



H.B. Compliance Solutions

Intentional Radiator Test Report

For the

Inergy Systems

SEMS

Tested under

The FCC Rules contained in Title 47 of the CFR, Part 15.249

Prepared for:

Inergy Systems

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Reviewed By:

A handwritten signature in black ink, appearing to read 'Hoosamuddin Bandukwala'.

Hoosamuddin Bandukwala



Cert # ATL-0062-E

Engineering Statement: The measurements shown in this report were made in accordance with the procedure indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurement made, the equipment tested is capable of operation in accordance with the requirements of Part 15 of the FCC Rules under normal use and maintenance. All results contained herein relate only to the sample tested.

Report Status Sheet

Revision #	Report Date	Reason for Revision
Ø	December 7, 2022	Initial Issue

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EXECUTIVE SUMMARY

1. Testing Summary

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15.249. All tests were conducted using measurement procedure from ANSI C63.4-2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9kHz to 40GHz as appropriate.

Test Name	Test Method/Standard	Result	Comments
Unintentional Radiated Emissions	15.109	Pass	
Radiated Fundamental Emissions	15.249(a)	Pass	
Radiated Spurious Emissions	15.249(a)(d)(e), 15.209(a), 15.205, 15.35(C)	Pass	
Emissions at Band Edges & Restricted Band	15.249, 15.209(a), 15.205	Pass	

EQUIPMENT CONFIGURATION

1. Overview

H.B Compliance Solutions was contracted by Inergy Systems to perform testing on the SEMS under the purchase order number 2000.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Inergy Systems, SEMS.

The tests were based on FCC Part 15 Rules. The tests described in this document were formal tests as described with the objective of the testing was to evaluate compliance of the Equipment Under Test (EUT) to the requirements of the aforementioned specifications. Microchip Technology should retain a copy of this document and it should be kept on file for at least five years after the manufacturing of the EUT has been permanently discontinued. The results obtained relate only to the item(s) tested.

Product Name:	SEMS
Model(s) Tested:	IH40
FCC ID:	2A93L-SEMS
Supply Voltage Input:	Primary Power: +5 Vdc
Frequency Range:	908.4-920MHz
No. of Channels:	5
Type(s) of Modulation:	908.4/916MHz: FSK/GFSK, 912/920MHz: DSSS OQPSK
Range of Operation Power:	908.4/916MHz: 0.7mW (Radiated) 912/920MHz: 19.7mW (Radiated)
Emission Designator:	N/A
Channel Spacing(s)	None
Test Item:	Pre-Production
Type of Equipment :	Portable
Antenna Requirement (§15.203) :	Type of Antenna: External, Whip Dipole Gain of Antenna: 2.7dBi
Environmental Test Conditions:	Temperature: 15-35°C Humidity: 30-60% Barometric Pressure: 860-1060 mbar
Modification to the EUT:	None
Evaluated By:	Staff at H.B Compliance Solutions
Test Date(s):	11/22/2022 till 12/06/2022

2. Test Facility

All testing was performed at H.B. Compliance Solutions. This facility is located at 5005 S. Ash Avenue, Suite # A-10, Tempe AZ-85282. All equipment used in making physical determination is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a GTEM chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at H.B. Compliance Solutions.

Test facility H.B. Compliance Solutions is an ANAB accredited test site. The ANAB certificate number is L2458. The scope of accreditation can be found on ANAB website www.anab.org



3. Description of Test Sample

The SEMS is a smart home automation device focused on energy management. The device contains multiple radios and interfaces (wired Ethernet, W-Fi, Z-wave, Zigbee, LTE cellular) to communicate to various smart devices in the home including energy meters, load switches, thermostats, and sensors.

4. Equipment Configuration

Ref. ID	Name / Description	Model Number	Serial Number
# 1	SEMS (Sample #1 for Conducted Testing)	IH40	20041341
# 2	SEMS (Sample #2 for Radiated Testing)	IH40	20041333
# 3	SEMS (Sample #1 for Unintentional Emissions Tests)	IH40	20041339

Table 1. Equipment Configuration

5. Support Equipment

All support equipment supplied is listed in the following Support Equipment List.

Ref ID	Name / Description	Manufacturer	Model #	Serial #
# 4	AC/DC Power Supply	CUI Inc	SWI15-5-N	-
# 5	Laptop Computer	Acer	Swift SF314-52	-
# 6	USB/Ethernet Adapter	Plugable	USB3-E1000	-

Table 2. Support Equipment

6. Ports and Cabling Information

Ref ID	Port name on the EUT	Cable Description	Qty.	Length (m)	Shielded? (Y/N)	Termination Box ID & Port ID
# 7	Power	2 Wire	1	2	N	AC Outlet
# 8	LAN	RJ45	1	1.8	N	# 6

Table 3. Ports and Cabling Information

7. Method of Monitoring EUT Operation

A test receiver will be used to monitor the data transmission from the EUT.

8. Mode of Operation

To support FCC testing, a GUI was provided to change the transmission channels and output power of the EUT.

9. Modifications

9.1 Modifications to EUT

No modifications were made to the EUT

9.2 Modifications to Test Standard

No Modifications were made to the test standard.

10. Disposition of EUT

The test sample including all support equipment submitted to H.B Compliance Solutions for testing will be returned to Inergy Systems upon completion of testing & certification.

Criteria for Un-Intentional Radiators

1. Radiated Emissions

Test Requirement(s):	§15.109	Test Engineer(s):	Sean E.
Test Results:	Pass	Test Date(s):	12/06/2022

Test Procedures:

The final radiated emissions test was performed using the parameters described above as worst case. That final test was conducted at a facility that meets the ANSI C63.4 NSA requirements. The frequency range noted in the data sheets was scanned/tested at that facility. Emissions were maximized as specified, by varying table azimuth, antenna height, and manipulating cables.

Using the mode of operation and configuration noted within this report, a final radiated emissions test was performed. The frequency range investigated (scanned), is also noted in this report. Radiated emissions measurements were made at the EUT azimuth and antenna height such that the maximum radiated emissions level will be detected. This requires the use of a turntable and an antenna positioner. The preferred method of a continuous azimuth search is utilized for frequency scans of the EUT field strength with both polarities of the measuring antenna. A calibrated, linearly polarized antenna was positioned at the specified distance from the periphery of the EUT.

Note: The specified distance is the horizontal separation between the closest periphery of the EUT and the center of the axis of the elements of the receiving antenna. However, if the receiving antenna is a log-periodic array, the specified distance shall be the distance between the closest periphery of the EUT and the front-to-back center of the array of elements.

Tests were made with the antenna positioned in both the horizontal and vertical polarization planes. The measurement was varied in height above the conducting ground plane to obtain the maximum signal strength. Though specified in the report, the measurement distance shall be 3 meters. At any measurement distance, the antenna height was varied from 1 meter to 4 meters. These height scans apply for both horizontal and vertical polarization, except that for vertical polarization the minimum height of the center of the antenna shall be increased so that the lowest point of the bottom of the antenna clears the ground surface by at least 25 cm.

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
30 MHz to 1 GHz	120 kHz	120 kHz	N/A
1 GHz to 11 GHz	1MHz	N/A	1MHz
Measurements were made using the bandwidths and detectors specified. The video filter was at least as wide as the IF bandwidth of the measuring receiver.			

Table 4. Radiated Emissions – Measurement Bandwidth

Emissions Tests Calculations

In the case of indoor measurements, radiated emissions measurements are made by the manipulation of correction factors using TILE4 software. This is done automatically by the software during the final measurement process.

In both cases, the level of the Field Strength of the interfering signal is calculated by adding the Antenna Factor, Cable Factor and by subtracting the Amplifier Gain from the measured reading. The basic equation is as follows:

$$FS = RA + AF + (CF - AG)$$

Where: FS = Field Strength

RA = Receiver (indicated) Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

This laboratory uses an approach of combining the CF and AG using an end-to-end measurement of the entire cabling system, including the test cable, any in-line amplifiers, attenuators, or transient protection networks, all measured in-situ.

For a sample calculation, assume a receiver reading of 52.5 dBuV is obtained. With an antenna factor of 7.4 and a combined cable factor (CF + AG) of -27.9:

$$FS = 52.5 + 7.4 + (-27.9) = 32 \text{ dBuV/m}$$

$$FS = 32 \text{ dBuV/m}$$

If desired, this can be converted into its corresponding level in uV/m:

$$FS = 10^{((32 \text{ dBuV/m})/20)} = 39.8 \text{ uV/m}$$

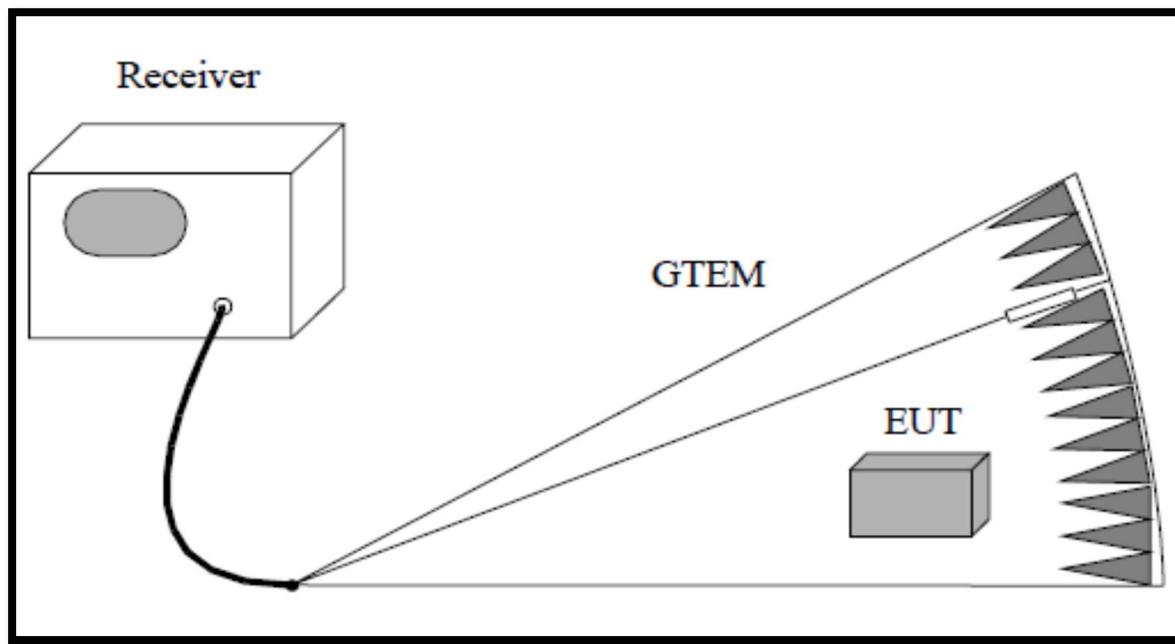
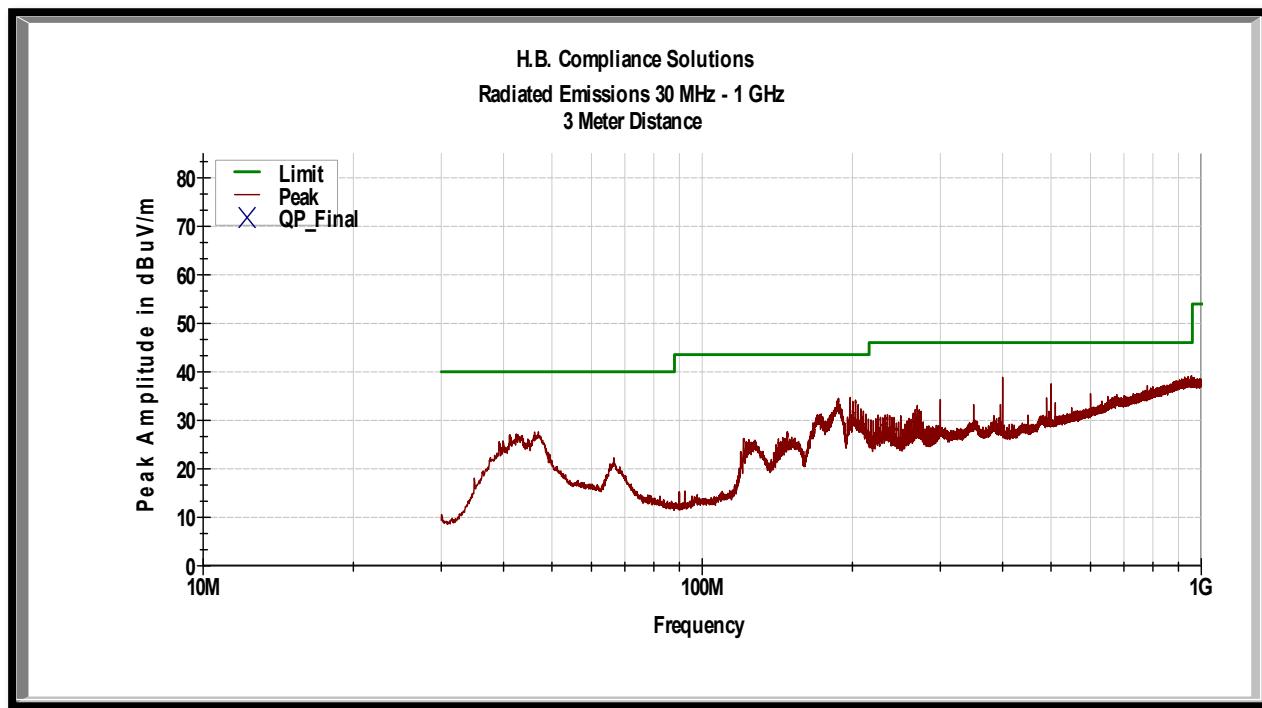


Figure 1. Radiated Emissions Test Setup (30MHz – 1GHz)



Plot 1 – Radiated Emissions – 30MHz to 1GHz

Frequency (MHz)	Measured Level	Limit (dBuV)	Margin (dB)
46.975	27.623	40	-12.377
197.956	34.713	43.52	-8.807
269.784	33.059	46.02	-12.961
300.048	34.242	46.02	-11.778
400.007	38.853	46.02	-7.167
500.159	37.456	46.02	-8.564

Table 5. Final Measurement Results for Radiated Emissions

Criteria for Intentional Radiators

1. Radiated Fundamental Emissions

Test Requirement(s):	§15.249(a)	Test Engineer(s):	Sean E.
Test Results:	Pass	Test Date(s):	11/28/2022

Test Procedures: As required by 47 CFR 15.249, Radiated emission measurements were made in accordance with the procedures of the ANSI C63.4 - 2014.

The EUT was placed on a wooden table inside a 3 meter semi-anechoic chamber. The EUT was set on continuous transmit.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT

Frequency Range	Detector Setting	Resolution Bandwidth	Video Bandwidth	Span
30MHz – 1000 MHz	Quasi Peak	120kHz	As Specified in §15.35(c)	Zero
1000 MHz – 5GHz	Peak	1MHz	1MHz	As necessary
1000 MHz – 5GHz	Average	1MHz	As Specified in §15.35(c)	As necessary

Table 6 - Analyzer Settings

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical

Frequency (MHz)	Peak Measurement @ 3m (dBuV/m)	Antenna Polarity (H/V)	Average Amplitude (dBuV/m)	FCC Average Limit (dBuV/m)	Margin (dB)	Comment
908.4	95.67	H	86	94	-8.0	Fundamental
916.0	95.83	H	56.5	94	-37.5	Fundamental
912.0	110.33	H	71.33	94	-22.67	Fundamental
920.0	110.0	H	73.33	94	-20.67	Fundamental

Table 7 – Fundamental Field Strength

Remark:

To get a maximum emission level from the EUT, the EUT was moved throughout the X-axis, Y-axis and Z-Axis. Worst case is X-axis.

2. Radiated Spurious Emissions

Test Requirement(s):	§15.249(a)(b)(e), 15.209(a), 15.205, 15.35	Test Engineer(s):	Sean E.
Test Results:	Pass	Test Date(s):	11/28/2022

Test Procedures: As required by 47 CFR 15.231, Radiated emission measurements were made in accordance with the procedures of the ANSI C63.4 - 2014.

The EUT was placed on a wooden table inside a 3 meter semi-anechoic chamber. The EUT was set on continuous transmit.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The frequency range up to the 10th harmonic was investigated.

To get a maximum emission level from the EUT, the EUT was moved throughout the X-axis, Y-axis and Z-Axis. Worst case is X-axis.

Frequency Range	Detector Setting	Resolution Bandwidth	Video Bandwidth	Span
30MHz – 1000 MHz	Quasi Peak	120kHz	As Specified in §15.35(c)	Zero
1000 MHz – 5GHz	Peak	1MHz	1MHz	As necessary
1000 MHz – 5GHz	Average	1MHz	As Specified in §15.35(c)	As necessary

Table 8 - Analyzer Settings

Test Setup:

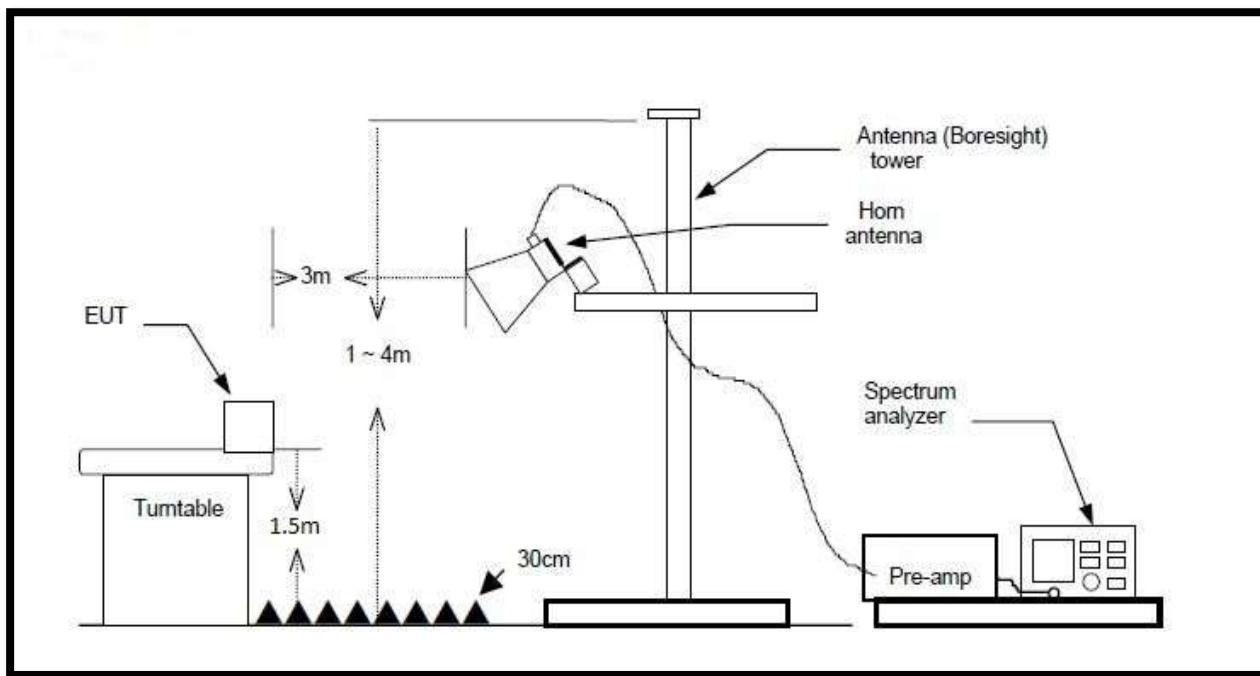


Figure 5. Radiated Emission Above 1GHz Test Setup

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical

Frequency (MHz)	Peak Measurement @ 3m (dBuV/m)	Antenna Polarity (H/V)	Average Amplitude (dBuV/m)	FCC Average Limit (dBuV/m)	FCC Peak Limit (dBuV/m)	Average Margin (dB)	Peak Margin (dB)	Comment
1816.8	41.0*	H	N/A	54	74	-13	-33	Harmonic

Table 9 - Radiated Spurious Emission Data – 30MHz – 10GHz (908.4MHz Fundamental)

Frequency (MHz)	Peak Measurement @ 3m (dBuV/m)	Antenna Polarity (H/V)	Average Amplitude (dBuV/m)	FCC Average Limit (dBuV/m)	FCC Peak Limit (dBuV/m)	Average Margin (dB)	Peak Margin (dB)	Comment
1832	32.5*	H	N/A	54	74	-21.5	-41.5	Harmonic

Table 10 - Radiated Spurious Emission Data – 30MHz – 10GHz (916MHz Fundamental)

Frequency (MHz)	Peak Measurement @ 3m (dBuV/m)	Antenna Polarity (H/V)	Average Amplitude (dBuV/m)	FCC Average Limit (dBuV/m)	FCC Peak Limit (dBuV/m)	Average Margin (dB)	Peak Margin (dB)	Comment
1824	45.67	H	N/A	54	74	-8.33	-28.33	Harmonic
2736	49.0	H	N/A	54	74	-5.0	-25.0	Harmonic

Table 11 - Radiated Spurious Emission Data – 30MHz – 10GHz (912MHz Fundamental)

Frequency (MHz)	Peak Measurement @ 3m (dBuV/m)	Antenna Polarity (H/V)	Average Amplitude (dBuV/m)	FCC Average Limit (dBuV/m)	FCC Peak Limit (dBuV/m)	Average Margin (dB)	Peak Margin (dB)	Comment
1840	47.0	H	N/A	54	74	-7.0	-27.0	Harmonic
2760	50.83	H	N/A	54	74	-3.17	-23.17	Harmonic

Table 12 - Radiated Spurious Emission Data – 30MHz – 10GHz (920MHz Fundamental)

Note: Emissions marked as “*” is system noise floor and no detectable emission were found from the EUT.

3. Emissions at Band Edges

Test Requirement(s):	§15.249(d), 15.209(a), 15.205	Test Engineer(s):	Sean E.
Test Results:	Pass	Test Date(s):	11/30/2022

Test Procedures: As required by 47 CFR 15.249, Band edge radiated emissions measurements were made at the RF antenna output terminals of the EUT.

The EUT was placed on a wooden table inside a 3 meter semi-anechoic chamber. The EUT was set on continuous transmit.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The EUT was set up at maximum power, first on the lowest operating channel, then on the highest operating channel of the transmit band.

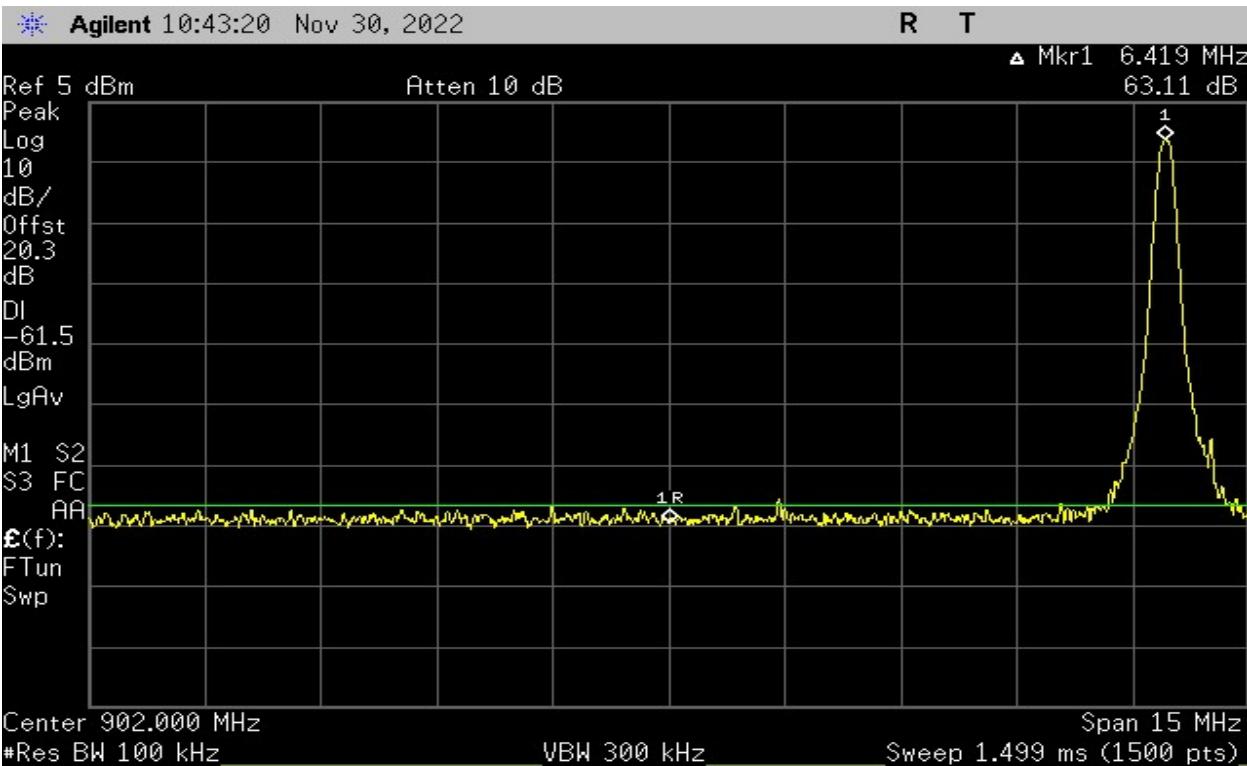
Test Results:

Frequency (MHz)	Measured Level (dBc)	Detector	Limit (dBc)
902.0	-63.11	Peak	-50
928.0	-62.83	Peak	-50

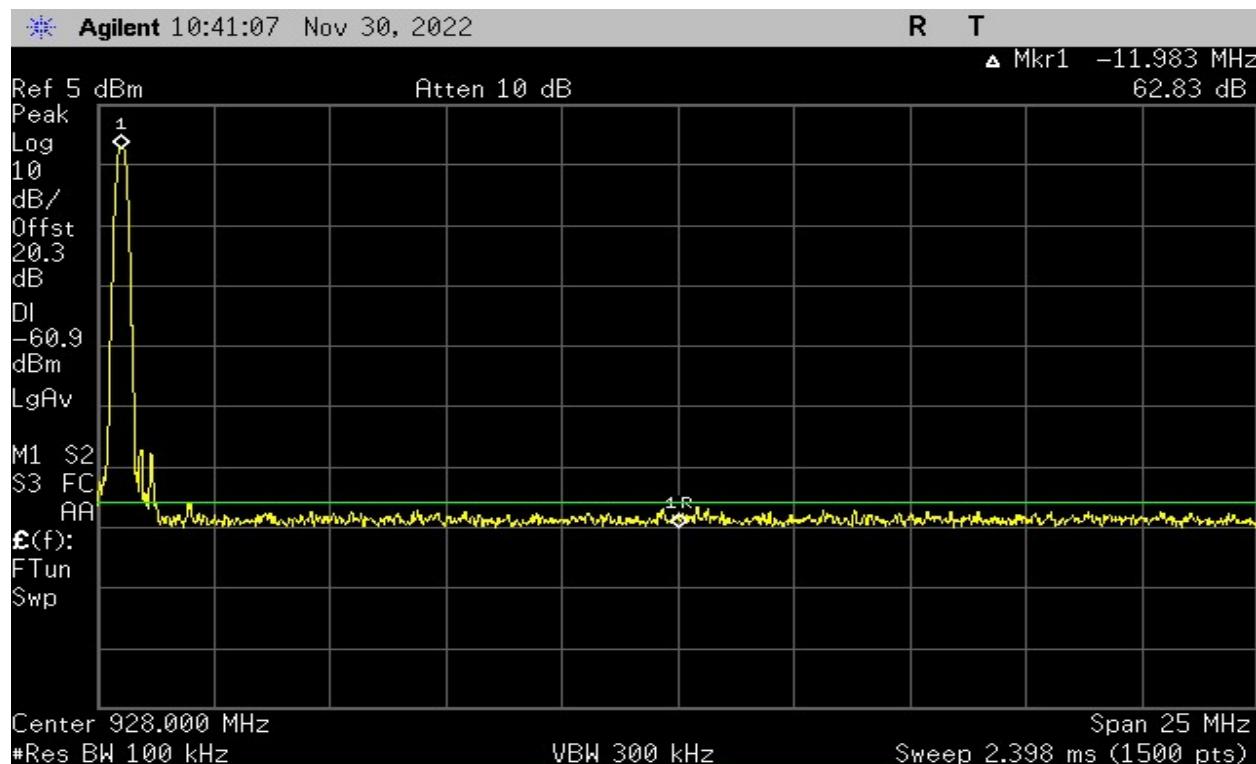
Table 13 – Band Edge Emissions Summary (908.4/916MHz)

Frequency (MHz)	Measured Level (dBc)	Detector	Limit (dBc)
902.0	-72.39	Peak	-50
928.0	-67.67	Peak	-50

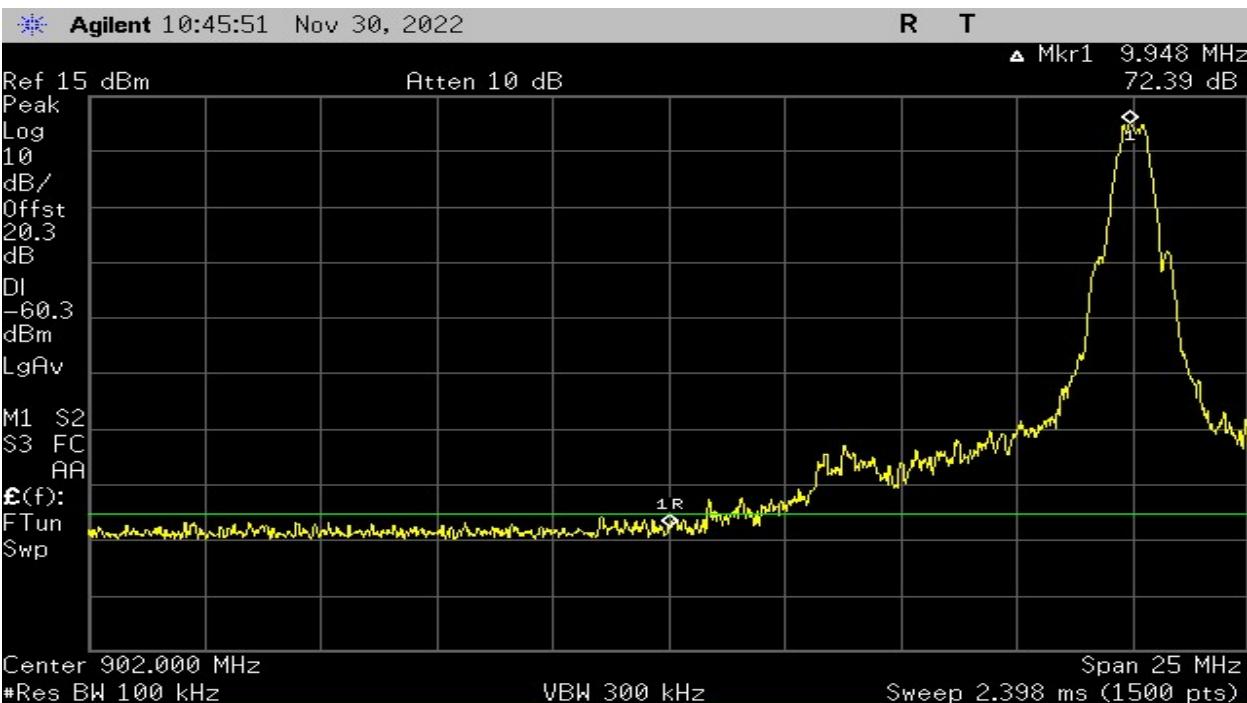
Table 14 – Band Edge Emissions Summary (912/920MHz)



Plot 2 – Band Edge – 908.4MHz Fundamental



Plot 3 – Band Edge – 916MHz Fundamental



Plot 4 – Band Edge – 912MHz Fundamental



Plot 5 – Band Edge – 920MHz Fundamental

4. Test Equipment

Equipment	Manufacturer	Model	Serial #	Last Cal Date	Cal Due Date
Spectrum Analyzer	Agilent	E4443A	US41420164	Mar-15-22	Mar-15-23
Spectrum Analyzer	Hewlett Packard	8563E	3821A09316	May-03-22	May-03-23
High Pass Filter	Mini-Circuits	VHF-1320+	1023	Verified	
EMI Receiver	Hewlett Packard	8666B	2747A05264	Dec-07-21	Dec-07-22
Power Supply	Hewlett Packard	Lambda	LA2-AA20-143 3535	NCR	None
High Pass Filter	Mini-Circuits	VHF-1320+	1034	Verified	
Attenuator 20dB	Weinschel	41-20-12	86332	May-27-21	May-27-23
Attenuator 10dB	HuberSuhner	6810.17A	757300	May-27-21	May-27-23
Horn Antenna	Com-Power	AHA-118	711150	Dec-17-20	Dec-17-22
Antenna	EMCO	GTEM 5417	1063	Verified	

Table 15 – Test Equipment List

***Statement of Traceability:** Test equipment is maintained and calibrated on a regular basis. All calibrations have been performed by a 17025 accredited test facility, traceable to National Institute of Standards and Technology (NIST)

5. Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The following measurement uncertainty values have been calculated as shown in the table below:

Measured Parameter	Measurement Unit	Frequency Range	Expanded Uncertainty
Conducted Emissions (AC Power)	dBuV or dBuA	150kHz – 30MHz	± 4.3dB
Radiated Emission below 30MHz	dBuV/m	9kHz-30MHz	± 2.96dB
Radiated Emissions below 1GHz	dBuV/m	30 – 1000MHz	± 5.6dB
Radiated Emissions above 1GHz	dBuV/m	1 – 26.5GHz	± 4.1dB

The reported expanded uncertainty has been estimated at a 95% confidence level (k=2)

END OF TEST REPORT