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Amended

FCC/IC Test Report

Includes NCEE Labs report R20170216-20-02B and its amendment in full

Prepared for: **Elster American Meter**

Address: **2221 Industrial Road**
Nebraska City, NE 68410

Product: **RFMD**
USB Wireless Dongle

Test Report No: **R20170216-20-02C**

Approved By:

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Technical Manager
iNARTE Certified EMC Engineer #EMC-003337-NE

DATE: **18 July 2017**

Total Pages: **52**

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Table of Figures

1.0 Summary of test results

1.1 Test Results

The EUT has been tested according to the following specifications:

SUMMARY			
Standard Section	**Test Type and Limit**	**Result**	**Remark**
FCC 15.203	Unique Antenna Requirement	Pass	Internal Antenna
FCC 15.209 RSS-Gen, 7.1.2	Receiver Radiated Emissions	Pass	Meets the requirement of the limit.
FCC 15.247(a)(1)(i) RSS-247, 5.1(c)	Minimum Bandwidth, Limit: Min. 250kHz	Pass	Meets the requirement of the limit.
FCC 15.247(b)(1) RSS-247, 5.4	Maximum Peak Output Power, Limit: Max. 24 dBm	Pass	Meets the requirement of the limit.
FCC 15.209 RSS-Gen, 8.9	Transmitter Radiated Emissions	Pass	Meets the requirement of the limit.
FCC 15.247(a) (1) (i) RSS-247, 5.1(c)	Frequency hopping system, Limit: Max. 0.4 Seconds in 10 Second Period	Pass	Meets the requirement of the limit.
FCC 15.209 RSS-247, 5.5 RSS-Gen, 8.9	Band Edge Measurement, Limit: 20dB less than the peak value of fundamental frequency	Pass	Meets the requirement of the limit.
FCC Part 15.207 RSS-Gen, Section 8.8	Conducted Emissions	Pass	Representative Power source was used

1.2 Reason for amendment

Conducted Emissions data was added.

2.0 Description

2.1 Equipment under test

The Equipment Under Test (EUT) was a transceiver used to communicate with a wireless gas metering unit transmitter. It operates from 907 to 924 MHz and has transmit capabilities only.

EUT Received Date: 11 April 2017
EUT Tested Dates: 28 April 2017 - 18 July 2017

MODEL	RFMD
Part No.	55217G438 Rev 4
POWER SUPPLY	5 VDC (USB 2.0 serial)
ANTENNA TYPE	EUT uses a reverse polarity connector

NOTE: For more detailed features description, please refer to the manufacturer's specifications or user's manual.

2.2 Laboratory description

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
4740 Discovery Drive
Lincoln, NE 68521

A2LA Certificate Number :	1953.01
FCC Accredited Test Site Designation No:	US1060
Industry Canada Test Site Registration No:	4294A-1
NCC CAB Identification No:	US0177

Environmental conditions varied slightly throughout the tests:
Relative humidity of 32 $\pm$ 4%
Temperature of 22 $\pm$ 3° Celsius

2.3 Description of test modes

The EUT operates on, and was tested at the frequencies below:

Channel	Frequency
Low	907.0
Middle	915.4
High	923.8

These are the only three representative channels tested in the frequency range according to FCC Part 15.31 and RSS-Gen Table A1. See the operational description for a list of all channel frequency and designations.

The EUT was tested with 2 antenna options:

1. ANT-916-CW-QW, peak gain = 1.8 dBi
2. ANT-ELE-S01-005, peak gain = 3 dBi

2.4 Applied standards

The EUT is a frequency hopping device operating in the 902 MHz to 928 MHz amateur band. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC Part 15, Subpart C; 15.209 and 15.247
Industry Canada, RSS-247, Issue 1
Industry Canada, RSS-Gen, Issue 4
ANSI C63.10:2013
ANSI C63.4:2014

All test items have been performed and recorded as per the above.

2.5 Description of support units

None

2.6 Configuration of system under test

This EUT was set to transmit in a worse-case scenario with modulation on. The manufacturer modified the unit to transmit continuously on the lowest, highest and one channel in the middle.

3.0 Test equipment used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Rohde & Schwarz Test Receiver	ES126	100037	24 Jan 2017	24 Jan 2018
EMCO Biconilog Antenna	3142B	1647	02 Aug 2016	02 Aug 2017
EMCO Horn Antenna	3115	6416	25 Jan 2016	25 Jan 2018
EMCO Horn Antenna	3116	2576	26 Jan 2016	26 Jan 2018
Rohde & Schwarz Preamplifier	TS-PR18	3545700803	9 Feb 2017*	9 Feb 2018*
Trilithic High Pass Filter	6HC330	23042	9 Feb 2017*	9 Feb 2018*
Rohde & Schwarz LISN	ESH3-Z5	100023	23 Jan 2017	23 Jan 2018

*Internal Characterization

4.0 Detailed results

4.1 Unique antenna requirement

4.1.1 Standard applicable

For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

4.1.2 Antenna description

The EUT has a reverse polarity connector and it can be used with only two sets of antennas the manufacturer provides.

The antennas tested were from AntennaFactor by Linx. Models ANT-ELE-S01-005 and ANT-916-CW-QW

4.2 Radiated emissions

Test Method: ANSI C63.10, Section(s) 6.5
ANSI C63.4. Section(s) 8.3

4.2.1 Limits for radiated emissions measurements

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

FREQUENCIES (MHz)	FIELD STRENGTH (μV/m)	MEASUREMENT DISTANCE (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (μV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.

4.2.2 Test procedures

a. The EUT was placed on the top of a rotating table above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. The table was 0.8m high for measurements form 30MHz-1Ghz and 1.5m for measurements from 1GHz and higher.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.

d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.

e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

g. The EUT was maximized in all 3 orthogonal positions.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.

2. The resolution bandwidth 1 MHz for all measurements and at frequencies above 1GHz, A peak detector was used for all measurements above 1GHz. Measurements were made with an EMI Receiver.

4.2.3 Deviations from test standard

No deviation.

4.2.4 Test setup

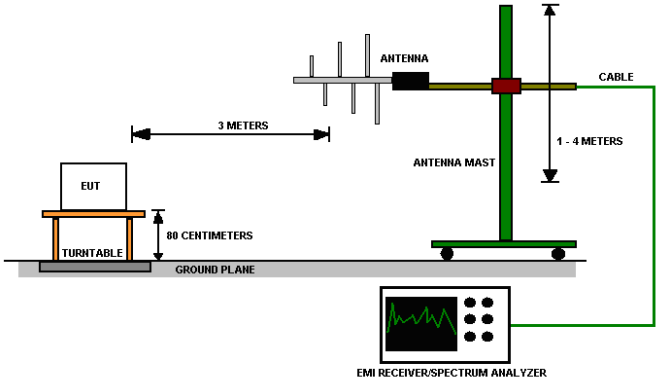

Figure 1 - Radiated Emissions Test Setup

The EUT was tested in all 3 orthogonal axis of the EUT and meet the requirements from ANS C63.10 Section 5.10.1.

4.2.5 EUT operating conditions

The EUT was powered by 5 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

4.2.6 Test results

EUT MODULE	RFMD	MODE	Transmit, Low Channel, ANT-919-CW-QW antenna
INPUT POWER	5 VDC	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

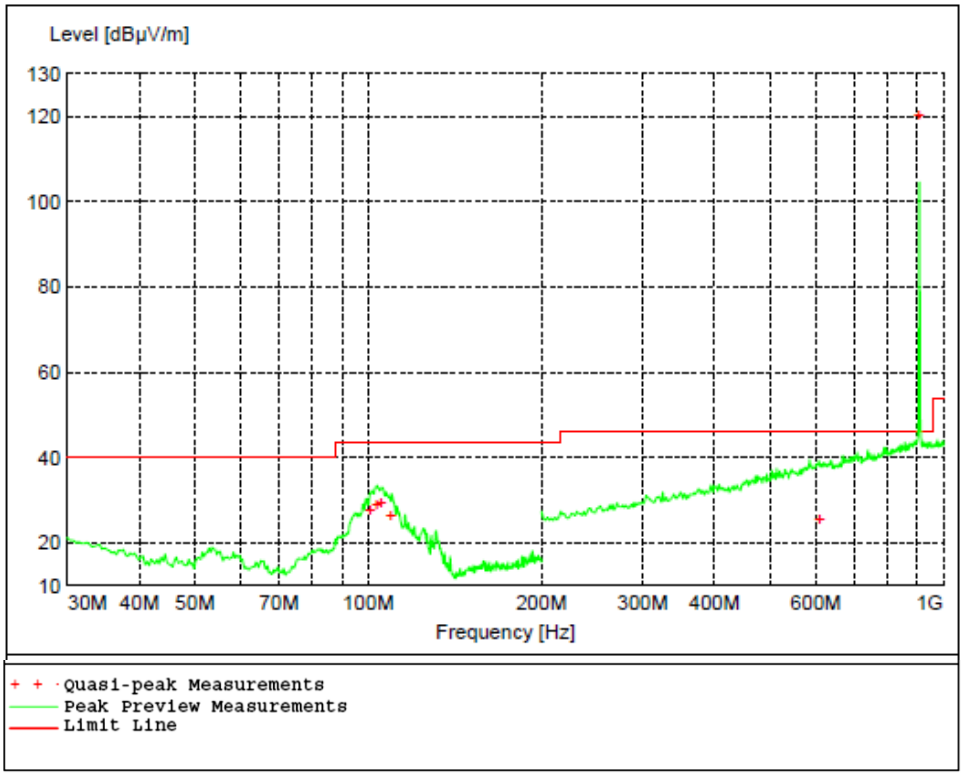

Figure 2 - Radiated Emissions Plot, Low Channel, ANT-919-CW-QW antenna

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value
5. The EUT was measured in both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

Table 1 - Radiated Emissions Quasi-peak Measurements, Low Channel, ANT-919-CW-QW antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
100.740000	28.09	43.50	15.40	99	287	VERT
103.620000	29.09	43.50	14.40	101	102	VERT
105.300000	29.41	43.50	14.10	101	307	VERT
109.380000	26.78	43.50	16.70	100	72	VERT
609.300000	25.98	46.00	20.00	99	195	VERT
907.000000	120.51	NA	NA	113	97	VERT

Table 2 - Radiated Emissions Average Measurements, Low Channel, ANT-919-CW-QW antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1814.000000	31.95	54.00	22.05	157	319	VERT
2721.000000	30.86	54.00	23.14	160	180	HORI
3628.400000	28.12	54.00	25.88	206	129	VERT
4533.000000	28.11	54.00	25.89	131	18	VERT
5441.800000	33.11	54.00	20.89	163	182	VERT
6349.600000	36.97	54.00	17.03	197	243	HORI
7255.200000	42.2	54.00	11.8	277	192	VERT
8162.200000	49.06	54.00	4.94	106	207	HORI
9069.000000	39.33	54.00	14.67	251	131	VERT

Note: Average Level = Peak Level – Duty Cycle Correction Factor
Duty Cycle Correction Factor is calculated in Figures 10 and 11. -13.40 dB was used.

Table 3 - Radiated Emissions Peak Measurements, Low Channel, ANT-919-CW-QW antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1814.000000	45.35	74.00	28.65	157	319	VERT
2721.000000	44.26	74.00	29.74	160	180	HORI
3628.400000	41.52	74.00	32.48	206	129	VERT
4533.000000	41.51	74.00	32.49	131	18	VERT
5441.800000	46.51	74.00	27.49	163	182	VERT
6349.600000	50.37	74.00	23.63	197	243	HORI
7255.200000	55.60	74.00	18.40	277	192	VERT
8162.200000	62.46	74.00	11.54	106	207	HORI
9069.000000	52.73	74.00	21.27	251	131	VERT

EUT MODULE	RFMD	MODE	Transmit, Low Channel, ANT-ELE-S01-005 antenna
INPUT POWER	5 VDC	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

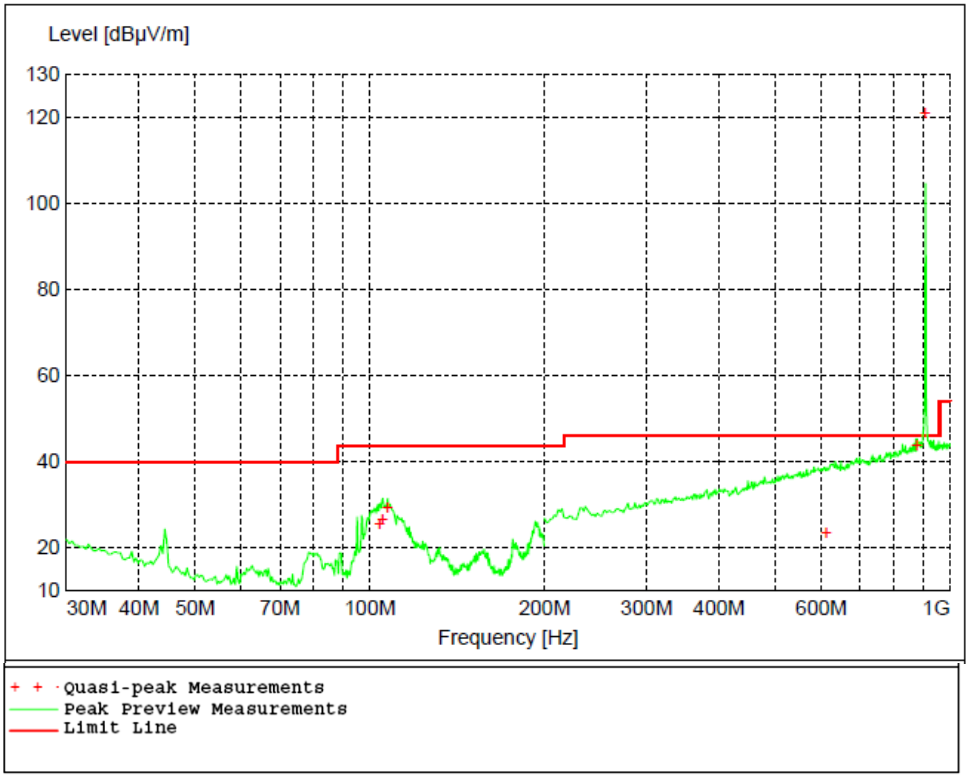

Figure 3 - Radiated Emissions Plot, Low Channel, ANT-ELE-S01-005 antenna

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value
5. The EUT was measured in both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

Table 4 - Radiated Emissions Quasi-peak Measurements, Low Channel, ANT-ELE-S01-005 antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
104.040000	25.60	43.50	17.90	110	360	VERT
105.300000	26.84	43.50	16.70	99	360	VERT
107.340000	29.39	43.50	14.10	99	43	VERT
612.120000	23.58	46.00	22.40	217	340	HORI
876.900000	43.76	46.00	2.20	101	288	VERT
907.000000	121.11	NA	NA	99	285	VERT

Table 5 - Radiated Emissions Average Measurements, Low Channel, ANT-ELE-S01-005 antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1814.200000	26.78	54.00	27.22	99	199	VERT
2721.400000	29.55	54.00	24.45	170	53	HORI
3628.200000	27.98	54.00	26.02	99	222	HORI
4527.800000	27.43	54.00	26.57	399	34	VERT
5441.600000	29.90	54.00	24.10	193	105	HORI
6349.000000	35.10	54.00	18.90	224	204	HORI
7255.200000	37.75	54.00	16.25	189	81	VERT
8164.000000	45.89	54.00	8.11	99	128	HORI
9069.200000	40.02	54.00	13.98	165	129	HORI

Note: Average Level = Peak Level – Duty Cycle Correction Factor
Duty Cycle Correction Factor is calculated in Figures 10 and 11. -13.40 dB was used

Table 6 - Radiated Emissions Peak Measurements, Low Channel, ANT-ELE-S01-005 antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1814.200000	40.18	74.00	33.82	99	199	VERT
2721.400000	42.95	74.00	31.05	170	53	HORI
3628.200000	41.38	74.00	32.62	99	222	HORI
4527.800000	40.83	74.00	33.17	399	34	VERT
5441.600000	43.30	74.00	30.70	193	105	HORI
6349.000000	48.50	74.00	25.50	224	204	HORI
7255.200000	51.15	74.00	22.85	189	81	VERT
8164.000000	59.29	74.00	14.71	99	128	HORI
9069.200000	53.42	74.00	20.58	165	129	HORI

EUT MODULE	RFMD	MODE	Transmit, Mid Channel, ANT-919-CW-QW antenna
INPUT POWER	5 VDC	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

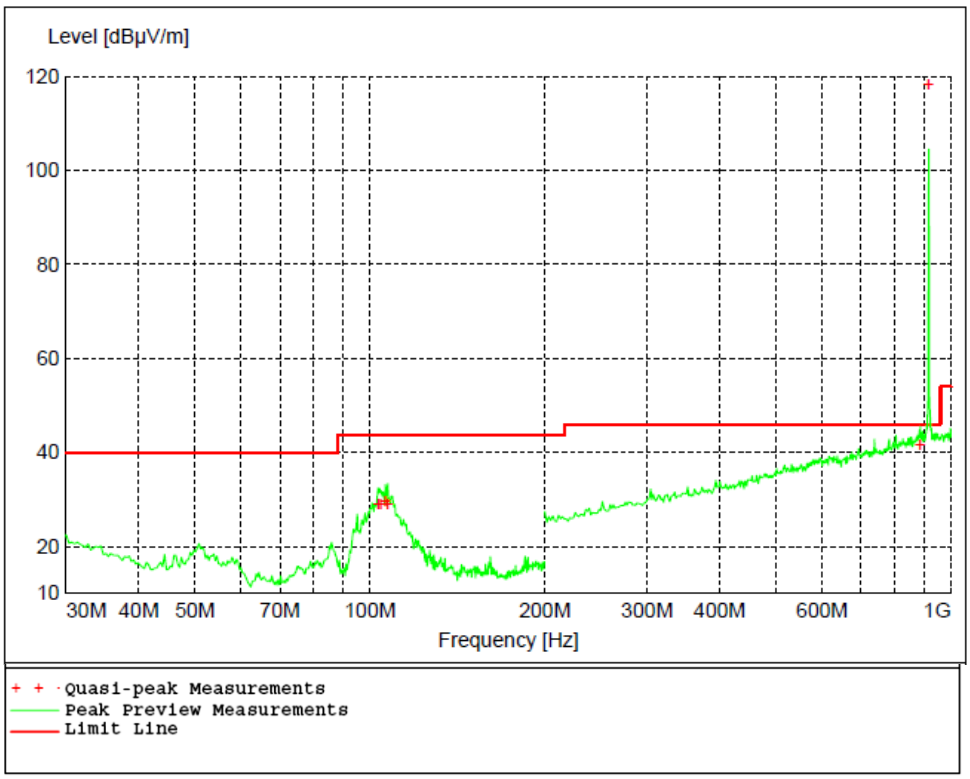

Figure 4 - Radiated Emissions Plot, Mid Channel, ANT-919-CW-QW antenna

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. The EUT was measured in both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

Table 7 - Radiated Emissions Quasi-peak Measurements, Mid Channel, ANT-919-CW-QW antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
103.320000	29.17	43.50	14.40	100	243	VERT
104.460000	29.07	43.50	14.40	99	102	VERT
106.260000	29.74	43.50	13.80	101	106	VERT
107.280000	29.13	43.50	14.40	101	38	VERT
885.300000	41.77	46.00	4.20	183	326	VERT
915.400000	118.29	NA	NA	99	9	VERT

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

Table 8 - Radiated Emissions Average Measurements, Mid Channel, ANT-919-CW-QW antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1831.000000	31.04	54.00	22.96	153	312	VERT
2746.600000	29.66	54.00	24.34	125	209	HORI
3661.200000	30.19	54.00	23.81	190	104	HORI
4571.600000	28.08	54.00	25.92	101	216	HORI
5497.400000	29.89	54.00	24.11	99	47	VERT
6408.400000	37.50	54.00	16.50	123	290	HORI
7324.000000	42.21	54.00	11.79	99	157	VERT
8237.800000	48.25	54.00	5.75	101	199	HORI
9153.000000	41.92	54.00	12.08	126	202	HORI

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

Note: Average Level = Peak Level – Duty Cycle Correction Factor
Duty Cycle Correction Factor is calculated in Figures 10 and 11. -13.40 dB was used

Table 9 - Radiated Emissions Peak Measurements, Mid Channel, ANT-919-CW-QW antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1831.000000	44.44	74.00	29.56	153	312	VERT
2746.600000	43.06	74.00	30.94	125	209	HORI
3661.200000	43.59	74.00	30.41	190	104	HORI
4571.600000	41.48	74.00	32.52	101	216	HORI
5497.400000	43.29	74.00	30.71	99	47	VERT
6408.400000	50.90	74.00	23.10	123	290	HORI
7324.000000	55.61	74.00	18.39	99	157	VERT
8237.800000	61.65	74.00	12.35	101	199	HORI
9153.000000	55.32	74.00	18.68	126	202	HORI

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

EUT MODULE	RFMD	MODE	Transmit, Mid Channel, ANT-ELE-S01-005 antenna
INPUT POWER	5 VDC	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

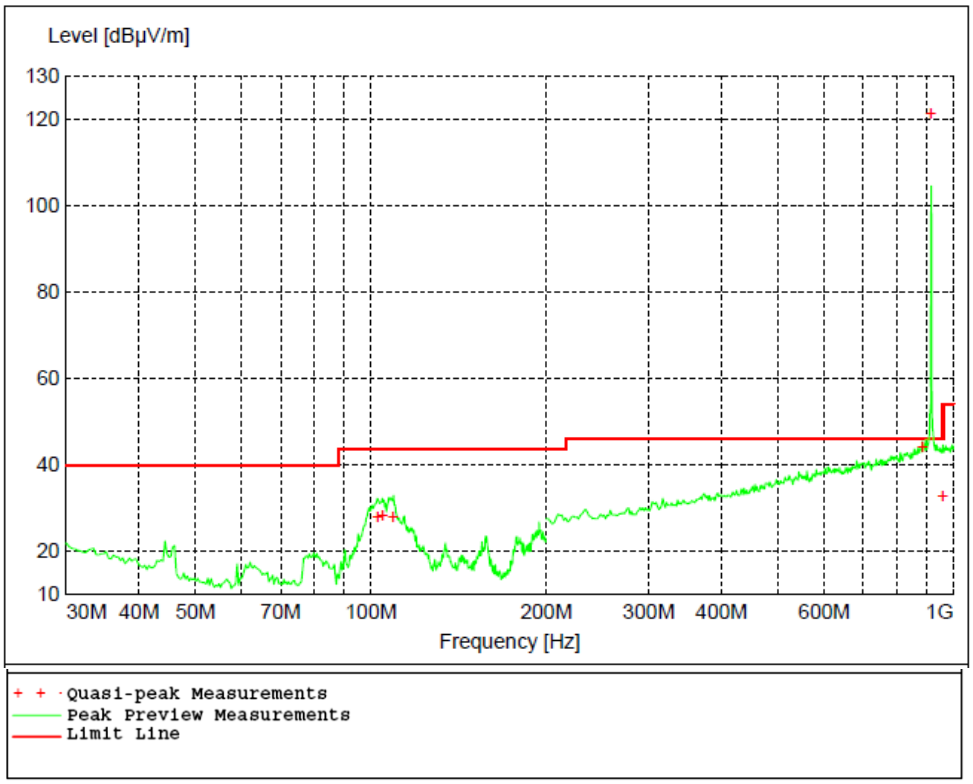

Figure 5 - Radiated Emissions Plot, Mid Channel, ANT-ELE-S01-005 antenna

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. The EUT was measured in both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

Table 10 - Radiated Emissions Quasi-peak Measurements, Mid Channel, ANT-ELE-S01-005 antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
102.840000	28.21	43.50	15.30	104	359	VERT
104.760000	28.47	43.50	15.10	99	0	VERT
109.140000	27.98	43.50	15.50	99	25	VERT
885.300000	44.12	46.00	1.90	99	285	VERT
915.400000	121.39	NA	NA	99	286	VERT
959.220000	32.79	46.00	13.20	110	217	VERT

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

Table 11 - Radiated Emissions Average Measurements, Mid Channel, ANT-ELE-S01-005 antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1831.000000	30.55	54.00	23.45	180	221	HORI
2746.600000	29.40	54.00	24.60	136	63	HORI
3662.000000	30.07	54.00	23.93	151	285	HORI
4577.400000	28.88	54.00	25.12	101	197	VERT
5492.800000	31.52	54.00	22.48	312	148	VERT
6407.200000	36.44	54.00	17.56	98	185	HORI
7324.000000	41.73	54.00	12.27	271	120	VERT
8239.600000	46.70	54.00	7.30	100	118	HORI
9155.200000	38.94	54.00	15.06	145	119	VERT

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

Note: Average Level = Peak Level – Duty Cycle Correction Factor
Duty Cycle Correction Factor is calculated in Figures 10 and 11. -13.40 dB was used

Table 12 - Radiated Emissions Peak Measurements, Mid Channel, ANT-ELE-S01-005 antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1831.000000	43.95	74.00	30.05	180	221	HORI
2746.600000	42.80	74.00	31.20	136	63	HORI
3662.000000	43.47	74.00	30.53	151	285	HORI
4577.400000	42.28	74.00	31.72	101	197	VERT
5492.800000	44.92	74.00	29.08	312	148	VERT
6407.200000	49.84	74.00	24.16	98	185	HORI
7324.000000	55.13	74.00	18.87	271	120	VERT
8239.600000	60.10	74.00	13.90	100	118	HORI
9155.200000	52.34	74.00	21.66	145	119	VERT

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

EUT MODULE	RFMD	MODE	Transmit, High Channel, ANT-919-CW-QW antenna
INPUT POWER	5 VDC	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

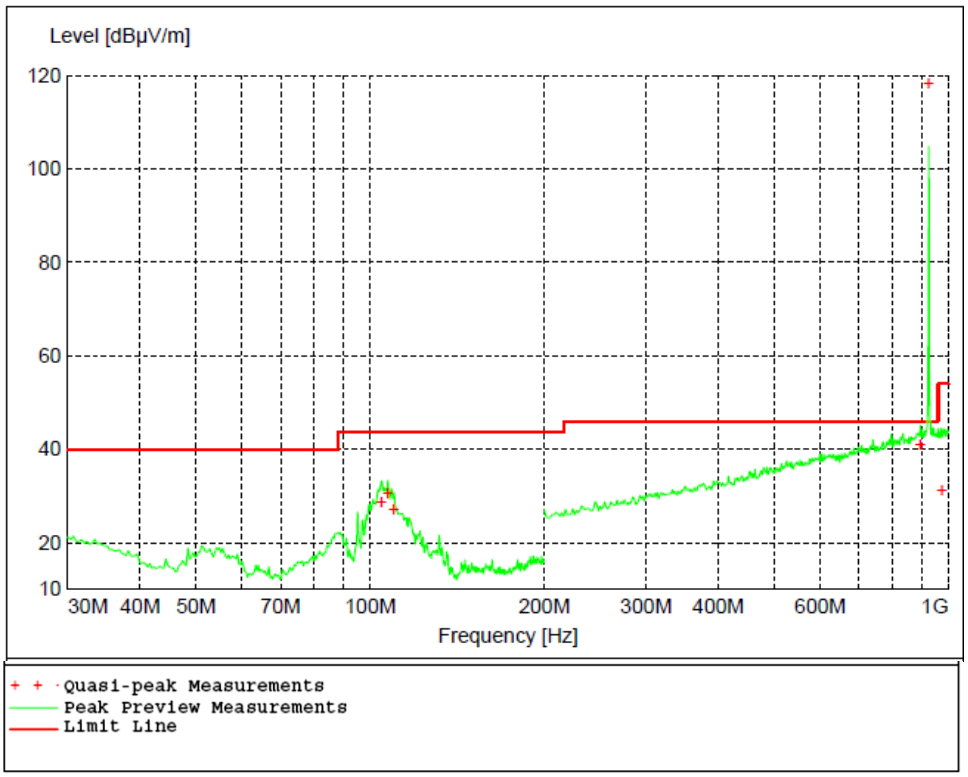

Figure 6 - Radiated Emissions Plot, High Channel, ANT-919-CW-QW antenna

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. The EUT was measured in both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

Table 13 - Radiated Emissions Quasi-peak Measurements, High Channel, ANT-919-CW-QW antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
104.520000	28.74	43.50	14.80	99	322	VERT
107.280000	30.61	43.50	12.90	98	304	VERT
109.860000	27.09	43.50	16.40	101	297	VERT
893.820000	41.00	46.00	5.00	118	11	VERT
923.800000	118.25	NA	NA	99	8	VERT
973.620000	31.21	54.00	22.79	101	9	VERT

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

Table 14 - Radiated Emissions Average Measurements, High Channel, ANT-919-CW-QW antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1847.400000	31.28	54.00	22.72	107	178	VERT
2771.200000	28.56	54.00	25.44	100	216	VERT
3661.200000	30.19	54.00	23.81	190	104	HORI
4571.600000	28.08	54.00	25.92	101	216	HORI
5497.400000	29.89	54.00	24.11	99	47	VERT
6408.400000	37.50	54.00	16.50	123	290	HORI
7324.000000	42.21	54.00	11.79	99	157	VERT
8237.800000	48.25	54.00	5.75	101	199	HORI
9153.000000	41.92	54.00	12.08	126	202	HORI

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

Note: Average Level = Peak Level – Duty Cycle Correction Factor
Duty Cycle Correction Factor is calculated in Figures 10 and 11. -13.40 dB was used

Table 15 - Radiated Emissions Peak Measurements, High Channel, ANT-919-CW-QW antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1847.400000	44.68	74.00	29.32	107	178	VERT
2771.200000	41.96	74.00	32.04	100	216	VERT
3661.200000	43.59	74.00	30.41	190	104	HORI
4571.600000	41.48	74.00	32.52	101	216	HORI
5497.400000	43.29	74.00	30.71	99	47	VERT
6408.400000	50.90	74.00	23.10	123	290	HORI
7324.000000	55.61	74.00	18.39	99	157	VERT
8237.800000	61.65	74.00	12.35	101	199	HORI
9153.000000	55.32	74.00	18.68	126	202	HORI

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

EUT MODULE	RFMD	MODE	Transmit, High Channel, ANT-ELE-S01-005 antenna
INPUT POWER	5 VDC	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

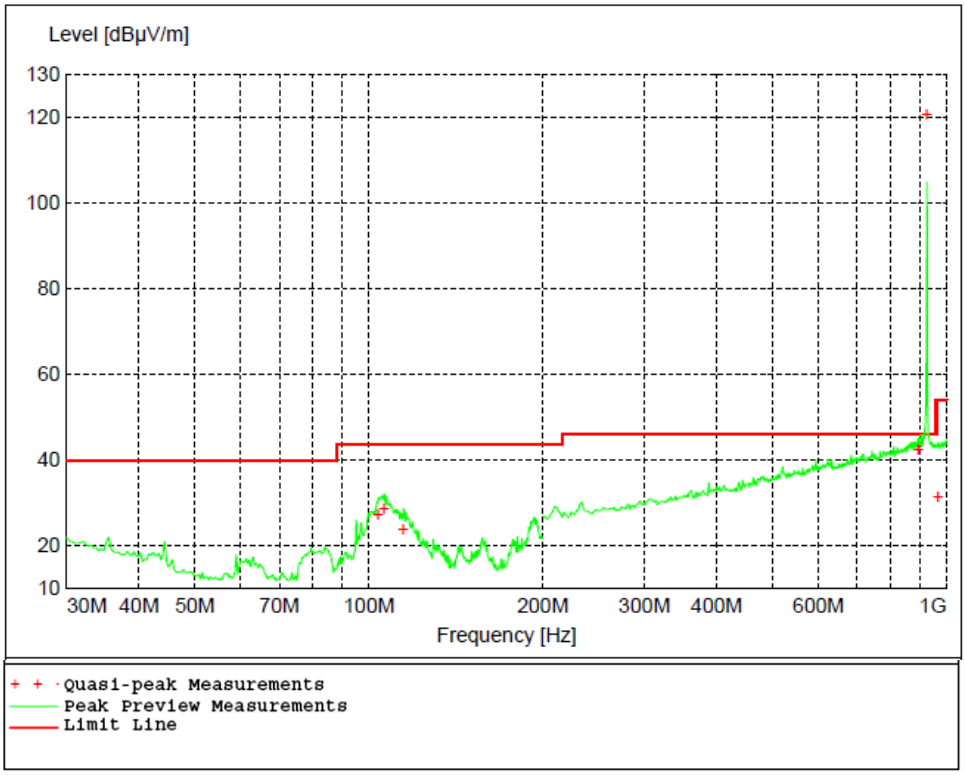

Figure 7 - Radiated Emissions Plot, High Channel, ANT-ELE-S01-005 antenna

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. The EUT was measured in both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

Table 16 - Radiated Emissions Quasi-peak Measurements, High Channel, ANT-ELE-S01-005 antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
103.800000	27.22	43.50	16.28	99	112	VERT
106.260000	28.74	43.50	14.76	114	28	VERT
114.600000	24.00	43.50	19.50	99	326	VERT
893.760000	42.65	46.00	3.35	101	292	VERT
923.800000	120.58	NA	NA	99	287	VERT
967.380000	31.35	54.00	22.65	98	360	VERT

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

Table 17 - Radiated Emissions Average Measurements, High Channel, ANT-ELE-S01-005 antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1847.800000	39.67	54.00	14.33	103	100	VERT
2771.400000	32.51	54.00	21.49	163	146	VERT
3695.000000	28.07	54.00	25.93	187	69	HORI
4607.400000	26.91	54.00	27.09	99	129	VERT
5536.000000	29.25	54.00	24.75	399	84	HORI
6467.400000	37.68	54.00	16.32	173	89	HORI
7389.800000	43.75	54.00	10.25	180	84	VERT
8315.200000	45.04	54.00	8.96	98	124	HORI
9239.200000	39.70	54.00	14.30	133	134	HORI

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

Note: Average Level = Peak Level – Duty Cycle Correction Factor
Duty Cycle Correction Factor is calculated in Figures 10 and 11. -13.40 dB was used

Table 18 - Radiated Emissions Peak Measurements, High Channel, ANT-ELE-S01-005 antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1847.800000	53.07	74.00	20.93	103	100	VERT
2771.400000	45.91	74.00	28.09	163	146	VERT
3695.000000	41.47	74.00	32.53	187	69	HORI
4607.400000	40.31	74.00	33.69	99	129	VERT
5536.000000	42.65	74.00	31.35	399	84	HORI
6467.400000	51.08	74.00	22.92	173	89	HORI
7389.800000	57.15	74.00	16.85	180	84	VERT
8315.200000	58.44	74.00	15.56	98	124	HORI
9239.200000	53.10	74.00	20.90	133	134	HORI

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

EUT MODULE	RFMD	MODE	Receive, High Channel, ANT-919-CW-QW antenna
INPUT POWER	5 VDC	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

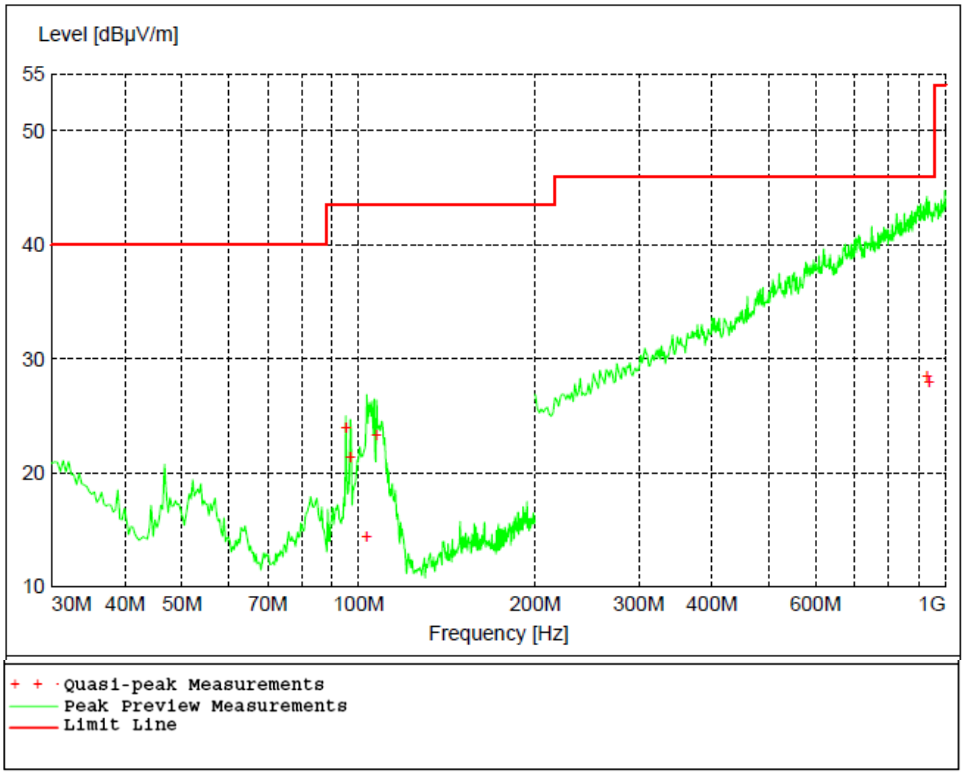

Figure 8 - Radiated Emissions Plot, Receive Mode, ANT-919-CW-QW antenna

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. The EUT was measured in both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

Table 13 - Radiated Emissions Quasi-peak Measurements, Receive Mode, ANT-919-CW-QW antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
95.160000	24.04	43.50	19.46	100	124	VERT
96.840000	21.45	43.50	22.05	98	249	VERT
103.320000	14.42	43.50	29.08	367	81	VERT
107.220000	23.30	43.50	20.20	102	360	VERT
931.140000	28.56	46.00	17.44	400	222	VERT
938.580000	28.05	46.00	17.95	100	214	HORI

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

Table 14 - Radiated Emissions Peak Measurements, Receive Mode, ANT-919-CW-QW antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1841.200000	32.91	54.00	21.09	98	309	VERT
2746.800000	35.75	54.00	18.25	98	137	VERT
3667.200000	38.79	54.00	15.21	101	341	HORI
4562.400000	40.08	54.00	13.92	101	92	VERT
5473.200000	42.07	54.00	11.93	101	104	VERT
9509.000000	45.00	54.00	9.00	98	90	VERT

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

EUT MODULE	RFMD	MODE	Receive, High Channel, ANT-ELE-S01-005 antenna
INPUT POWER	5 VDC	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

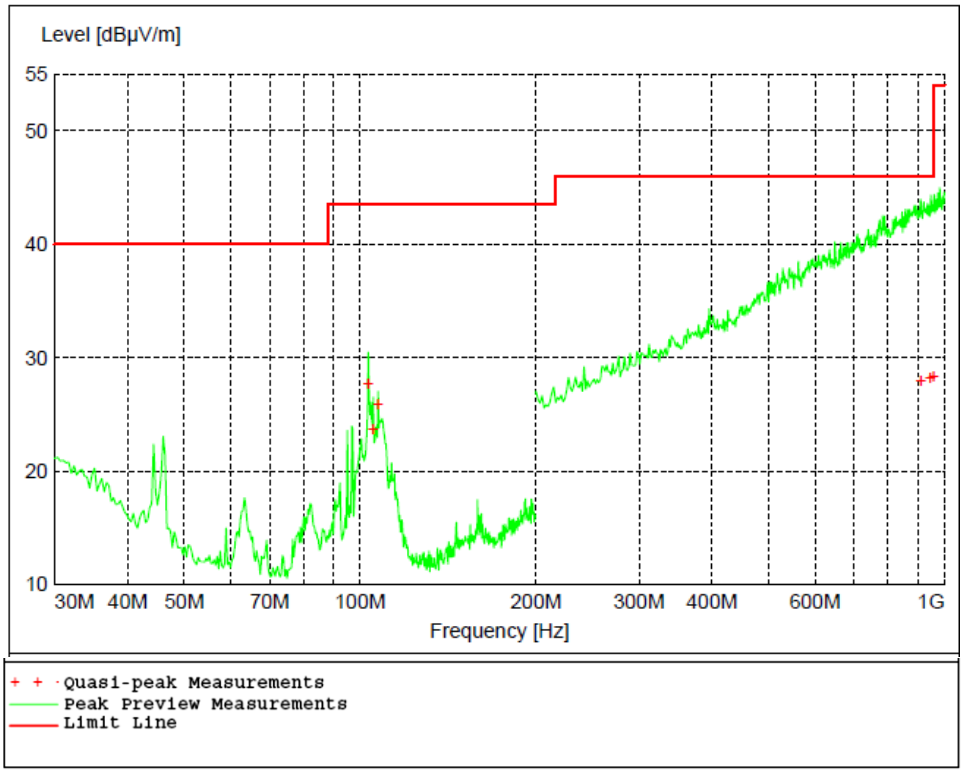

Figure 9 - Radiated Emissions Plot, Receive Mode, ANT-ELE-S01-005 antenna

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. The EUT was measured in both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

Table 16 - Radiated Emissions Quasi-peak Measurements, Receive Mode, ANT-ELE-S01-005 antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
103.320000	27.69	43.50	15.81	101	360	VERT
105.300000	23.76	43.50	19.74	99	360	VERT
107.280000	25.97	43.50	17.53	100	265	VERT
911.880000	27.97	46.00	18.03	390	195	VERT
946.020000	28.24	46.00	17.76	233	222	VERT
958.260000	28.36	46.00	17.64	148	60	HORI

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

Table 17 - Radiated Emissions Peak Measurements, Receive Mode, ANT-ELE-S01-005 antenna

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1823.000000	32.15	54.00	21.85	101	165	HORI
2736.200000	34.99	54.00	19.01	98	121	VERT
3649.200000	38.97	54.00	15.03	399	94	VERT
4574.200000	40.00	54.00	14.00	313	0	VERT
5490.400000	42.38	54.00	11.62	399	172	VERT
9469.800000	45.20	54.00	8.80	145	235	VERT

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

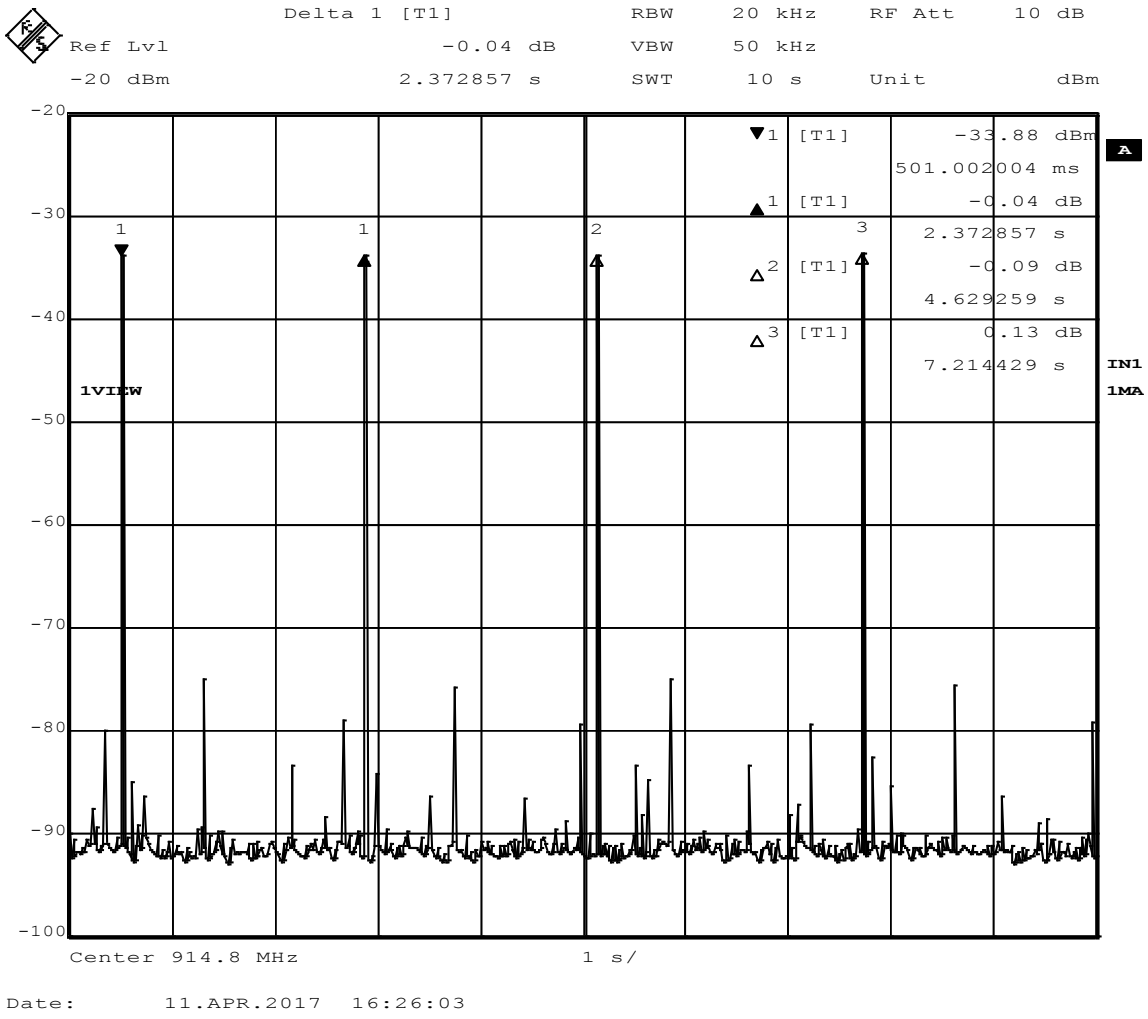

Figure 10 – Period

A maximum of 1 pulses can occur in any 100 ms window

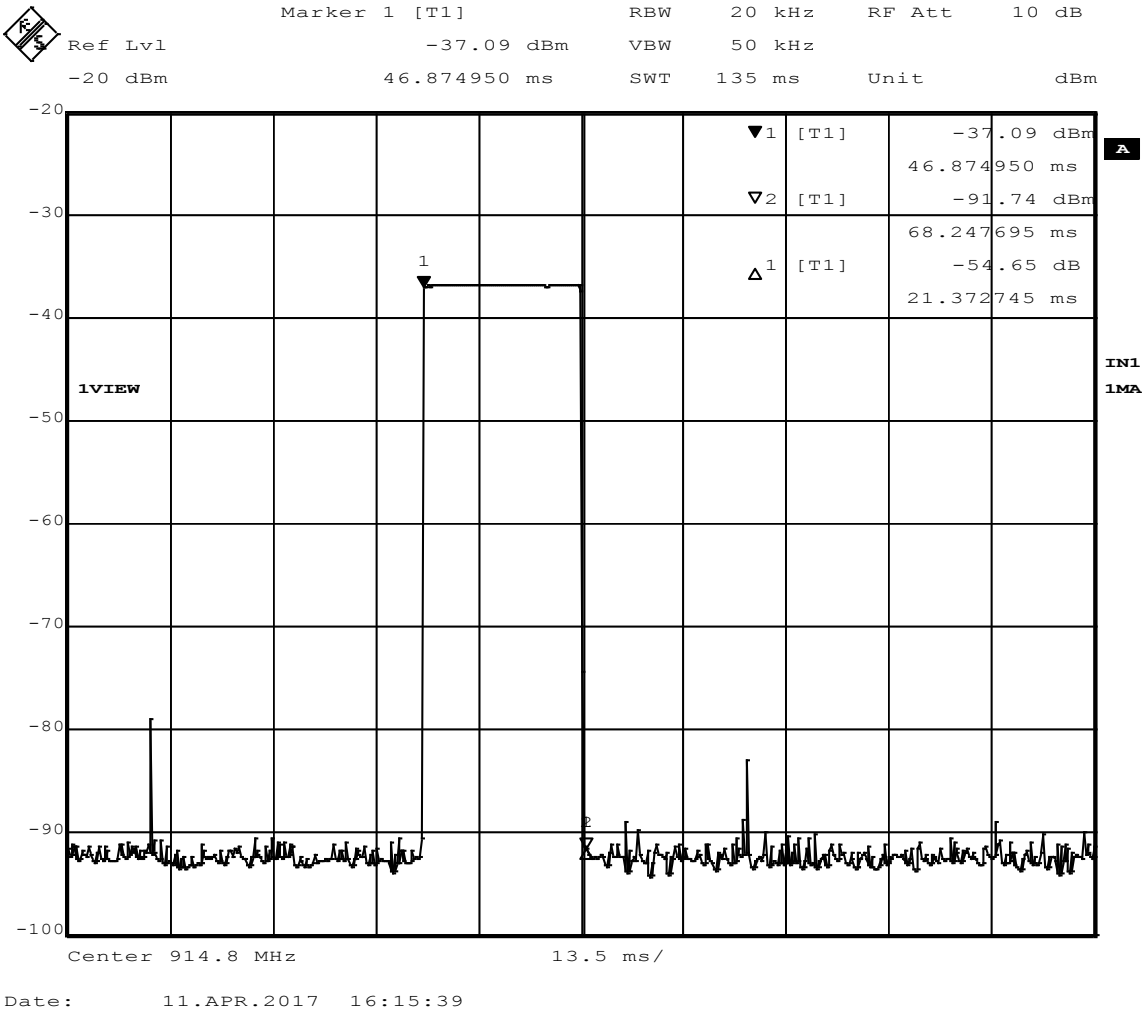

Figure 11 – Maximum Pulse Width

Duty cycle correction factor = 20*log(21.37/100) = -13.40 dB

Note 1: 100ms is the longest allowed period per FCC Part 15.35

Note 2: there was only one 21.37 ms pulses per 100ms period.

4.3 Bandwidth and Peak Output Power

Test Method: ANSI C63.10, Section(s) 6.7, 6.9, 7.8.5

4.3.1 Limits of bandwidth measurements

The 20 dB occupied bandwidth limit is 250 kHz minimum and peak output power limit is 24 dBm are displayed for informational purposes only. The peak EIRP was measured using a 10 MHz RBW, which was over-laid on the plot showing the bandwidth using a 100 kHz RBW.

4.3.2 Test procedures

The EUT was connected to the spectrum analyzer directly with a low-loss shielded coaxial cable and an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 3 kHz RBW and 10 kHz VBW.

The signal was captured with a 3 kHz resolution bandwidth and the frequencies where the measurements were 20dB below the maximum power were marked. The bandwidth between these frequencies was recorded as the 20 dB bandwidth.

4.3.3 Deviations from test standard

No deviation.

4.3.4 Test setup

Figure 12 - Bandwidth Measurements Test Setup

*20dB Attenuator was used and it was accounted for in the plots

4.3.5 EUT operating conditions

The EUT was powered by 5 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

4.3.6 Test results

EUT MODULE	RFMD	MODE	Transmit
INPUT POWER	5 VDC	FREQUENCY RANGE	907MHz – 924 MHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

20 dB Bandwidth

CHANNEL	CHANNEL FREQUENCY (MHz)	20 dB BW (kHz)
1	907.0	303.40
2	915.4	303.00
3	923.8	304.40

*The limit is 250 kHz minimum. The measurements were conducted at 3 kHz RBW and 10 kHz VBW.

REMARKS:
None

Peak Output Power

CHANNEL	CHANNEL FREQUENCY (MHz)	PEAK POWER OUTPUT (dBm)	RESULT
1	907.0	23.09	PASS
2	915.4	22.58	PASS
3	923.8	22.20	PASS

*The limit is 24dBm. The measurements were conducted at 10 MHz RBW and 10 MHz VBW. See marker 1 on the plots.

All measurements were taken from Figures 16 - 18

REMARKS:
None

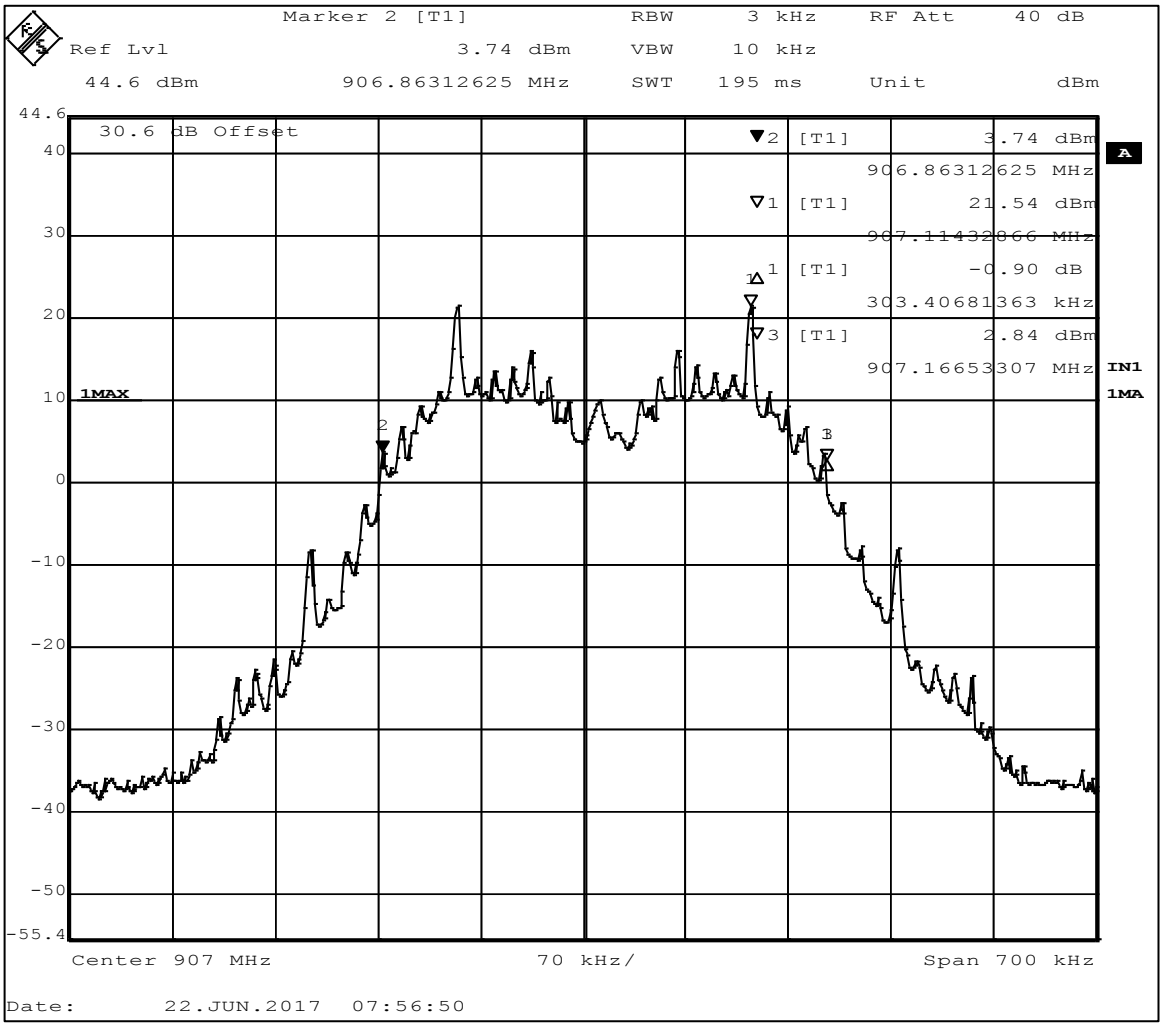

Figure 13 - 20 dB Bandwidth, Low Channel. 303.40 kHz

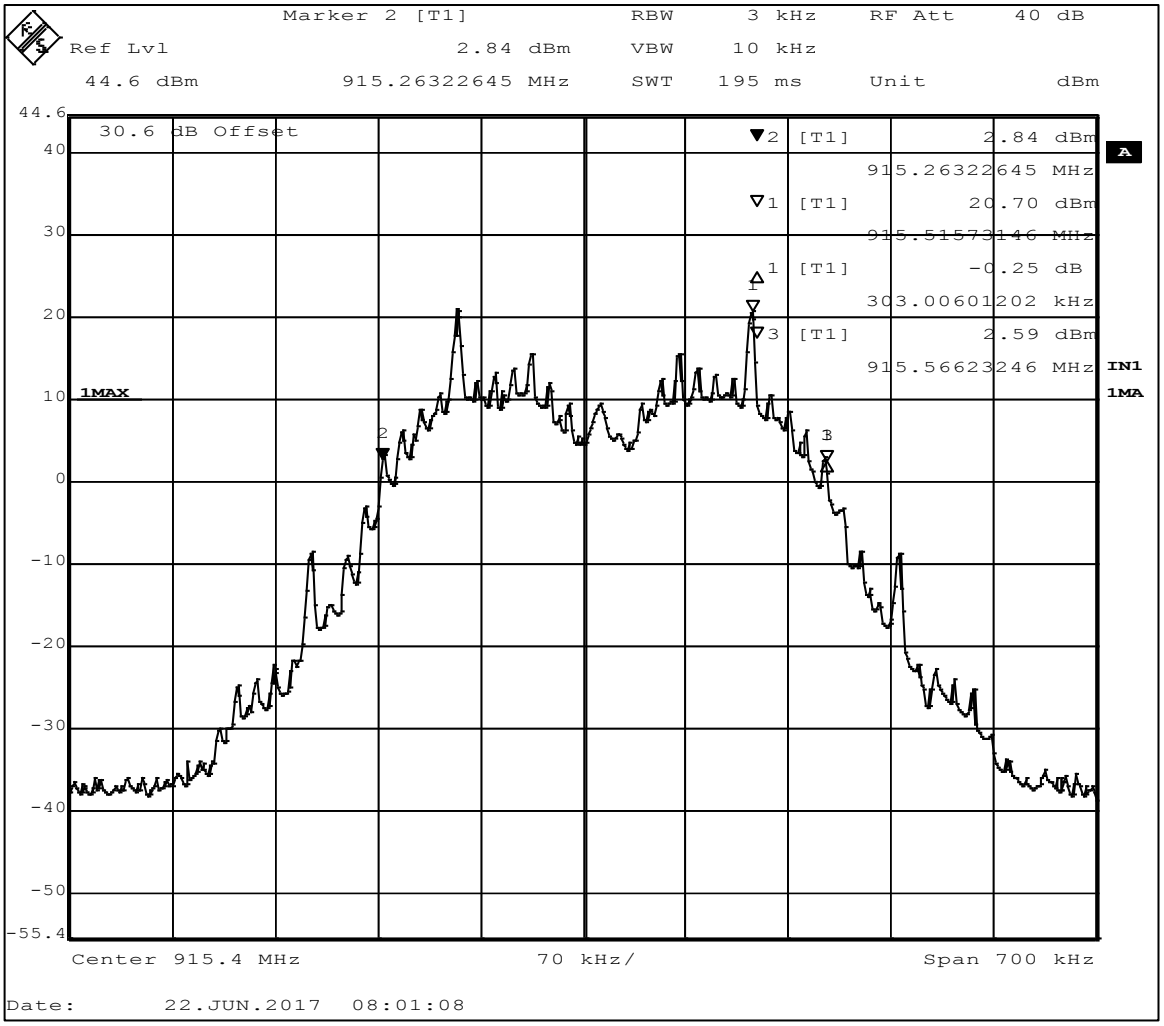

Figure 14 - 20 dB Bandwidth, Mid Channel, 303.00 kHz

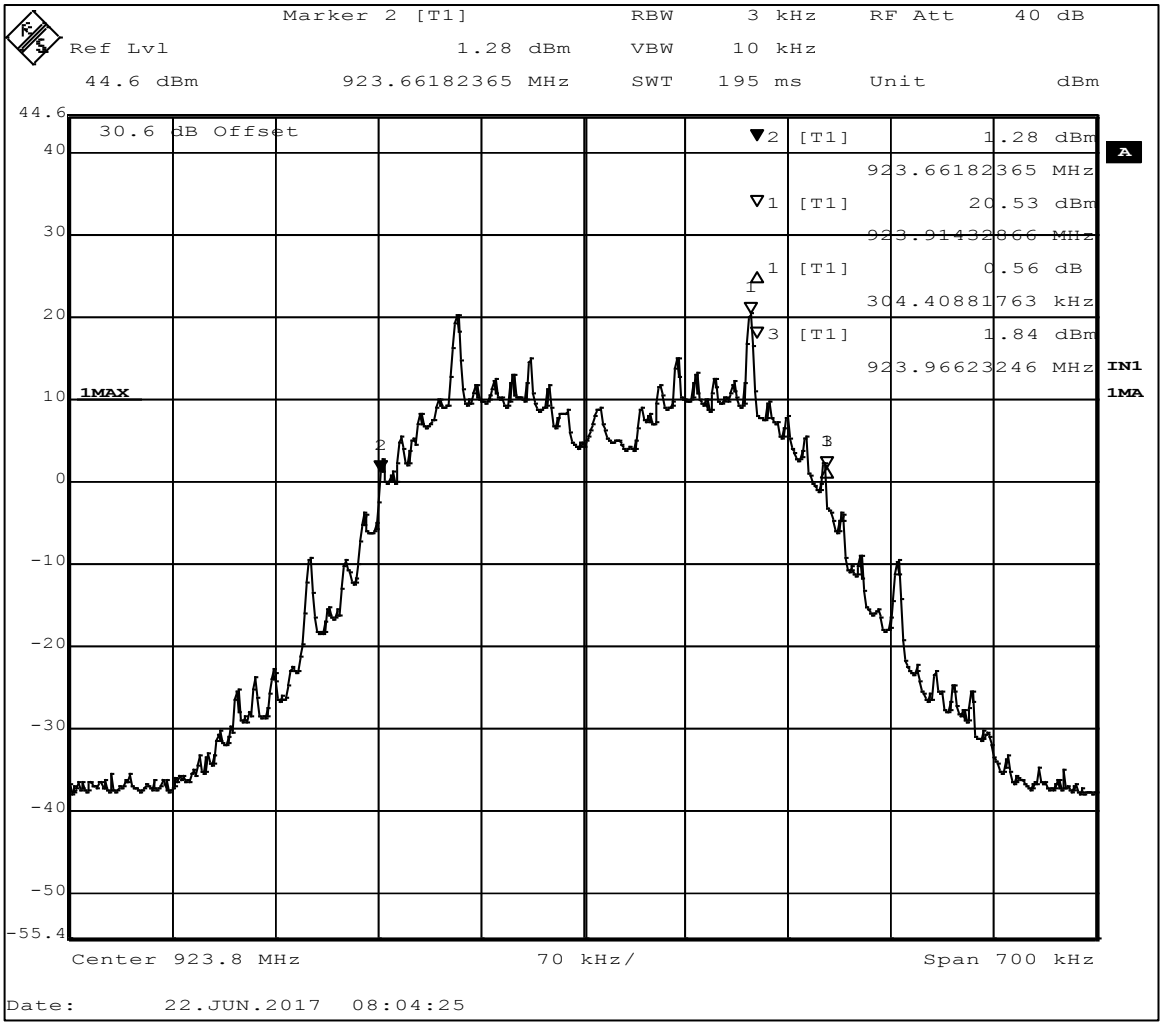

Figure 15 - 20 dB Bandwidth, High Channel, 304.40 kHz

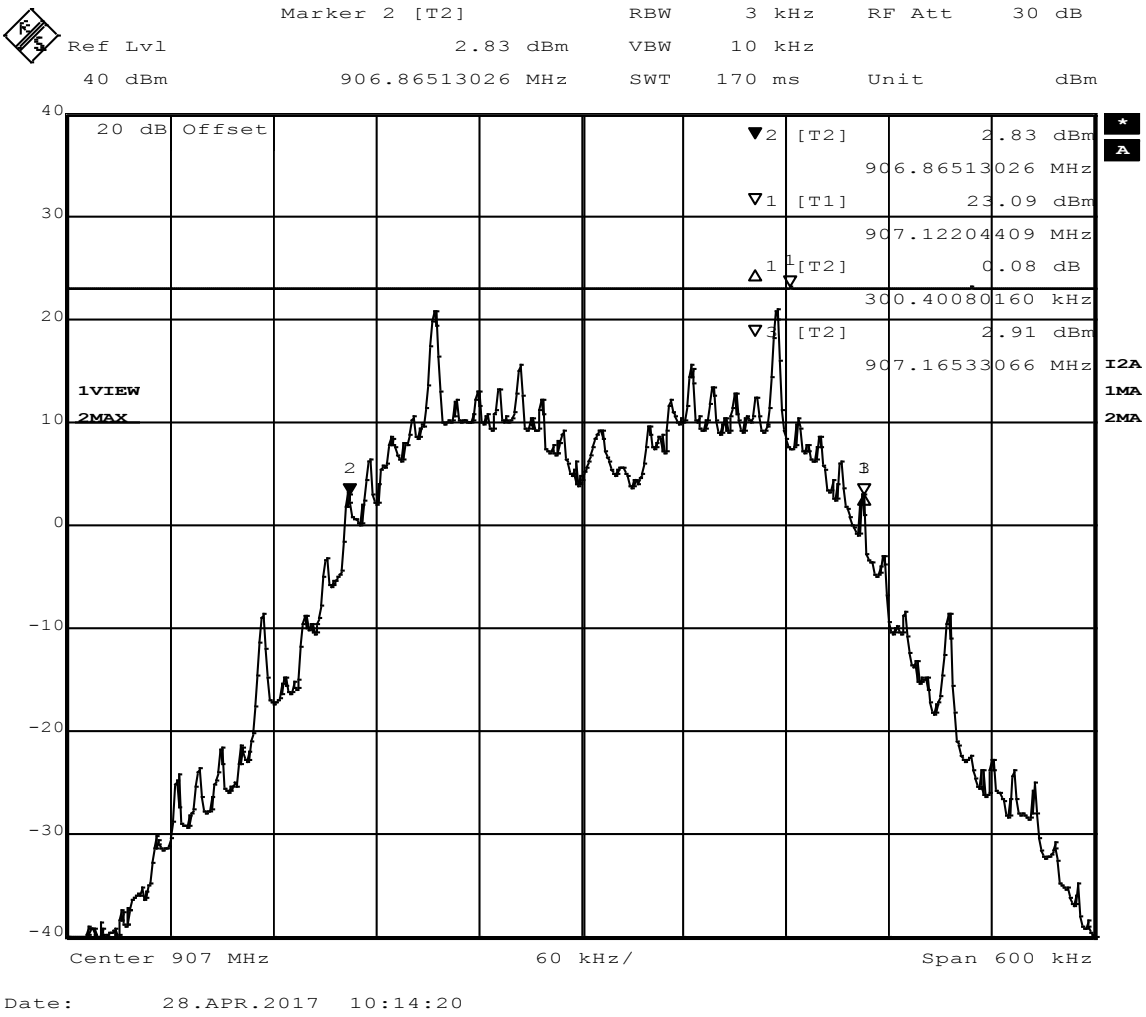

Figure 16 - Output Power, Low Channel

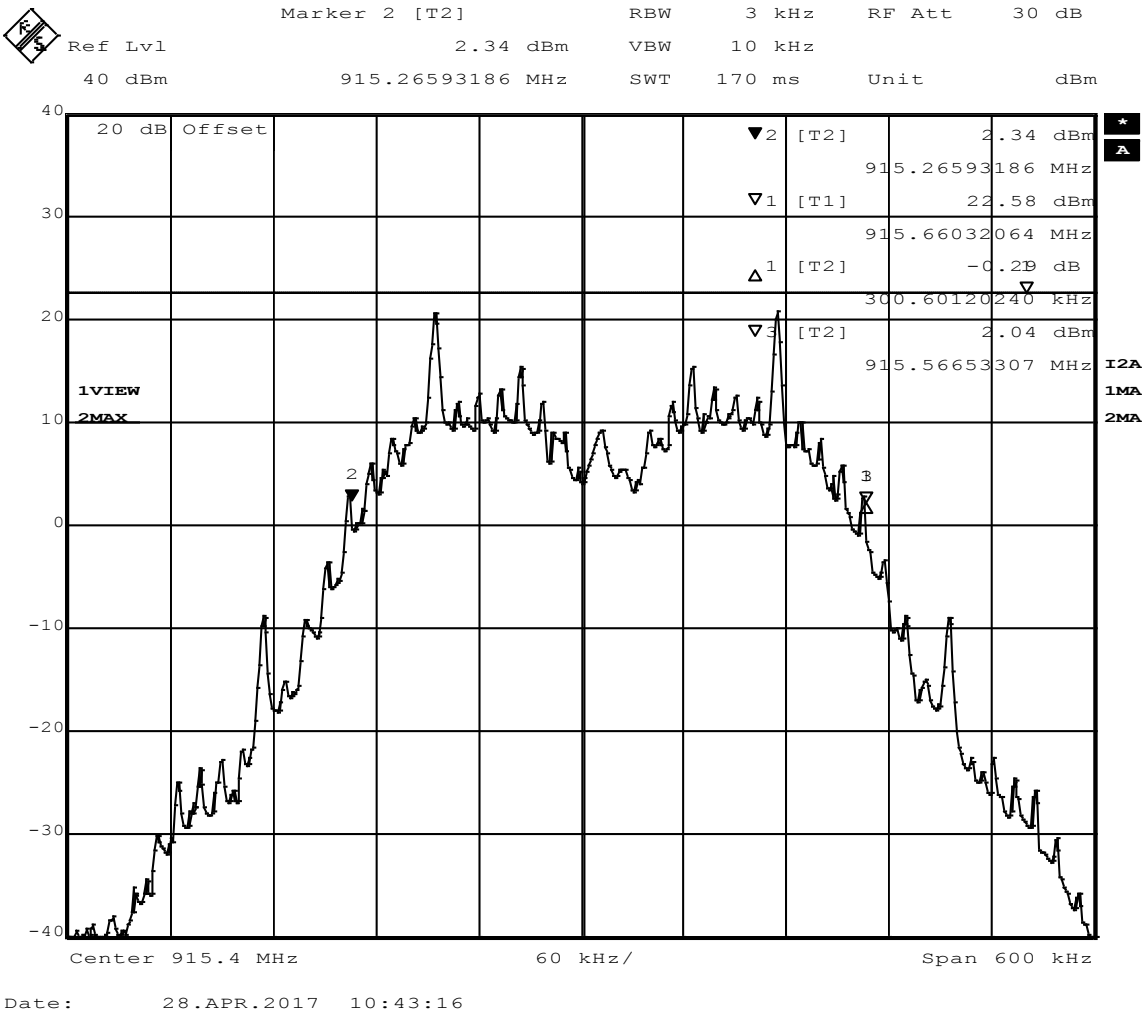

Figure 17 - Output Power, Mid Channel

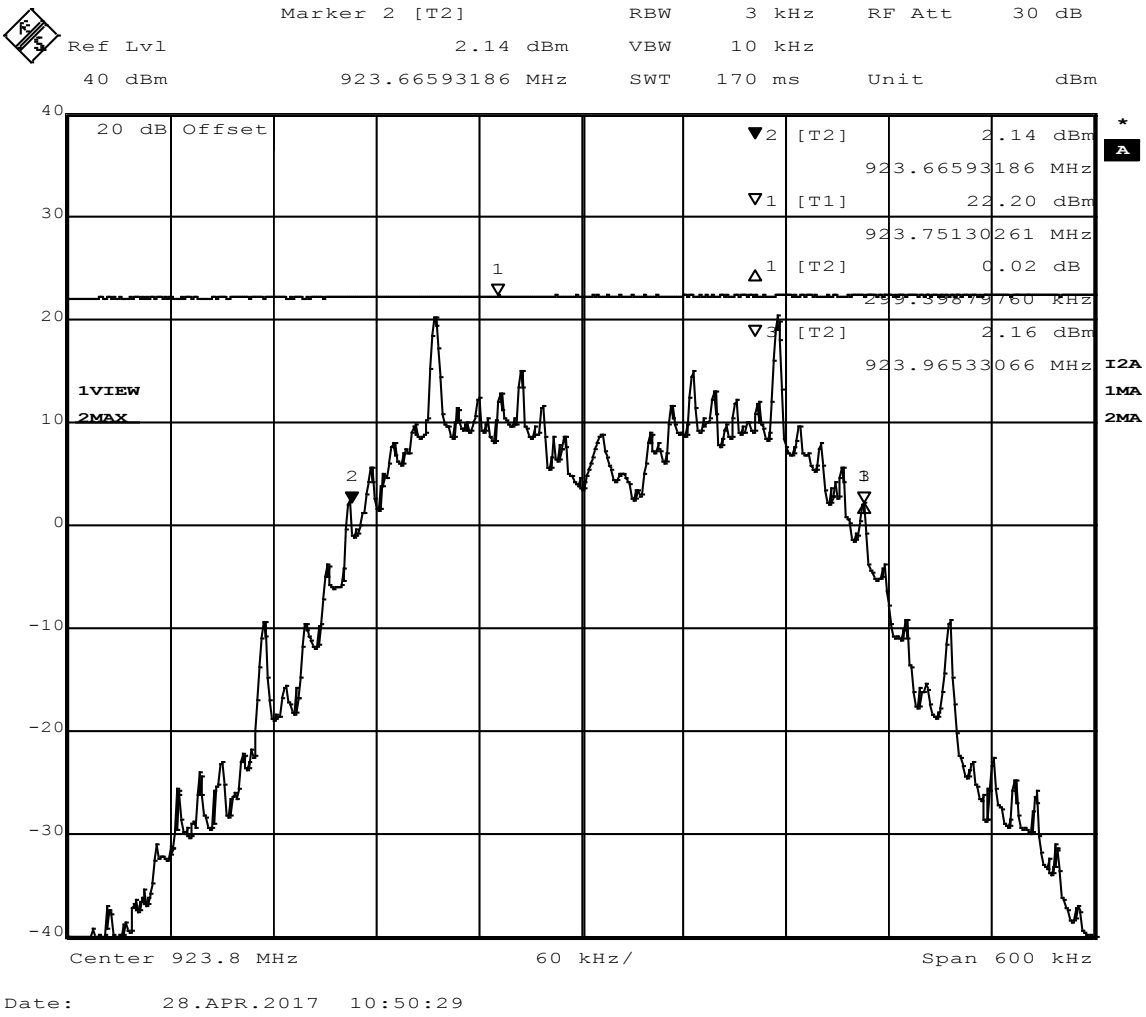

Figure 18 - Output Power, High Channel

4.4 Bandedges

Test Method: ANSI C63.10, Section(s) 6.10.5.2

4.4.1 Limits of bandedge measurements

For emissions outside of the allowed band of operation (902 to 928 MHz), the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

4.4.2 Test procedures

The EUT was tested in the same method as described in section *4.3 - Bandwidth*. The resolution bandwidth was set to 100kHz and the EMI receiver was used to scan from the bandedge to the fundamental frequency with a quasi-peak detector. The highest emissions level beyond the bandedge was measured and recorded. All band edge measurements were evaluated to the general limits in Part 15.209.

4.4.3 Deviations from test standard

No deviation.

4.4.4 Test setup

See Section 4.3

4.4.5 EUT operating conditions

The EUT was powered by 5 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

4.4.6 Test results

EUT MODULE	RFMD	MODE	Transmit
INPUT POWER	5 VDC	FREQUENCY RANGE	907MHz – 924 MHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

Highest Out of Band Emissions

CHANNEL	Band edge Measurement Frequency (MHz)	Relative Highest out of band level dBm	Relative Fundamental Level (dBm)	Delta	Min (dBc)	Result
1	907	-65.78	22.87	88.65	75.11	PASS
3	924	-53.61	22.19	75.80	75.39	PASS

*Minimum delta = [highest fundamental peak field strength from Section 4.2] – [Part 15.209 radiated emissions limit.]

From Section 4.2

Fundamental average field strength at 902MHz for low channel = 121.11dBµV/m
Fundamental average field strength at 928MHz for high channel = 121.39dBµV/m

Channel 1 minimum delta = 121.11- 46.0 dBµV/m = 75.11 dBc
Channel 3 minimum delta = 121.39 - 46.0 dBµV/m = 75.39 dBc

*ANT-ELE-S01-005 antenna
Measurements do not include correction factors and are intended to be relative measurements only.

The restricted bandedges below 914 MHz and above 960 MHz were measured in the spurious emissions scans of Section 4.2. They were found to be at least 10 dB below the limits from Part 15.209 or are reported in the tables.

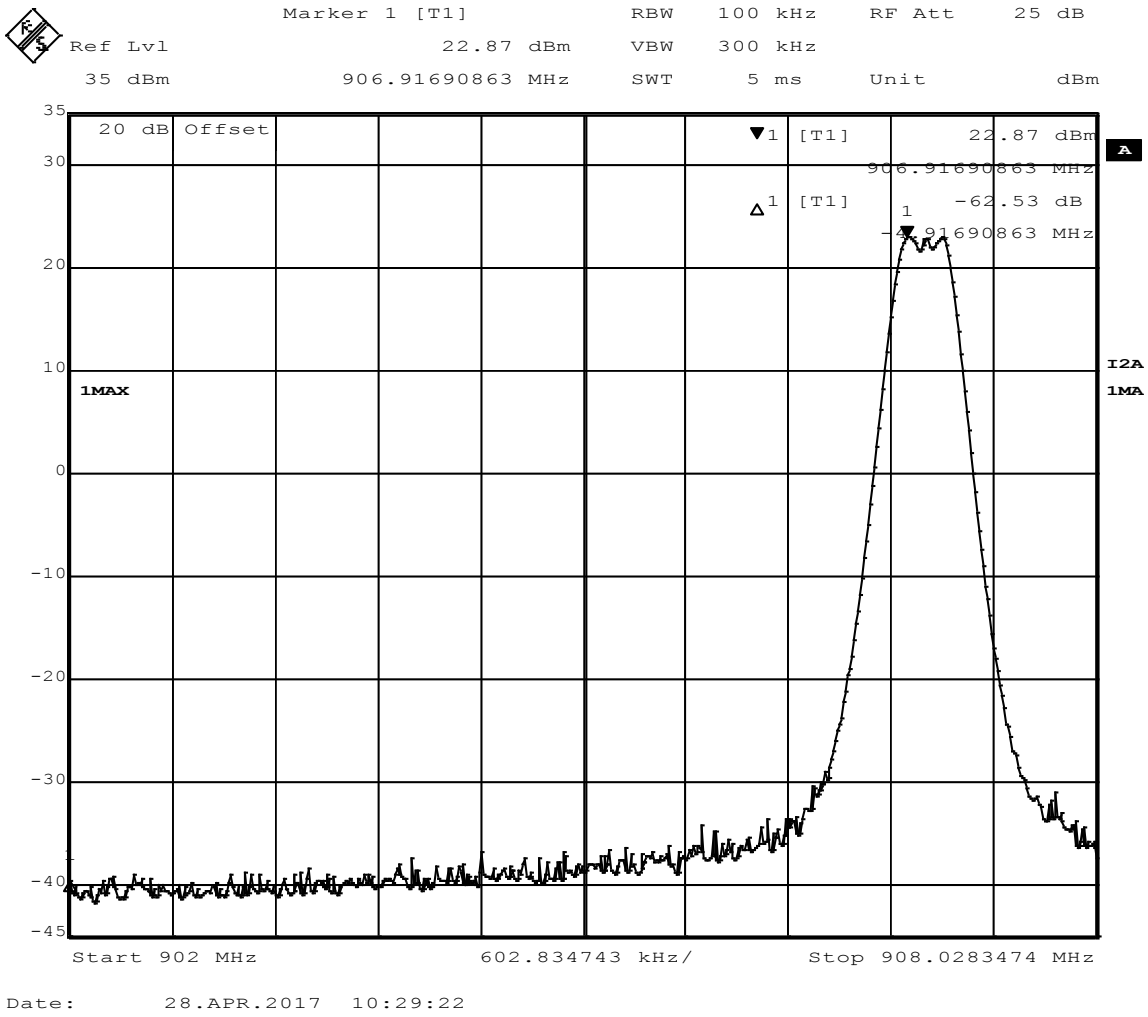

Figure 19 - Band-edge Measurement, Low Channel

The plot shows an uncorrected measurement, used for relative measurements only.

Delta = 62.53 dB Min = 20 dB

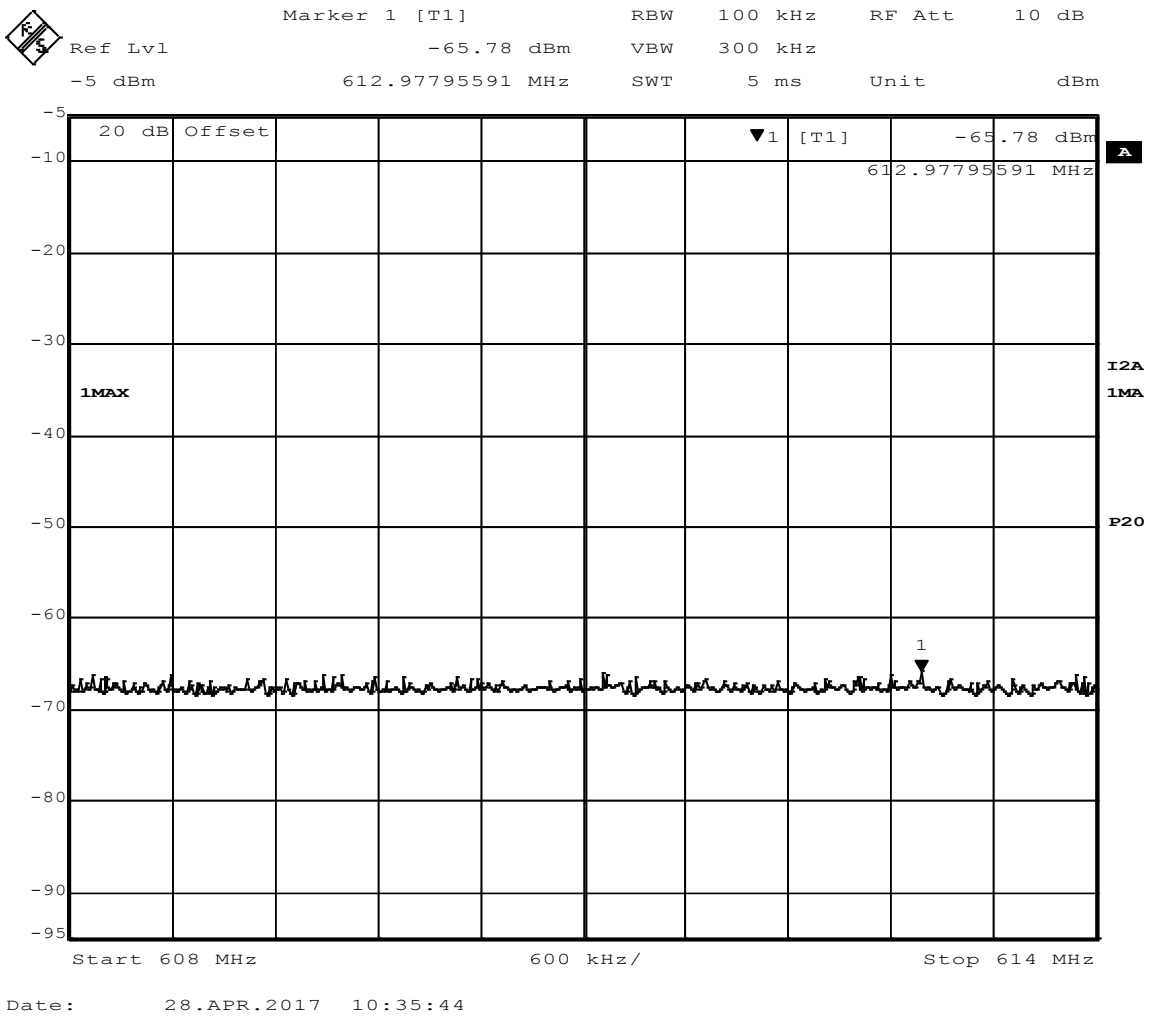

Figure 20 - Band-edge Measurement, Low Channel, Restricted

The plot shows an uncorrected measurement, used for relative measurements only.

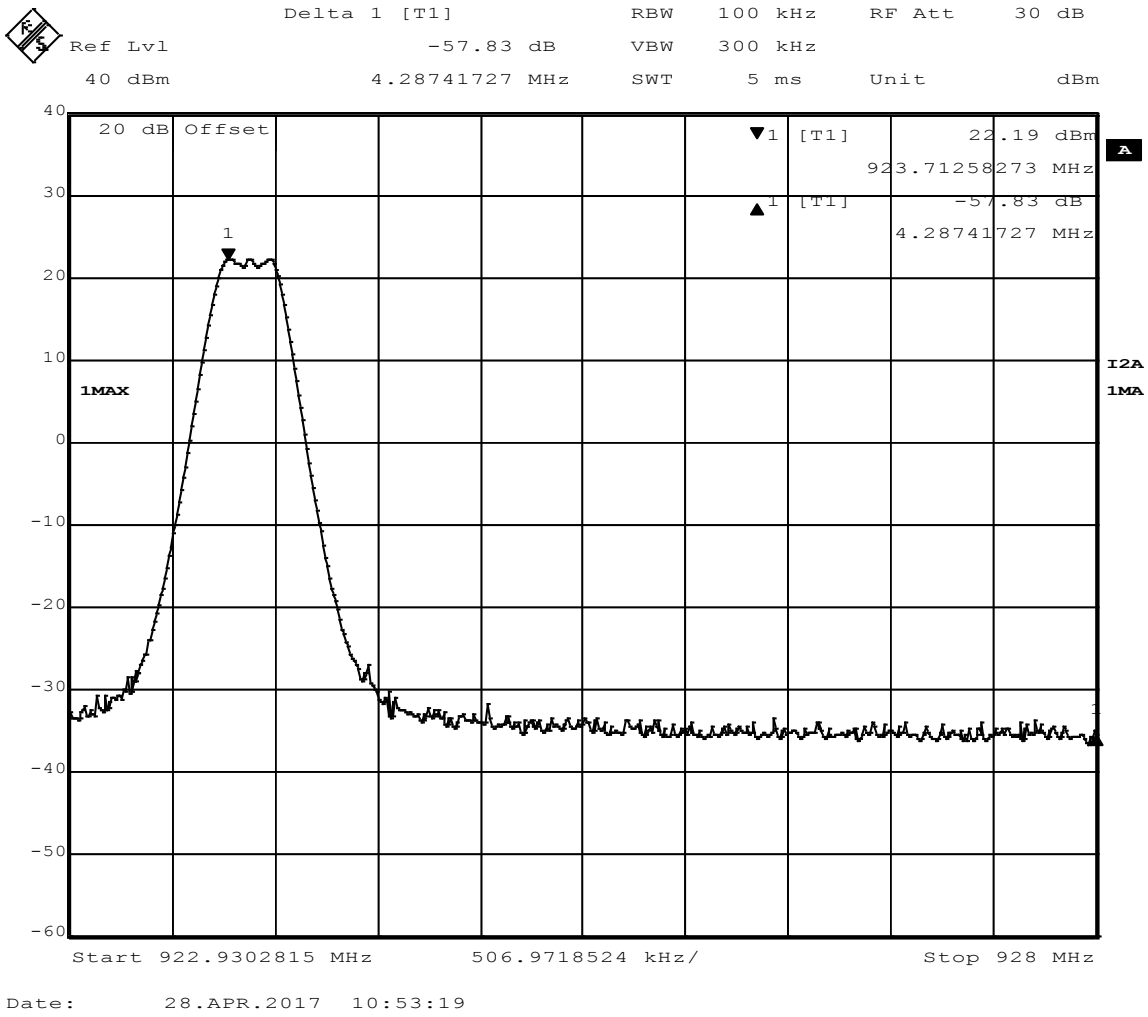

Figure 21 - Band-edge Measurement, High Channel, Unrestricted Frequency

The plot shows an uncorrected measurement, used for relative measurements only.

Delta = 57.83 dB Min = 20 dB

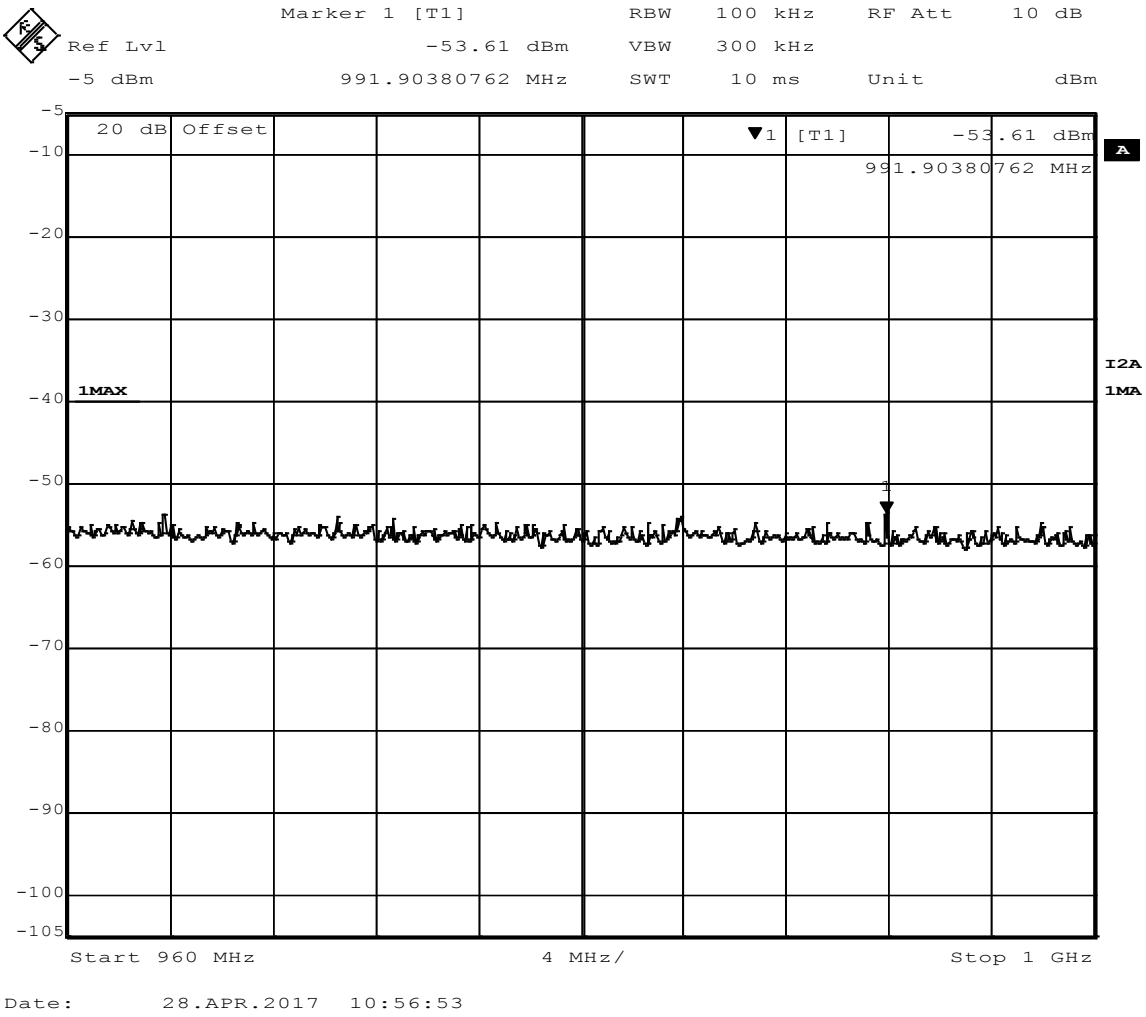

Figure 22 - Band-edge Measurement, High Channel, Restricted Frequency

The plot shows an uncorrected measurement, used for relative measurements only.

4.5 Carrier frequency separation, Number of hopping channels, Time of Occupancy

4.5.1 Limits for Time of Occupancy

Average time of occupancy on any frequency not to exceed 0.4 seconds

4.5.2 Test procedures

The method from ANSI C63.10 Section 7.7.2, 7.7.3 and 7.7.4 were used.

The EUT was connected to the spectrum analyzer directly with a low-loss shielded coaxial cable and an attenuator.

4.5.3 Deviations from test standard

No deviation.

4.5.4 Test setup

*20dB Attenuator was used.

4.7.5 EUT operating conditions

The EUT was powered by 5 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

4.5.6 Test results

EUT MODULE	RFMD	MODE	Continuous Hop
INPUT POWER	5 VDC	FREQUENCY RANGE	907MHz – 924 MHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

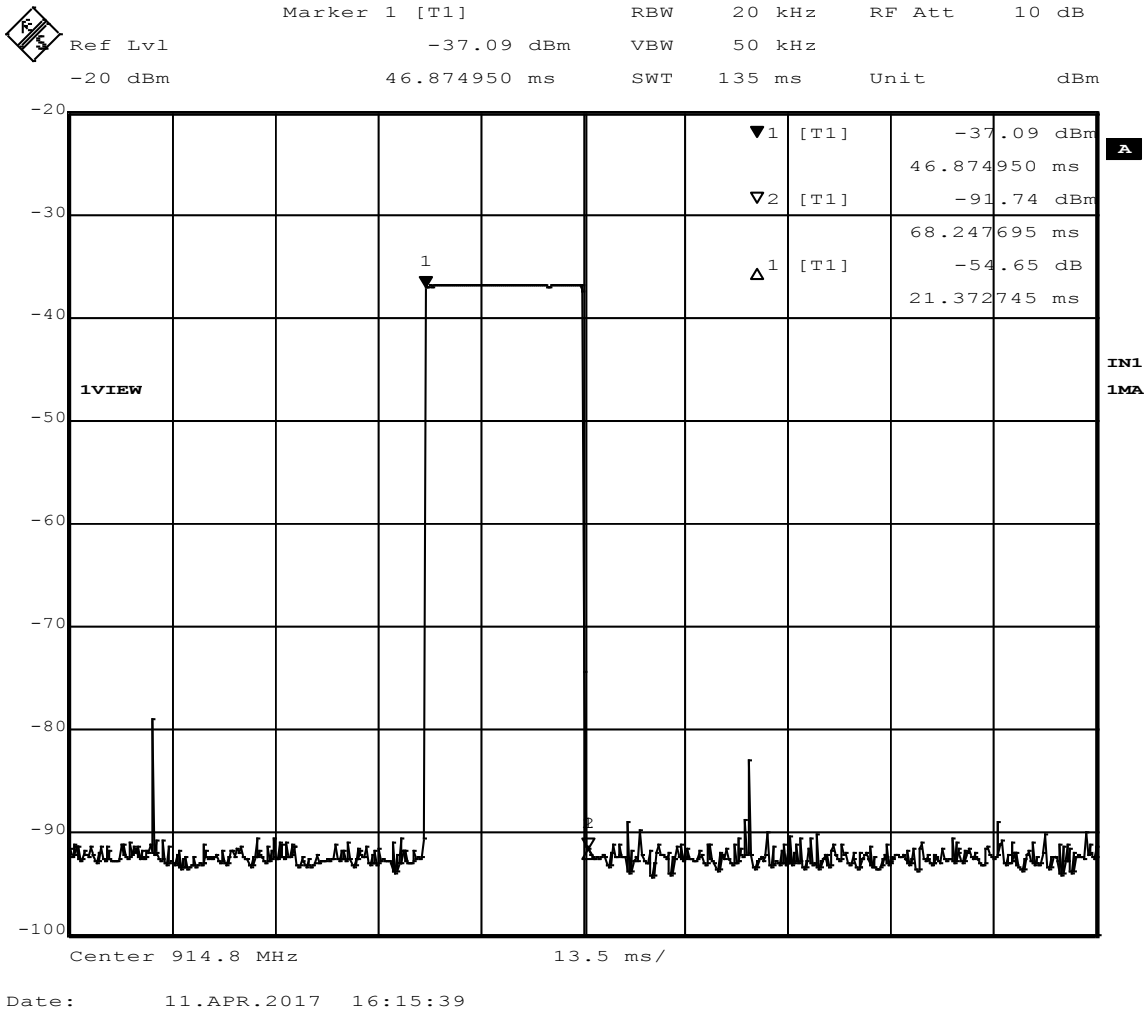

Figure 23 – Time of Occupancy (21.37 ms per Hop - Pass)

Max = 0.4 sec in 10 sec window

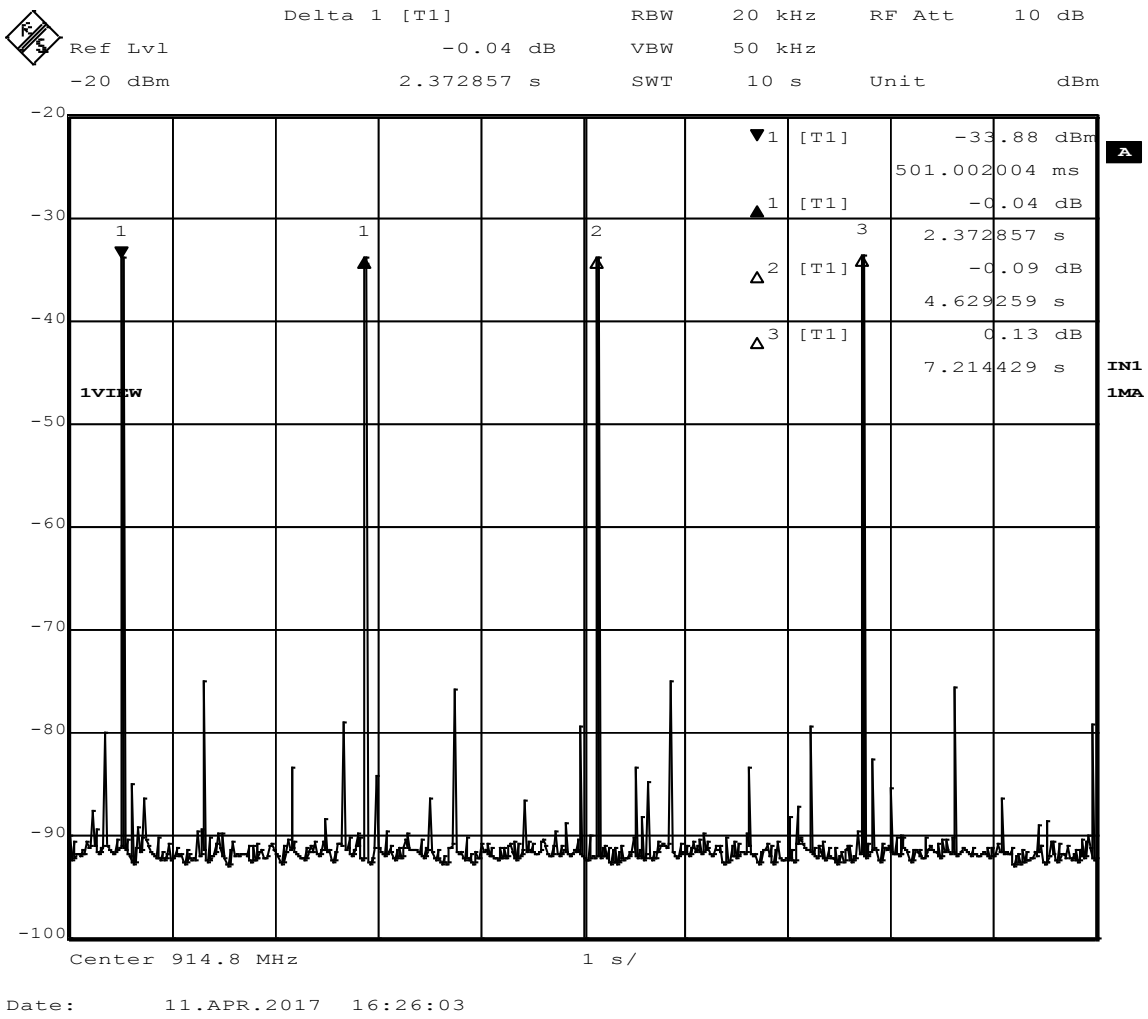

Figure 24 – Time of Occupancy - Period (Max – 4 peaks in 10 seconds window)

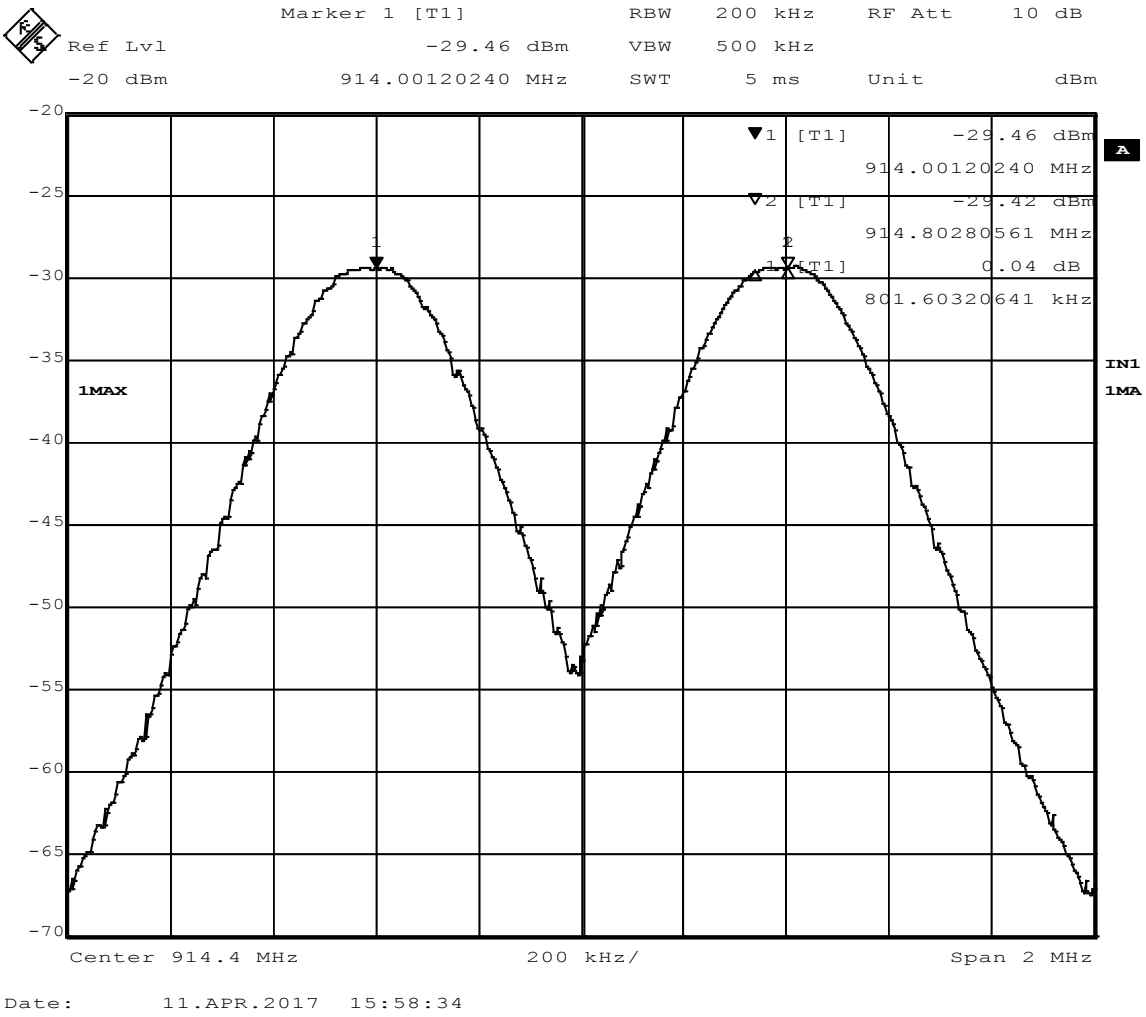

Figure 25 – Frequency Separation (801.60 kHz)

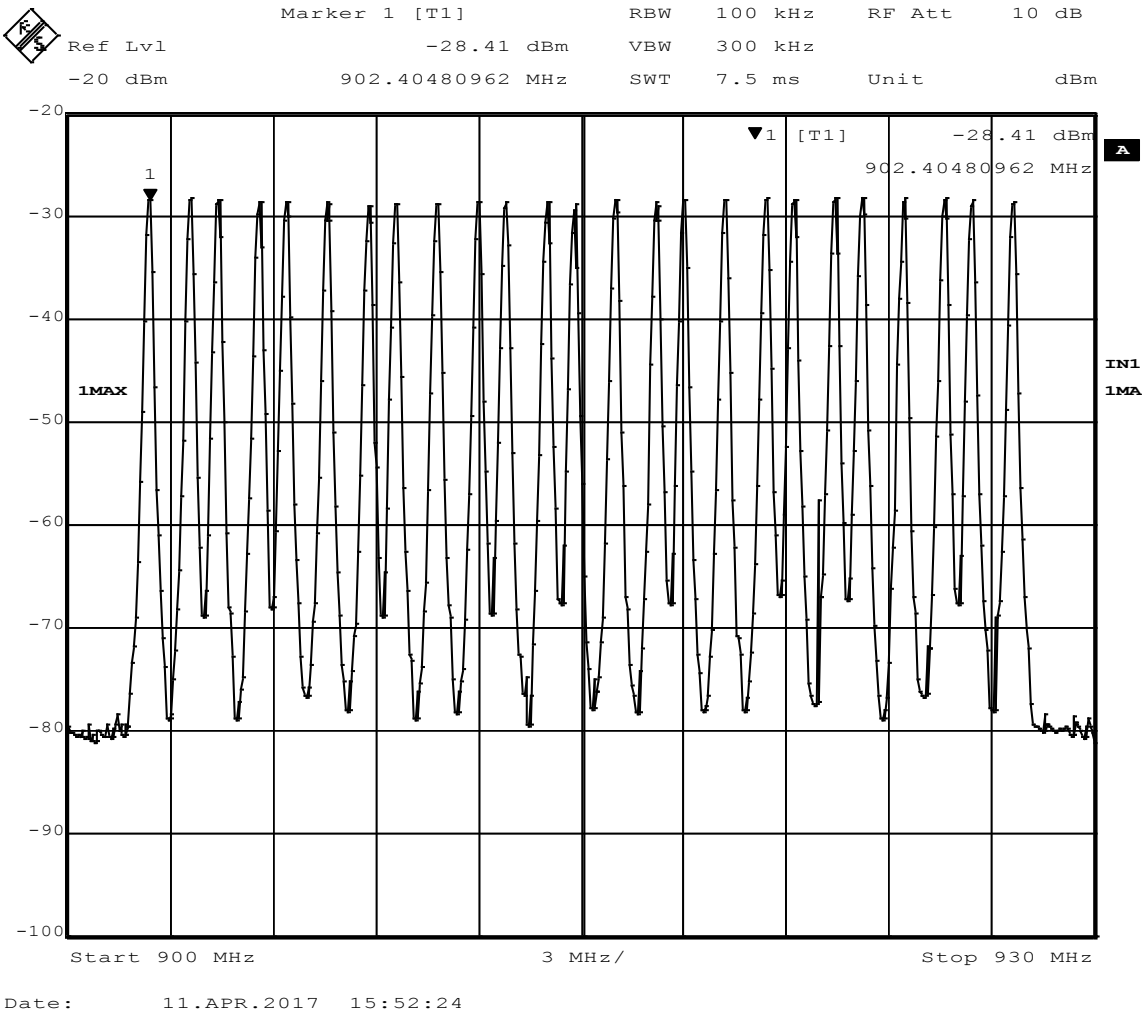

Figure 26 – Hopping Channel Count (25 Channels)

4.6 Conducted AC Mains Emissions

Test Method: ANSI C63.10, Section(s) 6.2

4.6.1 Limits for conducted emissions measurements

FREQUENCY OF EMISSION (MHz)	CONDUCTED LIMIT (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5	56	46
5-30	60	50

NOTE: 1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz.
3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

4.6.2 Test Procedures

a. The EUT was placed 0.8m above a ground reference plane and 0.4 meters from the conducting wall of a shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). The LISN provides 50 ohm/ 50uH of coupling impedance for the measuring instrument.
b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference as well as the ground.
c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels over 10dB under the prescribed limits could not be reported.
d. Results were compared to the 15.207 limits.

4.6.3 Deviation from the test standard

No deviation

4.6.4 Test setup

The EUT was tested as part of a system and a Laptop computer was used for the test as a representative sample only.

4.6.5 EUT operating conditions

The EUT was powered by 5 VDC using a DELL Latitude D 620 computer for conducted emissions test and is set to transmit continuously on the lowest frequency channel, however the power supply (MN: DA130PE1-00 SN:CN-OJU012-48661-98E-6C1W-A02) for the laptop was powered by 120 VAC/ 60 Hz for the test.

4.6.6 Test Results

EUT MODULE	RFMD	MODE	Transmit (low channel used)
INPUT POWER	5 VDC	FREQUENCY RANGE	150kHz – 30MHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

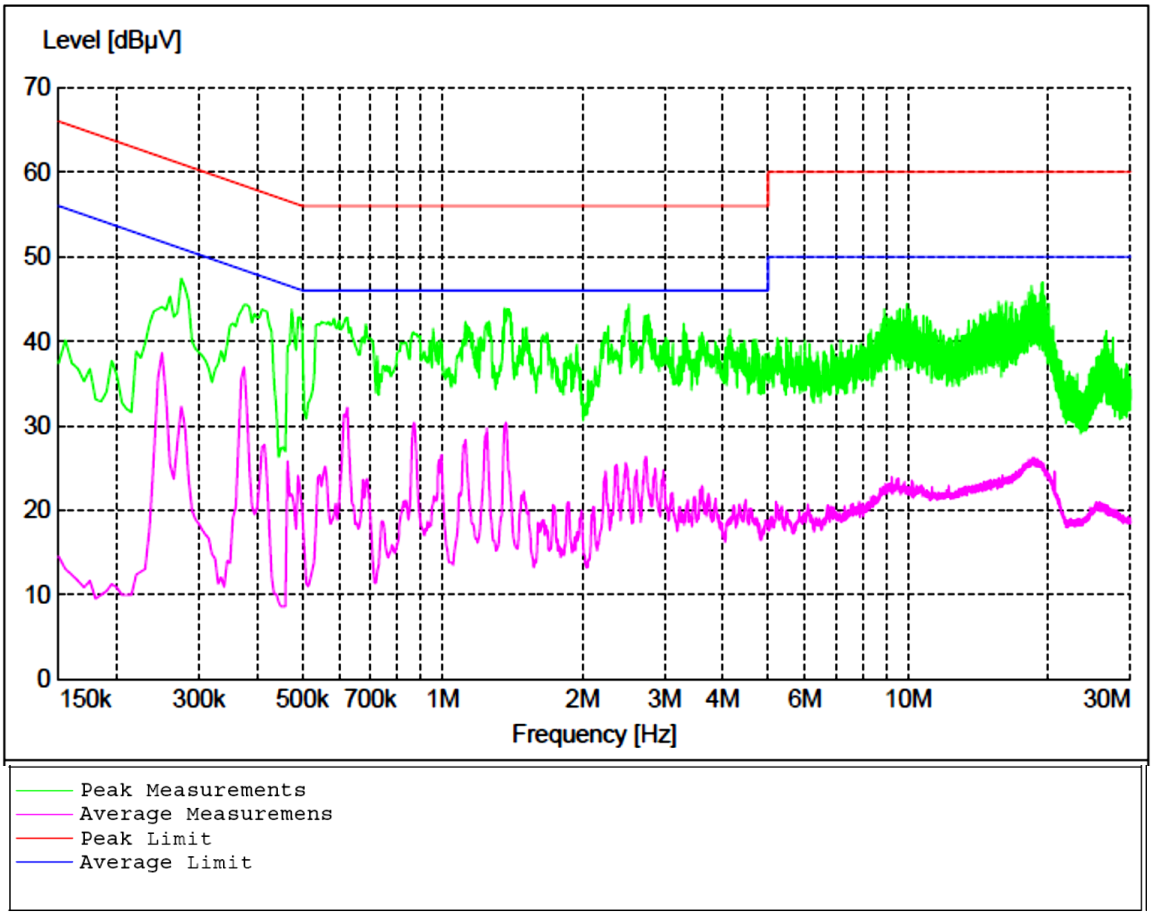

Figure 27 - Conducted Emissions Plot

*All measurements were found to be at least 10dB below the applicable limit.

Appendix A: Sample Calculation

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:
FS = RA + AF – (-CF + AG) + AV

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBμV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

AV is calculated by the taking the 20*log(T_{on}/100) where T_{on} is the maximum transmission time in any 100ms window.

EIRP Calculations

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

EIRP (Watts) = [Field Strength (V/m) x antenna distance (m)]^2 / [30 x Gain (numeric)]

Power (watts) = 10^[Power (dBm)/10] x 1000

Field Strength (dBµV/m) = Field Strength (dBm) = 107 (for 50Ω measurement systems)

Field Strength (V/m) = 10^[Field Strength (dBµV/m) / 20] / 10^6

Gain = 1 (numeric gain for isotropic radiator)

Conversion from 3m field strength to EIRP (d=3):

EIRP = (FS x d^2)/30 = FS [(d^2)/30] = FS [0.3}

EIRP(dBm) = FS(dBµV/m) – 10(log 10^9)+ 10log[0.3] = -95.23

10log(10^) is the conversion from micro to milli

Annex B – Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	3.82
Radiated Emissions, 3m	1GHz - 18GHz	4.44
Emissions limits, conducted	150kHz – 18GHz	±3.30 dB

Expanded uncertainty values are calculated to a confidence level of 95%.

CISPR 16-4-2:2011 was used to calculate the above values.