Excellence in Compliance Solutions

Certification Test Report

FCC ID: 2AFR8ED0991

FCC Rule Part: Part 15.517

ACS Report Number: 15-3027.W03.1A

Manufacturer: InVue Security
Model: ED0991

Test Begin Date: July 7, 2015
Test End Date: July 28, 2015

Report Issue Date: October 14, 2015

ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code AT-1921

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

Reviewed by:

M. R de Aranzeta

Mario de Aranzeta
Lab Manager Durham (RTP)
ACS Inc.

This report contains 21 pages

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1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 15 Subpart F (15.517) of the FCC's Code of Federal Regulations for modular approval.

1.2 Product Description

The module is a self contained RF circuit consisting of the UWB transceiver system and antenna in a chip like package 0.875 X 0.5 inches.

Technical Information:

Detail	Description
Frequency Range	Center Frequency 4.00760 GHz
Number of Channels	1
Modulation Format	BPM w/ BPSK
Data Rates	6.8 Mbps
Operating Voltage	3.6 Vdc
Antenna Type / Gain	Ceramic Chip 2.73 dBi (Peak)

Manufacturer Information:
InVue Security
15015 Lancaster Highway
Charlotte, NC 28277

Contact: Satish Kartha, Director of Quality

EUT Serial Numbers: N/A

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

1.3 Test Methodology and Considerations

The module is physically small, 0.875 X 0.5 inches, and can be used in a host in many orientations. Three orientations were investigated that encompass most possibilities.

1. The antenna of the module in the vertical plane.
2. The antenna of the module in the horizontal plane.
3. The antenna lying flat in plane with a tabletop and with the antenna facing up.

An interface board was utilized to provide power to the module. The EUT was evaluated for radiated emissions in multiple orientations. The worst case emissions were from the antenna in the horizontal plane.

TEST FACILITIES

1.4 Location

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

Advanced Compliance Solutions
2320 Presidential Drive, Suite 101
Durham, NC 27703
Phone: (919) 381-4235

1.5 Laboratory Accreditations/Recognitions/Certifications

ACS is accredited to ISO/IEC 17025 by ANSI-ASQ National Accreditation Board under their ANAB program and has been issued certificate number AT-1921 in recognition of this accreditation. Unless otherwise specified, all test methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

1.6 Radiated Emissions Test Site Description

1.6.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 18' x 28' x 18' shielded enclosure. The chamber is lined with Samwha Electronics Co. LTD Ferrite Absorber, model number SFA300 (HSN-1). The ferrite tile is 10cm x 10 cm and weighs approximately 1.4lbs. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber. On top of the ferrite tiles is DMAS HT-45 (Dutch Microwave Absorber Solutions) hybrid absorber on all walls except the wall behind the antenna mast which has a shorter DMAS HT-25 absorber.

The turntable is 1.50m in diameter and is located 150cm 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 short #6 copper wire. 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 turntable. 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.

Behind the turntable is a 2' x 6' x 1.5' deep shielded pit used for support equipment if necessary. The pit is equipped with 2 - 4" PVC chase 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.

To comply with the requirements of the test methods given on page 4, RF absorbing foam was placed inside the chamber in a configuration that provided the best results. First, a 12ft X 12ft. patch of 10" tall absorber was placed on the floor between the turntable and the receiving antenna. This absorber meets the absorption requirements specified in ANSI C63.4:2009.

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

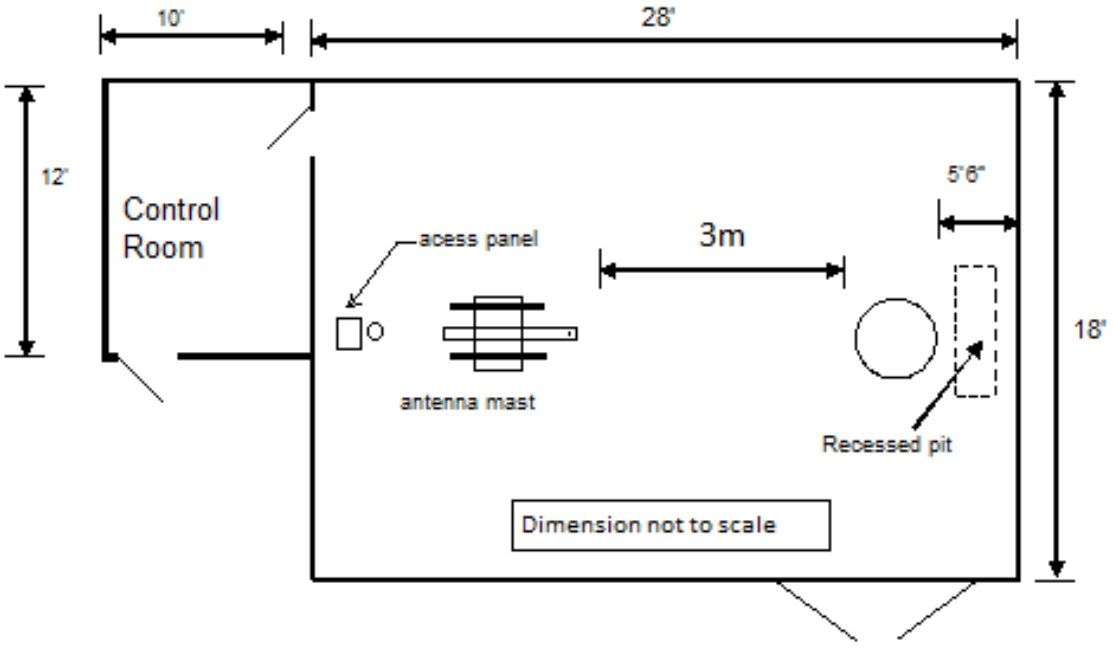


Figure 1.6-1: Semi-Anechoic Chamber Test Site

1.7 Conducted Emissions Test Site Description

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 10' sheet galvanized steel horizontal ground reference plane (GRP) bonded every 6" to an 8' X 8' aluminum vertical ground plane.

A diagram of the room is shown below in figure 1.7-1:

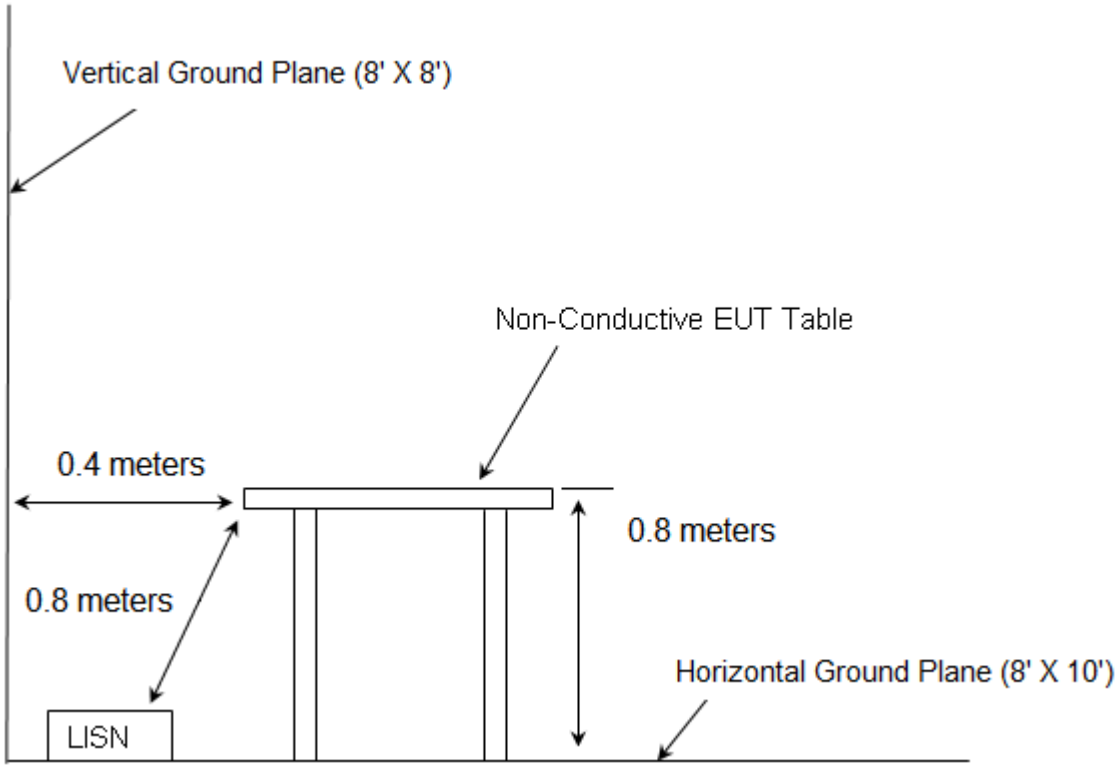


Figure 1.7-1: AC Mains Conducted EMI Site

2 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart F: Radio Frequency Devices, Intentional Radiators, 2015

3 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 3-1: Test Equipment

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
3002	Rohde & Schwarz	ESU40	Receiver	100346	7/6/2015	7/6/2016
3038	Florida RF Labs	NMSE-290AW-60.0-NMSE	Cable Set	1448	1/12/2015	1/12/2016
3039	Florida RF Labs	NMSE-290AW-396.0-NMSE	Cable Set	1447	1/12/2015	1/12/2016
3016	Fei Teng Wireless Technology	HA-07M18G-NF	Antennas	2013120203	1/14/2015	1/14/2016
3057	Advanced Technical Materials	42-441-6/BR	Antennas	R110602	NCR	NCR
626	EMCO	3110B	Antennas	9411-1945	2/26/2014	2/26/2016
277	Emco	93146	Antennas	9904-5199	9/2/2014	9/2/2016
3006	Rohde & Schwarz	TS-PR18	Amplifiers	122006	7/24/2014	7/24/2015
3007	Rohde & Schwarz	TS-PR26	Amplifiers	100051	6/29/2015	6/29/2016
3054	Mountain View Cable	BMS-RG400-36.0-BMS	Cables	3054	1/12/2015	1/12/2016
3020	Rohde & Schwarz	SMB100A	Signal Generators	175943	7/24/2014	7/24/2015
3046	Aeroflex Inmet	26AH-10	Attenuator	1443	1/15/2015	1/15/2016
3033	Hasco, Inc.	HLL142-S1-S1-36	Cables	1435	1/15/2015	1/15/2016
3034	Hasco, Inc.	HLL142-S1-S1-12	Cables	3076	1/18/2015	1/18/2016
3012	Rohde & Schwarz	EMC32-EB	Software	100731	1/19/2015	7/19/2016
RE168	Rohde & Schwarz	FSW26-OP006	Analyzer	101375	5/12/2015	5/12/2016
335	Suhner	SF-102A	Cables	882/2A	7/23/2014	7/23/2015
332	Rohde & Schwarz	TS-PR40	Amplifiers	100021	2/19/2014	2/19/2016
333	Rohde & Schwarz	3160-10	Antennas	45576	NCR	NCR
3011	Rohde & Schwarz	ENV216	LISN	3011	7/10/2015	7/10/2016
3051	Mountain View Cable	BMS-RG400-3264.0-BMS	Cable	3051	1/12/2015	1/12/2016

NCR = No Calibration Required
Firmware Version: ESU40 is 4.73 SP1
Software Version: EMC32-B is 9.15
Firmware version: FSW26 is 2.2

4 SUPPORT EQUIPMENT

Table 4-1: EUT and Support Equipment (Radiated Emissions)

Item #	Type Device	Manufacturer or Responsible Party	Model/Part #	Serial #
1	(EUT)	InVue Security	ED0991	N/A
2	Interface Bd	InVue Security	F1443602	N/A
3	Power Supply	Sorensen ACS Asset 0315	QRD-20-4	N/A

Table 4-2: Cable Description (Radiated Emissions)

Cable #	Cable Type	Length	Shield	Termination
A	DC Cable	2m	No	EUT to Power Supply
B	AC Cable	1m	No	Power Supply to AC mains

Table 4-3: EUT and Support Equipment (Conducted Emissions)

Item #	Type Device	Manufacturer or Responsible Party	Model/Part #	Serial #
1	(EUT)	InVue Security	ED0991	N/A
2	Interface Board	InVue Security	F1443302/ F1443602	N/A
3	Power Supply	Helms-Man (Hui Yang) Electric	SEB0532850P	N/A
4	USB A molded connectors	InVue Security	Part of Power Supply and Interface Assem.	N/A

Table 4-4: Cable Description (Conducted Emissions)

Cable #	Cable Type	Length	Shield	Termination
A	DC Cable	100 cm	No	EUT to USB A
B	DC Cable	17 cm	No	USB A to Power Supply
C	AC Extension Cord	1 m	No	DC Adapter to Mains

5 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

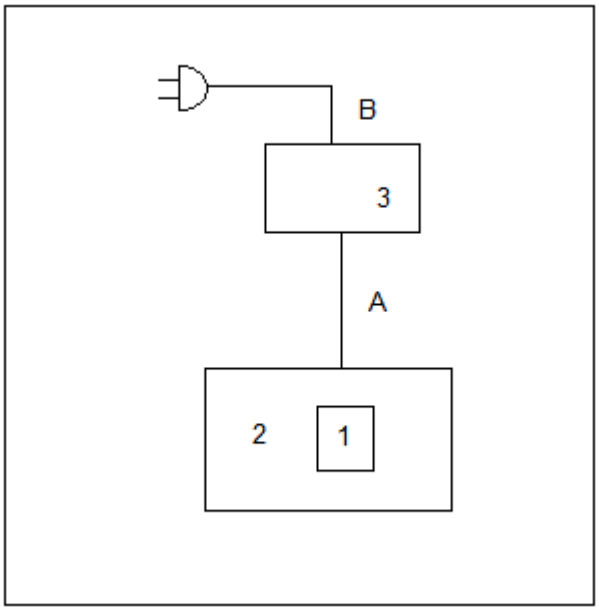


Figure 5-1: EUT Test Setup Block Diagram for Radiated Emissions

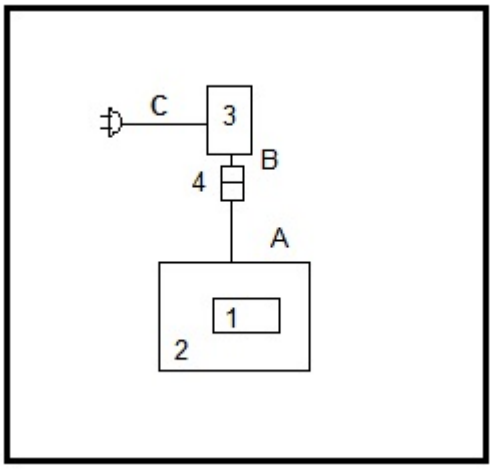


Figure 5-2: EUT Test Setup Block Diagram for Conducted Emissions

6 SUMMARY OF TESTS

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

6.1 Antenna Requirement – FCC 15.203

The antenna is permanently affixed to the module.

6.2 Power Line Conducted Emissions – FCC 15.207

6.2.1 Measurement Procedure

ANSI C63.10 section 6.2 was the guiding document for this evaluation. Conducted emissions were performed from 150 kHz to 30 MHz with the spectrum analyzer's resolution bandwidth set to 9 kHz and the video bandwidth set to 30 kHz. The calculation for the conducted emissions is as follows:

Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss
Margin = Applicable Limit - Corrected Reading

6.2.2 Measurement Results

The equipment under test is a module and compliance for conducted emissions was tested in a representative configuration of a final product.

Table 6.2.2-1 - Line

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.224250	32.54	---	62.48	29.94	1000.0	9.000	L1	9.7
0.224250	---	18.96	52.44	33.48	1000.0	9.000	L1	9.7
0.228750	34.35	---	62.31	27.96	1000.0	9.000	L1	9.7
0.228750	---	17.53	52.27	34.74	1000.0	9.000	L1	9.7
0.429000	---	24.25	47.17	22.92	1000.0	9.000	L1	9.7
0.429000	38.89	---	57.18	18.29	1000.0	9.000	L1	9.7
0.431250	---	23.33	47.13	23.80	1000.0	9.000	L1	9.7
0.431250	37.10	---	57.14	20.04	1000.0	9.000	L1	9.7
2.793750	---	16.88	46.00	29.12	1000.0	9.000	L1	9.8
2.793750	32.30	---	56.00	23.70	1000.0	9.000	L1	9.8

Table 6.2.2-2 - Neutral

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.426750	35.14	---	47.21	12.07	1000.0	9.000	N	9.7
0.426750	---	20.01	57.22	37.21	1000.0	9.000	N	9.7
0.429000	35.22	---	47.17	11.95	1000.0	9.000	N	9.7
0.429000	---	20.15	57.18	37.03	1000.0	9.000	N	9.7
2.769000	24.44	---	46.00	21.56	1000.0	9.000	N	9.8
2.769000	---	9.20	56.00	46.80	1000.0	9.000	N	9.8
2.791500	26.02	---	46.00	19.98	1000.0	9.000	N	9.8
2.791500	---	10.49	56.00	45.51	1000.0	9.000	N	9.8
2.793750	---	10.89	56.00	45.11	1000.0	9.000	N	9.8
2.793750	26.34	---	46.00	19.66	1000.0	9.000	N	9.8
2.811750	---	6.25	56.00	49.75	1000.0	9.000	N	9.8
2.811750	20.84	---	46.00	25.16	1000.0	9.000	N	9.8

6.3 10 dB Bandwidth – FCC 15.517(b)

6.3.1 Measurement Procedure

The 10 dB bandwidth was measured in accordance with the ANSI C63.10: 2013 Section 10.1. The resolution bandwidth (RBW) of the spectrum analyzer was set to 1MHz. The video bandwidth (VBW) was set to ≥ 1 to 3 times the RBW. The trace was set to max hold with a Peak detector active.

6.3.2 Measurement Results

Table 6.3.2-1 – Frequency Bounds

Frequency Bounds	Frequency [MHz]
f_m	4127.1
f_l	3659.15
f_h	4353.06

Table 6.3.2-2: 10 dB Bandwidth

Frequency [MHz]	10 dB Bandwidth [MHz]
4006.1	693.91

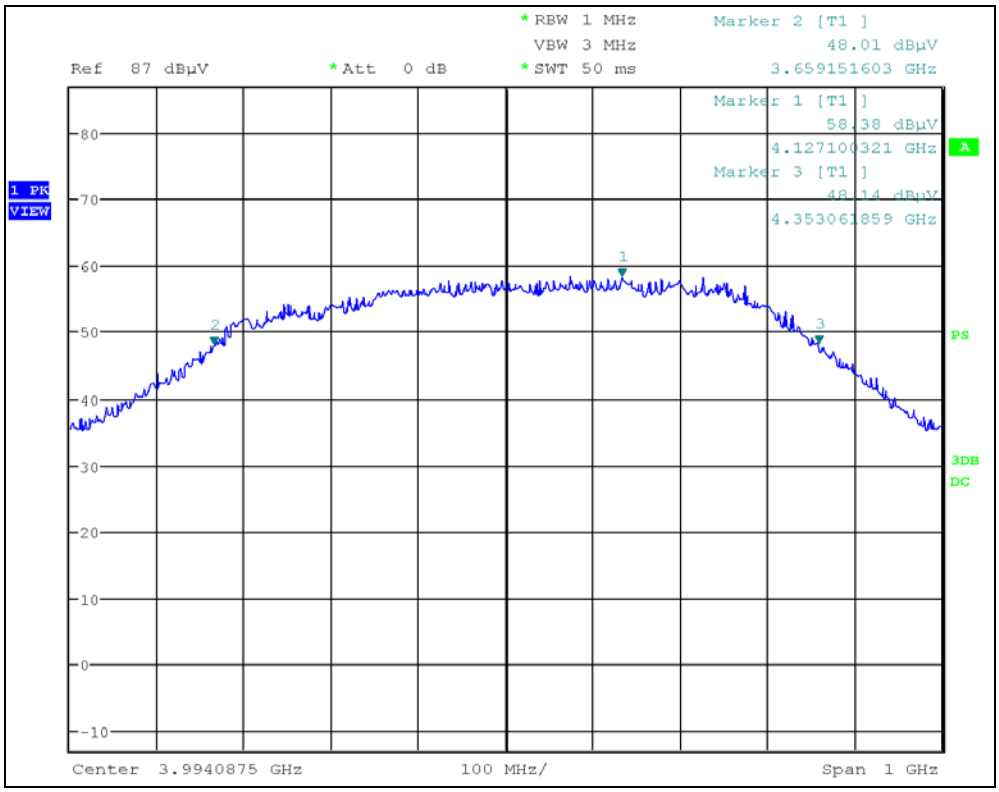


Figure 6.3.2-1: 10 dB Bandwidth

6.4 Fundamental Emission Peak Power – FCC 15.517(e)

6.4.1 Measurement Procedure

The maximum peak radiated output power was measured in accordance with ANSI C63.10: 2013 Section 10.3.5. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 50MHz. The Video Bandwidth (VBW) was set to its maximum 80MHz. The trace was set to max hold with a peak detector active.

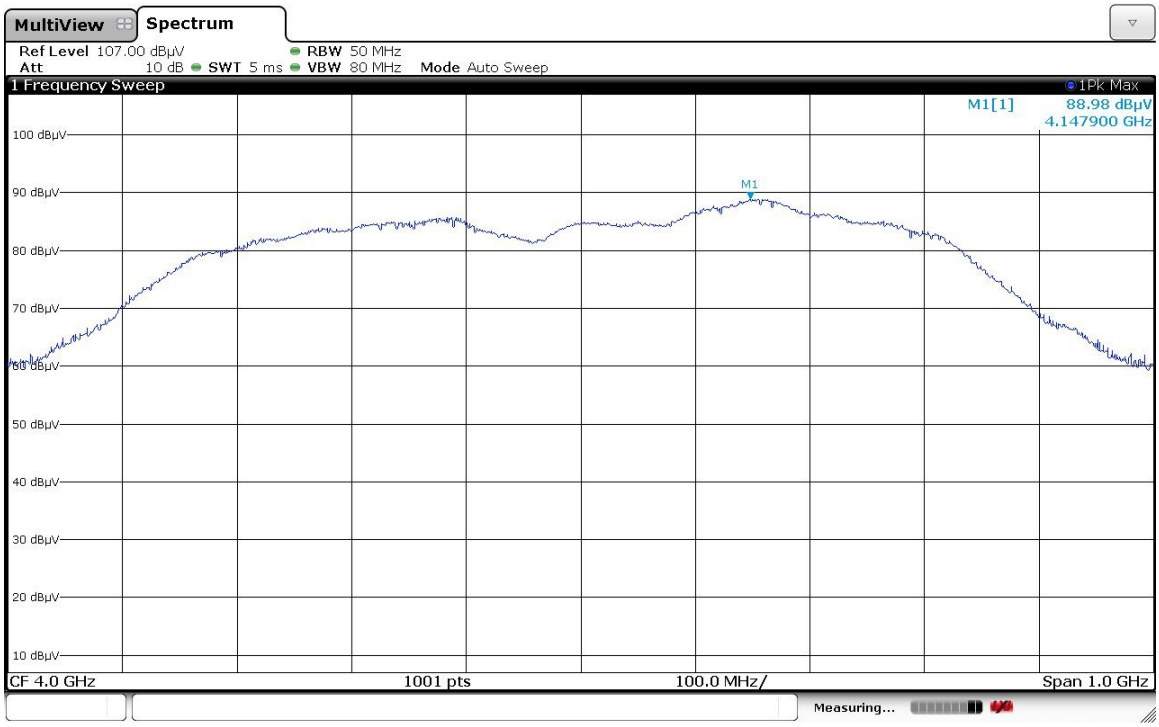
6.4.2 Measurement Results

The Field Strength becomes: 88.98 dBµV + 4.94 dB/m = 93.92 dBµV/m

The formula for conversion to dBm: 93.92 - 95.3 = -1.38 dBm
Per 15.517(e) the peak limit on the fundamental is 0 dBm EIRP.

Table 6.4.2-1: Maximum Peak Radiated Output Power

Frequency (MHz)	Output Power (EIRP) (dBm)
4147.9	-1.38



6.5 Power Spectral Density in the Fundamental Emission – FCC 15.517(c).

6.5.1 Measurement Procedure

The power spectral density was measured in accordance with the ANSI C63.10 Section 10.3.7. The equipment under test was tested radiated. The resolution bandwidth (RBW) of the spectrum analyzer was set to 1 MHz. The video bandwidth (VBW) was set to ≥1 MHz. Span was set to a convenient frequency segment. The trace was set to max hold with a RMS detector active. The sweep time did not exceed 1ms per bin. For the 625 bins used a 500 ms sweep time was used.

6.5.2 Measurement Results

Field Strength : Data (from plot) + antenna CF = Field Strength
48.49 dBµV + 5.03 dB/m = 53.52 dBµV/m

The formula for conversion to dBm: 53.52 - 95.3 = -41.78 dBm
Per 15.517(c) the limit on the fundamental is -41.3 dBm EIRP.

Table 6.5.2-1: Power Spectral Density

Frequency (MHz)	PSD Level (dBm)
4173.1	-41.78

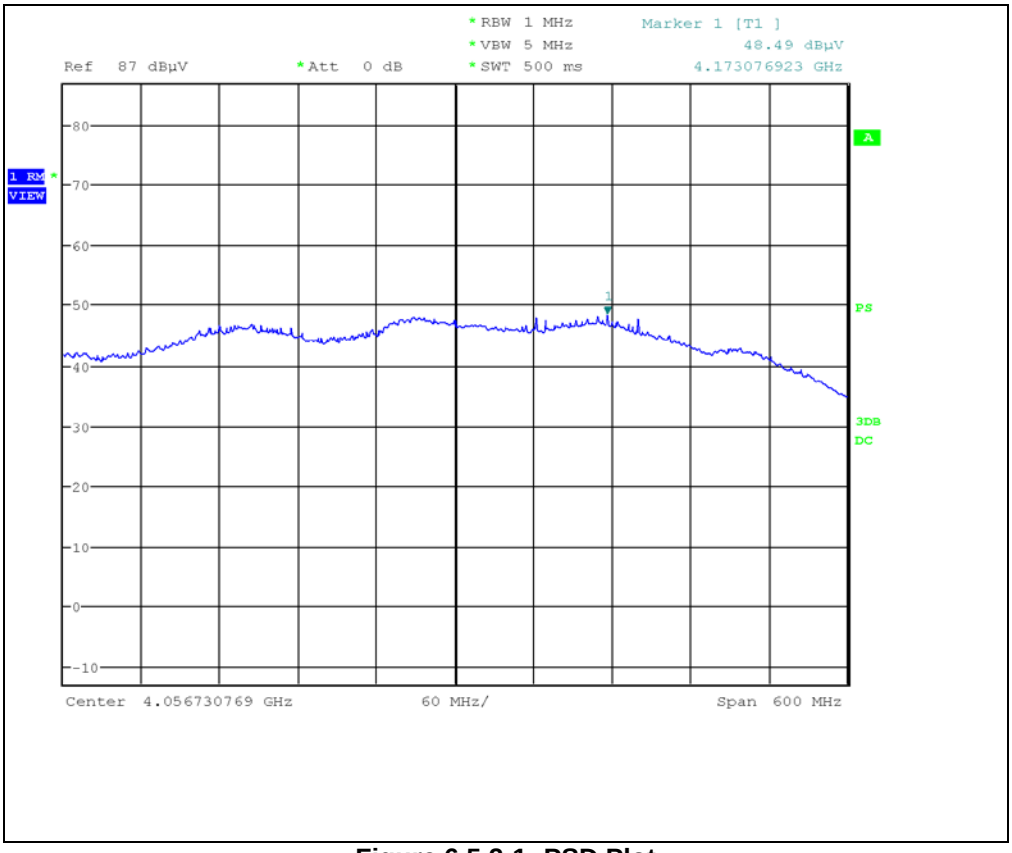


Figure 6.5.2-1: PSD Plot

6.6 Radiated Emissions – FCC 15.517(c), 15.209

6.6.1 Emissions into Frequency Bands above 960 MHz

6.6.1.1 Measurement Procedure

The unwanted emissions above 960 MHz were measured radiated in accordance with ANSI 63.10: 2013 Section 10.3. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 1 MHz. The Video Bandwidth (VBW) was set to ≥ 1MHz. The trace was set to max hold with a RMS detector active. The sweep time did not exceed 1ms per bin. For the 625 bins used ≤ 600 ms sweep time was used.

The correction factor is a combination of coax cable loss, preamp gain, antenna factor, and a measurement distance correction factor (when needed).

6.6.1.2 Sample Calculation:

$R_C = R_U + CF_T$

Where:

CF_T	=	Total Correction Factor (AF+CA+AG)+DCF
R_U	=	Uncorrected Reading
R_C	=	Corrected Level
AF	=	Antenna Factor
CA	=	Cable Attenuation
AG	=	Amplifier Gain
DCF	=	Distance Correction Factor

Example Calculation: RMS

Corrected Level: 28.91 + -5.19 - 9.54 = 8.99dBµV/m
Conversion to dBµV/m: dBm + 95.3 = dBµV/m

Table 6.6.1.2-1 Limits from 15.517(c):

Frequency MHz	EIRP dBm	Limit dBµV/m @3m
960 to 1610	-75.3	20
1610 to 1990	-53.3	42
1990 to 3100	-51.3	44
3100 to 10600	-41.3	54
Above 10600	-51.3	44

6.6.1.3 Measurement Results

Emission Frequency MHz	Reading From plot dBµV	Antenna Polarity	Measurement Distance meter	Correction Factors dB/m	Field Strength dBµV/m	Limit dBµV/m @3m
1425.6	28.91	V	1	-14.73	8.99	20
1821.9	28.31	V	3	-3.95	24.36	42
1990.0	28.23	V	3	-3.39	24.84	42
4926.9	28.60	V	3	5.93	34.53	54
7984.6	31.46	V	3	9.88	41.34	54
8744.2	27.09	V	3	11.99	39.08	54
15343.9	25.95	V	3	10.58	36.53	44
18912.6	30.62	V	1	-0.28	30.34	44
39156.2	43.93	V	1	-9.64	34.29	44

There were no measurable emissions above 10.6 GHz, and up to 40 GHz. The measurements in the table above for emissions greater than 10.6 GHz are of the noise floor.

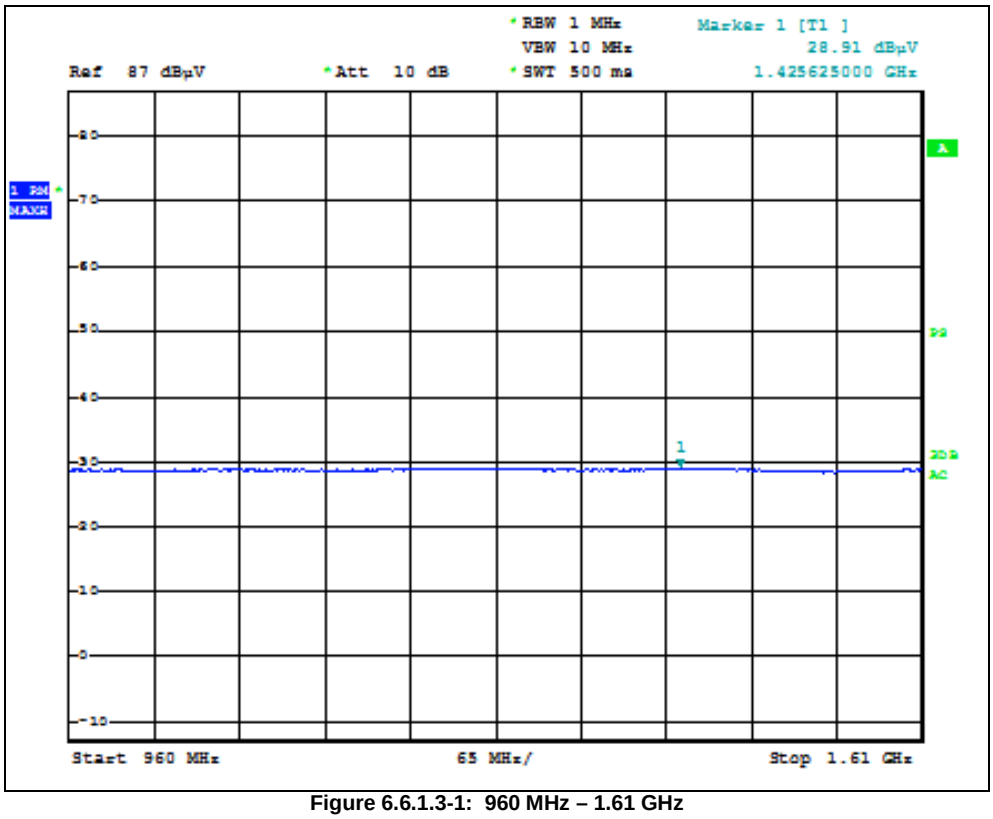


Figure 6.6.1.3-1: 960 MHz – 1.61 GHz

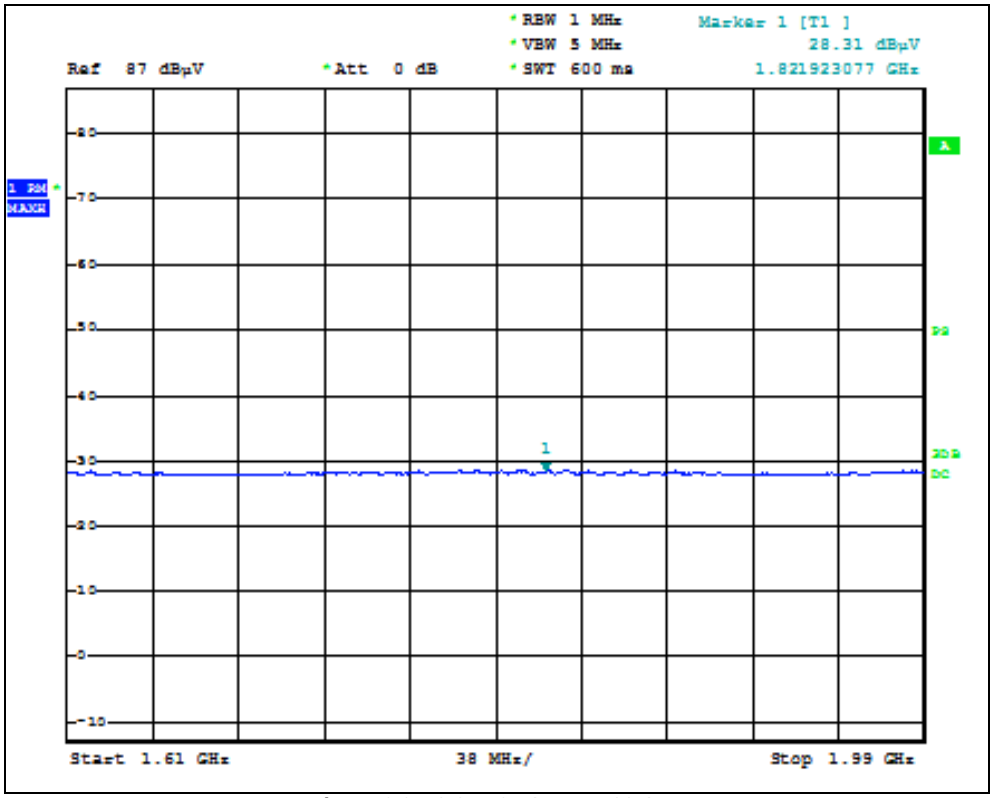


Figure 6.6.1.3-2: 1.61 GHz – 1.99 GHz

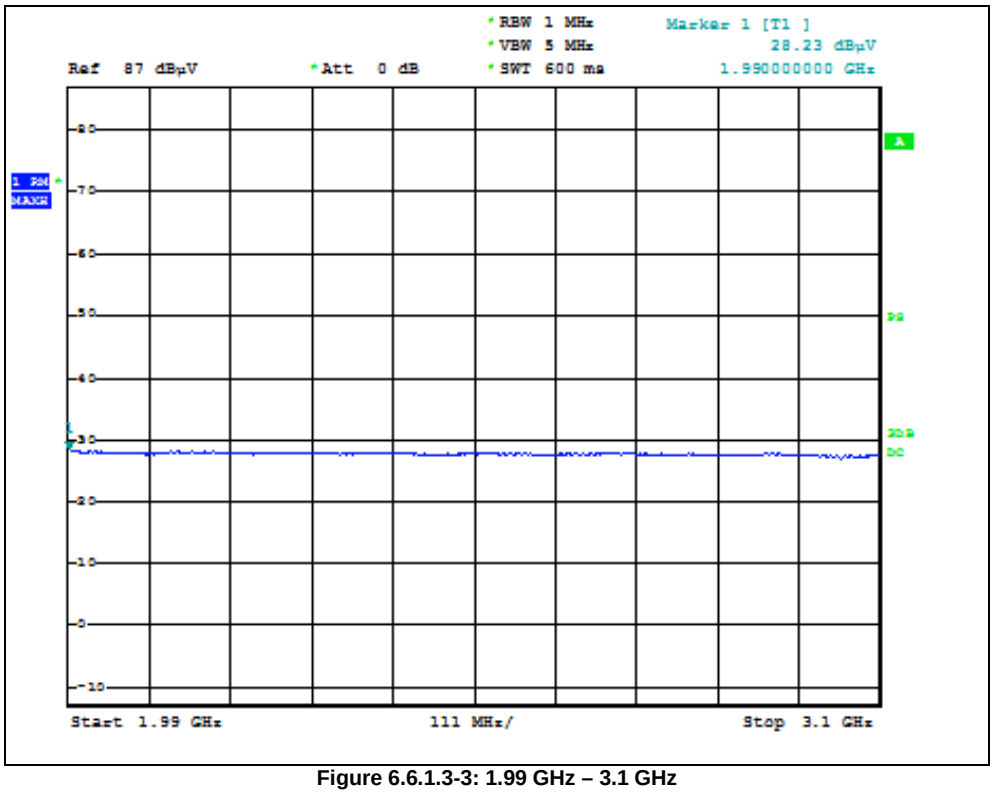


Figure 6.6.1.3-3: 1.99 GHz – 3.1 GHz

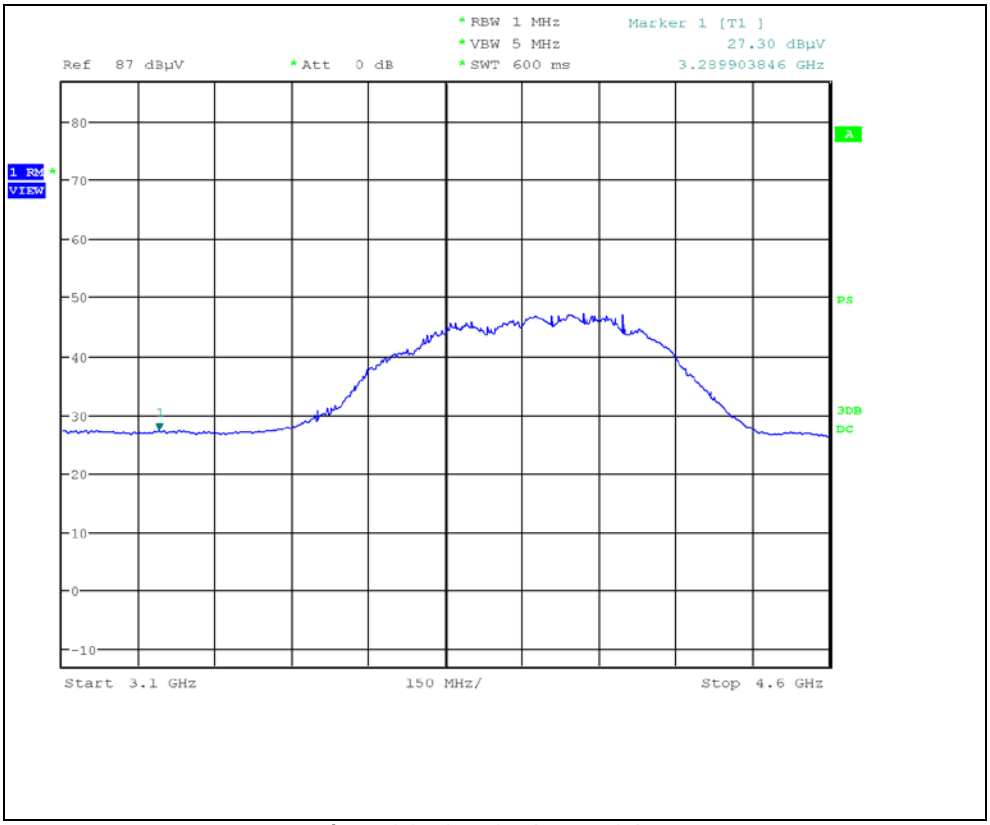


Figure 6.6.1.3-4: 3.1 GHz – 4.6 GHz

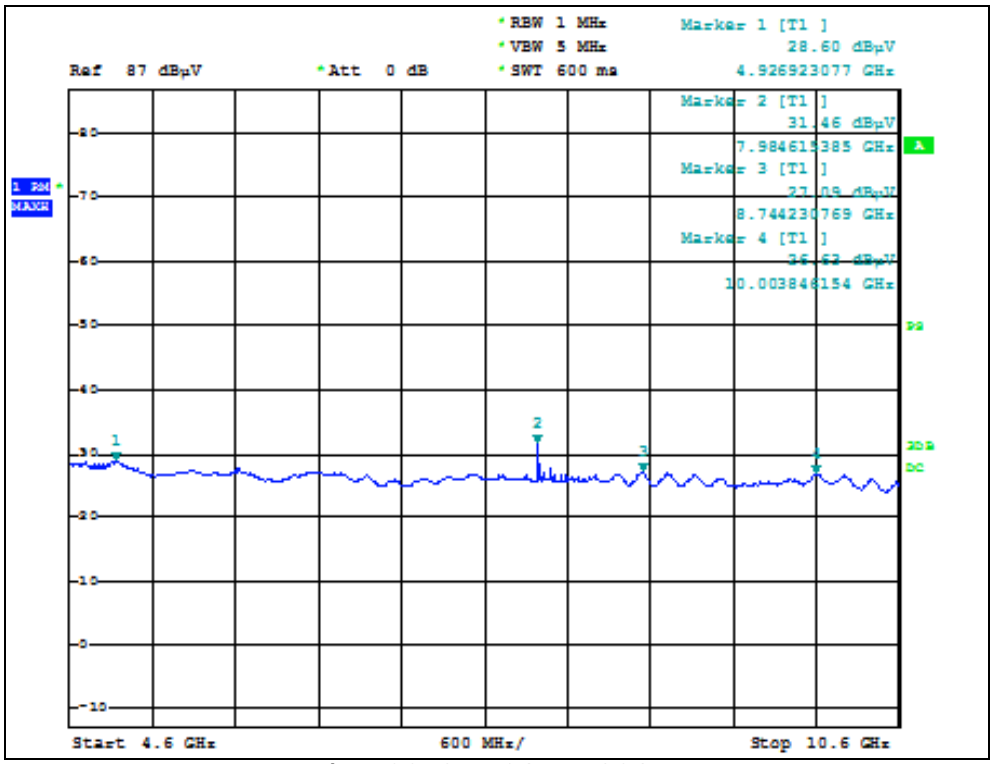


Figure 6.6.1.3-5: 4.6 GHz – 10.6 GHz

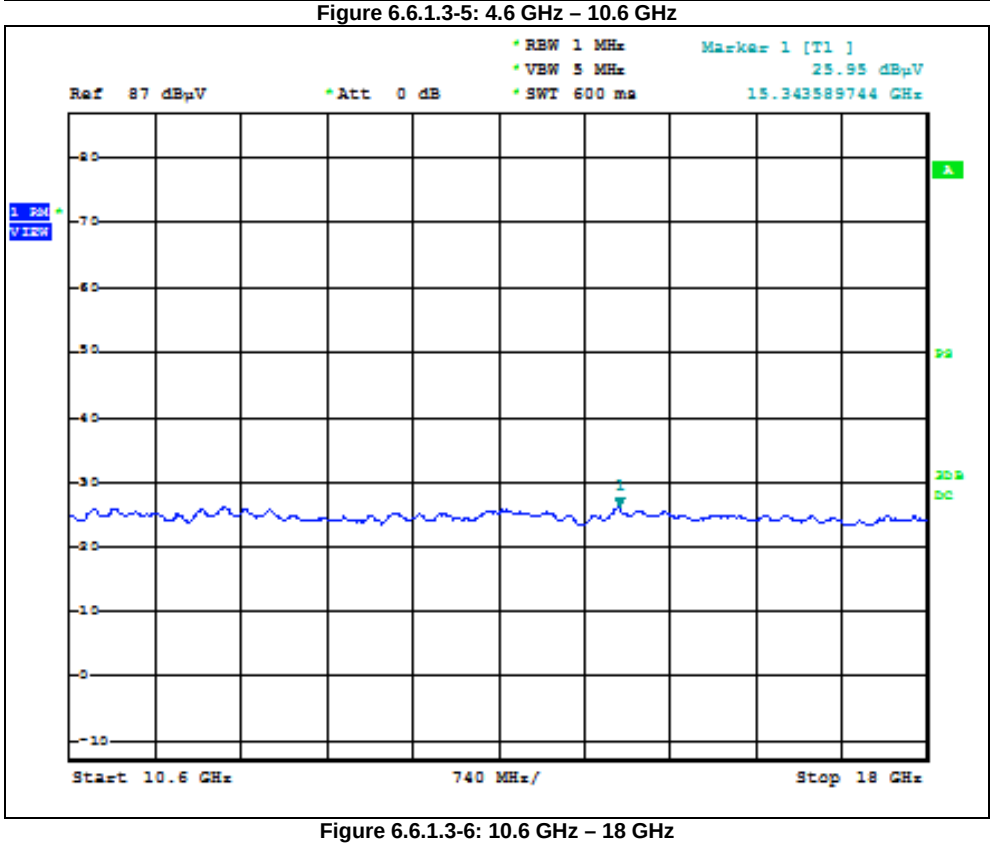


Figure 6.6.1.3-6: 10.6 GHz – 18 GHz

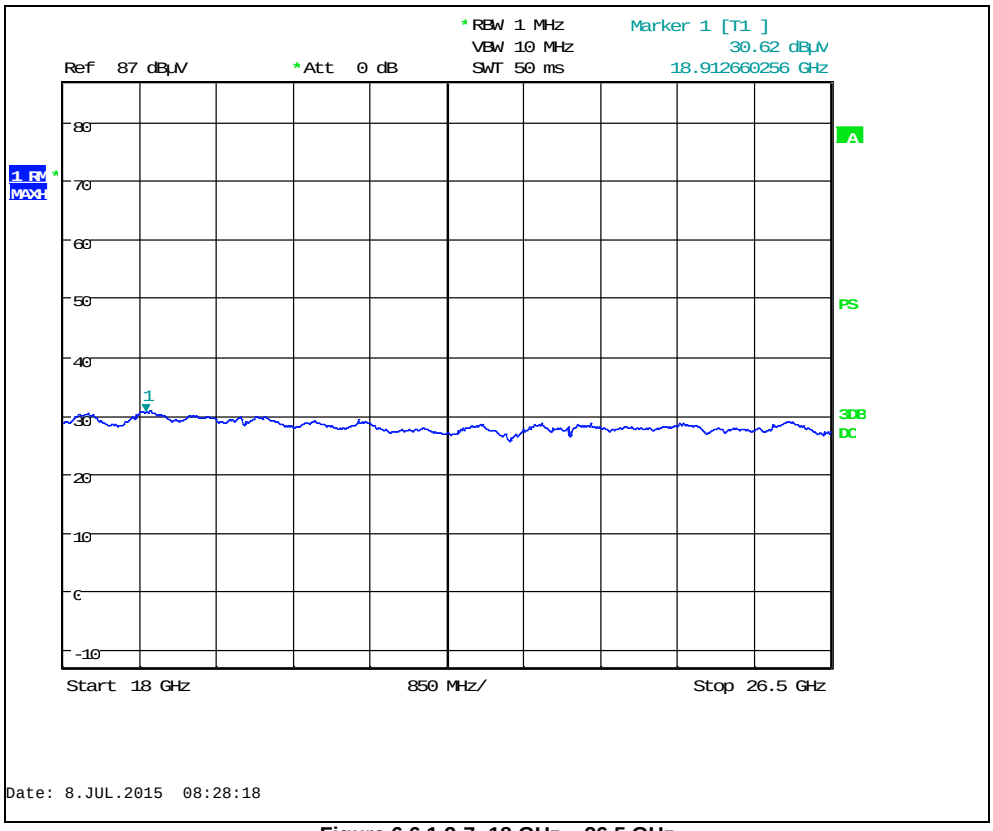


Figure 6.6.1.3-7: 18 GHz – 26.5 GHz

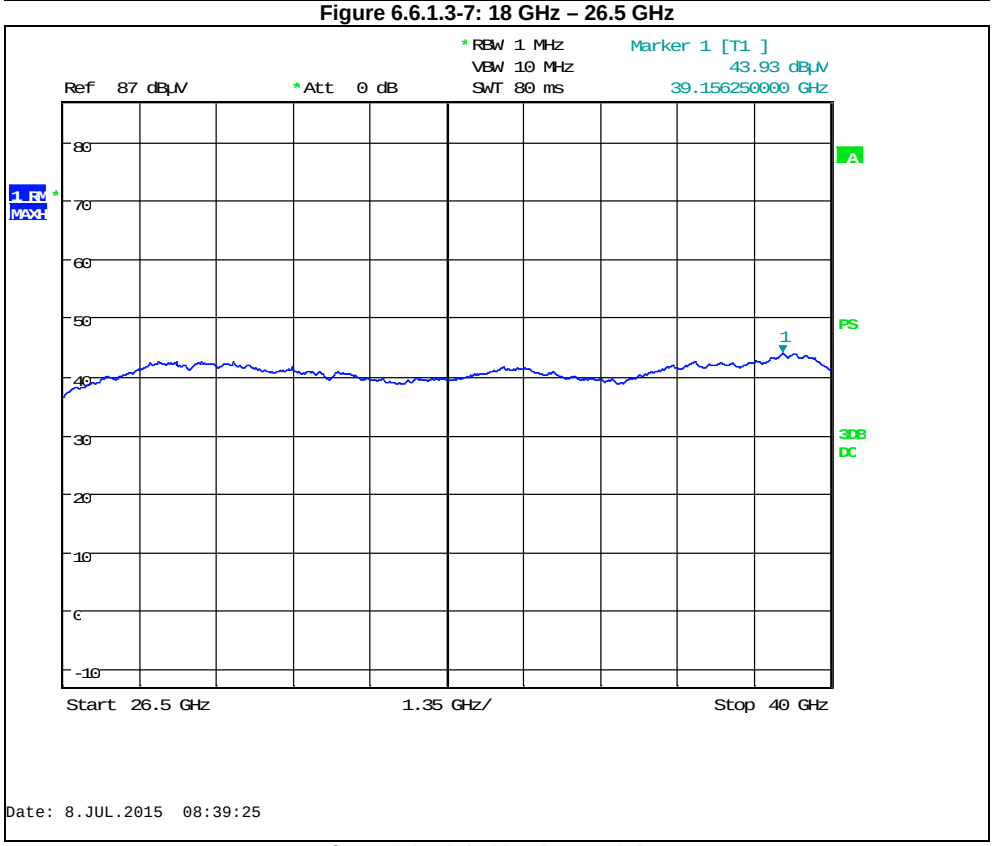


Figure 6.6.1.3-8: 26.5 GHz – 40 GHz

6.6.2 Emissions into Frequency Bands below 960 MHz

6.6.2.1 Measurement Procedure

The unwanted emissions from the lowest frequency generated or 9 kHz to 960 MHz in accordance with ANSI 63.10: 2013 Section 10.2. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz. The Video Bandwidth (VBW) was set to ≥ 100 kHz. The trace was set to max hold with a Q-P detector active.

The correction factor is a combination of coax cable loss, preamp gain, antenna factor, and a distance correction factor (if needed).

Table 6.6.2.1-1 Limits from 15.109:

Emission Type	Frequency Range (MHz)	Voltage limits (dBµV/m)
Radiated Class B @ 3 meters	0.009 to 0.490	20log(2400/F(kHz)) @300m
	0.490 to 1.705	20log(24000/F(kHz)) @30m
	30.0 to 88.0	40.0
	88.0 to 216.0	43.5
	216.0 to 960.0	46.0

6.6.2.2 Measurement Results

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
30.39	---------	-1.70	H	13.61	---------	11.91	--------	40.0	---------	28.1
30.39	---------	-1.00	V	13.61	---------	12.61	--------	40.0	---------	27.4
44	---------	-2.20	H	10.56	---------	8.36	--------	40.0	---------	31.6
44	---------	-1.60	V	10.56	---------	8.96	--------	40.0	---------	31.0
119.9	---------	-2.20	H	11.87	---------	9.67	--------	43.5	---------	33.8
119.9	---------	-2.20	V	11.87	---------	9.67	--------	43.5	---------	33.8
291	---------	0.90	H	14.49	---------	15.39	--------	46.0	---------	30.6
291	---------	-1.10	V	14.49	---------	13.39	--------	46.0	---------	32.6
692.2	---------	0.20	H	22.00	---------	22.20	--------	46.0	---------	23.8
692.2	---------	-0.06	V	22.00	---------	21.94	--------	46.0	---------	24.1

6.6.3 Radiated Emissions in the GPS bands FCC 15.517(d)

6.6.3.1 Measurement Procedure

The frequency bands to be investigated and the associated limits are:

Table 6.6.3.1-1 Frequency Bands

Frequency MHz	EIRP dBm	Field Strength @3m dBµV/m
1164 to 1240	-85.3	10
1559 to 1610	-85.3	10

Unwanted emissions in the above bands were measured radiated in accordance with ANSI 63.10: 2013 Section 10.3.10 and 10.3.7 and the FCC rules. The resolution bandwidth (RBW) of the spectrum analyzer was set to 20 kHz with the minimum allowed being 1 kHz. The ratio of the RBW to Video Bandwidth (VBW) was set to ≥ 3 where possible. The trace was set to max hold with a RMS detector active. The sweep time did not exceed 1ms per bin. For the 625 bins used a 500 ms sweep time was used.

6.6.3.2 Measurement Results:

Emission Frequency MHz	Reading From plot dBµV	Antenna Polarity	Measurement Distance m	Correction Factors dB/m	Field Strength dBµV/m	Limit dBµV/m @3m
1225.6	14.03	V	1	-15.18	-1.15	10
1593.0	13.91	V	1	-14.27	-0.36	10

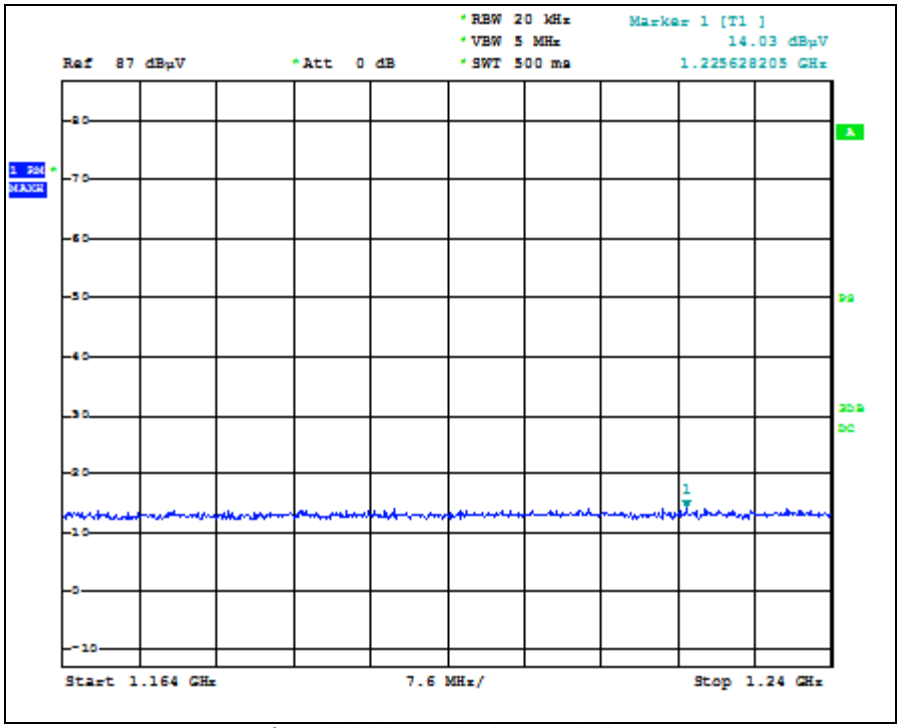


Figure 6.6.3.2-1: 1.164 GHz – 1.24 GHz

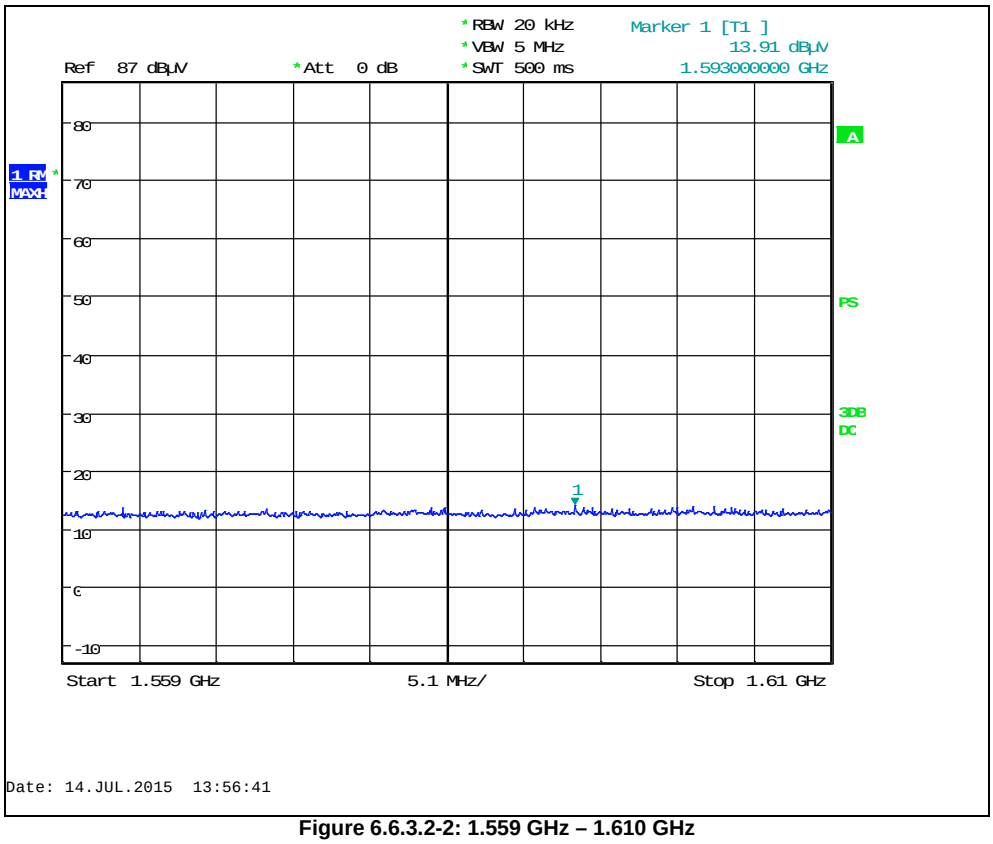


Figure 6.6.3.2-2: 1.559 GHz – 1.610 GHz

7 CONCLUSION

In the opinion of ACS, Inc. the ED0991, manufactured by InVue Security meets the requirements of FCC Part 15 subpart F.

END REPORT