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Test Report

Company:	Greenfield Direct, LLC 14015 238th St. Greenwood, NE 68003
Contact:	Scott Morgan
Product:	FloodBug
FCC ID: IC ID:	YBR-FB-2 8924A-FB100
Test Report No:	R081011-40E
APPROVED BY:	Nic Johnson Test Engineer
DATE:	19 October 2011
Total Pages:	26

1.0 Summary of test results

1.1 Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARDS: 47 CFR Part 15 & RSS-210			
Standard Section	**Test Type and Limit**	**Result**	**Remark**
15.207 RSS-Gen	Conducted AC Mains Emissions	Pass	Meets the requirement of the limit.
15.209, 15.231 RSS-Gen	Radiated Emissions Peak Output Field Strength Limit: 80.83dBµV/m	Pass	Meets the requirement of the limit.
15.231 RSS-210 Issue 8	Bandwidth	Pass	Meets the requirement of the limit.

1.2 Reason for amendment.

The Table from Section 1.1 was updated to list RSS-210 Issue 8. All testing was reviewed to ensure methods and results from previous testing were in accordance to the new standard.

This report, R031510-01-01A is meant to amend and replace report R031510-01-01.

Amendment B:
FCC ID Changed
A RF duty cycle document was proided by KZCO.
Calibration dates were corrected.
The resolution bandwidth of conducted emissions measurements was added to Section 4.1.2.

Amendment C:
Changed contact to Scott Morgan
Changed IC number back to 8924A-FB100

Amendment D:

1. Figure 5 showing the duty cycle has been put back in the report. The duty cycle correction factor has been correct to 20*log(85.577/100) = -1.35dB. All of the values in Table 4 were reduced by 0.30dB because the original duty cycle correction factor used was -1.05dB. All original test values were verified with original data to ensure that the values listed in the table are of the original field strength measurements and the -1.35dB correction factor.
2. For the 1 - 5GHz range, only peak measurements are shown, since they comply with the average limits. The noet under Table 5 has been modified to state this, and that the peak measurements are also compliant with the peak limit.
3. FCC Id is listed as YBR-FB-2. Contact is listed as Scott Morgan
4. Updated Theory of operation from KZCO has been put in report to replace old theory of operation.

Amendment E:

1. The duty cycle correction factor was corrected using 88.577ms
2. The theory of operation was corrected.

2.0 Description

2.1 Equipment under test

The FloodBug is a moisture detector which wirelessly transmits an alarm to a central valve controller (the VIP or Valve Interface Panel) to shut off water in a home or business. The FloodBug can operate either using battery or an external DC power supply. It can use a built-in water sensor or a remote water sensor, connected by a cable.

The FloodBug is anticipated to be more often than not powered by two AA non-rechargeable alkaline cell batteries. The ground line on the battery will be disconnected, however, when a 5VDC power supply is plugged into the 2.1 MM power jack. The EUT is supplied with a 5VDC Tech Power Int. power supply, M/N TSA9-050120WU.

EUT Received Date: 8/10/2011
EUT Tested Date: 8/10/2011

PRODUCT	FloodBug
SERIAL NUMBER	Continuous transmit unit: 708
POWER SUPPLY	2 AA Batteries/5VDC power supply
MODULATION TYPE	FSK
FREQUENCY RANGE	433.92MHz
NUMBER OF CHANNELS	1
ANTENNA TYPE	Internal dipole
I/O PORTS	1 – External water sensor, Sidekick
ASSOCIATED DEVICES	FloTrax, V.I.P. Digital

Figure 1 - EUT Photo, Normal Firmware

Figure 2 - EUT Photo, Normal Firmware

Figure 3 - EUT Photo, Normal Firmware

FCC Label covered pending final design

NOTE:

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

2.2 Laboratory description

All testing was performed at the NCEE Lincoln facility, which is a FCC and IC registered lab. This site has been fully described in previously submitted reports. Laboratory environmental conditions varied slightly throughout the tests:

Relative humidity of 45 ± 4%

Temperature of 20 ± 3° Celsius

2.3 Description of test modes

The EUT was modified by the manufacturer to transmit continuously for testing purposes. It was set to transmit one packet after another with 20ms in between transmissions

2.4 Applied standards

The EUT is a low-power transmitter device operating on one frequency at 433.92MHz. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC Part 15.207, 15.209 and 15.231 using ANSI/IEEE C63.4: 2003
Industry Canada, RSS 210, Issue 7, Category I Equipment

All test items have been performed and recorded as per the above standards.

2.5 Configuration of system under test

The EUT was set to transmit a continuous carrier signal at the lowest possible frequency, highest possible frequency, and on in the middle of the operating range. The EUT was also tested in a mode of operation in which it ran in its normal operating condition, waiting to receive data.

The EUT was tested with the 5VDC supply and remote water sensor (See Appendix A for photos).

2.6 Duty Cycle Calculation

The FloodBug (Part No. GF1001 Rev-2) is designed to have a very low duty cycle. All messages are short transmission (measured to be 88.577 ms) and contain the FloodBug ID (serial number) and status.

The FloodBug tests system integrity by transmitting a message at power up and approximately every 6 hours, under normal circumstances. This message is repeated up to a maximum of 10 times. Each message is prefaced by a random delay interval which is 125 milliseconds multiplied by a random number between 1 and 16 plus the time spent in communicating with the transceiver chip plus five seconds. The system integrity messages cease after the first acknowledgement is received from the VIP.

On water detect (alarm condition) a message is sent (message is prefaced by a random delay interval which is 125 milliseconds multiplied by a random number between 1 and 16 plus the time spent in communicating with the transceiver chip) by the FloodBug to notify the system controller of a water leak. Once the

message has been sent the FloodBug resumes the sleep state and sets a timer for approximately 30 seconds at which time it wakes itself up and checks the water sensor again. If the sensor is wet then an alarm message is sent (message is prefaced by a random delay interval which is 125 milliseconds multiplied by a random number between 1 and 16 plus the time spent in communicating with the transceiver chip). If the FloodBug wakes up from the "short sleep" and the sensor is not still wet the FloodBug will send an "all clear" message (message is prefaced by a random delay interval which is 125 milliseconds multiplied by a random number between 1 and 16 plus the time spent in communicating with the transceiver chip) and set the sleep timer back to 6 hours.

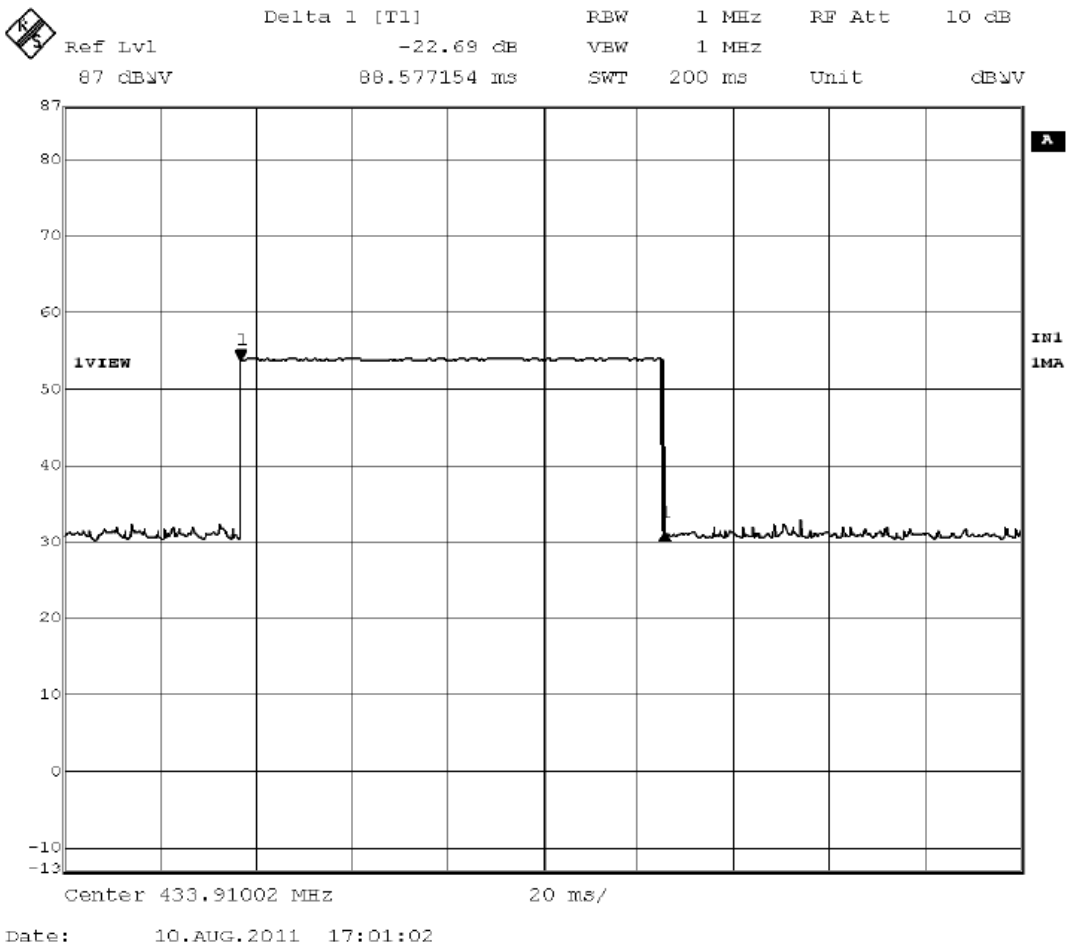


Figure 4 - Transmission Length Plot, 88.577ms

3.0 Test equipment used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE
*Rohde & Schwarz Test Receiver	ESIB26	100037	06/09/2009
Rohde & Schwarz Test Receiver	ESI7	100007	06/09/2009
EMCO Biconilog Antenna	3142B	1647	02/10/2010
EMCO Horn Antenna	3115	6416	02/06/2009
Rohde & Schwarz Preamplifier	TS-PR18	082001/003	12/15/2009*
Rohde & Schwarz LISN	ESH3-Z5	836679/010	2/10/2010

*Internal characterization

4.0 Detailed results

4.1 15.207 Conducted AC emissions

4.1.1 Limits for conducted emissions measurements

FREQUENCY OF EMISSION (MHz)	CONDUCTED LIMIT (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5	56	46
5-30	60	50

NOTE: 1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz.
3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

4.1.2 Test Procedures

a. The EUT was placed 0.8m above a ground reference plane and 0.4 meters from the conducting wall of a shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). The LISN provides 50 ohm/ 50uH of coupling impedance for the measuring instrument. The resolution bandwidth was 9kHz.

b. Both lines of the power mains connected to the EUT were checked form maximum conducted interference as well as the ground. The EUT was powered by a 5VDC power supply.

c. The frequency range from 150 kHz to 30 MHz was searched.

4.1.3 Deviation from the test standard

No deviation

4.1.4 Test setup

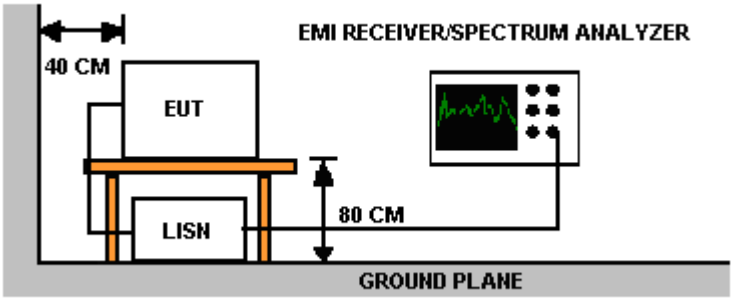


Figure 5 - Conducted Emissions Test Setup

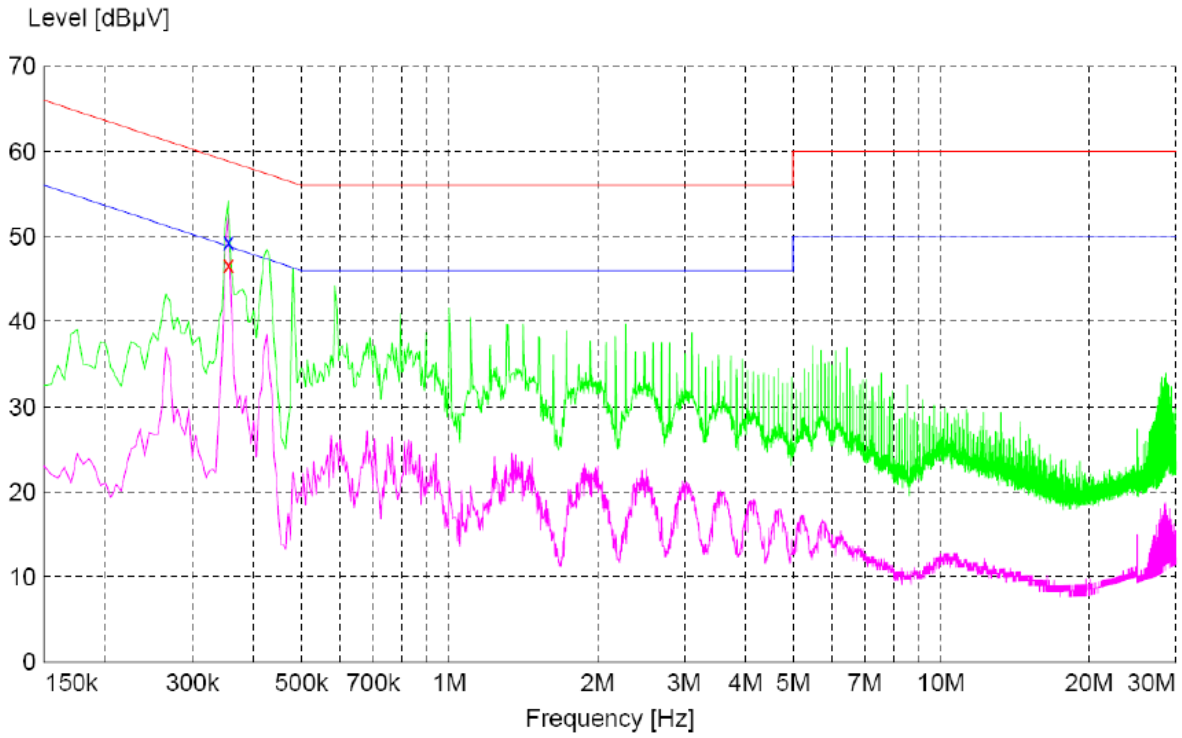
For actual test configuration, see photographs in Appendix A

4.1.5 EUT operating conditions

The conducted emissions were tested from a 5VDC power supply from Tech-power International, M/N TSA9-050120WU while providing power to the EUT. The EUT was set to transmit continuously.

4.1.6 Test Results

EUT	FloodBug	MODE	Cont. Transmit
INPUT POWER	120VAC/60Hz	DATE	10 August 2011
Power Supply Voltage	5VDC	FREQUENCY RANGE	150kHz – 30MHz
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson



REMARKS:
1. Q.P. and AV. are abbreviations for quasi-peak and average respectively.
2. The red line indicates the quasi-peak/peak limits, and the green line the peak measurements.
3. The blue line indicates the average limits, and the violet the peak measurements.

Table 1 - Conducted Emissions Measurements

Frequency	Level	Limit	Margin	Line	Detector
MHz	dBµV/m	dBµV/m	dB		
0.335000	49.50	59.00	9.4	N	Peak
0.355000	46.70	49.00	2.1	N	Average

Table 2 – 6 Highest Peak Measurements with respect to the Limit

Frequency	Level	Line
MHz	dBµV	
0.3550	53.56	L1
0.4250	49.03	N
0.3500	48.73	L1
0.4200	47.96	L1
0.4300	47.70	N
0.4150	44.98	N

4.2 15.209, 15.231 Radiated emissions

4.2.1 Limits for radiated emissions measurements

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

FREQUENCIES (MHz)	FIELD STRENGTH (μV/m)	MEASUREMENT DISTANCE (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (uV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.
4. The radiated emissions limit according to FCC Part 15.231(b) for a transmitter operating at 433.02MHz is 80.84dBμV/m at a 3m test distance.

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 receive 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.

NOTE:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.

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

4.2.3 Deviations from test standard

No deviation.

4.2.4 Test setup

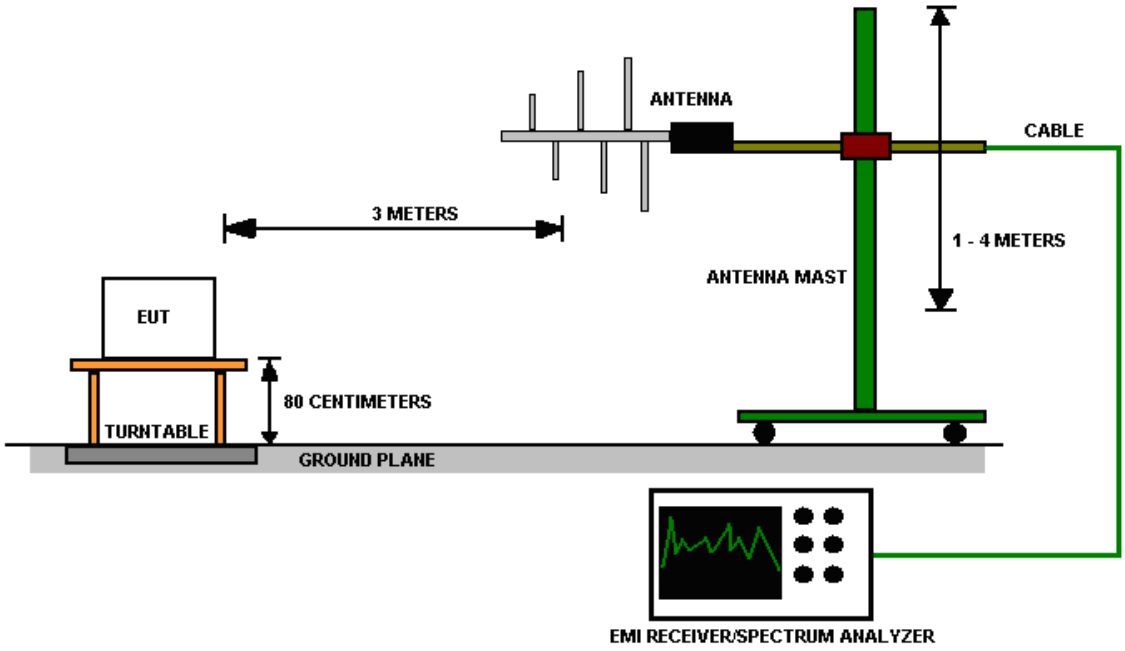


Figure 6 - Radiated Emissions Test Setup

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

4.2.5 EUT operating conditions

See section 2.5 for details.

4.2.6 Test results

EUT	FloodBug	DATE	10 August 2011
MODE	Transmit Continuously Receive/Standby	FREQUENCY RANGE	30MHz – 5GHz
INPUT POWER (SYSTEM)	120VAC/60Hz to 5VDC Power supply/ 2 AA Batteries	ORIENTATION	Vertical/Horizontal
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

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. The radiated emissions limit according to FCC Part 15.231(a) is 80.83dBµV/m for 433.92MHz at a 3m test distance. This applies to an average measurement. See calculations after the chart.

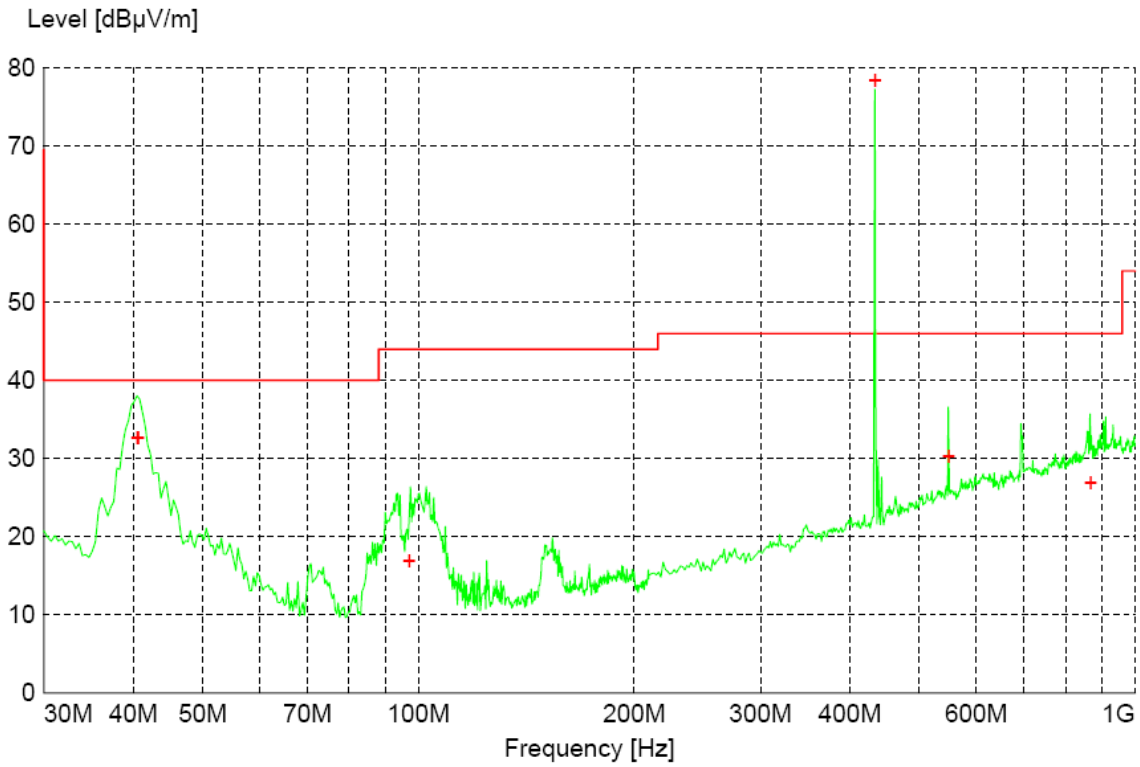


Figure 7 - Radiated Emissions Plot, EUT Orientation 1

Table 3 - Radiated Emissions Quasi-peak Measurements, 30MHz – 1GHz, Transmit Mode

Frequency	Level	Limit	Margin	Height	Angle	Pol	EUT Orientation
MHz	dBìV/m	dBìV/m	dB	cm.	deg.		
40.5000	32.79	40.00	7.20	99	326	VERT	EUT Flat, AC
40.6200	32.80	40.00	7.20	100	256	VERT	EUT Flat, AC
97.0800	17.03	44.00	27.00	101	109	VERT	EUT Flat, AC
549.2400	30.40	46.00	15.60	291	106	VERT	EUT Flat, AC
867.0600	26.91	46.00	19.10	147	172	HORI	EUT Flat, AC

Table 4 - Radiated Emissions Peak Measurements, 30MHz – 1GHz, Transmit Mode

Frequency	Level	Limit	Margin	Height	Angle	Pol	EUT Orientation
MHz	dBìV/m	dBìV/m	dB	cm.	deg.		
433.9200	77.37_2	80.84_1	3.47	126	253	VERT	EUT Flat, AC
433.9200	76.92_2	80.84_1	3.92	115	214	VERT	EUT on Side, AC
433.9200	77.54_2	80.84_1	3.30	114	6	VERT	EUT Upright, AC
433.9200	79.12_2	80.84_1	1.72	130	62	VERT	EUT Upright, battery

Note$_1$: Average Limit from FCC Part 15.231(b)

Note$_2$: Averaging factor of -1.35dB was applied to peak field strength measurement. Averaging factor is calculated over a 100ms period per FCC Part 15.35, this is based on the duty cycle as measured in Section 2.6.

(20 × Log(88.577ms/100ms) = **-1.05dB** (Duty Cycle Correction Factor)

Measurements of the fundmental were performed with the EUT in each of three axis. The worse-case orientation was tested also with the EUT powered by 2 AA batteries and no AC connection.

Table 5 – Radiated Emissions Peak Measurements, 1-5GHz, Transmit Mode

Frequency	Level	Limit	Margin	Height	Angle	Pol	EUT
MHz	dBìV/m	dBìV/m	dB	cm.	deg.		Orientation
1289.5000	43.77	54.00	10.20	304	202	HORI	EUT Flat, AC
1729.0000	33.54	54.00	20.50	163	165	HORI	EUT Flat, AC
2169.5000	36.27	54.00	17.70	100	131	HORI	EUT Flat, AC
2609.5000	37.98	54.00	16.00	317	360	VERT	EUT Flat, AC

Peak Measurements listed above comply with the average limits, so average measurements were not taken. Peak measurements were also found to comply with the peak field strength limit of 74.00dBµV/m

Table 6 - Radiated Emissions Quasi-peak Data, 30MHz - 1GHz, Receive Mode

Frequency	Level	Limit	Margin	Height	Angle	Pol	EUT
MHz	dBìV/m	dBìV/m	dB	cm.	deg.		Orientation
40.1400	27.28	40.00	12.70	101	307	VERT	EUT Flat, AC
99.7200	21.46	44.00	22.50	135	146	VERT	EUT Flat, AC
432.9000	16.69	46.00	29.30	350	238	HORI	EUT Flat, AC
865.0200	32.96	46.00	13.00	98	19	VERT	EUT Flat, AC

Table 7 – Radiated Emissions Peak Measurements, 1-5GHz Receive Mode

Frequency	Level	Limit	Margin	Height	Angle	Pol	EUT
MHz	dBìV/m	dBìV/m	dB	cm.	deg.		Orientation
1289.5000	43.41	54.00	10.51	304	202	HORI	EUT Flat, AC
1729.0000	34.01	54.00	19.99	163	165	HORI	EUT Flat, AC
2169.5000	35.18	54.00	18.82	100	131	HORI	EUT Flat, AC
2609.5000	37.42	54.00	16.58	317	360	VERT	EUT Flat, AC

Peak Measurements listed above comply with the average limits, so average measurements were not taken. Peak measurements were also found to comply with the peak field strength limit of 74.00dBµV/m

4.3 15.231, Bandwidth

4.3.1 Limits of bandwidth measurements

FCC Part 15.231 (c):
The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

4.3.2 Test procedures

The EUT was tested in the same method as described in section *4.2 - Radiated emissions*. The EUT was oriented as to produce the maximum emission levels. The resolution bandwidth was set to 100kHz.

4.3.3 Deviations from test standard

No deviation.

4.3.4 Test setup

Bandwidth was made as a radiated measurement as specified in Section 4.3.4. Screen capture was taken at angle/pol/height of maximum emission.

4.3.5 EUT operating conditions

The EUT was operating off of the 5VDC power supply.

4.4.6 Test results

EUT	FloodBug	DATE	10 August 2011
MODE	Cont. Transmit	INPUT POWER (SYSTEM)	120VAC/60Hz to 5VDC Power supply/ 2 AA Batteries
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

Bandwidth

CHANNEL	Bandwidth (kHz)	Limit (Max, kHz)
1	282.56	1084.80

NOTE:
The plot does not include transducer factor from receiving antenna or cables. Measurement is relative, so they are not necessary.

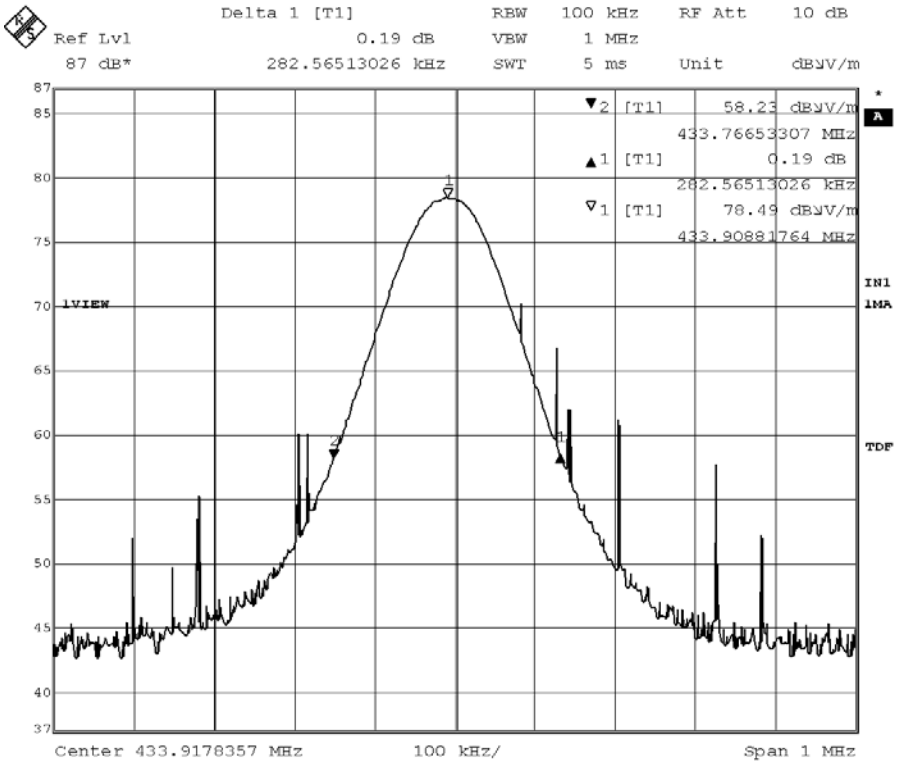


Figure 8 - Bandwidth Measurement

Appendix A: Test Photos

Figure 9 - Radiated Emissions Test Setup 1

Figure 10 - Radiated Emissions Test Setup 1

Appendix B: Table of Figures

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