Excellence in Compliance Testing

Certification Test Report

FCC ID: 2AFJSSET100-2015

FCC Rule Part: 15.249

ACS Report Number: 14-0039.W03.1A

Manufacturer: Smart Earth Technologies LLC
Model: SET 100 Smart Valve

Test Begin Date: September 2, 2014
Test End Date: September 8, 2014

Report Issue Date: December 29, 2015

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612-0

This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

Reviewed by:

Kirby Munroe
Director, Wireless Certifications
ACS, Inc.

This report contains 17 pages

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1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations.

1.2 Product description

The SET 100 Smart Valve is a battery powered, residential water chrome plated water valve. The valve is controlled by an electric motor, requiring approximately 41mA of current to turn the motor.

Technical Information:
Band of operation: 2402 – 2480 MHz
Number of channels: 40
Modulation format: GFSK
Antenna Type / Gain: PCB Antenna / 3.3dBi gain
Operating Voltage: 3.6VDC (Lithium Ion Battery)

Manufacturer Information:
Smart Earth Technologies LLC
4651 Woodstock Rd
Ste 208
Roswell, GA 30075

Test Sample Serial Number(s): Itron0004

Test Sample Condition: The test samples were provided in good working order with no visible defects.

1.3 Test Methodology and Considerations

For radiated emissions, including band edge, the EUT was evaluated in an orientation of typical use.

The EUT is battery operated therefore AC power line conducted emissions was not performed.

2 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following address:

Advanced Compliance Solutions
5015 B.U. Bowman Drive
Buford, GA 30518
Phone: (770) 831-8048
Fax: (770) 831-8598

2.2 Laboratory Accreditations/Recognitions/Certifications

ACS is accredited to ISO/IEC 17025 by the National Institute of Standards and Technology under their National Voluntary Laboratory Accreditation Program (NVLAP), Lab Code 200612-0. Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

The Semi-Anechoic Chamber Test Site, Open Area Test Site (OATS) and Conducted Emissions Site have been fully described, submitted to, and accepted by the FCC, Industry Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

FCC Registration Number: 511277
Industry Canada Lab Code: 4175A
VCCI Member Number: 1831

- VCCI OATS Registration Number R-1526
- VCCI Conducted Emissions Site Registration Number: C-1608

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 20' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 150cm in diameter and is located 160cm from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is all steel, flush mounted table installed in an all steel frame. The table is remotely operated from inside the control room located 25' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Behind the turntable is a 3' x 6' x 4' deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4" PVC chases from the turntable to the pit that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3-1 below:

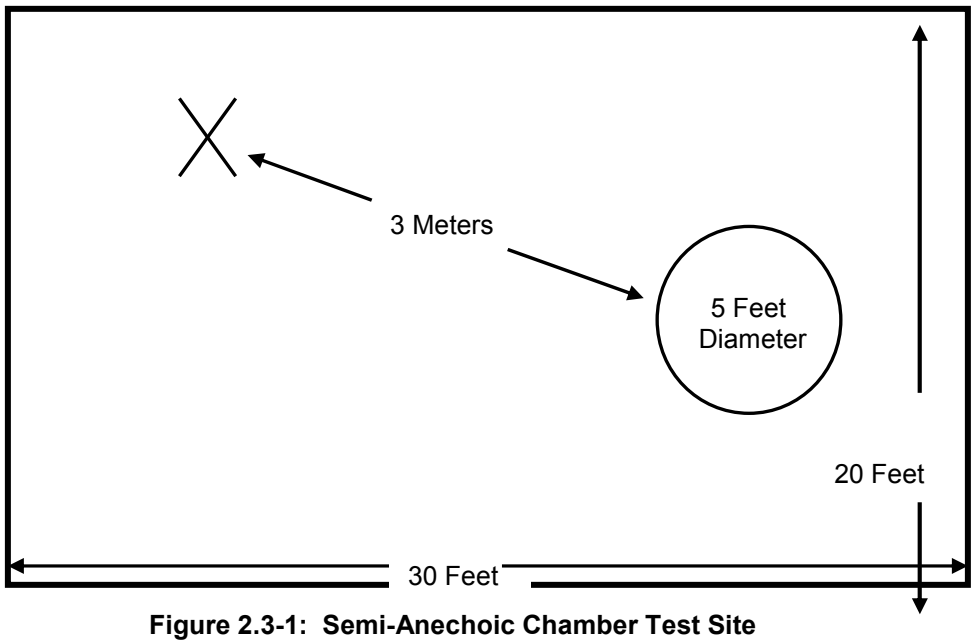

Figure 2.3-1: Semi-Anechoic Chamber Test Site

2.3.2 Open Area Tests Site (OATS)

The open area test site consists of a 40' x 66' concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8" holes that are staggered every 3/16". The individual sheets are placed to overlap each other by 1/4" and are riveted together to provide a continuous seam. Rivets are spaced every 3" in a 3 x 20 meter perimeter around the antenna mast and EUT area. Rivets in the remaining area are spaced as necessary to properly secure the ground plane and maintain the electrical continuity.

The entire ground plane extends 12' beyond the turntable edge and 16' beyond the antenna mast when set to a 10 meter measurement distance. The ground plane is grounded via 4 - 8' copper ground rods, each installed at a corner of the ground plane and bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is an all aluminum 10' flush mounted table installed in an all aluminum frame. The table is remotely operated from inside the control room located 40' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Adjacent to the turntable is a 7' x 7' square and 4' deep concrete pit used for support equipment if necessary. The pit is equipped with 5 - 4" PVC chases from the pit to the control room that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit. The pit is covered with 2 sheets of 1/4" diamond style re-enforced steel sheets. The sheets are painted to match the perforated steel ground plane; however the underside edges have been masked off to maintain the electrical continuity of the ground plane. All reflecting objects are located outside of the ellipse defined in ANSI C63.4.

A diagram of the Open Area Test Site is shown in Figure 2.3-2 below:

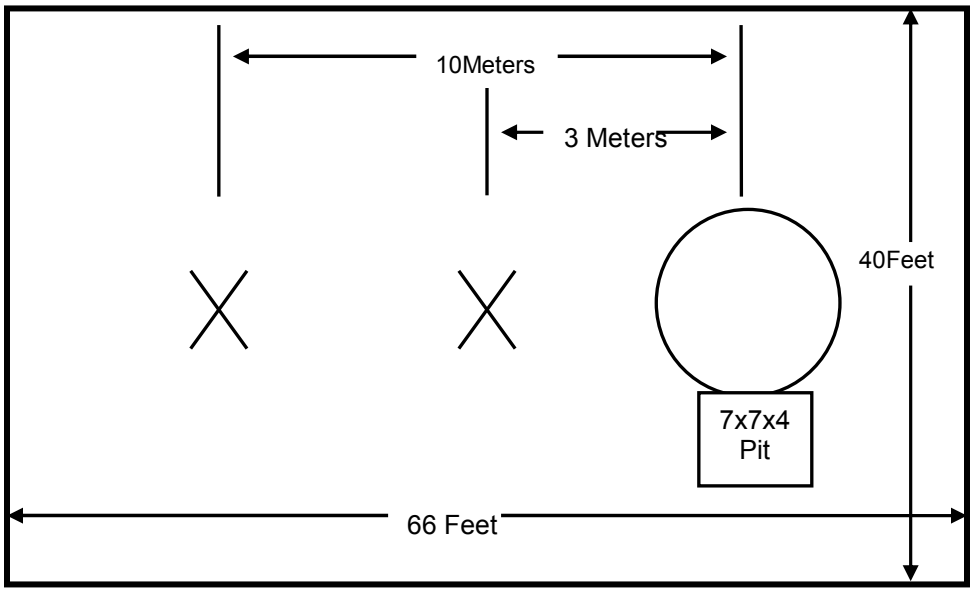

Figure 2.3-2: Open Area Test Site

2.4 Conducted Emissions Test Site Description

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 8' solid aluminum horizontal ground reference plane (GRP) bonded every 3" to an 8' X 8' vertical ground plane.

The site is of sufficient size to test table top and floor standing equipment in accordance with section 6.1.4 of ANSI C63.4.

A diagram of the room is shown below in figure 4.1.3-1:

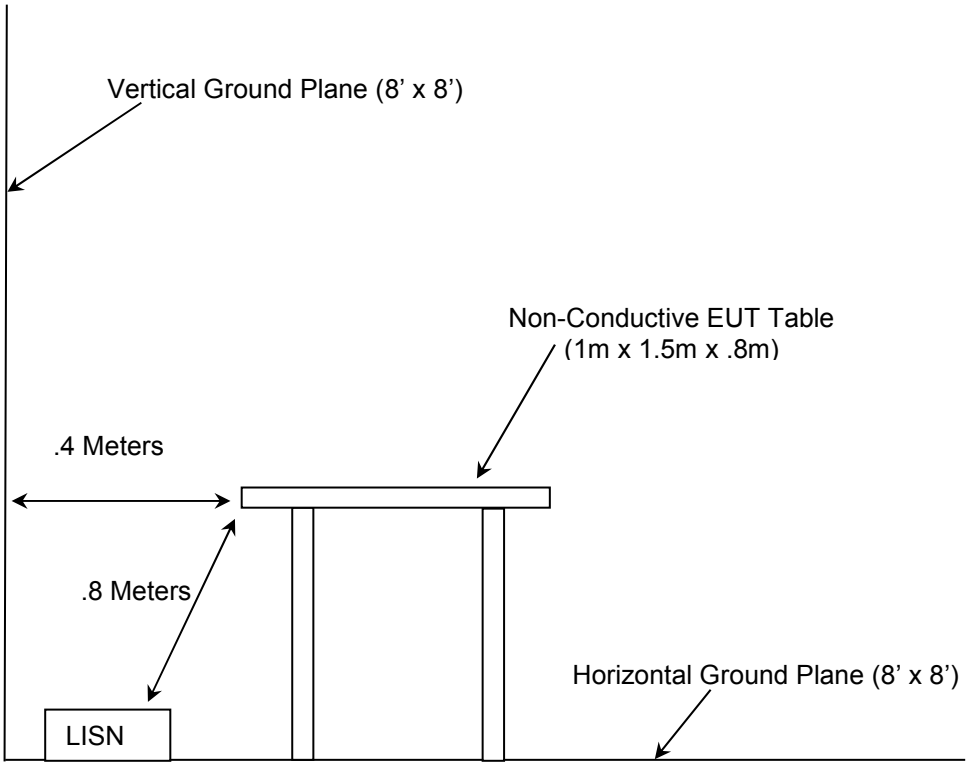

Figure 2.4-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.4-2009: American National Standard for Methods of Measurement of Radio-Noise Emissions from low-voltage electrical and electronic equipment in the range of 9kHz to 40 GHz
- ANSI C63.10-2009: American National Standard for Testing Unlicensed Wireless Devices
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2014
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2014

4 LIST OF TEST EQUIPMENT

The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

Table 4-1: Test Equipment

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
1	Rohde & Schwarz	ESMI - Display	Spectrum Analyzers	833771/007	7/11/2014	7/11/2016
2	Rohde & Schwarz	ESMI-Receiver	Spectrum Analyzers	839587/003	7/11/2014	7/11/2016
30	Spectrum Technologies	DRH-0118	Antennas	970102	4/23/2013	4/23/2015
40	EMCO	3104	Antennas	3211	2/14/2013	2/14/2015
73	Agilent	8447D	Amplifiers	2727A05624	7/15/2014	7/15/2015
167	ACS	Chamber EMI Cable Set	Cable Set	167	11/7/2013	11/7/2014
292	Florida RF Cables	SMR-290AW-480.0-SMR	Cables	None	3/17/2014	3/17/2015
334	Rohde&Schwarz	3160-09	Antennas	49404	11/4/2010	NCR
335	Suhner	SF-102A	Cables	882/2A	7/23/2014	7/23/2015
338	Hewlett Packard	8449B	Amplifiers	3008A01111	7/30/2013	7/30/2015
345	Suhner Sucoflex	102A	Cables	1077/2A	7/23/2014	7/23/2015
412	Electro Metrics	LPA-25	Antennas	1241	7/24/2014	7/24/2016
422	Florida RF	SMS-200AW-72.0-SMR	Cables	805	11/7/2013	11/7/2014
432	Microwave Circuits	H3G020G4	Filters	264066	6/2/2014	6/2/2015
616	Florida RF Cables	SMRE-200W-12.0-SMRE	Cables	N/A	9/26/2013	9/26/2014
622	Rohde & Schwarz	FSV40	Analyzers	101338	7/12/2014	7/12/2015

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
The EUT is a standalone battery operated device with no support equipment utilized.				

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

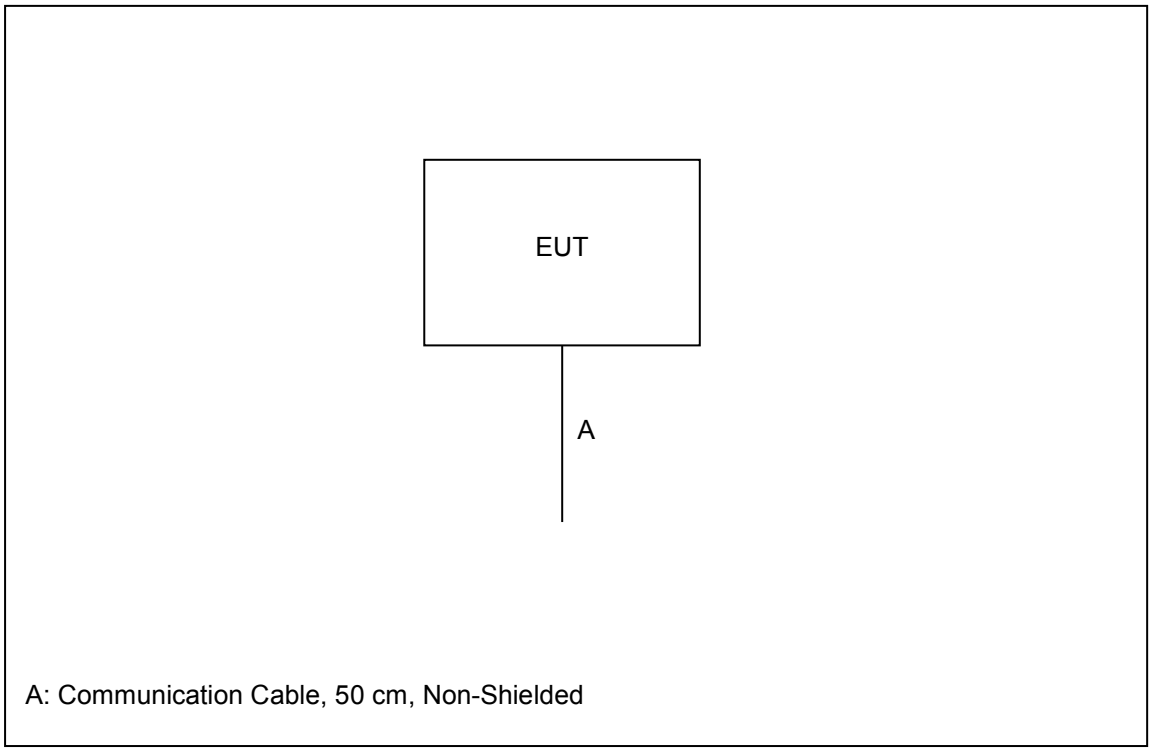

Figure 6-1: Test Setup Block Diagram

7 SUMMARY OF TESTS

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

7.1 Antenna Requirement – FCC 15.203

The EUT utilizes an integral PCB antenna which cannot be removed without permanently damaging the device thus satisfying Part 15.203. The gain on the antenna is 3.3dBi.

7.2 Power Line Conducted Emissions – FCC 15.207

7.2.1 Measurement Procedure

The EUT is battery operated therefore AC power conducted emissions is not applicable.

7.3 20dB / 99% Bandwidth – FCC 15.215

7.3.1 Measurement Procedure

The span of the spectrum analyzer display was set between two times and five times the occupied bandwidth (OBW) of the emission. The RBW of the spectrum analyzer was set to approximately 1 % to 5 % of the OBW. The trace was set to max hold with a peak detector active. The Delta function of the analyzer was utilized to determine the 20 dB bandwidth of the emission.

The occupied bandwidth measurement function of the analyzer was used for the 99% bandwidth. The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth. A sampling detector was used.

7.3.2 Measurement Results

Results are shown below in Table 7.3.2-1 and Figures 7.3.2-1 to 7.3.2-6.

Table 7.3.2-1: 20dB / 99% Bandwidth

Frequency [MHz]	20dB Bandwidth [MHz]	99% Bandwidth [MHz]
2402	1.252	1.093
2440	1.245	1.085
2480	1.252	1.078

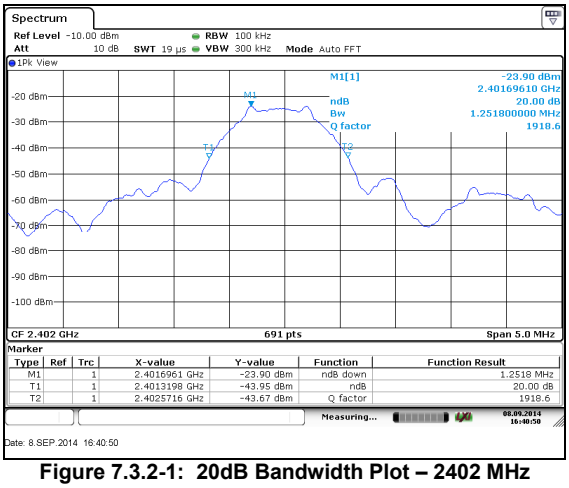

Figure 7.3.2-1: 20dB Bandwidth Plot – 2402 MHz

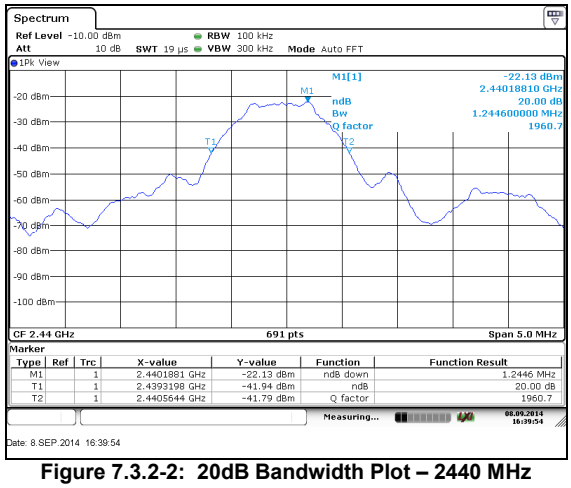

Figure 7.3.2-2: 20dB Bandwidth Plot – 2440 MHz

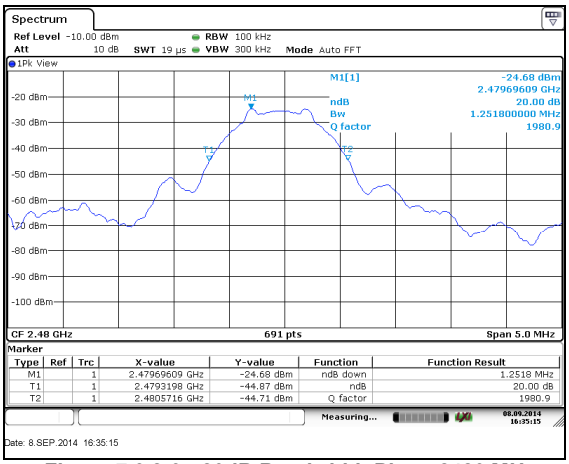

Figure 7.3.2-3: 20dB Bandwidth Plot – 2480 MHz

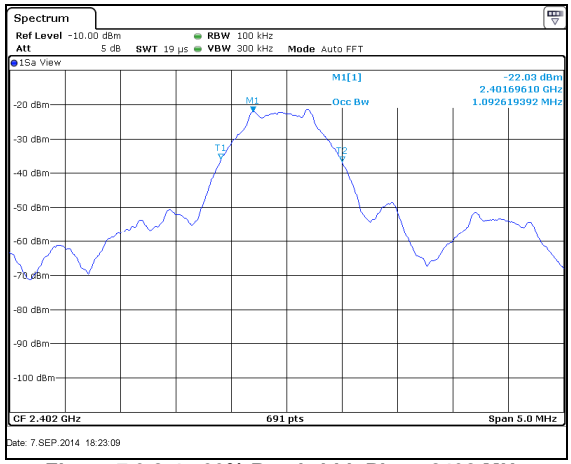

Figure 7.3.2-4: 99% Bandwidth Plot – 2402 MHz

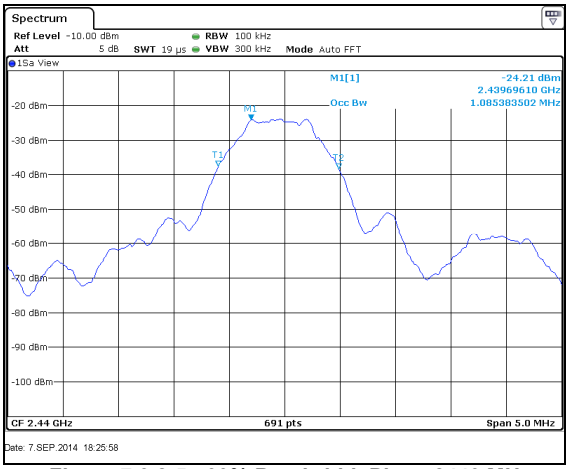

Figure 7.3.2-5: 99% Bandwidth Plot – 2440 MHz

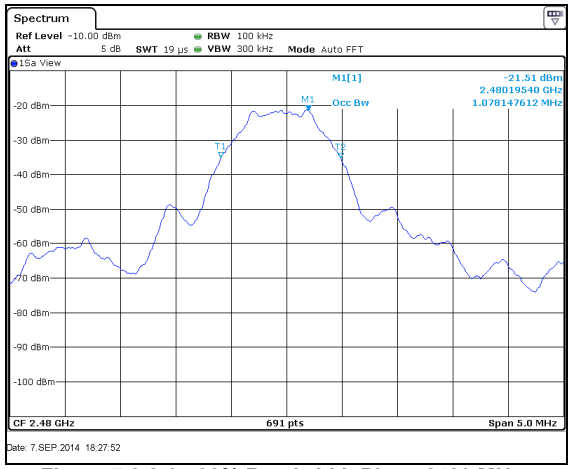

Figure 7.3.2-6: 99% Bandwidth Plot – 2480 MHz

7.4 Fundamental Field Strength – FCC 15.249(a)

7.4.1 Measurement Procedure

The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. Peak and average measurements were made with RBW and VBW of 3 MHz and 10 MHz respectively. The average emissions were further corrected by applying the duty cycle correction of the EUT for comparison to the average limit. See section 7.5.2 for additional details on the duty cycle correction.

7.4.2 Measurement Results

Results are shown below in Table 7.4.2-1.

Table 7.4.2-1: Fundamental Field Strength

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2402	107.17	106.11	H	-6.32	100.85	63.31	114.0	94.0	13.2	30.7
2402	100.30	99.31	V	-6.32	93.98	56.51	114.0	94.0	20.0	37.5
2440	107.07	106.26	H	-6.11	100.96	63.67	114.0	94.0	13.0	30.3
2440	100.71	99.62	V	-6.11	94.60	57.03	114.0	94.0	19.4	37.0
2480	106.72	105.68	H	-5.90	100.82	63.31	114.0	94.0	13.2	30.7
2480	100.33	99.23	V	-5.90	94.43	56.86	114.0	94.0	19.6	37.1

7.5 Radiated Spurious Emissions – FCC 15.249(a)(d)(e)

7.5.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 30MHz to 25 GHz, 10 times the highest fundamental frequency.

The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. For frequencies below 1000MHz, quasi-peak measurements were made using a resolution bandwidth RBW of 120 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000MHz, peak and average measurements were made with RBW and VBW of 1 MHz and 3MHz respectively. The average emissions were further corrected by applying the duty cycle correction of the EUT for comparison to the average limit.

All out of band emissions were evaluated, including any emissions at or near the band-edge.

Above 10 GHz testing was performed at a distance of 1m and the limit adjusted accordingly.

7.5.2 Duty Cycle Correction

For average radiated measurements, using a 1.5% duty cycle, the measured level was reduced by a factor -36.48dB. The duty cycle correction factor is determined using the formula: 20log (1.5/100).

A detail explanation of the duty cycle is provided in the theory of operation accompanying this report.

7.5.3 Measurement Results

Radiated spurious emissions are reported in the table 7.5.3-1 below.

Table 7.5.3-1: Radiated Spurious Emissions Tabulated Data

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2402 MHz (Low Channel)										
479.97	------	31.62	H	-5.80	------	25.82	------	46.0	------	20.2
479.97	------	33.47	V	-5.80	------	27.67	------	46.0	------	18.3
543.97	------	33.65	H	-5.06	------	28.59	------	46.0	------	17.4
543.97	------	30.10	V	-5.06	------	25.04	------	46.0	------	21.0
4739.85	50.72	40.87	H	1.58	52.30	5.97	74.0	54.0	21.7	48.0
4804	62.76	58.67	H	1.70	64.46	23.89	74.0	54.0	9.5	30.1
4804	57.63	52.86	V	1.70	59.33	18.08	74.0	54.0	14.7	35.9
7206	47.68	37.72	H	7.69	55.37	8.93	74.0	54.0	18.6	45.1
7206	46.20	34.83	V	7.69	53.89	6.04	74.0	54.0	20.1	48.0
12010	50.19	39.37	H	14.24	64.43	17.13	83.5	63.5	19.1	46.4
12010	49.31	38.50	V	14.24	63.55	16.26	83.5	63.5	20.0	47.3
2440 MHz (Middle Channel)										
479.97	------	31.70	H	-5.80	------	25.90	------	46.0	------	20.1
479.97	------	33.25	V	-5.80	------	27.45	------	46.0	------	18.6
543.97	------	33.65	H	-5.06	------	28.59	------	46.0	------	17.4
543.97	------	30.20	V	-5.06	------	25.14	------	46.0	------	20.9
2503.8	52.34	44.12	H	-5.77	46.57	1.88	74.0	54.0	27.4	52.1
2503.8	49.17	40.08	V	-5.77	43.40	-2.16	74.0	54.0	30.6	56.2
4815.8	49.20	38.97	H	1.72	50.92	4.22	74.0	54.0	23.1	49.8
4880	60.98	56.59	H	1.85	62.83	21.96	74.0	54.0	11.2	32.0
4880	55.65	50.44	V	1.85	57.50	15.81	74.0	54.0	16.5	38.2
7320	47.62	37.44	H	7.83	55.45	8.80	74.0	54.0	18.5	45.2
7320	46.75	35.99	V	7.83	54.58	7.35	74.0	54.0	19.4	46.7
12200	47.74	36.45	V	15.37	63.11	15.34	83.5	63.5	20.4	48.2
2480 MHz (High Channel)										
479.97	------	32.64	H	-5.80	------	26.84	------	46.0	------	19.2
479.97	------	34.87	V	-5.80	------	29.07	------	46.0	------	16.9
543.97	------	33.70	H	-5.06	------	28.64	------	46.0	------	17.4
543.97	------	29.92	V	-5.06	------	24.86	------	46.0	------	21.1
2483.5	60.51	49.58	H	-5.88	54.63	7.23	74.0	54.0	19.4	46.8
2483.5	54.20	43.97	V	-5.88	48.32	1.62	74.0	54.0	25.7	52.4
2543.8	52.67	45.03	H	-5.55	47.12	3.01	74.0	54.0	26.9	51.0
2543.8	48.27	38.61	V	-5.55	42.72	-3.41	74.0	54.0	31.3	57.4
4960	58.06	52.70	H	2.01	60.07	18.23	74.0	54.0	13.9	35.8
4960	55.01	48.72	V	2.01	57.02	14.25	74.0	54.0	17.0	39.8
7440	46.45	35.48	H	7.99	54.44	6.99	74.0	54.0	19.6	47.0
7440	47.12	36.27	V	7.99	55.11	7.78	74.0	54.0	18.9	46.2

7.5.4 Sample Calculation:

$R_C = R_U + CF_T$

Where:

CF_T	=	Total Correction Factor (AF+CA+AG)-DC (Average Measurements Only)
R_U	=	Uncorrected Reading
R_C	=	Corrected Level
AF	=	Antenna Factor
CA	=	Cable Attenuation
AG	=	Amplifier Gain
DC	=	Duty Cycle Correction Factor

Example Calculation: Peak
Corrected Level: 50.72 + 1.58 = 52.30dBuV
Margin: 74dBuV – 52.30dBuV = 21.7dB

Example Calculation: Average
Corrected Level: 40.87 + 1.58 - 36.48 = 5.97dBuV
Margin: 54dBuV – 5.97dBuV = 48.0dB

8 CONCLUSION

In the opinion of ACS, Inc. the SET 100 Smart Valve, manufactured by Smart Earth Technologies LLC meets the requirements of FCC Part 15 subpart C as applicable.

END REPORT