Certification Test Report

FCC ID: YWZ-S3I0004
IC: 3356F-S3I0004

FCC Rule Part: 15.247
IC Radio Standards Specification: RSS-210

ACS Report Number: 14-2070.W06.1A

Applicant: Alpha - High Theft Solutions,
A Division of Checkpoint Systems, Inc.
Model(s): S3I-0004

Test Begin Date: **June 30, 2014**
Test End Date: **July 10, 2014**

Report Issue Date: July 28, 2014

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 ACLASS, ANSI, or any agency of the Federal Government.

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This report contains 30 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-210.

1.2 Applicant Information

Alpha - High Theft Solutions
10715 Sikes Place, Ste 200
Charlotte, NC 28277

1.3 Product Description

The model S3I-0004 is an IEEE 802.15.4 wireless transceiver which allows the monitoring of items for sale in a retail environment. The EUT is wrapped around the product to be monitored, securing each side of the package, with a buckle on one side and an alarm unit on the other side. Un-authorized removal causes an alarm to sound and the store network to be notified electronically.

Technical Details

Mode of Operation:	IEEE 802.15.4
Frequency Range:	2405 MHz - 2480 MHz
Number of Channels:	16
Channel Separation:	5 MHz
Modulations:	O-QPSK
Antenna Type/Gain:	PCB Wiggle Antenna, 2.15 dBi
Input Power:	3 VDC CR2477 Lithium Battery

Model Number: S3I-0004

Test Sample Serial Number(s): 15F0 (RF Conducted), DE00030A (Radiated)

Test Sample Condition: The EUT was in good condition with no observable physical damages.

1.4 Test Methodology and Considerations

The EUT was evaluated for radiated and RF conducted emissions while powered via battery.

The RF conducted measurements were performed on the PCB configured with an SMA connector for direct coupling with the measurement equipment.

For the radiated emissions evaluation, preliminary evaluations were performed for the EUT set in three orthogonal orientations with the fastening cables configured for worst case results. The highest emissions relative to the limits were observed for the EUT set lengthwise on the test table. The corresponding measurement results are documented in this document.

The EUT was also evaluated for unintentional emissions. The results are documented separately in a verification test 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 ACLASS 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:

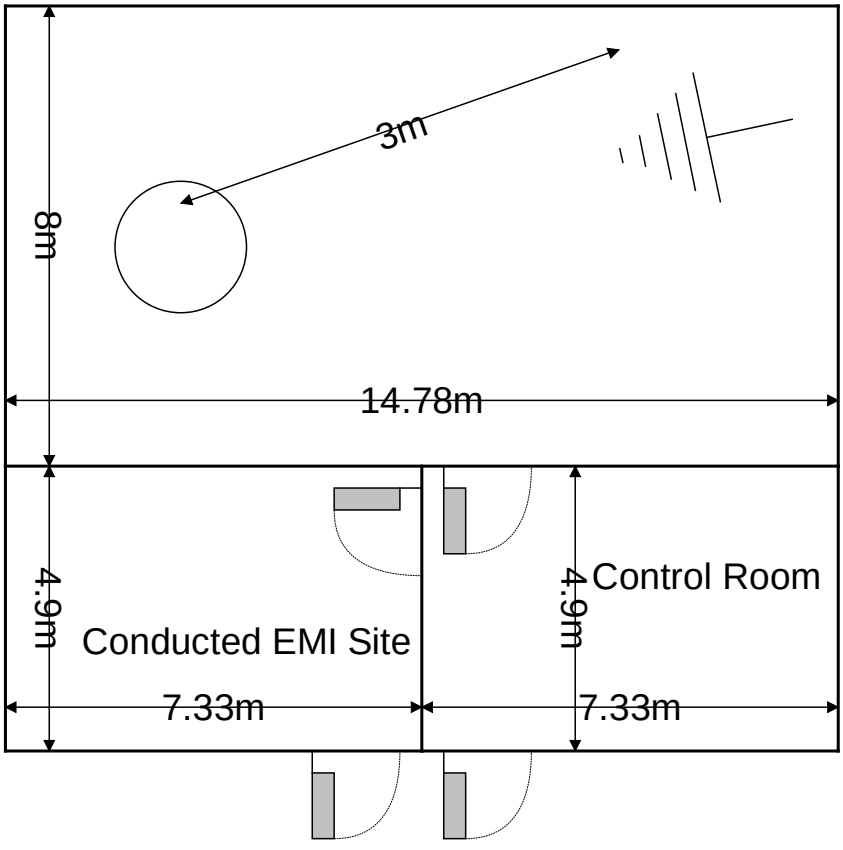

Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

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 2003 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 220 V, 50 Hz, 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:

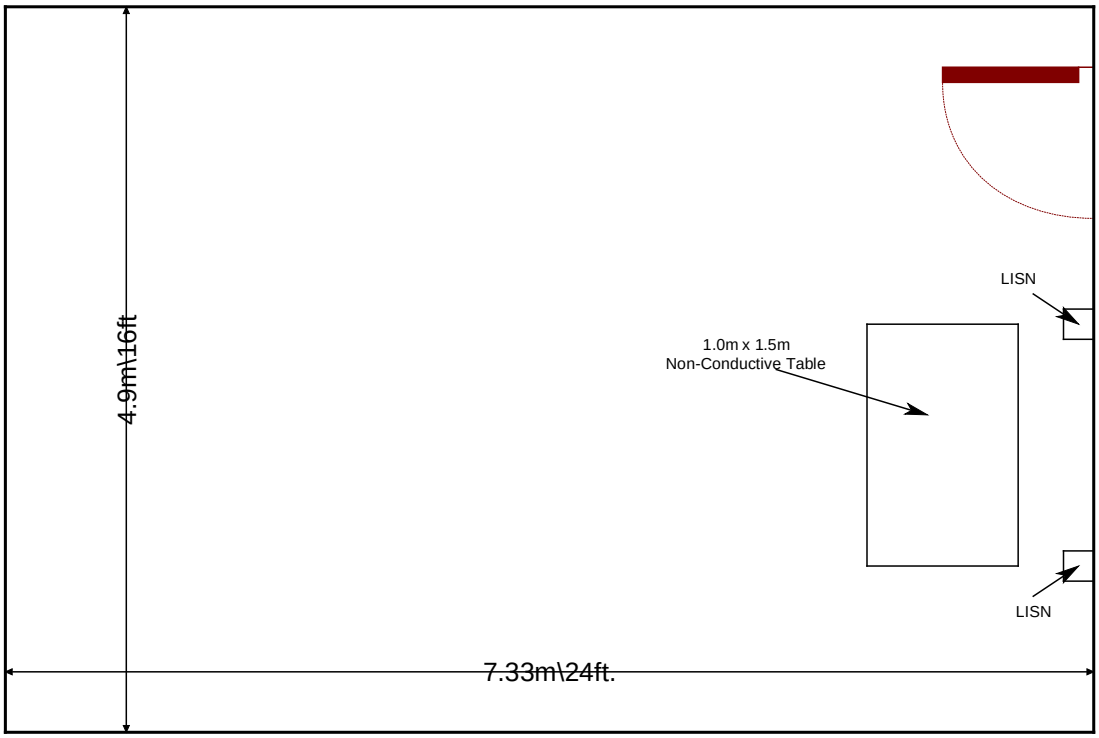

Figure 2.3.2-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.4-2003: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the 9 kHz 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
- KDB Publication No. 558074 D01 DTS Meas Guidance v03r01 – Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247, June 5, 2014.
- Industry Canada Radio Standards Specification: RSS-210 - Low-power License-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, Issue 8 December 2010.
- Industry Canada Radio Standards Specification: RSS-GEN – General Requirements and Information for the Certification of Radiocommunication Equipment, Issue 3, December 2010.

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
283	Rohde & Schwarz	FSP40	Spectrum Analyzers	1000033	9/18/2013	9/18/2015
341	Aeroflex/Weinschel	54A-20	Attenuators	4686	7/29/2013	7/29/2014
523	Agilent	E7405	Spectrum Analyzers	MY45103293	1/8/2013	1/8/2015
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	4/24/2013	4/24/2015
2008	COM-Power	AH-826	Antennas	81009	NCR	NCR
2011	Hewlett-Packard	HP 8447D	Amplifiers	2443A03952	12/31/2013	12/31/2014
2037	ACS Boca	Chamber EMI Cable Set	Cable Set	2037	2/27/2014	2/27/2015
2044	QMI	N/A	Cables	2044	12/31/2013	12/31/2014
2070	Mini Circuits	VHF-8400+	Filter	2070	1/1/2014	1/1/2015
2072	Mini Circuits	VHF-3100+	Filter	30737	1/1/2014	1/1/2015
2076	Hewlett Packard	HP5061-5458	Cables	2076	12/31/2013	12/31/2014
2086	Merrimac	FAN-6-10K	Attenuators	23148-83-1	12/31/2013	12/31/2014
2089	Agilent Technologies, Inc.	83017A	Amplifiers	3123A00214	12/16/2013	12/16/2014
2095	ETS Lindgren	TILE4! - Version 4.2.A	Software	85242	NCR	NCR

NCR = No Calibration Required

5 SUPPORT EQUIPMENT

Table 5-1: EUT and Support Equipment

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Alpha - High Theft Solutions, A Division of Checkpoint Systems, Inc.	S3I-0004	DE00030A

Note: The EUT is standalone equipment with no provision for support equipment

Table 5-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	Fastening Cable	0.5 m	No	Looped Back
B	Fastening Cable	0.5 m	No	Looped Back

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

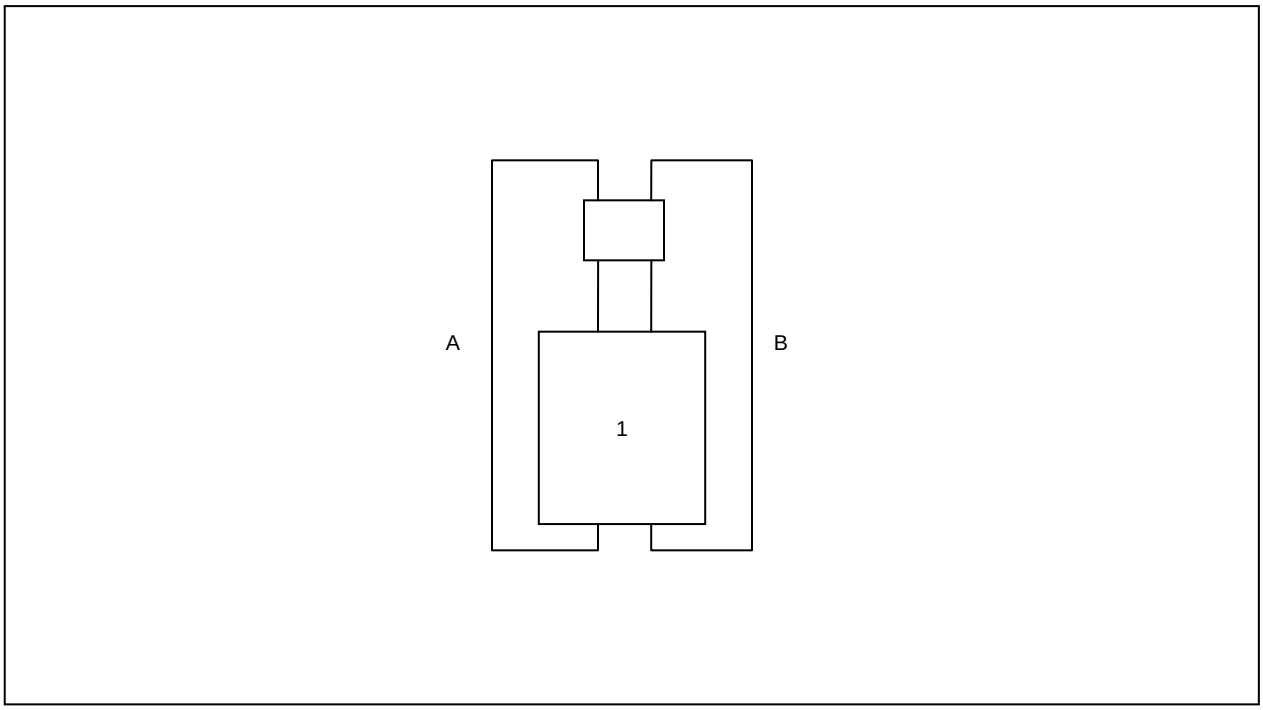

Figure 6-1: Radiated Emission Setup

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 internal PCB wiggle antenna which is printed on the PCB. The antenna cannot be removed without damaging the product, thus meeting the requirements of FCC Section 15.203.

7.2 6 dB Bandwidth - FCC: Section 15.247(a)(2) 99% Bandwidth IC: RSS-210 A8.2(a)

7.2.1 Measurement Procedure

The 6dB bandwidth was measured in accordance with the FCC KDB Publication No. 558074 “Guidance for Performing Compliance Measurements on Digital Transmission Systems (47 CFR 15.247)” DTS 6-dB Signal Bandwidth Option 1. The RBW of the spectrum analyzer was set to 100 kHz and VBW 300 kHz. Span was set large enough to capture the entire emissions and >> RBW.

The 99% occupied bandwidth was measured with the spectrum analyzer span set to fully display the emission, including the emissions skirts. The RBW was to 1% of the span. The occupied 99% bandwidth was measured using the occupied bandwidth function of the analyzer.

7.2.2 Measurement Results

Results are shown below.

Table 7.2.2-1: 6dB / 99% Bandwidth

Frequency [MHz]	6dB Bandwidth [kHz]	99% Bandwidth (kHz)
2405	1542.5	2347.5
2440	1580.0	2400.0
2480	1602.5	2460.0

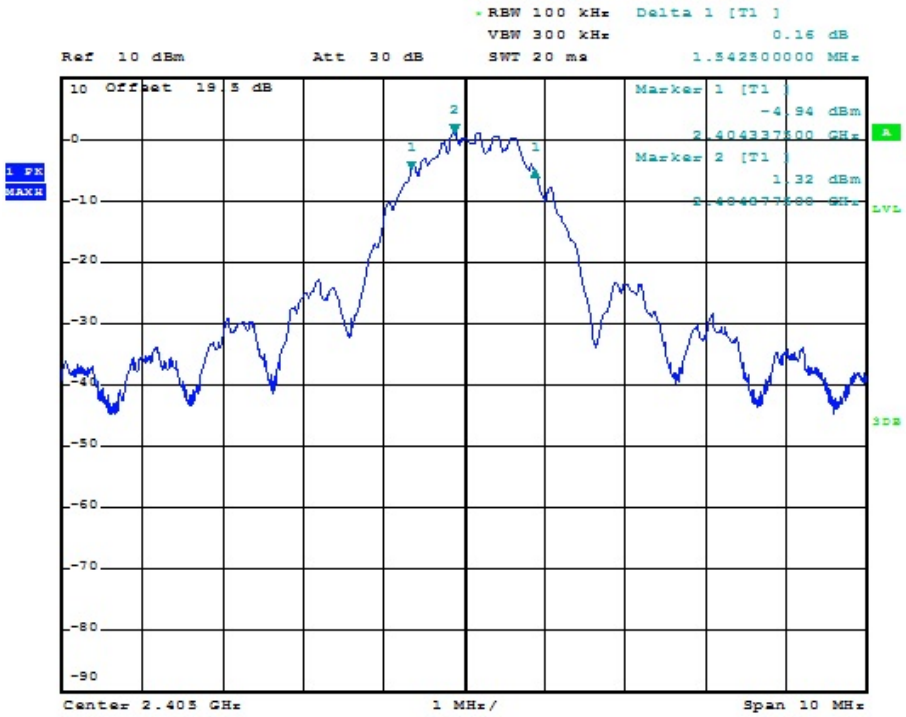

Figure 7.2.2-1: 6dB BW - Low Channel

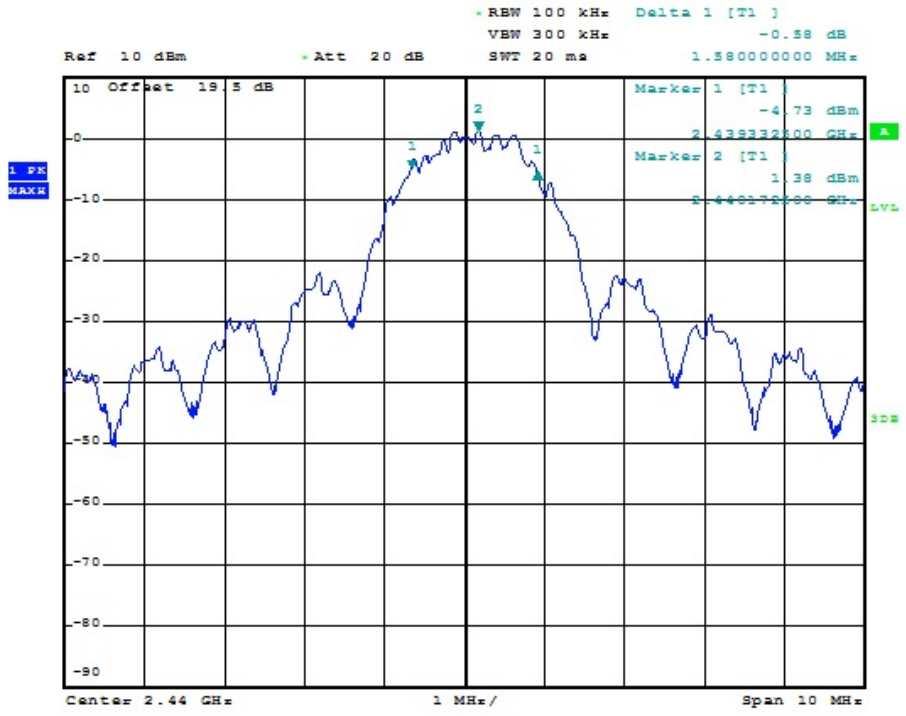

Figure 7.2.2-2: 6dB BW - Middle Channel

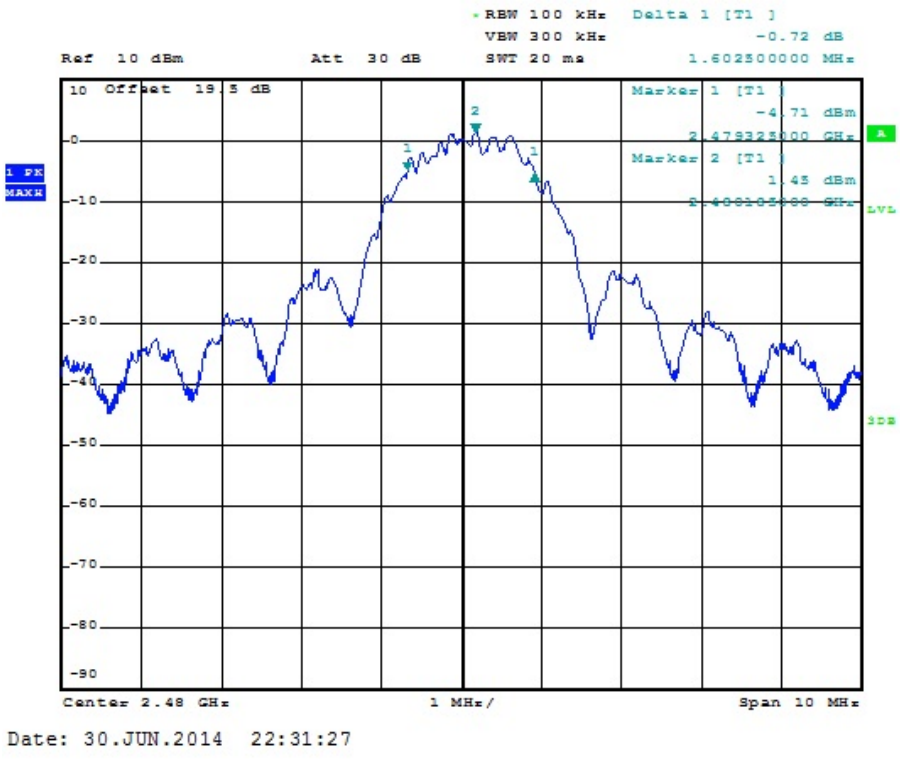

Figure 7.2.2-3: 6dB BW - High Channel

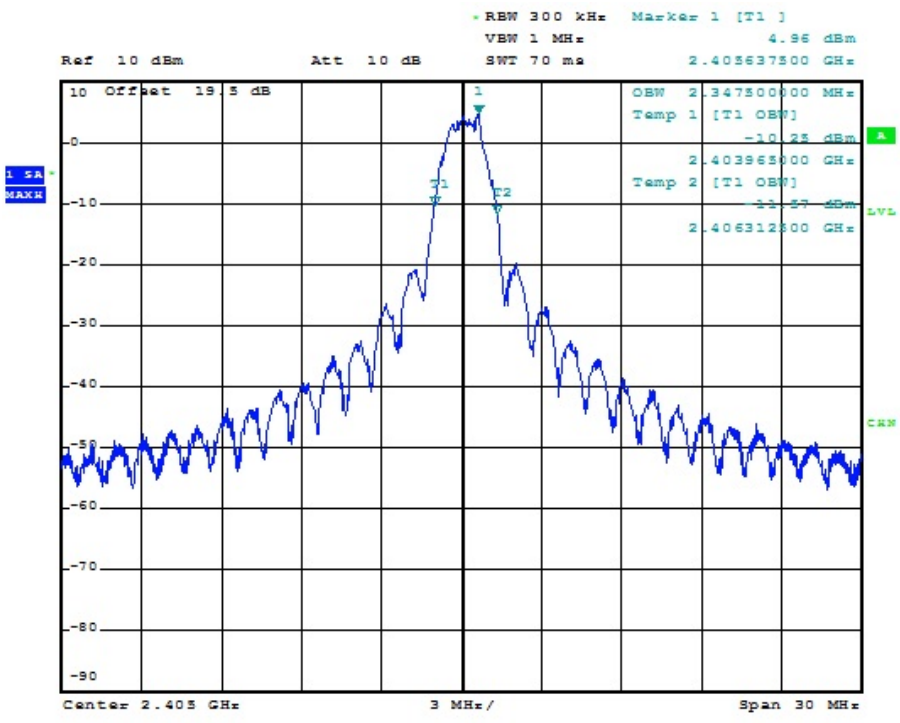

Figure 7.2.2-4: 99% OBW - Low Channel

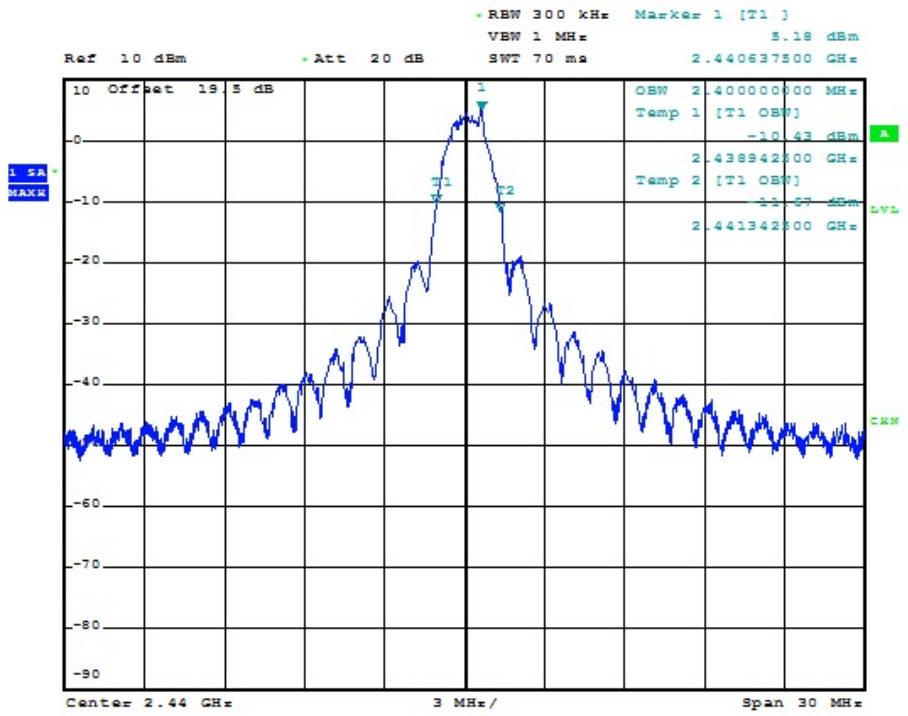

Figure 7.2.2-5: 99% OBW - Middle Channel

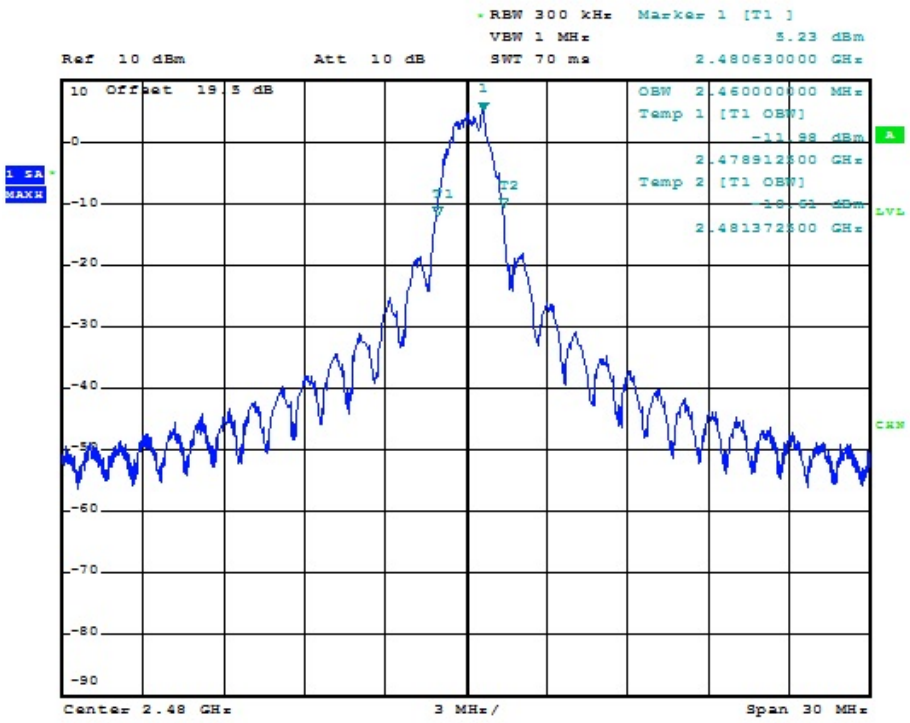

Figure 7.2.2-6: 99% OBW - High Channel

7.3 Peak Output Power - FCC Section 15.247(b)(3) IC: RSS-210 A8.4(4)

7.3.1 Measurement Procedure (Conducted Method)

The Peak Output Power was measured in accordance with the FCC KDB Publication No. 558074 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (47 CFR 15.247)" Section 9.1.1 RBW ≥ DTS Bandwidth Method. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer through suitable attenuation.

7.3.2 Measurement Results

Results are shown below.

Table 7.3.2-1: RF Output Power

Frequency [MHz]	Level [dBm]
2405	3.71
2440	3.73
2480	3.92

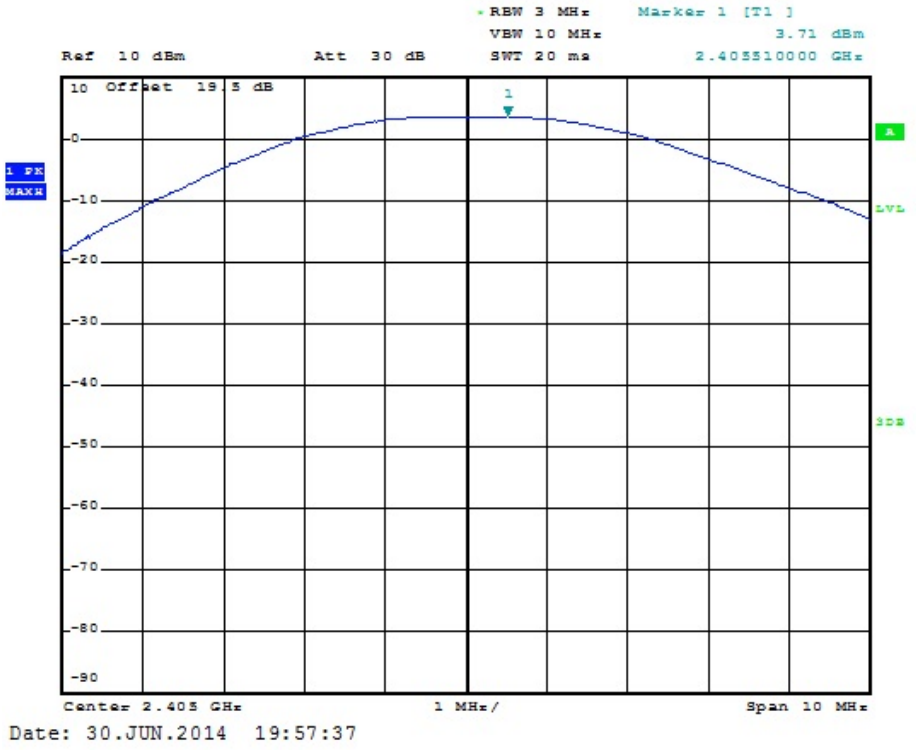

Figure 7.3.2-1: RF Output Power - Low Channel

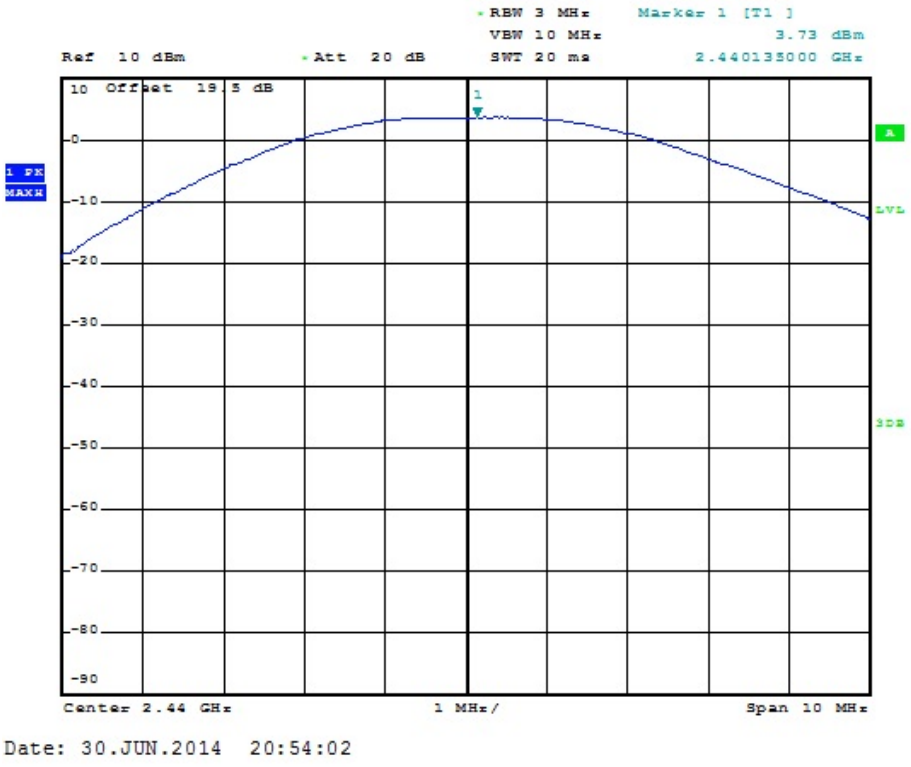

Figure 7.3.2-2: RF Output Power - Middle Channel

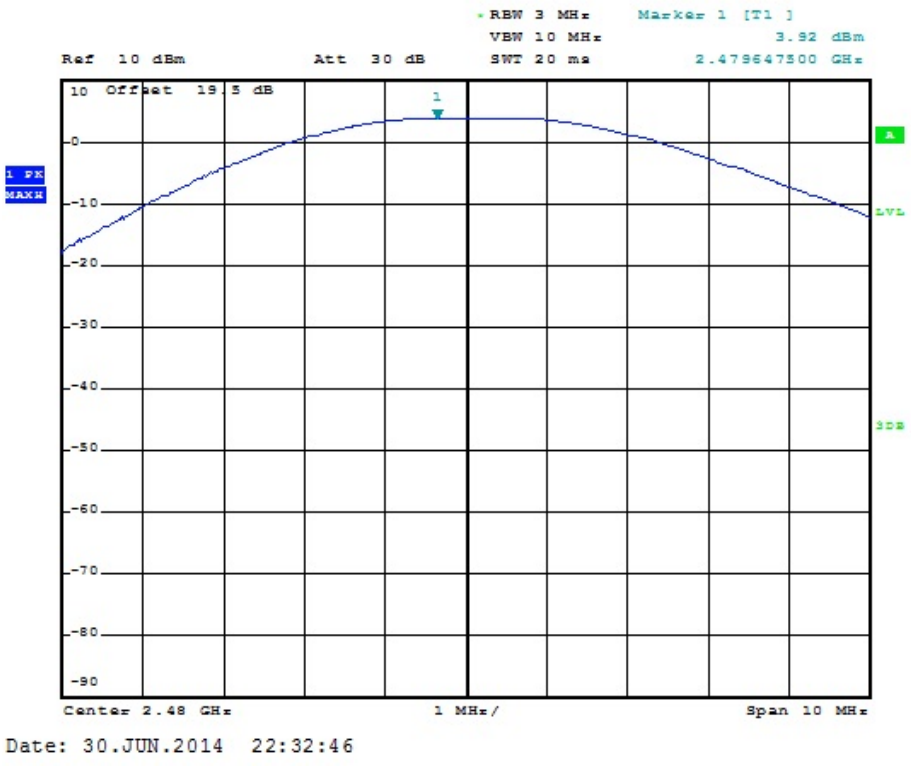

Figure 7.3.2-3: RF Output Power - High Channel

7.4 Band-Edge Compliance and Spurious Emissions-FCC 15.247(d) IC: RSS-210 A8.5

7.4.1 Band-Edge Compliance of RF Conducted Emissions

7.4.1.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer via 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, and the VBW was set to 300 kHz.

7.4.1.2 Measurement Results

Results are shown below.

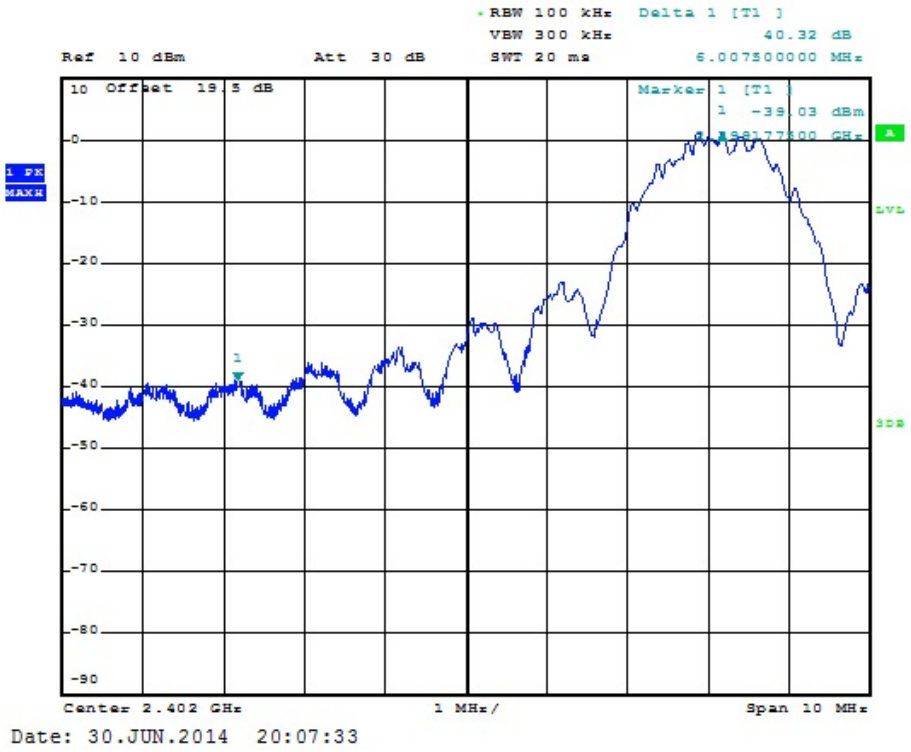

Figure 7.4.1.2-1: Lower Band-edge

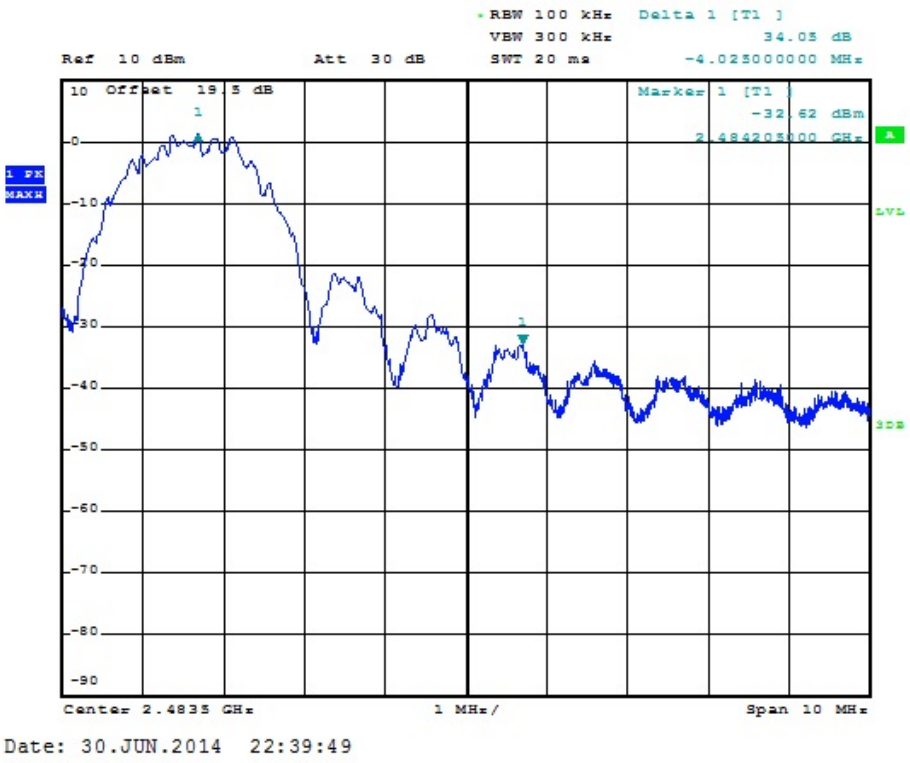

Figure 7.4.1.2-2: Upper Band-edge

7.4.2 RF Conducted Spurious Emissions

7.4.2.1 Measurement Procedure

The RF Conducted Spurious Emissions were measured in accordance with the FCC KDB Publication No. 558074 “Guidance for Performing Compliance Measurements on Digital Transmission Systems (47 CFR 15.247)”. The RF output port of the equipment under test was directly connected to the input of the spectrum analyzer. The EUT was investigated for conducted spurious emissions from 30MHz to 26 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 and the VBW was set to 300 kHz. The peak Max Hold function of the analyzer was utilized. The reference level for the limits was determined by measuring the Peak PSD level in any 100 kHz bandwidth within the DTS channel bandwidth.

7.4.2.2 Measurement Results

Results are shown below.

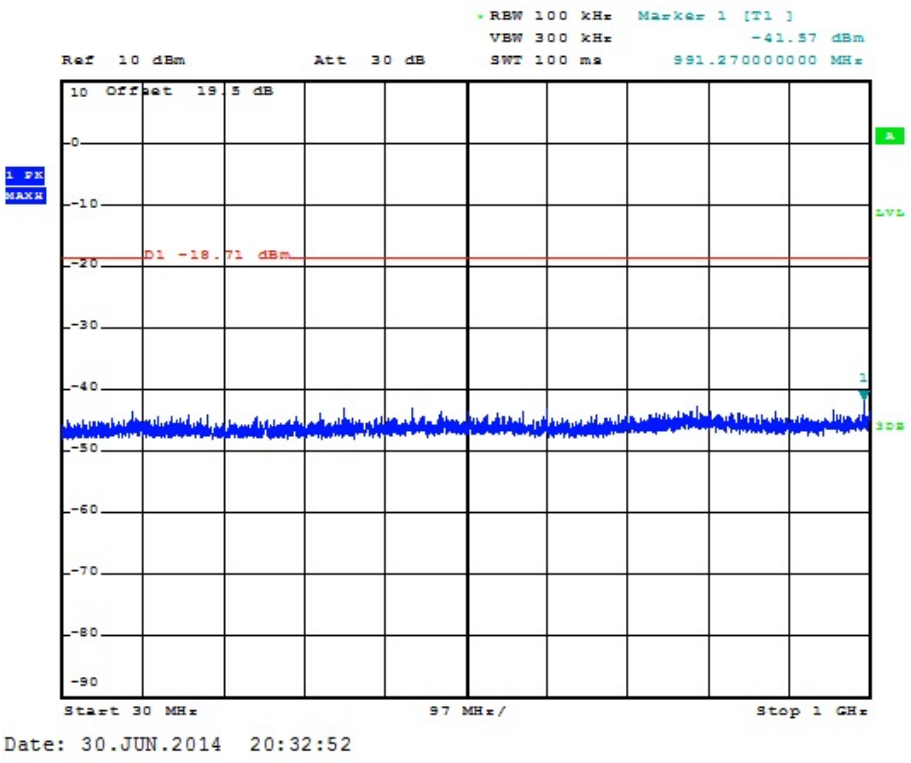

Figure 7.4.2.2-1: 30 MHz – 1 GHz – Low Channel

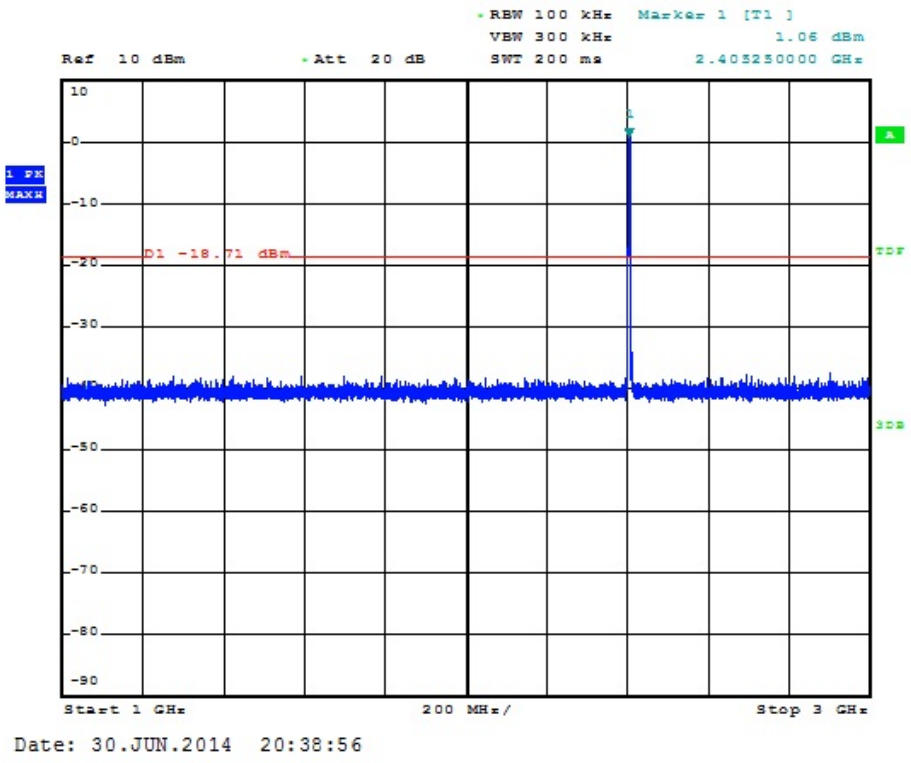

Figure 7.4.2.2-2: 1 GHz – 3 GHz – Low Channel

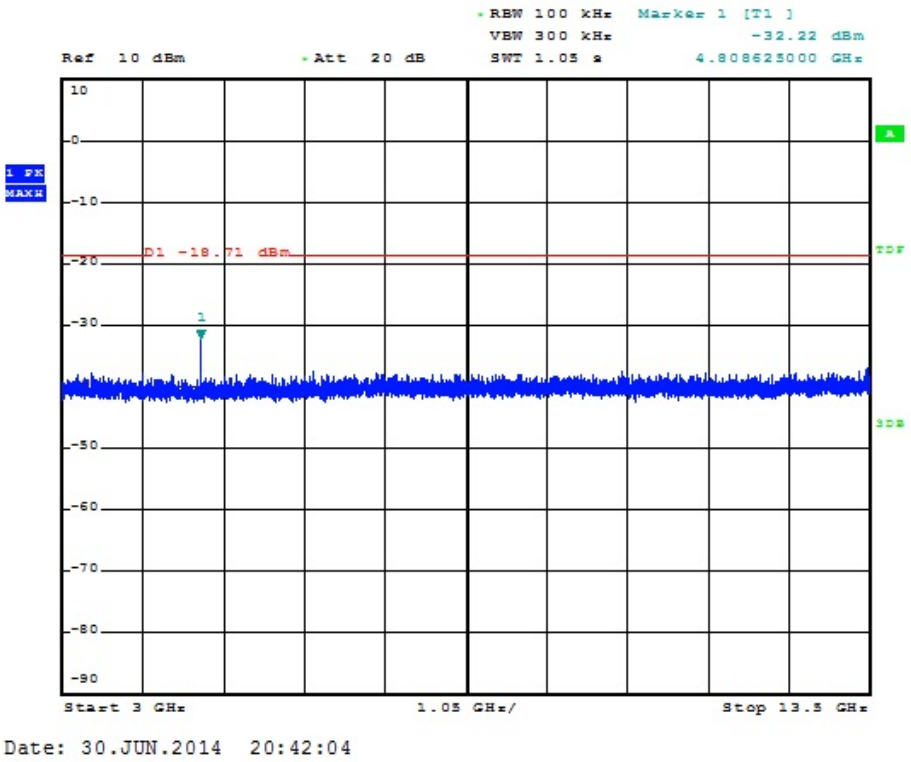

Figure 7.4.2.2-3: 3 GHz – 13.5 GHz – Low Channel

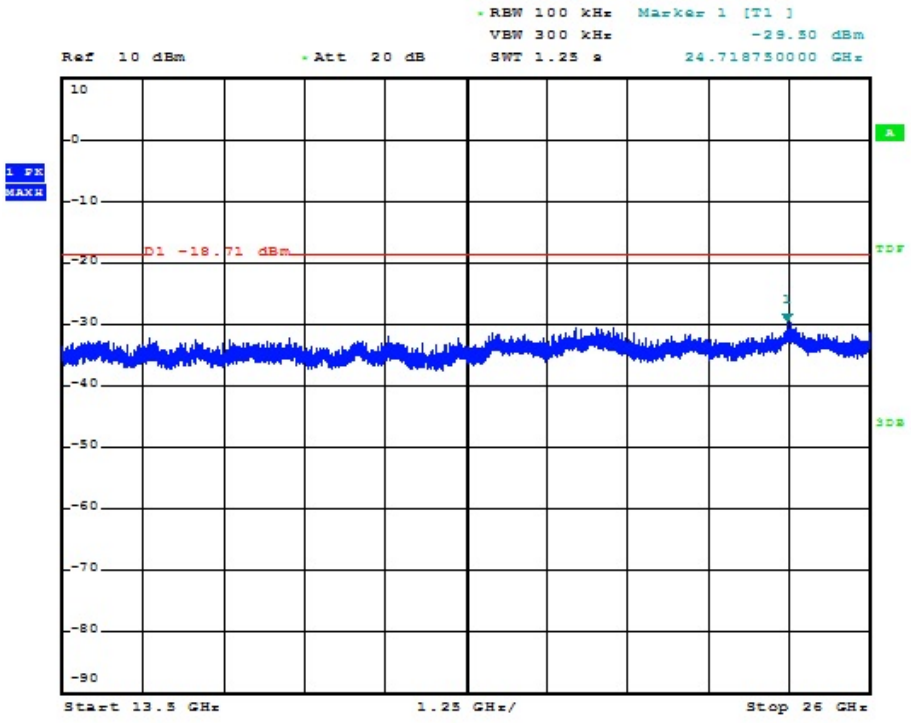

Figure 7.4.2.2-4: 13.5 GHz – 26 GHz – Low Channel

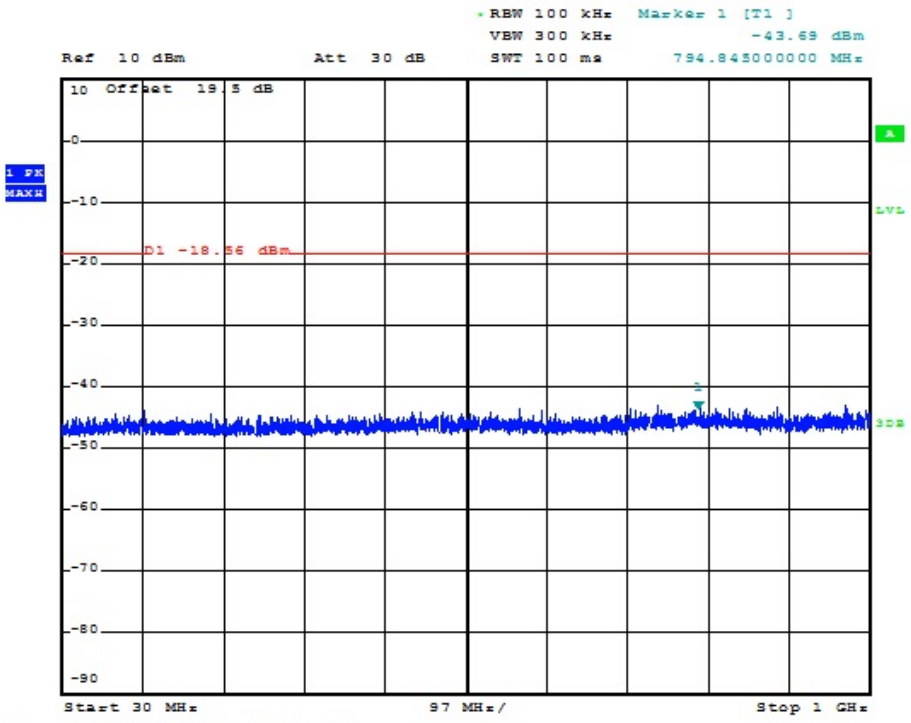

Figure 7.4.2.2-5: 30 MHz – 1 GHz –Middle Channel

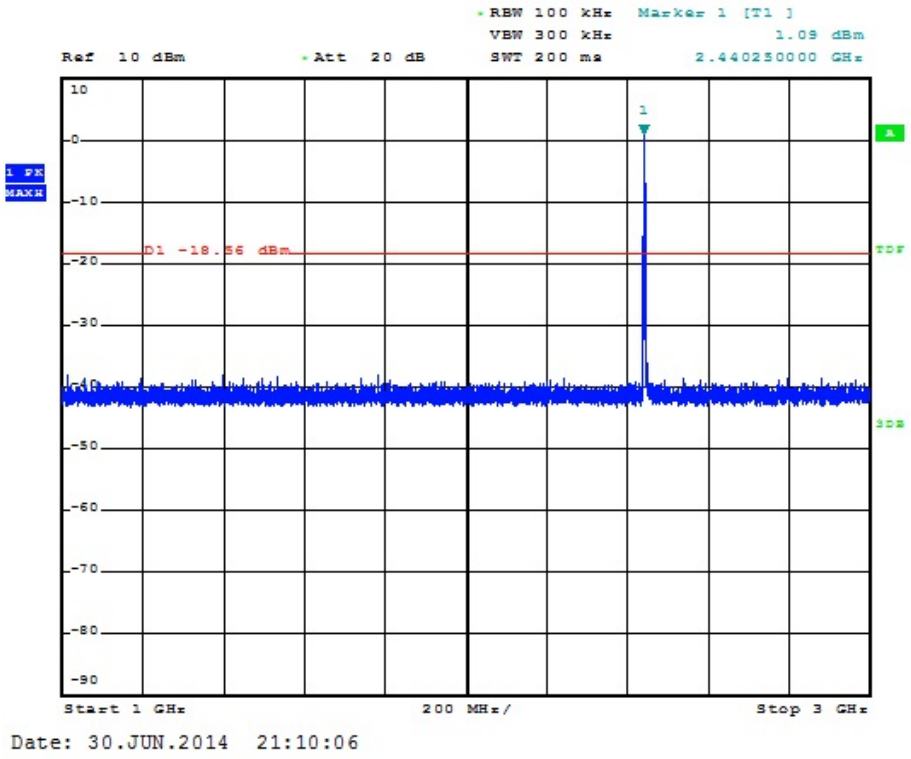

Figure 7.4.2.2-6: 1 GHz – 3 GHz – Middle Channel

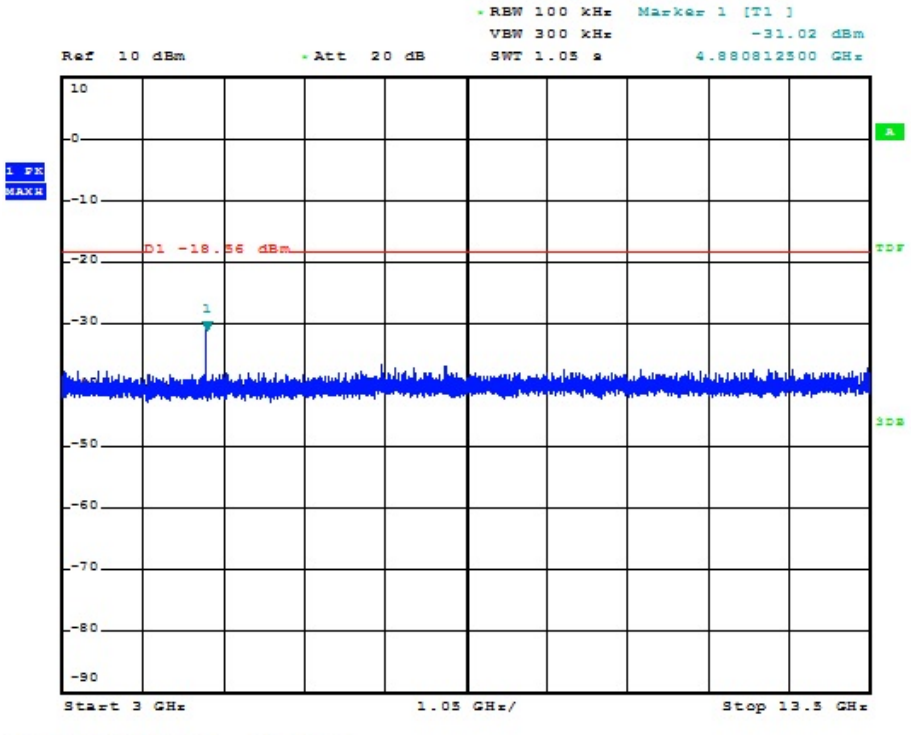

Figure 7.4.2.2-7: 3 GHz – 13.5 GHz – Middle Channel

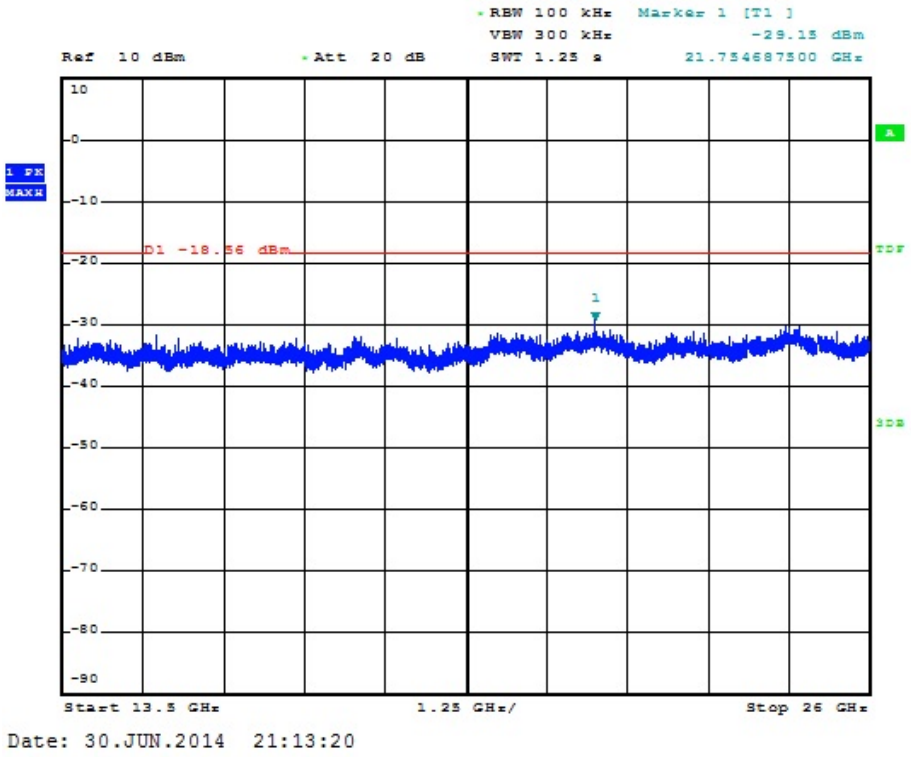

Figure 7.4.2.2-8: 13.5 GHz – 26 GHz – Middle Channel

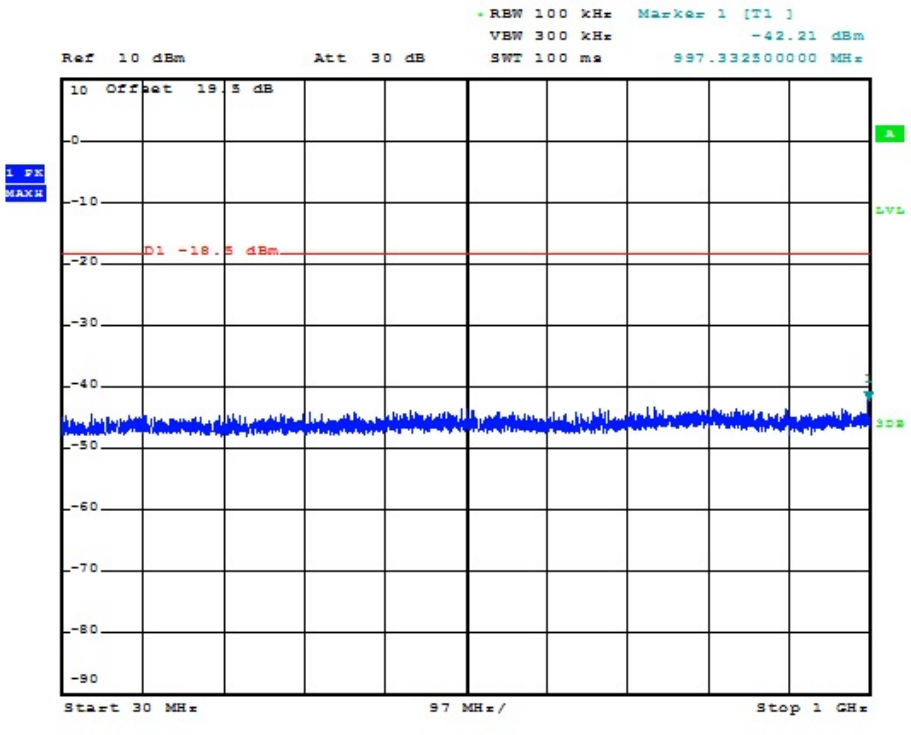

Figure 7.4.2.2-9: 30 MHz – 1 GHz – High Channel

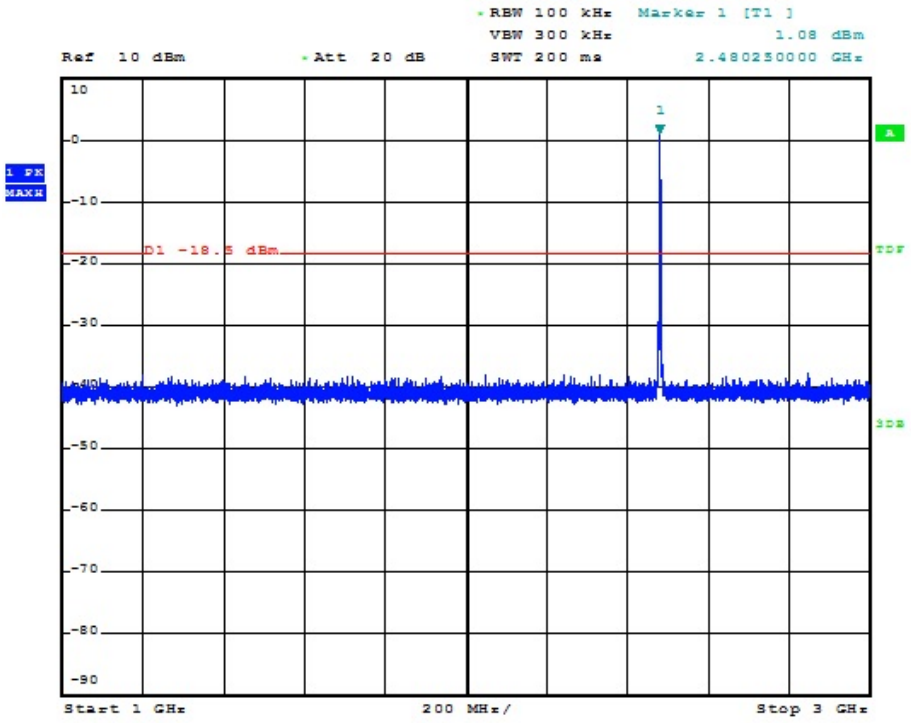

Figure 7.4.2.2-10: 1 GHz – 3 GHz –High Channel

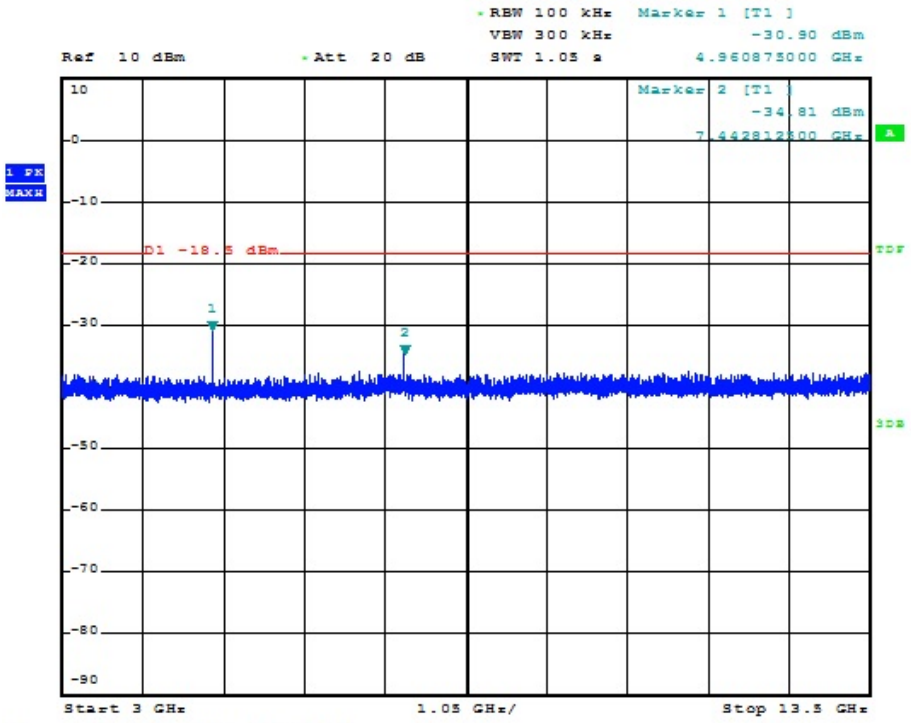

Figure 7.4.2.2-11: 3 GHz – 13.5 GHz –High Channel

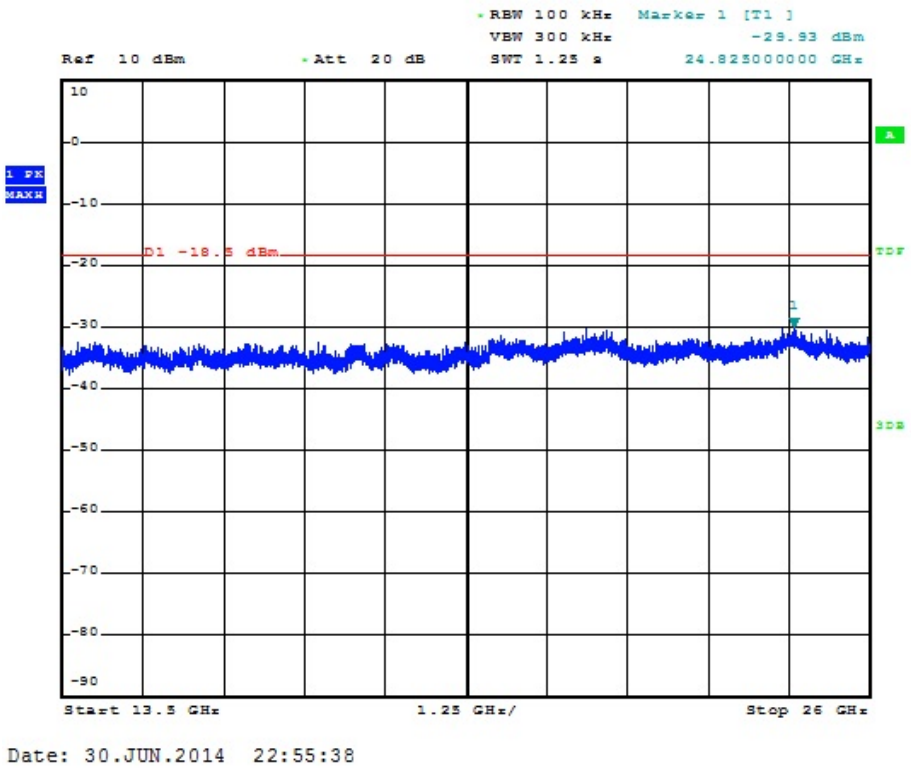

Figure 7.4.2.2-12: 13.5 GHz – 26 GHz –High Channel

7.4.3 Radiated Spurious Emissions into Restricted Frequency Bands - FCC 15.205, 15.209; IC: RSS-210 2.2, RSS-Gen 7.2.2, 7.2.5

7.4.3.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 30 MHz to 26 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.

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 are made with RBW of 1 MHz and VBW of 3 MHz. Average measurements are performed in the linear scale using VBW of 30 Hz over a 5 second sweep.

A duty cycle correction factor of 15.4% was used for the average measurements. The justification for the duty cycle is provided in the manufacturer's theory of operation document.

7.4.3.2 Measurement Results

Radiated band-edge and spurious emissions found in the restricted frequency bands of 30MHz to 26 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 (2405 MHz)										
2390	58.73	48.15	V	-8.00	50.73	23.90	74.0	54.0	23.3	30.1
4810	62.41	56.39	H	-0.26	62.15	39.88	74.0	54.0	11.8	14.1
4810	60.75	54.44	V	-0.26	60.49	37.93	74.0	54.0	13.5	16.1
12025	44.88	32.25	H	12.74	57.62	28.74	83.5	63.5	25.9	34.8
12025	44.47	32.32	V	12.74	57.21	28.81	83.5	63.5	26.3	34.7
Middle Channel (2440 MHz)										
4880	63.04	56.86	H	-0.04	63.00	40.57	74.0	54.0	11.0	13.4
4880	61.57	55.50	V	-0.04	61.53	39.21	74.0	54.0	12.5	14.8
7320	49.13	39.06	H	5.58	54.71	28.39	74.0	54.0	19.3	25.6
7320	48.89	37.90	V	5.58	54.47	27.23	74.0	54.0	19.5	26.8
12200	45.97	34.00	H	12.99	58.96	30.74	83.5	63.5	24.5	32.8
12200	45.56	33.57	V	12.99	58.55	30.31	83.5	63.5	24.9	33.2
High Channel (2480 MHz)										
2483.5	65.91	57.04	H	-7.61	58.30	33.18	74.0	54.0	15.7	20.8
2483.5	76.48	68.53	V	-7.61	68.87	44.67	74.0	54.0	5.1	9.3
4960	62.84	56.74	H	0.20	63.04	40.69	74.0	54.0	11.0	13.3
4960	62.67	56.59	V	0.20	62.87	40.54	74.0	54.0	11.1	13.5
7440	49.14	38.34	H	6.00	55.14	28.09	74.0	54.0	18.9	25.9
7440	50.42	39.81	V	6.00	56.42	29.56	74.0	54.0	17.6	24.4
12400	44.69	33.45	H	13.28	57.97	30.48	83.5	63.5	25.5	33.0
12400	45.37	33.32	V	13.28	58.65	30.35	83.5	63.5	24.9	33.2

Notes:

- **All the emissions above 12.4 GHz were attenuated below the limits and the noise floor of the measurement equipment.**
- **The average measurements were further corrected using a duty cycle correction factor of 20*log(15.4/100) dB.**
- **The emissions above 10 GHz were investigated at a test distance of 1m. The measurement results were corrected accordingly using a distance factor of 20*log(3/1) dB.**

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(15.4/100) dB = -16.25 dB

Example Calculation: Peak
Corrected Level: 58.73+ (-8.0) = 50.73 dBµV/m
Margin: 74 dBµV/m – 50.73 dBµV/m = 23.3 dB

Example Calculation: Average
Corrected Level: 48.15 + (-8.0) - 16.25 = 23.9 dBµV/m
Margin: 54 dBµV/m – 23.9 dBµV/m = 30.1 dB

7.5 Power Spectral Density - FCC Section 15.247(e) IC: RSS-210 A8.2(b)

7.5.1 PSD Measurement Procedure (Conducted Method)

The power spectral density was measured in accordance with the FCC KDB Publication No. 558074 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (47 CFR 15.247)" Section 10.2 Method PKPSD (peak PSD). The RF output port of the EUT was directly connected to the input of the spectrum analyzer. Offset values were input for cable and external attenuation. The spectrum analyzer RBW was set to 100 kHz and VBW 300 kHz. Span was adjusted to 1.5 times the 6 dB bandwidth and the sweep time was set to auto.

7.5.2 Measurement Results

Results are shown below.

Table 7.5.2-1: Power Spectral Density

Frequency (MHz)	PSD (dBm)	Limit (dBm)	Margin (dB)
2405	-13.92	8.0	21.92
2440	-13.96	8.0	21.96
2480	-14.01	8.0	22.01

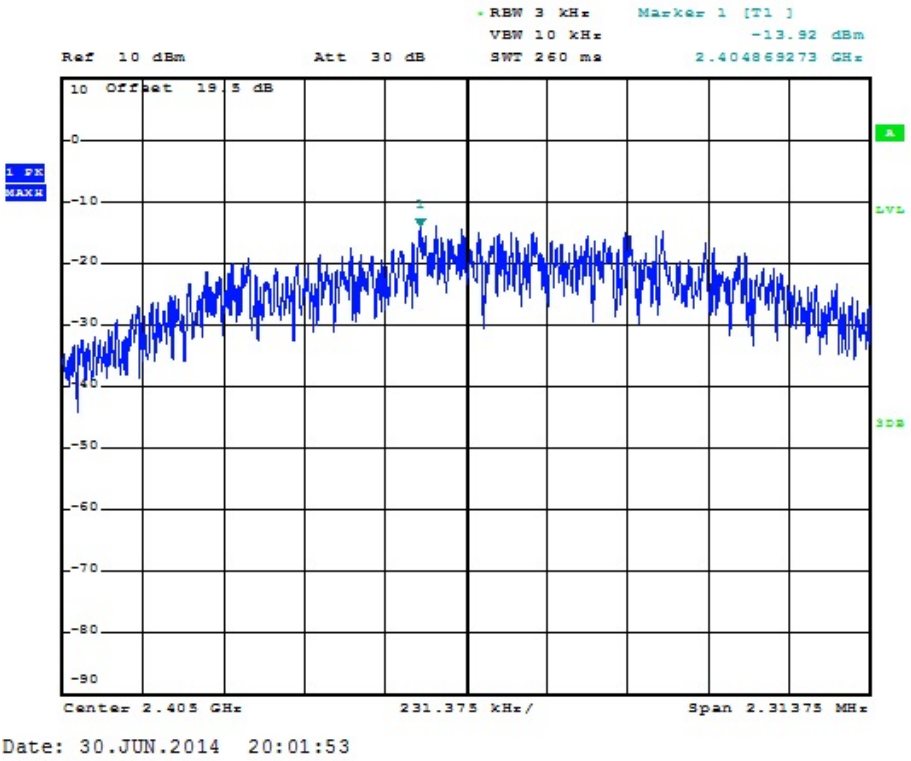

Figure 7.5.2-1: Power Spectral Density - Low Channel

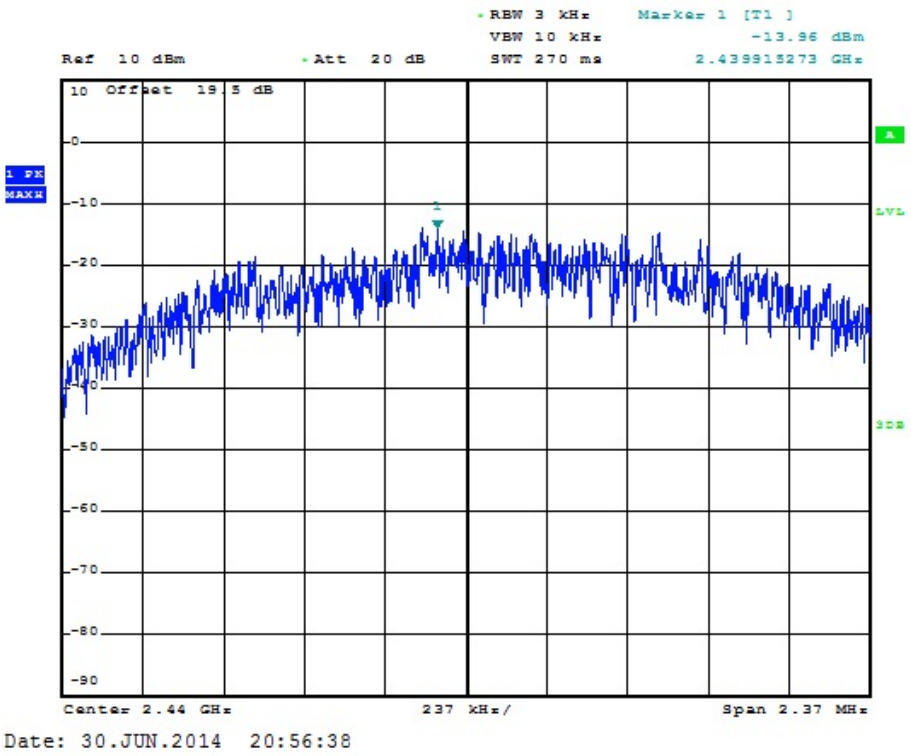

Figure 7.5.2-2: Power Spectral Density - Middle Channel

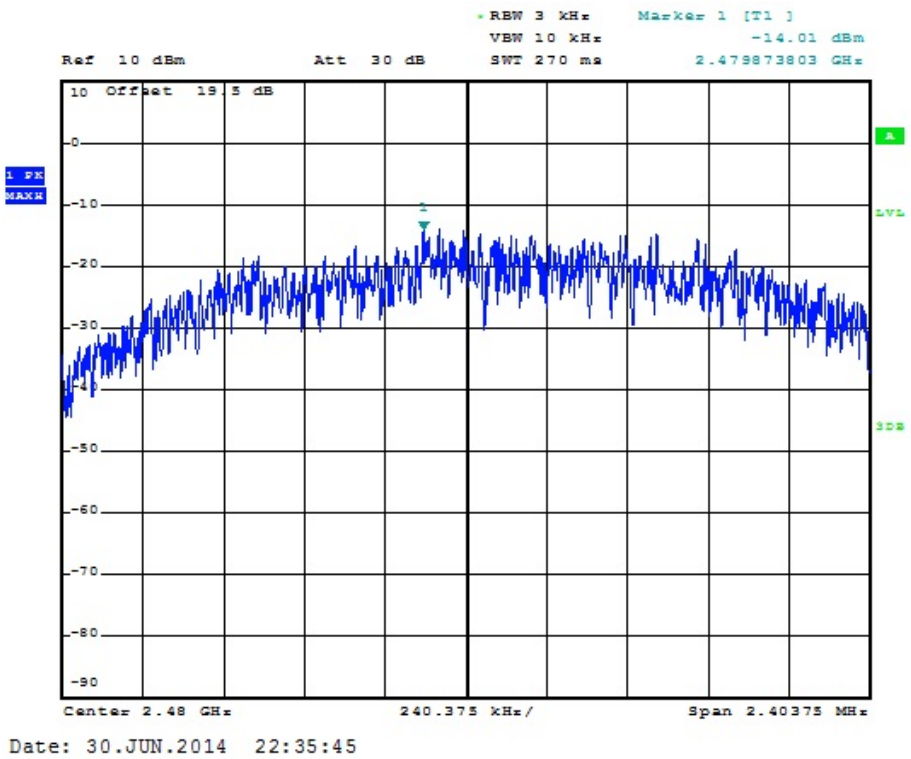

Figure 7.5.2-3: Power Spectral Density – High Channel

8 CONCLUSION

In the opinion of ACS, Inc., the model S3I-0004 meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-210 for the test procedures documented in the test report.

END REPORT