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Amended Radio Test Report

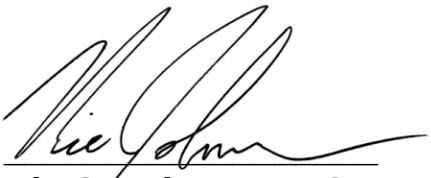
Client: **Johnson Outdoors**
1531 Madison Ave.
Mankato, MN 56001

Product: **Ulterra with i-Pilot Link System**
902-928 MHz band Main and Trim Boards

FCC ID: **T62 –ULTERRAIP20**
IC: **IC:4397A-ULTERRAIP20**

Test Report No: **R20131014-21-12B**

Approved By:



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DATE: **8 December 2014**

Total Pages: **46**

ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

1.0 Summary of test results

The EUT has been tested according to the following specifications:

APPLIED STANDARDS: FCC Part 15, Subpart C Industry Canada RSS-Gen, RSS-210 Issue 7 AS/NZS 4268:2008			
Standard Section	**Test Type and Limit**	**Result**	**Remark**
15.203 RSS-Gen Issue 4	Unique Antenna Requirement	Pass	Permanently attached antenna
15.207 RSS-Gen Issue 4	Conducted Emissions	NA	No connection to AC mains network
15.209 RSS-Gen Issue 4	Radiated Emissions	Pass	Meets the requirement of the limit.
15.249 RSS-210 Issue 8	Bandwidth	Pass	Meets the requirement of the limit.
15.249 RSS-210 Issue 8	Transmitter Radiated Emissions, Limit: Table 15.209	Pass	Meets the requirement of the limit.

1.1 Reason for amendment:

RSS-Gen was updated to Issue 4.
The frequency range reference for the iPilot link radio was corrected to start at 2437 MHz.
Page 5 has been corrected to reference 15.249 and not 15.247.
The bandwidth measurements for the main board were corrected to match the plots.
Figure 14, the calculation were corrected to list the correct output power.
The frequency range in Section 4.5.1 was corrected to 902 – 928 MHz

2.0 Description

2.1 Equipment under test

The Equipment Under Test (EUT) was an Ulterra trolling motor with i-Pilot Link system controller pre-installed, which operates from 2437 to 2447 MHz. This radio is intended to communicate with an external remote (previously tested). The test results from this radio are covered in NCEE Labs report R20141014-21-11.

The EUT included 2 additional transceivers on the main board and on the trim board which operate between 915 and 921 MHz. These radios communicate only between one another. This report is specific to these radios.

EUT Received Date: 10 March 2014
EUT Tested Dates: 10 March 2014 – 16 September 2014

PRODUCT	Ulterra with i-Pilot Link system Main board and trim board
POWER SUPPLY	24 VDC Battery
MODULATION TYPE	FM
RADIO TECHNOLOGY	Half-duplex RF Link
ANTENNA TYPE	Internal Dipole

NOTE:

1. For more detailed features description, please refer to the manufacturer's specifications or the User's Manual.

2.2 Laboratory description

All testing was performed at the NCEE Lincoln facility. Laboratory environmental conditions varied slightly throughout the tests:

Relative humidity of 26 ± 4%
Temperature of 23 ± 3° Celsius

2.3 Description of test modes

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

Main Board:

Channel	Frequency
1	915
2	918
3	921

These are the only three frequencies possible Main Board.

Trim Board:

Channel	Frequency
1	915
2	918
3	921

These are the only three frequencies possible Trim Board

2.4 Applied standards

The EUT uses digital modulation and operates between 2400.0MHz and 2483.5MHz. It has no provisions for connection to the AC mains connection. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC Part 15, Subpart C (15.249)
FCC Part 15, Subpart C (15.209)
Industry Canada RSS-GEN Issue 4
Industry Canada RSS-210 Issue 8
ANSI C63.10:2013

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 Channel 1, 2 or 3.

The EUT was tested with an optional foot pedal and fish finder.

3.0 Test equipment used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE
Rohde & Schwarz Test Receiver	ES126	100037	21 Jan 2014
EMCO Biconilog Antenna*	3142B	1654	13 Jan 2014
EMCO Horn Antenna**	3115	6416	14 Jan 2014
EMCO Horn Antenna***	3116	2576	31 Mar 2014
Rohde & Schwarz Preamp*	TS-PR18	NCEEPAHF20	26 Mar 2014****
Trilithic High Pass Filter*	6HC330	23042	26 Mar 2014****

*Used for radiated measurements above 3GHz
**Used for measurements above 6GHz
***Used for measurements above 18GHz
****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 antennas are permanently attached and internal to the EUT and not replaceable.

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 (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 0.8 meters 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.

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 measured in both the horizontal and vertical orientation. It was found that the vertical position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

Table 1 – Correction Factor Applied in Sections 4.3, 4.4 and 4.6

CHANNEL	CHANNEL FREQUENCY (MHz)	ANTENNA FACTOR	CABLE LOSS
1	915	23.70	4.50
2	918	23.70	4.50
3	921	23.70	4.50

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, The video bandwidth was 1MHz for peak measurements and 10Hz for average measurements. 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

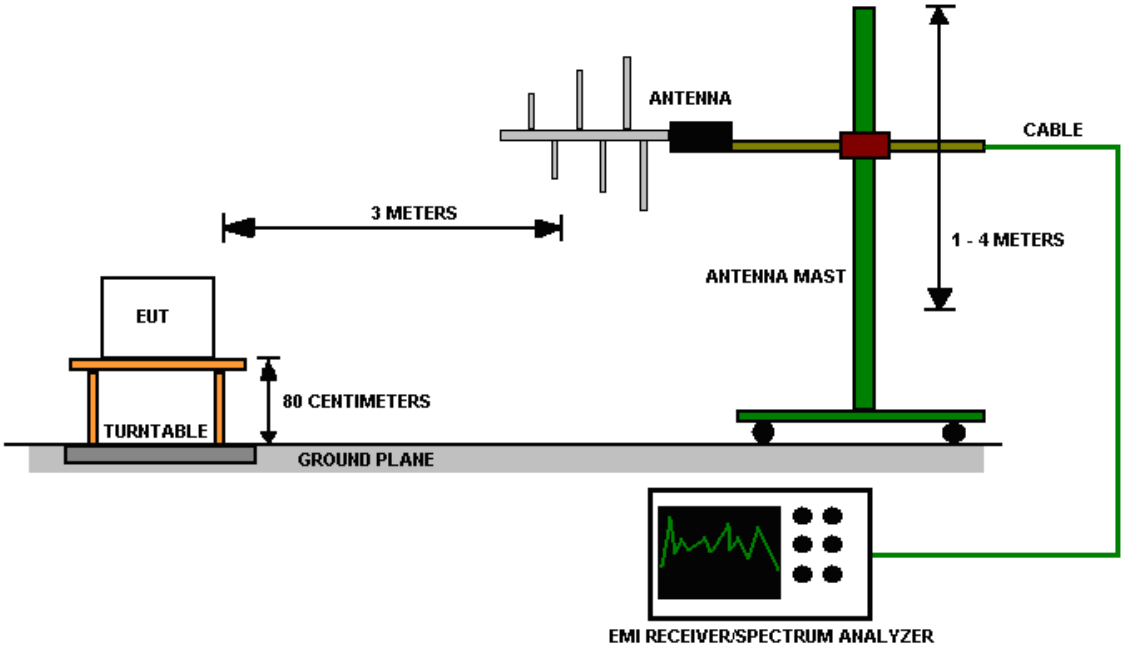

Figure 1 - Radiated Emissions Test Setup

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

4.2.5 EUT operating conditions

The EUT was powered by 24 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.

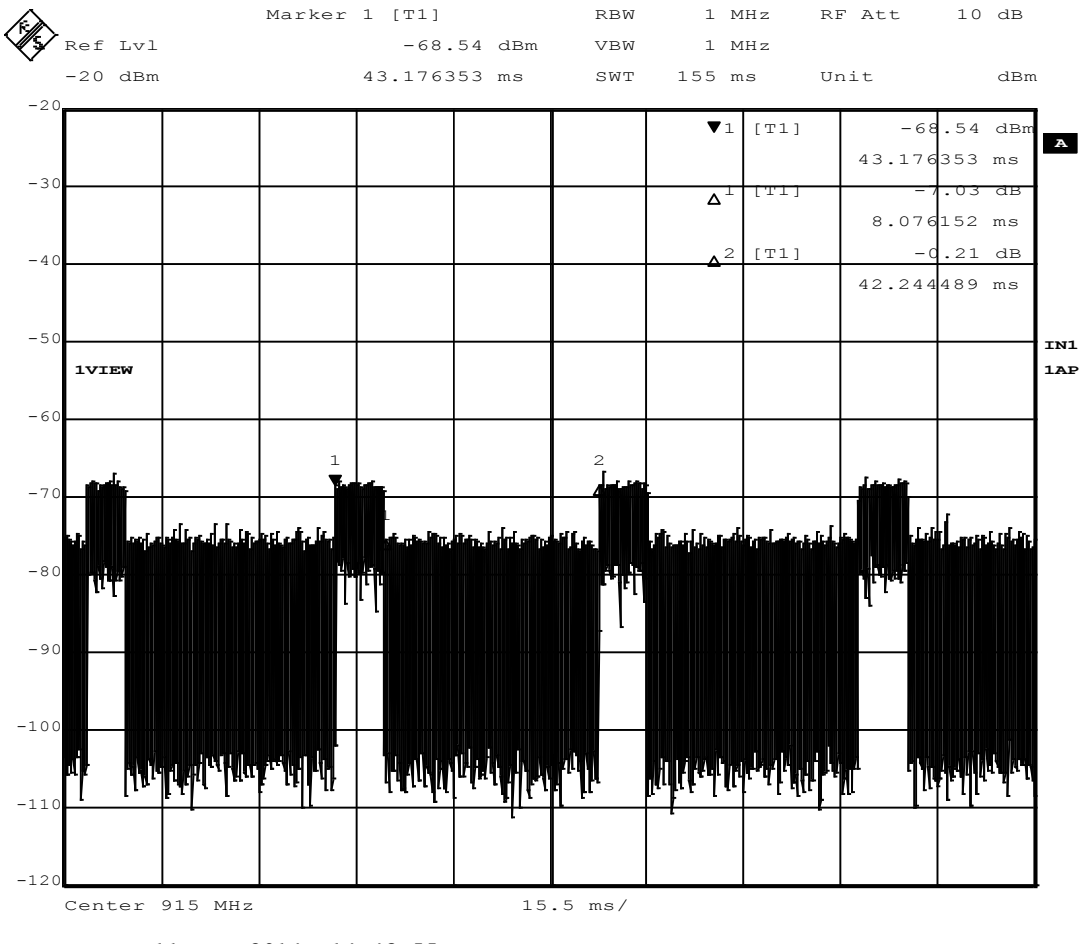

Figure 2 – Duty Cycle, Main Board

20 log (8.08 mS / 42.24 mS) = -14.37 dB

Note: Correction for peak to average measurement = -14.36 dB

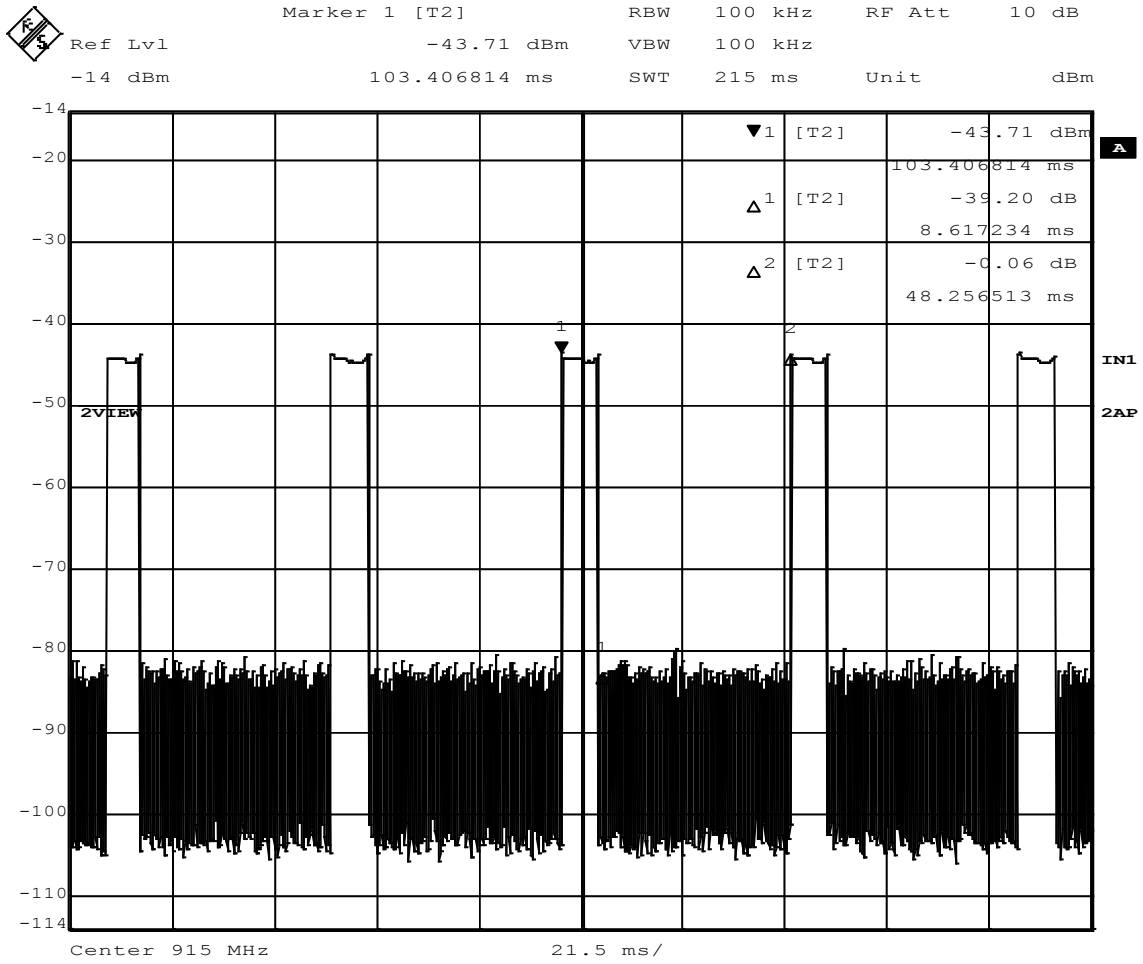

Figure 3 – Duty Cycle, Trim Board,
20 log (8.61 mS / 48.26 mS) = -14.97 dB
Note: Correction for peak to average measurement = -14.97 dB

4.2.6 Test results

EUT MODULE	Main Board	MODE	Receive
INPUT POWER	24 VDC Battery	FREQUENCY RANGE	30MHz – 10 GHz
ENVIRONMENTAL CONDITIONS	26 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

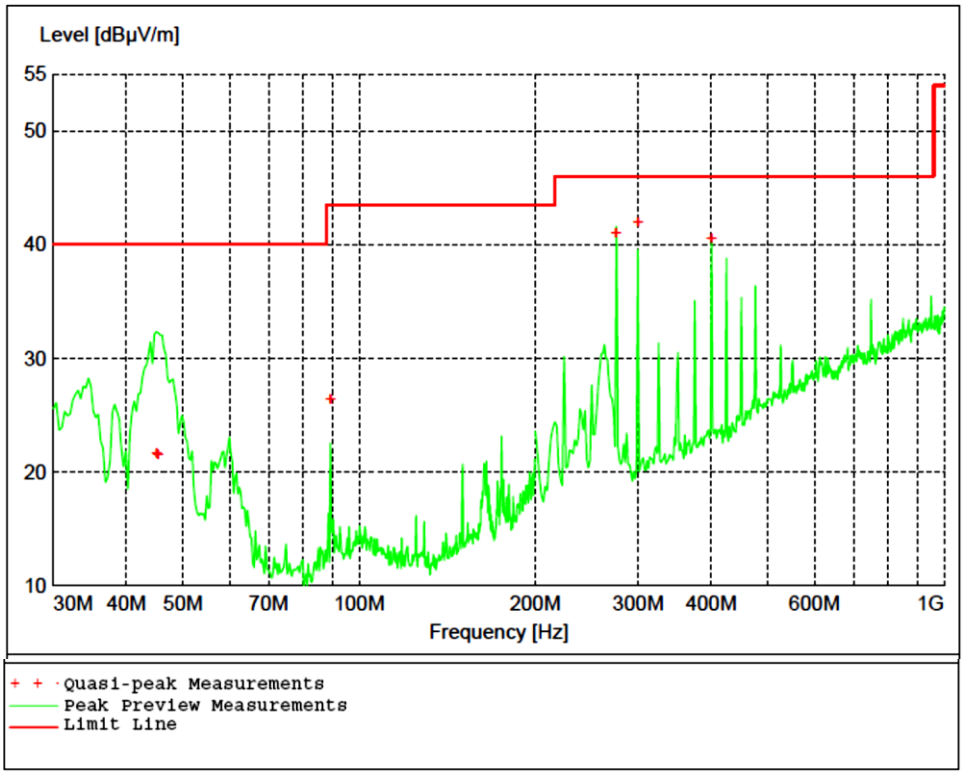

Figure 4 - Radiated Emissions Plot, Receive

Table 2 - Radiated Emissions Quasi-peak Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
45.120000	21.64	40.00	18.40	99	26	VERT
45.300000	21.47	40.00	18.50	101	360	VERT
89.340000	26.33	43.50	17.20	247	91	HORI
274.980000	40.98	46.00	5.00	180	7	HORI
300.000000	41.90	46.00	4.10	156	25	HORI
400.020000	40.56	46.00	5.40	213	360	HORI

Table 3 - Radiated Emissions Peak Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1851.800000	36.64	74.00	37.36	184	217	HORI
2762.000000	38.58	74.00	35.42	99	64	HORI
3682.000000	48.89	74.00	25.11	150	348	VERT
4604.400000	45.17	74.00	28.83	244	238	HORI
5516.400000	49.13	74.00	24.87	352	0	VERT

Table 4 - Radiated Emissions Average Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1851.800000	22.27	54.00	31.73	184	217	HORI
2762.000000	24.21	54.00	29.79	99	64	HORI
3682.000000	34.52	54.00	19.48	150	348	VERT
4604.400000	30.80	54.00	23.20	244	238	HORI
5516.400000	34.76	54.00	19.24	352	0	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.
5. Average measurements were calculated from applying the averaging factors from Figures 2 – 4 to the peak measurements

EUT MODULE	Main Board	MODE	Transmit, Ch 1
INPUT POWER	24 VDC Battery	FREQUENCY RANGE	30MHz – 10 GHz
ENVIRONMENTAL CONDITIONS	26 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

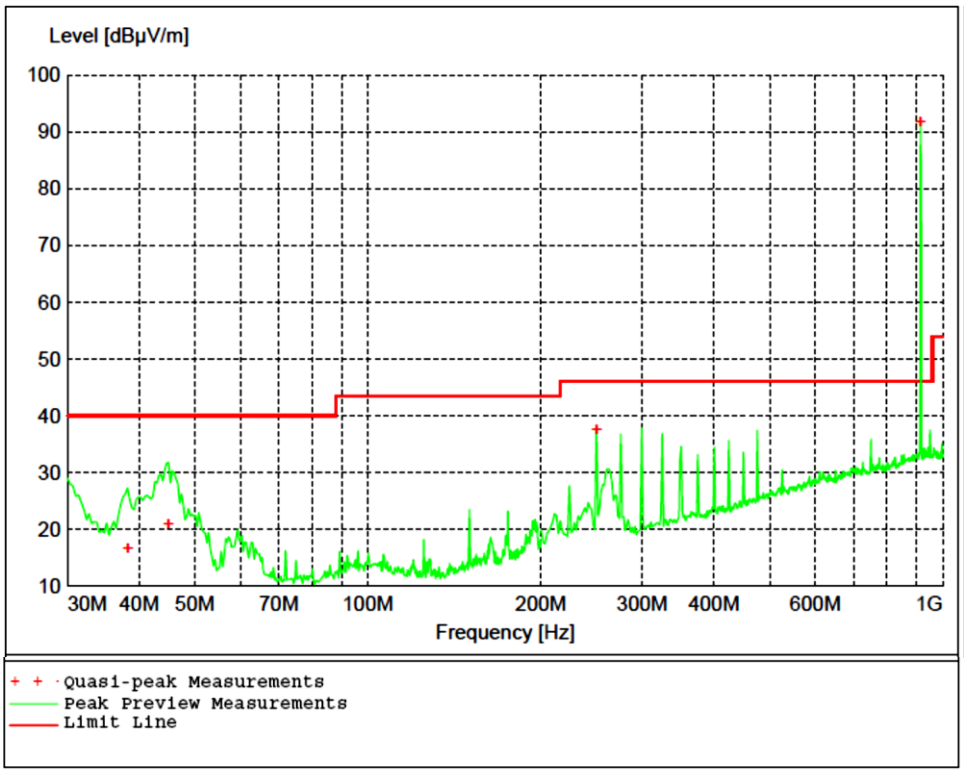

Figure 5 - Radiated Emissions Plot, Channel 1

Table 5 - Radiated Emissions Quasi-peak Measurements, Channel 1

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
38.220000	16.51	40.00	23.50	99	273	VERT
45.000000	20.90	40.00	19.10	101	322	VERT
250.020000	37.61	46.00	8.40	203	1	HORI
915.000000	91.84*	93.98	2.14	126	258	VERT

*Peak measurement

Table 6 - Radiated Emissions Peak Measurements, Channel 1

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1830.000000	54.02	74.00	19.98	184	246	VERT
2745.000000	61.64	74.00	12.36	130	280	VERT
3659.800000	63.83	74.00	10.17	143	300	VERT
4575.000000	55.59	74.00	18.41	99	249	VERT
5489.600000	63.60	74.00	10.40	100	217	VERT
6401.000000	50.29	74.00	23.71	143	237	VERT
7330.800000	48.67	74.00	25.33	183	68	HORI
7342.600000	64.56	74.00	9.44	199	58	VERT
8221.200000	48.92	74.00	25.08	183	360	HORI

Table 7 - Radiated Emissions Average Measurements, Channel 1

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1830.000000	39.65	54.00	14.35	184	246	VERT
2745.000000	47.27	54.00	6.73	130	280	VERT
3659.800000	49.46	54.00	4.54	143	300	VERT
4575.000000	41.22	54.00	12.78	99	249	VERT
5489.600000	49.23	54.00	4.77	100	217	VERT
6401.000000	35.92	54.00	18.08	143	237	VERT
7330.800000	34.30	54.00	19.70	183	68	HORI
7342.600000	50.19	54.00	3.81	199	58	VERT
8221.200000	34.55	54.00	19.45	183	360	HORI

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. Average measurements were calculated from applying the averaging factors from Figures 2 – 4 to the peak measurements

EUT MODULE	Main Board	MODE	Transmit, Ch 2
INPUT POWER	24 VDC Battery	FREQUENCY RANGE	30MHz – 10 GHz
ENVIRONMENTAL CONDITIONS	26 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

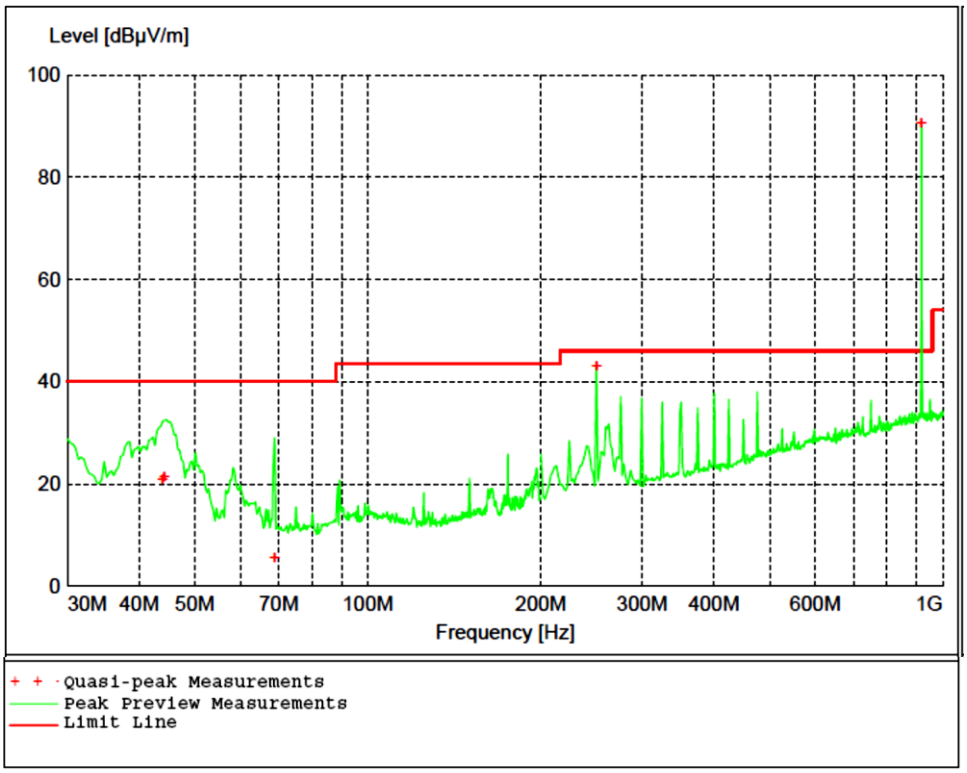

Figure 6 - Radiated Emissions Plot, Channel 2

Table 8 - Radiated Emissions Quasi-peak Measurements, Channel 2

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
43.980000	20.93	40.00	19.10	101	305	VERT
44.280000	21.34	40.00	18.70	99	299	VERT
68.880000	5.50	40.00	34.50	98	70	HORI
250.020000	42.92	46.00	3.10	193	14	HORI
918.000000	90.61*	93.98	3.37	126	258	VERT

*Peak measurement

Table 9 - Radiated Emissions Peak Measurements, Channel 2

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1836.000000	55.47	74.00	18.53	200	246	VERT
2754.000000	61.14	74.00	12.86	98	280	VERT
3671.800000	61.59	74.00	12.41	101	243	HORI
4589.800000	54.86	74.00	19.14	99	294	VERT
5508.000000	60.85	74.00	13.15	200	137	VERT
6427.600000	50.84	74.00	23.16	99	217	HORI
7309.400000	63.57	74.00	10.43	199	63	VERT
7327.200000	63.18	74.00	10.82	99	341	VERT
8246.600000	48.53	74.00	25.47	106	75	HORI

Table 10 - Radiated Emissions Average Measurements, Channel 2

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1836.000000	41.10	54.00	12.90	200	246	VERT
2754.000000	46.77	54.00	7.23	98	280	VERT
3671.800000	47.22	54.00	6.78	101	243	HORI
4589.800000	40.49	54.00	13.51	99	294	VERT
5508.000000	46.48	54.00	7.52	200	137	VERT
6427.600000	36.47	54.00	17.53	99	217	HORI
7309.400000	49.20	54.00	4.80	199	63	VERT
7327.200000	48.81	54.00	5.19	99	341	VERT
8246.600000	34.16	54.00	19.84	106	75	HORI

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. Average measurements were calculated from applying the averaging factors from Figures 2 – 4 to the peak measurements

EUT MODULE	Main Board	MODE	Transmit, Ch 3
INPUT POWER	24 VDC Battery	FREQUENCY RANGE	30MHz – 10 GHz
ENVIRONMENTAL CONDITIONS	26 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

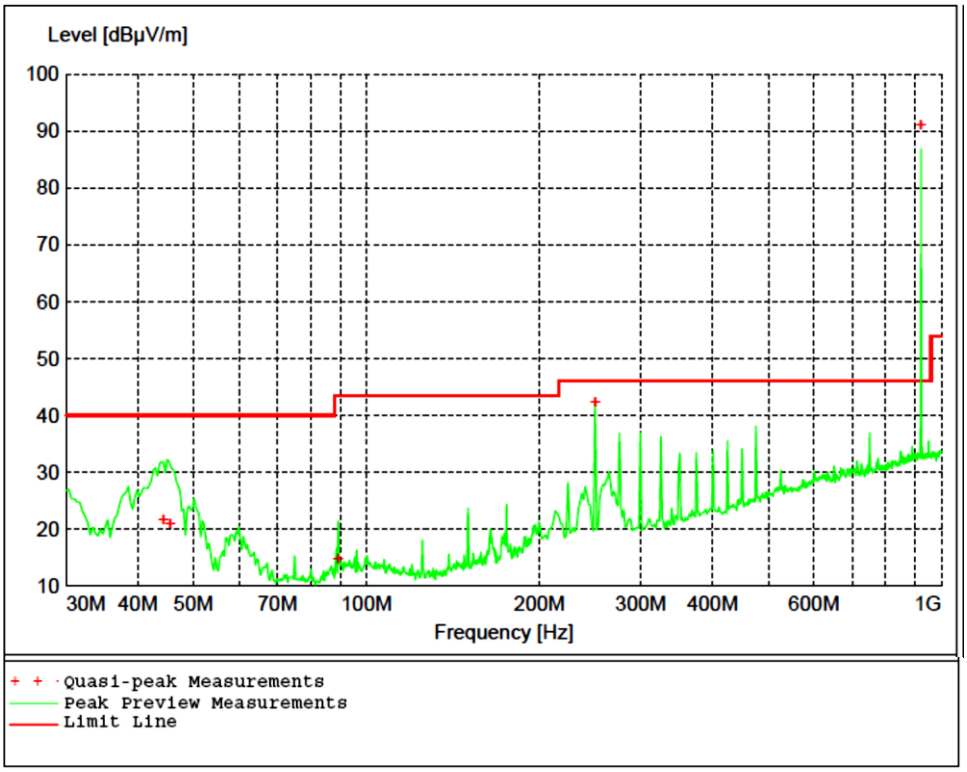

Figure 7 - Radiated Emissions Plot, Channel 3

Table 11 - Radiated Emissions Quasi-peak Measurements, Channel 3

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
44.340000	21.66	40.00	18.30	99	282	VERT
45.540000	20.85	40.00	19.10	101	275	VERT
89.280000	14.68	43.50	28.80	400	173	VERT
250.020000	42.23	46.00	3.80	193	12	HORI
921.000000	91.12*	93.98	2.86	116	250	VERT

*Peak measurement

Table 12 - Radiated Emissions Peak Measurements, Channel 3

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1842.000000	55.53	74.00	18.47	200	253	VERT
2763.000000	61.18	74.00	12.82	106	297	VERT
3683.800000	61.95	74.00	12.05	115	302	VERT
4605.000000	55.15	74.00	18.85	112	251	VERT
5526.000000	64.20	74.00	9.80	200	221	VERT
6447.200000	56.40	74.00	17.60	191	170	VERT
7364.600000	48.71	74.00	25.29	200	231	VERT
8293.400000	48.95	74.00	25.05	180	320	HORI
9199.800000	50.21	74.00	23.79	122	265	VERT

Table 13 - Radiated Emissions Average Measurements, Channel 3

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1842.000000	41.16	54.00	12.84	200	253	VERT
2763.000000	46.81	54.00	7.19	106	297	VERT
3683.800000	47.58	54.00	6.42	115	302	VERT
4605.000000	40.78	54.00	13.22	112	251	VERT
5526.000000	49.83	54.00	4.17	200	221	VERT
6447.200000	42.03	54.00	11.97	191	170	VERT
7364.600000	34.34	54.00	19.66	200	231	VERT
8293.400000	34.58	54.00	19.42	180	320	HORI
9199.800000	35.84	54.00	18.16	122	265	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
5. Average measurements were calculated from applying the averaging factors from Figures 2 – 4 to the peak measurements

EUT MODULE	Trim Board	MODE	Receive
INPUT POWER	24 VDC Battery	FREQUENCY RANGE	30MHz – 10 GHz
ENVIRONMENTAL CONDITIONS	26 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

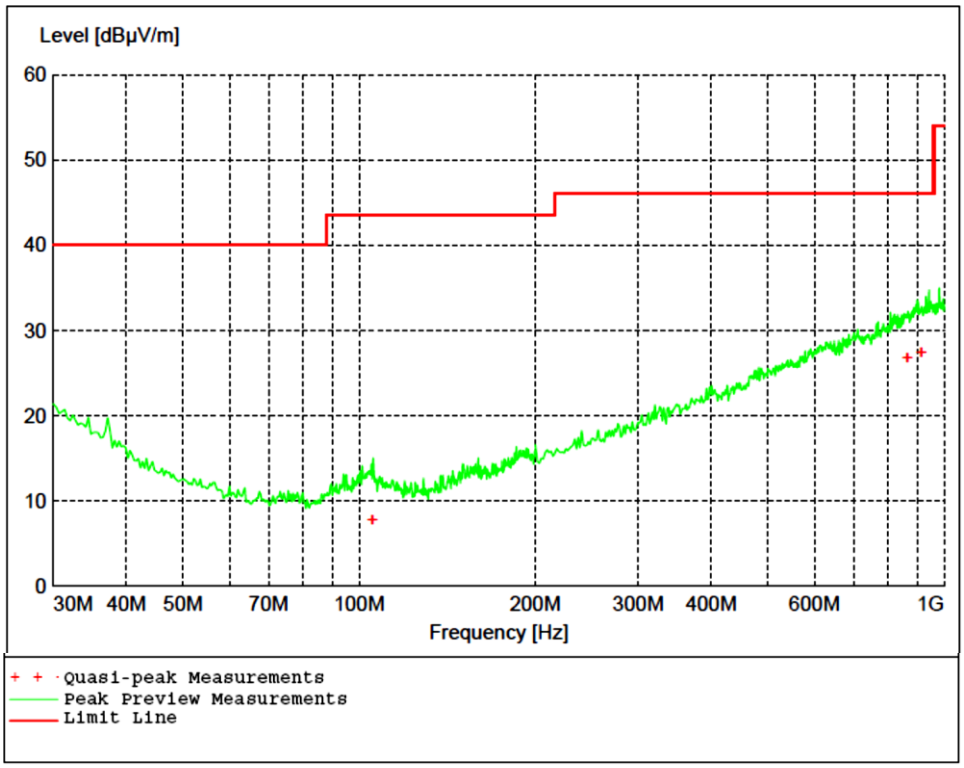

Figure 8 - Radiated Emissions Plot, Receive

Table 14 - Radiated Emissions Quasi-peak Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
105.480000	7.82	43.50	35.70	273	229	VERT
866.040000	26.82	46.00	19.20	251	104	HORI
913.980000	27.38	46.00	18.60	399	209	HORI

Table 15 - Radiated Emissions Average Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1819.400000	19.75	54.00	34.25	101	101	HORI
2754.400000	22.78	54.00	31.22	301	3	VERT
3667.000000	26.98	54.00	27.02	98	280	HORI
4571.600000	28.82	54.00	25.18	99	0	HORI
5481.200000	32.47	54.00	21.53	382	49	VERT

Table 16 - Radiated Emissions Peak Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1819.400000	34.72	54.00	19.30	101	101	HORI
2754.400000	37.75	54.00	16.30	301	3	VERT
3667.000000	41.95	54.00	12.00	98	280	HORI
4571.600000	43.79	54.00	10.20	99	0	HORI
5481.200000	47.44	54.00	6.60	382	49	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.
5. Average measurements were calculated from applying the averaging factors from Figures 2 – 4 to the peak measurements

EUT MODULE	Trim Board	MODE	Transmit, Ch 1
INPUT POWER	24 VDC Battery	FREQUENCY RANGE	30MHz – 10 GHz
ENVIRONMENTAL CONDITIONS	26 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

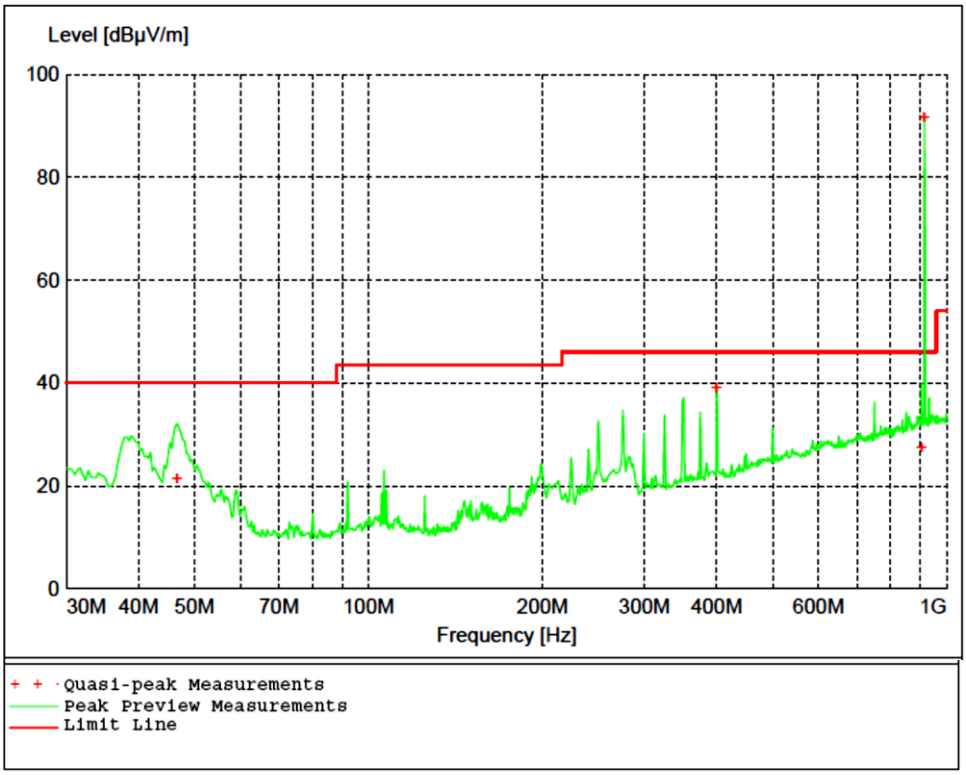

Figure 9 - Radiated Emissions Plot, Channel 1

Table 17 - Radiated Emissions Quasi-peak Measurements, Channel 1

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
46.620000	21.50	40.00	18.50	99	135	VERT
399.960000	39.04	46.00	7.00	100	177	HORI
905.160000	27.48	46.00	18.50	149	71	HORI
915.000000*	91.79	93.98	2.19	106	353	VERT

*Peak measurement

Table 18 - Radiated Emissions Average Measurements, Channel 1

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1835.000000	33.84	54.00	20.16	375	0	HORI
2732.000000	37.92	54.00	16.08	394	134	VERT
3660.000000	36.19	54.00	17.81	100	5	HORI
4574.800000	39.41	54.00	14.59	100	360	HORI
5489.800000	40.60	54.00	13.40	173	2	HORI
6405.200000	37.78	54.00	16.22	100	326	HORI
7336.400000	33.07	54.00	20.93	170	23	VERT
8225.200000	32.87	54.00	21.13	115	119	HORI
9146.600000	34.93	54.00	19.07	356	45	VERT

Table 19 - Radiated Emissions Peak Measurements, Channel 1

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1835.000000	48.81	74.00	25.19	375	0	HORI
2732.000000	52.89	74.00	21.11	394	134	VERT
3660.000000	51.16	74.00	22.84	100	5	HORI
4574.800000	54.38	74.00	19.62	100	360	HORI
5489.800000	55.57	74.00	18.43	173	2	HORI
6405.200000	52.75	74.00	21.25	100	326	HORI
7336.400000	48.04	74.00	25.96	170	23	VERT
8225.200000	47.84	74.00	26.16	115	119	HORI
9146.600000	49.90	74.00	24.10	356	45	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.
5. Average measurements were calculated from applying the averaging factors from Figures 2 – 4 to the peak measurements

EUT MODULE	Trim Board	MODE	Transmit, Ch 2
INPUT POWER	24 VDC Battery	FREQUENCY RANGE	30MHz – 10 GHz
ENVIRONMENTAL CONDITIONS	26 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

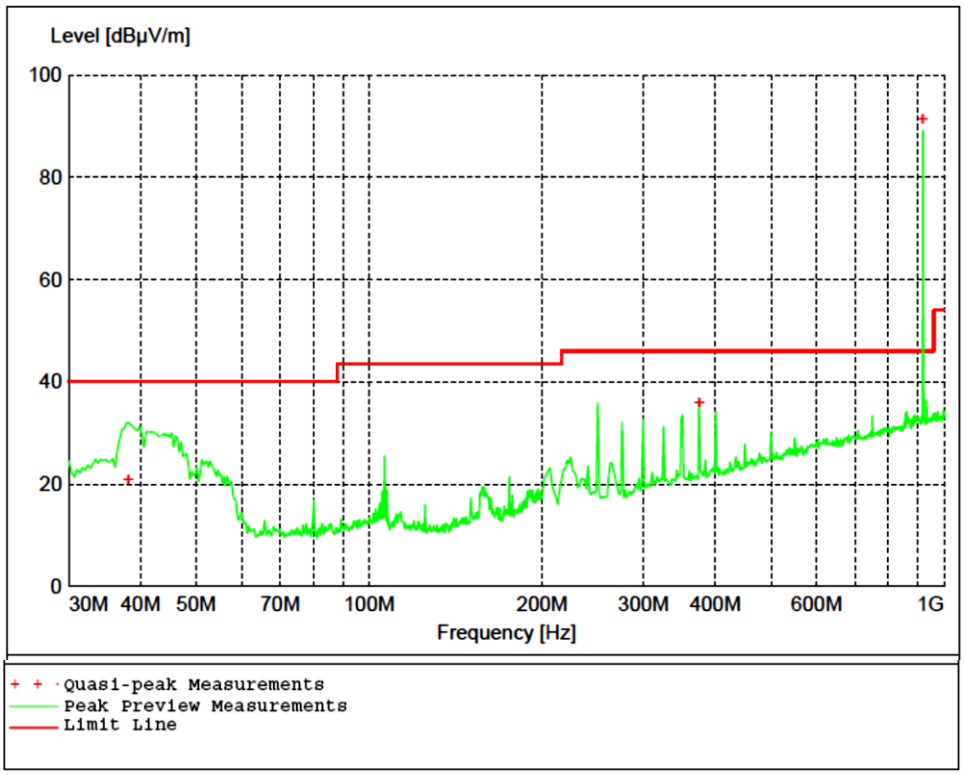

Figure 10 - Radiated Emissions Plot, Channel 2

Table 20 - Radiated Emissions Quasi-peak Measurements, Channel 2

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
38.100000	20.96	40.00	19.00	99	263	VERT
375.000000	35.89	46.00	10.10	99	60	HORI
918.000000	91.30*	93.98	2.68	179	342	VERT

*Peak measurement

Table 21 - Radiated Emissions Average Measurements, Channel 2

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1846.000000	34.49	54.00	19.51	224	280	VERT
2754.000000	41.48	54.00	12.52	139	12	VERT
3671.800000	36.95	54.00	17.05	101	351	HORI
4589.800000	39.34	54.00	14.66	98	351	HORI
5507.800000	38.05	54.00	15.95	99	310	VERT
6435.200000	34.97	54.00	19.03	386	109	VERT
7364.800000	33.76	54.00	20.24	284	130	VERT
8179.600000	33.40	54.00	20.60	271	227	HORI
9180.400000	34.82	54.00	19.18	137	235	VERT

Table 22 - Radiated Emissions Peak Measurements, Channel 2

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1846.000000	49.46	74.00	24.54	224	280	VERT
2754.000000	56.45	74.00	17.55	139	12	VERT
3671.800000	51.92	74.00	22.08	101	351	HORI
4589.800000	54.31	74.00	19.69	98	351	HORI
5507.800000	53.02	74.00	20.98	99	310	VERT
6435.200000	49.94	74.00	24.06	386	109	VERT
7364.800000	48.73	74.00	25.27	284	130	VERT
8179.600000	48.37	74.00	25.63	271	227	HORI
9180.400000	49.79	74.00	24.21	137	235	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.
5. Average measurements were calculated from applying the averaging factors from Figures 2 – 4 to the peak measurements

EUT MODULE	Trim Board	MODE	Transmit, Ch 3
INPUT POWER	24 VDC Battery	FREQUENCY RANGE	30MHz – 10 GHz
ENVIRONMENTAL CONDITIONS	26 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

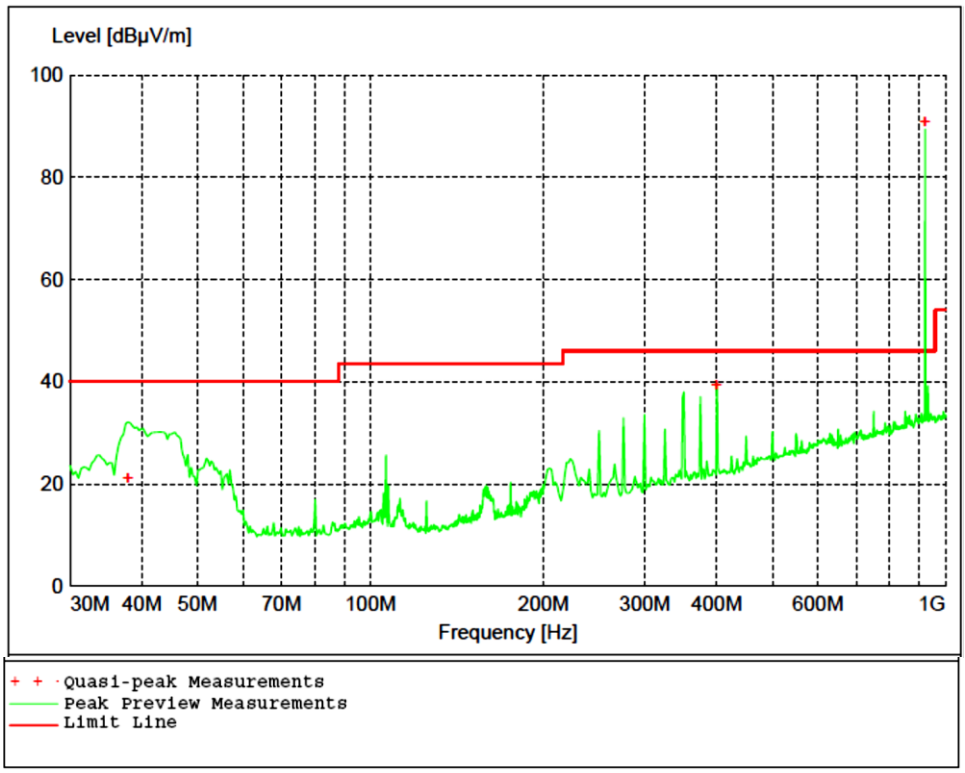

Figure 11 - Radiated Emissions Plot, Channel 3

Table 23 - Radiated Emissions Quasi-peak Measurements, Channel 3

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
37.860000	20.97	40.00	19.00	100	222	VERT
399.960000	39.20	46.00	6.80	203	198	HORI
921.000000	90.89*	93.98	3.09	180	341	VERT

*Peak measurement

Table 24 - Radiated Emissions Average Measurements, Channel 3

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1846.000000	34.49	54.00	19.51	352	7	HORI
2763.000000	37.86	54.00	16.14	200	141	HORI
3682.000000	37.15	54.00	16.85	180	226	VERT
4605.200000	39.78	54.00	14.22	100	346	HORI
5525.600000	39.23	54.00	14.77	99	248	HORI
6451.400000	35.12	54.00	18.88	274	360	VERT
7368.800000	33.50	54.00	20.50	238	360	HORI
8304.000000	33.20	54.00	20.80	99	118	VERT
9215.800000	34.82	54.00	19.18	136	191	VERT

Table 25 - Radiated Emissions Peak Measurements, Channel 3

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1846.000000	49.46	74.00	24.54	352	7	HORI
2763.000000	52.83	74.00	21.17	200	141	HORI
3682.000000	52.12	74.00	21.88	180	226	VERT
4605.200000	54.75	74.00	19.25	100	346	HORI
5525.600000	54.20	74.00	19.80	99	248	HORI
6451.400000	50.09	74.00	23.91	274	360	VERT
7368.800000	48.47	74.00	25.53	238	360	HORI
8304.000000	48.17	74.00	25.83	99	118	VERT
9215.800000	49.79	74.00	24.21	136	191	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
5. Average measurements were calculated from applying the averaging factors from Figures 2 – 4 to the peak measurements

4.3 Bandwidth

4.3.1 Limits of bandwidth measurements

The 6dB bandwidth of the signal must be greater than 0.500MHz.

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 100 kHz RBW and 1 MHz 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.

4.3.3 Deviations from test standard

No deviation.

4.3.4 Test setup

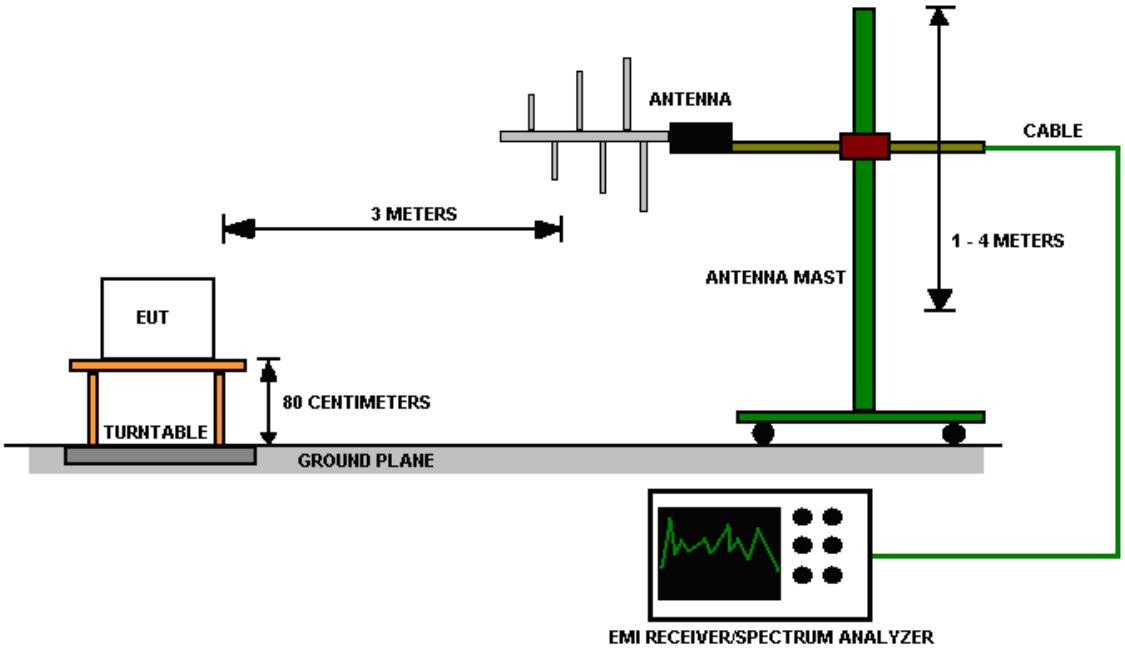

Figure 12 - Bandwidth Measurements Test Setup

4.3.5 EUT operating conditions

The EUT was powered by 24 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	Main Board	MODE	Cont. Transmit
INPUT POWER	24 VDC Battery	FREQUENCY RANGE	902-928 MHz
ENVIRONMENTAL CONDITIONS	26 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

CHANNEL	CHANNEL FREQUENCY (MHz)	99% Occupied BW (kHz)
1	915	434.87
2	918	440.88
3	921	444.89

REMARKS:
None

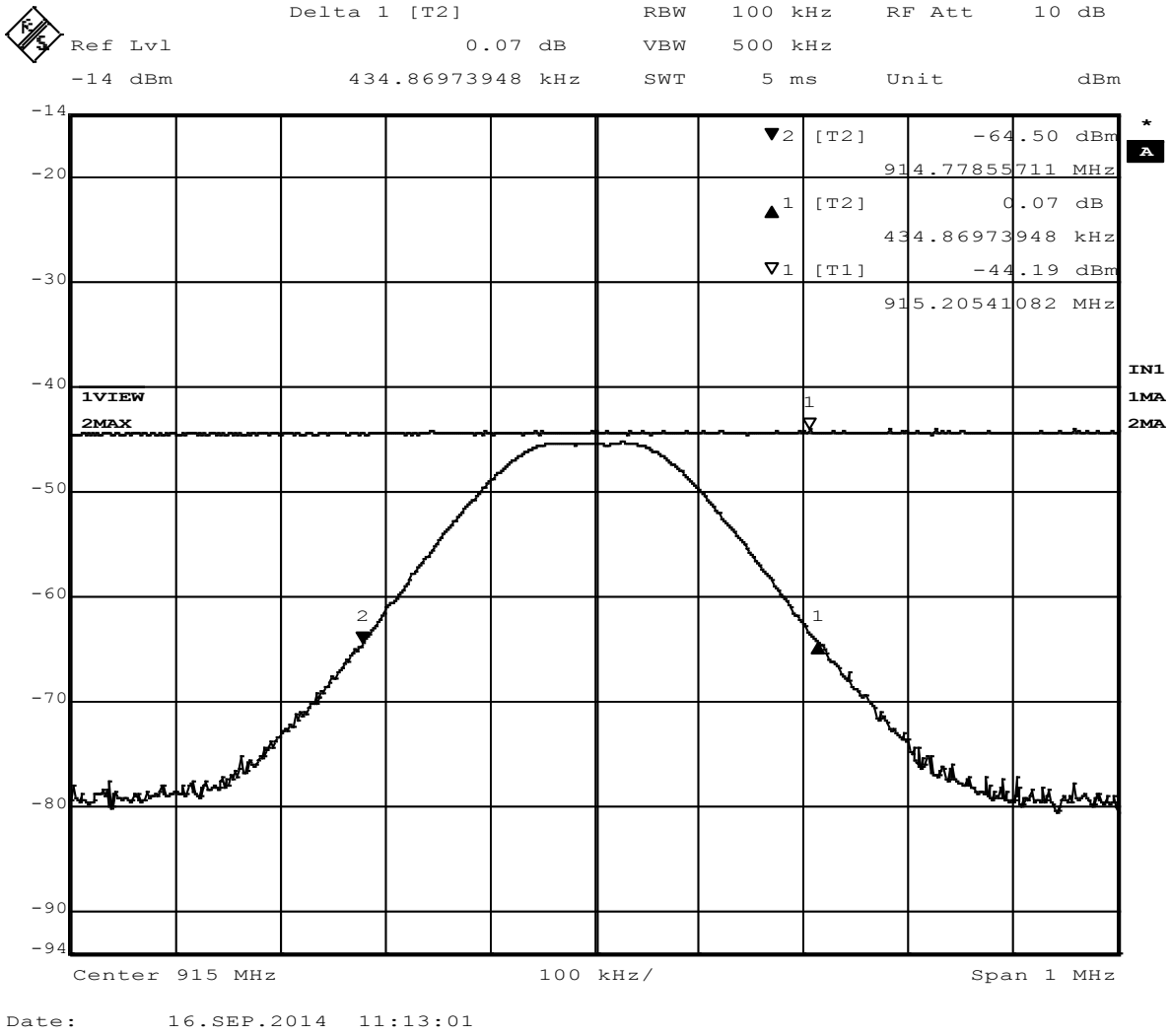

Figure 13 - 99% Occupied Bandwidth, Low Channel
The plot shows an uncorrected measurement.

Maximum power = -44.19 dBm + 107 + CL + AF - 95.23 = -4.22 dBm

CF = cable loss = 4.50 dB
AF = antenna factor = 23.70 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.

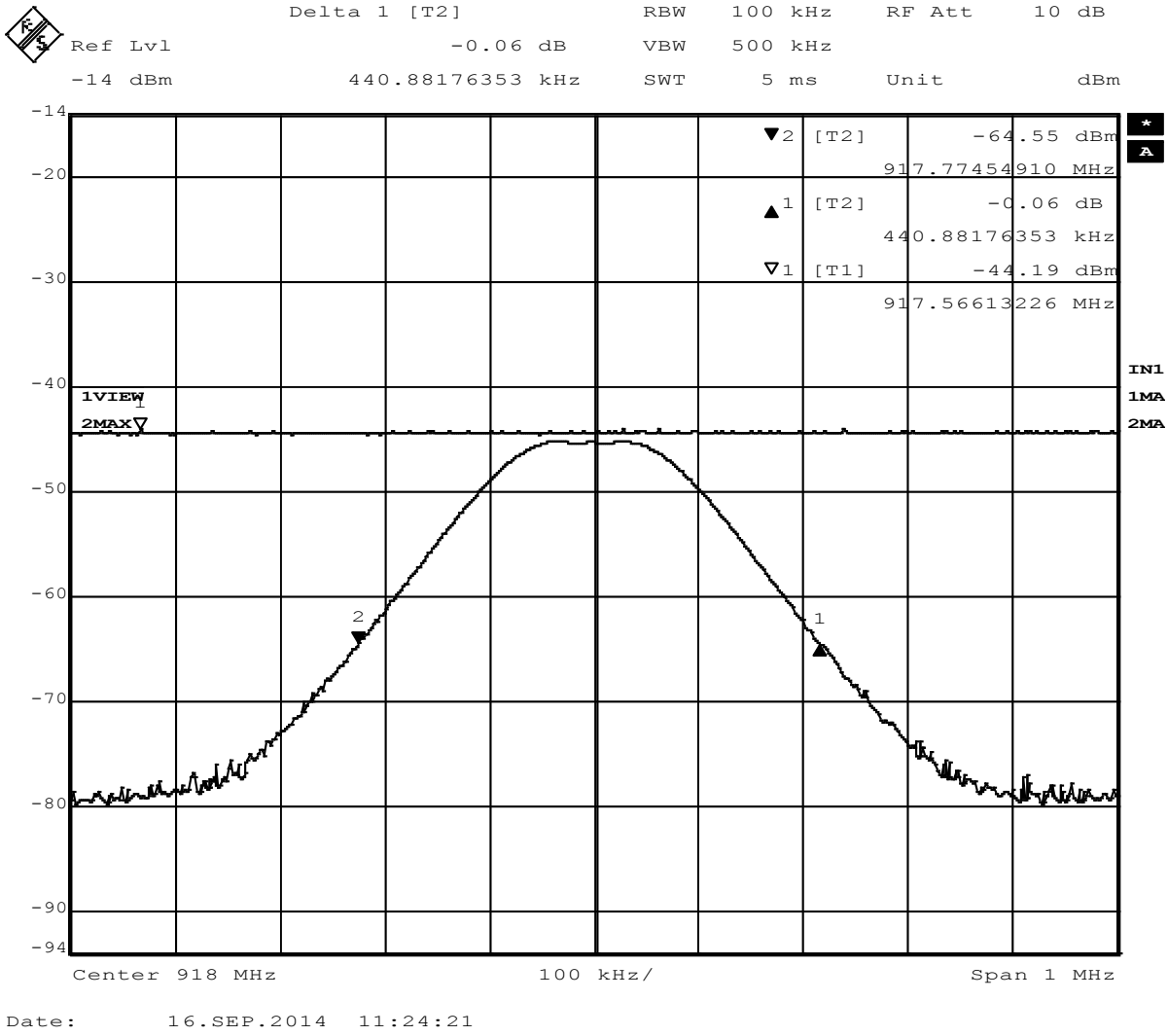

Figure 14 - 99% Occupied Bandwidth, Mid Channel

The plot shows an uncorrected measurement.

Maximum power = -44.19 dBm + 107 + CL + AF - 95.23 = -4.22 dBm

CF = cable loss = 4.50 dB
AF = antenna factor = 23.70 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.

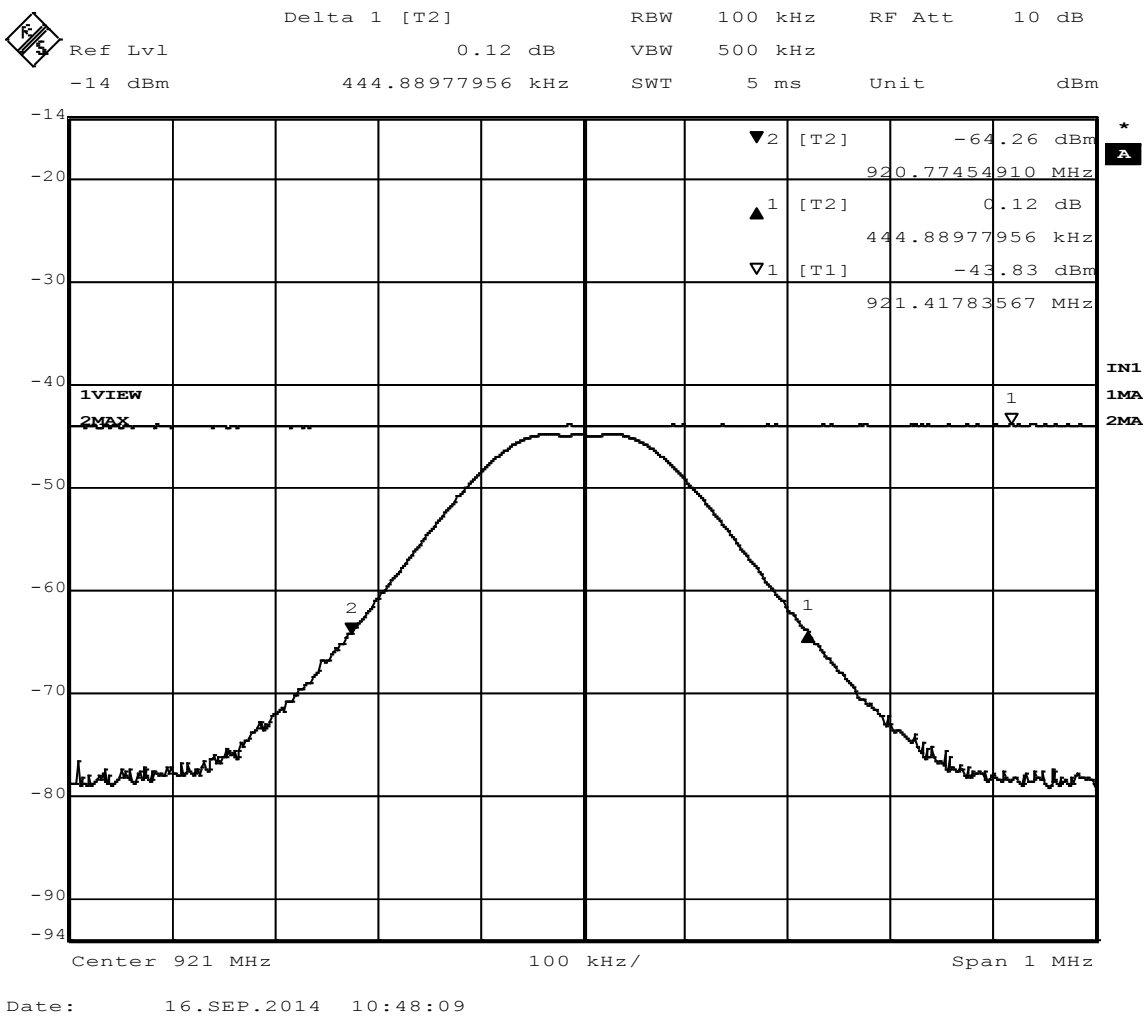

Figure 15 - 99% Occupied Bandwidth, High Channel

The plot shows an uncorrected measurement.

Maximum power = -43.83 dBm + 107 + CL + AF - 95.23 = -3.86 dBm

CF = cable loss = 4.50 dB
AF = antenna factor = 23.70 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.

EUT MODULE	Trim Board	MODE	Cont. Transmit
INPUT POWER	24 VDC Battery	FREQUENCY RANGE	902-928 MHz
ENVIRONMENTAL CONDITIONS	26 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

CHANNEL	CHANNEL FREQUENCY (MHz)	99% Occupied BW (kHz)
1	915	438.87
2	918	434.86
3	921	436.87

REMARKS:
None

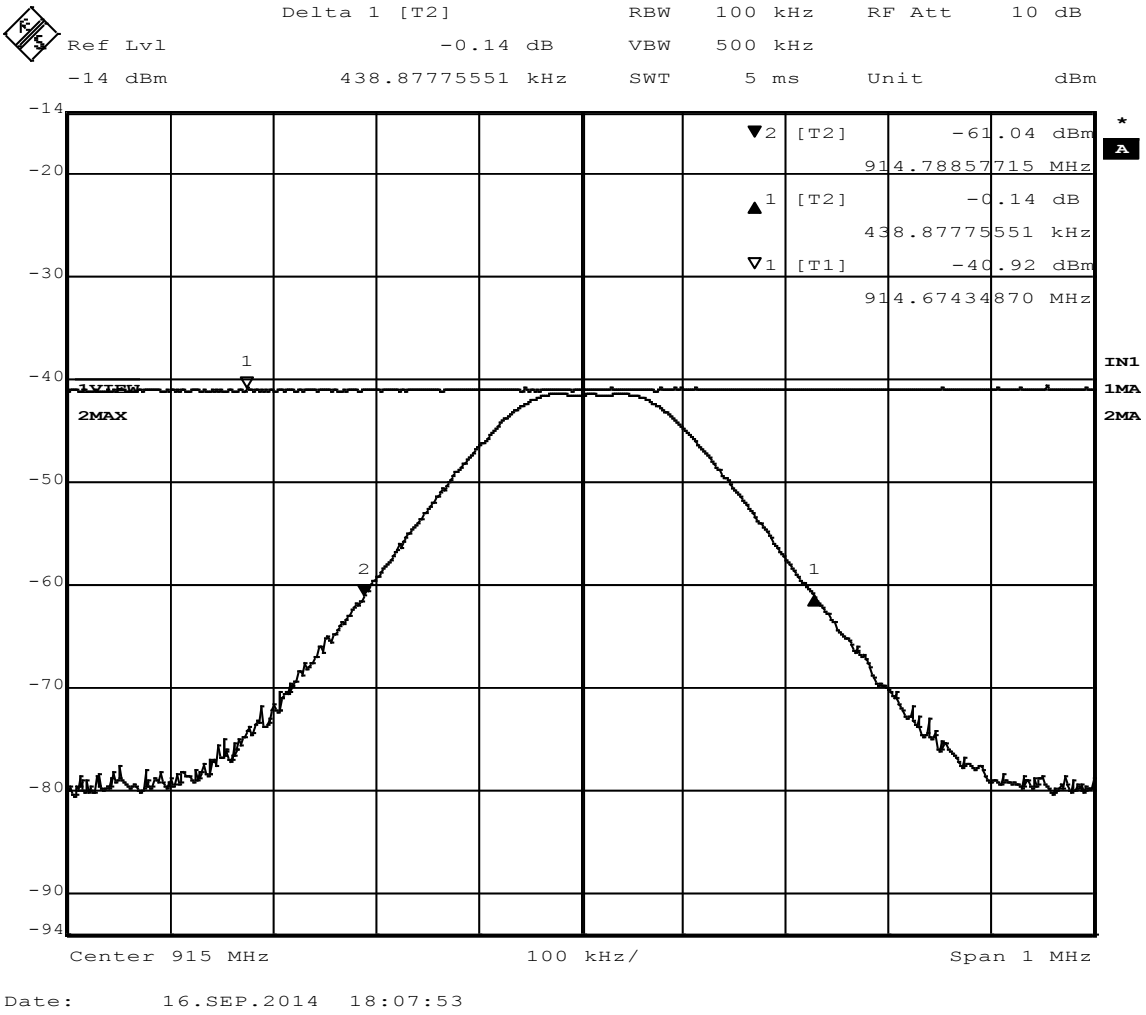

Figure 16 - 99% Occupied Bandwidth, Low Channel
The plot shows an uncorrected measurement.

Maximum power = -40.92 dBm + 107 + CL + AF - 95.23 = -0.95 dBm

CF = cable loss = 4.50 dB
AF = antenna factor = 23.70 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.

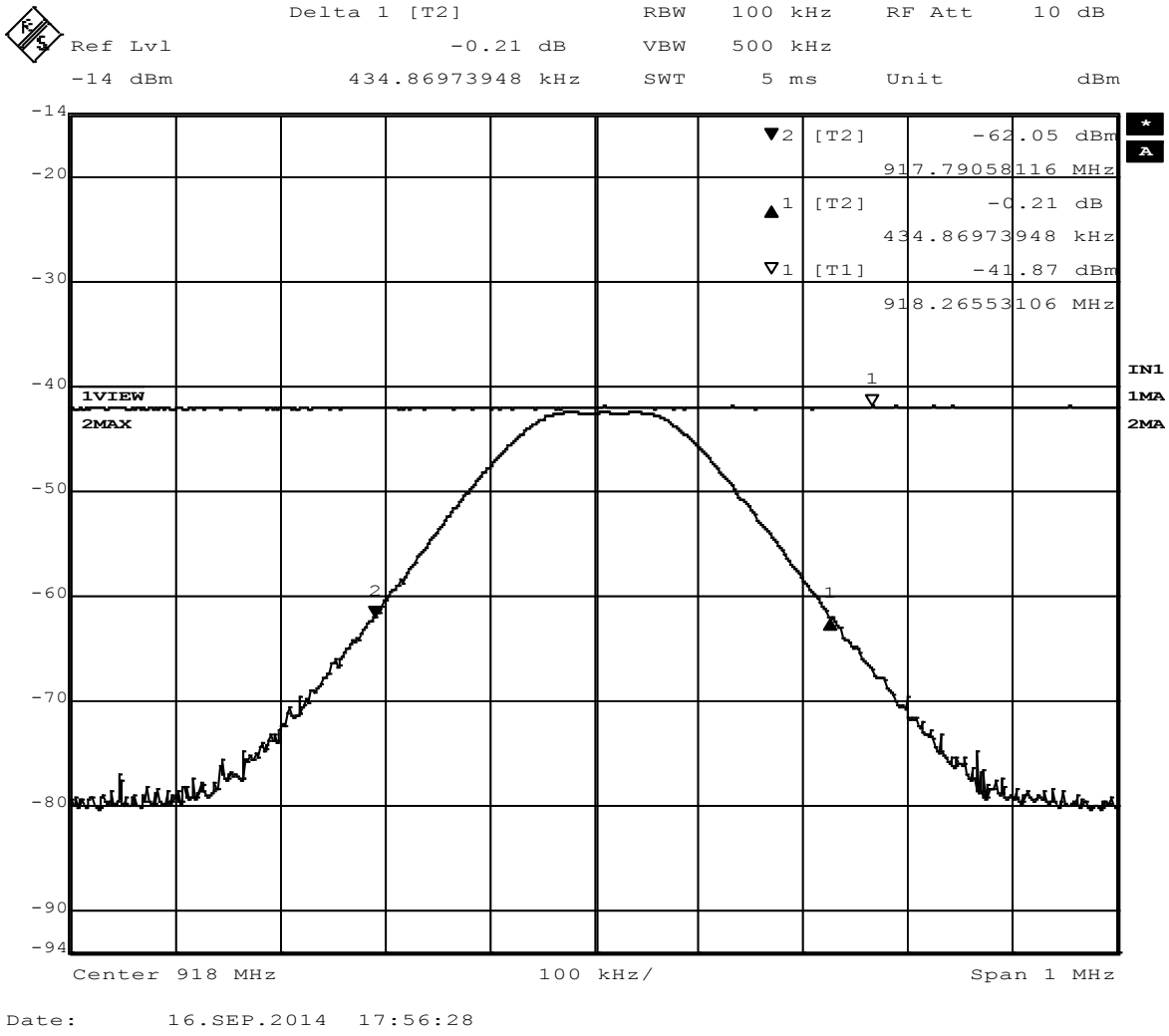

Figure 17 - 99% Occupied Bandwidth, Mid Channel

The plot shows an uncorrected measurement.

Maximum power = -41.87 dBm + 107 + CL + AF - 95.23 = -1.90 dBm

CF = cable loss = 4.50 dB
AF = antenna factor = 23.70 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.

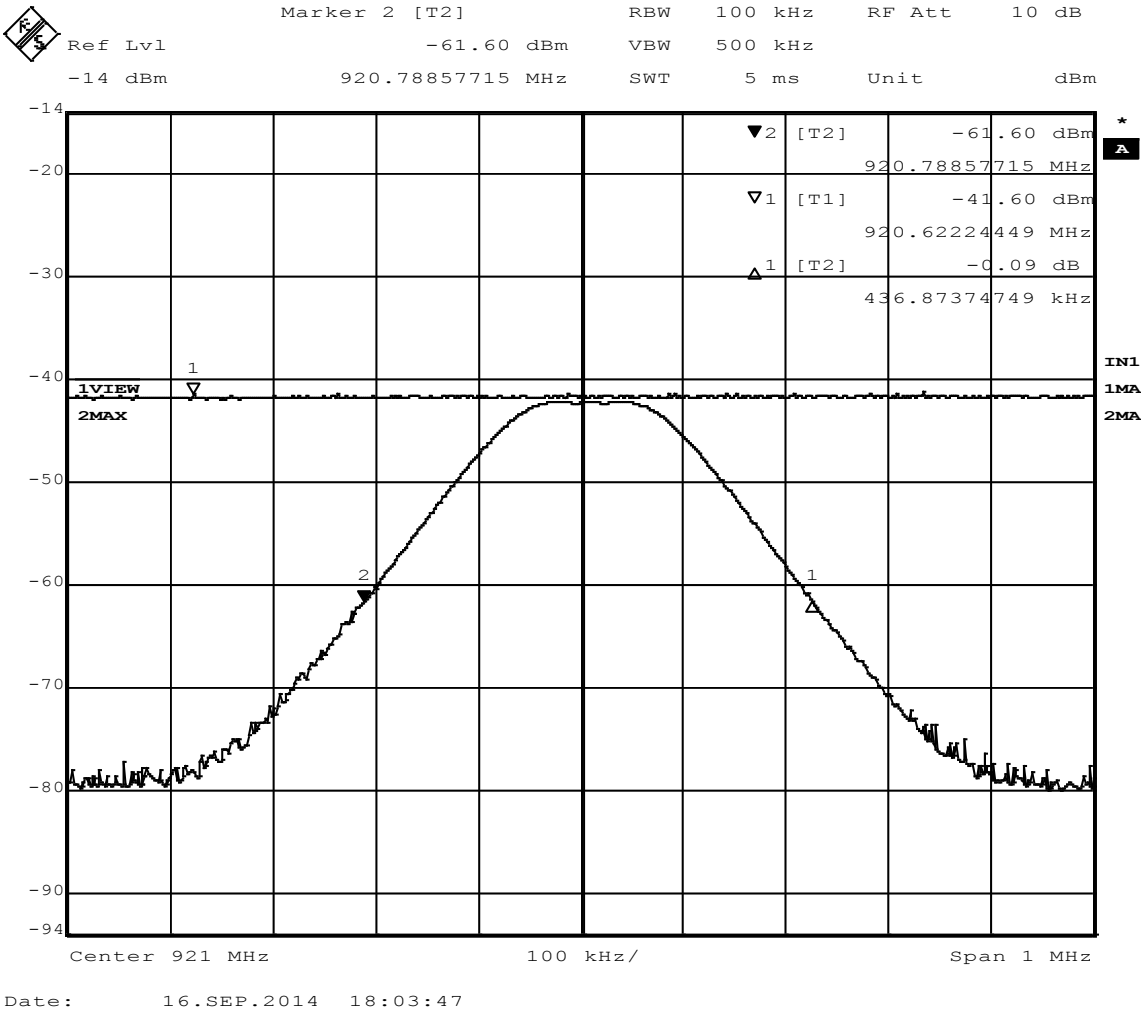

Figure 18 - 99% Occupied Bandwidth, High Channel
The plot shows an uncorrected measurement.

Maximum power = -41.60 dBm + 107 + CL + AF - 95.23 = -1.63 dBm

CF = cable loss = 4.50 dB
AF = antenna factor = 23.70 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.

4.4 Maximum peak output power

4.4.1 Limits of power measurements

The maximum peak output power allowed is 30dBm (1000mW).

4.4.2 Test procedures

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

2. 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.

3. See Annex B for an example of how the EIRP is calculated in order to report maximum power output.

4.4.3 Deviations from test standard

No deviation.

4.4.4 Test setup

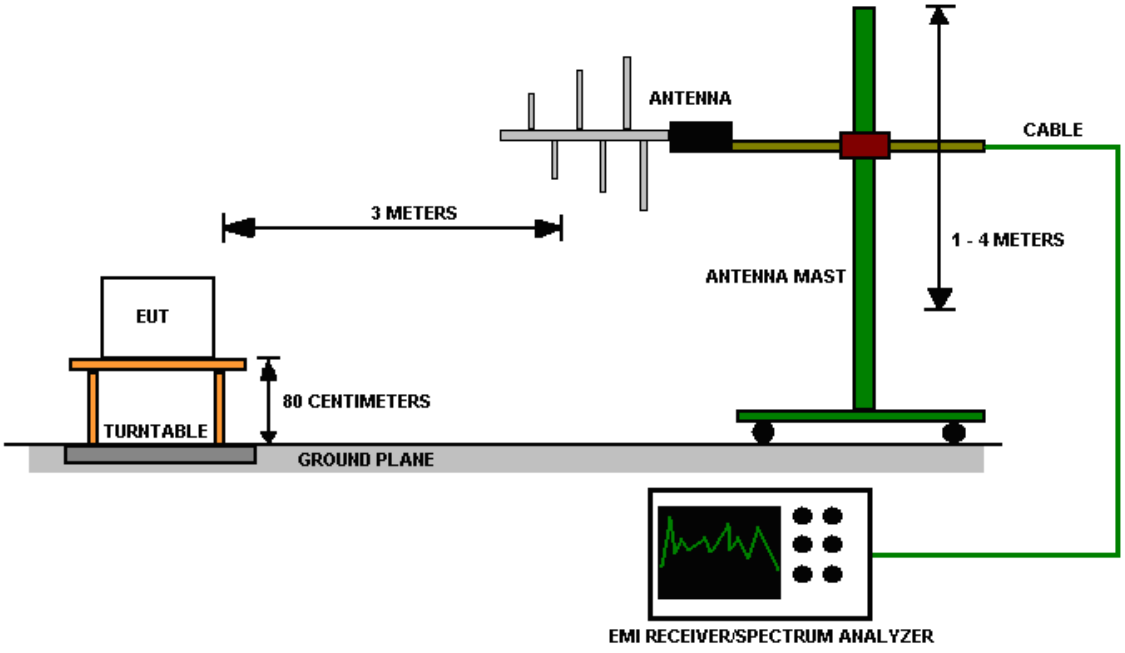

Figure 19 - Power Measurements Test Setup

4.4.5 EUT operating conditions

a 24 VDC battery supply and set to transmit continuously unless specified on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

4.4.6 Test results

EUT MODULE	Main Board	MODE	Cont. Transmit
INPUT POWER	24 VDC Battery	FREQUENCY RANGE	902-928 MHz
ENVIRONMENTAL CONDITIONS	26 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

Maximum peak output power

CHANNEL	CHANNEL FREQUENCY (MHz)	EIRP PEAK POWER OUTPUT (dBm)	PEAK POWER LIMIT (dBm)	RESULT
1	915	-4.22	30	PASS
2	918	-4.22	30	PASS
3	921	-3.86	30	PASS

All measurements were taken from the 99% occupied bandwidth screen captures in Section 4.3.

REMARKS:
None

EUT MODULE	Trim Board	MODE	Cont. Transmit
INPUT POWER	24 VDC Battery	FREQUENCY RANGE	902-928 MHz
ENVIRONMENTAL CONDITIONS	26 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

Maximum peak output power

CHANNEL	CHANNEL FREQUENCY (MHz)	EIRP PEAK POWER OUTPUT (dBm)	PEAK POWER LIMIT (dBm)	RESULT
1	915	-0.95	30	PASS
2	918	-1.90	30	PASS
3	921	-1.63	30	PASS

All measurements were taken from the 99% occupied bandwidth screen captures in Section 4.3.

REMARKS:
None

4.5 Bandedges

4.5.1 Limits of bandedge measurements

For emissions outside of the allowed band of operation (902MHz – 928MHz), the emission level needs to be meet the field strength levels need to be under that of the limits in 15.209.

4.5.2 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 120kHz 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. 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. If the out of band emission falls with a restricted band from 15.205, then it is required that the emission be below the limits from 15.209.

4.5.3 Deviations from test standard

No deviation.

4.5.4 Test setup

See Section 4.4

4.5.5 EUT operating conditions

The EUT was powered by a 24 VDC battery supply unless specified and set to transmit continuously on the lowest frequency channel and the highest frequency channel.

4.5.6 Test results

EUT MODULE	Main Board	MODE	Cont. Transmit
INPUT POWER	24 VDC Battery	FREQUENCY RANGE	902-928 MHz
ENVIRONMENTAL CONDITIONS	26 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

Highest Out of Band Emissions

CHANNEL	Bandedge/Measurement Frequency (MHz)	Level (dBm)	Fund. Level (dBm)	Delta
1	902 MHz	-73.79	-15.2	58.59
3	928 MHz	-74.42	-15.94	58.48

EUT MODULE	Trim Board	MODE	Cont. Transmit
INPUT POWER	24 VDC Battery	FREQUENCY RANGE	902-928 MHz
ENVIRONMENTAL CONDITIONS	26 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

Highest Out of Band Emissions

CHANNEL	Bandedge/Measurement Frequency (MHz)	Level (dBm)	Fund. Level (dBm)	Delta
1	902 MHz	-74.45	-16.54	57.91
3	928 MHz	-73.52	-15.47	58.05

Appendix A: Test Photos

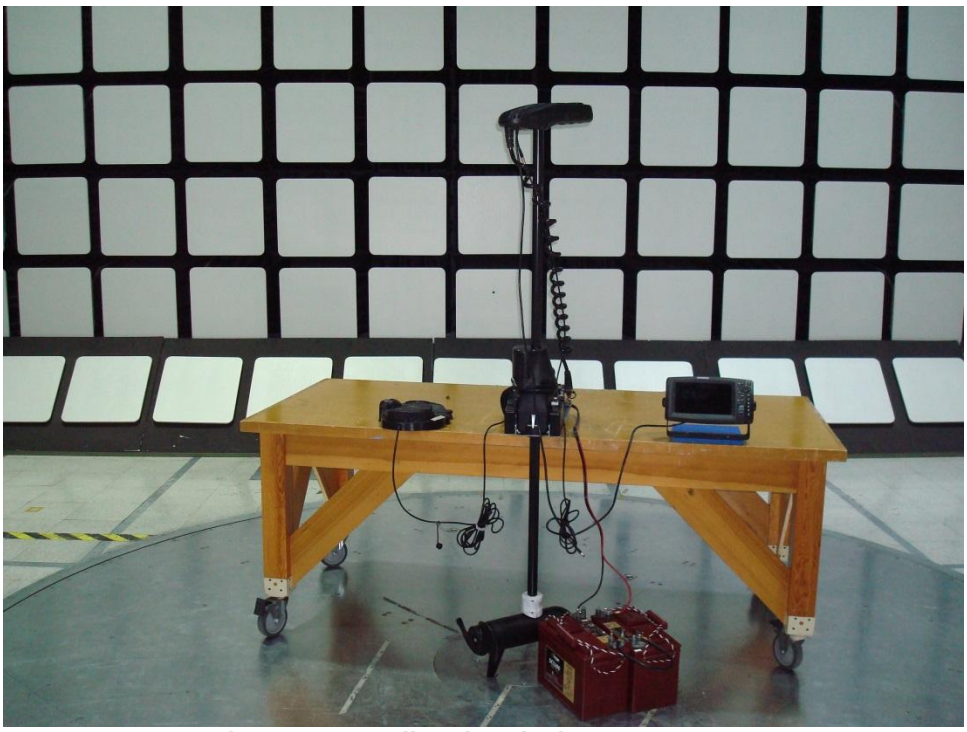

Figure 20 – Radiated Emissions Test Setup

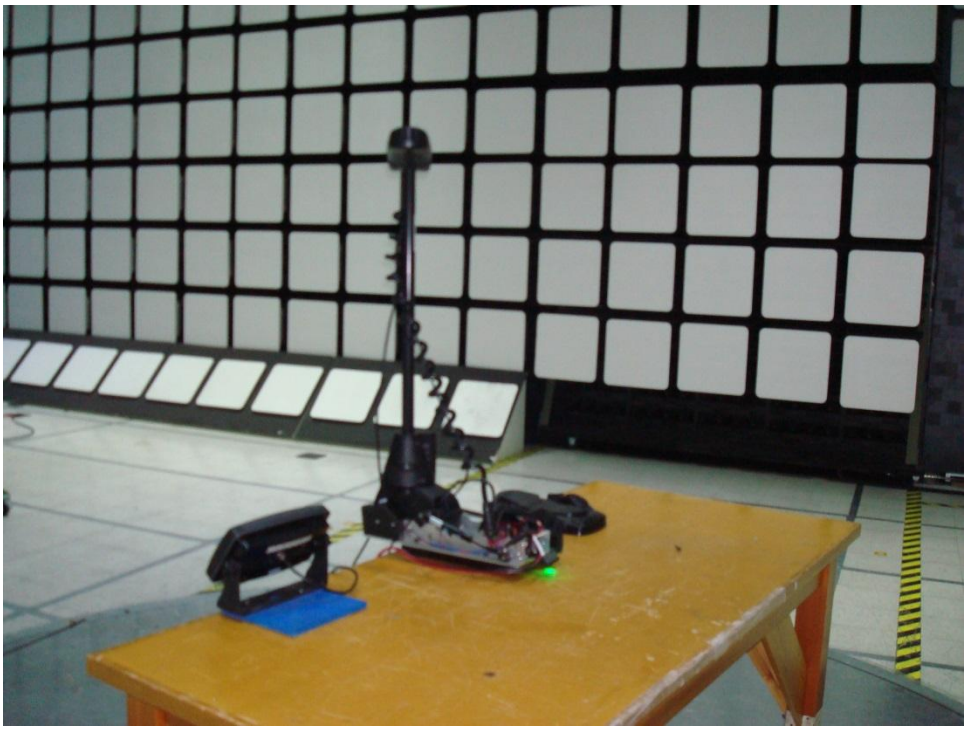

Figure 21 - Radiated Emissions Test Setup

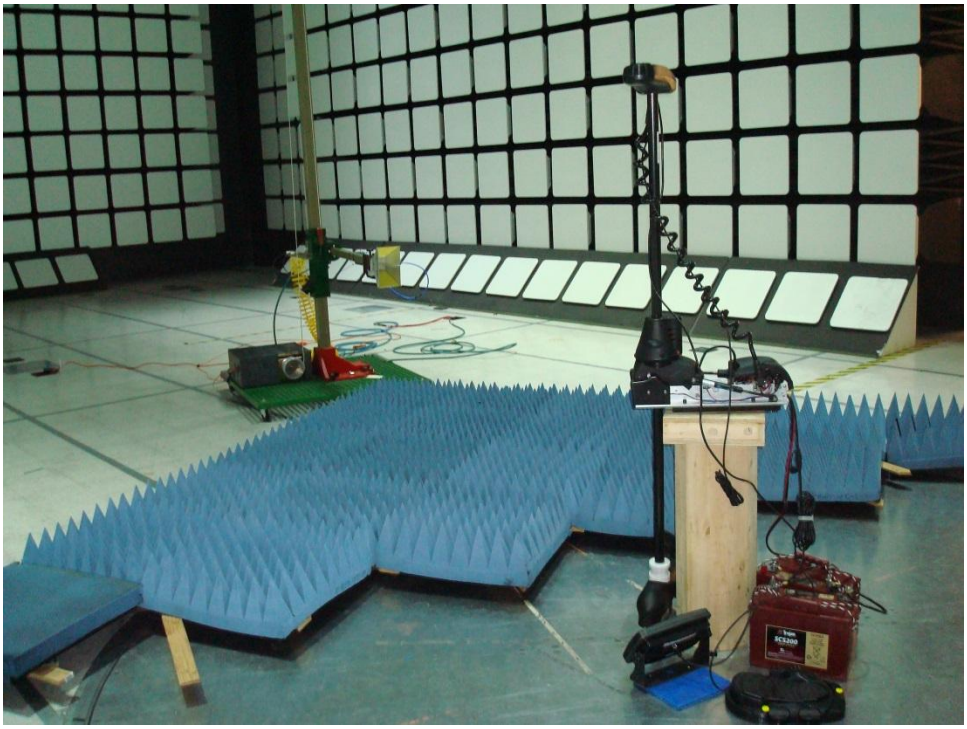

Figure 22 - Radiated Emissions Test Setup

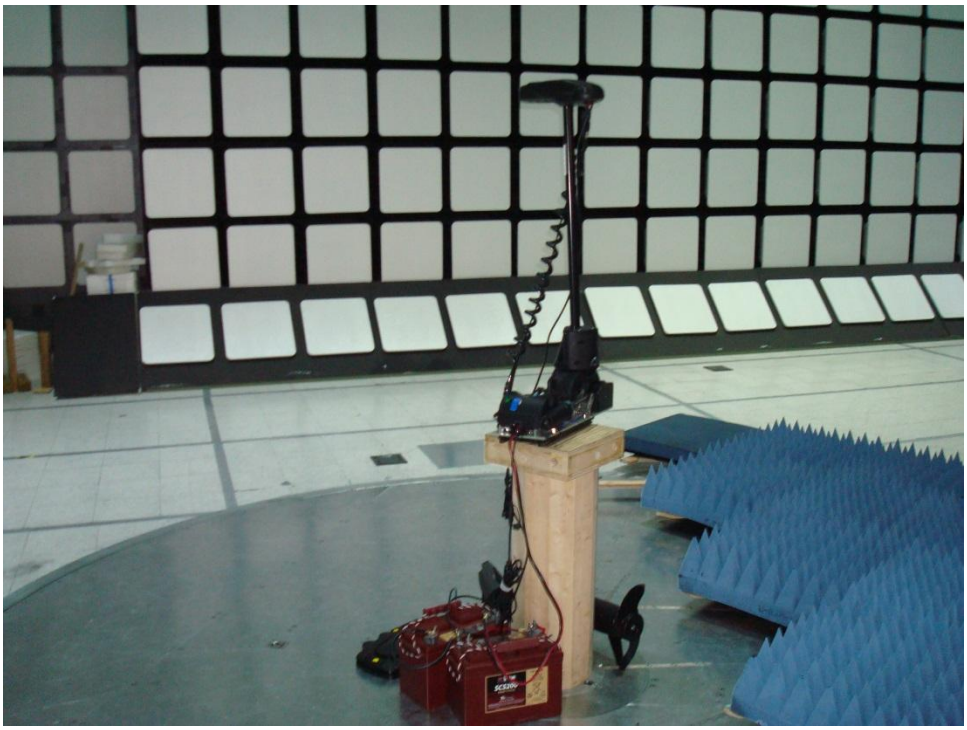

Figure 23 - Radiated Emissions Test Setup

Appendix B: 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 Stregnth (V/m) x antenna distance (m)]^2 / [30 x Gain (numeric)]

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

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

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

Gain = 1 (numeric gain for isotropic radiator

For an antenna distance of 3m and a numeric antenna gain of zero,

EIRP (dBm) = FS (dBµV/m) – 95.23

Table 26 – Correction Factor Applied in Sections 4.3, 4.4 and 4.6

CHANNEL	CHANNEL FREQUENCY (MHz)	ANTENNA FACTOR	CABLE LOSS
1	915	23.70	4.50
2	918	23.70	4.50
3	921	23.70	4.50

Appendix C: Table of Figures

Figure Number **Page**

Table Number **Page**