
Project #: 22752-15

Company: Hetronic

EUT: RX-MFS-ESCAN-HS1 Receiver

Wireless Test Report

**FCC
Industry Canada**

Prepared for:

Hetronic
3905 NW 36th Street
Oklahoma City, OK 73112

By

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April 11, 2022

Written by

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Revision History

Revision Number	Description	Date
Draft01	Initial release for review	4/29/2022

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Compliance Certificate

FCC MRA Designation Number: US5270 NVLAP Accreditation Number: 200062-0

Applicant	Device & Test Identification
Hetronic 3905 NW 36th Street Oklahoma City, OK 73112	Model(s): RX-MFS-ESCAN-HS1 Receiver Laboratory Project ID: 22752-15

The device named above was tested utilizing the following standards and found to be in compliance with the required criteria:

Requirement	Reference	Detail
FCC 47 CFR Part 15 C	15.247	Operation within the bands <u>2400-2483.5 MHz</u>
FCC 47 CFR Part 15 C	15.209	Radiated emission limits; general requirements
FCC 47 CFR Part 15 C	15.205	Restricted Bands of Operation
FCC 47 CFR Part 15 C	15.203	Antenna requirement
FCC 47 CFR Part 1 I*	1.1310	Radiofrequency radiation exposure limits
RSS-247	Issue 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS-Gen	Issue 5	General Requirements and Information for the Certification of Radio Apparatus
RSS-102	Issue 5	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

*MPE is reported separately from this document. **Corresponding RSS references are listed in the body of the report.

I, Shakil Murad, for Nemko PTI, Inc., being familiar with the above requirements and test procedures have reviewed the test setup, measured data, and this report. I believe them to be true and accurate.



Shakil Murad
Wireless Engineer



This report has been reviewed and accepted by the Applicant. The undersigned is responsible for ensuring that this device will continue to comply with the requirements listed above.

Representative of Applicant

Test Result Summary

Test	FCC Part 15 Rule Paragraphs	IC RSS References	Test Results
Antenna Requirement	15.203	RSS-Gen 6.8	Pass
Fundamental Power	15.247 (b)(3)	RSS-247 5.4 (d)	Pass
Duty Cycle	15.247 (f)	RSS-247 5.3 (a)	Pass
Power Spectral Density	15.247 (e)	RSS-247 5.2 (b)	Pass
Occupied Bandwidth	15.247 (a)(2), 2.1049	RSS-247 5.2 (a)	Pass
Band Edge	15.247 (d); 15.205 (a)	RSS-247 5.5;	Pass
Conducted Spurious Emissions	15.247 (d); 15.209 (a)	RSS-247 5.5; RSS-GEN 6.13	Pass
Transmitter Radiated Spurious Emissions	15.247 (d); 15.209 (a)	RSS-247 5.5; RSS-Gen 6.13 & 8.10	Pass
Receiver Radiated Spurious Emissions	15.109	RSS-Gen 7.3	Pass

1.0 Introduction

1.1 Scope

This report describes the extent to which the equipment under test (EUT) conformed to the intentional radiator requirements of the United States and Canada.

Nemko PTI, Inc., follows the guidelines of National Institute of Standards and Technology (NIST) for all uncertainty calculations, estimates, and expressions thereof for electromagnetic compatibility testing.

1.2 EUT Description

Manufacturer / Model	Serial #	Description
Hetronic Model: RX-MFS-ESCAN-HS1 Receiver	HI1911R05	2.4 GHz Non FHSS transceiver Bluetooth radio protocols.

1.3 EUT Test Configuration

The EUT was exercised in a manner consistent with normal operations. The EUT is powered by +12 VDC via an external DC power supply.

1.4 Modifications to Equipment

No modifications.

1.5 Test Site

Measurements were made at the Nemko PTI semi-anechoic facility designated Site 45 (FCC 776781, IC 3036B-1) in Austin, Texas. The site is registered with the FCC under Section 2.948 and Industry Canada per RSS-GEN, and is subsequently confirmed by laboratory accreditation (NVLAP). The test site is located at 11400 Burnet Road, Austin, Texas 78758, while the main office is located at 1601 North A.W. Grimes Boulevard, Suite B, Round Rock, Texas, 78665. CAB Identifier: US 0123.

1.6 Measurement Corrections

Parameter	From Sums Of
Radiated Field Strength	Raw Measured Level + Antenna Factor + Cable Losses – Amplifier Gain
Conducted Antenna Port	Raw Measured Level + Attenuator Factor + Cable Losses
Conducted Mains Port	Raw Measured Level + LISN Factor + Cable/Filter/Limiter Losses

Additionally, measurement distance extrapolation factors (such as 1/d above 30 MHz) are applied and documented where used.

1.7 Applicable Documents

Table 1.7.1: Applicable Documents

Document	Title
47 CFR	Part 15 – Radio Frequency Devices Subpart C -Intentional Radiators
RSS-247 Issue 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS-102 Issue 5	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
RSS-Gen Issue 5	General Requirements and Information for the Certification of Radio Apparatus
ANSI C63.10 2020	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
KDB 558074 D01	GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES
KDB 412172 D01	GUIDELINES FOR DETERMINING THE EFFECTIVE RADIATED POWER (ERP) AND EQUIVALENT ISOTROPICALLY RADIATED POWER (EIRP) OF AN RF TRANSMITTING SYSTEM
OET Bulletin 65 Edition 97-01	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

2.0 Fundamental Power

2.1 Test Procedure

The radio was connected directly to the spectrum analyzer for measurement. Low, mid, and high channel output power was measured.

2.2 Test Criteria

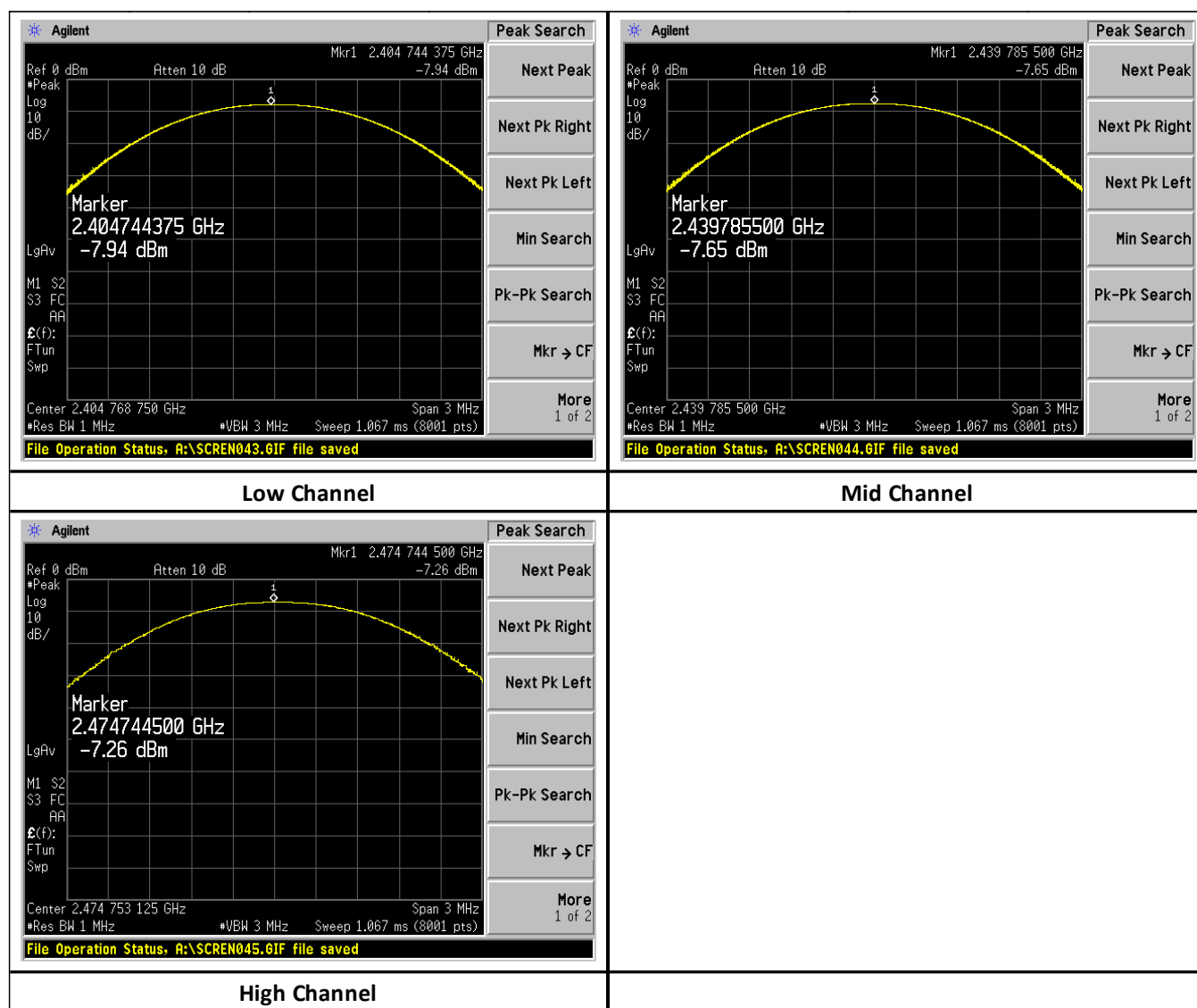
47 CFR (USA) // IC (Canada)	
Section Reference	Conducted Power Limit
15.247(b)(3) // RSS-247 (d)	1 Watt peak (+30dBm)

2.3 Test Results, Peak Power

Peak Output Power - Conducted Test Data											
Environmental Conditions:		Temperature	21.4	°C	Humidity	58	RH	Barometric Pressure	29.78	in Hg	
EUT (6 or 20 dB)		Bandwidth:	1.54	MHz							
Measurement Parameters:		RBW	1	MHz	VBW	3	MHz	Span	3	MHz	Detector Peak
Channel	Frequency (MHz)	Measured Power (dBm)	Attenuator Factor (dB)	Corrected Power (dBm)		Limit (dBm)		Test Result			
Low	2405	-7.94	20.12	12.18		30		Pass			
Mid	2440	-7.65	20.12	12.47		30		Pass			
High	2475	-7.26	20.12	12.86		30		Pass			

The requirements were satisfied.

Peak output power test plots:



3.0 Occupied Bandwidth

3.1 Test Procedure

Bandwidth is measured and recorded. The bandwidth measurement is used to verify DTS characteristics and/or for general reporting for agency application.

3.2 Test Criteria

47 CFR (USA) // IC (Canada)	
Section Reference	Bandwidth
15.247(a)(2), 2.1049 // RSS-247 5.2(a)	6 dB 500 kHz minimum 99% (all methods)

In cases where the software function fails to find/mark the correct edge of the modulated envelope, a manual measurement (marker-delta over display line) is taken with the same spectrum analyzer settings.

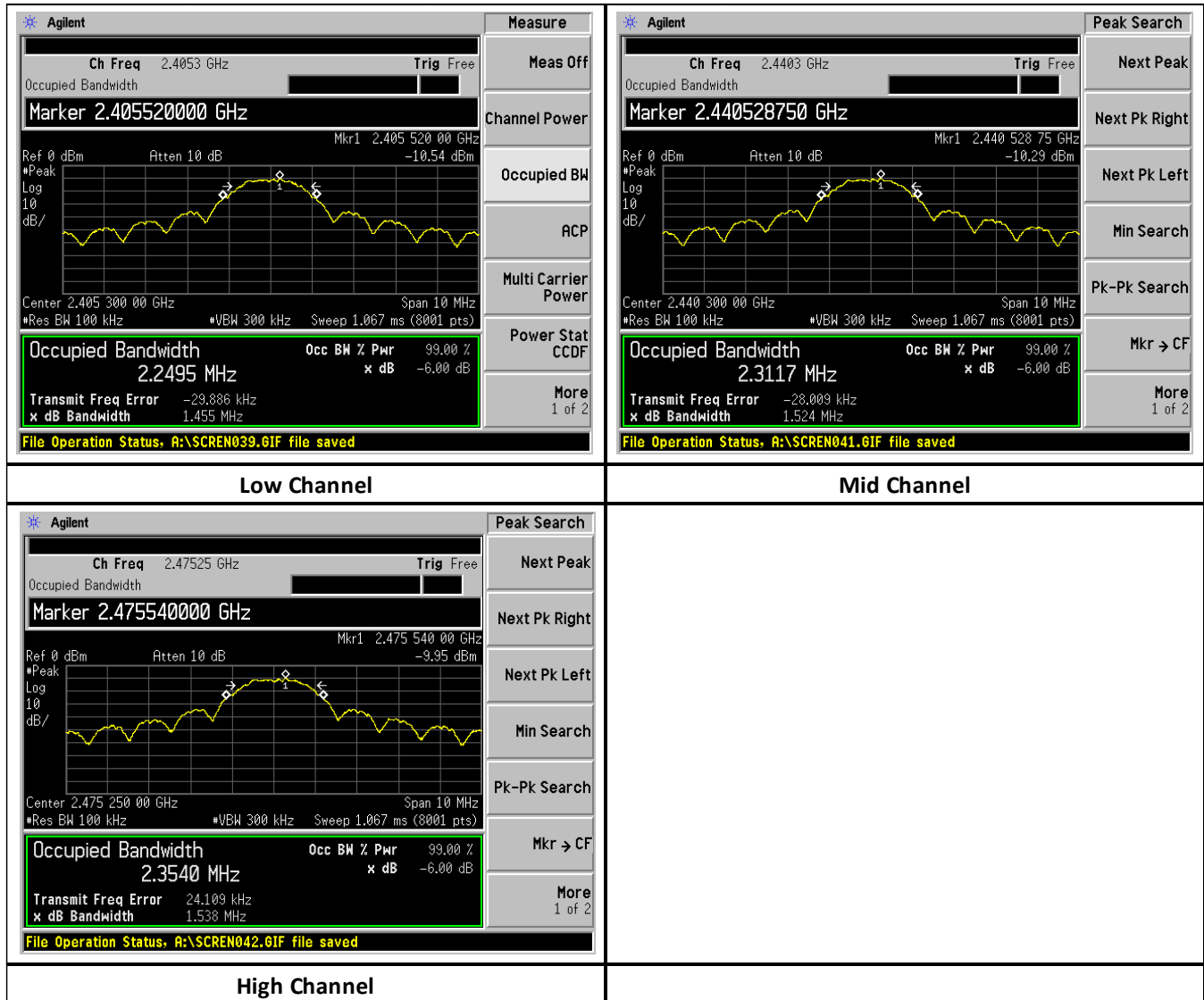
3.3 Test Results, Occupied Bandwidth

Occupied Bandwidth - Conducted Test Data															
Environmental Conditions:		Temperature		21.4	°C	Humidity		58	RH	Barometric Pressure		29.78	in Hg		
Measurement Parameters:		RBW		100	kHz	VBW		300	kHz	Span		10	MHz	Detector	Peak
Measurement Bandwidth:				- 6		dB									
Channel	Frequency		Measured Bandwidth				Reported Maximum Bandwidth								
	(MHz)		(MHz)				(MHz)								
Low	2405		1.455				1.538								
Mid	2440		1.524												
High	2475		1.538												

Environmental Conditions:		Temperature		21.4	°C	Humidity		58	RH	Barometric Pressure			29.78	in Hg
Measurement Parameters:		RBW	100	kHz	VBW		300	kHz	Span		10	MHz	Detector	Peak
Measurement Bandwidth:				99	%									
Channel	Frequency		Measured Bandwidth				Reported Maximum Bandwidth							
	(MHz)		(MHz)				(MHz)							
Low	2405		2.2495				2.354							
Mid	2440		2.3117											
High	2475		2.354											

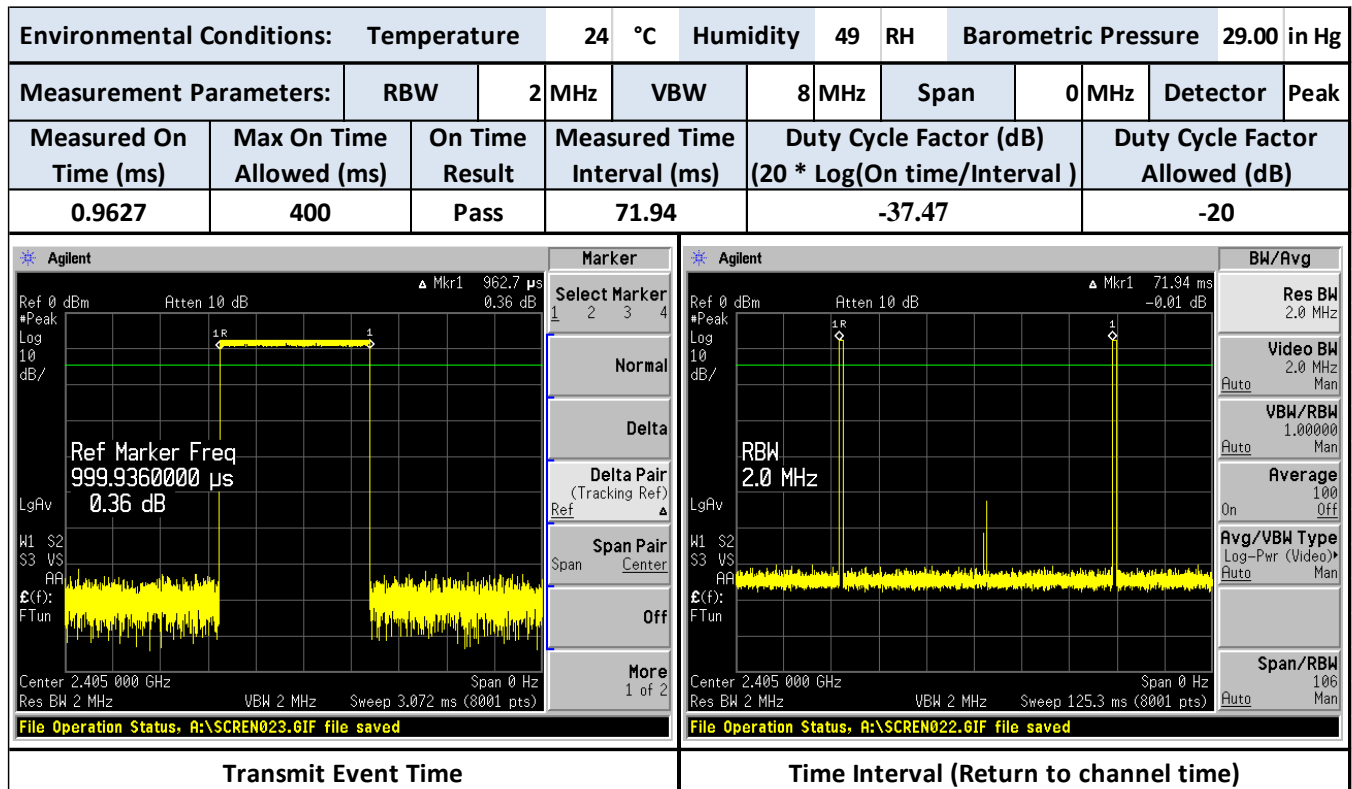
The EUT met the requirements.

Occupied Bandwidth data plots, Recorded: 6 dB, 99% BW



4.0 Duty Cycle

Measurement is based on intervals not to exceed 100 msec. Maximum transmitter on time is divided by the lesser of 100 msec or the actual measured minimum transmitter interval time. The result is converted to dB and applied as needed to peak measurements of transmitter artifacts to determine average power. This is not a pass/fail measurement.



Duty Cycle Measurement

5.0 Power Spectral Density

5.1 Test Procedure

The radio was connected directly to the spectrum analyzer for measurement. Low, mid, and high channel was measured.

5.2 Test Criteria

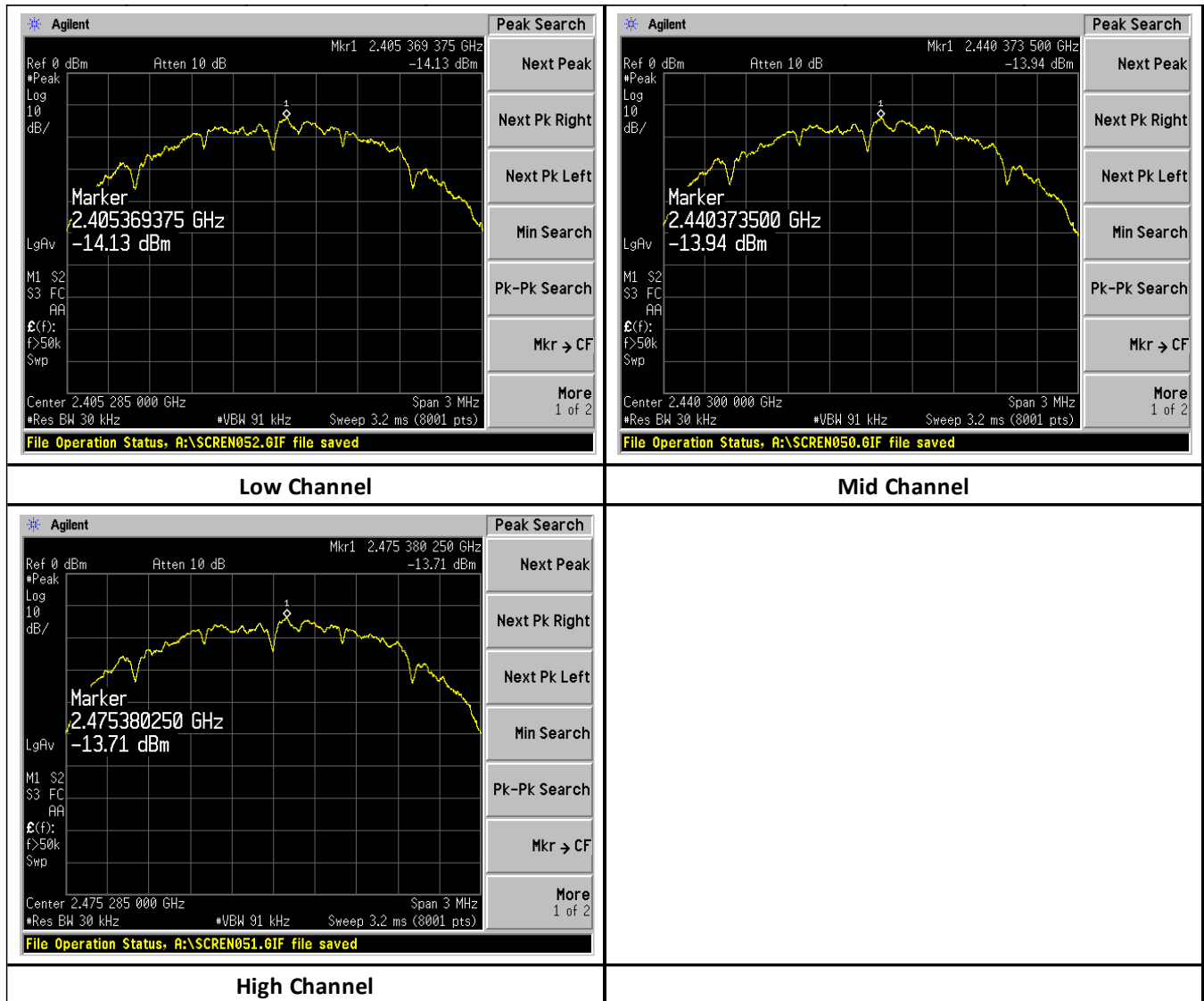
47 CFR (USA) // IC (Canada)	
Section Reference	Power Spectral Density, Conducted Limit
15.247(e) // RSS-247 5.2 (b)	8 dBm / 3 kHz Restated as field strength: 103.23 dB μ V/m at 3 m

5.3 Test Results, Power Spectral Density

Power Spectral Density - Conducted Test Data														
Environmental Conditions:		Temperature		21.4	°C	Humidity		58	RH	Barometric Pressure		29.78 in Hg		
EUT Channel Bandwidth:		1.5		MHz										
Measurement Parameters:		RBW		30	kHz	VBW		90	kHz	Span		3 MHz	Detector	Peak
Channel	Frequency	Measured Power		Attenuator Factor		Corrected Power			Limit			Test Result		
	(MHz)	(dBm)		(dB)		(dBm)			(dBm)					
Low	2405	-14.13		20.12		5.99			8			Pass		
Mid	2440	-13.94		20.12		6.18			8			Pass		
High	2480	-13.71		20.12		6.41			8			Pass		

The requirements were satisfied.

Power Spectral Density test plots:



6.0 Band Edge

6.1 Test Procedure

EUT is placed into normal transmit operation on the nearest band edge channel. The spectrum analyzer is approximately centered on the band edge frequency with span sufficient to include the peak of the adjacent fundamental signal. Measurement includes at least two standard bandwidths from the respective band edge. If required, the band-edge marker-delta method is utilized. The radio was connected directly to the spectrum analyzer for measurement.

6.2 Test Criteria

47 CFR (USA) // IC (Canada)	
Section Reference	Unwanted Emissions
15.247 (d); 15.205 (a) // RSS-247 5.5; RSS-Gen 6.13	Emissions Adjacent to Authorized Band

6.3 Test Results

Measurements included fundamental and more than 2 standard bandwidths (standard bandwidth 1 MHz) beyond the band edges to provide a clear view of the fundamental and the declining emission levels. Beyond this point, the general emission limits are applied in the radiated emission tests reported elsewhere in the report.

This is a conducted measurement with limits derived from the general emission field strength limits. The far field path loss equation is utilized to convert the field strength limits to EIRP limits in dBm as follows:

$$\text{Given EIRP} = E_{\text{dB}\mu\text{V/m}} + 20\text{Log}_{10}(d) - 104.8$$

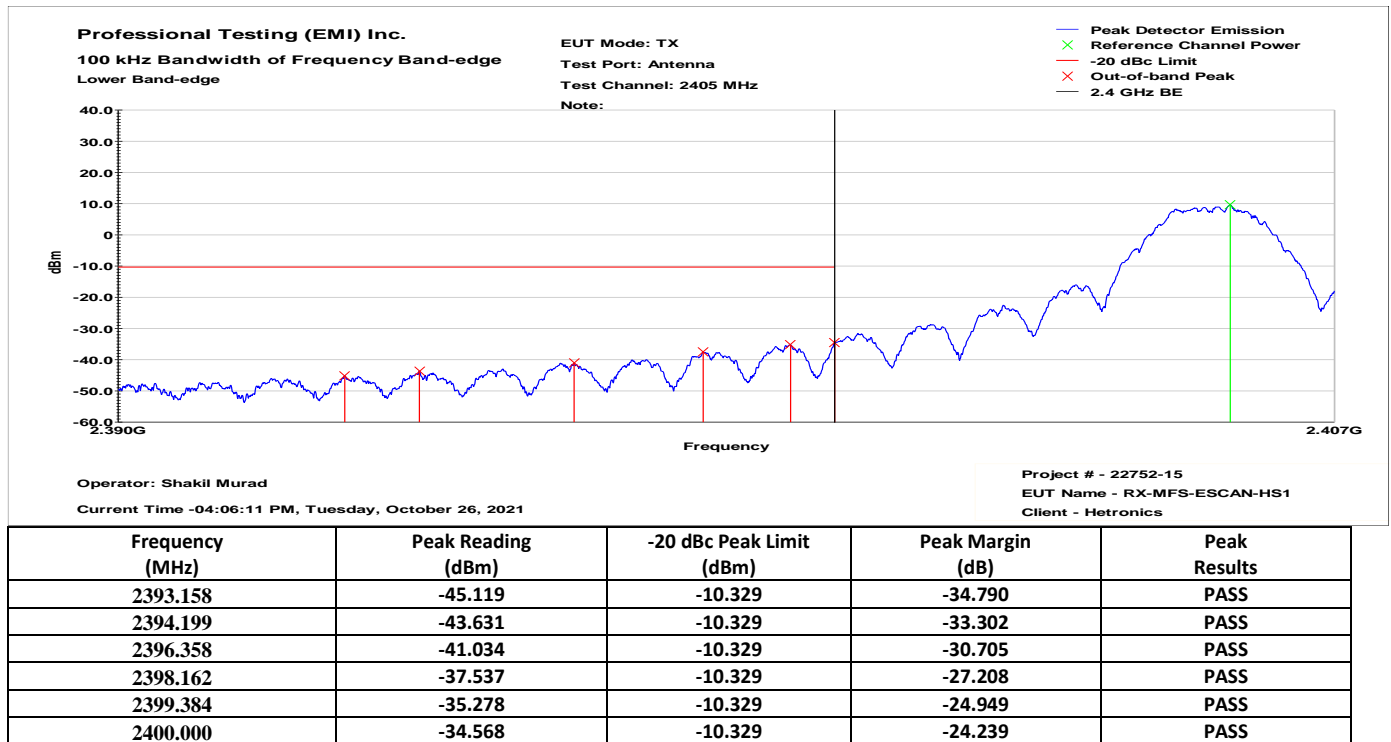
$$\text{EIRP} = 54 \text{ dB}\mu\text{V/m} + 20\text{Log}_{10}(3 \text{ m}) - 104.8 \text{ dB} = -41.25 \text{ dBm (commonly -41 dBm is applied)}$$

Emissions below band were measured with peak detection in 100 kHz RBW.

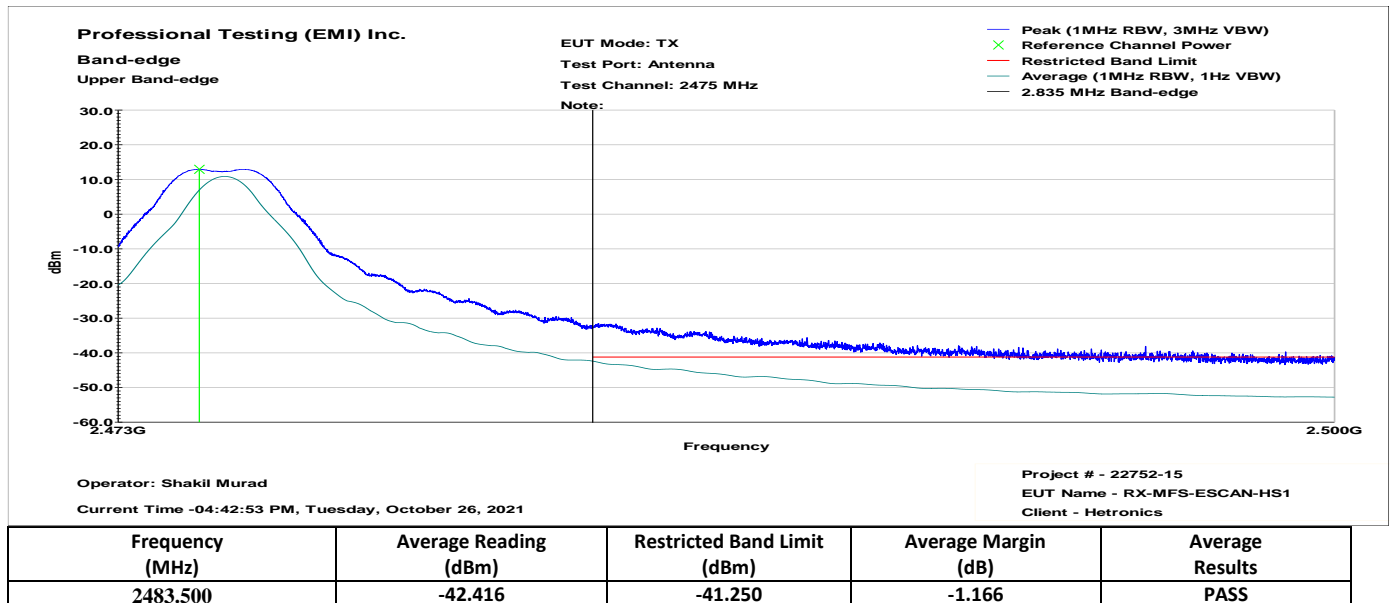
Emissions above band measured with peak detection and 1 Hz video average in 1 MHz RBW if the peak emission exceeds the average limit.

The requirement was satisfied. Plotted results appear on the following page.

Lower Band-edge



Upper Band-edge



7.0 Conducted Antenna Port Spurious Emissions, Transmit Mode

7.1 Test Procedure

Conducted antenna port emissions are measured with the EUT transmitting on the required frequencies.

Table 7.1.1: Test Parameters

30 MHz to 1 GHz	1 GHz to 18 GHz	18 GHz to 25 GHz
120kHz RBW / 300kHz VBW	1MHz RBW / 3MHz VBW	1MHz RBW / 3MHz VBW
Quasi-peak	Peak & Average	Peak & Average

7.2 Test Criteria

47 CFR (USA) // IC (Canada)	
Section Reference	Unwanted Emissions
15.247 (d), 15.209 (a) // RSS-247 5.5, RSS-Gen 6.13	Antenna Port Conducted Spurious/Harmonic Emissions Transmit Mode

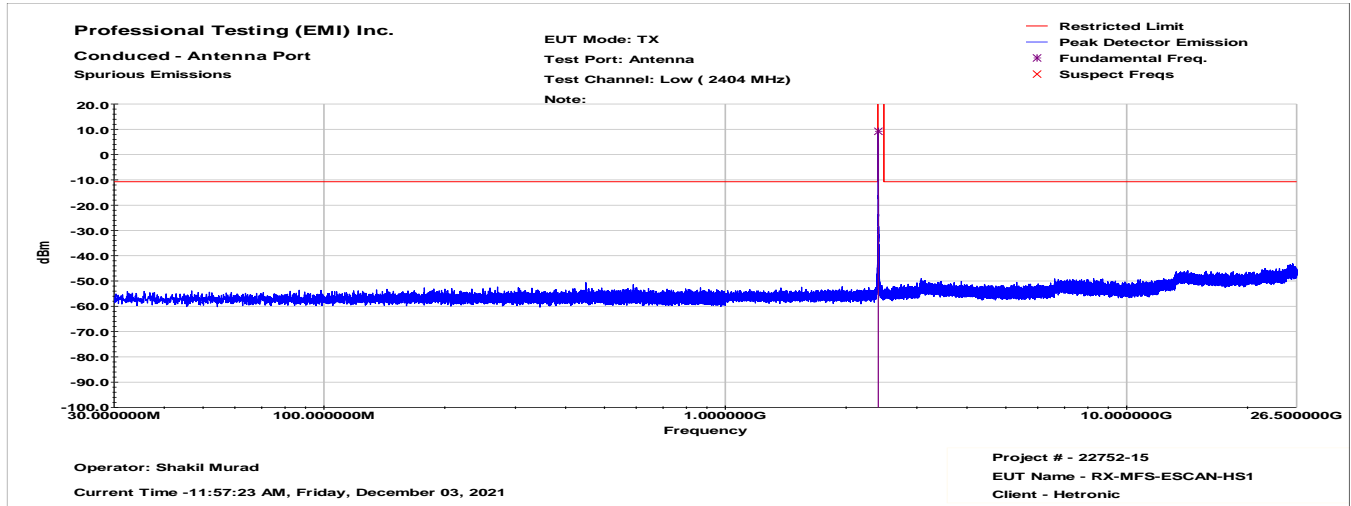
7.3 Test Results

Three channels were tested. EUT was transmitting continuously and unmodulated.

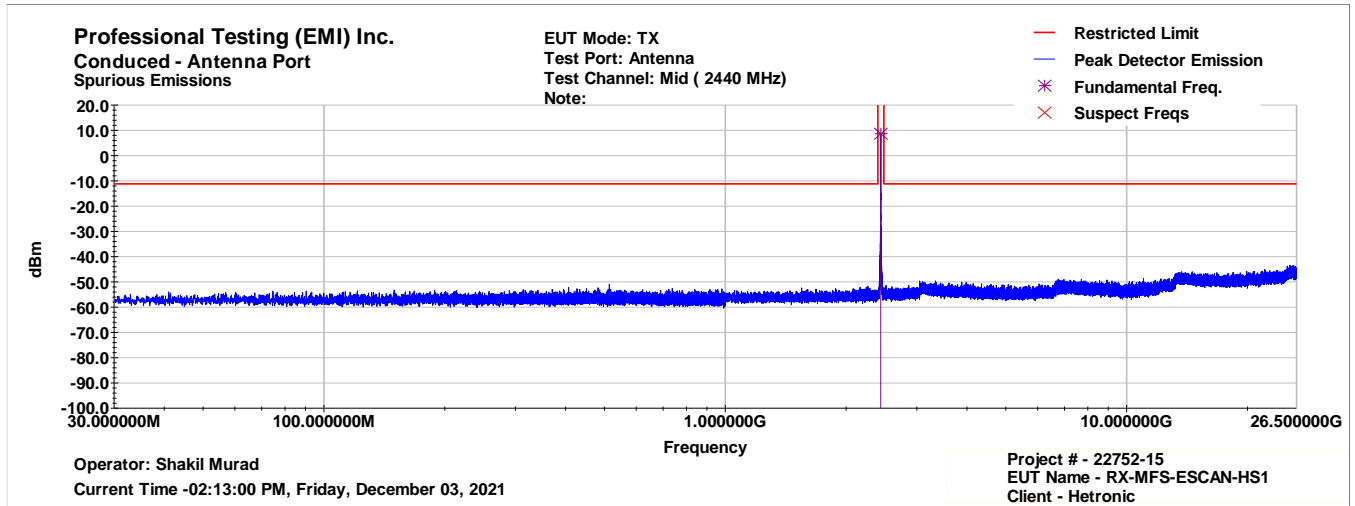
The top, middle and bottom channels were tested. The EUT satisfied the requirements.

7.3.1 100 kHz Bandwidth Test data

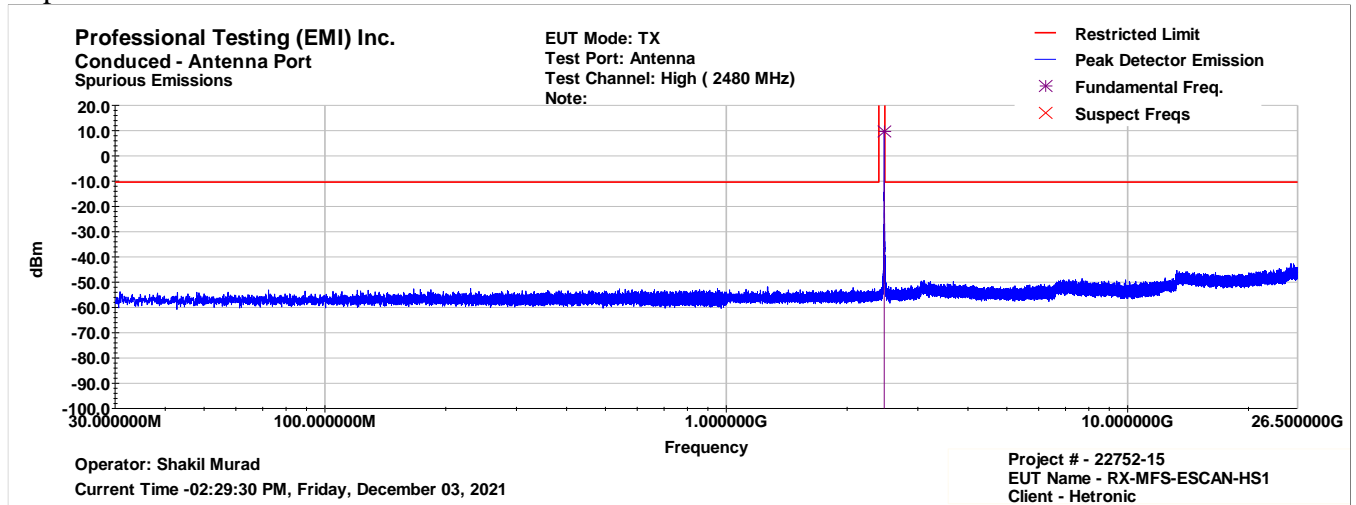
Bottom Channel: 100 kHz Bandwidth



Middle Channel: 100 kHz Bandwidth

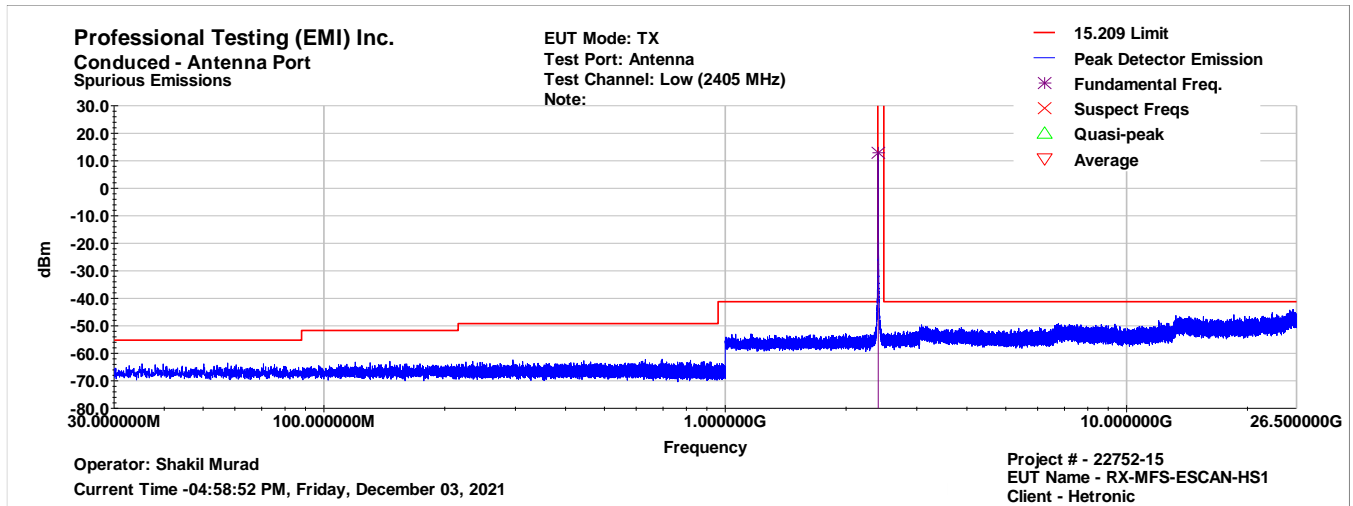


Top Channel: 100 kHz Bandwidth

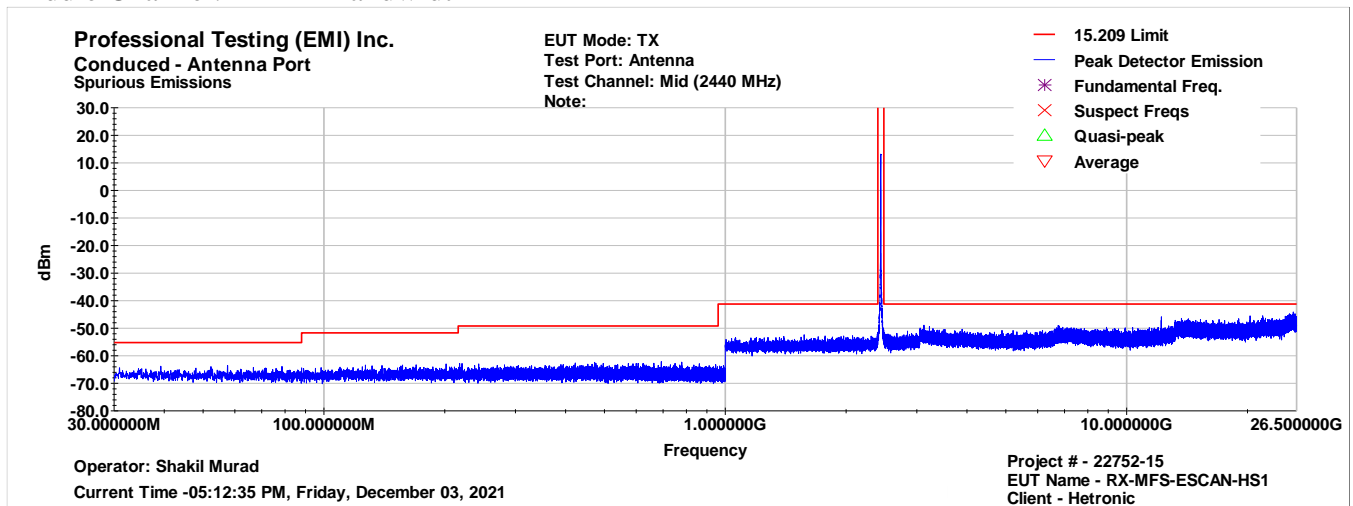


7.3.1 1 MHz Bandwidth Test data

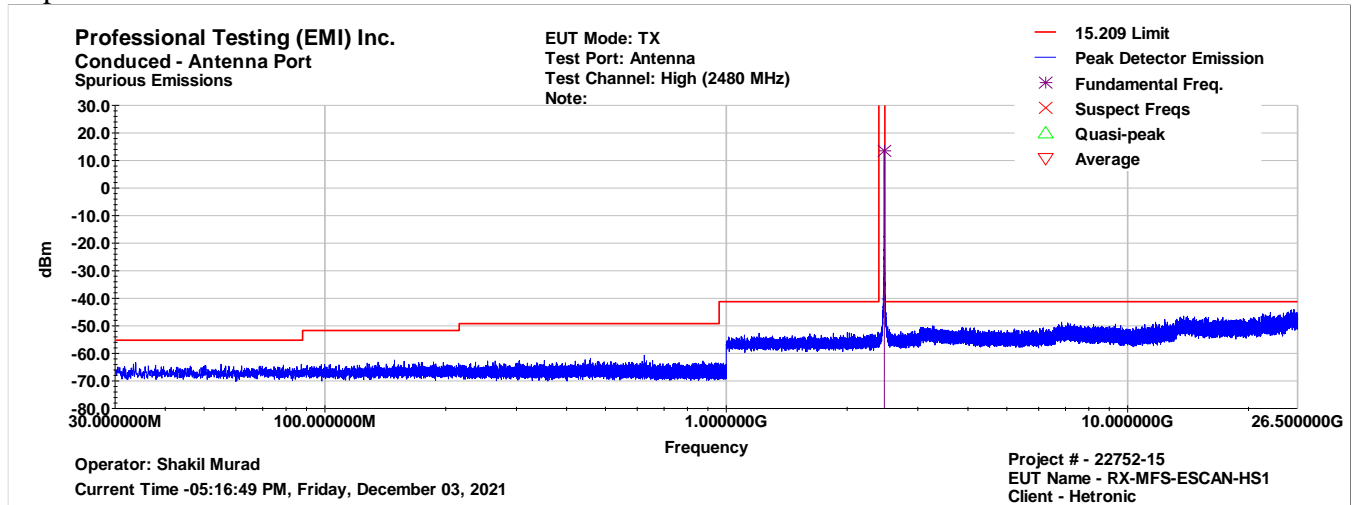
Bottom Channel: 1 MHz Bandwidth



Middle Channel: 1 MHz Bandwidth



Top Channel: 1 MHz Bandwidth



8.0 Transmitter Radiated Spurious Emissions

8.1 Test Procedure

Radiated emissions are measured with the EUT transmitting on the required frequencies.

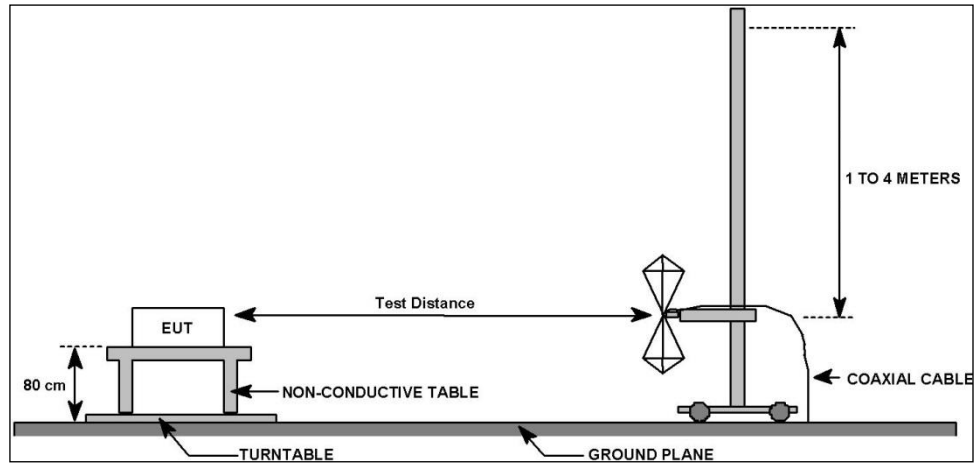


Table 8.1.1: Test Distance, Table Height, and Detection Method

30 MHz to 1 GHz	1 GHz to 18 GHz	18 GHz to 26.5 GHz
10 m, 80 cm	3 m, 1.5 m	1 m, 1.5 m
Quasi-peak	Peak & Average	Peak & Average

8.2 Test Criteria

47 CFR (USA) // IC (Canada)	
Section Reference	Parameter
15.247(d), 15.209 (a) // RSS-247 5.5, RSS-Gen 6.13 & 8.10	Field Strength of Radiated Spurious/Harmonic Emissions Transmit Mode

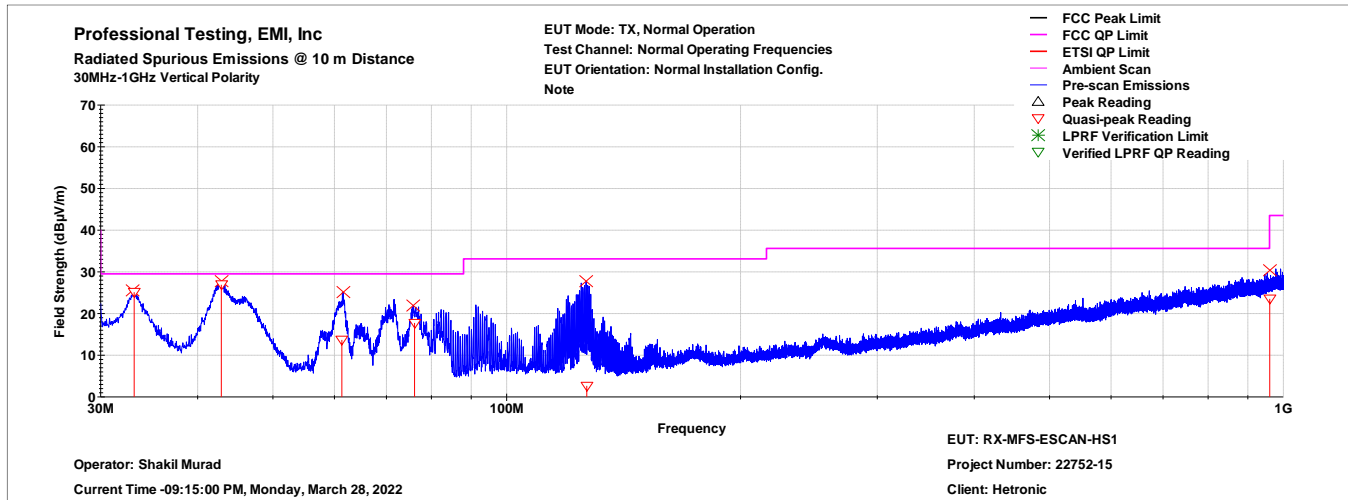
8.3 Test Results

EUT was in normal operation with modulation and tested in normal installation orientation.

The EUT satisfied the requirement. Graphical and tabular data appears below.

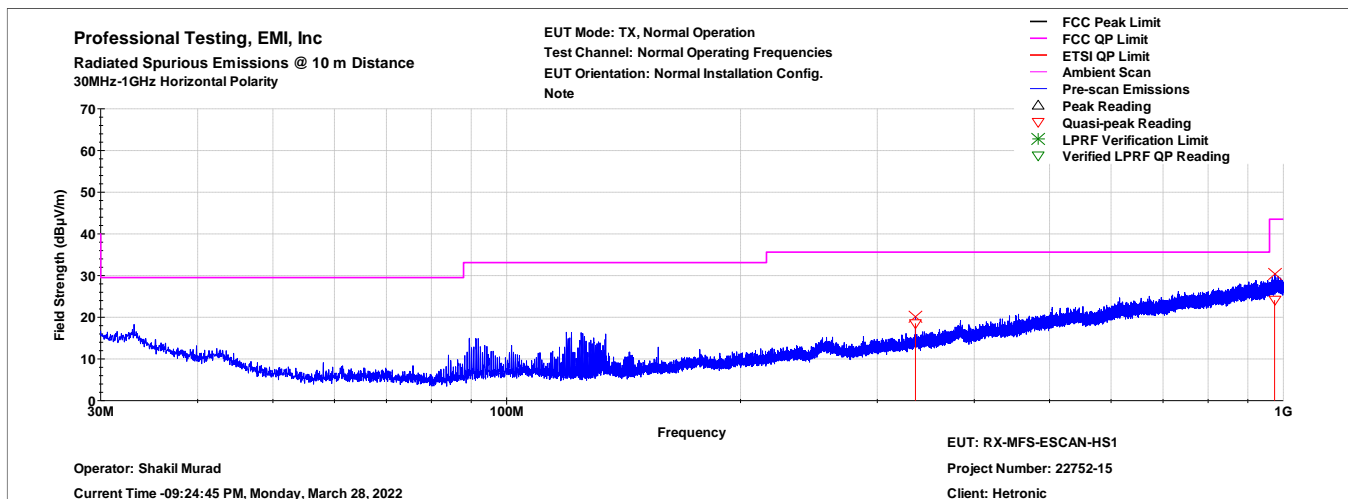
8.3.1 30 MHz to 26.5 GHz

30MHz - 1GHz Vertical Polarity Emissions Data



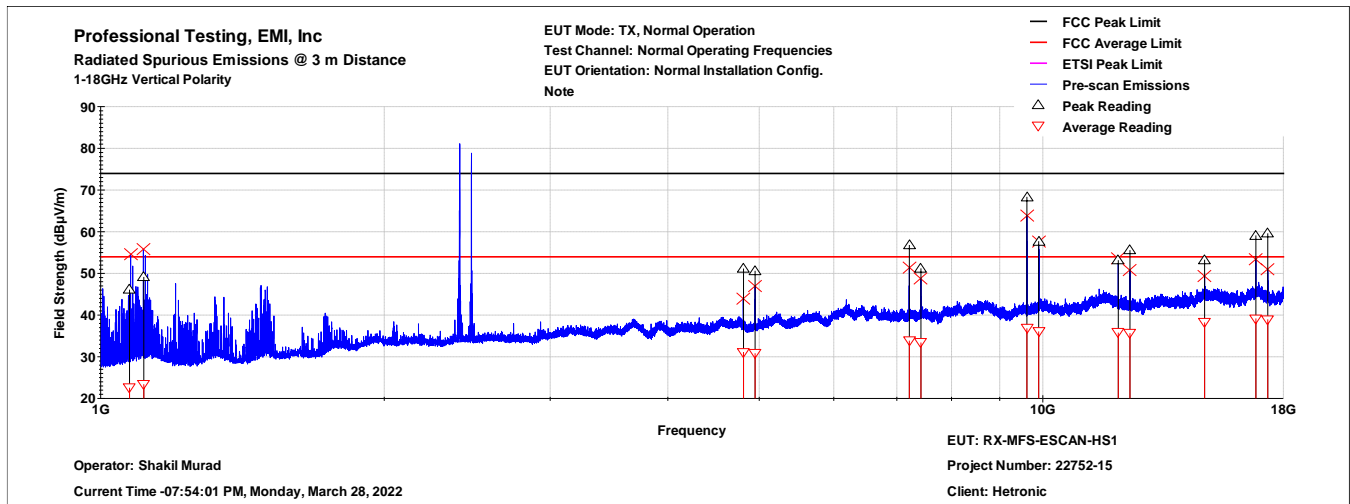
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBμV)	Quasi-peak Limit (dBμV)	Quasi-peak Margin (dB)	Quasi-peak Results
33.138	4.000	106.000	25.116	29.500	-4.384	PASS
42.906	158.000	127.000	26.892	29.500	-2.608	PASS
61.348	135.000	271.000	13.662	29.500	-15.838	PASS
76.099	4.000	214.000	17.738	29.500	-11.762	PASS
126.781	47.000	177.000	2.642	33.100	-30.458	PASS
960.500	156.000	124.000	23.514	43.500	-19.986	PASS

30MHz - 1GHz Horizontal Polarity Emissions Data



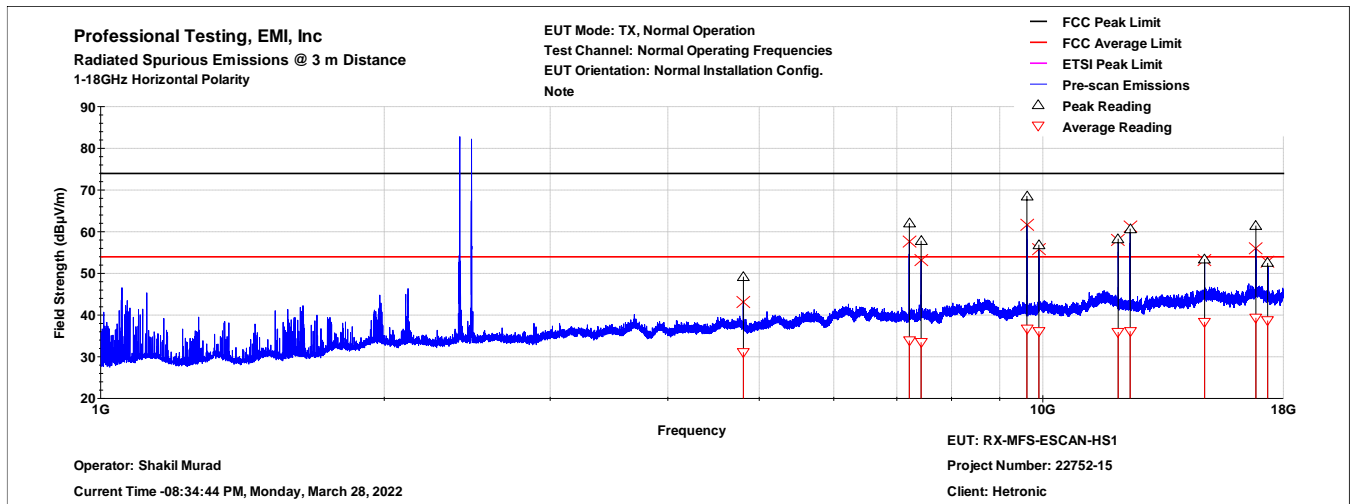
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBμV)	Quasi-peak Limit (dBμV)	Quasi-peak Margin (dB)	Quasi-peak Results
335.989	257.000	162.000	18.533	35.600	-17.067	PASS
974.529	272.000	312.000	24.085	43.500	-19.415	PASS

1GHz - 18GHz Vertical Polarity Emissions Data



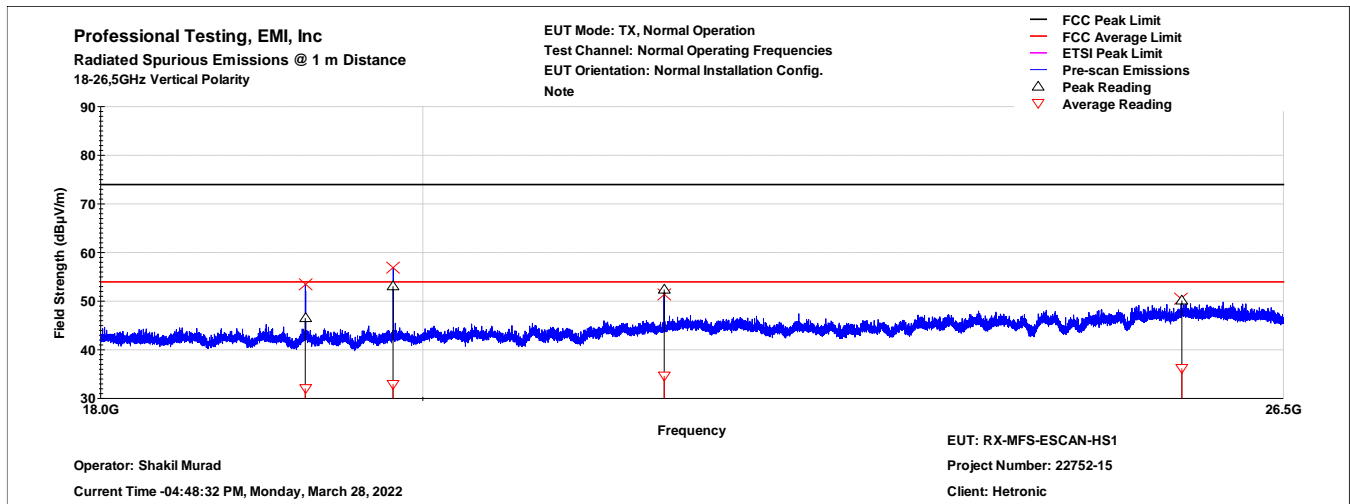
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
1073.10	25	375	46.083	73.958	-27.875	PASS	22.573	53.958	-31.385	PASS
1111.13	4	257	49.136	73.958	-24.822	PASS	23.399	53.958	-30.559	PASS
4811.52	83	108	51.155	73.958	-22.803	PASS	31.133	53.958	-22.825	PASS
4949.64	77	132	50.608	73.958	-23.350	PASS	30.832	53.958	-23.126	PASS
7217.26	46	267	56.788	73.958	-17.170	PASS	33.869	53.958	-20.089	PASS
7424.28	26	400	51.182	73.958	-22.776	PASS	33.405	53.958	-20.553	PASS
9619.13	46	263	68.342	73.958	-5.616	PASS	36.834	53.958	-17.124	PASS
9899.12	252	271	57.696	73.958	-16.262	PASS	36.076	53.958	-17.882	PASS
12024.07	200	375	53.166	73.958	-20.792	PASS	35.775	53.958	-18.183	PASS
12373.88	183	257	55.553	73.958	-18.405	PASS	35.646	53.958	-18.312	PASS
14849.04	18	107	53.269	73.958	-20.689	PASS	38.239	53.958	-15.719	PASS
16833.21	117	286	59.082	73.958	-14.876	PASS	39.184	53.958	-14.774	PASS
17330.54	84	271	59.578	73.958	-14.380	PASS	38.971	53.958	-14.987	PASS

1GHz - 18GHz Horizontal Polarity Emissions Data



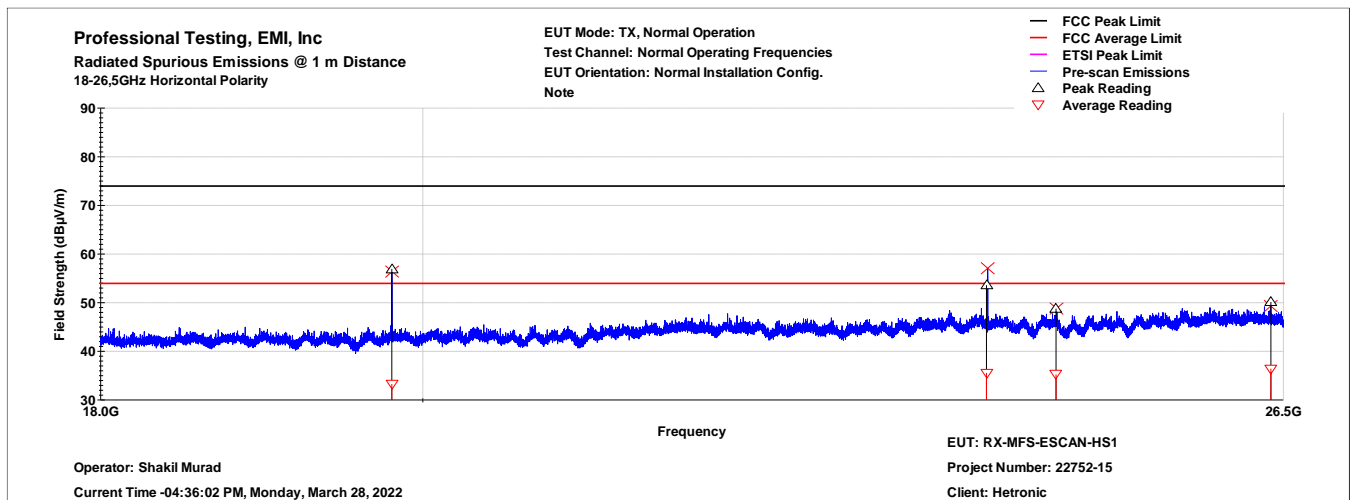
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
4811.40	209	108	49.206	73.958	-24.752	PASS	31.076	53.958	-22.882	PASS
7217.30	46	213	62.055	73.958	-11.903	PASS	33.871	53.958	-20.087	PASS
7427.42	78	238	57.813	73.958	-16.145	PASS	33.473	53.958	-20.485	PASS
9619.19	18	146	68.567	73.958	-5.391	PASS	36.760	53.958	-17.198	PASS
9903.13	295	142	56.854	73.958	-17.104	PASS	36.106	53.958	-17.852	PASS
12023.72	156	137	58.318	73.958	-15.640	PASS	35.942	53.958	-18.016	PASS
12379.00	153	108	60.719	73.958	-13.239	PASS	36.131	53.958	-17.827	PASS
14848.70	8	371	53.421	73.958	-20.537	PASS	38.358	53.958	-15.600	PASS
16833.60	29	329	61.448	73.958	-12.510	PASS	39.341	53.958	-14.617	PASS
17323.56	294	141	52.485	73.958	-21.473	PASS	38.690	53.958	-15.268	PASS

18GHz - 26.5GHz Vertical Polarity Emissions Data



Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBμV)	Peak Limit (dBμV)	Peak Margin (dB)	Peak Results	Average Reading (dBμV)	Average Limit (dBμV)	Average Margin (dB)	Average Results
19246.17	73	100.000	46.529	73.958	-27.429	PASS	32.055	53.958	-21.903	PASS
19806.52	33	100.000	53.080	73.958	-20.878	PASS	32.934	53.958	-21.024	PASS
21643.00	309	100.000	52.378	73.958	-21.580	PASS	34.619	53.958	-19.339	PASS
25634.96	233	100.000	50.138	73.958	-23.820	PASS	36.167	53.958	-17.791	PASS

18GHz - 26.5GHz Horizontal Polarity Emissions Data



Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBμV)	Peak Limit (dBμV)	Peak Margin (dB)	Peak Results	Average Reading (dBμV)	Average Limit (dBμV)	Average Margin (dB)	Average Results
19798.21	232	100.000	56.935	73.958	-17.023	PASS	33.271	53.958	-20.687	PASS
24047.92	197	100.000	53.586	73.958	-20.372	PASS	35.553	53.958	-18.405	PASS
24601.39	291	100.000	48.757	73.958	-25.201	PASS	35.253	53.958	-18.705	PASS
26392.43	302	100.000	50.137	73.958	-23.821	PASS	36.419	53.958	-17.539	PASS

9.0 Radiated Spurious Emissions, Receive Mode

9.1 Test Procedure

Receive mode radiated emissions were measured with the EUT in normal Operation.

Table 9.1.1: Test Distance, Table Height, and Detection Method

30 MHz to 1 GHz	1 GHz to 18 GHz	18 GHz to 25 GHz
10 m, 80 cm	3 m, 80 cm	1 m, 80 cm
Quasi-peak	Peak & Average	Peak & Average

9.2 Test Criteria

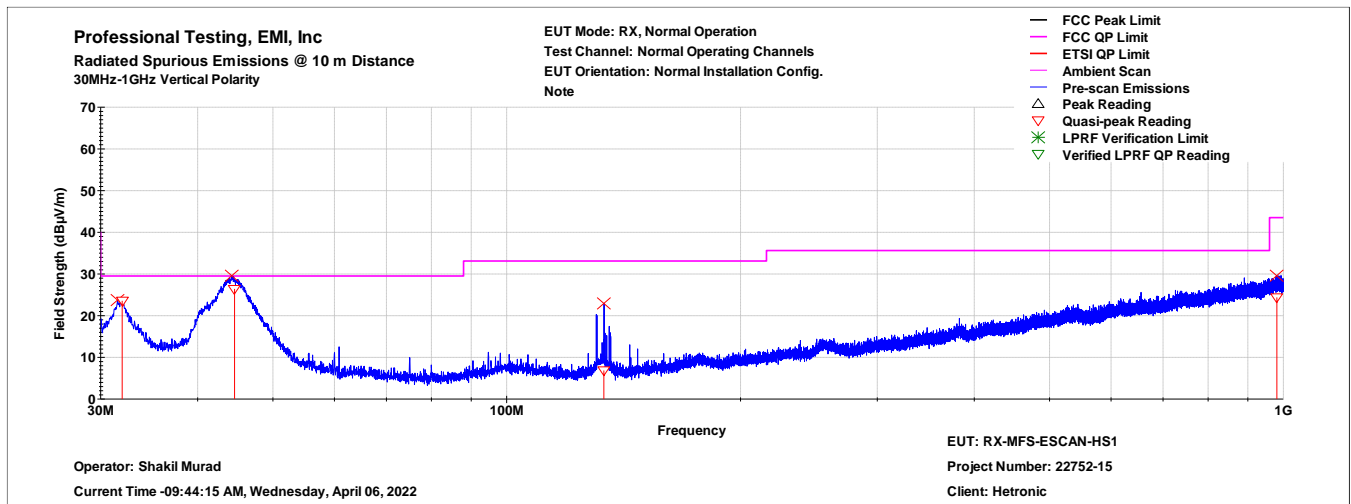
47 CFR (USA) // IC (Canada)	
Section Reference	Parameter
15.109 // RSS-Gen 7.3	Field Strength of Radiated Spurious/Harmonic Emissions Receive Mode

9.3 Test Results

The requirement was satisfied. Graphical and tabular data appears below.

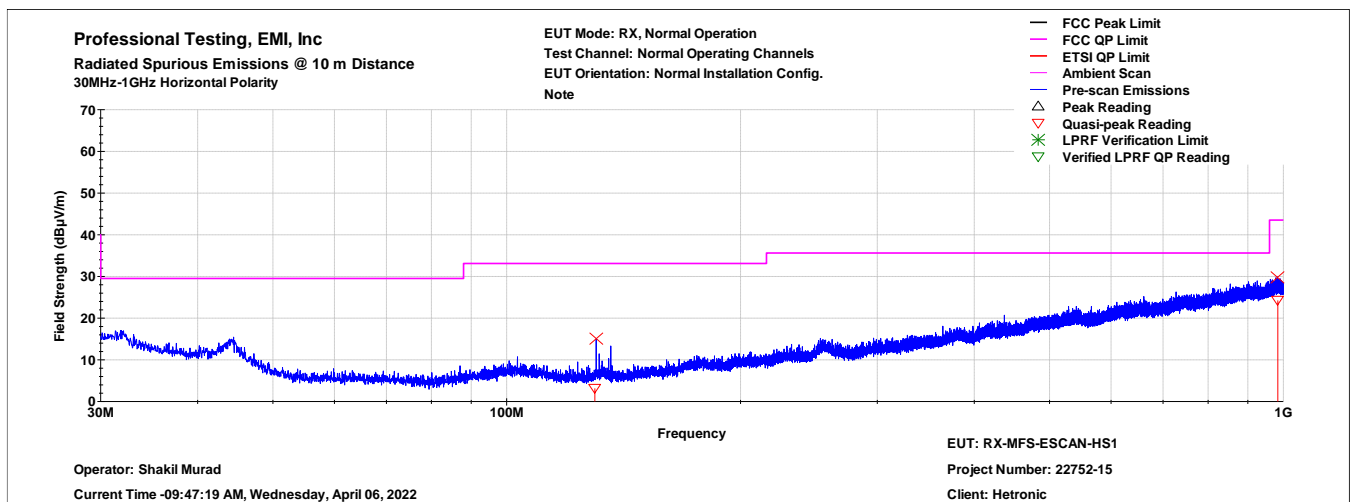
9.3.1 30 MHz to 1 GHz

30MHz - 1GHz Vertical Polarity Emissions Data



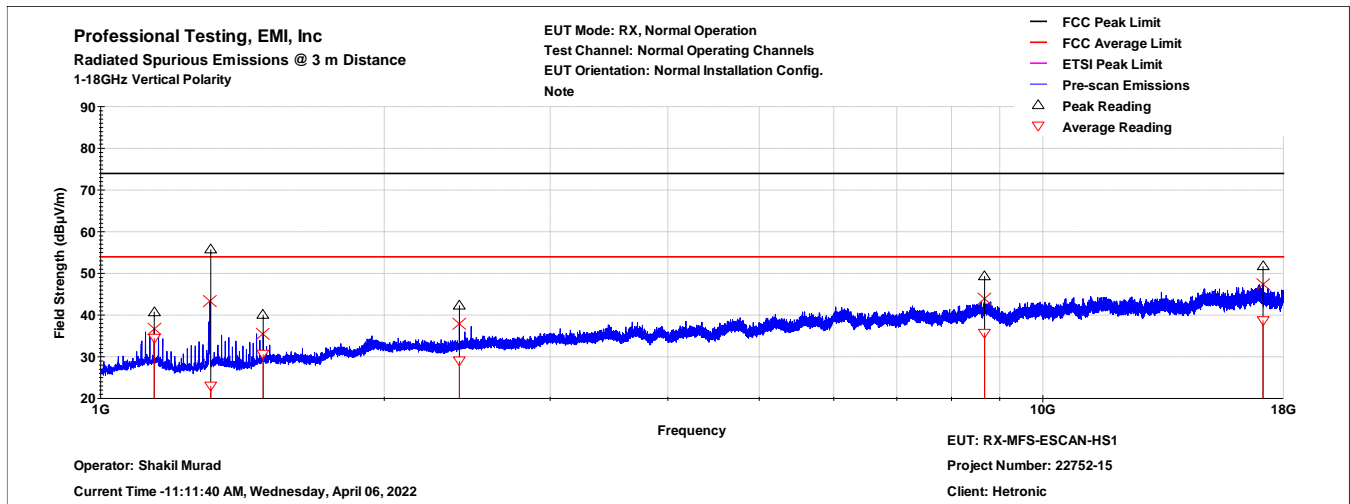
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBμV)	Quasi-peak Limit (dBμV)	Quasi-peak Margin (dB)	Quasi-peak Results
31.984	6.000	108.000	23.560	29.500	-5.940	PASS
44.628	162.000	130.000	26.417	29.500	-3.083	PASS
133.389	197.000	205.000	6.852	33.100	-26.248	PASS
981.050	243.000	260.000	24.365	43.500	-19.135	PASS

30MHz - 1GHz Horizontal Polarity Emissions Data



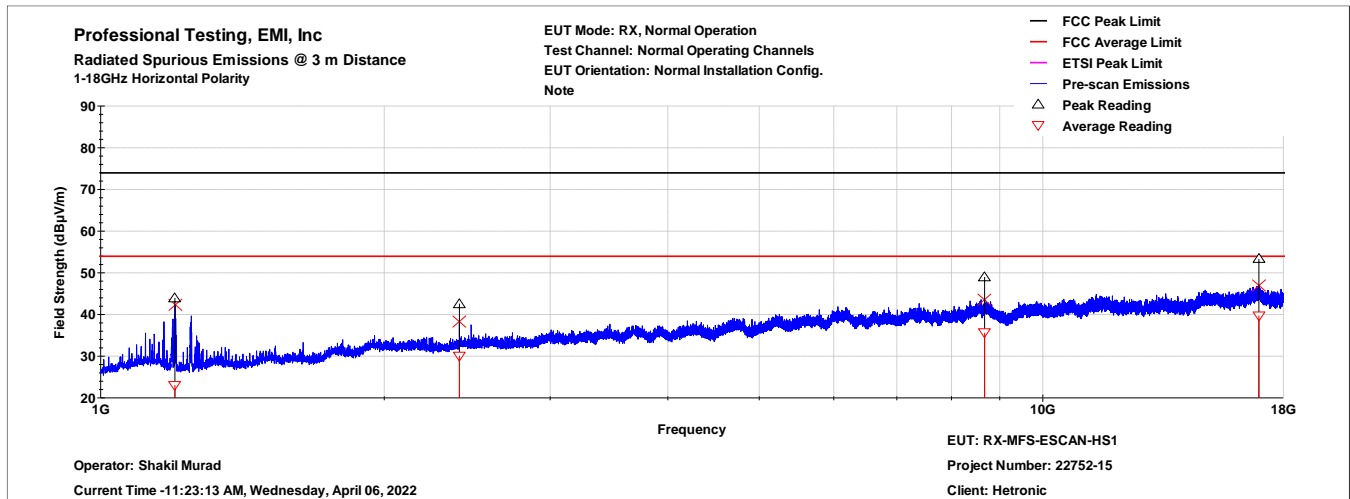
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBμV)	Quasi-peak Limit (dBμV)	Quasi-peak Margin (dB)	Quasi-peak Results
129.849	254.000	229.000	3.151	33.100	-29.949	PASS
983.664	316.000	109.000	24.252	43.500	-19.248	PASS

1GHz - 18GHz Vertical Polarity Emissions Data



Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBμV)	Peak Limit (dBμV)	Peak Margin (dB)	Peak Results	Average Reading (dBμV)	Average Limit (dBμV)	Average Margin (dB)	Average Results
1139.88	207	204	40.773	73.958	-33.185	PASS	34.499	53.958	-19.459	PASS
1308.93	139	204	55.742	73.958	-18.216	PASS	23.008	53.958	-30.950	PASS
1487.78	15	181	40.091	73.958	-33.867	PASS	30.561	53.958	-23.397	PASS
2403.30	225	301	42.299	73.958	-31.659	PASS	28.959	53.958	-24.999	PASS
8674.76	192	170	49.320	73.958	-24.638	PASS	35.753	53.958	-18.205	PASS
17128.44	252	348	51.682	73.958	-22.276	PASS	38.723	53.958	-15.235	PASS

1GHz - 18GHz Horizontal Polarity Emissions Data



Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBμV)	Peak Limit (dBμV)	Peak Margin (dB)	Peak Results	Average Reading (dBμV)	Average Limit (dBμV)	Average Margin (dB)	Average Results
1199.17	218	207	43.933	73.958	-30.025	PASS	23.074	53.958	-30.884	PASS
2403.42	198	295	42.598	73.958	-31.360	PASS	30.114	53.958	-23.844	PASS
8673.39	21	151	48.984	73.958	-24.974	PASS	35.604	53.958	-18.354	PASS
16953.85	162	107	53.334	73.958	-20.624	PASS	39.741	53.958	-14.217	PASS

10.0 Antenna Construction

10.1 Procedure

A direct examination of the antenna construction is performed and compared to rule criteria that prevent wireless device antennas from being modified by end users.

10.2 Criteria

47 CFR (USA) // IC (Canada)	
Section Reference	Antenna Construction
15.203 // RSS-Gen 6.8	Type of Antenna(s) Type of Connector Gain

10.3 Results

Table 8.3.1 Antenna Construction Details
Chip Antenna
Manufacturer: Hetronic Model/PN: T-201H-0-R Antenna gain: 3 dBi. Antenna Type: Half wave flexible Dipole Antenna Connector: TNC-Plug.

Datasheet of the antenna is presented in the following page.

NO	件號 PAT.NO	品名 NAME	材質 MATL	件數 QTY	處理 TREAT	備註 REMARK	NO	件號 PAT.NO	品名 NAME	材質 MATL	件數 QTY	處理 TREAT	備註 REMARK
1	T-201H-0-R	TNC-P		1			5	B-290BXA-R	接管 PIPE	銅合金 COPPER ALLOY	1		
2	K-359BC-R	導梢 CONTACT	銅合金 COPPER ALLOY	1	鍍金 M-Au		6	Q-535BU-R	絞鋼線 ELEMENT	硬鋼線材 SWRH	1	鍍銅 M-Cu	
3	H-107PX	套管 TUBE	NYLON+15%GF	1	黑色 BLACK		7	A-134PX	保護蓋 TOP	NYLON+15%GF	1	黑色 BLACK	
4	I-193DXA	絕緣體 INSULATOR	塑膠 DELRIN	1			8	H-120BX	線管 PIPE	銅合金 COPPER ALLOY	1		

智慧財產權 請勿抄襲盜用

APEX CONNECTOR PROPRIETARY

本產品符合 RoHS 指令

RoHS

COMPLIANT
2002/95/EC

承認圖

APPROVE DRAWING

NO	PERFORMANCE PARAMETER	DIPOLE ANTENNA REQUIREMENT
1	Operating Frequency	Frequency range: 2.4 GHz
2	Gain	3 dB
3	Polarization	Linear, vertical
4	VSWR (relative to 50Ω)	< 2.0
5	Construction	Half-wave (1/2λ), flexible dipole
6	Input Power Handling	10 W max.
7	Input Connector	TNC-Plug
8	Temperature Operating	0~+50°C
9	Temperature Storage	-40~+80°C

灌AB膠
Epoxy

EDITION
2007.08.20
R&D
APEX CONNECTOR

ISO-9001:2000 CERTIFIED MANUFACTURER	機種 MODEL	DATE	UNIT	DESIGNER	CHECKED	APPROVED
錫鋼精密科技股份有限公司 APEX PRECISION TECHNOLOGY CORP.	GK-442TF-R	96.08.20	mm	開發部	黃	核
NO. 變更說明 CORRECTION	品名 NAME	TOLERANCE	SCALE	2007.08.20	查	准
	TNC ANTENNA REVERSE	±0.2	2X	Rev	07.8.31	准

Antenna Datasheet

This is a non-standard antenna with TNC female connector; therefore, user cannot substitute a different antenna.

Gain is under maximum limit of 6 dBi.

The requirements were satisfied.

12.0 Measurement Bandwidths

Radiated Emissions Spectrum Analyzer Bandwidth and Measurement Time - Peak Scan				
Frequency Band Start (MHz)	Frequency Band Stop (MHz)	6 dB Bandwidth (kHz)	Number of Ranges Used	Measurement Time per Range
0.009	0.15	0.3	2	Multiple Sweeps
0.15	30	9	6	Multiple Sweeps
30	1000	120	2	Multiple 800 mS Sweeps
1000	6000	1000	2	Multiple Sweeps
6000	18000	1000	2	Multiple Sweeps
18000	26500	1000	2	Multiple Sweeps

*Notes:

1. The settings above are specifically calculated for the E4440A series of spectrum analyzers, which have 8,000 data points per range.
2. The measurement receiver resolution bandwidth setting was 300 Hz for quasi-peak measurements from 9-150 kHz.
3. The measurement receiver resolution bandwidth setting was 9 kHz for quasi-peak measurements from 0.15-30 MHz.
4. The measurement receiver resolution bandwidth setting was 120 kHz for quasi-peak measurements from 30-1000 MHz.
5. The measurement receiver resolution bandwidth setting was 1 MHz for average measurements from 1-18 GHz.

13.0 Test Equipment

13.1 Conducted Measurements at the antenna Port

Asset#	Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
1937	Agilent	E4440A - AYZ	PSA , 3 Hz - 26.5 GHz, Opt. AYZ	MY44808298	11/12/2022
A118	Narda	768A-20	20 dB 20 W Attenuator, DC - 11GHz	105357	12/10/2022
1117	HP	6296A	Power Supply, DC, 60V 3A	1552A02489	N/A

13.2 Radiated Spurious Emissions

Tile! Software Version:		Version: 7.1.2.17 (Jan 08, 2016 - 02:12:48 PM) or 4.1.A.0, April 14, 2009, 11:01:00PM			
Test Profile:		2020_RE_Unintentional_TILE7_v4			
Asset #	Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
1509A	Braden	TDK 10M	TDK 10M Chamber, NSA < 1 GHz	DAC-012915-005	4/9/2023
1969	HP	11713A	Attenuator/Switch Driver	3748A04113	N/A
942	EMCO	11968D	Turntable, 4ft.	9510-1835	N/A
1326	EMCO	1051-12	Controller, Antenna Mast	9101-1564	N/A
1244	EMCO	1050C	Controller, Antenna Mast	1100	N/A
C026A	none	RG-233U	Cable Coax, N-N, 0.914m, 9 kHz - 30 MHz	None	10/21/2022
C026	none	RG214	Cable Coax, N-N, 25m, 9 kHz - 30 MHz	None	10/21/2022
C027A	none	RG214	Cable Coax, N-N, 25m, 25MHz - 1GHz	None	9/9/2022
1293	EMCO	6502	Antenna, Loop, Active, .01-30MHz	2040	9/14/2022
C027	none	RG214	Cable Coax, N-N, 25m, 25MHz - 1GHz	None	9/14/2022
C233	Sucoflex	None	Cable, SMA-SMA, 7.62m, 9kHz - 1.5 GHz, Purple	None	10/22/2023
1926	ETS-Lindgren	3142D	Antenna, Biconilog, 26 MHz - 6 GHz	135454	4/20/2022
1457	HP	8447D	Preamp, .1-1300MHz	1937A02800	10/21/2022
C289	Pasternack	PE354-24	Cable, N-SMA, 0.610m Blue	1310	9/9/2022
C030	none	none	Cable Coax, N-N, 30m, 1 - 18GHz	None	9/15/2022
C038	none	LMR-400	Cable Coax, N-N, 0.15m	None	N/A
1780	ETS-Lindgren	3117	Antenna, Double Ridged Guide Horn, 1 - 18 GHz	110313	4/16/2023
2004	Miteq	AFS44-00101800-2S-10P-44	Amplifier, 40dB, 100MHz-18GHz	None	1/14/2024
745	0	ZKL1500-1	Amplifier, 40dB, 0.1-1500MHz	618-00180	N/A
1326	EMCO	1051-12	Controller, Antenna Mast	9101-1564	N/A
1542	A.H. Systems	SAS-572	Antenna, Horn 18-26.5GHz, 20dB gain	225	N/A
1973	Agilent	83017A	Amplifier, Microwave 0.5-26.5 GHz	MY39500497	11/10/2022
1937	Agilent	E4440A - AYZ	PSA , 3 Hz - 26.5 GHz, Opt. AYZ	MY44808298	11/12/2022

Appendix: Policy, Rationale, and Evaluation of EMC Measurement Uncertainty

All uncertainty calculations, estimates and expressions thereof shall be in accordance with NIST policy. Since PTI operates in accordance with NIST (NVLAP) Handbook 150-11: 2007, all instrumentation having an effect on the accuracy or validity of tests shall be periodically calibrated or verified traceable to national standards by a competent calibration laboratory. The certificates of calibration or verification on this instrumentation shall include estimates of uncertainty as required by NIST Handbook 150-11.

1. Rationale and Summary of Expanded Uncertainty.

Each piece of instrumentation at Nemko PTI that is used in making measurements for determining conformance to a standard (or limit), shall be assessed to evaluate its contribution to the overall uncertainty of the measurement in which it is used. The assessment of each item will be based on either a type A evaluation or a type B evaluation. Most of the evaluations will be type B, since they will be based on the manufacturer's statements or specifications of the calibration tolerances, or uncertainty will be stated along with a brief rationale for the type of evaluation and the resulting stated uncertainties.

The individual uncertainties included in the combined standard uncertainty for a specific test result will depend on the configuration in which the item of instrumentation is used. The combination will always be based on the law of propagation of uncertainty. Any systematic effects will be accommodated by including their uncertainties, in the calculation of the combined standard uncertainty; except that if the direction and amount of the systematic effect cannot be determined and separated from its uncertainty, the whole effect will be treated as uncertainty and combined along with the other elements of the test setup.

Type A evaluations of standard uncertainty will usually be based on calculating the standard deviation of the mean of a series of independent observations, but may be based on a least-squares curve fit or the analysis of variance for unusual situations. Type B evaluations of standard uncertainty will usually be based on manufacturer's specifications, data provided in calibration reports, and experience. The type of probability distribution used (normal, rectangular, a priori, or u-shaped) will be stated for each Type B evaluation.

In the evaluation of the uncertainty of each type of measurement, the uncertainty caused by the operator will be estimated. One notable operator contribution to measurement uncertainty is the manipulation of cables to maximize the measured values of radiated emissions. The operator contribution to measurement uncertainty is evaluated by having several operators independently repeat the same test. This results in a Type A evaluation of operator-contributed measurement uncertainty.

A summary of the expanded uncertainties of Nemko PTI measurements is shown as Table 1. These are the worst-case uncertainties considering all operative influence factors.

Table 1: Summary of Measurement Uncertainties for Site 45

Type of Measurement	Frequency Range	Meas. Dist.	Expanded Uncertainty U, dB (k=2)
Mains Conducted Emissions	150 kHz to 30 MHz	N/A	2.9
Telecom Conducted Emissions	150 kHz to 30 MHz	N/A	2.8
Radiated Emissions	30 to 1,000 MHz	10 m	4.8
	1 to 18 GHz	3 m	5.7

End of Report