The Nebraska Center for Excellence in Electronics
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Amended

FCC/IC Test Report

Includes NCEE Labs report R20170623-21 and its amendment in full

Prepared for: **Digital Monitoring Products**

Address: **2500 North Partnership Blvd.**
Springfield, MO 6582

Product: **1158 Wireless Module**

Test Report No: **R20170623-21A**

Approved By:

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DATE: **7 September 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, 5.1c	Minimum Bandwidth, Limit: Max. <250 kHz/ 50+ channels	Pass	Meets the requirement of the limit.
FCC 15.247(b)(1) RSS-247, 5.4	Maximum Peak Output Power, Limit: Max. 30 dBm	Pass	Meets the requirement of the limit.
FCC 15.209 RSS-Gen, 8.9 RSS-247, 5.3	Transmitter Radiated Emissions	Pass	Meets the requirement of the limit.
FCC 15.247(a) (1) (i) RSS-247, 5.1c	Frequency hopping system, Limit: Max. 0.4 Seconds in 10 Second Period	Pass	Meets the requirement of the limit.
FCC 15.209, 15.205 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 15.207 RSS-Gen, 8.8	Conducted AC Emissions	Pass	Meets the requirement of the limit.

1.2 Amendment description

Updated Section 2.4 to state RSS-247 Issue 2
Section 4.3.6 was corrected to show the 20dB BW as 72.14 kHz to match the plot.

2.0 Description

2.1 Equipment under test

The Equipment Under Test (EUT) was 1158 a Wireless module Manufactured by DMP wireless devices. It operates from 905 to 924.4 MHz and has transmit and receive capabilities.

EUT Received Date: 12 July 2017
EUT Tested Dates: 13 July 2017 – 31 July 2017

MODEL	1158
Serial No.	08201001 / 08201002 for all other measurements 08204001 / 08204002 for on time measurements
POWER SUPPLY	16.5 VAC / 60Hz
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 ± 4%
Temperature of 22 ± 3° Celsius

2.3 Description of test modes

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

Channel	Frequency
Low	905.6
Middle	915.0
High	924.4

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 905 MHz to 924 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 2
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
RF Cable (preamplifier to antenna)	MFR-57500	01-07-002	09 Feb 2017*	09 Feb 2018*
RF Cable (antenna to 10m chamber bulkhead)	FSCM 64639	01E3872	09 Feb 2017*	09 Feb 2018*
RF Cable (10m chamber bulkhead to control room bulkhead)	FSCM 64639	01E3874	09 Feb 2017*	09 Feb 2018*
RF Cable (Control room bulkhead to RF switch)	FSCM 64639	01E3871	09 Feb 2017*	09 Feb 2018*
RF Cable (RF switch to test receiver)	FSCM 64639	01F1206	09 Feb 2017*	09 Feb 2018*
RF switch – Rohde and Schwarz	TS-RSP	1113.5503.14	09 Feb 2017*	09 Feb 2018*
N connector bulkhead (10m chamber)	PE9128	NCEEBH1	09 Feb 2017*	09 Feb 2018*
N connector bulkhead (control room)	PE9128	NCEEBH2	09 Feb 2017*	09 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 an antenna on the PCB so it’s not user replaceable.

4.2 Radiated emissions

Test Method: ANSI C63.10, Section(s) 6.5, 6.6

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

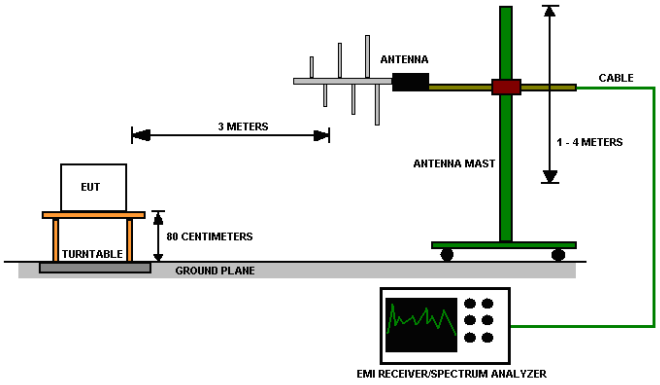


Figure 1 - Radiated Emissions Test Setup

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 16.5 VAC / 60Hz 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	1158	MODE	Receive
INPUT POWER	16.5 VAC / 60Hz	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	DHoffman/ KVepuri

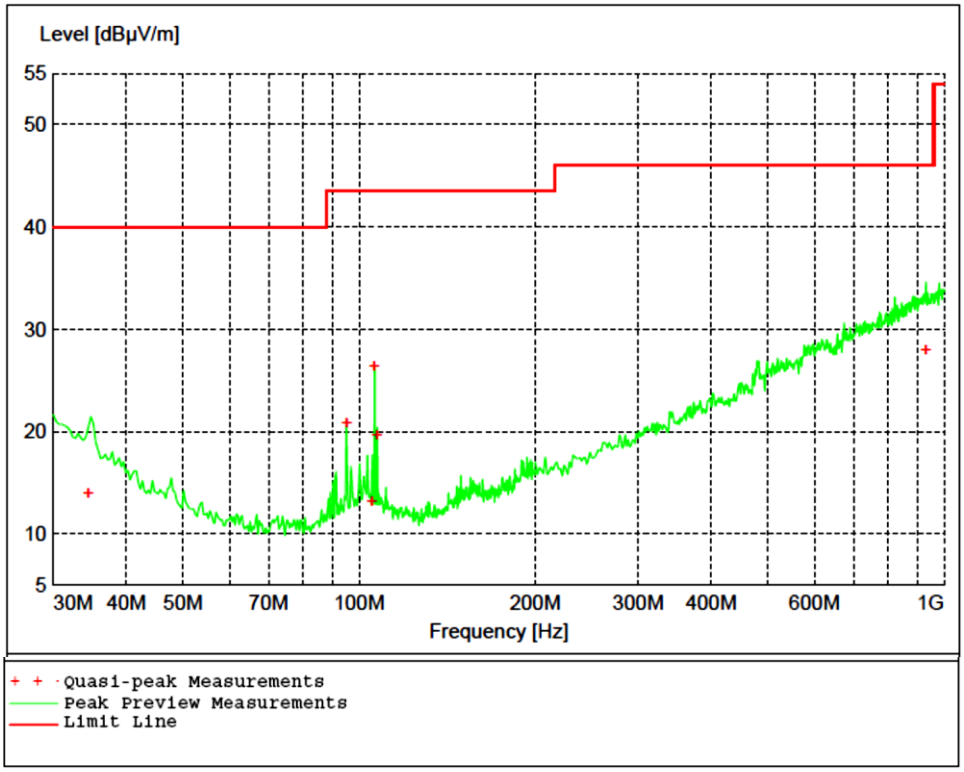


Figure 2 - Radiated Emissions Plot, Receive

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, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
34.440000	13.93	40.00	26.10	339	71	VERT	x
95.160000	20.85	43.50	22.70	100	133	VERT	x
105.300000	13.24	43.50	30.30	242	163	VERT	x
106.260000	26.44	43.50	17.10	99	0	VERT	x
107.280000	19.61	43.50	23.90	101	68	VERT	x
930.840000	27.98	46.00	18.00	377	161	VERT	x

Table 2 - Radiated Emissions Peak Measurement vs Average Limits, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
5933.800000	45.16	54.00	8.84	203	48	VERT	x
8741.800000	45.44	54.00	8.56	150	33	VERT	x

Peak measurements were compared to average limit and found to be compliant so average measurements were not performed

EUT	1158	MODE	Transmit, Low Channel
INPUT POWER	16.5 VAC / 60Hz	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	DHoffman/ KVepuri

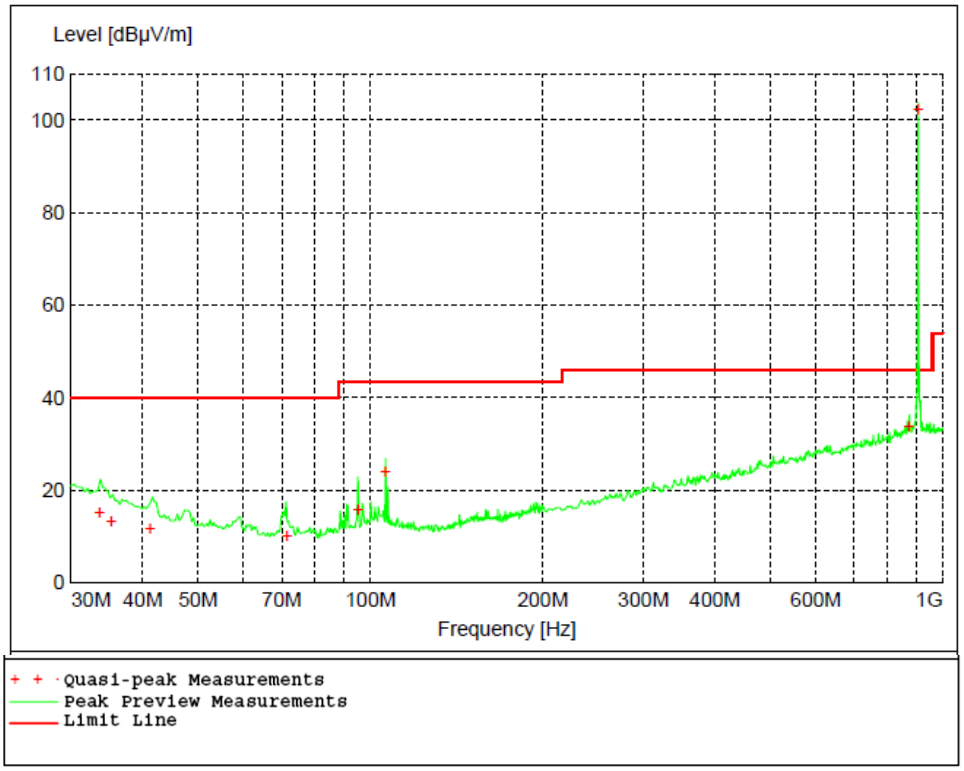


Figure 3 - Radiated Emissions Plot, Low Channel

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 3 - Radiated Emissions Quasi-peak Measurements, Low Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
33.660000	15.14	40.00	24.90	254	33	VERT	x
35.220000	13.47	40.00	26.50	334	4	VERT	x
41.220000	11.80	40.00	28.20	291	307	VERT	x
71.460000	10.27	40.00	29.70	137	277	VERT	x
95.100000	16.00	43.50	27.50	361	113	VERT	x
106.260000	24.17	43.50	19.40	99	121	VERT	x
873.600000	34.00	46.00	12.00	100	271	HORI	x
905.600000	102.35	NA	NA	99	353	HORI	x

Table 4 - Radiated Emissions Average Measurements, Low Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
1811.200000	39.08	54.00	14.92	99	51	HORI	x
2716.800000	32.16	54.00	21.84	200	70	HORI	x
3622.400000	42.35	54.00	11.65	184	74	HORI	x
4527.800000	42.21	54.00	11.79	160	41	HORI	x
5433.600000	37.25	54.00	16.75	200	280	VERT	x
6339.200000	35.77	54.00	18.23	170	258	VERT	x
7244.600000	33.16	54.00	20.84	299	86	VERT	x
8150.200000	34.71	54.00	19.29	169	260	HORI	x
9055.800000	35.15	54.00	18.85	227	243	VERT	x

Note: Average Level = Peak Level – Duty Cycle Correction Factor
Duty Cycle Correction Factor is calculated in Figures 6 and 7. 16.81 dB was used.

Table 5 - Radiated Emissions Peak Measurements, Low Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
1811.200000	55.89	74.00	18.11	99	51	HORI	x
2716.800000	48.97	74.00	25.03	200	70	HORI	x
3622.400000	59.16	74.00	14.84	184	74	HORI	x
4527.800000	59.02	74.00	14.98	160	41	HORI	x
5433.600000	54.06	74.00	19.94	200	280	VERT	x
6339.200000	52.58	74.00	21.42	170	258	VERT	x
7244.600000	49.97	74.00	24.03	299	86	VERT	x
8150.200000	51.52	74.00	22.48	169	260	HORI	x
9055.800000	51.96	74.00	22.04	227	243	VERT	x

EUT	1158	MODE	Transmit, Mid Channel
INPUT POWER	16.5 VAC / 60Hz	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	DHoffman/ KVepuri

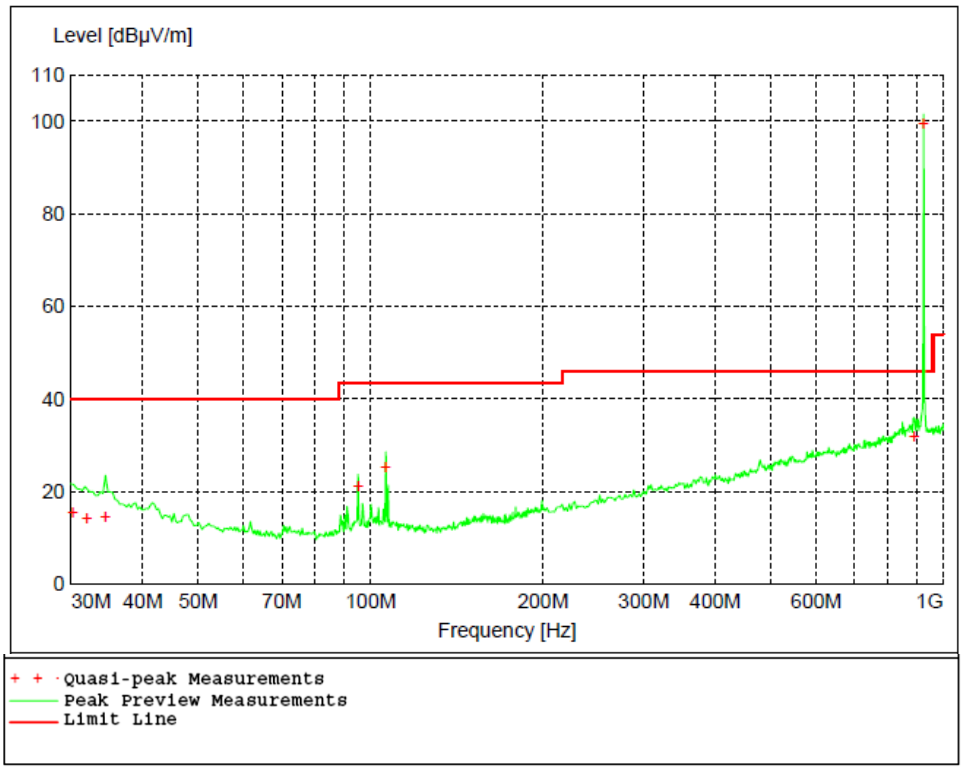


Figure 4 - Radiated Emissions Plot, Mid Channel

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 6 - Radiated Emissions Quasi-peak Measurements, Mid Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
30.600000	15.40	40.00	24.60	381	47	VERT	x
34.500000	14.28	40.00	25.70	264	167	VERT	x
41.700000	12.15	40.00	27.80	339	179	VERT	x
95.160000	22.52	43.50	21.00	98	219	VERT	x
106.260000	24.50	43.50	19.00	101	120	VERT	x
107.280000	19.72	43.50	23.80	99	11	VERT	x
906.960000	35.25	46.00	10.80	99	360	HORI	x
915.000000	100.38	NA	NA	101	360	HORI	x

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

Table 7 - Radiated Emissions Average Measurements, Mid Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
1830.000000	38.94	54.00	15.06	126	27	VERT	x
2745.000000	34.86	54.00	19.14	170	63	HORI	x
3660.000000	44.60	54.00	9.40	133	61	VERT	x
4575.000000	46.08	54.00	7.92	190	226	HORI	x
5490.000000	55.90	74.00	18.10	187	117	HORI	x
6405.200000	43.70	74.00	30.30	99	40	HORI	x
7320.000000	51.32	74.00	22.68	227	332	HORI	x
8221.200000	46.91	74.00	27.09	400	339	VERT	x
9150.000000	56.94	74.00	17.06	145	194	VERT	x

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 6 and 7. 16.81 dB was used.

Table 8 - Radiated Emissions Peak Measurements, Mid Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
1830.000000	55.75	74.00	18.25	126	27	VERT	x
2745.000000	51.67	74.00	22.33	170	63	HORI	x
3660.000000	61.41	74.00	12.59	133	61	VERT	x
4575.000000	62.89	74.00	11.11	190	226	HORI	x
5490.000000	39.09	54.00	14.91	187	117	HORI	x
6405.200000	26.89	54.00	27.11	99	40	HORI	x
7320.000000	34.51	54.00	19.49	227	332	HORI	x
8221.200000	30.10	54.00	23.90	400	339	VERT	x
9150.000000	40.13	54.00	13.87	145	194	VERT	x

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

EUT	1158	MODE	Transmit, High Channel
INPUT POWER	16.5 VAC / 60Hz	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	DHoffman/ KVepuri

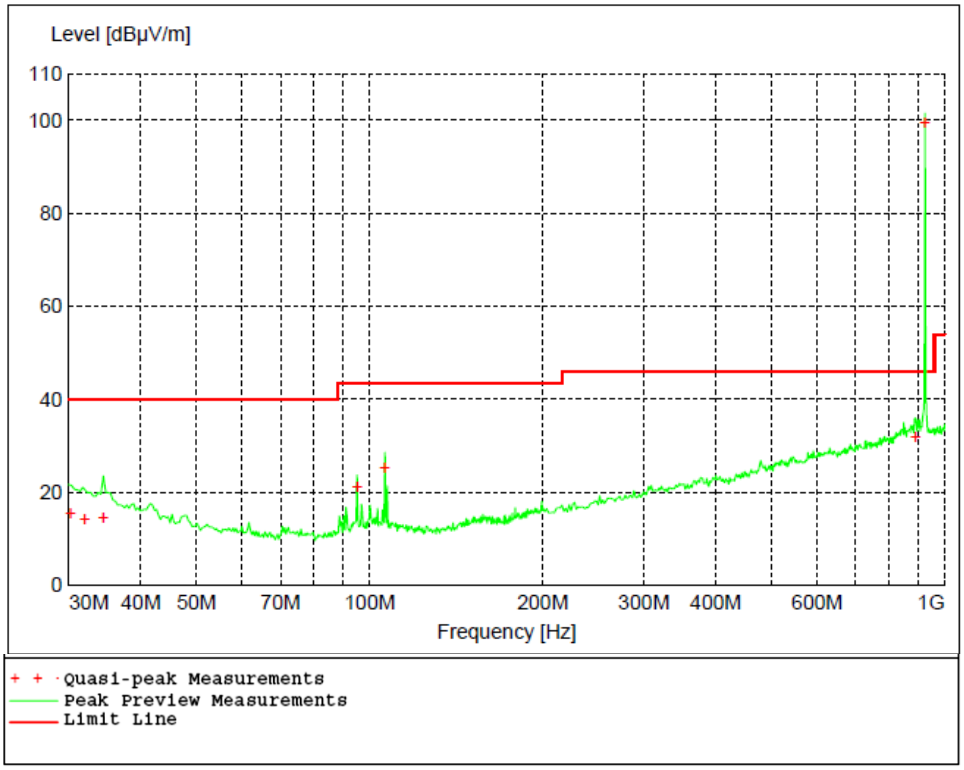


Figure 5 - Radiated Emissions Plot, High Channel

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 9 - Radiated Emissions Quasi-peak Measurements, High Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
30.180000	15.69	40.00	24.30	334	12	HORI	x
31.980000	14.48	40.00	25.50	400	196	VERT	x
34.440000	14.68	40.00	25.30	267	333	VERT	x
95.100000	21.37	43.50	22.10	101	136	VERT	x
106.260000	25.45	43.50	18.10	99	121	VERT	x
889.920000	31.89	46.00	14.10	101	0	HORI	x
924.400000	99.61	NA	NA	99	0	HORI	x

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

Table 10 - Radiated Emissions Average Measurements, High Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
1848.800000	38.08	54.00	15.92	100	23	VERT	x
2773.200000	36.05	54.00	17.95	177	25	VERT	x
3697.600000	45.90	54.00	8.10	136	68	VERT	x
4622.200000	47.14	54.00	6.86	190	33	HORI	x
5546.200000	37.85	54.00	16.15	170	118	VERT	x
6479.800000	26.56	54.00	27.44	394	360	VERT	x
7395.000000	34.55	54.00	19.45	204	330	VERT	x
8305.400000	29.73	54.00	24.27	398	6	HORI	x
9244.200000	39.12	54.00	14.88	130	189	VERT	x

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 6 and 7. 16.81 dB was used.

Table 11 - Radiated Emissions Peak Measurements, High Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
1848.800000	54.89	74.00	19.11	100	23	VERT	x
2773.200000	52.86	74.00	21.14	177	25	VERT	x
3697.600000	62.71	74.00	11.29	136	68	VERT	x
4622.200000	63.95	74.00	10.05	190	33	HORI	x
5546.200000	54.66	74.00	19.34	170	118	VERT	x
6479.800000	43.37	74.00	30.63	394	360	VERT	x
7395.000000	51.36	74.00	22.64	204	330	VERT	x
8305.400000	46.54	74.00	27.46	398	6	HORI	x
9244.200000	55.93	74.00	18.07	130	189	VERT	x

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

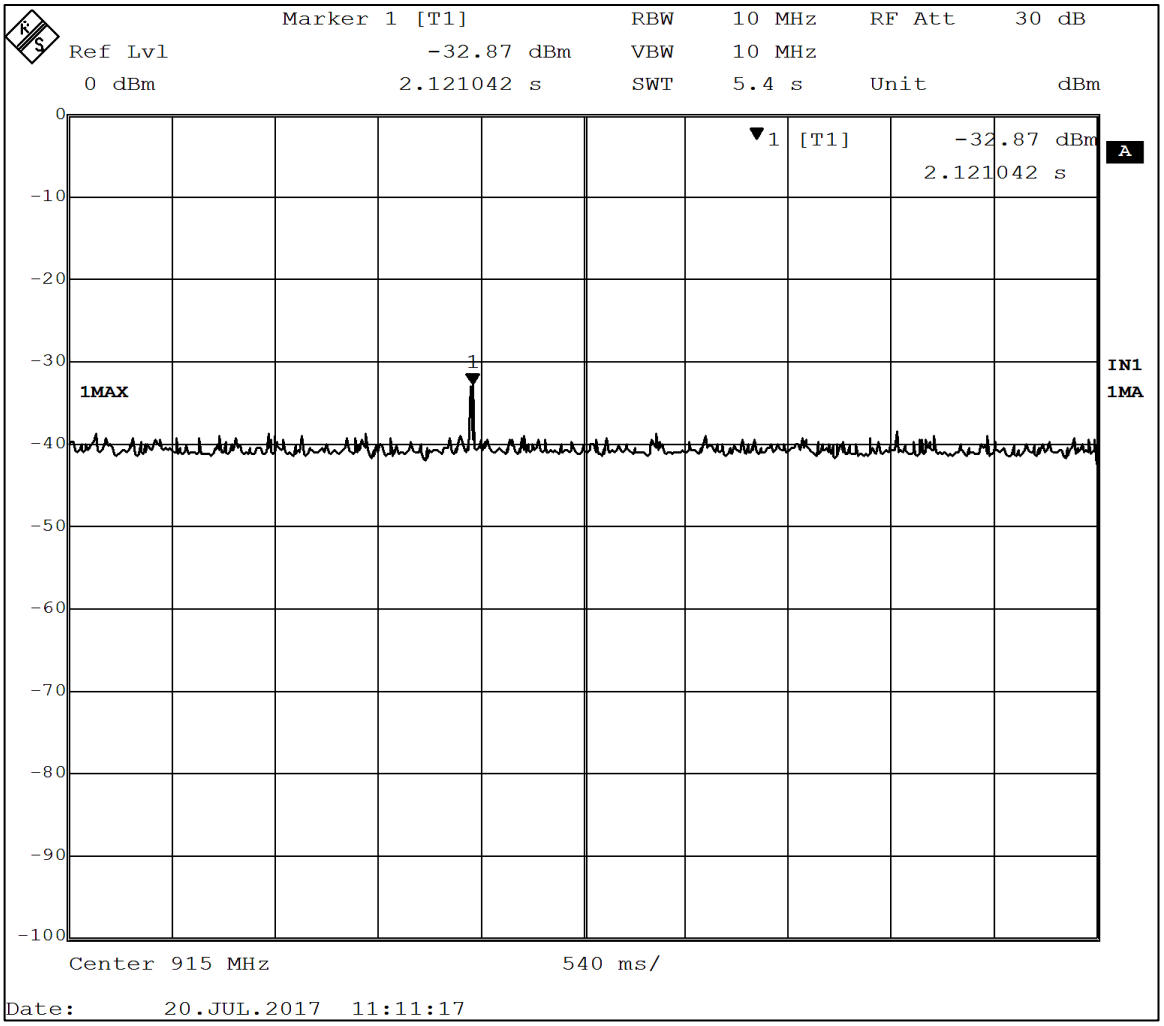


Figure 6 – Period

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

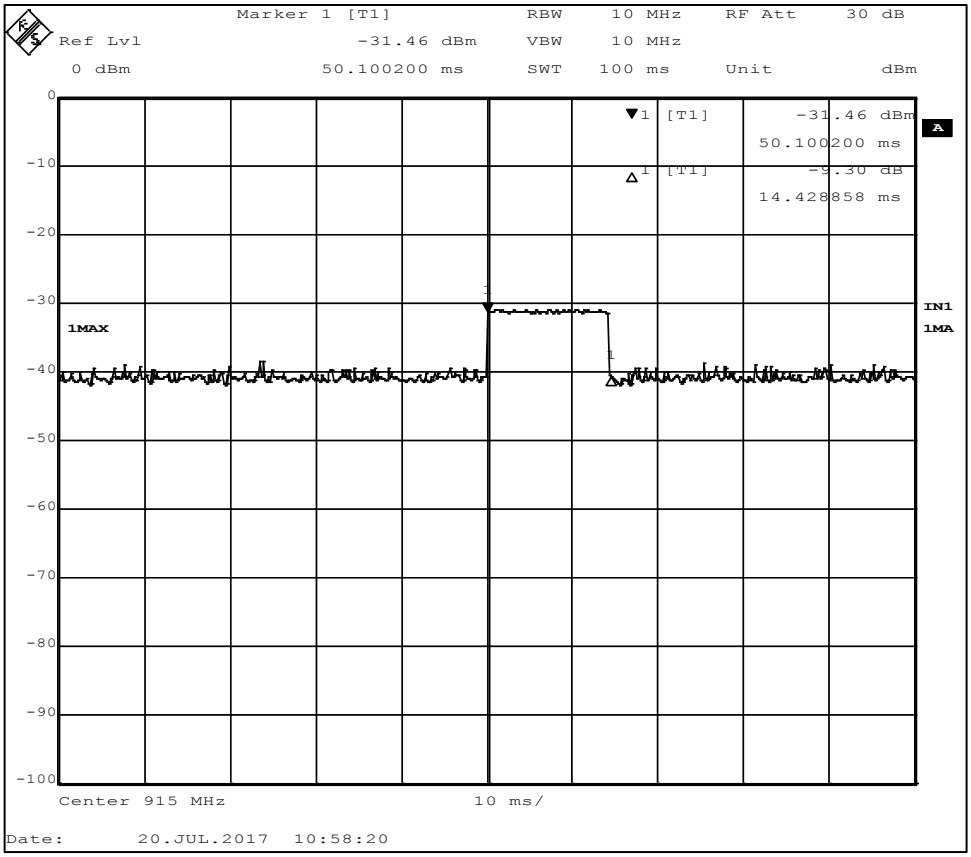


Figure 7 – Maximum Pulse Width

Duty cycle correction factor = 20*log(14.43/100) = -16.81 dB

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

Note 2: there was only one 14.43 ms pulses per 100ms period.

4.3 Bandwidth and Peak EIRP

Test Method: ANSI C63.10, Section(s) 7.8.5, 6.9.2

4.3.1 Limits of bandwidth measurements

From FCC Part 15.247 (1) (i) and RSS-247 5.1(c)

The 20 dB occupied bandwidth and peak EIRP are displayed separately. The peak EIRP was measured using a 10 MHz RBW. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz. The output power is required to be less than 30 dBm for systems employing more than 50 channels.

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 20dB band width is defined as the bandwidth that is measured 20 dB down from the peak of the signal.

The maximum power was measured with the largest resolution bandwidth possible (10MHz) and this value was recorded.

4.3.3 Deviations from test standard

No deviation.

4.3.4 Test setup

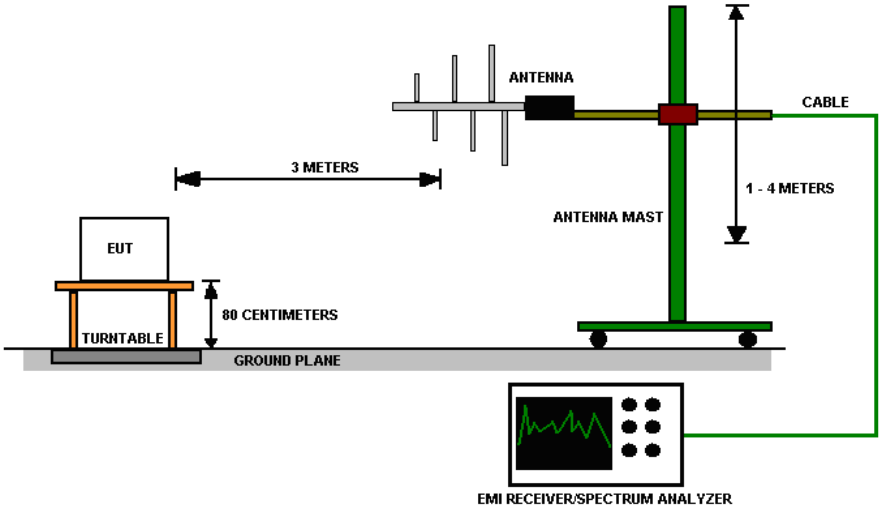


Figure 8 - Bandwidth Measurements Test Setup

4.3.5 EUT operating conditions

The EUT was powered by 16.5 VAC / 60Hz 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	1158	MODE	Transmit
INPUT POWER	16.5 VAC / 60Hz	FREQUENCY RANGE	905.6 MHz – 924.4 MHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

20 dB Bandwidth

CHANNEL	CHANNEL FREQUENCY (MHz)	20dB BW (kHz)
1	905	72.14
2	915	71.74
3	924	72.14

*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)	EIRP LIMIT (dBm)	RESULT
1	905.6	9.04	30	PASS
2	915.0	8.79	30	PASS
3	924.4	7.89	30	PASS

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

All measurements were taken from the Output Power screen captures.

REMARKS:
None

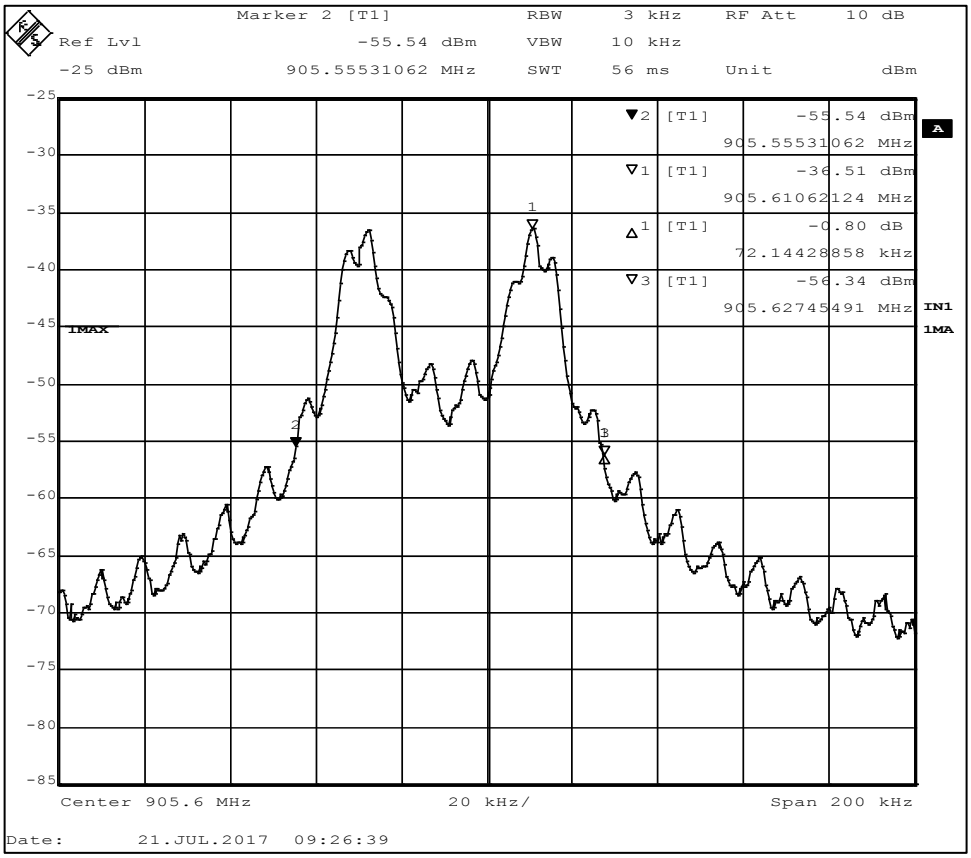


Figure 9 – 20 dB Bandwidth, Low Channel. 72.14 kHz

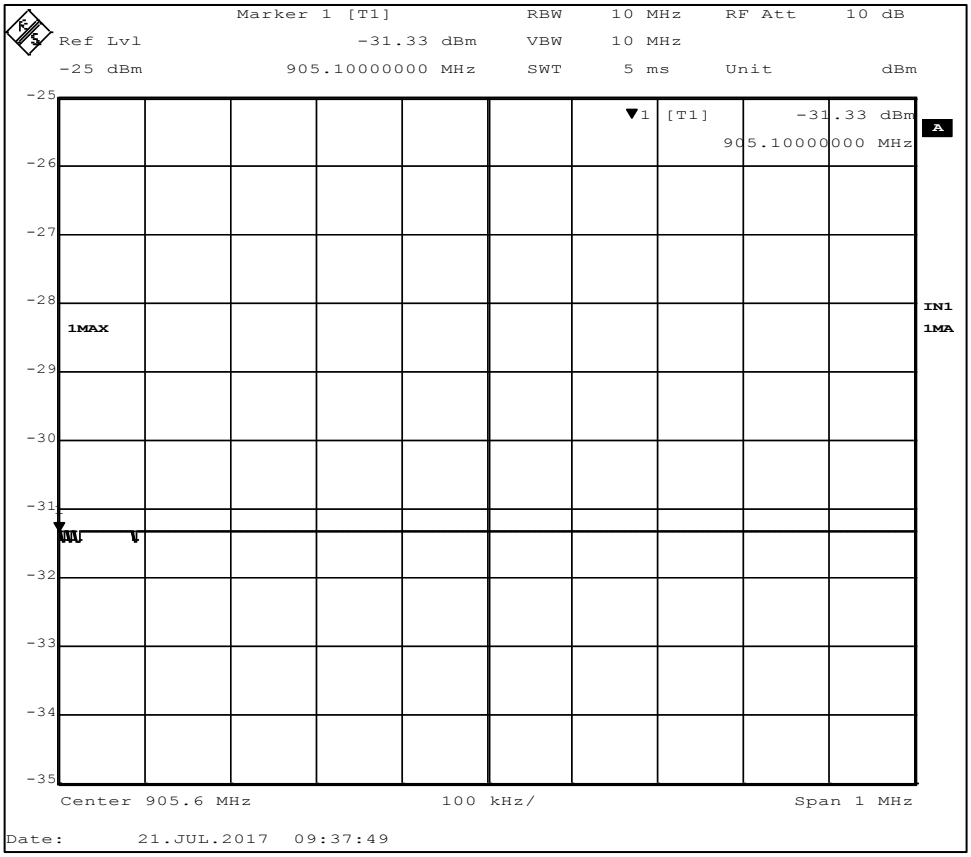


Figure 10 – Output Power, Low Channel.

Maximum power = -31.33 dBm + 107 + CL + AF - 95.23 = 9.04 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.

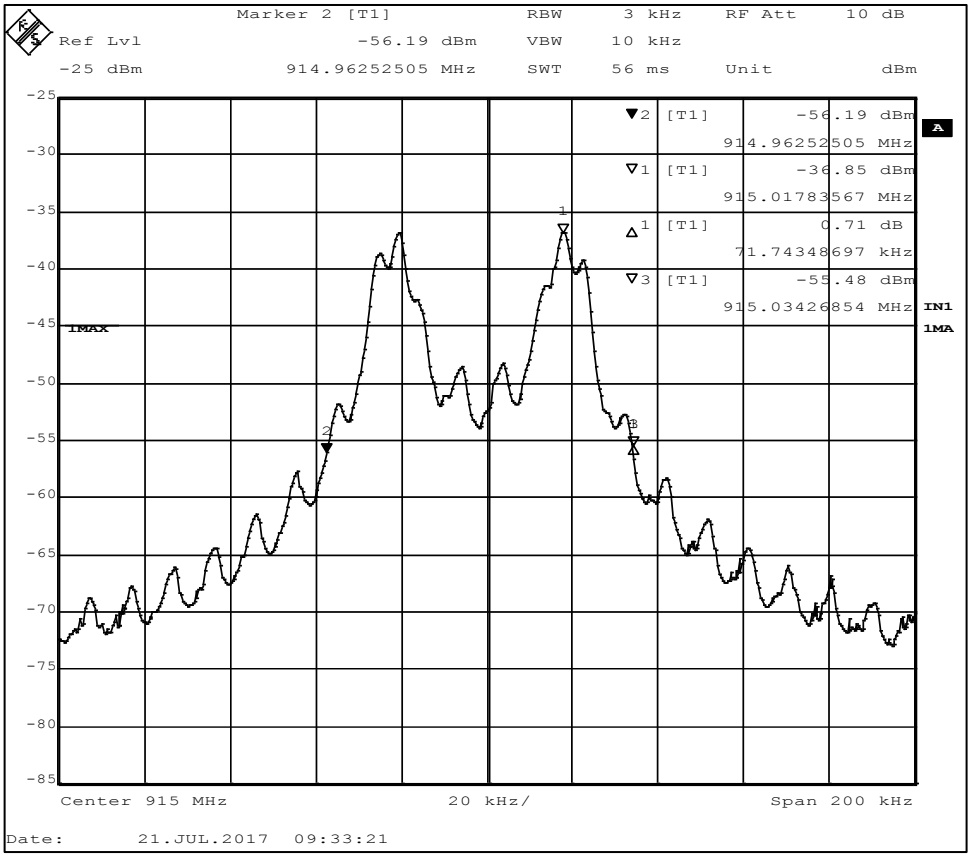


Figure 11 – 20 dB Bandwidth, Mid Channel, 71.74 kHz

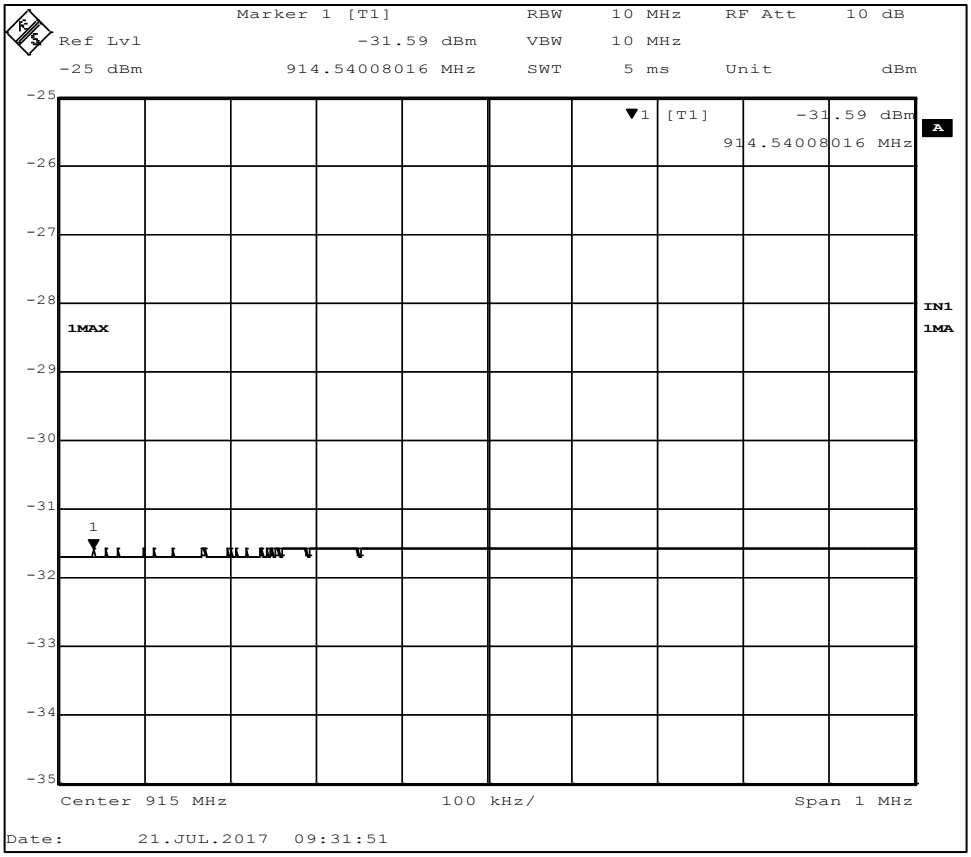


Figure 12 – Output Power, Mid Channel

Maximum power = -31.58 dBm + 107 + CL + AF - 95.23 = 8.79 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.

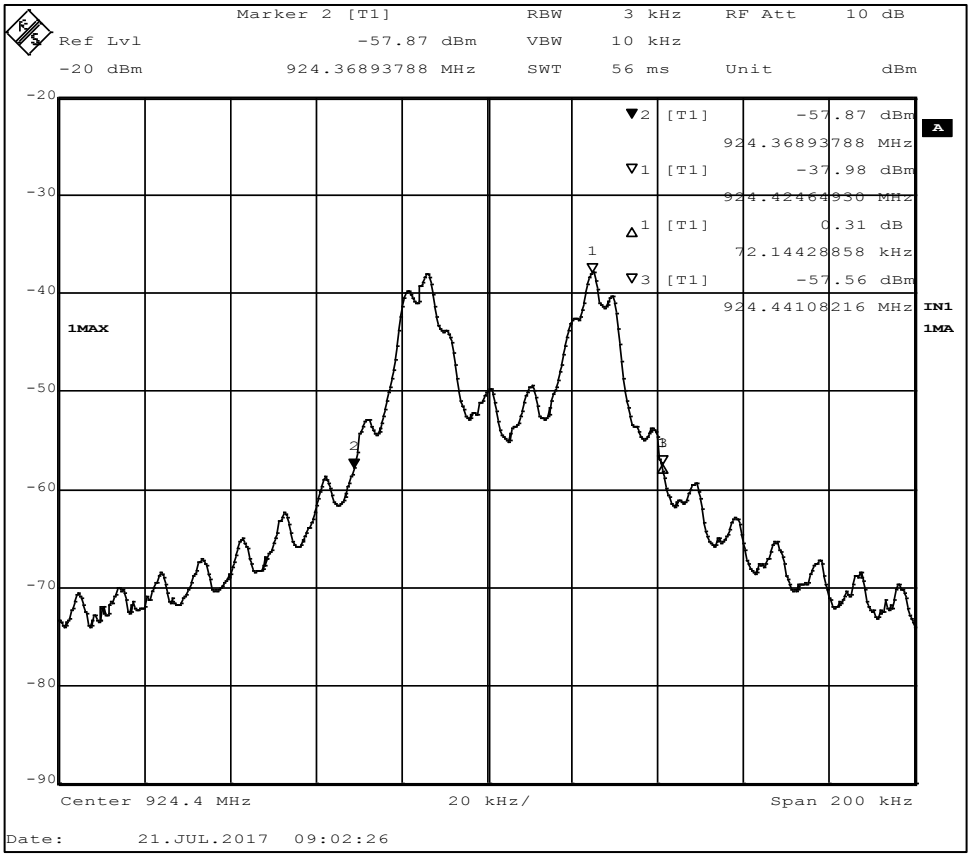


Figure 13 – 20 dB Bandwidth, High Channel, 72.14 kHz

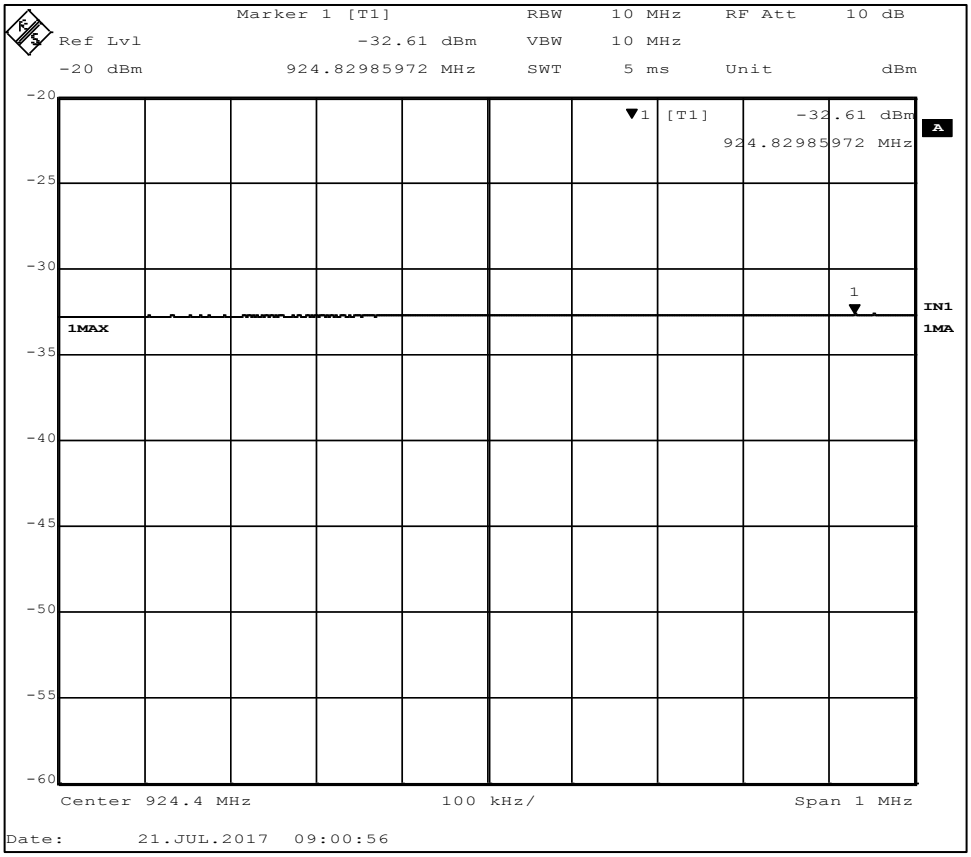


Figure 14 – Output Power, High Channel

Maximum power = -32.61 dBm + 107 + CL + AF - 95.23 = 7.96 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.

4.4 Bandedges

Test Method: ANSI C63.10, Section(s) 6.10.4

4.4.1 Limits of bandedge measurements

For emissions outside of the allowed band of operation (905.6 MHz – 924.4 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 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 16.5 VAC / 60Hz 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	1158	MODE	Transmit
INPUT POWER	16.5 VAC / 60 Hz	FREQUENCY RANGE	905.6 MHz – 924.4 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	902	-96.84	-31.67	65.17	20.00	PASS
3	928	-95.35	-33.02	62.33	20.00	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 905MHz for low channel = 102.35 dBµV/m
Fundamental average field strength at 924MHz for high channel = 99.61 dBµV/m

Channel 1 minimum delta = 102.35 - 54.0 dBµV/m = 48.35 dBc
Channel 3 minimum delta = 99.61 - 54.0 dBµV/m = 45.61 dBc

Measurements do not include correction factors and are intended to be relative measurements only.

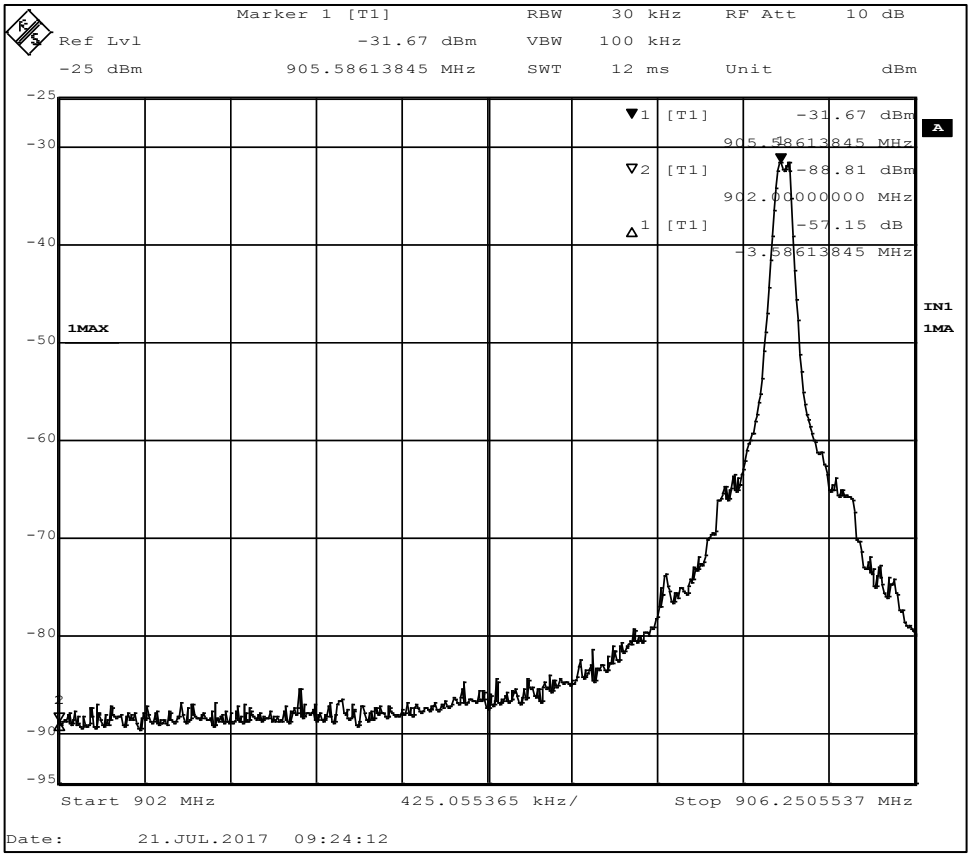


Figure 15 - Band-edge Measurement, Low Channel, Fundamental

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

Delta = 57.15 dB Min = 20 dB

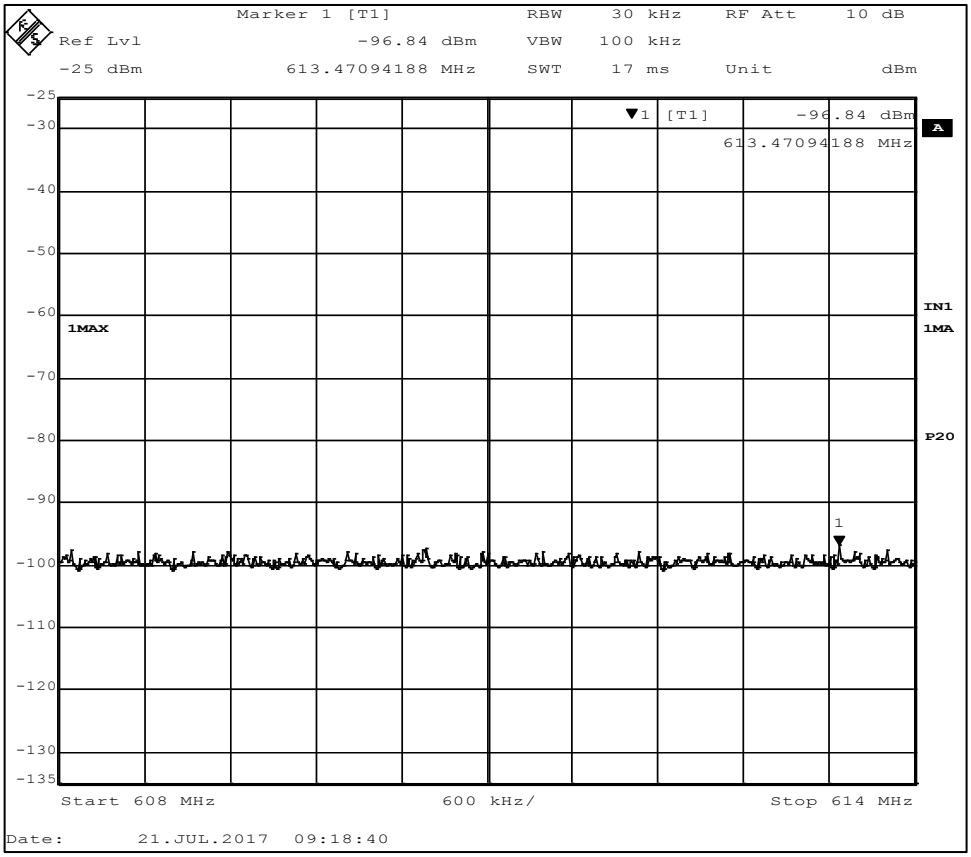


Figure 16 - Band-edge Measurement, Low Channel, Restricted

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

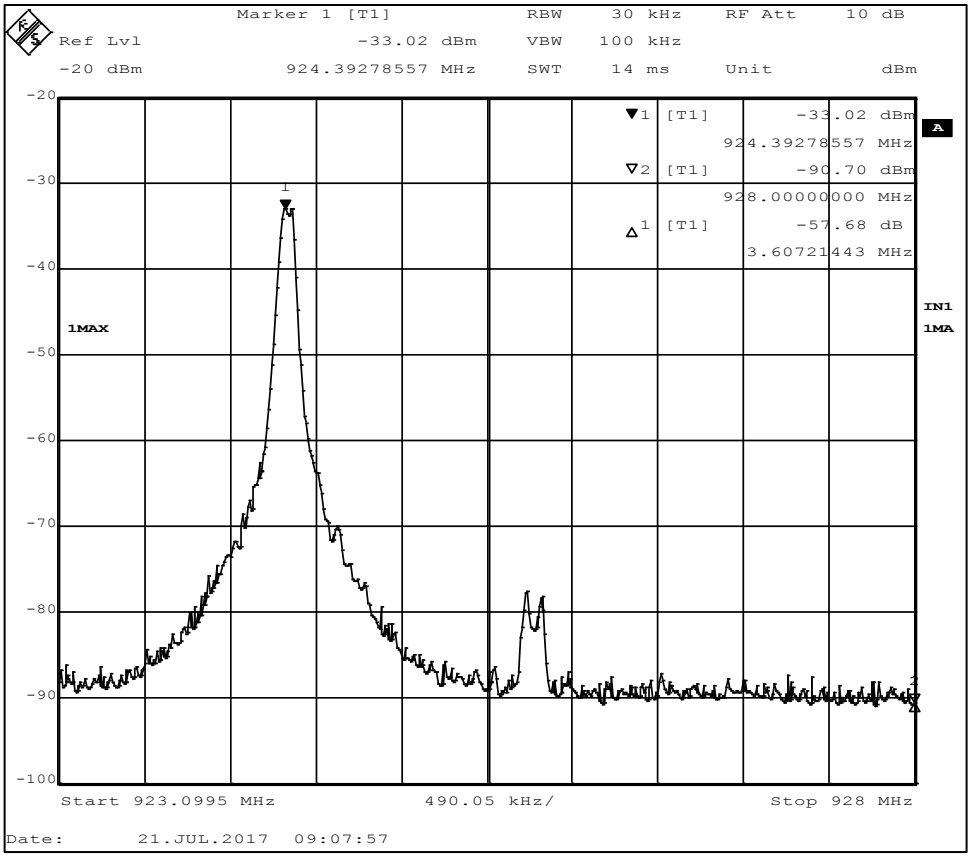


Figure 17 - Band-edge Measurement, High Channel, Fundamental

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

Delta = 57.68 dB Min = 20 dB

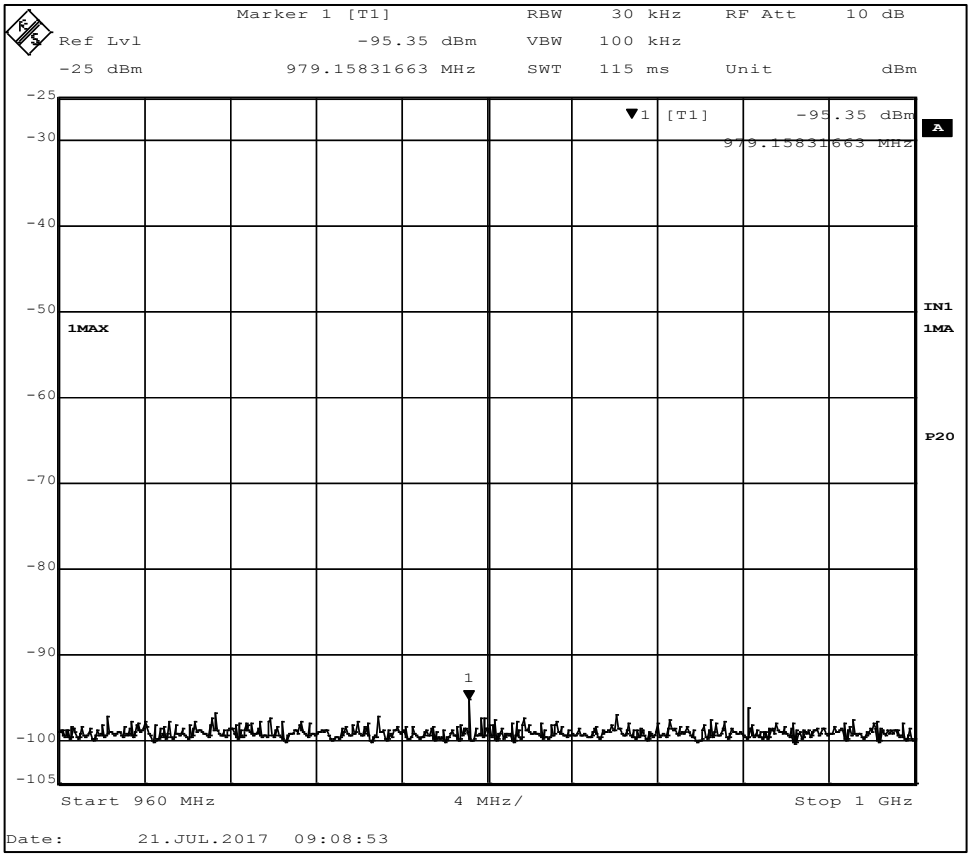


Figure 18 - Band-edge Measurement, High Channel, Restricted

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

For frequency hopping systems operating in the 902-928 MHz band:

If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

4.5.2 Test procedures

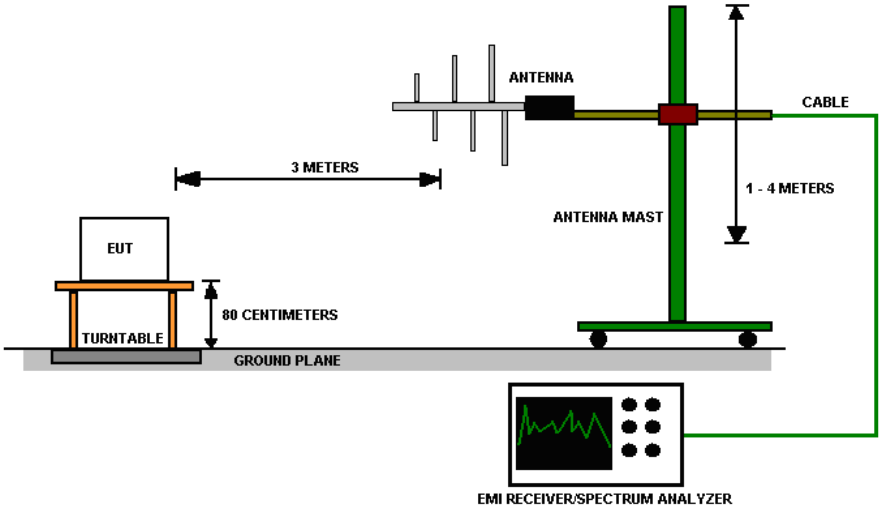
The method from FCC DA 00-705 was used.

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



4.5.5 EUT operating conditions

The EUT was powered by 16.5 VAC / 60Hz unless specified and set to continuously Hop on all the channels.

4.5.6 Test results

EUT	1158	MODE	Continuous Hop
INPUT POWER	16.5 VAC / 60 Hz	FREQUENCY RANGE	905.6 MHz – 924.4 MHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

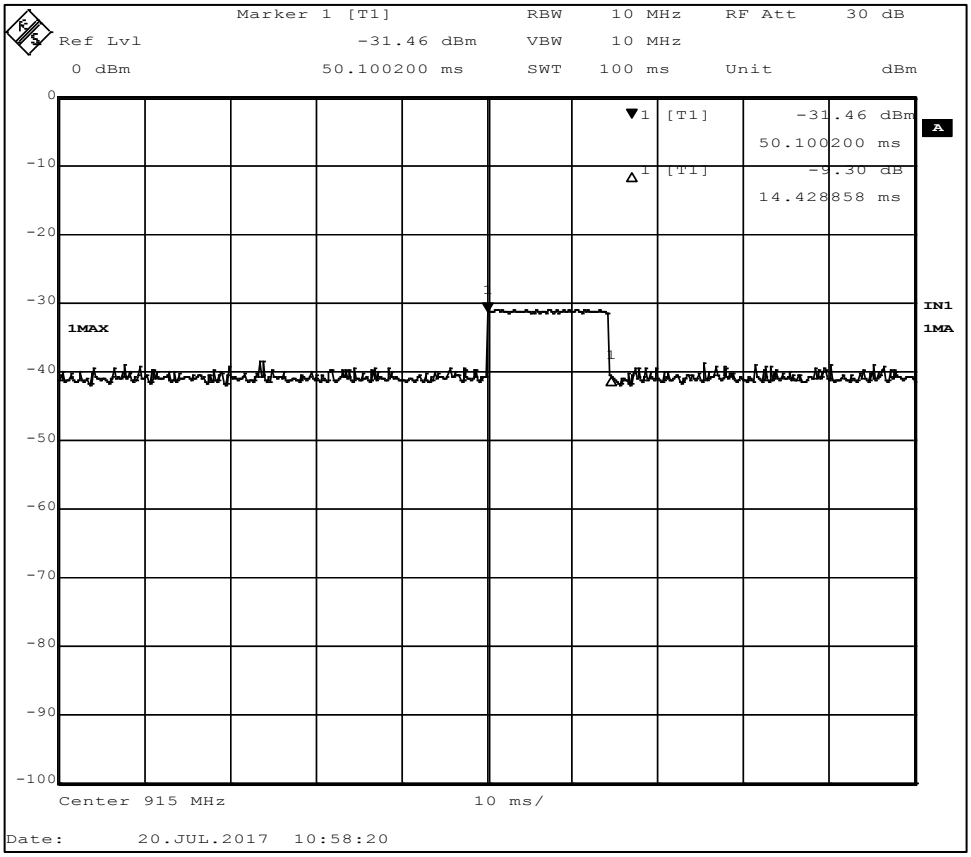


Figure 19 – Time of Occupancy (14.43 ms per Hop - Pass)

Max = 0.4 sec in 10 sec window

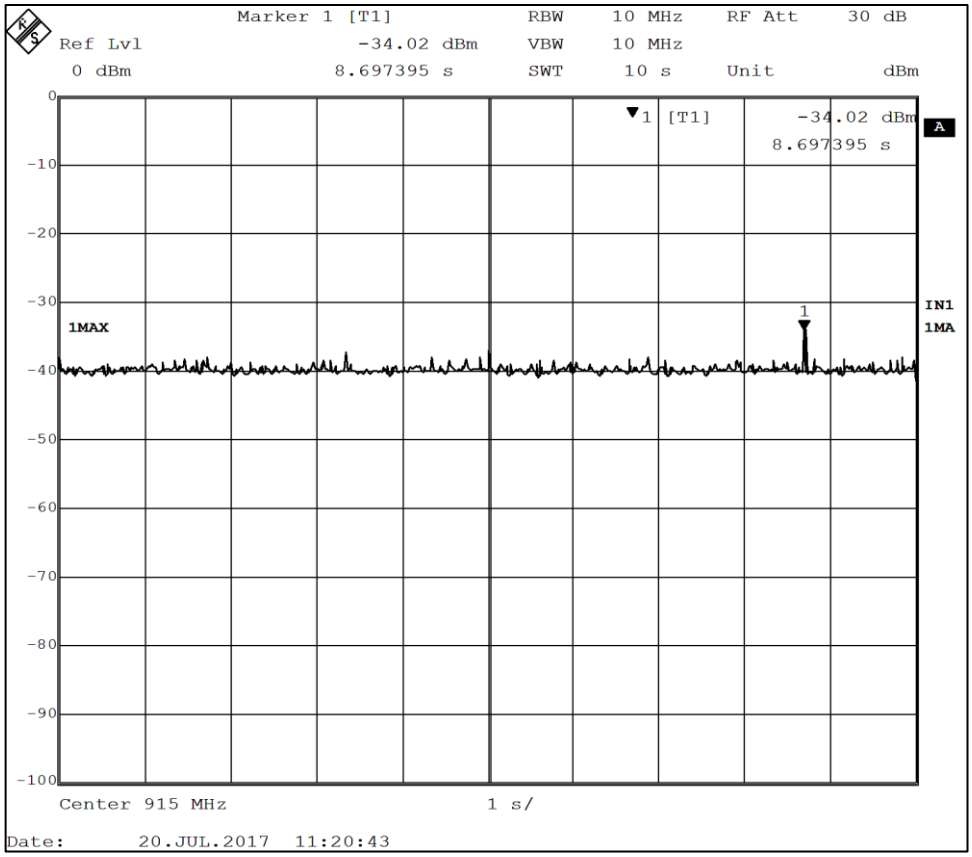


Figure 20 – Time of Occupancy - Period (Max – 1 peak in 10 seconds window)

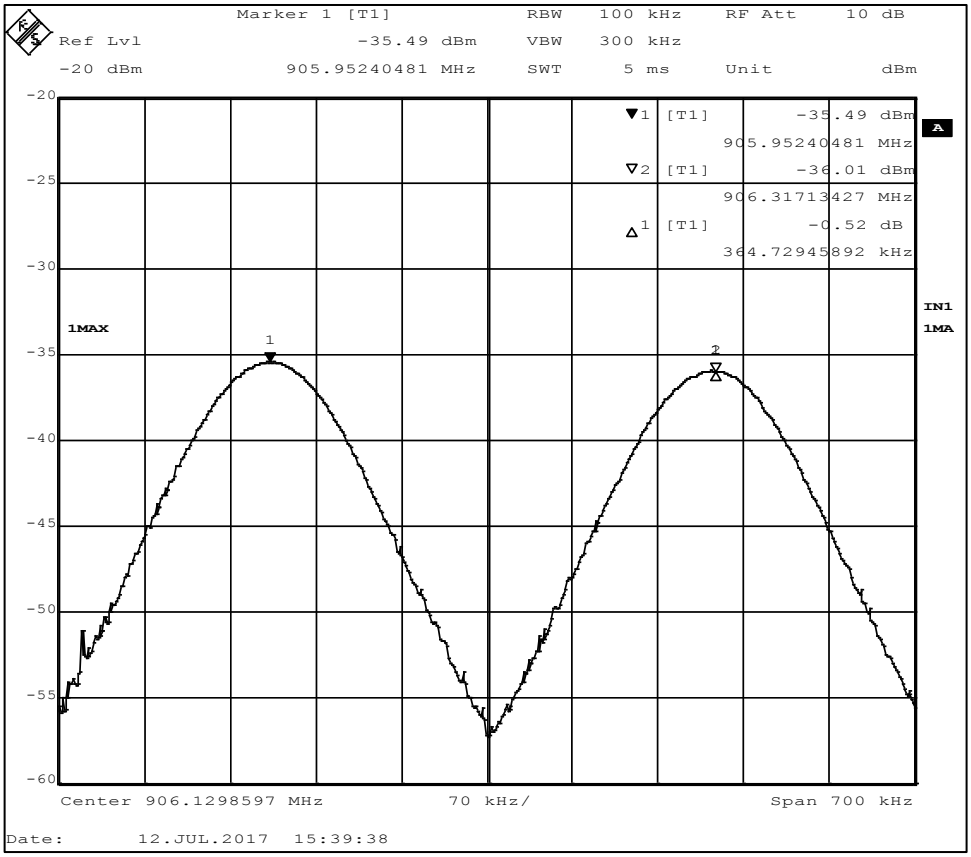


Figure 21 – Frequency Separation (364.73 kHz)

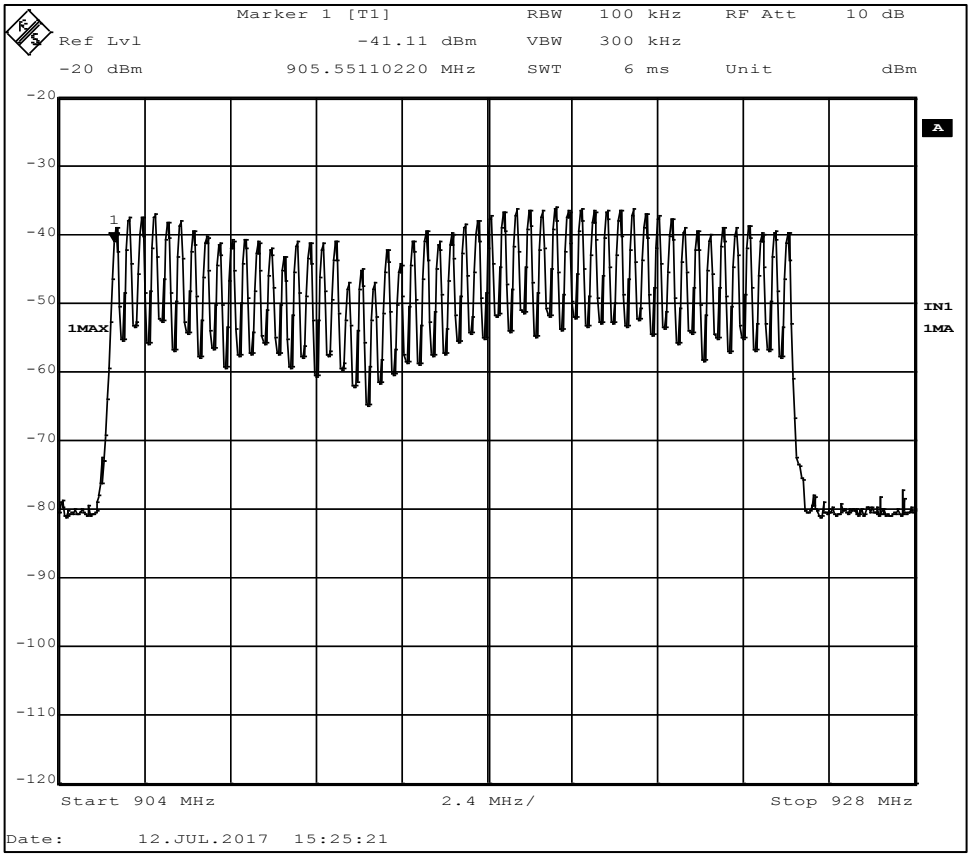


Figure 22 – Hopping Channel Count (53 Channels - Pass)

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

See section 4.3.

4.6.5 EUT operating conditions

The EUT was powered by 16.5 VAC / 60Hz unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

4.6.6 Test Results

EUT	1158	MODE	Transmit, Mid Channel
INPUT POWER	16.5 VAC / 60Hz	FREQUENCY RANGE	150 kHz – 30 MHz
ENVIRONMENTAL CONDITIONS	32 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

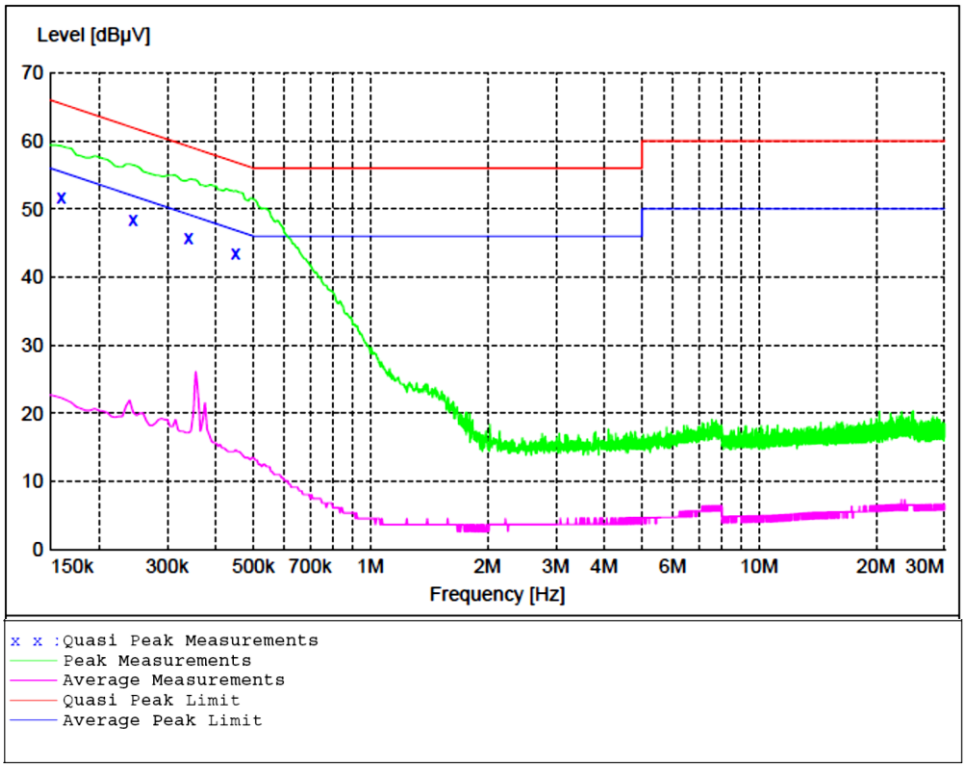


Figure 23 - Conducted Emissions Plot

Table 12 - Conducted Emissions Quasi-Peak Data

Frequency	Level	Limit	Margin	Line	PE
MHz	dBµV	dBµV	dB		
0.160000	51.80	66.00	13.60	N	GND
0.245000	48.40	62.00	13.60	N	GND
0.340000	45.80	59.00	13.40	N	GND
0.450000	43.60	57.00	13.30	N	GND

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.