

# Global EMC Inc. Labs EMC & RF Test Report

As per

**RSS 210 Issue 6:2005**

**&**

**FCC Part 15 Subpart C:2006**

**Unlicensed Intentional Radiators**

On the

**EnviroGrid Controller – RM2-0001**




Ashwani Malhotra  
Global EMC Inc.  
180 Brodie Dr, Unit 2  
Richmond Hill, ON L4B 3K8  
Canada  
Ph: (905) 883-3919

Testing produced for




See Appendix A for full customer & EUT details.



Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

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Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## Report Scope

This report addresses the EMC verification testing and test results of the EnviroGrid Controller RM2-0001 Zigbee module, herein referred to as EUT (Equipment Under Test) performed at Global EMC Labs.

The EUT was tested for compliance against the following standards:


RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006

Test procedures, results, justifications, and engineering considerations, if any, follow later in this report.

The results contained in this report relate only to the item(s) tested.

This report does not imply product endorsement by A2LA or any other accreditation agency, any government, or Global EMC Inc.


Opinions/interpretations expressed in this report, if any, are outside the scope of Global EMC Inc accreditation. Any opinions expressed do not necessarily reflect the opinions of Global EMC Inc, unless otherwise stated.

Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## Summary


The results contained in this report relate only to the item(s) tested.

EUT FCC Certification #, FCC ID:	WMB – RM2-0001
EUT Industry Canada Certification #, IC:	7894A – RM2-0001
EUT Passed all tests performed.	Yes (see test results summary)
Tests conducted by	Ashwani Malhotra

Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## Test Results Summary

Standard/Method	Description	Class/Limit	Result
FCC 15.203	Antenna Requirement	Unique	Pass See Justification
FCC 15.205 RSS 210 (Table 1)	Restricted Bands for intentional operation	QuasiPeak Average	Pass
FCC 15.207	Power line conducted emissions	QuasiPeak Average	Pass
FCC 15.209 RSS-210 (Table 2)	Spurious Radiated emissions	QuasiPeak Average	Pass
FCC 15.247(a)2 RSS-210 A8.2(a)	6 dB Bandwidth	> 500 kHz	Pass
FCC 15.247(b)2 RSS-210 A8.4(4)	Max output power	< 1 Watt	Pass
FCC 15.247(b)(4) RSS-210 A8.4(5)	Antenna Gain	< 6 dBi	Pass
FCC 15.247(d) RSS-210 A8.5	Antenna conducted spurious	< 20 dBc	Pass
FCC 15.247(e) RSS-210 A8.2(b)	Spectral Density	< 8 dBm (3 kHz BW)	Pass
FCC 15.247(i) IC Safety code 6	Maximum Permissible Exposure	> 20 cm separation.	Pass See justification and calculations
<b>Overall Result</b>			<b>PASS</b>

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All tests were performed by Ashwani Malhotra

If the product as tested or otherwise complies with the specification, the EUT is deemed to comply with the requirement and is deemed a 'PASS' grade. If not 'FAIL' grade will be issued. Note that 'PASS' / 'FAIL' grade is independent of any measurement uncertainties. A 'PASS' / 'FAIL' grade within measurement uncertainty is marked with a '\*'.

### ***Justifications, Descriptions, or Deviations***

The following justifications for tests not performed or deviations from the above listed specifications apply:

For the Antenna requirement specified in FCC 15.203 (RSS 210 section 5.5), the unit uses a reverse polarity SMA connector on the EUT. The antenna used is a rubber duck type with a gain of 5.5dbi. This antenna is connected to the EUT through an extension cable.

There are two possible manufacturers of Antennas for this product. Both antennas are of the same type (rubber duck) and have the same gain. Both antennas were used for initial assessment and Quantech antenna with higher recorded field strength was used for testing.

Antenna model tested: Quantech/DPAC (ACH2-AT-DP011)


Alternate antenna: Hyperlinktech technologies (HG2405RD-RSP)

For the Restricted Bands of operation, the EUT is designed to only operate between 2400 – 2480.0MHz.

For the Antenna gain, the EUT uses a 5.5 dbi antenna. The unit can also be used with 1 other antennas of the same type and same gain (5.5 dbi). For the scope of this testing the antenna with the maximum emissions as tested in both horizontal and vertical orientation was used. The EUT was also flipped vertically and horizontally in order to obtain the maximum emissions.


For maximum permissible exposure, this device operates at less than 1 Watt at 2400 – 2480.0 MHz and is designed to operate greater than 20 cm from personnel during normal operation. No testing is required, however worst case calculated exposure compliance follows later in this report.

The EUT is not a hybrid system and FCC 15.247 (f) does not apply to it. However the 15.247 (d) requirement of power density were met and are detailed on page 59 of this test report.

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## ***Applicable Standards, Specifications and Methods***

ANSI C63.4:2003	- Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
CFR 47 FCC 15	- Code of Federal Regulations – Radio Frequency Devices
CISPR 22:1997	- Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement
ICES-003:2004	- Digital Apparatus - Spectrum Management and Telecommunications Policy Interference-Causing Equipment Standard
ISO 17025:2005	- General Requirements for the competence of testing and calibration laboratories
RSS 210:2005	- Issue 6: Spectrum Management and Telecommunications Policy. Radio Standards Specification Low Power Licence-Exempt Radiocommunication Devices

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### ***Sample calculation(s)***

Margin = limit – (received signal + antenna factor + cable loss – pre-amp gain)

Margin = 50.5dBuV/m – (50dBuV + 10dB + 2.5dB – 20dB)

Margin = 8.5 dB


### ***Document Revision Status***

Revision 1 - August 13, 2008

Revision 2 - August 31, 2008 – Minor corrections as requested by TCB.

Note: This report replaces the report issued on August 13<sup>th</sup>, 2008 in its entirety.



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## Definitions and Acronyms

The following definitions and acronyms are applicable in this report.  
See also ANSI C63.14.

**AE** – Auxillary Equipment.

**BW** – Bandwidth. Unless otherwise stated, this refers to the 6 dB bandwidth.

**EMC** – Electro-Magnetic Compatibility

**EMI** – Electro-Magnetic Immunity


**EUT** – Equipment Under Test

**ITE** – Information Technology Equipment with a primary function(s) of entry, storage, display, retrieval, transmission, processing, switching, or control, of data.

**LISN** – Line impedance stabilization network

**NCR** – No Calibration Required

**RF** – Radio Frequency


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## Testing Facility

Testing for EMC on the EUT was carried out at Global EMC labs in Toronto, Ontario, Canada. The testing lab consists of a 3m semi-anechoic chamber calibrated to be able to allow measurements on an EUT with a maximum width or length of up to 2m and height up to 3m. The chamber is equipped with a turn table that is capable of testing devices up to 3300lb in weight. This facility is capable of testing products that are rated for 120 Vac and 240Vac single phase, or 208 Vac 3 phase input. DC capability is also available. The chamber is equipped with an antenna mast that controls polarization and height from the control room adjoining the shielded chamber. Radiated emissions measurements are performed using a Bilog, and Horn antenna where applicable. Conducted emissions, unless otherwise stated, are performed using a LISN.

## Calibrations and Accreditations


The measurement site used is registered with Federal Communications Commission (FCC) and Industry Canada (IC). This site is calibrated for Normalized Site Attenuation (NSA) using test procedures outlined in ANSI C63.4 “Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz”. The semi-anechoic chamber is lined with ferrite tiles and absorption cones to minimize any undesired reflections. All measuring equipment is calibrated on an annual or bi-annual basis as listed for each respective test.

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## ***Testing Environmental Conditions and Dates***

Following were the environmental conditions in the facility during time of testing –

<b>Date</b>	<b>Test</b>	<b>Init.</b>	<b>Temperature (°C)</b>	<b>Humidity (%)</b>	<b>Pressure (kPa)</b>
August 9 - 13, 2008	All	AM	22-24°C	38-43%	101.1 -101.5 kPa

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## Detailed Test Results Section

Client	Regen Energy	
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Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## ***Spurious Radiated Emissions***

### **Purpose**

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT does not exceed the limits listed below as defined in the applicable test standard, as measured from a receiving antenna. This helps protect broadcast radio services such as television, FM radio, pagers, cellular telephones, emergency services, and so on, from unwanted interference.

### **Limit(s) and Method**

The method is as defined in ANSI C63.4:2003.


The limits, as defined in 15.247(d) for unintentional radiated emissions apply for those emissions that fall in the restricted bands, as defined in Section 15.205(a). These emissions must comply with the radiated emission limits specified in Section 15.209(a).

All unintentional emissions must also meet the ‘Spurious Conducted Emissions’ requirements of -20 dBc or greater. See also ‘Spurious Conducted Emissions’ for further details.

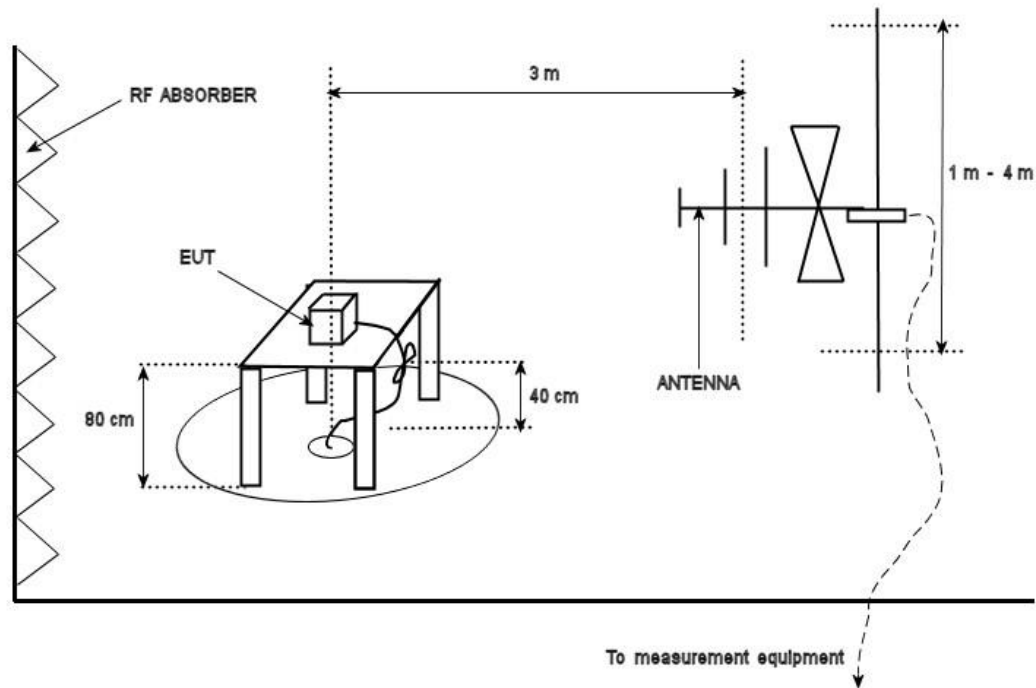
30 MHz – 88 MHz, 100 uV/m (40.0 dBuV/m<sup>1</sup>) at 3 m  
88 MHz – 216 MHz, 150 uV/m (43.5 dBuV/m<sup>1</sup>) at 3 m  
216 MHz – 960 MHz, 200 uV/m (46.4 dBuV/m<sup>1</sup>) at 3 m  
Above 960 MHz, 500 uV/m (54.0 dBuV/m<sup>1</sup>) at 3 m  
Above 1000 MHz, 500 uV/m (54.0 dBuV/m<sup>2</sup>) at 3m


<sup>1</sup>Limit is with 120 kHz measurement bandwidth and a using a Quasi Peak detector.

<sup>2</sup>Limit is with 1 MHz measurement bandwidth and using an Average detector, scanned in accordance with 15.33 to above the 10<sup>th</sup> harmonic.

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## Typical Radiated Emissions Setup



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## Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is +/-4.4 dB with a 'k=2' coverage factor and a %95 confidence level.

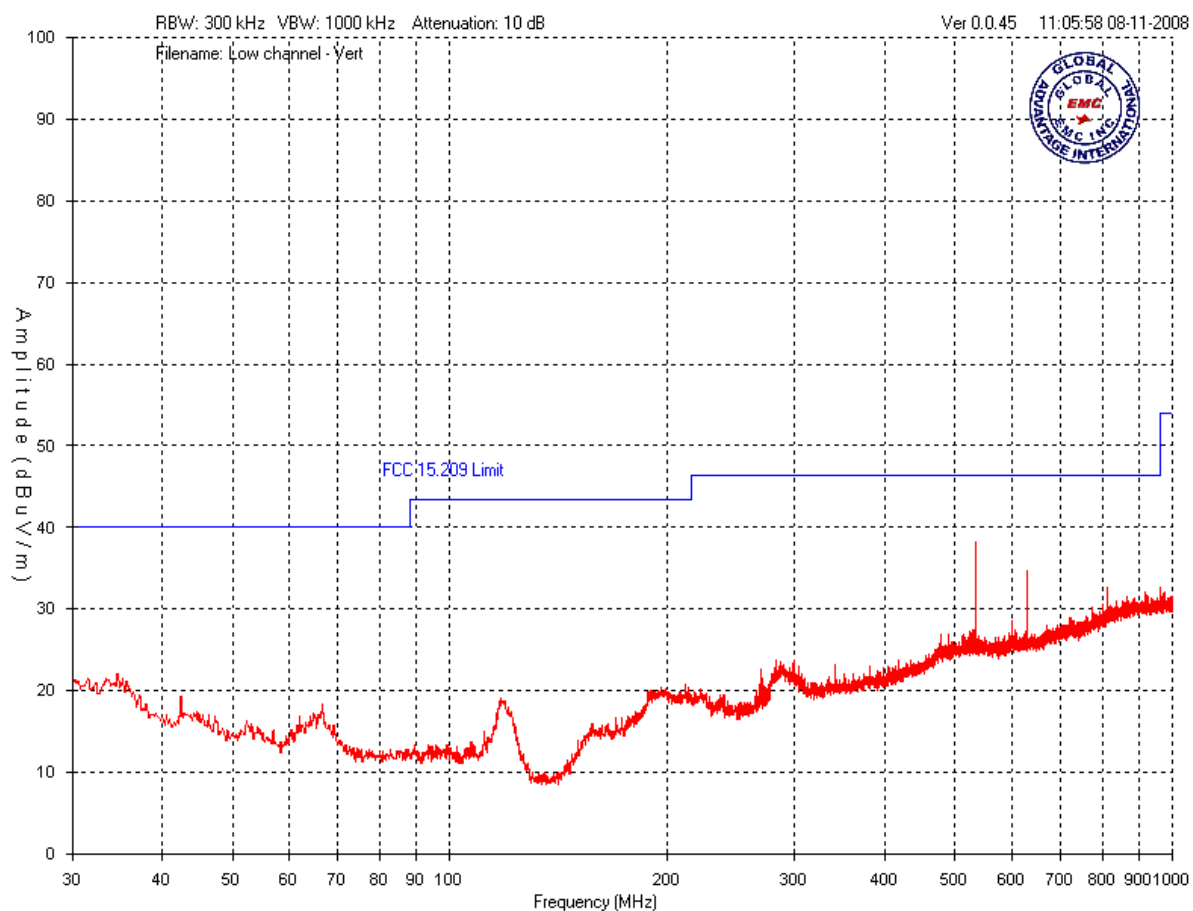
## Preliminary Graphs

Note the graphs shown below are for graphical illustration only. For final measurements with the appropriate detector, please refer to the final measurement table where applicable. The graph shown below is a maximized peak measurement graph, measured with a resolution bandwidth greater than the final required detector and over a full 0-360 rotation. This peaking process is done as a worst case measurement. This process enables the detection of frequencies of concern for final measurement, and provides considerable time savings.


In accordance with FCC Part 15, Subpart A, Section 15.33, the device was scanned to a minimum of a 25 GHz.

Client	Regen Energy	
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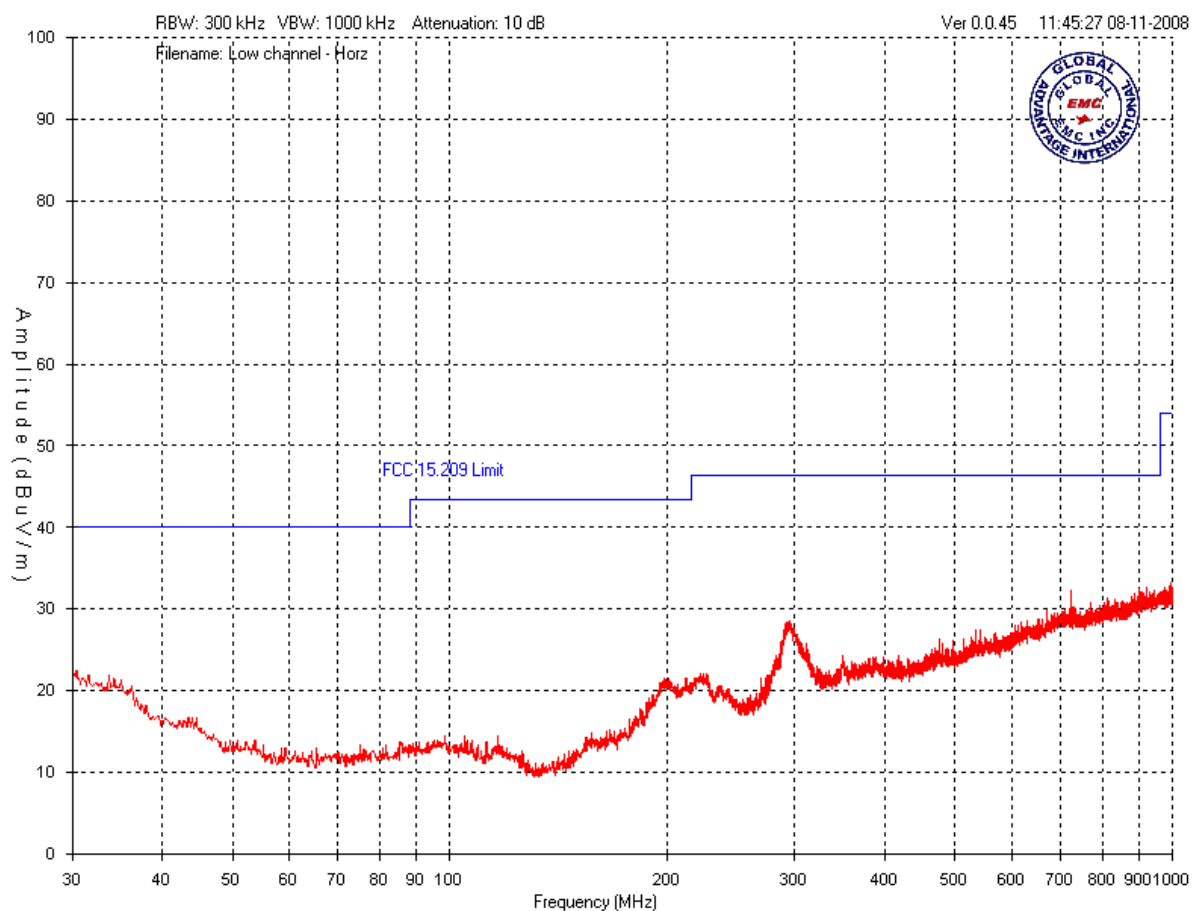
Low Channel – 30MHz – 1 GHz  
Vertical – Peak Emissions Graph






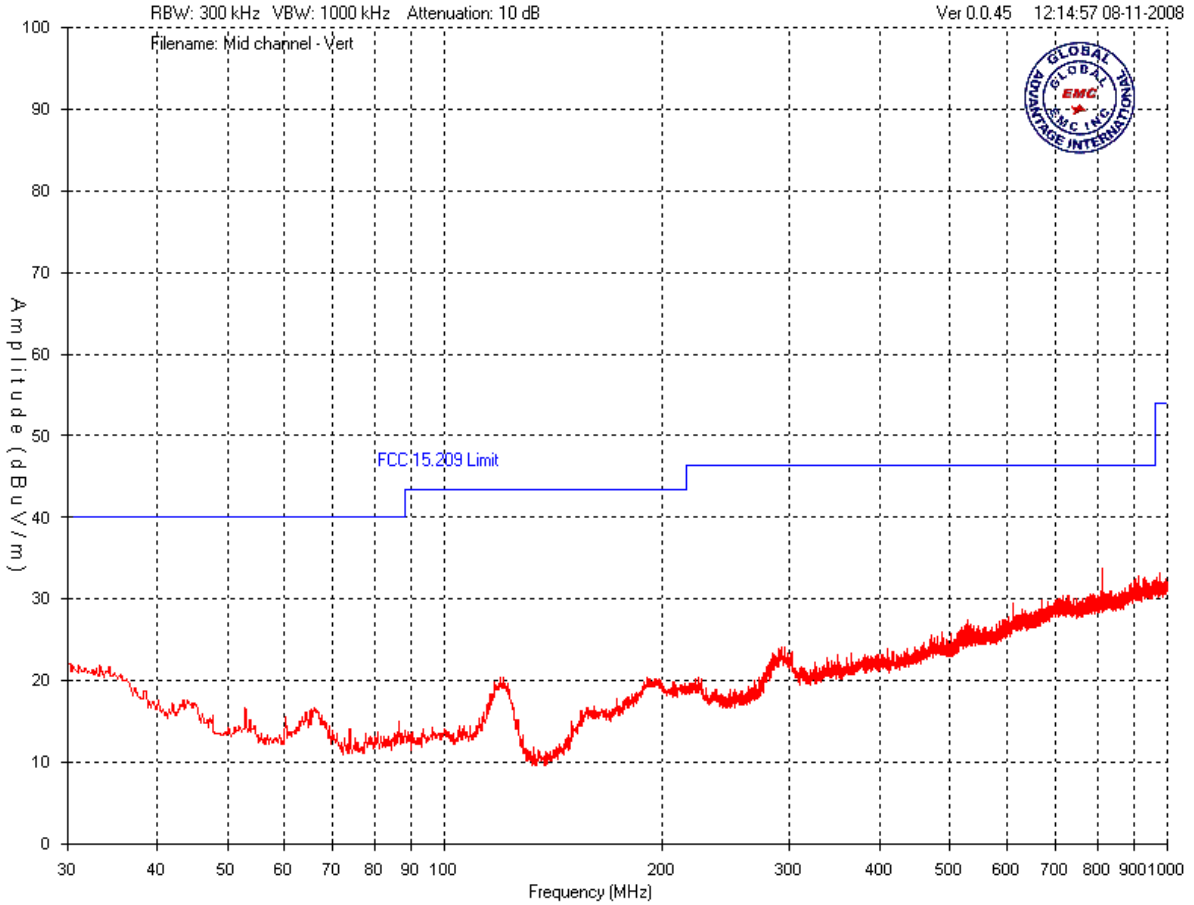
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


Low Channel – 30MHz – 1 GHz  
Horizontal – Peak Emissions Graph



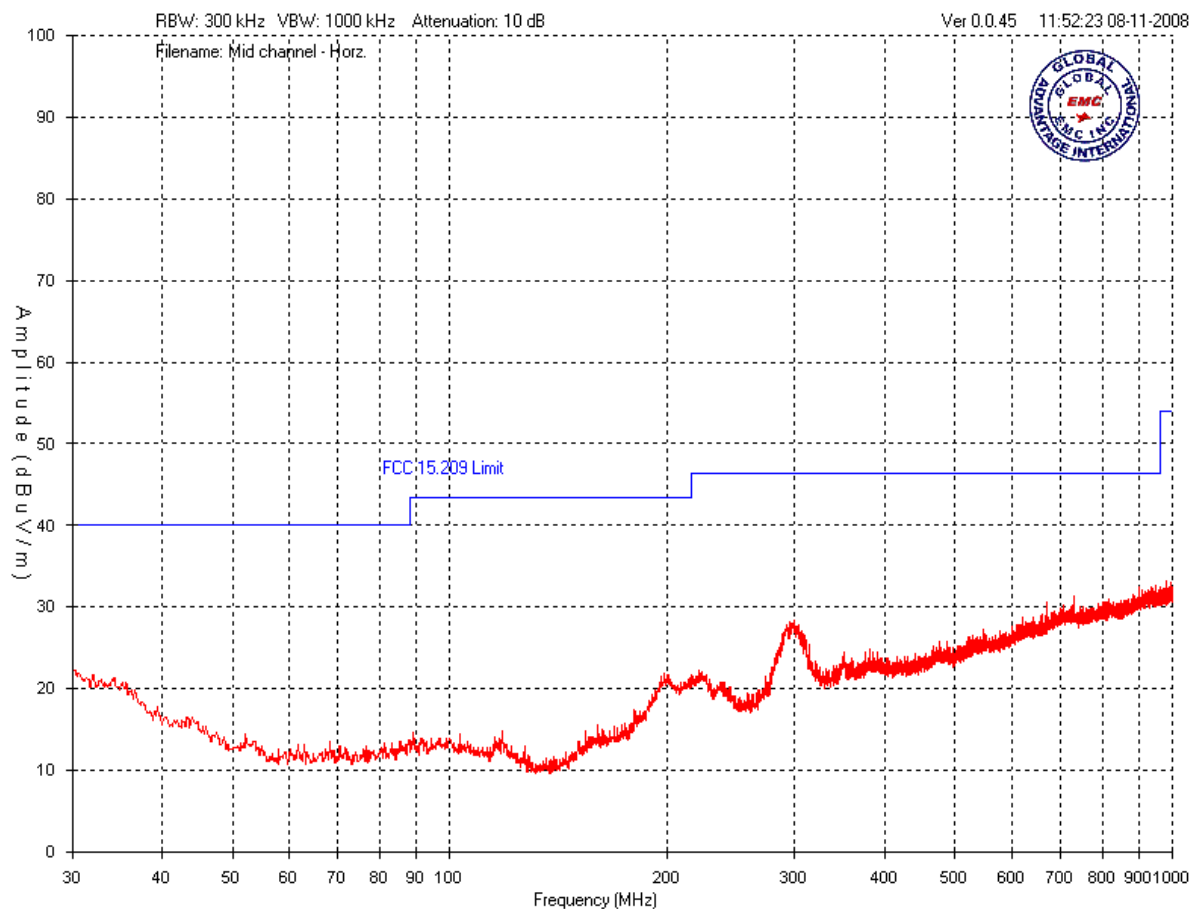
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


Mid Channel – 30MHz – 1 GHz  
Vertical – Peak Emissions Graph



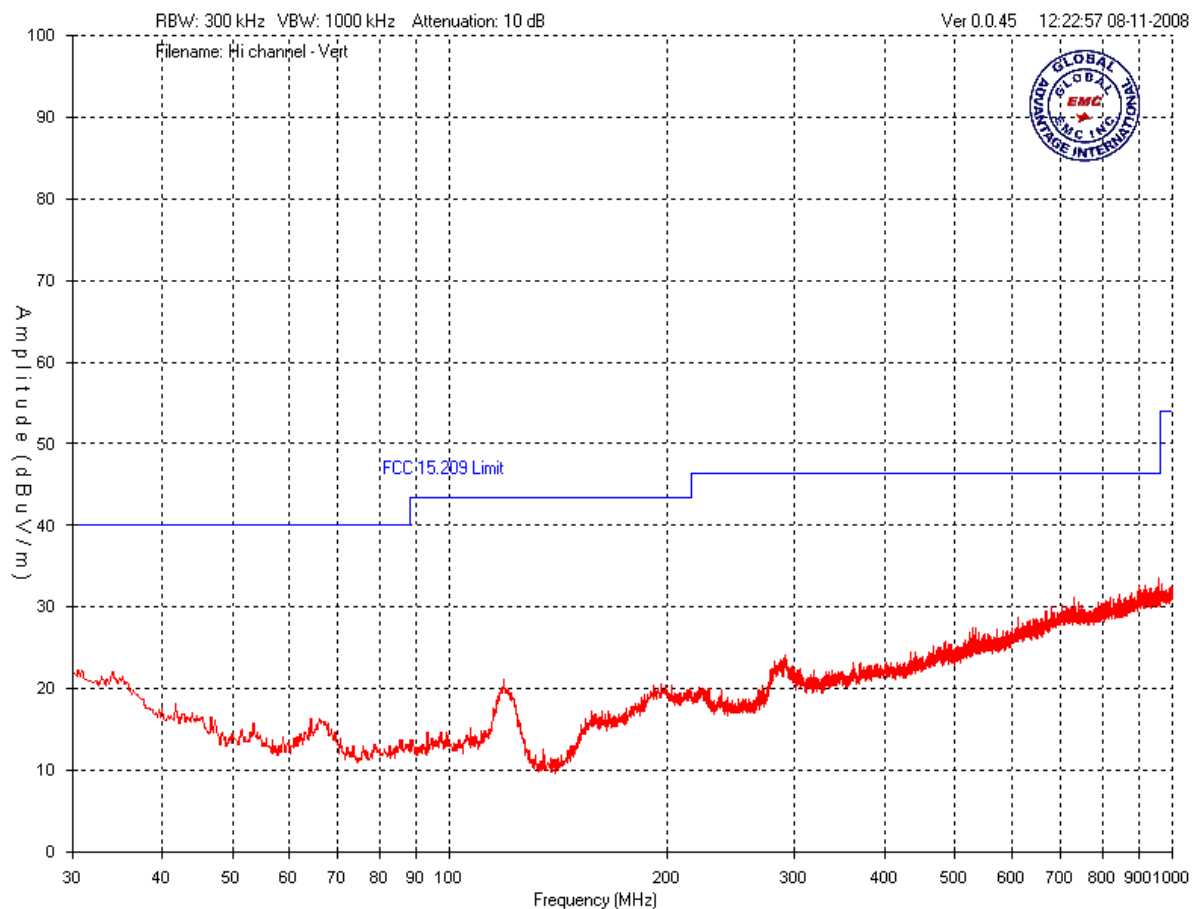
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


Mid Channel – 30MHz – 1 GHz  
Horizontal – Peak Emissions Graph



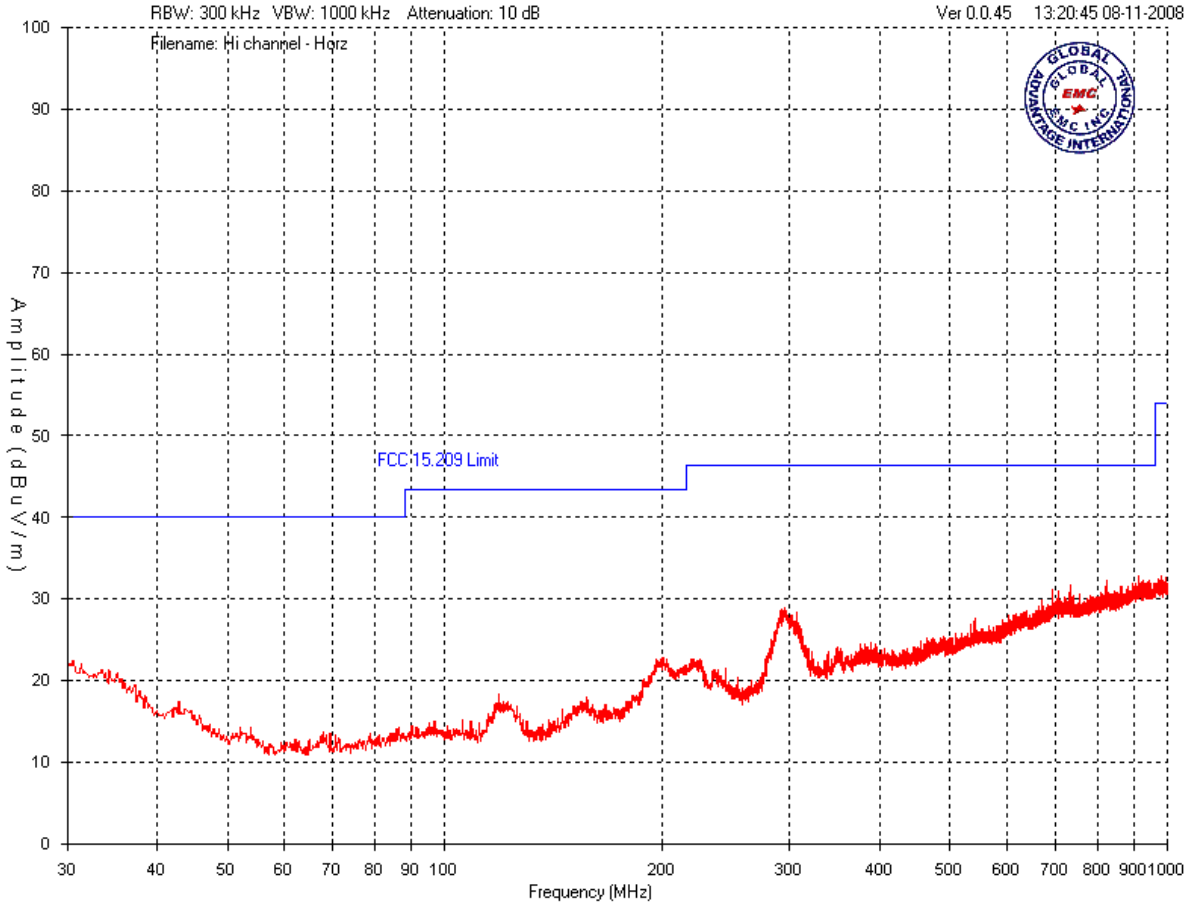
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


# Hi Channel – 30MHz – 1 GHz Vertical – Peak Emissions Graph



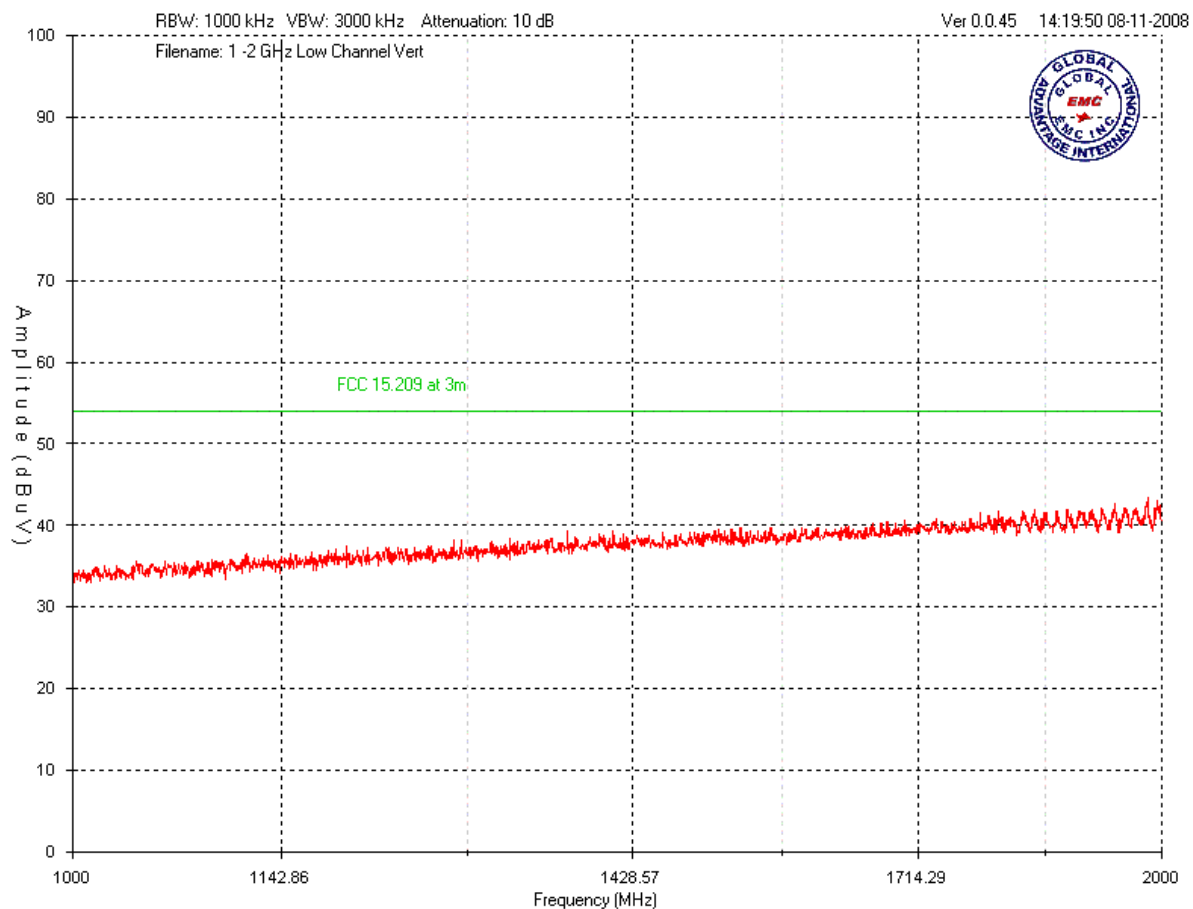
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


# Hi Channel – 30MHz – 1 GHz Horizontal – Peak Emissions Graph



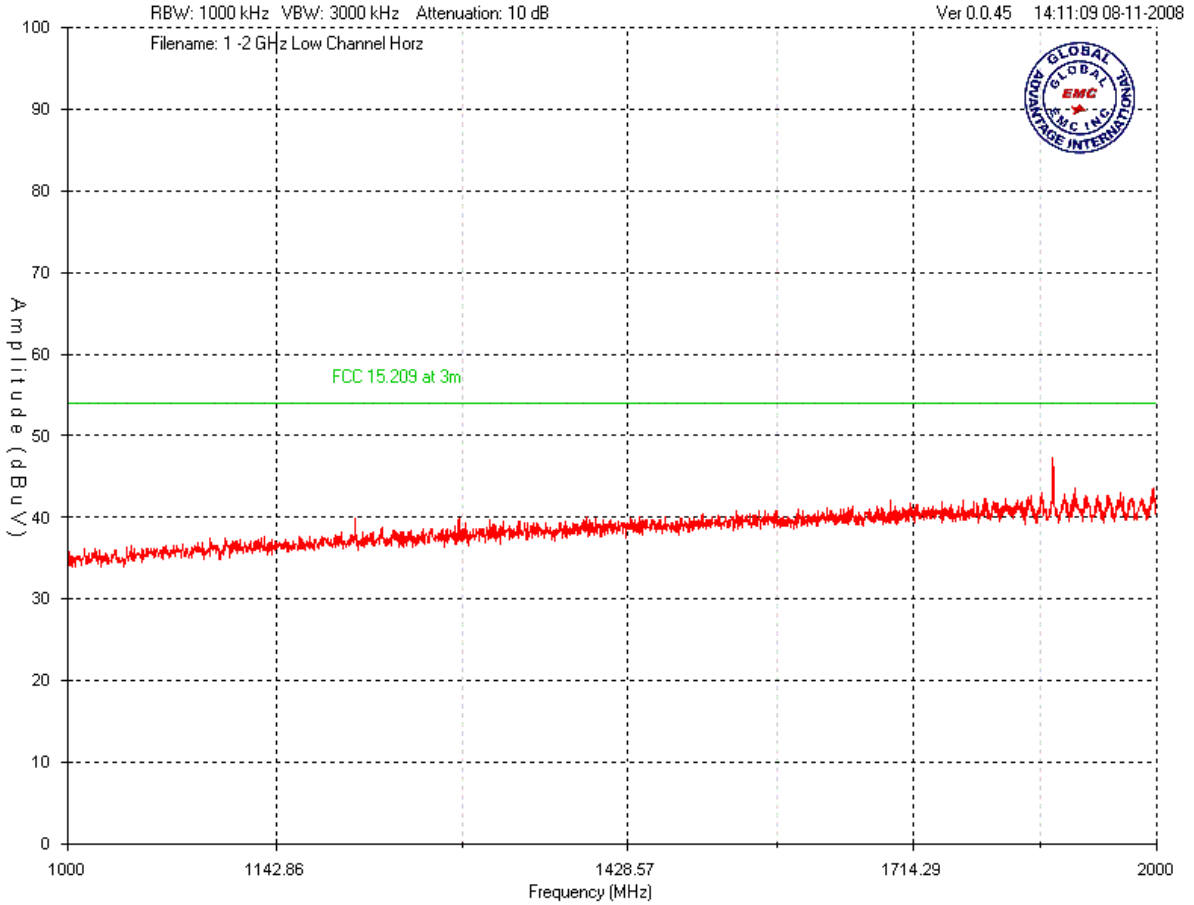
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


# Low Channel – 1 – 2 GHz Vertical – Peak Emissions Graph



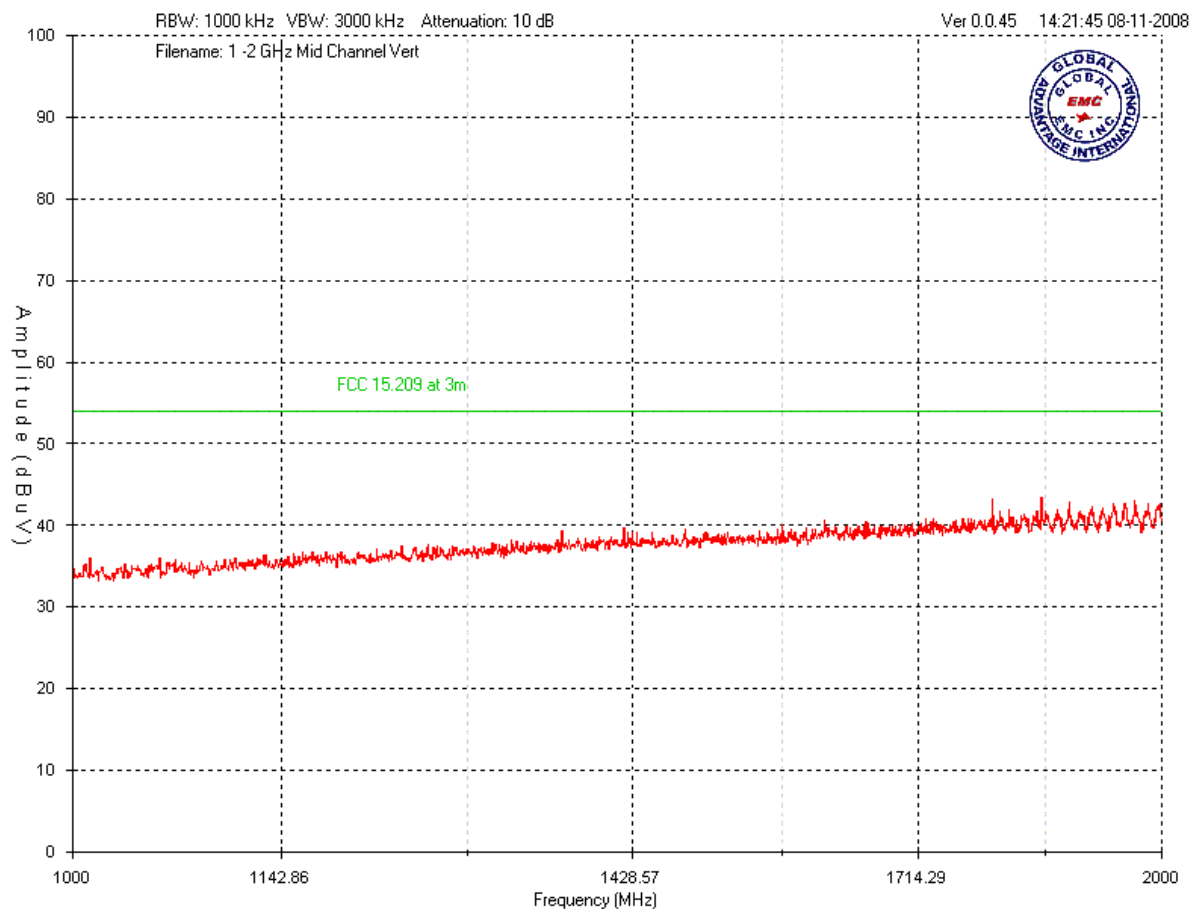
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

# Low Channel – 1 – 2 GHz Horizontal – Peak Emissions Graph




Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

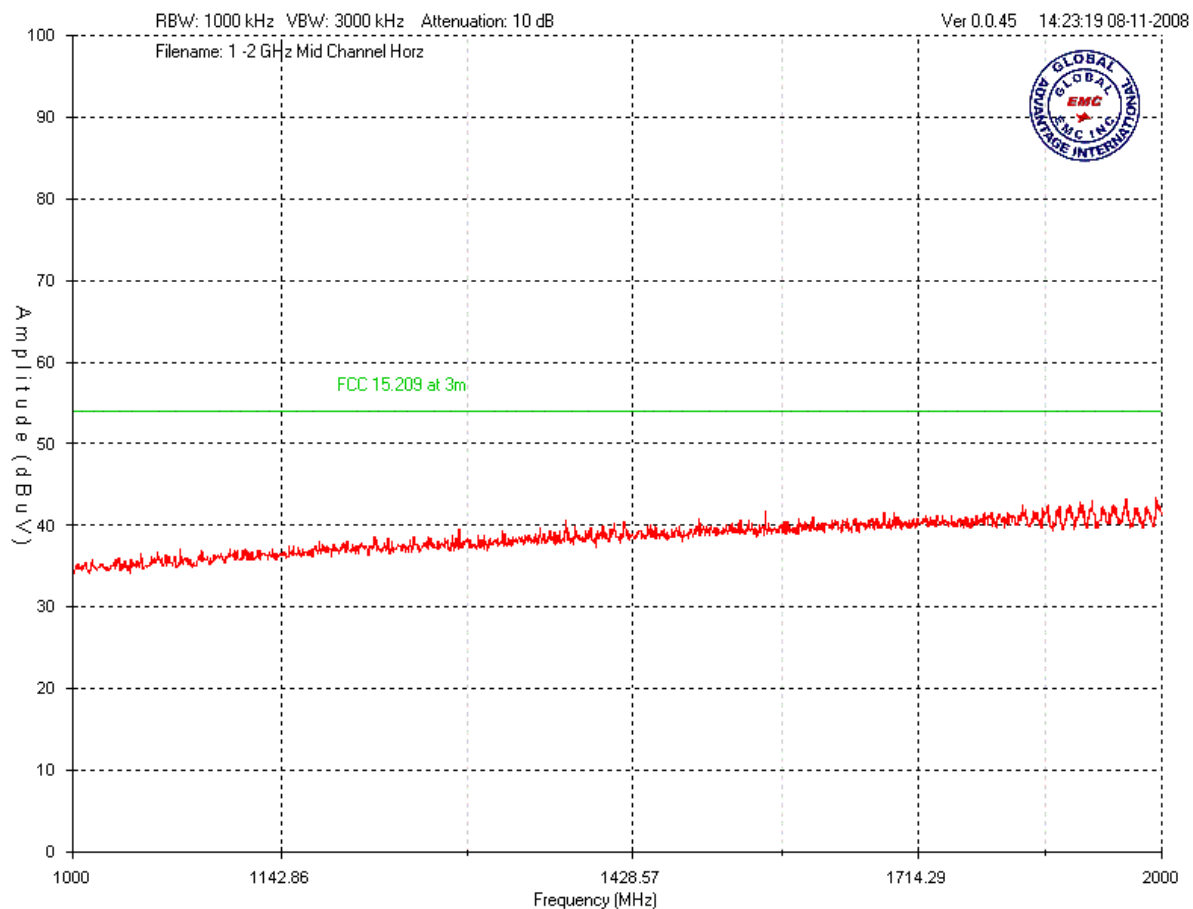
# Mid Channel – 1 – 2GHz Vertical – Peak Emissions Graph






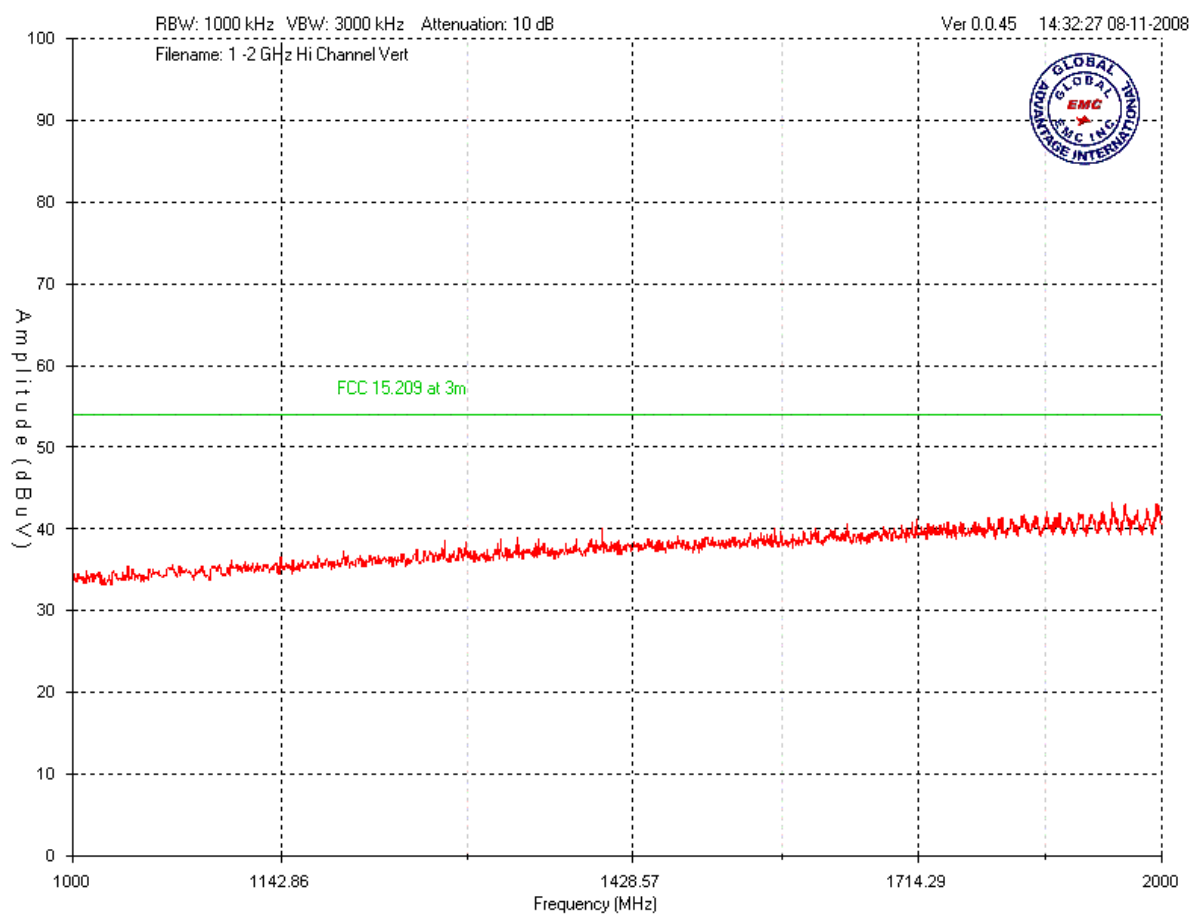
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
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## Mid Channel – 1 – 2GHz Horizontal – Peak Emissions Graph



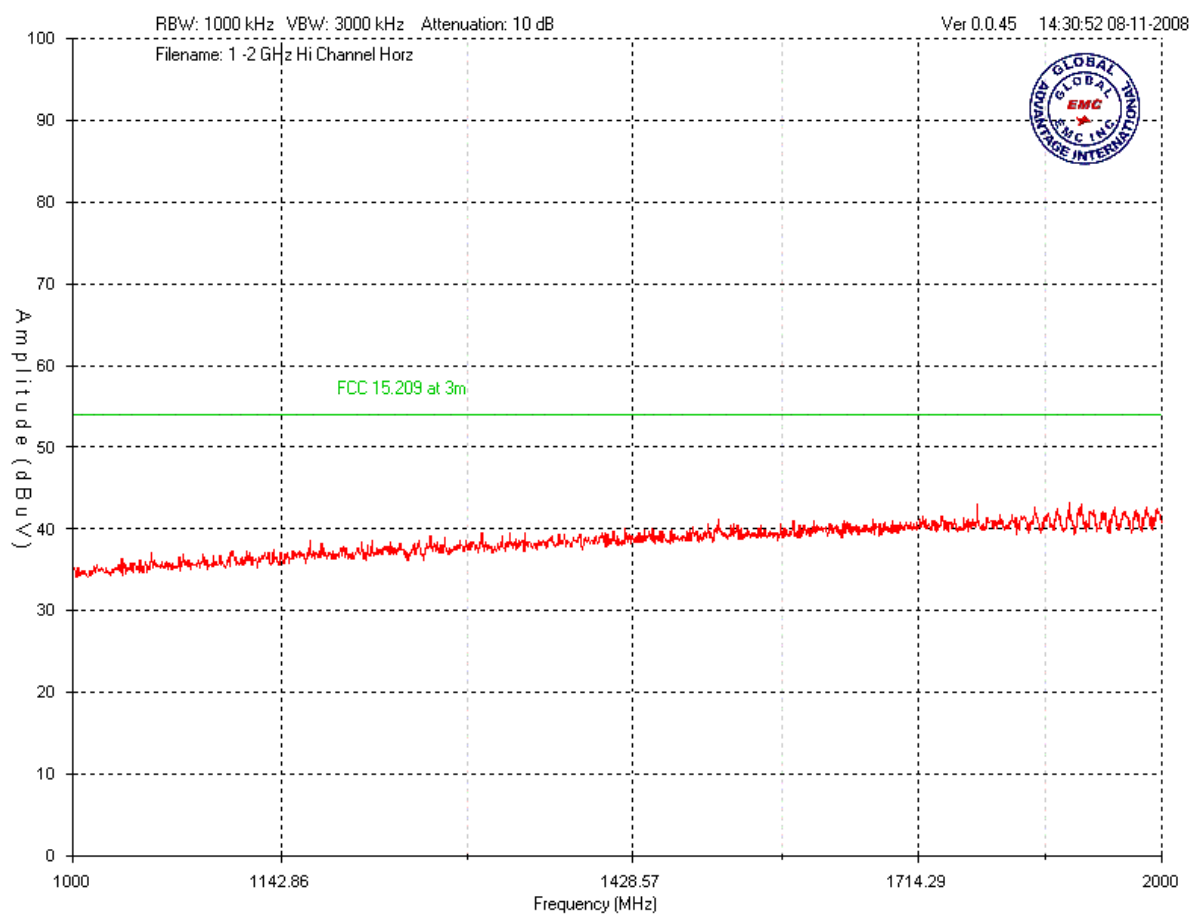
Client	Regen Energy	
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# Hi Channel – 1 – 2GHz Vertical – Peak Emissions Graph



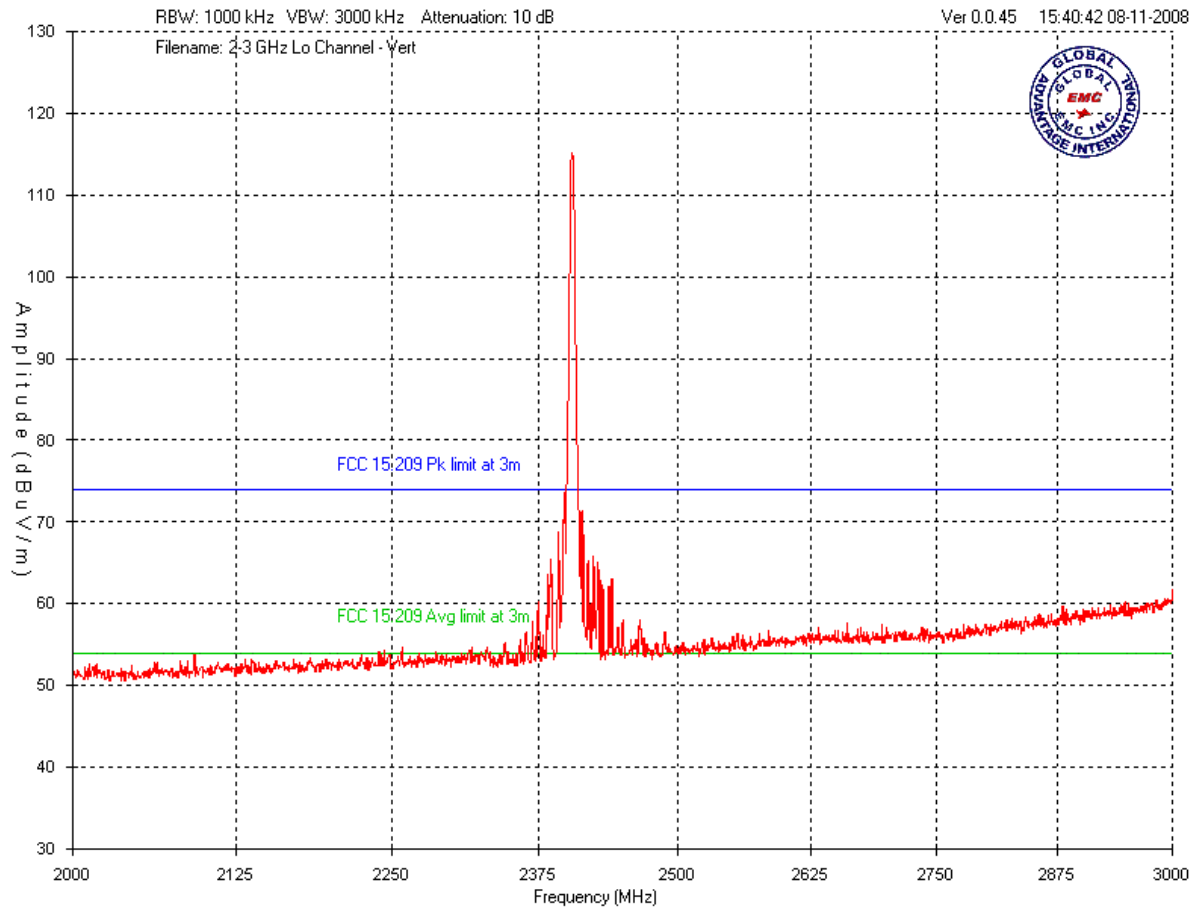
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


# Hi Channel – 1 – 2GHz Horizontal – Peak Emissions Graph



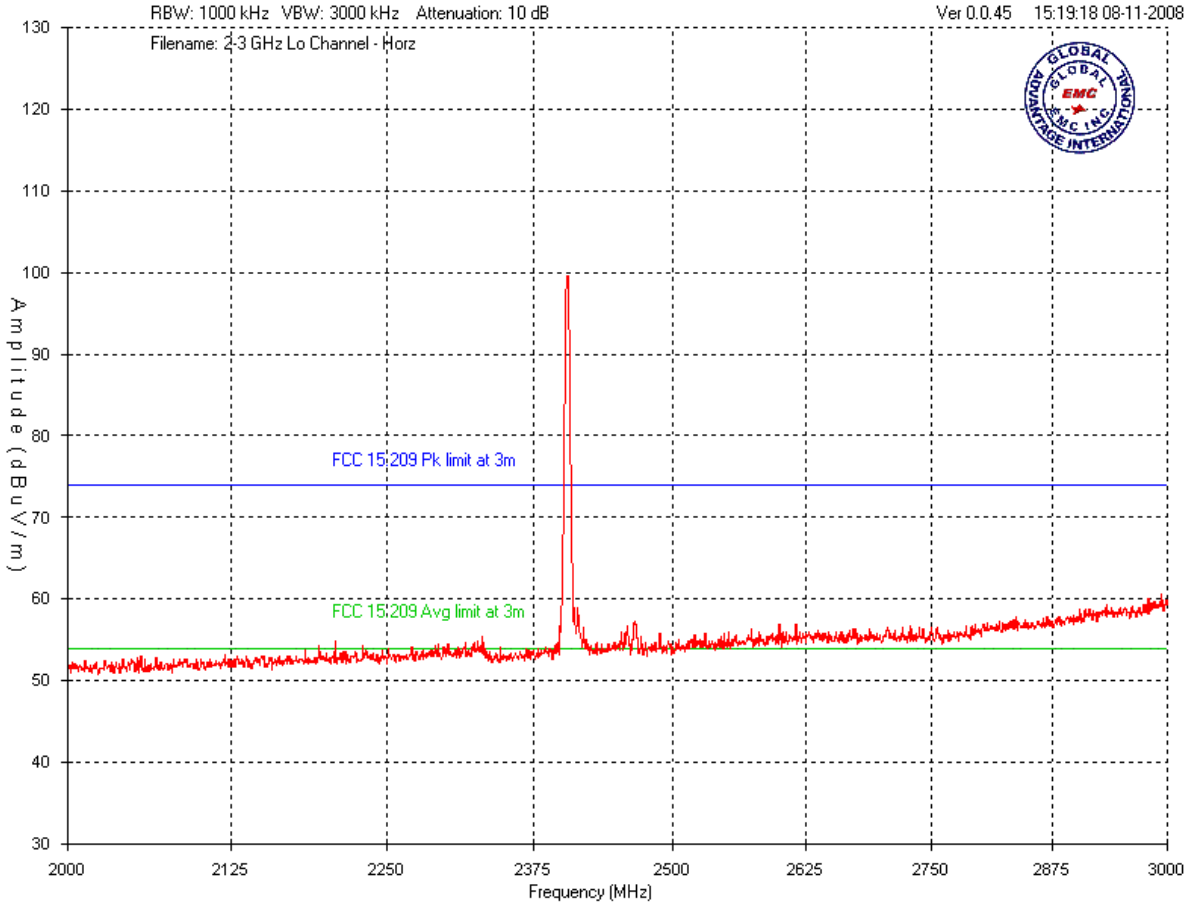
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


## Low Channel – 2-3 GHz Vertical – Peak Emissions Graph



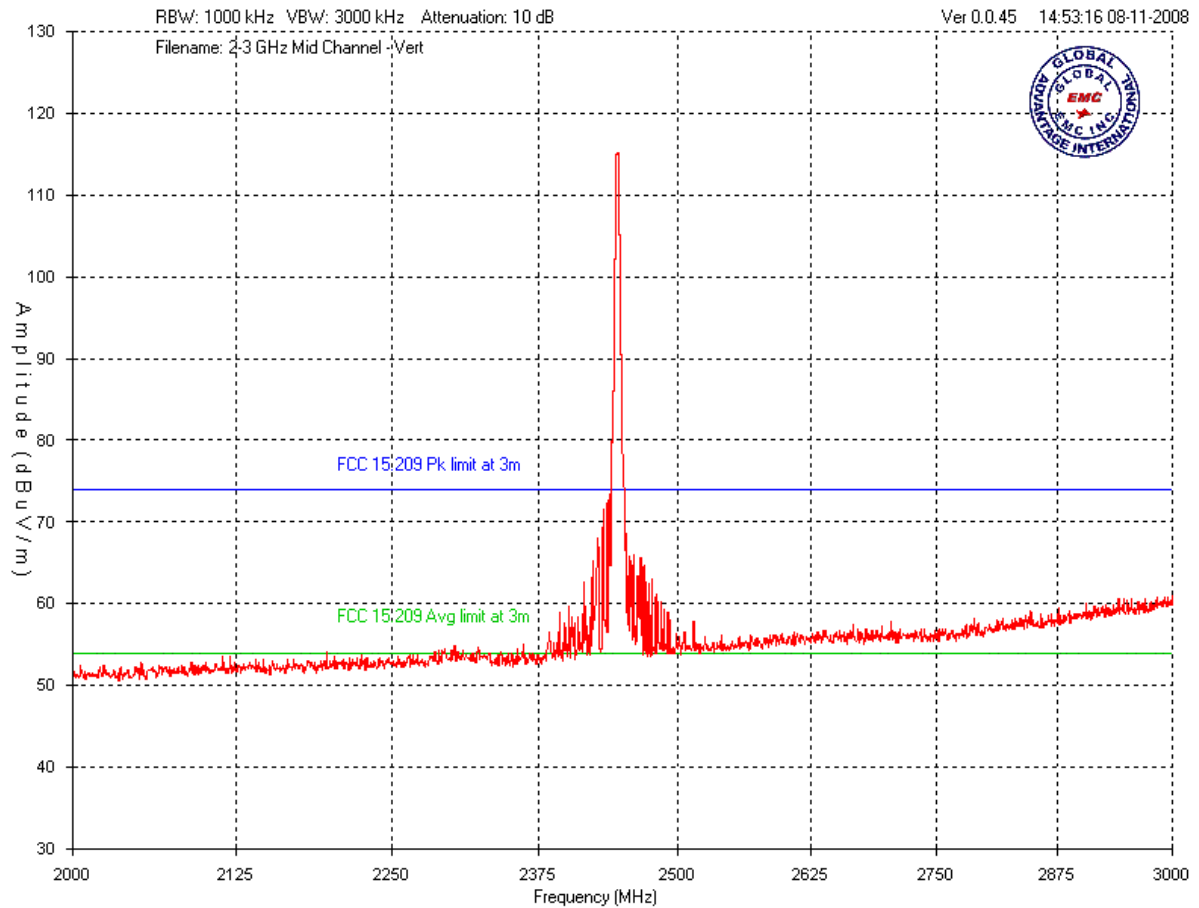
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


# Low Channel – 2-3 GHz Horizontal – Peak Emissions Graph



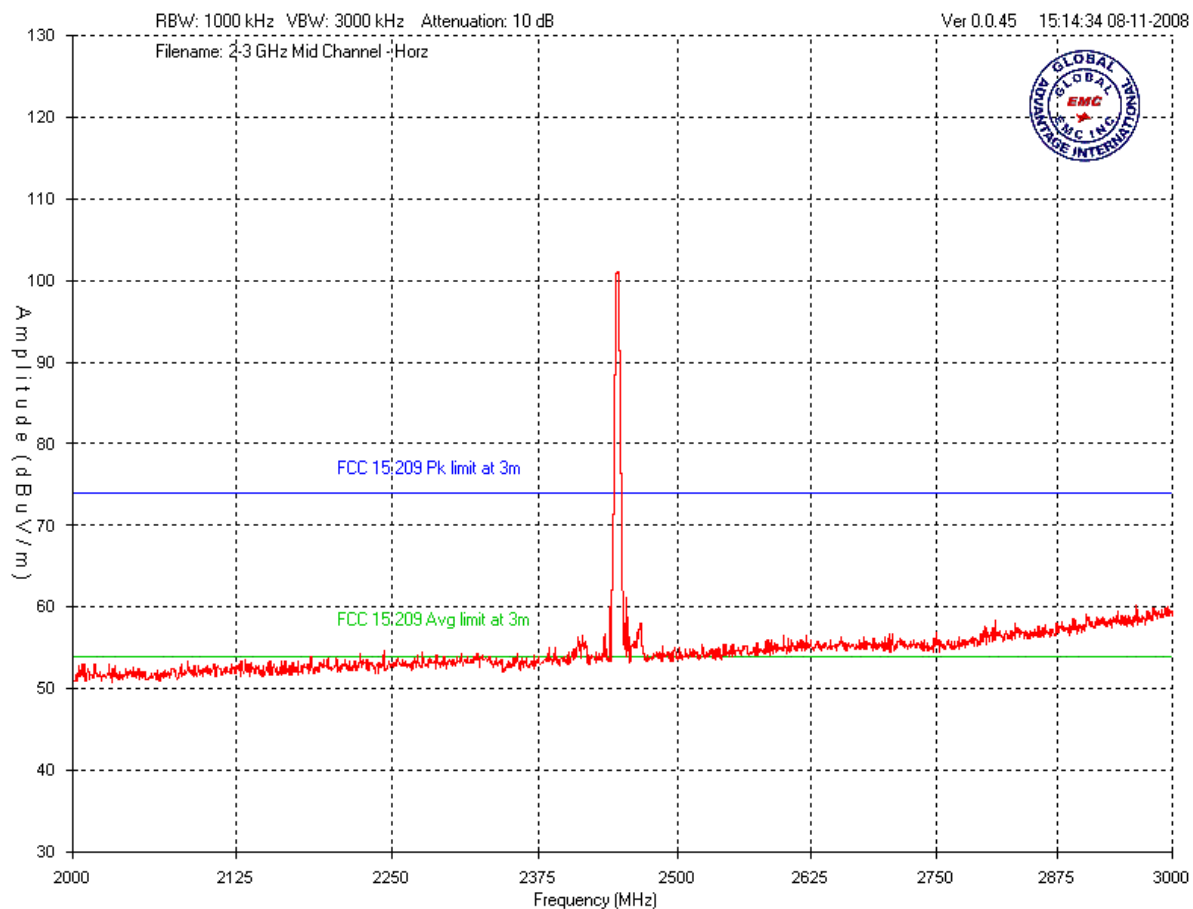
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


# Mid Channel – 2-3 GHz Vertical – Peak Emissions Graph



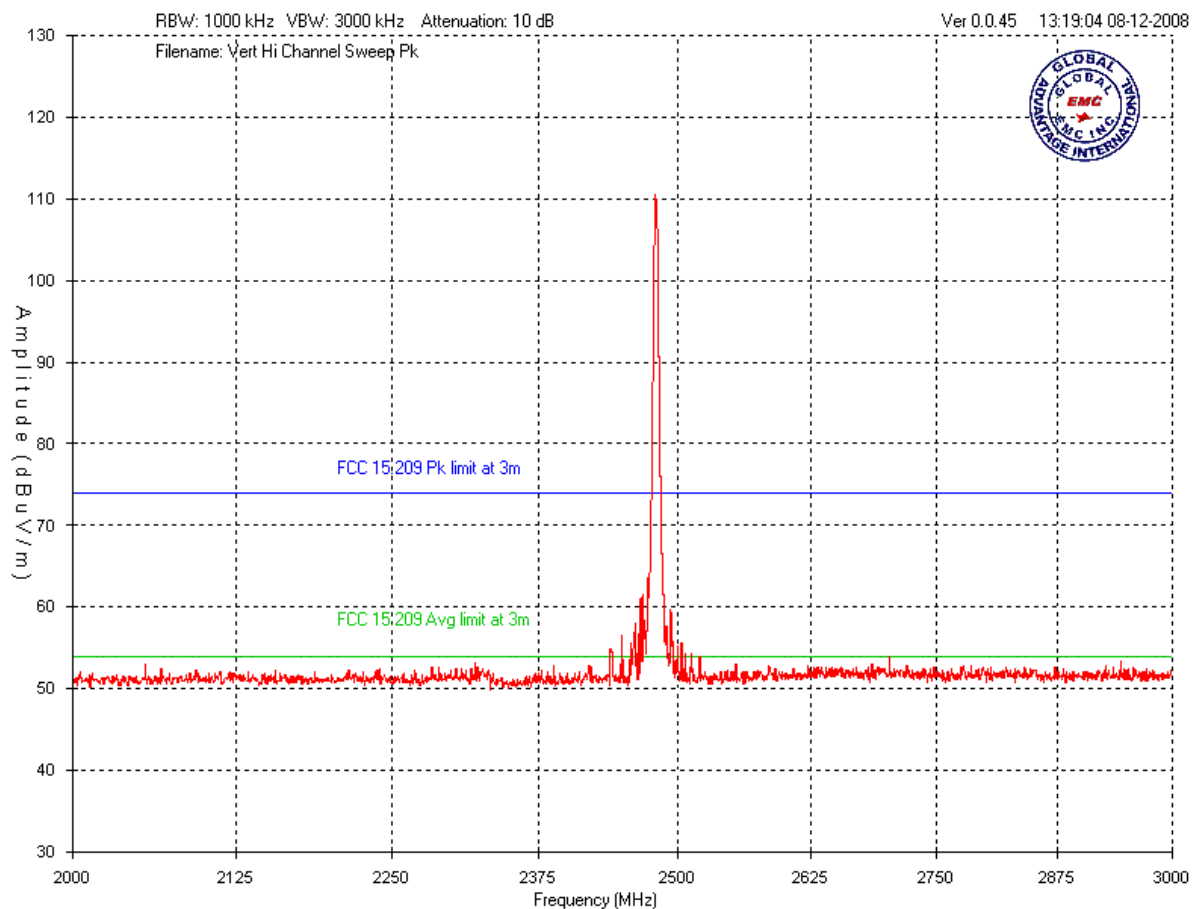
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

### Mid Channel – 2-3 GHz Horizontal – Peak Emissions Graph




Client	Regen Energy	
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Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

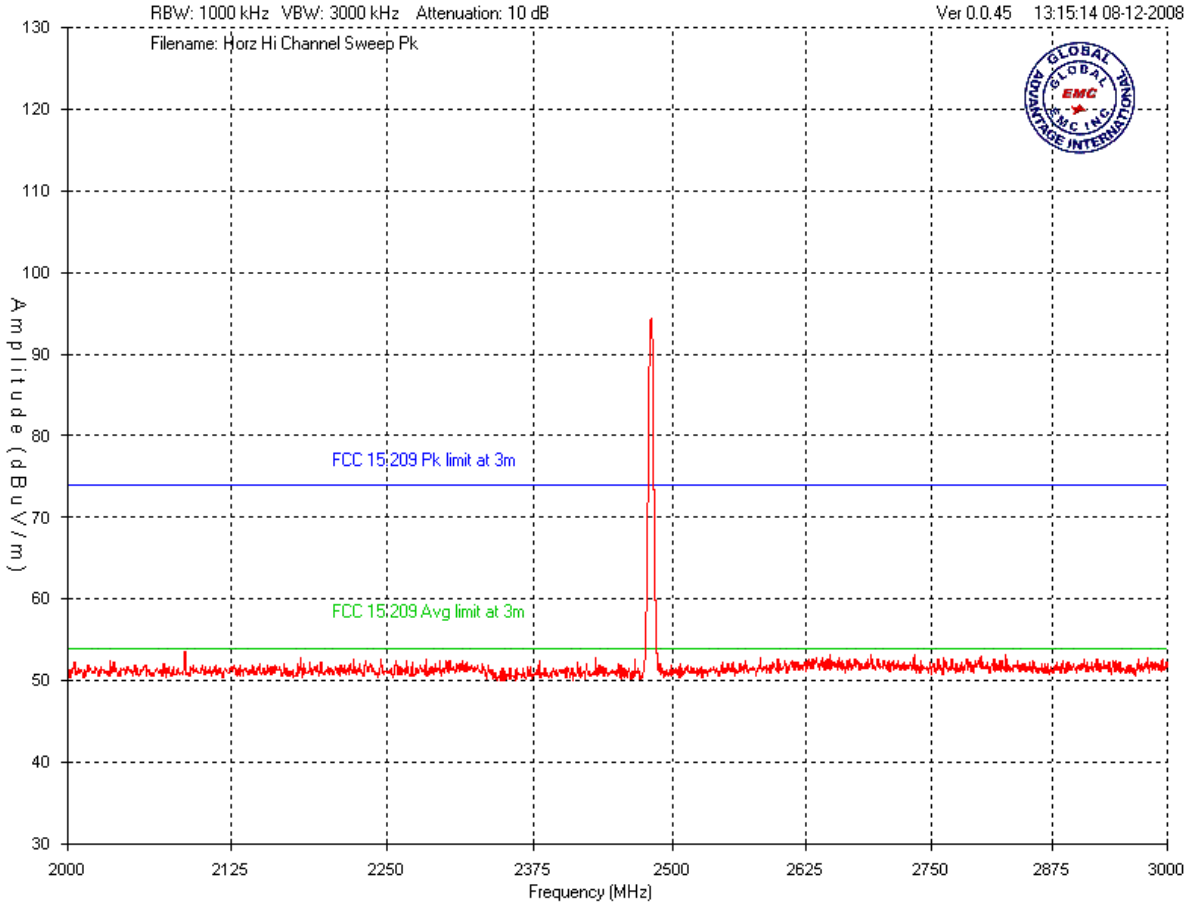
### Hi Channel – 2-3 GHz Vertical – Peak Emissions Graph






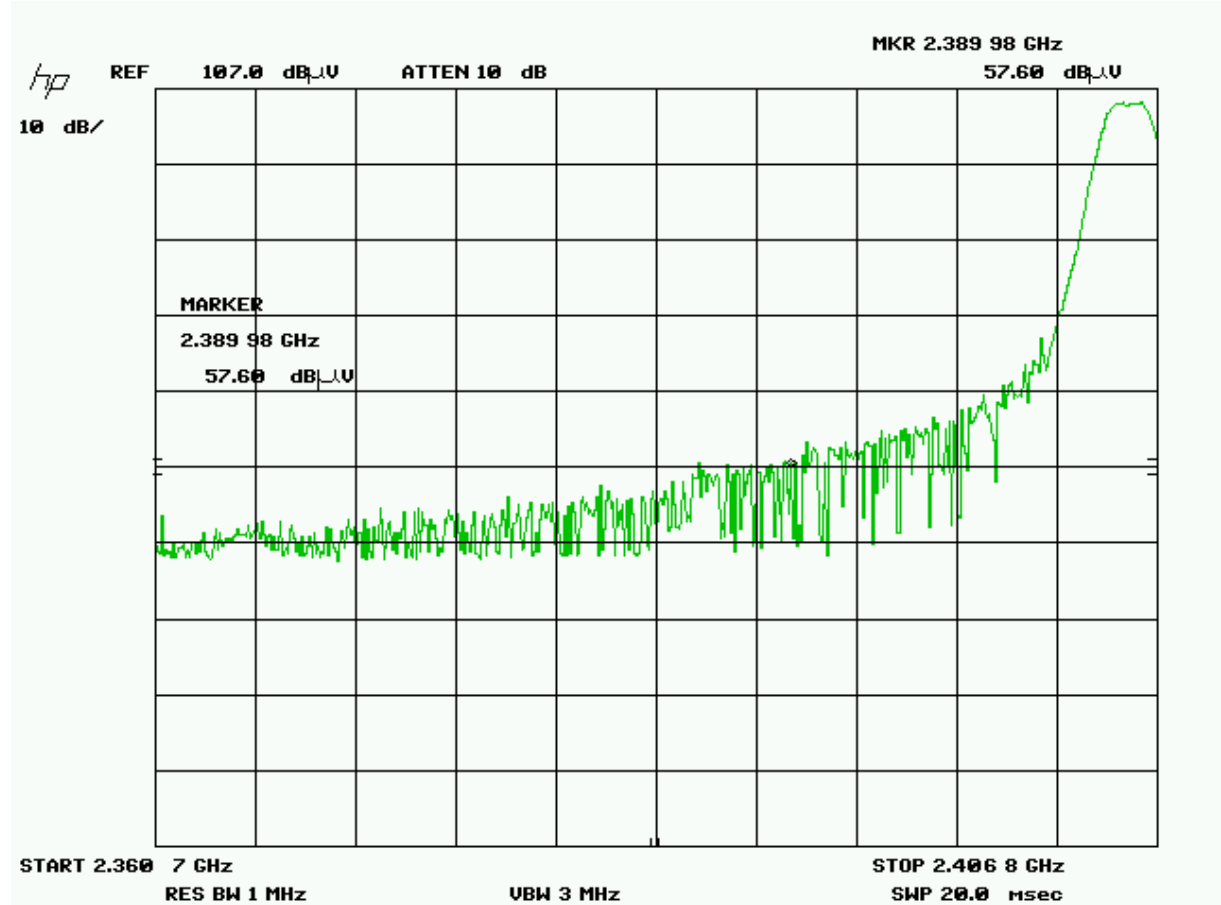
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


# Hi Channel – 2-3 GHz Horizontal – Peak Emissions Graph



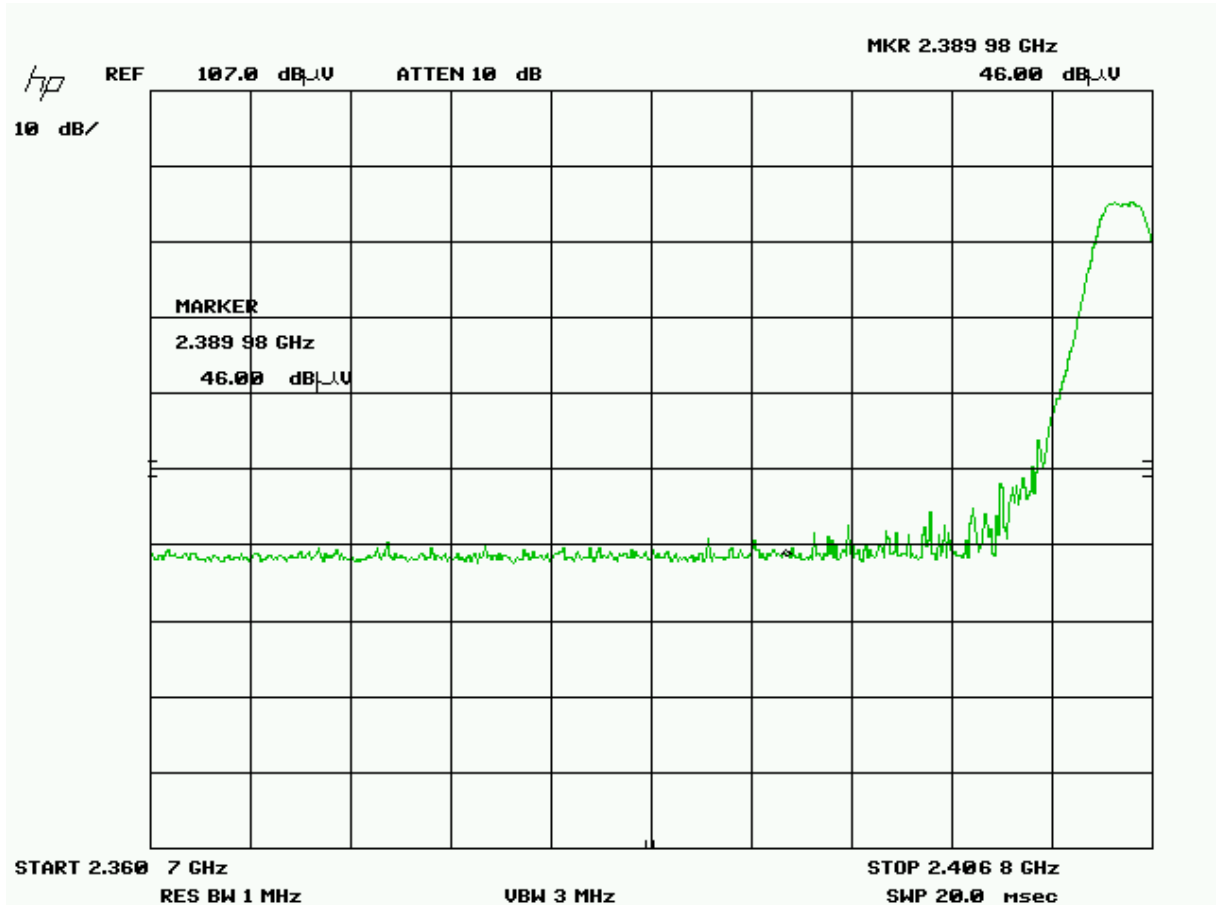
Client	Regen Energy	
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Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


Band Edge – Low channel  
Vertical peak emissions



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Band Edge – Low channel  
Horizontal peak emissions



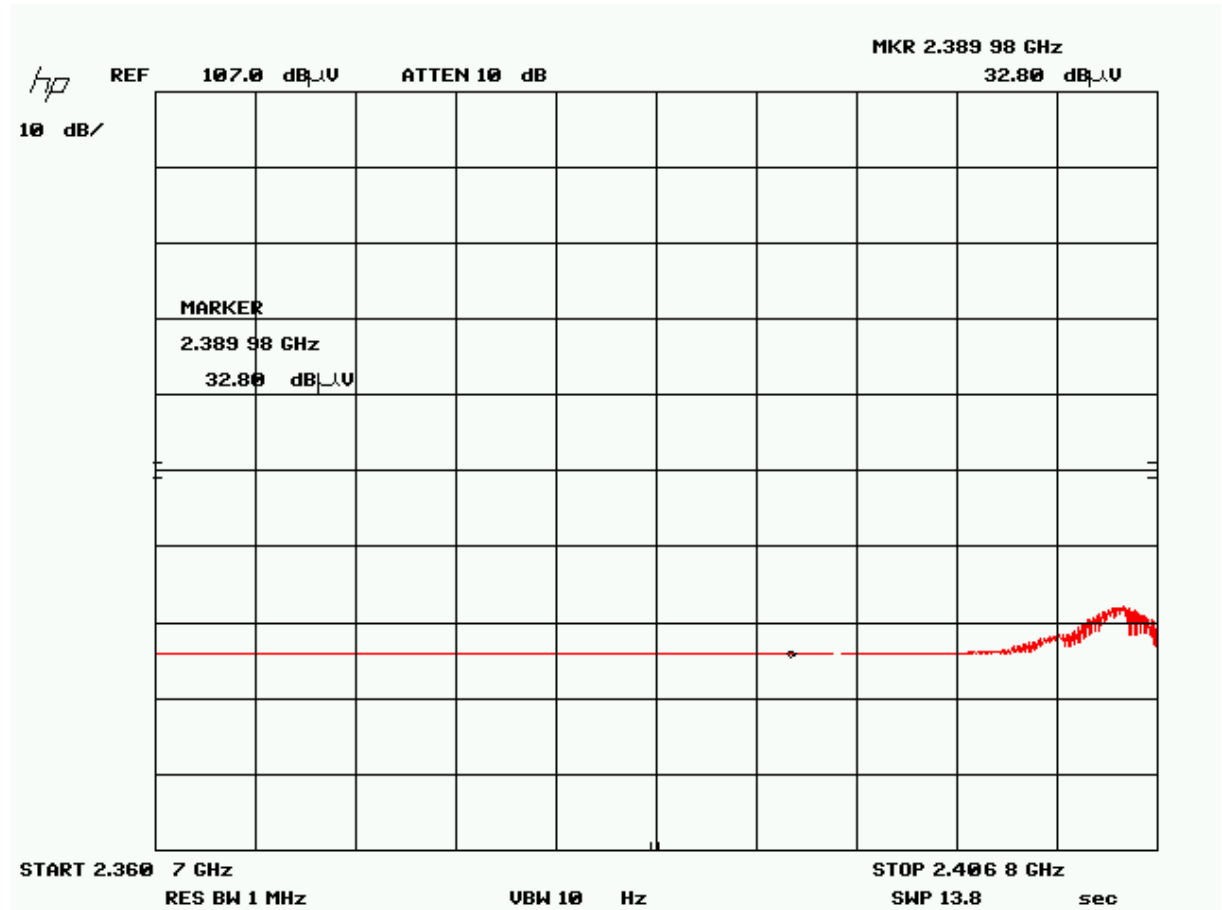
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


Band Edge – Low channel  
Vertical Average emissions



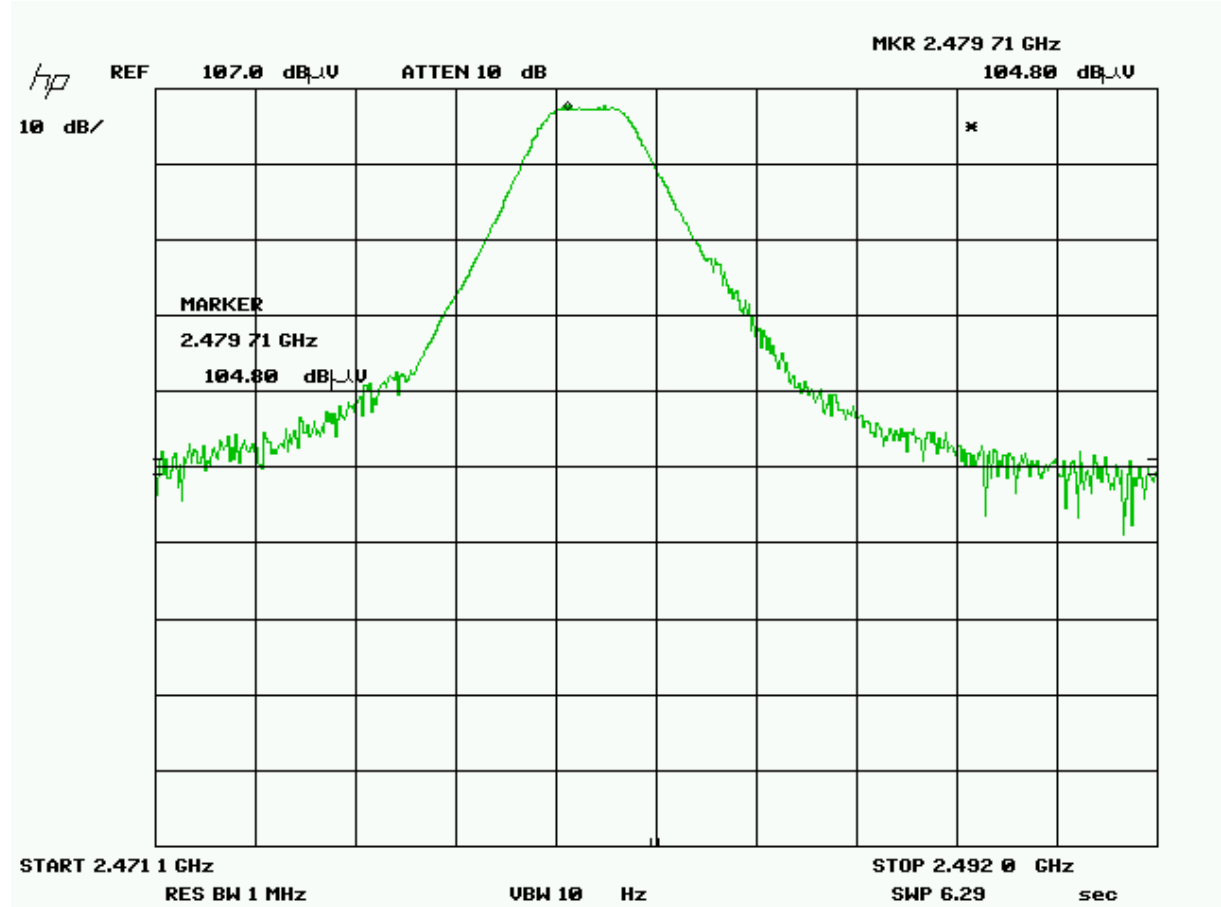
Client	Regen Energy	
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Band Edge – Low channel  
Horizontal Average emissions



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Band Edge – Hi channel  
Vertical peak emissions



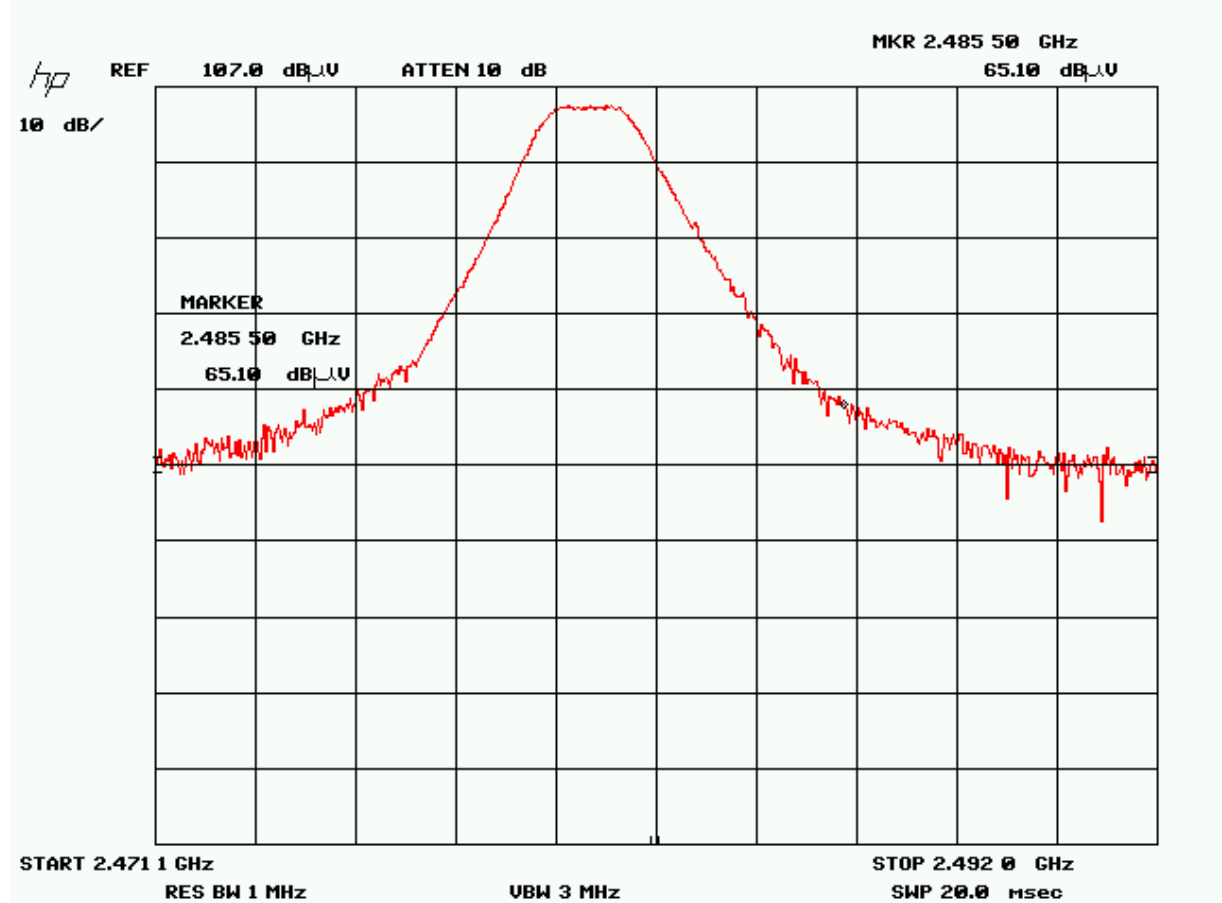
Client	Regen Energy	
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Band Edge – Hi channel  
Vertical peak emissions  
Marker Delta Method (Delta Calculation)




Client	Regen Energy	
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Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

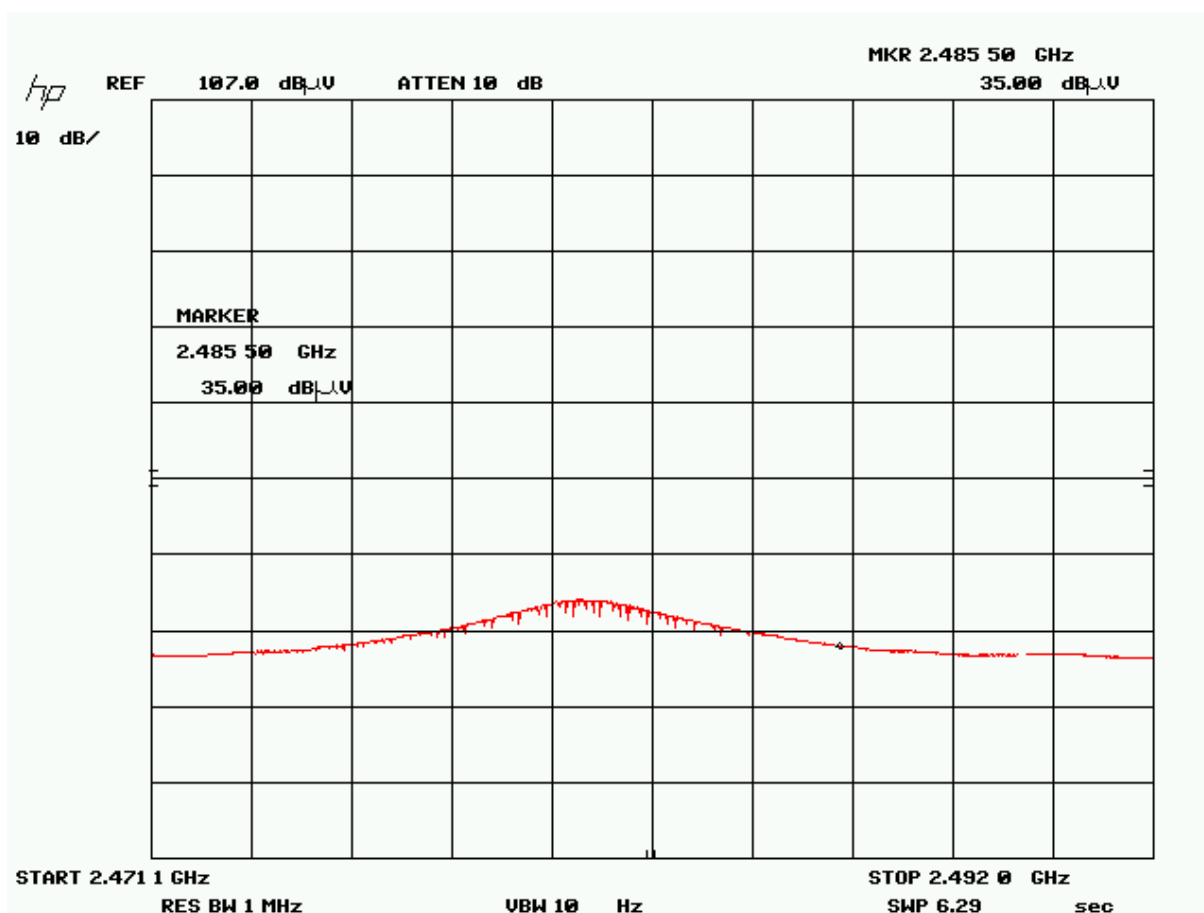
Band Edge – Hi channel  
Vertical peak emissions  
2485.5 MHz






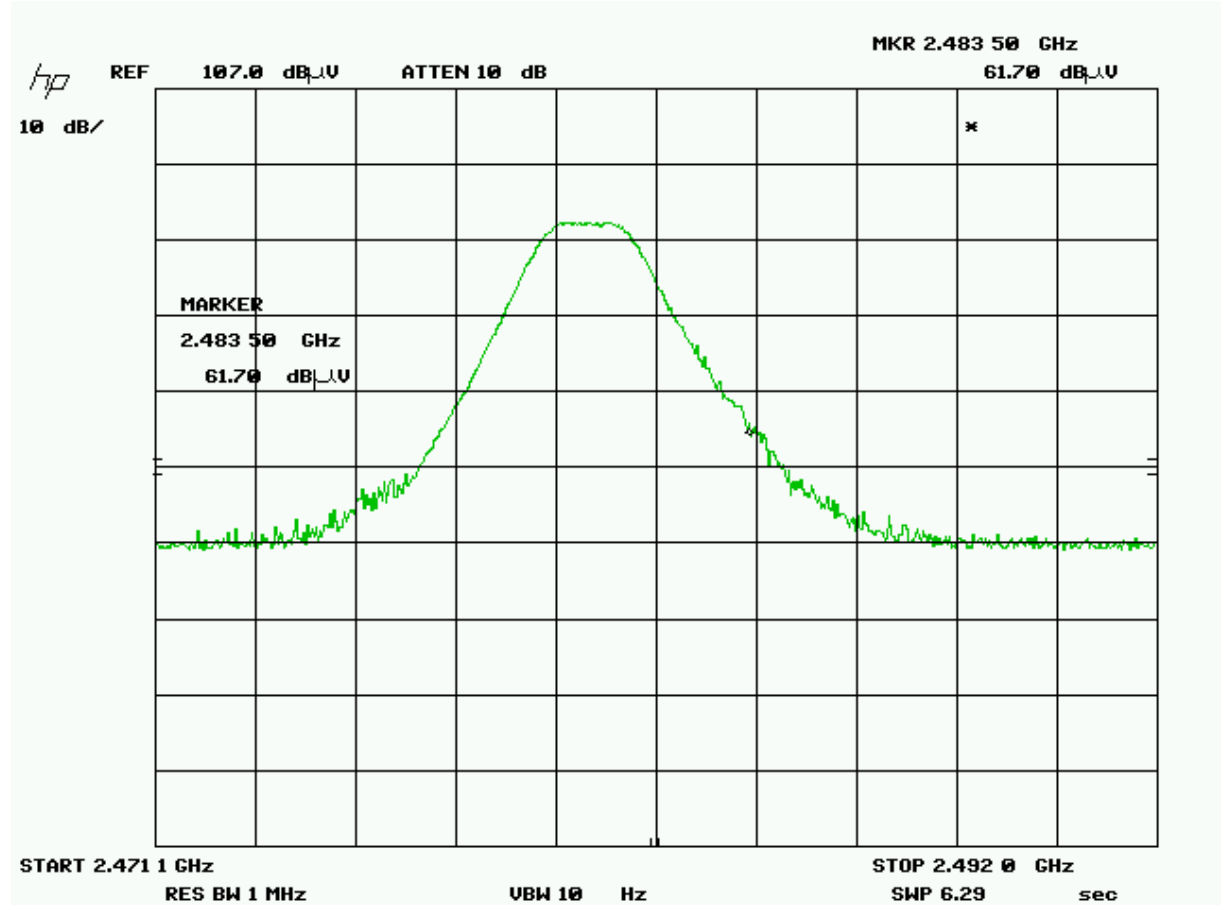
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


Band Edge – Hi channel  
Vertical average emissions  
2485.5 MHz



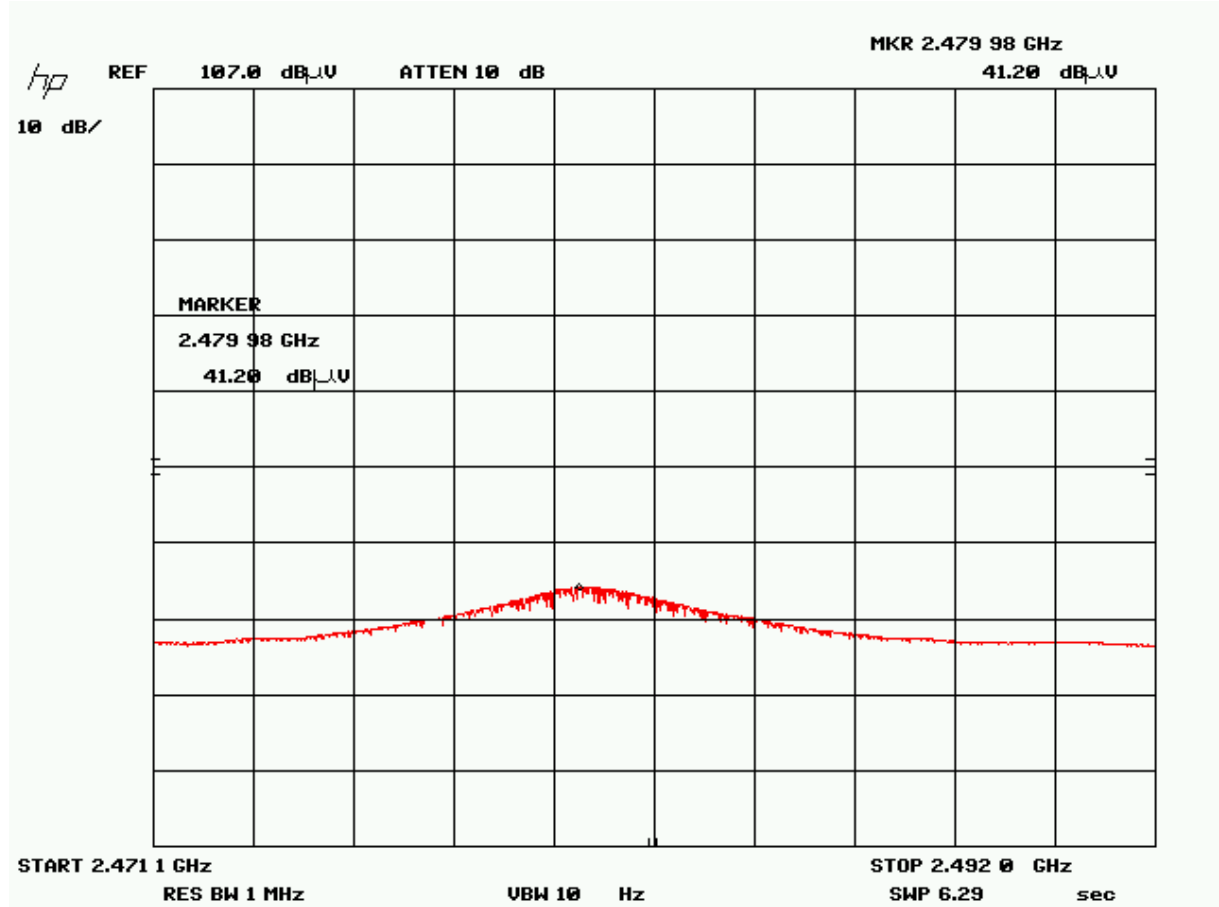
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


Band Edge – Hi channel  
Horizontal peak emissions



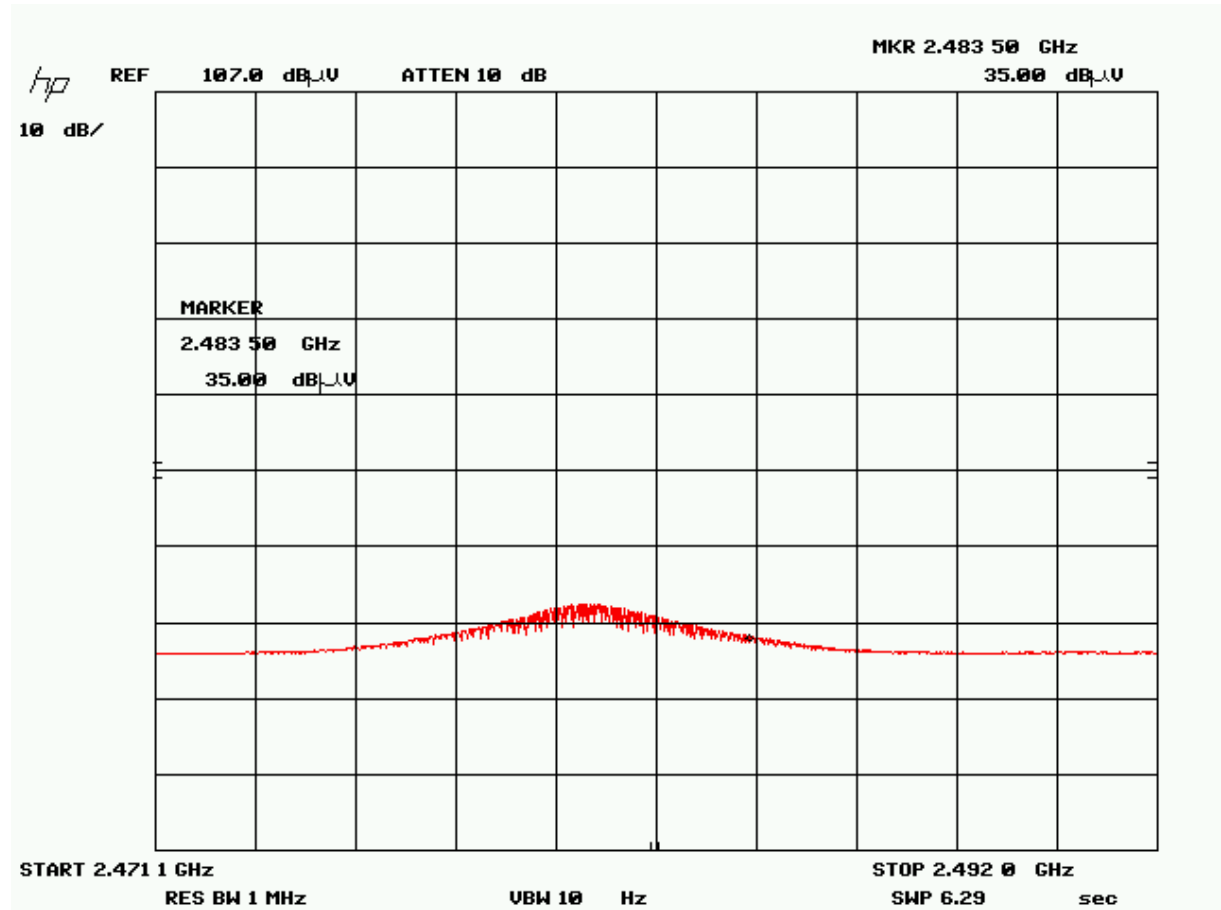
Client	Regen Energy	
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Band Edge – Hi channel  
Vertical Average emissions



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Band Edge – Hi channel  
Horizontal Average emissions



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## Final Measurements

Note:

1. For Vertical peak emissions at hi channel the unit did not meet the band edge requirements at 2483.5 MHz (using the marker delta method). As a result the power was dropped on the Hi channel to 16.3 dbm. Performing the marker delta procedure again at this lower power met the band edge limits. However since this method cannot be used past 2 regular bandwidths (2 MHz) at 2485.5 MHz regular peak readings were recorded and deemed to pass the limits. Plots of these steps are attached above.
2. In accordance with 15.247(d), only radiated emissions exceeding the 15.209 limit that occur within the bands listed in 15.205, need to be verified with a quasi-peak detector or an average detector.

Marker Delta tests –

1. For radiated emissions vertical orientation the marker delta method was used for band edge measurements. The peak recorded was 104.8 dbuV/m raw data = 111.2 dbuV/m (with factors applied)
2. The delta between peak and band edge at RBW = 100 kHz was 40.1 db. This lead to a raw signal of  $104.8 - 40.1 = 64.7$  dbuV/m raw data. The final reading with factors applied is 71.1 dbuV/m which has a 2.9 db margin.
3. The average readings and readings in horizontal orientation met the limits without the marker delta approach and are recorded.


The requirement of -20dBc is verified by the conducted method, please see ‘Spurious Antenna Conducted Emissions’ section of this report.

Some of the frequencies shown on the peak graph do not fall within a restricted band as listed in FCC 15.205 and does not need to be verified.

For information purposes, the fundamental was measured to be 114.2 dBuV/m at 3 meters, and none of the unintentional radiated emissions that fall outside of the restricted bands exceeded the -20dBc (or 94.2 dBuV/m) requirement.


The following measurements were made at the harmonics shown in the above graphs.

See ‘Spurious Antenna Conducted Emissions’ measurements for -20 dBc requirements. No other emissions above the 2<sup>nd</sup> harmonic were detected.


Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

### Radiated Emissions Measurements

Product category	FCC 15.247 Spurious Radiated Emissions										
Project Name / Number	RF Module										
Test Frequency (MHz)	Detection mode (Q-Peak)	Antenna polarity (Horz/Vert)	Raw signal dB(μV)	Antenna factor dB	Cable loss dB	Attenuator dB	Pre-Amp Gain dB	Received signal dB(μV/m)	Emission limit dB(μV/m)	Margin dB(μV)	Result
Hi Channel											
4960	Peak	Vert	52.1	30.0	6.0	10.0	30.0	68.1	74.0	5.9	PASS
4960	Avg	Vert	31.7	30.0	6.0	10.0	30.0	47.7	54.0	6.3	PASS
4960	Peak	Horz	50.0	30.0	6.0	10.0	30.0	66.0	74.0	8.0	PASS
4960	Avg	Horz	31.6	30.0	6.0	10.0	30.0	47.6	54.0	6.4	PASS
2485.5	Peak	Vert	65.1	30.0	2.4	10.0	36.0	71.5	74.0	2.5	PASS
2485.5	Avg	Vert	35.0	30.0	2.4	10.0	36.0	41.4	54.0	12.6	PASS
2480	Peak	Vert	104.8	30.0	2.4	10.0	36.0	111.2			
2480	Avg	Vert	41.2	30.0	2.4	10.0	36.0	47.6			
2483.5	Peak	Vert	64.7	30.0	2.4	10.0	36.0	71.1	74.0	2.9	PASS
2483.5	Avg	Vert	37.1	30.0	2.4	10.0	36.0	43.5	54.0	10.5	PASS
2480	Peak	Horz	89.4	30.0	2.4	10.0	36.0	95.8			
2480	Avg	Horz	39.3	30.0	2.4	10.0	36.0	45.7			

Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

2483.5	Peak	Horz	61.7	30.0	2.4	10.0	36.0	68.1	74.0	5.9	PASS
2483.5	Avg	Horz	35.0	30.0	2.4	10.0	36.0	41.4	54.0	12.6	PASS
2485.5	Peak	Horz	50.8	30.0	2.4	10.0	36.0	57.2	74.0	16.8	PASS
2485.5	Avg	Horz	33.3	30.0	2.4	10.0	36.0	39.7	54.0	14.3	PASS
Mid Channel											
2445	Peak	Horz	94.0	31.6	2.4	10.0	36.0	102.0			PASS
2445	Peak	Vert	106.3	31.5	2.4	10.0	36.0	114.2			PASS
4890	Peak	Vert	52.6	30.0	6.0	10.0	36.0	62.6	74.0	11.4	PASS
4890	Avg	Vert	31.7	30.0	6.0	10.0	36.0	41.7	54.0	12.3	PASS
Low Channel											
2405	Peak	Horz	92.2	31.6	2.4	10.0	36.0	100.2			PASS
2405	Avg	Horz	38.8	31.6	2.4	10.0	36.0	46.8			PASS
2390	Peak	Horz	46.0	31.6	2.4	10.0	36.0	54.0	74.0	20.0	PASS
2390	Avg	Horz	32.8	31.6	2.4	10.0	36.0	40.8	54.0	13.2	PASS
2405	Peak	Vert	106.0	31.5	2.4	10.0	36.0	113.9			PASS
2405	Avg	Vert	41.0	31.5	2.4	10.0	36.0	48.9			PASS
2390	Peak	Vert	57.6	31.5	2.4	10.0	36.0	65.5	74.0	8.5	PASS
2390	Avg	Vert	32.9	31.5	2.4	10.0	36.0	40.8	54.0	13.2	PASS
4810	Peak	Vert	50.1	30.0	6.0	10.0	36.0	60.1	74.0	13.9	PASS
4810	Avg	Vert	32.9	30.0	6.0	10.0	36.0	42.9	54.0	11.1	PASS


Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	2006-08-09	2008-10-09	GEMC 6
Quasi Peak Adapter	85650A	HP	2006-08-07	2008-10-07	GEMC 7
BiLog Antenna	3142-C	ETS	2006-08-06	2008-10-06	GEMC 8
Horn Antenna	6878/24	Q-Par	On file	2008-10-01	GEMC 65
1-26G pre-amp	HP 8449B	HP	On file	2008-10-01	GEMC 68
Attenuator 3 dB	FP-50-3	Trilithic	NCR	NCR	GEMC 40
Pre-Amplifier	PA-2.5-26	Vican	2006-09-12	2008-10-12	GEMC 9
IFR Spectrum Analyzer	AN940	IFR	2006-4-4	6008-10-4	GEMC 6350
Horn Antenna	SAS-572	AH	NCR	NCR	GEMC 6371
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
RF Cable 0.5M	LMR-400-0.5M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 31

This report module is based on GEMC template "FCC - 15.209 - Radiated Emissions\_Rev2.doc"



Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## ***6dB Bandwidth of Digitally Modulated Systems***

### **Purpose**


The purpose of this test is to ensure that the bandwidth occupied exceeds a stated minimum. This helps ensure the utilization of the frequency allocation is sufficiently wide. This also helps prevent corruption of data by ensuring adequate data separation to distinguish the reception of the intended information.

### **Limits**

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. This should be measured with a 100 kHz RBW and a 300 kHz VBW.

### **Results**

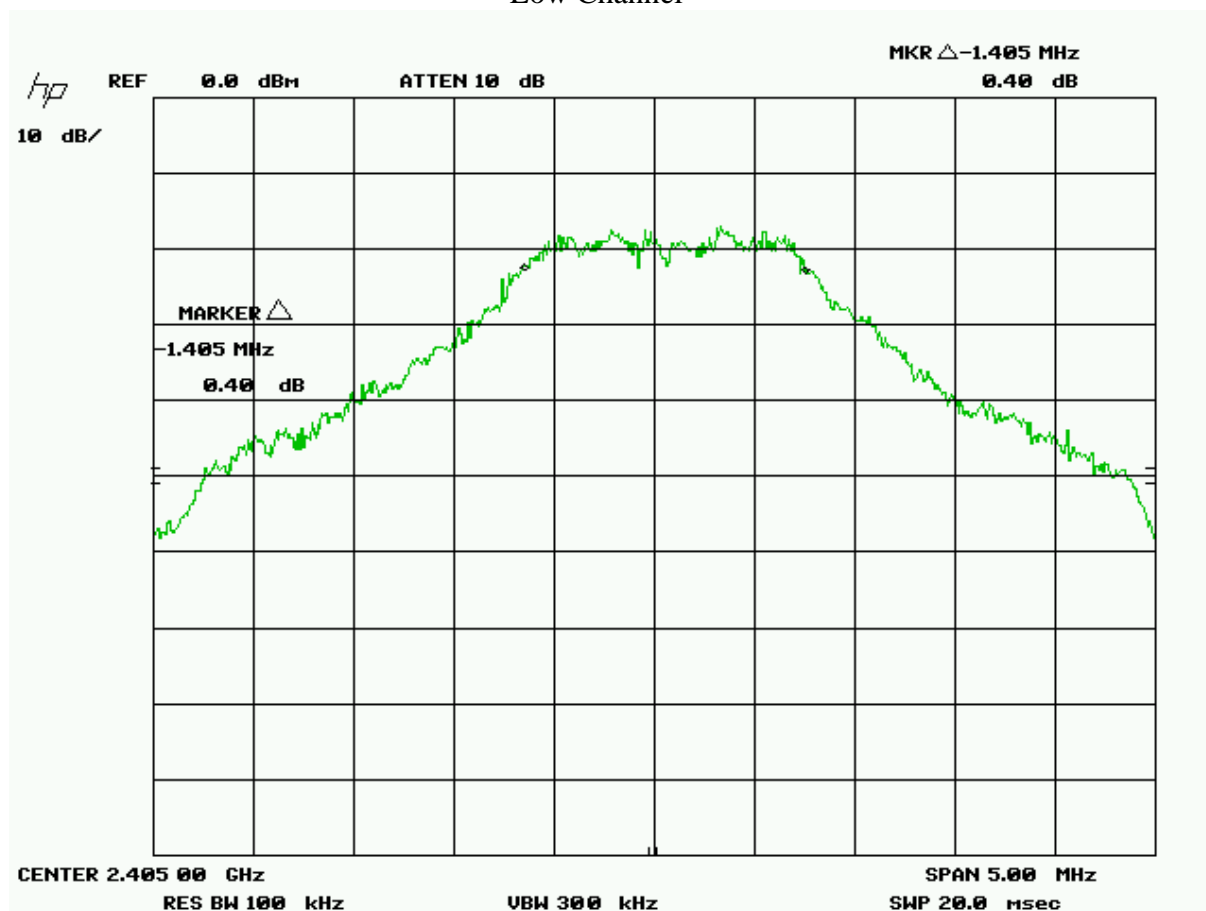
The EUT passed. The 6 dB BW measured was 1.37 MHz.


Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## Graph(s)

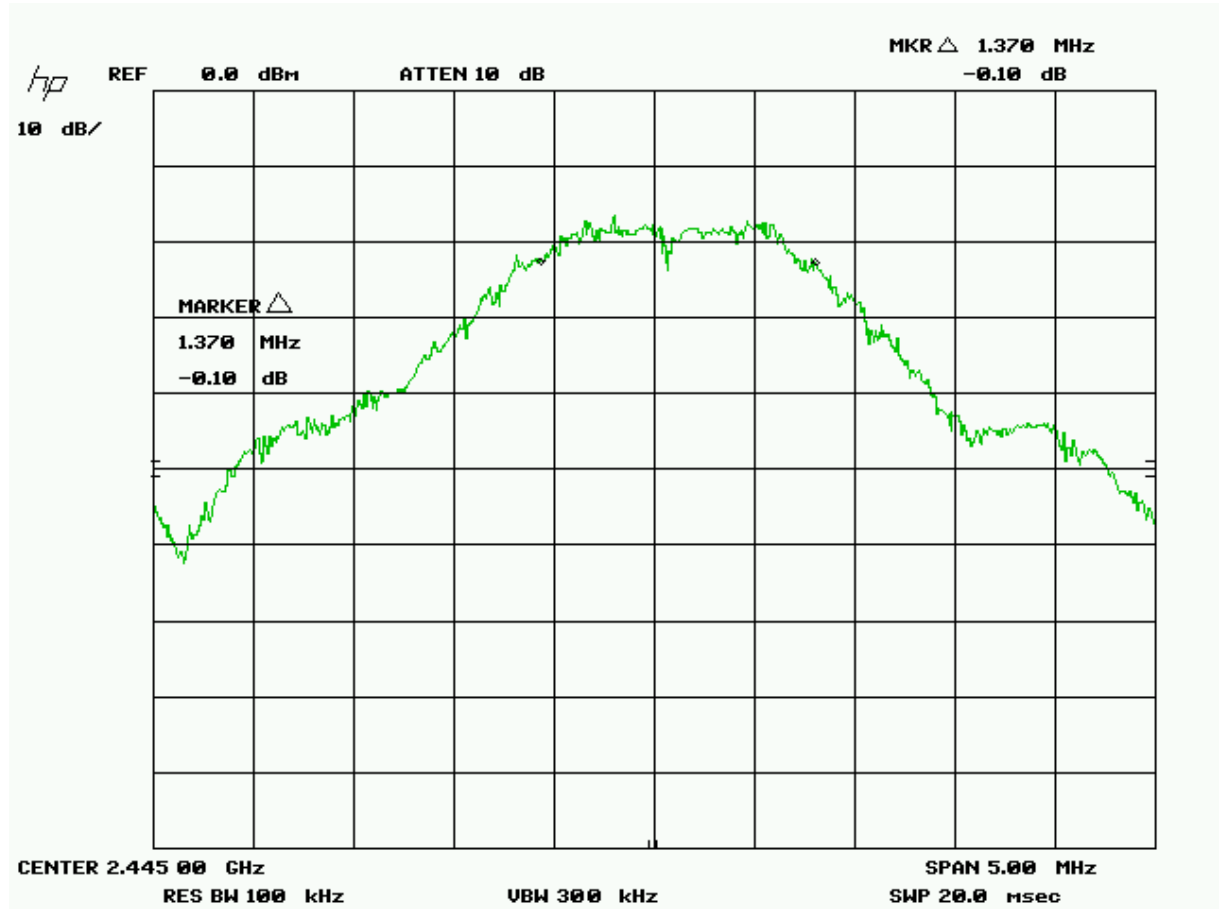
The graphs shown below show the channel spacing during the operation of the device. This is measured by a max hold on the spectrum analyzer. This measurement is a peak measurement. Max hold is performed for a duration of not less than 1 minute.


Low Channel



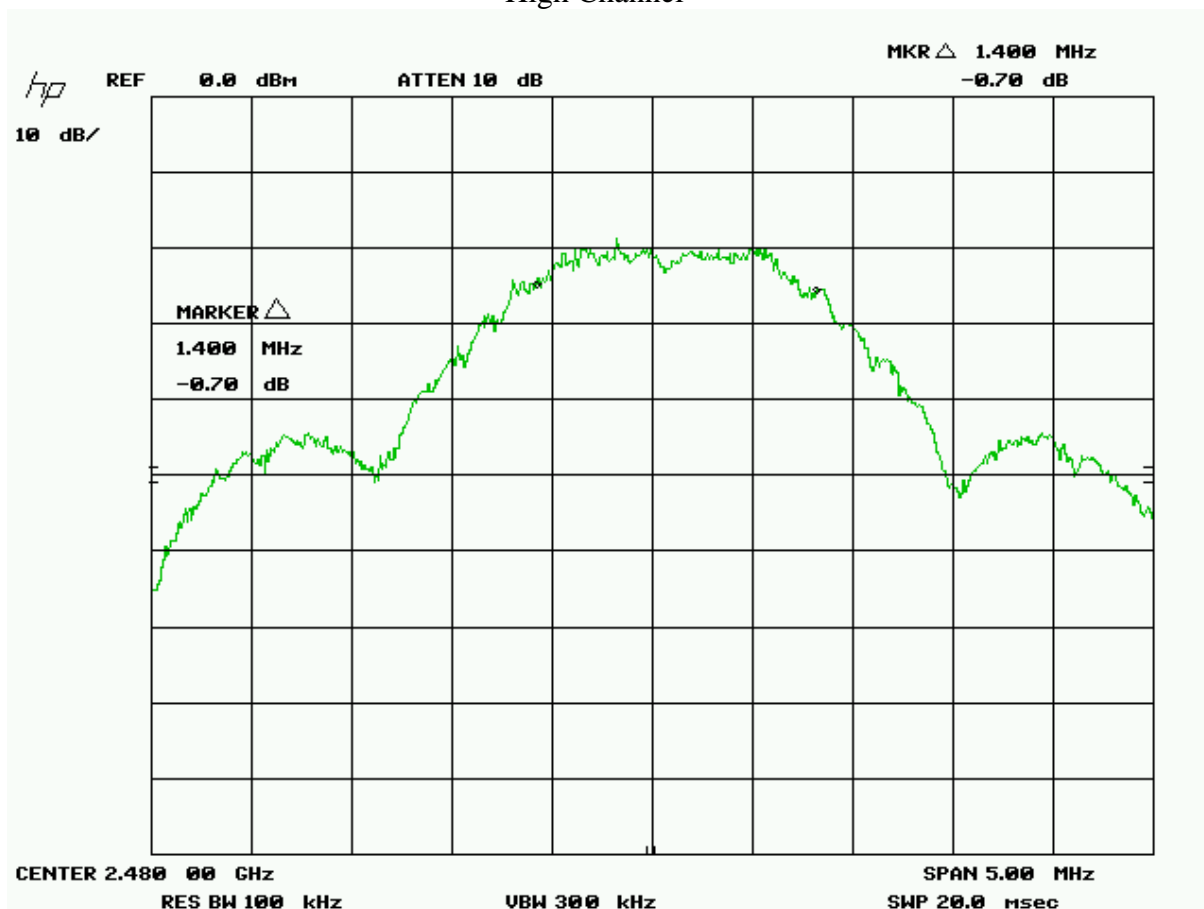
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

Medium Channel




Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

### High Channel




Note: See ‘Appendix B – EUT & Test Setup Photographs’ for photos showing the test set-up.

Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Attenuator 20 dB	FP-50-20	Trilithic	NCR	NCR	GEMC 43
Spectrum Analyzer	8566B	HP	2006-08-09	2008-10-09	GEMC 6
Quasi Peak Adapter	85650A	HP	2006-08-07	2008-10-07	GEMC 7
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
Power Attenuator 20 dB	25-A-FFN-20	Bird / Hutton	NCR	NCR	GEMC 49

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B\_Rev1"

Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## ***Maximum Peak Envelope Conducted Power***

### **Purpose**

The purpose of this test is to ensure that the maximum power conducted to the radiating element does not exceed the limits specified. This ensures that if the end-user replaces the antenna, that the maximum power does not exceed an amount which may create an excessive power level.


### **Limits**

The limits are defined in 15.247(b).

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands, the peak limit is 1 watt.

### **Results**

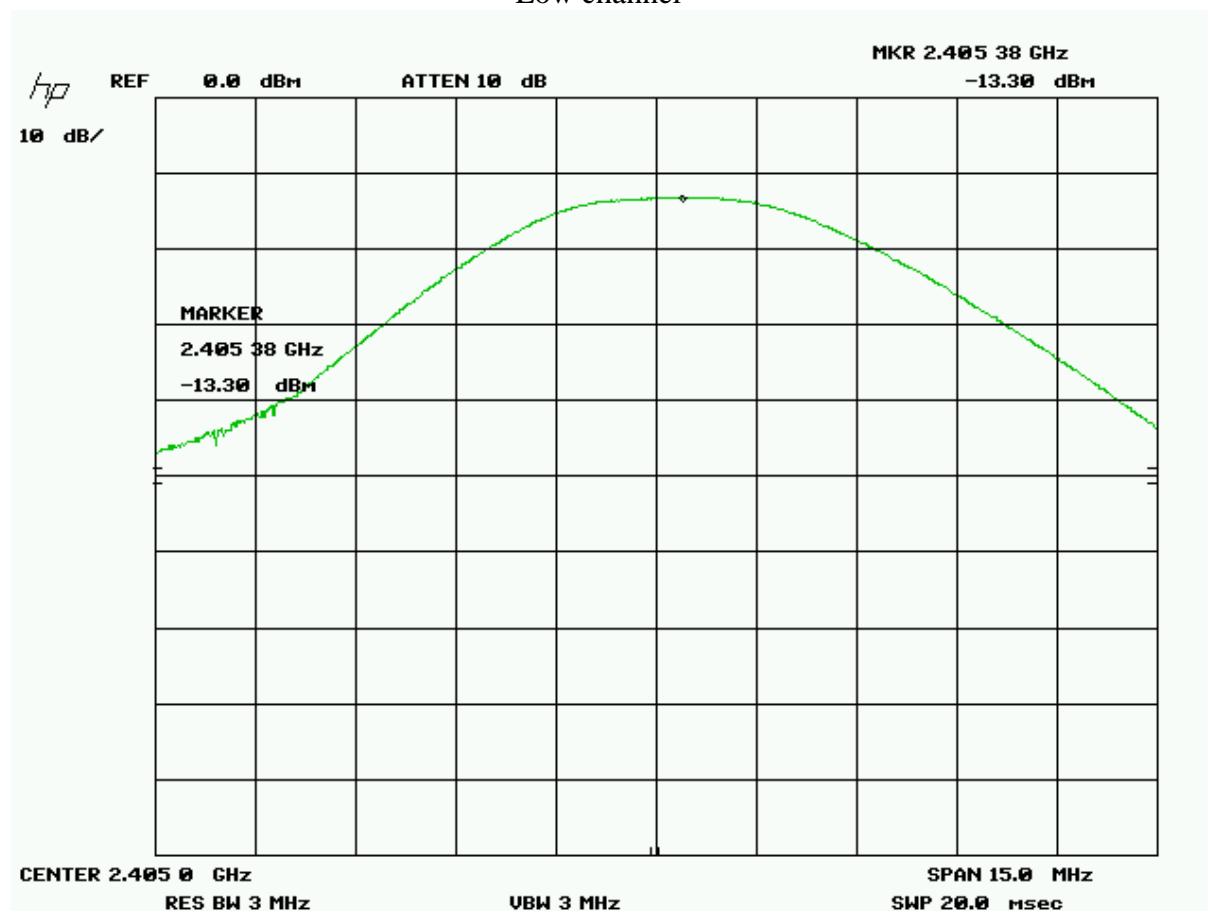
The EUT passed. The peak power measured was 18.9 dBm (77.6 mW).


Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## Table(s)

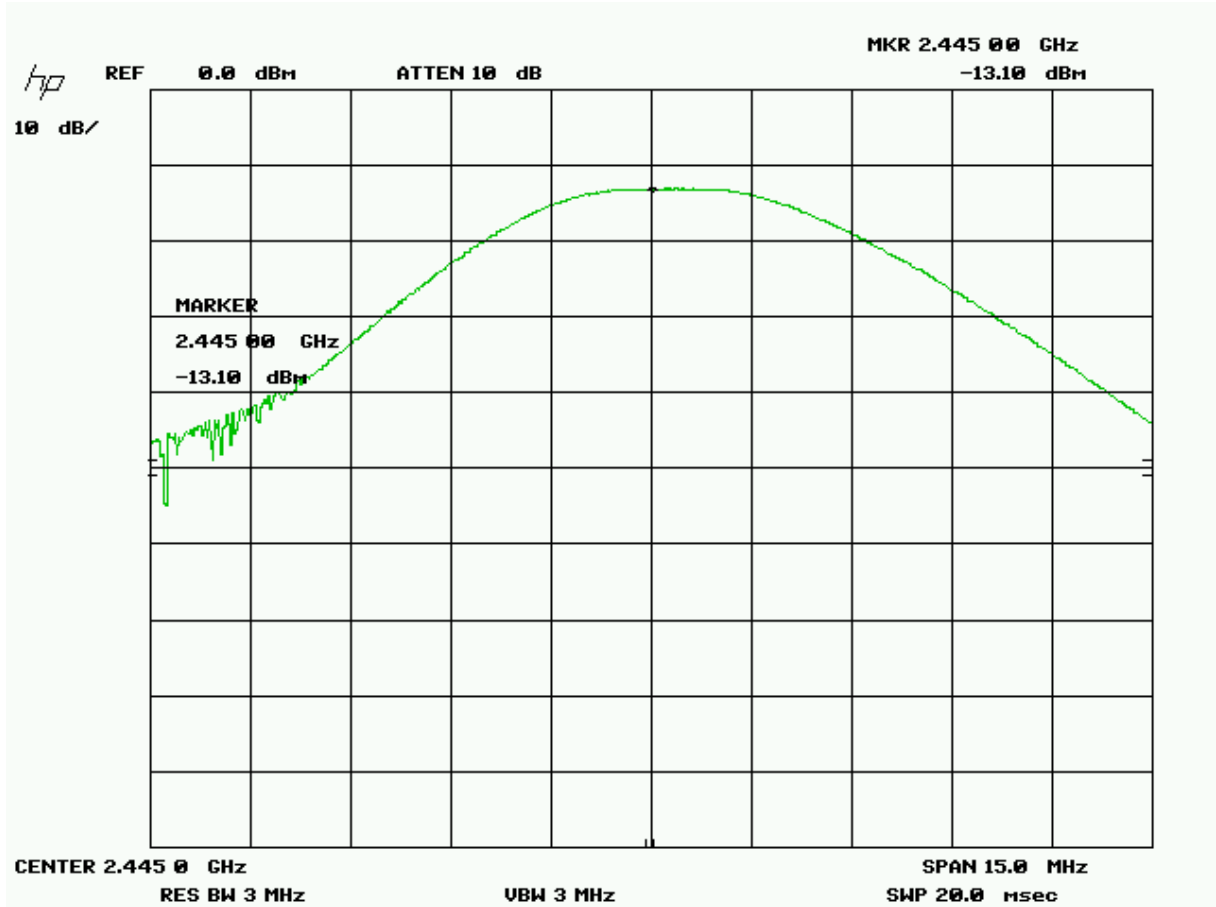
The tables shown below shows the peak power output of the device during the antenna conducted measurement during transmit operation of the EUT. Note there was 20 dB of external attenuation taken during this measurement.

### Low channel




Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

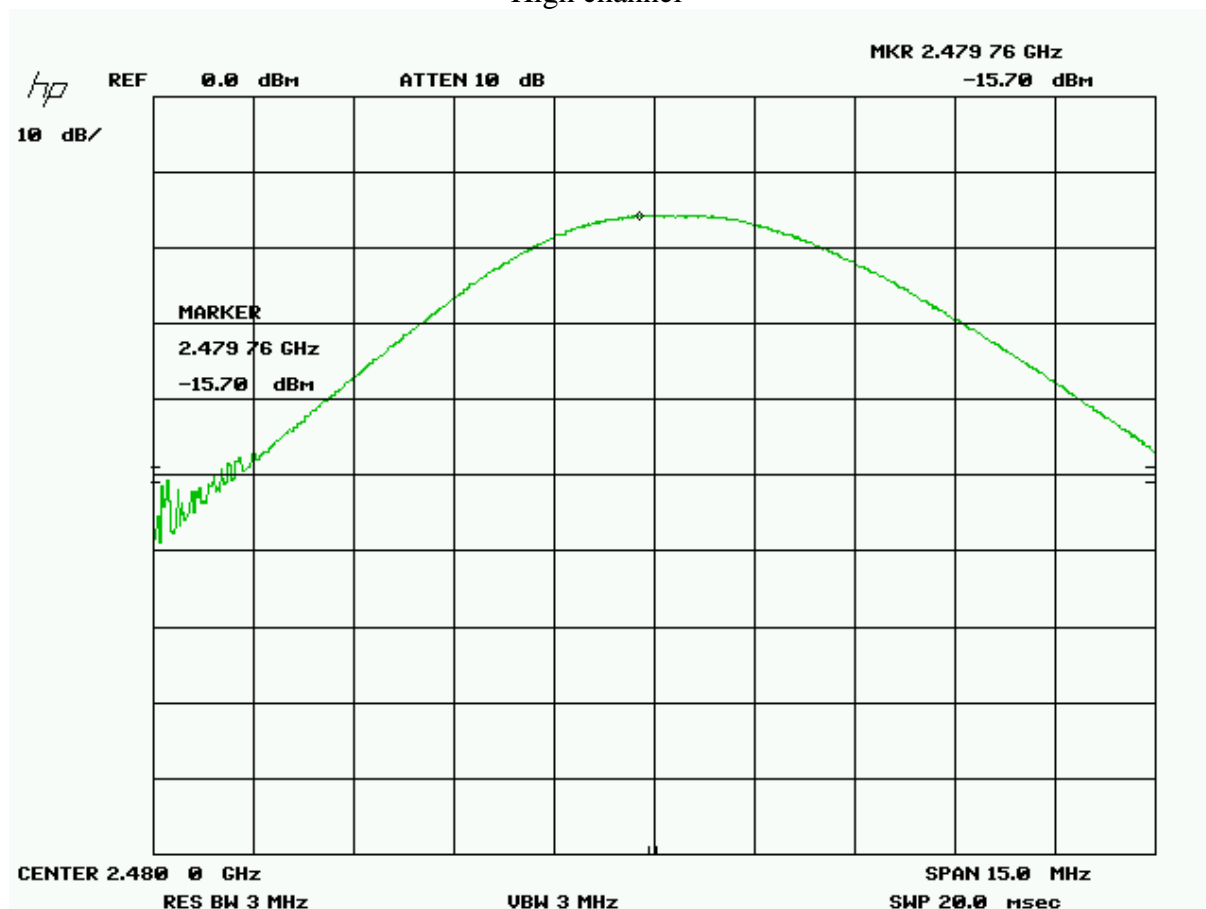
# Medium channel






Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

### High channel



The calculated value is:  
 $-13.1 \text{ dBm} + 30 \text{ dB (attenuator)} + 2 \text{ dB cable losses}$   
 $= 18.9 \text{ dbm}$


Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Power Head	PH 2000	AR	2006-10-13	2008-10-13	GEMC 15
Power meter	PM 2002	AR	2006-10-13	2008-10-13	GEMC 16
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
Power Attenuator 20 dB	25-A-FFN-20	Bird / Hutton	NCR	NCR	GEMC 49

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B\_Rev1"

Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## ***Antenna Spurious Conducted Emissions ( - 20 dbc Requirement)***

### **Purpose**

The purpose of this test is to ensure that the maximum power conducted to the radiating element at frequencies outside of the authorized spectrum does not exceed the limits specified. This ensures that the only the intended signal is delivered to the radiating element.

### **Limits**


The limits are defined in 15.247(d). In any 100 kHz band, the peak spurious harmonics emissions must be at least 20 dB below the fundamental. Spurious Conducted emissions are to be evaluated up to the 10<sup>th</sup> harmonic. This -20 dBc requirement also applies at the 'band edge' or 2.4 GHz and 2.4835 GHz.

### **Results**

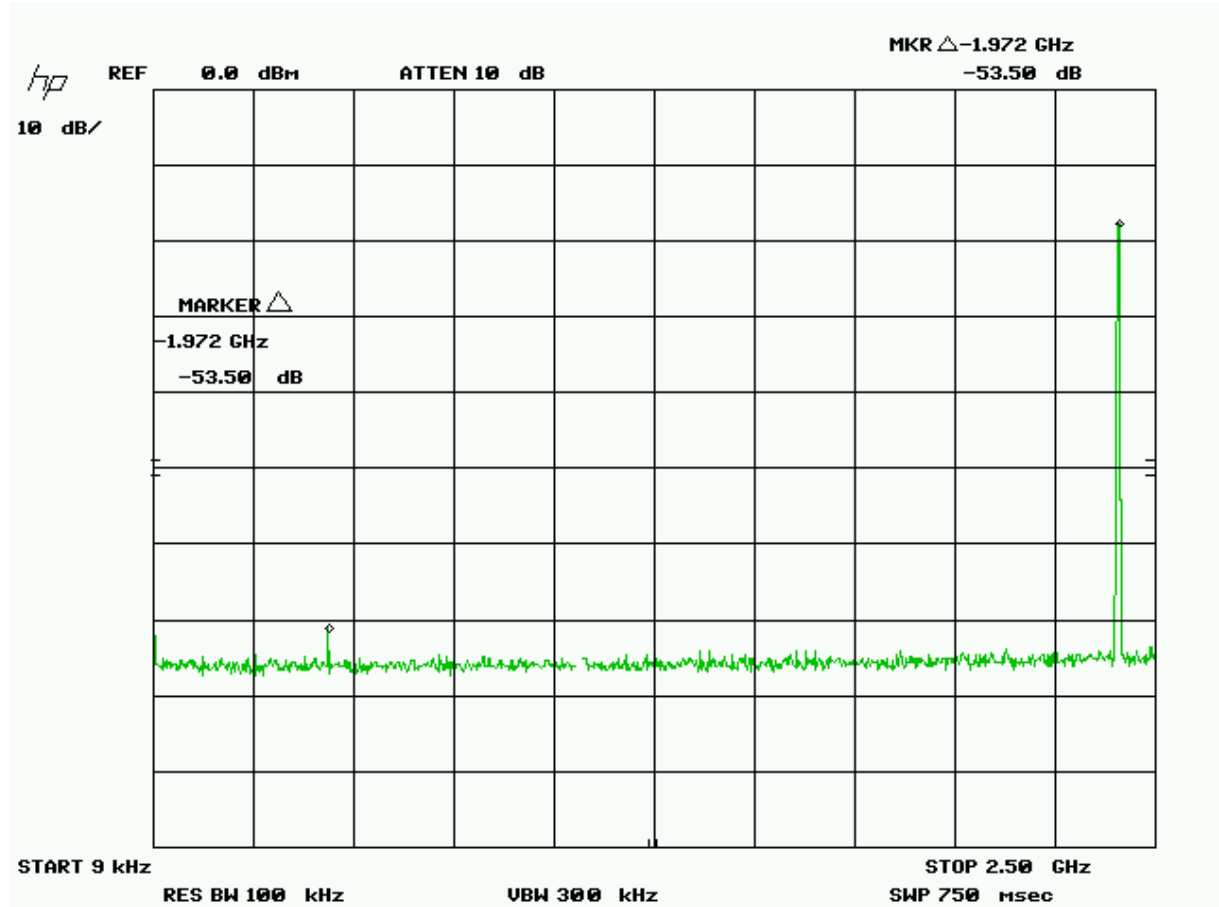
The EUT passed the limits. Low, middle and high band was measured. The worst case for each mode is presented as a graph for the spectrum. The -20 dBc requirement is shown for the lower band edge at 2.4 GHz in the low band. The -20 dBc requirement is also shown for the higher band edge at 2.4835 GHz in the high band.


### **Graph(s)**

The graphs shown below shows the peak power output of the device during the antenna conducted measurement during transmit operation of the EUT. Note there was 20 dB of external attenuation taken during this measurement.

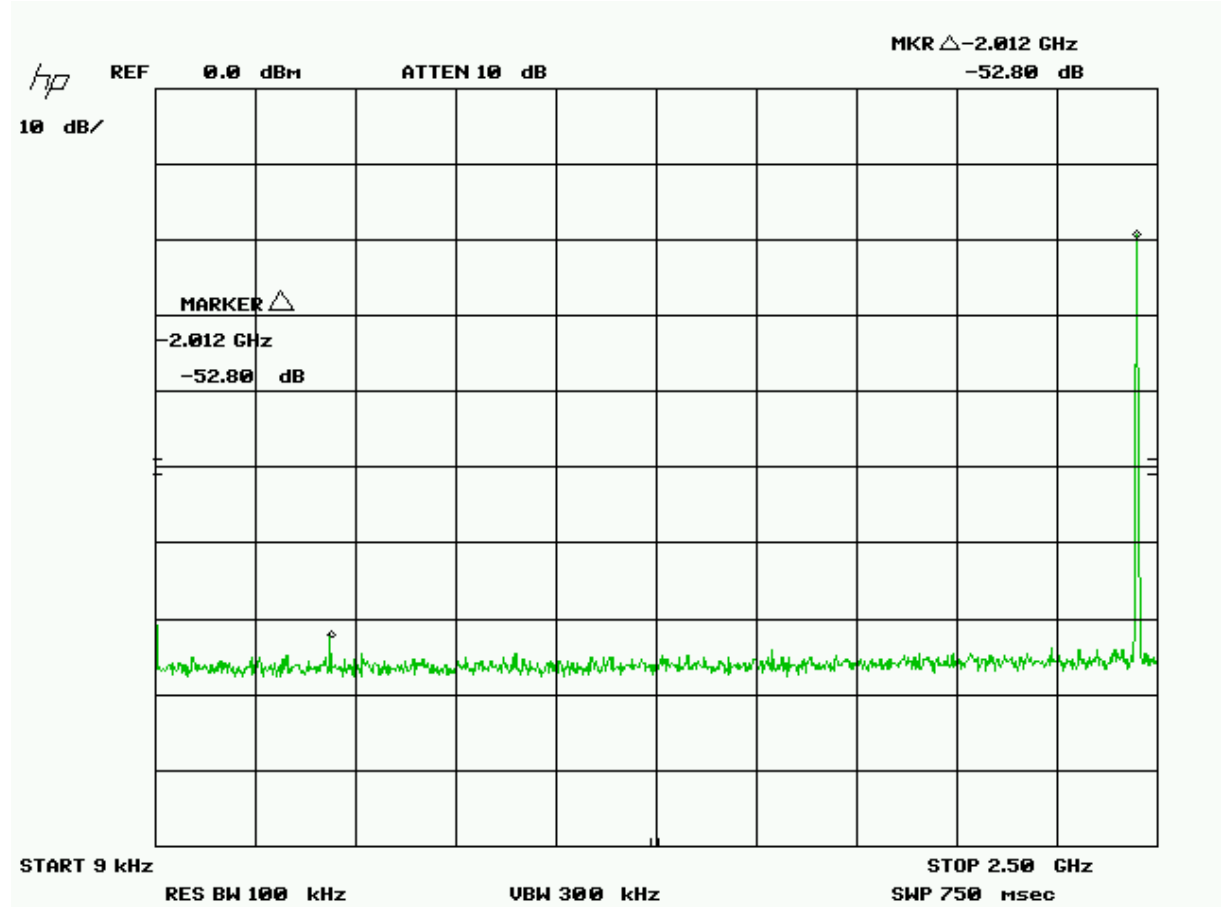
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


9 kHz – 2.5 GHz Lo



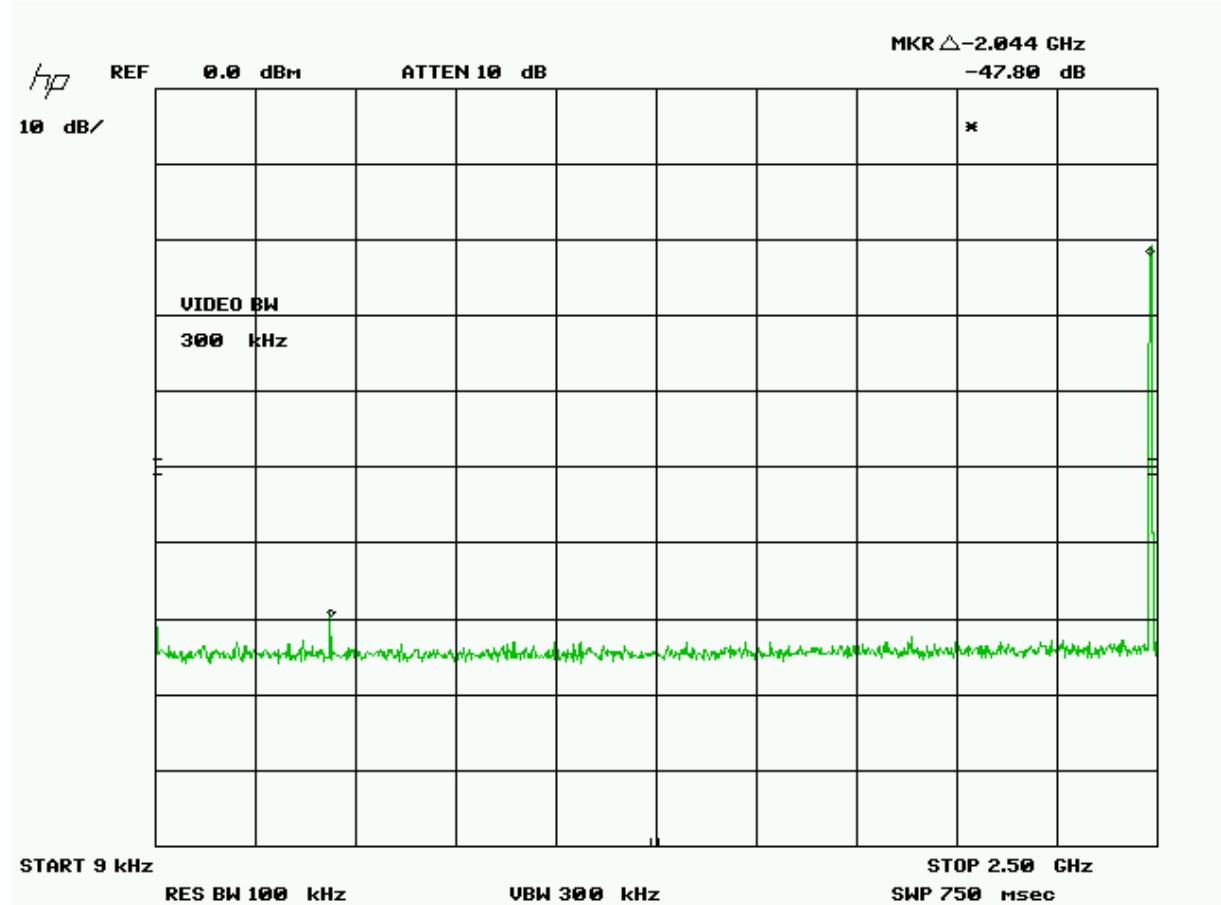
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


9 kHz – 2.5 GHz Med



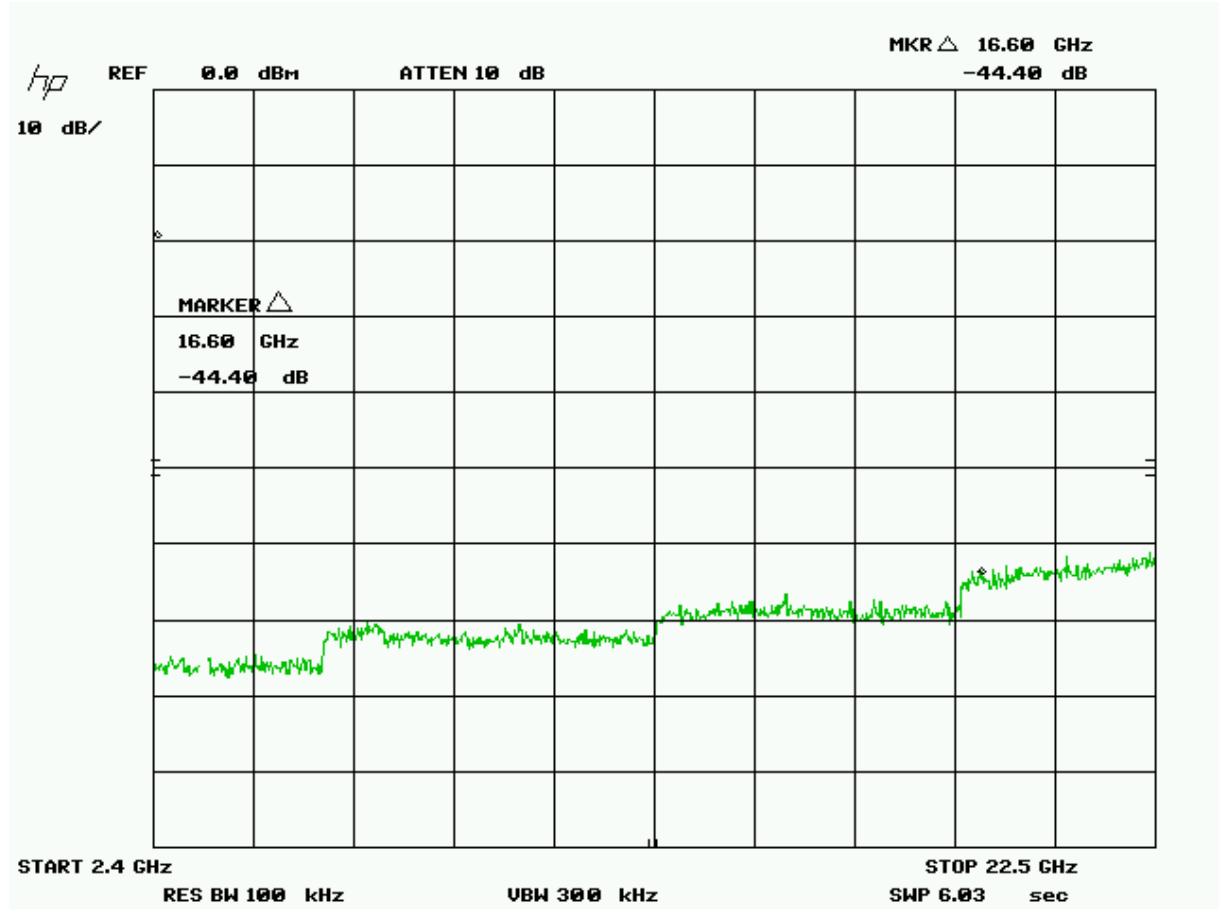
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


9 kHz – 2.5 GHz Hi



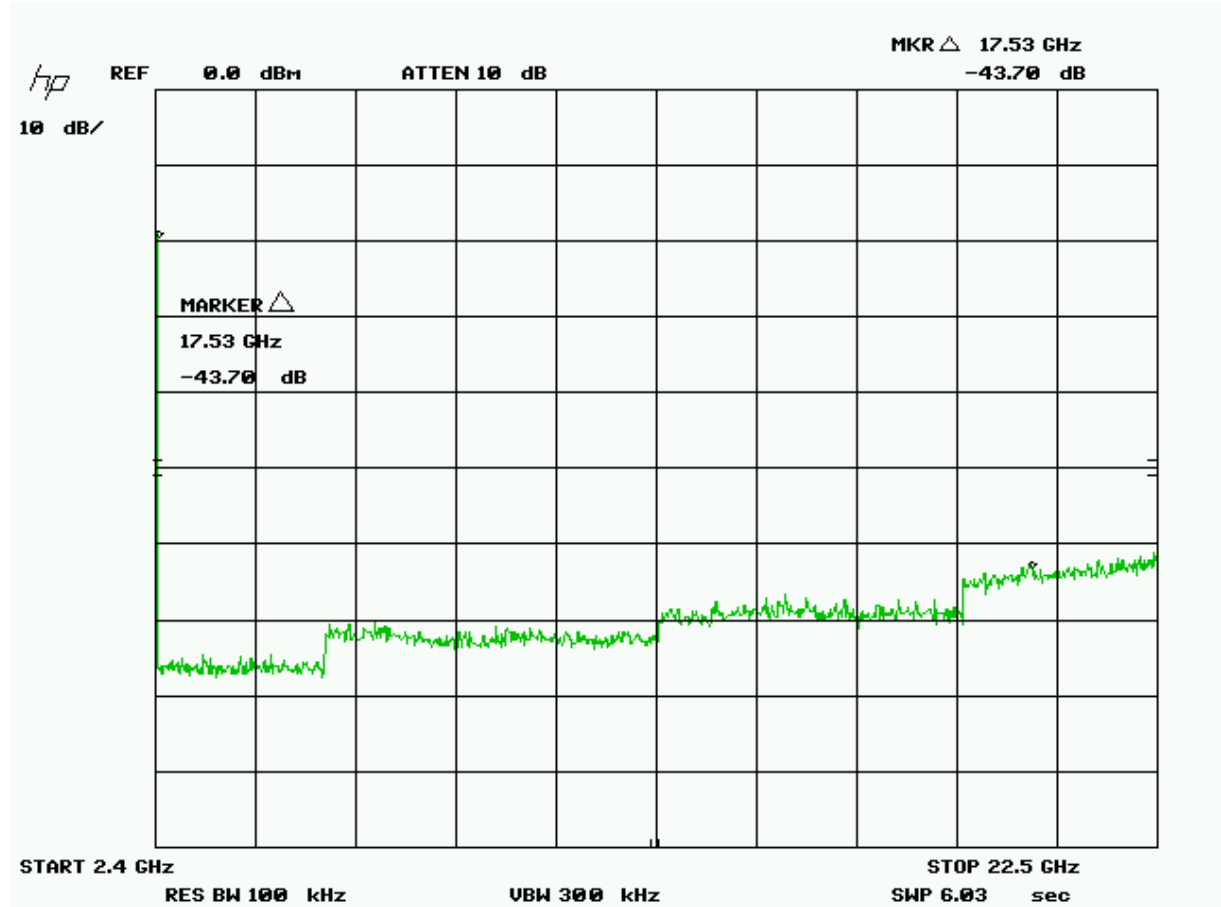
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

2 GHz – 22.5 GHz Lo




Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

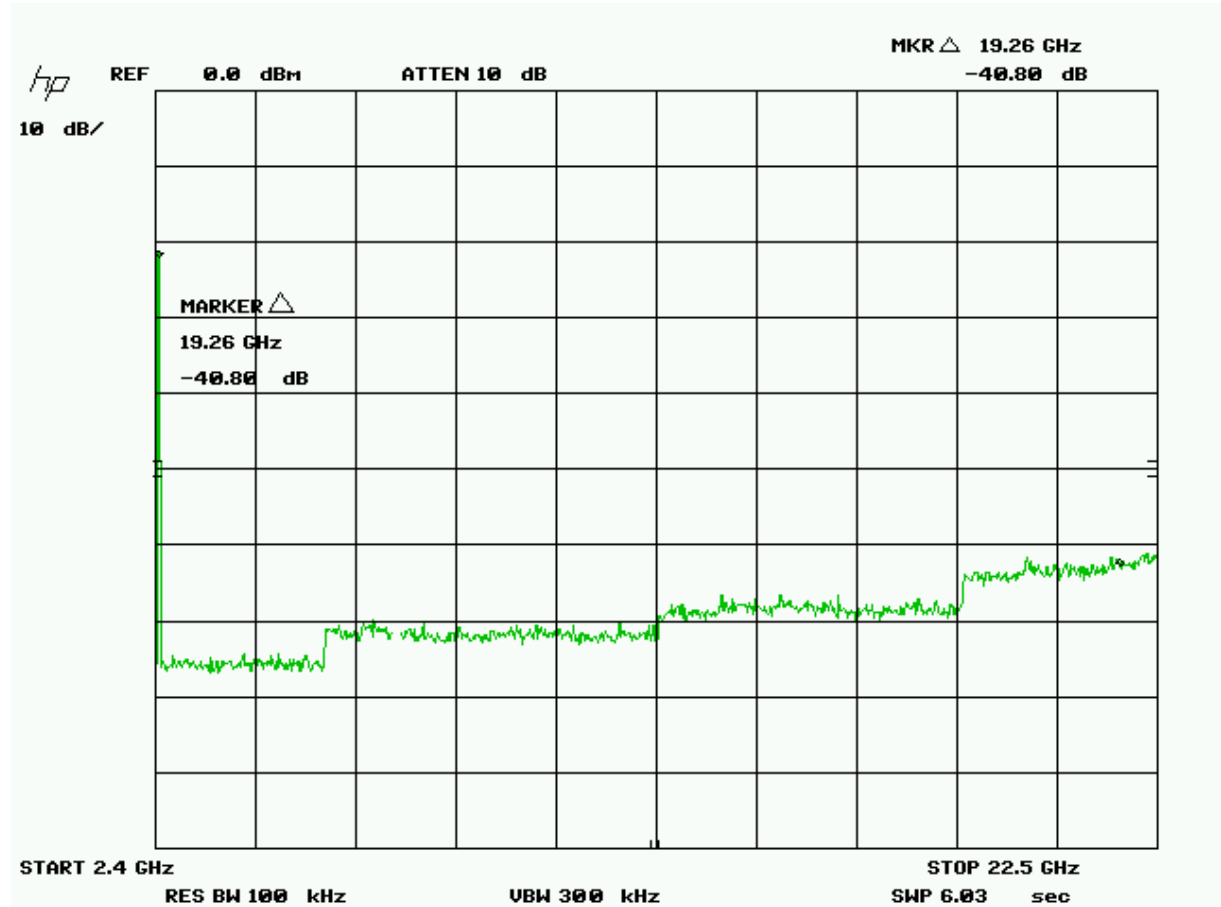
2 GHz – 22.5 GHz Med






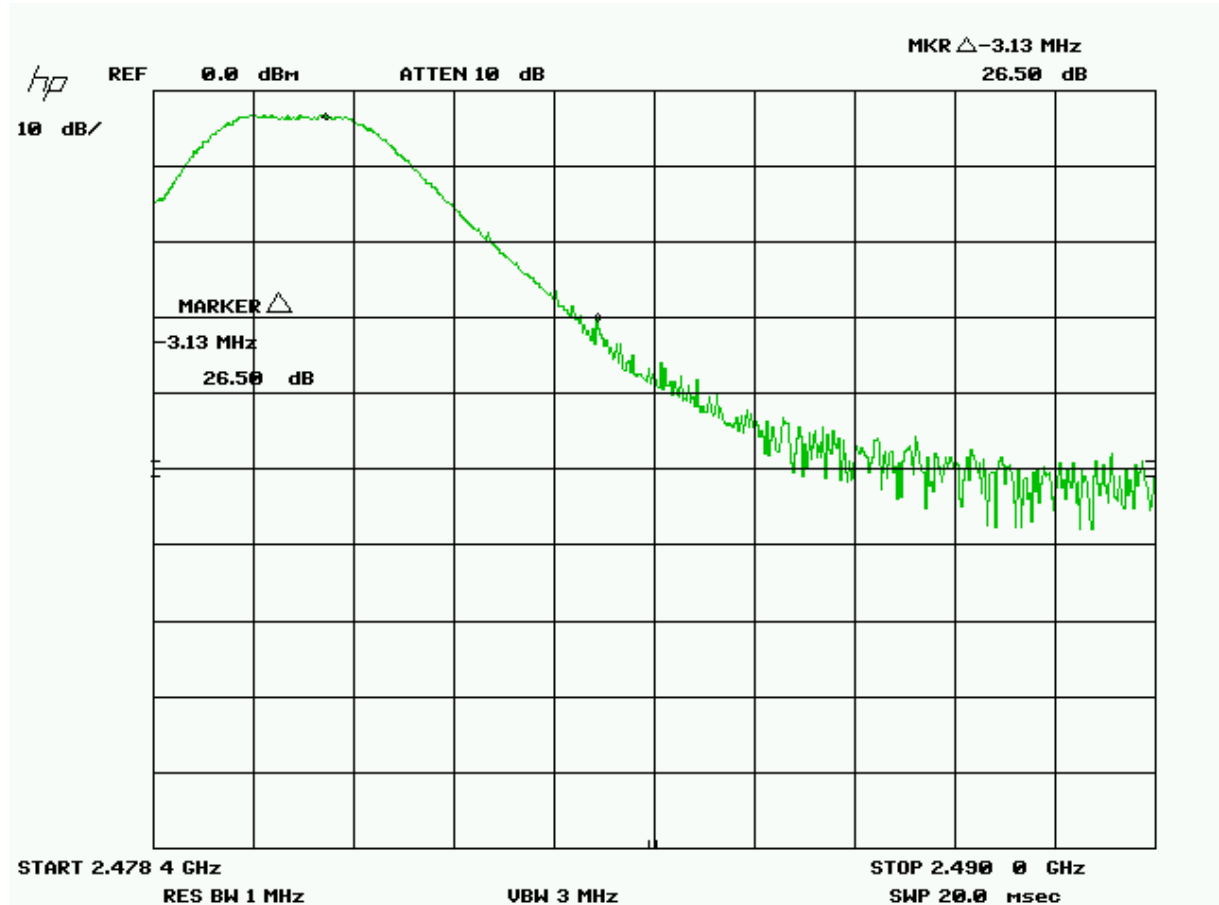
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


2 GHz – 22.5 GHz Hi



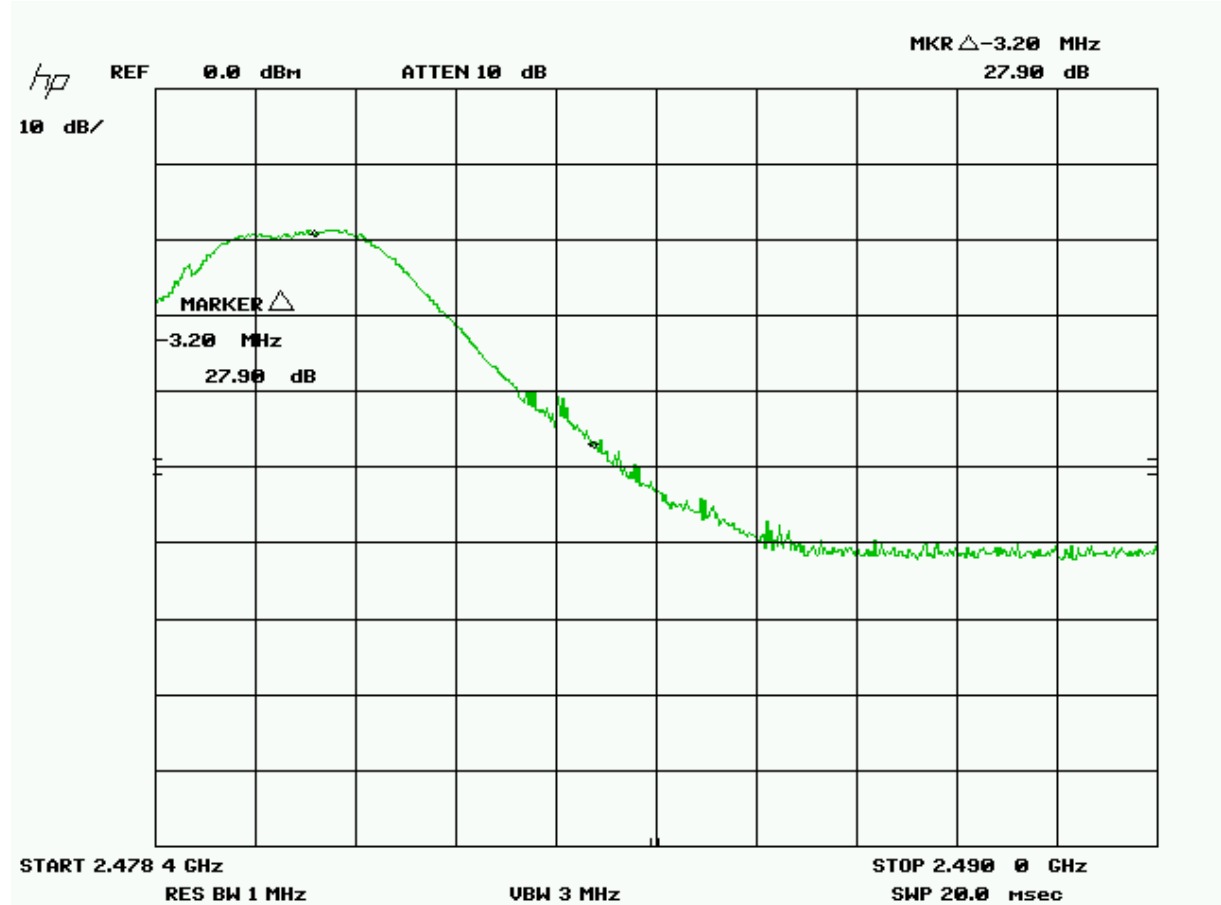
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


2483.5 MHz Band edge  
Vertical peak emissions



Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


2483.5 MHz Band edge  
Horizontal peak emissions



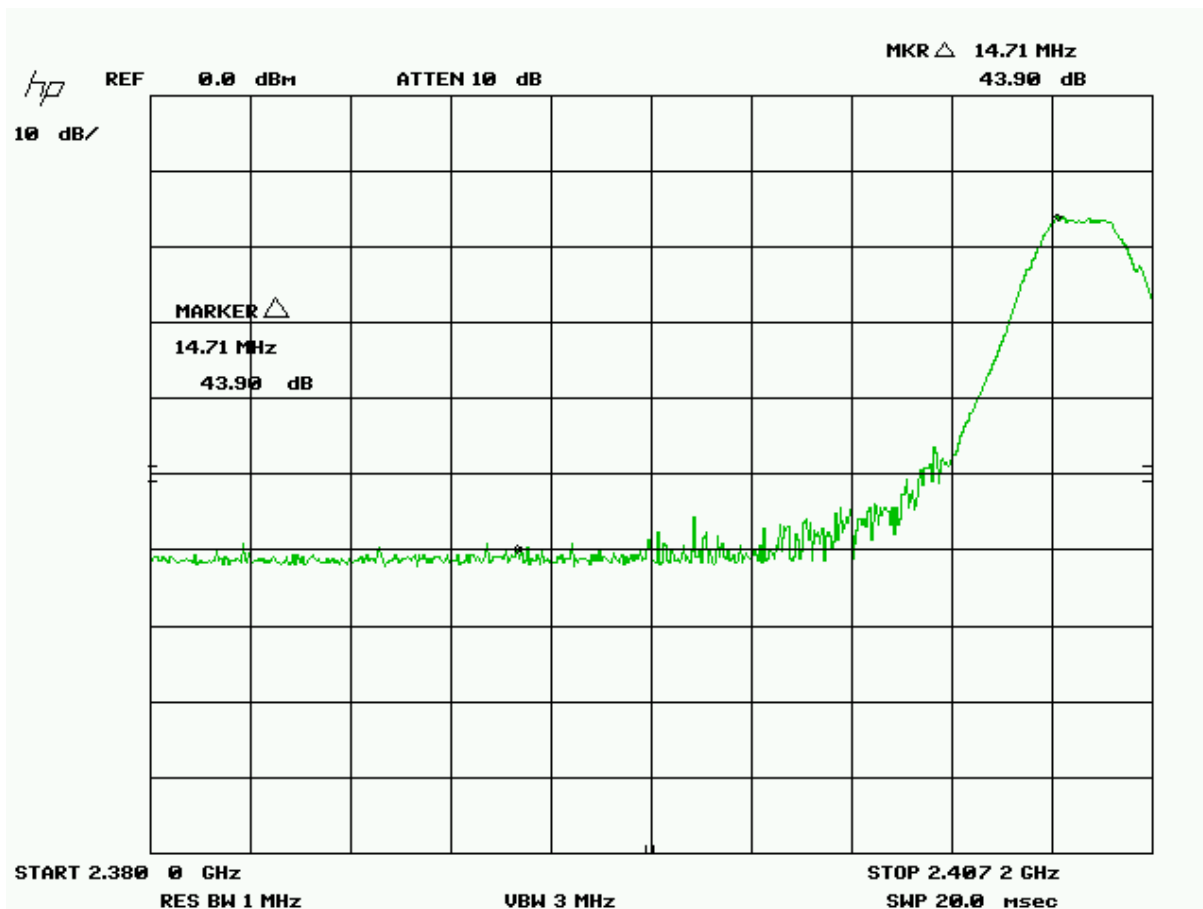
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


2390 MHz Band edge  
Vertical peak emissions



Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

2390 MHz Band edge  
Horizontal peak emissions



Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

The frequency range of 22.5 – 25 GHz, the 10<sup>th</sup> harmonic and 9<sup>th</sup> harmonic where applicable, was additionally scanned using an alternate spectrum analyzer, in low, middle and high band for each mode. No emissions were detected at the 9<sup>th</sup> and 10<sup>th</sup> harmonic.


The plots show raw data and no correction factors are applied. They simply show a 20dbc differential between the peak and the band edge

Note: See ‘Appendix B – EUT & Test Setup Photographs’ for photos showing the test set-up.

## Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Attenuator 1 dB	FP-50-1	Trilithic	NCR	NCR	GEMC 38
Attenuator 3 dB	FP-50-3	Trilithic	NCR	NCR	GEMC 40
Attenuator 6 dB	FP-50-6	Trilithic	NCR	NCR	GEMC 41
Attenuator 10 dB	FP-50-10	Trilithic	NCR	NCR	GEMC 42
Attenuator 20 dB	FP-50-20	Trilithic	NCR	NCR	GEMC 43
Spectrum Analyzer	8566B	HP	2006-08-09	2008-10-09	GEMC 6
Quasi Peak Adapter	85650A	HP	2006-08-07	2008-10-07	GEMC 7
IFR Spectrum Analyzer	AN940	IFR	2006-4-4	6008-10-4	GEMC 6350
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
Power Attenuator 20 dB	25-A-FFN-20	Bird / Hutton	NCR	NCR	GEMC 49

This report module is based on GEMC template “FCC – Power Line Conducted Emissions Class B\_ Rev1”

Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## ***Power Spectral Density***

### **Purpose**

The purpose of this test is to ensure that the maximum power spectral density to the radiating element does not exceed the limits specified. This ensures that the modulation is significantly wide enough, or low enough in power that it will allow for co-operation of other wireless devices operating within this frequency allocation.

### **Limits**

The limits are defined in 15.247(e).


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.

### **Results**

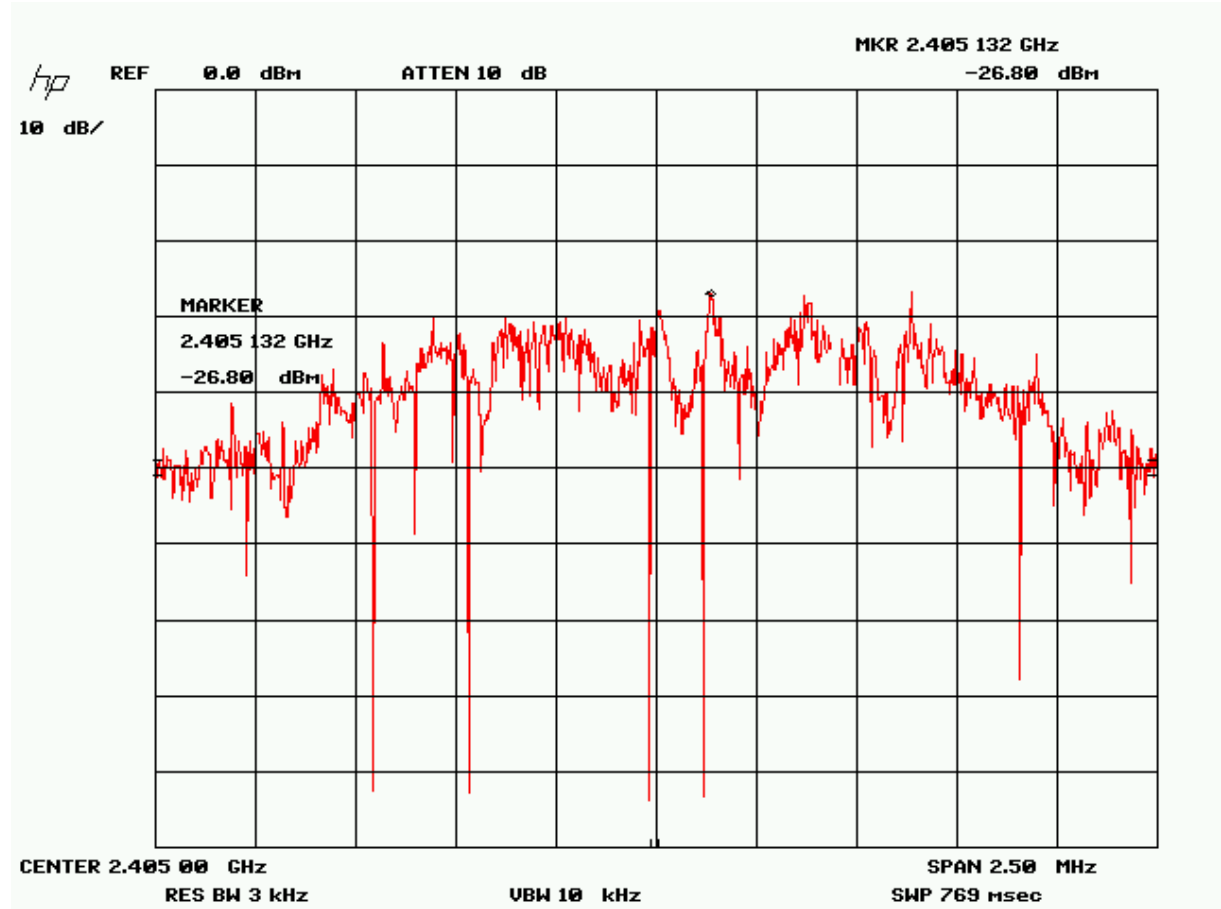
The EUT passed. Each mode was tested at low, medium, and high band. The worst case value is 5.2 dbm  $\{-26.8 + 32 \text{ dbm (attenuator + cable losses)} = 5.2 \text{ dbm}\}$ .

### **Graph(s)**


The graphs shown below show the power spectral density of the device during the conducted measurement operation of the EUT. Low, middle, and high channel was investigated in each mode.

Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

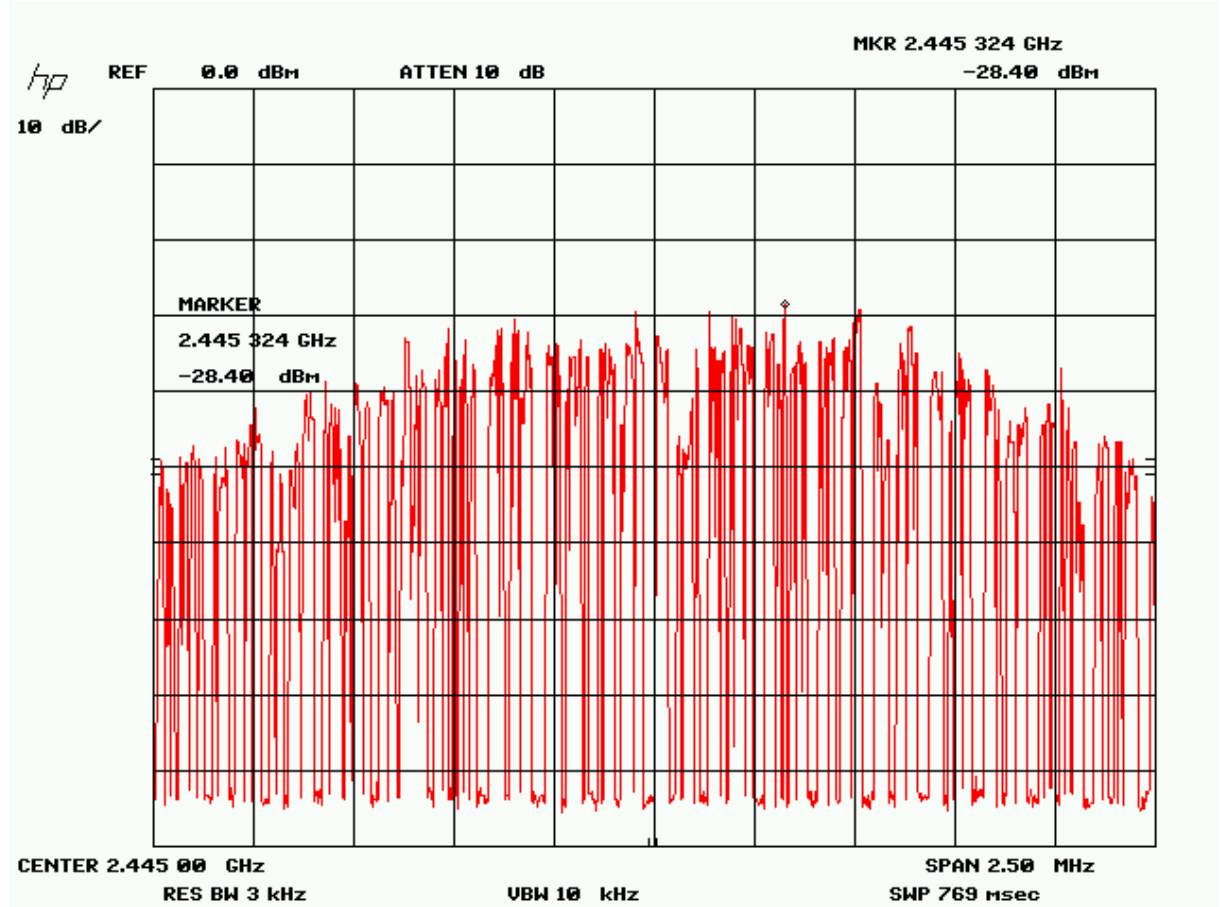
Low channel






Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

Med channel






Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	2006-08-09	2008-10-09	GEMC 6
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
Power Attenuator 20 dB	25-A-FFN-20	Bird / Hutton	NCR	NCR	GEMC 49

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B\_Rev1"

Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## **Maximum Permissible Exposure**

### **Purpose**

The purpose of this test is to ensure that the RF energy intentionally transmitted, in terms of power density emitted from the EUT at a stated operating distance does not exceed the limits listed below as defined in the applicable test standard, as calculated based upon readings obtained during testing. This helps protect human exposure to excessive RF fields.

### **Limit(s) and Method**

The limits, as defined in FCC 15.247(i) and FCC 1.1310 Table 1 (B) limits for general public exposure was applied. The limit for the frequency range of 1.5 GHz to 100 GHz was applied. This is a limit of 1.0 mW/cm<sup>2</sup>. The distance used for calculations was 20cm, as this is the minimum distance an operator will be from the EUT during normal operation, as stated by the manufacturer.

### **Results**

The EUT passed the requirements. The worst case calculated power density was 0.0017 mW/cm<sup>2</sup>, this is significantly under the 1.0 mW/cm<sup>2</sup> requirement.

### **Calculations**

Method 1 (conducted power)

$$P_d = (P_t * G) / (4 * \pi * R^2)$$

Where  $P_t$  = 18.9 dbm or 77.6mW as per Peak power conducted output


Where  $G$  = 5.5 dBi, or numerically 3.55

Where  $R$  = 20 cm

$$P_d = (77.6 \times 3.55) / (4 \times \pi \times 20\text{cm}^2)$$

$$P_d = 275.4 \text{ mW} / 5026 \text{ cm}^2$$

$$P_d = 0.055 \text{ mW/cm}^2$$

Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## ***Power Line Conducted Emissions***

### **Purpose**

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT's power line does not exceed the limits listed below as defined in the applicable test standard, as measured from a LISN. This helps protect lower frequency radio services such as AM radio, shortwave radio, amateur radio operators, maritime radio, CB radio, and so on, from unwanted interference.

### **Limits & Method**

The limits are as defined in 47 CFR FCC Part 15 Section 15.207


Method is as defined in ANSI C64:2003

Average Limits		QuasiPeak Limits	
150 kHz – 500 kHz	56 to 46 dBuV	150 kHz – 500 kHz	66 to 56 dBuV
500 kHz – 5 MHz	46 dBuV	500 kHz – 5 MHz	56 dBuV
5 MHz – 30 MHz	50 dBuV	500 kHz – 30 MHz	60 dBuV

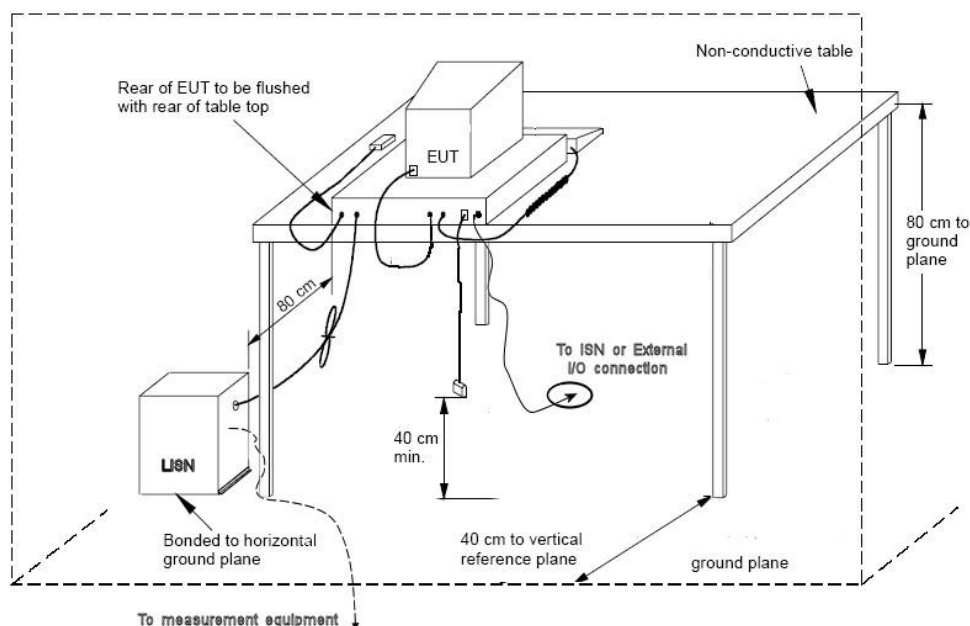
The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

Note: If the Peak or Quasi Peak detector measurements do not exceed the Average limits, then the EUT is deemed to have passed the requirements.

Both limits are applicable, and each is specified as being measured with a 9 kHz measurement bandwidth.

Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## Typical Setup Diagram




Note: The vertical reference plane is optional as per ANSI C63.4 section 5.2.2

## Measurement Uncertainty

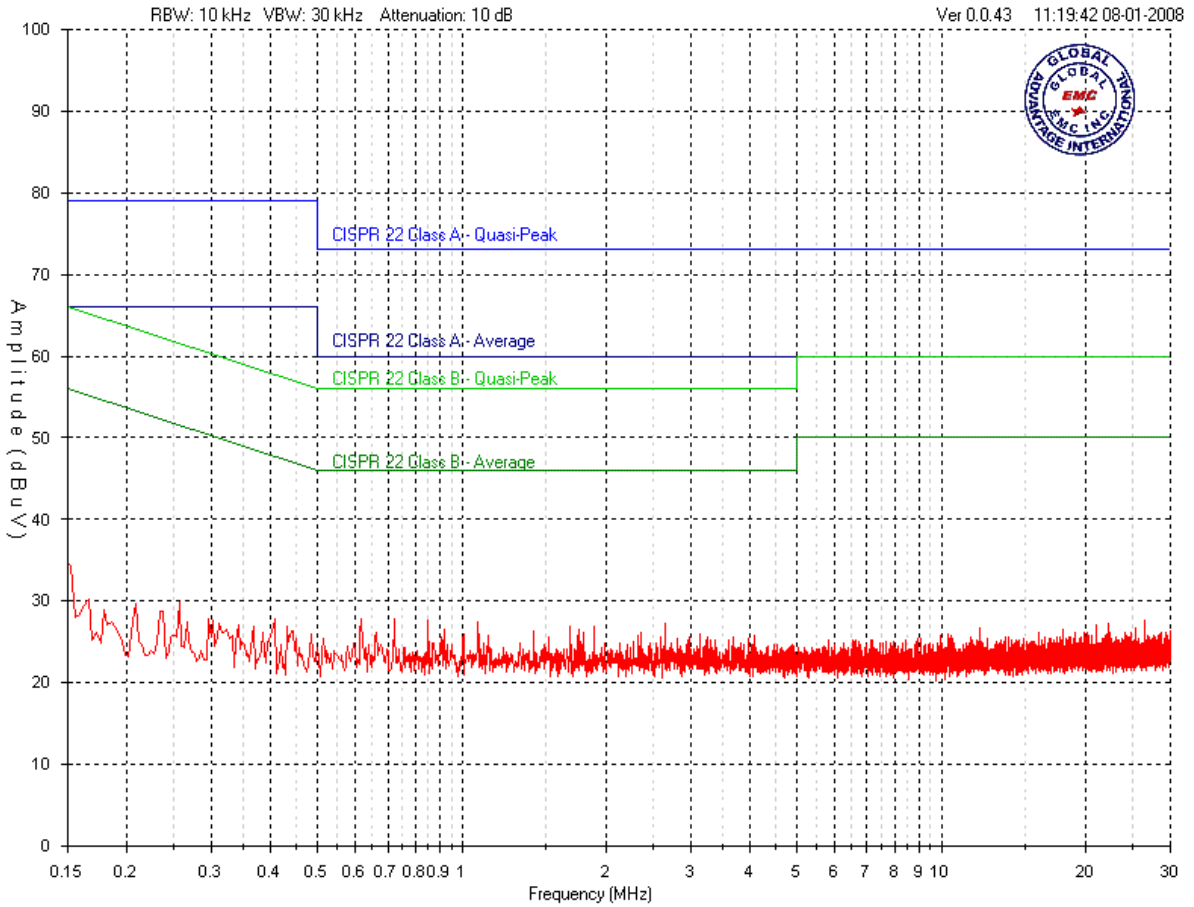
The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is  $\pm 3.6$  dB with a 'k=2' coverage factor and a %95 confidence level.


## Preliminary Graphs

Note the graphs shown below are for graphical illustration only. For final measurements with the appropriate detector where applicable, please refer to the table. The graph shown below is a peak measurement graph, measured with a resolution bandwidth greater than or equal to the final required detector. These graphs are performed as a worst case measurement to enable the detection of frequencies of concern and for considerable time savings.

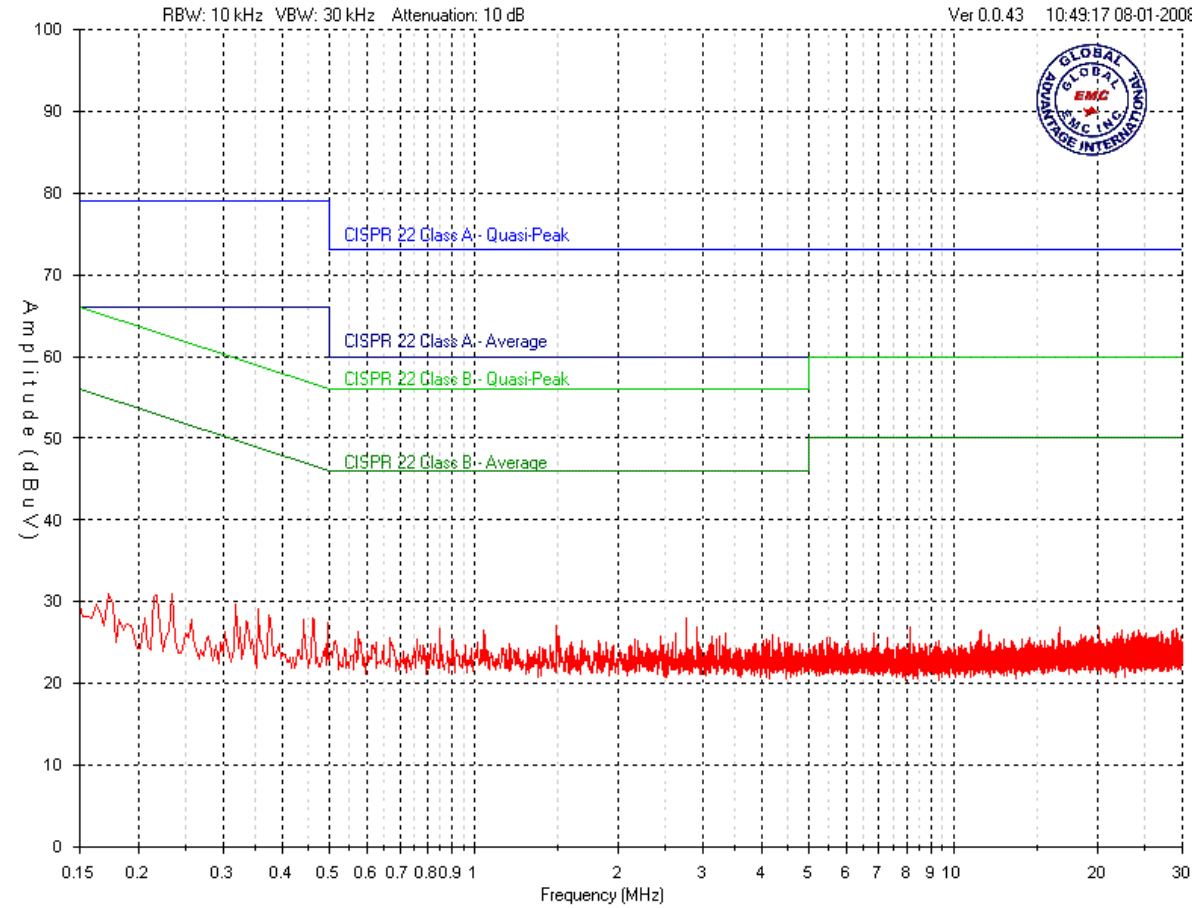
Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

# 120V Line Peak emissions




Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

# 120V Neutral Peak emissions





Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	


## Final Measurements

Average Emissions Table

Product category	Class B Avg								
Project	Zigbee wireless Energy management module								
Test Frequency (MHz)	Detection mode (Q-Peak / Avg)	Raw signal (dBuV)	Cable loss (dB)	Attenuator (dB)	LISN factor (dB)	Received signal (dBuV)	Emission limit (dBuV)	Margin (dBuV)	Result
120V 60Hz Line									
0.15	QP	19	0.2	10	1.75	30.95	56	25.05	PASS
0.252	QP	18	0.2	10	1	29.2	54	24.8	PASS
0.445	QP	15.9	0.2	10	0.4	26.5	48	21.5	PASS
120V 60Hz N									
0.157	QP	17	0.2	10	1.75	28.95	56	27.05	PASS
0.175	QP	19	0.2	10	1.75	30.95	56	25.05	PASS
0.32	QP	16.5	0.2	10	0.6	27.3	52	24.7	PASS

Note:


1. All readings were recorded using QP detector and compared against Average limits.
2. See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up for the highest line conducted emission

Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	2006-08-09	2008-10-09	GEMC 6
Quasi Peak Adapter	85650A	HP	2006-08-07	2008-10-07	GEMC 7
LISN	LISN 275-25-1	Vican	2006-09-12	2008-10-12	GEMC 12
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
Attenuator 10 dB	FP-50-10	Trilithic	NCR	NCR	GEMC 42

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B\_ Rev1"


Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## Appendix A – EUT Summary

### General EUT Description

Client	
Organization	Regen Energy
Contact	Roman Kulyk
Phone	1-416-934-1040
Email	roman.kulyk@regenenergy.com
EUT Details	
EUT Model number	RM2-0001
Equipment Category	Wireless module for energy management applications.
Basic EUT Functionality	RM2-0001 is a energy management wireless switch that is used to control high current devices. The current clamp on the unit is used to measure the current of the machine being monitored and based on a algorithm it is switched.
Input Voltage and Frequency	120V 60Hz
Connectors available on EUT	None.
Peripherals Required for Test	None.
Release type	Final
Intentional Radiator Frequency	2400 – 2480.0 MHz for Zigbee protocol.

Note the EUT is considered to have been received the date of the commencement of the first test, unless otherwise stated. For a close-up picture of the EUT, see ‘Appendix B – EUT & Test Setup Photographs’.

Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

## Appendix B – EUT and Test Setup Photographs


Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	



Figure 1 – EUT


Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	



Figure 2 – Radiated emission setup





Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	



Figure 3 – Power line conducted emissions

Client	Regen Energy	
Product	EnviroGrid Controller – RM2-0001	
Standard(s)	RSS 210 Issue 6:2005 / FCC Part 15 Subpart C 15:2006	

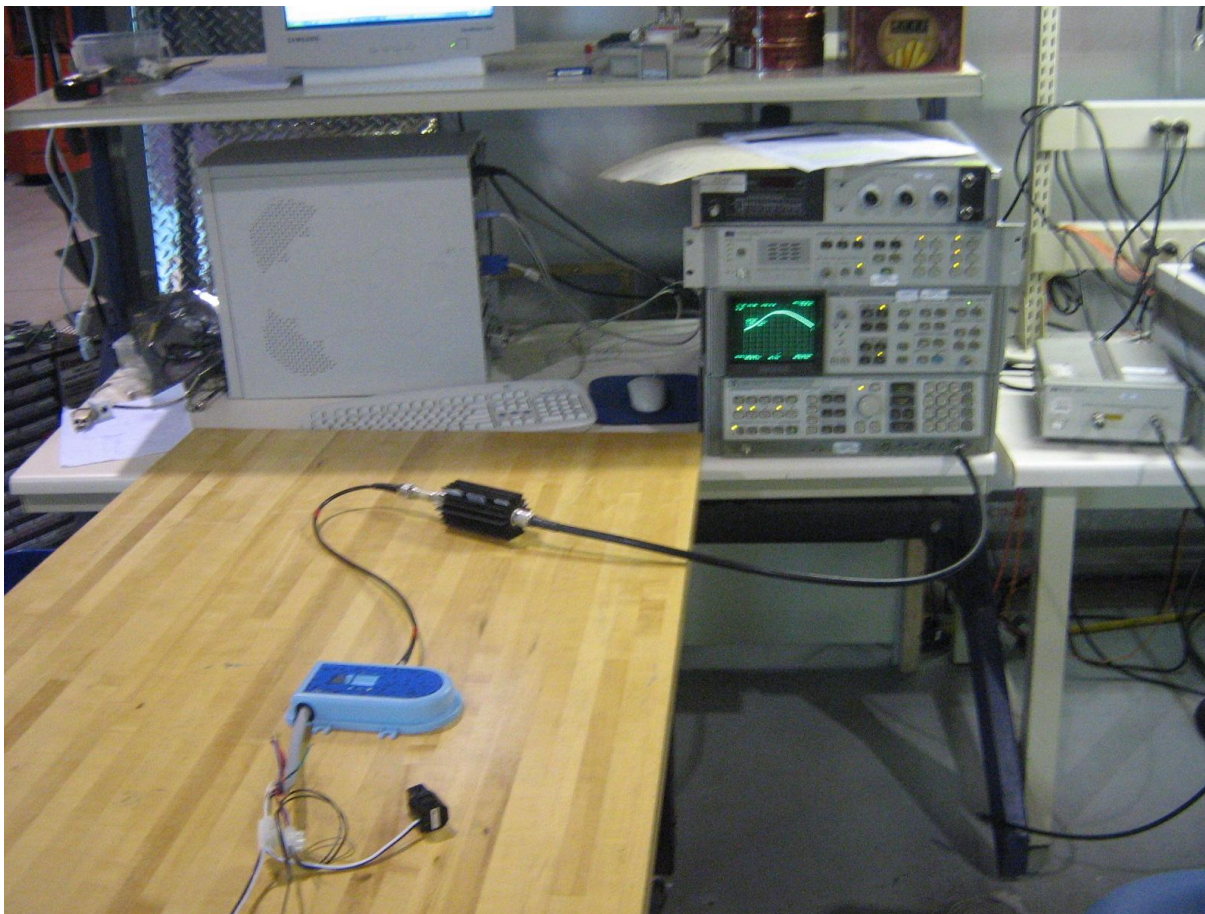


Figure 4 – Conducted power emissions

Note: These photos are for information purposes only. Also refer to PDF files that are separate from this test report.