



Measurement of RF Emissions from a Aqua One Poolside Alarm Transmitter

For First Alert
Aurora, IL 60504

P.O. Number NP5181731
Date Tested August 12 through 22, 2010
Test Personnel Richard E. King
Test Specification FCC "Code of Federal Regulations" Title 47
Part15, Subpart C
Industry Canada RSS-GEN
Industry Canada RSS-210

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REVISION HISTORY

Revision	Date	Description
—	August 31, 2010	Initial release

Measurement of RF Emissions from a Poolside Alarm, Model No. Aqua One Transmitter

1. INTRODUCTION

1.1. Scope of Tests

This report presents the results of the RF emissions measurements performed on a Poolside Alarm, Model No. Aqua One, Serial No. prototype, (hereinafter referred to as the Equipment Under Test (EUT)). The test item was designed to transmit at approximately 418MHz using an internal. The EUT was manufactured and submitted for testing by First Alert located in Aurora, IL.

1.2. Purpose

The test series was performed to determine if the test item meets the conducted and radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.231 for Intentional Radiators. Testing was performed in accordance with ANSI C63.4-2003.

1.3. Deviations, Additions and Exclusions

There were no deviations, additions to, or exclusions from the test specification during this test series.

1.4. EMC Laboratory Identification

This series of tests was performed by Elite Electronic Engineering Incorporated of Downers Grove, Illinois. The laboratory is accredited by The American Association for Laboratory Accreditation (A2LA). A2LA Certificate Number: 1786.01.

1.5. Laboratory Conditions

The temperature at the time of the test was 23.3°C and the relative humidity was 42%.

2. APPLICABLE DOCUMENTS

The following documents of the exact issue designated form part of this document to the extent specified herein:

- Federal Communications Commission "Code of Federal Regulations", Title 47, Part 15, Subpart C, dated 1 October 2009
- ANSI C63.4-2003, "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz"
- Industry Canada Radio Standards Specification, RSS-Gen, "General Requirements and Information for the Certification of Radiocommunication Equipment", Issue 2, June 2007
- Industry Canada Radio Standards Specification, RSS-210, "Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment", Issue 7, June 2007

3. EUT SETUP AND OPERATION

3.1. General Description

The EUT is a First Alert, Poolside Alarm, Model No. Aqua One. A block diagram of the EUT setup is shown as Figure 1.



3.1.1. Power Input

The EUT obtained 9VDC from six (6) "AA" batteries.

3.1.2. Peripheral Equipment

The test item does have peripheral equipment.

3.1.3. Signal Input/Output Leads

The EUT does not have signal input or output leads.

3.1.4. Grounding

The EUT was battery powered and not grounded during the tests.

3.2. Operational Mode

For all tests the EUT was placed on an 80cm high non-conductive stand. The EUT was energized. The test item has two separate modes of operation. In the first mode the test item will poll to the receiver 1 pulse every 72 minutes. The second mode is the alarm activation mode and occurs whenever the alarm has been activated during a safety of life event. The alarm will sound and transmit for a period of 5 minutes.

3.3. EUT Modifications

No modifications were required for compliance to the FCC CFR 15.231 requirements.

4. TEST FACILITY AND TEST INSTRUMENTATION

4.1. Shielded Enclosure

All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. With the exception of the floor, the reflective surfaces of the shielded chamber are lined with ferrite tiles on the walls and ceiling. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2003 for site attenuation.

4.2. Test Instrumentation

The test instrumentation and auxiliary equipment used during the tests are listed in Table 9-1.

Conducted and radiated emission measurements were performed with a spectrum analyzer. This receiver allows measurements with the bandwidths and detector functions specified by the FCC. The receiver bandwidth was 120kHz for the 30MHz to 1000MHz radiated emissions data and 1MHz for the 1000MHz to 5000MHz radiated emissions data.

4.3. Calibration Traceability

Test equipment is maintained and calibrated on a regular basis. All calibrations are traceable to the National Institute of Standards and Technology (NIST).

4.4. Measurement Uncertainty

All measurements are an estimate of their true value. The measurement uncertainty characterizes, with a specified confidence level, the spread of values which may be possible for a given measurement system.

The measurement uncertainty for these tests is presented below:

Conducted Emissions Measurements		
Combined Standard Uncertainty	1.07	-1.07
Expanded Uncertainty (95% confidence)	2.1	-2.1

Radiated Emissions Measurements		
Combined Standard Uncertainty	2.26	-2.18
Expanded Uncertainty (95% confidence)	4.5	-4.4

5. TEST PROCEDURES

5.1. Powerline Conducted Emissions

5.1.1. Requirements

Since the EUT was powered by internal batteries, the conducted emission tests are not required.

5.2. Periodic Operation Measurements

5.2.1. Requirements

A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released. Also, a transmitter activated automatically shall cease transmission within 5 seconds after activation. Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition

Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

In addition, devices operated under the provisions of paragraph 15.231(e) shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

5.2.2. Procedures

The spectrum analyzer was setup to display the time domain trace. The test item was set to transmit normally. The spectrum analyzer was used to record the amount of time that the test item remained active following activation and the silent period up to 30 times the transmission time.

5.2.3. Results

The plot of the periodic timing is shown on data page 15. The data shows that the test item silent period is greater than 30 times the transmission period. The periodic transmission is once every 72 minutes which is less than the 2 seconds within an hour time restriction. Since the test items intended use is for a safety of life event the test item is allowed to transmit for the pendency of the alarm condition.

5.3. Duty Cycle Factor Measurements

5.3.1. Procedures

The duty cycle factor is used to convert peak detected readings to average readings. This factor is computed from the time domain trace of the pulse modulation signal.

Since the EUT utilizes a rolling code on/off keying modulation, the duty cycle factor is calculated based on the

worst case possible duty cycle. The worst case bit has a pulse on-time of 842uS in a 1.082mS word. Assuming that all the bits can be the worst case, we can calculate the on time in 100mS to be 84.2mS. The following procedure was used to measure a representative sample:

- a) With the transmitter set up to transmit for maximum pulse density, the time domain trace is displayed on the spectrum analyzer.
- b) This trace is obtained by tuning center frequency to the transmitter frequency and then setting a zero span width with 10msec/div.
- c) The amplitude settings are adjusted so that the on/off transitions clear the 4th division from the bottom of the display. The markers are set at the beginning and end of a word period. If the word period exceeds 100 msec the word period is set to 100 msec.
- d) The on-time and off-time are then measured. The on-time is total time signal level exceeds the 4th division. Off-time is time under for the word period.
- e) The duty cycle is then computed as the (On-time/ word period) where the word period = (On-time + Off-time).
- f) The duty cycle factor is computed from the duty cycle.
- g) The first plot shows the smallest pulse width possible.
- h) Plots two and three show the next pulse widths.
- i) The fourth plot shows the widest possible pulse width.
- j) The last plot shows the pulse train in 100mS.

5.3.2.Results

The plots of the duty cycle pulses are shown on data pages 16 through 20. The duty cycle factor was computed to be $20 \cdot \log(84.2\text{mS}/100\text{mS}) = -1.5 \text{ dB}$.

5.4. Radiated Measurements

5.4.1.Requirements

The test item must comply with the requirements of FCC "Code of Federal Regulations Title 47", Part 15, Subpart C, Section 15.205 et seq. 15.231(e).

Paragraph 15.231(e) has the following radiated emission limits:

Fundamental Frequency MHz	Field Intensity uV/m @ 3 meters	Field Strength Harmonics and Spurious @ 3 meters
260 to 470	1,500 to 5000*	150 to 500*

* - Linear Interpolation

For 418MHz, the limit at the fundamental is 4133.3 uV/m @ 3m and the limit on the harmonics is 413.3 uV/m @ 3m.

In addition, emissions appearing in the Restricted Bands of Operation listed in paragraph 15.205(a) shall not exceed the general requirements shown in paragraph 15.209.

5.4.2.Procedures

All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. The walls and ceiling of the shielded chamber are lined with ferrite tiles. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI

C63.4-2003 for site attenuation.

The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

A preliminary radiated emissions test was performed to determine the emission characteristics of the test item. For the preliminary test, a broadband measuring antenna was positioned at a 3 meter distance from the test item. The entire frequency range from 30MHz to 5.0GHz was investigated using a peak detector function. The data was then processed by the computer to calculate equivalent field intensity.

The final open field emission tests were then manually performed over the frequency range of 30MHz to 4000MHz. Between 30MHz and 1000MHz, a tuned dipole antenna was used as the pick-up device. A broadband double ridged waveguide antenna was used as the pick-up device for all frequencies above 1GHz. All significant broadband and narrowband signals were measured and recorded. The peak detected levels were converted to average levels using a duty cycle factor which was computed from the pulse train.

To ensure that maximum or worst case, emission levels were measured, the following steps were taken:

- 1) The test item was rotated so that all of its sides were exposed to the receiving antenna.
- 2) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.
- 3) The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.
- 4) For hand-held or body-worn devices, the test item was rotated through three orthogonal axes to determine which orientation produces the highest emission relative to the limit.

5.4.3.Results

The preliminary plots, with the test item transmitting at 418MHz, are presented on data pages 21 through 24. The plots are presented for a reference only, and are not used to determine compliance.

The final radiated emission levels, with the test item transmitting at 418MHz, are presented on data page 25. As can be seen from the data, all emissions measured from the test item were within the specification limits. The effective radiated power was calculated to be -37.5dBm. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figure 2.

5.5. Occupied Bandwidth Measurements

5.5.1.Requirement

In accordance with paragraph 15.231(c), all emissions within 20dB of the peak amplitude level of the center frequency are required to be within a band less than 0.25% of the center frequency wide per FCC CFR 15.231.

5.5.2.Procedures

The test item was placed on an 80cm high non-conductive stand. The unit was set to transmit continuously. With an antenna positioned nearby, occupied bandwidth emissions were displayed on the spectrum analyzer. The resolution bandwidth was set to 50 kHz and span was set to 2 MHz. The frequency spectrum near the fundamental was plotted.

5.5.3.Results

The plot of the emissions near the fundamental frequency is presented on data page 26. As can be seen from this data page, the transmitter met the occupied bandwidth requirements. The 99% bandwidth was measured to be 512kHz.



6. OTHER TEST CONDITIONS

6.1. Test Personnel and Witnesses

All tests were performed by qualified personnel from Elite Electronic Engineering Incorporated. The test series was witnessed by First Alert personnel.

6.2. Disposition of the EUT

The EUT and all associated equipment were returned to First Alert upon completion of the tests.

7. CONCLUSIONS

It was determined that the First Alert Poolside Alarm, Model No. Aqua One, Serial No. prototype, did fully meet the radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.205 et seq. for Intentional Radiators, when tested per ANSI C63.4-2003.

8. CERTIFICATION

Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the test specifications.

The data presented in this test report pertains to the EUT at the test date as operated by First Alert personnel. Any electrical or mechanical modification made to the EUT subsequent to the specified test date will serve to invalidate the data and void this certification.

This report must not be used to claim product endorsement by NVLAP or any agency of the US Government.



9. EQUIPMENT LIST

Table 9-1 Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
CDS2	COMPUTER	GATEWAY	MFATXPNT NMZ 500L	0028483108	1.8GHZ	N/A	
CMA1	Controllers	EMCO	2090	9701-1213	---	N/A	
NTA2	BILOG ANTENNA	TESEQ	6112D	28040	25-1000MHz	6/7/2010	6/7/2011
NWP0	DOUBLE RIDGED WAVEGUIDE ANTENNA	EATON	3115	2099	1GHZ-18GHZ	12/5/2009	12/5/2010
RAKG	RF SECTION	HEWLETT PACKARD	85462A	3549A00284	0.009-6500MHZ	2/16/2010	2/16/2011
RAKH	RF FILTER SECTION	HEWLETT PACKARD	85460A	3448A00324	---	2/16/2010	2/16/2011
RBB0	EMI TEST RECEIVER 20HZ TO 40 GHZ.	ROHDE & SCHWARZ	ESIB40	100250	20 HZ TO 40GHZ	3/16/2010	3/16/2011
XLTH	5W, 50 OHM TERMINATION	JFW INDUSTRIES	50T-052	017	DC-2GHZ	1/5/2010	1/5/2011

I/O: Initial Only

N/A: Not Applicable

Note 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.

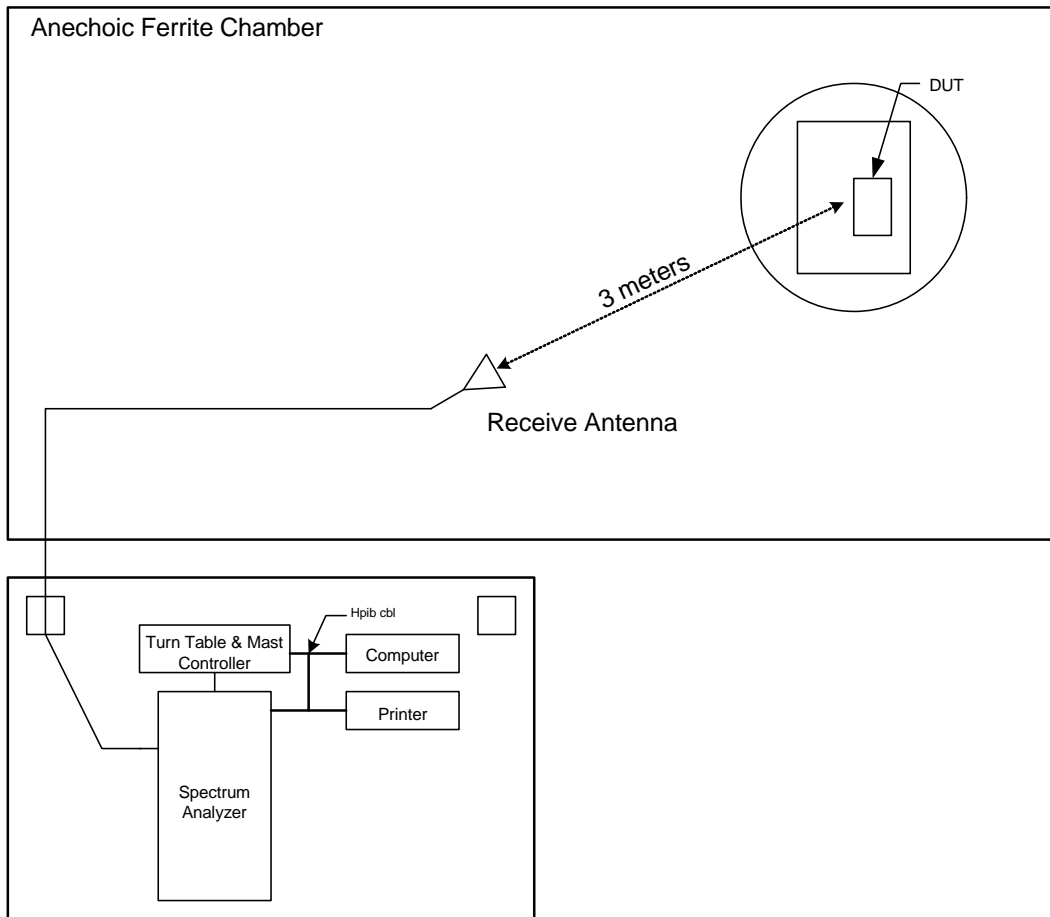
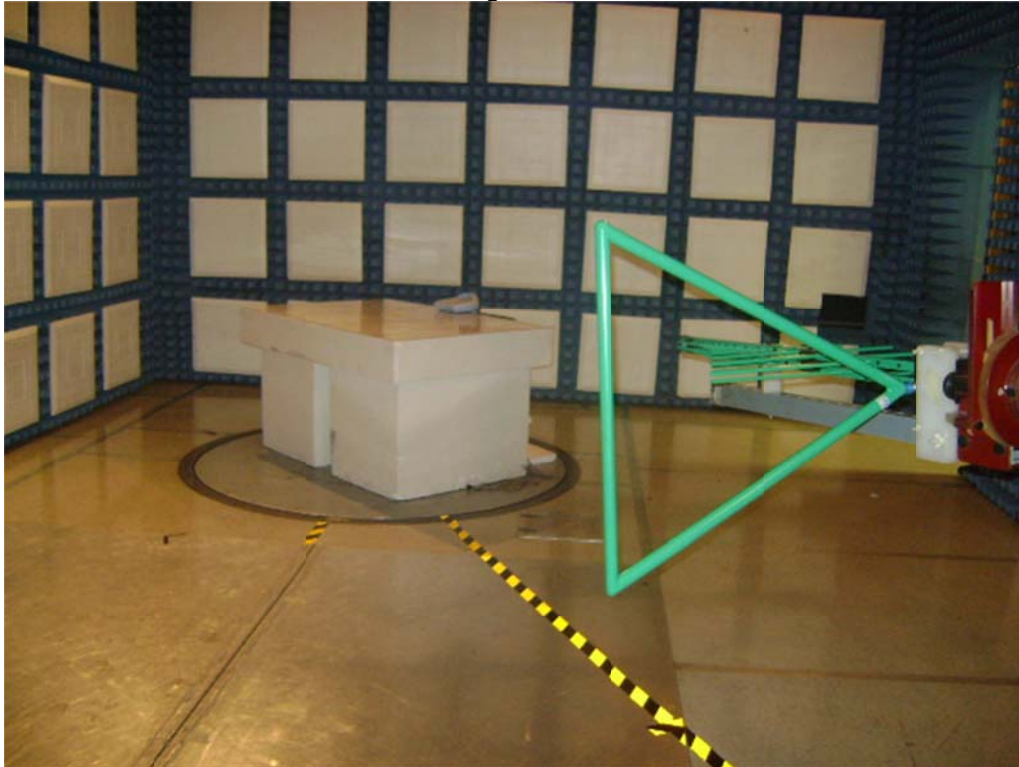


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2

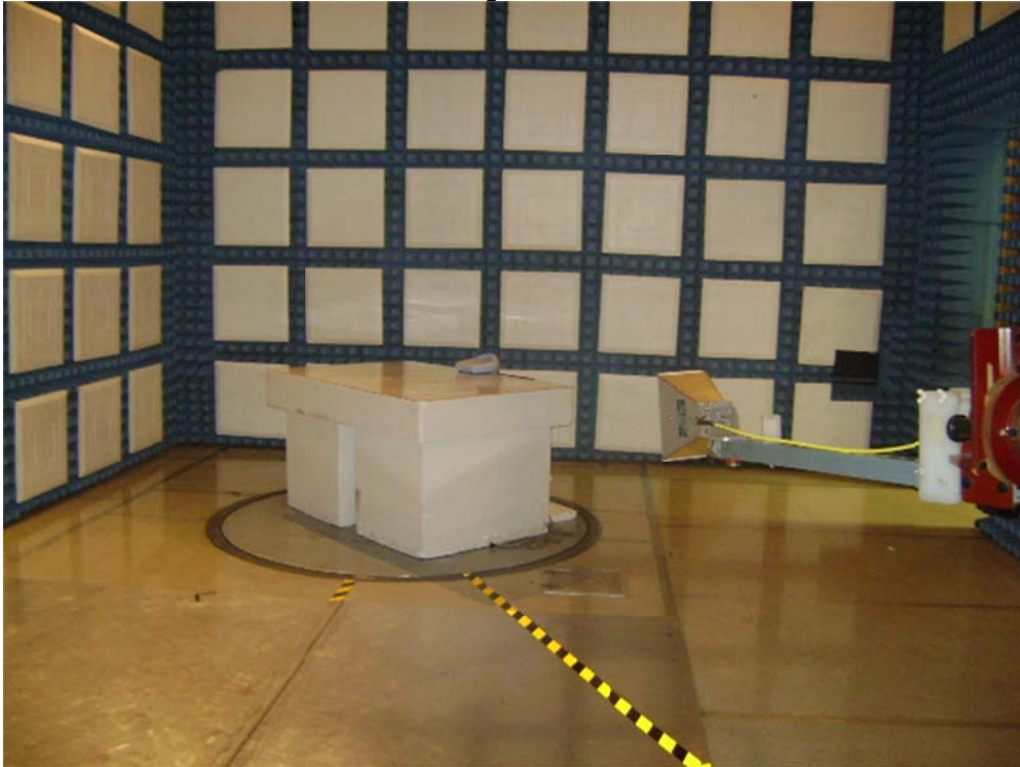


Test Setup for Radiated Emissions, 30MHz to 1GHz – Horizontal Polarization



Test Setup for Radiated Emissions, 30MHz to 1GHz – Vertical Polarization

Figure 3



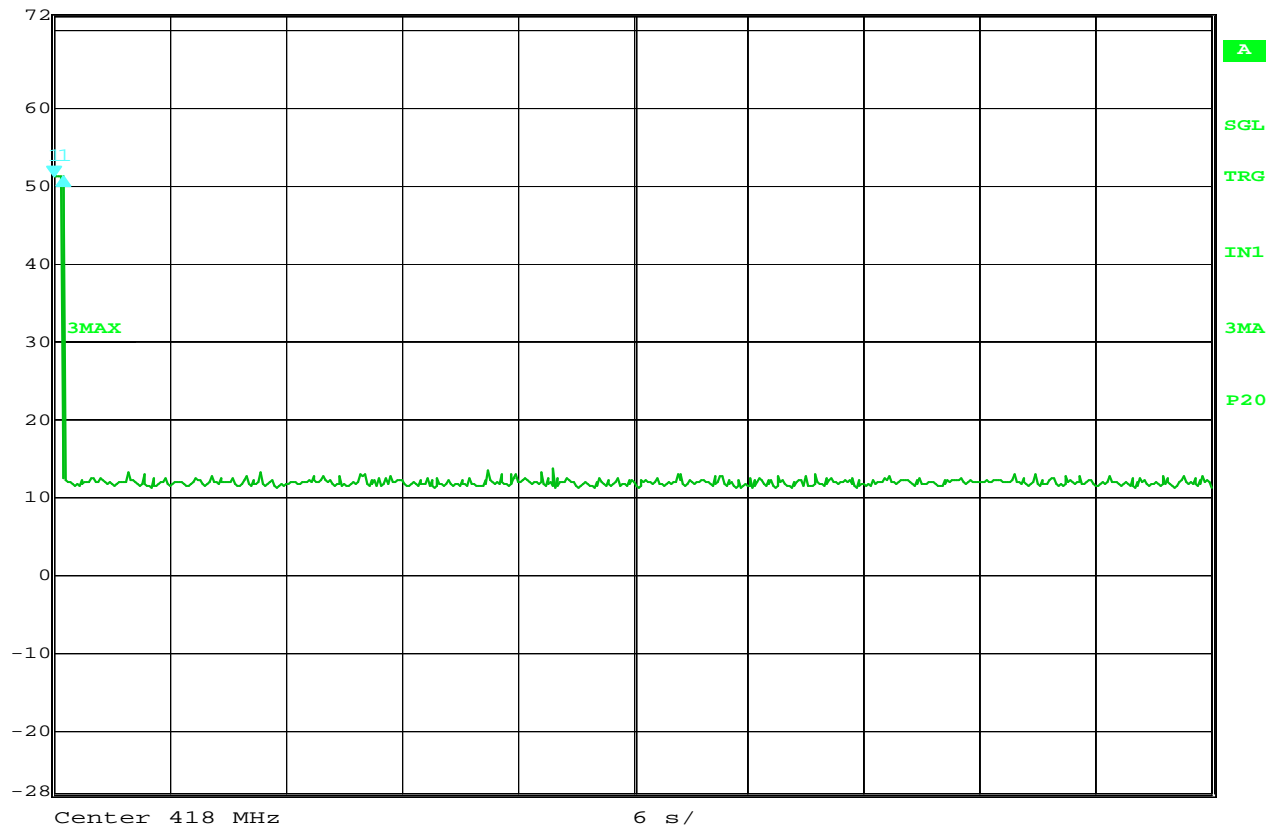
Test Setup for Radiated Emissions, Above 1GHz – Horizontal Polarization



Test Setup for Radiated Emissions, Above 1GHz – Vertical Polarization



Delta 1 [T3] RBW 1 MHz RF Att 0 dB
Ref Lvl 0.00 dB VBW 10 MHz
72 dBV 480.961924 ms SWT 60 s Unit dBV



Date: 23.AUG.2010 08:19:41

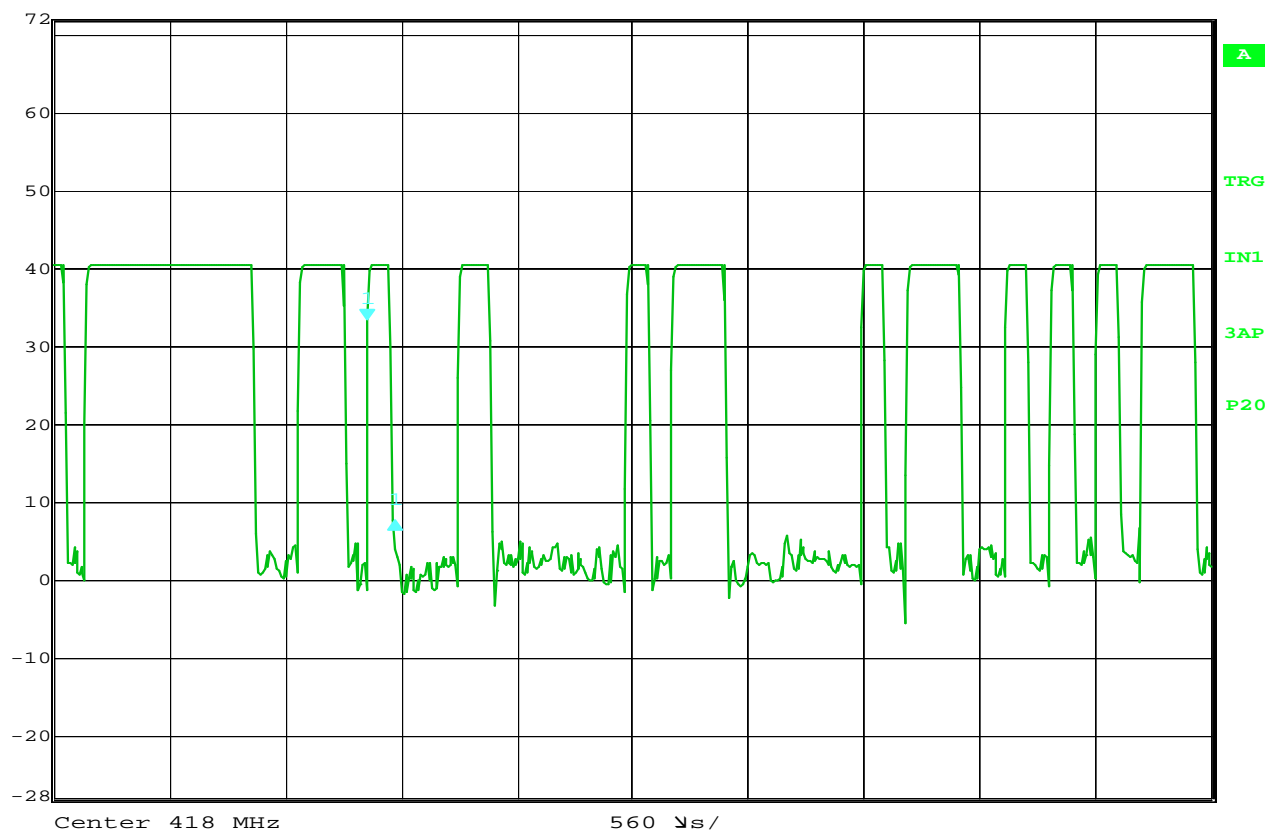
Periodic Operation

MANUFACTURER : First Alert
MODEL NUMBER : Aqua One
SERIAL NUMBER :
TEST MODE : Pulse width = 480.9mS
TEST PARAMETERS : The silent period between transmissions is greater than 30 times the transmission

NOTES



Delta 1 [T3] RBW 50 kHz RF Att 0 dB
Ref Lvl -25.78 dB VBW 50 kHz
72 dBμV 134.669339 μs SWT 5.6 ms Unit dBμV



Date: 12.AUG.2010 09:52:29

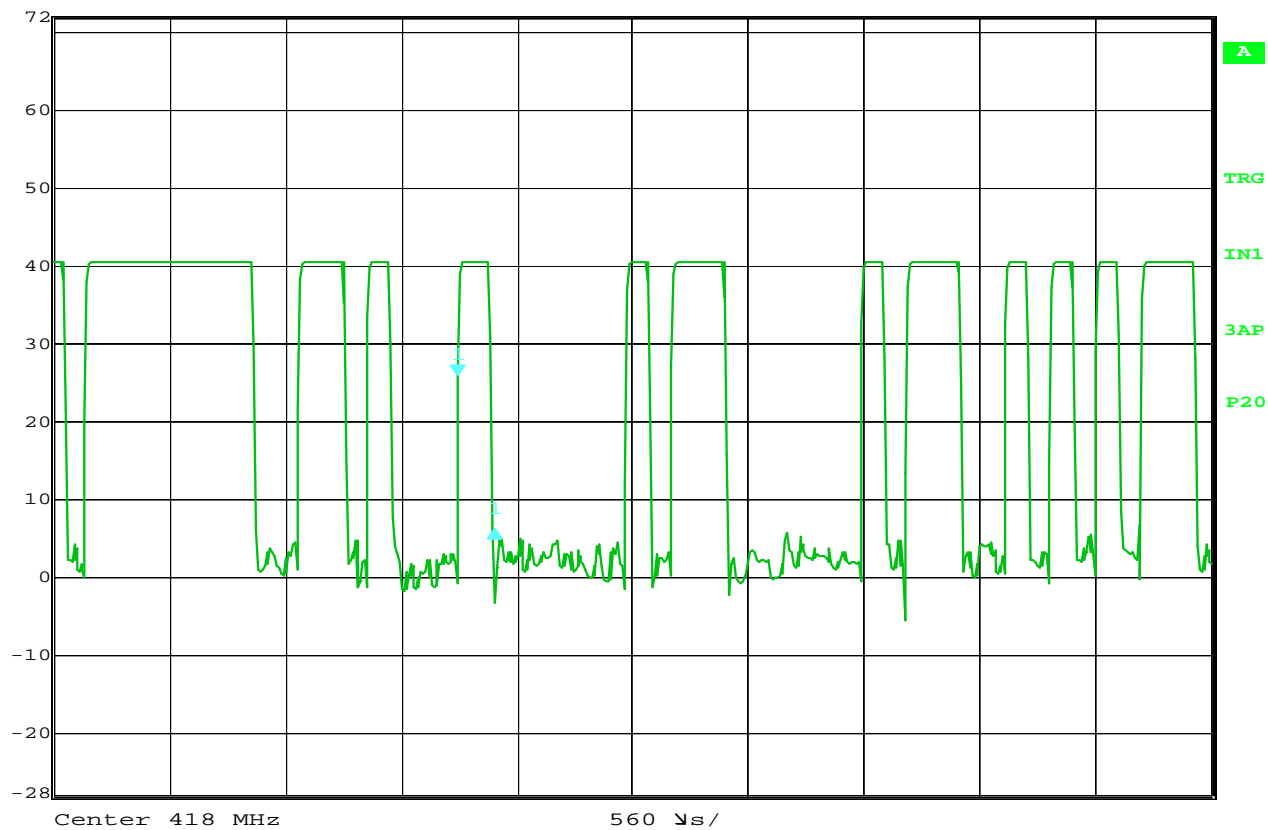
Duty Cycle Factor

MANUFACTURER : First Alert
MODEL NUMBER : Aqua One
SERIAL NUMBER :
TEST MODE : 134.6 μs pulse width
TEST PARAMETERS :

NOTES



Delta 1 [T3] RBW 50 kHz RF Att 0 dB
Ref Lvl -19.82 dB VBW 50 kHz
72 dBV 179.559118 μ s SWT 5.6 ms Unit dBV



Date: 12.AUG.2010 09:49:53

Duty Cycle Factor

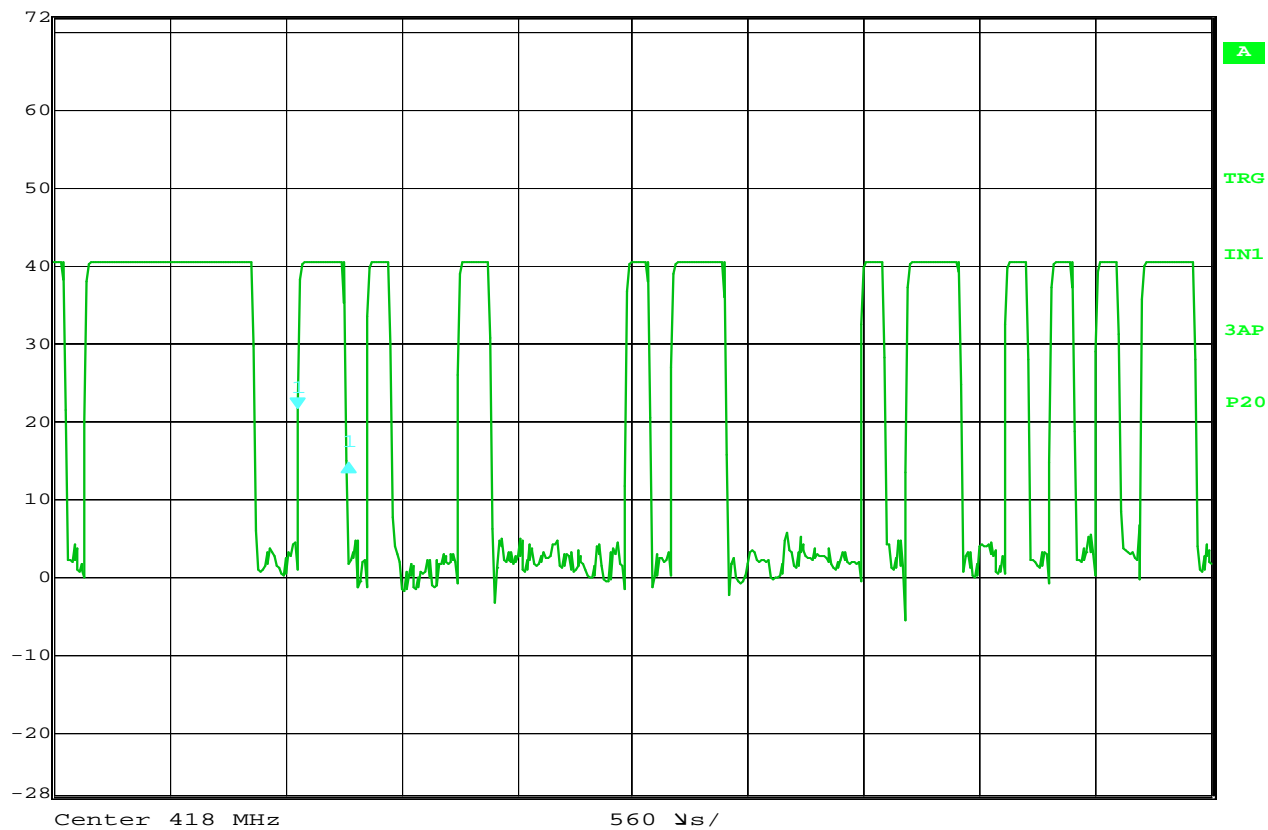
MANUFACTURER : First Alert
MODEL NUMBER : Aqua One
SERIAL NUMBER :
TEST MODE : 179.6 μ s pulse width
TEST PARAMETERS :

NOTES



Delta 1 [T3]
Ref Lvl -6.87 dB
72 dBμV 246.893788 μs

RBW 50 kHz RF Att 0 dB
VBW 50 kHz
SWT 5.6 ms Unit dBμV



Date: 12.AUG.2010 09:51:07

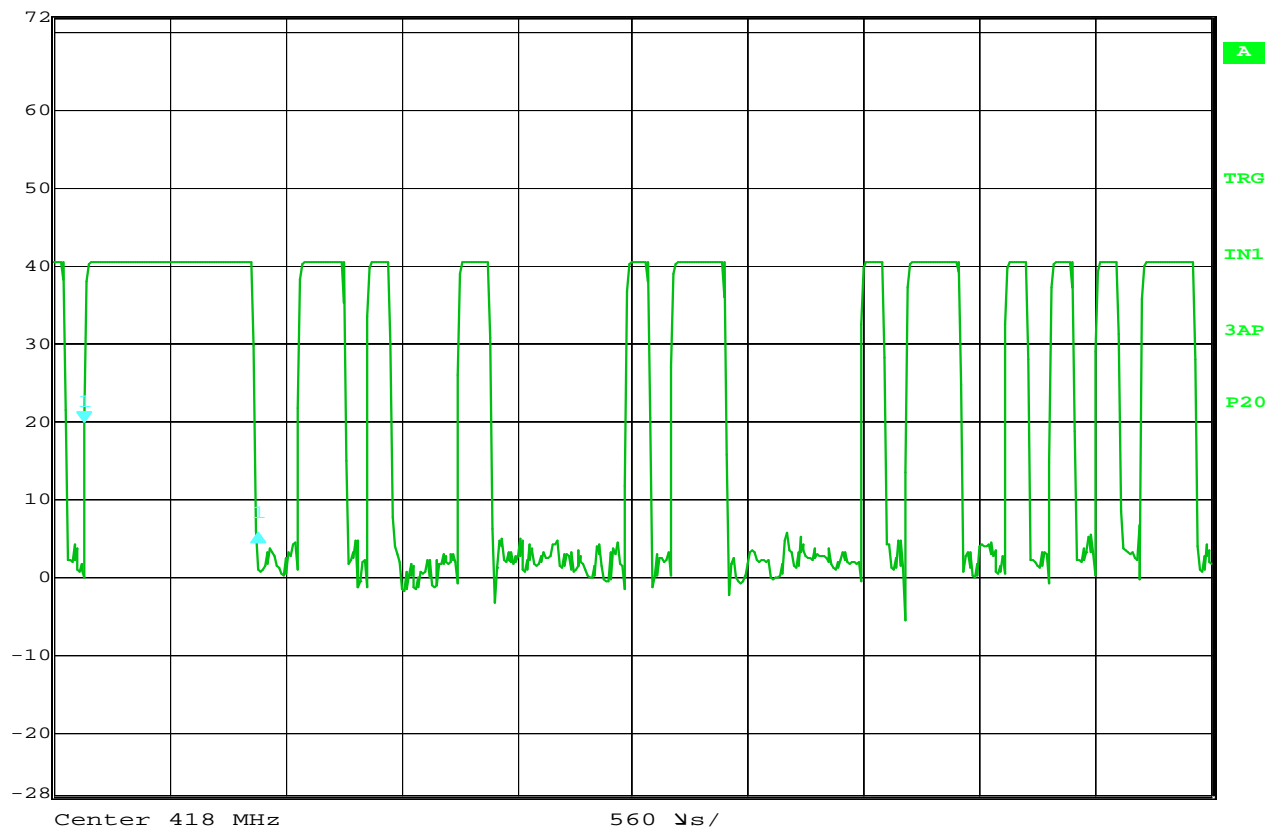
Duty Cycle Factor

MANUFACTURER : First Alert
MODEL NUMBER : Aqua One
SERIAL NUMBER :
TEST MODE : 246.89 μs pulse width
TEST PARAMETERS :

NOTES



Delta 1 [T3] RBW 50 kHz RF Att 0 dB
Ref Lvl -14.21 dB VBW 50 kHz
72 dBV 841.683367 μ s SWT 5.6 ms Unit dBV



Date: 12.AUG.2010 09:47:32

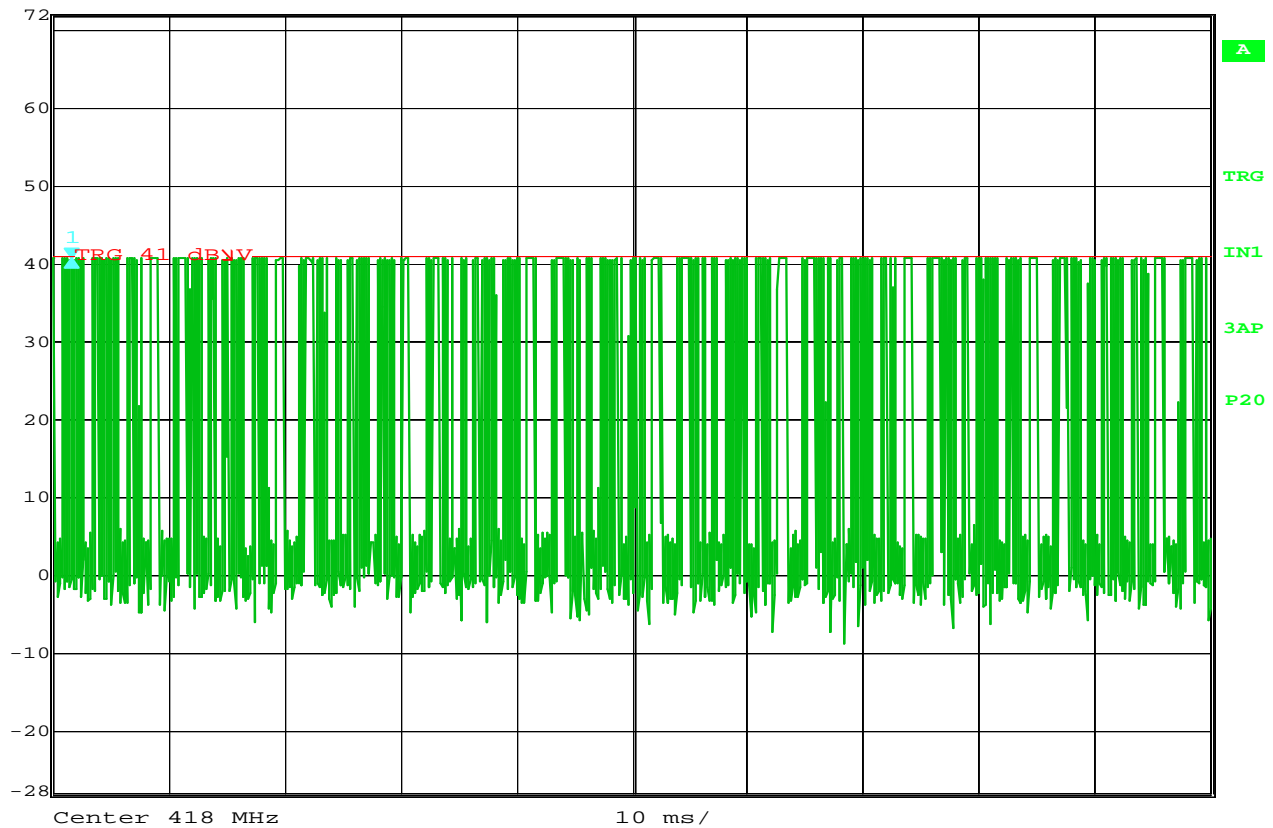
Duty Cycle Factor

MANUFACTURER : First Alert
MODEL NUMBER : Aqua One
SERIAL NUMBER :
TEST MODE : 841.68 μ s pulse width
TEST PARAMETERS :

NOTES



Delta 1 [T3] RBW 50 kHz RF Att 0 dB
Ref Lvl 0.00 dB VBW 50 kHz
72 dBV 134.669339 μ s SWT 100 ms Unit dBV



Date: 12.AUG.2010 09:54:00

Duty Cycle Factor

MANUFACTURER : First Alert
MODEL NUMBER : Aqua One
SERIAL NUMBER :
TEST MODE : Pulse train in 100mS
TEST PARAMETERS :

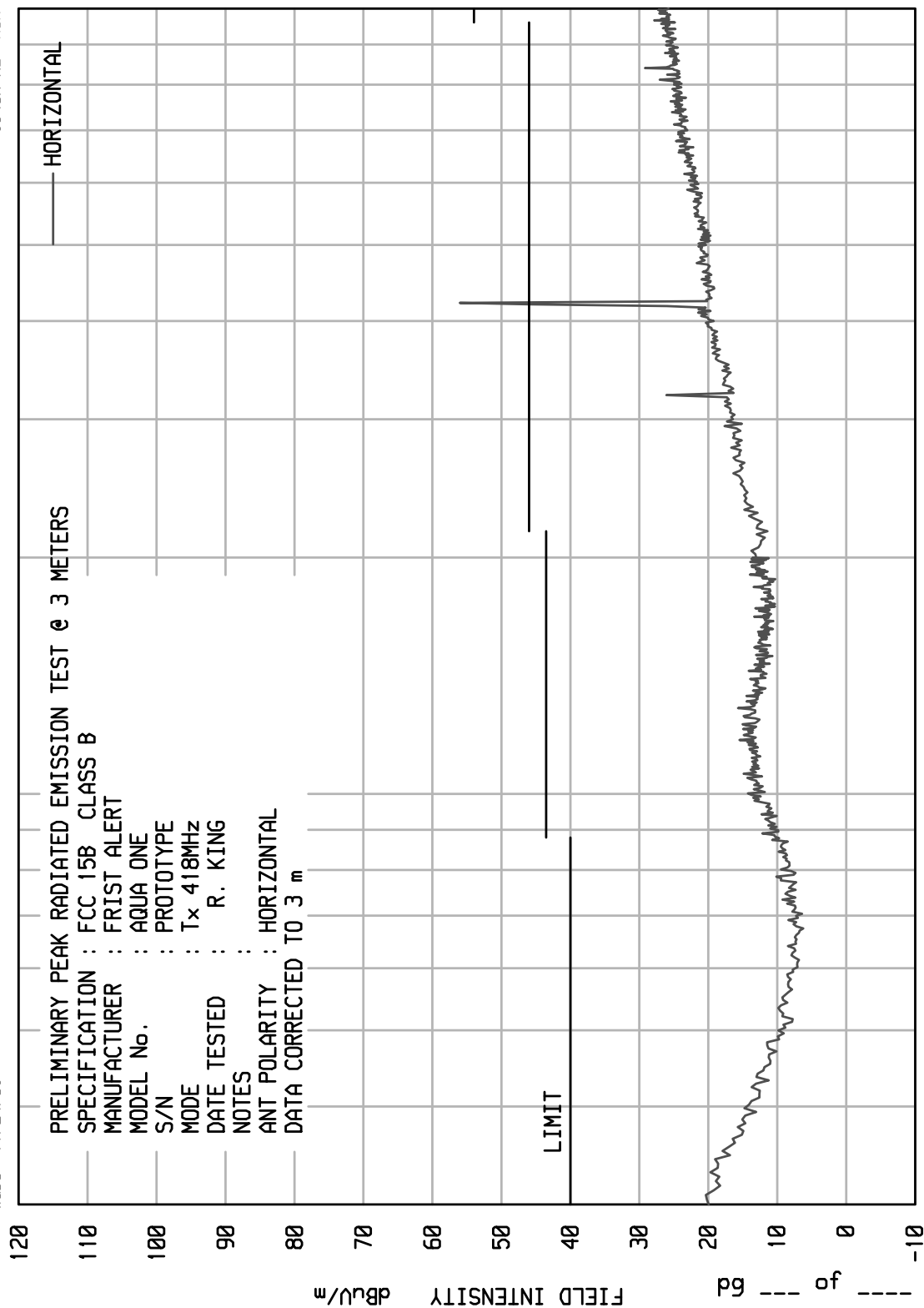
NOTES



ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515

11/24/08

8546A RE RUN 1

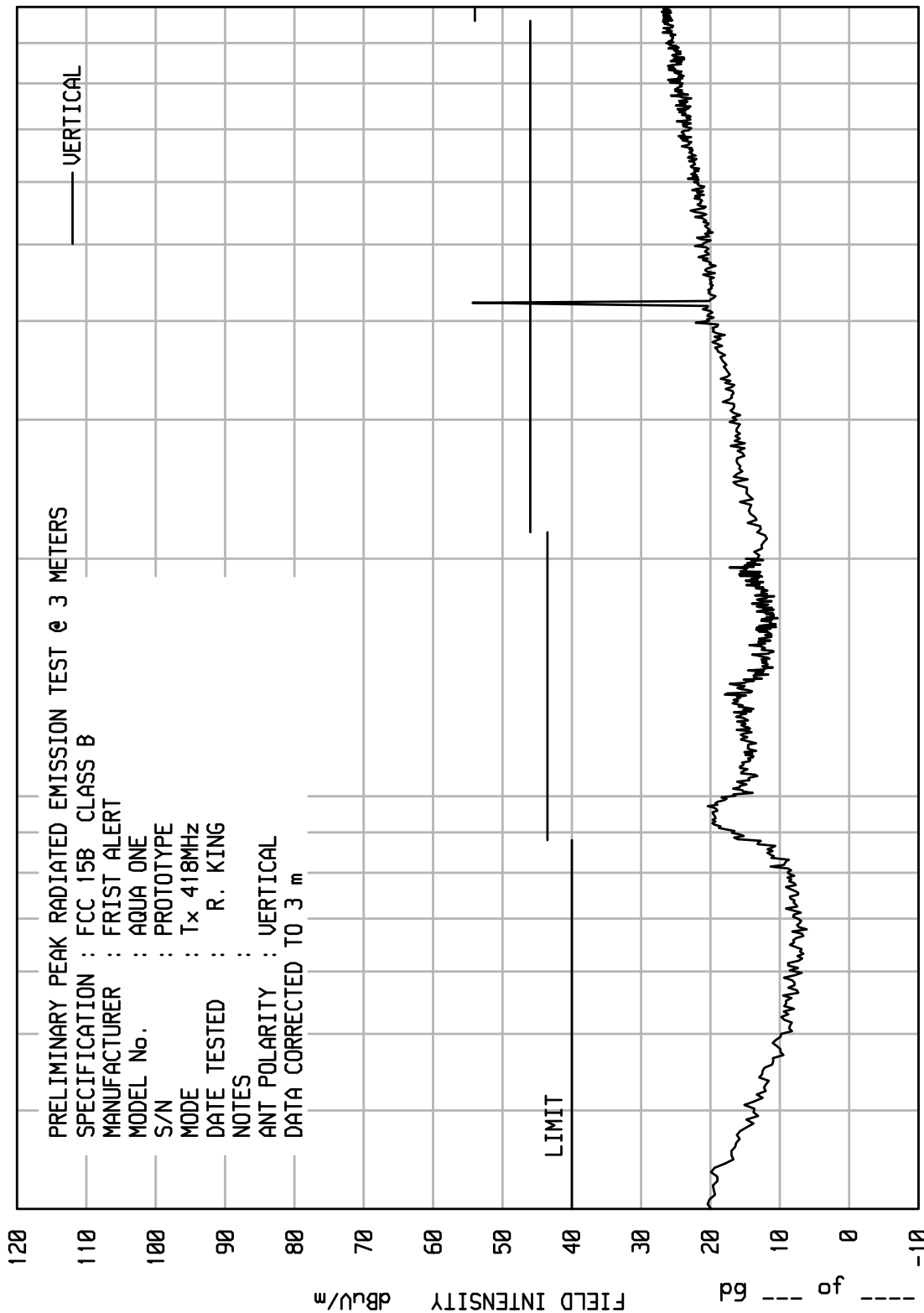


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515

11/24/08

8546A RE RUN 1

PRELIMINARY PEAK RADIATED EMISSION TEST @ 3 METERS
SPECIFICATION : FCC 15B CLASS B
MANUFACTURER : FRIST ALERT
MODEL No. : AQUA ONE
S/N : PROTOTYPE
MODE : Tx 418MHz
DATE TESTED : R. KING
NOTES :
ANT POLARITY : VERTICAL
DATA CORRECTED TO 3 m

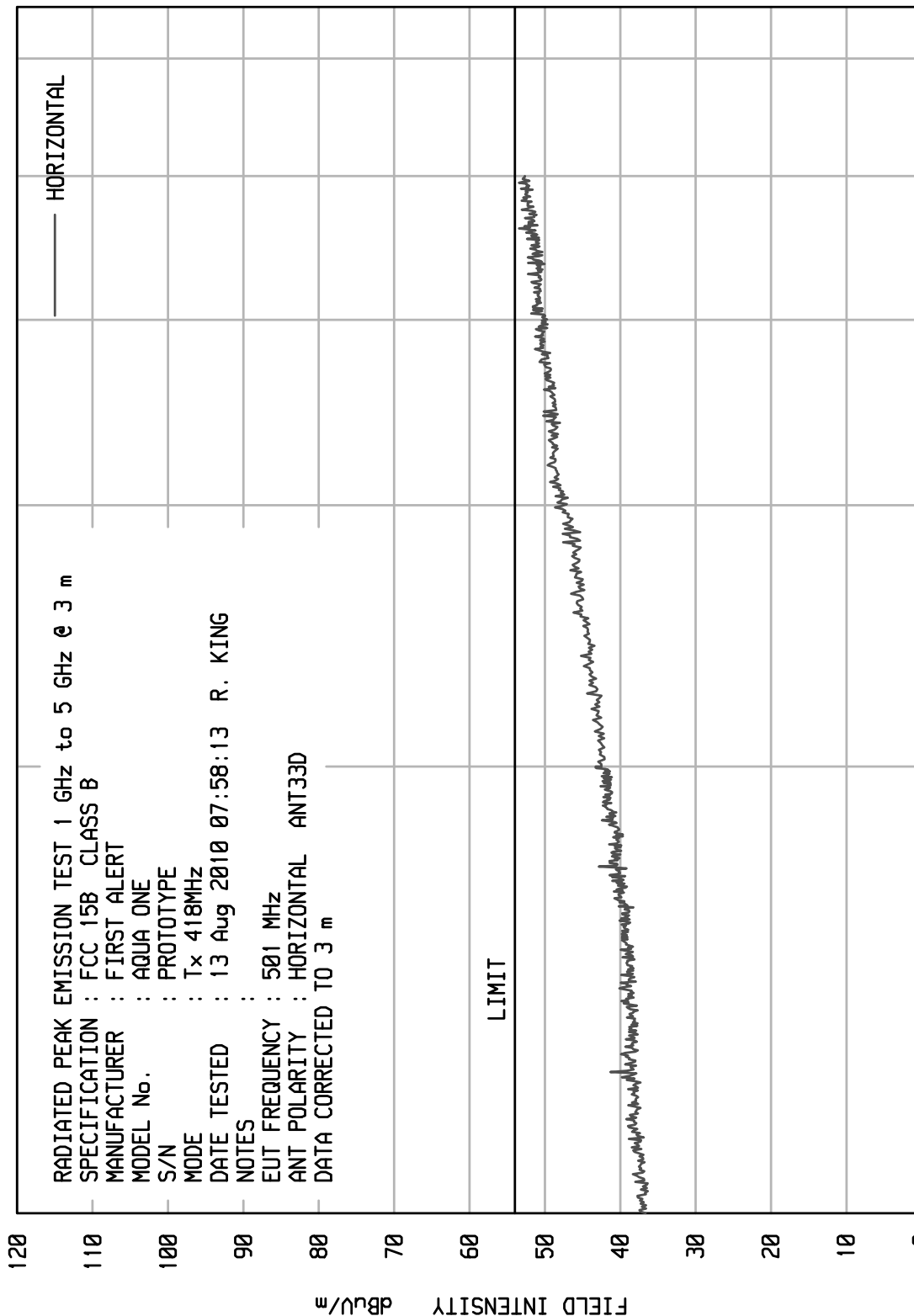




ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515

WQC08 03/19/09

8546A HF RUN 1



START = 1000

FREQUENCY - MHz

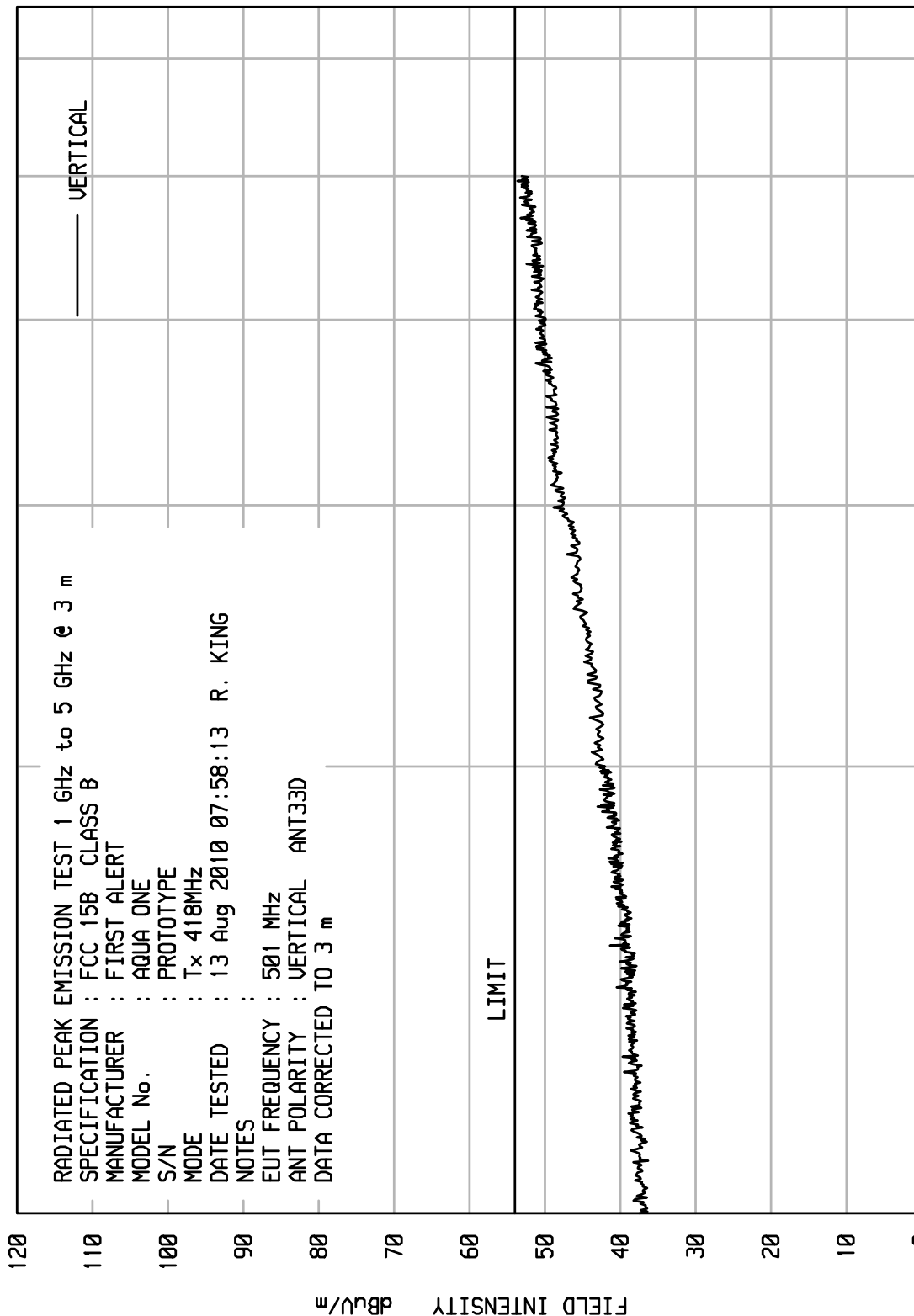
STOP = 6500



ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515

WQC08 03/19/09

8546A HF RUN 1



START = 1000

FREQUENCY - MHz

STOP = 6500



Data Page

MANUFACTURER : First Alert
TEST ITEM : Poolside Alarm
MODEL NO. : Aqua One
SERIAL NO. : none
SPECIFICATION : FCC- 15C Transmitter Open Field Data
DATE : August 12 and 13, 2010
NOTES : Test Distance is 3 Meters

Freq (MHz)	Ant Pol	Meter Reading (dBuV)	CBL Fac (dB)	Ant Fac (dB)	Duty Cycle Factor (dB)	Total dBuV/m at 3 M	Total uV/m at 3M	Limit uV/m at 3M	Margin (dB)
418.0	H	41.5	1.6	18.0	-1.5	59.7	967.4	4133.3	-12.6
418.0	V	36.7	1.6	18.0	-1.5	54.9	554.8	4133.3	-17.4
836.0	H	10.5	2.3	22.2	-1.5	33.5	47.2	413.3	-18.8
836.0	V	6.6	2.3	22.2	-1.5	29.7	30.4	413.3	-22.7
1254.0	H	16.4	2.8	25.6	-1.5	43.3	146.9	500.0	-10.6
1254.0	V	14.7	2.8	25.6	-1.5	41.7	121.5	500.0	-12.3
1672.0	H	14.7	3.3	26.8	-1.5	43.4	148.6	500.0	-10.5
1672.0	V	13.6	3.3	26.8	-1.5	42.3	130.1	500.0	-11.7
2090.0	H	15.8	3.7	28.4	-1.5	46.5	210.2	500.0	-7.5
2090.0	V	15.3	3.7	28.4	-1.5	45.9	197.0	500.0	-8.1
2508.0	H	14.0	3.9	29.4	-1.5	45.8	194.5	500.0	-8.2
2508.0	V	13.3	3.9	29.4	-1.5	45.1	180.3	500.0	-8.9
2926.0	H	14.0	4.0	30.9	-1.5	47.4	235.8	500.0	-6.5
2926.0	V	14.6	4.0	30.9	-1.5	48.1	252.9	500.0	-5.9
3344.0	H	13.8	4.4	32.3	-1.5	49.1	285.0	500.0	-4.9
3344.0	V	14.0	4.4	32.3	-1.5	49.2	289.3	500.0	-4.8
3762.0	H	14.8	4.8	33.4	-1.5	51.6	381.6	500.0	-2.3
3762.0	V	14.8	4.8	33.4	-1.5	51.6	380.2	500.0	-2.4
4180.0	H	13.5	5.2	33.8	-1.5	51.0	356.6	500.0	-2.9
4180.0	V	14.6	5.2	33.8	-1.5	52.1	404.8	500.0	-1.8

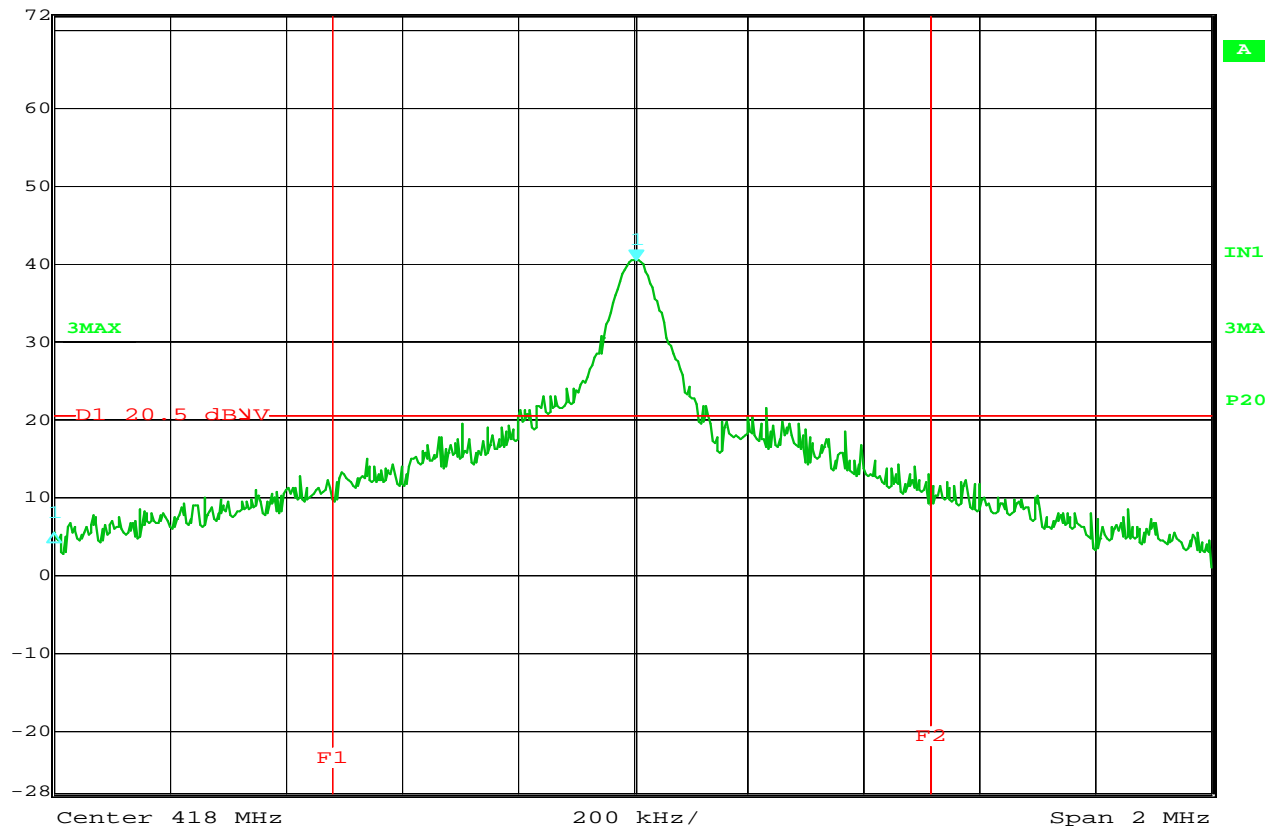
Note: Since the duty cycle factor is less than 20dB, the emissions also meet the peak limit.

Checked BY : RICHARD E. King

Richard E. King



Marker 1 [T3] RBW 50 kHz RF Att 0 dB
Ref Lvl 40.48 dBμV VBW 50 kHz
72 dBμV 418.00601202 MHz SWT 5.5 ms Unit dBμV



Date: 12.AUG.2010 09:59:34

Occupied Bandwidth

MANUFACTURER : First Alert
MODEL NUMBER : Aqua One
SERIAL NUMBER : prototype
TEST MODE : transmit at 418MHz
TEST PARAMETERS :

NOTES