FCC 47 CFR PART 15 SUBPART C
INDUSTRY CANADA RSS-210 ISSUE 9 Annex B.10

BLUETOOTH LOW ENERGY
C2PC CERTIFICATION TEST REPORT

FOR

FAN SPEED CONTROL SWITCH WITH BLE

MODEL NUMBER: DDF01

FCC ID: QGH-DDMX1
IC: 2473A-DDMX1

REPORT NUMBER: R11412386-E3

ISSUE DATE: 2016-11-23

Prepared for
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Revision History

Ver.	Issue Date	Revisions	Revised By
1	2016-11-23	Initial Issue	Richard Jankovics

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1. DATA REUSE

1.1. INTRODUCTION

The 15.249 antenna port conducted and high/low channel radiated spurious results for DDF01 are represented by Leviton device DDMX1 test report R11081167A (FCC ID: QGH-DDMX1, IC: 2473A-DDMX1). This report for DDF01 contains radiated field strength, duty cycle, high/low channel bandedge, and middle channel spurious measurements.

Leviton takes full responsibility that the data as referenced in report R11081167A (FCC ID: QGH-DDMX1, IC: 2473A-DDMX1) represent compliance for this model.

1.2. DIFFERENCES

Leviton devices DDMX1 and DDF01 have similar logic/RF circuit boards, with the same BLE IC and antenna (PCB trace); with the mains board and function being unique to the application (standard light dimmer vs fan speed control). Therefore, DDMX1 antenna port test results are used to represent how DDF01 operates from a conducted perspective. Fundamental radiated field strength measurements were made on DDF01 to ensure that the fundamental and radiated emissions are aligned between the DDF01 and DDMX1 EUT's.

1.3. TESTING PERFORMED

Testing performed under this Report (R11412386-E3) are radiated field strength, duty cycle, high/low channel bandedge, and middle channel spurious measurements. All other data is referenced to R11081167A (FCC ID: QGH-DDMX1, IC: 2473A-DDMX1).

1.4. REFERENCE DETAIL SECTION

Equipment Class	Reference FCC ID	Type Grant	Grant Date	Report Title
DTS	FCC ID: QGH-DDMX1, IC: 2473A-DDMX1	New	2016-02-24	R11081167A

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2. ATTESTATION OF TEST RESULTS

COMPANY NAME: LEVITON MFG CO INC
201 N SERVICE RD
MELVILLE, NY, 11747-3138, USA

EUT DESCRIPTION: Fan Speed Control Switch with BLE

MODEL: DDF01

SERIAL NUMBER: 22

DATE TESTED: 2016-09-20 – 2016-09-26

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C	Pass
INDUSTRY (ISED) CANADA RSS-210 Issue 9 Annex B.10	Pass
INDUSTRY (ISED) CANADA RSS-GEN Issue 4	Pass

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

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

Approved & Released
For UL LLC By:

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EMC Program Manager
UL – Consumer Technology Division

Prepared By:

Richard Jankovics
WiSE Engineer
UL – Consumer Technology Division

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3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10-2013, FCC CFR 47 Part 2, FCC CFR 47 Part 15, RSS-GEN Issue 4, and RSS-210 Issue 9.

4. FACILITIES AND ACCREDITATION

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

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

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

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

UL LLC (RTP) is accredited by NVLAP, Laboratory Code 200246-0. The full scope of accreditation can be viewed at https://www-s.nist.gov/niws/index.cfm?event=directory.search.

5. CALIBRATION AND UNCERTAINTY

5.1. 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.

5.2. 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

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5.3. MEASUREMENT UNCERTAINTY

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

PARAMETER	UNCERTAINTY
Total RF power, conducted	± 0.45 dB
RF power density, conducted	± 1.5 dB
Spurious emissions, conducted	± 2.94 dB
All emissions, radiated up to 40 GHz	± 5.36 dB
Temperature	± 0.07°C
Humidity	± 2.26% RH
DC and low frequency voltages	± 1.27%
Conducted Emissions (0.150-30MHz)	± 3.65dB

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

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6. EQUIPMENT UNDER TEST

6.1. DESCRIPTION OF EUT

The EUT is an Fan Speed Control Switch with BLE.

The radio module is manufactured by TI.

6.2. MAXIMUM OUTPUT E-FIELD STRENGTH

The transmitter has a maximum output average E-field as follows:

Frequency Range (MHz)	Mode	Output Avg E-field Strength (dBuV/m)
2402 - 2480	Tx	88.02

6.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an integrated trace antenna, with a maximum gain of 5.3 dBi.

6.4. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was TI HostTestRelease v31449.

The test utility software used during testing was Realterm 2.0.0.70.

6.5. WORST-CASE CONFIGURATION AND MODE

The EUT only operates with in single mode and single orientation (as wall mounted) and it was tested as such.

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6.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
Laptop	Lenovo	T450	PC-0A2UQS	PD97265NGU
Serial to USB converter	FTDI	TTL-232R-3V3	NA	NA
Laptop and Serieal to USB converter only used for programming EUT in test mode. Not connected during measurements.				

I/O CABLES

I/O Cable List						
Cable No	**Port**	**# of identical ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	AC	1	Wired to EUT leads	3 wire AC	1.8	None
2	I/O	1	pin connected to EUT I/O port on PCB	Serial to USB	1.8	Only used for Programming. Not on final product.

TEST SETUP

The EUT is a fan speed control switch with a Bluetooth radio. The laptop was connected to the EUT with a Serial to USB converter cable, a script was sent to the EUT to place into a constant transmit test mode, and the cable and laptop was removed for testing.

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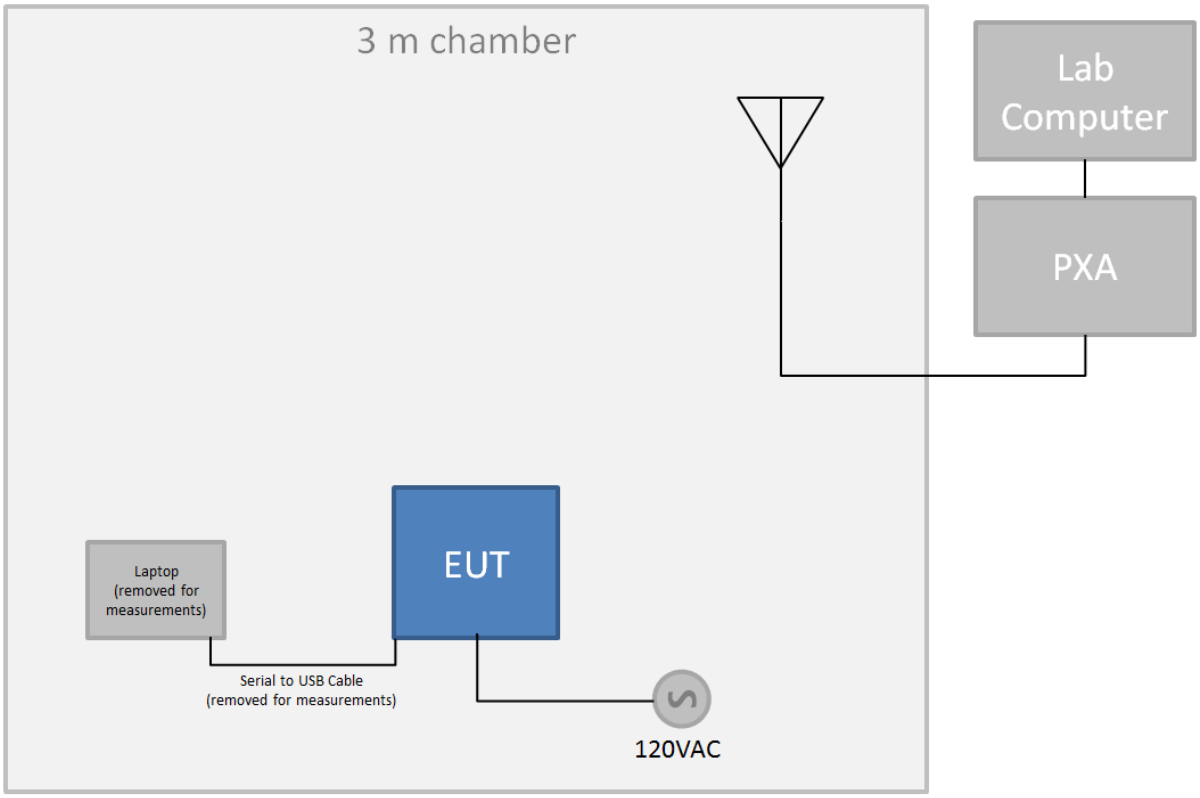
SETUP DIAGRAM FOR TESTS



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7. TEST AND MEASUREMENT EQUIPMENT

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

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

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	30-1000 MHz				
AT0074	Hybrid Broadband Antenna	Sunol Sciences Corp.	JB3	2016-06-07	2017-06-30
	1-18 GHz				
AT0069	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2016-03-07	2017-03-31
	18-26 GHz				
AT0076	Horn Antenna, 18-26.5GHz	ARA	MWH-1826/B	2016-09-06	2017-09-06
	Gain-Loss Chains				
S-SAC02	Gain-loss string: 30-1000MHz	Various	Various	2016-06-26	2017-06-30
S-SAC03	Gain-loss string: 1-18GHz	Various	Various	2016-08-28	2017-08-28
S-SAC04	Gain-loss string: 18-40GHz	Various	Various	2016-02-29	2017-02-28
	Receiver & Software				
SA0025	Spectrum Analyzer	Agilent	N9030A	2016-03-17	2017-03-31
SA0026 (18-40GHz RSE)	Spectrum Analyzer	Agilent	N9030A	2016-02-24	2017-02-28
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA
	Additional Equipment used				
139843	Temp/Humid/Pressure Meter	Control Co./Fisher	14-650-118	2016-02-19	2017-02-19
PS215	AC Power Source	Elgar	CW2501M (s/n 1523A02397)	NA	NA

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7.1. MEASUREMENT METHODS

General Radiated Emissions: ANSI C63.10:2013 Sections 6.3-6.6

Radiated Bandedge: ANSI C63.10:2013 Sections 6.10.5

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8. RADIATED EMISSIONS

LIMIT

IC RSS-210, B.10, RSS-GEN Clause 8.9
FCC 15.249, 15.205, 15.209

Operation within the bands 902–928 MHz, 2400–2483.5 MHz, 5725–5875 MHZ, and 24.0–24.25 GHz.
(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (microvolts/meter)
902–928 MHz	50	500
2400–2483.5 MHz	50	500
5725–5875 MHz	50	500
24.0–24.25 GHz	250	2500

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009–0.490	2400/F(kHz)	300
0.490–1.705	24000/F(kHz)	30
1.705–30.0	30	30
30–88	100 **	3
88–216	150 **	3
216–960	200 **	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54–72 MHz, 76–88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

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TEST PROCEDURE

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

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

For peak measurements above 1 GHz, the resolution bandwidth is set to 1 MHz and the video bandwidth is set to 3 MHz. For average measurements above 1GHz, the resolution bandwidth and video bandwidth are set as described in ANSI C63.10:2013 for the applicable measurement. For this evaluation, Voltage Averaging was used for the fundamental and restricted band edge, RMS Power Averaging was used for spurious emissions and the resolution/video bandwidth settings were 1MHz/3MHz.

The spectrum from 9 kHz to 26 GHz is investigated with the transmitter set to the middle channel in each applicable band.

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

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8.1. FUNDAMENTAL FREQUENCY RADIATED EMISSION

Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2.402	73.33	Pk	32.3	-24.1	81.53	-	-	114	-32.47	115	222	H
2.402	72.2	Av	32.3	-24.1	80.4	94	-13.6	-	-	115	222	H
2.402	80.88	Pk	32.3	-24.1	89.08	-	-	114	-24.92	98	114	V
2.402	79.82	Av	32.3	-24.1	88.02	94	-5.98	-	-	98	114	V
2.442	72.17	Pk	32.3	-24.3	80.17	-	-	114	-33.83	51	116	H
2.442	71.01	Av	32.3	-24.3	79.01	94	-14.99	-	-	51	116	H
2.442	80.64	Pk	32.3	-24.3	88.64	-	-	114	-25.36	92	119	V
2.442	79.48	Av	32.3	-24.3	87.48	94	-6.52	-	-	92	119	V
2.48	70.64	Pk	32.4	-24.6	78.44	-	-	114	-35.56	313	142	H
2.48	69.44	Av	32.4	-24.6	77.24	94	-16.76	-	-	313	142	H
2.48	78.96	Pk	32.4	-24.6	86.76	-	-	114	-27.24	107	194	V
2.48	77.79	Av	32.4	-24.6	85.59	94	-8.41	-	-	107	194	V

Pk - Peak detector
Av - Average detection

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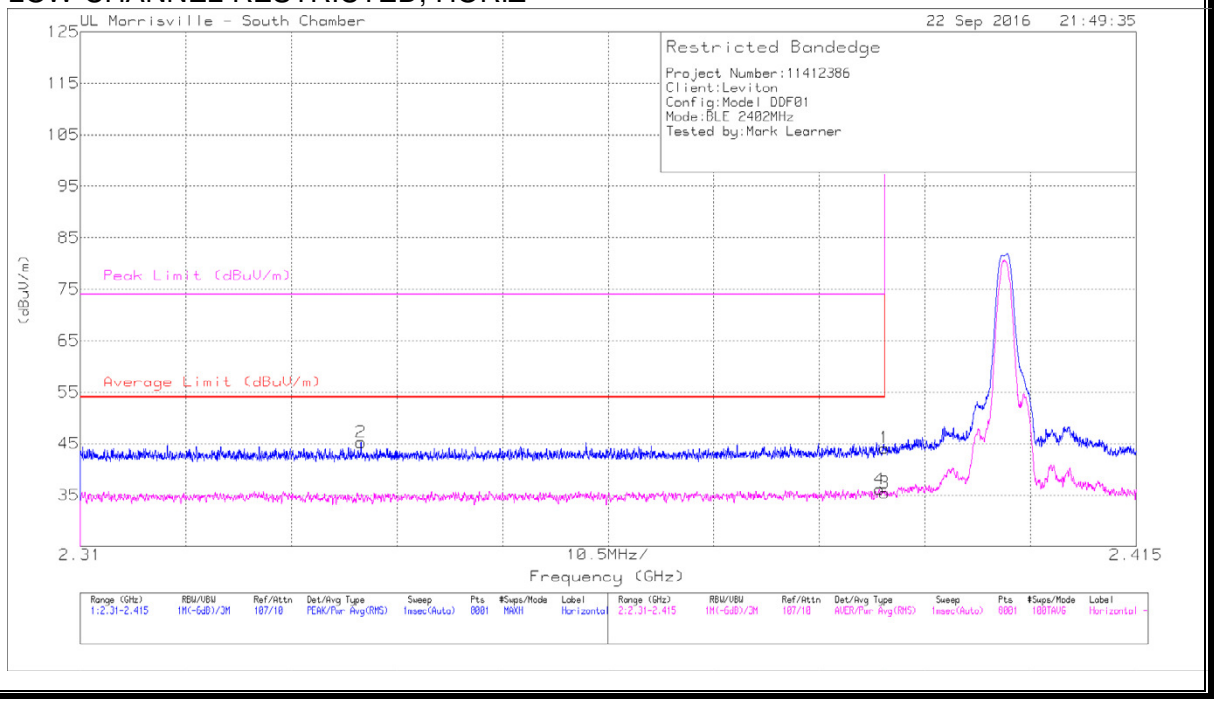
8.2. TRANSMITTER ABOVE 1 GHz

8.2.1. TX ABOVE 1 GHz FOR BLUETOOTH LOW ENERGY MODE IN THE 2.4 GHz BAND

RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)

LOW CHANNEL RESTRICTED, HORIZ



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	36.05	Pk	32.2	-24.1	44.15	-	-	74	-29.85	92	218	H
2	* 2.338	37.38	Pk	31.8	-23.9	45.28	-	-	74	-28.72	92	218	H
3	* 2.39	25.32	RMS	32.2	-24.1	33.42	54	-20.58	-	-	92	218	H
4	* 2.389	26.02	RMS	32.2	-24.1	34.12	54	-19.88	-	-	92	218	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

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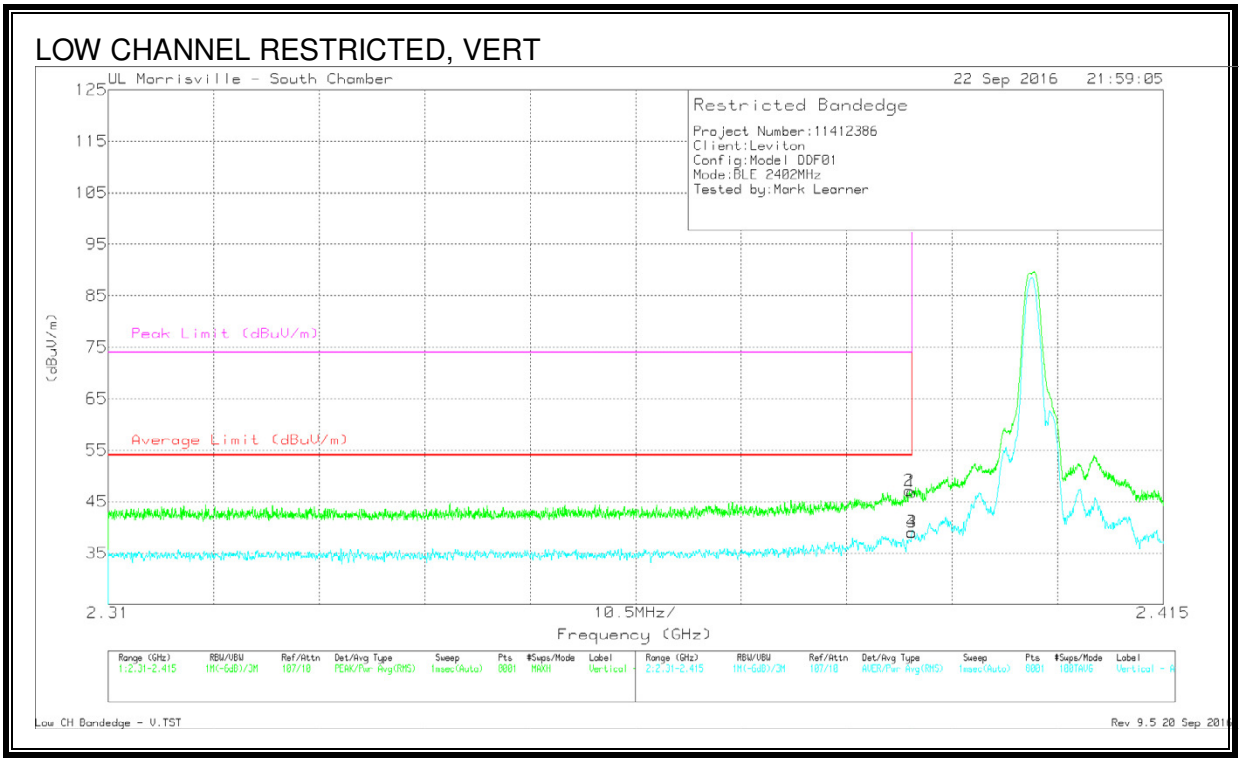
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	38.75	Pk	32.2	-24.1	46.85	-	-	74	-27.15	100	208	V
2	* 2.39	39.04	Pk	32.2	-24.1	47.14	-	-	74	-26.86	100	208	V
3	* 2.39	28.99	RMS	32.2	-24.1	37.09	54	-16.91	-	-	100	208	V
4	* 2.39	28.90	RMS	32.2	-24.1	37.00	54	-17.00	-	-	100	208	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

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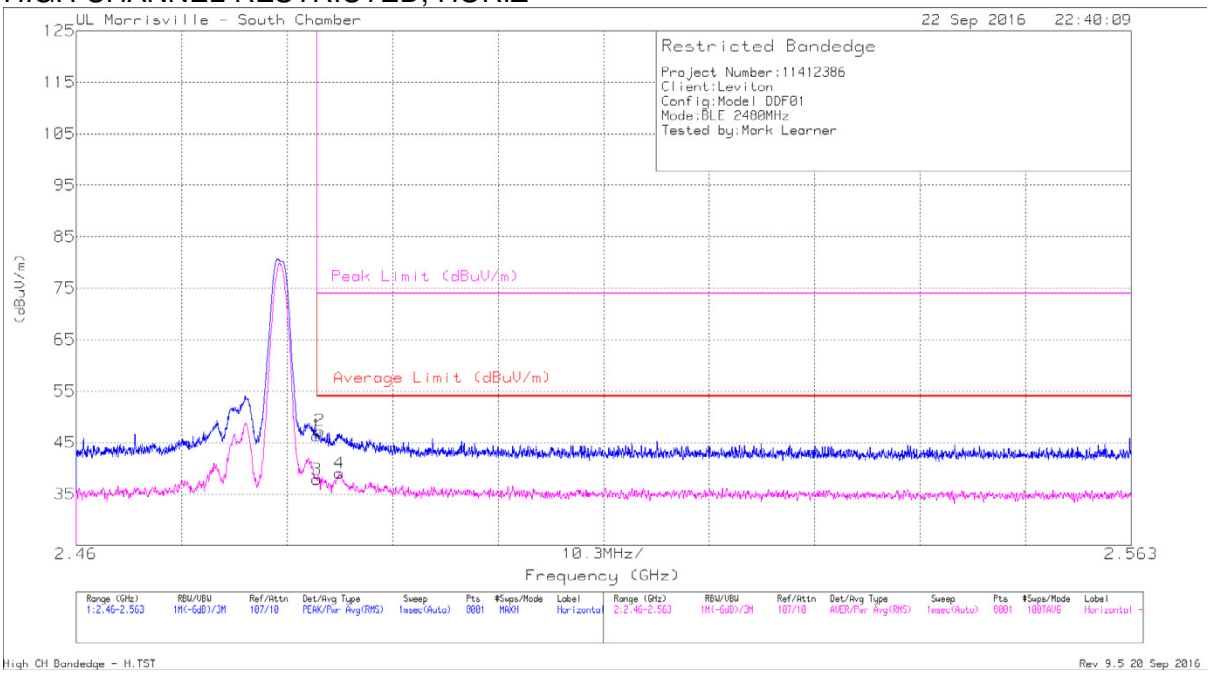
RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)

HIGH CHANNEL RESTRICTED, HORIZ



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	38.53	Pk	32.4	-24.6	46.33	-	-	74	-27.67	168	197	H
2	* 2.484	39.53	Pk	32.4	-24.6	47.33	-	-	74	-26.67	168	197	H
3	* 2.484	28.02	RMS	32.4	-24.6	35.82	54	-18.18	-	-	168	197	H
4	* 2.486	29.24	RMS	32.4	-24.6	37.04	54	-16.96	-	-	168	197	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

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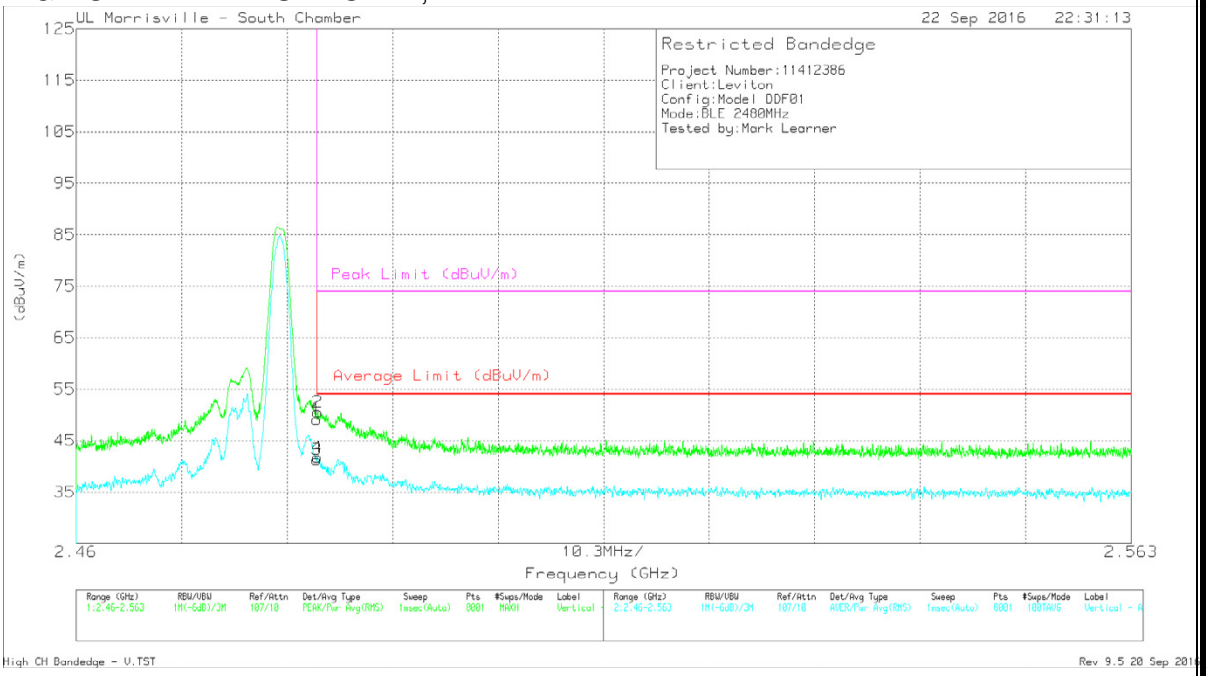
RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)

HIGH CHANNEL RESTRICTED, VERT



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	41.32	Pk	32.4	-24.6	49.12	-	-	74	-24.88	105	224	V
2	* 2.484	42.78	Pk	32.4	-24.6	50.58	-	-	74	-23.42	105	224	V
3	* 2.484	31.53	RMS	32.4	-24.6	39.33	54	-14.67	-	-	105	224	V
4	* 2.484	31.93	RMS	32.4	-24.6	39.73	54	-14.27	-	-	105	224	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

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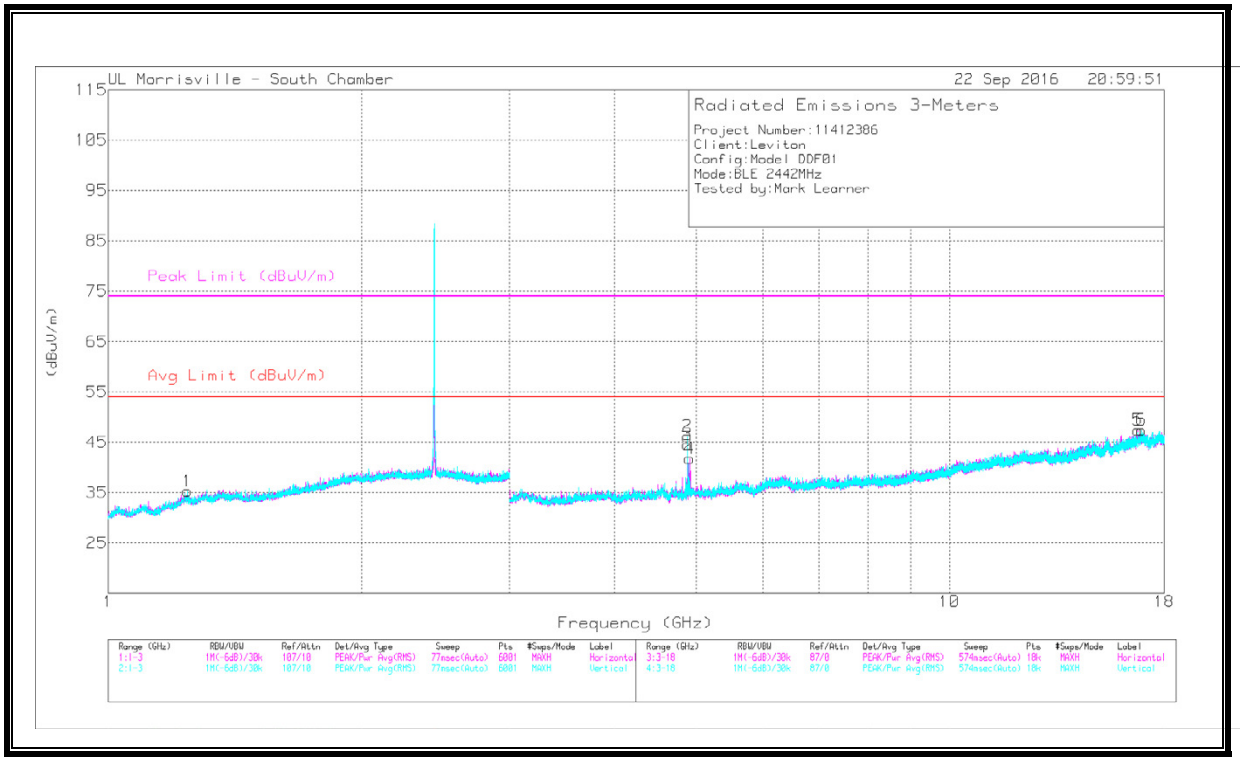
HARMONICS AND SPURIOUS EMISSIONS



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0069 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.241	35.94	PK2	28.7	-23.5	41.14	-	-	74	-32.86	36	100	V
	* 1.242	24.46	MAv1	28.7	-23.5	29.66	54	-24.34	-	-	36	100	V
3	* 4.883	45.66	PK2	34.1	-31	48.76	-	-	74	-25.24	59	129	H
	* 4.883	37.7	MAv1	34.1	-31	40.8	54	-13.2	-	-	59	129	H
4	* 4.911	43.44	PK2	34.1	-31	46.54	-	-	74	-27.46	146	118	H
	* 4.911	28.54	MAv1	34.1	-31	31.64	54	-22.36	-	-	146	118	H
2	* 4.883	46.57	PK2	34.1	-31	49.67	-	-	74	-24.33	9	207	V
	* 4.884	39.06	MAv1	34.1	-31	42.16	54	-11.84	-	-	9	207	V
5	16.752	30.64	Pk	41.6	-24.8	47.44	-	-	-	-	0-360	101	H
6	16.917	29.45	Pk	41.6	-23.6	47.45	-	-	-	-	0-360	101	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
PK2 - Maximum Peak
MAv1 - Maximum RMS Average

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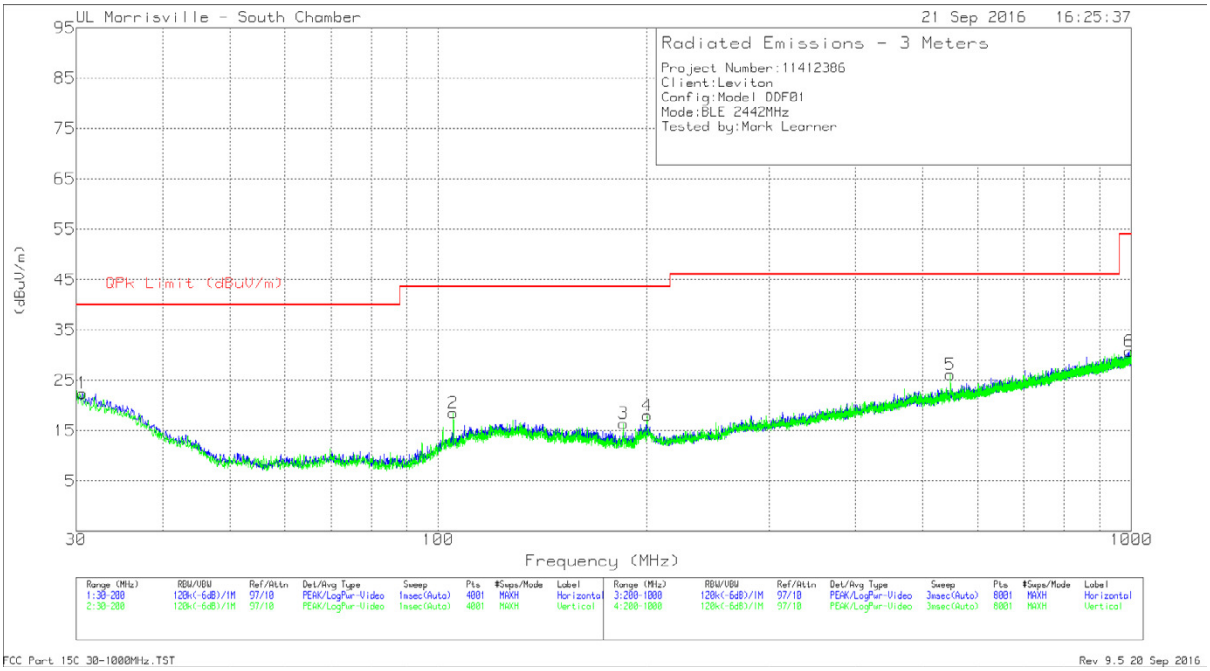
8.3. WORST-CASE BELOW 1 GHz

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



Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0074 AF (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
6	* 992.9	28.74	Pk	27.8	-25.8	30.74	53.97	-23.23	0-360	398	H
1	30.6375	28.74	Pk	25.5	-31.8	22.44	40	-17.56	0-360	98	H
2	105.0763	33.61	Pk	15.9	-31	18.51	43.52	-25.01	0-360	101	V
3	184.9125	31.16	Pk	15.6	-30.3	16.46	43.52	-27.06	0-360	101	V
4	200.2	30.81	Pk	17.4	-30.2	18.01	43.52	-25.51	0-360	202	V
5	548.3	32.03	Pk	22.8	-28.7	26.13	46.02	-19.89	0-360	301	V

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

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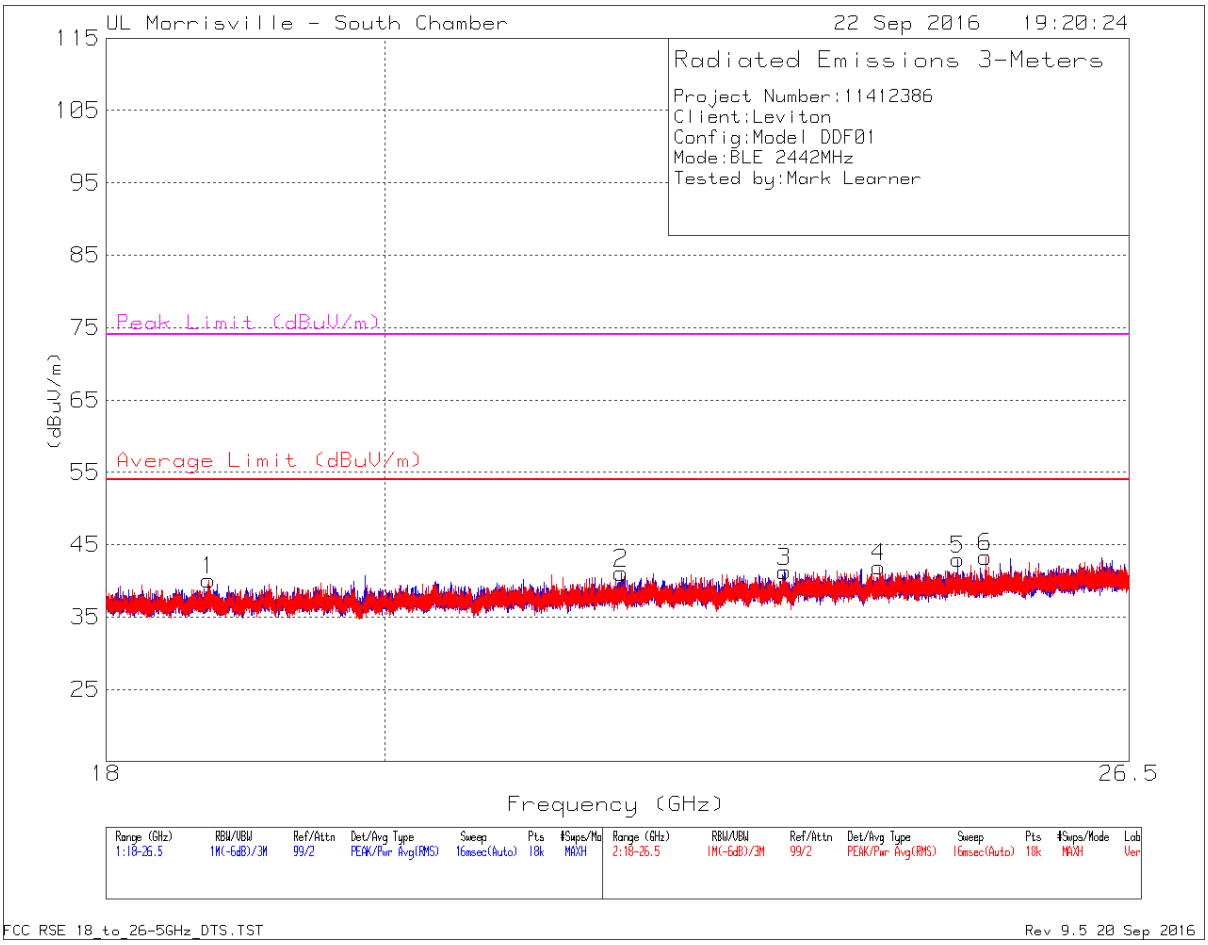
8.4. WORST-CASE ABOVE 18GHz

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



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF AT0076 (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 18.711	48.17	PK2	32.7	-40.5	40.37	54	-13.63	74	-33.63	34	300	V
2	21.87	47.58	Pk	33.4	-39.9	41.08	54	-12.92	74	-32.92	0-360	151	H
3	23.264	46.61	Pk	33.8	-39.1	41.31	54	-12.69	74	-32.69	0-360	101	H
4	24.11	46.63	Pk	34.1	-38.8	41.93	54	-12.07	74	-32.07	0-360	249	V
5	24.84	47.1	Pk	34.5	-38.6	43	54	-11	74	-31	0-360	201	H
6	25.1	47.13	Pk	34.5	-38.3	43.33	54	-10.67	74	-30.67	0-360	101	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
PK2 - Maximum Peak
MAv1 - Maximum RMS Average

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