

Certification Test Report

FCC ID: P2SCMIU-1

FCC Rule Part: 15.247

ACS Report Number: 15-3049.W03.1A

Manufacturer: Neptune Technology Group
Model: CMIU

Test Begin Date: October 13, 2015

Test End Date: November 5, 2015

Report Issue Date: January 14, 2016



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:

A handwritten signature in black ink, which appears to read "M. R. de Aranzeta".

Mario de Aranzeta
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This report contains 19 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 Certification.

1.2 Product Description

The CMIU product is a wireless device which interfaces with a water meter to provide water meter readings over a commercial LTE network. This CMIU utilizes two independently activated RF radiating devices which have been integrated into the product:

- LTE Cellular radio module (LE910-SVG) (FCC preapproved) manufactured by Telit Wireless Solutions (FCC ID RI7LE910SV)
- BTLE radio using the (nRF8001) integrated circuit manufactured by Nordic Semiconductor

The device is powered by an internal battery with a 3.6 VDC output; 3.6 VDC from the battery is used to power the BTLE Radio. The CMIU uses the integrated LTE radio module (preapproved) which allows it to wirelessly connect and send data over a cellular carrier network. The CMIU uses the integrated BTLE radio to transmit / receive data for the purposes of installation and maintenance sessions.

This report addresses the BTLE radio only.

Technical Information:

Detail	Description
Frequency Range	2402 to 2480 MHz
Number of Channels	3 advertising 37 data
Modulation Format	GFSK (F1D)
Data Rates	To 1 Mbps
Number of Inputs/Outputs	1 RF output to an integral antenna
Operating Voltage	3.6 Vdc
Antenna Type / Gain	Loaded monopole/ -1.5 dBi peak

Manufacturer Information:
Neptune Technology Group
1600 Alabama Highway 229
Tallahassee, AL 36078

EUT Serial Numbers: 0005 (Radiated and AC Power Line Conducted Emissions) and 0006 (RF Conducted)).

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 the normal (upright) orientation of the EUT was evaluated. The EUT was powered with a DC bench supply due to current restrictions with using a battery while in test mode.

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

Radiated inter-modulation testing was evaluated for all combinations of simultaneous transmission between the pre-approved Telit Wireless Solutions LTE Cellular radio module (LE910-SVG) and the BLE radio. All emissions were found to be in compliance.

2 TEST FACILITIES**2.1 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

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-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.

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of an 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:

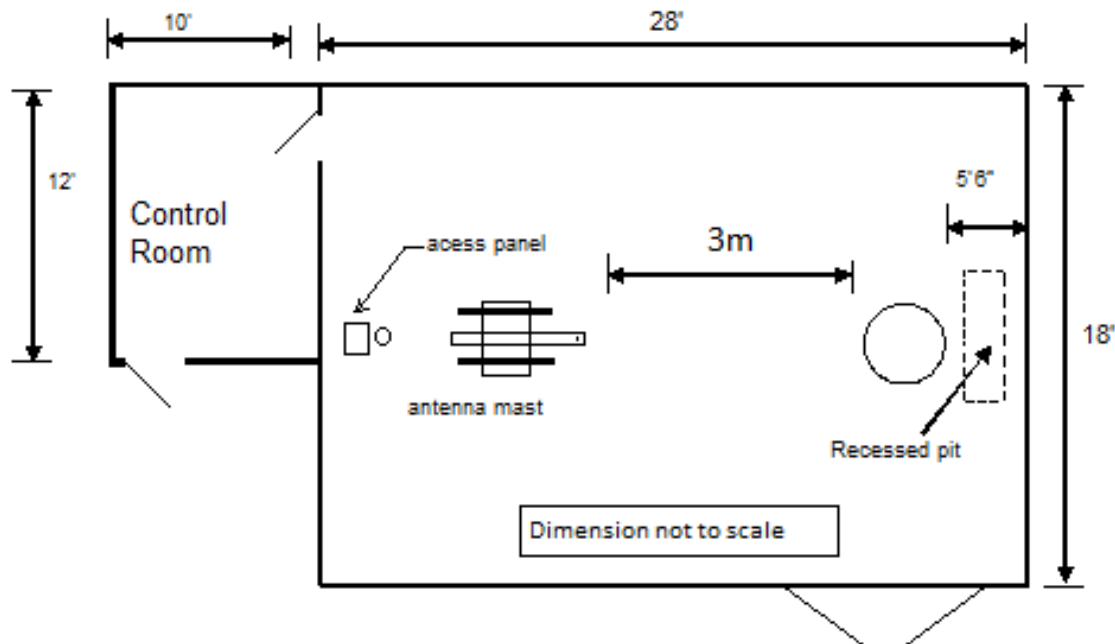


Figure 2.3-1: Semi-Anechoic Chamber Test Site

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 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 2.4-1:

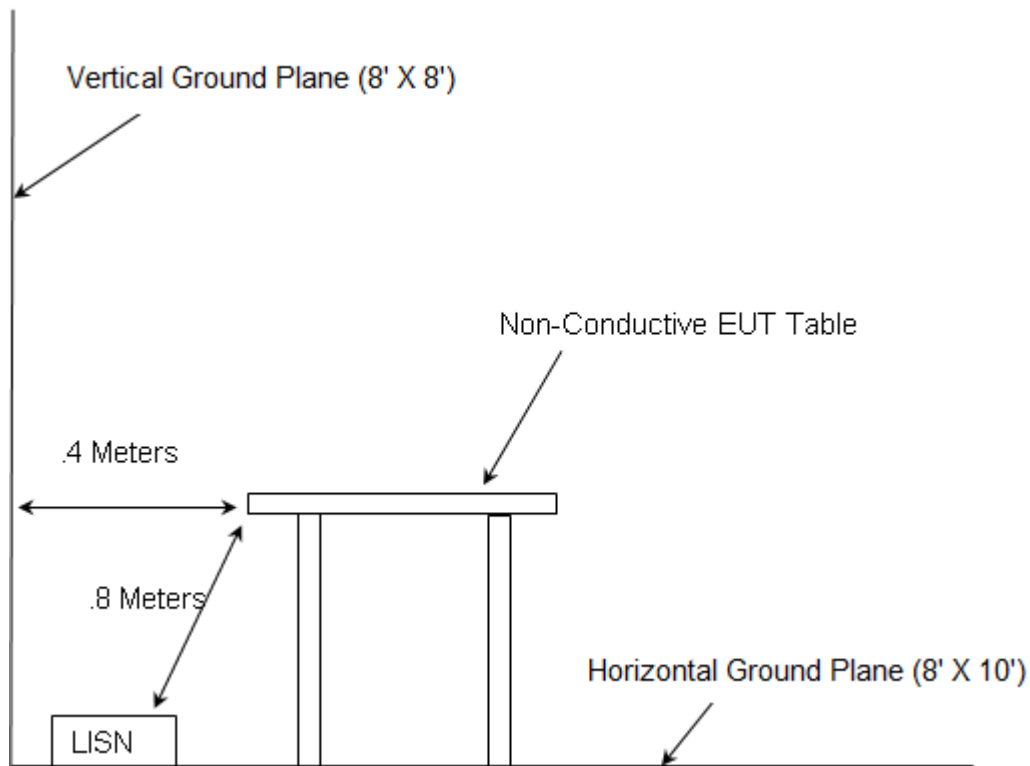


Figure 2.4-1: AC Mains Conducted EMI Site

3 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 2, Subpart J: Equipment Authorization Procedures, 2016
- ❖ US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2016
- ❖ FCC KDB 558074 D01 DTS Meas Guidance v03r03 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, June 9, 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, Nov 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
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	6/29/2015	6/29/2016
3007	Rohde & Schwarz	TS-PR26	Amplifiers	100051	6/29/2015	6/29/2016
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
3033	Hasco, Inc.	HLL142-S1-S1-36	Cables	1435	1/15/2015	1/15/2016
3049	Aeroflex Inmet	26AH-20	Attenuator	1443	1/15/2015	1/15/2016

DMAS MT-25 RF absorber material was used on the floor for all final measurements above 1 GHz.

NCR = No Calibration Required

Firmware Version: ESU40 is 4.73 SP1

Software Version: EMC32-B is 9.15

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	EUT	Neptune Technology Group	CMIU	0005
2	Power Supply	Sorensen	QRD-20-4	2716

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

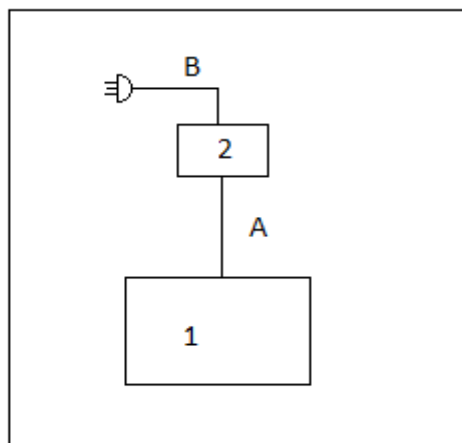


Figure 6-1: Test Setup Block Diagram

Table 6-1: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	DC Power Cable	2.5 m	No	EUT
B	AC Mains Cord	1.8 m	No	Power Supply

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 antenna is integral to the device and cannot be removed or replaced by the end user. The peak gain of the antenna is -1.5 dBi.

7.2 Power Line Conducted Emissions – FCC 15.207, IC: RSS-Gen 8.8

The EUT is a battery operated device, therefore AC power line conducted emissions testing was not performed.

7.3 6dB / 99% Bandwidth – FCC 15.247(a)(2), IC: RSS-247 5.2(1)

7.3.1 Measurement Procedure

The 6dB bandwidth was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance v03r03. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz. The Video Bandwidth (VBW) was set to ≥ 3 times the RBW. The trace was set to max hold with a peak detector active. The marker-delta function of the spectrum analyzer was utilized to determine the 6 dB bandwidth of the emission.

The occupied bandwidth measurement function of the spectrum analyzer was used to measure the 99% bandwidth. The span of the analyzer was set to capture all products of the modulation process, including the emission sidebands. The resolution bandwidth was set to 1% to 5% of the occupied bandwidth. The video bandwidth was set to 3 times the resolution bandwidth.

7.3.2 Measurement Results

Table 7.3.2-1: 6dB / 99% Bandwidth

Frequency [MHz]	6dB Bandwidth [MHz]	99% Bandwidth [MHz]
2402	713.14	1.033
2440	801.28	1.360
2480	801.28	1.923

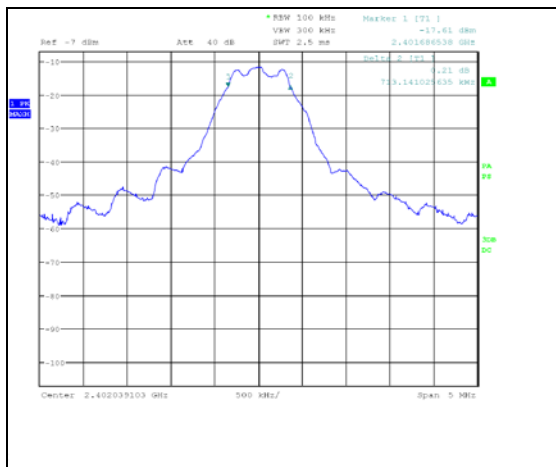


Figure 7.3.2-1: 6dB Bandwidth Low Channel

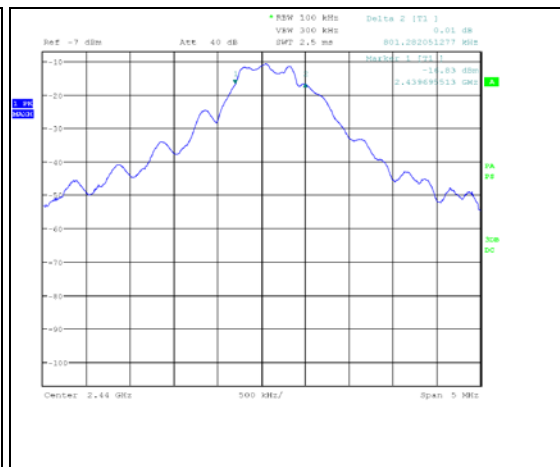


Figure 7.3.2-2: 6dB Bandwidth Mid Channel

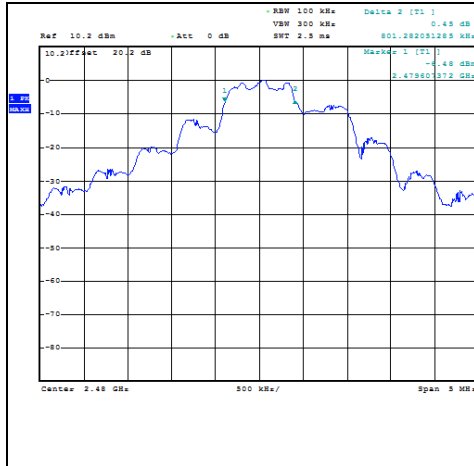


Figure 7.3.2-3: 6dB Bandwidth High Channel

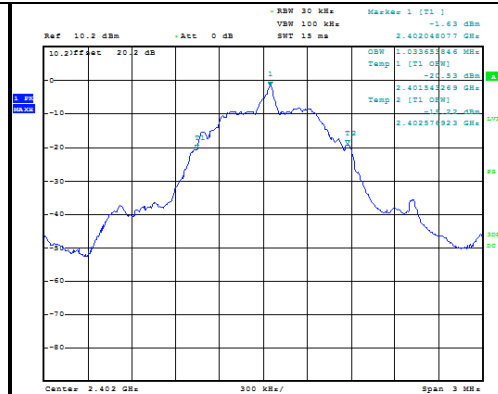


Figure 7.3.2-4: 99% Bandwidth Low Channel

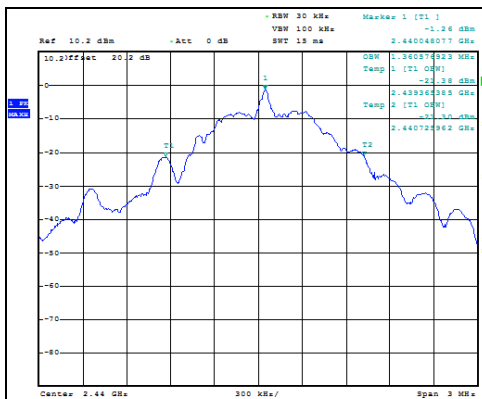


Figure 7.3.2-5: 99% Bandwidth Mid Channel

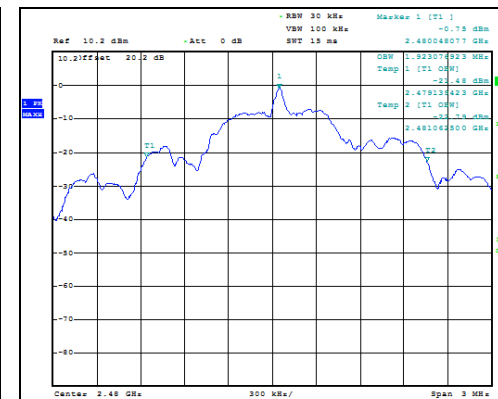


Figure 7.3.2-6: 99% Bandwidth High Channel

7.4 Fundamental Emission Output Power – FCC 15.247(b)(3), IC: RSS-247 5.4(4)

7.4.1 Measurement Procedure

The maximum peak conducted output power was measured in accordance with FCC KDB 558074 D01 DTS Measurement Guidance v03r03 utilizing a spectrum analyzer with a RBW>= DTS bandwidth. The RF output of the equipment under test was connected to the input of the spectrum analyzer applying suitable attenuation.

7.4.2 Measurement Results

Table 7.4.2-1: Maximum Peak Conducted Output Power

Frequency (MHz)	Output Power (dBm)	Output Power (mW)
2402	-1.30	0.74
2440	-0.47	0.90
2480	-0.06	0.99

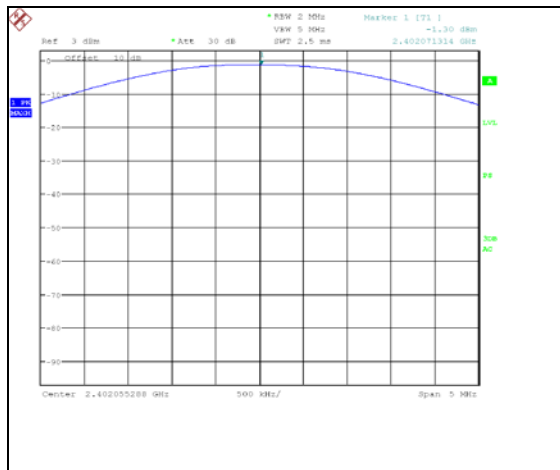


Figure 7.4.2-1: Output Power Low Channel

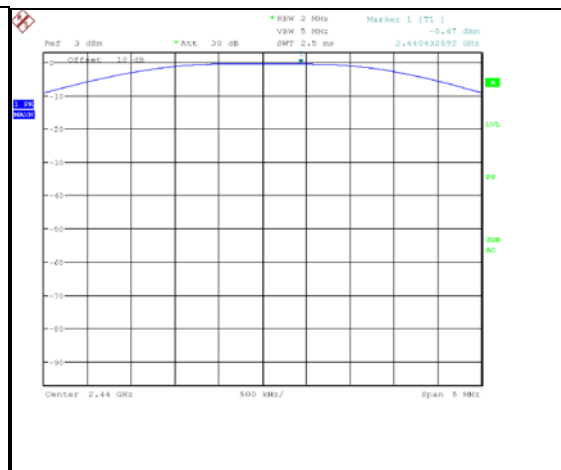


Figure 7.4.2-2: Output Power Mid Channel

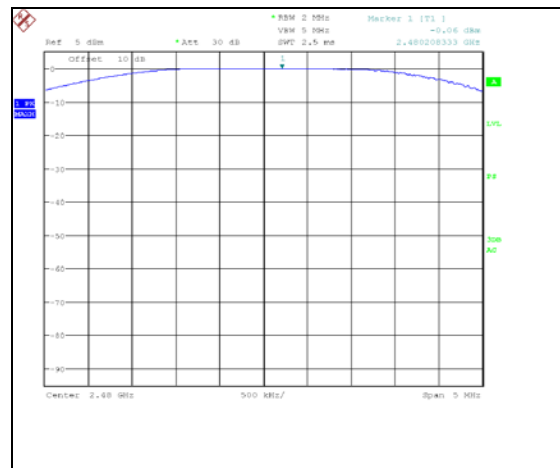


Figure 7.4.2-3: Output Power High Channel

7.5 Emission Levels – FCC 15.247(d), 15.205, 15.209; IC RSS-247 5.5, RSS-Gen 8.9/8.10

7.5.1 Emissions into Non-restricted Frequency Bands

7.5.1.1 Measurement Procedure

The unwanted emissions into non-restricted bands were measured conducted in accordance with FCC KDB 558074 D01 DTS Measurement Guidance v03r03. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer applying suitable attenuation. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz. The Video Bandwidth (VBW) was set to ≥ 300 kHz. Span was set to 1.5 times the DTS bandwidth. The trace was set to max hold with a peak detector active. The resulting spectrum analyzer peak level was used to determine the reference level with respect to the 20 dBc limit. The spectrum span was then adjusted for the measurement of spurious emissions from 30 MHz to 25GHz, 10 times the highest fundamental frequency. Additionally a prescan was performed from 9 kHz or the lowest frequency generated to 30 MHz.

7.5.1.2 Measurement Results

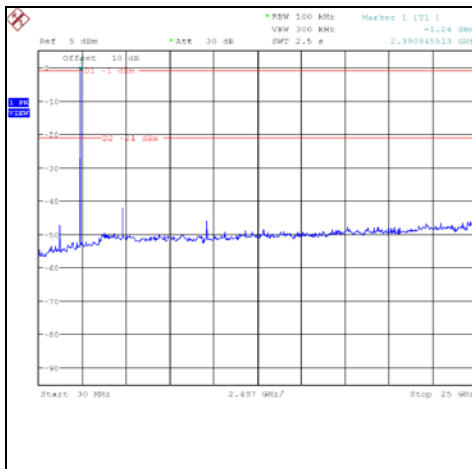


Figure 7.5.1.2-1: 30 MHz – 25 GHz – LCH

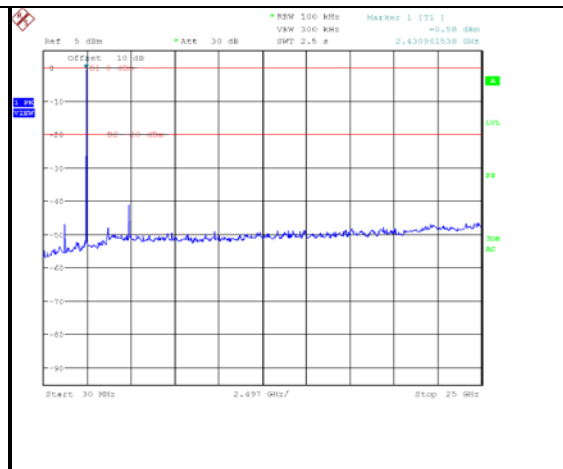


Figure 7.5.1.2-2: 30 MHz – 25 GHz – MCH

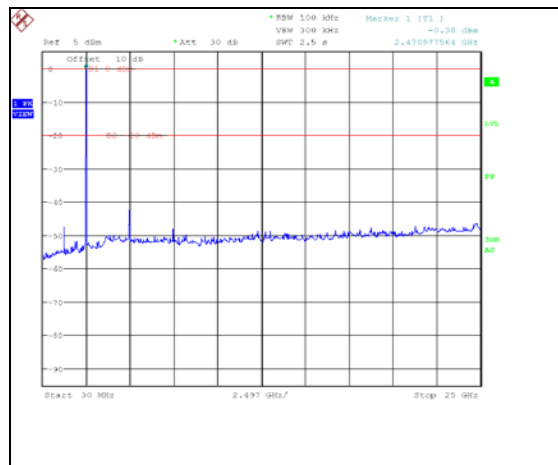


Figure 7.5.1.2-3: 30 MHz – 25 GHz – HCH

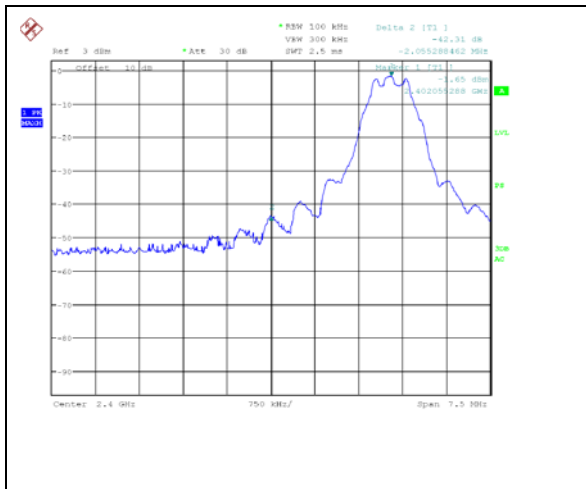


Figure 7.5.1.2-4: Lower Band-edge - LCH

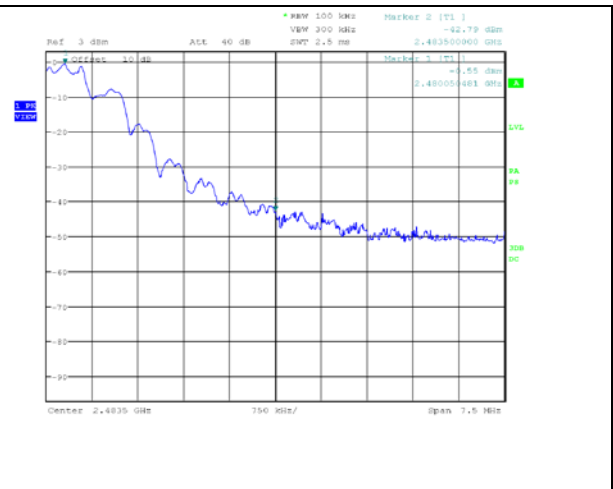


Figure 7.5.1.2-5: Upper Band-edge - HCH

7.5.2 Emissions into Restricted Frequency Bands

7.5.2.1 Measurement Procedure

The unwanted emissions into restricted bands were measured radiated over the frequency range of 30MHz to 25GHz, 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 RBW of 120 kHz and a VBW of 300 kHz. For frequencies above 1000MHz, peak and average measurements were made with RBW and VBW of 1 MHz and 3 MHz respectively.

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.

7.5.2.2 Duty Cycle Correction

The Duty Cycle Correction was not required.

7.5.2.3 Measurement Results

Table 7.5.2.3-1: Radiated Spurious Emissions Tabulated Data

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
4804	51.00	43.50	H	6.02	57.02	49.52	74.0	54.0	17.0	4.5
2388.9	46.10	25.30	H	-2.18	43.92	23.12	74.0	54.0	30.1	30.9
2388.9	47.80	25.80	V	-2.18	45.62	23.62	74.0	54.0	28.4	30.4
2331.7	47.20	25.60	H	-2.35	44.85	23.25	74.0	54.0	29.2	30.8
2331.7	48.60	25.20	V	-2.35	46.25	22.85	74.0	54.0	27.8	31.2
Middle Channel										
4880	47.30	38.80	H	5.97	53.27	44.77	74.0	54.0	20.7	9.2
4880	51.10	43.40	V	5.97	57.07	49.37	74.0	54.0	16.9	4.6
7320	52.40	43.20	H	9.26	61.66	52.46	74.0	54.0	12.3	1.5
7320	49.90	39.90	V	9.26	59.16	49.16	74.0	54.0	14.8	4.8
High Channel										
4960	48.00	39.80	H	5.91	53.91	15.54	74.0	54.0	20.1	38.5
4960	50.70	43.00	V	5.91	56.61	18.74	74.0	54.0	17.4	35.3
7440	57.50	47.90	H	9.60	67.10	27.33	74.0	54.0	6.9	26.7
7440	56.20	46.50	V	9.60	65.80	25.93	74.0	54.0	8.2	28.1
2483.5	56.20	26.60	H	-1.89	54.31	-5.46	74.0	54.0	19.7	59.5
2483.5	57.30	26.90	V	-1.89	55.41	-5.16	74.0	54.0	18.6	59.2

7.5.2.4 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: $51.0 + 6.02 = 57.02\text{dBuV/m}$

Margin: $74\text{dBuV/m} - 57.02\text{dBuV/m} = 17\text{dB}$

Example Calculation: Average

Corrected Level: $43.5 + 6.02 = 49.52\text{dBuV}$

Margin: $54\text{dBuV} - 49.52\text{dBuV} = 4.5\text{dB}$

7.6 Power Spectral Density in the Fundamental Emission – FCC 15.247(e) IC: RSS-247 5.2(2)

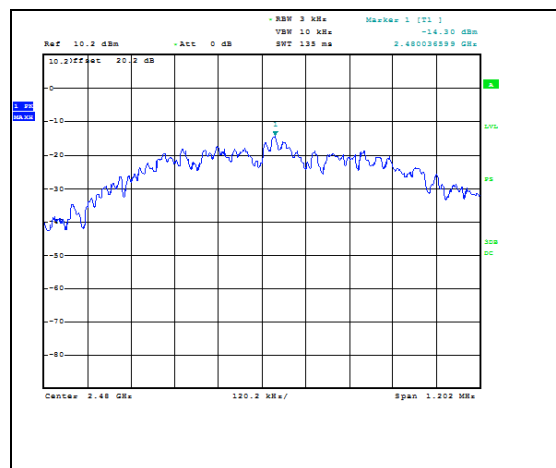
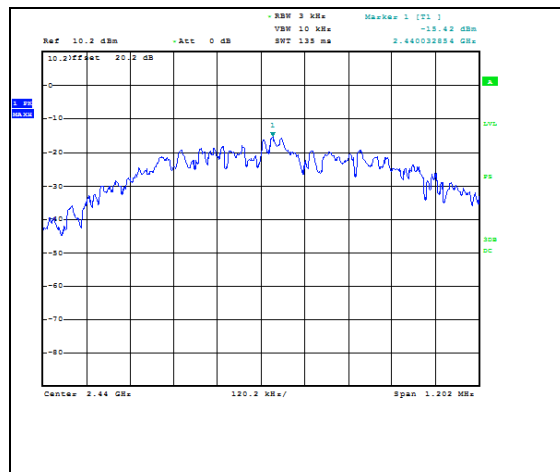
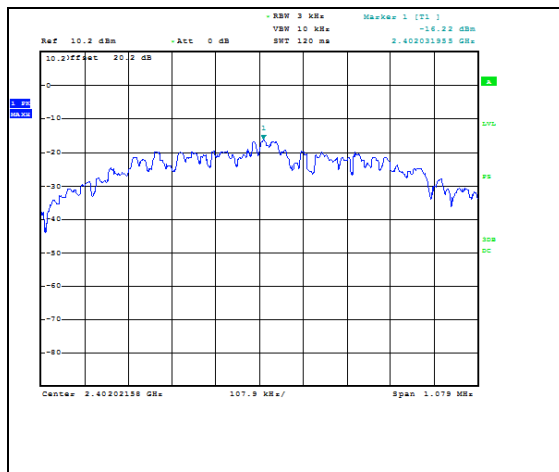
7.6.1 Measurement Procedure

The power spectral density was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance v03r03 utilizing the PKPSD (peak PSD) method. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer applying suitable attenuation. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 3 kHz. The Video Bandwidth (VBW) was set to 10 kHz. Span was set to 1.5 times the DTS bandwidth. The trace was set to max hold with a peak detector active.

7.6.2 Measurement Results

Table 7.6.2-1: Peak Power Spectral Density

Frequency (MHz)	PSD Level (dBm)
2402	-16.22
2440	-15.42
2480	-14.30



8 CONCLUSION

In the opinion of ACS, Inc. the CMIU, manufactured by Neptune Technology Group meets the requirements of FCC Part 15 subpart C.

END REPORT