



**Report of Measurements
for
Aquabot, Pulse-modulated Transmitter, P/N: 221016C**

**Manufactured by
Aqua Products, Inc.
25 Rutgers Avenue
Cedar Grove, NJ 07009**

**Tested by
TUV Rheinland of North America, Inc.
Newtown, CT 06470**

**Mark Ryan
Senior Specialist, EMC**

**Date of Test: 26, 27 AUG 2003
Date of Report: 12 SEP 2003**

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Test Report Number: 30361189.001		Test Report Summary	
Prübericht Nr.			
Applicant: Aqua Products, Inc. Auftraggeber 25 Rutgers Avenue Cedar Grove, NJ 07009		Tel: (973) 857-2700 Fax: (973) 557-0532 Web page: http://www.aquaproducts.com	
Type of Equipment:		Aquabot R/C Transmitter Ultra, Pulse-modulated Radio Remote Control	
Gegenstand der Prüfung			
Model Number: P/N: 220106C Bezeichnung:		Trademark: Ursprungszeichen: 	
Standards: FCC Part 15 Subpart C Prüfgrundlage:		Date of Test: 6-7 May, 2003	
Standard Number	Description	Severity Level or Limit	Minimum Acceptable Performance Criteria
FCC part 15, Subpart C	Radiated Emissions	Sections 15.33, 15.209 and 15.231	NA
FCC part 15, Subpart C	Emission Bandwidth	Sections 15.35	NA
FCC part 15, Subpart C	Conducted Emissions	Connection to AC Mains not possible	NA
Place of Test: TUV Rheinland of North America Prüfort 12 Commerce Road, Newtown, CT 06470 USA E-mail: info-new@tuv.com Web: http://www.tuv.com Phone: (203) 426-0888 Fax: (203) 270-8883		 FOR THE SCOPE OF ACCREDITATION UNDER NVLAP LAB CODE 200111-0	
Test Result: Prüfergebnis	The unit presented for testing complied with criteria shown above. Additional Information is contained in the following pages.		
Tested By: Mark Ryan Der Sachverständige		Checked By: Bruce Fagley geprüft	
20 NOV 2003, Date, Signature Datum, Unterschrift		20 NOV 2003, Date, Signature Datum, Unterschrift	

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TABLE OF CONTENTS

1. GENERAL	4
1.1 EQUIPMENT TESTED	4
1.2 APPLICANT / MANUFACTURER	4
1.3 FCCID	4
1.4 DESCRIPTION	4
1.4.1 Physical:	4
1.4.2 Functional:	4
1.4.3 Electrical and EMC Related:	4
1.5 DESCRIPTION of CIRCUIT FUNCTION	5
1.6 BLOCK DIAGRAM SHOWING OSCILLATORS	5
2. MEASUREMENT EQUIPMENT USED	5
3. REPORT OF MEASUREMENTS	6
3.1 TEST CONFIGURATION BLOCK DIAGRAM	6
3.2 CONDUCTED EMISSIONS	7
3.3 RADIATED EMISSIONS	7
3.3.1 Mode of Operation	7
3.3.2 Test Procedure	7
3.3.3 Frequency Range Investigated	7
3.3.4 Criteria	7
3.3.5 Measurement Data	8
3.3.6 Signal Bandwidth	9
3.3.7 Signal Level Calculation	9
3.3.8 Test Results	9
4. MODIFICATIONS to EQUIPMENT TESTED	9
5. MEASUREMENT DATA SHEETS	10
5.1 PRELIMINARY EMISSIONS (SAR) 30-5000 MHz	11
5.2 PRELIMINARY EMISSIONS (SAR) 30-5000 MHz	12
5.3 Final Emissions and Bandwidth (OATS 3 m) - §§15.231(b), 15.35(c), & 15.231(c)	13
5.4 AVERAGED PULSE TRAIN - §15.35(c)	14

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1. GENERAL

1.1 EQUIPMENT TESTED

**Aquabot R/C Transmitter, Pulse-modulated Transmitter Unit
P/N: 221016C**

1.2 APPLICANT / MANUFACTURER

**Aqua Products, Inc.
25 Rutgers Avenue
Cedar Grove, NJ 07009**

1.3 FCCID

FCC ID#: RCR G3779-E7542H

1.4 DESCRIPTION

The Aquabot R/C Transmitter P/N: 221016C unit is a pulse-modulated transmitter that provides a wireless link control to an automatic pool cleaner system (the receiver is not covered in this report). The bottom of the transmitter unit has the battery compartment. The top of the transmitter has three buttons and a transmit indicator LED (red). The unit is battery powered and has no provisions for AC Power input. For more information refer to product's web page at: <http://www.aquaproducts.com>

1.4.1 Physical:

The transmitter is in a plastic enclosure that measures 5.5" x 2.5" x 1.2" and weighs 1 lb with battery installed.

1.4.2 Functional:

The Aquabot RC transmitter is intended for operation at 433.92MHz in accordance with the provisions of FCC part §15.231(a).

1.4.3 Electrical and EMC Related:

The Aquabot RC transmitter is battery operated and no means is provided for connection of external power. The Unit is powered from a single 9 Volt battery.

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1.5 DESCRIPTION of CIRCUIT FUNCTION

Refer to "Operational Description" Folder.

1.6 BLOCK DIAGRAM SHOWING OSCILLATORS

Refer to "Block Diagram" Folder.

2. MEASUREMENT EQUIPMENT USED

The measuring equipment used for signal measurement is shown in the following table.

Equipment	Frequency Range of Measurements Performed	Manufacturer and Model	Calibration Last/Next
EMI Receiver	30 - 5000 MHz	HP85462A ¹	Dec 02/Dec 03
RF Filter/pre-amp	30 - 5000 MHz	HP85460A ¹	Dec 02/Dec 03
Spectrum Analyzer	1 - 5 GHz	HP8593E	Aug 03/Aug 04
Pre-Amp	1 – 5 GHz	HP8449A	Aug 03/Aug 04
Bi-Conical Antenna	30 – 300 MHz	EMCO 3109	Oct 02/Oct 03
Log-Periodic Antenna	300 – 1000 GHz	EMCO 3146	Sep 02/Sep 03
Bi-Log Antenna	30 – 2000 MHz	Schaffner CBL6112B	Oct 02/Oct 03
Ridged Horn Antenna	1000 - 5000 MHz	EMCO 3115	Sep 02/Sep 03

¹Note: The HP85462A Receiver and the HP85469A Filter/pre-amp are also known collectively as the **HP8546A**.

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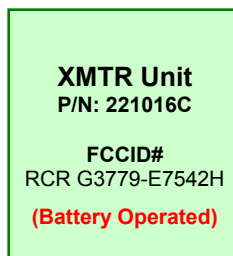


3. REPORT OF MEASUREMENTS

3.1 TEST CONFIGURATION BLOCK DIAGRAM

Legend:

EUT; 
Support; 
Power; 



Cable #	Cable Description	Fixed or Detachable	Length	Shielding
N/A	No Cables	N/A	N/A	N/A

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3.2 CONDUCTED EMISSIONS

Conducted emissions measurements were not performed, as the Aquabot R/C Transmitter R/C has no provision for connection to the AC mains.

3.3 RADIATED EMISSIONS

3.3.1 Mode of Operation

The Aquabot R/C Transmitter was set to continuous transmission by placing a plastic clamp on unit to engage a control button. The transmitter has three control buttons. Each button produces two wider pulses in the pulse train, but in different positions. Therefore the total emission would be equivalent regardless of which control button was used. Refer to photographs in the "Photos Test Setup" folder.

3.3.2 Test Procedure

Preliminary radiated measurements were made at a distance of 3 meters in a semi-anechoic chamber. The preliminary plots are included in the test data section. Final radiated measurements were performed on an Open Area Test Site (OATS) at measurement distances of 3 meters for all frequencies measured. The OATS plots are also included in the test data section.

Radiated emissions measurements were performed using the ANSI C63.4-1992 measurement procedures as specified in paragraph 15.31(a)(6).

Date of Test:	25 AUG 2003
Frequency Range:	30 - 5000 MHz
Detector:	Peak, Quasi Peak and Average
Peak Measurement Bandwidth:	120 kHz
Quasi-Peak Measurement Bandwidth:	120 kHz
Average Measurement Bandwidth:	300 kHz
Avg. BW for spurious emissions above 1GHz:	1MHz (See NOTE 1 of measurement data, Page 8.)

3.3.3 Frequency Range Investigated

Per §15.33(a)(1), the frequency range investigated will be to the tenth harmonic of the highest fundamental frequency. The highest fundamental frequency of the equipment tested is 433.92MHz. The tenth harmonic is 4.3392GHz. The frequency range investigated will be from 30MHz to 5GHz.

3.3.4 Criteria

CFR 47 (FCC) Section 15.231

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3.3.5 Measurement Data

Radiated Emissions		Final OATS Measurements				D= 3 m		Antenna = Schaffner CBL6112B				
Device Tested: Aquabot, R/C Pulse Modulated Transmitter, P/N: 221016C												
Meas. #	Freq	Measured Levels			FCC Limit with type detector used	Δ	Antenna + Cable Correction Factor (included in measured levels)	Result	Antenna Polarization	Antenna Height	Turntable Angle	Comment
See Notes 1 & 2		Peak	Quasi-Peak	Average								
	(MHz)	(dB μ V/m)	(dB μ V/m)	(dB μ V/m)	(dB μ V/m)	(dB)	(dB)		V or H	(m)	(°)	
1	434.0	79.3	NA	NA	80.8 pk	-1.5	16.8	See Note 2	V	1.0	0.0	Averaging §15.35(c)
2	867.9	57.9	56.4	49.5	60.8 QP	-4.4	20.4	Complied	V	1.0	25.0	§15.231(b)(2)
3	1305	56.6	55.3	49.1	54.0 avg	-4.9	29.5	Complied	V	1.0	225.0	§15.205(b) - 1MHz BW
4	1736	37.8	36.4	31.5	60.8 QP	-3.16	31.7	Complied	V	1.0	225.0	§15.231(b)(2)
5	2170	40.4	39.1	38.7	60.8 QP	-12.1	33.3	Complied	V	1.0	25.0	§15.231(b)(2)
6	2603	50.3	48.7	43.2	60.8 QP	-10.5	28.8	Complied	H	1.0	25.0	§15.231(b)(2)
7	3037	40.8	39.6	34.7	60.8 QP	-21.6	30.4	Complied	H	1.0	25.0	§15.231(b)(2)
8	4339	32.1	31.2	27.4	60.8 QP	-29.6	31.1	Complied	H	1.0	25.0	§15.231(b)(2)

TUV Rheinland of North America, Inc. 12 Commerce Road Newtown, CT 06470 Tel:(203) 426-0888 Fax: (203) 428-4009

Note 1: Per §15.231(a), the maximum permitted fundamental field strength is 80.8dB μ V/m (11,000 μ V/m). This limit is used for measurement numbers 4 and 5 in above table. The formula for calculating the maximum permitted fundamental field strengths for the 260-470 MHz band at 3 meters is: Limit in μ V/m = 41.6667(F in MHz) – 7083.3333, where F is the operating frequency of 434MHz. Or: (41.6667x434) - 7083.3333 = 11,000 μ V/m. Therefore, 20 log(11,000 μ V/m) = 80.8dB μ V/m. The maximum permitted unwanted emissions level is 20 dB below the maximum permitted fundamental level, or 60.8dB μ V/m (1,100 μ V/m). This limit is used for measurement numbers 2, 4, 5, 6, 7, and 8 in above table. See Plot on page 15 for fundamental bandwidth measurement.

Measurement number 3 in the above table is located within the restricted band of 1300 – 1427MHz. Per §15.205(b), the emission shall therefore be in compliance with the limits of Section15.209. Since the frequency is above 1000MHz, the provisions in §15.35(b) for employing an average detector function with a minimum resolution bandwidth of 1MHz will apply. Limit = 500 μ V/m (54.0dB μ V/m).

Note 2: Per §15.35(c), "...when the radiated emission limits are expressed in terms of average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds..."

Refer to the plot on page 14. The pulse train of the device tested is 30mS in length, with 8.7mS of "ON" time, and 21.3mS of "OFF" time. This equals to 30% (8.7mS / 30mS x 100) of average "ON" emission. The maximum peak signal measured was 89.7dB μ V/m peak (8.9dB over the limit). When the 30% averaged value is applied, the measured emissions were adjusted by a -10.4dB μ V/m correction value. The resulting 79.2dB μ V/m peak emission (measurement in line number 1) is therefore **compliant**, and has a 1.5dB margin to the limit. The 10.4dB μ V/m correction factor used was calculated at by taking 30% of the peak emission:

$$30\% \text{ of } 30549\mu\text{V/m (89.7dB}\mu\text{V/m)} = 9165 \mu\text{V/m (79.2dB}\mu\text{V/m)}.$$

$$\text{And, } 79.2\text{dB}\mu\text{V/m} - 89.7\text{dB}\mu\text{V/m} = -10.4\text{dB}\mu\text{V/m correction value.}$$

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3.3.6 Signal Bandwidth

Per §15.231(c), the maximum allowed bandwidth is 0.25% of 434MHz = 1.085MHz.
Bandwidth is determined at the points 20 dB down from the modulated carrier. Refer to plot on page 13.

3.3.7 Signal Level Calculation

Refer to the table on the previous page.

The values in the table on the previous page were calculated using the following:

Measured Level (dBμV) + Cable Loss (dB) + Antenna Factor dB = Field Strength (dBμV/m)

These calculations are included in the values.

3.3.8 Test Results

Refer to the results column in the table on previous page.

All of the radiated emissions of the Aquabot R/C Transmitter were within their respective limits, as reflected in the comments column in the table and in the notes on the previous page.

4. MODIFICATIONS to EQUIPMENT TESTED

No modifications were made to the Aquabot R/C Transmitter. The transmitter was engaged using a plastic clamp on a control button.

Refer to photograph on page 2 in the "Photos Product Internal" folder.

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5. MEASUREMENT DATA SHEETS

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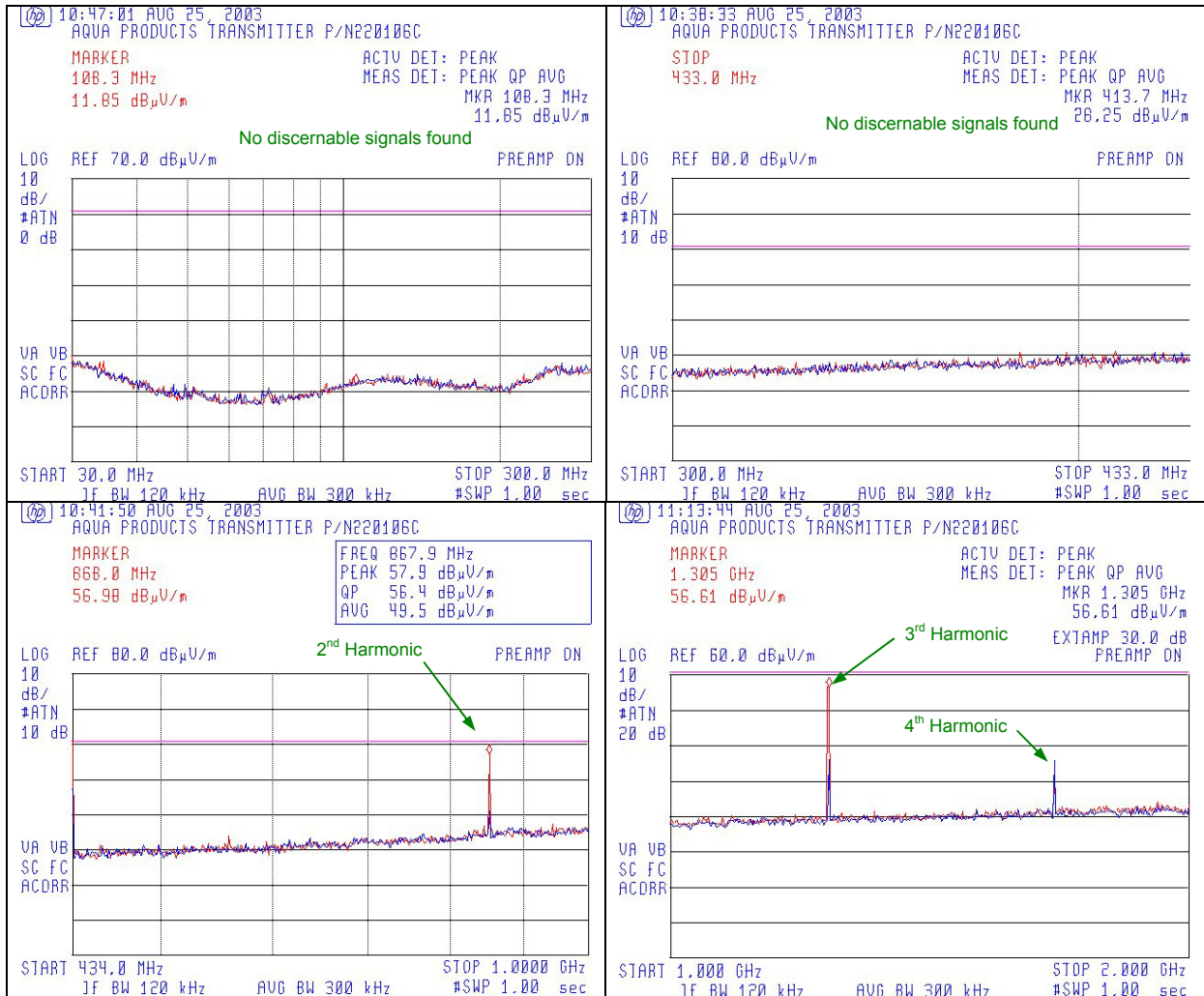


TUV Rheinland
of North America

5.1 PRELIMINARY EMISSIONS (SAR) 30-5000 MHz

NOTES:

Aquabot R/C Transmitter – Radiated Emissions
HP8546A EMI Receiver used from 30MHz to 5000MHz and used for all final measurements.



ANTENNA/COUPLER:

- | | | | |
|---|--|---|--|
| ☐ 9124 Bicon (30 - 1000 MHz) | ☒ 3109 Bicon (30 - 1000 MHz) | ☐ CBL6140 X-Wing | ☐ NNB-4/63TL LISN |
| ☒ 3146 Log (300-1000 MHz) | ☒ 3115 Horn (1 - 5 GHz) | ☐ MDS-21 Clamp | ☐ NNB-4/200X LISN |
| ☐ 3106 Horn | ☐ CBL6112B Bilog | ☐ NSLK 8126 LISN | ☐ Other _____ |

MEAS TYPE:

- ☒ Radiated Prescan
☐ Radiated Final
☐ Conducted
☐ Disturbance Power
☐ Other _____

POLARIZATION:

- ☒ Vertical
☒ Horizontal
☐ Line
☐ Neutral
☐ NA

DISTANCE:

- ☒ 3 Meter
☐ 10 Meter
☐ _____ Meter
☐ NA

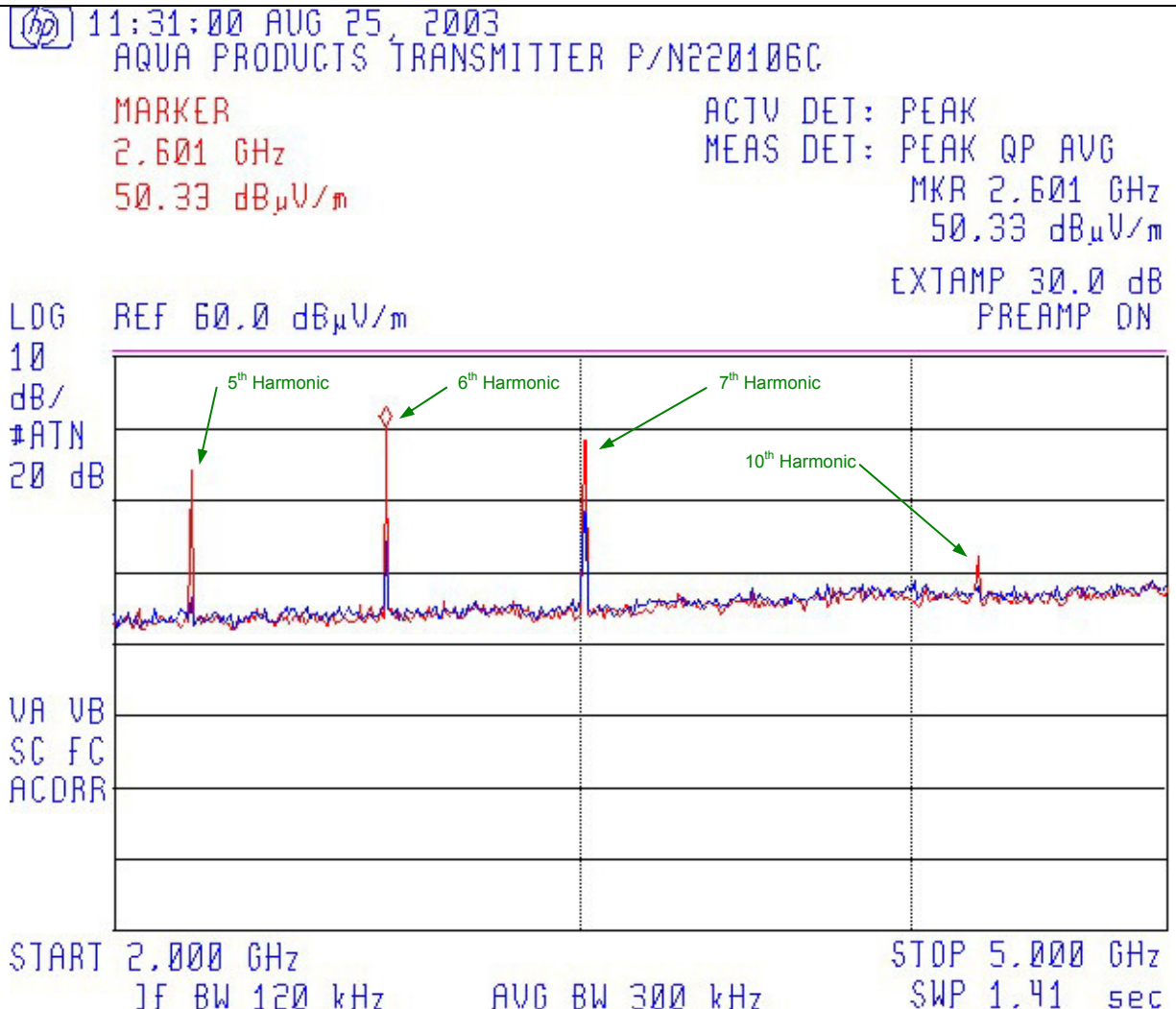
LOCATION:

- ☐ OATS
☒ Semi-Anechoic
☐ Shielded Room
☐ Factory Floor
☐ Other _____

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**5.2 PRELIMINARY EMISSIONS (SAR) 30-5000 MHz****NOTES:**

Aquabot R/C Transmitter – Radiated Emissions
HP8546A EMI Receiver used from 2GHz to 5GHz.

**ANTENNA/COUPLER:**

- ☐ 9124 Bicon (30 - 1000 MHz)
☐ 3146 Log (300-1000 MHz)
☐ 3106 Horn

- ☐ 3109 Bicon (30 - 1000 MHz)
☒ 3115 Horn (1 - 5 GHz)
☐ CBL6112B Bilog

- ☐ CBL6140 X-Wing
☐ MDS-21 Clamp
☐ NSLK 8126 LISN

- ☐ NNB-4/63TL LISN
☐ NNB-4/200X LISN
☐ Other _____

MEAS TYPE:

- ☒ Radiated Prescan
☐ Radiated Final
☐ Conducted
☐ Disturbance Power
☐ Other _____

POLARIZATION:

- ☒ Vertical
☒ Horizontal
☐ Line
☐ Neutral
☐ NA

DISTANCE:

- ☒ 3 Meter
☐ 10 Meter
☐ _____ Meter
☐ NA

LOCATION:

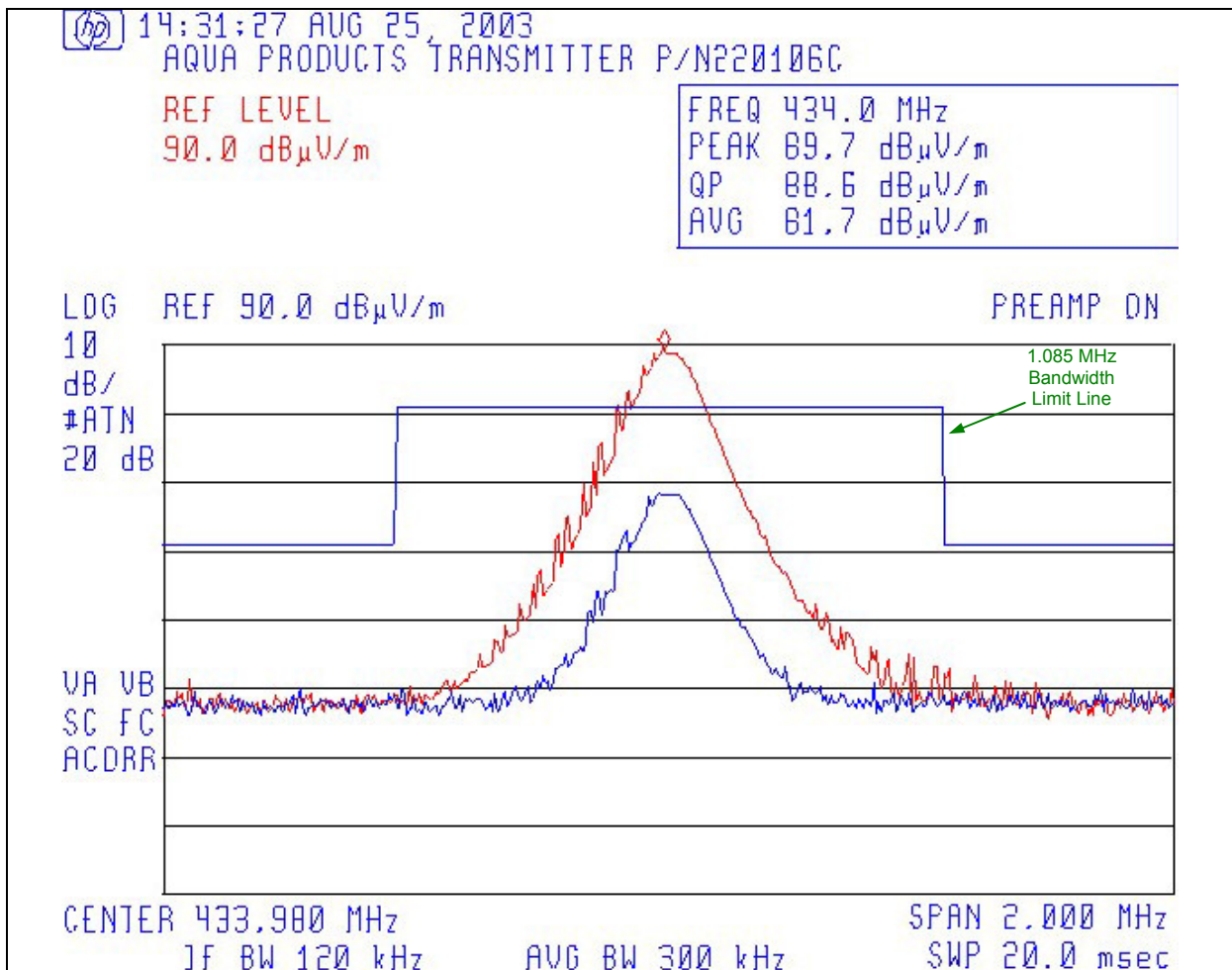
- ☐ OATS
☒ Semi-Anechoic
☐ Shielded Room
☐ Factory Floor
☐ Other _____

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5.3 Final Emissions and Bandwidth (OATS 3 m) - §§15.231(b), 15.35(c), & 15.231(c)

NOTES: Aquabot R/C Transmitter – OATS measurement, Worst Case
 HP8546A EMI Receiver used (using Max. Hold for 30 Seconds, and peak detector)
 Per §15.231(c), the maximum Allowed Bandwidth is 0.25% of 434MHz = 1.085MHz.
 Bandwidth is determined at the points 20 dB down from the modulated carrier.
 (Refer to Table and **Note 2** of Measurement data on page 8.)



ANTENNA/COUPLER:

- | | | | |
|---------------------------------------|--|---|--|
| ☐ 9124 Bicon | ☐ 3109 Bicon | ☐ CBL6140 X-Wing | ☐ NNB-4/63TL LISN |
| ☐ 3146 Log Per | ☐ 3115 Horn | ☐ MDS-21 Clamp | ☐ NNB-4/200X LISN |
| ☐ 3106 Horn | ☒ CBL6112B Bilog | ☐ NSLK 8126 LISN | ☐ Other |

MEAS TYPE:

- ☐ Radiated Prescan
☒ Radiated Final
☐ Conducted
☐ Disturbance Power
☐ Other _____

POLARIZATION:

- ☒ Vertical
☒ Horizontal
☐ Line
☐ Neutral
☐ NA

DISTANCE:

- ☒ 3 Meter
☐ 10 Meter
☐ _____ Meter
☐ NA

LOCATION:

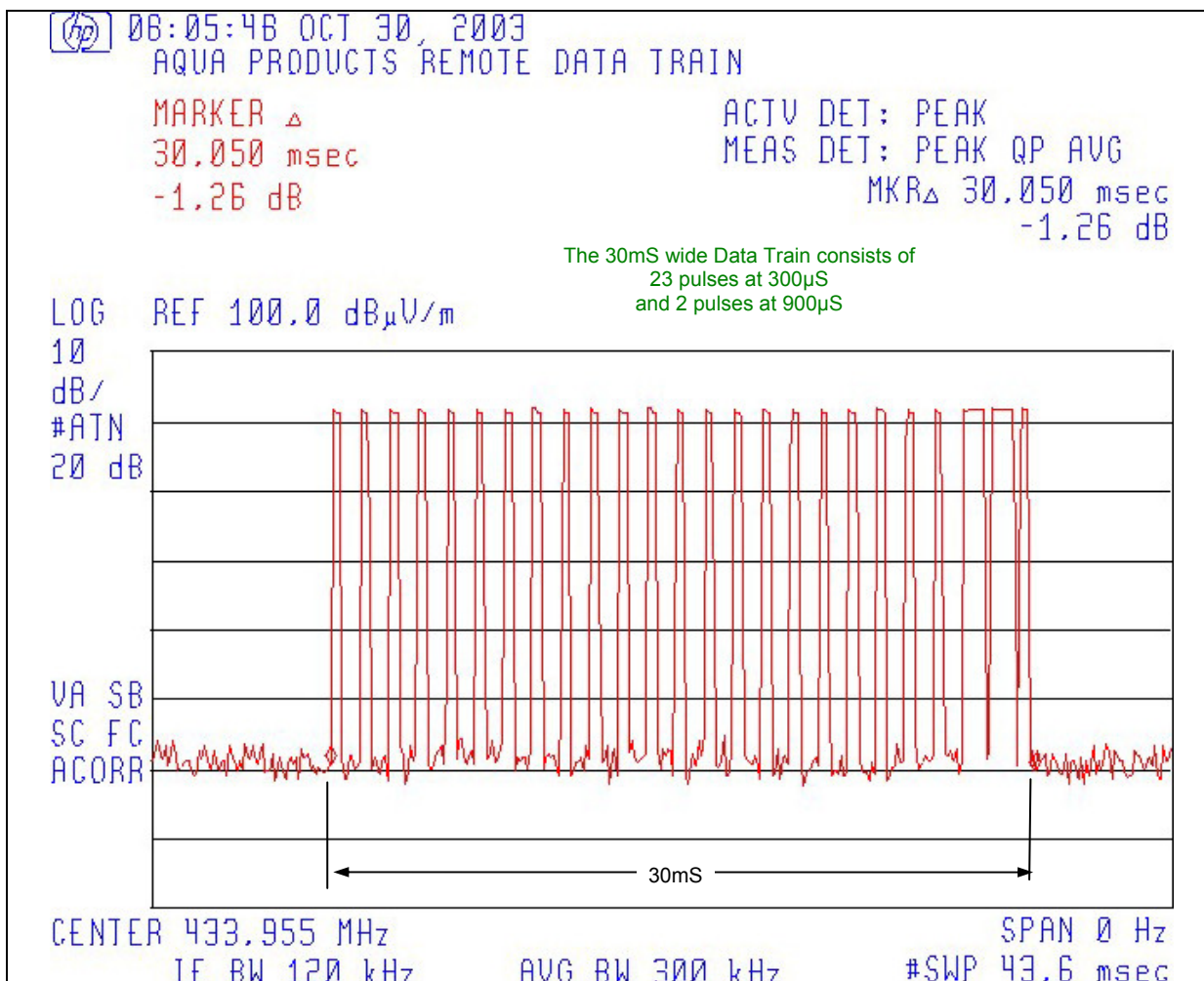
- ☒ OATS
☐ Semi-Anechoic
☐ Shielded Room
☐ Factory Floor
☐ Other _____

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**5.4 AVERAGED PULSE TRAIN - §15.35(c)**

NOTES: Aquabot R/C Transmitter Transmitter – Averaged pulse train

HP8546A EMI Receiver used.

Total "ON" time: $(2 \times 900\mu\text{S}) + (23 \times 300\mu\text{S}) = 8.7\text{mS}$ Per §15.35(c), Averaged pulse train signal: $8.7\text{mS} / 30\text{mS} = 30\%$ (Rounded up)(Refer to Table and **Note 2** of Measurement data on page 8.)**ANTENNA/COUPLER:**☐ 9124 Bicon (30 - 1000 MHz)☒ 3146 Log (300-1000 MHz)☐ 3106 Horn☐ 3109 Bicon (30 - 1000 MHz)☐ 3115 Horn (1 - 5 GHz)☐ CBL6112B Bilog☐ CBL6140 X-Wing☐ MDS-21 Clamp☐ NSLK 8126 LISN☐ NNB-4/63TL LISN☐ NNB-4/200X LISN☐ Other _____**MEAS TYPE:**☒ Radiated Prescan☐ Radiated Final☐ Conducted☐ Disturbance Power☐ Other _____**POLARIZATION:**☒ Vertical☐ Horizontal☐ Line☐ Neutral☐ NA**DISTANCE:**☒ 3 Meter☐ 10 Meter☐ _____ Meter☐ NA**LOCATION:**☐ OATS☒ Semi-Anechoic☐ Shielded Room☐ Factory Floor☐ Other _____

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