



MEASUREMENT AND TEST REPORT

VERSION 1.00

Report Prepared for: Syscor Controls & Automation Inc.
201 - 60 Bastion Square
Victoria, BC V8W 1J2

Equipment Under Test (EUT): 000472

Trade Name: FR-Tracker™ Base Station

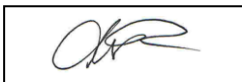

FCC ID: 2AAZE-000472

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FCC RULE PART(s): Part 15B, 15C

INDUSTRY CANADA RULE PART(s) RSS-210

Tested by: Island Compliance Services Inc.
6454 Fitzgerald Road
Courtenay, BC
V9J 1N7

Prepared By		Authorized By	
A. Horel (Technical Writer)		A. Eadie (Sr. EMC Eng.)	

Note: This test report has been prepared for the Applicant and device described herein. It may not be duplicated or used in part without prior written consent from Island Compliance Services Inc.

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Revision History

Version	Date	Author	Comment
1.0	31/10/2013	A. Horel	Original Release

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2 SUMMARY OF TEST RESULTS

The equipment under test was found to comply with the test standards and criteria outlined herein.

Test Description	Reference Specification FCC	Reference Specification Industry Canada	Result	Comment
RF Peak Power Output	FCC Subpart C 15.247(b) (3)	RSS 210 Issue 8 A8.4(4)	Complies	
Occupied Bandwidth 6dB Bandwidth	FCC Subpart C 15.247 (a) (2)	RSS 210 Issue 8 A8.2(a)	Complies	
Occupied Bandwidth 20dB Bandwidth	N/A	RSS-Gen Issue 3 4.6.1	Complies	
Power Spectral Density	FCC Subpart C 15.247(e)	RSS 210 Issue 8 A8.2(b)	Complies	
Conducted Spurious Emissions	FCC Subpart C 15.247(d)	RSS 210 Issue 8 A8.5	Complies	
Radiated Spurious Emissions Band Edge	FCC Subpart C 15.209(a) 15.205(a)	RSS 210 Issue 8 2.5, A8.5	Complies	
Radiated Spurious Emissions (TX and RX)	FCC Subpart C 15.247, 15.205 FCC Subpart B 15.109	RSS 210 Issue 8 2.5, A8.5 RSS Gen Issue 3 Section 4.10 and section 6 for RX ICES-003 Issue 4	Complies	
Power line Conducted Emission	FCC Subpart C 15.207 (a) FCC Subpart B 15.107	RSS-Gen Issue 3 7.2.4 Ices-003 Issue 4	Complies	

2.1 ENVIRONMENTAL CONDITIONS

Description	Reading
Testing Dates	28 th -30 th Oct 2013
Indoor Temperature	17C-25C
Indoor Humidity	30-45%
Outdoor Temperature	9C-15C
Outdoor Humidity	60-80%

2.2 STANDARD TEST CONDITIONS AND ENGINEERING PRACTICES

Except as noted herein, the following conditions and procedures were observed during the testing:

CFR 47, FCC rules Part 15 subpart C, ANSI C63.4 (2003), Public DTS procedures KDB 558074, IC standards RSS-GEN and RSS0210. ANSI C63.4-2003 or later, was used for all test procedures as required by RSS-Gen I3 2010, Section 4.1. Deviations, modification or clarifications (if any) to above mentioned documents are described herein.

As per ANSI C63.4-2003, the EUT antenna was manipulated through typical positions during exploratory testing to maximize emission levels.

Measurement results, unless otherwise noted, are worst-case measurements.

2.3 TEST METHODS

All tests were undertaken with transmitters set to power level 'C', apart from highest channel which was reduced to power level '8'.

The maximum power level will be limited to power level '8' for the upper channels at the factory. The Freescale chipset firmware has the ability to set a 'power lock' function when programming at the factory to limit the power levels that the end customer can select. This will be implemented on the product to ensure that power settings above those approved cannot be selected.

2.4 ANTENNA COMPLIANCE WITH 15.203

This equipment is highly specialized and as such, the full system requires professional installation. The installer is responsible for ensuring that the proper antenna(s) are installed so that the limits of this part are not exceeded.

3 GENERAL EQUIPMENT SPECIFICATIONS

All 3 FR-Tracker devices contain an identical implementation of the Freescale MC13224 Advanced ZigBee™-Compliant Platform-in-Package (PiP) for the 2.4 GHz IEEE® 802.15.4 Standard. Although the RF schematic and RF PCB layout are identical in all Syscor products, there are 2 distinct PCB implementations of the design. These are a Multi-sensors PCBa and a Repeater PCBa. As discussed previously, both the Repeater and the Base Station use the same Repeater PCBa.

Item	Description
Manufacturer	Syscor Controls & Automation Inc.
Applicant	Syscor Controls & Automation Inc.
Model Number	000472
Model Description	RF Tracker Base Station
Size	6"x7"x8", 6lb
Transmitter(s)	2 x Freescale MC13224
Function	Collects and processes sensor data
Power Supply Input	External 6VDC – 40VDC
Power Output	17mW (conducted)
Antenna Gain/Type	2 x Antenna Factor ANT-2.4-OM-CM-01-N, 1/2-wave, 7dBi gain
Channel Spacing	5MHz
Frequency Range	2405-2475MHz
Modulation	O-QPSK

3.1 AUXILIARY EQUIPMENT

Equipment	Description
HP Pavilion Laptop	Model: dv2-1044ca SN: CNC92922N0
BK Precision DC Power Supply	SN: 17432057405110040

3.2 ENGINEERING CHANGES TO PRODUCTION UNIT

N/A

4 RF PEAK POWER OUTPUT

Test Name	Reference Specification	Result	Notes
RF Peak Power Output	15.247(b)(3) A8.4 (4)	Complies	

4.1 TEST METHOD

RSS-Gen Issue 3 4.8 and FCC Publication 558074, Section 15.247(b) – 2. Set the RBW \geq EBW. Set VBW \geq 3 x RBW. Set span = zero. Sweep time = auto couple. Detector = peak. Trace mode = max hold. Allow trace to fully stabilize. Use peak marker function to determine the peak amplitude level within the fundamental emission.

4.2 NOTE

- Note that power level was reduced on high channel from power setting 'C' to power setting '8' for the highest channel.

4.3 DATA

Channel	Tuned Frequency (GHz)	Peak Power (dBm)	CF (dB)	Corrected (dBm)	Limit (dBm)
Low (11)	2.405	-7.7	20	12.3	30
Mid (18)	2.440	-8.0	20	12.0	30
High (25)	2.475	-18.0	20	2.0	30

4.4 PLOT(S)

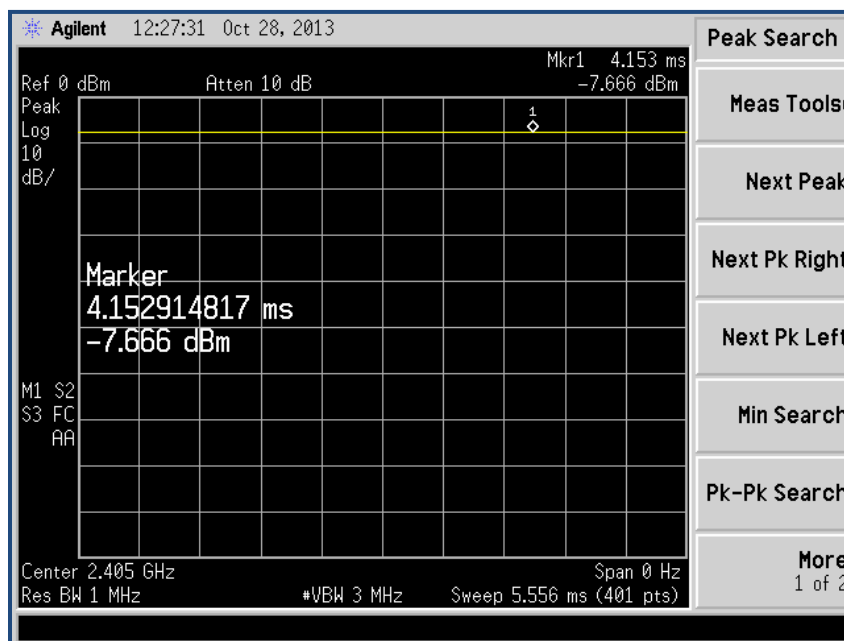


FIGURE 1 - PEAK OUTPUT POWER, LOW CHANNEL

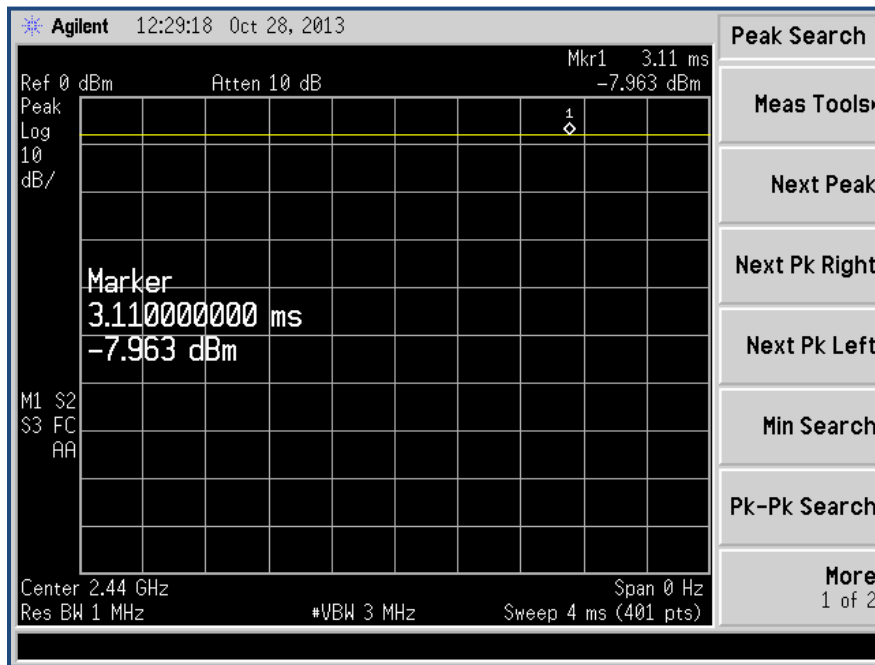


FIGURE 2 - PEAK POWER, MID CHANNEL

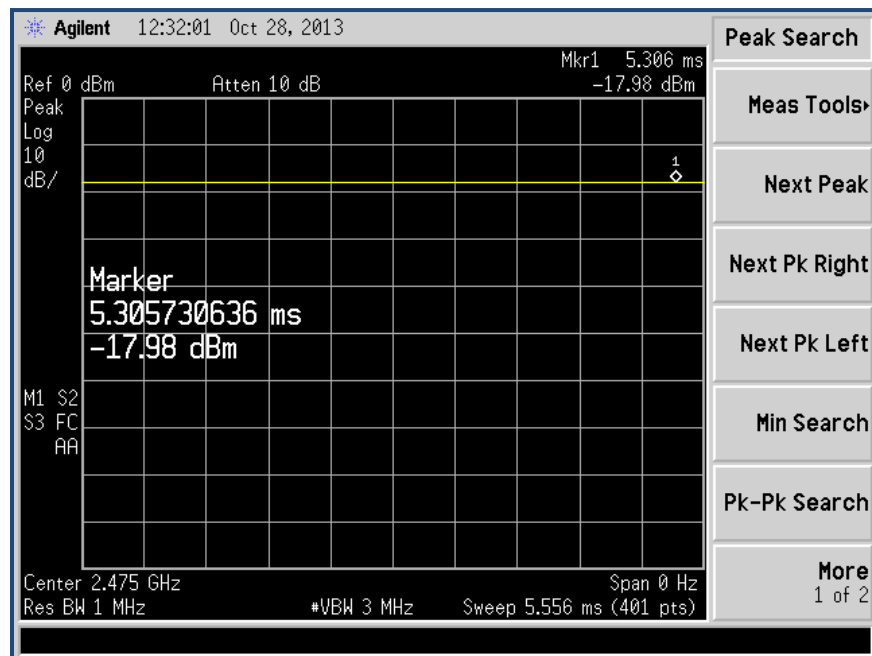


FIGURE 3 - PEAK POWER, HIGH CHANNEL

5 OCCUPIED BANDWIDTH

Test Description	Reference Specification	Result	Notes
Occupied Bandwidth 6dB and 20dB	15.247(a) A8.2(a) 4.6.1	Complies	

5.1 TEST METHOD

RSS-Gen Issue 4.6.1 and FCC Publication 558074, Section 15.247(a) (2) – Emission Bandwidth (EBW) - Method: Set RBW=1-5% of the emission bandwidth (EBW), VBW= $\geq 3 \times$ RBW, Detector=Peak, Trace mode=max hold, Sweep=auto couple, allow trace to stabilize. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB to the maximum level measured in the fundamental emission. Compare the resultant bandwidth with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is 1-5%.

5.2 DATA

Channel	Frequency (GHz)	20dB Bandwidth (MHz)	6dB Bandwidth (MHz)
Low (11)	2.405	2.45	1.43
Mid (18)	2.44	2.45	1.43
High (25)	2.475	2.46	1.43

5.3 PLOTS

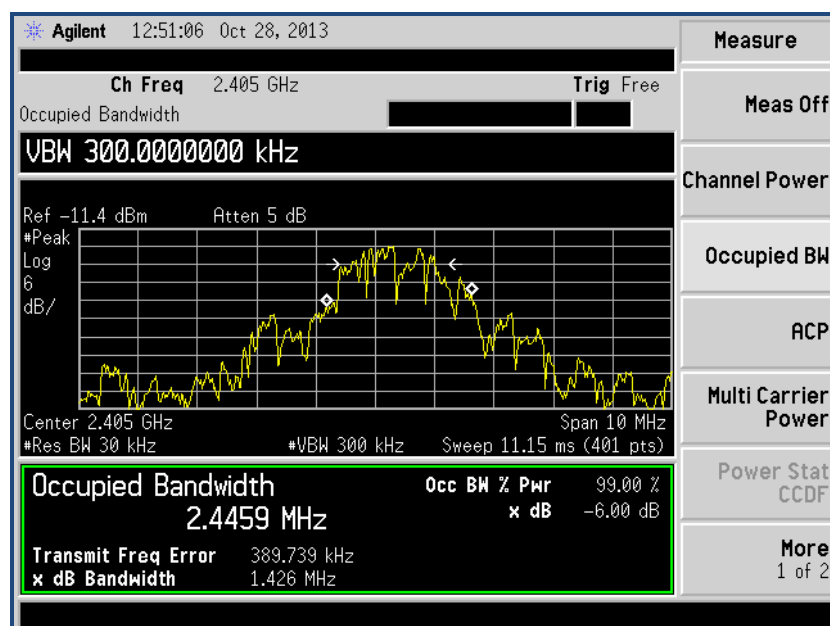


FIGURE 4 - LOW CHANNEL OCCUPIED BANDWIDTH

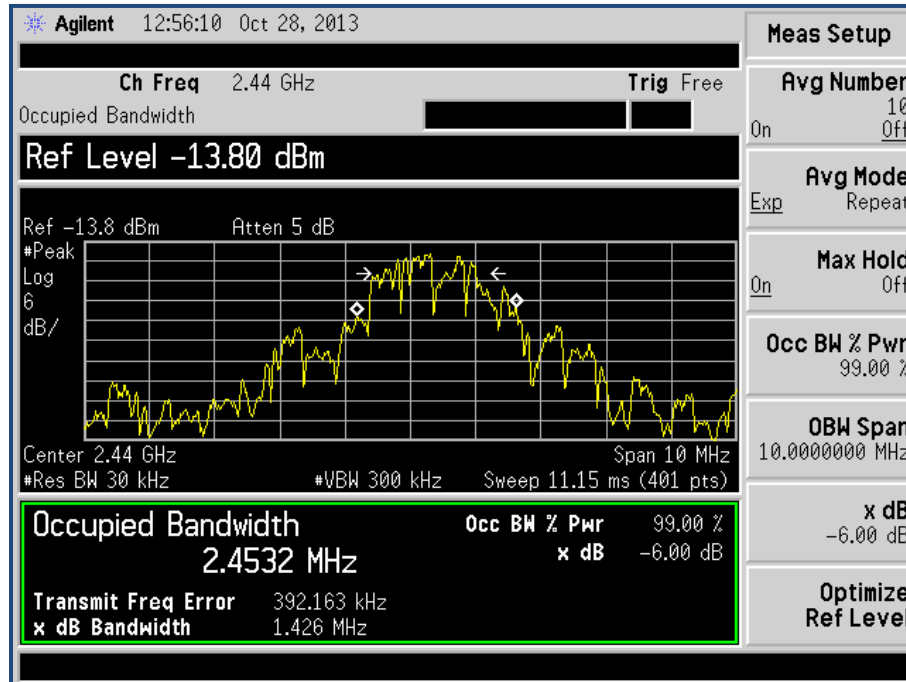


FIGURE 5 – MID CHANNEL OCCUPIED BANDWIDTH

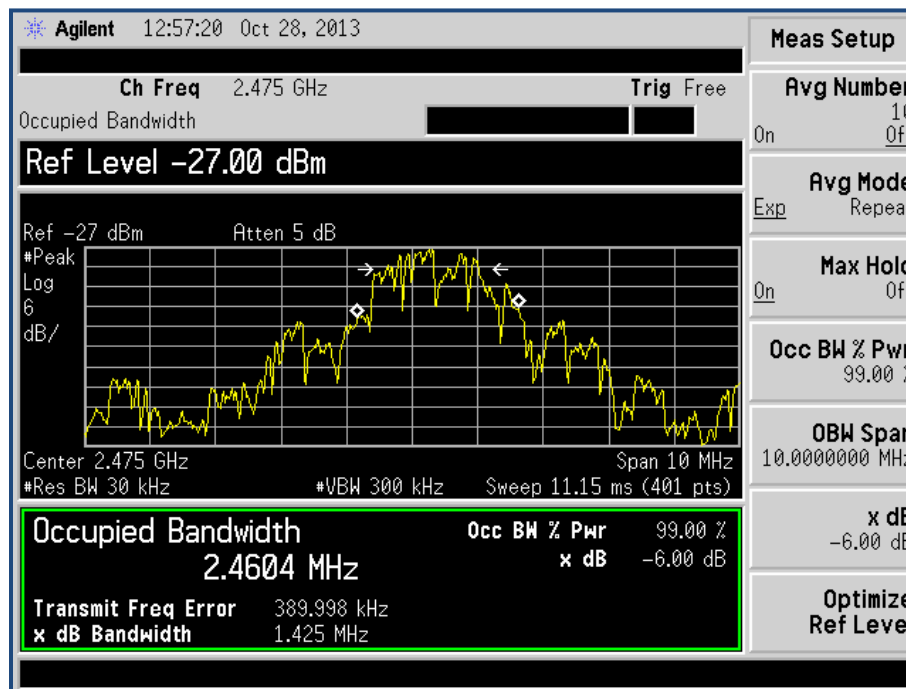


FIGURE 6 - HIGH CHANNEL OCCUPIED BANDWIDTH

6 POWER SPECTRAL DENSITY

Test Description	Reference Specification	Result	Notes
Power Spectral Density	15.247(e) A8.2 (b)	Complies	maximum measured power spectral density: -7.9 dBm

6.1 TEST METHOD

RSS-210 Issue 8 and FCC Publication 558074, Section 15.247(e) - Maximum Power Spectral Density Level in the Fundamental Emission (PSD) – Method: RBW = 100 kHz, VBW ≥ 300 kHz, Span=5-30 % greater than the EBW, Detector= peak, Sweep time = auto couple, Trace mode = max hold, allow trace to fully stabilize. The peak marker function is used to determine the maximum power level in any 100 kHz band segment within the fundamental EBW. The observed power level is scaled to an equivalent value in 3 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where $BWCF = 10\log(3\text{ kHz}/100\text{kHz}) = -15.2\text{ dB}$.

6.2 NOTE(S)

- 20 dB ext. attenuation used

6.3 LIMITS

15.247(e) specifies a conducted power spectral density (PSD) limit of 8 dBm in any 3 kHz band segment within the fundamental EBW during any time interval of continuous transmission.

6.4 DATA

Channel	Frequency (GHz)	Pk Power (dBm)	CF (dB)	PSD (dBm)
Low (11)	2.405	-12.7	4.8	-7.9
Mid (18)	2.44	-13.1	4.8	-8.3
High (25)	2.475	-23.2	4.8	-18.4

Note: All final reported values are corrected values

6.5 PLOTS

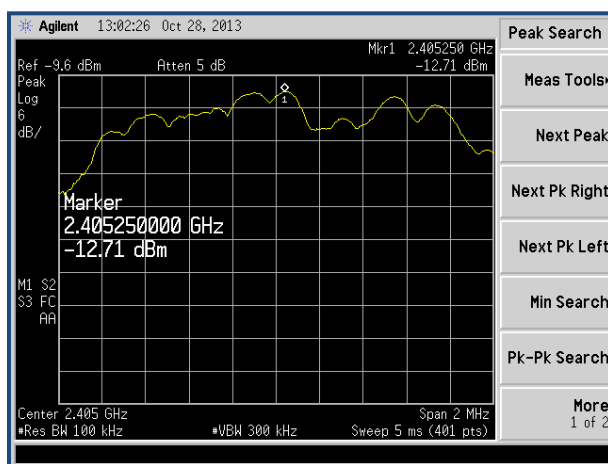


FIGURE 7 – PSD (LOW CHANNEL)

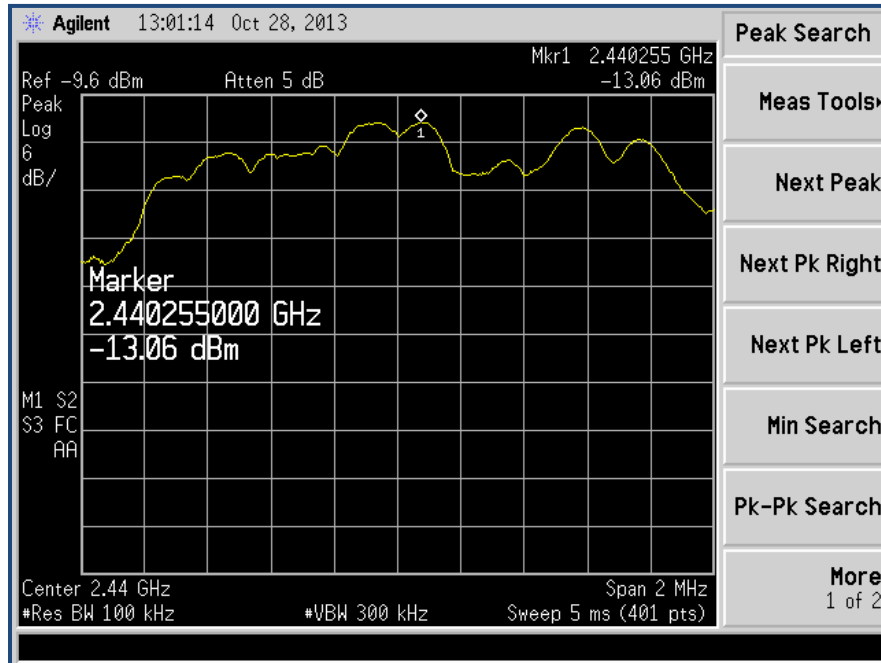


FIGURE 8 - PSD (MID CHANNEL)

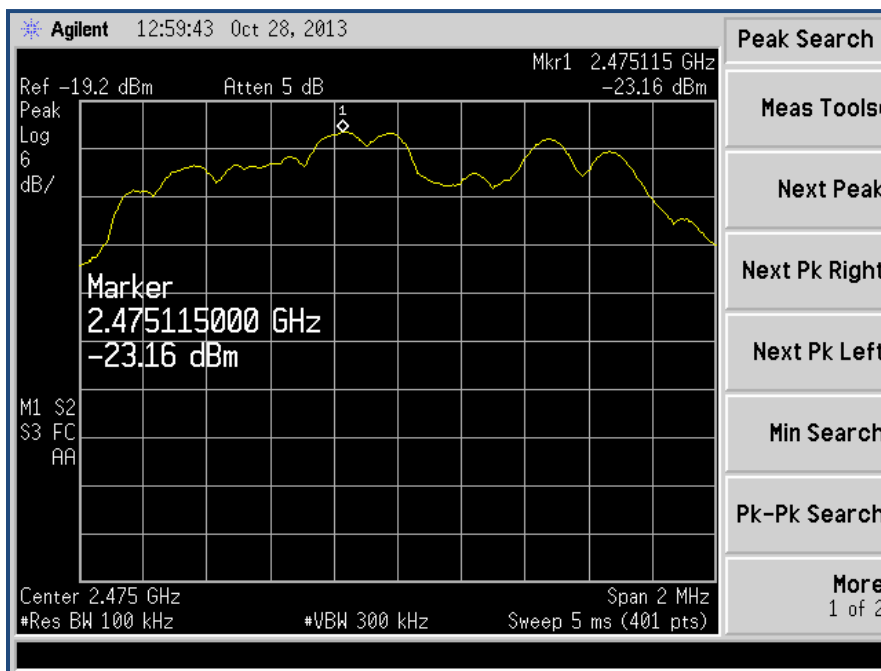


FIGURE 9 - PSD (HIGH CHANNEL)

7 CONDUCTED SPURIOUS EMISSIONS

Test Description	Reference Specification	Result	Notes
Conducted Spurious Emissions	15.247(c) A8.5	Complies	

7.1 TEST METHOD

RF conducted as per FCC Publication 558074
RSS-210 Issue 8 A8.5

7.2 NOTE(S)

- 20dB ext. attenuation

7.3 LIMITS

15.247(c) In any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in 15.205(a), must also comply with the radiated emission limits specified in 15.209(1) (see 15.205(c)).

7.4 DATA

Channel	Harmonic2 (dBc)	Harmonic3 (dBc)	Harmonic4 (dBc)	Limit (dBc)	Result
Low (11)	59.4	62.3	-	20	Complies
Mid (18)	59.0	63.8	-	20	Complies
High (25)	48.4	54.9	53.4	20	Complies

Note: worst case harmonic: 48.4 dBc

7.5 PLOTS (LOW CHANNEL)

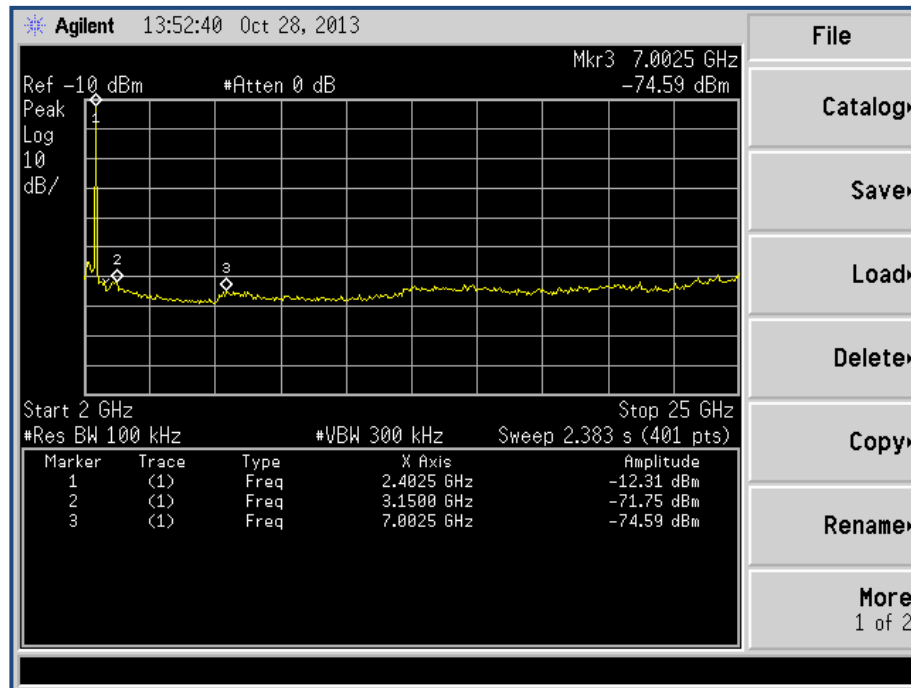


FIGURE 10 - LOW CHANNEL HARMONICS

7.6 PLOTS (MID CHANNEL)

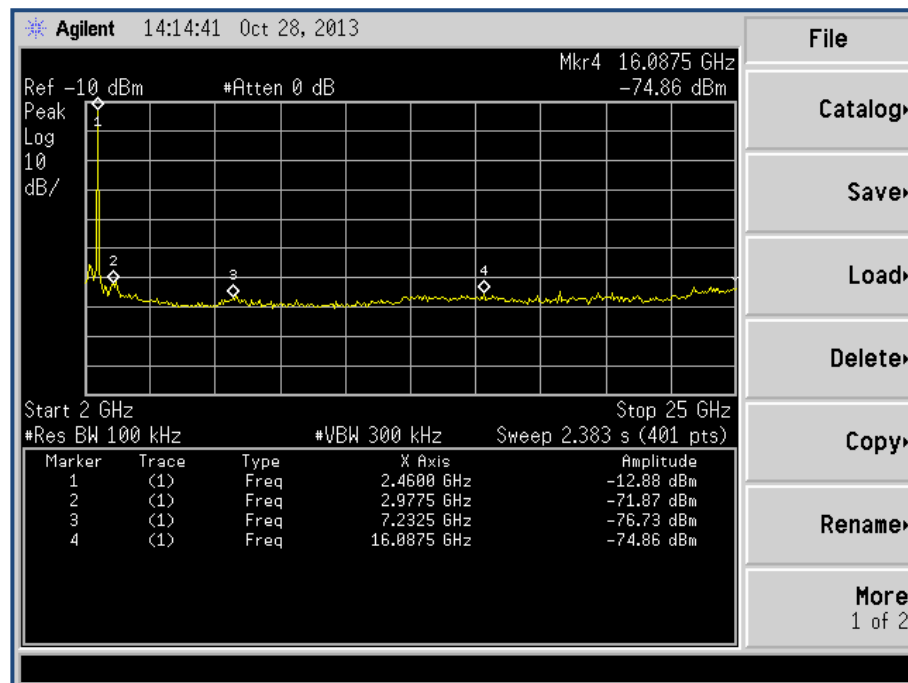
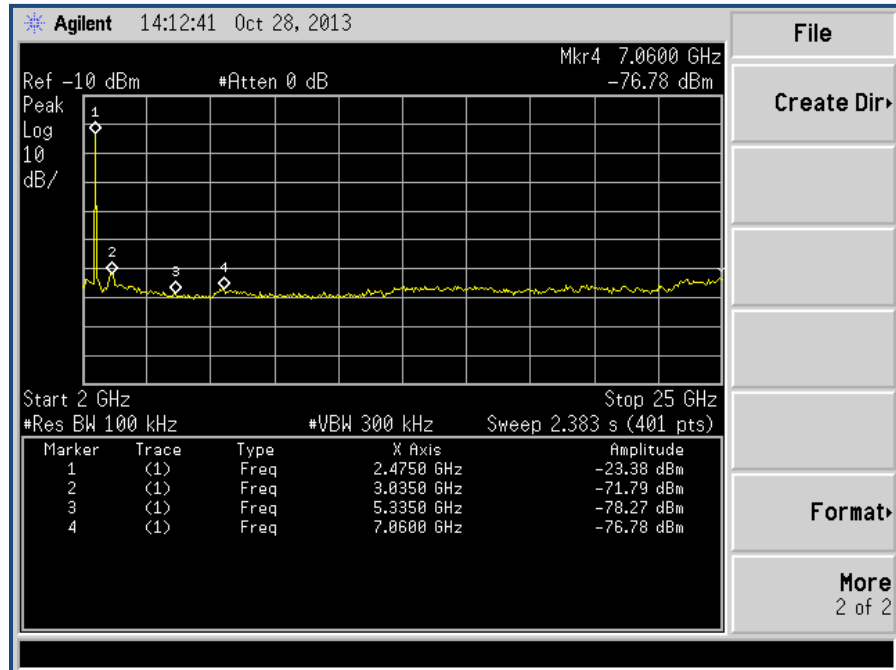


FIGURE 11 - MID CHANNEL HARMONICS

7.7 PLOTS (HIGH CHANNEL)



8 RADIATED SPURIOUS EMISSIONS BAND EDGE

8.1 TEST PROCEDURE

The EUT is placed on a non-conductive turntable on the 3m OATS. An in-band field strength measurement of the fundamental emissions using RBW and detector function for the frequency being measured. The measurements are repeated with average detector. Spectrum analyzer span is chosen that encompasses both the peak and the fundamental emissions and the band edge emissions under investigation. Analyzer is set, RBW to 1% of total span (never less than 30kHz) with a video bandwidth equal to or greater than the RBW. Peak levels of the fundamental emissions and the relevant band edge emissions are recorded.

8.2 SUMMARY OF TEST RESULTS

Test Description	Reference Specification	Result	Notes
Radiated Spurious Emissions Band Edge	FCC Subpart C 15.209(a) 15.205(a) RSS 210 Issue 8 2.5, A8.5	Complies	

8.2.1 SUMMARY OF 15.205 LIMITS

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
10.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	(2)
13.36–13.41			

FIGURE 12 - RESTRICTED BANDS

8.3 DATA (HIGH CHANNEL)

Spurious Emission Frequency (Hz)	Reading (dBuV)	Corrected (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Result
2475.05M (Fund)	89.6	103.7	-	-	Pk	Complies
2479.960M	51.0	65.2	74.0	-8.8	Pk	Complies
2499.950M	43.5	57.8	74.0	-16.2	Pk	Complies
2475.05M (Fund)	82.8	96.9	-	-	Avg	Complies
2499.473M	32.5	46.8	54.0	-7.2	Avg	Complies
2483.500M	30.3	44.6	54.0	-9.4	Avg	Complies

8.4 DATA (LOW CHANNEL)

Spurious Emission Frequency (Hz)	Reading (dBuV)	Corrected (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Result
2404.973M (Fund)	94.9	108.6	-	-	Pk	Complies
2381.885M	44.4	58.0	74.0	-16.0	Pk	Complies
2358.004M	41.0	54.5	74.0	-19.5	Pk	Complies
2386.353M	39.0	52.6	74.0	-21.4	Pk	Complies
2332.848M	39.1	52.4	74.0	-21.6	Pk	Complies
2361.395M	35.4	48.9	74.0	-25.1	Pk	Complies
2376.671M	34.9	48.5	74.0	-25.5	Pk	Complies
2405.066M (Fund)	88.5	102.2	-	-	Avg	
2382.071M	35.9	49.5	54.0	-4.5	Avg	Complies
2357.637M	31.6	45.1	54.0	-8.9	Avg	Complies
2332.938M	29.8	43.1	54.0	-10.9	Avg	Complies

8.5 PLOTS (HIGH CHANNEL)

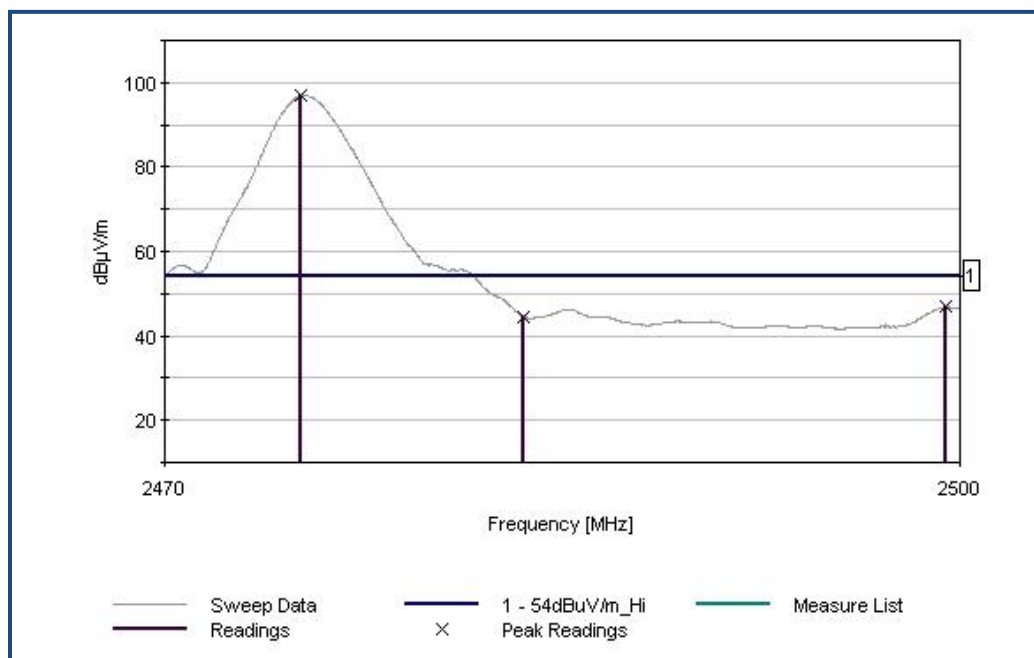


FIGURE 13 - HIGH CHANNEL (AVG) RESTRICTED BAND (2483.5 – 2500 MHz)

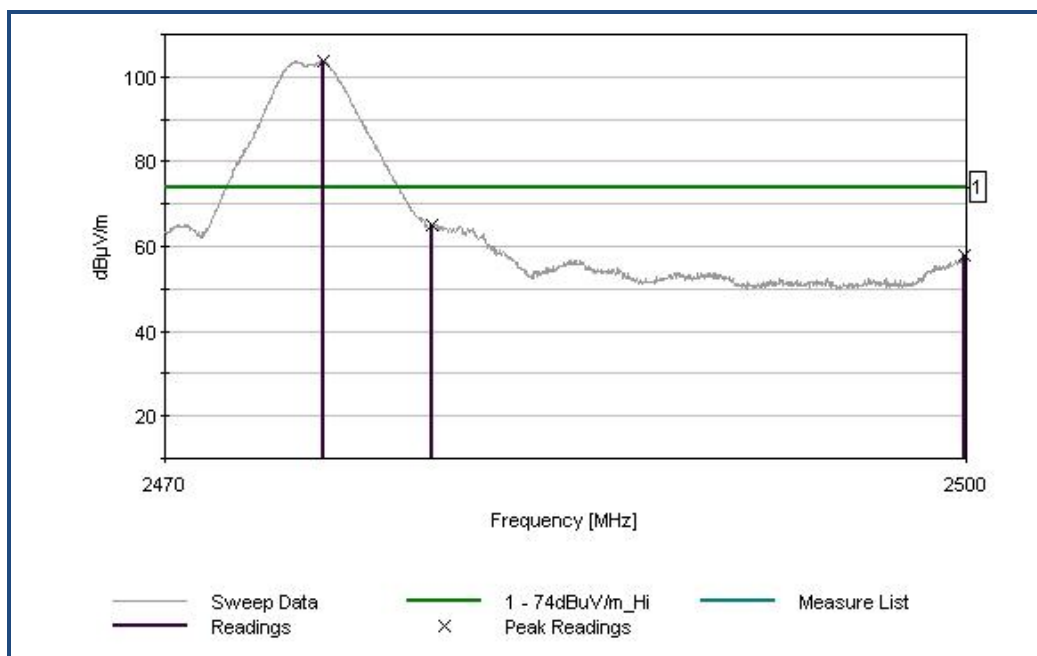


FIGURE 14 - HIGH CHANNEL (PK) RESTRICTED BAND (2483.5 – 2500 MHz)

8.6 PLOTS (LOW CHANNEL)

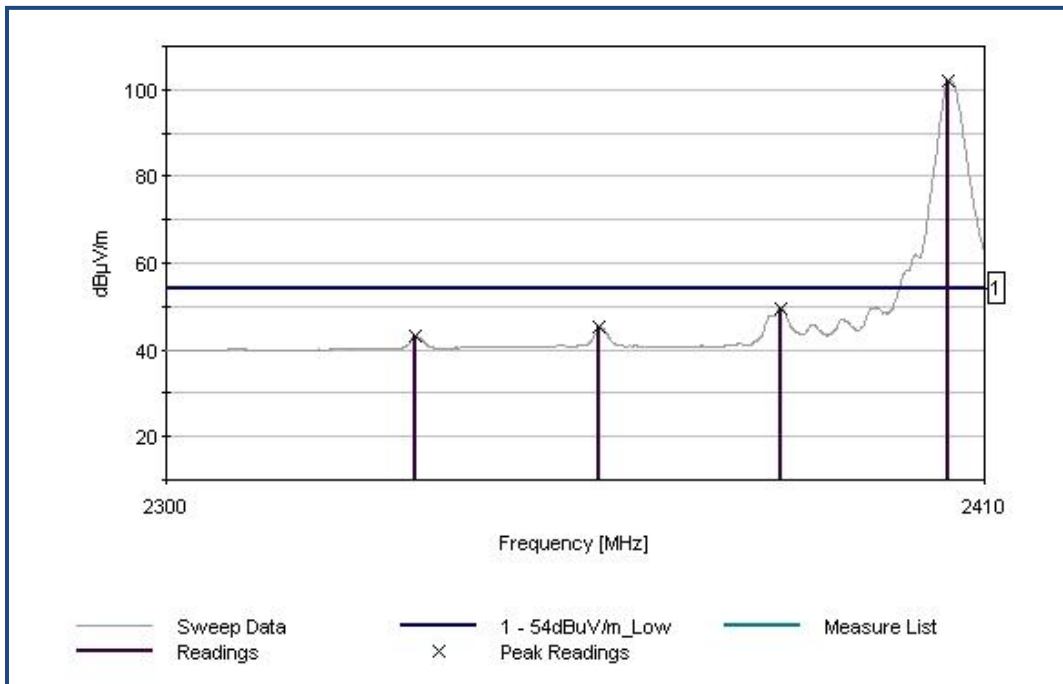


FIGURE 15 - LOW CHANNEL (AVG) RESTRICTED BAND (2310-2390 MHZ)

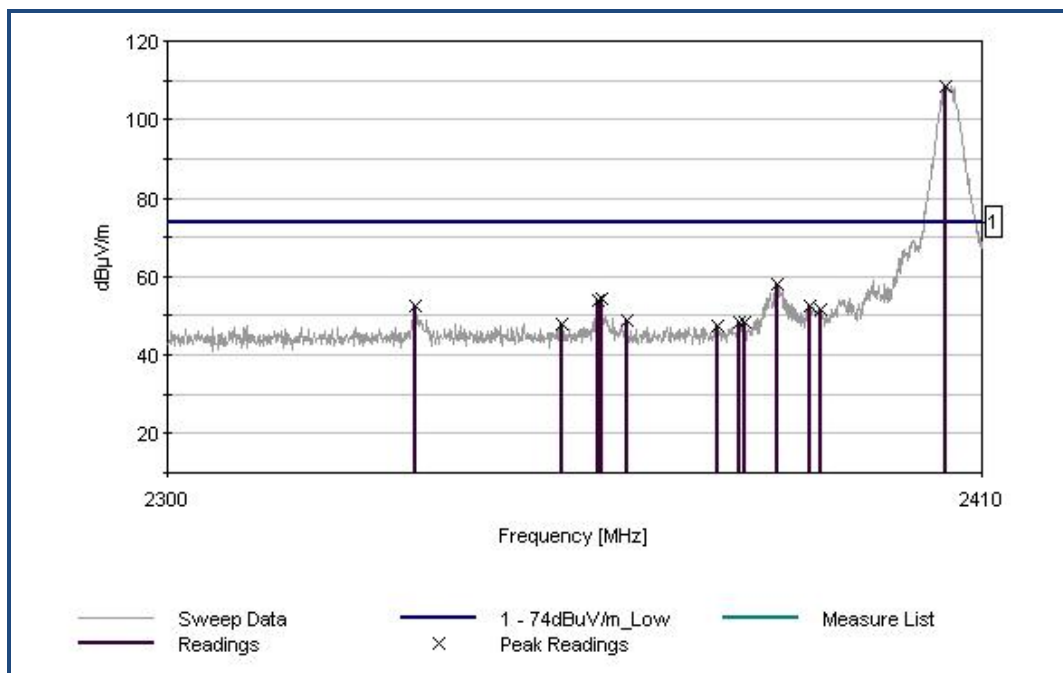


FIGURE 16 - LOW CHANNEL (PK) RESTRICTED BAND (2310-2390 MHZ)

8.7 NOTES

Note that both antennas were connected and set to transmit mode. The plots show readings from both transmitters.

The restricted bands were investigated using both peak and average detectors (with 54dBuV/m limit). Where applicable, RBW was reduced to lower the noise floor to assist in identifying emissions. No emissions were found above the noise floor in the restricted bands.

Note that the upper channel power was reduced to power level '8' to bring band edge emissions within limits.

9 RADIATED SPURIOUS EMISSIONS

9.1 TEST PROCEDURE

The EUT is placed on a non-conductive turntable on the 3m OATS. Exploratory measurements are made using a suitable antenna positioned within 1m of the EUT. Maximizing procedure was performed on the six (6) highest emissions readings between the lowest RF frequency generated on the device (without going below 9 kHz) and the 10th harmonic of the highest fundamental frequency. Where applicable, a hybrid antenna, horn antenna and loop antenna were used to cover the relevant frequency bands. Notable emissions are maximized and final measurements are taken if the initial results are within 20 dB of the permissible limit. The EUT is placed at nonconductive plate at the turntable center. For each suspected frequency, the turntable is rotated 360 degrees and antenna is scanned from 1 to 4 m. This is repeated for both horizontal and vertical receive antenna polarizations. The emissions less than 20 dB below the permissible value are reported.

The measurement results are obtained as described below:

$$E [\mu V/m] = URX + ATOT$$

Where URX is receiver reading and ATOT is total correction factor including cable loss, antenna factor and preamplifier gain (ATOT = LCABLES + AF - GPREAMP).

9.2 SUMMARY OF TEST RESULTS

Test Description	Reference Specification	Result	Notes
Radiated Spurious Emissions	15.209(a) 15.205(a) A8.5	Complies	

Emissions were investigated from the lowest present clock frequency, to the 10th harmonic of the highest present clock frequency (up to 25 GHz). No other emissions were observed within 20 dB of the limits.

9.2.1 SUMMARY OF 15.205 LIMITS

See Figure 15 above.

9.3 DATA

No.	Freq (MHz)	Rdng (dBuV)	Corrected (dBuV/m)	Spec (dBuV/m)	Margin (dB)	Polarity	Antenna Height (cm)
1	144.200	30.6	40.6	43.5	-2.9	Hz	107
2	329.311	25.0	42.1	46.0	-3.9	Hz	100
3	151.090	28.3	38.2	43.5	-5.3	Hz	171
4	64.110(QP)	24.4	32.4	40.0	-7.6	Vt	103
5	575.023	17.3	38.6	46.0	-7.4	Hz	100
6	243.414	24.3	37.8	46.0	-8.2	Vt	103

9.4 EMISSIONS PLOT (30MHz – 2GHz)

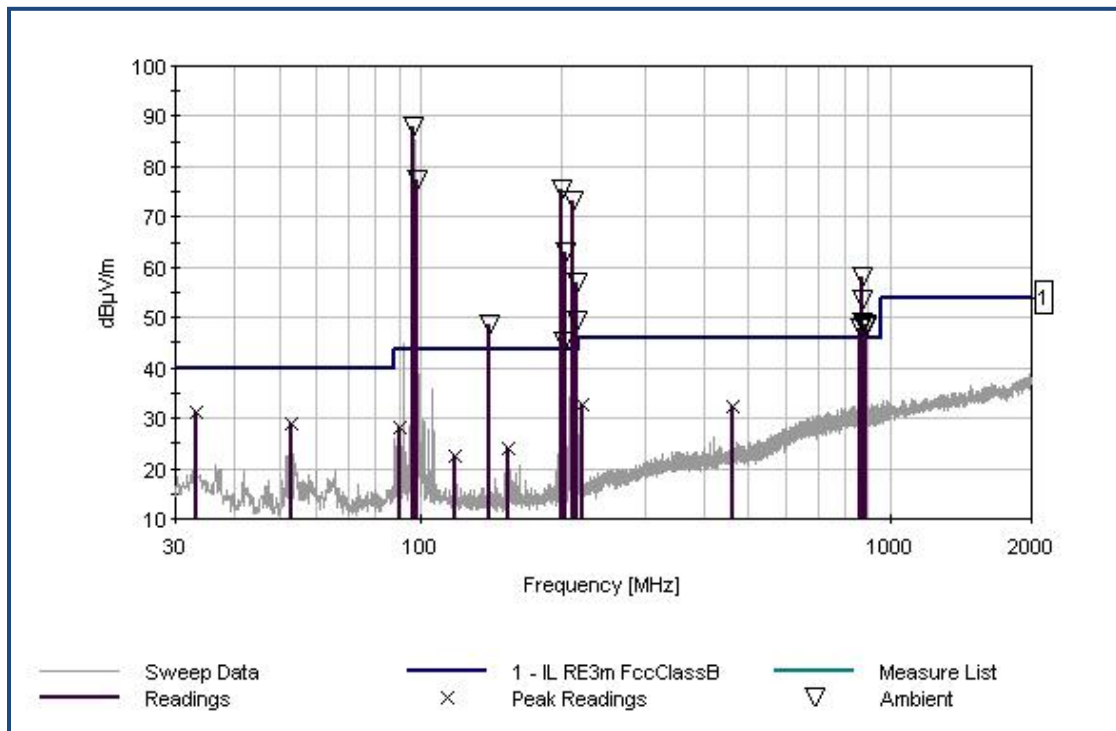


FIGURE 17 - SPURIOUS EMISSIONS PLOT (30MHZ – 2GHZ)

9.5 EMISSIONS PLOT (2 GHz – 18 GHz)

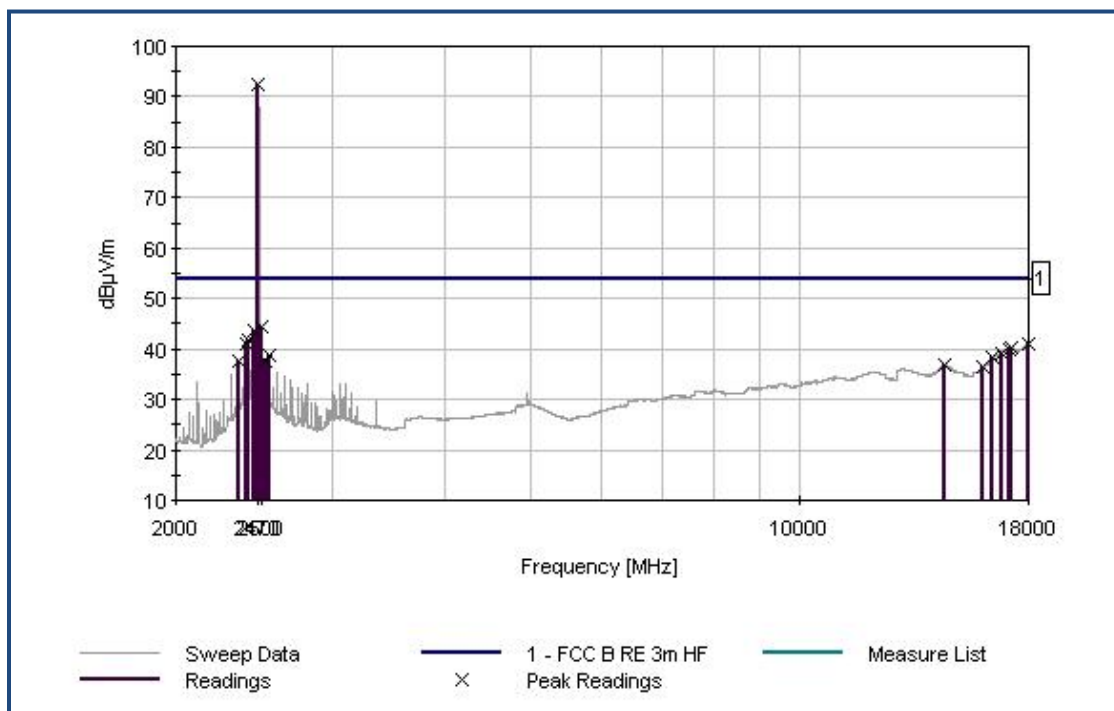


FIGURE 18 - SPURIOUS EMISSIONS PLOT (2GHz – 18GHz) – AVG DETECTOR

10 POWER LINE CONDUCTED EMISSIONS

10.1 TEST METHOD

For the duration of the conducted emissions test, the power cord of the EUT was connected to the main power outlet of the LISN. The LISN in turn is connected to an AC power source. Exploratory tests of the EUT are performed by varying modes and cable positioning. Maximizing procedures are performed on the highest emission readings from the EUT

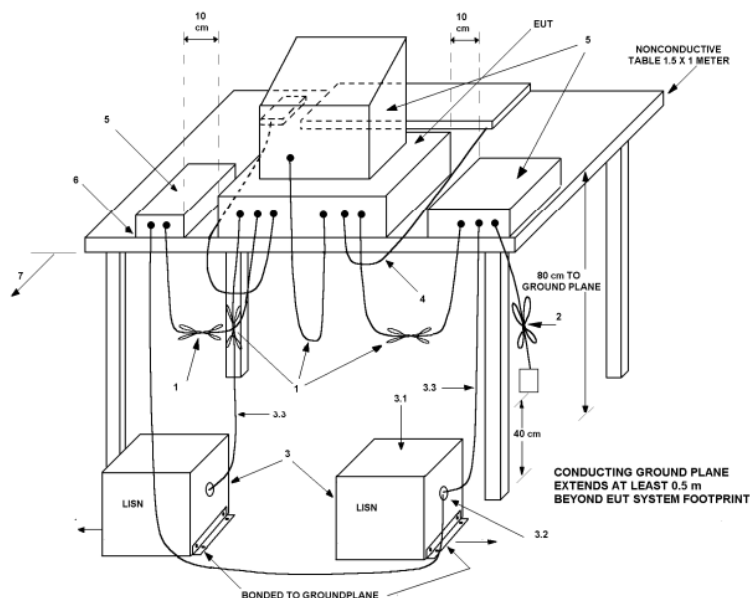


TABLE 1 - TEST ARRANGEMENT FOR CONDUCTED EMISSIONS OF TABLETOP EQUIPMENT

10.2 LIMITS AS PER 15.207

Frequency of emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66-56*	56-46*
0.5-5	56	46
5-30	60	50

TABLE 2 – CONDUCTED EMISSION LIMITS

10.3 NOTES

N/A

10.4 LINE RESULTS PLOT 120V

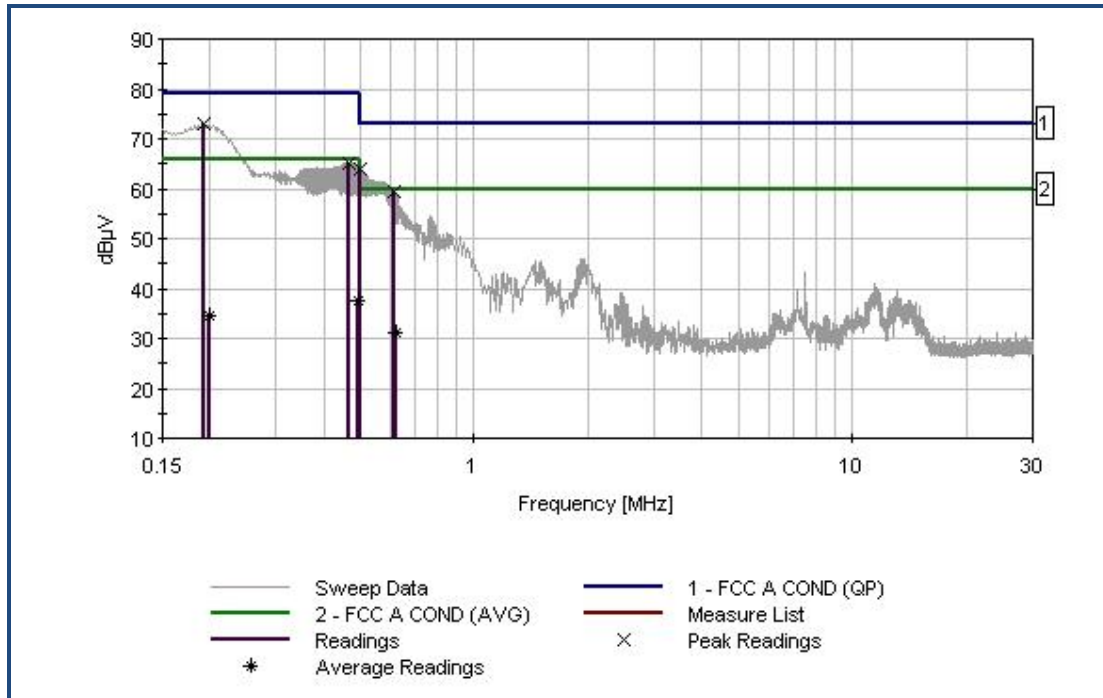


FIGURE 19 - CONDUCTED EMISSIONS PLOT – LINE 120V

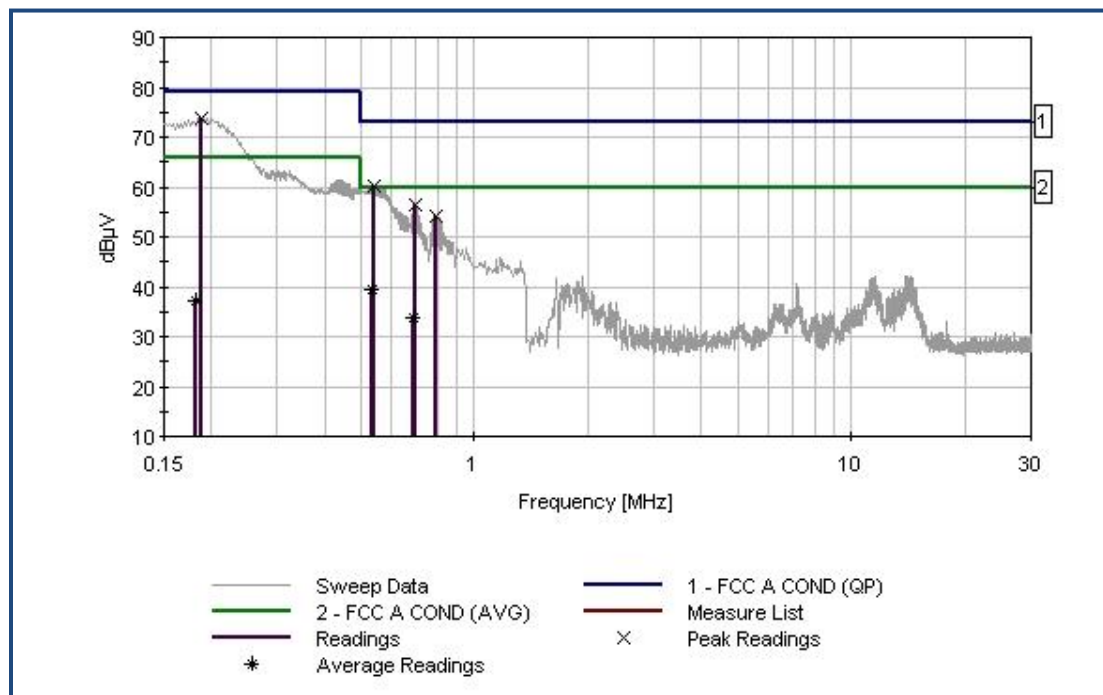


FIGURE 20 - CONDUCTED EMISSIONS PLOT – NEUTRAL 120V

10.5 MEASUREMENT DATA, LINE 120V

No.	Freq (Hz)	Rdng (dBuV)	Corrected (dBuV)	Spec (dBuV)	Margin (dB)	Detector	Polarity
1	193.632k	62.9	73.0	79.0	-6.0	Pk	Line
2	502.695k	53.7	63.8	73.0	-9.2	Pk	Line
3	611.775k	49.5	59.6	73.0	-13.4	Pk	Line
4	464.516k	55.1	65.2	79.0	-13.8	Pk	Line
5	492.250k	27.3	37.4	79.0	-41.6	Av	Line
6	622.250k	21.2	31.3	73.0	-41.7	Av	Line

10.6 MEASUREMENT DATA, NEUTRAL 120V

No.	Freq (Hz)	Rdng (dBuV)	Corrected (dBuV)	Spec (dBuV)	Margin (dB)	Detector	Polarity
1	188.178k	63.6	73.7	79.0	-5.3	Pk	Neutral
2	540.000k	50.0	60.1	73.0	-12.9	Pk	Neutral
3	693.586k	46.3	56.4	73.0	-16.6	Pk	Neutral
4	788.123k	44.1	54.2	73.0	-18.8	Pk	Neutral
5	534.200k	29.5	39.6	73.0	-33.4	Av	Neutral
6	687.000k	23.5	33.6	73.0	-39.4	Av	Neutral

11 TEST EQUIPMENT

All applicable test equipment will be calibrated in accordance with ANSI Standard NCSL Z540-1 or other NIST traceable calibration standard. Equipment is calibrated on a 2 year cycle or according to the manufacturer's recommendations.

Manufacturer	Description	Model	Serial Number	Cal/Char Due Date D/M/Y
Agilent	Spectrum Analyzer	E4407B	US4142960	10/10/2014
Com-Power	Loop Antenna	AL-130	301049	15/1/2014
Electro Metrics	Hybrid Antenna	EM-3141	9902-1141	07/12/2014
HP	RF Amplifier	11975A	2738A01196	01/03/2014
HP	RF Amplifier	8449B	N/A	19/9/2015
AH Systems	Horn Antenna	SAS-571	1242	18/11/2013
Amawima	Horn Antenna	ANT-K	002009	7/2/2014

12 TEST DIAGRAMS

12.1 CONDUCTED RF TEST SETUP



12.2 POWER LINE CONDUCTED EMISSIONS TEST SETUP



12.3 RADIATED EMISSIONS TEST SETUP

