



DATE: 15 February 2017

I.T.L. (PRODUCT TESTING) LTD.
FCC Radio Test Report
For

Aquatron Robotic Systems Ltd.

Equipment under test:

Aquabot

AQ21071W100

Tested by:

M. Zohar

Approved by:

D. Shidowsky

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This report relates only to items tested.



Measurement/Technical Report for Aquatron Robotic Systems Ltd.

Aquabot

AQ21071W100

FCC ID: VQBAQ21071W100

This report concerns:	Original Grant: <input checked="" type="checkbox"/> X
	Class I Change: <input type="checkbox"/>
	Class II Change: <input type="checkbox"/>
Equipment type:	Digital Transmission System
Limits used:	47CFR15 Section 15.247
Measurement procedure used is KDB 558074 D01 DTS Meas Guidance v03r05 and ANSI C63. 10-2013.	
Application for Certification prepared by:	Applicant for this device: (different from "prepared by")
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TABLE OF CONTENTS

1. GENERAL INFORMATION -----	5
1.1 Administrative Information.....	5
1.2 List of Accreditations	6
1.3 Product Description	7
1.4 Test Methodology.....	7
1.5 Test Facility	7
1.6 Measurement Uncertainty	7
2. SYSTEM TEST CONFIGURATION-----	8
2.1 Justification.....	8
2.2 EUT Exercise Software	8
2.3 Special Accessories	8
2.4 Equipment Modifications	8
2.5 Configuration of Tested System	8
3. TEST SET-UP PHOTOS-----	9
4. CONDUCTED EMISSION FROM AC MAINS-----	12
4.1 Test Specification	12
4.2 Test Procedure	12
4.3 Test Limit.....	12
4.4 Test Results.....	13
4.5 Test Equipment Used; Conducted Emission.....	18
5. 6 DB MINIMUM BANDWIDTH -----	19
5.1 Test Specification	19
5.2 Test Procedure	19
5.3 Test Limit.....	19
5.4 Test Results.....	19
5.5 Test Equipment Used; 6dB Bandwidth	21
6. MAXIMUM TRANSMITTED PEAK POWER OUTPUT -----	22
6.1 Test Specification	22
6.2 Test Procedure	22
6.3 Test Limit.....	22
6.4 Test Results.....	23
6.5 Test Equipment Used; Maximum Peak Power Output.....	27
7. BAND EDGE SPECTRUM -----	28
7.1 Test Specification	28
7.2 Test Procedure	28
7.3 Test Limit.....	28
7.4 Test Results.....	28
7.5 Test Equipment Used; Band Edge Spectrum	30
8. EMISSIONS IN NON-RESTRICTED FREQUENCY BANDS -----	31
8.1 Test Specification	31
8.2 Test Procedure	31
8.3 Test Limit.....	31
8.4 Test Results.....	32
8.5 Test Instrumentation Used, Emission in Non Restricted Frequency Bands ..	33
8.6 Field Strength Calculation	34
9. EMISSIONS IN RESTRICTED FREQUENCY BANDS -----	35
9.1 Test Specification	35
9.2 Test Procedure	35
9.3 Test Limit.....	36
9.4 Test Results.....	36
9.5 Test Instrumentation Used; Emissions in Restricted Frequency Bands	39



10. TRANSMITTED POWER DENSITY -----	40
10.1 Test Specification	40
10.2 Test Procedure	40
10.3 Test Limit.....	40
10.4 Test Results.....	41
10.5 Test Equipment Used; Transmitted Power Density	43
11. ANTENNA GAIN/INFORMATION-----	44
12. R.F EXPOSURE/SAFETY-----	45
13. APPENDIX A - CORRECTION FACTORS -----	46
13.1 Correction factors for RF OATS Cable 35m.....	46
13.2 Correction factors for RF OATS Cable 10m.....	46
13.3 Correction factors for ACTIVE LOOP ANTENNA ITL # 1075:	47
13.4 Correction factors for biconical antenna – ITL # 1356	48
13.5 Correction factors for log periodic antenna – ITL # 1349.....	49
13.6 Correction factors for Horn ANTENNA.....	50
13.7 Correction factors for Horn Antenna	51
13.8 Correction factor for RF CABLE for Semi Anechoic Chamber.....	52



1. General Information

1.1 ***Administrative Information***

Manufacturer: Aquatron Robotic Systems Ltd.

Manufacturer's Address: P.O. Box 1088
Alon Tavor Industrial Zone
Afula Elite 18550
Israel

Manufacturer's Representative: Benny Attar

Equipment Under Test (E.U.T): Aquabot

Equipment Model No.: AQ21071W100

Equipment Serial No.: Not designated

Date of Receipt of E.U.T: September 27, 2016

Start of Test: September 27, 2016
February 8, 2017*

End of Test: 15 November 2016
February 8, 2017*

Test Laboratory Location: I.T.L (Product Testing) Ltd.
1 Batsheva St.,
Lod
ISRAEL 7120101

Test Specifications: FCC Part 15, Subpart C, Section
15.247

*- Testing of Emissions in Restricted and Non-Restricted Frequency Bands for the 9kHz – 30MHz range was performed on February 8, 2017.



1.2 *List of Accreditations*

The EMC laboratory of I.T.L. is accredited by the following bodies:

1. The American Association for Laboratory Accreditation (A2LA) (U.S.A.), Certificate No. 1152.01.
2. The Federal Communications Commission (FCC) (U.S.A.), FCC Designation No. IL1005.
3. The Israel Ministry of the Environment (Israel), Registration No. 1104/01.
4. The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) (Japan), Registration Numbers: C-3006, R-2729, T-1877, G-245.
5. Industry Canada (Canada), IC File No.: 46405-4025; Site Nos. IC 4025A-1, IC 4025A-2.

I.T.L. Product Testing Ltd. is accredited by the American Association for Laboratory Accreditation (A2LA) and the results shown in this test report have been determined in accordance with I.T.L.'s terms of accreditation unless stated otherwise in the report.



1.3 **Product Description**

The EUT is a power and control unit for robotic pool cleaner. It operates on 29VDC output with a bluetooth remote control.

Model name	AQ21071W100
Working voltage	100-264VAC
Mode of operation	Transceiver
Modulations	BLE
Assigned Frequency Range	2400.0-2483.5MHz
Operating Frequency Range	2402MHz-2480MHz
Transmit power	~-1.4 dBm
Antenna Gain	5.3dBi
Modulation BW	~ 700MHz

1.4 **Test Methodology**

Both conducted and radiated testing was performed according to the procedures in KDB 558074 D01 DTS Meas Guidance v03r05 and ANSI C63. 10-2013. Radiated testing was performed at an antenna to EUT distance of 3 meters.

1.5 **Test Facility**

Emissions tests were performed at I.T.L.'s testing facility in Lod, Israel. I.T.L.'s EMC Laboratory is accredited by A2LA, certificate No. 1152.01 and its FCC Designation Number is IL1005.

1.6 **Measurement Uncertainty**

Conducted Emission

(CISPR 11, EN 55011, CISPR 22, EN 55022, ANSI C63.4)

0.15 – 30 MHz:

Expanded Uncertainty (95% Confidence, K=2):

± 3.44 dB

Radiated Emission

Radiated Emission (CISPR 11, EN 55011, CISPR 22, EN 55022, ANSI C63.4) for open site 30-1000MHz:

Expanded Uncertainty (95% Confidence, K=2):

± 4.98 dB

2. System Test Configuration

2.1 Justification

The unit was evaluated while transmitting at the low channel (2402MHz), the mid channel (2440MHz) and the high channel (2480MHz) in BLE technology.

Testing was performed in typical operation installation position. The evaluation was done with dummy load termination for simulation of the robotic swimming pool device (which only works in water).

2.2 EUT Exercise Software

No special exercise software was used.

2.3 Special Accessories

No special accessories were needed to achieve compliance.

2.4 Equipment Modifications

No modifications were necessary in order to achieve compliance.

2.5 Configuration of Tested System

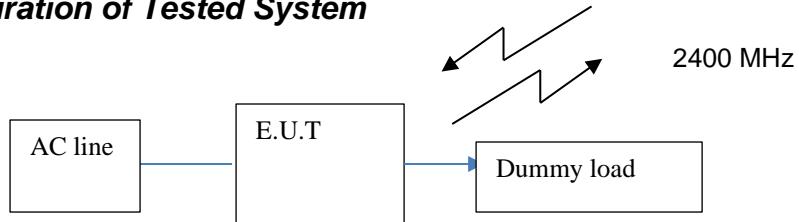


Figure 1. Configuration of Tested System

3. Test Set-Up Photos



Figure 2. Power Lines Conducted Emission Test

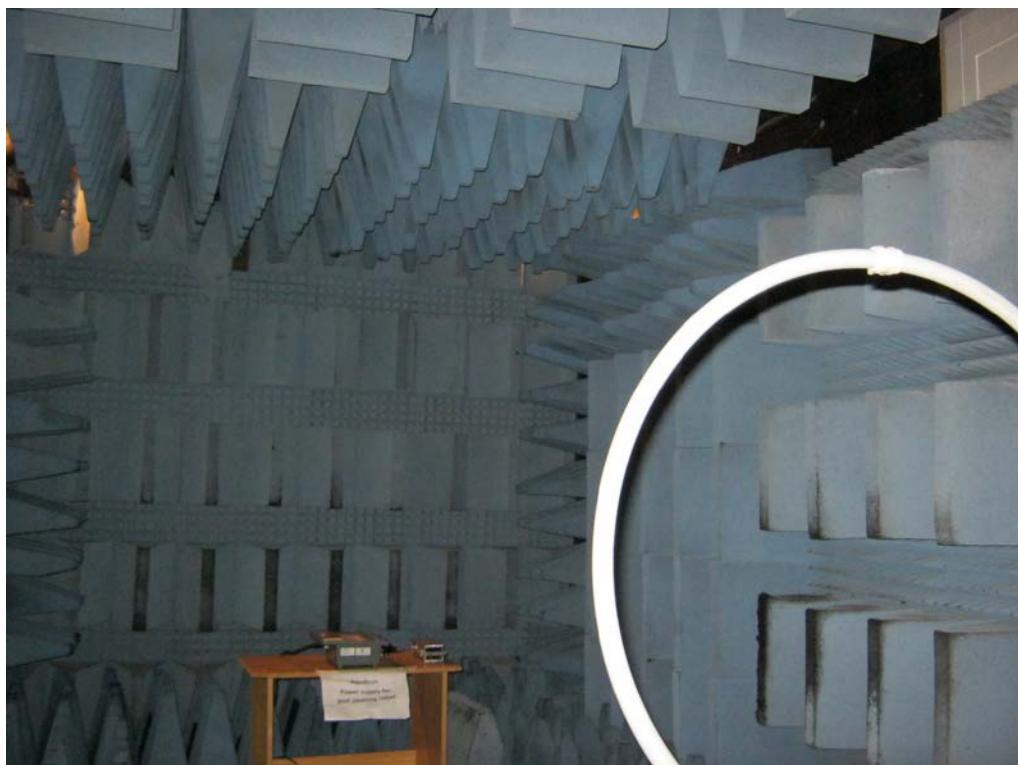


Figure 3. Radiated Emission Test



Figure 4. Radiated Emission Test



Figure 5. Radiated Emission Test

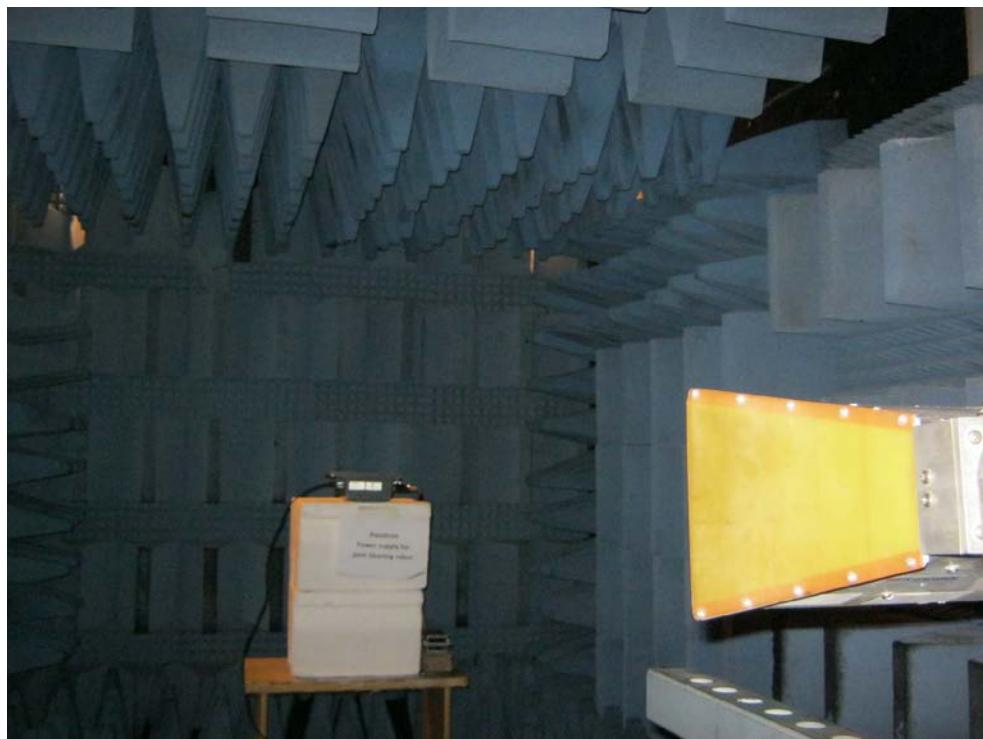


Figure 6. Radiated Emission Test



Figure 7. Radiated Emission Test

4. Conducted Emission From AC Mains

4.1 Test Specification

FCC Part 15, Subpart C, Section 15.207

4.2 Test Procedure

Temperature (22°C)/ Humidity (65%RH)

The E.U.T operation mode and test setup are as described in Section 2 of this report. In order to minimize background noise interference, the conducted emission testing was performed inside a shielded room, with the E.U.T placed on a 0.8 meter high wooden table, 0.4 meter from the room's vertical wall. In the case of a floor-standing E.U.T., it was placed on the horizontal ground plane.

The E.U.T was powered from 115 V AC / 60 Hz via 50 Ohm / 50 μ Hn Line Impedance Stabilization Network (LISN) on the phase and neutral lines. The LISN's were grounded to the shielded room ground plane (floor), and were kept at least 0.8 meters from the nearest boundary of the E.U.T

The center of the E.U.T.'s AC cable was folded back and forth, in order to form a bundle less than 0.40 meters and a total cable length of 1 meter.

The effect of varying the position of the cables was investigated to find the configuration that produces maximum emission. The configuration tested is shown in the photograph, *Figure 2. Power Lines Conducted Emission Test*

The emission voltages at the LISN's outputs were measured using a computerized receiver, complying with CISPR 16 requirements. The specification limits are loaded to the receiver and are displayed on the receiver's spectrum display.

The E.U.T was evaluated in TX operation mode

A frequency scan between 0.15 and 30 MHz was performed at 9 kHz I.F. band width, using peak detection.

The spectral components having the highest level on each line were measured using a quasi-peak and average detector.

4.3 Test Limit

Frequency of emission (MHz)	Conducted limit (dB μ V)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.



4.4 **Test Results**

JUDGEMENT: Passed by 2.6 dB

The margin between the emission levels and the specification limit is, in the worst case, 2.6 dB for the phase line at 12.66 MHz and 2.7 dB at 9.64 MHz for the neutral line.

The EUT met the F.C.C. Part 15, Subpart C specification requirements.

The details of the highest emissions are given in *Figure 8* to *Figure 11*.



Conducted Emission

E.U.T Description Aquabot
Type AQ21071W100
Serial Number: Not designated

Specification: FCC Part 15, Subpart C
Lead: Phase
Detectors: : Peak, Quasi-peak, Average

EDIT PEAK LIST (Final Measurement Results)				
Trace1:	CE22BQP	Trace2:	CE22BAP	Trace3:

TRACE	FREQUENCY	LEVEL dB μ V	DELTA	LIMIT dB
1	Quasi Peak 230 kHz	44.48	-17.96	
2	Average 230 kHz	43.51	-8.93	
1	Quasi Peak 338 kHz	46.45	-12.80	
2	Average 342 kHz	43.13	-6.01	
1	Quasi Peak 566 kHz	42.61	-13.38	
2	Average 570 kHz	35.72	-10.27	
2	Average 1.026 MHz	34.69	-11.30	
1	Quasi Peak 1.03 MHz	41.67	-14.32	
1	Quasi Peak 1.51 MHz	42.88	-13.12	
2	Average 1.51 MHz	35.69	-10.30	
2	Average 2.902 MHz	33.12	-12.87	
1	Quasi Peak 3.554 MHz	44.45	-11.54	
2	Average 4.758 MHz	38.16	-7.83	
1	Quasi Peak 4.962 MHz	49.21	-6.78	
1	Quasi Peak 10.314 MHz	56.07	-3.92	
2	Average 10.322 MHz	44.33	-5.66	
2	Average 11.258 MHz	45.68	-4.31	
1	Quasi Peak 12.658 MHz	57.37	-2.62	
2	Average 18.698 MHz	44.60	-5.39	
1	Quasi Peak 19.502 MHz	53.63	-6.36	

Date: 9.OCT.2016 16:27:56

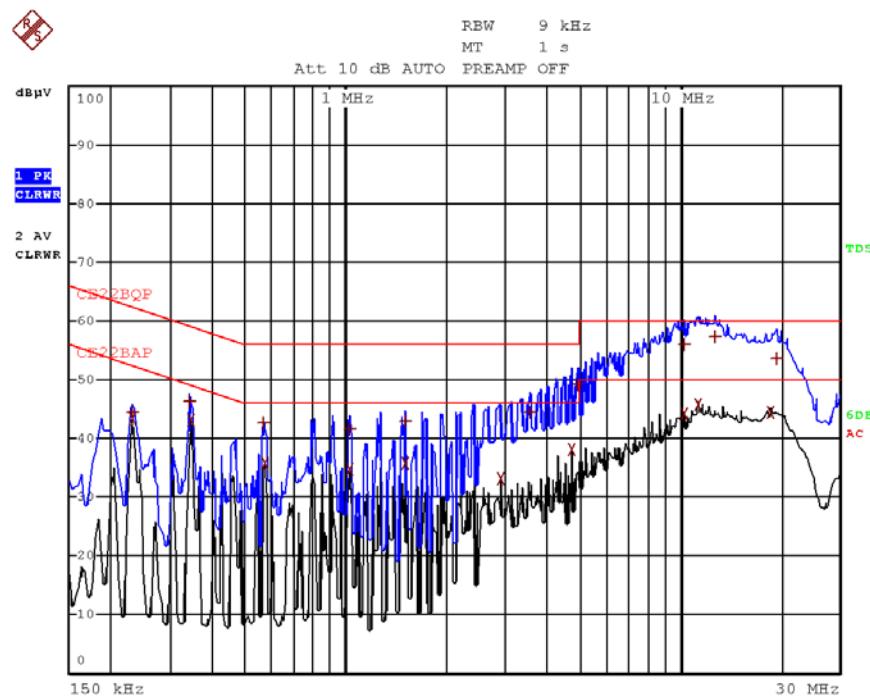
Figure 8. Detectors: Peak, Quasi-peak, Average

Note: *QP Delta/Av Delta refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.*

Conducted Emission

E.U.T Description Aquabot
Type AQ21071W100
Serial Number: Not designated

Specification: FCC Part 15, Subpart C
Lead: Phase
Detectors: Peak, Quasi-peak, Average



Date: 9.OCT.2016 16:26:31

Figure 9. Detectors: Peak, Quasi-peak, Average



Conducted Emission

E.U.T Description Aquabot
Type AQ21071W100
Serial Number: Not designated

Specification: FCC Part 15, Subpart C
Lead: Neutral
Detectors: Peak, Quasi-peak, Average

EDIT PEAK LIST (Final Measurement Results)				
Trace1:	CE22BQP			
Trace2:	CE22BAP			
Trace3:	---			
TRACE	FREQUENCY	LEVEL dB μ V	DELTA	LIMIT dB
2 Average	230 kHz	43.20	-9.24	
1 Quasi Peak	234 kHz	43.02	-19.28	
2 Average	346 kHz	45.78	-3.27	
1 Quasi Peak	350 kHz	48.19	-10.77	
1 Quasi Peak	578 kHz	45.66	-10.33	
2 Average	578 kHz	39.37	-6.62	
1 Quasi Peak	802 kHz	44.15	-11.84	
2 Average	810 kHz	37.32	-8.67	
1 Quasi Peak	1.51 MHz	46.24	-9.75	
2 Average	1.51 MHz	37.58	-8.41	
2 Average	2.902 MHz	34.72	-11.27	
1 Quasi Peak	3.598 MHz	48.35	-7.64	
2 Average	4.758 MHz	38.45	-7.54	
1 Quasi Peak	4.994 MHz	51.69	-4.30	
2 Average	8.71 MHz	43.49	-6.50	
1 Quasi Peak	9.638 MHz	57.30	-2.69	
1 Quasi Peak	11.258 MHz	56.53	-3.46	
2 Average	11.726 MHz	45.60	-4.39	
1 Quasi Peak	19.098 MHz	52.79	-7.20	
2 Average	19.23 MHz	43.45	-6.54	

Date: 9.OCT.2016 16:37:23

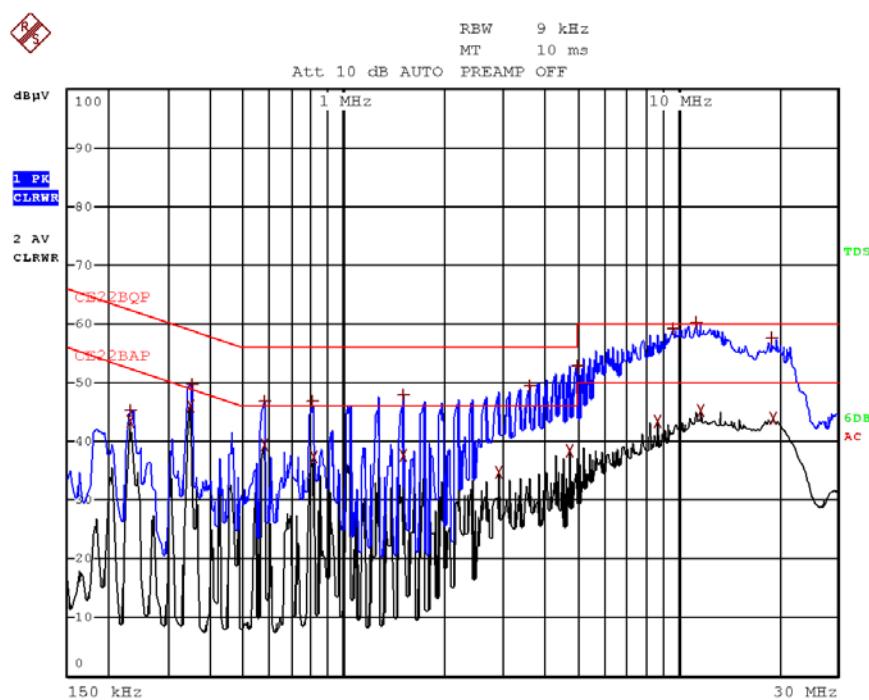
Figure 10. Detectors: Peak, Quasi-peak, Average

Note: *QP Delta/Av Delta refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.*

Conducted Emission

E.U.T Description Aquabot
Type AQ21071W100
Serial Number: Not designated

Specification: FCC Part 15, Subpart C
Lead: Neutral
Detectors: Peak, Quasi-peak, Average



Date: 9.OCT.2016 16:35:45

Figure 11 Detectors: Peak, Quasi-peak, Average



4.5 **Test Equipment Used; Conducted Emission**

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
LISN	Fischer	FCC-LISN-25A	127	23. June 2016	23. June 2017
Transient Limiter	HP	11947A	3107A03041	15. June 2016	15. June 2017
EMI Receiver	Rohde & Schwarz	ESCI7	100724	29. February 2016	01. March 2017
Low Loss Cable	Huber Suner		705A009301 EIM	30. May 2016	30. May 2017

Figure 12 Test Equipment Used

5. 6 dB Minimum Bandwidth

5.1 Test Specification

FCC Part 15, Subpart C, Section 247(a)(2)

5.2 Test Procedure

(Temperature (22°C)/ Humidity (70%RH))

The E.U.T operation mode and test set-up are as described in Section 2 of this report.

The E.U.T was tested in the chamber, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 1.5 meters above the ground. The configuration tested is shown in *Figure 1*.

The spectrum bandwidth of the E.U.T. at the point of 6 dB below maximum peak power was measured and recorded. The RBW was set to 100 kHz.

5.3 Test Limit

Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

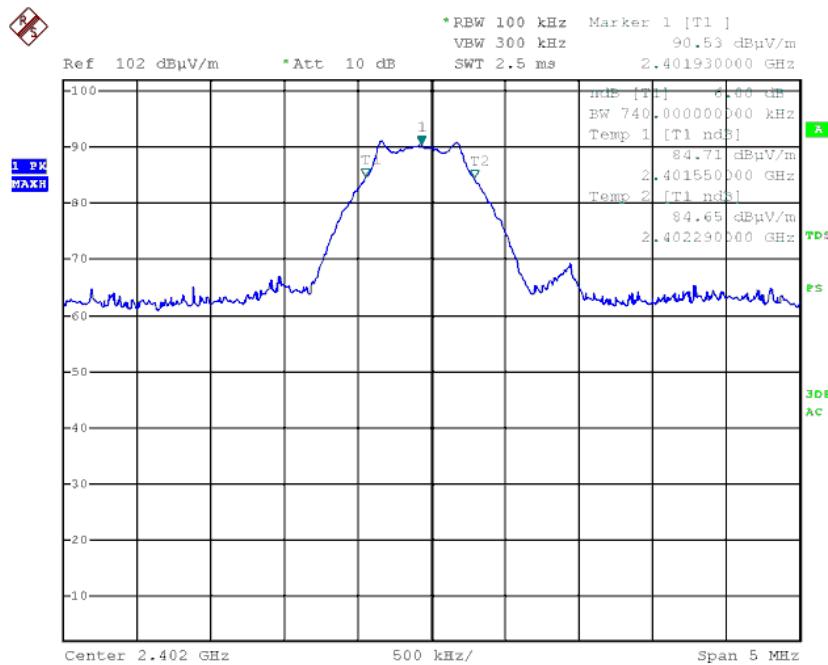
5.4 Test Results

Operation Frequency (MHz)	Reading (MHz)	Specification (MHz)
2402.0	0.7	≥0.5
2440.0	0.7	≥0.5
2480.0	0.7	≥0.5

Figure 13 6 dB Minimum Bandwidth

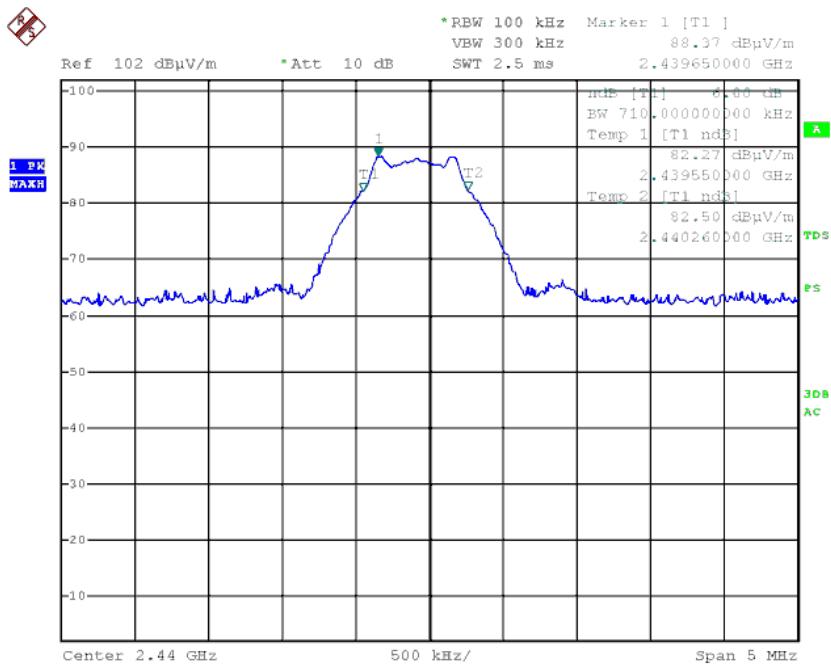
JUDGEMENT: Passed

For additional information see *Figure 14* to *Figure 16*.



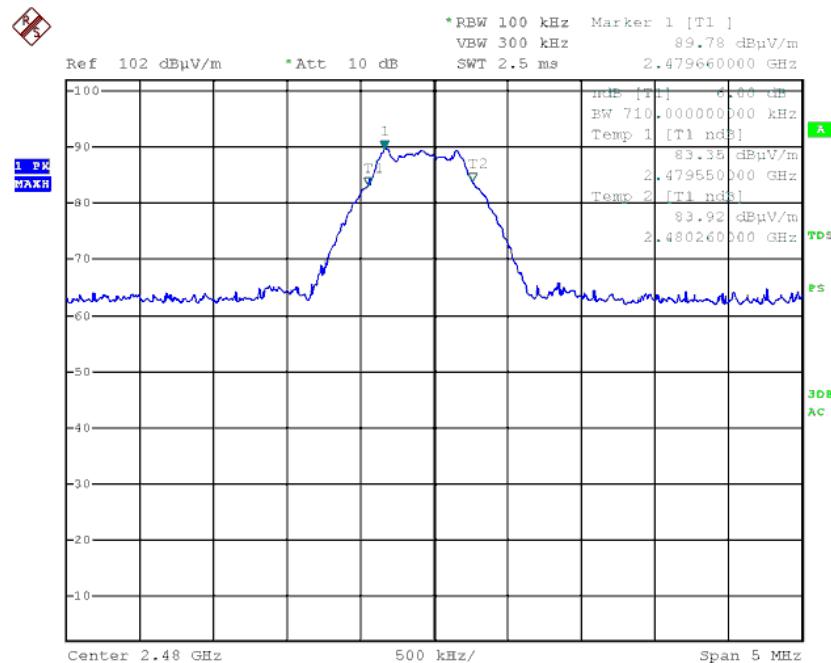
Date: 15.NOV.2016 14:27:33

Figure 14. 2402.0 MHz



Date: 15.NOV.2016 10:24:45

Figure 15. 2440.0 MHz



Date: 15.NOV.2016 10:02:46

Figure 16. 2480.0 MHz

5.5 *Test Equipment Used; 6dB Bandwidth*

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
Spectrum Analyzer	R&S	ESCI7		29. February 2016	01 March 2017
Horn Antenna	ETS	3115	6142	19. May 2015	19. May 2018
Semi Anechoic Civil Chamber	ETS	S81	SL 11643	NCR	NCR

Figure 17 Test Equipment Used



6. Maximum Transmitted Peak Power Output

6.1 Test Specification

FCC, Part 15, Subpart C, Section 247(b)(3)

6.2 Test Procedure

(Temperature (22°C)/ Humidity (70%RH))

The E.U.T operation mode and test set-up are as described in Section 2 of this report.

The E.U.T was tested in the chamber, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 1.5 meters above the ground. The configuration tested is shown in *Figure 2*.

The E.U.T was evaluated in 3 channels: low (2402.0 MHz), mid (2440.0 MHz) and high (2480 MHz).

Radiated output power levels were measured at selected operation frequencies and the results were converted to power level according to the formula as shown below:

$$P = \frac{(E_{V/m} \times d)^2}{(30 \times G)} \quad [W]$$

E - Field Strength (V/m)

d – Distance from transmitter (m)

G – Antenna gain

P – Peak power (W)

6.3 Test Limit

The maximum peak conducted output power of the intentional radiator for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.



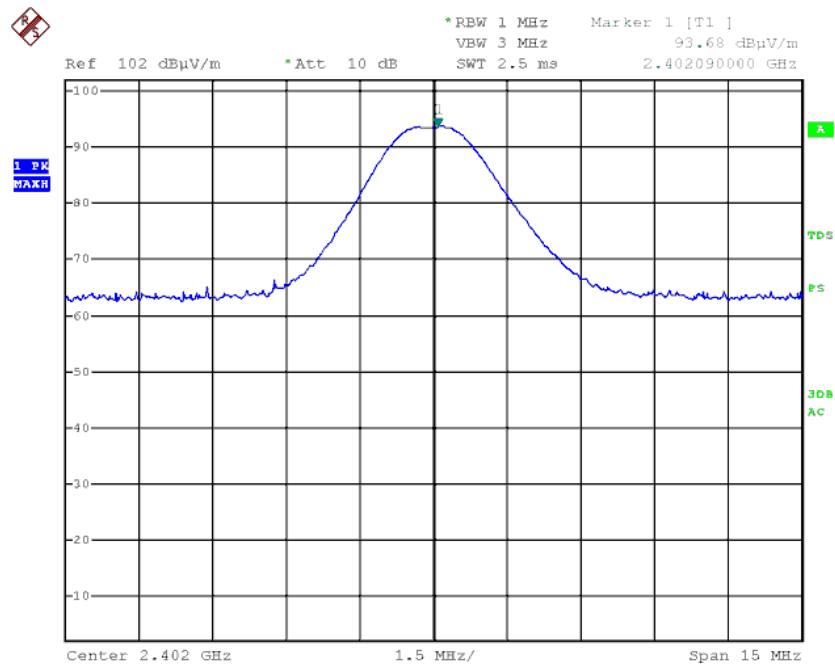
6.4 **Test Results**

Operation Frequency (MHz)	Polarization (V/H)	Power (dBuV/m)	Power (dBm)	Power (mW)	Specification (mW)	Margin
2402.0	V	93.7	-1.5	0.708	1000.0	-999.292
	H	89.3	-5.9	0.257	1000.0	-999.743
2440.0	V	93.8	-1.4	0.724	1000.0	-999.276
	H	88.1	-7.1	0.195	1000.0	-999.805
2480.0	V	91.4	-3.8	0.417	1000.0	-999.583
	H	88.1	-7.1	0.195	1000.0	-999.805

Figure 18 Maximum Peak Power Output

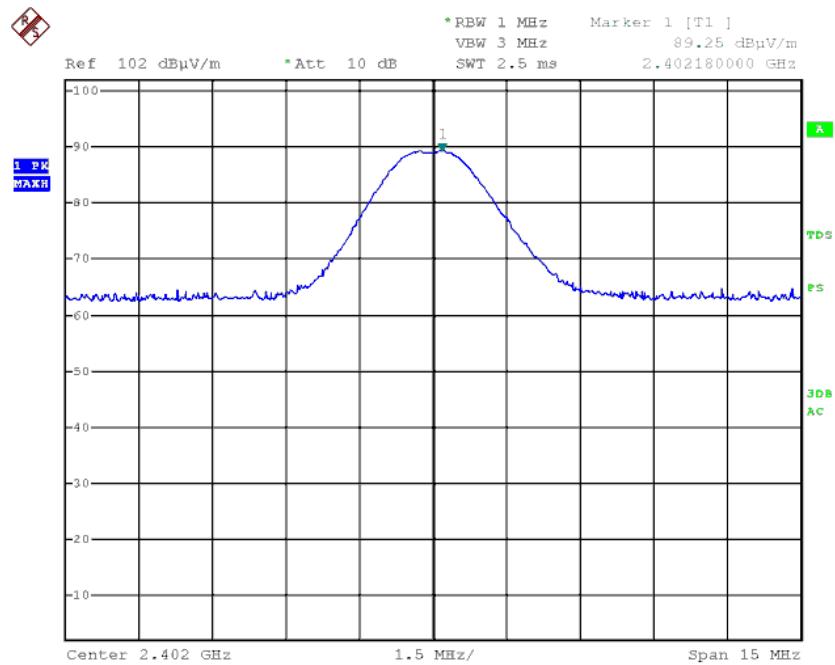
JUDGEMENT: Passed by 999.276 mW

For additional information see *Figure 19* to *Figure 24*.



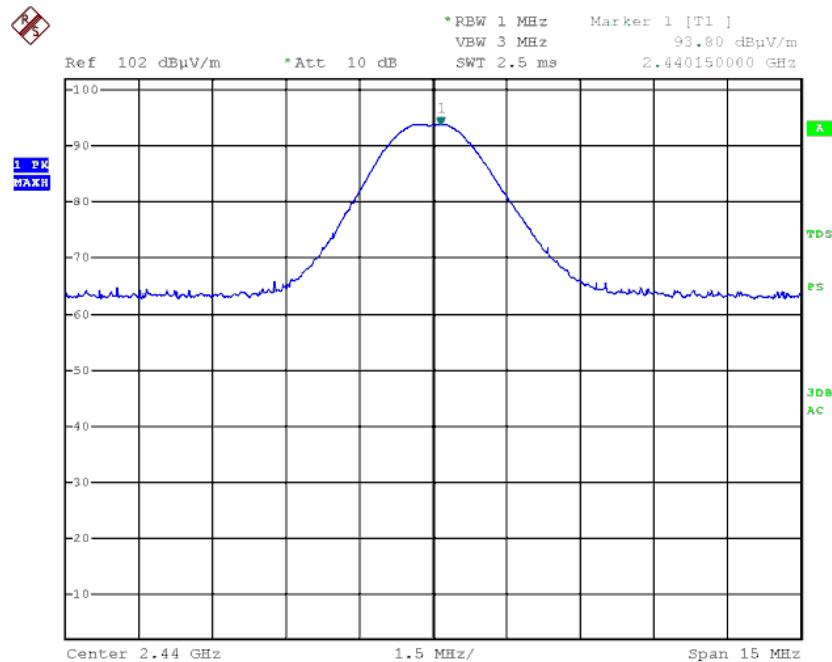
Date: 15.NOV.2016 14:23:38

Figure 19 2402.0 MHz – Vertical



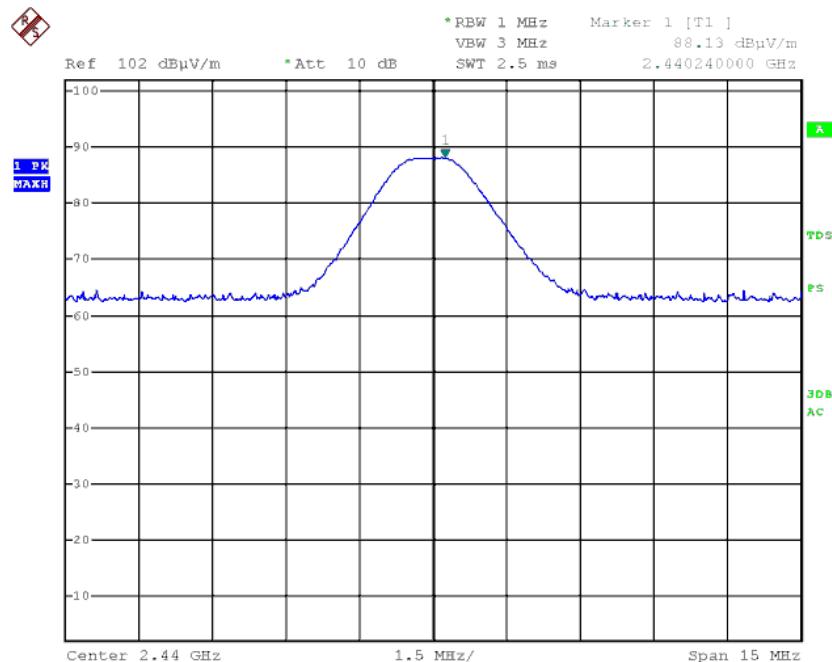
Date: 15.NOV.2016 14:19:08

Figure 20 2402.0 MHz – Horizontal



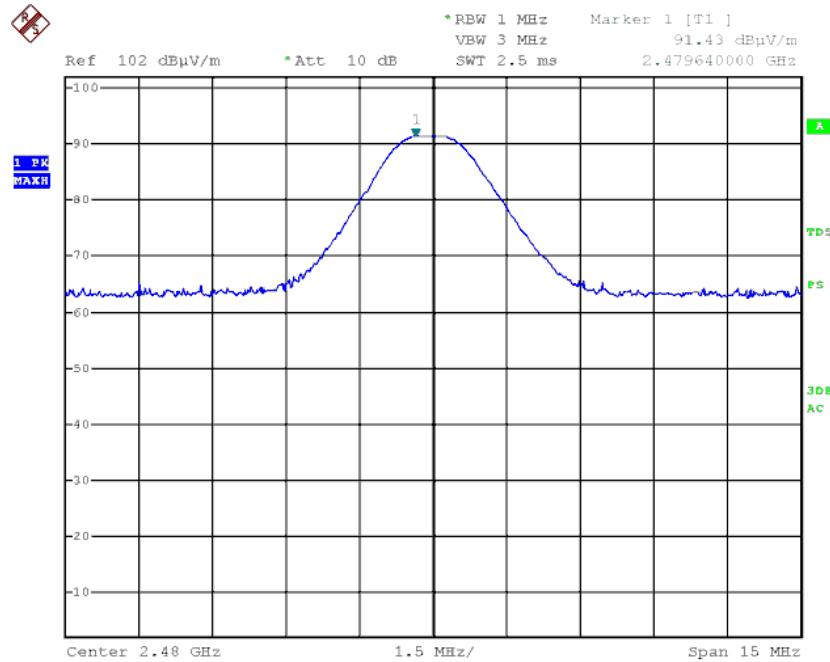
Date: 15.NOV.2016 10:23:22

Figure 21 2440.0 MHz – Vertical



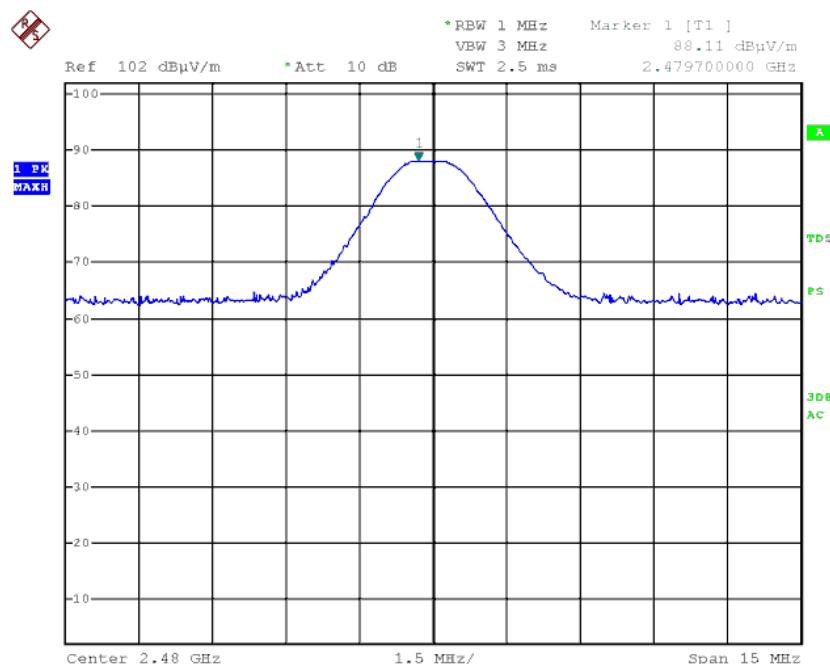
Date: 15.NOV.2016 10:43:08

Figure 22 2440.0 MHz – Horizontal



Date: 15.NOV.2016 09:41:35

Figure 23 2480.0 MHz – Vertical



Date: 15.NOV.2016 09:45:21

Figure 24 2480.0 MHz – Horizontal



6.5 **Test Equipment Used; Maximum Peak Power Output**

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
EMI Receiver	R&S	ESCI7	100724	29. February 2016	01. March 2017
Horn Antenna	ETS	3115	6142	19. May 2015	19. May 2018
Semi Anechoic Civil Chamber	ETS	S81	SL 11643	NCR	NCR

Figure 25 Test Equipment Used



7. Band Edge Spectrum

7.1 **Test Specification**

FCC, Part 15, Subpart C, Section 247(d)

7.2 **Test Procedure**

(Temperature (22°C)/ Humidity (70%RH))

The E.U.T operation mode and test set-up are as described in Section 2 of this report.

The E.U.T was tested in the chamber, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 1.5 meters above the ground. The configuration tested is shown in *Figure 1*.

The RBW was set to 100 kHz.

7.3 **Test Limit**

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power

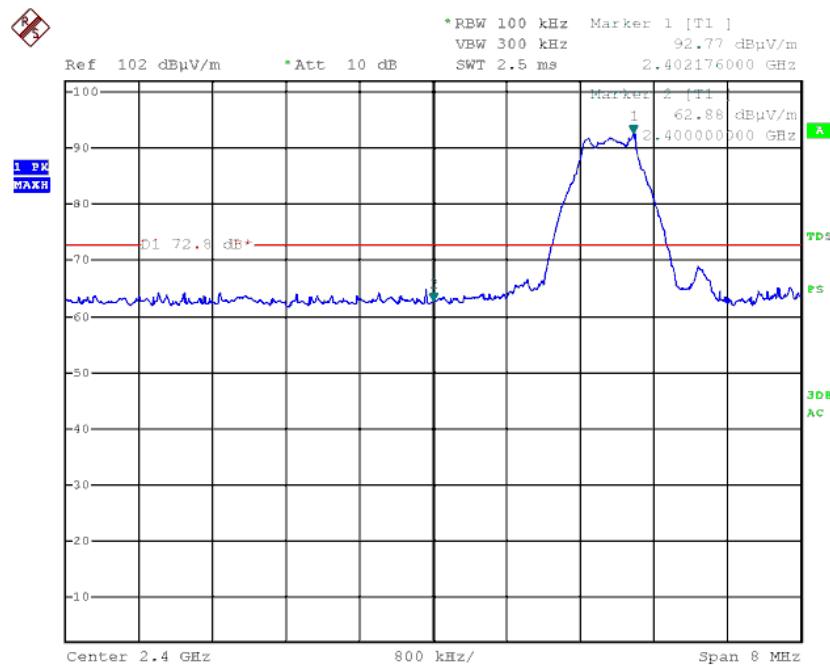
7.4 **Test Results**

Operation Frequency (MHz)	Band Edge Frequency (MHz)	Spectrum Level (dBuV/m)	Specification (dBuV/m)	Margin (dB)
Low	2400.0	62.9	72.8	-9.9
High	2483.5	53.2	69.7	-16.5

Figure 26 Band Edge Spectrum

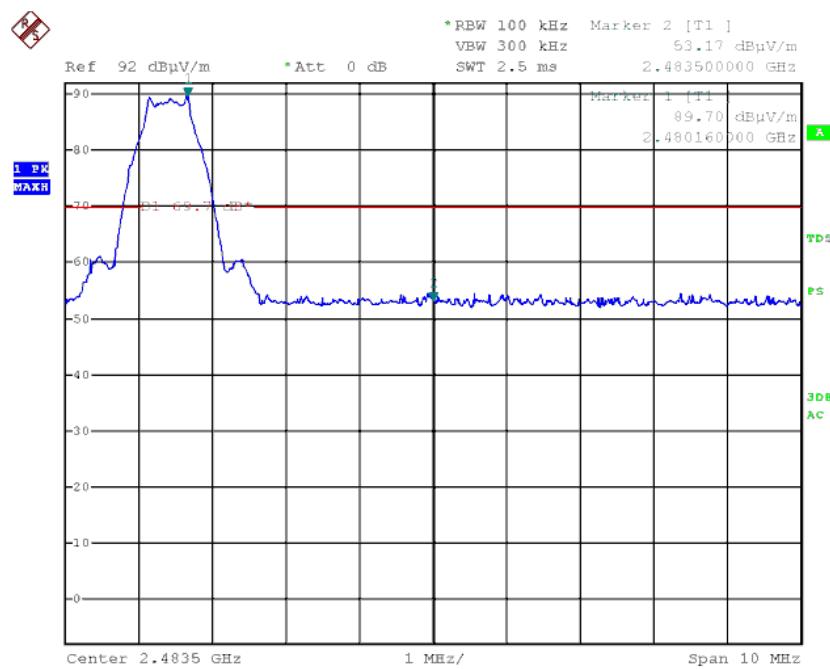
JUDGEMENT: Passed by 9.9dB

For additional information see *Figure 27* and *Figure 28*.



Date: 15.NOV.2016 14:33:48

Figure 27 —Lower Band Edge



Date: 15.NOV.2016 09:58:56

Figure 28 —Upper Band Edge



7.5 **Test Equipment Used; Band Edge Spectrum**

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
EMI Receiver	R&S	ESCI7	100724	29. February 2016	01. March 2017
Horn Antenna	ETS	3115	6142	19. May 2015	19. May 2018
Semi Anechoic Civil Chamber	ETS	S81	SL 11643	NCR	NCR

Figure 29 Test Equipment Used

8. Emissions in Non-Restricted Frequency Bands

8.1 ***Test Specification***

FCC, Part 15, Subpart C, Section 247(d)

8.2 ***Test Procedure***

(Temperature (22°C)/ Humidity (70%RH))

The E.U.T. operation mode and test set-up are as described in Section 2 of this report.

For measurements between 0.009MHz-30MHz:

The E.U.T was tested inside the shielded room at a distance of 3 meters and the E.U.T was placed on a non-metallic table, 0.8 meters above the ground. The frequency range 0.009MHz-30MHz was scanned. The readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization. The emissions were measured at a distance of 3 meters.

For measurements between 30.0MHz-1.0GHz:

A preliminary measurement to characterize the E.U.T was performed inside the shielded room at a distance of 3 meters, using peak detection mode and broadband antennas. The preliminary measurements produced a list of the highest emissions. The E.U.T was then transferred to the open site, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 0.8 meters above the ground. The frequency range 30.0MHz -1.0GHz was scanned and the list of the highest emissions was verified and updated accordingly.

The readings were maximized by adjusting the antenna height between 1-4 meters, the turntable azimuth between 0-360°, and the antenna polarization. The emissions were measured at a distance of 3 meters.

For measurements between 1.0GHz-25.0GHz:

The E.U.T was tested inside the shielded room and placed on a non-metallic table, 1.5 meters above the ground. The frequency range 1.0GHz -25.0GHz was scanned. The readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization.

The emissions were measured at a distance of 3 meters.

RBW was set to 100kHz

The E.U.T. was operated at the low (2402.0 MHz), mid (2440 MHz) and high channels (2480.0 MHz).

8.3 ***Test Limit***

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power



8.4 ***Test Results***

JUDGEMENT: Passed

All detected emissions were greater than 20dBc below the fundamental level.

The EUT met the requirements of the F.C.C. Part 15, Subpart C, Section 247(d) specification.



8.5 **Test Instrumentation Used, Emission in Non Restricted Frequency Bands**

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
EMI Receiver	R&S	ESCI7	100724	29. February 2016	01. March 2017
Spectrum Analyzer	HP	8592L	3826A01204	13. March 2016	13. March 2017
EMI Receiver	HP	8542E	3906A00276	03. March 2016	03. March 2017
RF Filter Section	HP	85420E	3705A00248	03. March 2016	03. March 2017
Spectrum Analyzer	HP	8564E	3442A00275	10. March 2016	10. March 2017
Biconical Antenna	EMCO	3104	2606	24. March 2016	24. March 2017
Active Loop Antenna	EMCO	6502	9506-2950	12 September 2016	12 September 2017
Log Periodic Antenna	EMCO	3146	9505-4081	23. April 2016	23. April 2017
Horn Antenna	ETS	3115	29845	19. May 2015	19. May 2018
Horn Antenna	ARA	SWH-28	1007	30. March 2014	30. March 2017
Low Noise Amplifier	Narda	DBS-0411N313	13	08. August 2016	08. August 2017
Low Noise Amplifier	Sophia Wireless	LNA28-B	232	08. August 2016	08. August 2017
Spectrum Analyzer	HP	8593EM	3536A00120ADI	10. March 2016	10. March 2017
Semi Anechoic Civil Chamber	ETS	S81	SL 11643	NCR	NCR

Figure 30 Test Equipment Used



8.6 **Field Strength Calculation**

The field strength is calculated directly by the EMI Receiver software, and a "Correction Factors", using the following equation:

$$FS = RA + AF + CF$$

FS: Field Strength [dB μ V/m]

RA: Receiver Amplitude [dB μ V]

AF: Receiving Antenna Correction Factor [dB/m]

CF: Cable Attenuation Factor [dB]

Example: $FS = 30.7 \text{ dB}\mu\text{V (RA)} + 14.0 \text{ dB (AF)} + 0.9 \text{ dB (CF)} = 45.6 \text{ dB}\mu\text{V}$

No external pre-amplifiers are used.



9. Emissions in Restricted Frequency Bands

9.1 ***Test Specification***

FCC, Part 15, Subpart C, Sections 15.209, 15.205, 15.247(d)

9.2 ***Test Procedure***

(Temperature (22°C)/ Humidity (70%RH))

For measurements between 0.009MHz-30MHz:

The E.U.T was tested inside the shielded room at a distance of 3 meters and the E.U.T was placed on a non-metallic table, 0.8 meters above the ground. The frequency range 0.009MHz-30MHz was scanned. The readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization.

The emissions were measured at a distance of 3 meters.

For measurements between 30.0MHz-1.0GHz:

A preliminary measurement to characterize the E.U.T was performed inside the shielded room at a distance of 3 meters, using peak detection mode and broadband antennas. The preliminary measurements produced a list of the highest emissions. The E.U.T was then transferred to the open site, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 0.8 meters above the ground. The frequency range 30.0MHz -1.0GHz was scanned and the list of the highest emissions was verified and updated accordingly.

The readings were maximized by adjusting the antenna height between 1-4 meters, the turntable azimuth between 0-360°, and the antenna polarization.

The emissions were measured at a distance of 3 meters.

For measurements between 1.0GHz-25.0GHz:

The E.U.T was tested inside the shielded room and was placed on a non-metallic table, 1.5 meters above the ground. The frequency range 1.0GHz -25.0GHz was scanned. The readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization.

The emissions were measured at a distance of 3 meters.

The E.U.T. was operated at the low (2402 MHz), mid (2440 MHz) and high channels (2480 MHz).

The levels of the emissions within the frequency ranges of the restricted bands (Section 15.205 of FCC Part 15) were compared to the limits of the table in Section 15.209 (a), General Requirements.



9.3 Test Limit

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)	Field strength (dB μ V/m)	Field strength* (dB μ V/m)@3m
0.009-0.490	2400/F(kHz)	300	48.5-13.8	128.5-73.8
0.490-1.705	24000/F(kHz)	30	33.8-23.0	73.8-63.0
1.705-30.0	30	30	29.5	69.5
30-88	100	3	40.0	40.0
88-216	150	3	43.5	43.5
216-960	200	3	46.0	46.0
Above 960	500	3	54.0	54.0

*The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector. For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

Figure 31 Table of Limits

9.4 Test Results

JUDGEMENT: Passed by 1.2dB

For the operation frequency of 2402 MHz, the margin between the emission level and the specification limit is in the worst case 3.2dB at the frequency of 2390.0 MHz, vertical polarization.

For the operation frequency of 2440 MHz, the margin between the emission level and the specification limit is in the worst case 8.3dB at the frequency of 4880.0 MHz, horizontal polarization.

For the operation frequency of 2480 MHz, the margin between the emission level and the specification limit is in the worst case 2.7dB at the frequency of 2483.5 MHz, vertical polarization.

The EUT met the requirements of the F.C.C. Part 15, Subpart C specification.

The details of the highest emissions are given in *Figure 32* to *Figure 33*.



Radiated Emission

E.U.T Description Aquabot
Type AQ21071W100
Serial Number: Not designated

Specification: FCC, Part 15, Subpart C

Antenna Polarization: Horizontal/Vertical Frequency range: 0.009MHz to 25.0 GHz
Test Distance: 3 meters Detector: Peak

Operation Frequency (MHz)	Frequency (MHz)	Polarity (H/V)	Peak Reading (dB μ V/m)	Peak Specification (dB μ V/m)	Peak Margin (dB)
2402.0	2390.0	H	64.3	74.0	-9.7
2402.0	2390.0	V	62.0	74.0	-12.0
2402.0	4804.0	H	39.3	74.0	-34.7
2402.0	4804.0	V	41.0	74.0	-33.0
2440.0	4880.0	H	42.3	74.0	-31.7
2440.0	4880.0	V	41.1	74.0	-32.9
2480.0	4960.0	H	43.2	74.0	-30.8
2480.0	4960.0	V	43.1	74.0	-30.9
2480.0	2483.5	H	53.6	74.0	-20.4
2480.0	2483.5	V	59.8	74.0	-14.2

**Figure 32. Radiated Emission. Antenna Polarization: HORIZONTAL / VERTICAL.
Detector: Peak**

Margin refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.

“Peak Reading” includes correction factor.

“Correction Factor” = Antenna Factor + Cable Loss- Low Noise Amplifier Gain



Radiated Emission

E.U.T Description Aquabot
Type AQ21071W100
Serial Number: Not designated

Specification: FCC, Part 15, Subpart C

Antenna Polarization: Horizontal/Vertical

Frequency range: 0.009MHz to 25.0 GHz

Test Distance: 3 meters

Detector: Average

Operation Frequency	Frequency	Polarity	Average Reading	Average Specification	Average Margin
(MHz)	(MHz)	(H/V)	(dB μ V/m)	(dB μ V/m)	(dB)
2402.0	2390.0	H	51.4	54.0	-2.6
2402.0	2390.0	V	50.6	54.0	-3.4
2402.0	4804.0	H	-	54.0	-
2402.0	4804.0	V	-	54.0	-
2440.0	4880.0	H	-	54.0	-
2440.0	4880.0	V	-	54.0	-
2480.0	4960.0	H	-	54.0	-
2480.0	4960.0	V	-	54.0	-
2480.0	2483.5	H	48.5	54.0	-5.5
2480.0	2483.5	V	52.8	54.0	-1.2

**Figure 33. Radiated Emission. Antenna Polarization: HORIZONTAL / VERTICAL.
Detector: Average**

Notes:

Margin refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.

“Average Reading” includes correction factor.

Correction Factor = Antenna Factor + Cable Loss- Low Noise Amplifier Gain



9.5 Test Instrumentation Used; Emissions in Restricted Frequency Bands

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
EMI Receiver	R&S	ESCI7	100724	29. February 2016	01. March 2017
Spectrum Analyzer	HP	8592L	3826A01204	13. March 2016	13. March 2017
EMI Receiver	HP	8542E	3906A00276	03. March 2016	03. March 2017
RF Filter Section	HP	85420E	3705A00248	03. March 2016	03. March 2017
Spectrum Analyzer	HP	8564E	3442A00275	10. March 2016	10. March 2017
Biconical Antenna	EMCO	3104	2606	24. March 2016	24. March 2017
Active Loop Antenna	EMCO	6502	9506-2950	12 September 2016	12 September 2017
Log Periodic Antenna	EMCO	3146	9505-4081	23. April 2016	23. April 2017
Horn Antenna	ETS	3115	29845	19. May 2015	19. May 2018
Horn Antenna	ARA	SWH-28	1007	30. March 2014	30. March 2017
Low Noise Amplifier	Narda	DBS-0411N313	13	08. August 2016	08. August 2017
Low Noise Amplifier	Sophia Wireless	LNA28-B	232	08. August 2016	08. August 2017
Spectrum Analyzer	HP	8593EM	3536A00120ADI	10. March 2016	10. March 2017
Semi Anechoic Civil Chamber	ETS	S81	SL 11643	NCR	NCR

Figure 34 Test Equipment Used



10. Transmitted Power Density

10.1 Test Specification

FCC, Part 15, Subpart C, Section 247(e)

10.2 Test Procedure

(Temperature (22°C)/ Humidity (70%RH))

The E.U.T operation mode and test set-up are as described in Section 2 of this report.

The E.U.T was tested in the chamber, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 1.5 meters above the ground. The configuration tested is shown in *Figure 2*.

The spectrum analyzer was set to 3 kHz RBW and VBW to 10 kHz.

The E.U.T was evaluated in 3 channels: low (2402MHz), mid (2440MHz) and high (2480MHz).

Radiated output power levels were measured at selected operation frequencies and the results were converted to power level according to the formula as shown below:

$$P = \frac{(E_{V/m} \times d)^2}{(30 \times G)} \quad [W]$$

E - Field Strength (V/m)

d – Distance from transmitter (m)

G – Antenna gain

P – Peak power (W)

10.3 Test Limit

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission



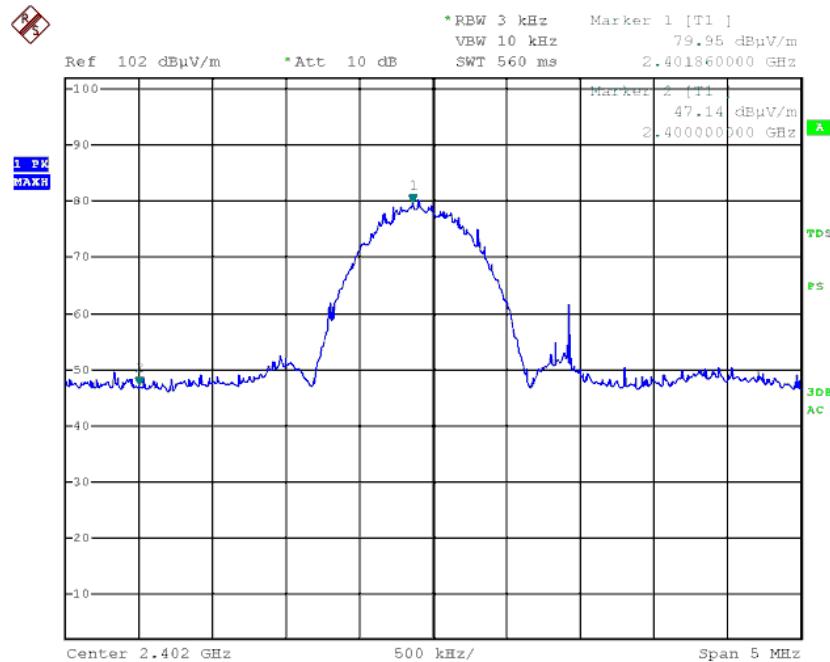
10.4 Test Results

Operation Frequency (MHz)	Reading Spectrum Analyzer (dB μ V/m)	Reading Spectrum Analyzer (dBm)	Specification (dBm)	Margin (dB)
2402.0	80.0	-15.2	8.0	-23.2
2440.0	79.6	-15.6	8.0	-23.6
2480.0	77.5	-17.7	8.0	-25.7

Figure 35 Test Results

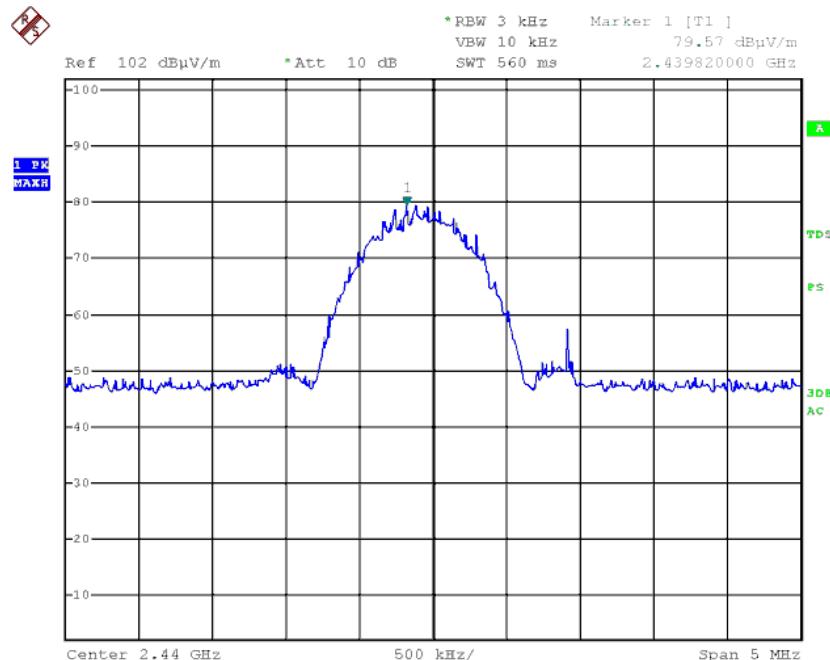
JUDGEMENT: Passed by 23.2dB

For additional information see *Figure 35*.



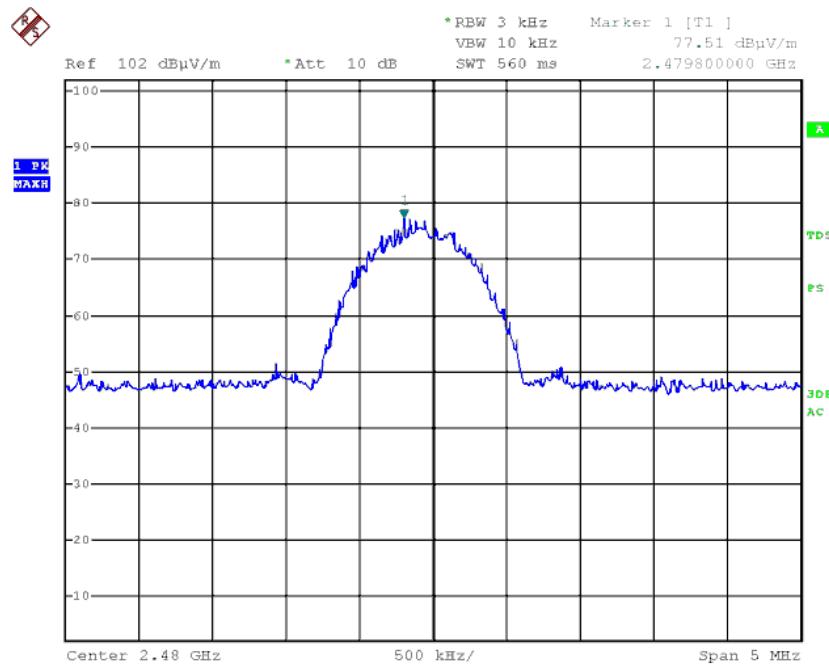
Date: 15.NOV.2016 14:38:51

Figure 36 — 2402.0 MHz



Date: 15.NOV.2016 10:28:03

Figure 37 — 2440.0 MHz



Date: 15.NOV.2016 09:51:21

Figure 38 — 2480.0 MHz

10.5 Test Equipment Used; Transmitted Power Density

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
EMI Receiver	R&S	ESCI7	100120	29. February 2016	01. March 2017
Horn Antenna	ETS	3115	29845	19. May 2015	19. May 2018
Semi Anechoic Civil Chamber	ETS	S81	SL 11643	NCR	NCR

Figure 39 Test Equipment Used



11. Antenna Gain/Information

The antenna gain is 5.3 dBi, integral.



12. R.F Exposure/Safety

Typical use of the E.U.T. is as a power and control unit for robotic pool cleaner.

The typical placement of the E.U.T.: Place the power and control unit at least 3.6 meters/11.8 feet from the pool and at least 12 cm/4 inches above the surface.

The typical distance between the E.U.T. and the user is 20 cm.

Calculation of Maximum Permissible Exposure (MPE)

Based on Section 1.1310 Requirements

(a) FCC limits at 2440 MHz is:

$$1 \frac{mW}{cm^2}$$

Using table 1 of Section 1.1310 limit for general population/uncontrolled exposures, the above level is an average over 30 minutes.

(b) The power density produced by the E.U.T. is

$$S = \frac{P_t G_t}{4\pi R^2}$$

P_t- Transmitted Power 93.8 dBuV/m (Peak) = -1.4dBm = 0.724 mW (testing performed radiated; power results include antenna gain)

G_T- Antenna Gain, 5.3 dBi

R- Distance from Transmitter using 20cm worst case

(c) The peak power density is:

$$S = \frac{(0.724)}{4\pi(20)^2} = 1.44 \times 10^{-4} \frac{mW}{cm^2}$$

(d) This is below the FCC limit.



13. APPENDIX A - CORRECTION FACTORS

13.1 Correction factors for RF OATS Cable 35m

ITL #1784

Frequency (MHz)	Cable loss (dB)
10.0	0.3
20.0	0.2
50.0	-0.1
100.0	-0.6
200.0	-1.2
500.0	-2.3
1000.0	-3.6

13.2 Correction factors for RF OATS Cable 10m

ITL #1794

Frequency(MHz)	Cable loss(dB)
10.0	-0.3
20.0	-0.3
50.0	-0.5
100.0	-0.7
200.0	-1.1
500.0	-1.8
1000.0	-2.7



13.3 **Correction factors for ACTIVE LOOP ANTENNA ITL # 1075:**
Model 6502 S/N 9506-2950

f(MHz)	MAF(dBs/m)	AF(dB/m)
0.01	-33.1	18.4
0.02	-37.2	14.3
0.03	-38.2	13.3
0.05	-39.8	11.7
0.1	-40.1	11.4
0.2	-40.3	11.2
0.3	-40.3	11.2
0.5	-40.3	11.2
0.7	-40.3	11.2
1	-40.1	11.4
2	-40	11.5
3	-40	11.5
4	-40.1	11.4
5	-40.2	11.3
6	-40.4	11.1
7	-40.4	11.1
8	-40.4	11.1
9	-40.5	11
10	-40.5	11
20	-41.5	10
30	-43.5	8



**13.4 Correction factors for biconical antenna – ITL #
1356**

**Model: EMCO 3110B
Serial No.: 9912-3337**

Frequency [MHz]	AF [dB/m]
30.0	14.18
35.0	13.95
40.0	12.84
45.0	11.23
50.0	11.10
60.0	10.39
70.0	9.34
80.0	9.02
90.0	9.31
100.0	8.95
120.0	11.53
140.0	12.20
160.0	12.56
180.0	13.49
200.0	15.27



**13.5 Correction factors for log periodic antenna – ITL #
1349**

**Model: EMCO 3146
Serial No.:9505-4081**

Frequency [MHz]	AF [dB/m]
200.0	11.47
250.0	12.06
300.0	14.77
400.0	15.77
500.0	18.01
600.0	18.84
700.0	20.93
800.0	21.27
900.0	22.44
1000.0	24.10



13.6 Correction factors for

Horn ANTENNA

Model: 3115 ITL # 1352
Antenna serial number: 6142
3 meter range

f(GHz)	AF(dB/m)	GA(dB)
0.75	25	3
1G	23.5	7
1.5G	26	8
2G	29	7
2.5G	27.5	10
3G	30	10
3.5G	31.5	10
4G	32.5	9.5
4.5G	32.5	10.5
5G	33	10.5
5.5G	35	10.5
6G	36.5	9.5
6.5G	36.5	10
7G	37.5	10
7.5G	37.5	10
8G	37.5	11
8.5G	38	11
9G	37.5	11.5
9.5G	38	11.5
10G	38.5	11.5
10.5G	38.5	12
11G	38.5	12.5
11.5G	38.5	13
12G	38	13.5
12.5G	38.5	13
13G	40	12
13.5G	41	12
14G	40	13
14.5G	39	14
15G	38	15.5
15.5G	37.5	16
16G	37.5	16
16.5G	39	15
17G	40	15
17.5G	42	13.5
18G	42.5	13



13.7 **Correction factors for**

Horn Antenna
Model: SWH-28
at 1 meter range.

Frequency, MHz	Measured antenna factor, dB/m 1)
18000	33.0
18500	32.9
19000	33.1
19500	33.3
20000	33.6
20500	33.6
21000	33.4
21500	33.8
22000	33.7
22500	33.9
23000	34.8
23500	34.5
24000	34.2
24500	34.8
25000	34.4
25500	35.2
26000	35.9
26500	36.0



13.8 Correction factor for RF CABLE for Semi Anechoic Chamber

ITL # 1841

FREQ (MHz)	LOSS (dB)
1000.0	1.5
2000.0	2.1
3000.0	2.7
4000.0	3.1
5000.0	3.5
6000.0	4.1
7000.0	4.6
8000.0	4.9
9000.0	5.7
10000.0	5.7
11000.0	6.1
12000.0	6.1
13000.0	6.2
14000.0	6.7
15000.0	7.4
16000.0	7.5
17000.0	7.9
18000.0	8.1
19000.0	8.8
20000.0	9.1

NOTES:

1. The cable is manufactured by Commscope
2. The cable type is 0623 WBC-400, serial # G020132 and 10m long