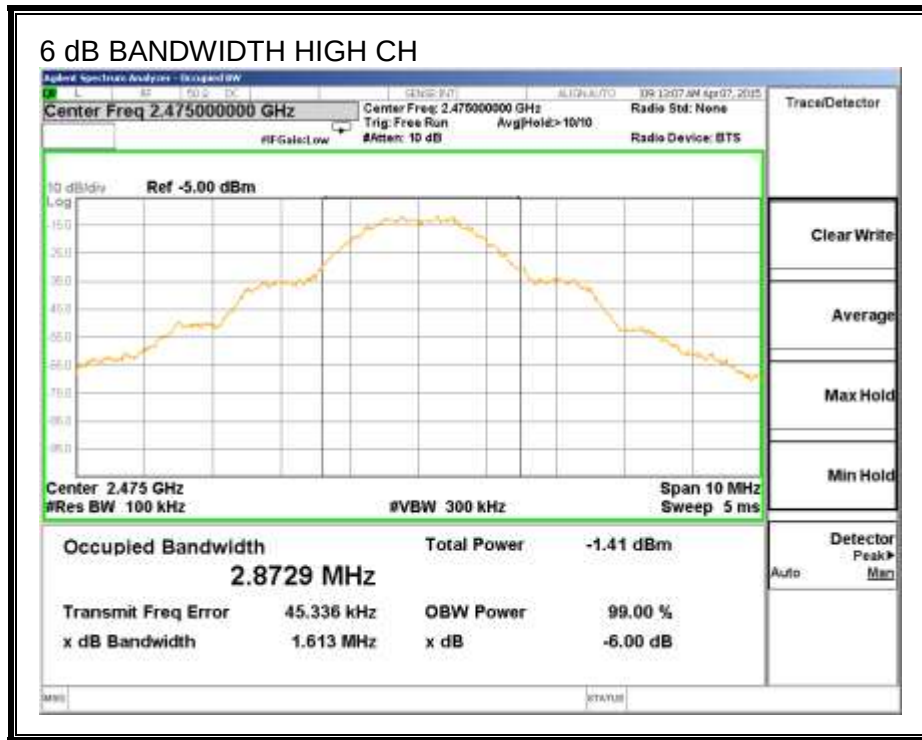
RESULTS

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2425	1.621	0.5
Middle	2450	1.627	0.5
High	2475	1.613	0.5

6 dB BANDWIDTH







7.1.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

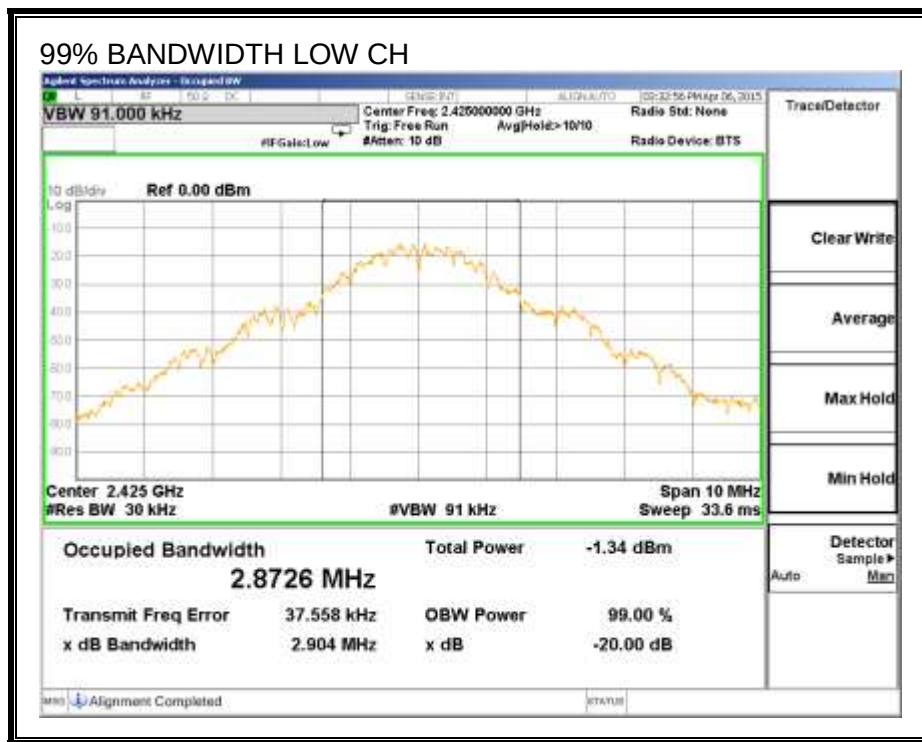
TEST PROCEDURE

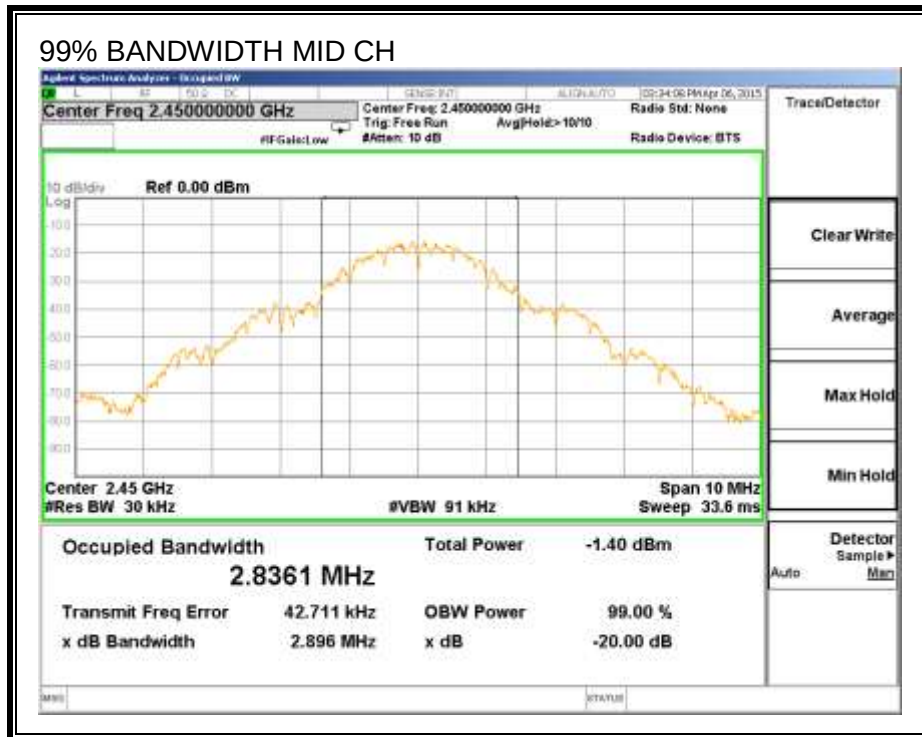
The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

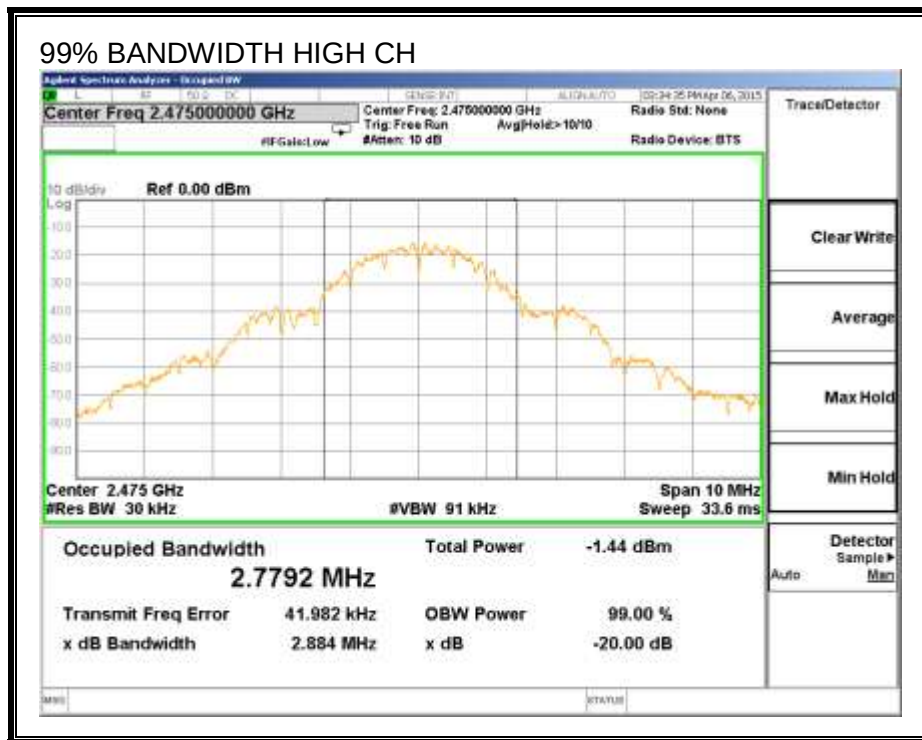
RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2425	2.8726
Middle	2450	2.8361
High	2475	2.7792

99% BANDWIDTH







7.1.3. OUTPUT POWER

LIMITS

FCC §15.247 (b)

IC RSS-210 A8.4

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

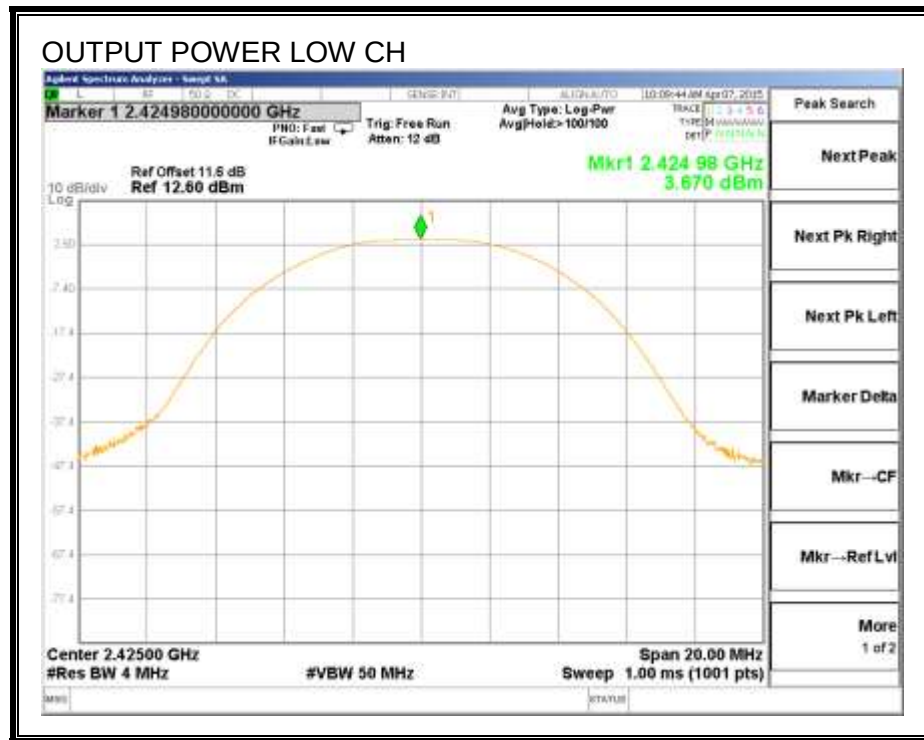
TEST PROCEDURE

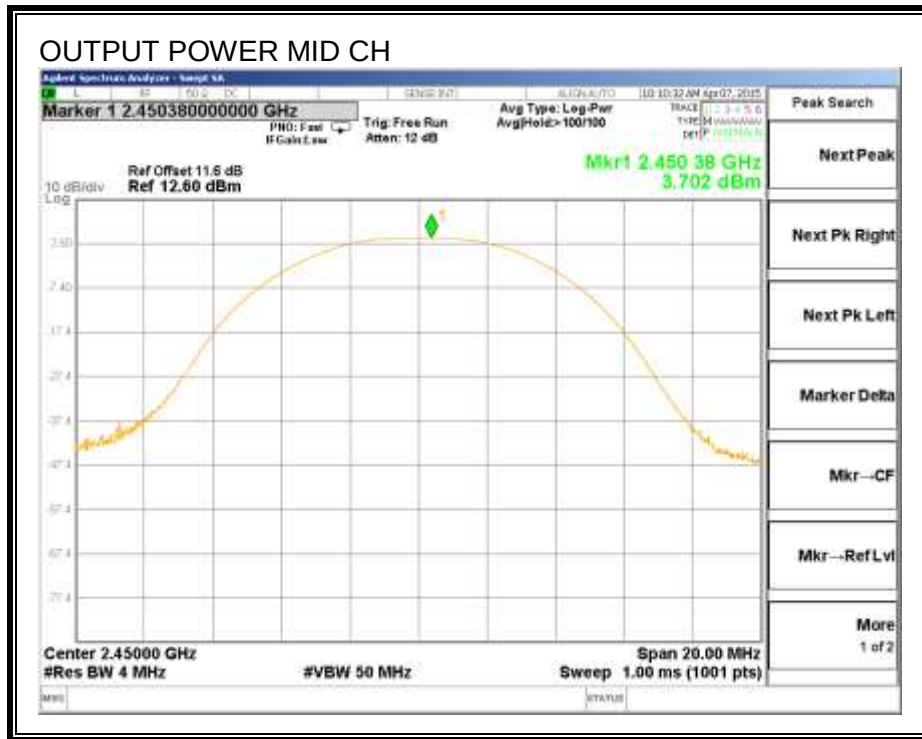
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 99% bandwidth of the EUT.

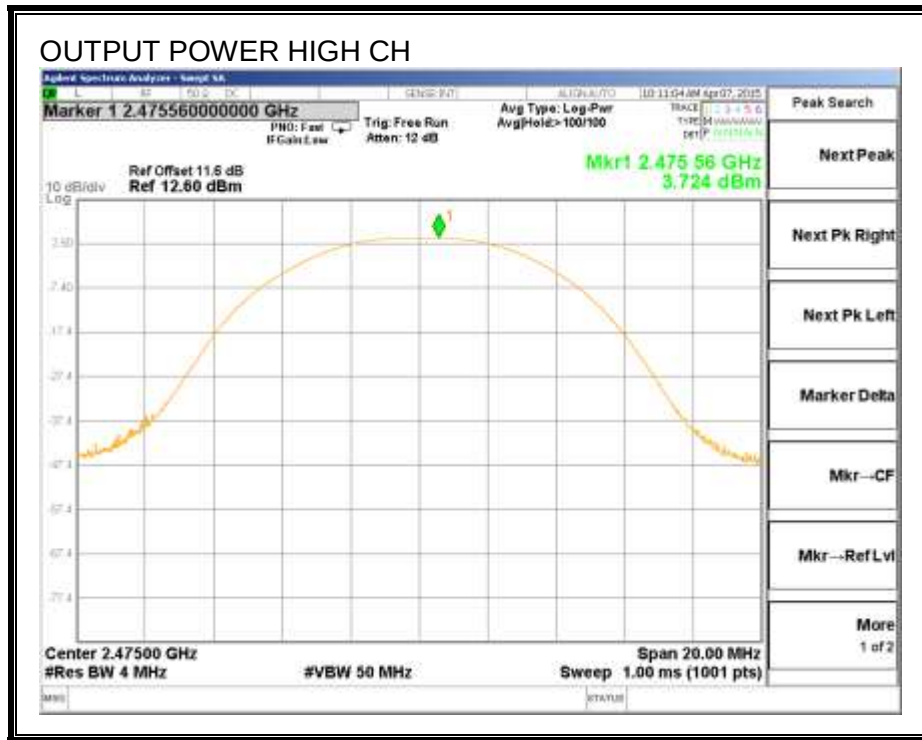
RESULTS

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2425	3.67	30	-26.33
Middle	2450	3.70	30	-26.30
High	2475	3.72	30	-26.28

OUTPUT POWER







7.1.4. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

The cable assembly insertion loss of 11.6 dB (including 10 dB pad and 1.6 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Power (dBm)
Low	2425	3.21
Middle	2450	3.19
High	2475	3.20

7.1.5. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247 (e)

IC RSS-210 A8.2 (b)

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

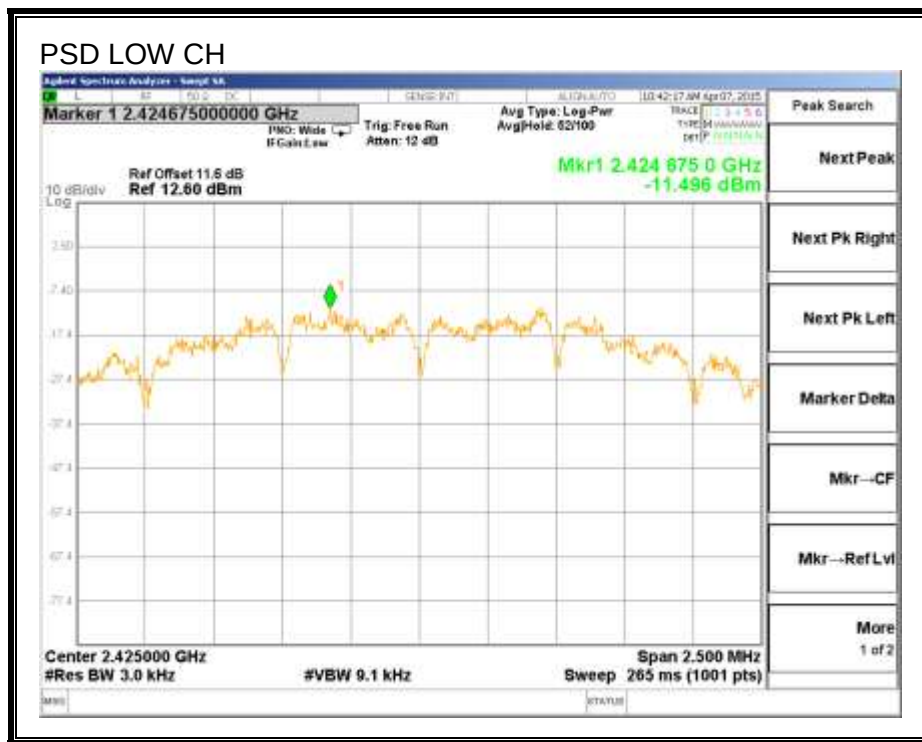
TEST PROCEDURE

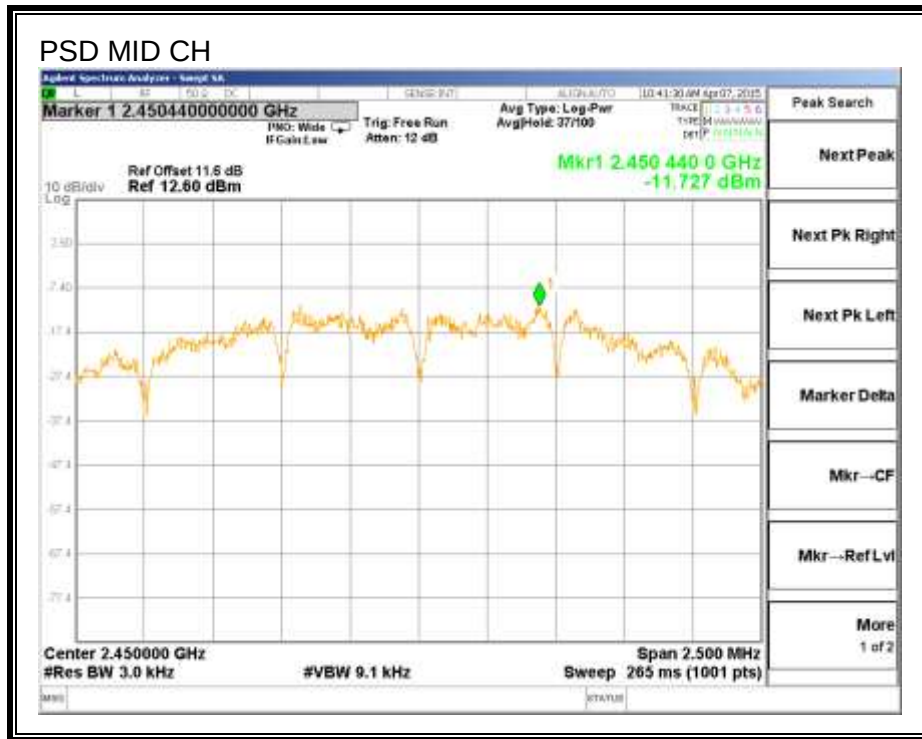
Output power was measured based on the use of a peak measurement, therefore the power spectral density was measured using PSD Section 10.2 in accordance with 558074 D01 v03r02.

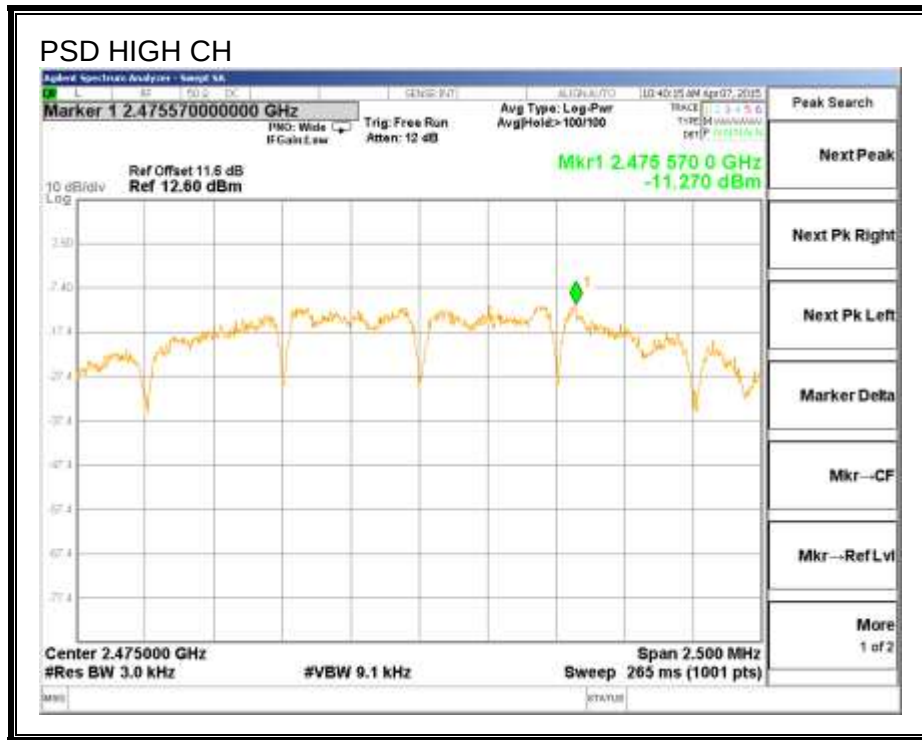
RESULTS

Channel	Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin (dB)
Low	2425	-11.50	8	-19.50
Middle	2450	-11.73	8	-19.73
High	2475	-11.27	8	-19.27

POWER SPECTRAL DENSITY







7.1.6. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

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

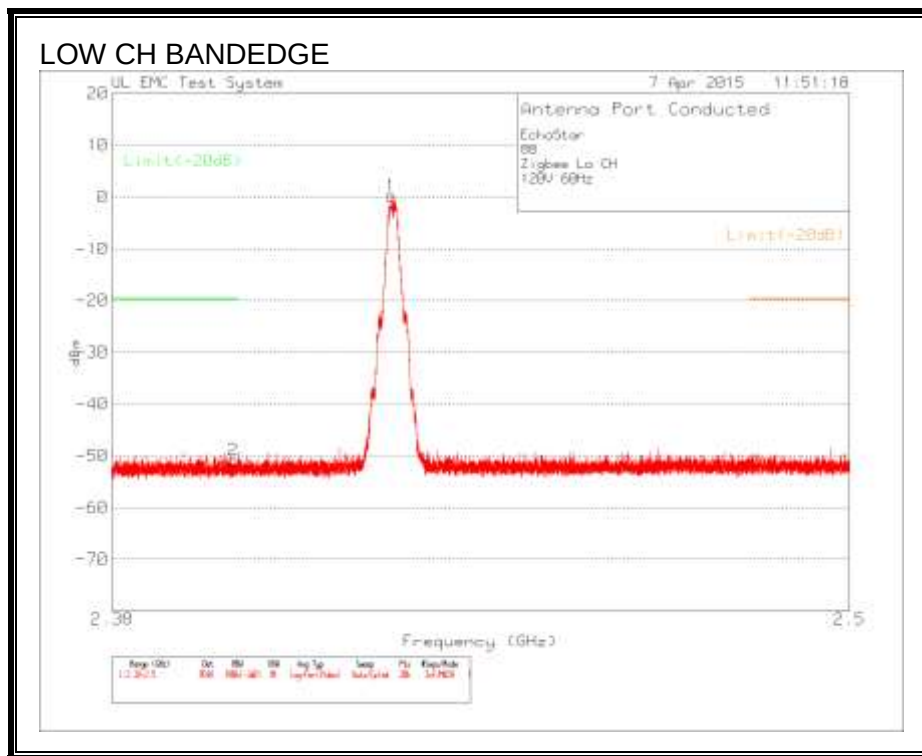
TEST PROCEDURE

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.

RESULTS

SPURIOUS EMISSIONS, LOW CHANNEL

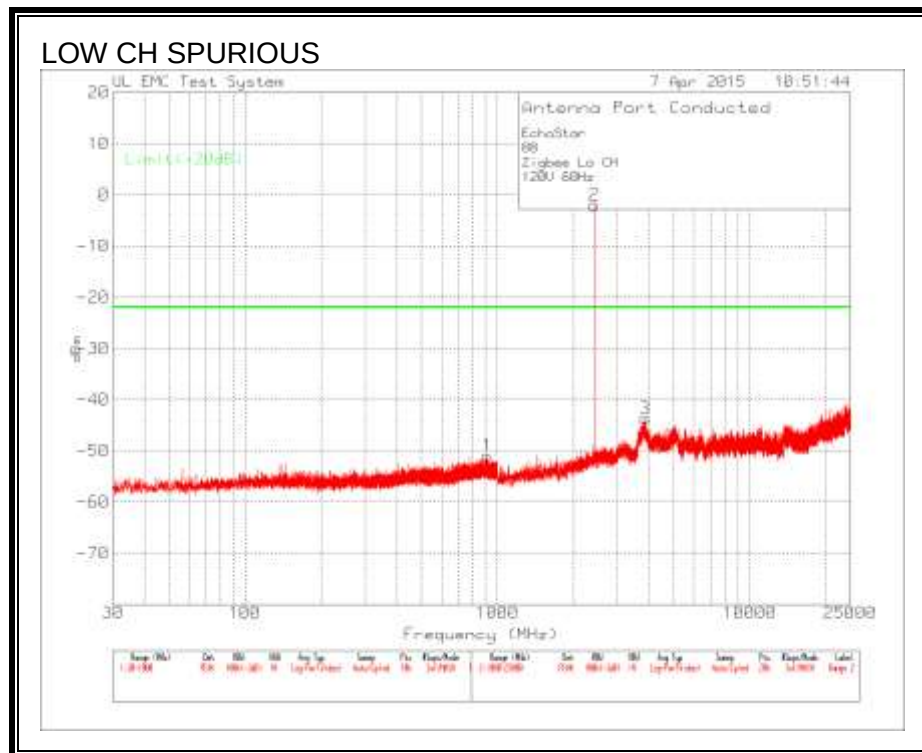


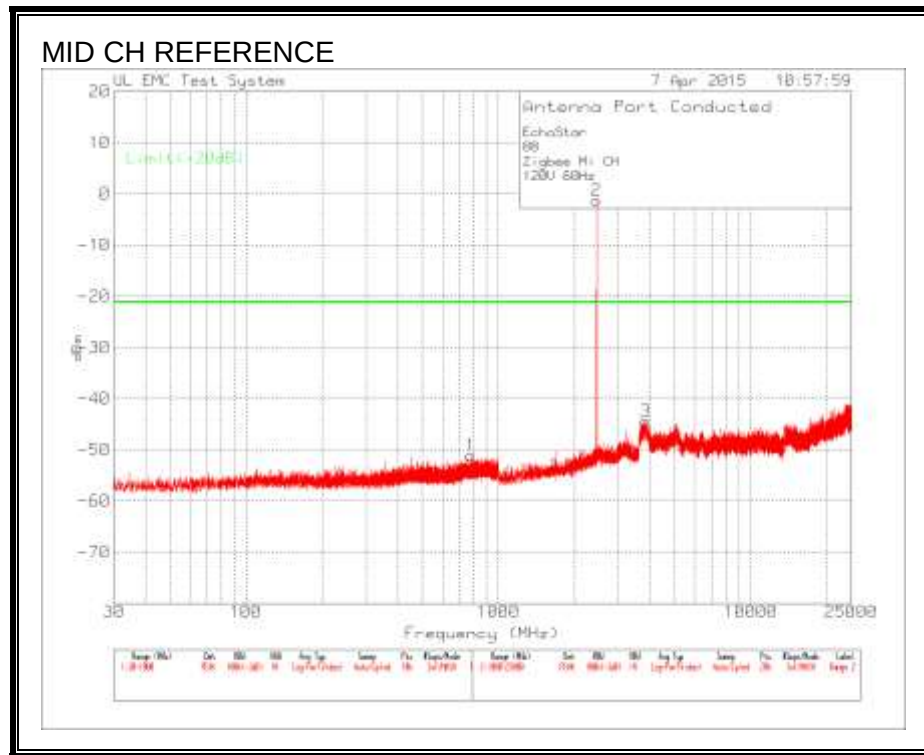
EchoStar
88
Zigbee Lo CH
120V 60Hz

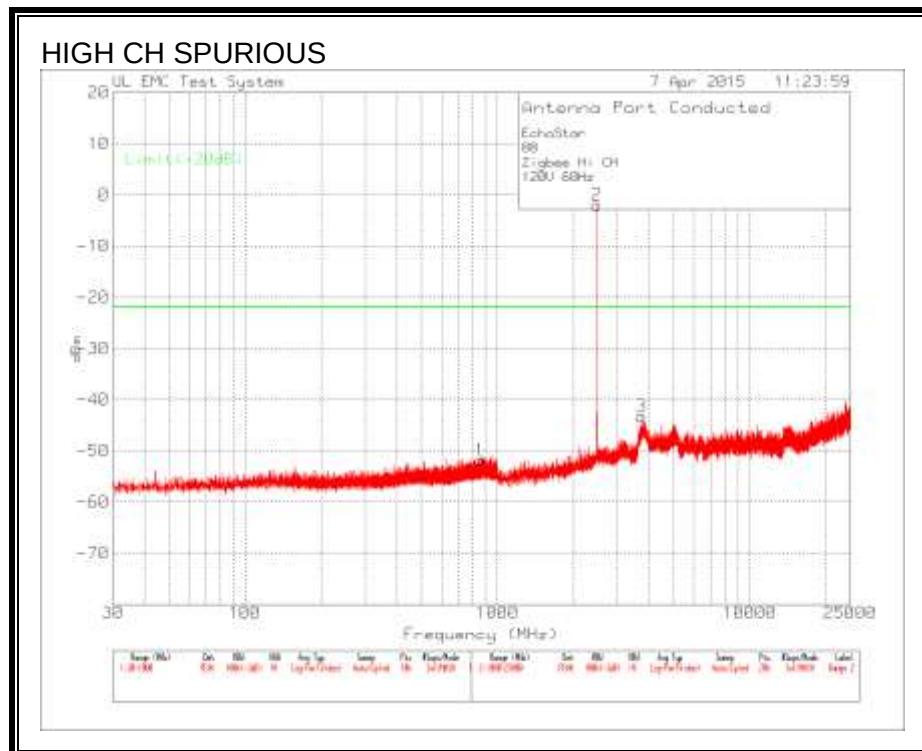
Trace Markers										
Test	Meter	Transducer	Gain/Loss	Corrected	Limit:1	2	3	4	5	6
No. Frequency	Reading	Factor	Factor	Reading dBm						
(GHz)		(dB)	(dB)							
=====										
Range 2 2.38 - 2.5GHz										
1 2.424757	96.15dBuV PK	-107	11.1	.25	-	-	-	-	-	-
				Margin (dB)	-	-	-	-	-	-
2 2.399362	45.05dBuV PK	-107	11.1	-50.85	-19.75	-	-	-	-	-
				Margin (dB)	-31.1	-	-	-	-	-

LIMIT 1: Limit
LIMIT 2: Limit

PK - Peak detector







8. RADIATED TEST RESULTS

8.1. LIMITS AND PROCEDURE

LIMITS

FCC §15.205 and §15.209

IC RSS-210 Clause 8.9 (Transmitter)

IC RSS-GEN Clause 7.1.2 (Receiver)

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

Test setup

80cm below 1GHz

1.5m above 1GHz

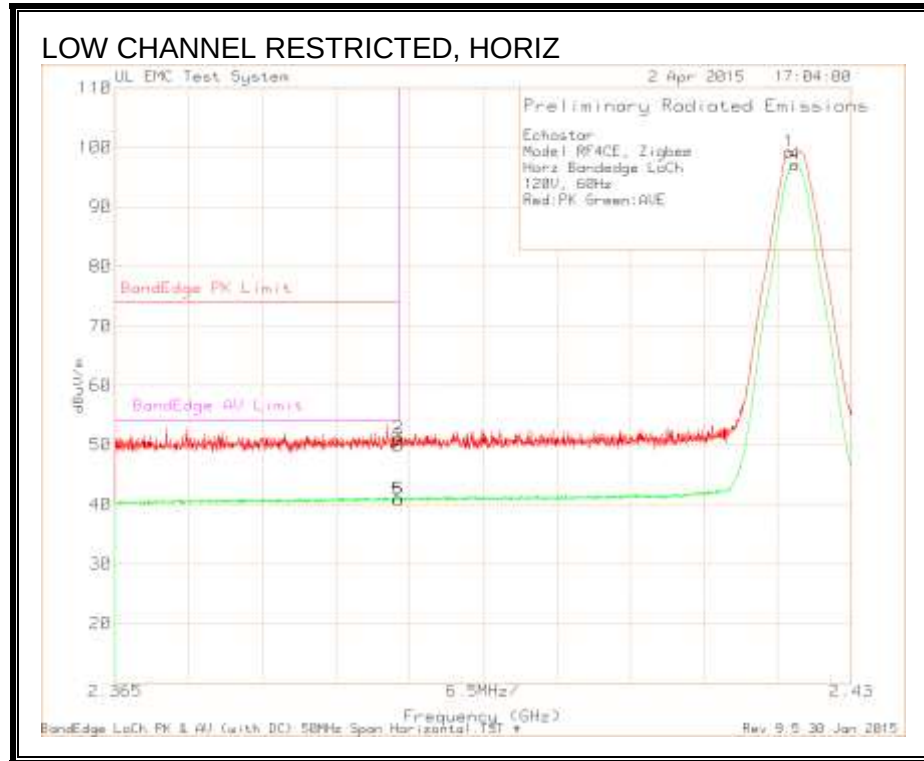
Peak 1MHz/1MHz – Peak detector

AV 1MHz/1MHz – AV dectector

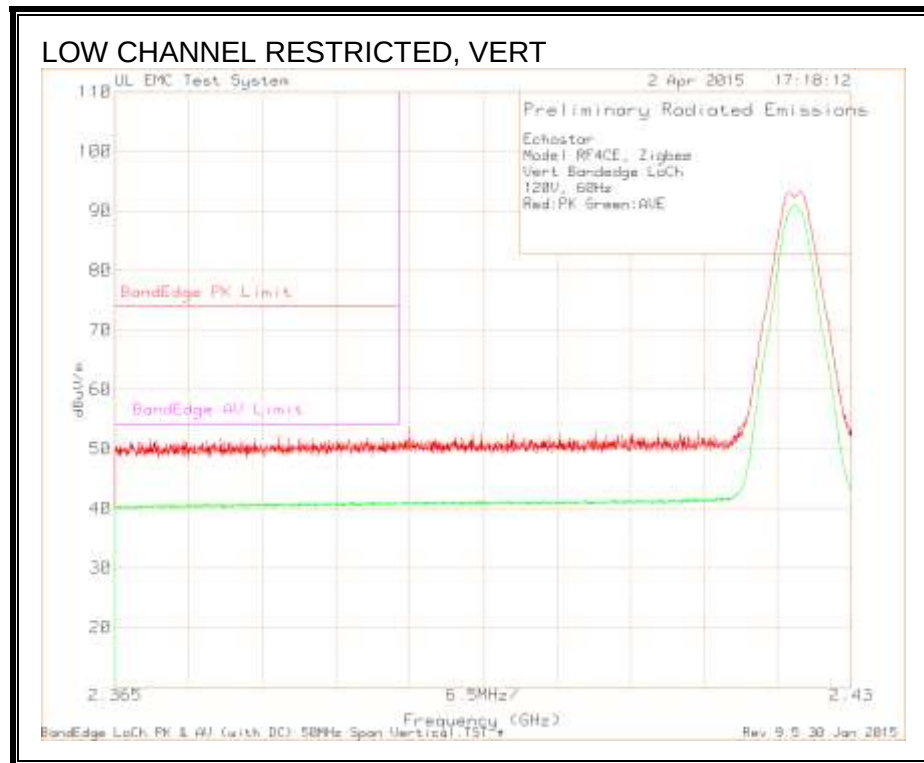
8.2. TRANSMITTER ABOVE 1 GHz

8.2.1. TX ABOVE 1 GHz FOR 802.15.4 MODE IN THE 2.4 GHz BAND

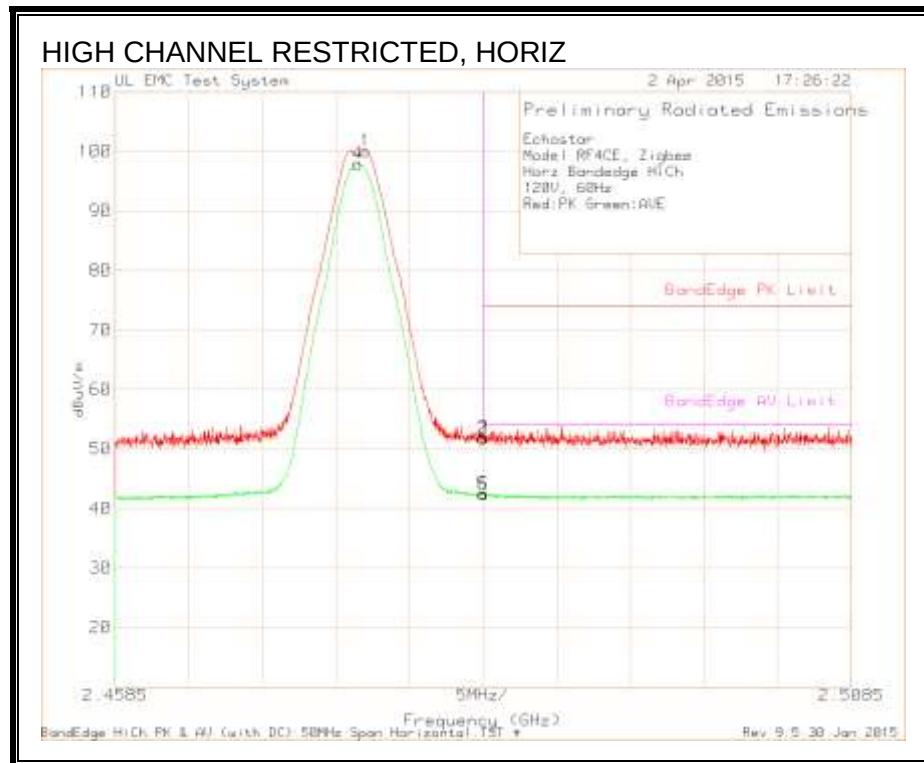
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



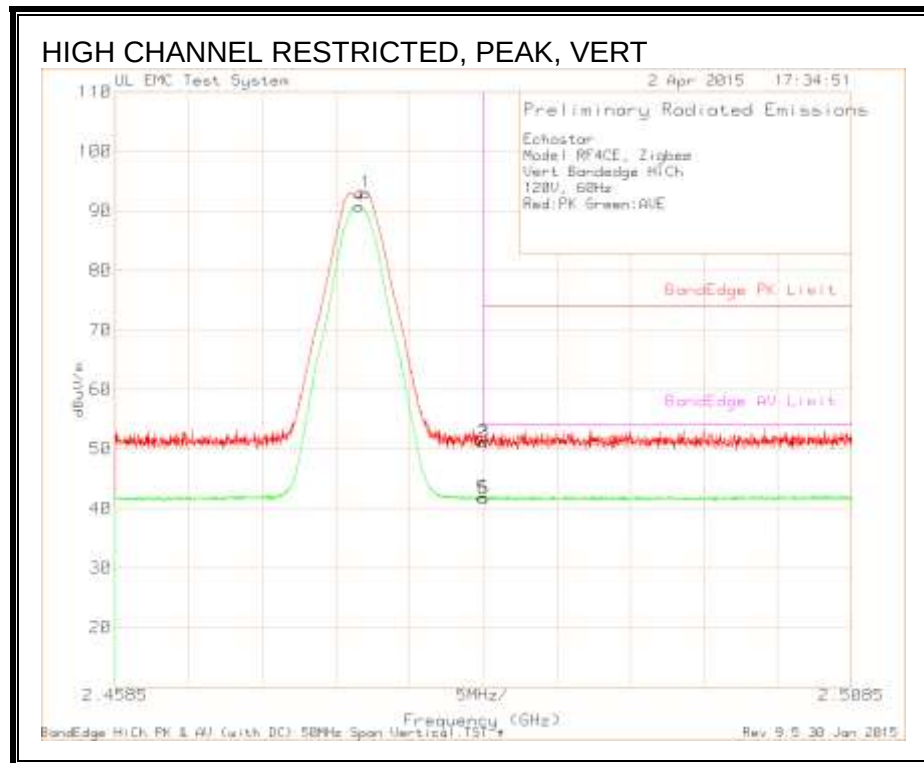
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



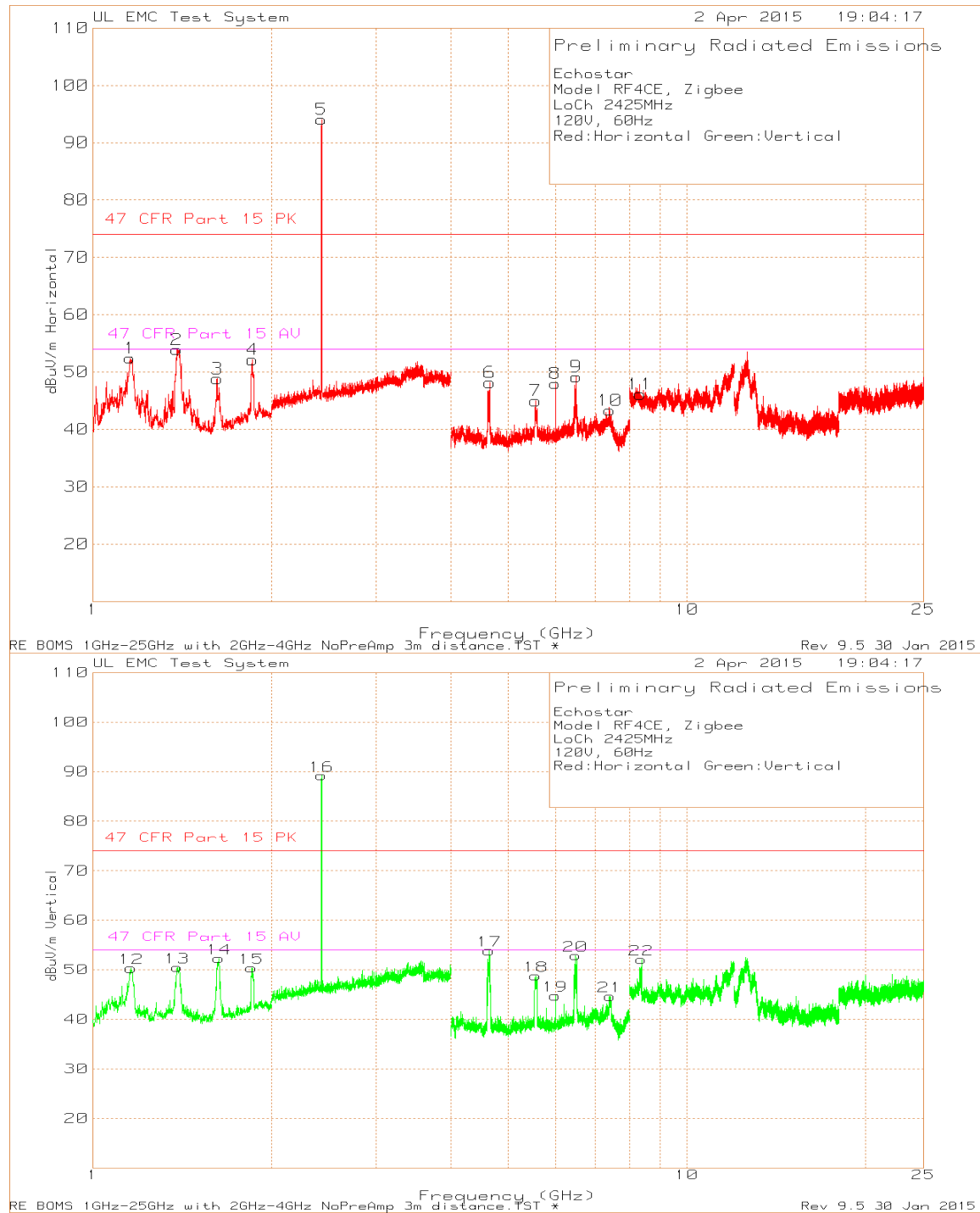
RESTRICTED BANEDGE (HIGH CHANNEL, HORIZONTAL)

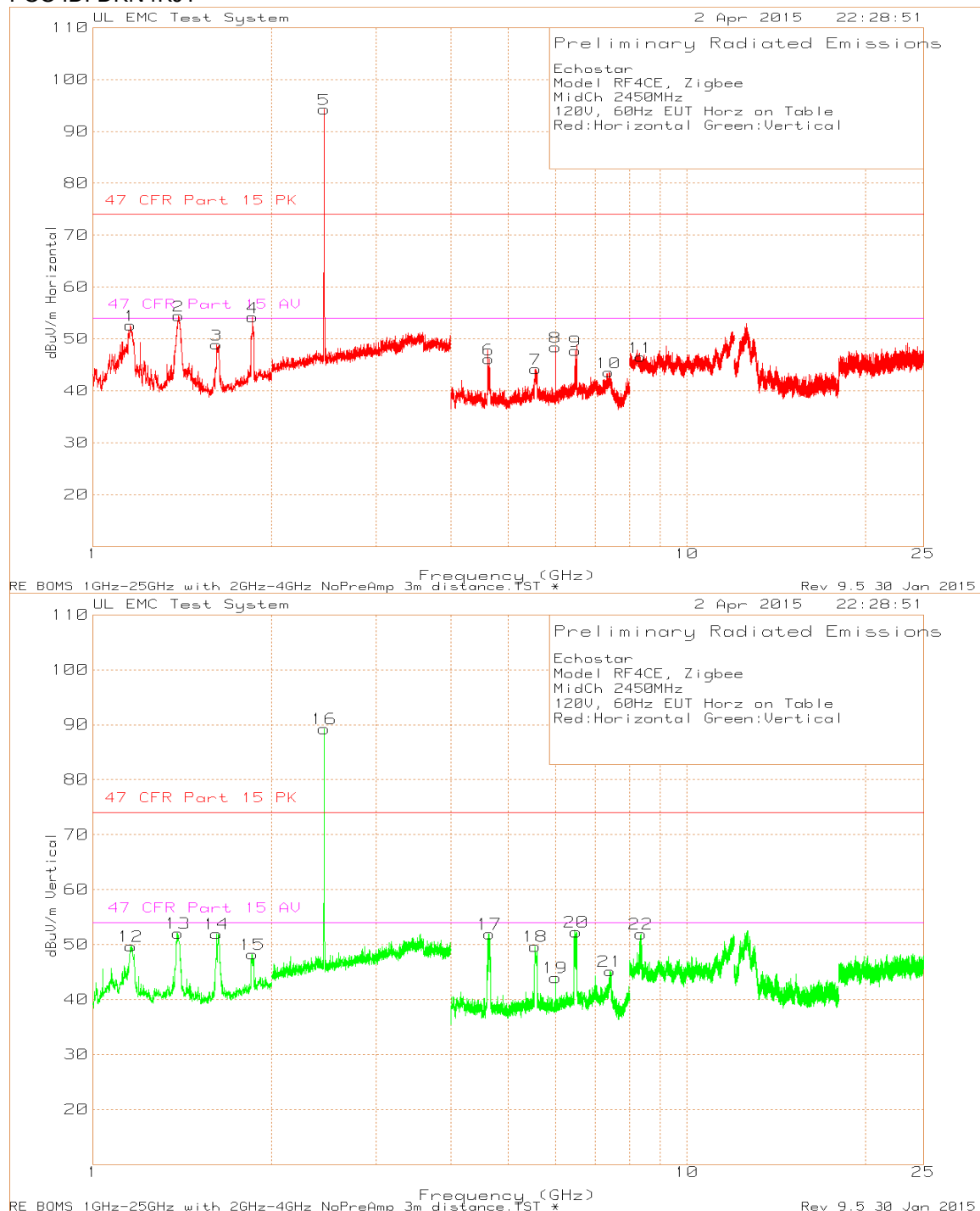


RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)



HARMONICS AND SPURIOUS EMISSIONS





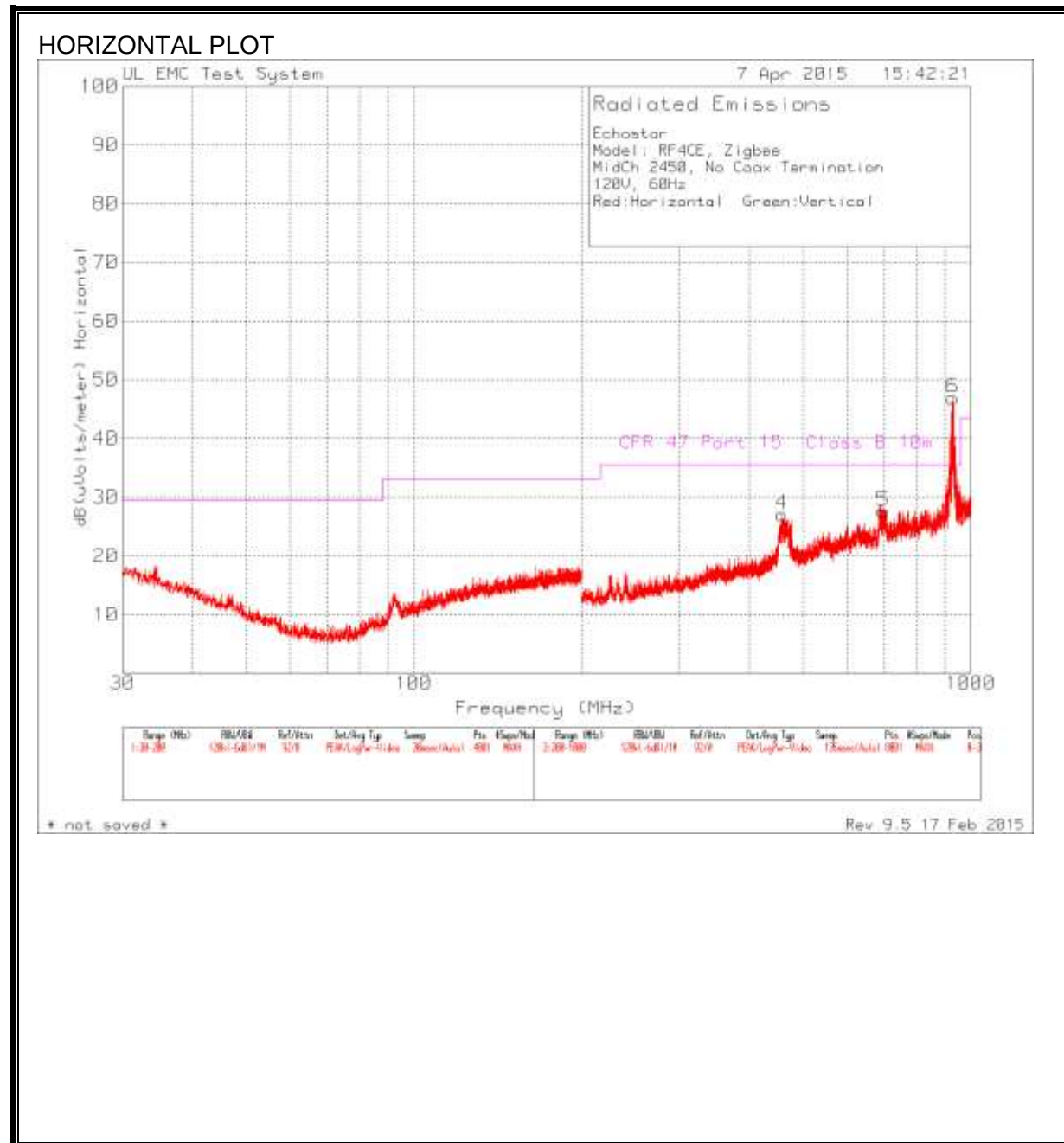


Echostar												
Model 088												
120V, 60Hz												
Test	Meter		Antenna		Corrected	47 CFR		47 CFR				
Frequency	Reading		factor	Gain/Loss	Reading	Part 15	Margin	Part 15	Margin	Azimuth	Height	
(GHz)	(dBuV)	Detector	dB/m	(dB)	dBuV/m	PK	(dB)	AV	(dB)	[Degs]	[cm]	Polarity
1.3921	82.43	Pk	29	-55.74	55.69	74	-18.31	-	-	10	193	H
1.3897	65.76	Av	29	-55.75	39.01	74	-34.99	54	-14.99	10	193	H
1.389	65.8	Av	29	-55.75	39.05	74	-34.95	54	-14.95	10	193	H
1.384	80.22	Pk	29	-55.78	53.44	74	-20.56	-	-	256	100	V
1.3891	63.87	Av	29	-55.75	37.12	74	-36.88	54	-16.88	256	100	V
1.1558	78.89	Pk	28	-56.43	50.46	74	-23.54	-	-	245	100	V
1.1562	63.36	Av	28	-56.43	34.93	74	-39.07	54	-19.07	245	100	V
1.1623	82.74	Pk	28.1	-56.42	54.42	74	-19.58	-	-	76	132	H
1.1619	65.64	Av	28.1	-56.42	37.32	74	-36.68	54	-16.68	76	132	H
1.6212	75.31	Pk	28.4	-54.33	49.38	74	-24.62	-	-	78	100	H
1.6219	57.79	Av	28.4	-54.34	31.85	74	-42.15	54	-22.15	78	100	H
1.6287	78.7	Pk	28.5	-54.36	52.84	74	-21.16	-	-	360	144	V
1.8551	78.18	Pk	30.9	-53.87	55.21	74	-18.79	-	-	325	169	H
1.8492	59.43	Av	30.8	-53.94	36.29	74	-37.71	54	-17.71	325	169	H
1.8529	72.21	Pk	30.8	-53.9	49.11	74	-24.89	-	-	151	140	V
1.8556	54.57	Av	30.9	-53.86	31.61	74	-42.39	54	-22.39	151	140	V
2.6812	29.86	Pk	22.1	4.56	56.52	74	-17.48	-	-	257	100	V
2.6812	16.35	Avg	22.1	4.56	43.01	74	-30.99	54	-10.99	257	100	V
6.4881	75.25	Pk	29.1	-47.71	56.64	74	-17.36	-	-	324	100	V
6.4803	50.86	Av	29.1	-47.74	32.22	74	-41.78	54	-21.78	324	100	V
6.5131	72.16	Pk	29	-47.59	53.57	74	-20.43	-	-	20	100	H
6.4833	49.08	Av	29.1	-47.74	30.44	74	-43.56	54	-23.56	20	100	H
4.6223	75.53	Pk	27.7	-51.9	51.33	74	-22.67	-	-	11	100	H
4.6323	53.88	Av	27.7	-51.83	29.75	74	-44.25	54	-24.25	11	100	H
4.6169	81.31	Pk	27.7	-51.87	57.14	74	-16.86	-	-	158	100	V
4.6344	57.01	Av	27.7	-51.78	32.93	74	-41.07	54	-21.07	158	100	V
5.5661	68.76	Pk	28.3	-49.8	47.26	74	-26.74	-	-	74	161	H
5.5448	51.86	Av	28.3	-49.75	30.41	74	-43.59	54	-23.59	74	161	H
5.5662	73.03	Pk	28.3	-49.8	51.53	74	-22.47	-	-	169	100	V
5.5448	53.4	Av	28.3	-49.75	31.95	74	-42.05	54	-22.05	169	100	V
6.0001	69.56	Pk	28.7	-48.75	49.51	74	-24.49	-	-	270	143	H
6.0001	66.43	Av	28.7	-48.75	46.38	74	-27.62	54	-7.62	270	143	H
6.0001	66.47	Pk	28.7	-48.75	46.42	74	-27.58	-	-	61	100	V
6.0001	60.65	Av	28.7	-48.75	40.6	74	-33.4	54	-13.4	61	100	V
8.3454	71.96	Pk	36.5	-48.77	59.69	74	-14.31	-	-	308	100	V
8.3654	50.7	Av	36.5	-49.07	38.13	74	-35.87	54	-15.87	308	100	V
12.6054	59.23	Pk	39.5	-34.53	64.2	74	-9.8	-	-	201	100	H
12.6059	46.59	Av	39.5	-34.52	51.57	74	-22.43	54	-2.43	201	100	H
12.6044	59.84	Pk	39.5	-34.56	64.78	74	-9.22	-	-	179	100	V
12.6062	45.01	Avg	39.5	-34.51	50	74	-24	54	-4	179	100	V

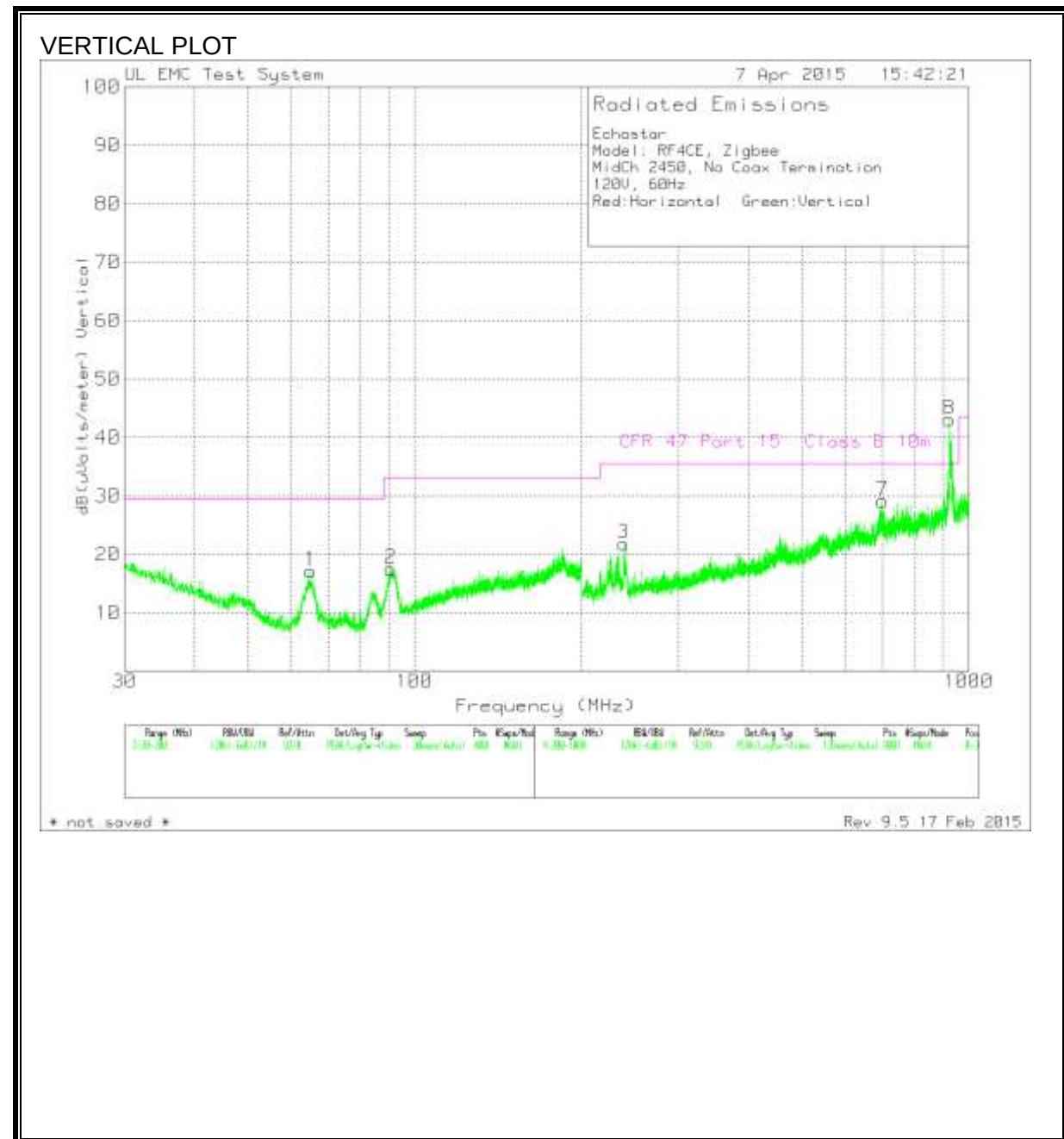
There were no harmonics found within 6dB of the limit. Emissions found were product of the digital portion of the device. Measurements were made with one mode to represent all modes.

8.3. WORST-CASE BELOW 1 GHz

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



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



DATA

Echostar
Model: RF4CE, Zigbee
MidCh 2450, No Coax Termination
120V, 60Hz
Red:Horizontal Green:Vertical

Trace Markers										
No.	Test	Meter	Transducer	Gain/Loss	Corrected	Limit:1	2	3	4	5
Frequency		Reading	Factor	Factor	Reading	dB(uVolts/meter)				
(MHz)			(dB)	(dB)						
=====										
Range 2: Bicon Vertical 30 - 200MHz -----										
1 64.9775		40.95dBuV Pk	6.3	-30.1	17.15	29.55	-	-	-	-
		Azimuth:0-360	Height:400	Vert	Margin (dB)	-12.4	-	-	-	-
2 90.6475		38.36dBuV Pk	9.2	-30	17.56	33.07	-	-	-	-
		Azimuth:0-360	Height:249	Vert	Margin (dB)	-15.51	-	-	-	-
Range 3: LogP Horizontal 200 - 1000MHz -----										
4 458.9		37.38dBuV Pk	17.2	-27.5	27.08	35.57	-	-	-	-
		Azimuth:0-360	Height:200	Horz	Margin (dB)	-8.49	-	-	-	-
5 696.9		33.12dBuV Pk	20.7	-26.2	27.62	35.57	-	-	-	-
		Azimuth:0-360	Height:100	Horz	Margin (dB)	-7.95	-	-	-	-
6 928.1		50.13dBuV Pk	22.8	-26	46.93	-	-	-	-	-
		Azimuth:0-360	Height:299	Horz	Margin (dB)	-	-	-	-	-
Range 4: LogP Vertical 200 - 1000MHz -----										
3 238.7		39.33dBuV Pk	11.3	-28.8	21.83	35.57	-	-	-	-
		Azimuth:0-360	Height:99	Vert	Margin (dB)	-13.74	-	-	-	-
7 699.9		34.41dBuV Pk	20.5	-25.8	29.11	35.57	-	-	-	-
		Azimuth:0-360	Height:298	Vert	Margin (dB)	-6.46	-	-	-	-
8 923.1		47.11dBuV Pk	22.8	-26.8	43.11	-	-	-	-	-
		Azimuth:0-360	Height:199	Vert	Margin (dB)	-	-	-	-	-

LIMIT 1: CFR 47 Part 15 Class B 10m

Pk - Peak detector

923, 928 MHz is not in the restricted band

9. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

RSS-Gen 7.2.2

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

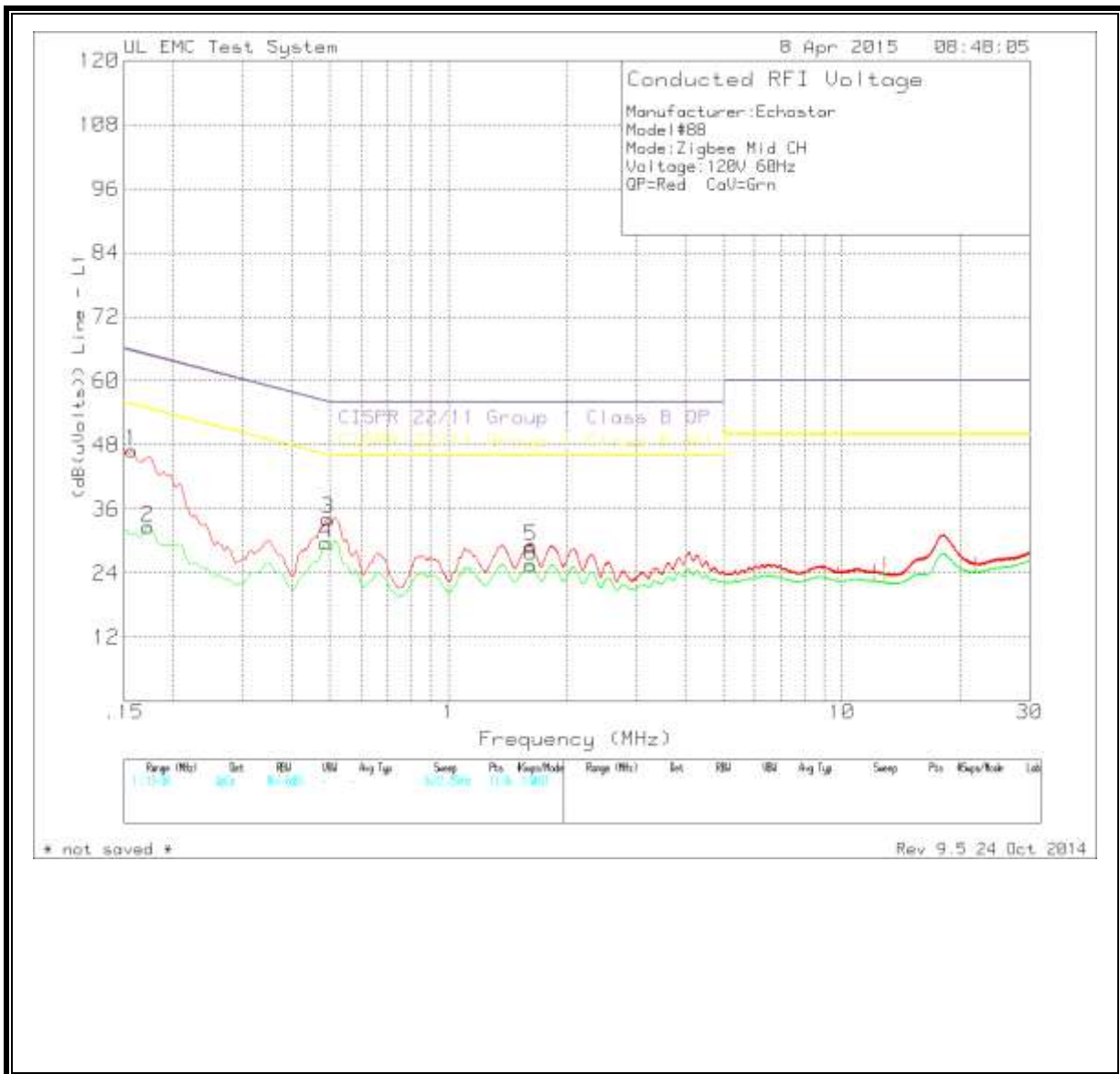
^{*} Decreases with the logarithm of the frequency.

TEST PROCEDURE

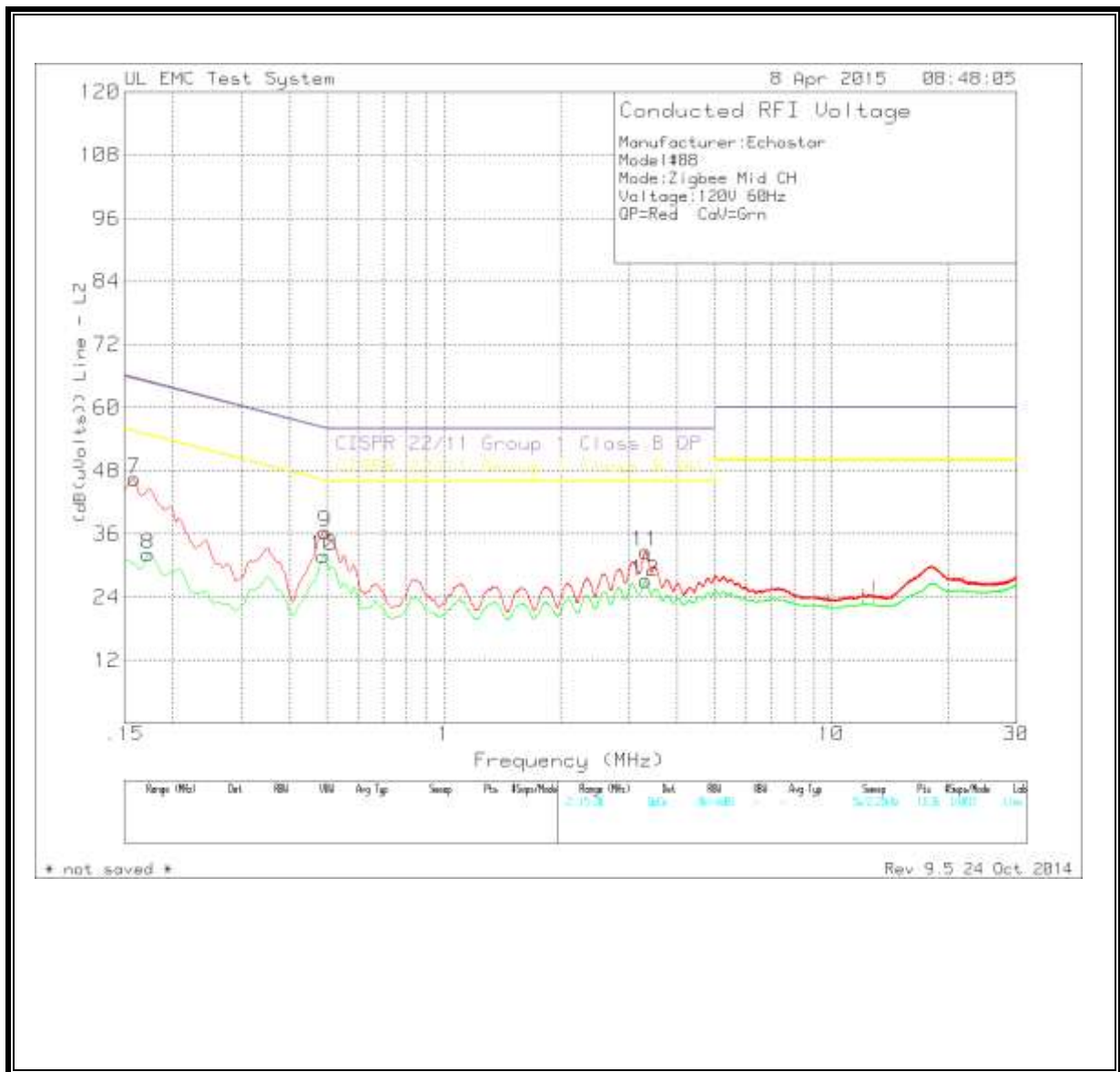
ANSI C63.4

RESULTS

LINE 1 RESULTS



LINE 2 RESULTS



FCC ID: DKN4KJT

Manufacturer: Echostar

Model#88

Mode: Zigbee Mid CH

Voltage: 120V 60Hz

QP=Red CaV=Grn

Trace Markers

Test	Meter	Transducer	Gain/Loss	Corrected	Limit:1	2	3	4	5
No. Frequency (MHz)	Reading	Factor (dB)	Factor (dB)	Reading (dB(uVolts))					
=====									
Line - L1 .15 - 30MHz	-----								
1 .15675	34.35dBuV Qp	.1	12.6	47.05	-	-	65.63	-	-
				Margin (dB)	-	-	-18.58	-	-
2 .1725	20.49dBuV Ca	.1	12.1	32.69	-	-	-	54.84	-
				Margin (dB)	-	-	-	-22.15	-
3 .49425	23.48dBuV Qp	.1	10.6	34.18	-	-	56.1	-	-
				Margin (dB)	-	-	-21.92	-	-
4 .48975	19dBuV Ca	.1	10.6	29.7	-	-	-	46.17	-
				Margin (dB)	-	-	-	-16.47	-
5 1.6215	18.43dBuV Qp	.1	10.5	29.03	-	-	56	-	-
				Margin (dB)	-	-	-26.97	-	-
6 1.61925	14.94dBuV Ca	.1	10.5	25.54	-	-	-	46	-
				Margin (dB)	-	-	-	-20.46	-
=====									
Line - L2 .15 - 30MHz	-----								
7 .159	33.77dBuV Qp	.1	12.6	46.47	-	-	65.52	-	-
				Margin (dB)	-	-	-19.05	-	-
8 .1725	19.85dBuV Ca	.1	12.2	32.15	-	-	-	54.84	-
				Margin (dB)	-	-	-	-22.69	-
9 .49425	25.58dBuV Qp	.1	10.7	36.38	-	-	56.1	-	-
				Margin (dB)	-	-	-19.72	-	-
10 .48975	20.93dBuV Ca	.1	10.8	31.83	-	-	-	46.17	-
				Margin (dB)	-	-	-	-14.34	-
11 3.3135	21.75dBuV Qp	.1	10.8	32.65	-	-	56	-	-
				Margin (dB)	-	-	-23.35	-	-
12 3.3135	16.21dBuV Ca	.1	10.8	27.11	-	-	-	46	-
				Margin (dB)	-	-	-	-18.89	-

LIMIT 3: CISPR 22/11 Group 1 Class B QP

LIMIT 4: CISPR 22/11 Group 1 Class B AV

Qp - Quasi-Peak detector

Ca - CISPR Average detection