Certification Test Report

FCC ID: V2A-ECO
IC: 7566A-ECO

FCC Rule Part: 15.247
IC Radio Standards Specification: RSS-247

ACS Report Number: 15-2038.W06.1A

Manufacturer: RG3 Meter Company
Model: ECO

Test Begin Date: **May 4, 2015**
Test End Date: **May 5, 2015**

Report Issue Date: June 19, 2015

FOR THE SCOPE OF ACCREDITATION UNDER CERTIFICATE NUMBER AT-1533

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.

Project Manager:

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This report contains 31 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 and Industry Canada's Radio Standards Specification RSS-247.

1.2 Product Description

The EUT is a meter transceiver interface operating in the 900 MHz ISM Band.

Technical Details

Mode of Operation:	FHSS
Frequency Range:	903 MHz - 913 MHz
Number of Channels:	50
Channel Separation:	0.2 MHz
Modulations:	GFSK
TX Data Rates:	38400
Antenna Type/Gain:	Monopole antenna, 0 dBi

1.3 Manufacturer Information

RG3 Meter Company
2912 S. Access Rd
Longview, TX 75602

Model Number: ECO

Test Sample Serial Number(s): 001 (Radiated Emissions), Not Provided (RF Conducted)

Test Sample Condition: The samples were in good conditions with no observable physical damages.

1.4 Test Methodology and Considerations

The EUT was evaluated for radiated and RF conducted emissions. The testing was performed with the EUT set to a software power setting of 4. The unit is battery powered only and therefore is exempted from the power line conducted emissions requirements.

For the radiated emissions evaluation, the unit was operating from a fully charged battery and was set in the orientation of typical installation. The unit was constantly pulsing during the measurements. A duty cycle correction factor was applied to the peak values of the spurious emissions for the average measurements. The duty cycle correction factor is provided by the logarithm of the dwell time over 100ms.

For the RF conducted measurements, the sample was configured with a temporary SMA connector for direct coupling to a spectrum analyzer. The evaluation was performed with the EUT powered using a DC power supply.

The evaluation for unintentional emission is documented separately in a verification report.

2 TEST FACILITIES

2.1 Location

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

Advanced Compliance Solutions, Inc.
3998 FAU Blvd, Suite 310
Boca Raton, Florida 33431
Phone: (561) 961-5585
Fax: (561) 961-5587
www.acstestlab.com

FCC Test Firm Registration #: 475089
Industry Canada Lab Code: 4175C

2.2 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-1533 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.

2.3 Radiated & Conducted Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The EMC radiated test facility consists of an RF-shielded enclosure. The interior dimensions of the indoor semi-anechoic chamber are approximately 48 feet (14.6 m) long by 36 feet (10.8 m) wide by 24 feet (7.3 m) high and consist of rigid, 1/8 inch (0.32 cm) steel-clad, wood core modular panels with steel framing. In the shielded enclosure, the faces of the panels are galvanized and the chamber is self-supporting. 8-foot RF absorbing cones are installed on 4 walls and the ceiling. The steel-clad ground plane is covered with vinyl floor.

The turntable is driven by pneumatic motor, which is capable of supporting a 2000 lb. load. The turntable is flushed with the chamber floor which it is connected to, around its circumference, with a continuous metallic loaded spring. An EMCO Model 1050 Multi-device Controller controls the turntable position.

A pneumatic motor is used to control antenna polarizations and height relative to the ground. The height information is displayed on the control unit EMCO Model 1050.

The control room is an RF shielded enclosure attached to the semi-anechoic chamber with two bulkhead panels for connecting RF, and control cables. The dimension of the room is 7.3 m x 4.9 m x 3 m high and the entrance doors of both control and conducted rooms are 3 feet (0.91 m) by 7 feet (2.13 m).

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3.1-1 below:

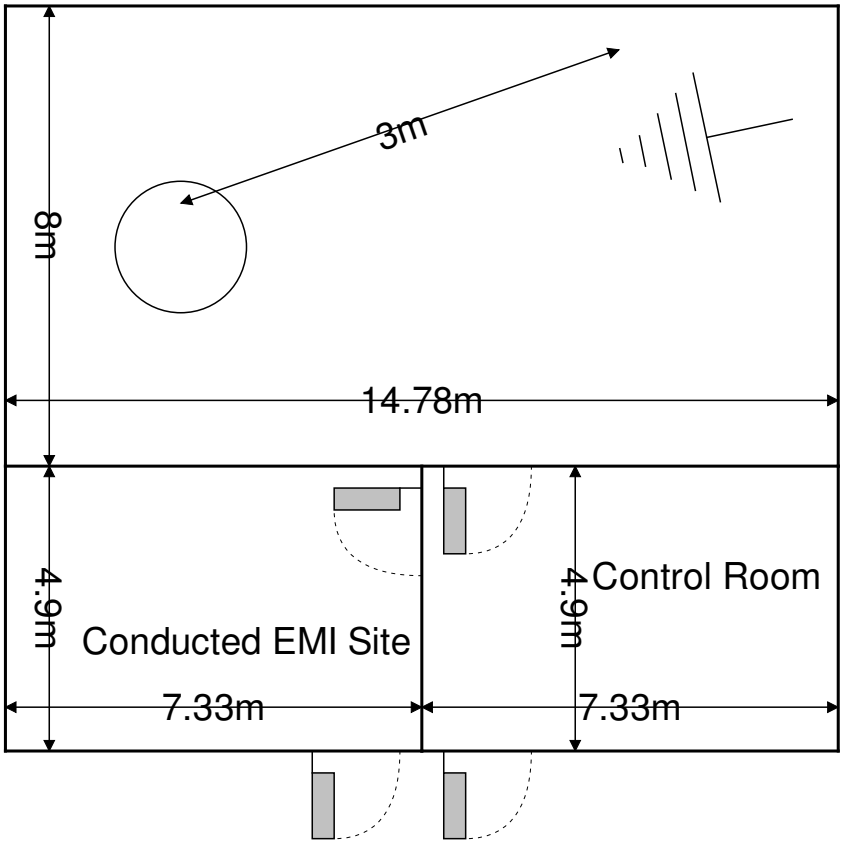


Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

2.3.2 Conducted Emissions Test Site Description

The dimensions of the shielded conducted room are 7.3 x 4.9 x 3 m^3. As per ANSI C63.4 2014 requirements, the data were taken using two LISNs; a Solar Model 8028-50 50 Ω/50 µH and an EMCO Model 3825, which are installed as shown in Photograph 3. For evaluations requiring 220 V, 50 Hz AC input, a Polarad LISN (S/N 879341/048) is used in conjunction with a 1 kVA, 50 Hz/220 V EDGAR variable frequency generator, Model 1001B, to filter conducted noise from the generator.

A diagram of the room is shown below in figure 2.3.2-1:

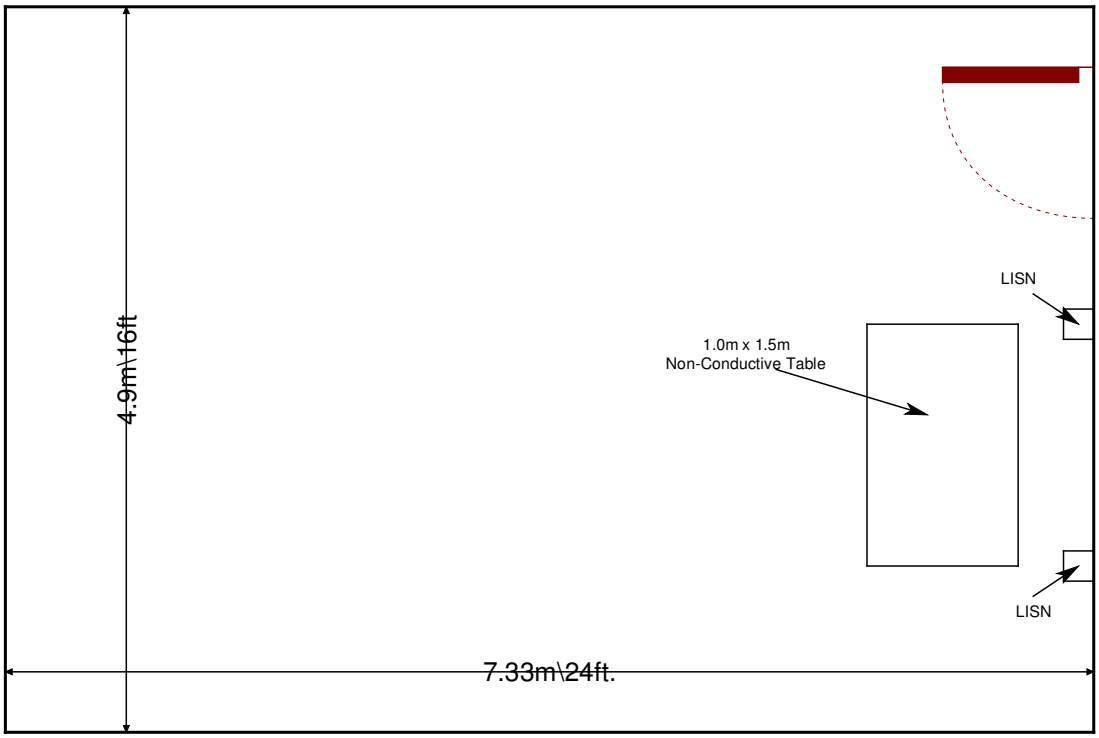


Figure 2.3.2-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.10-2009: American National Standard for Testing Unlicensed Wireless Devices
- ANSI C63.10-2013[1]: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2015
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2015
- Industry Canada Radio Standards Specification: RSS-247 — Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices, Issue 1, May 2015.
- Industry Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 4, November 2014.

[1] ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices – Reference for Industry Canada only

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 List

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
523	Agilent	E7405	Spectrum Analyzers	MY45103293	12/26/2014	12/26/2016
2002	EMCO	3108	Antennas	2147	11/22/2013	11/22/2015
2004	EMCO	3146	Antennas	1385	11/22/2013	11/22/2015
2006	EMCO	3115	Antennas	2573	4/14/2015	4/14/2017
2011	Hewlett-Packard	HP 8447D	Amplifiers	2443A03952	12/31/2014	12/31/2015
2037	ACS Boca	Chamber EMI Cable Set	Cable Set	2037	2/17/2015	2/17/2016
2044	QMI	N/A	Cables	2044	12/31/2014	12/31/2015
2082	Teledyne Storm Products	90-010-048	Cables	2082	4/22/2015	4/22/2016
2089	Agilent Technologies, Inc.	83017A	Amplifiers	3123A00214	12/12/2014	12/12/2015
2095	ETS Lindgren	TILE4! - Version 4.2.A	Software	85242	NCR	NCR
2071	Trilithic, Inc.	4HC1400-1-KK	Filter	9643263	12/31/2014	12/31/2015
2069	Trilithic, Inc.	7NM867/122-X1-AA	Notch Filter	200315126	3/27/2015	3/27/2016
78	EMCO	6502	Antennas	9104-2608	2/13/2015	2/13/2017
2111	Aeroflex Inmet	40AH2W-20	Attenuator	2111	7/25/2014	7/25/2015
RE619	Rhode & Schwarz	ESU	Spectrum Analyzers	802.6005K26 Ser. 1001	11/5/2014	11/5/2016

Notes: NCR=No Calibration Required

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	RG3 Meter Company	FHSS Water Meter Transceiver	001

Table 5-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	Data cable	0.65 m	No	None

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

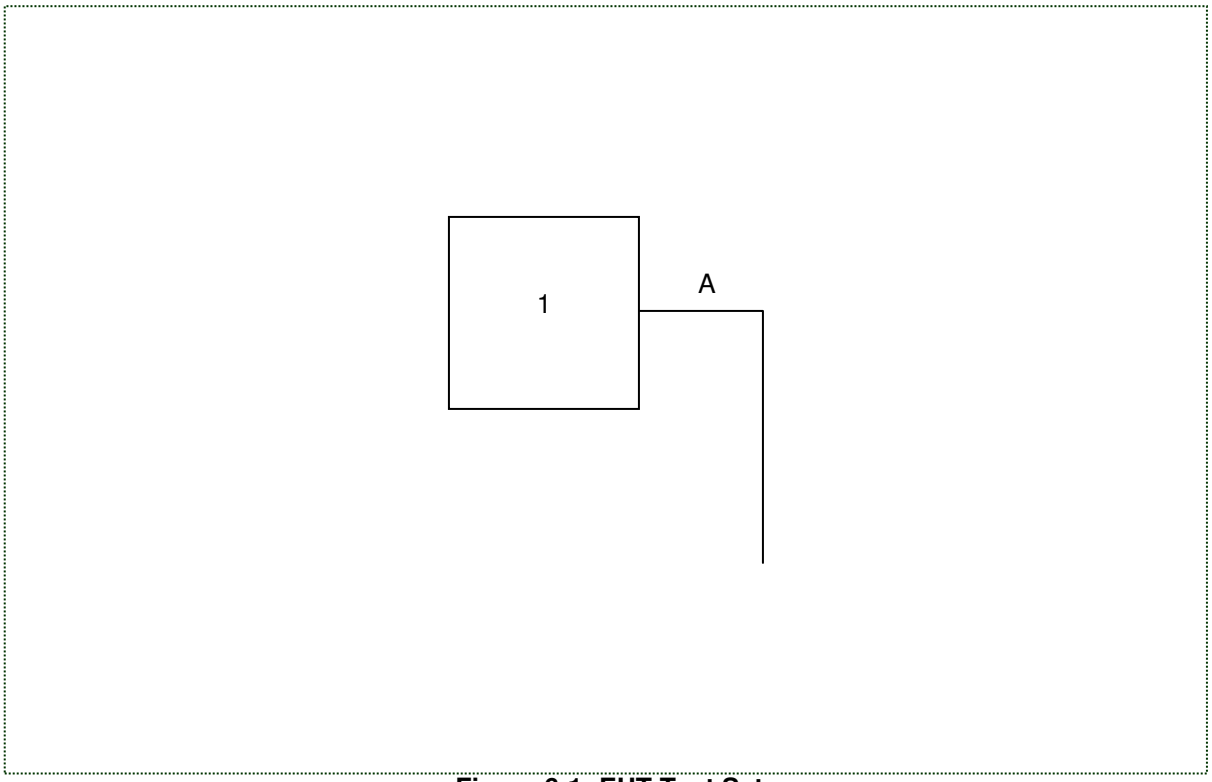


Figure 6-1: EUT Test Setup

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: Section 15.203

The EUT uses an integral monopole antenna which is directly soldered to the PCB. The antenna is not detachable, thus meeting the requirements of FCC 15.203.

7.2 Peak Output Power - FCC Section 15.247(b)(2) IC: RSS-247 5.4(1)

7.2.1 Measurement Procedure (Conducted Method)

The RF output port of the EUT was directly connected to the input of the spectrum analyzer through suitable attenuation.

7.2.2 Measurement Results

Results are shown below:

Table 7.2.2-1: RF Output Power

Frequency (MHz)	Power (dBm)
903	28.90
908	29.12
913	29.43

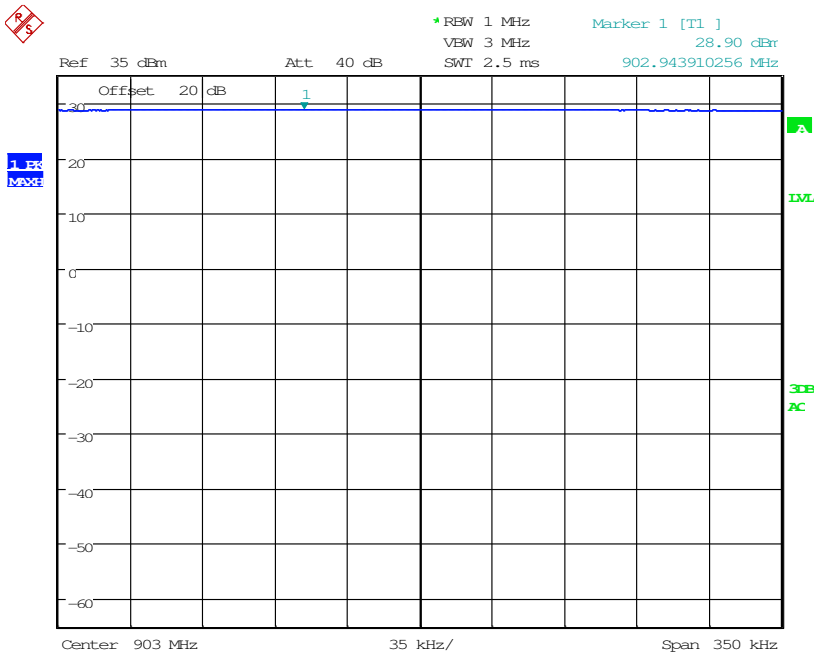


Figure 7.2.2-1: RF Output Power - Low Channel

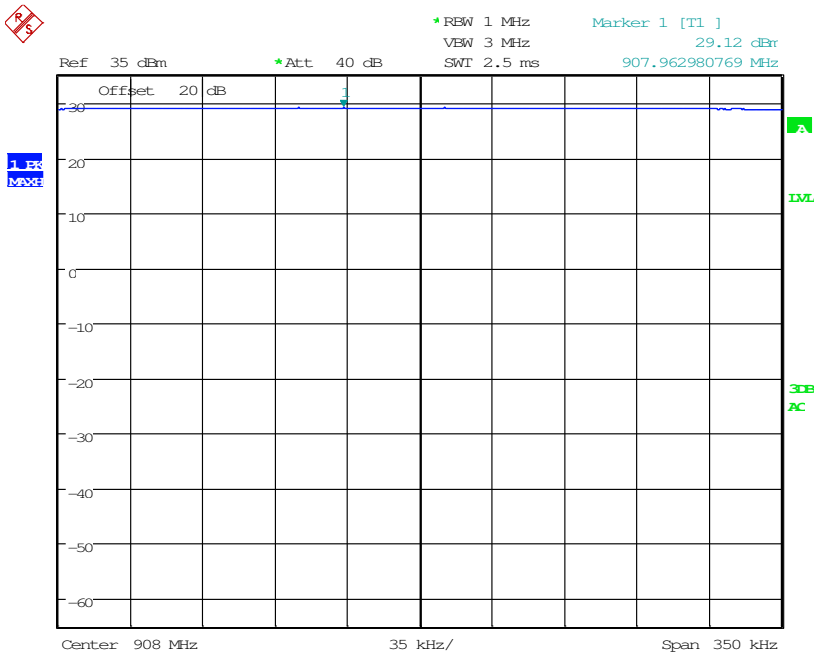


Figure 7.2.2-2: RF Output Power - Middle Channel

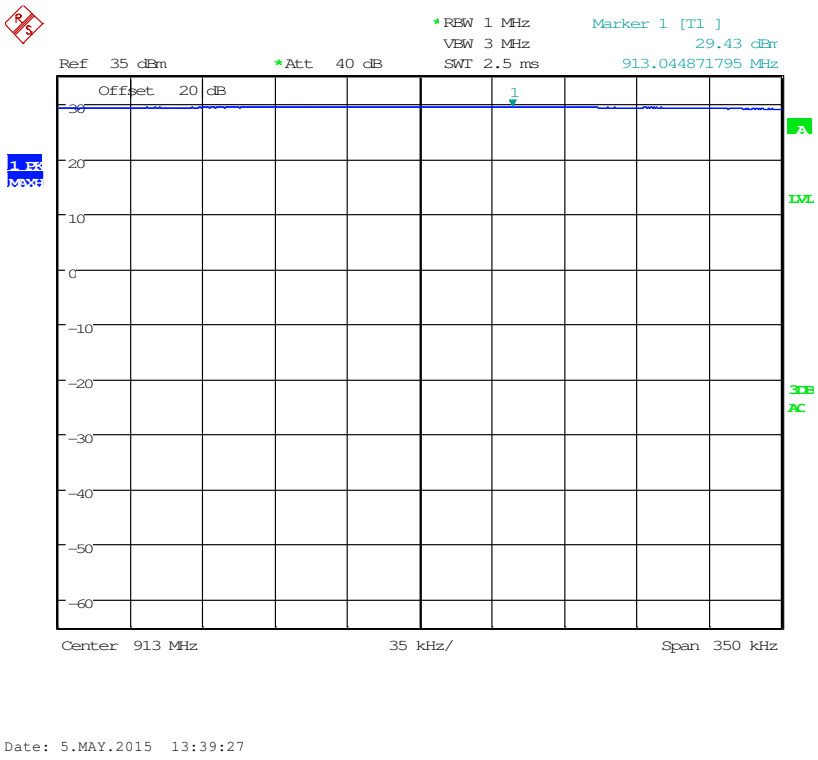


Figure 7.2.2-3: RF Output Power - High Channel

7.3 Channel Usage Requirements

7.3.1 Carrier Frequency Separation – FCC: Section 15.247(a)(1) IC: RSS-247 5.1(1)

7.3.1.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer. The span of the spectrum analyzer was set wide enough to capture two adjacent peaks and the RBW was set approximately to 30% of the channel spacing.

7.3.1.2 Measurement Results

Results are shown below:

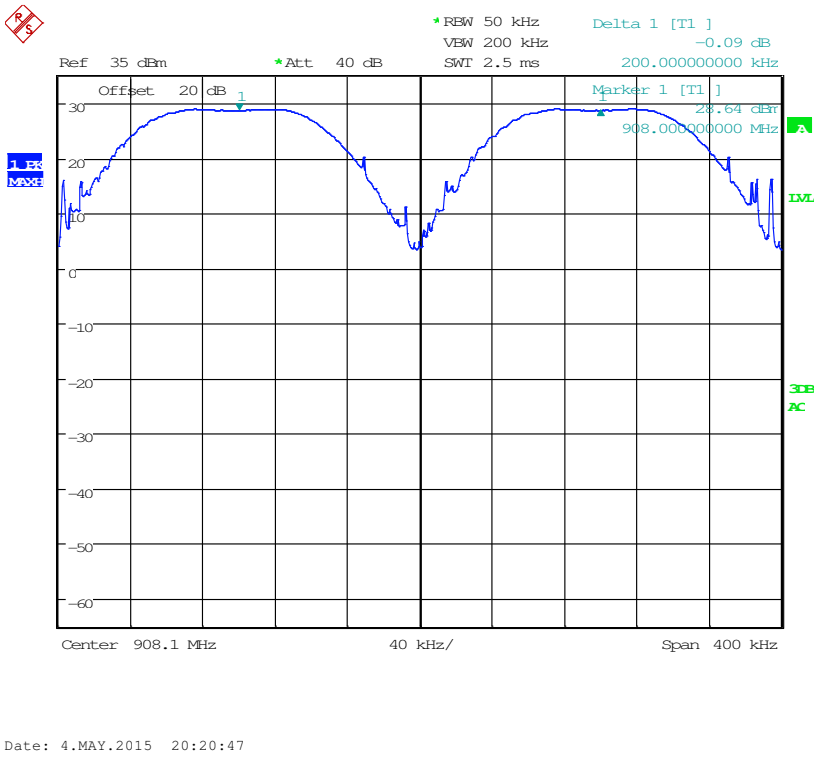


Figure 7.3.1.2-1: Carrier Frequency Separation

7.3.2 Number of Hopping Channels – FCC: Section 15.247(a)(1)(i) IC: RSS-247 5.1(3)

7.3.2.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer. The span of the spectrum analyzer was set wide enough to capture the number of hopping channels. The peak detector max hold function was enabled for the measurements.

7.3.2.2 Measurement Results

Results are shown below:

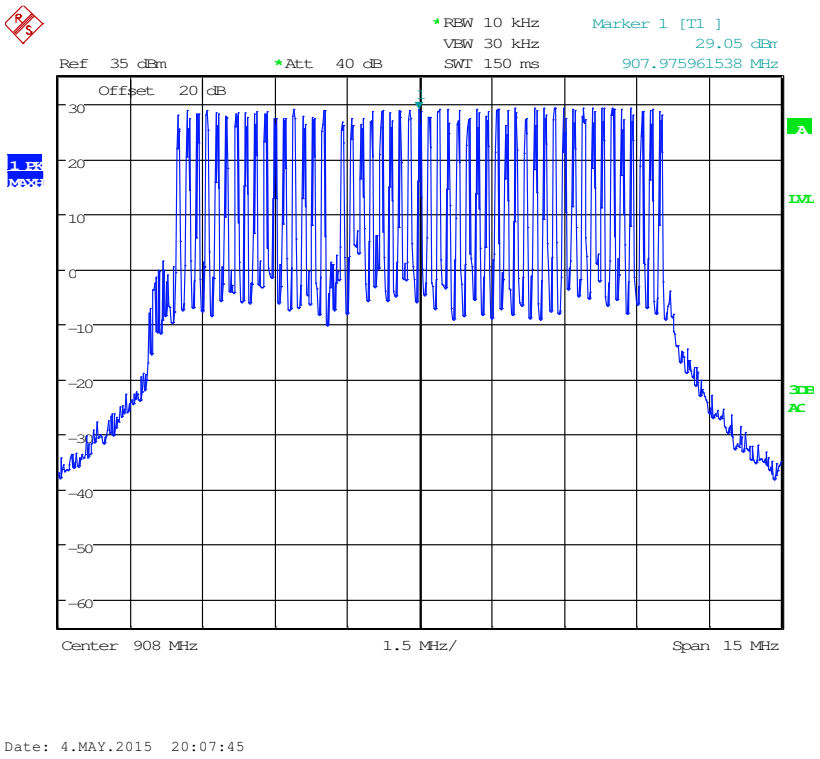


Figure 7.3.2.2-1: Number of Hopping Channels (1 – 50)

7.3.3 Channel Dwell Time – FCC: Section 15.247(a)(1)(i) IC: RSS-247 5.1(3)

7.3.3.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer. The span of the spectrum analyzer was set 0 Hz centered on a hopping channel. The RBW was set to 100 kHz and the sweep time adjusted to capture the entire dwell time per channel with peak detector max hold function.

7.3.3.2 Measurement Results

Results are shown below:

Table 7.3.3.2-1 Dwell Time on a 20 Second Cycle

Number of Hops Per Sec. (NHPS)	Number of Hops per Channel Per Sec. (NHPCPS)	Number of hops on a 20 s Cycle (NHPC)	Measured Dwell Times (ms)	Dwell Times on a 20 s Cycle (ms)	Limit (ms)	Status
8	0.16	4	9.832	39.33	400	PASS

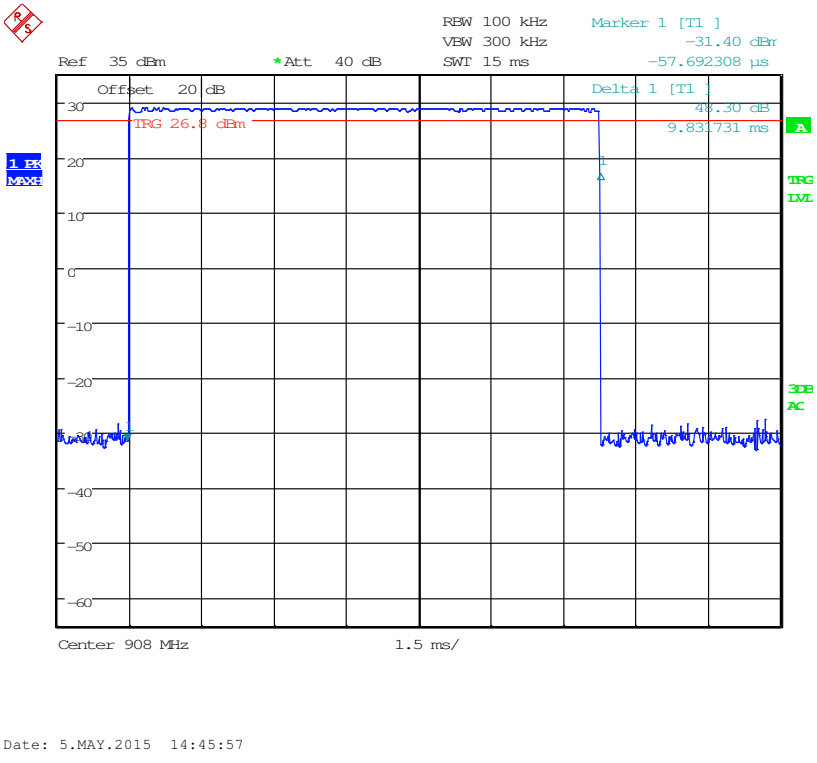


Figure 7.3.3.2-1: Channel Dwell Time

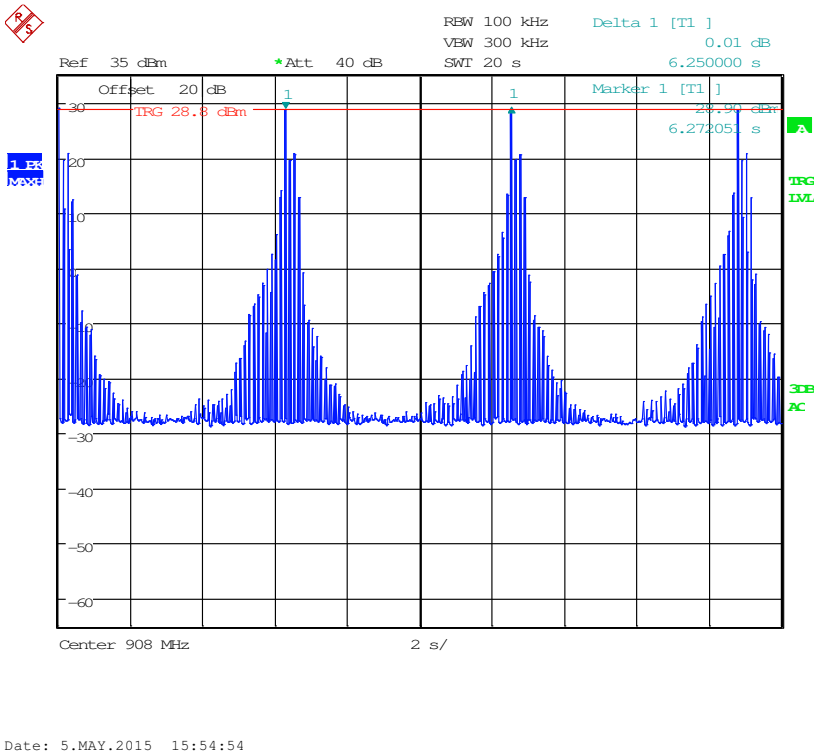


Figure 7.3.3.2-2: Channel Dwell Time – 20s

7.3.4 20dB / 99% Bandwidth - FCC: Section 15.247(a)(1) IC: RSS-247 5.1(1)

7.3.4.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer. The spectrum analyzer span was set between 2 to 5 times the estimated bandwidth of the emission. The RBW was set to 1% to 5% of the estimated emission bandwidth. 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 99% occupied bandwidth was measured with the spectrum analyzer span set to fully display the emission. The RBW was set to 1% to 5% of the approximated bandwidth. . The occupied 99% bandwidth was measured using the automated OBW measurement function of the SA.

7.3.4.2 Measurement Results

Results are shown below:

Table 7.3.4.2-1: 20dB / 99% Bandwidth

Frequency [MHz]	20dB Bandwidth [kHz]	99% Bandwidth [kHz]
903	71.6346	73.7179
908	69.5519	67.3077
913	69.7115	73.7179

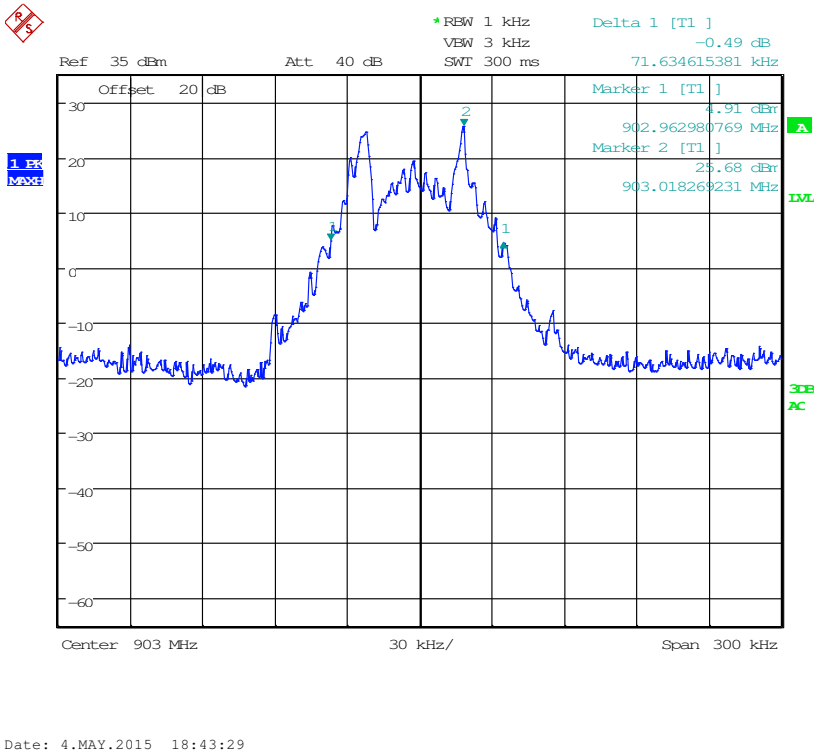


Figure 7.3.4.2-1: 20dB BW Low Channel

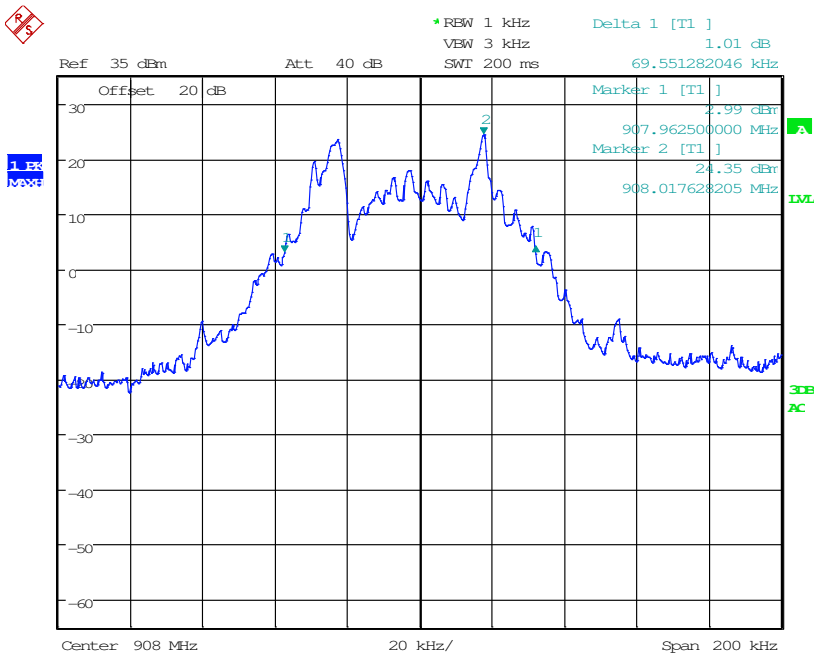


Figure 7.3.4.2-2: 20dB BW Middle Channel

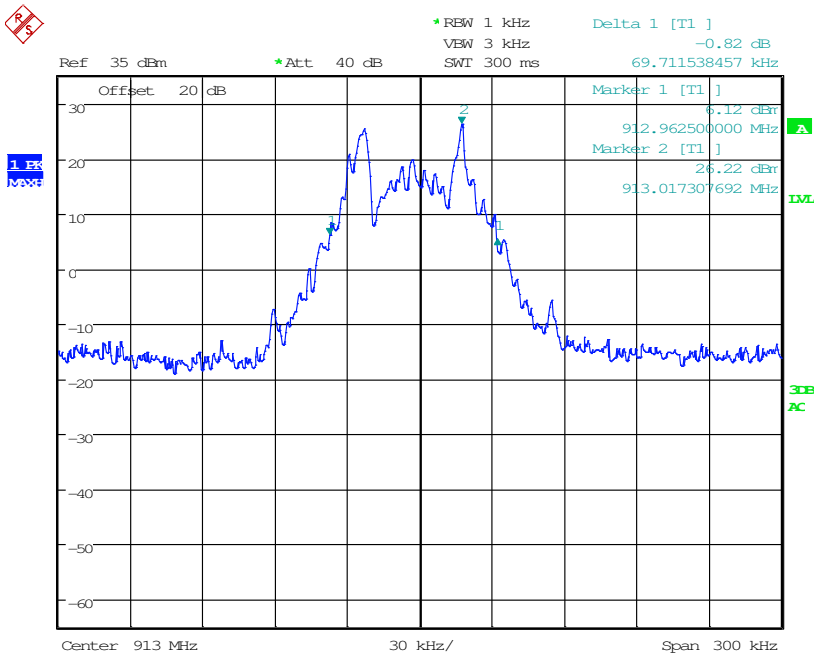


Figure 7.3.4.2-3: 20dB BW High Channel

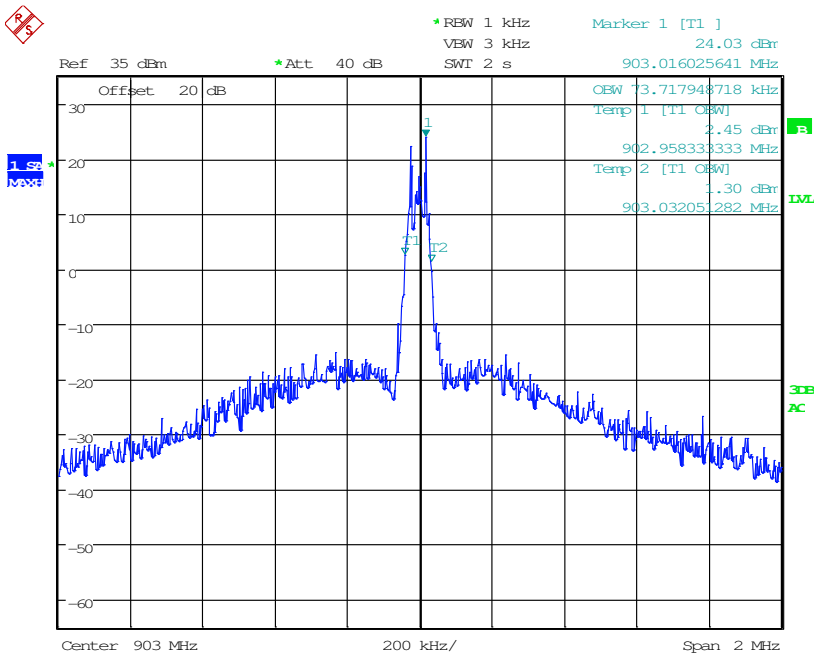


Figure 7.3.4.2-4: 99% OBW Low Channel

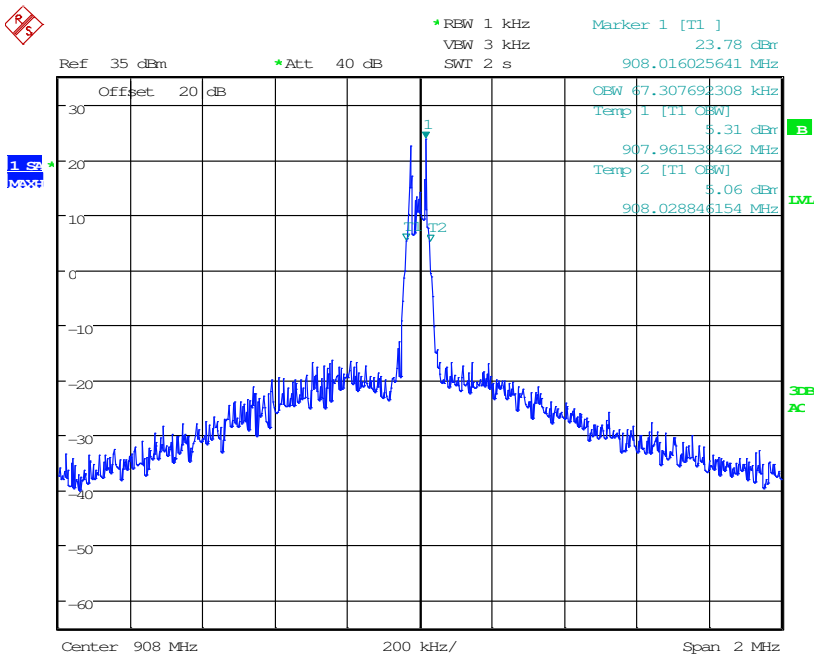


Figure 7.3.4.2-5: 99% OBW Middle Channel

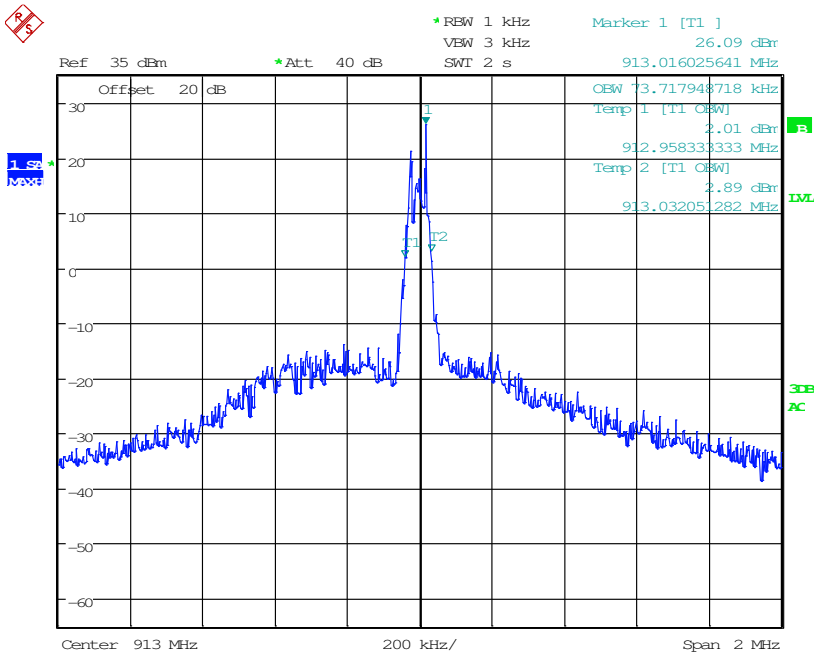


Figure 7.3.4.2-6: 99% OBW High Channel

7.4 Band-Edge Compliance and Spurious Emissions-FCC 15.247(d) IC: RSS-247 5.5

7.4.1 Band-Edge Compliance of RF Conducted Emissions

7.4.1.1 Measurement Procedure

The RF output port of the EUT was connected to the input of the spectrum analyzer through suitable attenuation. The EUT was investigated at the lowest and highest channel available to determine band-edge compliance. For each measurement the spectrum analyzer's RBW was set to 100 kHz, which is ≥ 1% of the span, and the VBW was set to >= 300 kHz.

7.4.1.2 Measurement Results

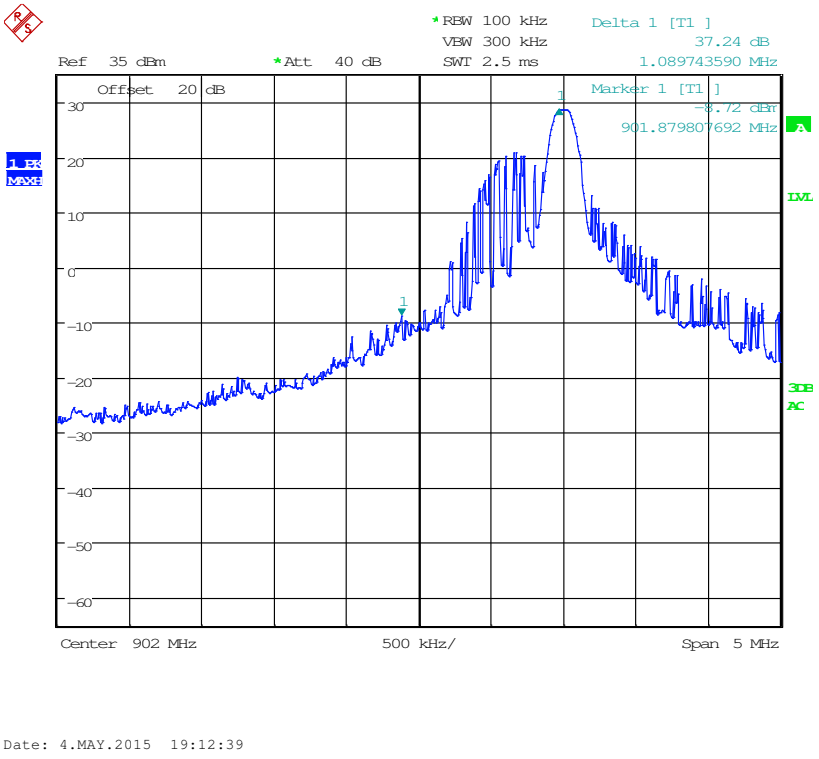
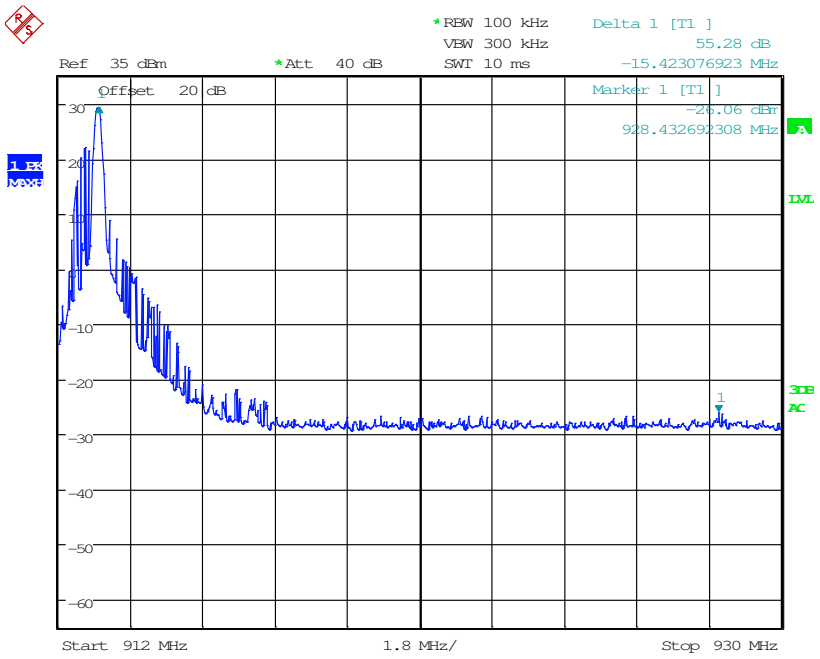


Figure 7.4.1.2-1: Lower Band-edge



Date: 4.MAY.2015 19:34:39

Figure 7.4.1.2-2: Upper Band-edge

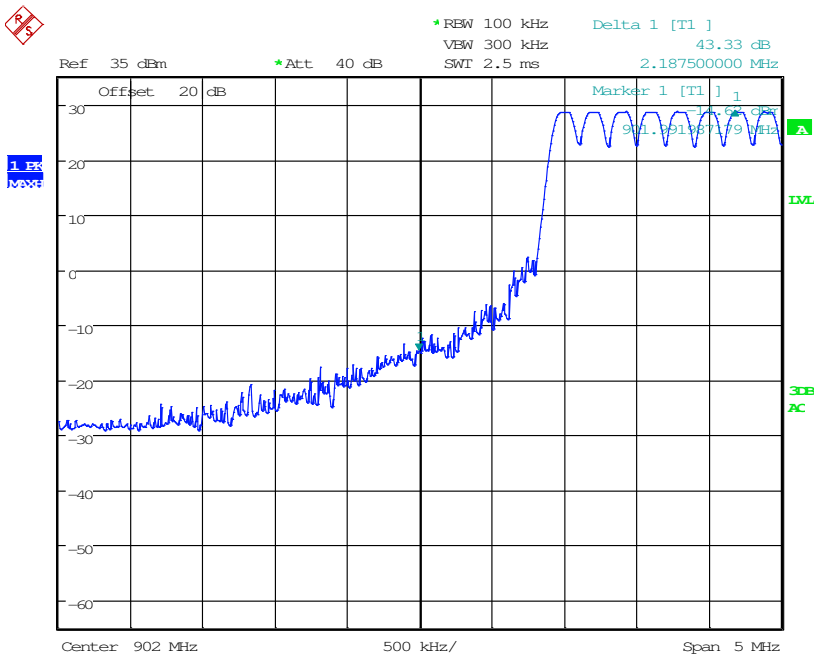


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Figure 7.4.1.2-3: Lower Band-edge – Hopping Mode

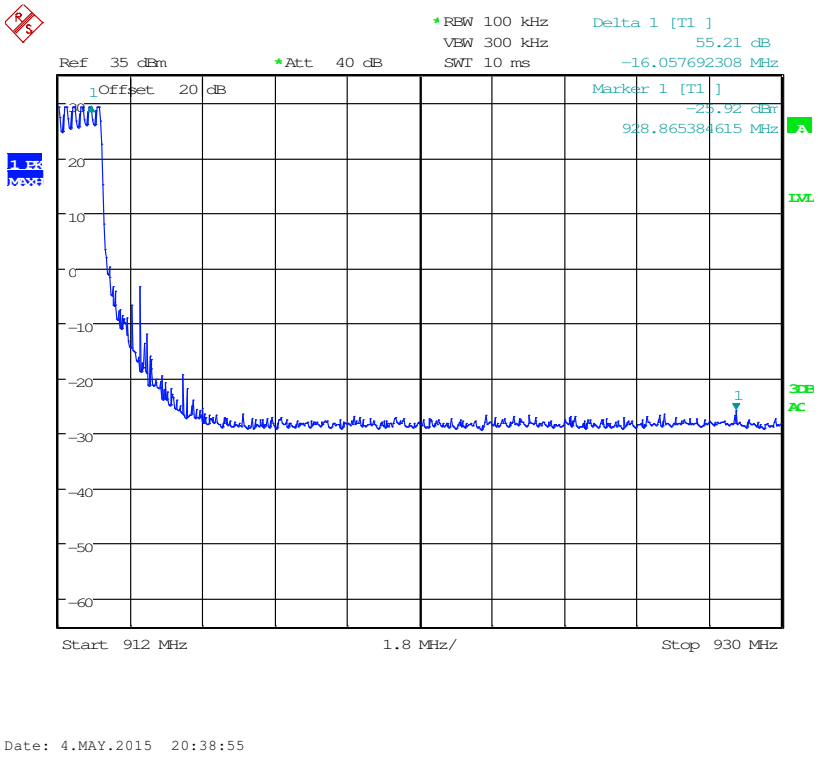

Figure 7.4.1.2-4: Upper Band-edge – Hopping Mode

7.4.2 RF Conducted Spurious Emissions

7.4.2.1 Measurement Procedure

The RF output port of the EUT was connected to the spectrum analyzer. The EUT was investigated for conducted spurious emissions from 30MHz to 10 GHz, 10 times the highest fundamental frequency. Measurements were made at the low, center and high channels of the EUT. For each measurement, the spectrum analyzer's RBW was set to 100 kHz. A peak detector function was used with the trace set to max hold. The levels were corrected for cable and attenuator losses.

7.4.2.2 Measurement Results

Results are shown below:

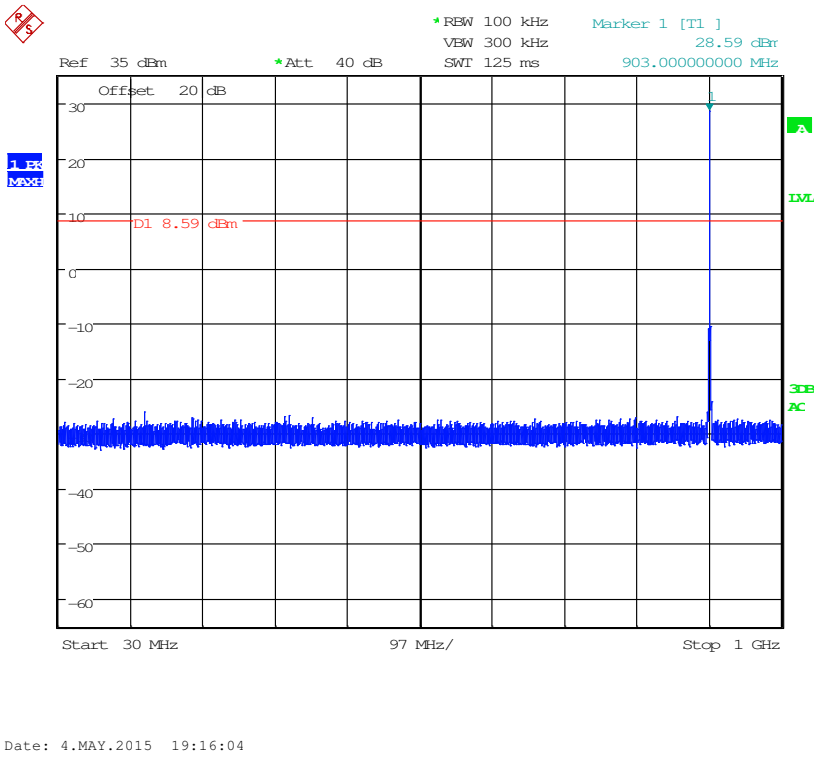

Figure 7.4.2.2-1: 30 MHz – 1 GHz – Low Channel

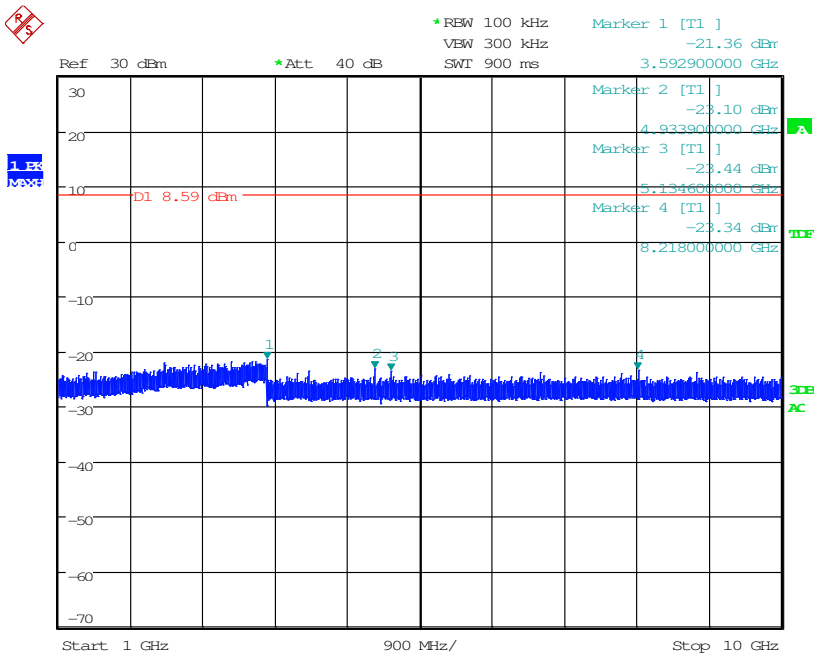

Figure 7.4.2.2-2: 1 GHz –10 GHz – Low Channel

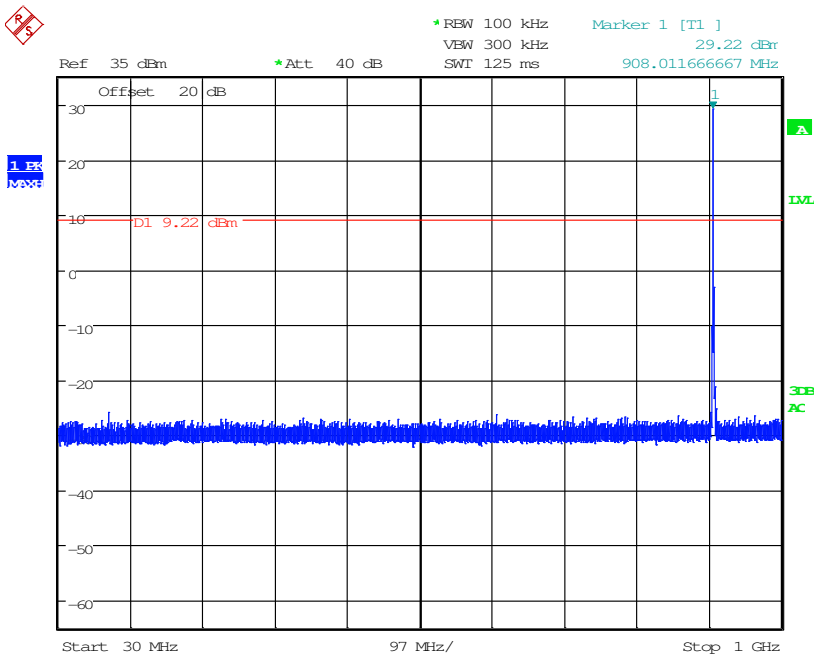

Figure 7.4.2.2-3: 30 MHz – 1 GHz –Middle Channel

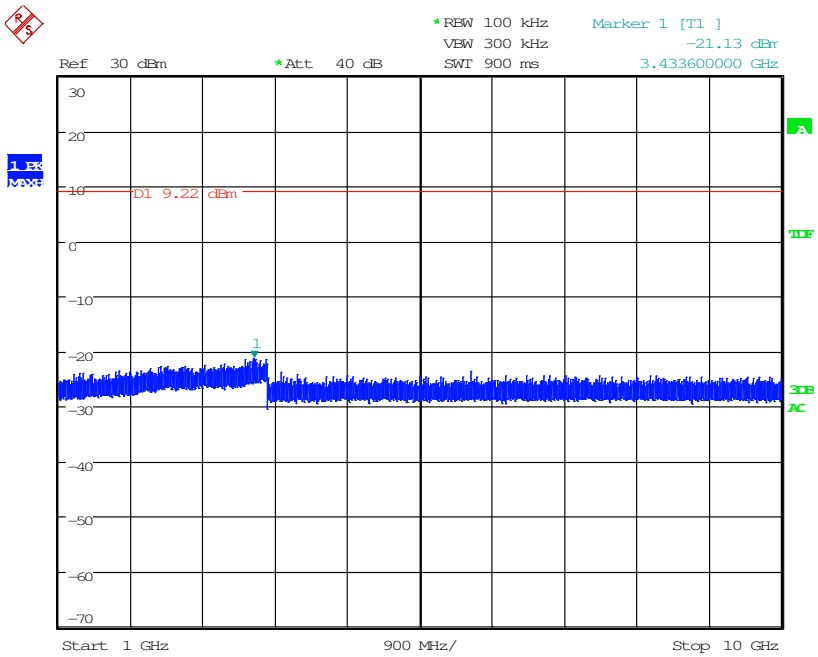

Figure 7.4.2.2-4: 1 GHz –10 GHz – Middle Channel

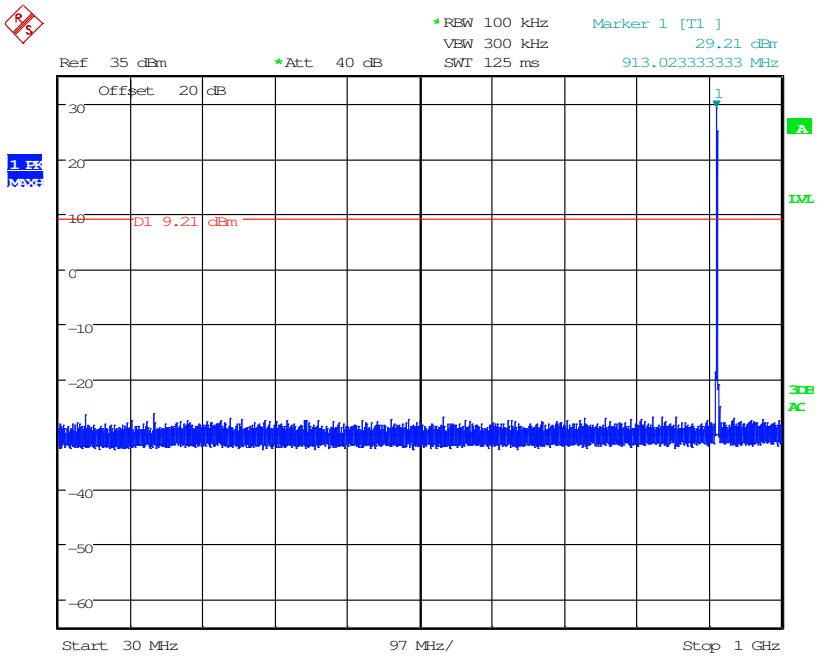

Figure 7.4.2.2-5: 30 MHz – 1 GHz – High Channel

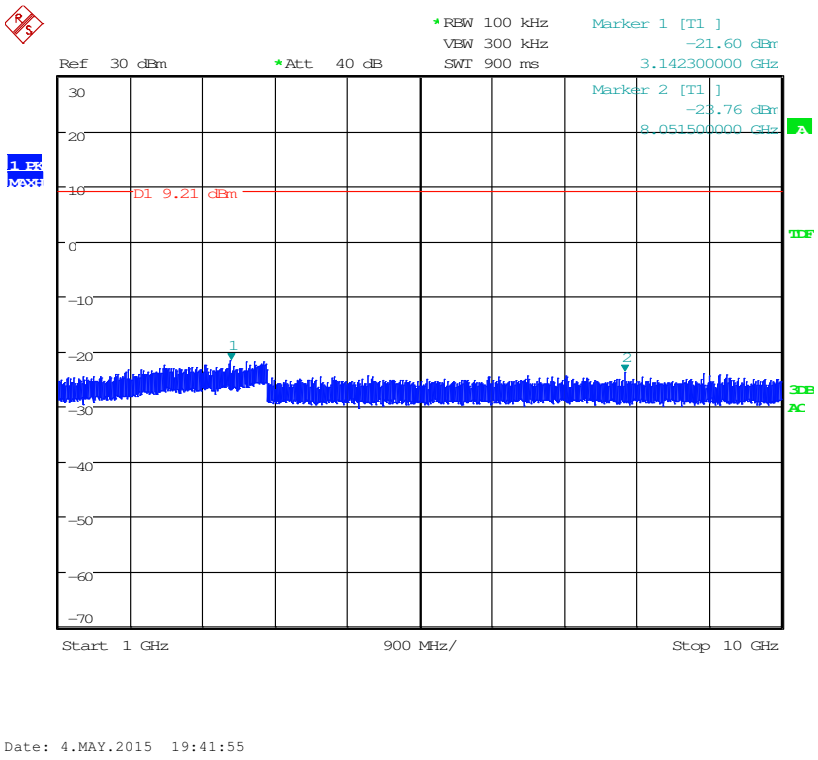

Figure 7.4.2.2-6: 1 GHz –10 GHz –High Channel

7.4.3 Radiated Spurious Emissions within the Restricted Bands - FCC Sections 15.205, 15.209; IC: RSS-Gen 8.9, 8.10

7.4.3.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 9 kHz to 10 GHz, 10 times the highest fundamental frequency. Each emission found to be in a restricted band as defined by section 15.205, including any emission at the operational band-edge, was compared to the radiated emission limits as defined in section 15.209.

For measurements below 30 MHz, the receive antenna height was set to 1m and the EUT was rotated through 360 degrees. The resolution bandwidth was set to 200 Hz below 150 kHz and to 9 kHz above 150 kHz.

For measurements above 30 MHz, 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 1000 MHz, peak measurements made with RBW and VBW of 1 MHz and 3 MHz respectively. Average measurements were collected in the linear amplitude scale with VBW of 30 Hz.

The EUT was caused to generate a continuous carrier signal on the hopping channel. The average measurements were corrected using a duty cycle correction factor corresponding to the logarithm of the dwell time over 100ms.

7.4.3.2 Measurement Results

Band-edge and radiated spurious emissions found in the restricted bands of 9 kHz to 10 GHz are reported in the tables below.

Table 7.4.3.2-1: 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
Low Channel = 903 MHz										
2709	63.57	63.57	H	-6.26	57.31	37.31	74.0	54.0	16.7	16.7
2709	62.37	62.37	V	-6.26	56.11	36.11	74.0	54.0	17.9	17.9
3612	62.94	62.94	H	-2.66	60.28	40.28	74.0	54.0	13.7	13.7
3612	66.20	66.20	V	-2.66	63.54	43.54	74.0	54.0	10.5	10.5
4515	72.29	72.29	H	-0.76	71.53	51.53	74.0	54.0	2.5	2.5
4515	70.06	70.06	V	-0.76	69.30	49.30	74.0	54.0	4.7	4.7
5418	62.45	62.45	H	1.68	64.13	44.13	74.0	54.0	9.9	9.9
5418	63.27	63.27	V	1.68	64.95	44.95	74.0	54.0	9.0	9.0
8127	57.40	57.40	H	6.24	63.64	43.64	74.0	54.0	10.4	10.4
8127	58.77	58.77	V	6.24	65.01	45.01	74.0	54.0	9.0	9.0
9030	48.85	48.85	H	7.87	56.72	36.72	74.0	54.0	17.3	17.3
9030	46.41	46.41	V	7.87	54.28	34.28	74.0	54.0	19.7	19.7
Middle Channel = 908 MHz										
2724	66.06	66.06	H	-6.20	59.86	39.86	74.0	54.0	14.1	14.1
2724	67.86	67.86	V	-6.20	61.66	41.66	74.0	54.0	12.3	12.3
3632	66.34	66.34	H	-2.57	63.77	43.77	74.0	54.0	10.2	10.2
3632	65.06	65.06	V	-2.57	62.49	42.49	74.0	54.0	11.5	11.5
4540	70.86	70.86	H	-0.68	70.18	50.18	74.0	54.0	3.8	3.8
4540	69.07	69.07	V	-0.68	68.39	48.39	74.0	54.0	5.6	5.6
5448	61.93	61.93	H	1.76	63.69	43.69	74.0	54.0	10.3	10.3
5448	61.55	61.55	V	1.76	63.31	43.31	74.0	54.0	10.7	10.7
7264	64.22	64.22	H	4.87	69.09	49.09	74.0	54.0	4.9	4.9
7264	67.60	67.60	V	4.87	72.47	52.47	74.0	54.0	1.5	1.5
8172	54.74	54.74	H	6.34	61.08	41.08	74.0	54.0	12.9	12.9
8172	55.04	55.04	V	6.34	61.38	41.38	74.0	54.0	12.6	12.6
9080	46.04	46.04	H	7.93	53.97	33.97	74.0	54.0	20.0	20.0
9080	44.85	44.85	V	7.93	52.78	32.78	74.0	54.0	21.2	21.2
High Channel = 913 MHz										
1013	61.56	61.56	V	-12.29	49.27	29.27	74.0	54.0	24.7	24.7
2739	66.90	66.90	H	-6.13	60.77	40.77	74.0	54.0	13.2	13.2
2739	65.78	65.78	V	-6.13	59.65	39.65	74.0	54.0	14.3	14.3
3652	61.75	61.75	H	-2.48	59.27	39.27	74.0	54.0	14.7	14.7
3652	64.23	64.23	V	-2.48	61.75	41.75	74.0	54.0	12.3	12.3
4565	71.48	71.48	H	-0.61	70.87	50.87	74.0	54.0	3.1	3.1
4565	69.20	69.20	V	-0.61	68.59	48.59	74.0	54.0	5.4	5.4
7304	63.78	63.78	H	4.99	68.77	48.77	74.0	54.0	5.2	5.2
7304	68.51	68.51	V	4.99	73.50	53.50	74.0	54.0	0.5	0.5
8217	56.38	56.38	H	6.44	62.82	42.82	74.0	54.0	11.2	11.2
8217	57.88	57.88	V	6.44	64.32	44.32	74.0	54.0	9.7	9.7
9130	49.44	49.44	H	7.98	57.42	37.42	74.0	54.0	16.6	16.6
9130	46.57	46.57	V	7.98	54.55	34.55	74.0	54.0	19.5	19.5

Notes

- **All the emissions above 9.13 GHz were attenuated below the limits and the noise floor of the measurement equipment.**
- **The peak levels were recorded for the average measurements. An additional duty cycle correction factor corresponding 20*log(9.83/100) ≈ 20 dB was used for the corrected level of the average measurements.**

7.4.3.3 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

Duty Cycle Correction Factor = 20*log(9.83/100) ≈ 20 dB

Example Calculation: Peak
Corrected Level: 63.57+ (-6.26) = 57.31 dBµV/m
Margin: 74 dBµV/m – 57.31 dBµV/m = 16.7 dB

Example Calculation: Average
Corrected Level: 63.57 + (-6.26) - 20 = 37.31 dBµV/m
Margin: 54 dBµV/m – 37.31 dBµV/m = 16.7 dB

8 CONCLUSION

In the opinion of ACS, Inc., the model ECO manufactured by RG3 Meter Company meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-247 for the test procedures documented in the test report.

END REPORT