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Amended

FCC/IC Test Report

Includes NCEE Labs report R20170216-20-01C and its amendment in full

Prepared for: **Elster American Meter**

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

Product: **RFMM**

Test Report No: **R20170216-20-01D**

Approved By:

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

DATE: **18 October 2017**

Total Pages: **44**

ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

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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.

1.2 Reason for amendment:

Time of occupancy plots and duty cycle plots were updated.

2.0 Description

2.1 Equipment under test

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

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

MODEL	RFMM
Part No.	55217G432 Rev 3
POWER SUPPLY	3.3 VDC
ANTENNA TYPE	Antenna is not user replaceable

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.

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.

For continuous transmit tests, the EUT was by a 3.3V power supply. This was used for testing purposes only because the battery would not last long enough to support testing.

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*

*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 antenna on the EUT is a not user replaceable.

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

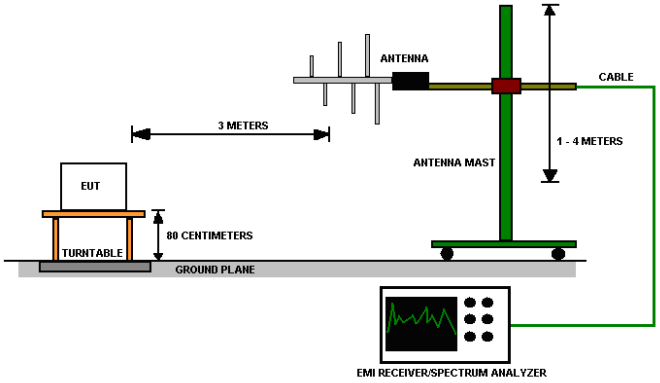


Figure 1 - Radiated Emissions Test Setup

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 3.3 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	RFMM	MODE	Transmit, Low Channel
INPUT POWER	3.3 VDC	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

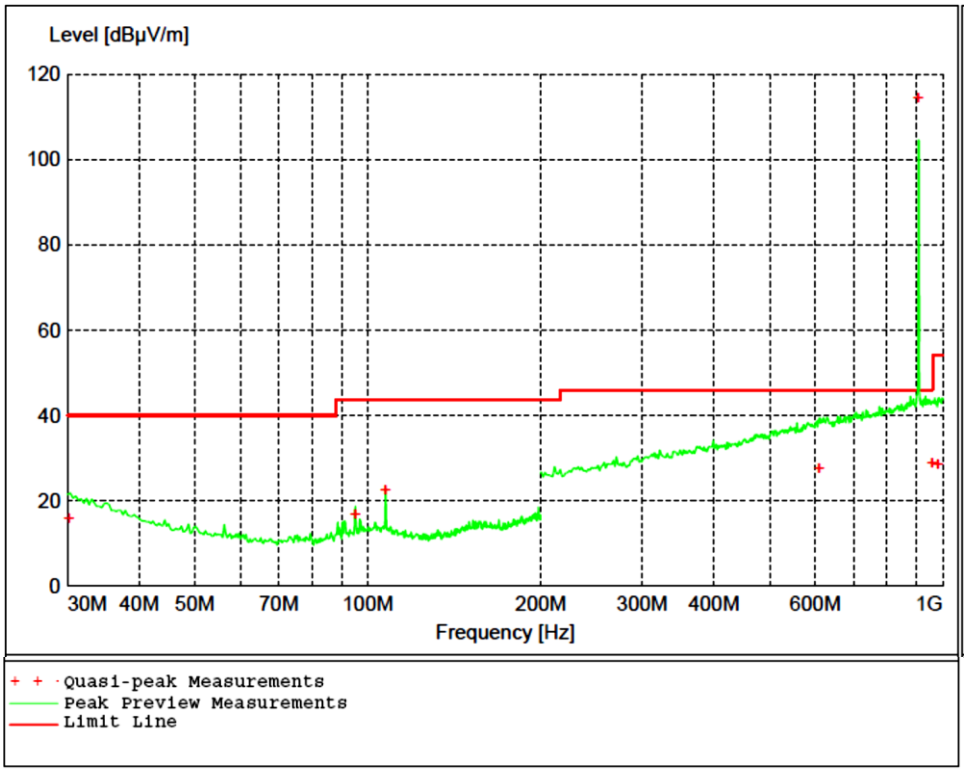


Figure 2 - Radiated Emissions Plot, Low Channel

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

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
30.180000	15.91	40.00	24.10	173	0	HORI
95.160000	16.86	43.50	26.70	129	317	VERT
107.340000	22.34	43.50	21.20	115	307	VERT
609.720000	27.67	46.00	18.30	357	43	VERT
907.000000	114.46	NA	NA	186	231	VERT
959.400000	28.86	46.00	17.10	206	70	VERT
982.080000	28.59	54.00	25.40	100	307	VERT

Table 2 - Radiated Emissions Average Measurements, Low Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1814.200000*	58.24	NA	NA	177	107	VERT
2720.800000	36.2	54.00	17.80	204	190	VERT
3627.600000	30.55	54.00	23.45	203	41	VERT
4535.600000	32.5	54.00	21.50	197	28	VERT
5441.800000	36.73	54.00	17.27	197	158	VERT
6349.400000	32.61	54.00	21.39	278	322	HORI
7255.200000	32.83	54.00	21.17	230	22	HORI
8162.200000	39.92	54.00	14.08	210	53	VERT
9070.200000	40.74	54.00	13.26	257	36	VERT

Note: Average Level = Peak Level – Duty Cycle Correction Factor
Duty Cycle Correction Factor is calculated in Figures 5, 6 and 7. 14.97 dB was used.
* Unrestricted Band

Table 3 - Radiated Emissions Peak Measurements, Low Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1814.200000*	73.21	NA	NA	177	107	VERT
2720.800000	51.17	74.00	22.83	204	190	VERT
3627.600000	45.52	74.00	28.48	203	41	VERT
4535.600000	47.47	74.00	26.53	197	28	VERT
5441.800000	51.70	74.00	22.30	197	158	VERT
6349.400000	47.58	74.00	26.42	278	322	HORI
7255.200000	47.80	74.00	26.20	230	22	HORI
8162.200000	54.89	74.00	19.11	210	53	VERT
9070.200000	55.71	74.00	18.29	257	36	VERT

* Unrestricted Band

EUT MODULE	RFMM	MODE	Transmit, Mid Channel
INPUT POWER	3.3 VDC	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

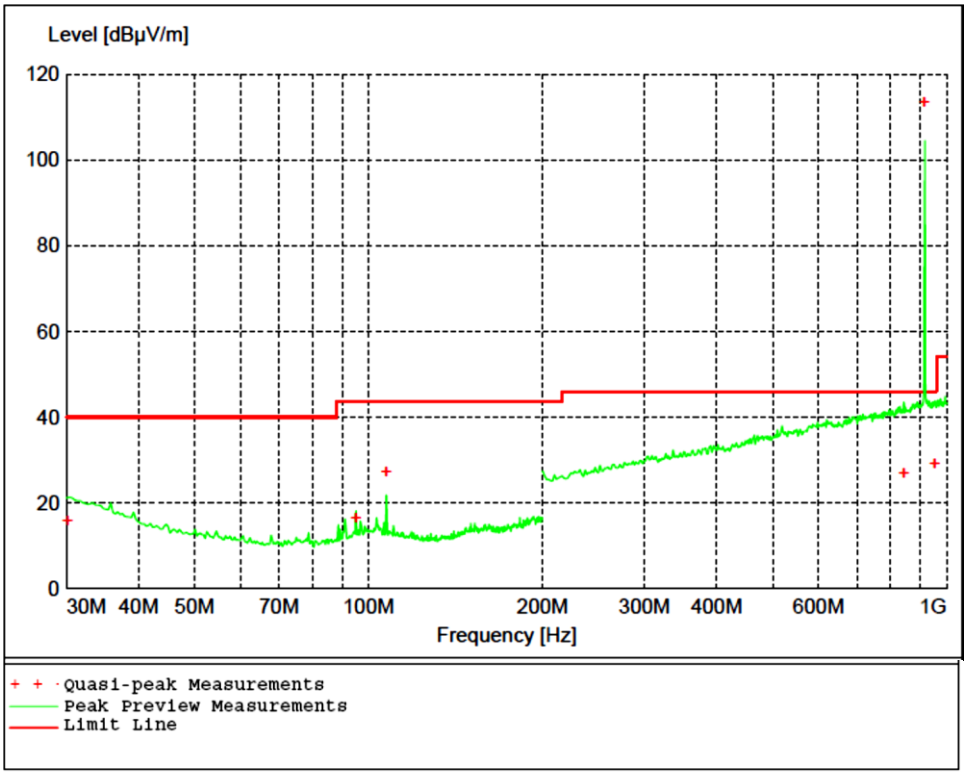


Figure 3 - Radiated Emissions Plot, Mid Channel

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, Mid Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
30.120000	15.95	40.00	24.10	230	212	VERT
95.160000	16.36	43.50	27.20	149	304	VERT
107.280000	27.07	43.50	16.40	136	219	VERT
843.660000	26.96	46.00	19.00	209	99	HORI
915.400000	113.33	NA	NA	180	214	VERT
953.340000	29.00	46.00	17.00	173	197	VERT

Table 5 - Radiated Emissions Average Measurements, Mid Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1830.800000	54.75	NA	NA	153	102	VERT
2746.200000	29.89	54.00	24.11	281	65	VERT
3662.000000	28.62	54.00	25.38	99	46	VERT
4576.600000	30.96	54.00	23.04	217	23	VERT
5491.800000	33.38	54.00	20.62	308	0	HORI
6408.600000	33.12	54.00	20.88	336	197	HORI
7323.400000	36.33	54.00	17.67	243	24	HORI
8239.600000	42.63	54.00	11.37	176	55	VERT
9154.000000	39.17	54.00	14.83	200	59	HORI

Note: Average Level = Peak Level – Duty Cycle Correction Factor
Duty Cycle Correction Factor is calculated in Figures 5, 6 and 7. 14.97 dB was used.
* Unrestricted Band

Table 6 - Radiated Emissions Peak Measurements, Mid Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1830.800000*	69.72	NA	NA	153	102	VERT
2746.200000	44.86	74.00	29.14	281	65	VERT
3662.000000	43.59	74.00	30.41	99	46	VERT
4576.600000	45.93	74.00	28.07	217	23	VERT
5491.800000	48.35	74.00	25.65	308	0	HORI
6408.600000	48.09	74.00	25.91	336	197	HORI
7323.400000	51.30	74.00	22.70	243	24	HORI
8239.600000	57.60	74.00	16.40	176	55	VERT
9154.000000	54.14	74.00	19.86	200	59	HORI

EUT MODULE	RFMM	MODE	Transmit, High Channel
INPUT POWER	3.3 VDC	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

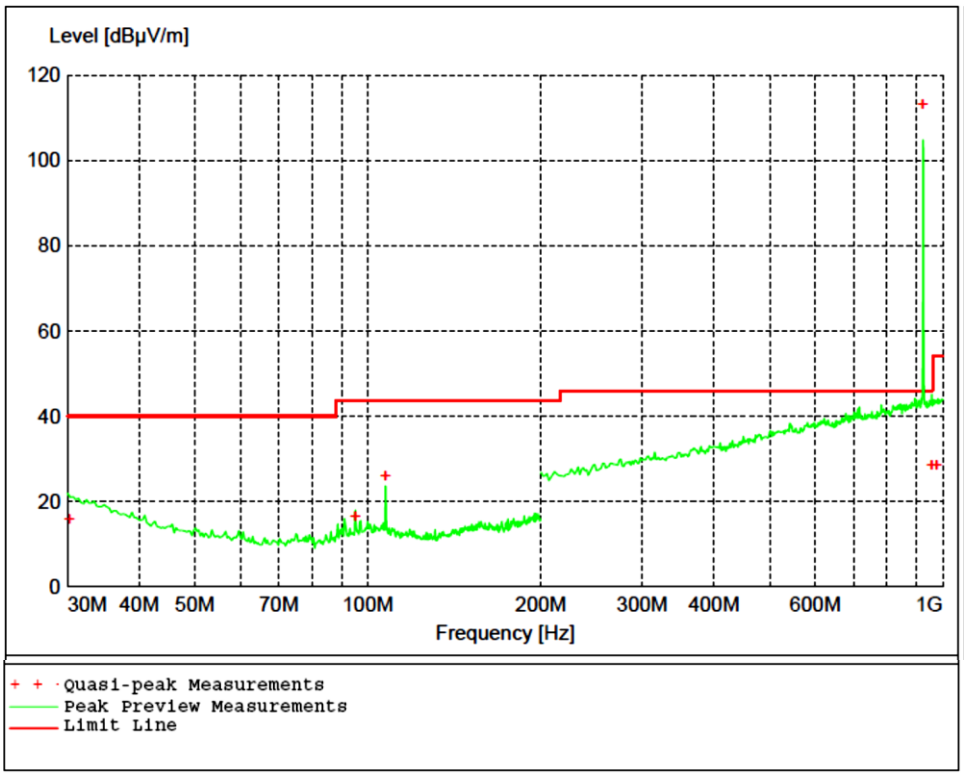


Figure 4 - Radiated Emissions Plot, High Channel

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, High Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
30.240000	15.87	40.00	24.10	176	293	VERT
95.100000	16.43	43.50	27.10	125	336	VERT
107.280000	26.01	43.50	17.50	132	219	VERT
923.800000	113.17	NA	NA	183	212	VERT
956.700000	28.43	46.00	17.60	290	229	HORI
976.860000	28.48	54.00	25.50	297	155	HORI

Table 8 - Radiated Emissions Average Measurements, High Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1847.800000*	49.98	NA	NA	173	111	VERT
2771.800000	31.97	54.00	22.03	294	156	VERT
3695.200000	33.42	54.00	20.58	206	55	VERT
4619.000000	31.43	54.00	22.57	336	264	VERT
5543.000000	33.92	54.00	20.08	190	160	VERT
6467.400000	31.73	54.00	22.27	291	201	HORI
7391.200000	34.00	54.00	20.00	264	20	HORI
8315.200000	40.25	54.00	13.75	233	330	HORI
9241.000000	31.09	54.00	22.91	99	327	VERT

Note: Average Level = Peak Level – Duty Cycle Correction Factor
Duty Cycle Correction Factor is calculated in Figures 5, 6 and 7. 14.97 dB was used.
* Unrestricted Band

Table 9 - Radiated Emissions Peak Measurements, High Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1847.800000	64.95	NA	NA	173	111	VERT
2771.800000	46.94	74.00	27.06	294	156	VERT
3695.200000	48.39	74.00	25.61	206	55	VERT
4619.000000	46.40	74.00	27.60	336	264	VERT
5543.000000	48.89	74.00	25.11	190	160	VERT
6467.400000	46.70	74.00	27.30	291	201	HORI
7391.200000	48.97	74.00	25.03	264	20	HORI
8315.200000	55.22	74.00	18.78	233	330	HORI
9241.000000	46.06	74.00	27.94	99	327	VERT

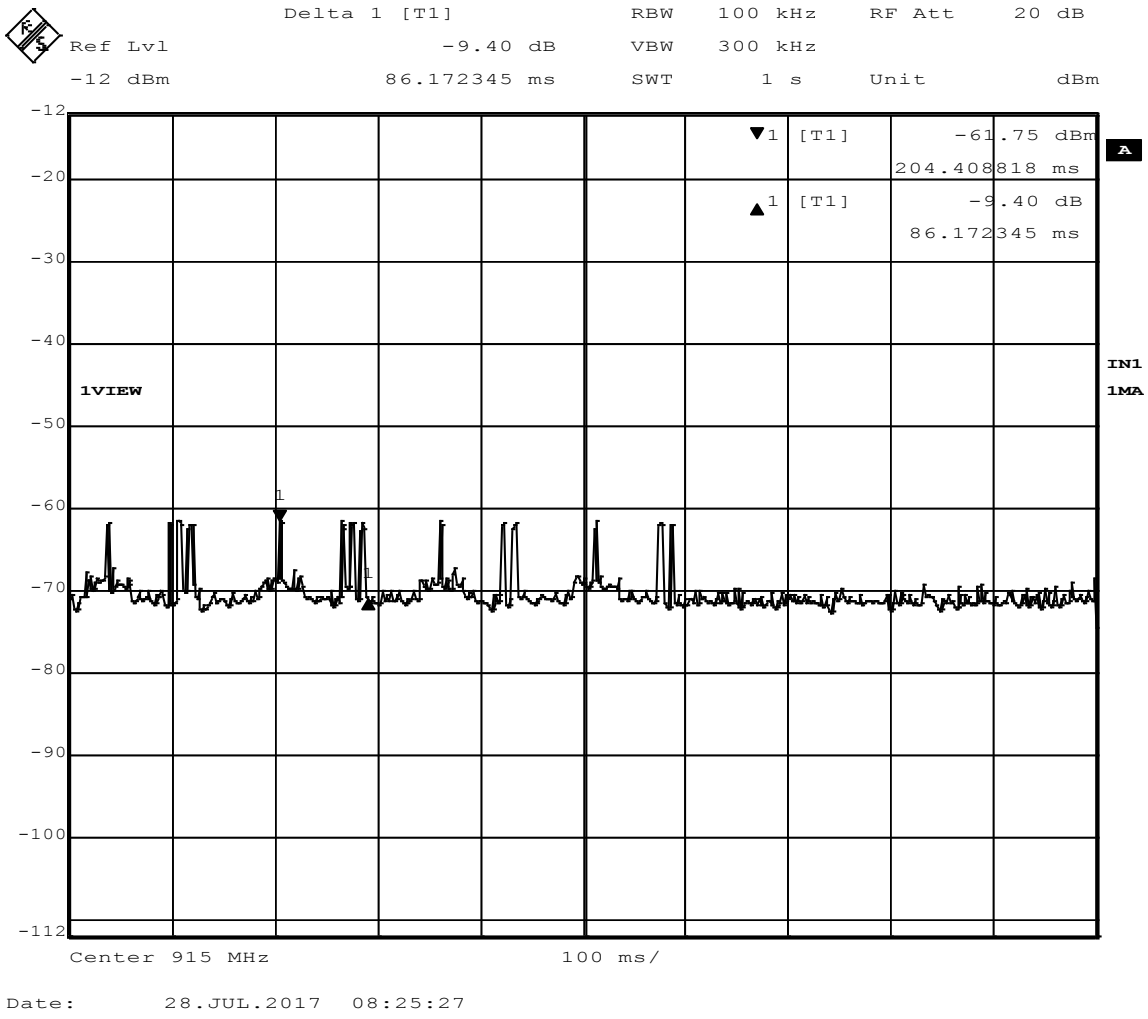


Figure 5 – Period

A maximum of 4 pulses can occur in any 100 ms window

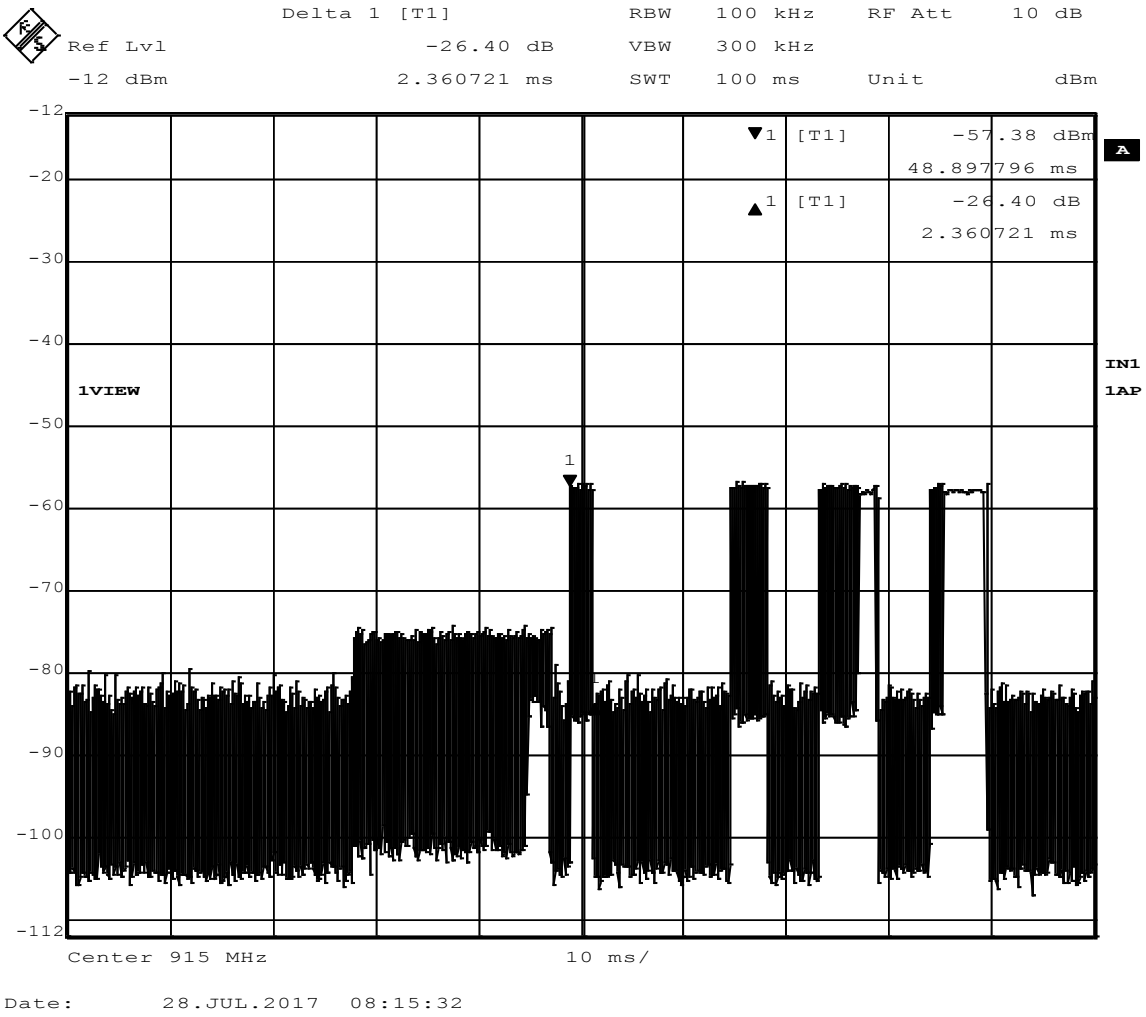


Figure 6 – Maximum Pulse Width -1, 2.36 ms

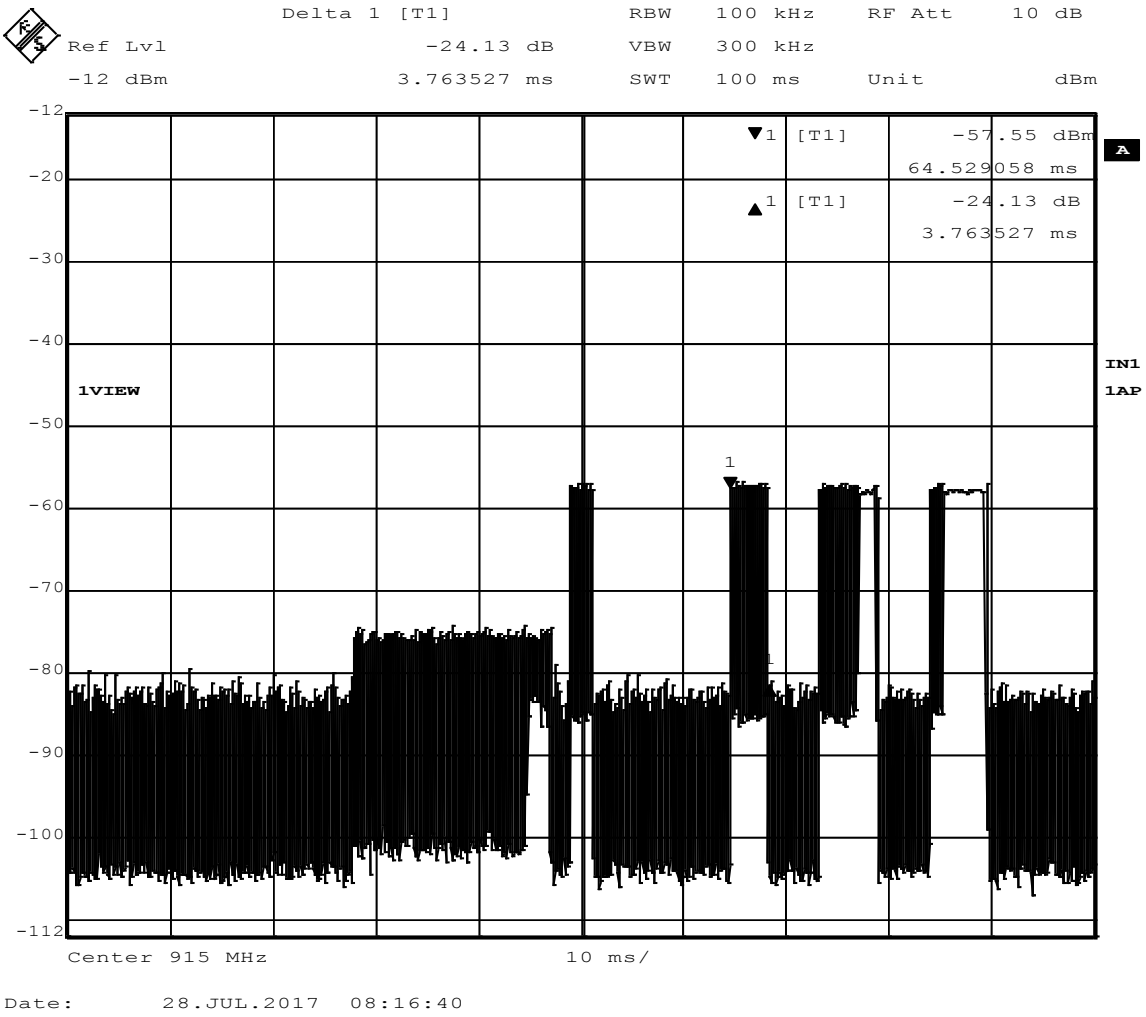


Figure 7 – Maximum Pulse Width -2, 3.76 ms

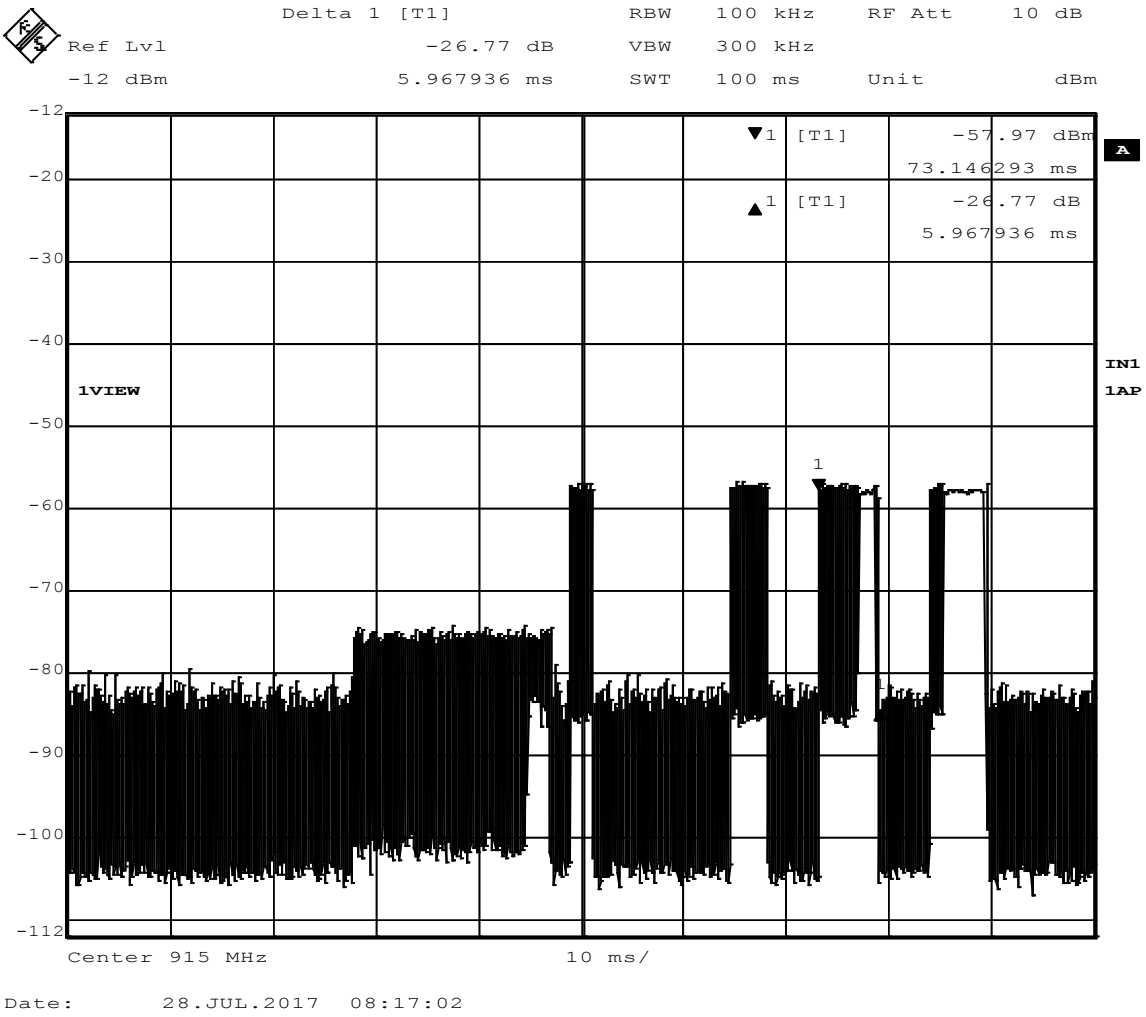


Figure 8 – Maximum Pulse Width -3, 5.96 ms

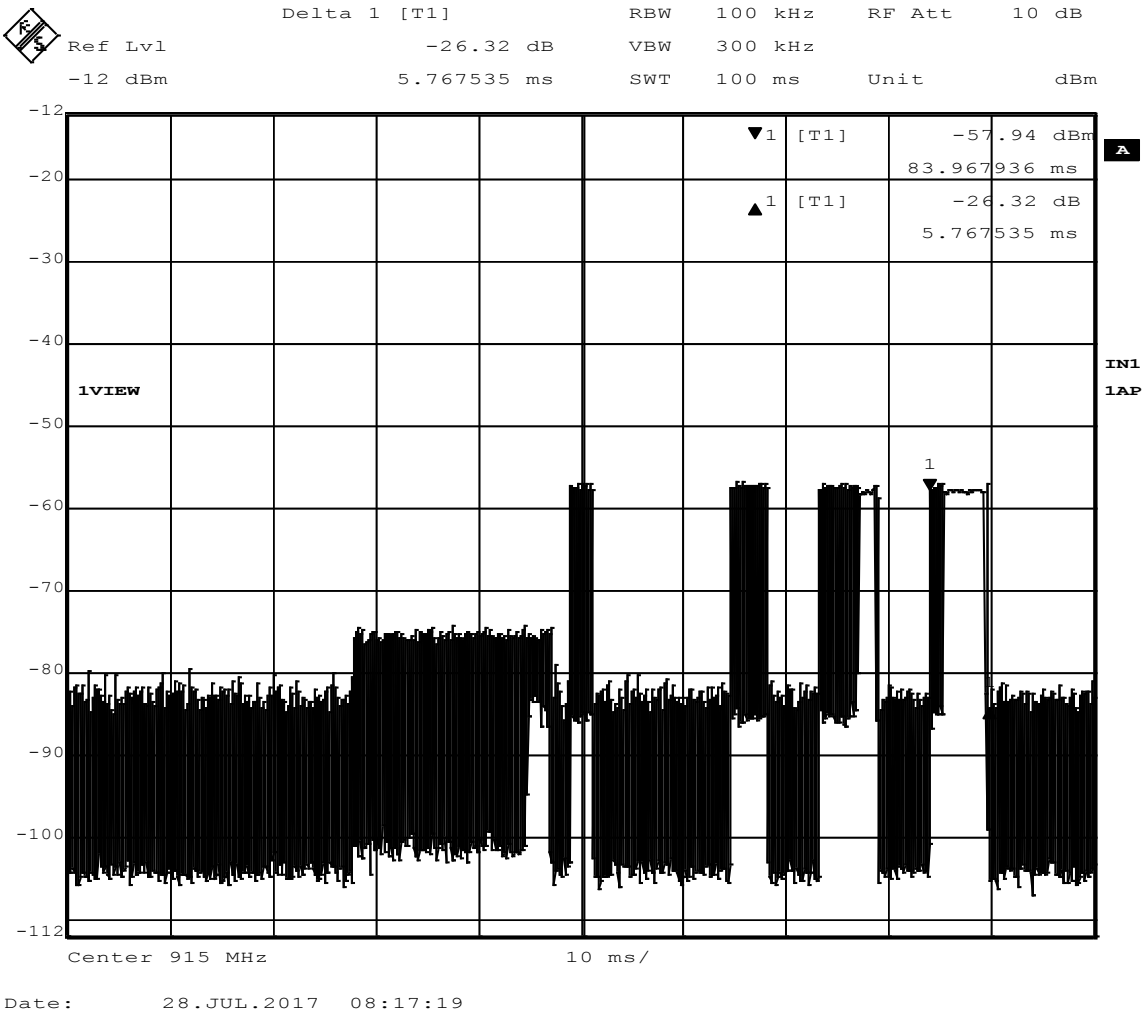


Figure 9 – Maximum Pulse Width – 4, 5.76 ms

Duty cycle correction factor = 20*log ((2.36+3.76+5.96+5.76)/100) = -14.97 dB

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

Note 2: There were maximum of four pulses per 100ms period.

4.3 Bandwidth and Peak EIRP

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

4.3.1 Limits of bandwidth measurements

The 99% occupied bandwidth and peak EIRP 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 3 kHz RBW.

EIRP was calculated from field strength measurements using ANSI C63.10:2013, Section 9.5, Equation (22).

4.3.2 Test procedures

All measurements were taken at a distance of 3m from the EUT. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 3 kHz RBW and 10 kHz VBW.

The 99% occupied is defined as the bandwidth at which 99% of the signal power is found. This corresponds to 20dB down from the maximum power level. The maximum power was measured with the largest resolution bandwidth possible (10MHz) and this value was recorded. The signal was then 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 99% occupied bandwidth.

4.3.3 Deviations from test standard

No deviation.

4.3.4 Test setup

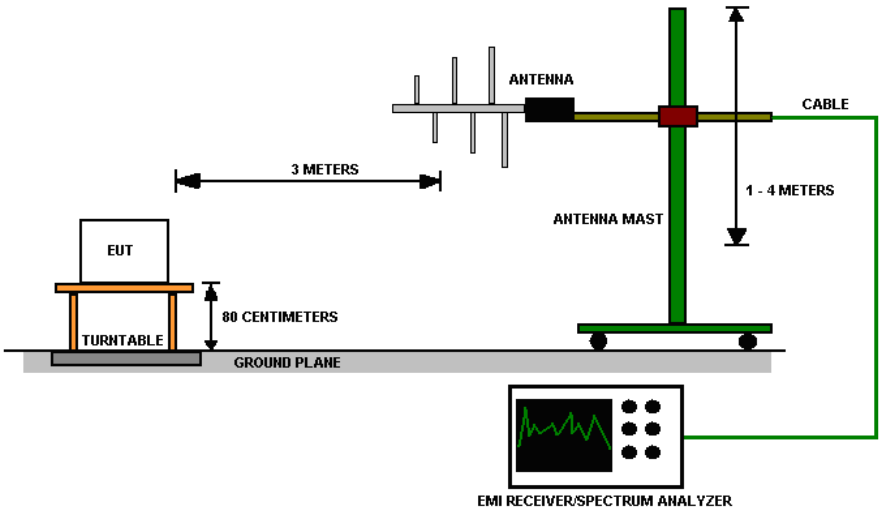


Figure 10 - Bandwidth Measurements Test Setup

4.3.5 EUT operating conditions

The EUT was powered by 3.3 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	RFMM	MODE	Transmit
INPUT POWER	3.3 VDC	FREQUENCY RANGE	907MHz – 924 MHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

20 dB Bandwidth

CHANNEL	CHANNEL FREQUENCY (MHz)	20 dB Bandwidth (kHz)
1	907.0	303.00
2	915.4	304.20
3	923.8	303.00

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

REMARKS:
None

Peak EIRP

CHANNEL	CHANNEL FREQUENCY (MHz)	EIRP PEAK POWER OUTPUT (dBm)	RESULT
1	907.0	22.07	PASS
2	915.4	19.89	PASS
3	923.8	19.33	PASS

*Peak EIRP measurements the limit is 24 dBm

EIRP was calculated from field strength measurements using ANSI C63.10:2013, Section 9.5, Equation (22).

All measurements were taken from the 99% occupied bandwidth screen captures.

REMARKS:
None

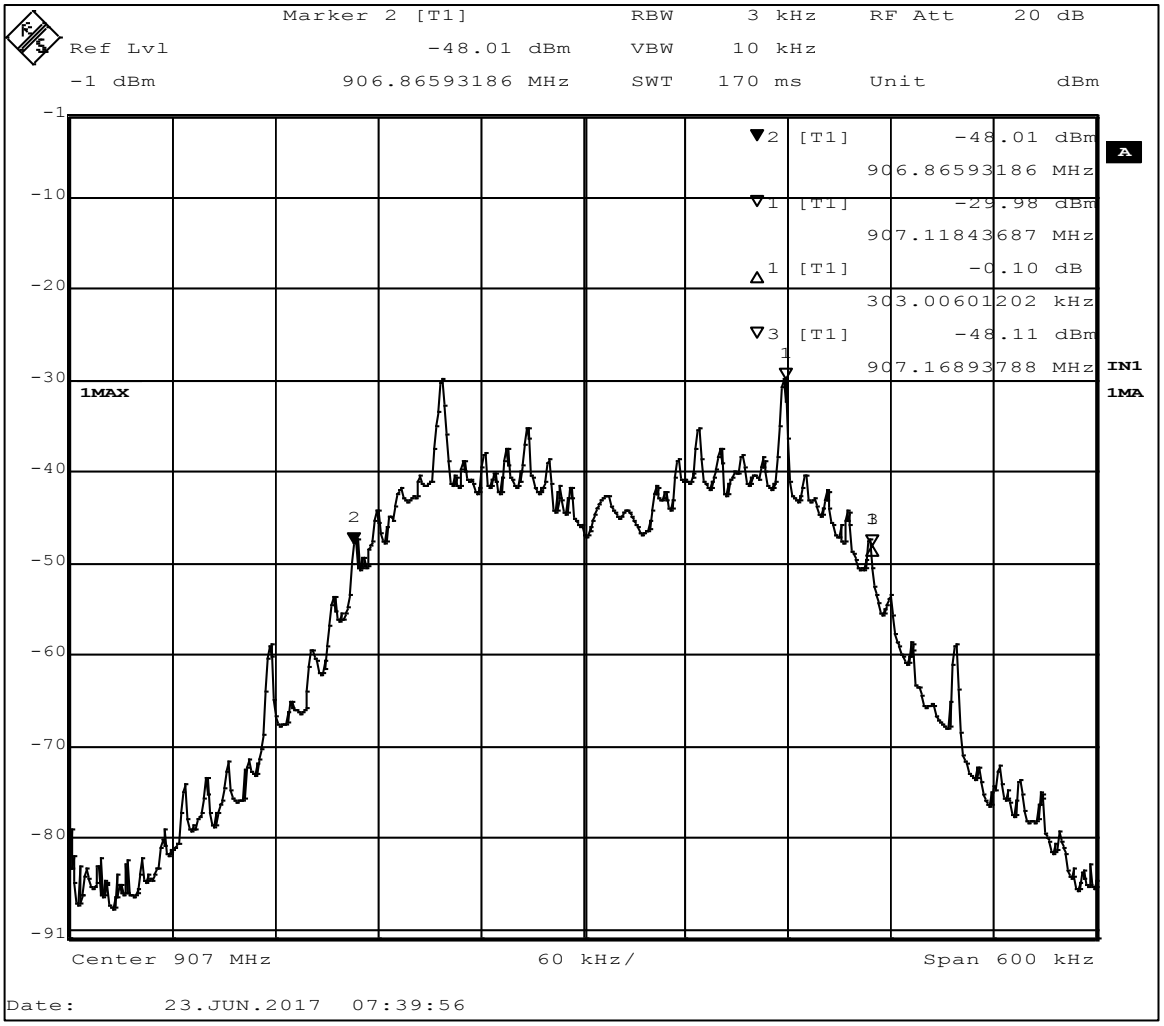


Figure 11 - 20 dB Bandwidth, Low Channel. 303.00 kHz

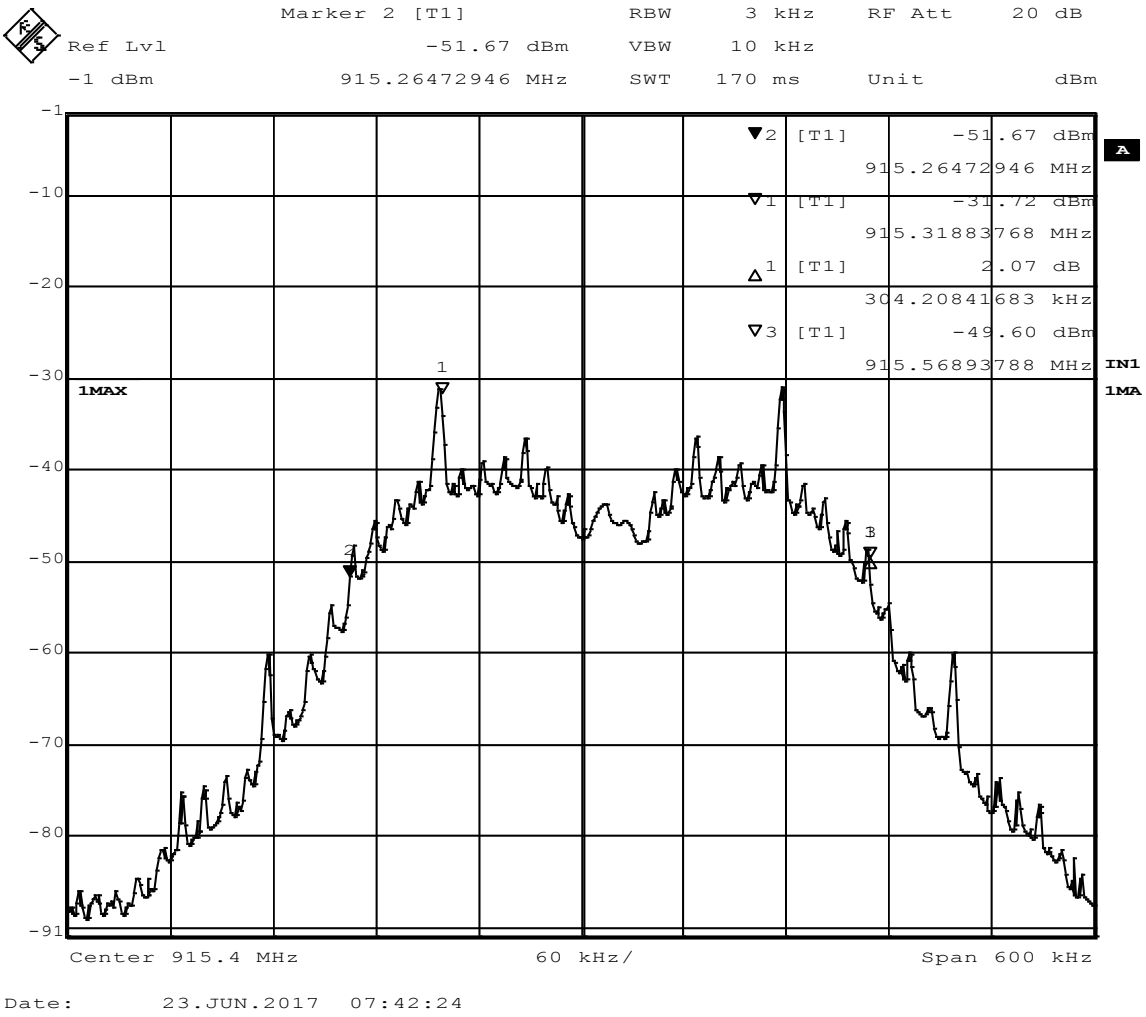


Figure 12 – 20 dB Bandwidth, Mid Channel, 304.20 kHz

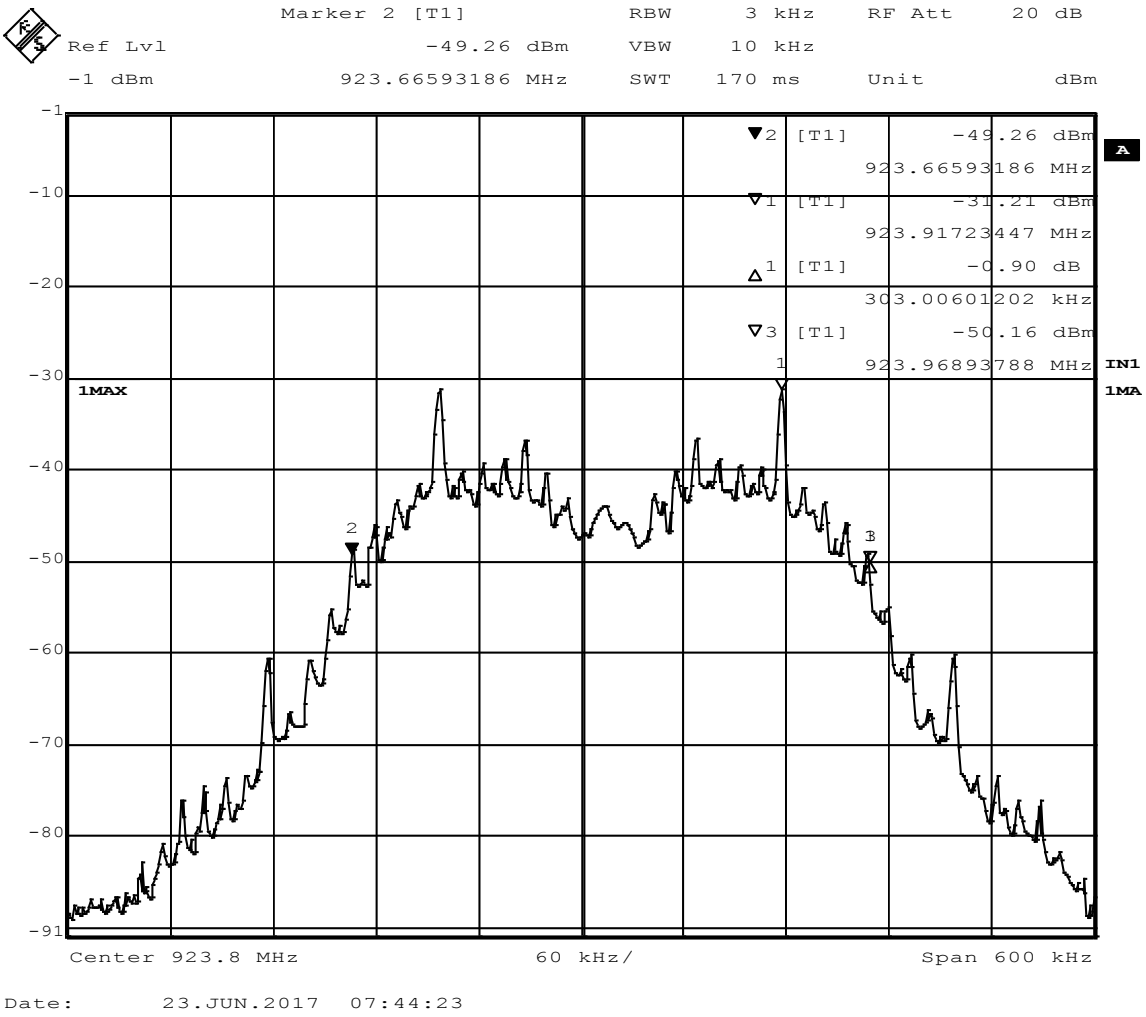


Figure 13 - 20 dB Bandwidth, High Channel, 303.00 kHz

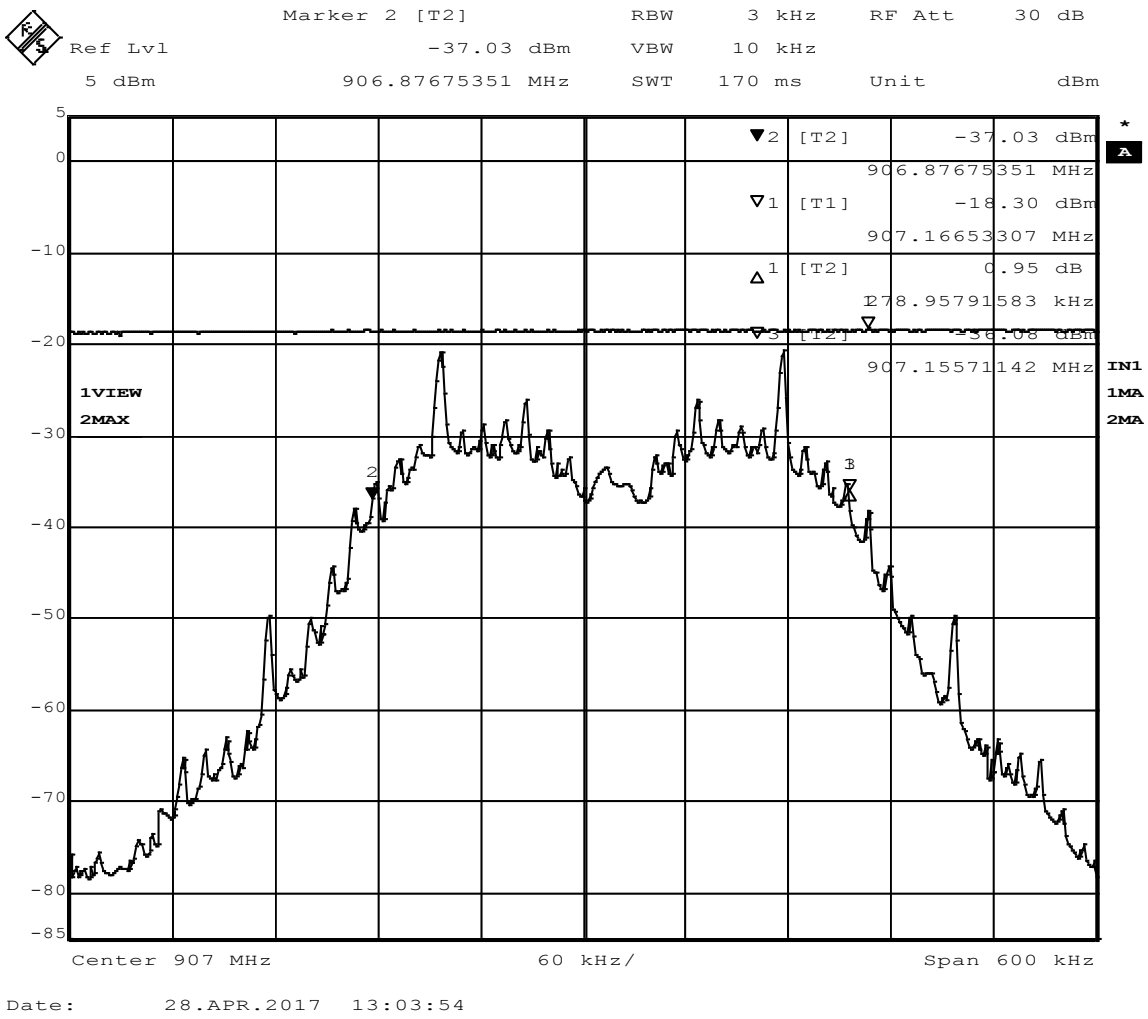


Figure 14 – Output Power, Low Channel

Maximum power = -18.30 dBm + 107 + CL + AF - 95.23 = 22.07 dBm

CL = cable loss = 4.70 dB
AF = antenna factor = 23.90 dB
107 = conversion from dBm to dBµV on a 50Ω measurement system
-95.23 = Conversion from field strength (dBµV/m) to EIRP (dBm) at a 3m measurement distance.

Note: the trace at the top where Marker 1 is located was made with a 10MHz resolution bandwidth and saved on the screen. The trace on the bottom was made with a 3 kHz RBW.

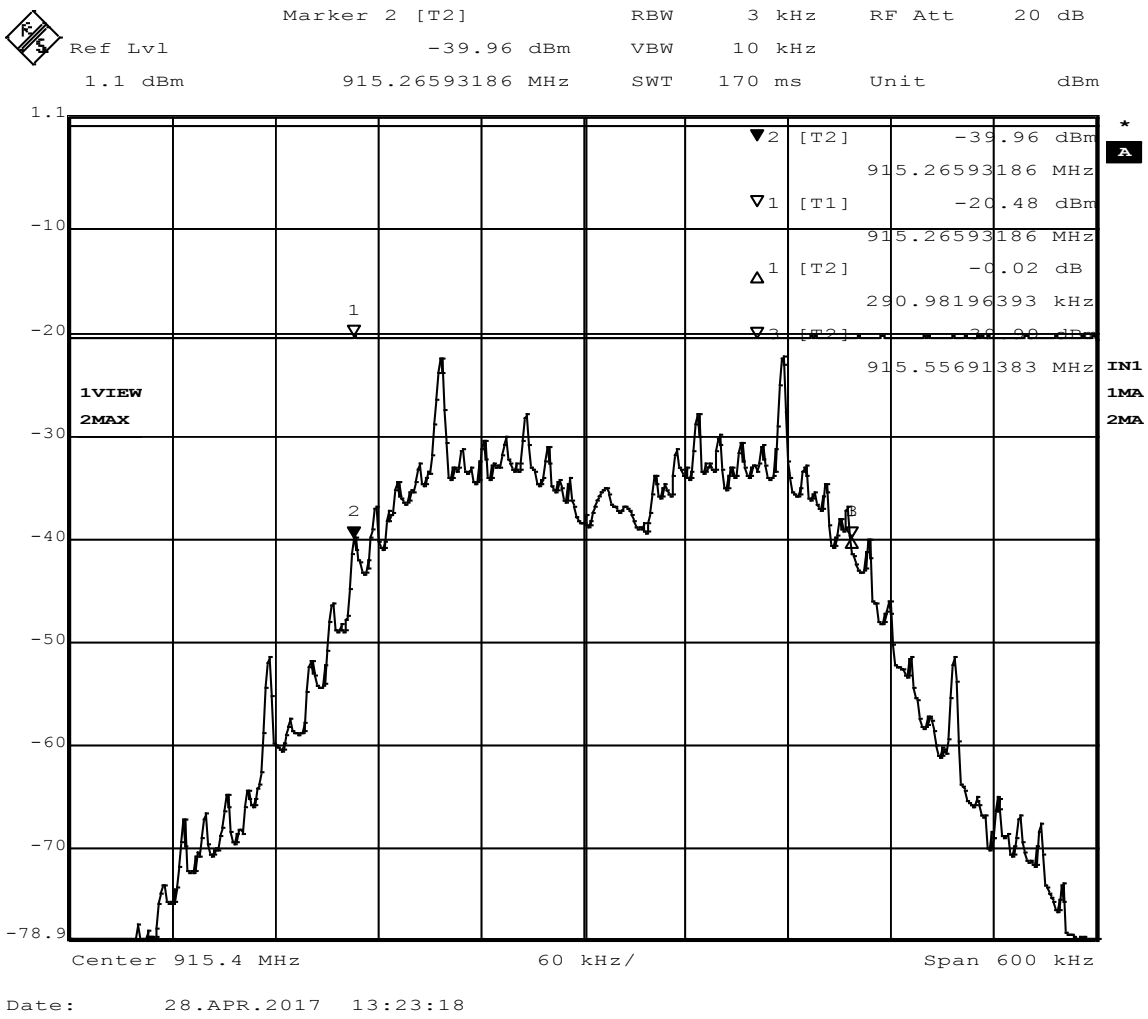


Figure 15 - Output Power, Mid Channel

Maximum power = -20.48 dBm + 107 + CL + AF - 95.23 = 19.89 dBm

CL = cable loss = 4.80 dB
AF = antenna factor = 23.80 dB
107 = conversion from dBm to dBµV on a 50Ω measurement system
-95.23 = Conversion from field strength (dBµV/m) to EIRP (dBm) at a 3m measurement distance.

Note: the trace at the top where Marker 1 is located was made with a 10MHz resolution bandwidth and saved on the screen. The trace on the bottom was made with a 3 kHz RBW.

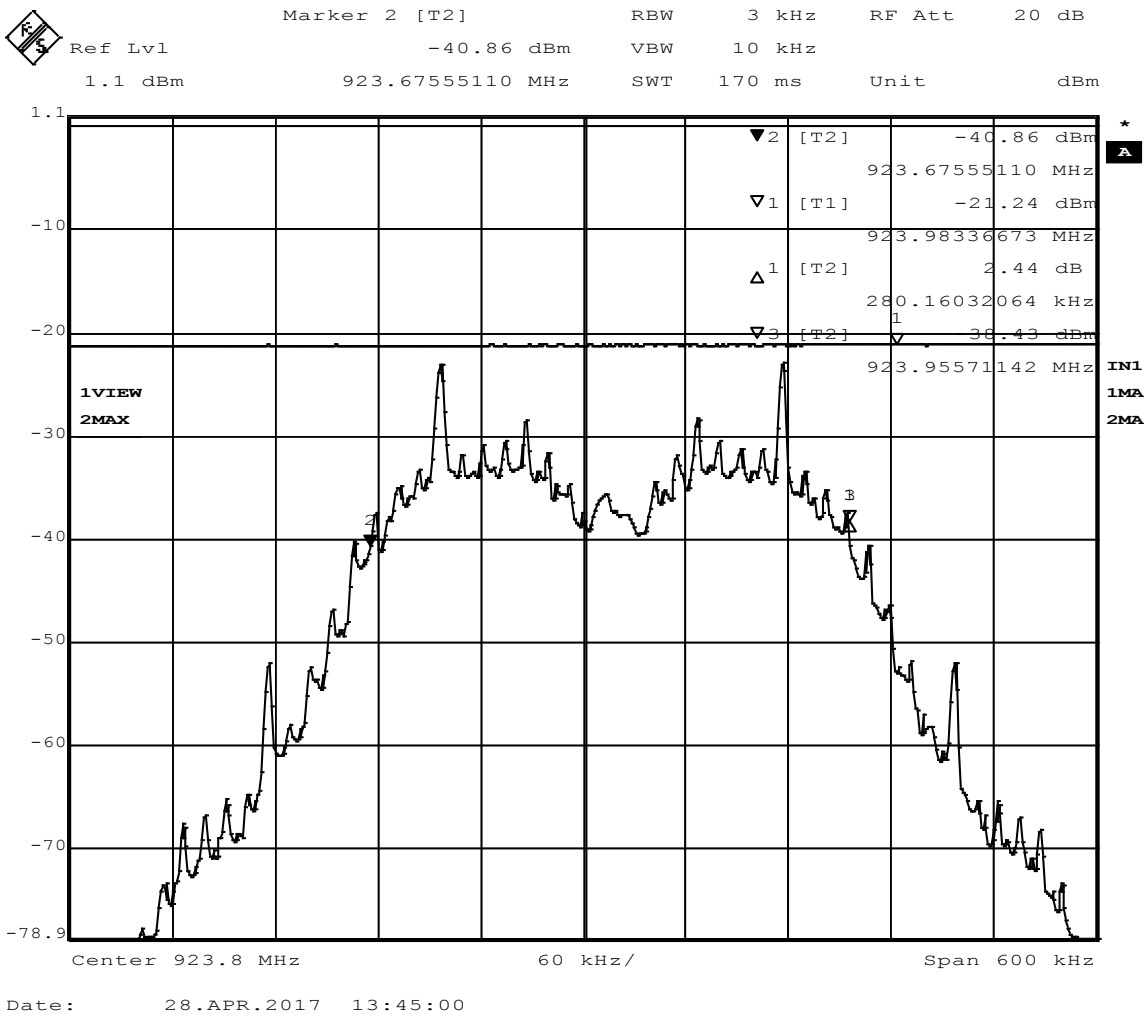


Figure 16 - Output Power, High Channel

Maximum power = -21.24 dBm + 107 + CL + AF - 95.23 = 19.33 dBm

CL = cable loss = 4.90 dB
AF = antenna factor = 23.90 dB
107 = conversion from dBm to dBµV on a 50Ω measurement system
-95.23 = Conversion from field strength (dBµV/m) to EIRP (dBm) at a 3m measurement distance.

Note: the trace at the top where Marker 1 is located was made with a 10MHz resolution bandwidth and saved on the screen. The trace on the bottom was made with a 3 kHz RBW.

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 – 928 MHz band) 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 EUT was oriented as to produce the maximum emission levels. The resolution bandwidth was set to 30kHz 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 3.3 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	RFMM	MODE	Transmit
INPUT POWER	3.3 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	-90.17	-18.83	71.34	68.46	PASS
3	924	-91.06	-21.06	70.00	67.17	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 =114.46 dBµV/m
Fundamental average field strength at 928MHz for high channel =113.17 dBµV/m

Channel 1 minimum delta = 114.46 - 46.0 dBµV/m = 68.46 dBc
Channel 3 minimum delta = 113.17 - 46.0 dBµV/m = 67.17 dBc

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.

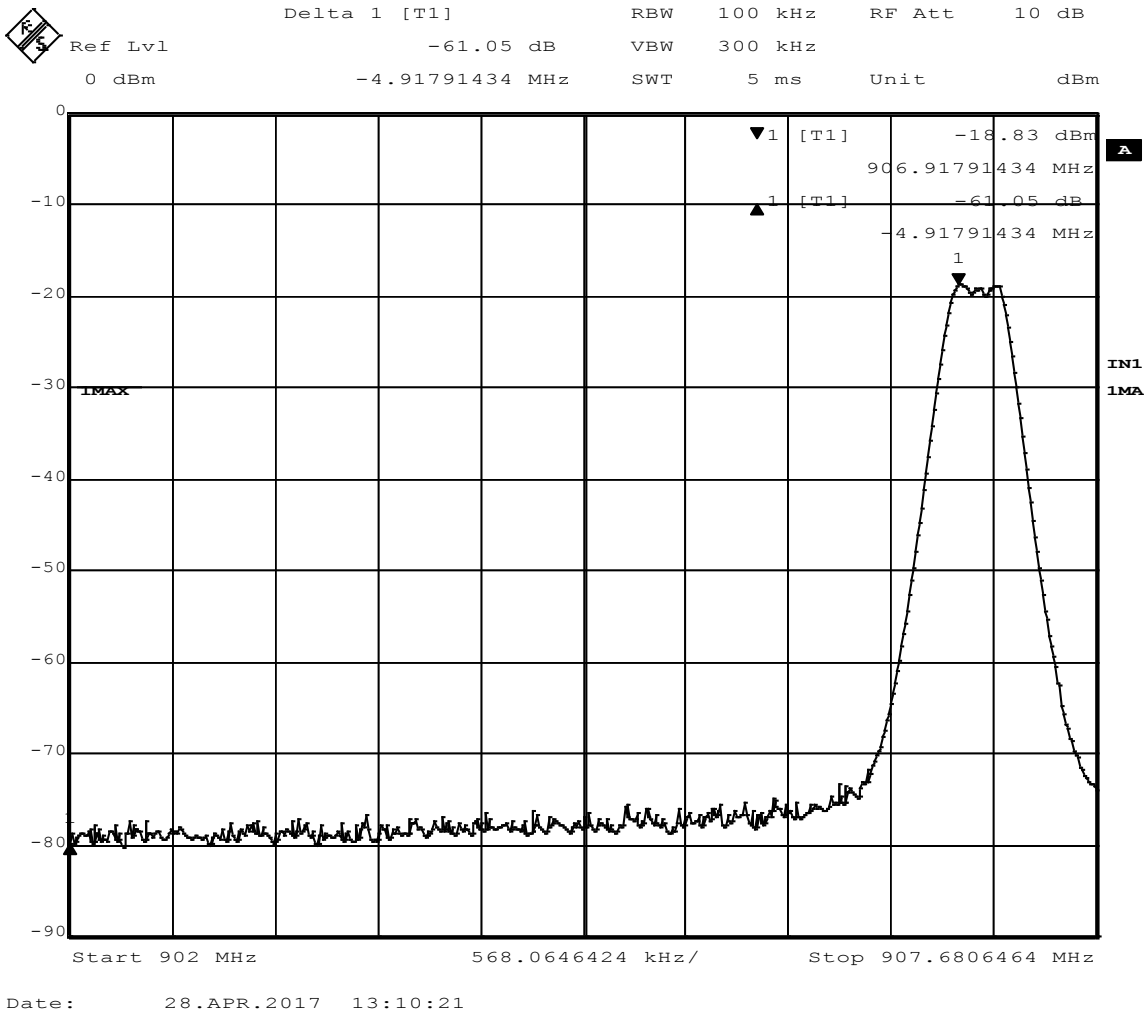


Figure 17 - Band-edge Measurement, Low Channel

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

Delta = 61.05 dB Min = 20 dB

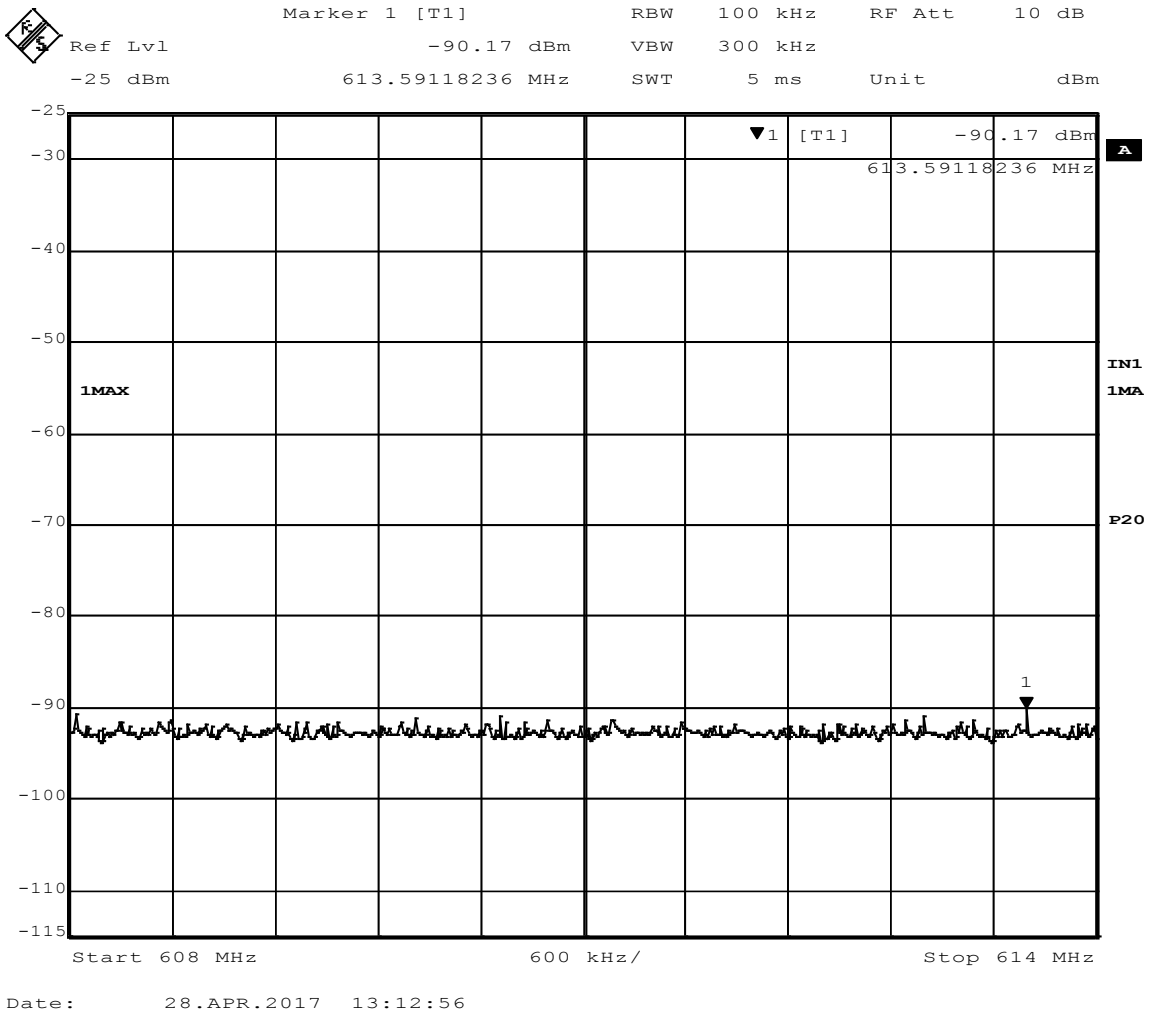


Figure 18 - Band-edge Measurement, Low Channel, Restricted

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

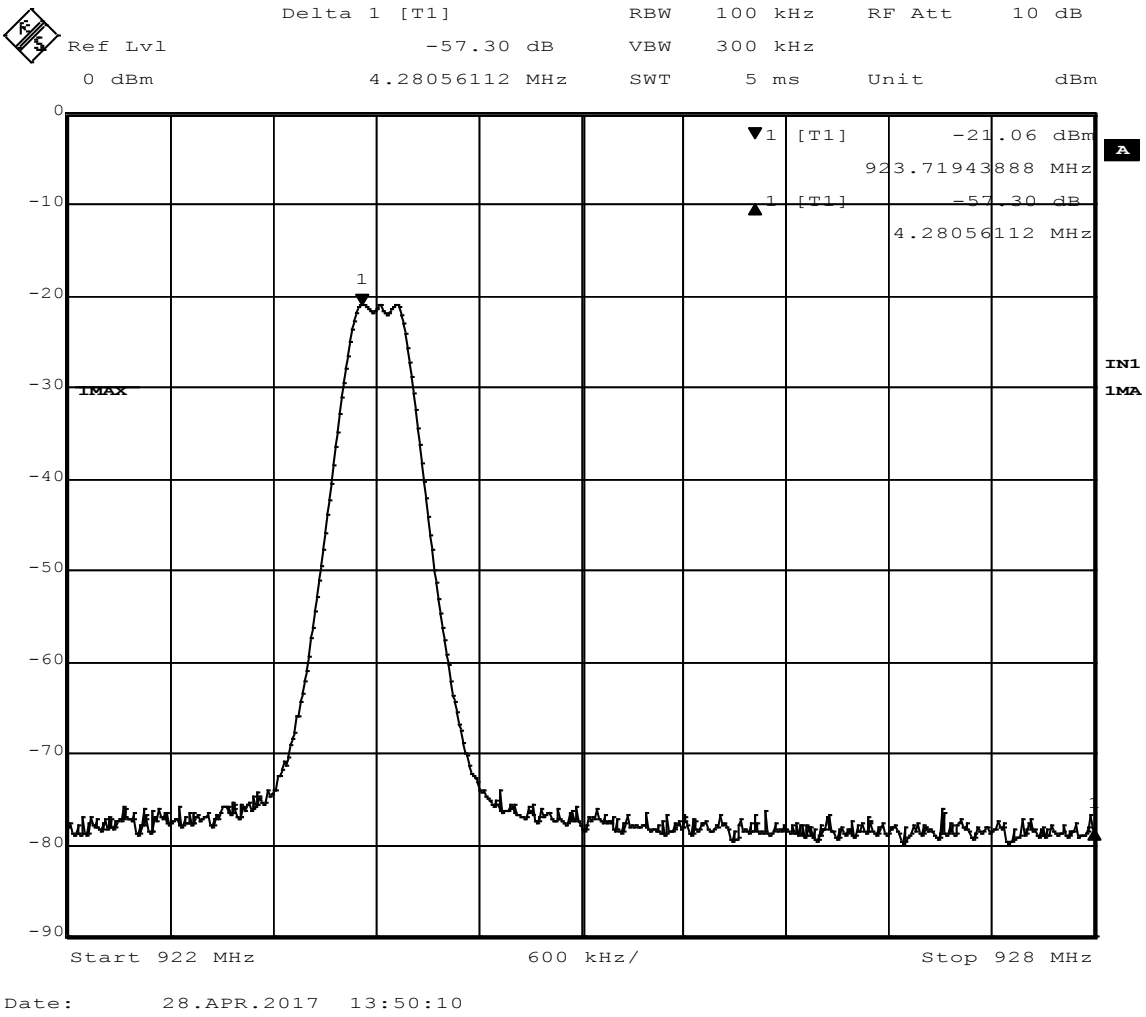


Figure 19 - Band-edge Measurement, High Channel, unrestricted Frequency

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

Delta = 57.30 dB Min = 20 dB

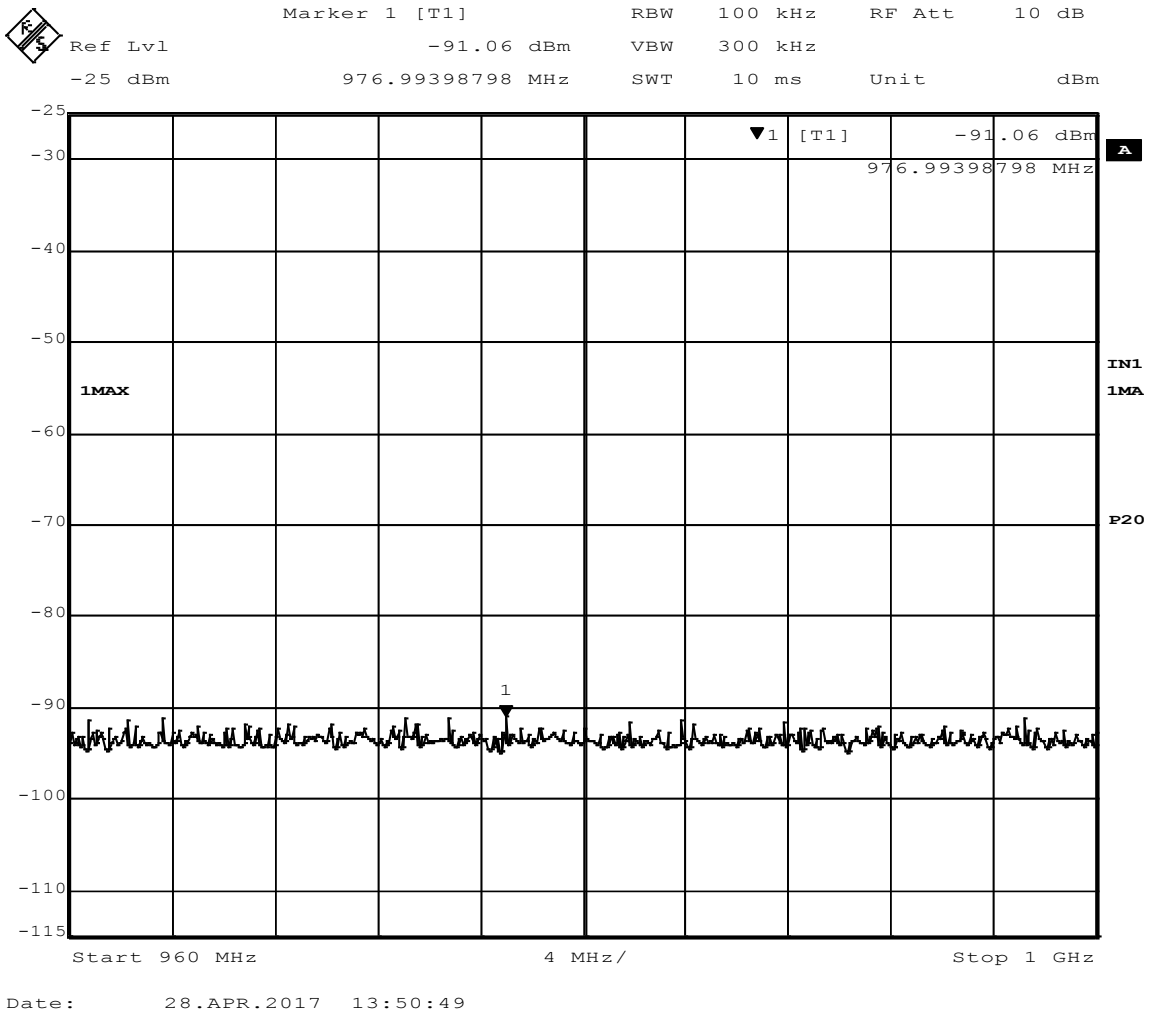


Figure 20 - Band-edge Measurement, High Channel, Restricted

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

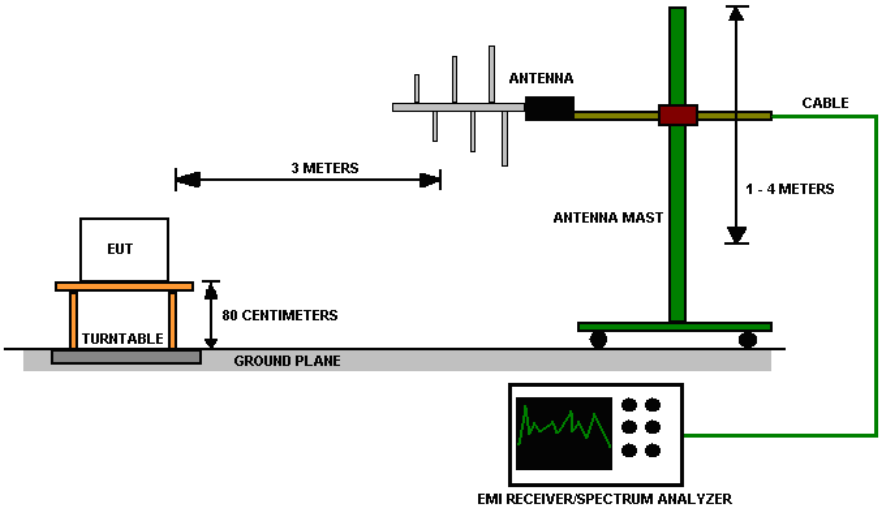
The method from ANSI C63.10 Section 7.7.2, 7.7.3 and 7.7.4 were used.

All measurements were taken at a distance of 3m from the EUT.

4.5.3 Deviations from test standard

No deviation.

4.5.4 Test setup



4.7.5 EUT operating conditions

The EUT was powered by 3.3 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.

4.7.6 Test results

EUT MODULE	RFMM	MODE	Continuous Hop
INPUT POWER	3.3 VDC	FREQUENCY RANGE	907MHz – 924 MHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

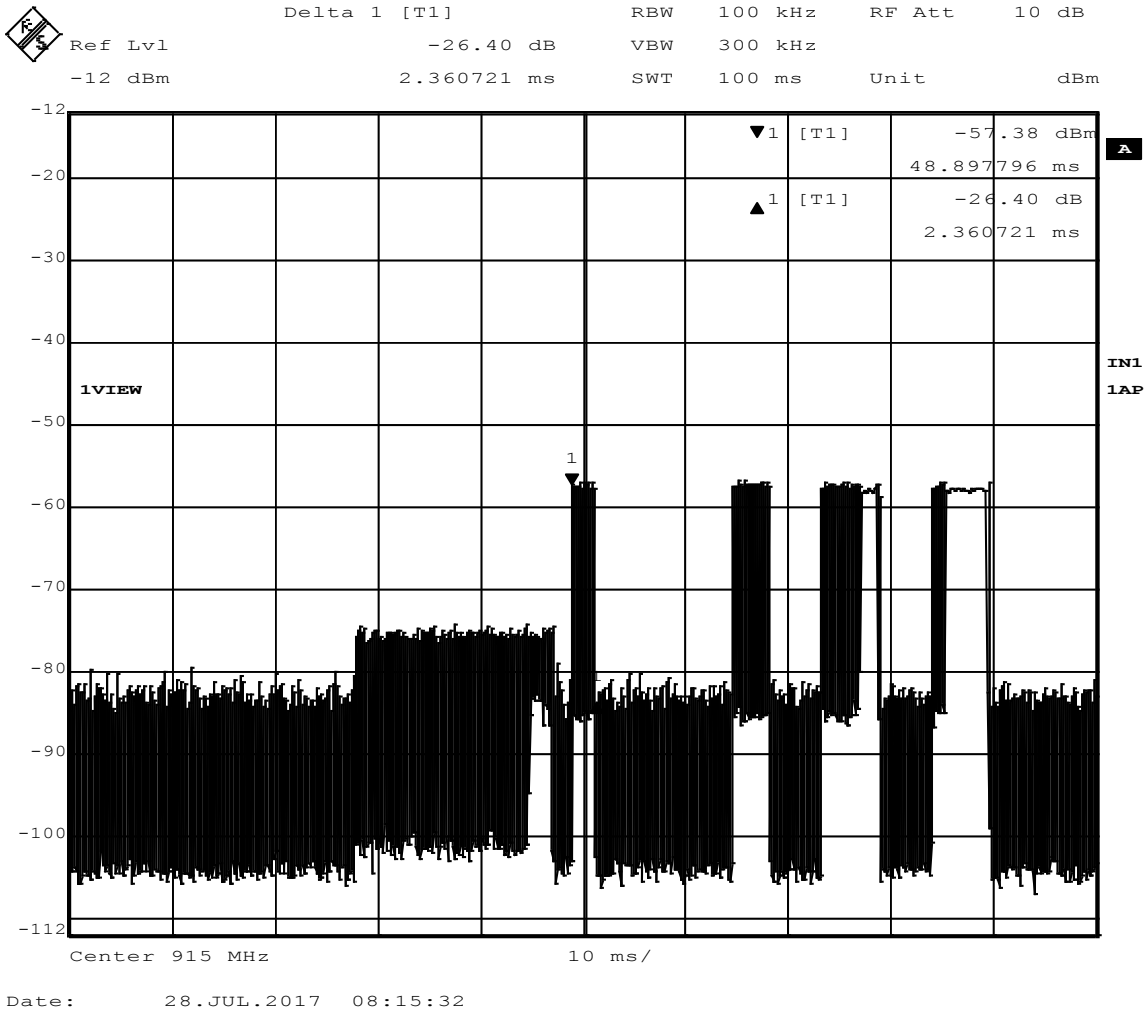


Figure 21 – Time of Occupancy -2 (17.84 ms total - Pass)

Time of occupancy = 17.84 ms (See figures 6 – 9)

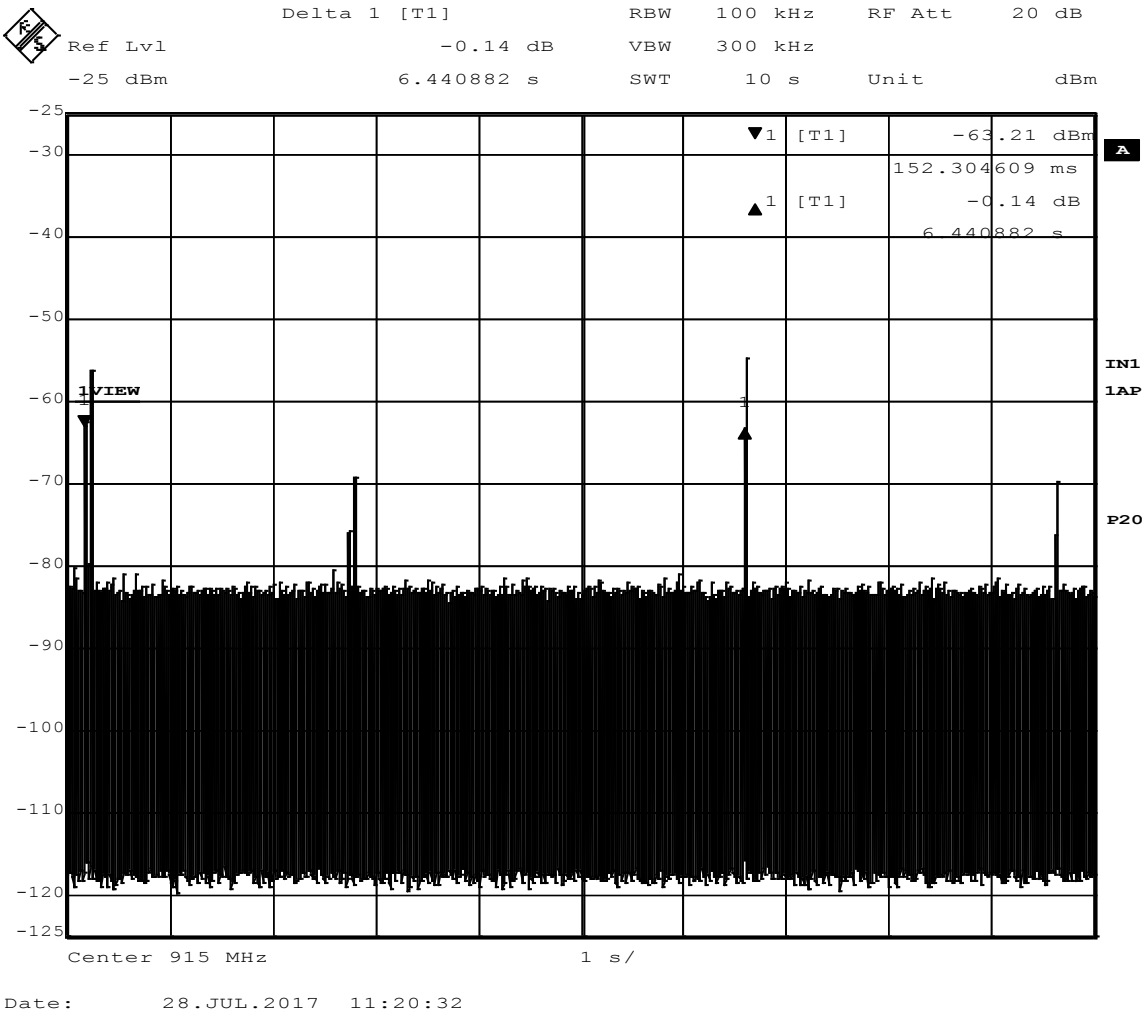


Figure 22 – Time of Occupancy - Period (Max – 4 peaks in 10 seconds window)

2 pulses occur at each marker
The full span shows 10 sec.
Time of occupancy in 10sec= 17.84 x 4 = <u>71.36 ms</u>

* Note that the two other shorter pulses in the plot are from RFMD the unit with which RFMM need to communicate to make this measurement.

Max = 0.4 s in 10 sec window

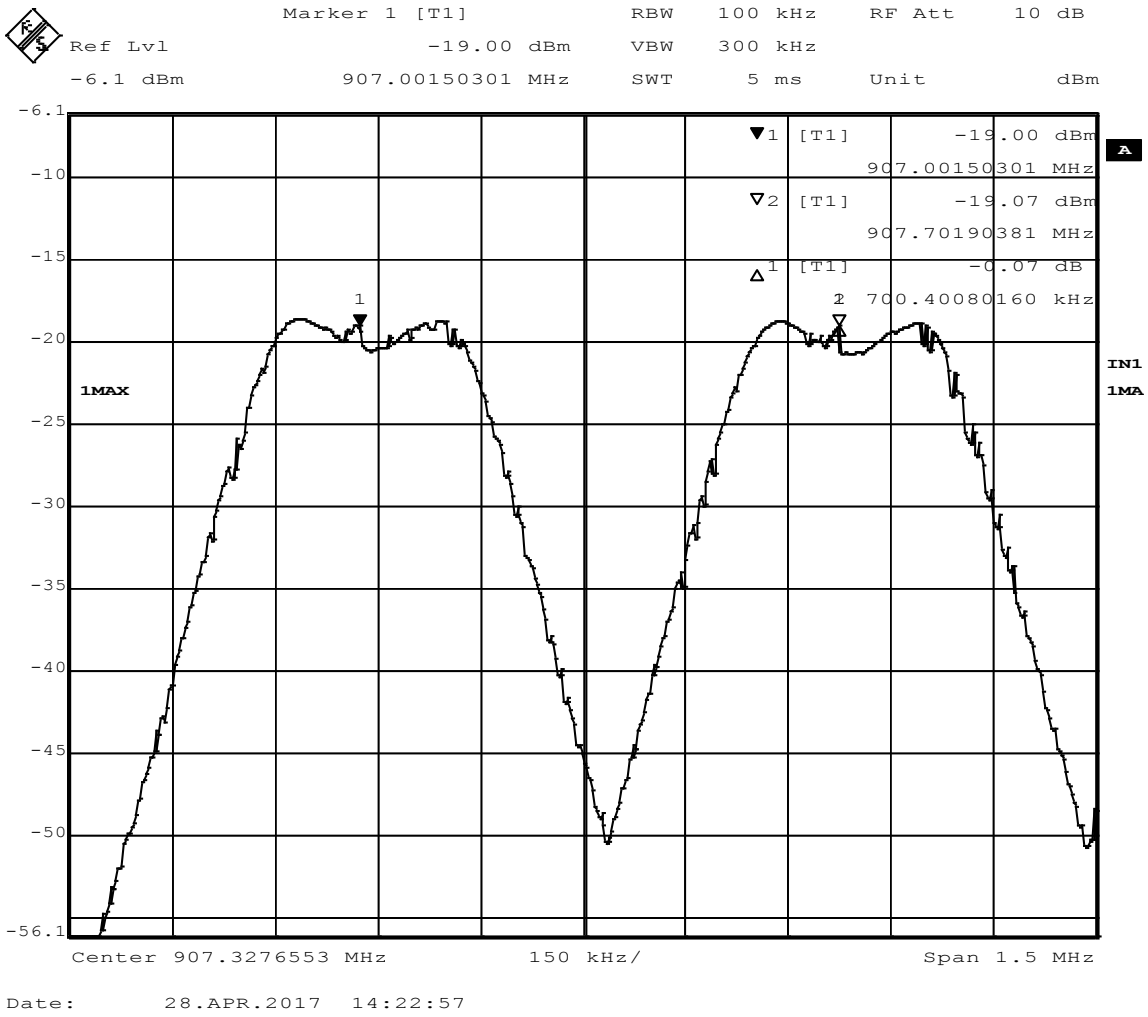


Figure 23 – Frequency Separation (700.40 kHz)

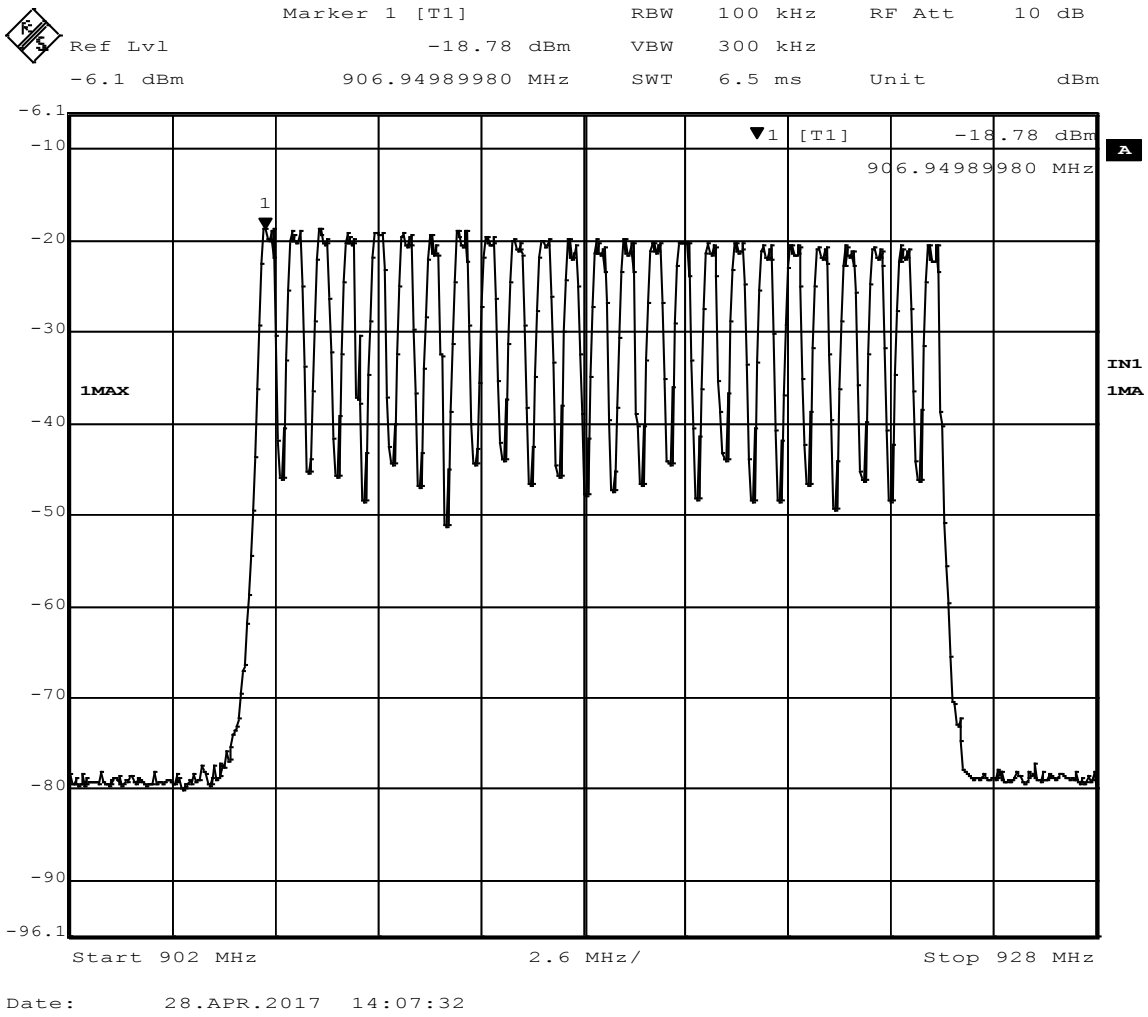


Figure 24 – Hopping Channel Count (25 Channels)

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.