



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

**CLASS II PERMISSIVE CHANGE
BLUETOOTH TEST REPORT**

FOR

802.11a/b/g/n WLAN + BLUETOOTH PCI-E MINI CARD

MODEL NUMBER: BCM943228HMB

**FCC ID: QDS-BRCM1058
IC: 4324A-BRCM1058**

REPORT NUMBER: 13U16745-3, Revision A

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Prepared for
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NVLAP LAB CODE 200065-0

Revision History

<u>Rev.</u>	<u>Issue Date</u>	<u>Revisions</u>	<u>Revised By</u>
--	01/29/14	Initial Issue	F. Ibrahim
A	02/25/2014	Revised AG in section 5.3 by changing 0.85 dBi to 1.58 dBi	F. Ibrahim

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: BROADCOM CORPORATION
190 MATHILDA PLACE
SUNNYVALE, CA 94086, U.S.A.

EUT DESCRIPTION: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card

MODEL: BCM943228HMB

SERIAL NUMBER: 1403512

DATE TESTED: JANUARY 23 - 24, 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:



Frank Ibrahim
WiSE PROGRAM MANAGER
UL Verification Services Inc.

Tested By:



Joey Gomez
WiSE Lab 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.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.

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
<input checked="" type="checkbox"/> Chamber A	<input type="checkbox"/> Chamber D
<input type="checkbox"/> Chamber B	<input type="checkbox"/> Chamber E
<input type="checkbox"/> Chamber C	<input type="checkbox"/> Chamber F

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:

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

4.3. MEASUREMENT UNCERTAINTY

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

PARAMETER	UNCERTAINTY
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

The EUT is an 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini card manufactured by Broadcom.

The radio module is manufactured by Broadcom.

5.2. MAXIMUM OUTPUT POWER

Average Output power was verified to be within +/- 0.5 dB from original values covered by report number 11U13795-16A

5.3. DESCRIPTION OF CLASS II PERMISSIVE CHANGE

Purpose of C2PC is to add the following antenna:

Antenna Type: Dipole Antenna

Antenna Gain (dBi)		
Band	Chain 0 (TX1)	Chain 1 (TX2)
2.4	-0.45	1.26
5.2	-0.36	1.58
5.3	-0.36	1.58
5.6	-0.07	1.01
5.8	0.83	1.09

5.4. SOFTWARE AND FIRMWARE

The test utility software used during testing was Broadcom BlueTool ver 1.7.5.1

5.5. WORST-CASE CONFIGURATION AND MODE

The EUT was tested as an external module installed in a test jig board connected to a host Laptop PC.

Radiated Emissions test in the frequency range of 30-1000 MHz was performed with the EUT set to transmit in the channel and mode with highest output power as worst-case scenario.

All legacy modes were measured at Aux port, connector J2 (chain 1), antenna TX2, as worst-case scenario; this port is connected to the antenna with higher gain.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Lenovo	G560	CBU4473193	DoC
AC Adapter	Lenovo	PA-1650-56LC	11S36001651ZZ40006E2PR	DoC
Adapter Board	Broadcom	BRCM JUAN01	1788087	N/A

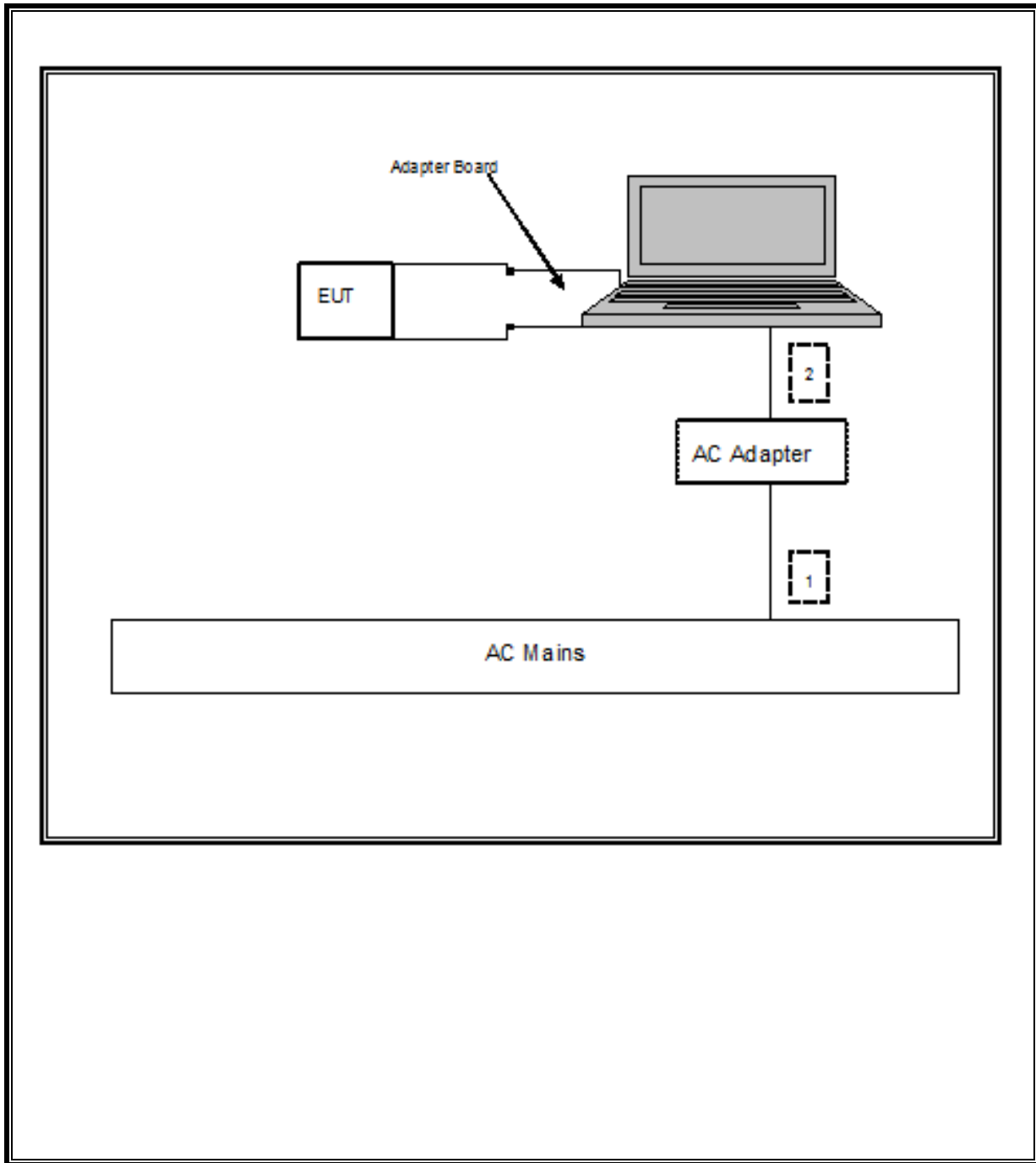
I/O CABLES

I/O CABLE LIST						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length	Remarks
1	AC	1	US 115V	Shielded	1.5m	NA
2	DC	1	DC	Un-shielded	1.5m	Ferrite at laptop's end

TEST SETUP

The EUT was attached to a jig board which was installed in the PCMCIA slot of a host laptop computer during the tests. Test software exercised the radio card.

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	Asset	Cal Date	Cal Due
Spectrum Analyzer, 26.5 GHz	Agilent / HP	E4440A	C01179	02/16/13	02/16/14
EMI Test Receiver, 9kHz-7GHz	R&S	ESCI 7	1000741	07/13/13	07/13/14
Horn Antenna, 1GHz-18GHz	ETS Lindgren	3117	T345	02/19/13	02/19/14
Antenna, Horn, 18 GHz	EMCO	3115	C01218/1000614	01/17/14	01/17/15
Antenna, Horn, 26.5 GHz	ARA	MWH-1826/B	C00980	11/14/13	11/14/14
Antenna, Bilog, 30MHz-1 GHz	Sunol Sciences	JB1	C01171	02/13/13	02/13/14
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C00749	10/19/13	10/19/14
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00885	06/26/14	06/26/15
Low Pass Filter	Micro-Tronics	LPS17541	F00219	06/26/13	06/26/14
High Pass Filter	Micro-Tronics	HPS17542	F00222	06/26/13	06/26/14
High Pass Filter	Micro-Tronics	HPM17543	F00224	06/26/13	06/26/14
PreAmplifier, 1-26.5GHz	Agilent	8449B	F00167	03/23/13	03/23/14
Antenna, Horn, 26.5 GHz	ARA	MWH-1826/B	C00980	11/26/13	11/26/14

7. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

PROCEDURE

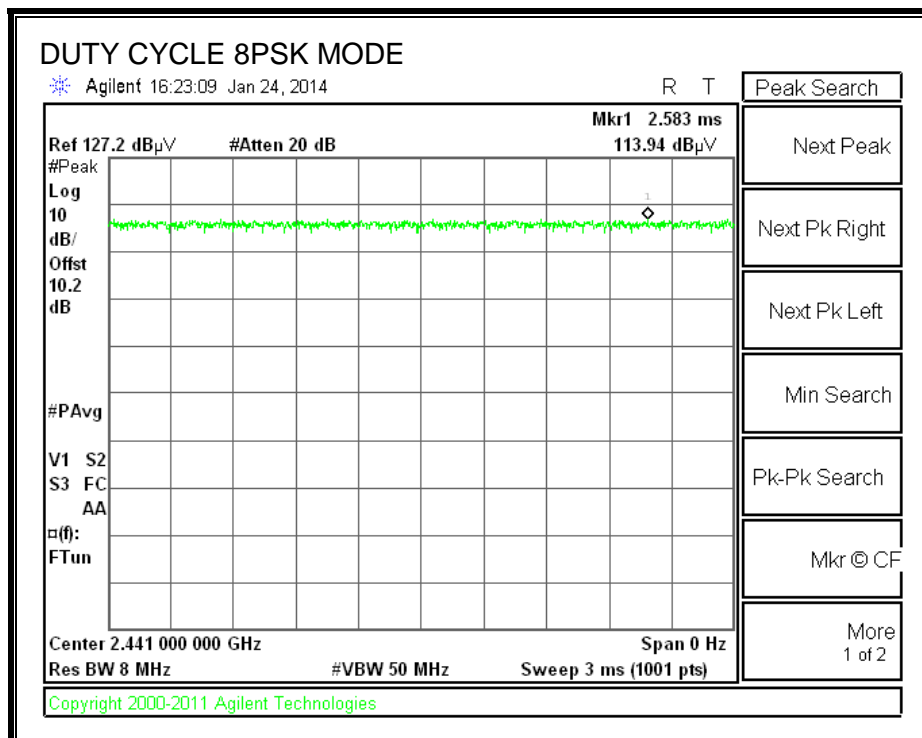
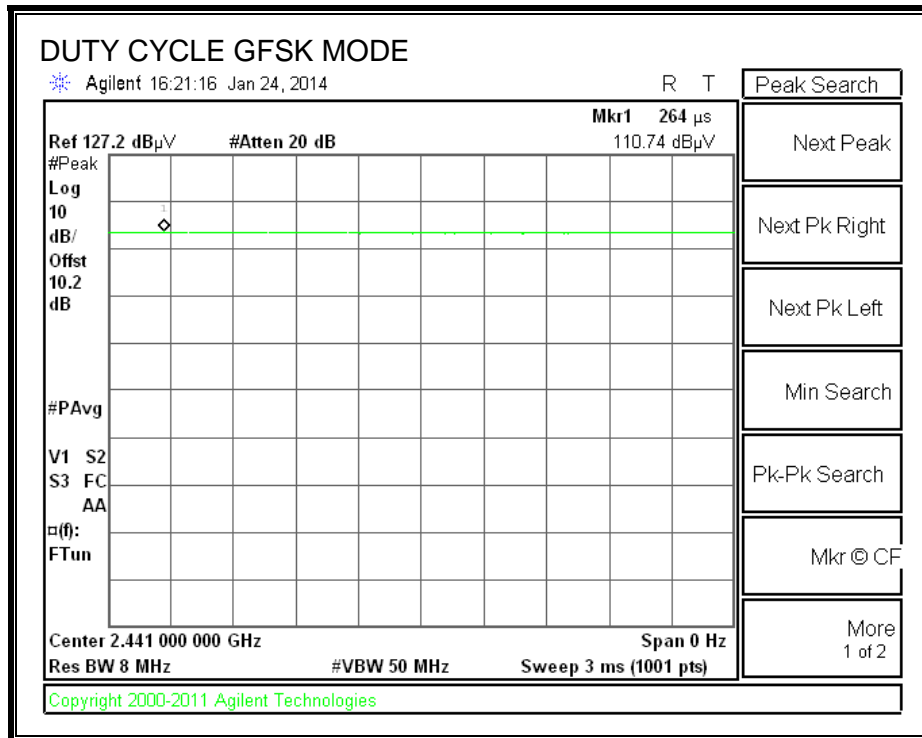
KDB 558074 Zero-Span Spectrum Analyzer Method.

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)
2.4 GHz band (Hopping OFF)						
Bluetooth GFSK	3.000	3.000	1.000	100.00%	0.00	0.010
Bluetooth 8PSK	3.000	3.000	1.000	100.00%	0.00	0.010

7.2. DUTY CYCLE PLOTS

HOPPING OFF



8. RADIATED TEST RESULTS

8.1. LIMITS AND PROCEDURE

LIMITS

FCC §15.205 and §15.209

IC RSS-210 Clause 2.6 (Transmitter)

IC RSS-GEN Clause 6 (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 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.

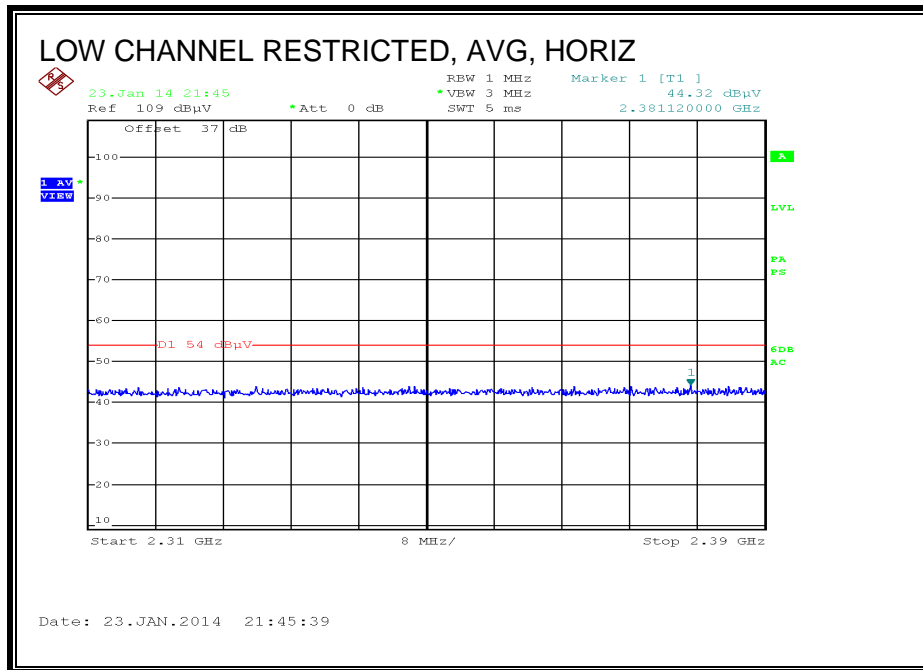
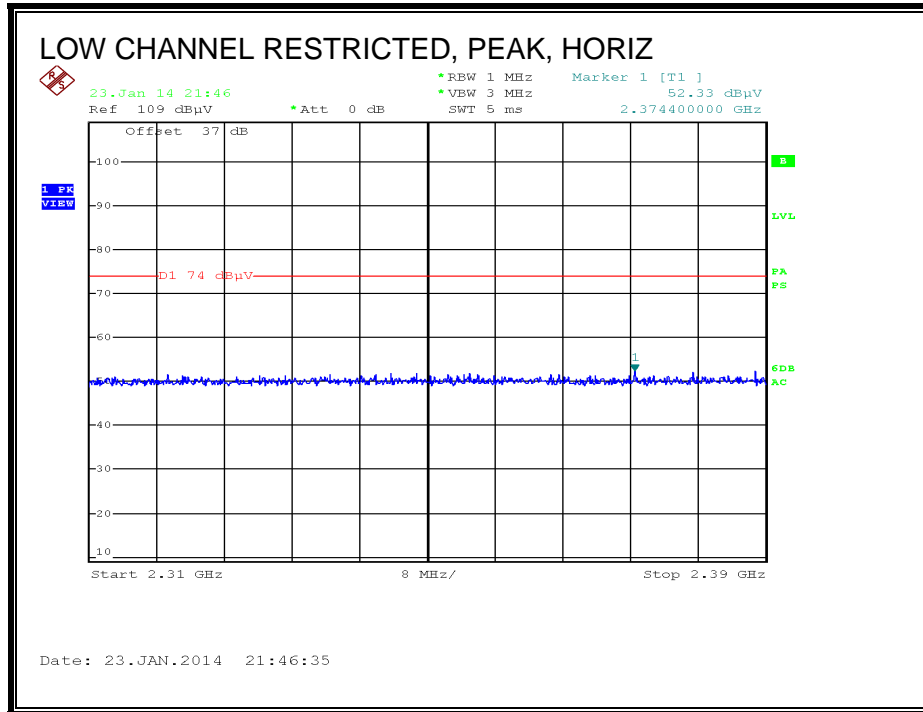
For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

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.

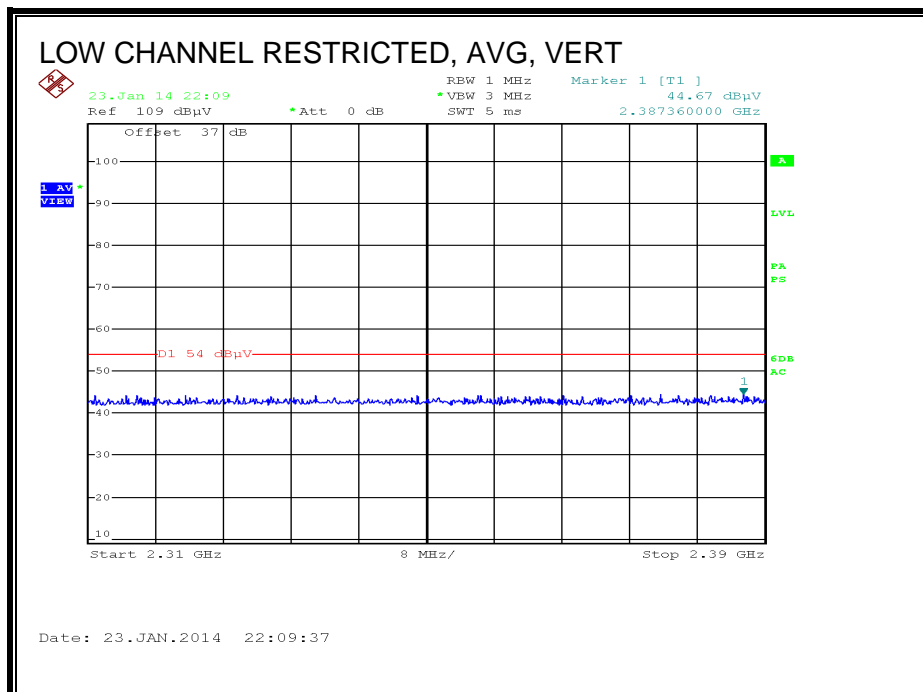
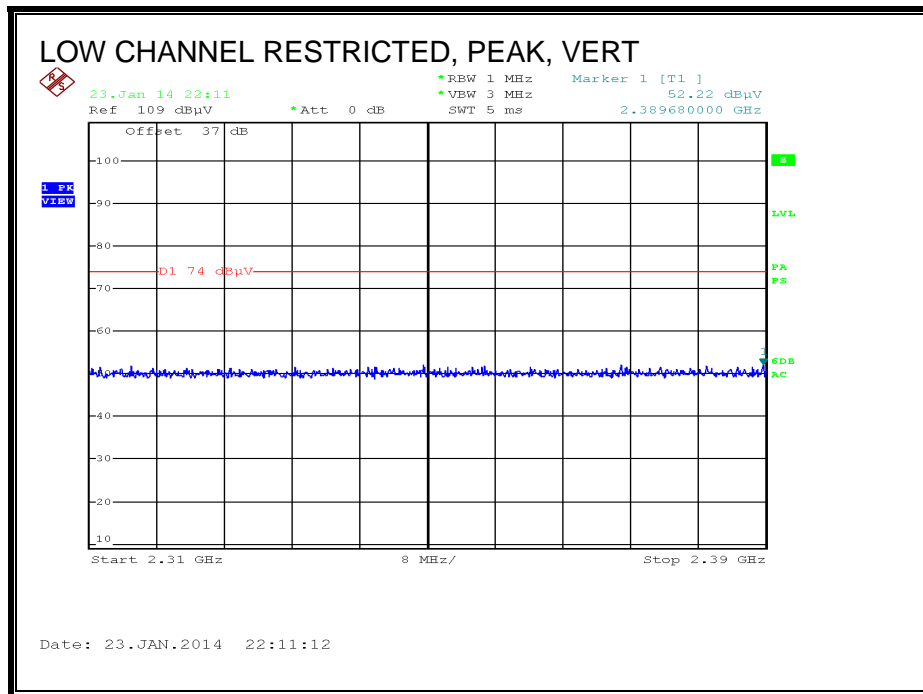
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized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

8.1.1. BASIC DATA RATE GFSK MODULATION

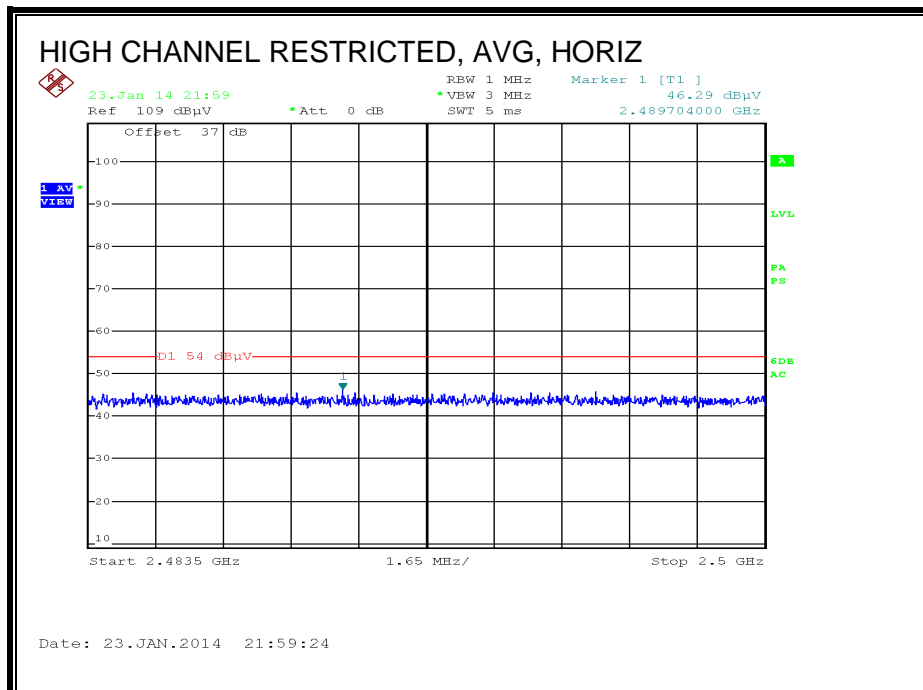
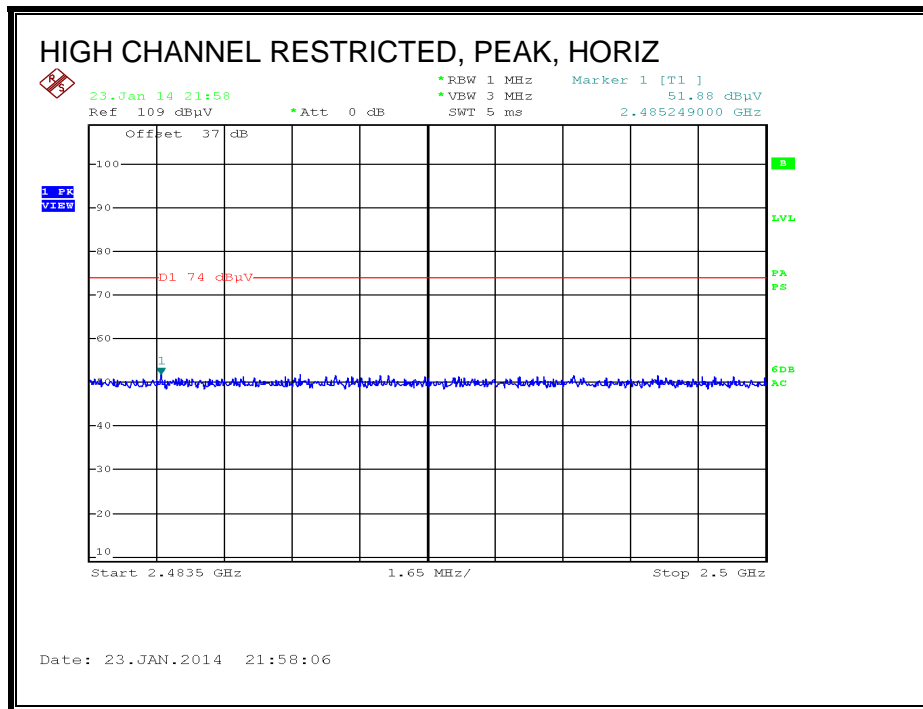
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



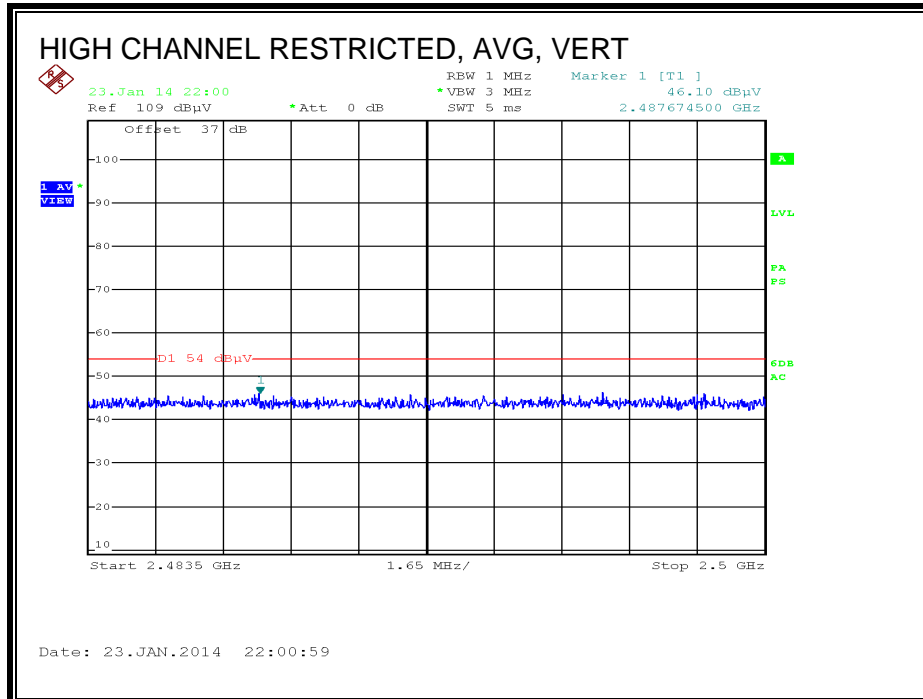
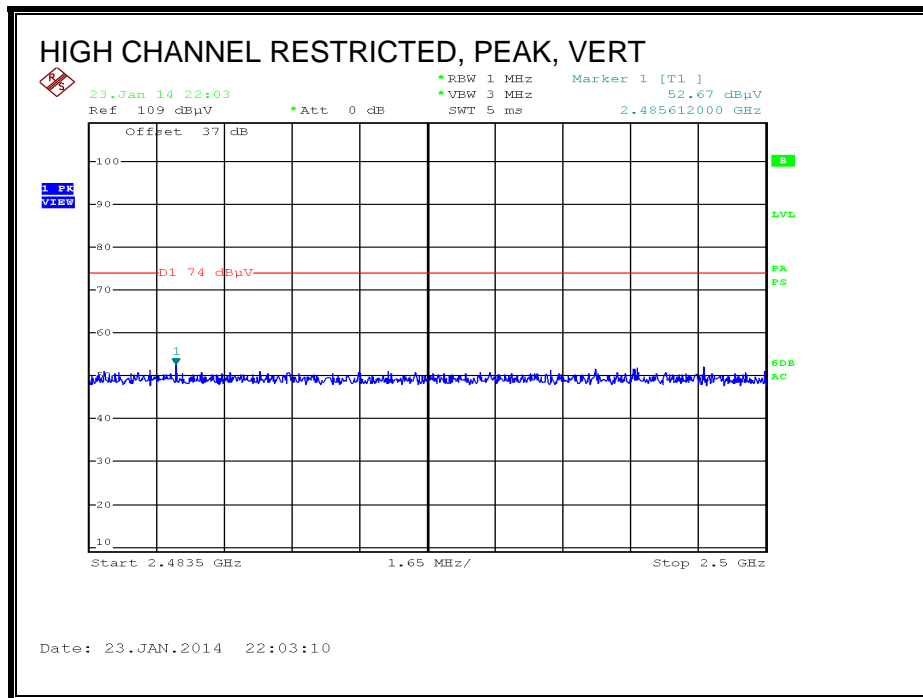
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



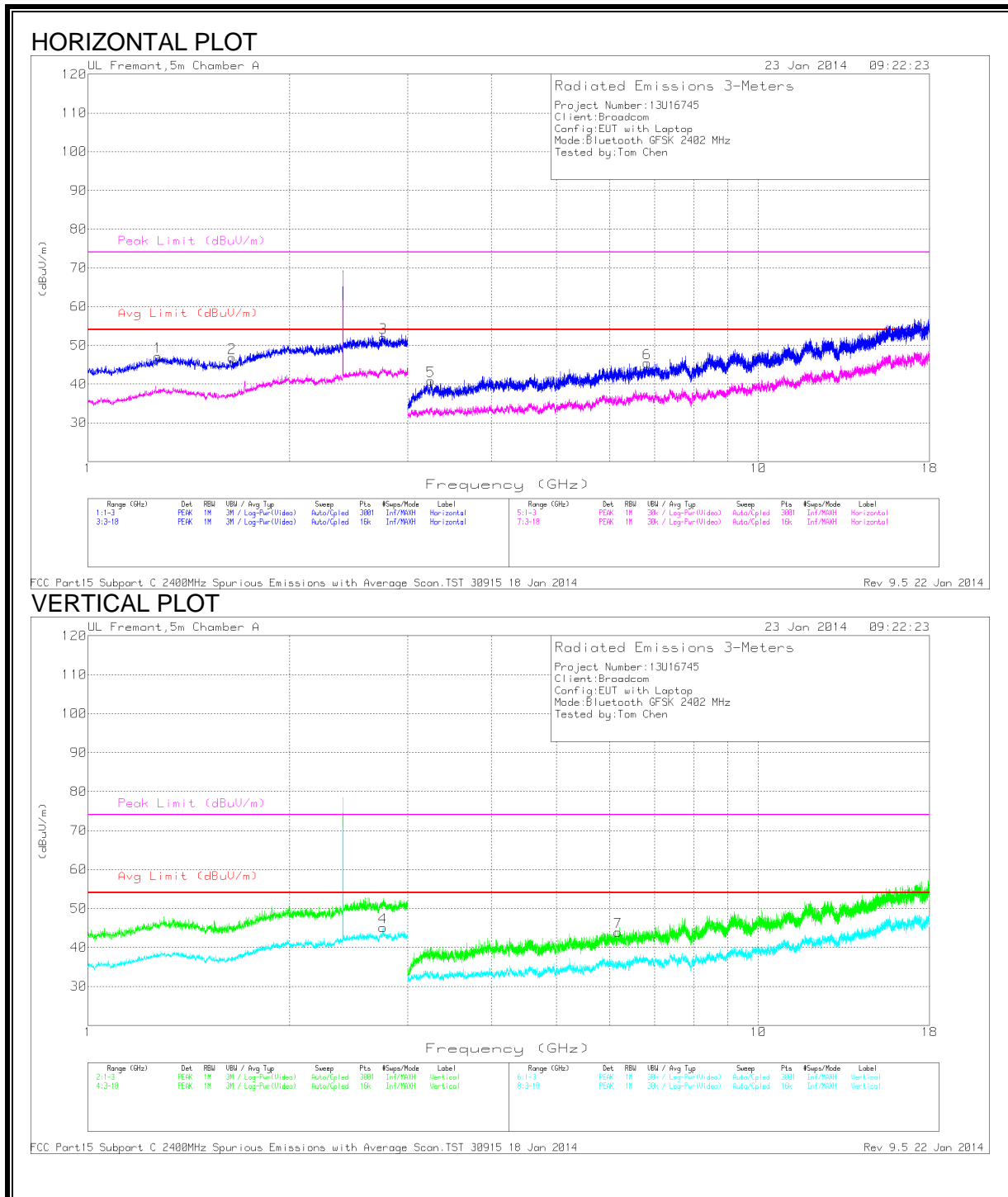
RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)



RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)



HARMONICS AND SPURIOUS EMISSIONS
LOW CHANNEL



Trace Markers

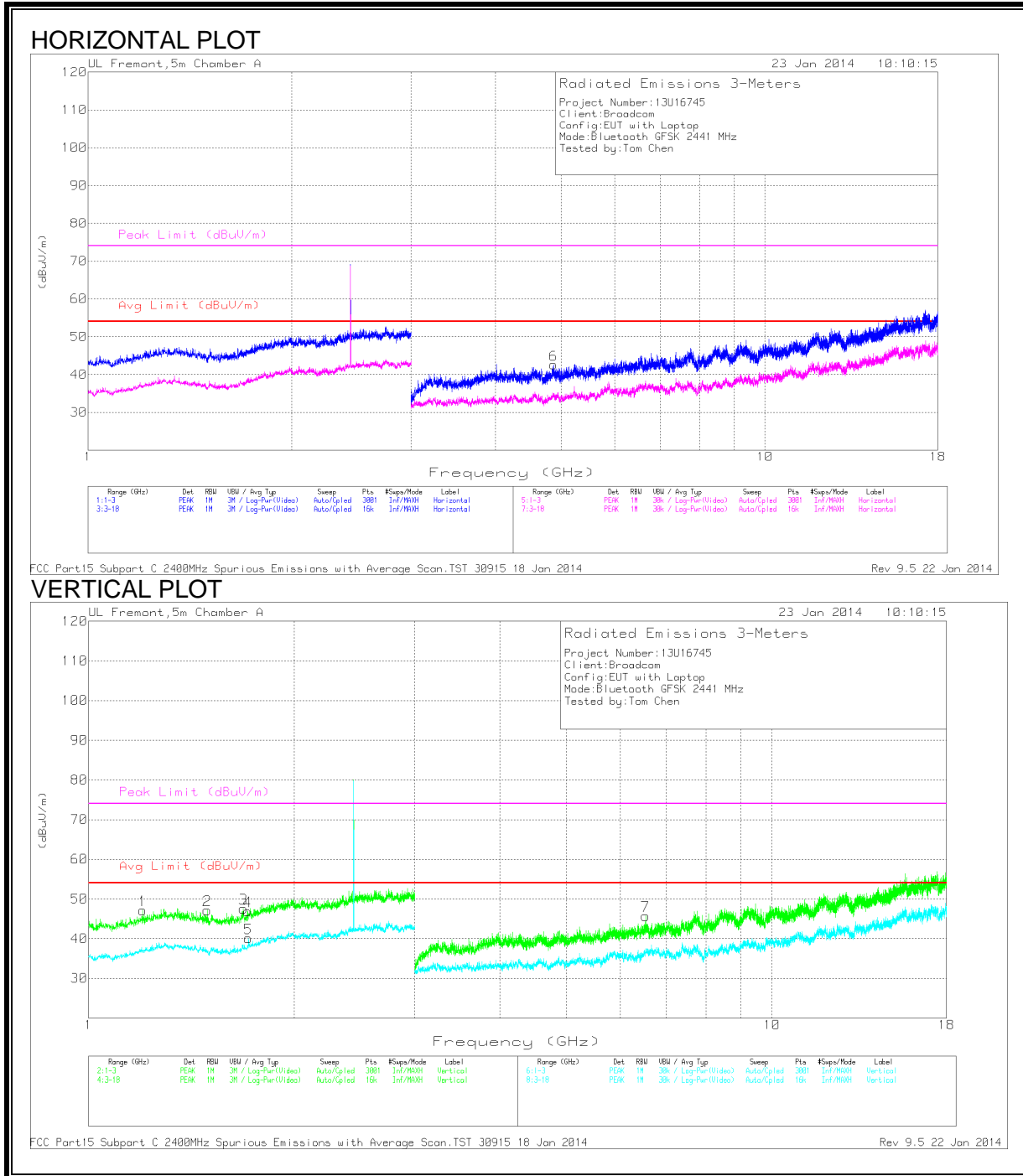
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T136 (dB/m)	Amp/Cbl/Flt r/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.272	43.96	PK	30.1	-27	47.06	54	-6.94	74	-26.94	0-360	200	H
4	* 2.755	34.84	Avg	32.6	-22.3	45.14	54	-8.86	-	-	0-360	101	V
3	* 2.757	41.78	PK	32.6	-22.4	51.98	-	-	74	-22.02	0-360	200	H
2	1.641	44.11	PK	28.7	-26	46.81	54	-7.19	74	-27.19	0-360	200	H
5	3.247	39.01	PK	33.3	-31.5	40.81	54	-13.19	74	-33.19	0-360	101	H
7	6.179	36.85	PK	35.4	-28.3	43.95	54	-10.05	74	-30.05	0-360	200	V
6	6.822	38.13	PK	35.4	-28.1	45.43	54	-8.57	74	-28.57	0-360	101	H

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

PK - Peak detector

Avg - Video bandwidth < Resolution bandwidth

MID CHANNEL



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T136 (dB/m)	Amp/Cb/F ltr/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	* 1.199	45.16	PK	29.5	-27.5	47.16	54	-6.84	74	-26.84	0-360	101	V
2	* 1.491	44.86	PK	29	-26.7	47.16	54	-6.84	74	-26.84	0-360	101	V
3	* 1.685	43.99	PK	29.2	-25.6	47.59	54	-6.41	74	-26.41	0-360	201	V
4	* 1.71	43.1	PK	29.5	-25.7	46.9	-	-	74	-27.1	0-360	101	V
6	* 4.873	36.93	PK	34	-28.3	42.63	54	-11.37	74	-31.37	0-360	200	H
5	*1.71	36.21	Avg	29.5	-25.6	40.11	54	-13.89	-	-	0-360	101	V
7	**6.532	37.33	PK	35.5	-27.1	45.73	-	-	-	-	0-360	201	V

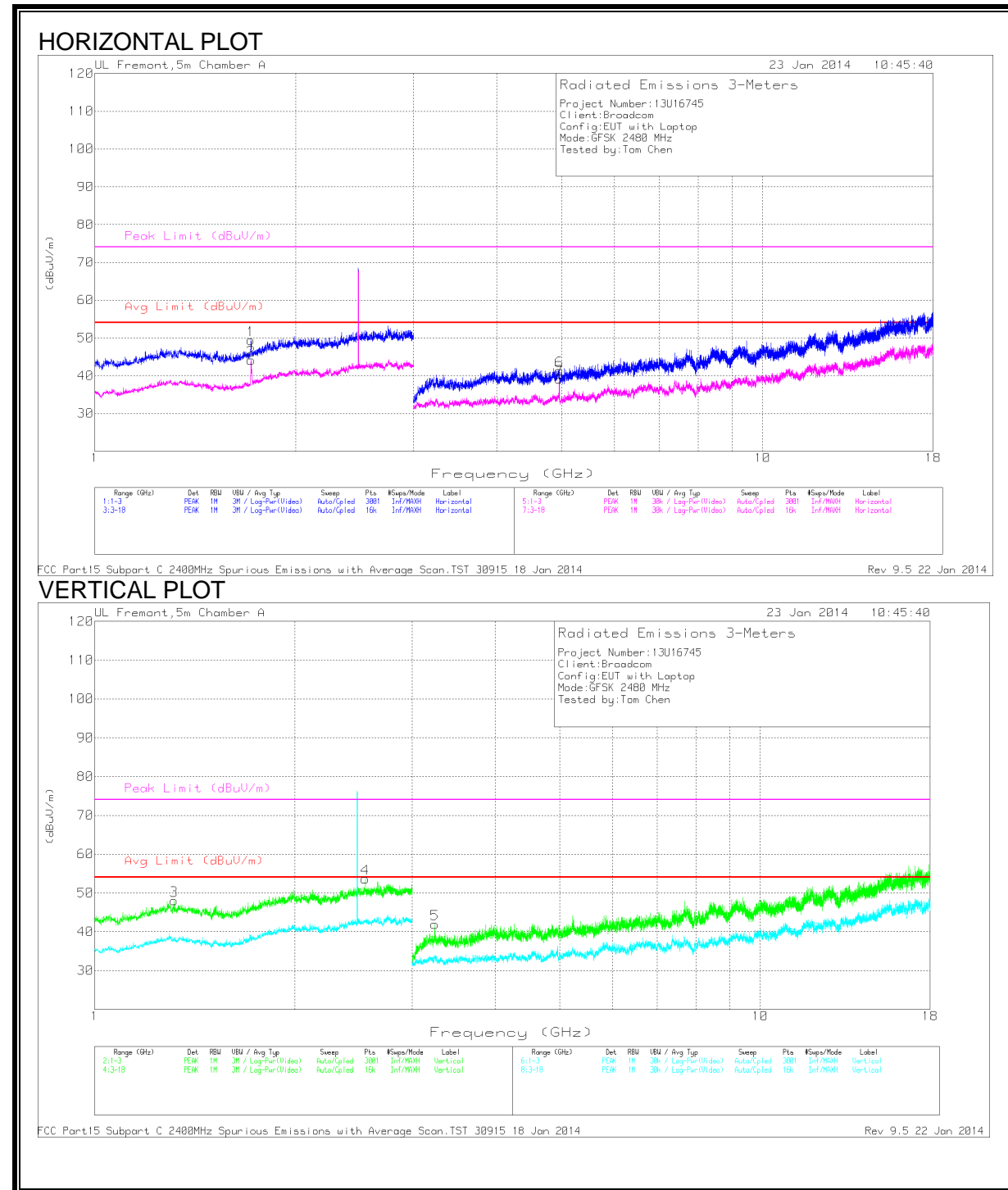
* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band

** - indicates frequency in non-restricted band. Compliance is shown in conducted Out of Band Emissions testing.

PK - Peak detector

Avg - Video bandwidth < Resolution bandwidth

HIGH CHANNEL



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T136 (dB/m)	Amp/Cb/F ltr/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	* 1.317	44.52	PK	30.2	-26.7	48.02	-	-	74	-25.98	0-360	200	V
6	* 4.962	37.22	PK	33.9	-29.8	41.32	-	-	74	-32.68	0-360	101	H
7	* 4.96	34.94	Avg	33.9	-29.7	39.14	54	-14.86	-	-	0-360	200	H
1	**1.712	45.52	PK	29.5	-25.6	49.42	-	-	-	-	0-360	101	H
2	**1.714	40.12	Avg	29.6	-25.6	44.12	-	-	-	-	0-360	101	H
4	**2.551	44.06	PK	32.7	-23.1	53.66	-	-	-	-	0-360	101	V
5	**3.244	40.06	PK	33.3	-31.4	41.96	-	-	-	-	0-360	101	V

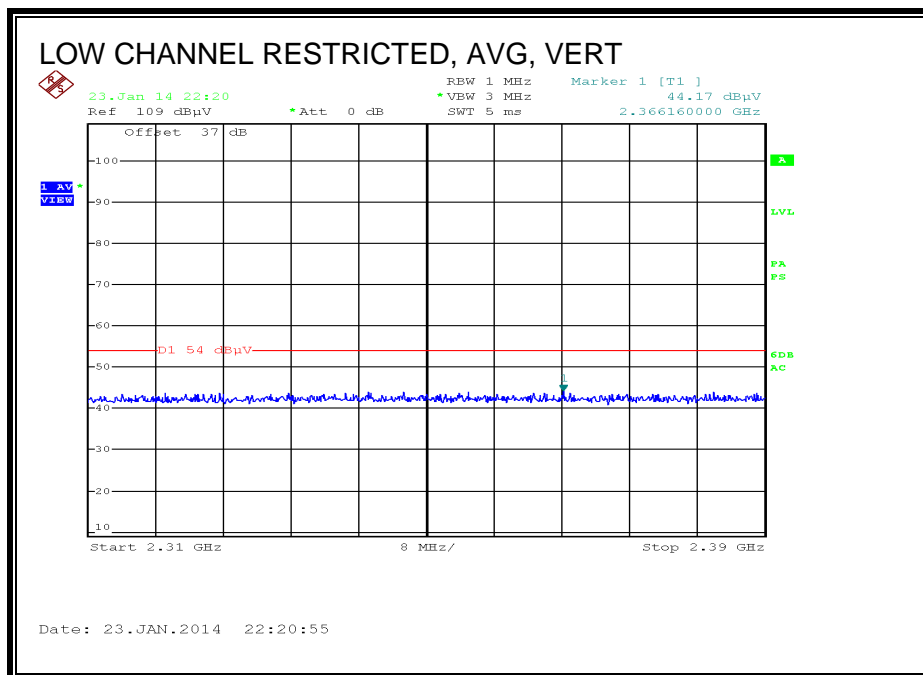
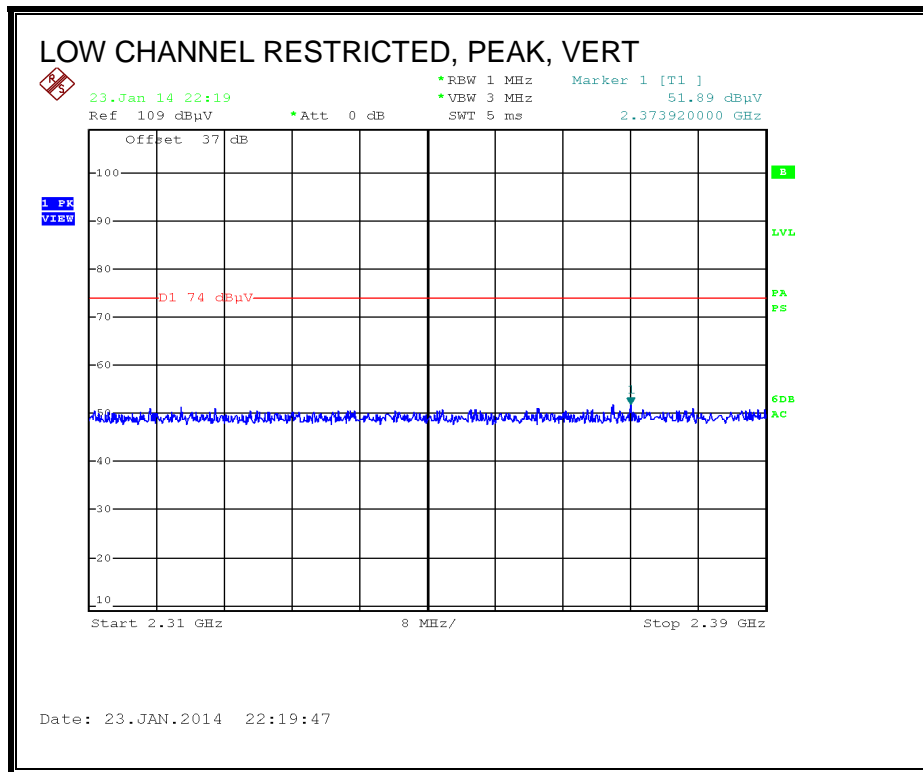
* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band

** - indicates frequency in non-restricted band. Compliance is shown in conducted Out of Band Emissions testing.

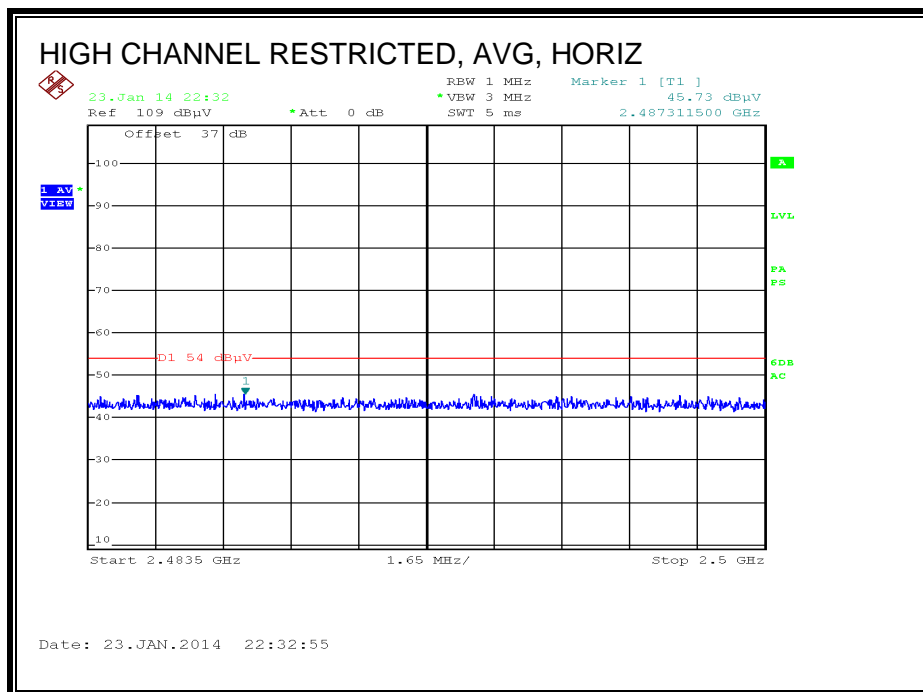
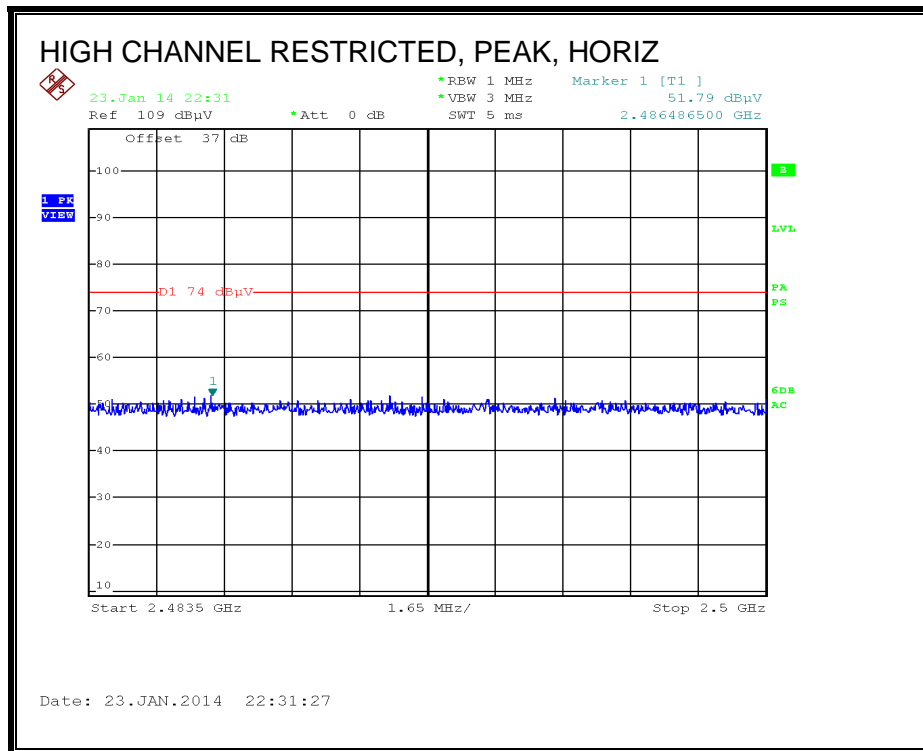
PK - Peak detector

Avg - Video bandwidth < Resolution bandwidth

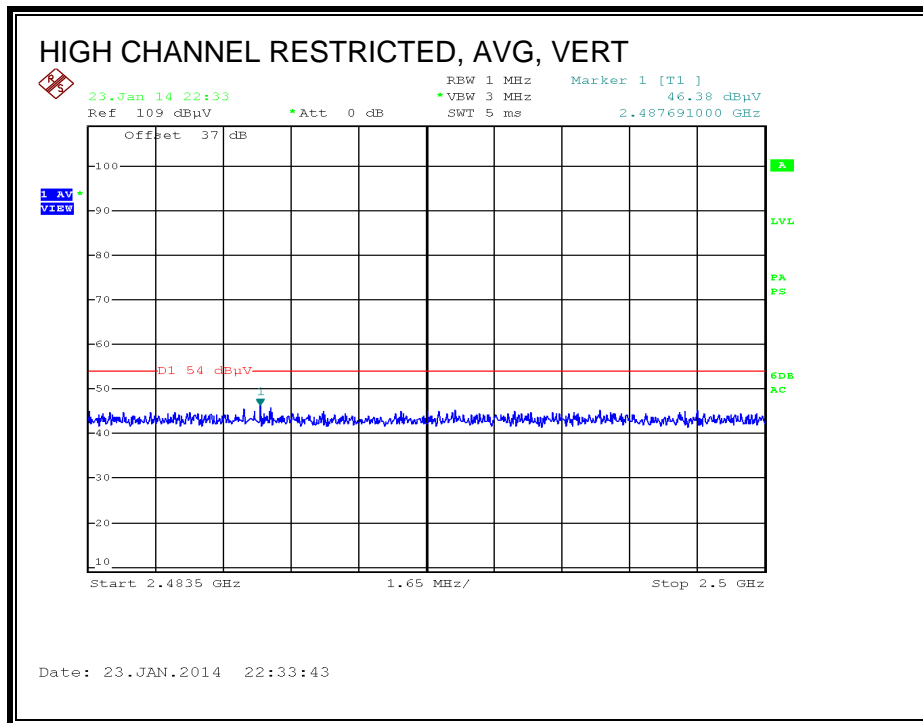
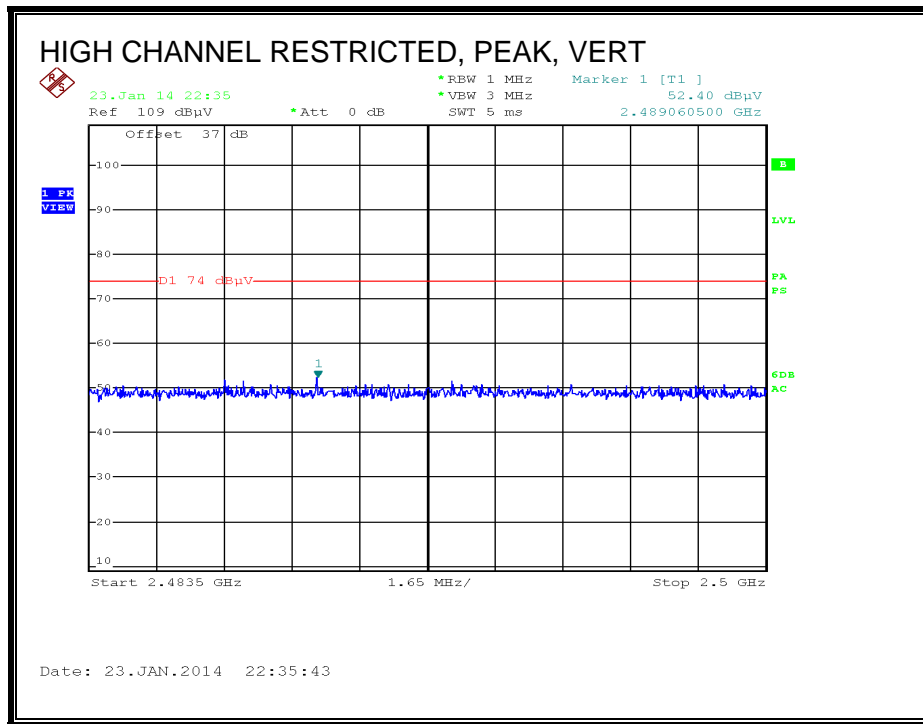
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



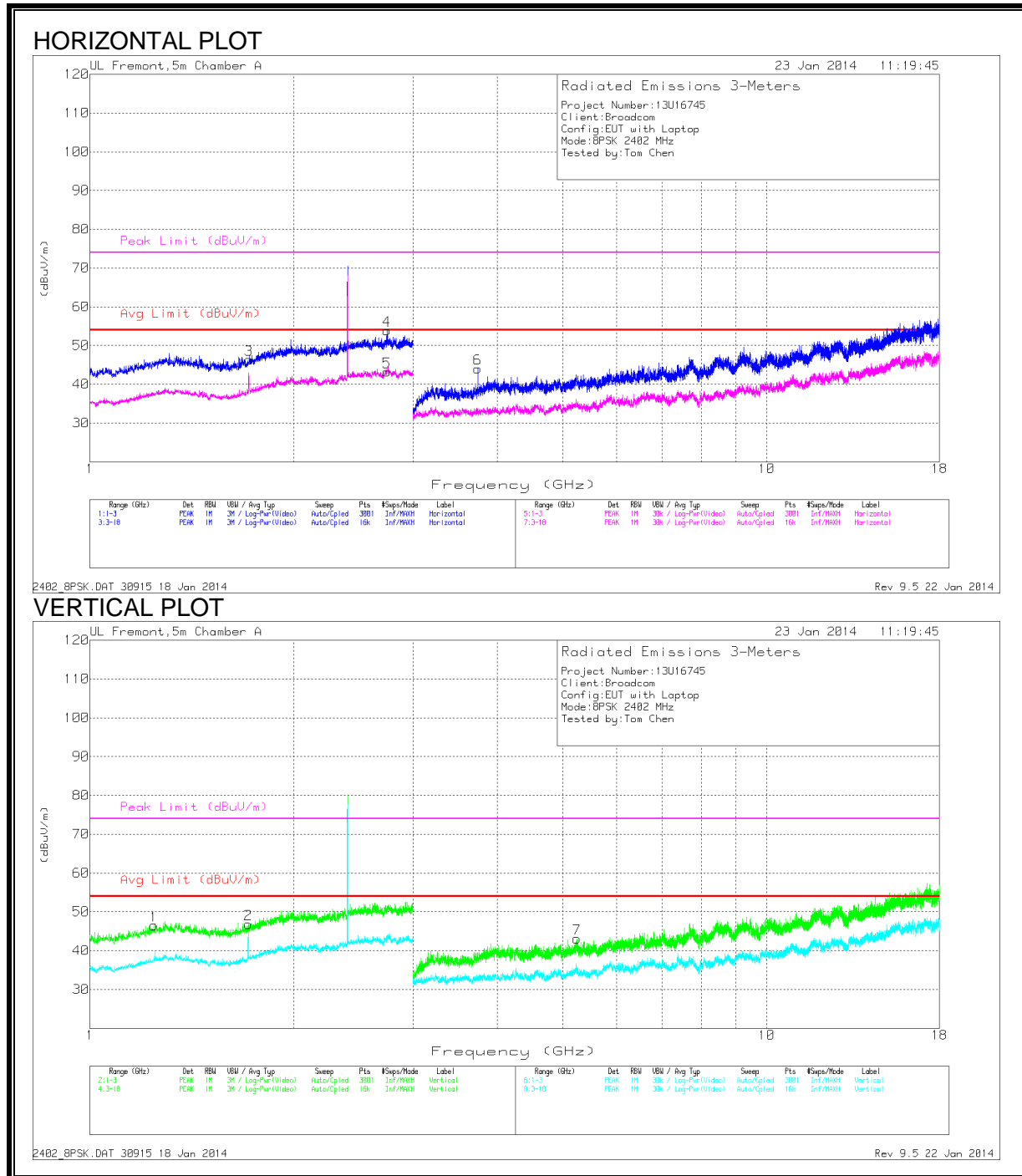
RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)



RESTRICTED BANDEGE (HIGH CHANNEL, VERTICAL)



HARMONICS AND SPURIOUS EMISSIONS
LOW CHANNEL



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T136 (dB/m)	Amp/Cb/F ltr/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	* 2.746	43.86	PK	32.7	-22.7	53.86	-	-	74	-20.14	0-360	200	H
1	* 1.243	43.7	PK	29.8	-27	46.5	54	-7.5	74	-27.5	0-360	201	V
6	* 3.741	41.1	PK	33.4	-30.5	44	54	-10	74	-30	0-360	101	H
5	* 2.746	33.18	Avg	32.7	-22.7	43.18	54	-10.82	-	-	0-360	200	H
2	**1.713	42.93	PK	29.5	-25.6	46.83	54	-7.17	74	-27.17	0-360	201	V
3	**1.717	42.31	PK	29.6	-25.6	46.31	54	-7.69	74	-27.69	0-360	200	H
7	**5.243	37.6	PK	34.2	-28.7	43.1	54	-10.9	74	-30.9	0-360	101	V

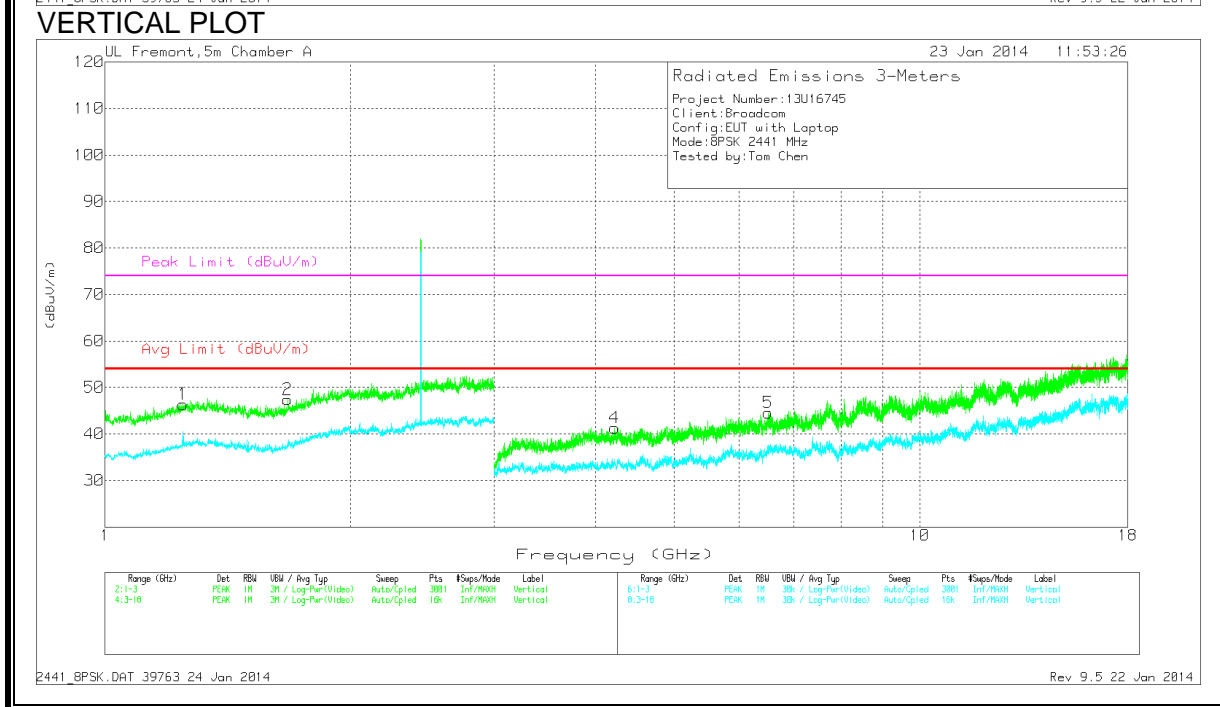
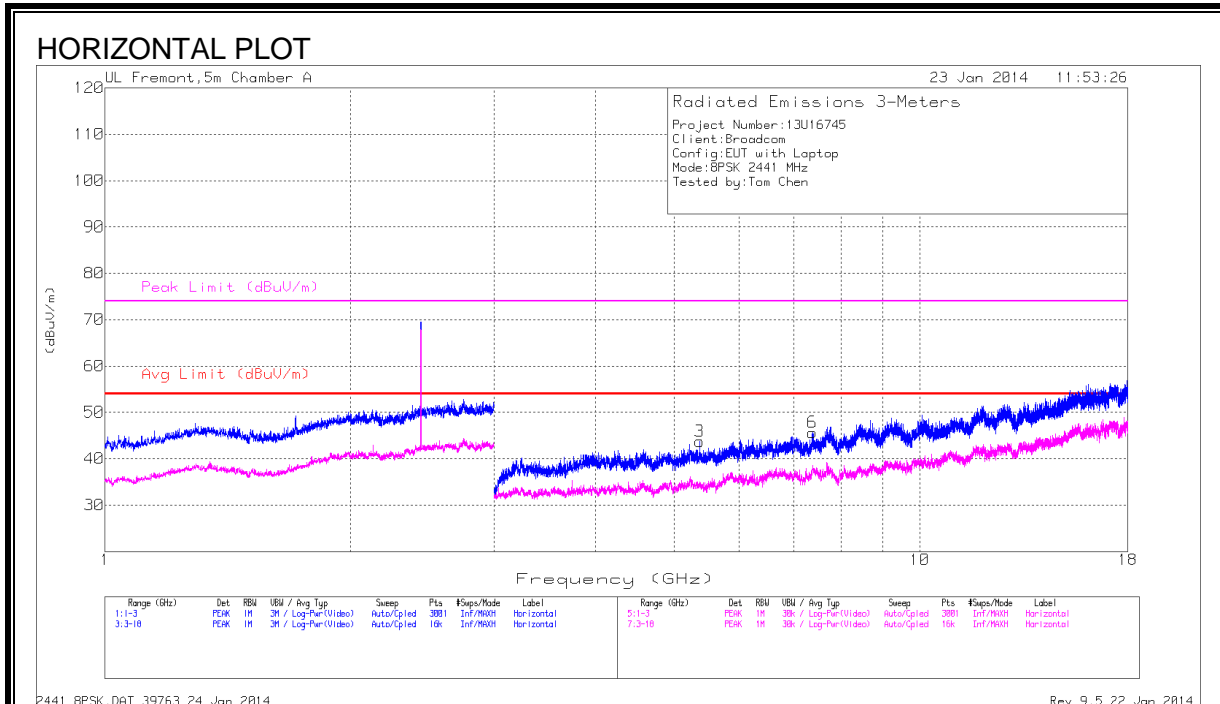
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** - indicates frequency in non-restricted band. Compliance is shown in conducted Out of Band Emissions testing.

PK - Peak detector

Avg - Video bandwidth < Resolution bandwidth

MID CHANNEL



Trace Markers

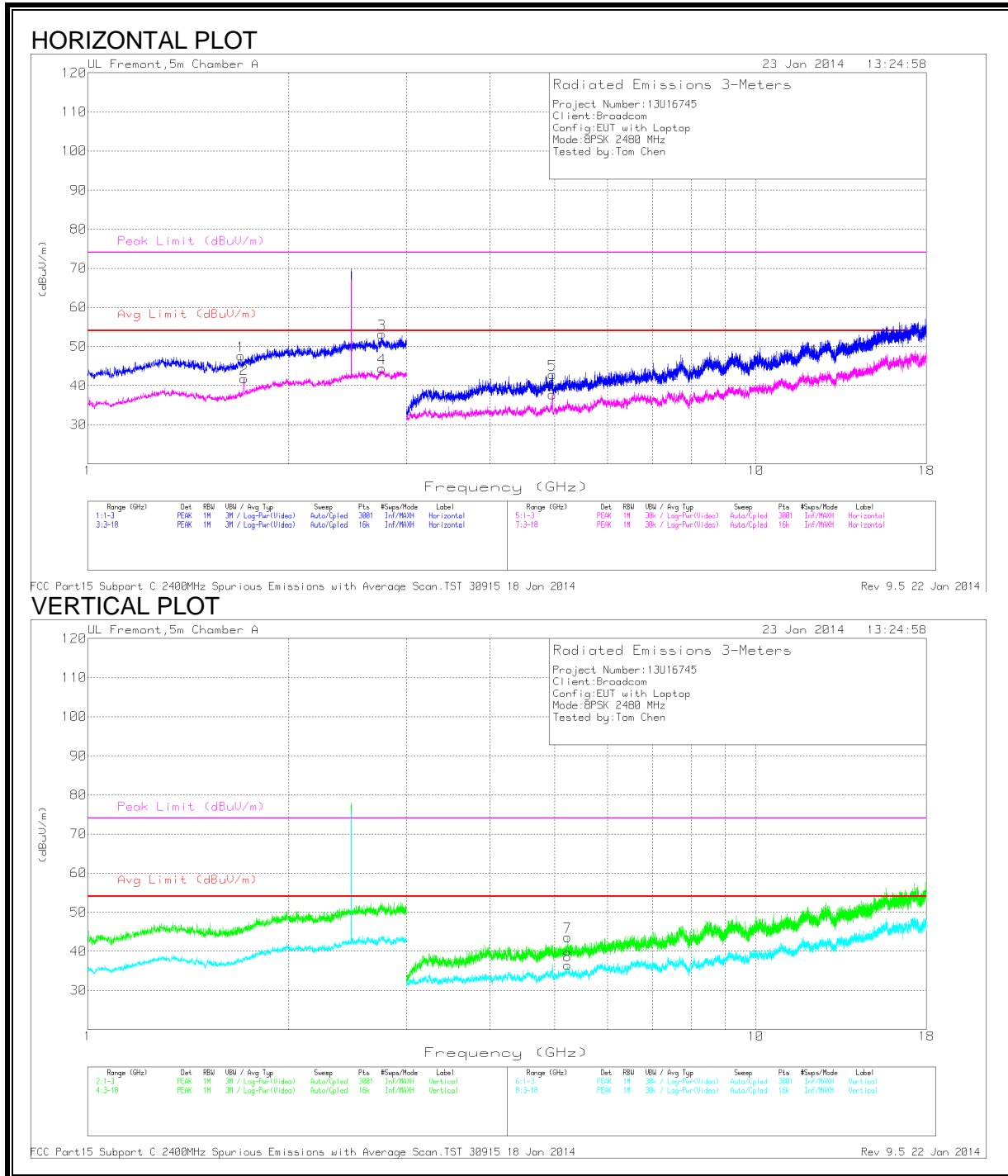
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T136 (dB/m)	Amp/Cbl/F ltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.247	43.37	PK	29.9	-26.9	46.37	54	-7.63	74	-27.63	0-360	201	V
2	* 1.675	43.98	PK	29.1	-25.7	47.38	54	-6.62	74	-26.62	0-360	201	V
4	* 4.22	37.13	PK	33.5	-29.3	41.33	54	-12.67	74	-32.67	0-360	200	V
3	* 5.368	39.01	PK	34.4	-29.7	43.71	54	-10.29	74	-30.29	0-360	101	H
6	* 7.383	34.52	PK	35.4	-24.3	45.62	54	-8.38	74	-28.38	0-360	101	H
5	**6.514	36.61	PK	35.5	-27.6	44.51	54	-9.49	74	-29.49	0-360	200	V

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

** - indicates frequency in non-restricted band. Compliance is shown in conducted Out of Band Emissions testing.

PK - Peak detector

HIGH CHANNEL



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T136 (dB/m)	Amp/Cb/F ltr/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	* 1.695	44.27	PK	29.3	-25.9	47.67	-	-	74	-26.33	0-360	101	H
3	* 2.755	42.78	PK	32.6	-22.2	53.18	-	-	74	-20.82	0-360	101	H
5	* 4.96	38.65	PK	33.9	-29.7	42.85	-	-	74	-31.15	0-360	200	H
4	* 2.756	34.14	Avg	32.6	-22.3	44.44	54	-9.56	-	-	0-360	200	H
6	* 4.959	33.54	Avg	33.9	-29.7	37.74	54	-16.26	-	-	0-360	200	H
2	1.714	37.77	Avg	29.6	-25.6	41.77	54	-12.23	-	-	0-360	200	H
7	5.229	37	PK	34.2	-27.6	43.6	-	-	74	-30.4	0-360	101	V
8	5.229	29.84	Avg	34.2	-27.6	36.44	54	-17.56	-	-	0-360	101	V

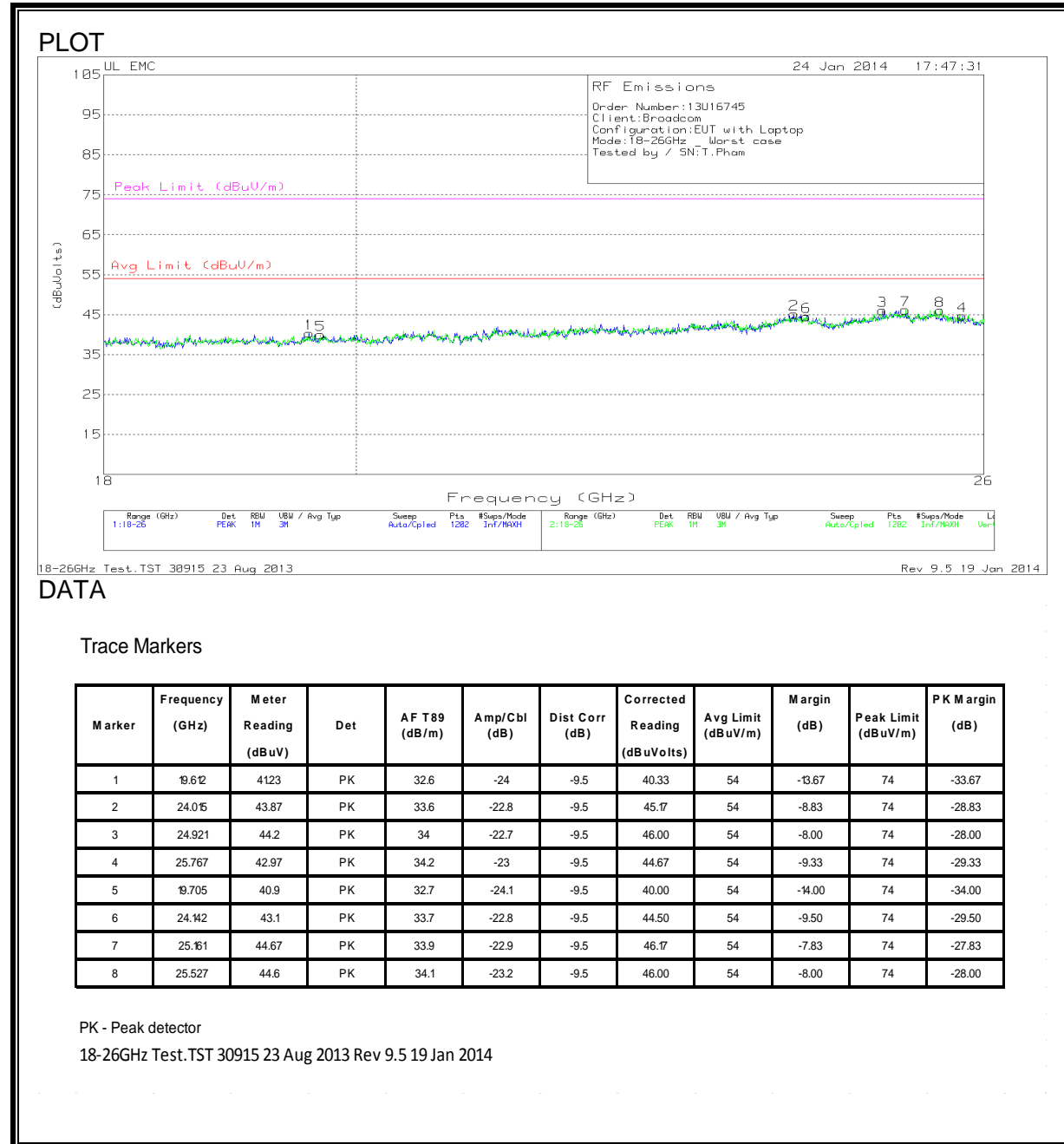
* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band

PK - Peak detector

Avg - Video bandwidth < Resolution bandwidth

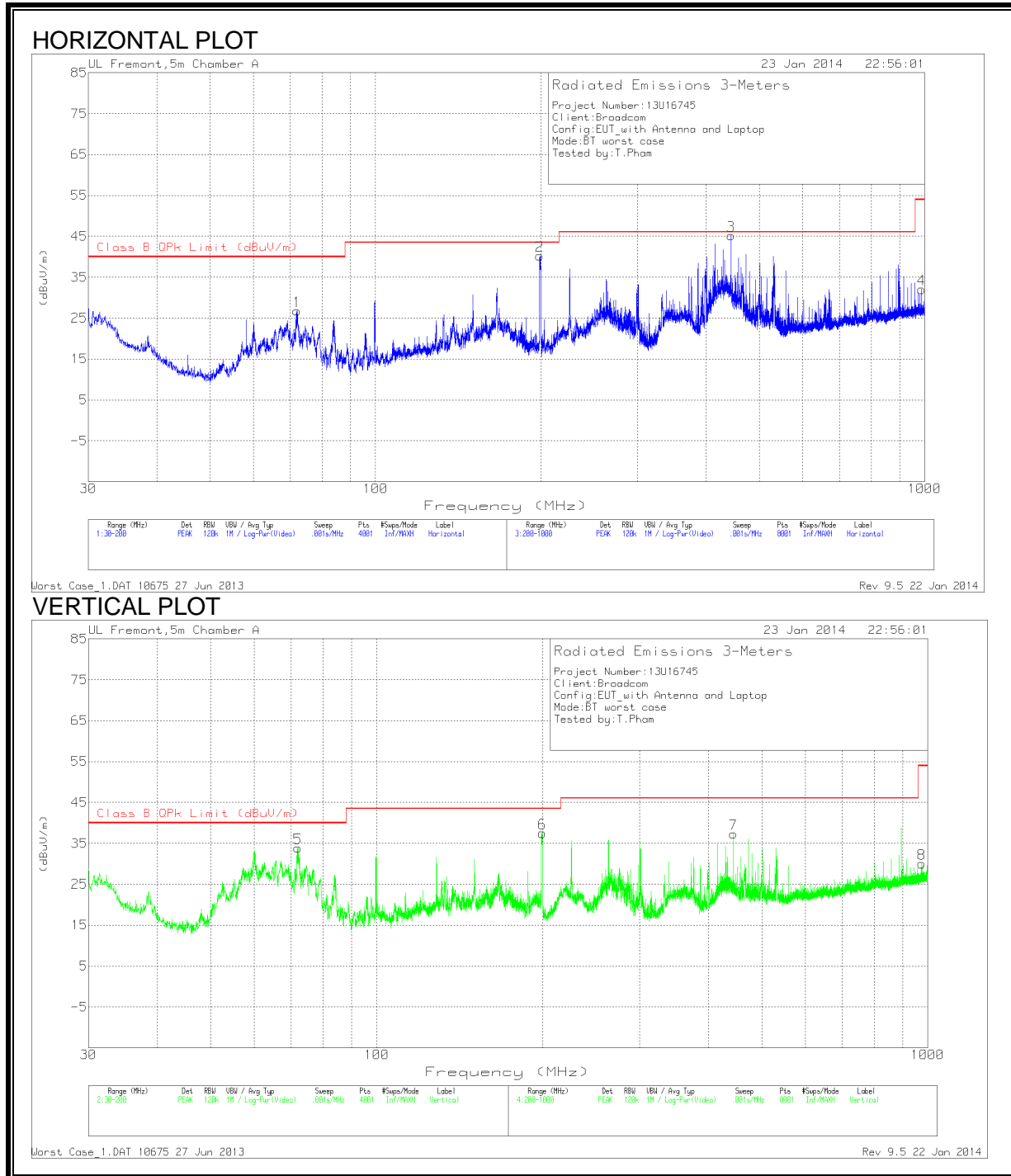
WORST-CASE 18GHz -26GHz

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



8.2. WORST-CASE BELOW 1 GHz

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



Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF T477 (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	Class B QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	71.99	45.6	PK	8.3	-27.1	26.8	40	-13.2	0-360	301	H
5	71.99	52.67	PK	8.3	-27.1	33.87	40	-6.13	0-360	101	V
2	199.15	54.08	PK	12.3	-26.1	40.28	43.52	-3.24	0-360	201	H
6	199.7875	51.32	PK	12.3	-26.1	37.52	43.52	-6	0-360	101	V
3	443.9	53.08	PK	16.9	-24.8	45.18	46.02	-84	0-360	101	H
7	443.9	45.24	PK	16.9	-24.8	37.34	46.02	-8.68	0-360	201	V
8	975.5	29.74	PK	22.8	-22.5	30.04	53.97	-23.93	0-360	201	V
4	987.9	31.87	PK	22.6	-22.4	32.07	53.97	-21.9	0-360	101	H

PK - Peak detector

Radiated Emissions

Frequency (MHz)	Meter Reading (dBuV)	Det	AF T477 (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	Class B QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
199.1446	52.25	QP	12.3	-26.1	38.45	43.52	-5.07	280	172	H
199.1794	51.74	PK	12.3	-26.1	37.94	43.52	-5.58	167	169	H
443.8553	32.83	QP	16.9	-24.8	24.93	46.02	-21.09	280	172	H
443.8553	50.29	QP	16.9	-24.8	42.39	46.02	-3.63	9	103	H
443.8559	47.79	PK	16.9	-24.8	39.89	46.02	-6.13	114	104	H

PK - Peak detector

QP - Quasi-Peak detector