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FCC/IC Test Report

Prepared for: **Digital Six Laboratories, LLC**
13117 SW 9th St.
Yukon OK 73099

Product: **Whisker.io**

Test Report No: **R20150330-20**

Approved By:

Nic S. Johnson, NCE
Technical Manager
iNARTE Certified EMC Engineer #EMC-003337-NE

DATE: **28 June 2018**

Total Pages: **41**

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TESTING LABORATORY
CERTIFICATE NO. 1953.01

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1.0 Summary of test results

The EUT has been tested according to the following specifications:

APPLIED STANDARDS AND REGULATIONS		
Standard Section	**Test Type**	**Result**
FCC Part 15.35 RSS Gen, Issue 4, Section 6.10	Duty Cycle	Pass
FCC Part 15.247(b)(3) RSS-247 Issue 2 Section 5.24	Peak output power	Pass
FCC Part 15.247(a)(2) RSS-247 Issue 2 Section 5.2	Bandwidth	Pass
FCC Part 15.209 RSS-Gen Issue 4, Section 7.1	Receiver Radiated Emissions	Pass
FCC Part 15.209 (restricted bands), 15.247(d) (unrestricted) RSS-247 Issue 2 Section 5.5, RSS-Gen Issue 4, Section 8.9	Transmitter Radiated Emissions	Pass
FCC Part 15.247(a)(2) RSS-247 Issue 2 Section 5.2	Power Spectral Density	Pass
FCC Part 15.209, 15.247(d) RSS-247 Issue 2 Section 11.13	Band Edge Measurement	Pass
FCC Part 15.207 RSS-Gen Issue 4, Section 7.1	Conducted Emissions	NA

2.0 Description

2.1 Equipment under test

The Equipment Under Test (EUT) was a transceiver module from Digital Six Laboratories.

EUT Received Date: 3 August 2015
EUT Tested Date: 3 August 2015 - 18 September 2015

PRODUCT	Whisker.io
MODEL	Whisker.io
POWER INPUT	3 VDC
MODULATION TYPE	FSK
RADIO TECHNOLOGY	Frequency-Shift Keying (FSK)
POWER SUPPLY	3 VDC (2 x AAA)
ANTENNA TYPE	External dipole
SERIAL NUMBER OF TEST UNIT	FCC DUT # 2 (Duty Cycle Measurement), DE1A0E67(all other measurements),

NOTE:
1. 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 54 ± 4%
Temperature of 23 ± 3° Celsius

2.3 Description of test modes

Channel	Frequency (MHz)
Lowest	905.38
Middle	914.42
Highest	925.48

2.4 Applied standards

The EUT is a digital transmission 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 standards.

2.5 Description of support units

None

2.6 Configuration of system under test

The EUT was powered by 3 VDC, 2 X AAA Batteries for all the tests and had no auxiliary devices. It was tested by itself. The EUT was programmed by the manufacturer to transmit continually for testing purposes only.

The EUT was modified by the manufacturer to test with the device continuously transmitting a series of 1's and 0's, or to set the EUT to continuous receive mode for testing purposes.

Manufacturer provided an equivalent EUT in normal mode for duty cycle measurement as a separate unit.

3.0 Test equipment used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Rohde & Schwarz Test Receiver	ES126	100037	20 Jan 2015	20 Jan 2016
EMCO Biconilog Antenna	3142B	1654	26 Jan 2015	26 Jan 2016
EMCO Horn Antenna	3115	6416	14 Jan 2014	14 Jan 2016
Rohde & Schwarz Preamplifier	TS-PR18	3545700803	19 Nov 2014*	19 Nov 2015*
Trilithic High Pass Filter	6HC330	23042	19 Nov 2014*	19 Nov 2015*

*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 supplied with the EUT is connected using a short 26cm cable with a reverse polarity SMA connector.

4.2 Radiated emissions

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 (uV/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.

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. Radiated limits according to 15.209 do not apply within the 902MHz to 928MHz band for transmitters or the unrestricted band between 1722.2 to 2200 MHz.
6.For frequencies not in a restricted band as specified in 15.205, spurious emissions shall be at least 20dB less than the field strength at the fundamental frequency.

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. The results are presented for the axis that had the highest emissions.

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 of test receiver/spectrum analyzer is 1 MHz for peak and average detectors at frequencies above 1GHz.

4.2.3 Deviations from test standard

No deviation.

4.2.4 Test setup

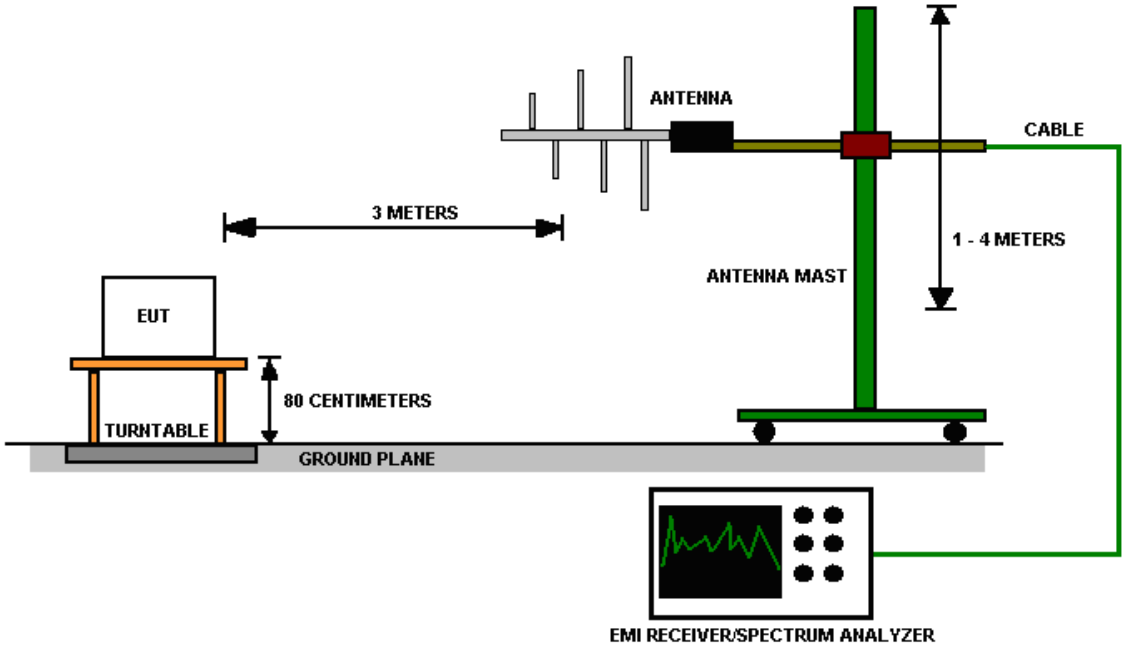

Figure 1 - Radiated Emissions Test Setup

For the actual test configuration, please refer to Appendix A for photographs of the test configuration.

4.2.5 EUT operating conditions

See section 2.6.

4.2.6 Test results

EUT MODULE	900 MHz Transmitter	MODE	Receive
INPUT POWER	3 VDC	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

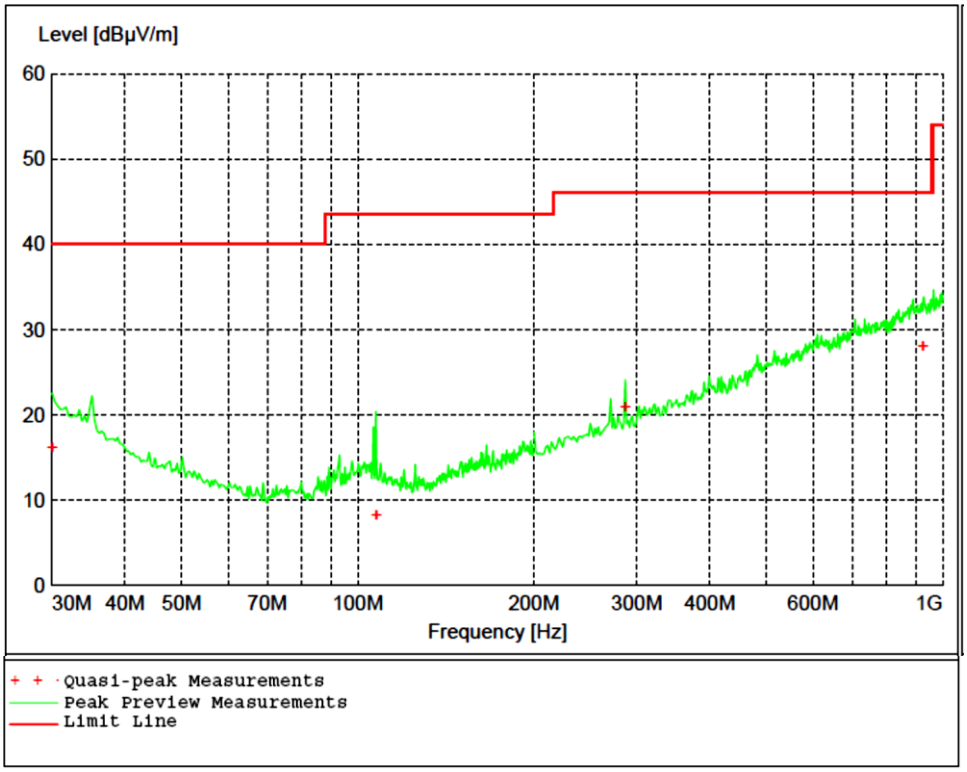

Figure 2 - Radiated Emissions Plot, Receive

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. Since peak measurements were compliant with the average limit, average measurements were not required.

Table 1 - Radiated Emissions Quasi-peak Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
30.060000	16.18	40.00	23.80	298	189	VERT
107.580000	8.23	43.50	35.30	370	343	VERT
286.920000	20.93	46.00	25.10	105	329	HORI
926.940000	27.98	46.00	18.00	122	290	VERT

Vertical EUT orientation was found to be the worse-case, all results are presented as such.

Table 2 - Radiated Emissions Peak Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1827.400000	35.55	54.00	18.50	99	343	VERT
2733.200000	37.97	54.00	16.00	148	334	VERT
3647.200000	40.89	54.00	13.10	400	290	HORI
4584.000000	41.87	54.00	12.10	100	263	HORI
5485.400000	43.29	54.00	10.70	156	0	VERT

Vertical EUT orientation was found to be the worse-case, all results are presented as such.

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

EUT MODULE	900 MHz Transmitter	MODE	Transmit, Low Channel
INPUT POWER	3 VDC	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

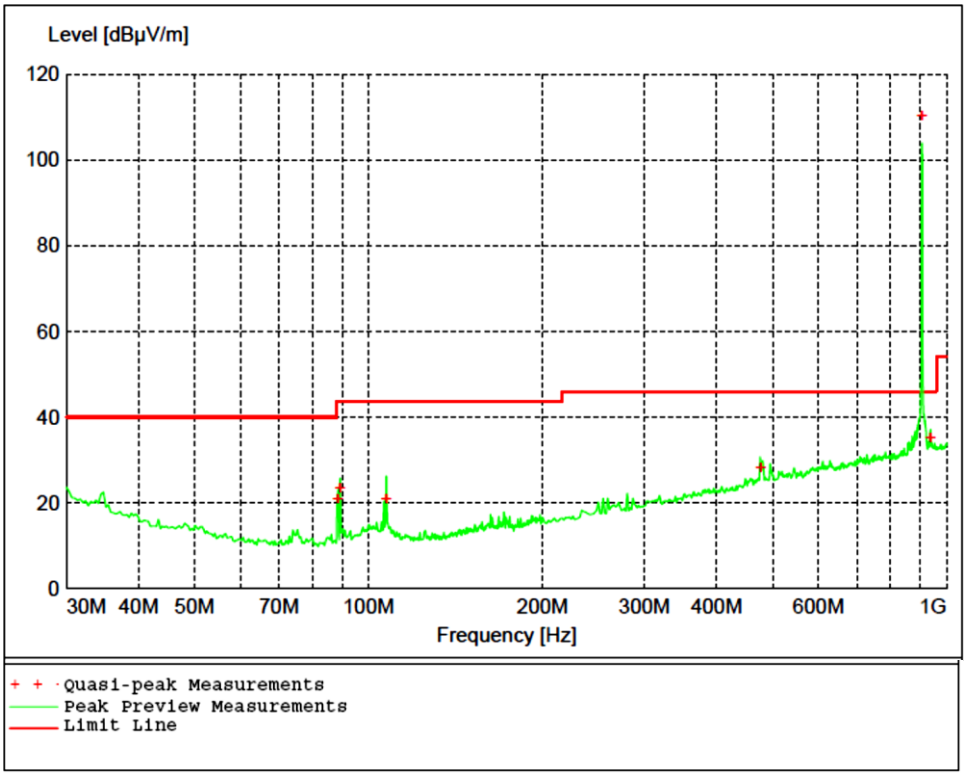

Figure 3 - Radiated Emissions Plot, Lowest Channel

Vertical antenna orientation was found to be the worse-case

Table 3 - Radiated Emissions Quasi-peak Measurements, Lowest Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
88.500000	20.87	43.50	22.60	399	0	HORI
89.280000	23.31	43.50	20.20	400	235	HORI
107.340000	20.76	43.50	22.80	172	21	HORI
477.300000	28.10	46.00	17.90	99	60	VERT
905.380000	110.22	NA	NA	107	78	VERT
937.560000	35.18	46.00	10.80	105	263	VERT

Table 4 - Radiated Emissions Average Measurements, Lowest Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2717.000000	46.91	54.00	7.09	210	97	VERT
3622.800000	49.56	54.00	4.44	173	17	VERT
4526.600000	38.00	54.00	16.00	177	317	VERT
5431.600000	41.05	54.00	12.95	190	322	VERT
6336.800000	43.37	54.00	10.63	210	244	VERT
7242.400000	49.41	54.00	4.59	187	155	HORI
8147.400000	46.62	54.00	7.38	183	133	HORI
9053.400000	41.05	54.00	12.95	180	156	HORI

Note: Average Level = Peak Level – Duty Cycle Correction Factor
Duty Cycle Correction Factor is calculated in Figures 6. 16.23 dB was used.

Table 5 - Radiated Emissions Peak Measurements, Lowest Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2717.000000	63.14	74.00	10.86	210	97	VERT
3622.800000	65.79	74.00	8.21	173	17	VERT
4526.600000	54.23	74.00	19.77	177	317	VERT
5431.600000	57.28	74.00	16.72	190	322	VERT
6336.800000	59.60	74.00	14.40	210	244	VERT
7242.400000	65.64	74.00	8.36	187	155	HORI
8147.400000	62.85	74.00	11.15	183	133	HORI
9053.400000	57.28	74.00	16.72	180	156	HORI

EUT MODULE	900 MHz Transmitter	MODE	Transmit, Mid Channel
INPUT POWER	3 VDC	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

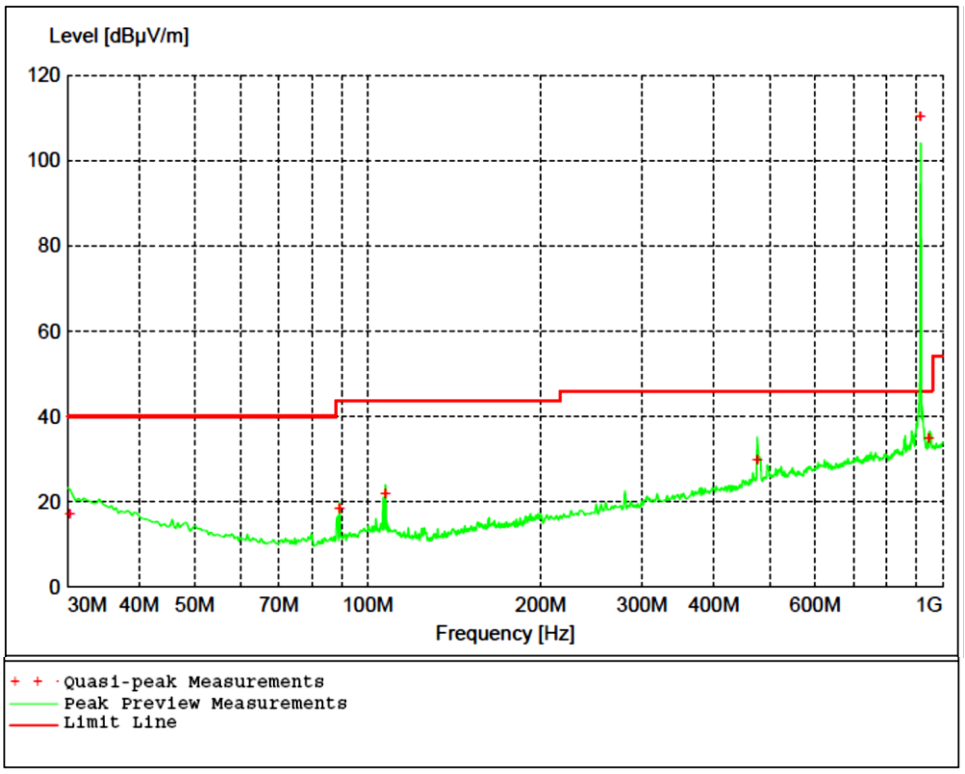

Figure 4 - Radiated Emissions Plot, Middle Channel

Vertical antenna orientation was found to be the worse-case

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.

Table 6 - Radiated Emissions Quasi-peak Measurements, Middle Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
30.300000	17.16	40.00	22.80	99	297	VERT
89.280000	18.40	43.50	25.10	119	348	VERT
107.340000	21.92	43.50	21.60	200	327	VERT
476.280000	29.70	46.00	16.30	334	53	VERT
914.420000	110.32	NA	NA	106	194	VERT
946.860000	34.72	46.00	11.30	113	162	VERT

Table 7 - Radiated Emissions Average Measurements, Middle Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2745.000000	46.42	54.00	7.58	129	45	HORI
3660.600000	49.09	54.00	4.91	204	22	VERT
4574.000000	41.74	54.00	12.26	197	8	VERT
5489.000000	39.44	54.00	14.56	268	60	VERT
6404.200000	44.86	54.00	9.14	143	81	VERT
7318.200000	48.89	54.00	5.11	187	160	HORI
8237.000000	42.91	54.00	11.09	190	148	HORI
9147.600000	39.55	54.00	14.45	173	22	HORI

Note: Average Level = Peak Level – Duty Cycle Correction Factor
Duty Cycle Correction Factor is calculated in Figures 6. 16.23 dB was used.

Table 8 - Radiated Emissions Peak Measurements, Middle Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2745.000000	62.65	74.00	11.35	129	45	HORI
3660.600000	65.32	74.00	8.68	204	22	VERT
4574.000000	57.97	74.00	16.03	197	8	VERT
5489.000000	55.67	74.00	18.33	268	60	VERT
6404.200000	61.09	74.00	12.91	143	81	VERT
7318.200000	65.12	74.00	8.88	187	160	HORI
8237.000000	59.14	74.00	14.86	190	148	HORI
9147.600000	55.78	74.00	18.22	173	22	HORI

EUT MODULE	900 MHz Transmitter	MODE	Transmit, High Channel
INPUT POWER	3 VDC	FREQUENCY RANGE	30MHz – 10GHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

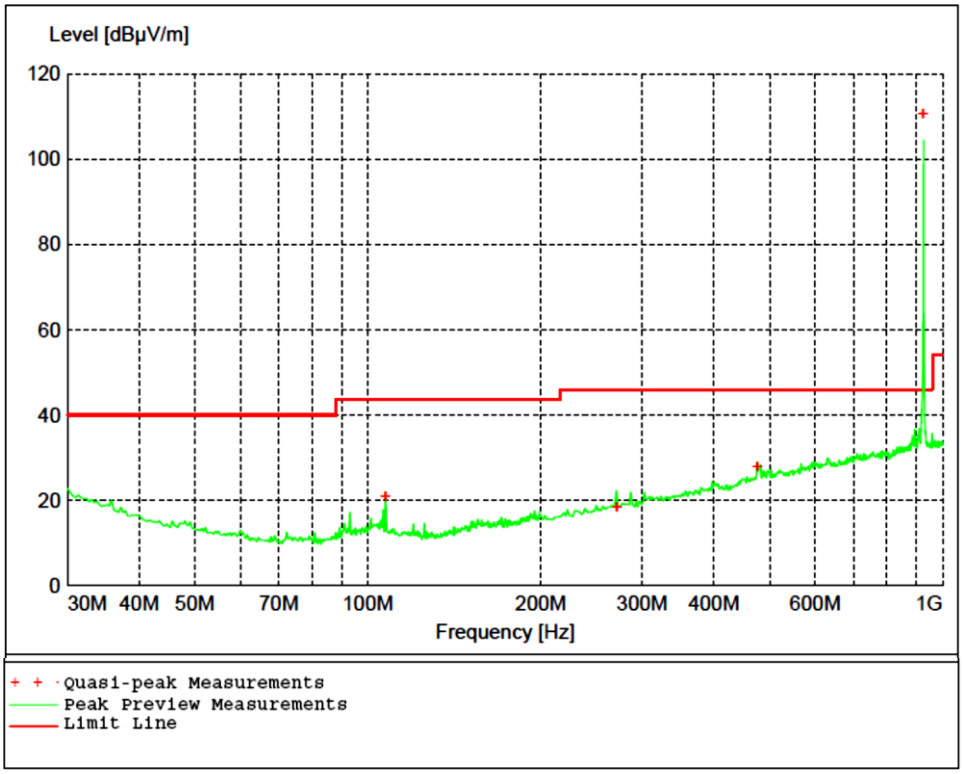

Figure 5 - Radiated Emissions Plot, Highest Channel

Vertical antenna orientation was found to be the worse-case

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.

Table 9 - Radiated Emissions Quasi-peak Measurements, Highest Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
107.280000	20.74	43.50	22.80	176	73	VERT
270.960000	18.44	46.00	27.60	100	159	HORI
476.280000	27.97	46.00	18.00	123	62	VERT
925.480000	110.59	NA	NA	105	217	VERT

Table 10 - Radiated Emissions Average Measurements, Highest Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2776.500000	46.17	54.00	7.83	99	97	VERT
3703.000000	46.76	54.00	7.24	206	17	VERT
4626.400000	40.71	54.00	13.29	190	324	VERT
5551.400000	40.80	54.00	13.20	187	0	VERT
6476.600000	46.33	54.00	7.67	146	86	VERT
7402.200000	50.15	54.00	3.85	187	155	HORI
8330.200000	42.26	54.00	11.74	197	127	HORI
9256.600000	38.41	54.00	15.59	100	140	VERT

Note: Average Level = Peak Level – Duty Cycle Correction Factor
Duty Cycle Correction Factor is calculated in Figures 6. 16.23 dB was used.

Table 11 - Radiated Emissions Peak Measurements, Highest Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2776.500000	62.40	74.00	11.60	99	97	VERT
3703.000000	62.99	74.00	11.01	206	17	VERT
4626.400000	56.94	74.00	17.06	190	324	VERT
5551.400000	57.03	74.00	16.97	187	0	VERT
6476.600000	62.56	74.00	11.44	146	86	VERT
7402.200000	66.38	74.00	7.62	187	155	HORI
8330.200000	58.49	74.00	15.51	197	127	HORI
9256.600000	54.64	74.00	19.36	100	140	VERT

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

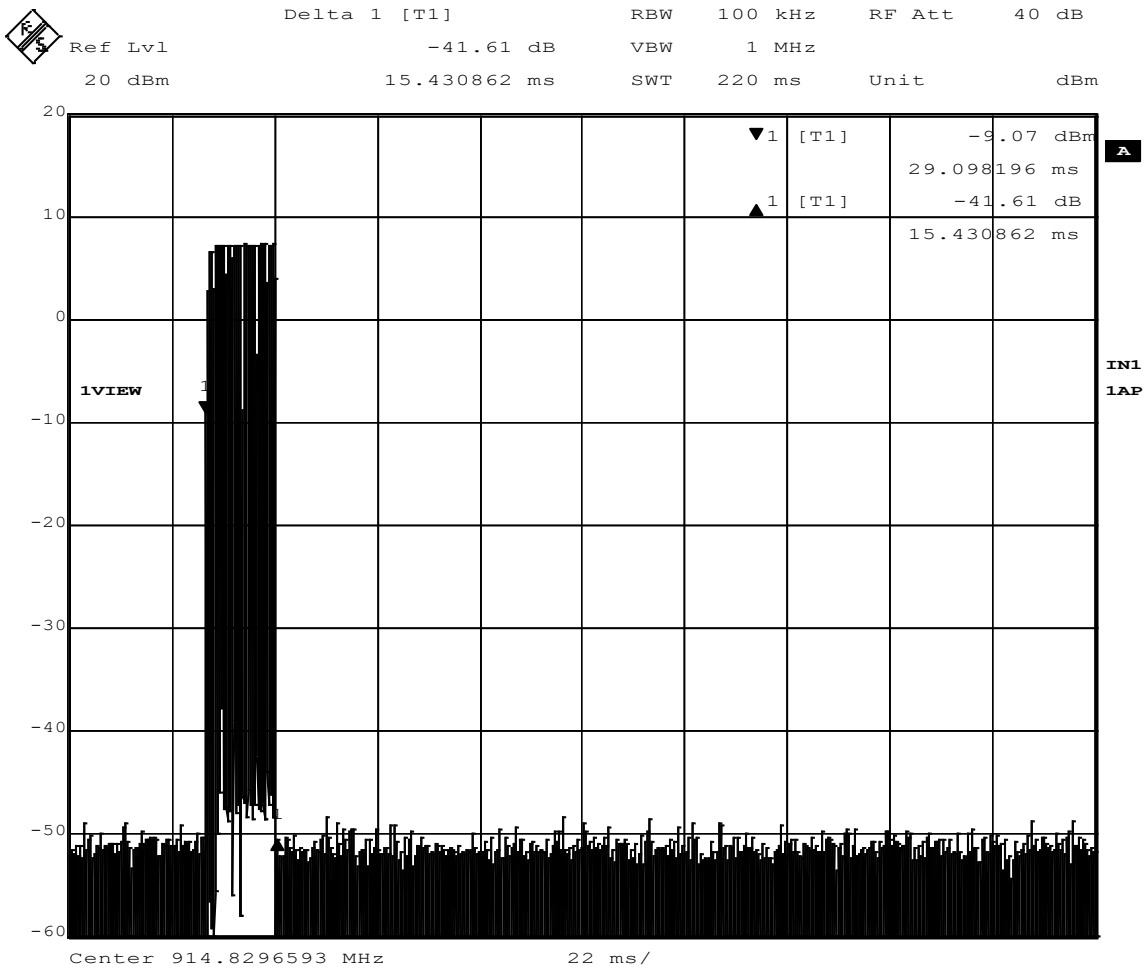

Figure 6 - Period >100 ms, Maximum Pulse Width = 15.43 ms

Duty cycle correction factor = 20*log(15.43/100) = -16.23 dB

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

4.4 Bandwidth

4.4.1 Limits of bandwidth measurements

The 6dB bandwidth of the signal must be greater than 500 kHz

4.4.2 Test procedures

The transmitter output was connected to the spectrum analyzer directly. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 kHz RBW and 300 kHz VBW. The 6 dB bandwidth is defined as the bandwidth of which is higher than peak power minus 6dB.

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 100kHz 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.

4.4.3 Deviations from test standard

No deviation.

4.4.4 Test setup

The cable used to go from the spectrum analyzer to the EUT had a loss of 0.25dB. This was not taken into account on the plot below because it is a relative measurement.

4.4.5 EUT operating conditions

See section 2.6.

4.4.6 Test results

EUT MODULE	900 MHz Transmitter	MODE	Transmit
INPUT POWER	3 VDC	FREQUENCY RANGE	902 MHz – 928 MHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

CHANNEL	CHANNEL FREQUENCY (MHz)	6dB BW (kHz)	6dB MINIMUM LIMIT (kHz)	99% Occupied BW (kHz)	RESULT
1	905.38	754.00	500.00	941.88	PASS
2	914.42	750.50	500.00	939.87	PASS
3	925.48	736.47	500.00	916.20	PASS

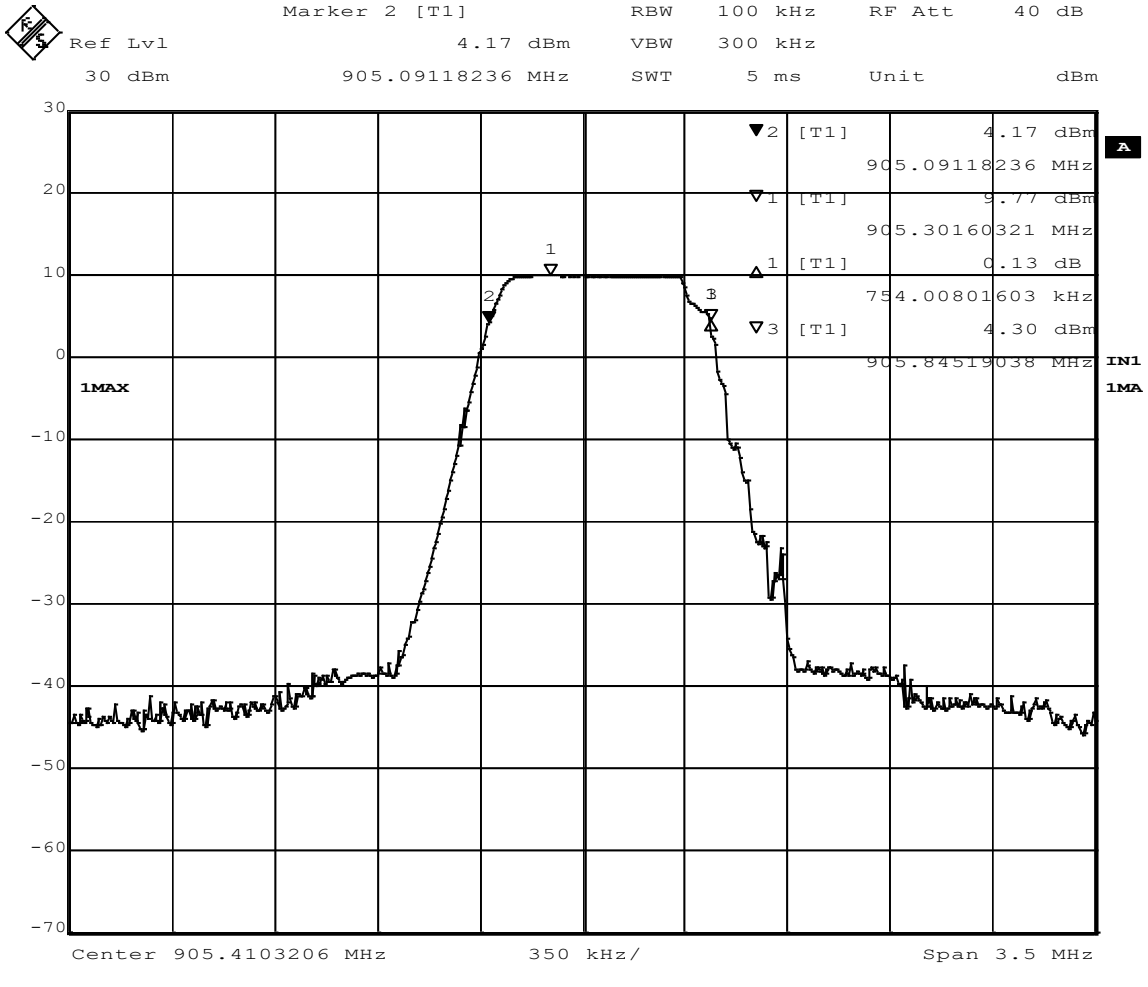

Figure 7 - 6dB Bandwidth, Lowest Channel

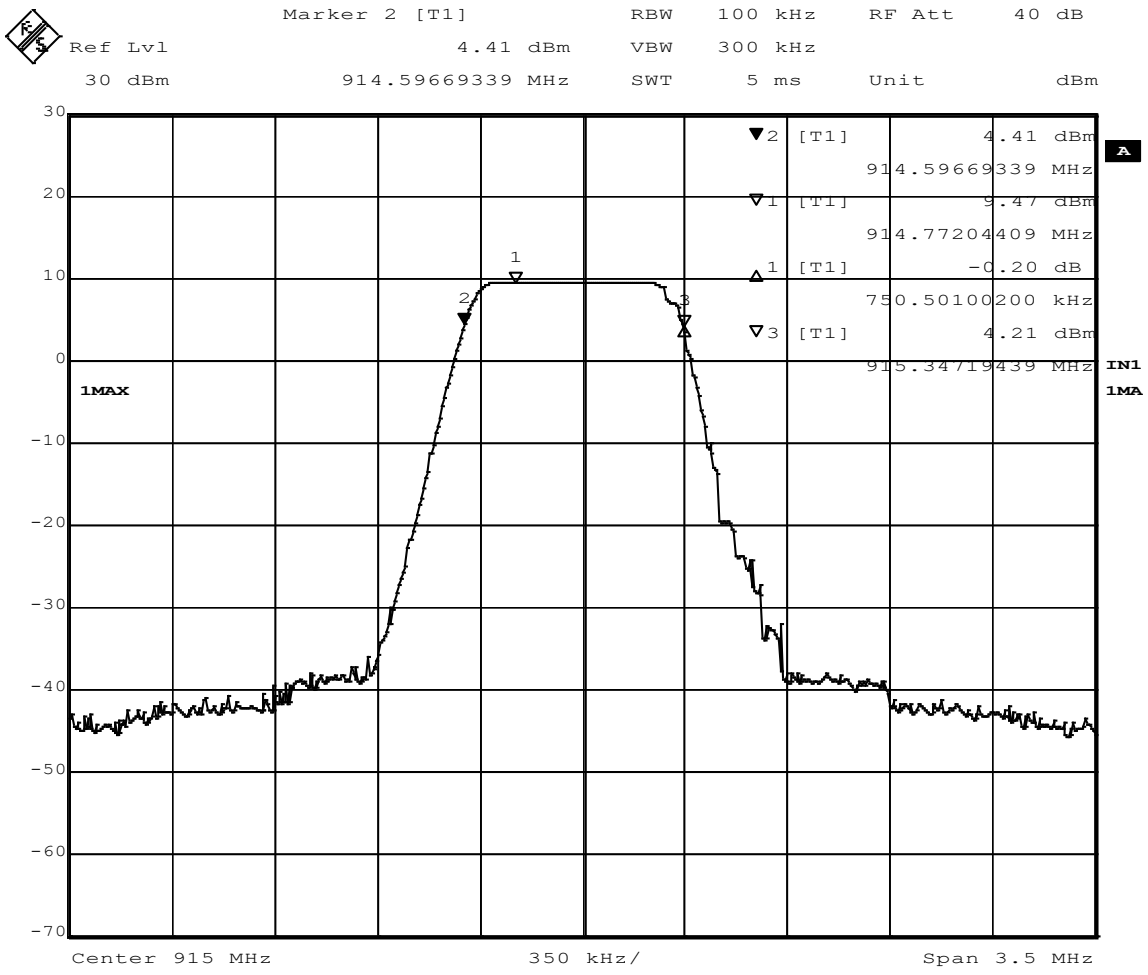

Figure 8 - 6dB Bandwidth, Middle Channel

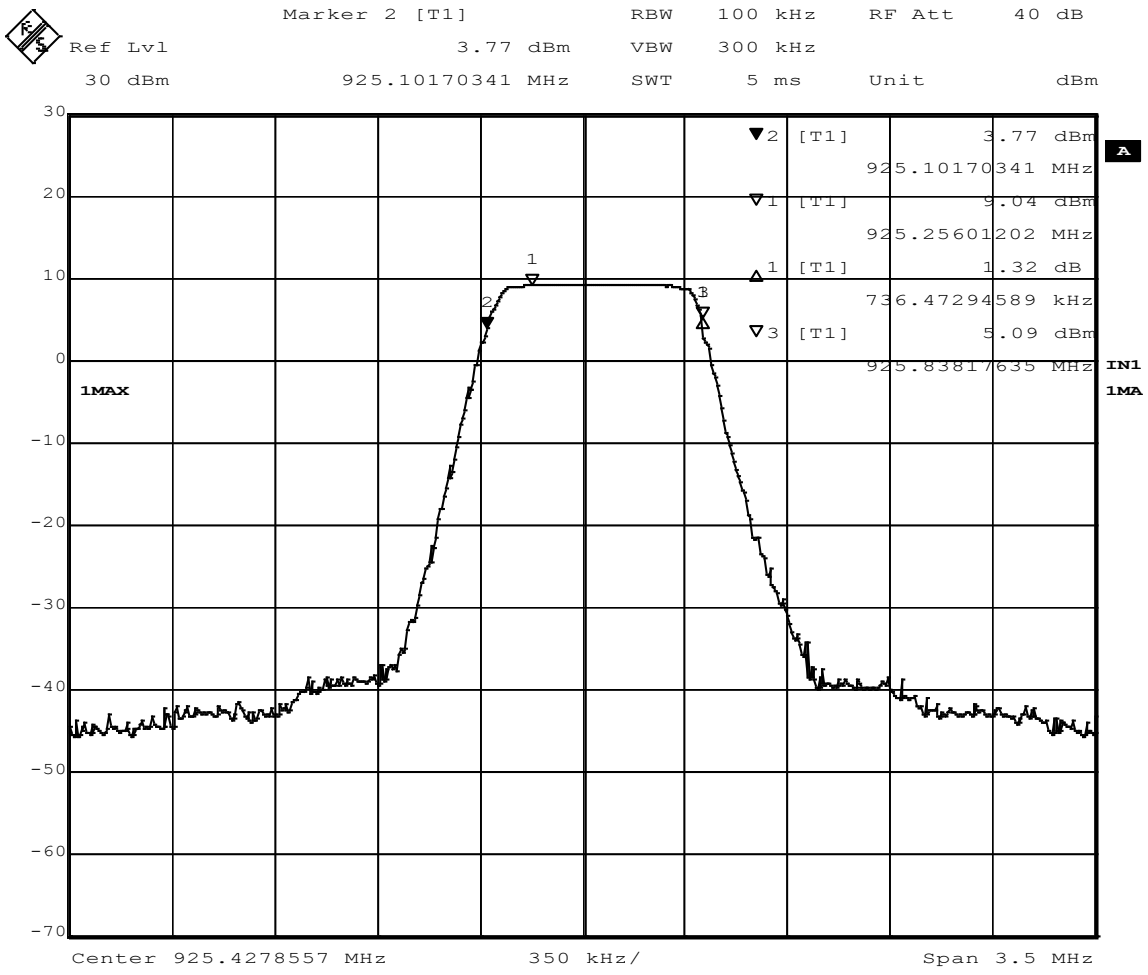

Figure 9 - 6dB Bandwidth, Highest Channel

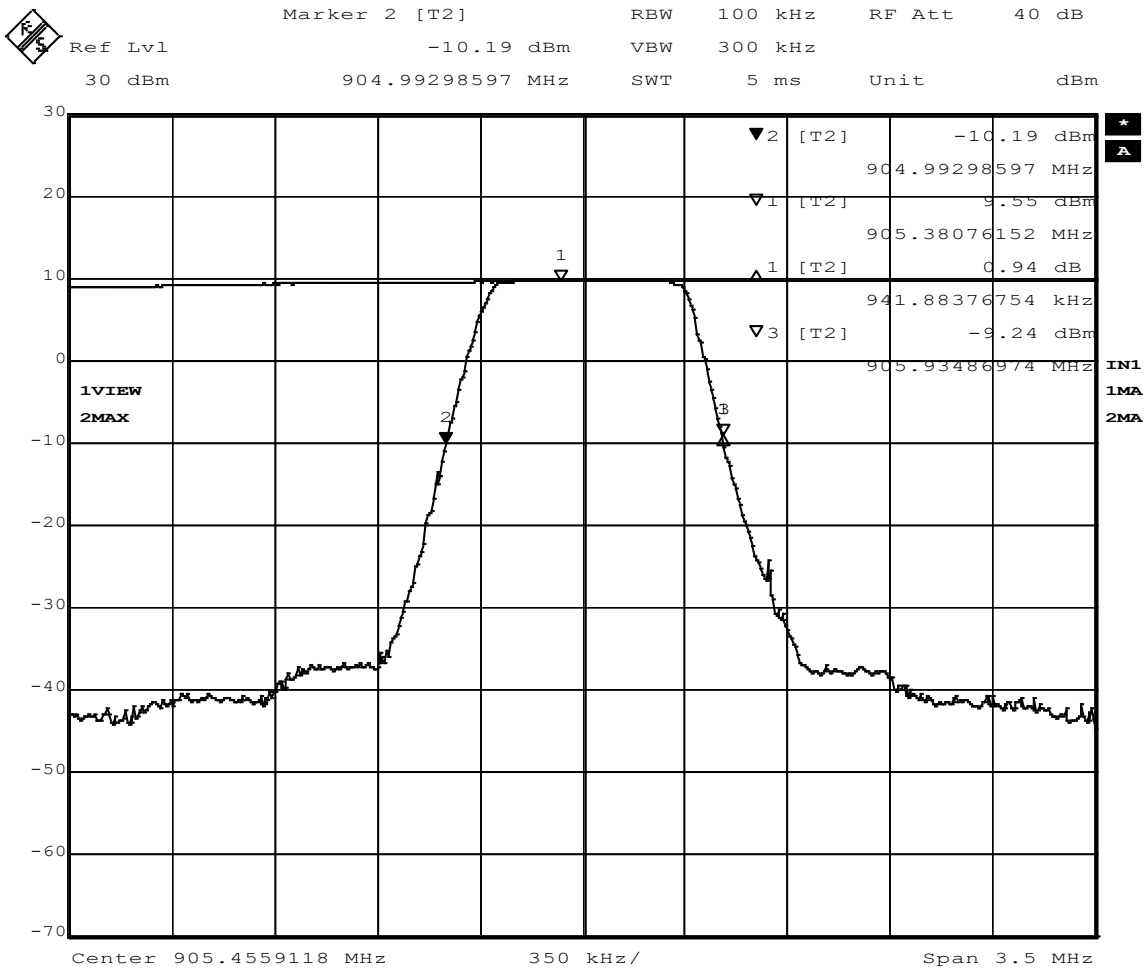

Figure 10 - 99% Occupied Bandwidth, Lowest Channel

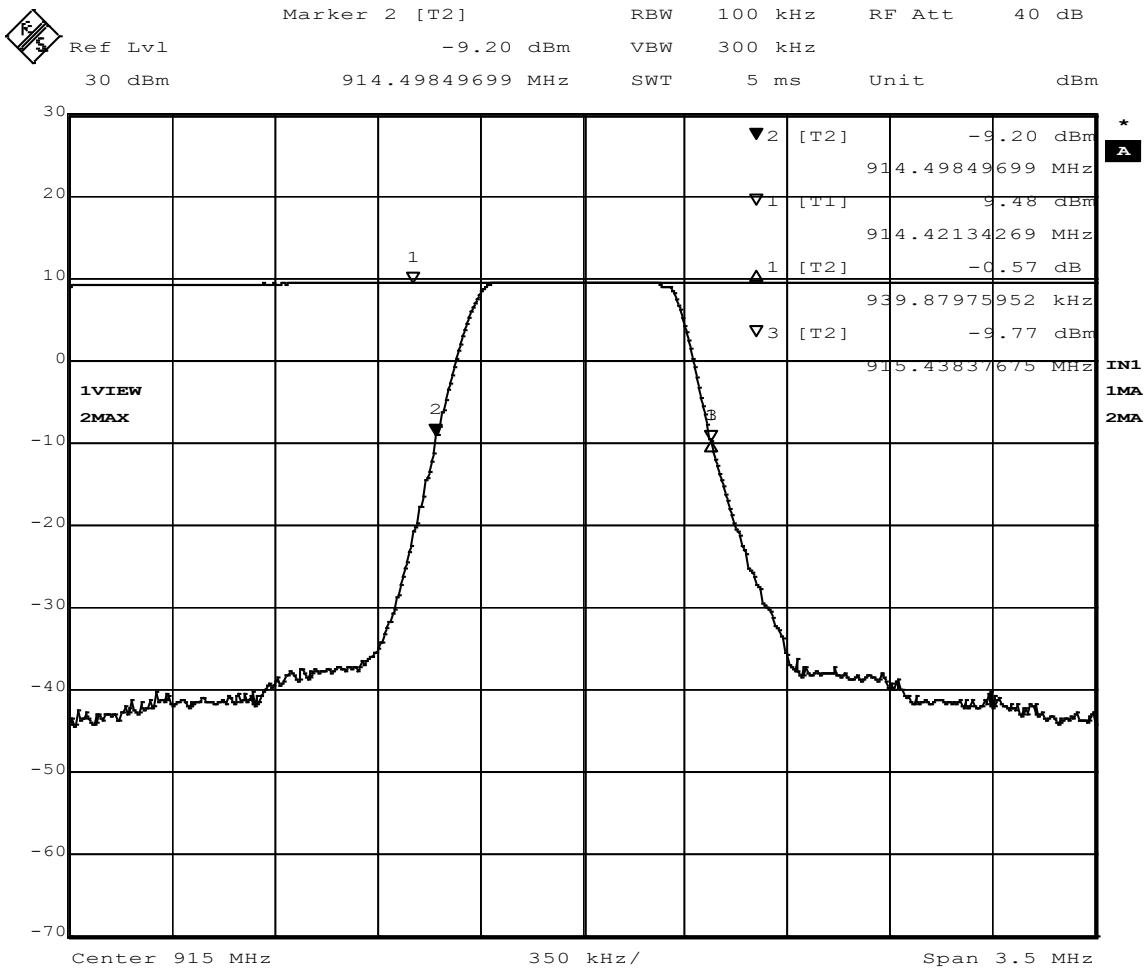

Figure 11 - 99% Occupied Bandwidth, Middle Channel

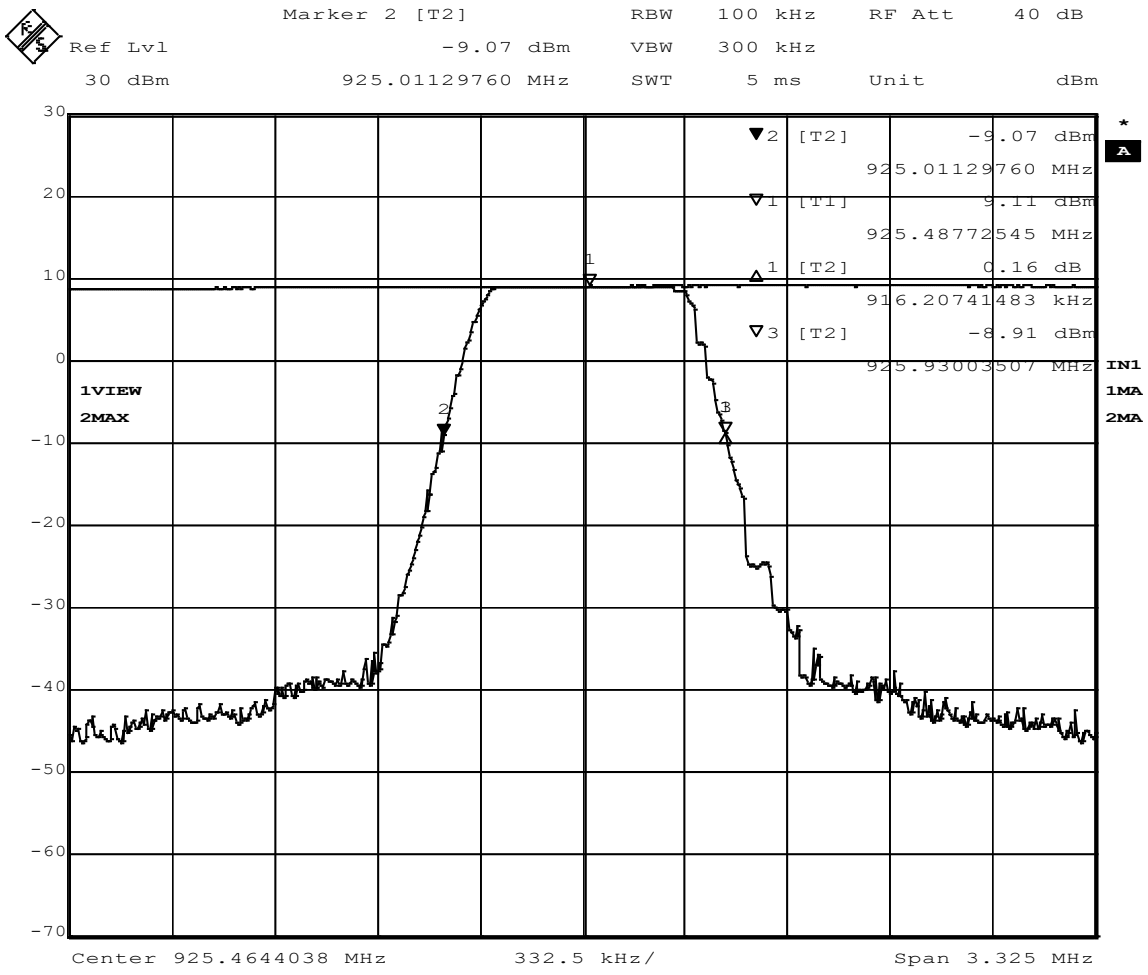

Figure 12 - 99% Occupied Bandwidth, Highest Channel

4.5 Maximum peak output power and conducted spurious emissions

4.5.1 Limits of power measurements

The maximum peak output power allowed is 30dBm

4.5.2 Test procedures

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

2. The channel power function of the spectrum analyzer was used to calculate the cumulative power output per MHz over the range of the set channel bandwidth. The channel bandwidth was set to 30MHz.

3. The resolution bandwidth was set to 10MHz and the video bandwidth was set to 10MHz to capture the maximum amount of signal. The analyzer used a peak detector in max hold mode. This represented the maximum output power.

4.5.3 Deviations from test standard

No deviation.

4.5.4 Test setup

The cable used to go from the spectrum analyzer to the EUT had a loss of 0.25dB. The plot shows the uncorrected value. The corrected value was recorded from this plot with 0.25dB added.

4.5.5 EUT operating conditions

See Section 2.6

4.5.6 Test results

Maximum peak output power

EUT MODULE	900 MHz Transmitter	MODE	Transmit
INPUT POWER	3 VDC	FREQUENCY RANGE	902 MHz – 928 MHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

CHANNEL	CHANNEL FREQUENCY (MHz)	PEAK POWER OUTPUT (dBm)	PEAK POWER LIMIT (dBm)	RESULT
1	905.38	9.80	30	PASS
2	914.42	9.73	30	PASS
3	925.48	9.36	30	PASS

*Corrected (0.25dB of attenuation added to account for RF cable)

Note: Screen captures of the measurements can be found in Section 4.4. The maximum power measurement with a 10MHz resolution bandwidth can be seen in the 99% occupied bandwidth plots.

Second Harmonic

EUT MODULE	900 MHz Transmitter	MODE	Transmit
INPUT POWER	3 VDC	FREQUENCY RANGE	902 MHz – 928 MHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

CHANNEL	FREQUENCY (MHz)	Peak Level (dBµV/m)	Average Level (dBµV/m)	Peak Margin	Average Margin	RESULT
1	1811.21	65.07	48.84	8.93	5.16	PASS
2	1830.13	65.60	49.37	8.40	4.63	PASS
3	1850.68	65.99	49.76	8.01	4.24	PASS

*Corrected (0.25dB of attenuation added to account for RF cable)

Note: Average Level = Peak Level – Duty Cycle Correction Factor
Duty Cycle Correction Factor is calculated in Figures 6. 16.23 dB was used.
Peak Margin = Peak Limit (74) -Peak Level
Average Margin = Average Limit (54) - Average Level
See Figure 6 for Duty Cycle correction factor plot and calculation

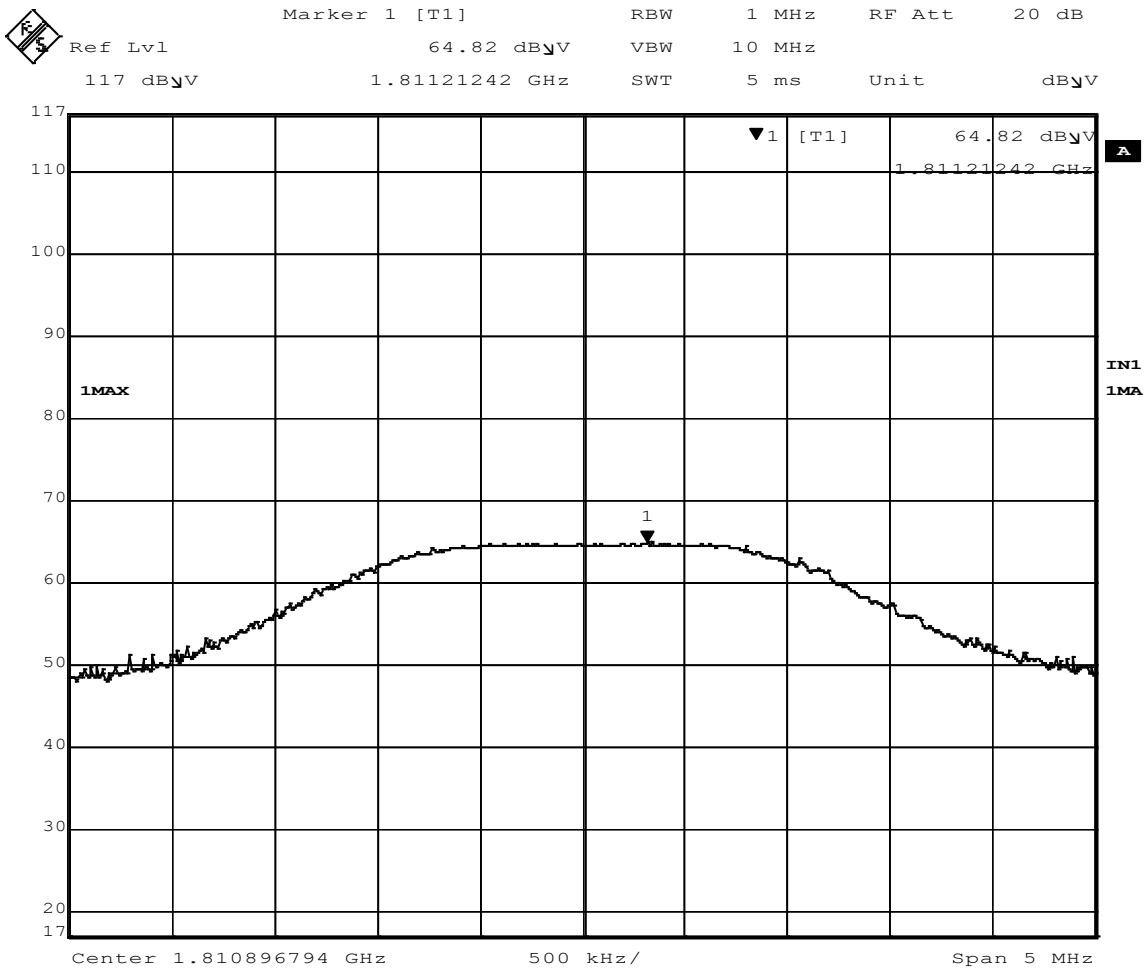

Figure 13 – Second Harmonic, Lowest Channel

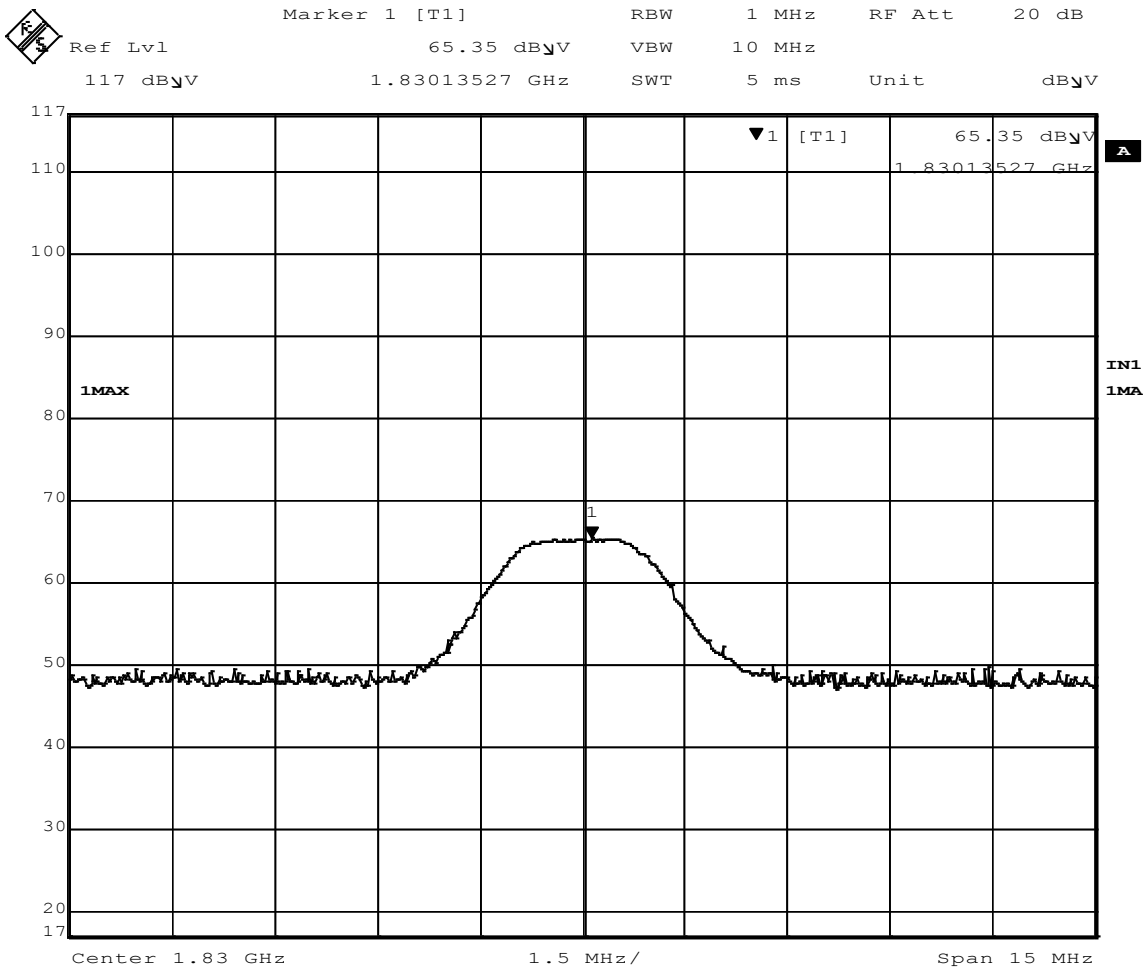

Figure 14 – Second Harmonic, Middle Channel

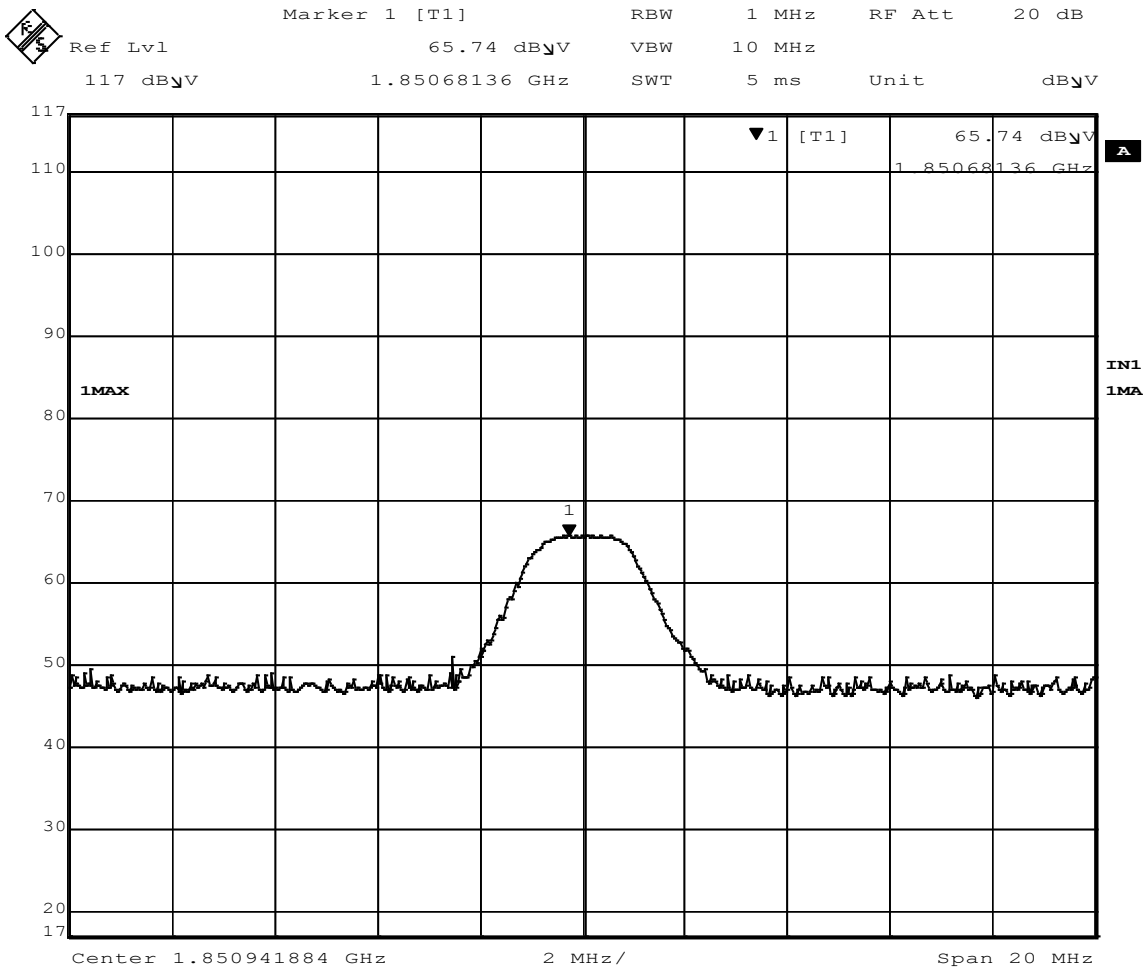

Figure 15 – Second Harmonic, Highest Channel

4.6 Power spectral density (PSD)

4.6.1 Limits of PSD measurements

The maximum power spectral density allowed is 8dBm.

4.6.2 Test procedures

The transmitter output was connected directly to the spectrum analyzer. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using 3 kHz RBW and 30 kHz VBW, the sweep time was set to auto. The power spectral density was measured and recorded at the frequency with the highest emission. The sweep time is allowed to be longer than span/3KHz for a full response of the mixer in the spectrum analyzer.

4.6.3 Deviations from test standard

No deviation.

4.6.4 Test setup

The cable used to go from the spectrum analyzer to the EUT had a loss of 0.25dB. The plot shows the uncorrected value. The corrected value was recorded from this plot with 0.25dB added.

4.6.5 EUT operating conditions

See Section 2.6.

4.6.6 Test results

Power Spectral Density

EUT MODULE	900 MHz Transmitter	MODE	Transmit
INPUT POWER	3 VDC	FREQUENCY RANGE	902 MHz – 928 MHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

CHANNEL	CHANNEL FREQUENCY (MHz)	RF POWER LEVEL (dBm)	MAXIMUM POWER LIMIT (dBm)	RESULT
1	905.38	-0.10	8.0	PASS
2	914.42	1.99	8.0	PASS
3	925.48	2.19	8.0	PASS

Table shows corrected measurements
(0.25dB of attenuation added to account for RF cable)

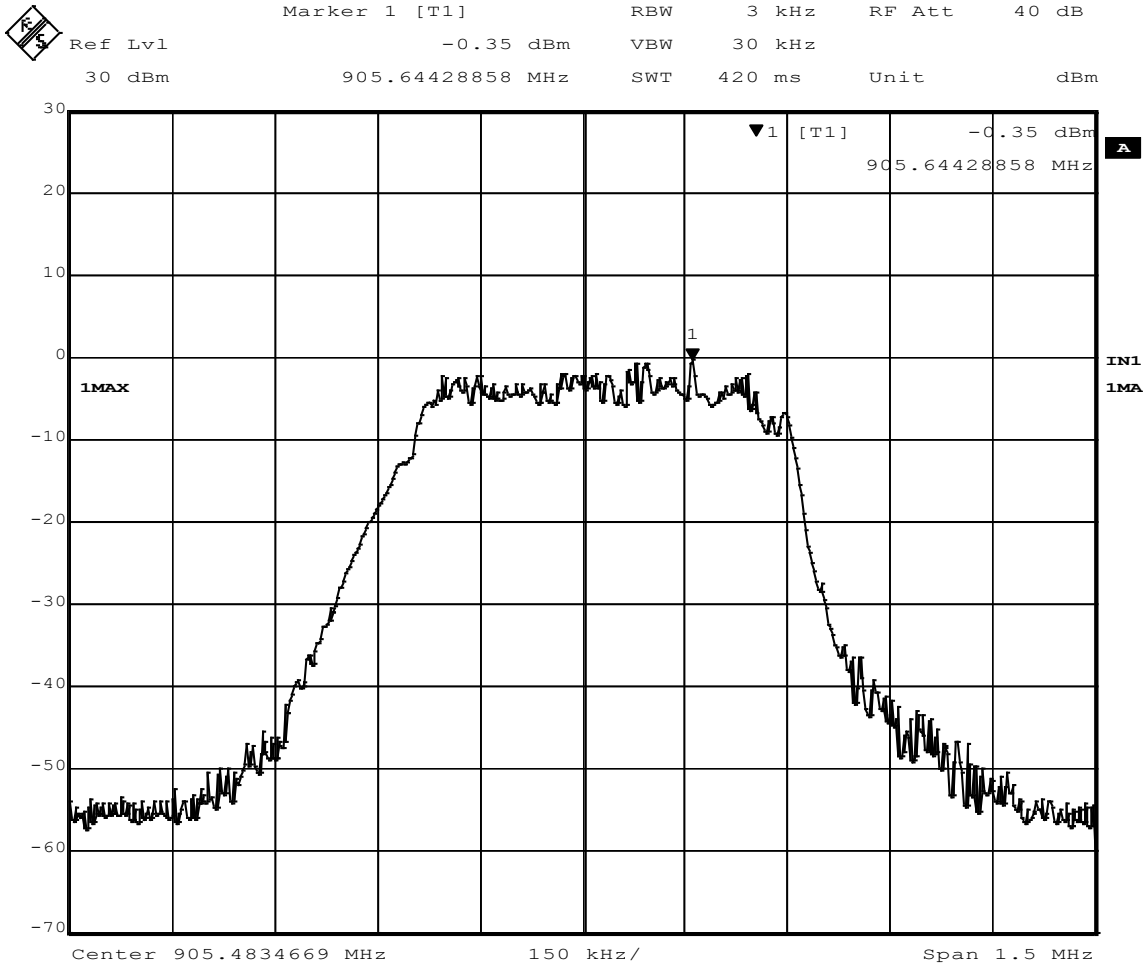

Figure 16 - Power Spectral Density Measurement, Lowest Channel

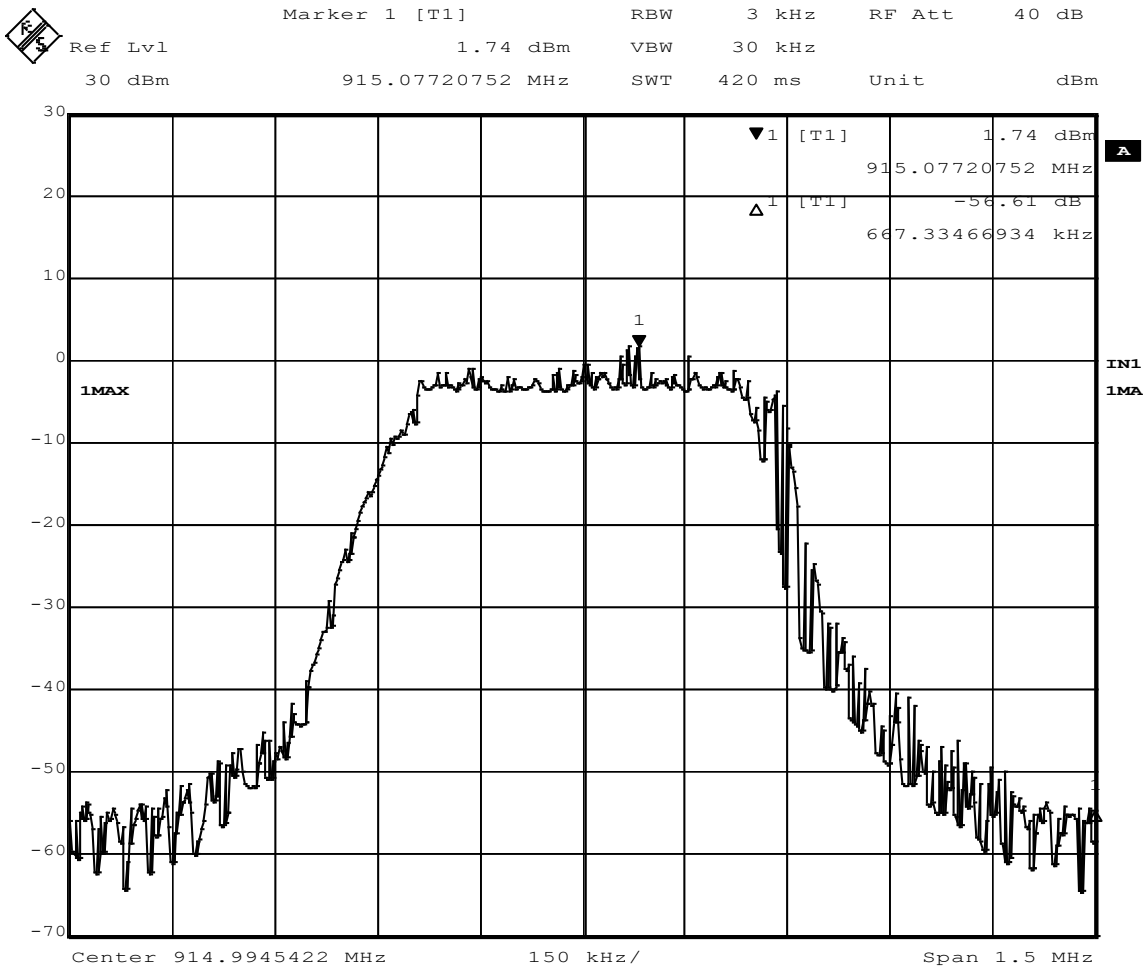

Figure 17 - Power Spectral Density Measurement, Middle Channel

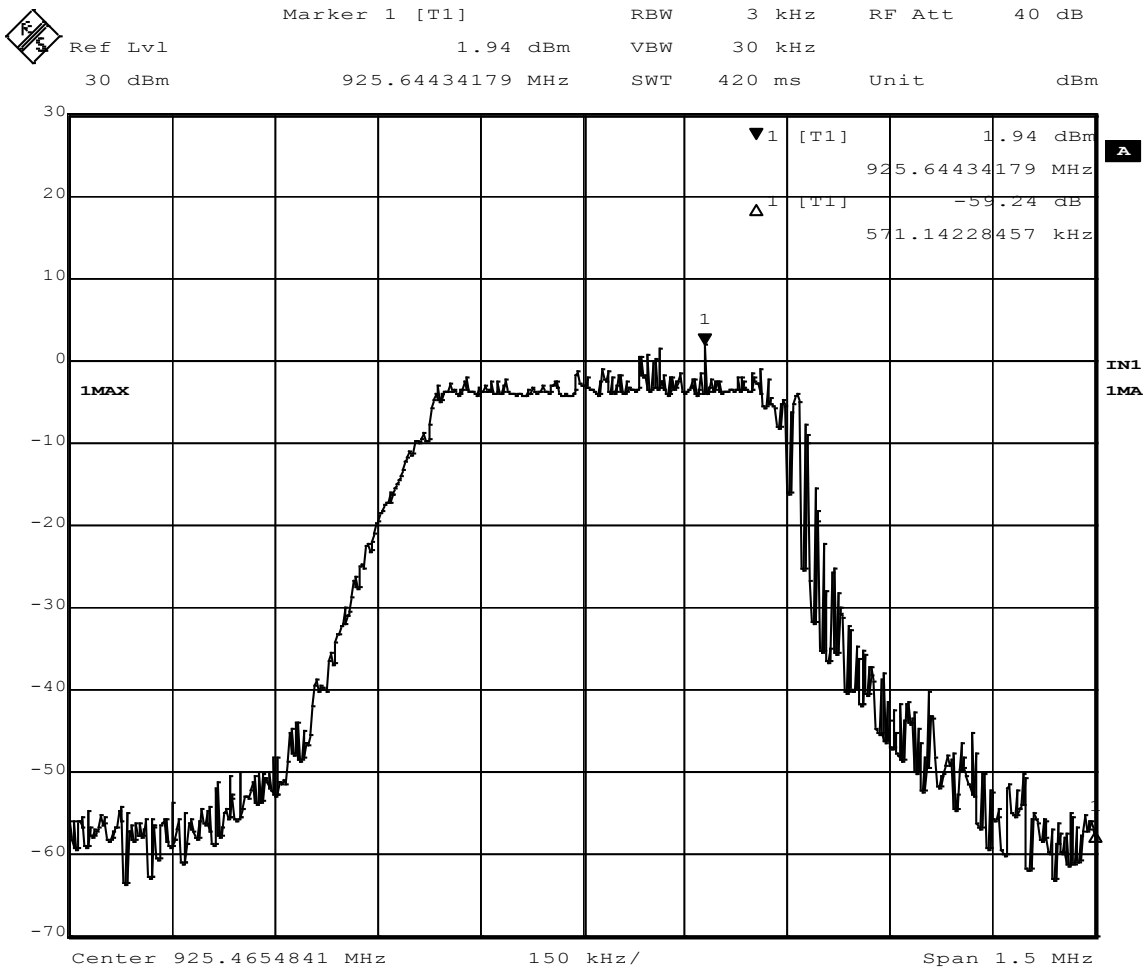

Figure 18 - Power Spectral Density Measurement, Highest Channel

4.7 Bandedges

4.7.1 Limits of bandedge measurements

For emissions outside of the allowed band of operation (902MHz – 928MHz), 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.

4.7.2 Test procedures

The transmitter output was connected directly to the spectrum analyzer. The resolution bandwidth was set to 100kHz and the spectrum analyzer was used at bandedges to the fundamental frequency with a peak detector. The highest emissions level beyond the bandedge was measured and recorded. If the out of band emissions do not fall within a restricted band from 15.205, then it is required that the out of band emission be 20dB below that of the fundamental emission level.

4.7.3 Deviations from test standard

No deviation.

4.7.4 Test setup

The cable used to go from the spectrum analyzer to the EUT had a loss of 0.25dB. This was not taken into account on the plot below because it is a relative measurement.

4.7.5 EUT operating conditions

See Section 2.6.

4.7.6 Test results

EUT MODULE	900 MHz Transmitter	MODE	Transmit
INPUT POWER	3 VDC	FREQUENCY RANGE	902 MHz – 928 MHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

Highest Out of Band Emissions

CHANNEL	Bandedge/Measurement Frequency (MHz)	Level (dBm)	Fund. Level (dBm)	Delta	Minimum per 15.247	Result
1	902 MHz	-48.08	9.65	57.73	20.00	PASS
3	928 MHz	-45.86	8.88	54.74	20.00	PASS

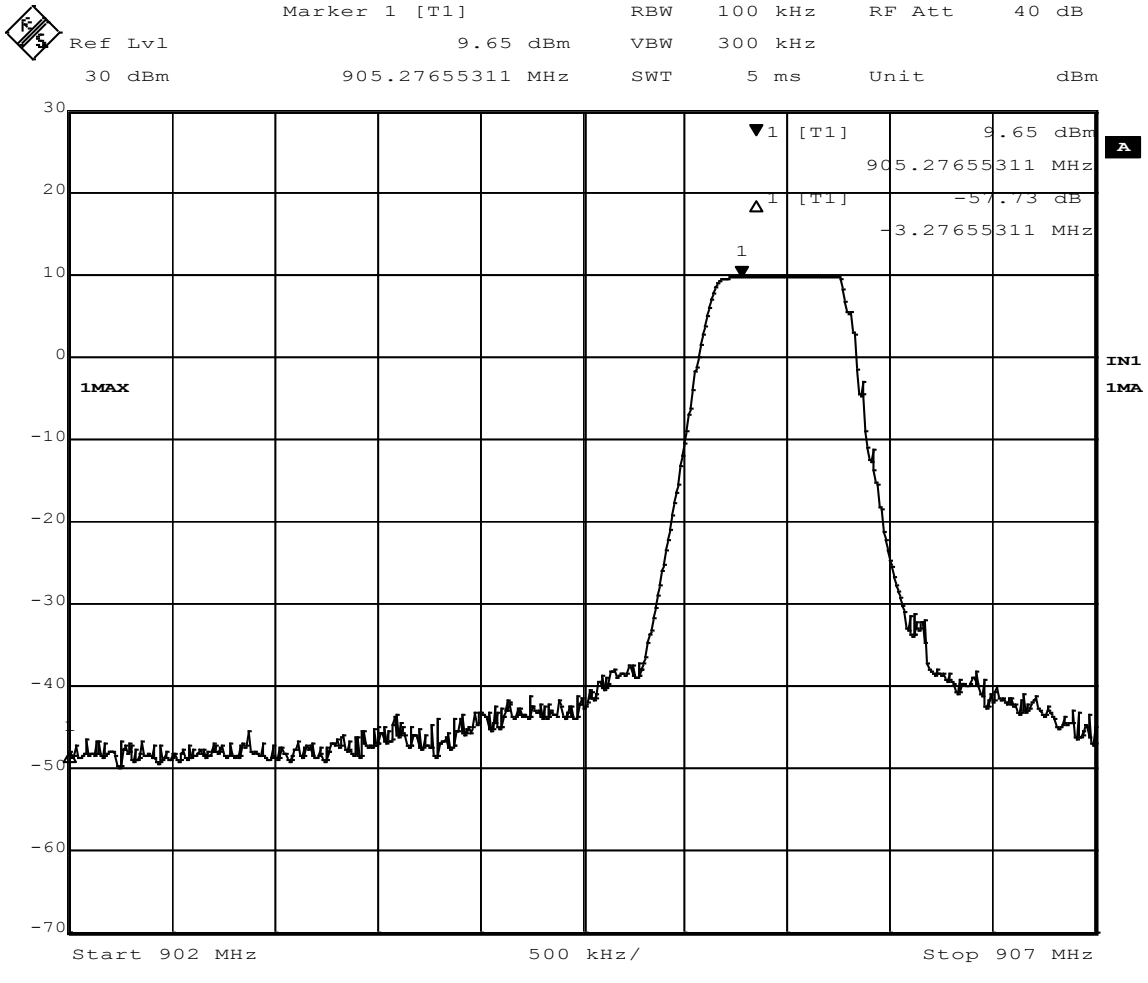

Figure 19 - Lower Band-edge Measurements

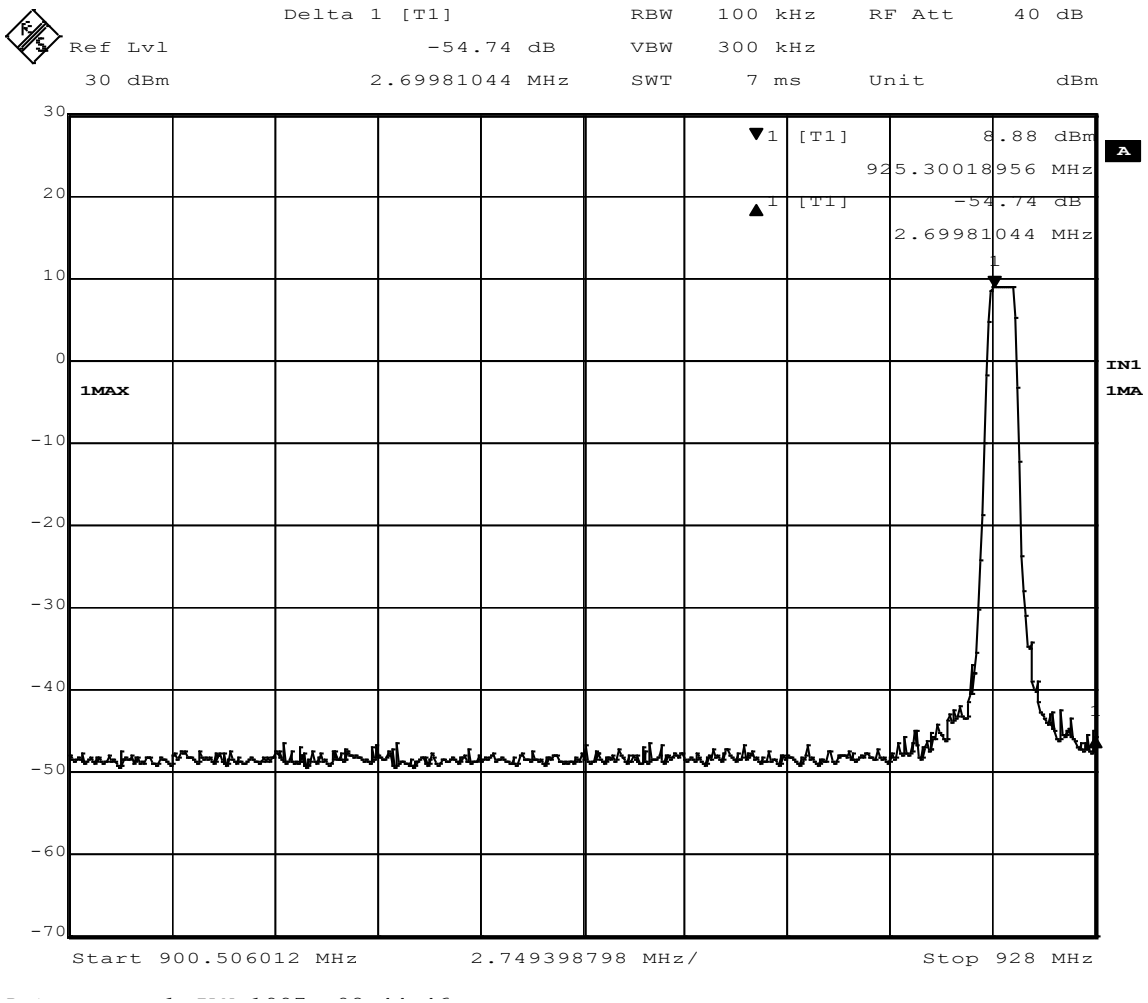

Figure 20 - Higher Band-edge Measurements

Appendix A: Sample Calculations

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
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Appendix 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	30MHz – 18GHz	±3.30 dB

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

REPORT END